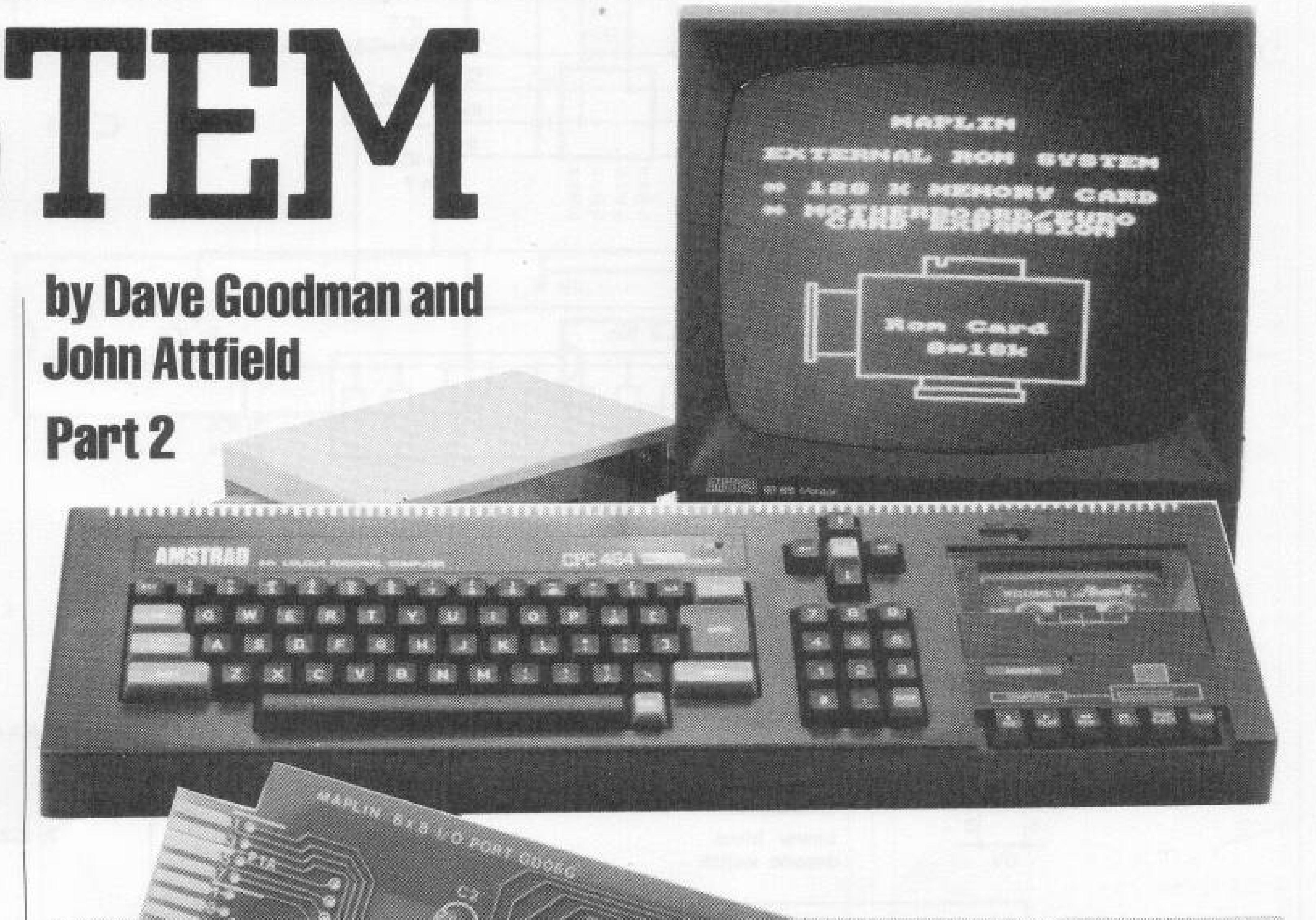
AMSTRAD EXPANSION SYSTEM

by Dave Goodman and John Attfield

Part 2



6 x 8 bit I/O Port

Part 1 of this series featured an External ROM Card and Motherboard system. The ROM Card can hold up to 8 ROMs with each ranging in size from 2K to 16K. A Motherboard module connects to the ROM Card, and can take up to six plug-in eurocard projects.

One such project is a 48-bit Input/Output Port card, another is a power supply module which drives the ROM Card buffer components and Motherboard cards, and it is these that we shall deal with in this issue.

Circuit Description

Figure 1 shows two 8255A (P.P.I.) devices, IC1 and IC2. Both devices are fully programmable for a variety of I/O functions, and contain four main registers each. In each case address lines A0 and A1 determine which 8255 register is accessed, with the RD and WR lines controlling data flow into or out of the register via data bus D0 to D7. IC3 and IC4 decode address blocks allocated by the Amstrad, and enable IC1 and IC2 at the correct time. IOSEL, A8 and A9, are decoded by IC3 to produce upper byte values (Hex) F8, F9, FA and FB. Any combination of values can be selected by switch S1, to produce a negative or active low ($\overline{E}$) pulse from IC5 to IC4 pin 4. Similarly, IC4 decodes lower byte values from A2, A3 and A4, being selected by switch S2 and switch S3. Again, any combination of 1 to 4 switches can be selected to produce a negative ($\overline{CS}$) select pulse from IC6 to IC1 and IC2. R1 and C2 produce a short positive pulse when the supply is first connected. This pulse RESETs both PPI's by clearing their control registers, thus setting all ports to the input

★ **Six 8-bit Input/Output Ports**
★ **Address Select Facilities**
★ **Plugs directly into Maplin Motherboard**
★ **Power Supply Card available**

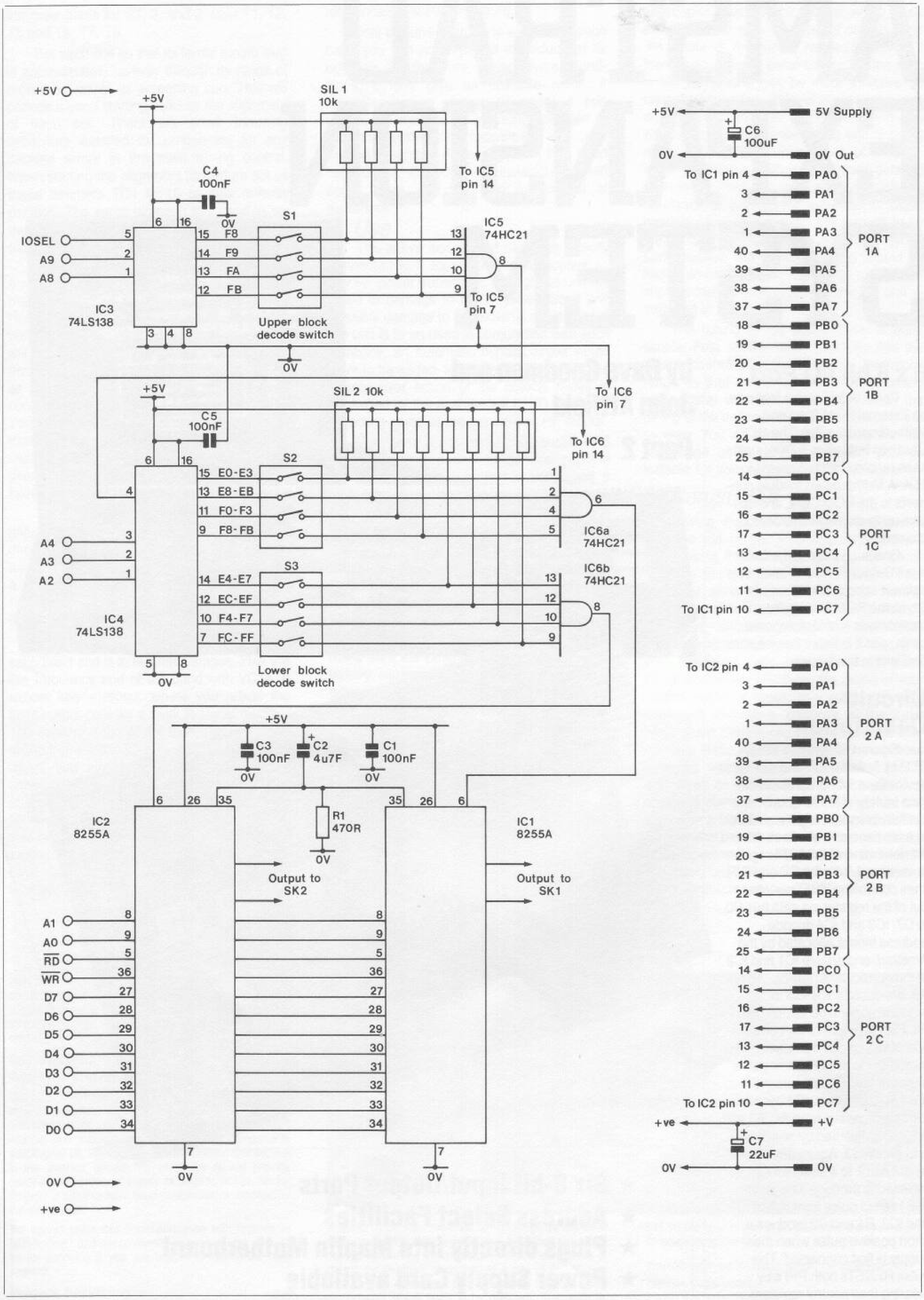


Figure 1. 6 x 8-bit Port Circuit

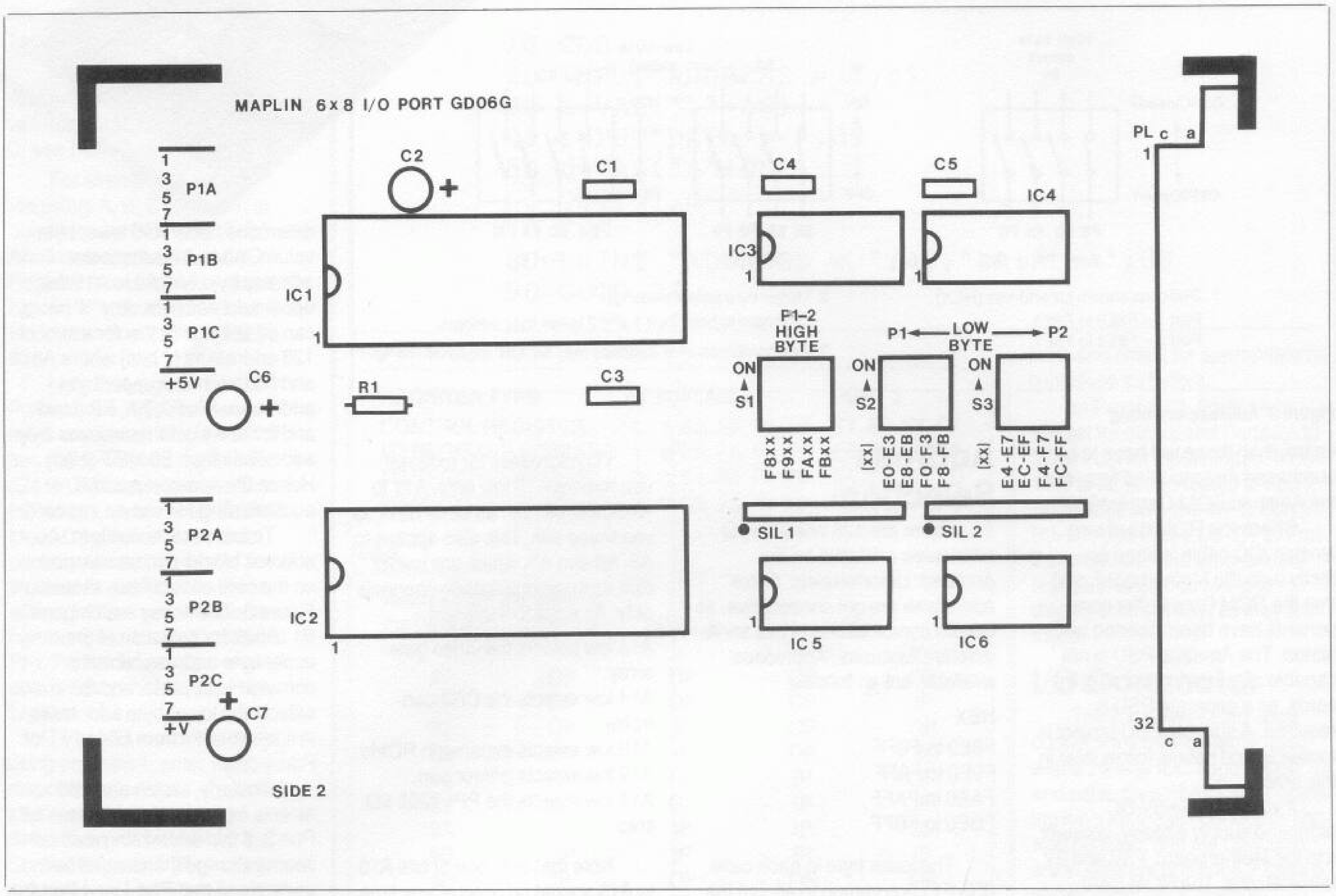


Figure 2. 6 x 8-bit Port PCB Overlay

mode. IC1 ports have been designated as P1A, P1B and P1C and IC2 ports are P2A, P2B and P2C. Each port has its own 8-bit bus, giving a total of 6 ports x 8 bits or 48 bits. Bits can be set to output data or input data in different configurations or modes, as will be explained later.

This project is designed to be plugged into our motherboard, and must not be connected to the Amstrad Expansion socket. For further details, please refer to Part 1 of this series.

Construction

Commence construction on the 6x8 port pcb (GD06G), where side 2 is the component side. With reference to the parts list and Figure 2, begin construction by inserting the IC sockets. Those for IC1 and 2 are 40-pin sockets, IC3 and 4 are 16-pin sockets and IC5 and 6 are 14-pin types.

Press them down onto the board, with the end notch or indent in-line with the white marker block on the legend. Bend a few of the legs on each socket to help keep them in position and solder in place. Do not fit any ICs until preliminary tests have been completed.

Fit the 4-way DIL switches S1, S2 and S3 in like manner and solder them in place. The two SIL resistor packs can now be inserted with the white dot, at one end of the body, matched with the white dot on the pcb legend. It is important to fit these two components correctly, as a SIL pack contains eight resistors, all commoned together at one end; this common pin is marked with the small white dot.

Fit electrolytic capacitors C6 and C7, taking note of lead polarity, and also the tantalum capacitor C2. This capacitor has its +V lead marked on the body. Insert the four remaining disk capacitors C1, C3 to C5 and also resistor R1.

Carefully solder all components in place on side 1 of the pcb, and remove excess leads and wire ends using side cutters. The 2 x 32-way right-angled plug is inserted in position PL1, from side 2, making sure that all 64 terminal pins pass through the board before soldering, see Figure 3. It might be advisable to secure this to the pcb using ½in. x 6BA screws and nuts first. Do ensure all components are fitted correctly before soldering, as the pcb track pads are plated-through the board from side 1 to side 2, thus making component removal difficult if necessary at a later date.

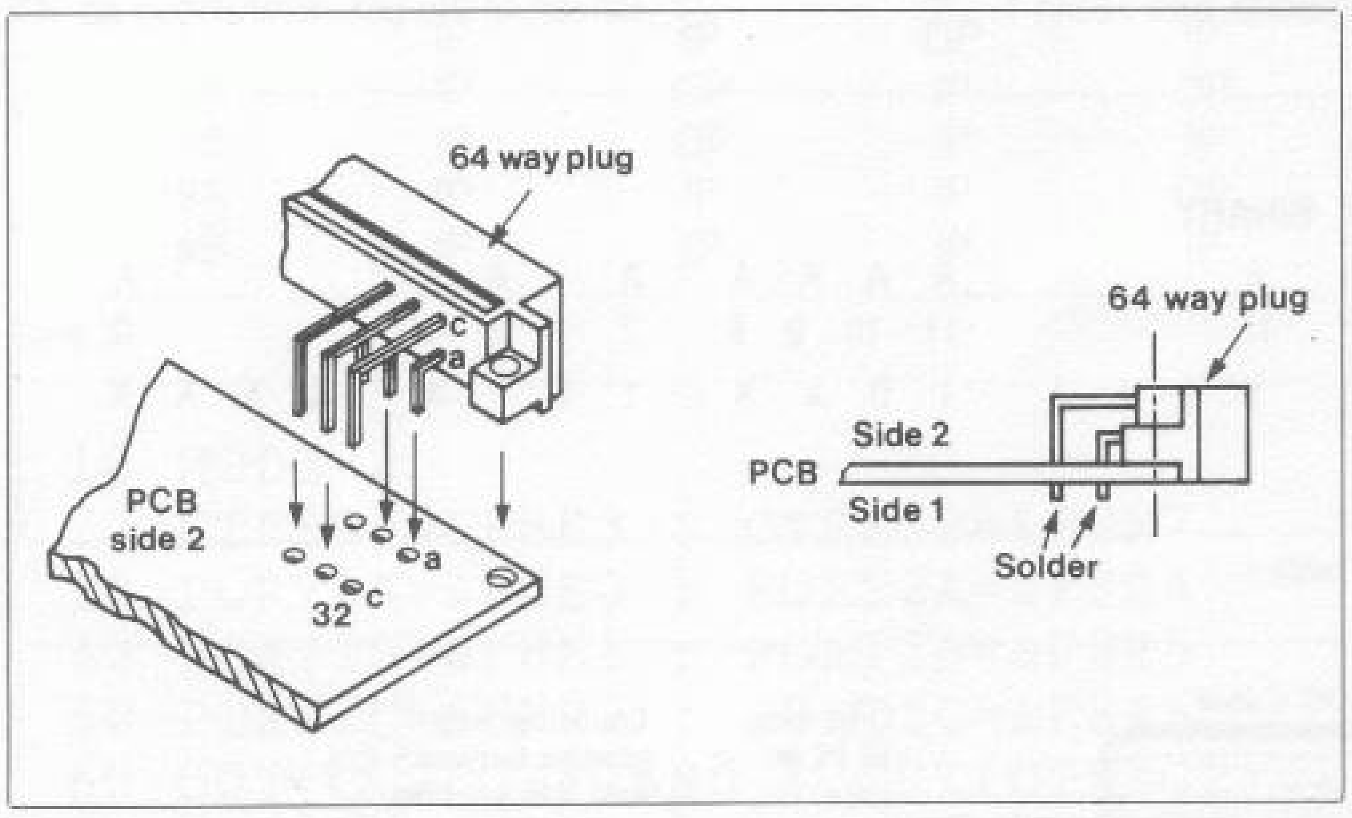


Figure 3. Fitting the 64-pin plug

Testing

Plug the I/O card into any socket position on the Motherboard. If you do not have 64-way receptacles fitted onto the mother-

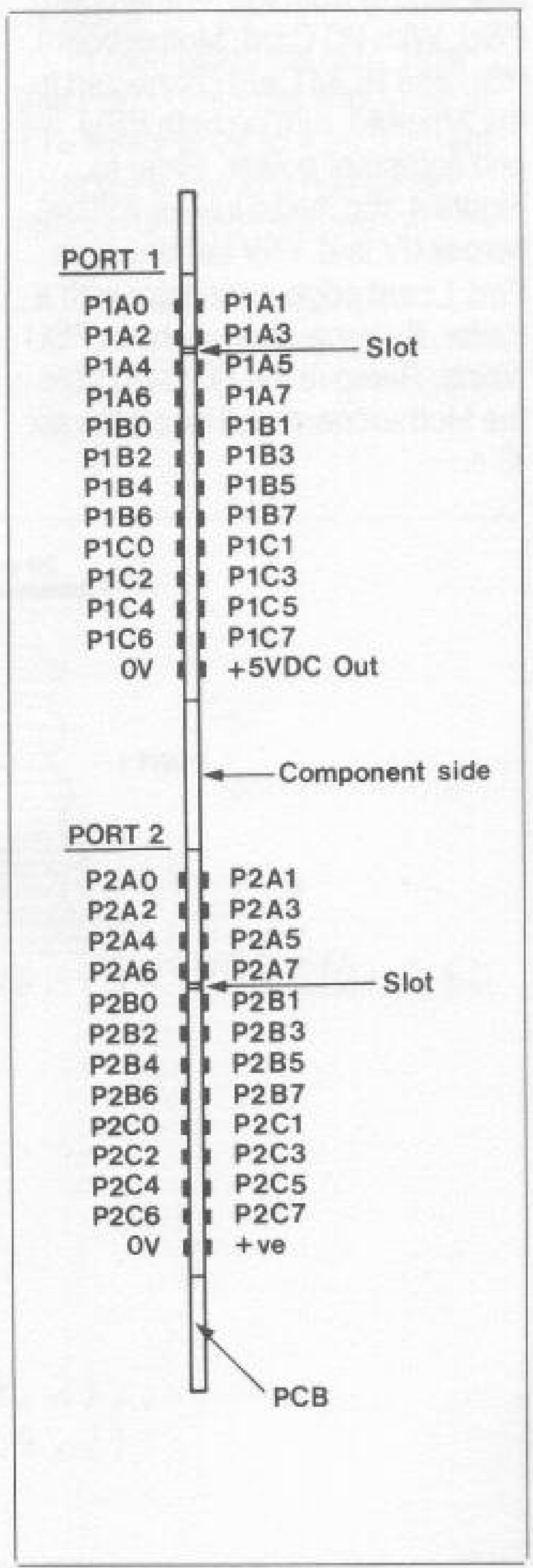
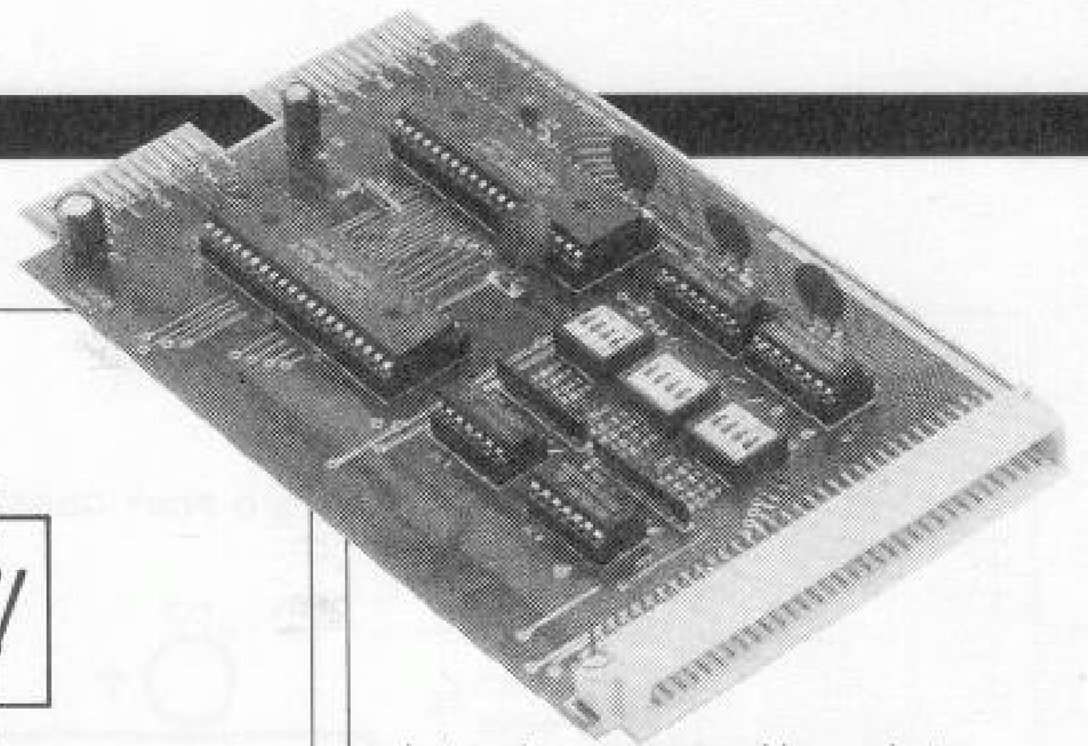


Figure 4. Edge Connections



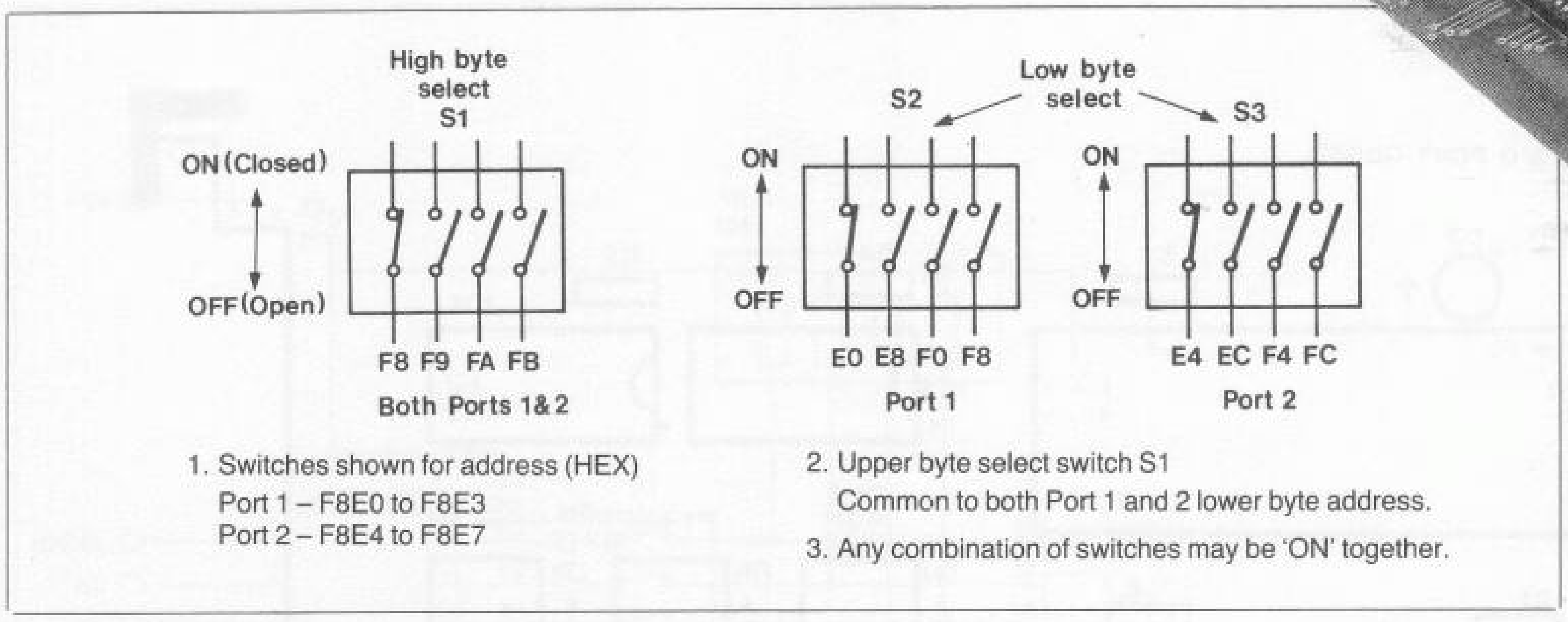


Figure 5. Address selecting

board, then these will have to be purchased and mounted first (see the Amstrad ROM Card leaflet).

Check the ROM Card extension IDC cable is fitted correctly onto the Motherboard, and that the ROM Card buffer components have been inserted and tested. The Amstrad PSU is not capable of supplying the plug-in cards, so a separate PSU is required. A suitable PSU project is available and details follow later in this article.

If you have a +5V DC regulated supply already, connect it to the Motherboard +5V and 0V terminal pins. The ROM Card buffer components also receive their supply from the Motherboard PSU. With I/O Card, Motherboard, PSU and ROM Card connected to the Amstrad, turn on both PSU and computer power. Refer to Figure 4 and measure the voltage across 0V and +5V terminals on Port 1 card edge-connector with a meter. If wrong, then recheck PSU wiring. Remove the I/O Card from the Motherboard and insert the six IC's.

Address Selection

There are 128 possible I/O addresses available on the Amstrad. Unfortunately, these addresses are not consecutive, as certain combinations of bits serve different functions. Addresses available are as follows:

HEX

F8E0 to F8FF
F9E0 to F9FF
FAE0 to FAFF
FBE0 to FBFF

The lower byte in each case (E0–FF) is common to all, but the upper or higher byte changes in blocks, see Table 1.

I/O addresses for external use require A10 low only. A11 to A15 must be high as other devices use these bits. This also applies to A5, A6 and A7, which are low for disk and communication channels only. As a point of interest:

A15 low selects the video gate array.
A14 low selects the CRT controller.
A13 low selects expansion ROMs.
A12 low selects printer port.
A11 low selects the PPI-8255 I/O chip.

Note that only one of bits A10 to A15 should be used at any time, so for I/O use, A10 is always low. Seven of the bits referenced as 'X' determine upper and lower byte values. A0 to A7 is the lower address byte and A8 to A15 the upper address byte. Any 'X' bit can be set high or low for a total of 128 addresses (7 bits) where A8 and A9 determine upper byte addresses F8, F9, FA, FB (Hex) and A0 to A4 determine lower byte addresses from E0 to FF (Hex). Hence the non-consecutive address range in use on this card.

To increase flexibility in use, address blocks can be selected on the card as required, shown in Figure 5. The 4-way switch bank S1 allows for selection of the upper byte address, which is common to all ports, and S2 selects the lower byte addresses in 4 byte blocks from E0 to FF, for Port 1 only.

Similarly, switch bank S3 selects 4 byte block addresses for Port 2. If this addressing method seems strange then it must be understood that Port 1 and Port 2 PPI chips have four internal registers selected by address lines A0 and A1. These register addresses are sequential, so for Port 1, address E0, E1, E2 and E3 can be selected (switch 1 on S2), and Port 2 address E4, E5, E6 and E7 selected by switch 1 on S3. If so desired, all twelve switches can be set 'ON' so that any of the 128 addresses will access the Ports, but doing so will cause problems if more than one I/O card is fitted on the Motherboard!

BINARY

A 15				A 11	A 10	A 9	A 8	A 7		A 5	A 4				A 0
1	1	1	1	1	0	X	X	1	1	1	X	X	X	X	X

Table 1

Test Routines

Set all twelve (S1 to S3) switches down to 'OFF', and select F8 (S1), E0–E3 (S2) and E4–E7 (S3) switches to 'ON' only. The remaining nine switches should not be in the 'ON' position!

Port 1 enable addresses are now F8E0 to F8E3, and Port 2 addresses are F8E4 to F8E7. Plug the I/O card into the Motherboard, and turn on the PSU and the Amstrad. Type in and RUN program 1.

Lines 20 and 40 ask for Port address and data to be sent using the BASIC OUT (port), data command.

P.P.I. Programming

The Programmable Peripheral Interface IC has four

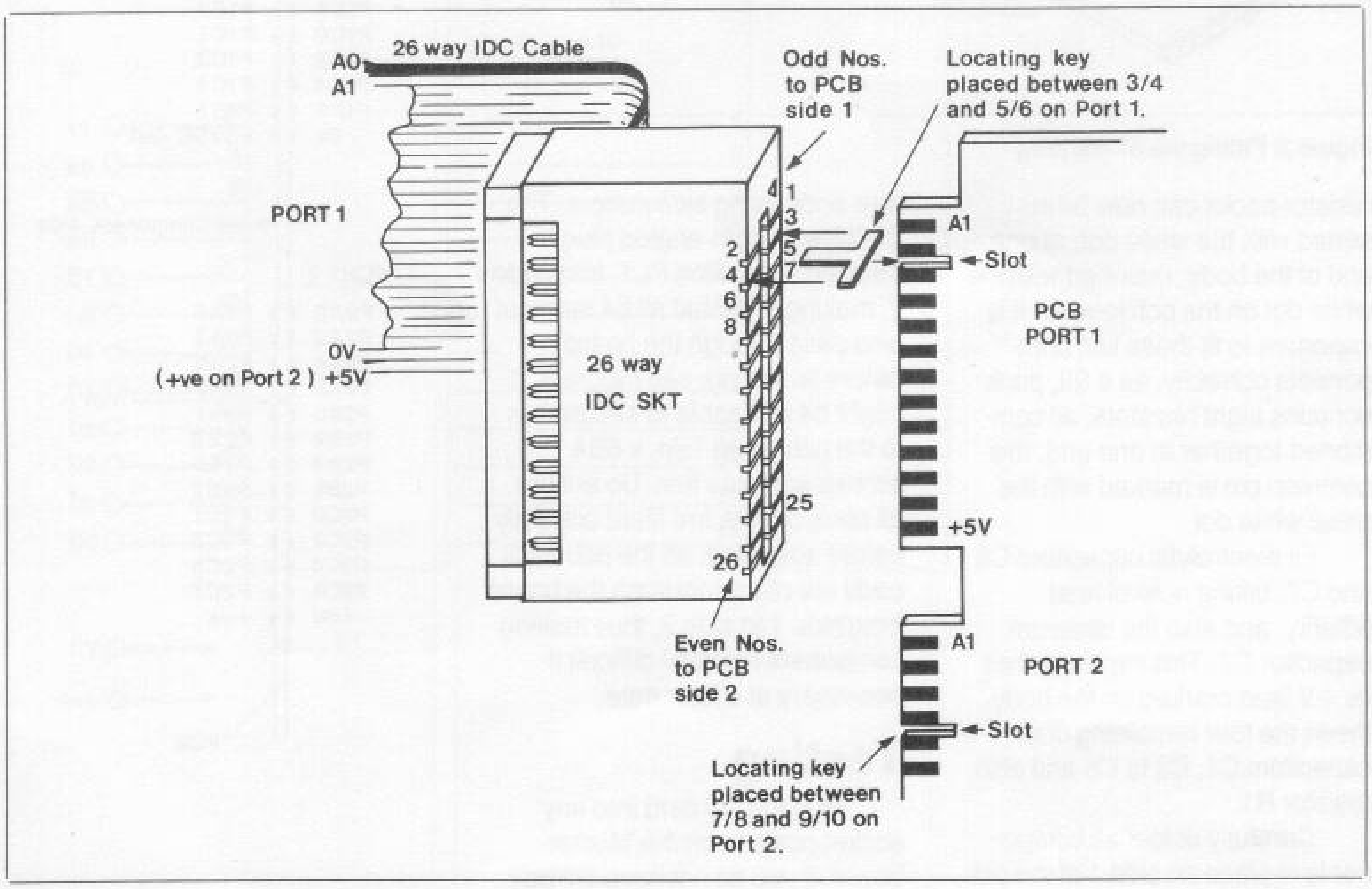


Figure 6. Connection to the 6 x 8-bit PCB

internal registers as shown in Table 2.

The Control Register has data written to it to determine various functions of Ports A, B and C, see Table 3.

For example, to set I/O Registers A, B, C on Port 1, to output mode: OUT (F8E3), 80. Another example is to set I/O Register A to output, B to input, C (upper) to output and C (lower) on to input on Port 2: OUT (F8E7), 83.

Note that register C of both Ports can be 'split' into two half bytes or nibbles. The lower half bus (C0 to C3) and upper half bus (C4 to C7) can be set to *different* I/O modes, as shown in Table 3. Mode 0 operation is the most commonly used method of passing data to and from the Ports, although there are a further two operating modes for the 8255A PPI. Further information is available on data sheets (see Parts List).

To continue with the testing using program 1, enter F8E3 in response to 'address =', and 80 after 'data ='. Both address and data values will be printed, and Control Register 1 (Port 1) will be programmed for Ports 1A, 1B and 1C to assume mode 0 output mode.

Refer to Figure 4 for the I/O edge connections, and connect a voltmeter to 0V and P1 A0 (the top connector). The reading should be 0V or very close.

Now enter address F8E0 and data 01, and the reading on Port 1A, bit 0 should be high (+4 to +5V). Using the same address (F8E0), enter data values 02, 04, 08, 10, 20, 40 and 80 (Hex), and check that all outputs P1 A0 to A7 each go high in turn.

Repeat this test on Port 1 B0 to B7, using address F8E1, and Port 1 C0 to C7, using address F8E2. Any bits that do not change indicate a fault and should be investigated. Data codes written out to all ports are 'latched' permanently within the IC until 'Reset' or overwritten by new data codes.

At any time, the Control Register can be accessed to change the status of Ports A, B and C. Please note that this particular register can be *written to only,* and status codes cannot be read from it.

Port 2 registers can be checked in the same way by entering data code 80 at address F8E7 to set P2 A, B and C registers to output mode. F8E4 will be Port 2A, F8E5 is Port 2B and F8E6 is Port 2C. Write data codes 00 to FF to each of these ports and check for appropriate bit conditions as before.

In Program 2, Ports 1A to 1C are set for output and Ports 2A to 2C are set for input modes. If Port 1 A0 to A7 is connected to Port 2 A0 to A7, Port 1 B0–B7 to Port 2 B0–B7, and Port 1 C0–C7 to Port 2 C0–C7, then the program will test each one of 48 bits and display errors, if any, as they are found.

I/O Connector

The 2 x 13-way card edge connections may be terminated with a 26-way IDC edge connector and cable (see Parts List). Polarising keys for these connectors can also be fitted, and the card slots are in different positions. Figure 6 shows these particular IDC sockets and terminal/cable connections.

When using the card, note that Port I/O signals should be at TTL levels of 0V to +5V. Current sourcing is low and relays, etc., cannot be driven directly. 0V,

```
10 CLS
20 INPUT"ADDRESS = ",a$
30 a=VAL("&"+a$)
40 INPUT"DATA = ",d$
50 d=VAL("&"+d$)
60 OUT(a),d
70 CLS
80 PRINT "ADDRESS = ";a$,"DATA = ";d$
90 GOTO 20
```

Program 1

REGISTER TYPE	A1	A0	PORT 1	PORT 2
CONTROL REGISTER	1	1	E3, EB, F3, FB	E7, EF, F7, FF
I/O REGISTER PORT C	1	0	E2, EA, F2, FA	E6, EE, F6, FE
I/O REGISTER PORT B	0	1	E1, E9, F1, F9	E5, ED, F5, FD
I/O REGISTER PORT A	0	0	E0, E8, F0, F8	E4, EC, F4, FC

Table 2

Mode 0 Port Definitions

DATA (HEX)	PORT A	PORT B	PORT C (UPPER)	PORT C (LOWER)
80	OP	OP	OP	OP
81	OP	OP	OP	IP
82	OP	IP	OP	OP
83	OP	IP	OP	IP
88	OP	OP	IP	OP
89	OP	OP	IP	IP
8A	OP	IP	IP	OP
8B	OP	IP	IP	IP
90	IP	OP	OP	OP
91	IP	OP	OP	IP
92	IP	IP	OP	OP
93	IP	IP	OP	IP
98	IP	OP	IP	OP
99	IP	OP	IP	IP
9A	IP	IP	IP	OP
9B	IP	IP	IP	IP

Table 3

```
10 MODE 2
20 CTREG1=&F8E3 : CTREG2=&F8E7
30 PORT1A=&F8E0 : PORT2A=&F8E4
40 PORT1B=&F8E1 : PORT2B=&F8E5
50 PORT1C=&F8E2 : PORT2C=&F8E6
60 OUT(CTREG1),&80 : OUT(CTREG2),&9B
70 PORT1=PORT1A : PORT2=PORT2A
80 FOR i%=0 TO 255
90 OUT(PORT1),i% : in%=INP(PORT2)
100 LOCATE 1,1
110 PRINT"PORT 1=";HEX$(PORT1);",";HEX$(i%,2),
130 PRINT"PORT 2=";HEX$(PORT2);",";HEX$(in%,2)
150 IF in%<>i% THEN GOSUB 1000:IF INKEY$="" THEN 150
170 NEXT
180 PORT1=PORT1+1:PORT2=PORT2+1
190 IF PORT1<>CTREG1 THEN 80
200 PRINT : PRINT"TEST COMPLETE"
999 END
1000 LOCATE 17,3
1005 PRINT"ERROR!"
1010 PRINT HEX$(PORT1,4);"=";HEX$(i%,2),,
1020 PRINT HEX$(PORT2,4);"=";HEX$(in%,2)
1030 RETURN
```

Program 2

+5V and +V PSU rails are extended out to the edge connector, and these terminals may need decoupling if currents greater than 500mA are envisaged.

PSU Module

Figures 7 and 8 show the circuit diagram and overlay of a small PSU module for driving the Motherboard buffer circuitry (ROM Card) and plug-in cards. A regulated +5V and unregulated +V are available for wiring to the associated Motherboard terminals, and maximum current is 1 Amp @ 5V DC, depending on the transformer used.

For general low current, low voltage use, a mains adaptor (see Parts List) can be fitted to the module. The particular adaptor specified requires a socket to be fitted (SK1) on the pcb for connecting one of the 4, 2.5mm plugs moulded onto the adaptor cable.

Alternatively, a mains transformer can be wired directly to the AC inputs on the PSU module. A transformer is necessary when fitting the EPROM Programmer module on to the '6 x 8 I/O CARD' as voltages of +21V to +25V are required for programming EPROMs (Note: maximum unregulated DC voltage must be less than +27V).

The PSU module comprises a simple bridge/smoothing circuit, 5V regulator, decoupling capacitor and indicator LED. REG1 is fitted onto a vaned heatsink before mounting on the pcb (see Figure 9) using ¼in. x 6BA bolt and nut and washer as shown. The BR1 rectifier package *must* be inserted correctly, with the + symbol on the package adjacent to the + on the legend. There may also be two ~ symbols on the package which denote the input AC terminals.

C1 must be fitted correctly. Note that it is the −V lead that is

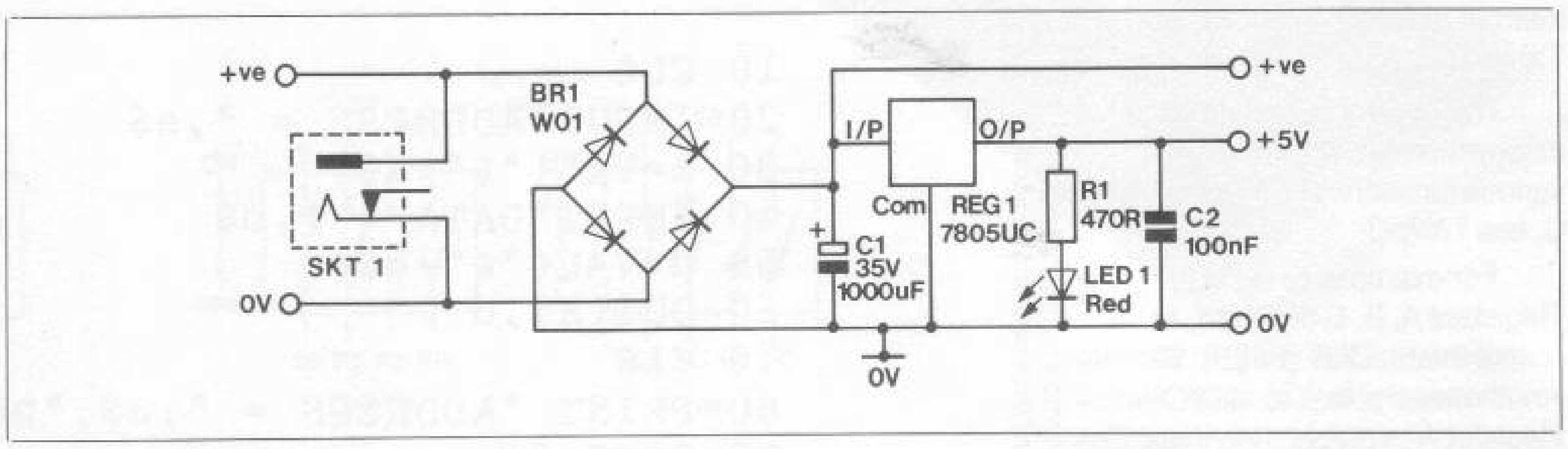


Figure 7. PSU Circuit

marked on the body, and *not* the +V lead. Insert the +V lead into the hole marked '+' on the legend.

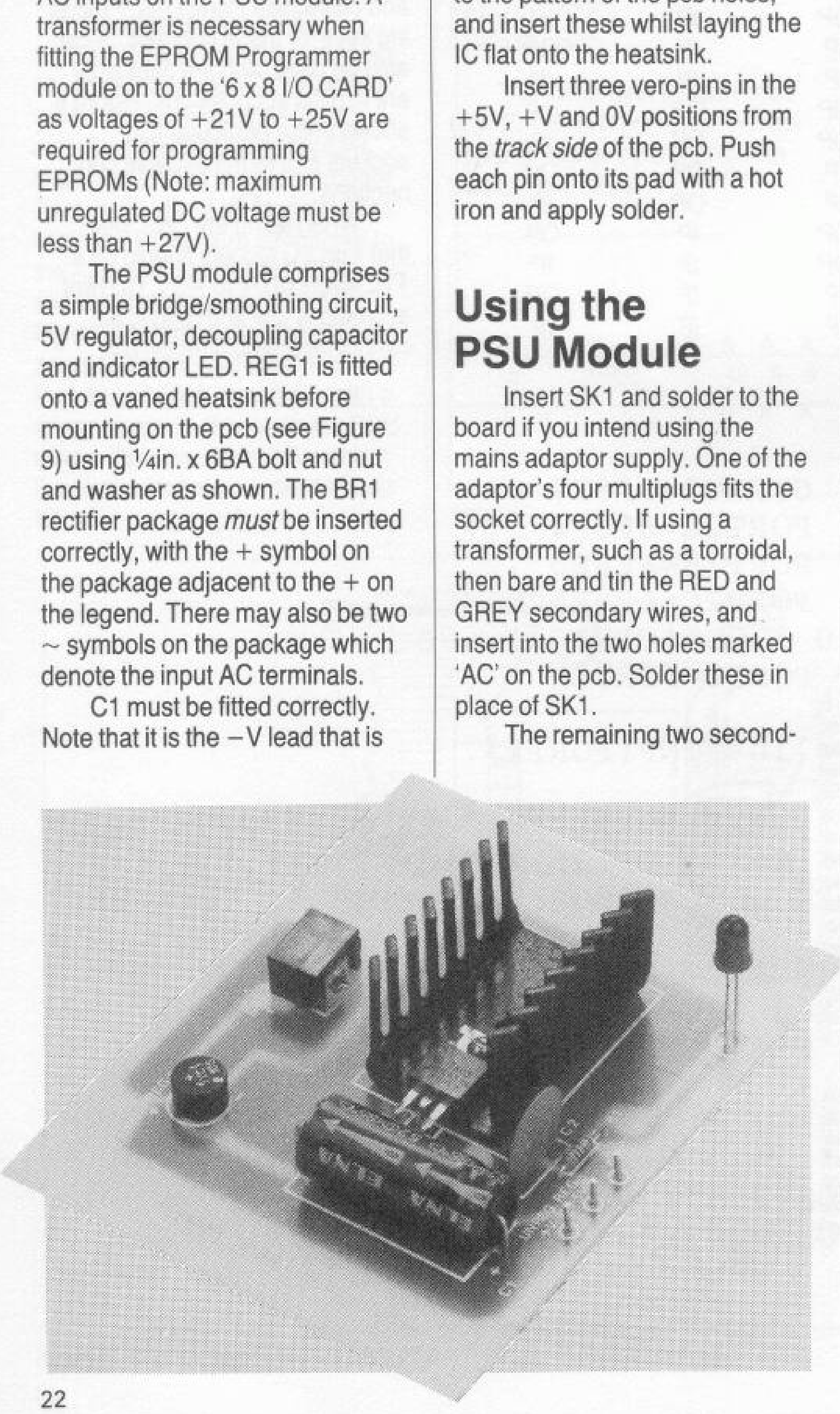
When mounting LED1, note that the cathode lead (k) is the shortest of the pair, and is also the lead directly beneath a flat edge on the package skirt. Carefully solder all components, but note that it might be a good idea to install the regulator IC1 complete with heatsink and bolted in position on the pcb, thus ensuring correct location before soldering – bend the 3 leads to 90° according to the pattern of the pcb holes, and insert these whilst laying the IC flat onto the heatsink.

Insert three vero-pins in the +5V, +V and 0V positions from the *track side* of the pcb. Push each pin onto its pad with a hot iron and apply solder.

Using the PSU Module

Insert SK1 and solder to the board if you intend using the mains adaptor supply. One of the adaptor's four multiplugs fits the socket correctly. If using a transformer, such as a torroidal, then bare and tin the RED and GREY secondary wires, and insert into the two holes marked 'AC' on the pcb. Solder these in place of SK1.

The remaining two second-



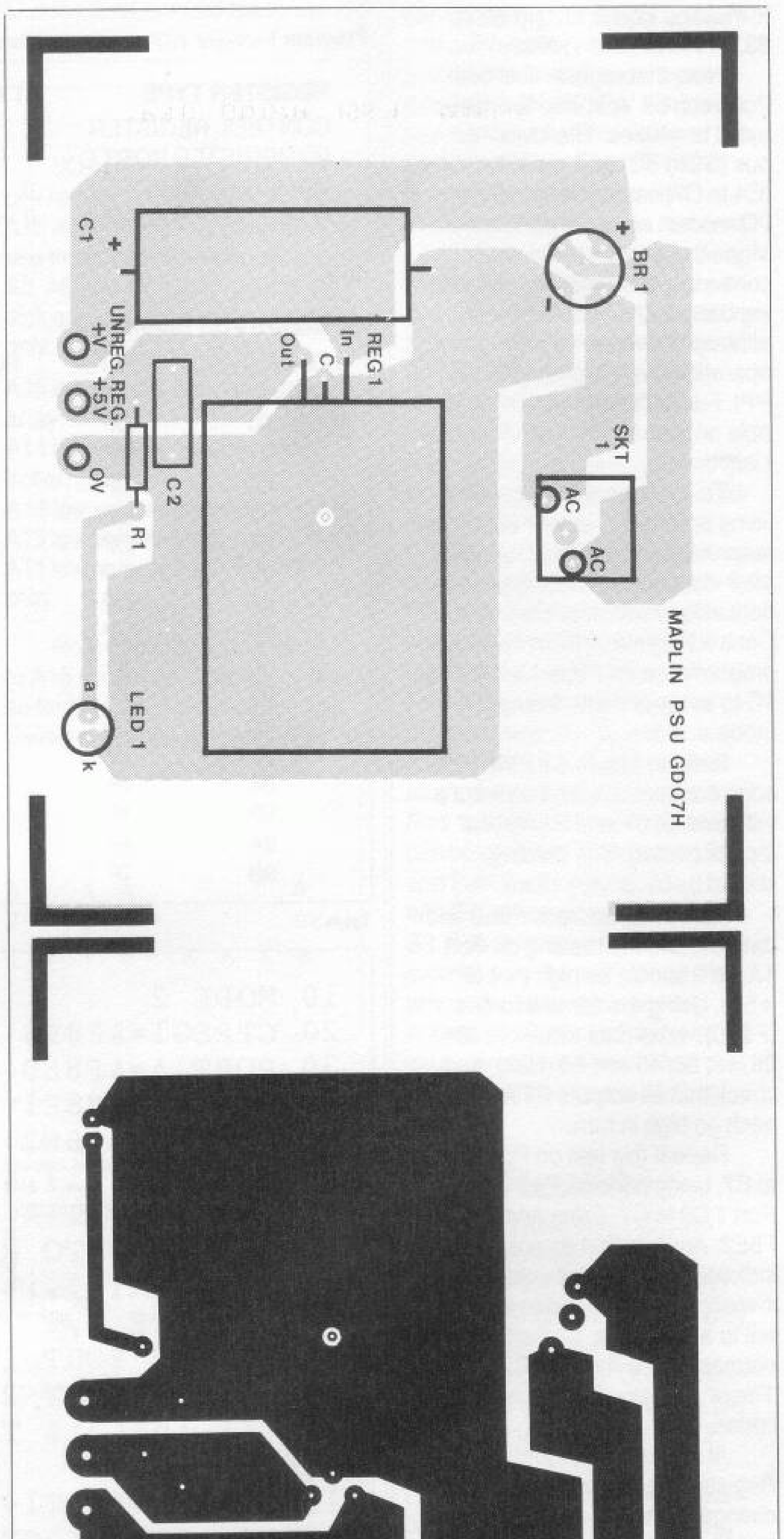


Figure 8. PSU PCB Track and Legend

aries, BLUE and YELLOW, are joined together by twisting the prepared ends and soldering. Insulate this termination with sleeving and/or insulation tape to prevent short circuit problems (see Figure 10).

Apply mains power to the supply source and check with a voltmeter connected between the 0V pin and +5V pin for 4.8 to 5.1V DC. The 0V to +V pin will be +15 to 18V with the adaptor connected (selector switch set to 12V). Check that LED1 glows brightly with the power supply on. This LED may also glow dimly once connected to the Motherboard and ROM Card, with the Amstrad supply on only.

Wire all three PSU module terminals to each corresponding terminal on the Motherboard. ROM Card buffer circuitry tests are covered in the booklet supplied with that module, so they will not be repeated here.

Standard 'Euro-Card' sizes have been adopted for the Motherboard system which allows PSU, I/O card and Motherboard to be fitted to Euro-Card rack frames. The PSU circuit board has been enlarged for this reason, and will fit vertically in rack guide rails if required.

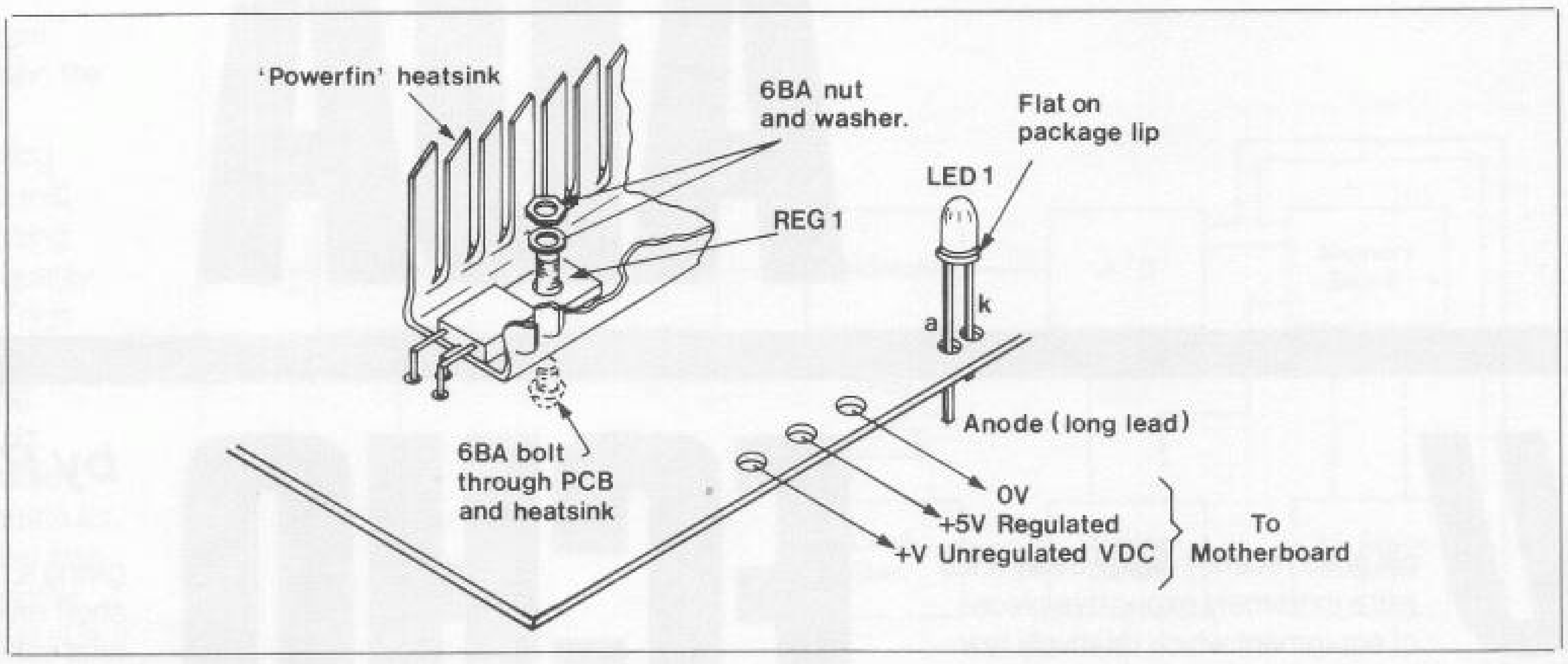


Figure 9. Fitting LED1 and REG1

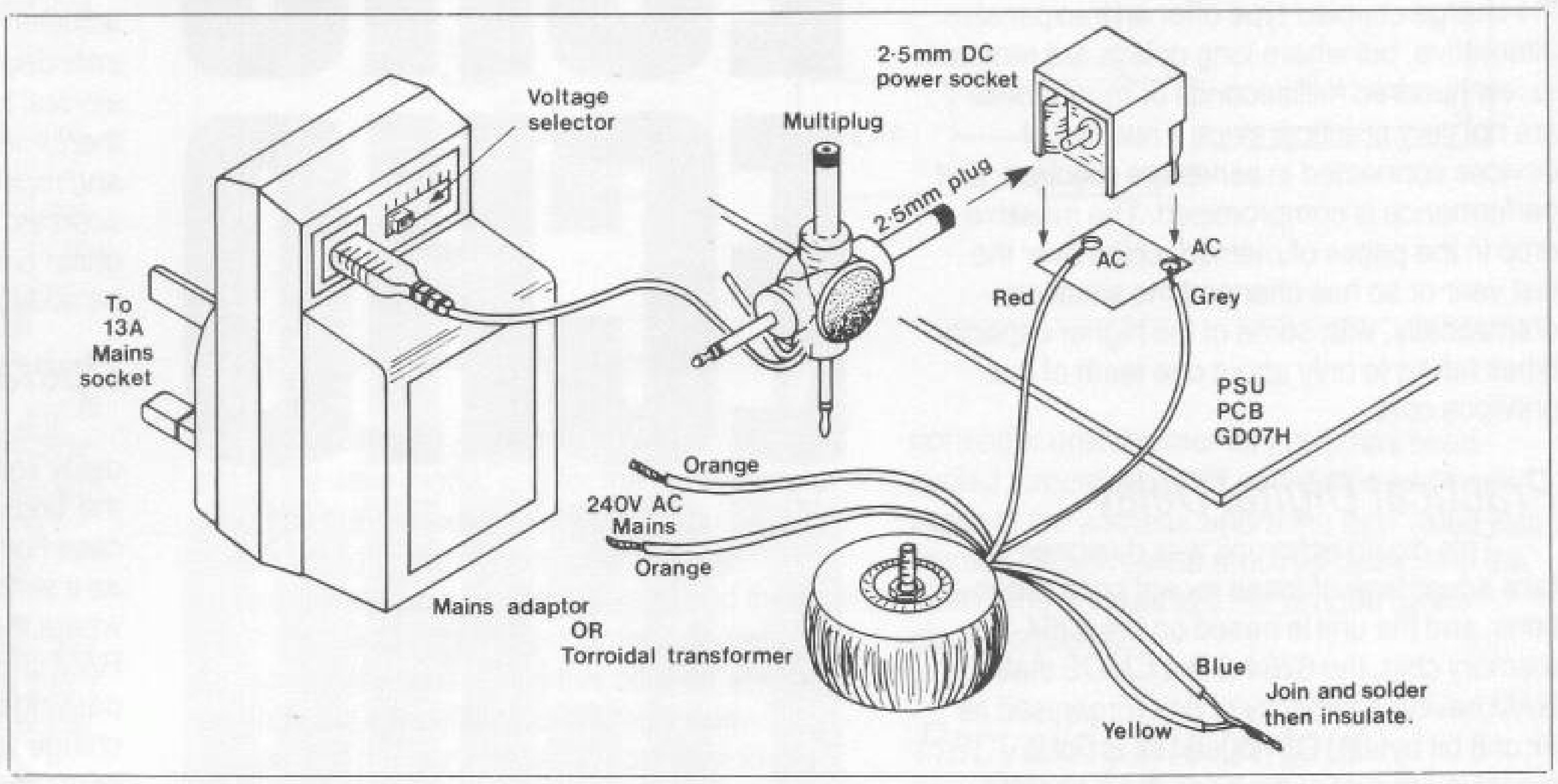


Figure 10. Mains Supply

EXPANSION SYSTEM PSU PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	470R	1	(M470R)
CAPACITORS			
C1	1000μF 35V Axial Electrolytic	1	(FB83E)
C2	100nF Disc ceramic	1	(BX03D)
SEMICONDUCTORS			
BR1	W01	1	(QL38R)
REG1	μA7805UC	1	(QL31J)
LED1	LED Red	1	(WL27E)
MISCELLANEOUS			
SK1	PCB 2.5mm DC Pwr Skt	1	(FK06G)
	Expansion PSU PCB	1	(GD07H)
	Powerfin plastic Heatsink	1	(FG55K)
	Bolt 6BA x ¼in.	1 Pkt	(BF05F)
	Nut 6BA	1 Pkt	(BF18U)
	Veropin 2145	1 Pkt	(FL24B)
OPTIONAL			
	AC adaptor Unregulated	1	(XX09K)

A complete kit of all parts, excluding optional items, is available for this project:
Order As LM03D (Expansion PSU Kit)
The following item included in the above kit list is also available separately, but is not shown in the 1986 catalogue:
Expansion PSU PCB. **Order As GD07H**

6 x 8 BIT PORT PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	470R	1	(M470R)
SIL 1,2	10k SIL Resistor	2	(RA30H)
CAPACITORS			
C1,3,4,5	100nF Minidisc	4	(YR75S)
C2	4μ7F 16V Tantalum	1	(WW64U)
C6	100μF 10V PC Electrolytic	1	(FF10L)
C7	22μF 63V PC Electrolytic	1	(FF07H)
SEMICONDUCTORS			
IC1,2	8255A	2	(YH50E)
IC3,4	74LS138	2	(YF53H)
IC5,6	74HC21	2	(UB12N)
MISCELLANEOUS			
	6 x 8 Bit Port PCB	1	(GD06G)
S1,2,3	DIL Switch SPST Quad	3	(FV43W)
	DIL Socket 14-pin	2	(BL18U)
	DIL Socket 16-pin	2	(BL19V)
	DIL Socket 40-pin	2	(HQ38R)
	PCB Plug Gold 64-way	1	(FJ51F)
OPTIONAL			
	26W IDC Edge Connector	2	(FT88V)
	Polarising Key IDC	2	(QY73Q)
	Flat IDC Cable 26-way	As req	(XR75S)
	PCB Receptacle Gold 64-way	1	(FJ47B)
	Colour coded IDC Cable 26-way	As req	(XR82D)
	8255A PPI Data Sheet		

A complete kit of all parts, excluding optional items, is available for this project:
Order As LM02C (6 x 8 bit Port Kit)
The following item included in the above kit list is also available separately, but is not shown in the 1986 catalogue:
6 x 8 bit Port PCB. **Order As GD06G**