6

The Apple Slot Repeater

This chapter describes an Apple computer "slot repeater" project. This will allow you to have your Apple all closed up, yet access the slots within the machine. A perfect example of this would be using the 6522 I/O board while you are trying to design some hardware for the prototype area and don't want to keep looking into the computer or opening it all the time. Your machine can sit there intact, and you can do all the work outside, where there is better light and more freedom (for making measurements and designing your circuits, for example). In order to make the Apple slot repeater card work, it will have to be connected to slot 7 within the computer by a 40-connector cable, which allows you to connect the 40-pin cable coming out of the Apple to a 40 pin-connector socket (dual inline socket) mounted on the repeater board itself. Inside the Apple we recommend using the 50-pin experimenter board, which can be purchased from almost any Apple dealer. The experimenter board has a 50-pin edge-card which fits into the slot, and can be used to solder the wires from the 40-pin cable to the appropriate locations on the edge-card.

Figure 6.1 below shows the wiring sequence for the slot repeater.

Not every line on the Apple bus will be brought out to the repeater board. Among the lines that won't be brought out are the power supply lines, as we wouldn't want to draw too much power from the Apple power supply. The repeater board has pins available for hooking-up an external power supply. The printed circuit board provides the appropriate circuitry for wiring up the sockets required for this slot repeater board, and it has been designed so that the addresses will be the same as they are inside the Apple computer itself. This way the experimenter will find that any experiments he tries will behave the same when he plugs them into the Apple as they do on the repeater board.

The decoding of the addresses mentioned above is performed in the circuit described in the schematic below.

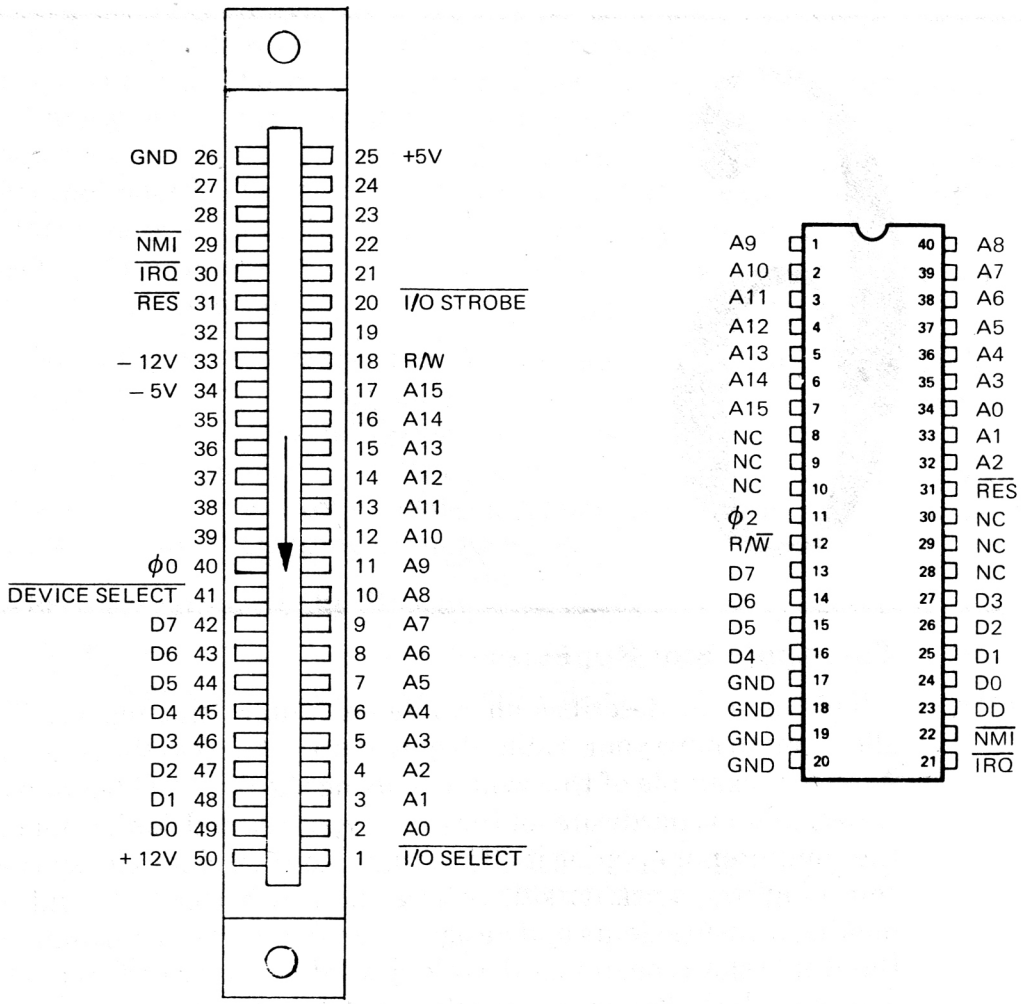

Figure 6.1 Connecting the Repeater Board

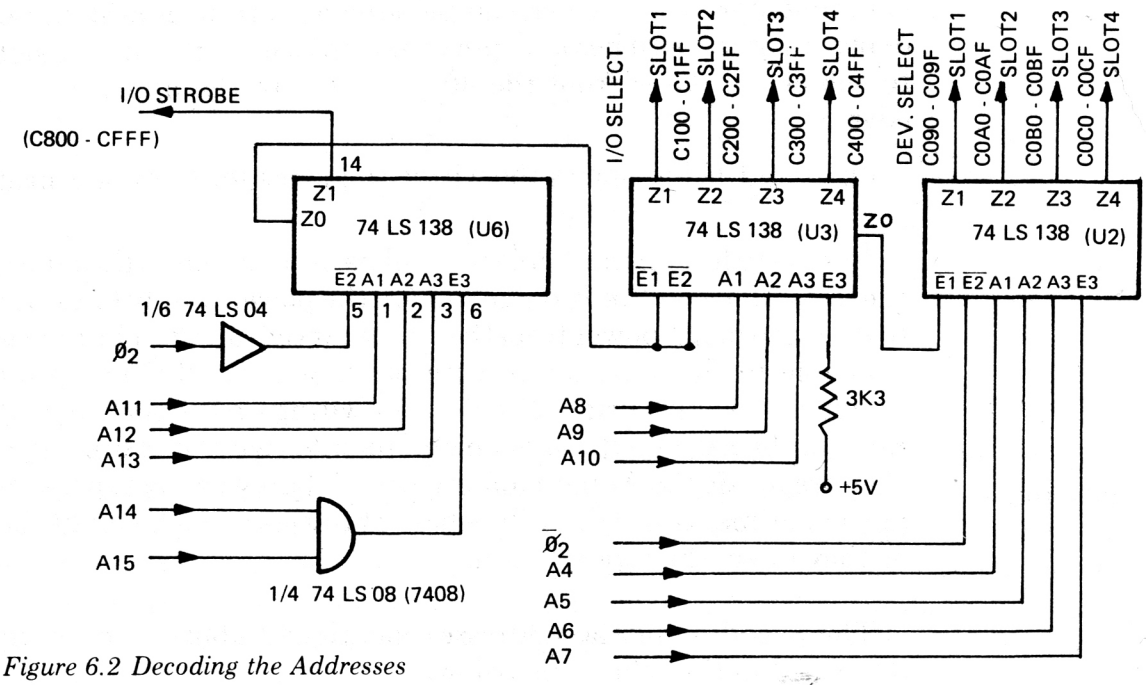

Figure 6.2 Decoding the Addresses

Address lines A11 through A15 are decoded by the 74LS138. This chip generates the select signal and the I/O strobe signal. Pin Z0 enables, with an active low signal, a second 74LS138 which decodes the address lines A8 through A10 and generates the I/O select lines for slots 1 through 4. These are, for example, the addresses **C100** to **C1FF** for the first slot. From this chip a third 74LS138 is enabled from Z0 of the second chip. It decodes the address lines A4 to A7. This creates a device select signal for the first four slots. For example, for slot one it would be **C090** through **C09F**.

The following table will show how to look up all the addresses of the device select, I/O select and the I/O strobe.

Slot	I/O SELECT	DEVICE SELECT	I/O-STROBE
2	C200 – C2FF	C0A0 – C0AF	C800 – CFFF
3	C300 – C3FF	C0B0 – C0BF	C800 – CFFF
4	C400 – C4FF	C0C0 – C0CF	C800 – CFFF
5	C500 – C5FF	C0D0 – C0DF	C800 – CFFF

Figure 6.3

On the memory repeater board, in the upper right-hand corner, there is a place to put in an S44 dual-inline female plug. However, this is for use by other 6502 computers and cannot be used in conjuction with the Apple. Just to the left of that area is a small prototype area for experimenting, or for changes you might want to make with your slot repeater board.

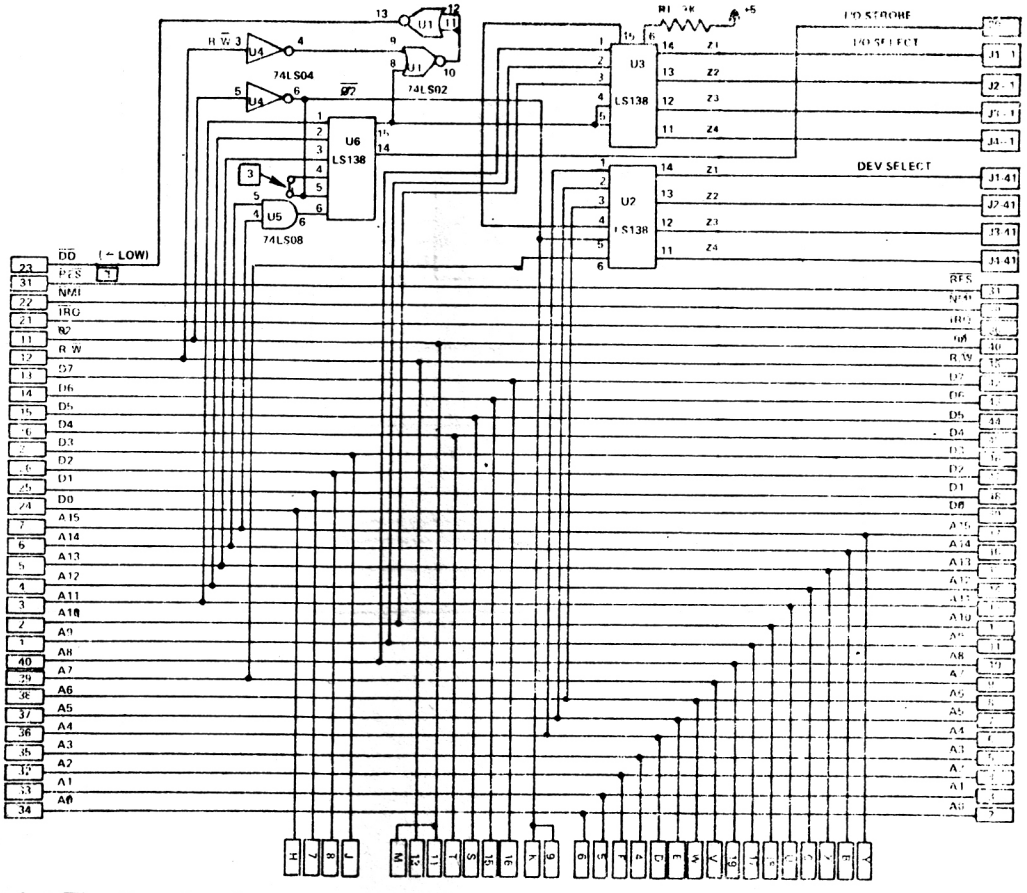

Figure 6.4 The Complete Schematic for the Slot Repeater

How to Assemble the Board

The first step is to mount all the female connectors and the sockets that will be required for the IC's used in this project. Then we connect the pins to the power supply. Next we can put on the capacitor C1, resistor R1, and the 50-pin female connector. The last step is to insert the IC's, making sure that they are lined up in the same manner as they are shown in the schematic (Figure 6.5).

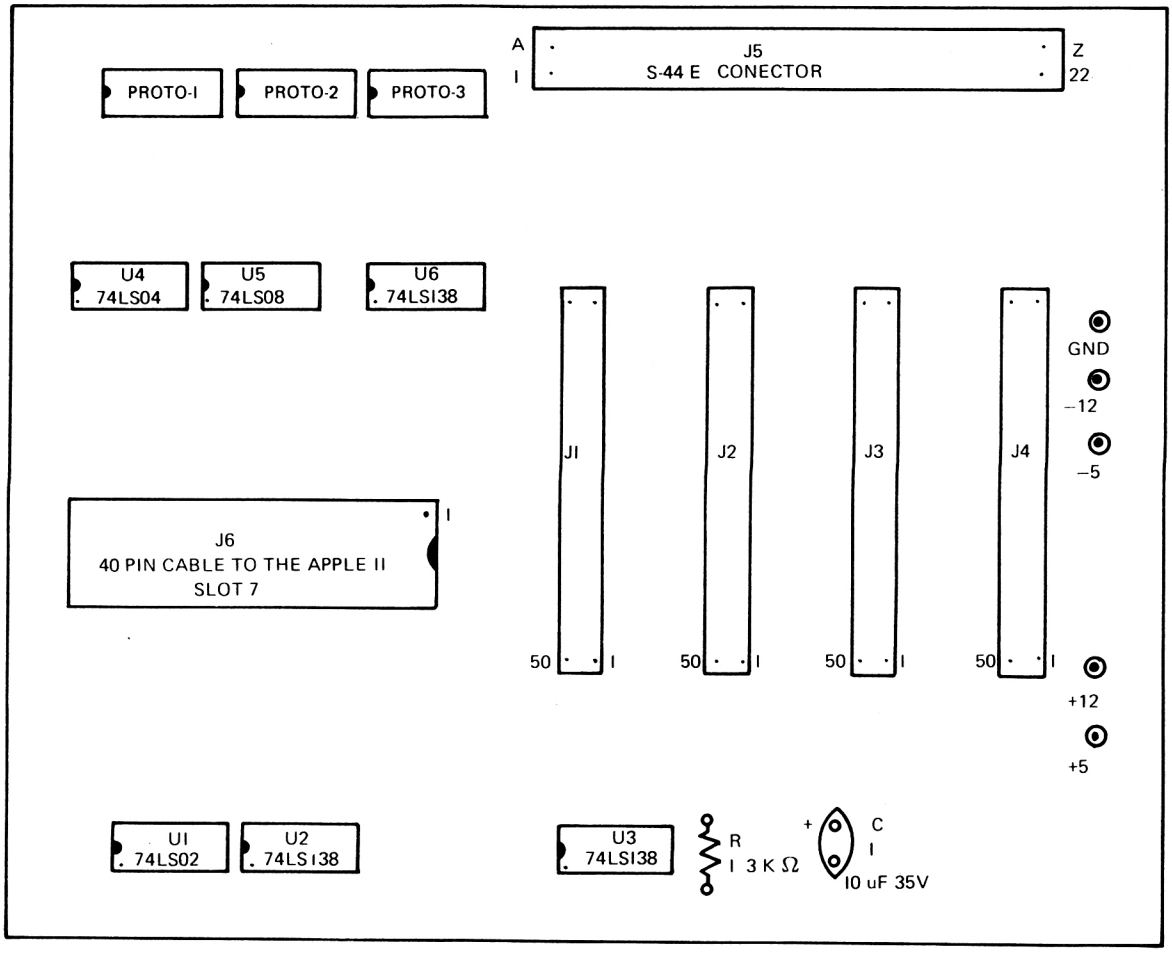

Figure 6.5 Parts Layout

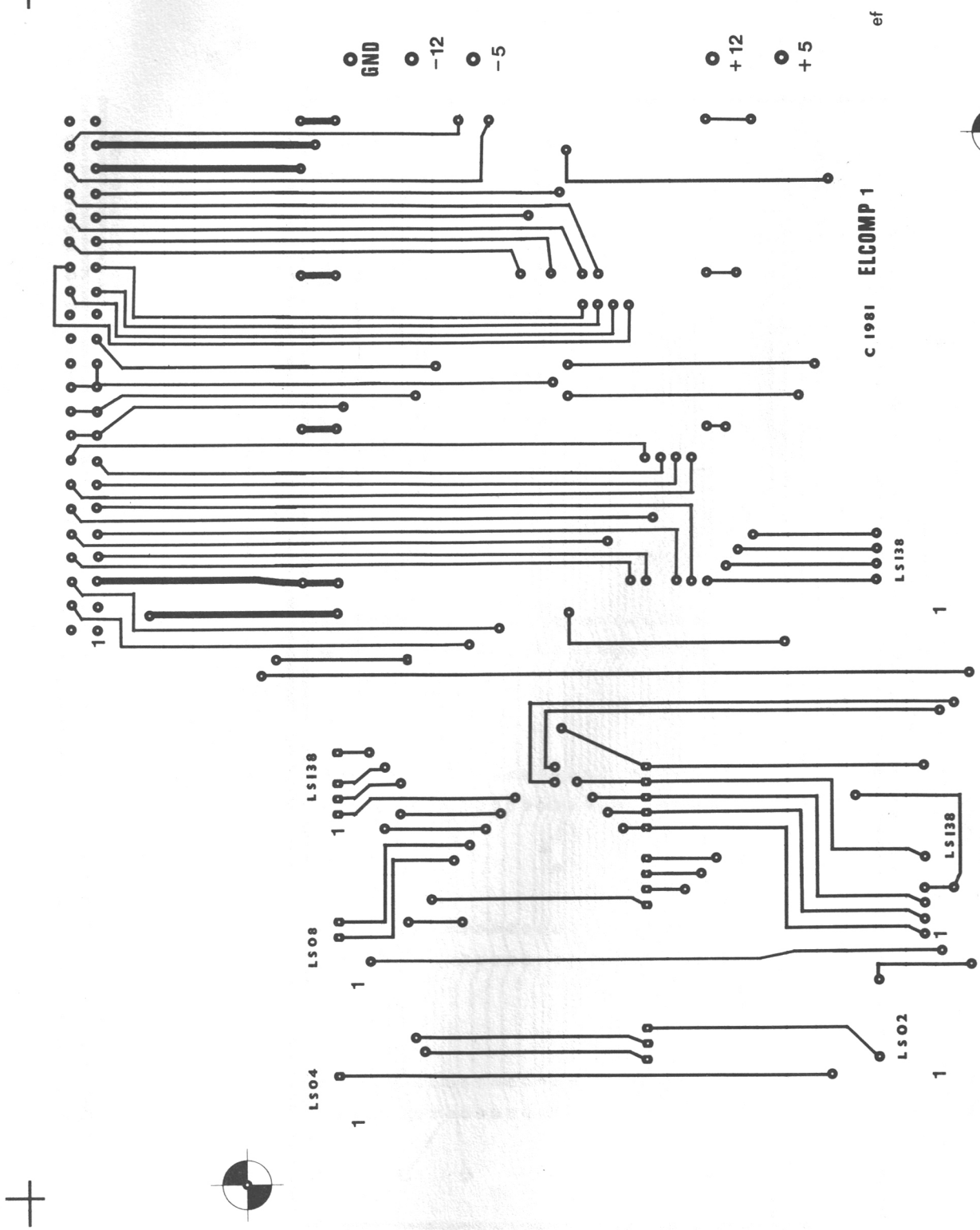

Figure 6.6a Top of the Printed Circuit Board

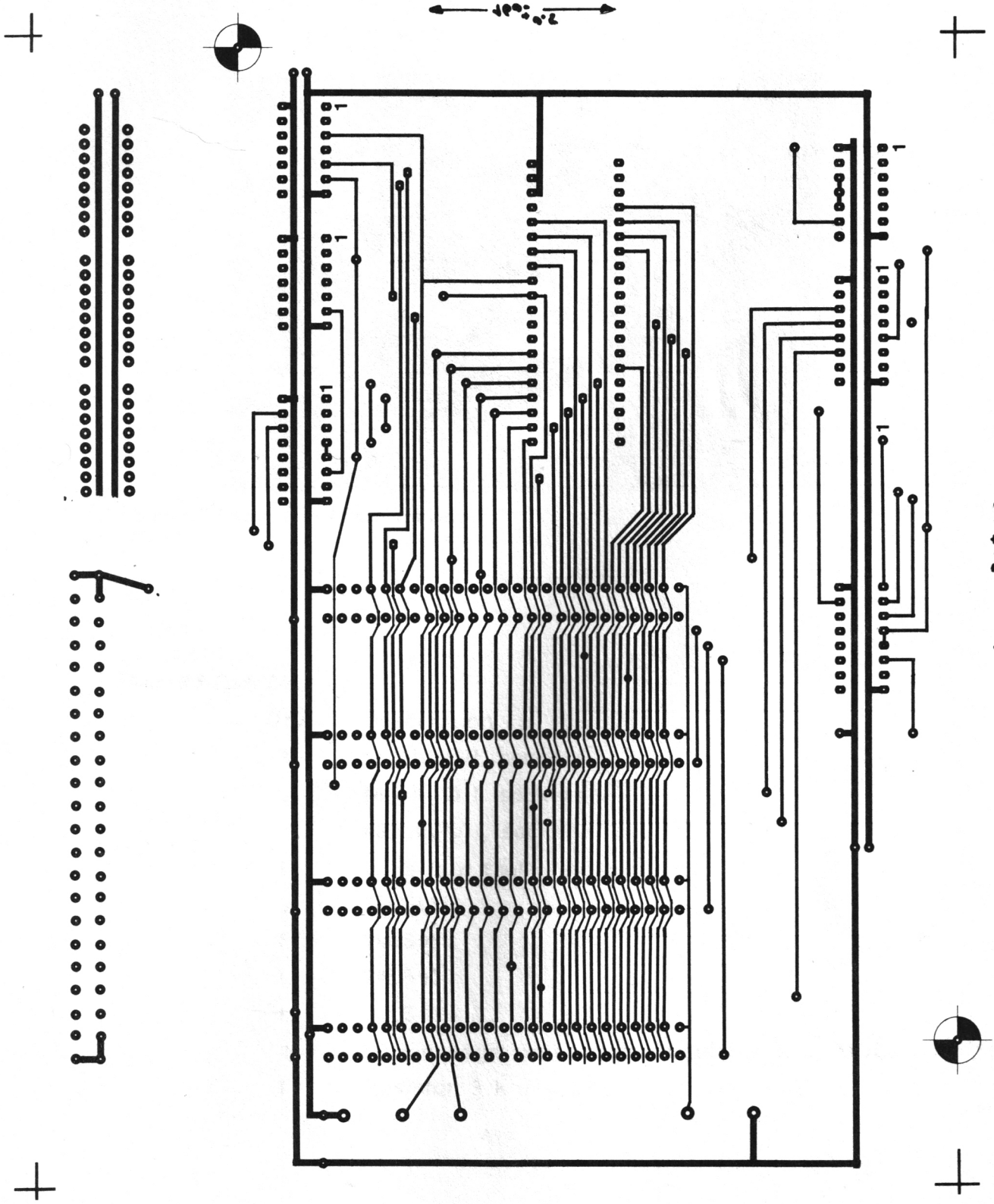

Figure 6.6b Bottom of the Printed Circuit Board

Here is a photograph of a completed board to give you an idea of how it should look if you have assembled it properly.

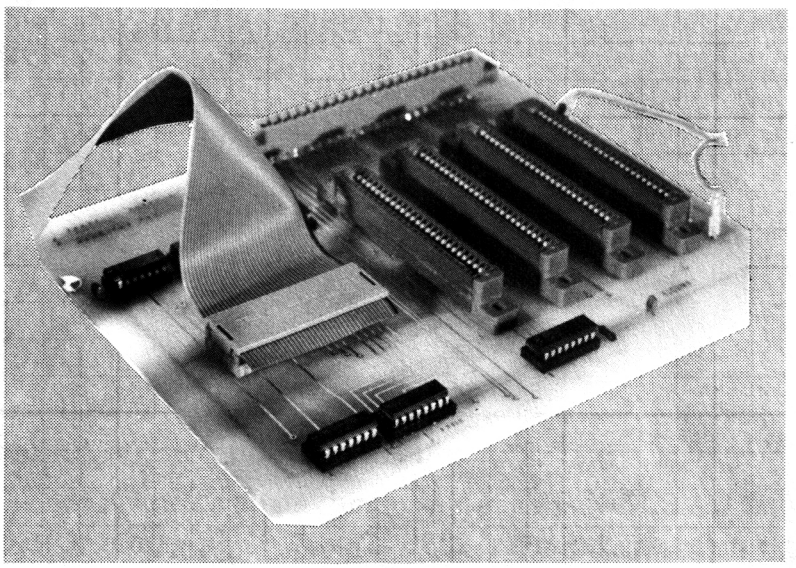

Figure 6.7 Photo of the Completed Board

Figure 6.8 Parts List

Qty	Description
3	14 pin DIL sockets
3	16 pin DIL sockets
1	40 pin DIL socket
1	capacitor 10µF/35V tantal
3	74LS138
1	74LS08
1	74LS02
1	74LS04
4	50 pin edge connectors (available from MOLEX)
1	Resistor 3 k / 0,25W

7

The Coupling of Two 6502 Systems

Many of the better known home computers, such as KIM, SYM, AIM, ATARI, PET, APPLE, OHIO, and VIC 20 have a 6502 microprocessor for their CPU. It is sometimes useful to connect two of these systems together to exchange data. This makes the transfer of machine-language programs easier, too.

To define a common interface, we use the 6522 I/O card for each computer. The 6522 card plugs directly into the Apple bus, but to use it with other computers, you'll need the expansion board described in Chapter 6. Figure 7.1 shows the coupling of an Ohio Scientific CIP with an Apple computer, and Fig. 7.2 the program for data exchange.

Program Description

The program in Fig. 7.2 consists of two parts: SEND APPLE —> OHIO and RECEIVE APPLE <— OHIO.

The version shown is for the Apple II computer. Needless to say, the program for the Ohio is exactly the same except for the address of the monitor.

To clarify the use of this program, an example of data transfer from the Apple to the Ohio is presented. In the Apple, the starting address of the data (FROM) and the ending address (UNTIL) are set, and the program is started by **800G**. The Apple then waits in a loop until the Ohio is ready.

In the Ohio, set the address (TO) where the data is to be stored. Then the program is started by jumping to location **842**. The Ohio sends a 1 over PB0 to the Apple, indicating it's ready, which will begin the data transfer. At the end of the data transfer, the Apple jumps to the monitor. The Ohio doesn't know that the Apple has finished, so the receiving program has to be interrupted by pushing the break key of the Ohio.

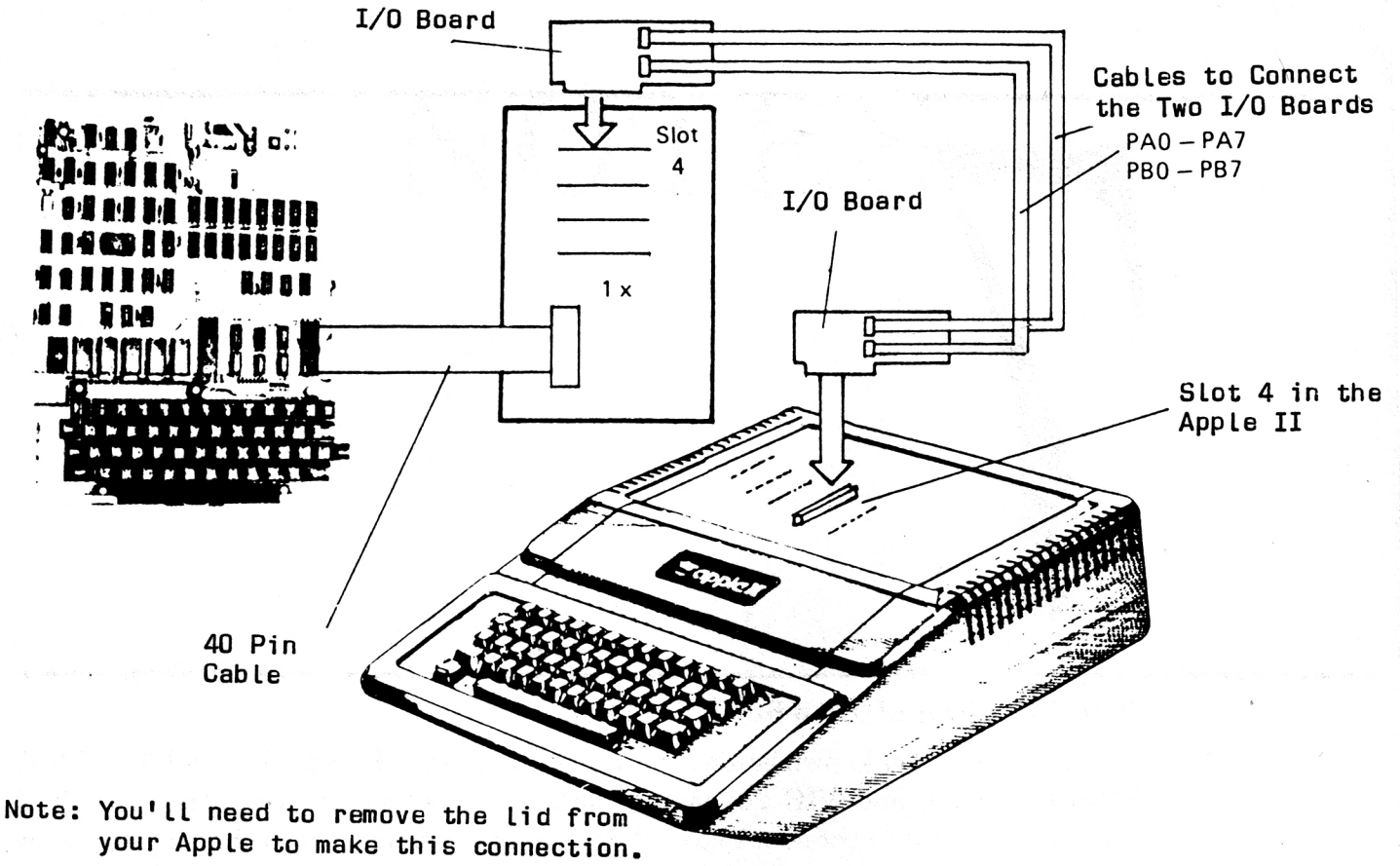

Figure 7.1 Block Diagram

Sending data from the Ohio to the Apple is done in the same manner, but now the Apple performs the receiving program while the Ohio performs the sending program.

This kind of data transfer program is very useful when you are developing programs for single-board computers like the SYM or KIM. The program can be developed and tested on the Apple with one of its powerful assemblers, then sent to a single-board computer without retyping the whole program.

Figure 7.2 Program Listing

```
0800              1          DCM "PR#1"
0800              2  ;SEND APPLE-->OHIO
C0C0              3          ORG $C0C0
C0C0              4  TORB    EQU *
C0C0              5  TORA    EQU *+!1
C0C0              6  DDRB    EQU *+!2
C0C0              7  DDRA    EQU *+!3
C0C0              8  MONITO  EQU $FF59
C0C0              9  ;
C0C0             10  VON     EPZ $10
C0C0             11  BIS     EPZ $12
C0C0             12  WOHIN   EPZ $14
C0C0             13  ;
```

Listing Continued . . .

Continued Listing

```
C0C0            14  ;
0800            15          ORG $800
0800 A000       16          LDY #$00
0802 A9FF       17          LDA #$FF
0804 8DC3C0     18          STA DDRA
0807 ADC0C0     19  M       LDA TORB
080A 2901       20          AND #$01
080C D0F9       21          BNE M
080E B110       22  M00     LDA (VON),Y
0810 8DC1C0     23          STA TORA
0813 A980       24          LDA #$80
0815 8DC2C0     25          STA DDRB
0818 A900       26          LDA #$00
081A 8DC0C0     27          STA TORB
081D EA         28          NOP
081E EA         29          NOP
081F EA         30          NOP
0820 A980       31          LDA #$80
0822 8DC0C0     32          STA TORB
0825 E610       33          INC VON
0827 D002       34          BNE M10
0829 E611       35          INC VON+1
082B A511       36  M10     LDA VON+1
082D C513       37          CMP BIS+1
082F 90D6       38          BCC M
0831 F002       39          BEQ M30
0833 B008       40          BCS FIN
0835 A510       41  M30     LDA VON
0837 C512       42          CMP BIS
0839 F0CC       43          BEQ M
083B 90CA       44          BCC M
083D A940       45  FIN     LDA #$40
083F 4C59FF     46          JMP MONITO
0842            47  ;
0842            48  ;
0842            49  ;RECIEVE APPLE<--OHIO
0842            50  ;
0842 A000       51          LDY #$00
0844 A901       52          LDA #$01
0846 8DC2C0     53          STA DDRB
0849 A900       54          LDA #$00
084B 8DC0C0     55          STA TORB
084E EA         56          NOP
084F EA         57          NOP
0850 EA         58          NOP
0851 ADC0C0     59  M1      LDA TORB
0854 2940       60          AND #$40
0856 F003       61          BEQ M0
0858 4C59FF     62          JMP MONITO
085B ADC0C0     63  M0      LDA TORB
085E 30FB       64          BMI M0
0860 A901       65          LDA #$01
0862 8DC0C0     66          STA TORB
0865 ADC1C0     67          LDA TORA
0868 9114       68          STA (WOHIN),Y
086A E614       69          INC WOHIN
```

Listing Continued

Continued Listing

```
086C D002      70          BNE M2
086E E615      71          INC WOHIN+1
0870 A900      72  M2      LDA #$00
0872 8DC0C0    73          STA TORB
0875 F0DA      74          BEQ M1
0877           75  ;
0877           76  ;
              77          END

          *************************
          *                       *
          * SYMBOL TABLE -- V 1.5 *
          *                       *
          *************************

LABEL. LOC.  LABEL. LOC.  LABEL. LOC.

** ZERO PAGE VARIABLES:

VON    0010  BIS    0012  WOHIN  0014

** ABSOLUTE VARABLES/LABELS

TORB   C0C0  TORA   C0C1  DDRB   C0C2
DDRA   C0C3  MONITO FF59  M      0807  M00    080E  M10  082B  M30  0835
FIN    083D  M1     0851  M0     085B  M2     0870

SYMBOL TABLE STARTING ADDRESS:6000
SYMBOL TABLE LENGTH:0092

0800- A0 00 A9 FF 8D C3 C0 AD
0808- C0 C0 29 01 D0 F9 B1 10
0810- 8D C1 C0 A9 80 8D C2 C0
0818- A9 00 8D C0 C0 EA EA EA
0820- A9 80 8D C0 C0 E6 10 D0
0828- 02 E6 11 A5 11 C5 13 90
0830- D6 F0 02 B0 08 A5 10 C5
0838- 12 F0 CC 90 CA A9 40 4C
0840- 59 FF A0 00 A9 01 8D C2
0848- C0 A9 00 8D C0 C0 EA EA
0850- EA AD C0 C0 29 40 F0 03
0858- 4C 59 FF AD C0 C0 30 FB
0860- A9 01 8D C0 C0 AD C1 C0
0868- 91 14 E6 14 D0 02 E6 15
0870- A9 00 8D C0 C0 F0 DA CD
*
```