March 12, 1975

LD12: Conversion from 16 word to 1K memory and/or 4K memory.

Conversion from 16 word to 1K

1. Installation of sockets for memory chips:
Install 12 16 pin, wirewrap sockets in locations D5 to D16. For the sockets in D6 to D15 inclusive, proceed as follows:
After inserting sockets, cut off all pins except numbers 11 and 12. Solder the 14 cut off pins to the busses in the back panel.
For socket D16:
After inserting socket, cut off pins 9, 10, 13, 14, 15 and 16. Solder all pins except numbers 11 and 12 to the busses provided in the back panel.
For Socket D5:
After inserting socket, cut off all pins except 11, 12, 13, 14, 15, and 16. Solder all pins except 11 and 12 to the busses provided in the back panel.
Great care must be taken to prevent solder from bridging between busses. It is recommended that this soldering be done with fine gage (28 - 30) solder, and that a cool iron be used. Either do the soldering under a microscope, or examine the job carefully under a microscope when completed.

2. Install socket for single shots:
Install a 16 pin, wirewrap socket in location B-17. Solder pin 8 (ground) to the plane of the back panel. Solder pin 16 (Vcc) to the plane of the back panel. This socket is for the Dual Retriggerable Monostable Multivibrator (Fairchild 9602).

3. Locate stake pins:
23 stake pins will have been installed on the back panel. 12 of the stake pins are immediately to the left of the three 16 pin socket positions above the portion of Row B which is bussed for memory. The socket installed in accordance with paragraph 2 should be in the lower of these three positions. Two rows of pads labeled 9 and 10 as shown in Figure 1 (viewed from the back of the panel) are next to the socket. Stake pins with the pins projecting toward the back of the panel (as do the socket pins) will be found in the holes in pads H, R, P and T. Note that the letters appear in Figure 1 only and not on the back panel.

4. Install RC timing combinations:
Install the two 270 pf capacitors from the front of the panel. Insert one in the holes in pads G and Q, and the other in the holes in pads O and S. Solder in place and cut off the excess leads. Install two 18K resistors from the front of the

panel through the hole in pad B and hole Y in the Vcc bus, and through the hole in pad J and hole Z of the Vcc bus. Solder in place and cut off the excess leads. Install two 1800 ohm resistors from the front of the panel in the two holes in pads C and F, and in the two holes in pads K and N. Solder in place and cut off the excess leads. The smaller resistors are the trimmer resistors and will give a pulse of from 1.5 to 2.0 microseconds. The Intel 2102 memory requires about 1 microsecond to read or write. The trimmer resistors may be changed if it is desired to change pulse length. It has been found that a .001 mfd capacitor and a single 4700 ohm resistor will give reasonable results. (See page 7-15 of Fairchild TTL Data Book, 1972.)

5. Wire the single shot (Fairchild 9602) socket:
The Fairchild TTL Data Book contains pin assignments if this information is desired. In the following instructions pins are referred to by column, row and pin number. The 9602 is located at B17; thus its pins are designated B17-1 to B17-16 inclusive. Wirewrap (or unwrap) as follows:
Connect F12-9 to B17-4.
Remove wire between G4-11 and E14-2.
Connect G4-11 to B17-11.
Connect B17-5 to B17-3.
Connect B17-3 to B17-13.
Connect B17-13 to B17-16(Vcc).
Connect B17-12 to B17-8(Gnd).
Connect B17-14 to the stake pin in pad P.
Connect B17-15 to the stake pin in pad T.
Connect B17-2 to the stake pin in pad H.
Connect B17-1 to the stake pin in pad R.

6. Connect And-Or-Invert gate (SN7451) as a NOR gate to the outputs of the single shot:
The SN7451 is already on the backboard at location K17.
Connect B17-6 to K17-1.
Connect K17-1 to K17-13.
Connect B17-10 to K17-10.
Connect K17-10 to K17-9.

7. Connect a WRITE signal to the proper memory bus:
The low side of one of the single shot outputs is used for this purpose.
Connect B17-9 to D16-3

8. Rewire D-type flip flop controlling CYCOMP:
The original wiring is shown in figure 2. Note that the write signal caused the D type flip flop to go high. 7489 memory is so fast that this simple system would work, and when the WRITE signal went down, $\overline{Q}$ became CYCOMP(Hi). However, the 2102 memory is comparatively slow, requiring about 1 microsecond to accomplish a read or a write. An LD12 has operated properly at clock speeds having a cycle

time of less than 1 microsecond. The ou[illegible] of the system used in this instance for this type of m[illegible] is shown in Figure 3. It will be seen that the WRIT[illegible]nal to the single shot now causes the D type flip f[illegible]o go down and to stay down until the single shot timi[illegible]le has been completed. At this time the output of th[illegible]OR gate goes high and the flip flop goes high. This situation requires that the leads to pins 5 and 6 on the D type flip flop be interchanged, because Q is now CYCOMP(Hi) instead of Q.

Remove wire between E14-1 and E14-13.
Connect K17-8 to E14-2.
Connect E14-2 to E14-1.

To exchange the wires on E14-5 and E14-6:

The wire on E14-5 extends across the board to M4-4.
It may be possible to disconnect this wire from E14-5 and connect it to E14-6 without using a new wire. If not,
Disconnect E14-5.
Disconnect E14-6.
Disconnect M4-4 and remove wire.
Connect M4-4 to E14-6.
The wire which has been disconnected from E14-6 was daisy chained E14-6 to F14-3 to F15-3 to F16-3 to J7-3. J7-3 is not the end of the daisy chain, but all wires noted should be removed up to this point because F14, F15 and F16 are the sockets containing the 16 word memory, which will no longer be used. After the 4 wires are removed, connect J7-3 to E14-5.

9. Connect the ten low order bits of the Memory Address Register to the 10 memory address bits:

The correspondence is:

2102 Memory	MA Register Bit
A0	MA2
A1	MA3
A2	MA4
A3	MA5
A4	MA6
A5	MA7
A6	MA8
A7	MA9
A8	MA10
A9	MA11

If it is desired to use the three 16 pin sockets occupied by the SN7489's for some purpose, the wires may be removed from these sockets (See paragraph 13). If these three sockets are to be cleared of all wiring, it should be done at this point. The following instructions may be carried out whether or not those in paragraph 13 have been completed.

Connect up Memory Address as follows:

Connect F13-7 to D16-8.
Connect F13-10 to D16-4.
Connect F13-12 to D16-5.
Connect F13-15 to D16-6.
Connect F12-2 to D16-7.
Connect F12-5 to D16-2.
Connect F12-7 to D16-1.

Connect F12-10 to D5-16.
Connect F12-12 to D5-15.
Connect F12-15 to D5-14.

In order to keep memory enabled, chip en[illegible] must be grounded.
Connect D5-13 to E5-7.

10. Connect Memory Buffer Register to Dat[illegible] In:
Connect F6-2 to D16-11.
Connect F6-5 to D15-11.
Connect F6-7 to D14-11.
Connect F6-10 to D13-11.
Connect F6-12 to D12-11.
Connect F6-15 to D11-11.
Connect F5-2 to D10-11.
Connect F5-5 to D9-11.
Connect F5-7 to D8-11.
Connect F5-10 to D7-11.
Connect F5-12 to D6-11.
Connect F5-15 to D5-11.

11. Connect Data Out lines to Muxes:
Connect D16-12 to H12-13.
Connect D15-12 to H11-13.
Connect D14-12 to H10-13.
Connect D13-12 to H9-13.
Connect D12-12 to H8-13.
Connect D11-12 to H7-13.
Connect D10-12 to H6-13.
Connect D9-12 to H5-13.
Connect D8-12 to H4-13.
Connect D7-12 to H3-13.
Connect D6-12 to H2-13.
Connect D5-12 to H1-13.

12. Insert 2102 chips in the twelve memory sockets.

13. It is desirable, if one expects ultimately to use 4K of memory and to interface peripherals, to remove all connections on the sockets at F14, F15 and F16. To accomplish this, remove the following connections:
F12-15 to F14-1
F14-1 to F15-1
F15-1 to F16-1
F14-2 to F14-8
F7-12 to F14-4
H4-13 to F14-5
F7-13 to F14-6
H3-13 to F14-7
H2-13 to F14-9
F7-14 to F14-10
H1-13 to F14-11
F7-15 to F14-12
F12-7 to F14-13
F14-13 to F15-13

F15-13 to F16-13
F16-13 to E16-12
F12-10 to F14-14
F14-14 to F15-14
F15-14 to F16-14
F12-12 to F14-15
F14-15 to F15-15
F15-15 to F16-15
F15-2 to F15-8
F7-6 to F15-4
H8-13 to F15-5
F7-7 to F15-6
H7-13 to F15-5
H6-13 to F15-9
F7-10 to F15-10
H5-13 to F15-11
F7-11 to F15-12
F16-2 to F16-8
F7-2 to F16-4
H12-13 to F16-5
F7-3 to F16-6
H11-13 to F16-7
H10-13 to F16-9
F7-4 to F16-10
H9-13 to F16-11
F7-5 to F16-12

Make the following connection:
F12-7 to E16-12.

<u>To install an additional 3K of memory</u>

14. Install sockets in A5 to A16, B5 to B16, and C5 to C16. Follow the procedure contained in paragraph 1 for each individual column. That is to say, whenever "D" appears in paragraph 1, referring to sockets, interpret it as "A", "B" or "C" depending upon which column of sockets is to be installed.

15. Connections for SN7442:
Ground unused inputs:
Connect H14-13 to H14-12.
Connect H14-12 to H14-8.
Connect 2 high order bits in the memory address:
Connect K16-11 to H14-14.
Connect K16-13 to H14-15.
Connect Chip Enable to the proper column:
Disconnect D5-13 from E7-5.
Connect H14-1 to D5-13.
Connect H14-2 to C5-13.
Connect H14-3 to B5-13.
Connect H14-4 to A5-13.
Insert SN7442 in Socket H14.

16. Daisy chain remainder of address signals:
Connect D16-8 to C16-8 to B16-8 to A16-8.
Connect D16-7 to C16-7 to B16-7 to A16-7.
Connect D16-6 to C16-6 to B16-6 to A16-6.
Connect D16-5 to C16-5 to B16-5 to A16-5.
Connect D16-4 to C16-4 to B16-4 to A16-4.
Connect D16-2 to C16-2 to B16-2 to A16-2.
Connect D16-1 to C16-1 to B16-1 to A16-1.
Connect D5-16 to C5-16 to B5-16 to A5-16.
Connect D5-15 to C5-15 to B5-15 to A5-15.
Connect D5-14 to C5-14 to B5-14 to A5-14.

17. Daisy chain memory WRITE signal:
Connect D16-3 to C16-3 to B16-3 to A16-3.

18. Daisy chain Data In:
Connect D16-11 to C16-11 to B16-11 to A16-11.
Connect D15-11 to C15-11 to B15-11 to A15-11.
Connect D14-11 to C14-11 to B14-11 to A14-11.
Connect D13-11 to C13-11 to B13-11 to A13-11.
Connect D12-11 to C12-11 to B12-11 to A12-11.
Connect D11-11 to C11-11 to B11-11 to A11-11.
Connect D10-11 to C10-11 to B10-11 to A10-11.
Connect D9-11 to C9-11 to B9-11 to A9-11.
Connect D8-11 to C8-11 to B8-11 to A8-11.
Connect D7-11 to C7-11 to B7-11 to A7-11.
Connect D6-11 to C6-11 to B6-11 to A6-11.
Connect D5-11 to C5-11 to B5-11 to A5-11.

19. Daisy chain Data Out:
Connect D16-12 to C16-12 to B16-12 to A16-12.
Connect D15-12 to C15-12 to B15-12 to A15-12.
Connect D14-12 to C14-12 to B14-12 to A14-12.
Connect D13-12 to C13-12 to B13-12 to A13-12.
Connect D12-12 to C12-12 to B12-12 to A12-12.
Connect D11-12 to C11-12 to B11-12 to A11-12.
Connect D10-12 to C10-12 to B10-12 to A10-12.
Connect D9-12 to C9-12 to B9-12 to A9-12.
Connect D8-12 to C8-12 to B8-12 to A8-12.
Connect D7-12 to C7-12 to B7-12 to A7-12.
Connect D6-12 to C6-12 to B6-12 to A6-12.
Connect D5-12 to C5-12 to B5-12 to A5-12.

20. Insert 2102 chips in the 36 memory sockets.

21. Material required:
To convert 16 words to 1K:
2 270 pf capacitors;
2 18K, ¼watt resistors;
2 1800 ohm, ¼watt resistors;
12 Intel 2102 memory chips, or equivalent;
1 Fairchild 9602 Dual Retriggerable Resettable Monostable Multivibrator;
13 16 pin wirewrap sockets.

To add an additional 3K of memory:
36 16 pin wirewrap sockets
1 SN 7442, 4 line to 10 line Decoder, BCD to Decimal;
36 Intel 2102 memory chips, or equivalent.

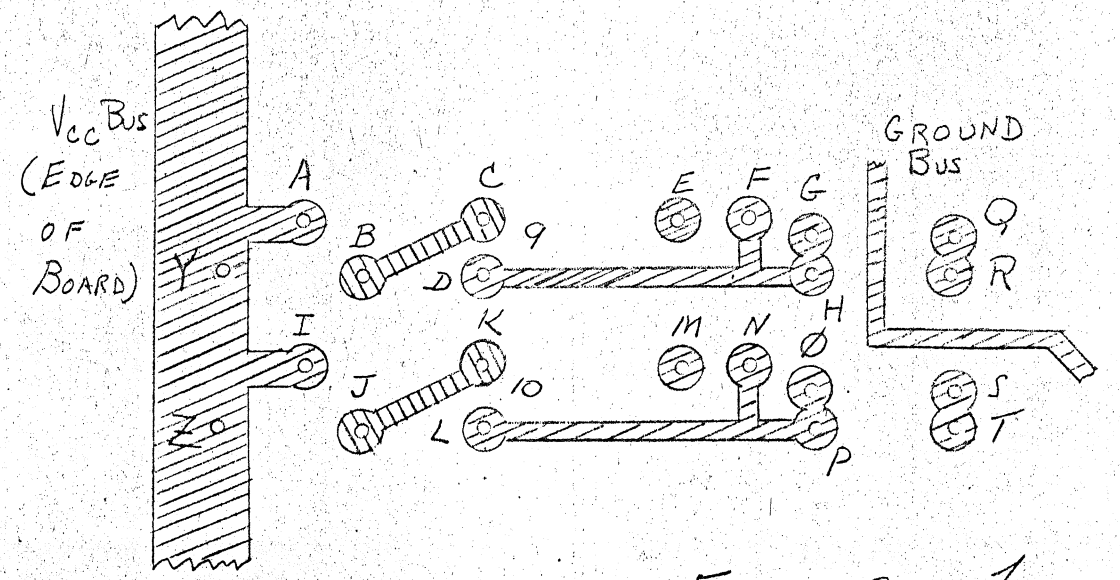

FIGURE 1

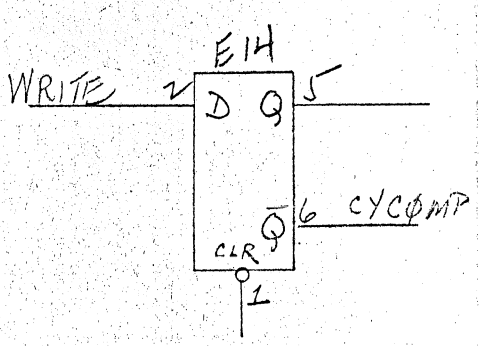

FIGURE 2

ORIGINAL
CYCOMP
SCHEME

Wiring Info

Magnifying hood:
Edmund Scientific 70697 (2½ X, 4"working distance) (for example) $13.75

Soldered logic probe:
T.I. Instruments LT-2 Tester about 28.00

Lab logic probe and pulser:
Hewlett-Packard 10525T probe about 90.00
10526T pulser about 90.00
10525-60015 pulse memory box about 20.00

Pliers and dikes:
Sears 9HT45924 Needle nose pliers 7 oz. 5.97
9HT45904 Diagonal Cutters 7 oz. 6.37
9HT45946 Very long nose pliers 8 oz. 5.97

Wire wrap tools:
OK Machine and Tool Co., Bronx, N.Y.
UW-093R Unwrap tool, 24-32 ga., LH, .040" hole 4.90
OK-3907-30 Cut/strip tool 7.25
OK-3907-30B Replacement blade 2.75

Gardner-Denver
A-20557-29 Wire wrap tool, 30 ga., .040" hole about 25.00
(Winkel says that .040" hole is important to save wear on pin edges. OK M&T Co. has .036" hole.)

Intel 2102 memory chips:
Advanced Micro Devices AM9102A in 100's 2.79
(equivalent to 2102 but cheaper and a bit faster) in 1000's 2.50

IC puller:
Vector P150 DIP hand extraction tool (catalog p IVA-9) 2.09

Stake pins:
Vector T44 miniwrap terminal 100: 2.96
(200 should be ample) 1000: 21.48

Solder tip IC connector:
Circuit Assembly Corp. (see address below)
CA-16P-00 16 pin solder tip plug

Wire:
Wirenetics 13161 Sherman Way, Bldg B, N. Hollywood, CA 91605
KY-30-130-9 30 ga. white, 500 ft. spools 1000 ft.: 7.15
KY-30-130-0 black
(apparently, price is same for any spooling (500', 200', etc). I have not seen their catalog, so I would suggest calling them up. Winkel says they are about half the price of most places).

Sockets:
Circuit Assembly Corp. 3169 Red Hill Av., Costa Mesa, CA 92626 (714)540-5490
CA-14S-103WW 14 pin DIP socket, 3 wire wrap, gold plate maybe .40
CA-16S-103WW 16 " " .40
CA-24S-103WW 24 " " .50
CA-40S-103WW 40 " " .80
(Tin plate instead of gold is okay; check current price to see if difference for gold is worth it. To order tin plate, change the "10" in order number to a "T".)

FIGURE 3

NOTE: MBO AND MO ARE TIED ONLY TO THE FOUR 2102's SHOWN. THE LOWER ORDER BITS OF MA (10 OF THEM) ARE TIED TO ALL 2102's.