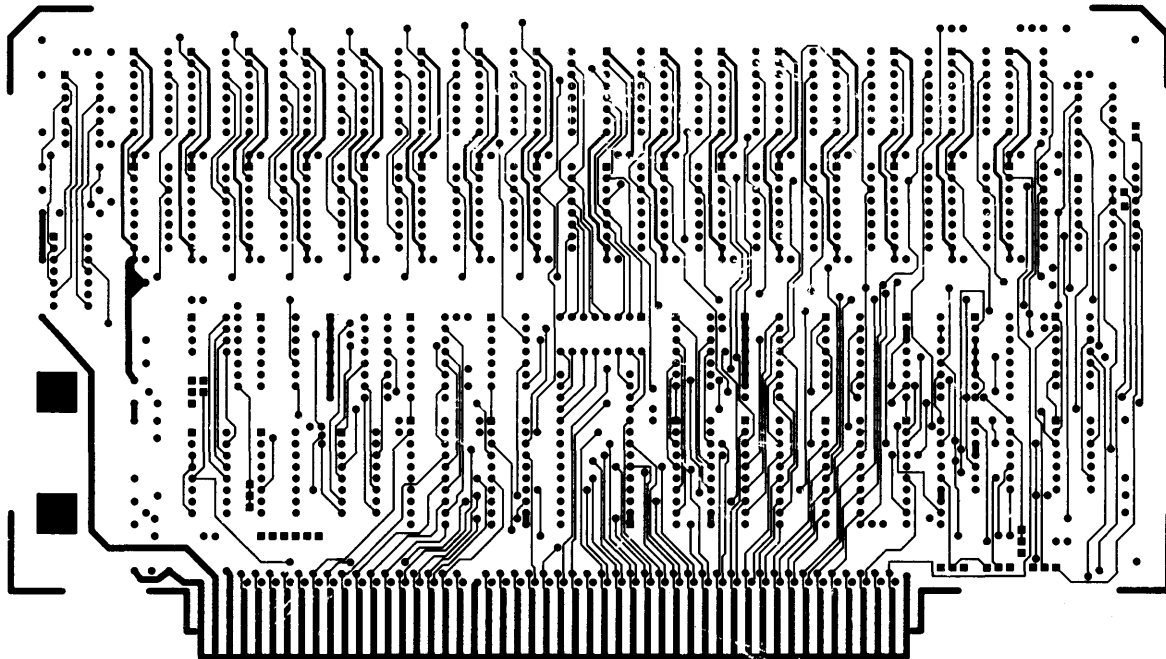


64K-DQ

OPERATION MANUAL



- FULLY BANK SELECTABLE
- I.O. PORT 40 (CROMEN CO) COMPATIBLE BANK SELECT
- DISABLE ON 16K BOUNDRIES
- ON BOARD REFRESH
- DMA COMPATIBLE
- EXTENDED ADDRESS LINES A16, A17, A18, A19
- FOUR LAYER CONSTRUCTION SUPER QUIET
- IEEE S-100

DELTA PRODUCTS

15392 Assembly Ln.,
Huntington Beach, CA 92649
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DEALER:

Telex: 681-367 DELTMAR HTBH

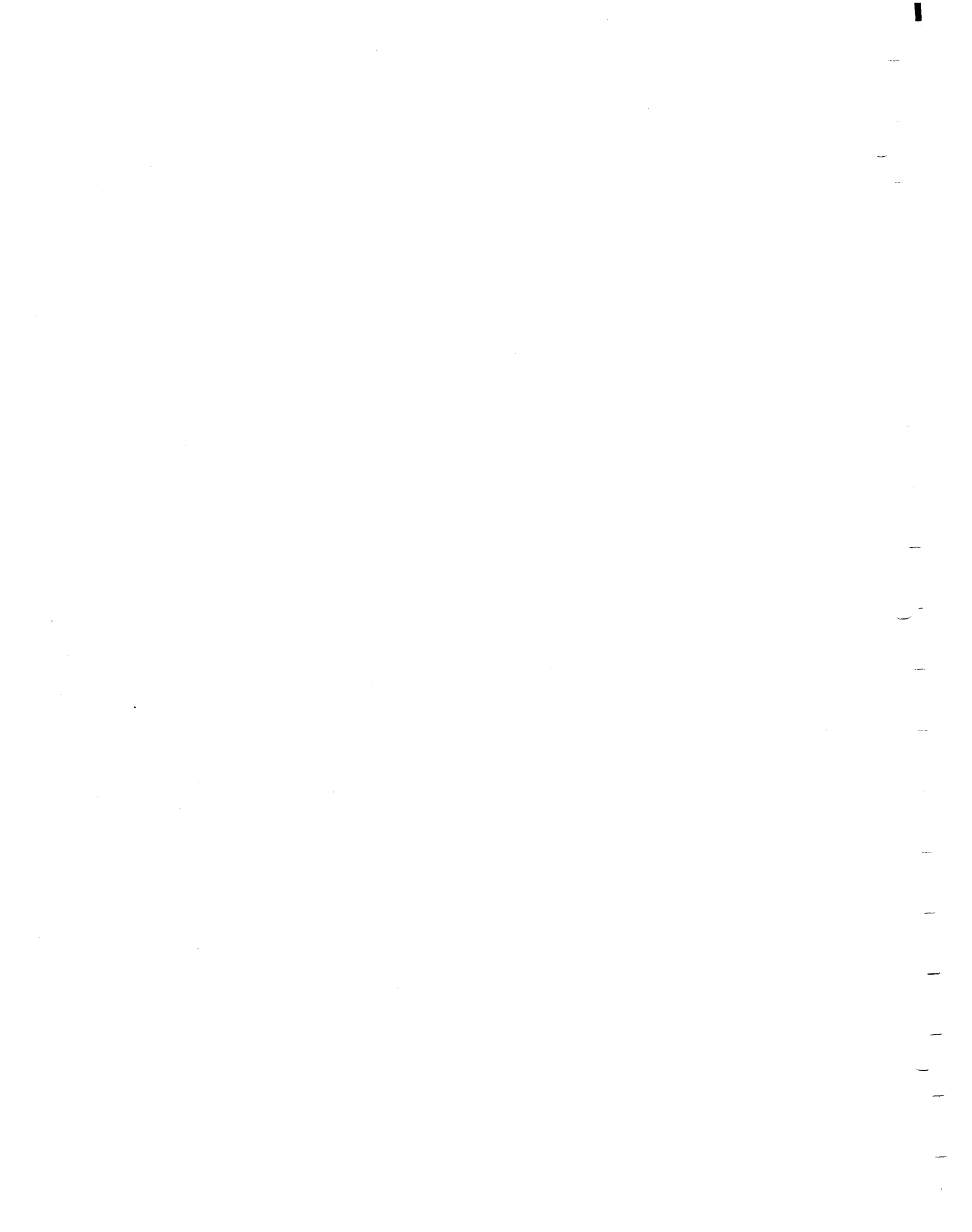


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EXAMPLES:

	off	on	off	on	off	on	off	on
A16---		X	X			X	X	
A17---		X		X	X		X	
A18---		X		X		X		X
A19---		X		X		X		X
A20---		X		X		X		X
A21---		X		X		X		X
A22---		X		X		X		X
A23---		X		X		X		X
	0-64K		64K-128K		128K-192K		292K-256K	

 | NOTE: To enable extended address mode, |
 | Jumper T-S must be removed and |
Jumper E-B must be removed.

BANK DISABLE *****

This board is configured as 4 contiguous 16K memory banks. The banks are clearly marked BANK 0,1,2,3, on the artwork. Any 16K cell may be removed from responding when the rest of the board is selected by the appropriate setting of the bits on switch SW#. Bit switch 1 corresponds with bank number 3 (highest 16K) and switch number 2 is for the next lower bank.

EXAMPLES:

off	on	off	on	off	on	off	on
	X	X			X		X
	X		X	X			X
	X		X		X	X	
	X		X		X	X	
ALL BANKS ENABLED		48K-64K DIS-ABLED		32K-48K DIS-ABLED		0K-32K DIS-ABLED	

PHANTOM LINE *****

All memory banks will become disabled when S-100 bus pin 67 is pulled low. To disable this feature, cut the trace between F - H.

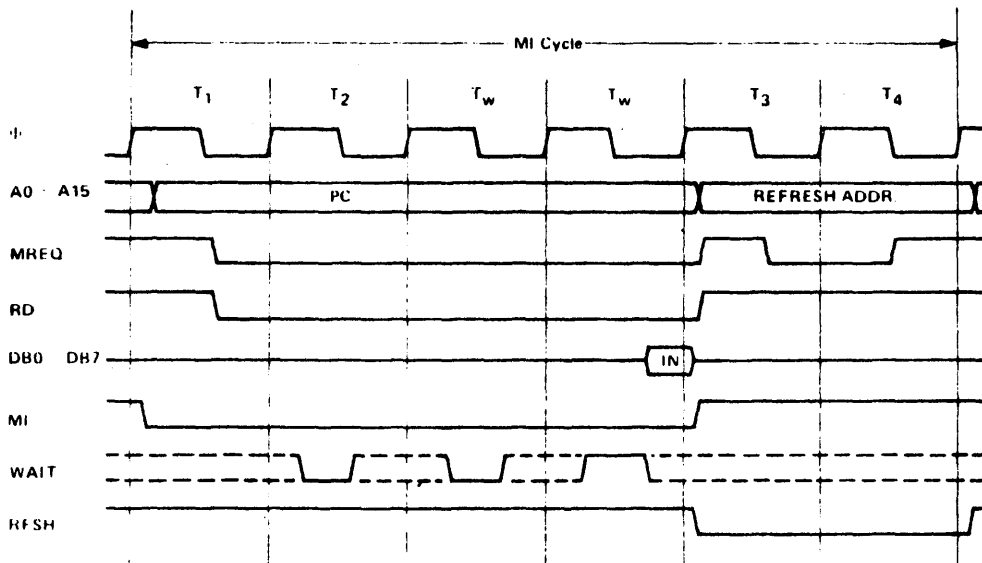
M-1 WAIT STATE GENERATION *****

In normal operation with a Z-80 CPU, no wait states will be generated.

There are certain asynchronous events that can cause the on board refresh circuitry to take over the job of periodically refreshing the dynamic memory chips. (i.e. DMA disk reads or other bus requests, or extended waits.)

When normal operation is resumed, (re-synchronization) a wait state may be automatically injected if the CPU should do a memory read while the board refresh circuitry is in midstate of a refresh cycle.

For further details of on/off board refresh timing, see theory of design and operation.



INSTRUCTION OP CODE FETCH WITH WAIT STATES

REFRESH CYCLE *****

A dynamic memory cell must be refreshed every 2ms. If not, the data bit in that cell will be lost. Refreshing a memory cell in a 4116 compatible RAM is done by placing the row address of the cell on the address inputs of the memory chip and pulsing the row address strobe (ras). Actually 128 cells are addressed and refreshed by one row address. There are 128 rows that must be refreshed, therefore a refresh cycle must occur every 2ms/128 or 15.6 us.

64K REFRESH CYCLE USING Z-80 TIMING *****

The Z80 CPU provides a time period for refresh cycles, (so that wait states are not needed) refresh pulse and a 7 bit refresh address after every instruction op code fetch (M1 cycle). The 64KDQ memory uses the timing and refresh pulses provided by the Z80 for its refresh cycles. There must be a connection between the Z80's refresh output and the 64KDQ refresh input (pin 66). The 64KDQ has its own refresh address counter inside the 3242 (IC U18). The refresh address provided by the Z80 CPU is ignored.

The refresh circuit (IC-U2) on the 64KDQ uses the falling edge of phi 2 (Z80 phi not) clock and refresh not to generate one 250 ns (at 4MHZ, 500 ns at 2 MHZ) ras refresh pulse. This pulse will coincide with T4 of the Z80's M1 cycle. At the end of the refresh cycle the on board refresh counter is incremented to the next row to be refreshed.

AUTOMATIC REFRESH CYCLES *****

The Z80 CPU does not always provide refresh cycles within the 15.6 us margin, therefore automatic refresh cycles must be inserted to maintain memory integrity. There are 3 cases where the Z80 may not provide refresh cycles. They are:

- RESET STATE
- WAIT STATE
- DMA CYCLES

The 64KDQ treats reset and wait states in the same way. If a reset or wait state occurs, an interval counter (IC U11) clocked by phi 2 is enabled. If the counter reaches a count of 14, the PRDY line (S-100 pin72) is pulled low by an open collector driver (IC U4). A refresh cycle is done during count 15. At the end of the refresh cycle the PRDY line is released, the refresh address is incremented and the interval counter starts over at zero. This continues until the reset or wait state ends.

NOTE: XRDY (S-100 BUS pin 3) is not monitored by the 64KDQ. If XRDY is pulled low the 64K will forget everything in 2ms.

DMA CYCLE *****

No automatic refresh cycles can occur during a DMA cycle. The current temporary bus master must either provide refresh pulses that are synchronized with phi 2 and that look like the refresh pulses provided by the Z80, or it must release control of the bus back to the Z80 in less than 14 us (DMA cycles must be less than 14 us total). Temporary masters must also provide MREQ on S-100 bus pin 60.

INTERFACING THE 64KDQ TO A CPU *****

The 64KDQ comes jumpered from the factory to run with the XOR CPU. Other Z80 CPU cards must provide, besides the normal S-100 bus signals, memory request/not and refresh cycle not to run with the 64KDQ. These two signals are present on all Z80 CPU chips, but may not be brought out to the S-100 bus. If your CPU does not have these signals you need to find two spare non-inverting buffers and connect the inputs to the Z80 chip pin 19 (MREQ) and pin 28 (RFSH). The buffered MREQ should be connected to S100 bus pin 60. The buffered RFSH should be connected to S100 bus pin 66. Note: you should have good technical experience before attempting to add these modifications to your cpu.

FACTORY INSTALLED JUMPERS *****

JUMPER	INSTALLED	OPEN	FUNCTION IF INSTALLED
B-C		X	NO MEMORY MANAGEMENT
B-E		X	I/O PORT MEMORY MANAGE
S-T	X		ENABLE EXTENDED ADDRESS
F-H	X		ENABLE PHANTOM PIN 67
F-J	X		PULL UP PHANTOM
M-K	X		MREQ NO INVERSION
M-L		X	INVERT MREQ
P-N	X		USE MREQ TO START MEMORY CYCLE
P-R		X	USE MWRT+SMEMR TO START CYCLE
V-U	X		IGNORE A20,21,22,23 ADD LINES
V-W		X	USE ALL EXTENDED ADDRESS LINES
E8-E9	X		RESET I/O PORT LATCH ON PR75
E8-E10		X	RESET I/O PORT LATCH ON SLV 54
E16-E15	X		RFSH NO INVERSION
E16-E14		X	INVERT RFSH
E19-E18	X		RFSH ON PIN 66
E19-E17		X	RFSF ON PIN 66
E22-E21	X		NO INVERSION OF PHI TO COUNTER
E22-E20		X	INVERT PHI 2 TO AUTO RFSH
E23-E20	X		INVERT PHI TO RFSH CYCLE FLOP
E23-E21		X	NO INVERSION OF PHI 2 TO RFSH

64K - DQ PARTS LIST

PART NO.	DESCRIPTION	QTY.	PART NO.	DESCRIPTION	QTY.
I-0000-06	HTSNK-B	2	I-7000-10	ZEN+5.1	1
I-0000-13	NUT 4-40	2	I-7000-54	74S138	1
I-0000-27	SCREW 4-40	2	I-7400-15	4116-200NS	32
I-1000-22	S164KBD	1	I-7400-28	7438	1
I-2000-05	14PSOC	10	I-7400-50	74109	1
I-2000-06	16PSOC	39	I-7400-57	74161	1
I-2000-08	20PSOC	6	I-7400-71	74LS00	1
I-2000-10	28PSOC	1	I-7400-74	74LS04	1
I-3000-11	33 OHM RES	5	I-7400-79	74LS11	1
I-3000-28	10KSIP	3	I-7400-82	74LS85	1
I-3000-51	4DIPSW	1	I-7400-87	74LS74	1
I-3000-54	8DIPSW	2	I-7400-88	74LS85	2
I-3000-58	.1MF50VR	44	I-7401-07	74LS175	1
I-3000-59	1KRESC	1	I-7401-09	74LS244	1
I-3000-68	220RES	1	I-7401-10	74LS240	5
I-3000-81	33R-PAK	1	I-7401-20	3242	1
I-3001-17	4.7MF25VR	10	I-7401-22	74LS30	1
I-7000-02	REG+5	1	I-7401-39	PE21199	1
I-7000-03	REG+12	1			

TROUBLESHOOTING

If the memory board has been in service for some time and a problem with it is suspected, a memory test should be run.

There are many faults that can occur on a memory board. Not all errors can be found by running any single memory test. We have supplied two tests that were created from years of manufacturing experience.

The first test ('MEMTEST') when run in its fundamental mode (executed under CP/M by typing M (cr) then (cr) (cr) in response to the start and stop questions,) will calculate the system size and begin a typical pattern of tests to uncover the most common problems first and the most uncommon ones last.

Typing a 'P' along with the address in the address field will PAUSE the test program after the memory fill passes. After the operator has waited an appropriate amount of time he may hit (cr) to continue the test. This feature will test for the existence of Phantom-bits. These are memory cells that change after being left un-accessed for a period of time. Initiating the test with M<sp>R<cr> will exclude the address and data tests and drop immediately into the random numbers test.

A second test called 'WORM' is designed to find memory cells that cannot stand rapid cycle time demands placed on them by some of the Z80 block move and math routines. While these chips will pass all standard memory tests for hours on end, they randomly fail during program execution time for seemingly unexplained reasons. The reason is that there is a difference between a chips ACCESS time and its CYCLE time. We generally only rate a memory board by its access time, (i.e. 450ns or 250ns.)

Worm starts itself at the load address and relocates itself repeatedly, reporting its current location periodically. It 'tests' by simply moving itself and constantly doing instruction fetches. A RAM failure is evidenced by the program crashing. The last reported address on the CRT should be interpreted to be the bank in which the errant chip resides. Binary replacing of chips, one half at a time, watching to see when the problem moves to the new bank, will uncover the bad device.

S100 BUS LINE ASSIGNMENTS

X=Recommended lines
to terminate

LINE	NAME	TYPE	POLARITY	LINE	NAME	TYPE	POLARITY
1	+8	BUS		51	+8	B	
2	+15	B		52	-15	B	
3	XRDY	B	P	53	GND	B	
4	V10	SLAVE	N	54	SLV/CLR	B	N
5	V11	S	N	55	DMA0	M	N
6	V12	S	N	56	DMA1	M	N
7	V13	S	N	57	DMA2	M	N
8	V14	S	N	58	SXTRQ	M	N
9	V15	S	N	59	A19	M	N
10	V16	S	N	60	SIXTN	S	N
11	V17	S	N	61	A20	M	P
12	NMI	S	N	62	A21	M	P
13	PWRFAIL	B	N	63	A22	M	P
14	DMA3	MASTER	N	64	A23	M	P
15	A18	M	P	65	MRQ	TTL	
16	A16	M	P	66	REFRESH	TTL	
17	A17	M	P	67	PHANTOM	B	N
18X	STAT DSB	M	N	68X	MWRITE	B	P
19	C/C DSB	M	N	69	RFU		
20	GND	B		70	GND		
21	RFU			71	RFU		
22X	ADD DSB	M	N	72	pRDY	S	P
23X	D0 DSB	M	N	73	pINT	S	N
24X	O2	B	P	74	pHOLD	M	N
25X	pSTVAL	M	N	75	pRESET	B	N
26X	pHLDA	M	P	76X	pSYNC	M	P
27	RFU			77	PWR	M	N
28	RFU			78X	pDBIN	M	P
29X	A5	M	P	79X	A0	M	P
30X	A4	M	P	80X	A1	M	P
31X	A3	M	P	81X	A2	M	P
32X	A15	M	P	82X	A6	M	P
33X	A12	M	P	83X	A7	M	P
34X	A9	M	P	84X	A8	M	P
35X	D01/D1	M,M/S	P	85X	A13	M	P
36X	D00/D0	M,M/S	P	86X	A14	M	P
37X	A10	M	P	87X	A11	M	P
38X	D04/D4	M,M/S	P	88X	D02/D2	M,M/S	P
39X	D05/D5	M,M/S	P	89X	D03/D3	M,M/S	P
40X	D06/D6	M,M/S	P	90X	D07/D7	M,M/S	P
41X	D12/D11	S,M/S	P	91X	D14/D12	S,M/S	P
42X	D13/D11	S,M/S	P	92X	D15/D13	S,M/S	P
43X	D17/D15	S,M/S	P	93X	D16/D14	S,M/S	P
44X	sM1	M	P	94X	D11/D9	S,M/S	P
45X	sOUT	M	P	95X	D10/D8	S,M/S	P
46X	sINP	M	P	96X	sINTA	M	P
47X	sMEMR	M	P	97X	sWO	M	N
48	sHLTA	M	P	98	ERROR	M/S	N
49X	CLOCK	B	N	99	POC		N
50	GND	B		100	GND	B	

RFU = Reserved for future use.

PIN NO.	SIGNAL	POLARITY	DESCRIPTION
1	+8(B)		INSTANTANEOUS MIN GREATER THAN 7 VOLTS BUT LESS THAN 25 VOLTS AVERAGE LESS THAN 11 VOLTS
2	+16(B)		INSTANTANEOUS MIN GREATER THAN 14.5 VOLTS BUT LESS THAN 35 V AVERAGE LESS THAN 21.5 VOLTS
3	XRDY	P	ONE OF TWO READY INPUTS TO THE CURRENT BUS MASTER. THE BUS IS READY WHEN BOTH THESE INPUTS ARE TRUE.
4	<u>V10</u> (S)	N	VECTORED INTERRUPT LINE 0
5	<u>V11</u> (S)	N	VECTORED INTERRUPT LINE 1
6	<u>V12</u> (S)	N	VECTORED INTERRUPT LINE 2
7	<u>V13</u> (S)	N	VECTORED INTERRUPT LINE 3
8	<u>V14</u> (S)	N	VECTORED INTERRUPT LINE 4
9	<u>V15</u> (S)	N	VECTORED INTERRUPT LINE 5
10	<u>V16</u> (S)	N	VECTORED INTERRUPT LINE 6
11	<u>V17</u> (S)	N	VECTORED INTERRUPT LINE 7
12	<u>NMI</u> (S)	N	NON-MASKABLE INTERRUPT
13	<u>PWR FAIL</u> (B)	N	POWER FAIL BUS INTERRUPT
14	<u>DMA3</u> (M)	N	DIRECT MEMORY ACCESS DEVICE ADDRESS AT BIT 3
15	A18 (M)	P	EXTENDED ADDRESS BIT 18
16	A16 (M)	P	EXTENDED ADDRESS BIT 16
17	A17 (M)	P	EXTENDED ADDRESS BIT 17
18	<u>STAT DSB</u> (M)	N	THE CONTROL SIGNAL TO DISABLE THE 9 STATUS SIGNALS
19	<u>C/C DSB</u> (M)	N	THE CONTROL SIGNAL TO DISABLE THE COMMAND/CONTROL SIGNALS.

PIN NO.	SIGNAL	POLARITY	DESCRIPTION
20	GROUND		
21	RFU		
22	<u>ADD DSB (M)</u>	N	THE CONTROL SIGNAL TO DISABLE THE 16 ADDRESS SIGNALS
23	<u>DO/DSB(M)</u>	N	THE CONTROL SIGNAL TO DISABLE THE 8 DATA OUTPUT SIGNALS
24	<u>φ 2 (B)</u>	P	THE MASTER BUS TIMING SIGNAL
25	<u>pSTVAL (M)</u>	N	STATUS VALID STROBE
26	<u>pHLDA (M)</u>	P	A COMMAND CONTROL SIGNAL USED WITH PHOLD TO COORDINATE BUS MASTER TRANSFER OPERATIONS
27	RFU		
28	RFU		
29	A5 (M)	P	ADDRESS BIT 5
30	A4 (M)	P	ADDRESS BIT 4
31	A3 (M)	P	ADDRESS BIT 3
32	A15 (M)	P	ADDRESS BIT 15 (MOST SIGNIFICANT FOR NON-EXTENDED ADDRESSING)
33	A12 (M)	P	ADDRESS BIT 12
34	A9 (M)	P	ADDRESS BIT 9
35	D01 (M)/DATA 1	P	DATA OUT BIT 1
36	D00 (M)/DATA 0	P	DATA OUT BIT 0
37	A10 (M)	P	ADDRESS BIT 10
38	D04 (M)/DATA4	P	DATA OUT BIT 4, BI DATA 4
39	D05 (M)/DATA5	P	DATA OUT BIT 5, BI DATA 5
40	D06 (M)/DATA6	P	DATA OUT BIT 6, BI DATA 6
41	D12 (S)/DATA10	P	DATA IN BIT 2, BI DATA 10

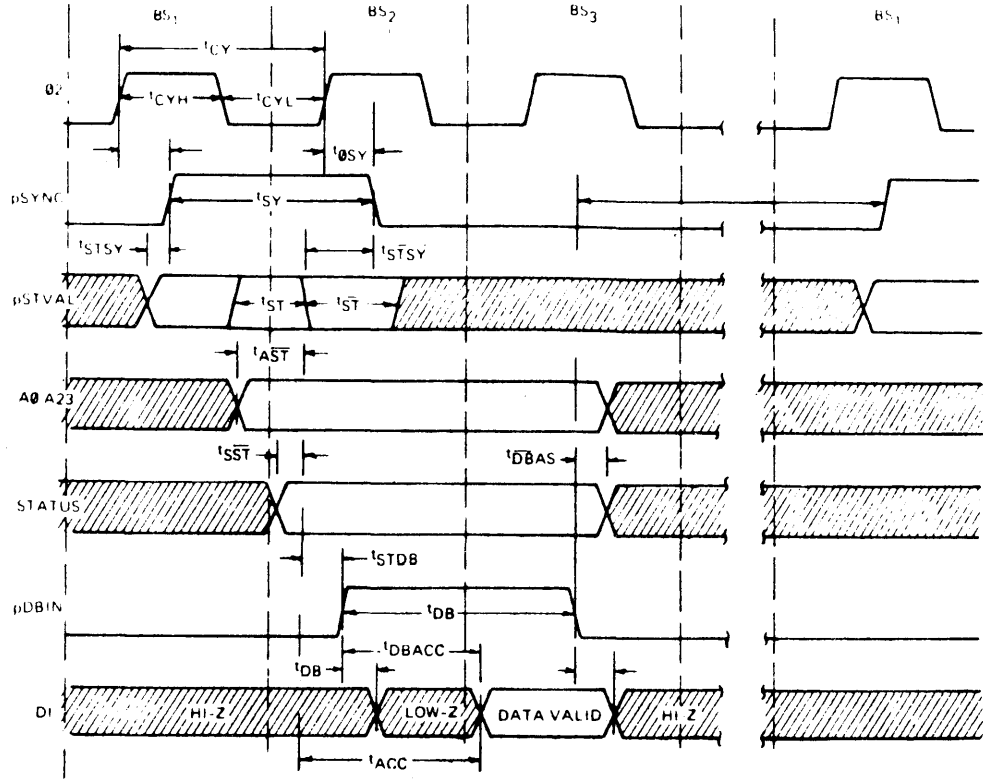
PIN NO.	SIGNAL	POLARITY	DESCRIPTION
42	D13 (S)/DATA11	P	DATA IN BIT 3 BI DATA 11
43	D17 (S)/DATA15	P	DATA IN BIT 7 BI DATA 15
44	sM1 (M)	P	THE STATUS SIGNAL WHICH INDICATES THAT THE CURRENT CYCLE IS IN OP CODE FETCH.
45	sOUT (M)	P	THE STATUS SIGNAL IDENTIFYING THE DATA TRANSFER BUS CYCLE OF AN OUT INSTRUCTION
46	sINP (M)	P	THE STATUS SIGNAL IDENTIFYING THE DATA TRANSFER BUS CYCLE OF AN INPUT INSTRUCTION
47	sMEMR (M)	P	THE STATUS SIGNAL IDENTIFYING BUS CYCLES WHICH TRANSFER DATA FROM MEMORY TO A BUS MASTER WHICH ARE NOT INTERRUPT ACKNOWLEDGE INSTRUCTION FETCH CYCLES.
48	sHLTA (M)		THE STATUS SIGNAL WHICH ACKNOWLEDGES THAT A HLT INST HAS BEEN EXECUTED
49	<u>CLOCK</u> (B)		2MHZ (2%) 40-60 DUTY CYCLE. NOT REQUIRED TO BE SYNCHRONOUS WITH ANY OTHER BUS SIGNAL.
50	GROUND		
51	+8 VOLTS (B)		SEE PIN 1
52	- 16 VOLTS (B)		MAX LESS THAN -14.5 MIN GREATER THAN -35 AVERAGE MIN LESS THAN -21.5
53	GROUND		
54	<u>SLAVE CLR</u> (B)	N	RESET BUS SLAVES. MUST BE ACTIVE WITH POC AND MAY ALSO BE GENERATED BY EXT SIG.
55	<u>DMA0</u> (M)	N	DMA DEVICE ADDRESS BIT 0
56	<u>DMA1</u> (M)	N	DMA DEVICE ADDRESS BIT 1
57	<u>DMA2</u> (M)	N	DMA DEVICE ADDRESS BIT 2

PIN NO.	SIGNAL	POLARITY	DESCRIPTION
58	<u>SXTRQ</u> (M)	N	THE STATUS SIGNAL WHICH REQUESTS 16 BIT SLAVES TO ASSERT SIXTN
59	A19	P	EXTENDED ADDRESS BIT 19
60	<u>SIXTN</u> (S)	N	THE SIGNAL GENERATED BY 16 BIT SLAVES IN RESPONSE TO THE 16 BIT REQUEST SIG SXTRQ
61	A20 (M)	P	EXTENDED ADDRESS BIT 20
62	A21 (M)	P	EXTENDED ADDRESS BIT 21
63	A22 (M)	P	EXTENDED ADDRESS BIT 22
64	A23 (M)	P	EXTENDED ADDRESS BIT 23
65	MRQ		MEMORY REQUEST
66	REFRESH		REFRESH CYCLE
67	<u>PHANTOM</u> (B)	N	A BUS SIGNAL WHICH DISABLES NORMAL SLAVE DEVICES AND ENABLES PHANTOM SLAVES PRIMARILY USED FOR BOOT-STRAPPING SYSTEMS WITHOUT HARDWARE FRONT PANELS
68	MWRITE(B)	P	PWR+sOUT THIS SIGNAL MUST FOLLOW PWR BY NOT NOTE THAN 30 NS.
69	RFU		
70	GND		
71	RFU		
72	PRDY(S)	P	SEE PIN 3
73	<u>PINT</u> (S)	P	THE PRIMARY INTERRUPT REQUEST BUS SIGNAL
74	pHOLD (M)	N	THE COMMAND CONTROL SIG USED WITH PHLDA TO COORDINATE BUS MASTER TRANSFER OPERATIONS.

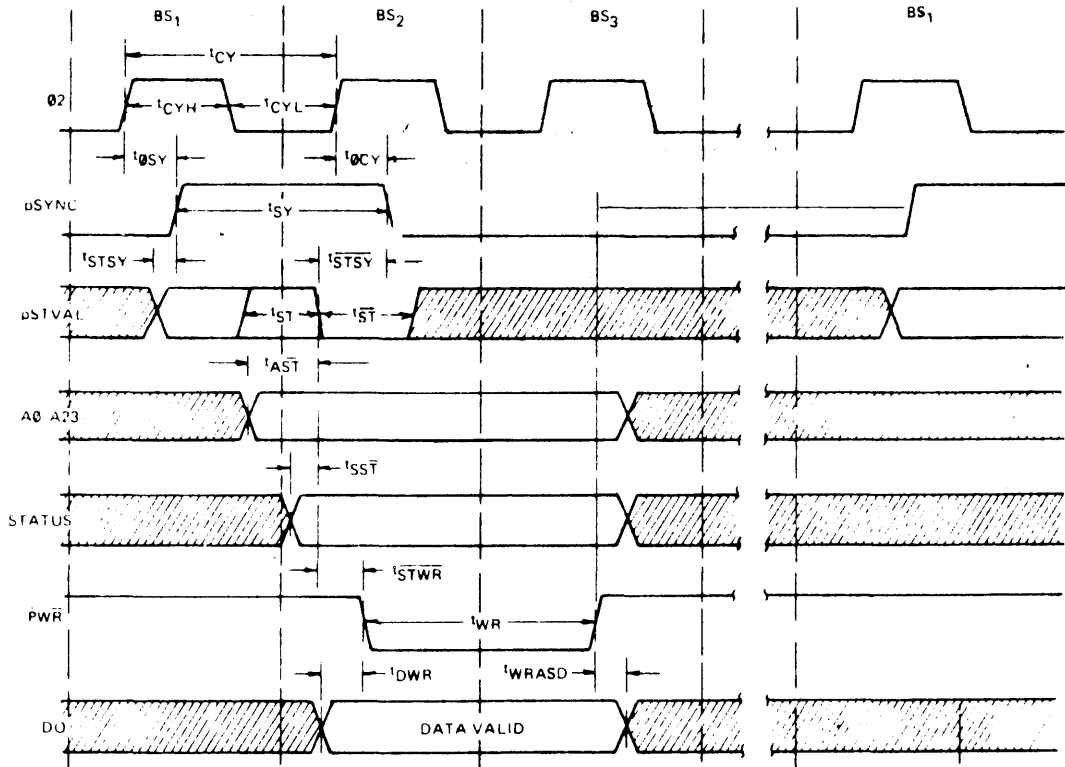
PIN NO.	SIGNAL	POLARITY	DESCRIPTION
75	$\overline{\text{pRESET}}$ (M)	N	THE RESET SIGNAL TO RESET BUS MASTER DEVICES. THIS SIGNAL MUST BE ACTIVE WITH POC AND MAY ALSO BE GENERATED BY EXTERNAL MEANS.
76	pSYNC (M)	P	THE COMMAND CONTROL SIGNAL IDENTIFYING BS
77	$\overline{\text{pWR}}$ (M)	N	THE COMMAND CONTROL SIGNAL SIGNIFYING THE PRESENCE OF VALID DATA ON DO BUS OR DATA BUS
78	pDBIN(M)	P	THE COMMAND CONTROL SIGNAL THAT REQUESTS DATA ON THE D1 BUS OR DATA BUS FROM THE CURRENTLY ADDRESSED SLAVE
79	A0 (M)	P	ADDRESS BIT 0
80	A1 (M)	P	ADDRESS BIT 1
81	A2 (M)	P	ADDRESS BIT 2
82	A6 (M)	P	ADDRESS BIT 6
83	A7 (M)	P	ADDRESS BIT 7
84	A8 (M)	P	ADDRESS BIT 8
85	A13 (M)	P	ADDRESS BIT 13
86	A14 (M)	P	ADDRESS BIT 14
87	A11 (M)	P	ADDRESS BIT 11
88	D02 (M)DATA2	P	DATA OUT 2 BIDATA 2
89	D03 (M)DATA3	P	DATA OUT 3 BIDATA 3
90	D07 (M)DATA7	P	DATA OUT 7 BIDATA 7
91	D14 (M)DATA12	P	DATA IN BIT 4 BIDATA BIT 12
92	D15 (S)DATA13	P	DATA IN BIT 5 BIDATA BIT 13
93	D16 (S)DATA14	P	DATA IN BIT 6 BIDATA BIT 14
94	D11 (S)DATA9	P	DATA IN BIT 1 BIDATA BIT 9

PIN NO.	SIGNAL	POLARITY	DESCRIPTION
95	D10 (S)DATA8	P	DATA IN BIT 0 BIDATA BIT 8
96	sINTA (M)	P	THE STATUS SIGNAL IDENTIFYING THE BUS INPUT CYCLE THAT MAY FOLLOW AN ACCEPTED INTERRUPT REQUEST PRESENTED ON pINT.
97	$\overline{s}W0$ (M)	N	THE STATUS SIGNAL IDENTIFYING A BUS CYCLE WHICH TRANSFERS DATA FROM A BUS MASTER TO A SLAVE
98	\overline{ERROR} (S)	N	THE BUS STATUS SIGNAL SIGNIFYING AN ERROR CONDITION DURING A PRESENT OR PREVIOUS BUS CYCLE.
99	\overline{POC} (B)	N	THE POWER ON CLEAR SIGNAL FOR ALL BUS DEVICES. WHEN THIS SIGNAL GOES LOW, IT MUST STAY LOW FOR AT LEAST 3 BUS STATES.
100	GROUND		

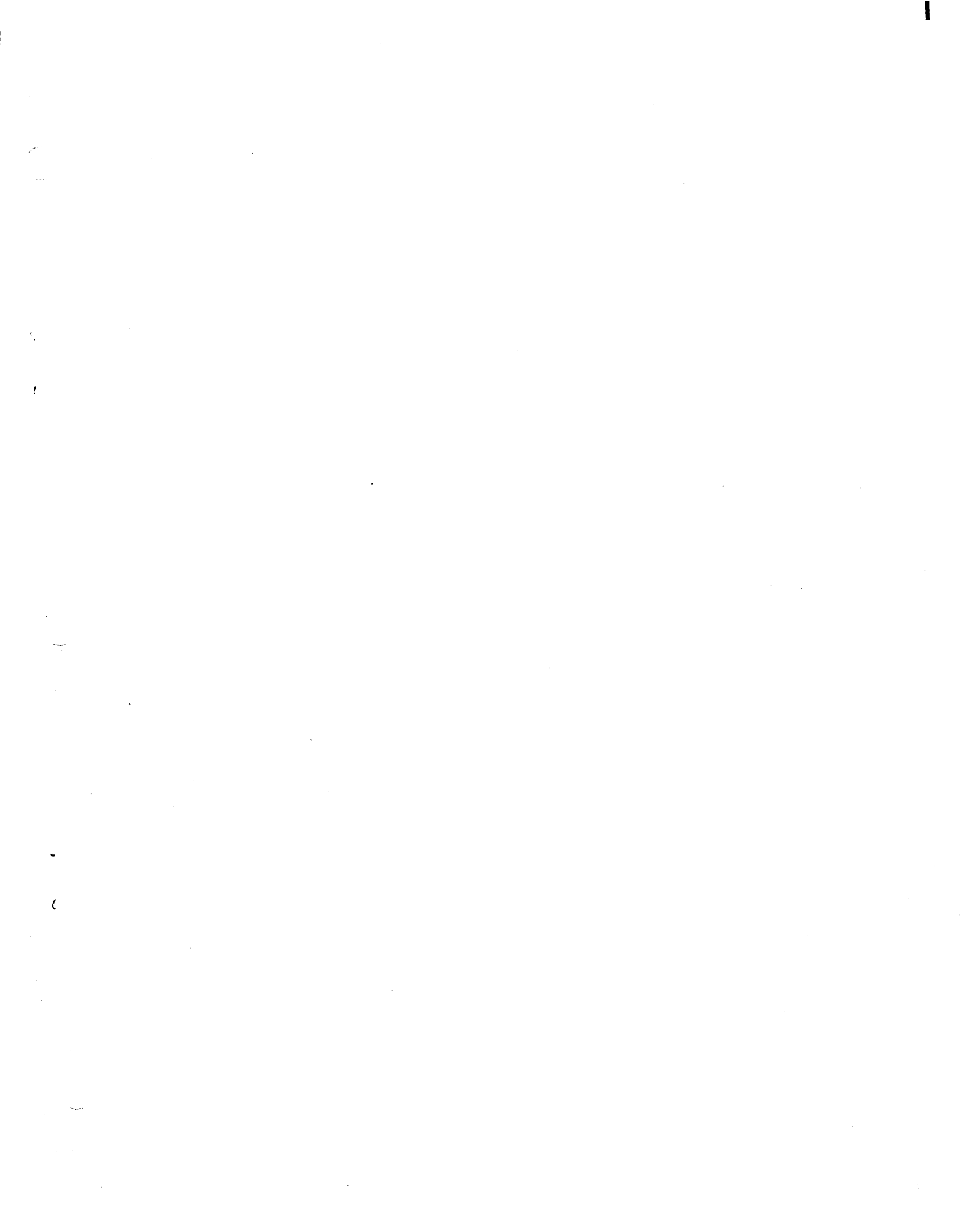
**READ
CYCLE**

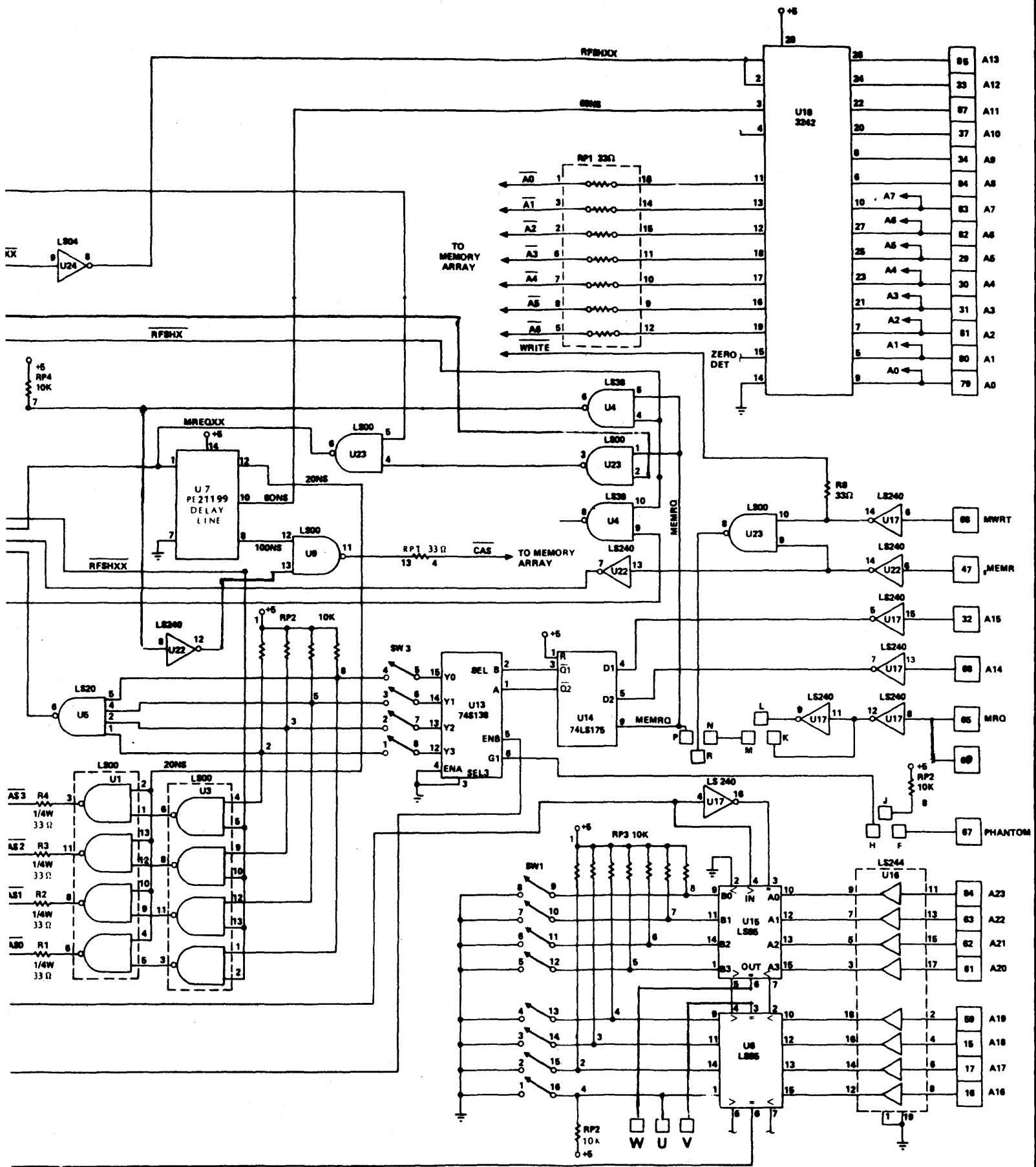


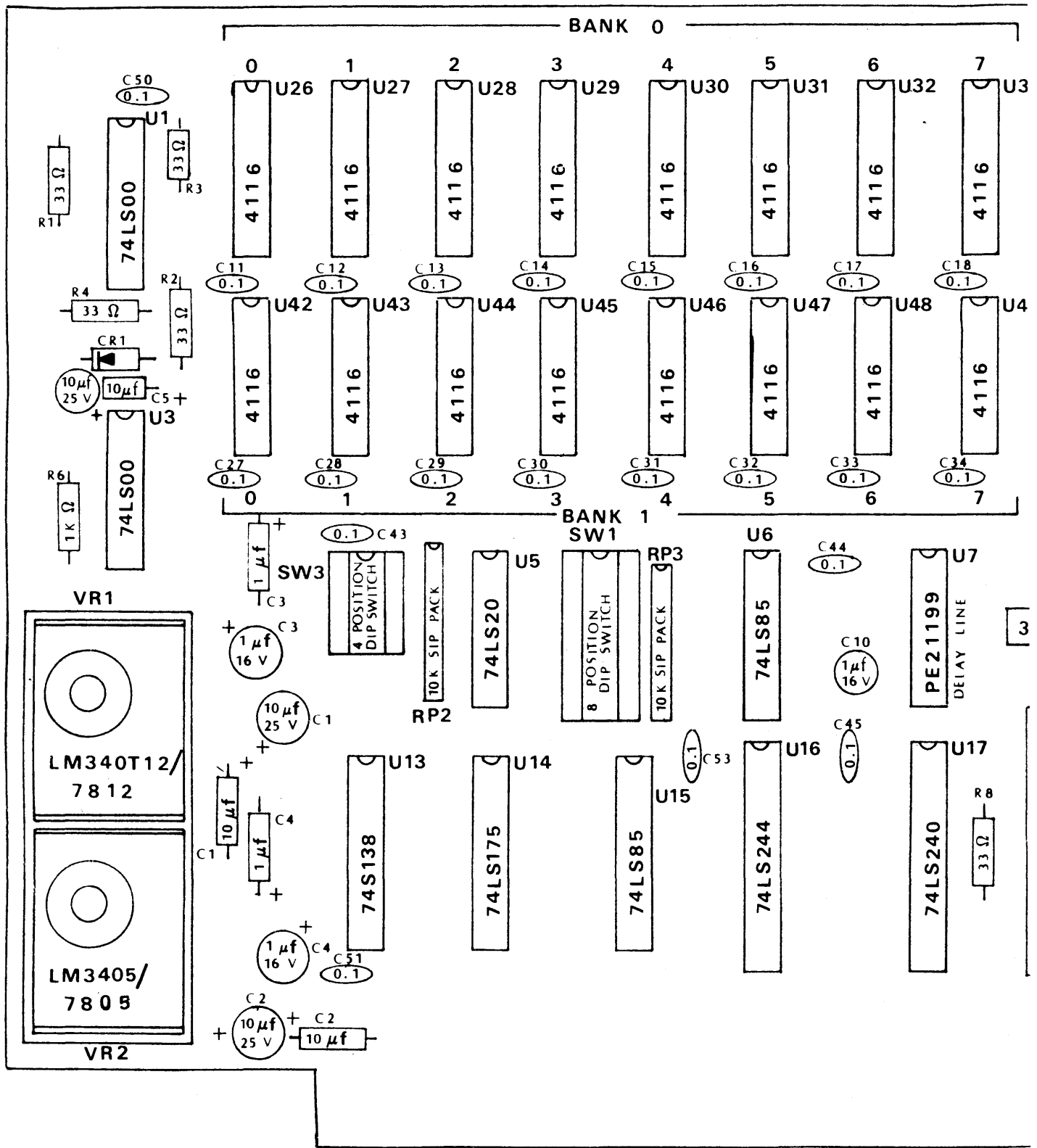
**WRITE
CYCLE**



Timing Diagrams

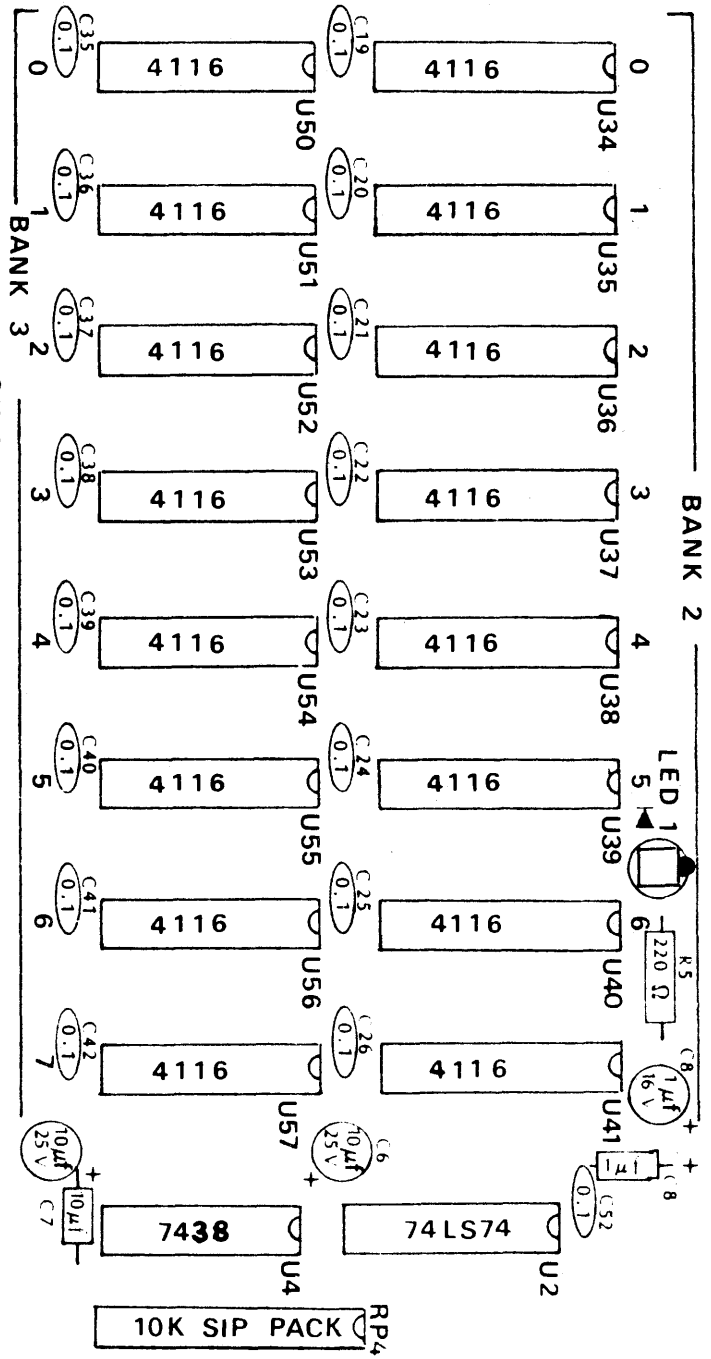






3242
REFRESH CONTROLLER

RP1
10 DIP PACK



BANK 1

BANK 3

