88-16K
STATIC
RAM
CARD

(88-16MCS)

16K STATIC
PARTS LIST
APRIL, 1976

BAG 1

1	7402	101021
1	74L02	101072
1	7406	101054
5	74L04	101073
1	74LS27	101103
1	74LS74	101088
1	74L139/93L21	101138
1	8212	101071
2	8T97/74367/8097	101040
1	7805	101074
1	7812	101085

BAG 2

32	4200	101137

BAG 3

3	33MF 16V	100326
51	.1MF 12V	100348

BAG 4

5	330 Ohm ½W	101926
1	100 Ohm 2W	102009
1	5V Zener	100721

BAG 5

32	22 Pin Socket	102108

BAG 6

2	Heat Sink (Small)	101870
2	Card Guides	101714
1	100 Pin Connector	101864
6	#6-32 x 3/8" Screw	100925
2	#6 Nut	100933
2	#6 Lock Washer	100942
1	24 Pin Socket	102105
1	4-Pos. SPST Dip Switch	102348

MISC.

1	16K Static PC Board	100194
1	16K Static Manual	101565
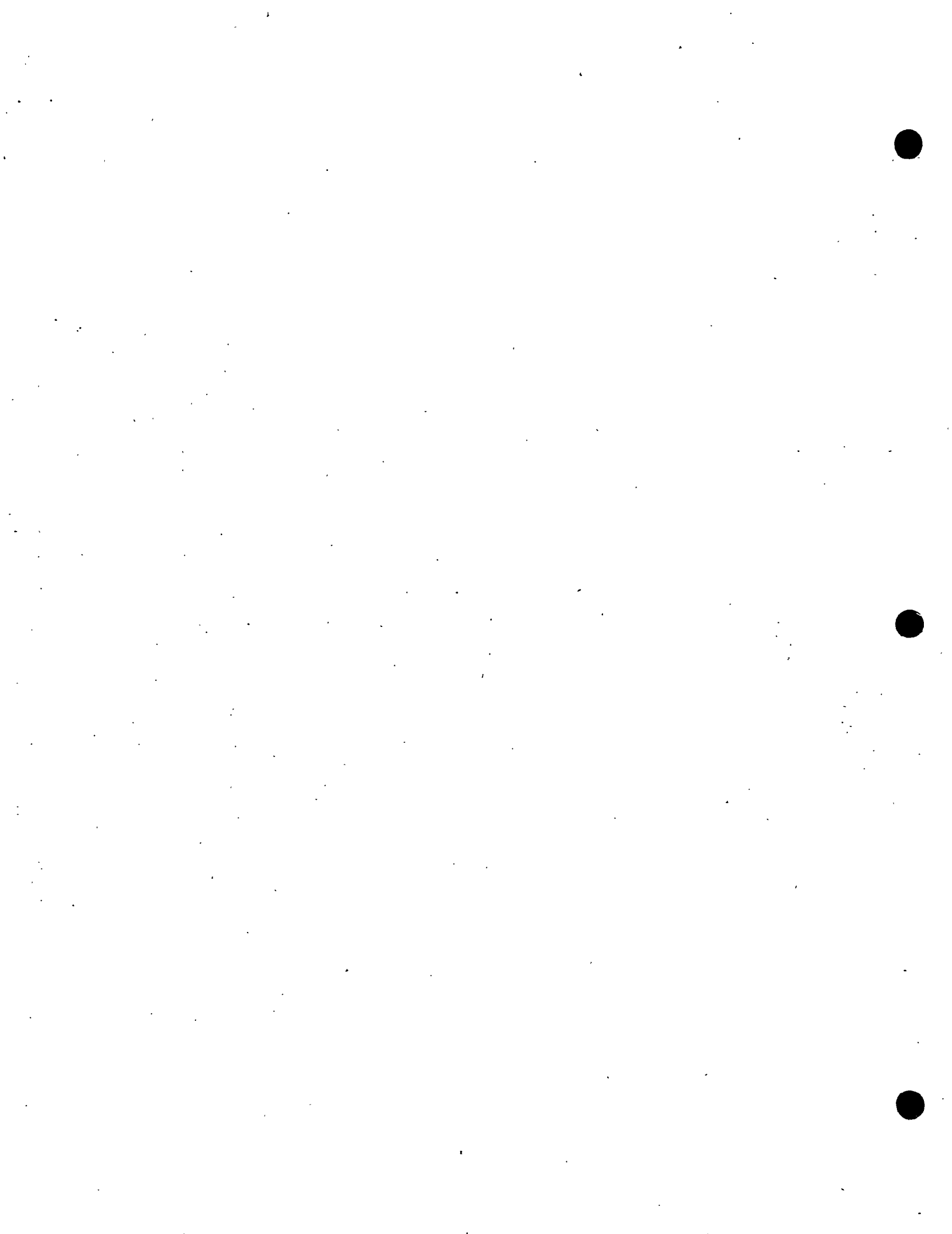
TABLE OF CONTENTS
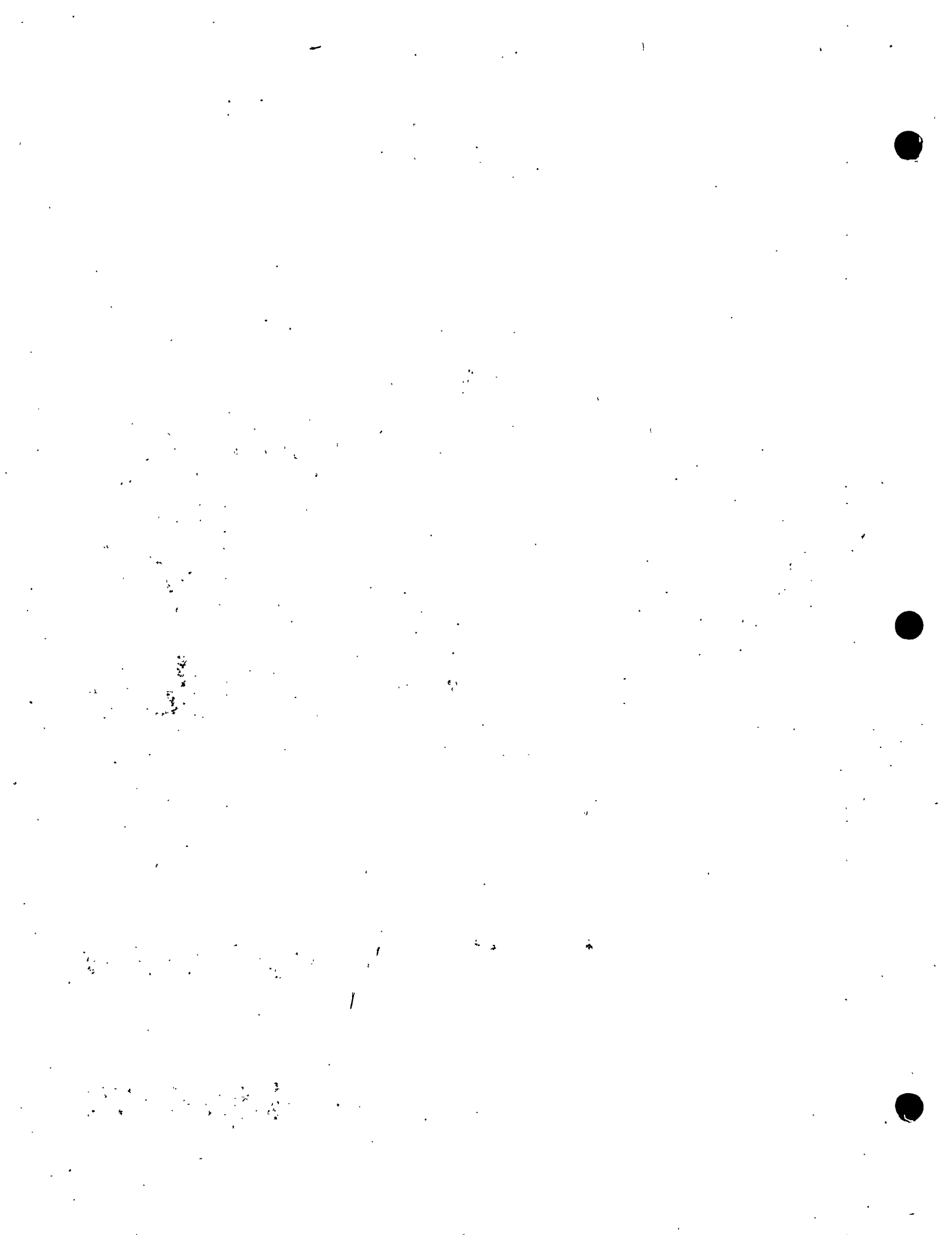
88-16K
STATIC
RAM
CARD

(88-16MCS)

theory of operation

schematics

88-16MCS THEORY OF OPERATION

The 88-16MCS is based around a 4096 X 1 bit static random access
integrated circuit. These RAMs offer the advantage of low power
consumption and extremely fast access time (215 ns.), and also
eliminates the need for the additional refresh logic common to
most dynamic memories.

BOARD/BLOCK SELECT

See Schematic and Timing Diagram at the end of this section.
Since only four 88-16MCS boards are required for the maximum
amount of memory directly accessible by the computer, only the
upper two address bits (A14 and A15) are required to select a
particular board. IC G is a dual 2 to 4 decoder that selects
one of four outputs according to the state of A14 and A15. These
outputs are fed to SW-1, which selects the board through one of
the switches by enabling the input control signals at gates M2,
M10, and N3. This signal is labeled TP1 on the schematic. TP1
enables the remaining 2 to 4 decoder of IC G. This decoder se-
lects one of four 4096-word memory blocks according to address
bits A12 and A13. Thus the upper four address bits select a
single 4K block on a particular 16K card. The remaining twelve
address bits are buffered and inverted through ICs R and T to
select one location within a block.

READ

See timing diagram at the end of this section. When the address
(TP1), PSYNC (M1) and $\overline{D07}$ (H8) are all true (M13, 2 and 1), M12-
K12 cause K9 to go high when Q1 goes high at K11. [During PSYNC
and Q1, D7 is latched on the CPU board and becomes SMEMR on the
system bus. $\overline{D07}$ is used instead of SMEMR at IC K so that the
read status will be valid earlier.] This forces M6 low to par-
tially enable gates F (F3, 6, 9, and 12). One of the four block-
select outputs (G4, 5, 6, or 7) will be low to cause one of the
gates (F) to go active. This provides a $\overline{CS}$ (chip select) signal
through IC E to one of the blocks of eight RAMs for a valid 8-bit
read.

N13 is forced high by M6 to enable data latch IC S at pin 11.
500 nanoseconds after the read sequence begins, Q1 again goes high.
K12 is low at this time, causing K9 to go back low. This forces
$\overline{CS}$ back high (to +12 volts) and S11 low, which latches the data
in IC S. It is necessary to latch the data for display when the
computer is stopped. Continued RAM selection ($\overline{CS}$ = low) is un-
desirable, since the RAMs consume much more power when selected.

The CPU requests data by forcing PDBIN high. When PDBIN, SMEMR
and TP1 are valid (see above) M8 goes high and L2 low (TP3) to
enable the data buss drivers, IC V and W2-3, 4-5 for 500 nanose-
conds (the pulse width of PDBIN). In the stopped mode, the buss
drivers are enabled to display data (PDBIN remains high).

1

WRITE

The MWRITE signal defines that a memory write is taking place.
This signal is a gating of $\overline{PWR}$, the actual write pulse from the
CPU, and $\overline{OUT}$, a signal that defines a memory cycle as opposed to
an output operation. This gating takes place on the C/D board
and MWRITE is brought out to buss line 68.

The MWRITE signal is buffered and inverted through L13-12 to N2
and E3. With TP1 valid at N3, N1 goes high, forcing M6 low.
When M6 goes low, $\overline{CS}$ is forced low as described in the READ sec-
tion.

The R/W (TP4) signal into the RAMs is forced high by E4 and W14-
13 for write operations. When the computer is in the run mode,
the write sequence is active for 500 nanoseconds (the pulse-width
of MWRITE). When the computer is in the stopped mode, a front-
panel deposit occurs for a greater amount of time, defined by the
C/D board deposit logic.

The data presented by the CPU during a write cycle is buffered/
inverted at IC U and H5-6, 9-8. The data is again inverted with-
in the RAMs when accessed during a read so that after two inver-
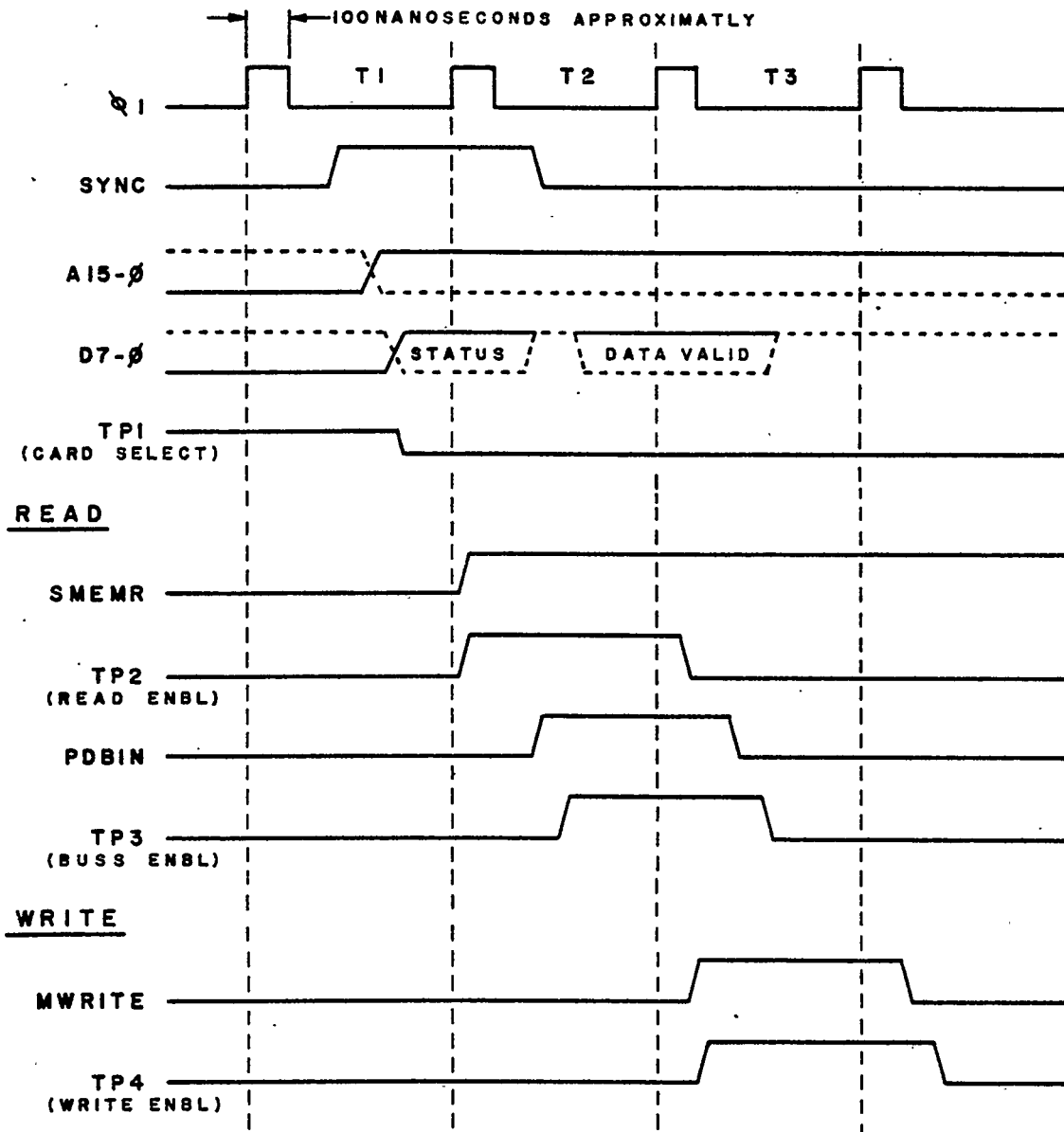sions, the written data equals the read data.

POWER SUPPLY

The unregulated +5 and +V voltages are filtered by C2 and C5
and regulated through VR-2 and VR-1 to produce regulated +5 volts
and +12 volts, respectively. The -V is filtered by C1, fed through
R6, a current limiting resistor, and regulated to -5 volts by
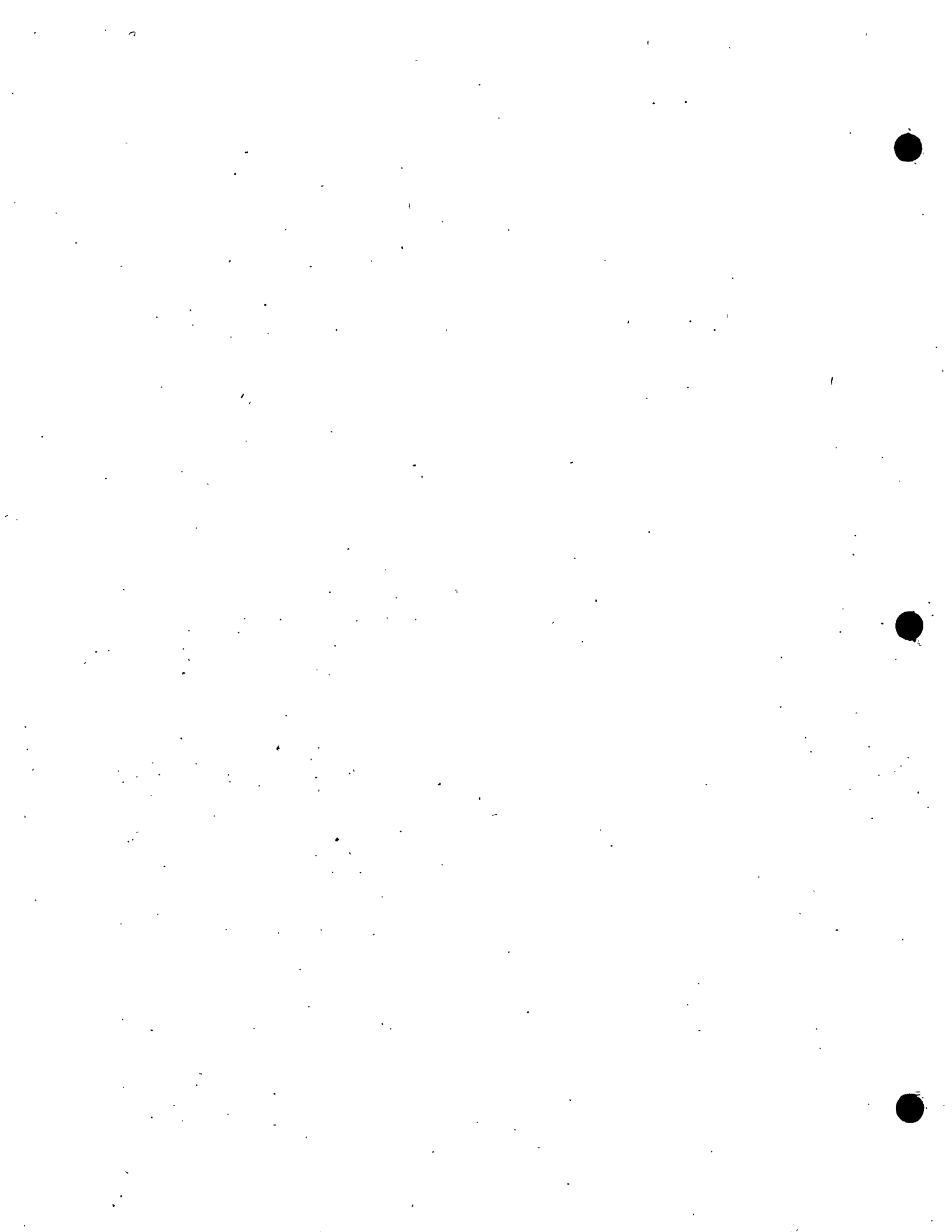zener diode D1.

The remaining .1 µf capacitors are used for noise suppression.
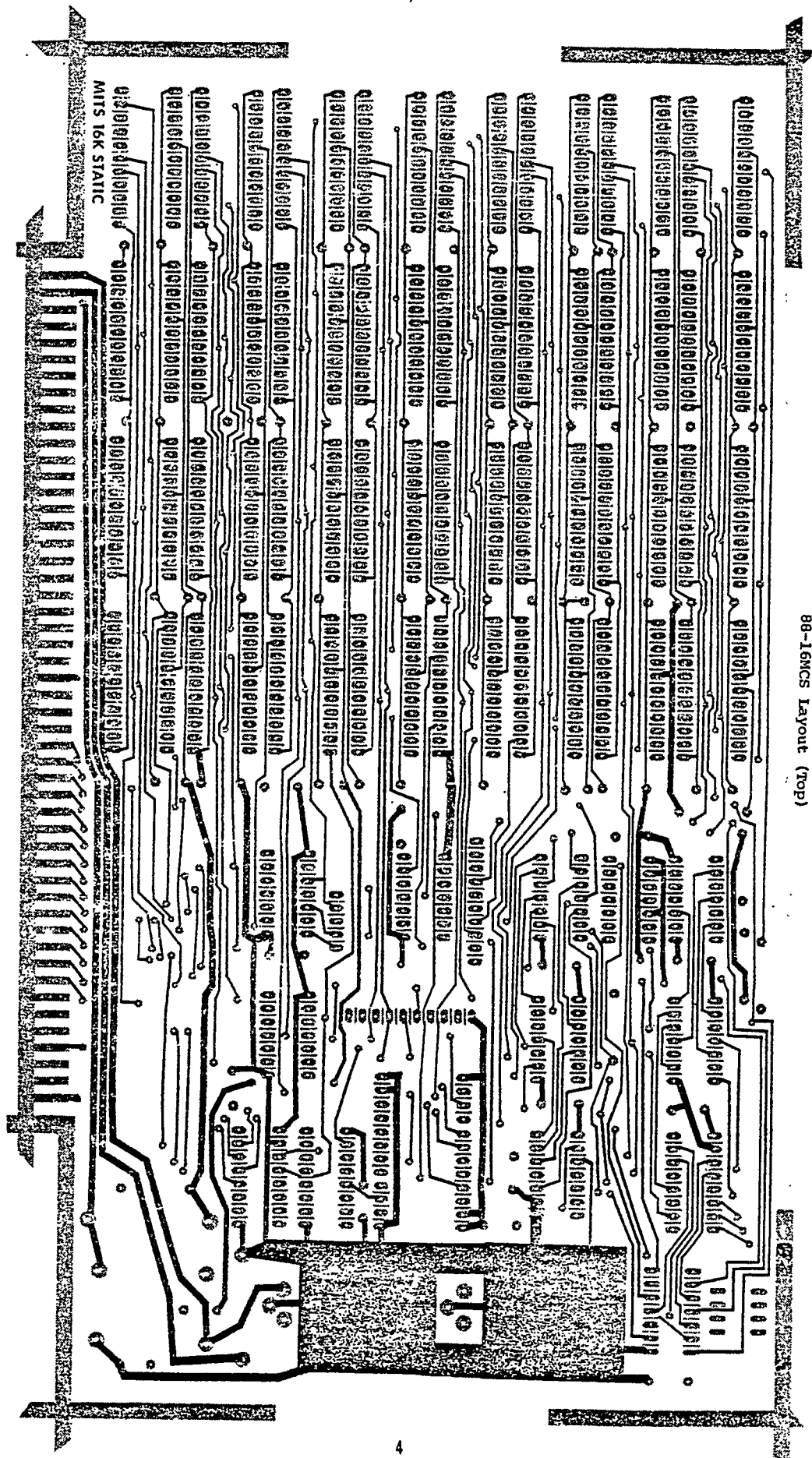The currents drawn from these supplies are listed below:

+5 volts	400 milliamps
+12 volts	160 milliamps
-5 volts	100 milliamps

READ/WRITE TIMING

NOTE: EACH STATE (T1, T2, T3) IS
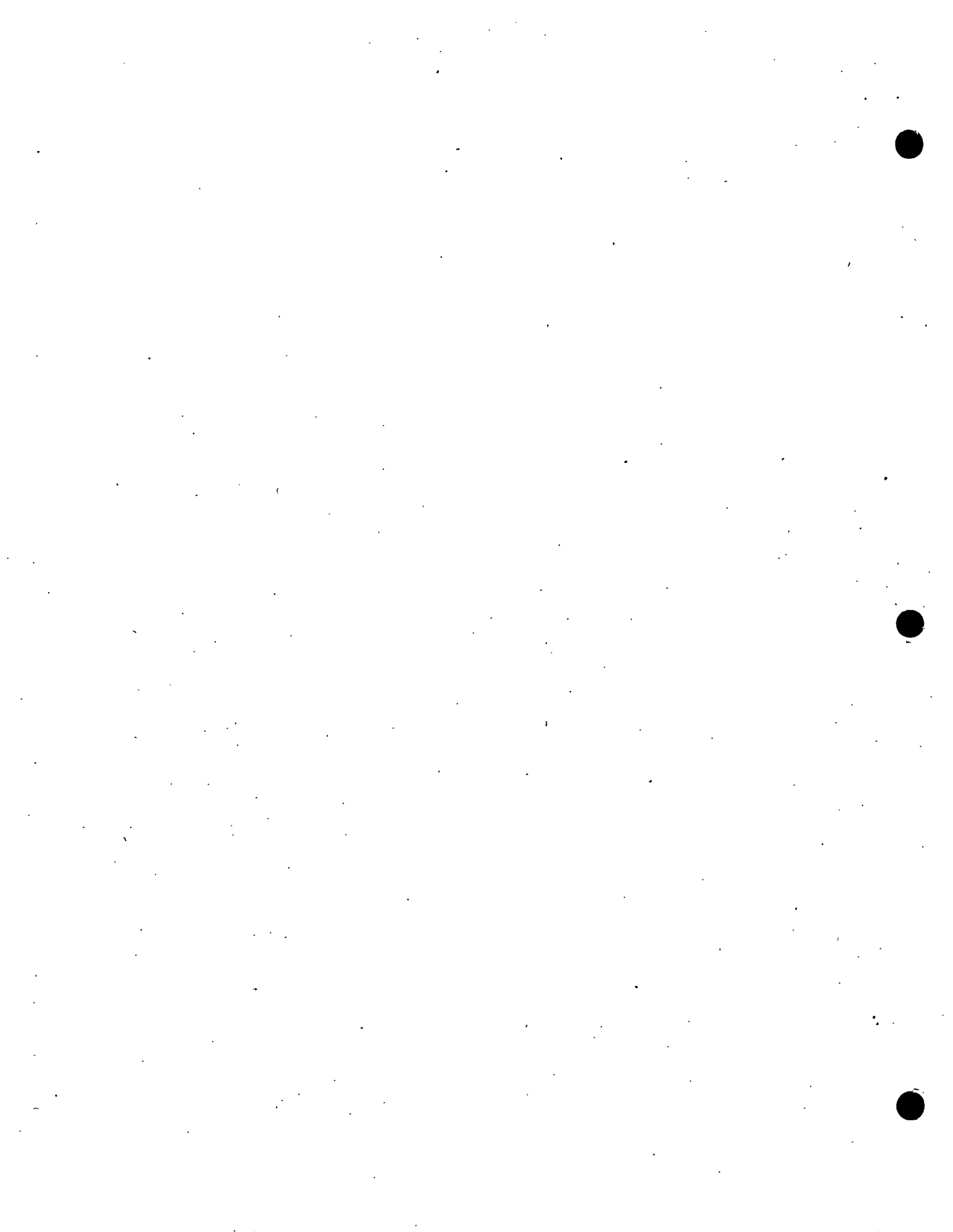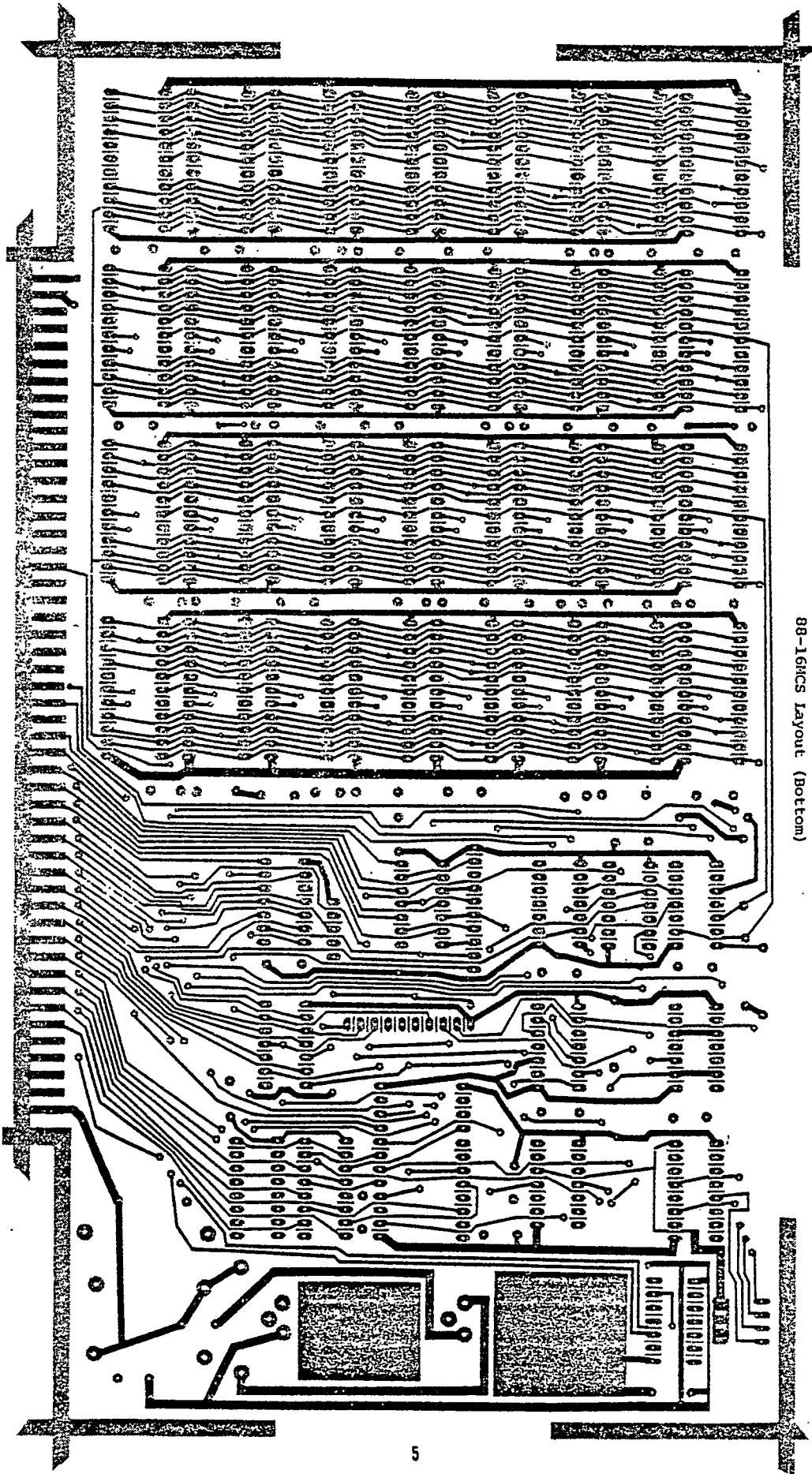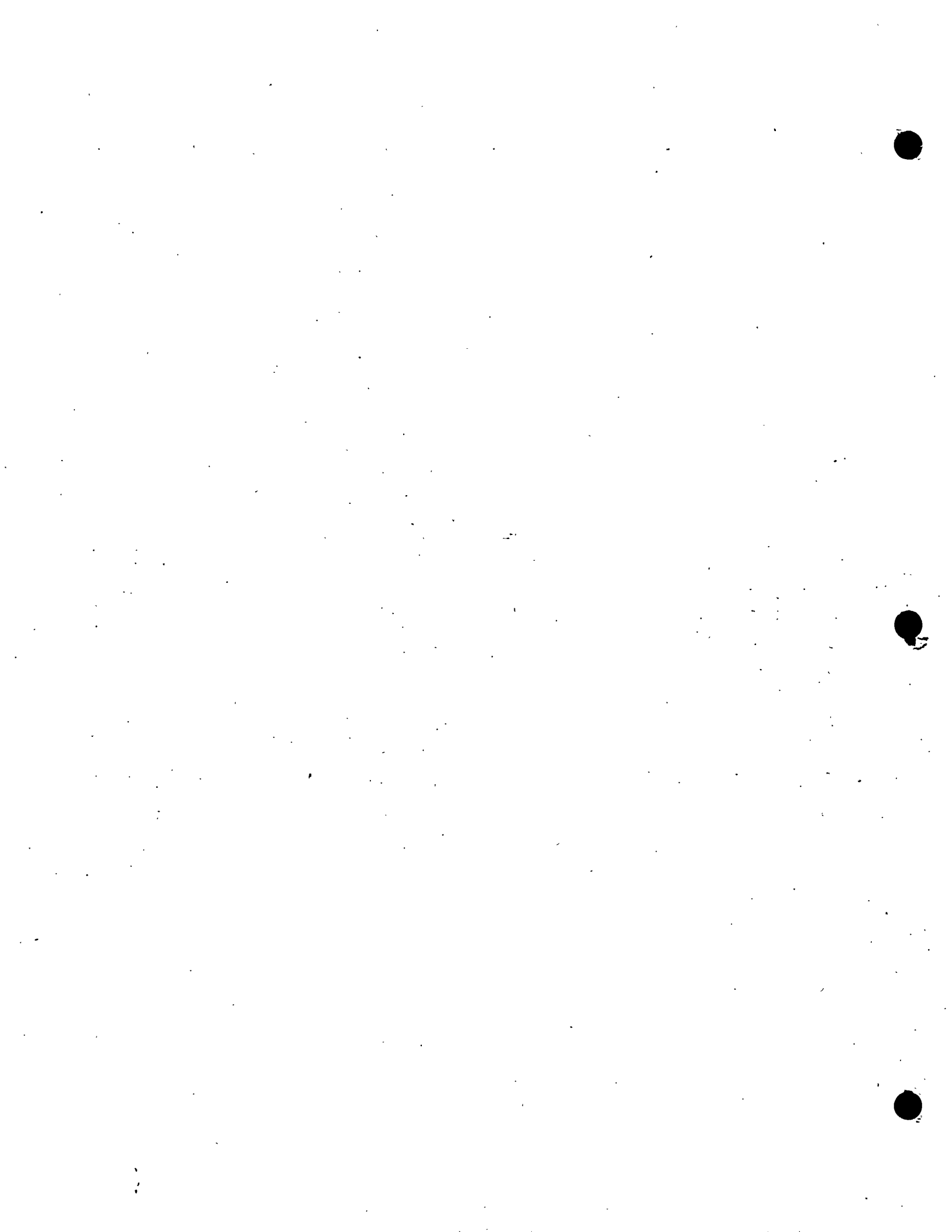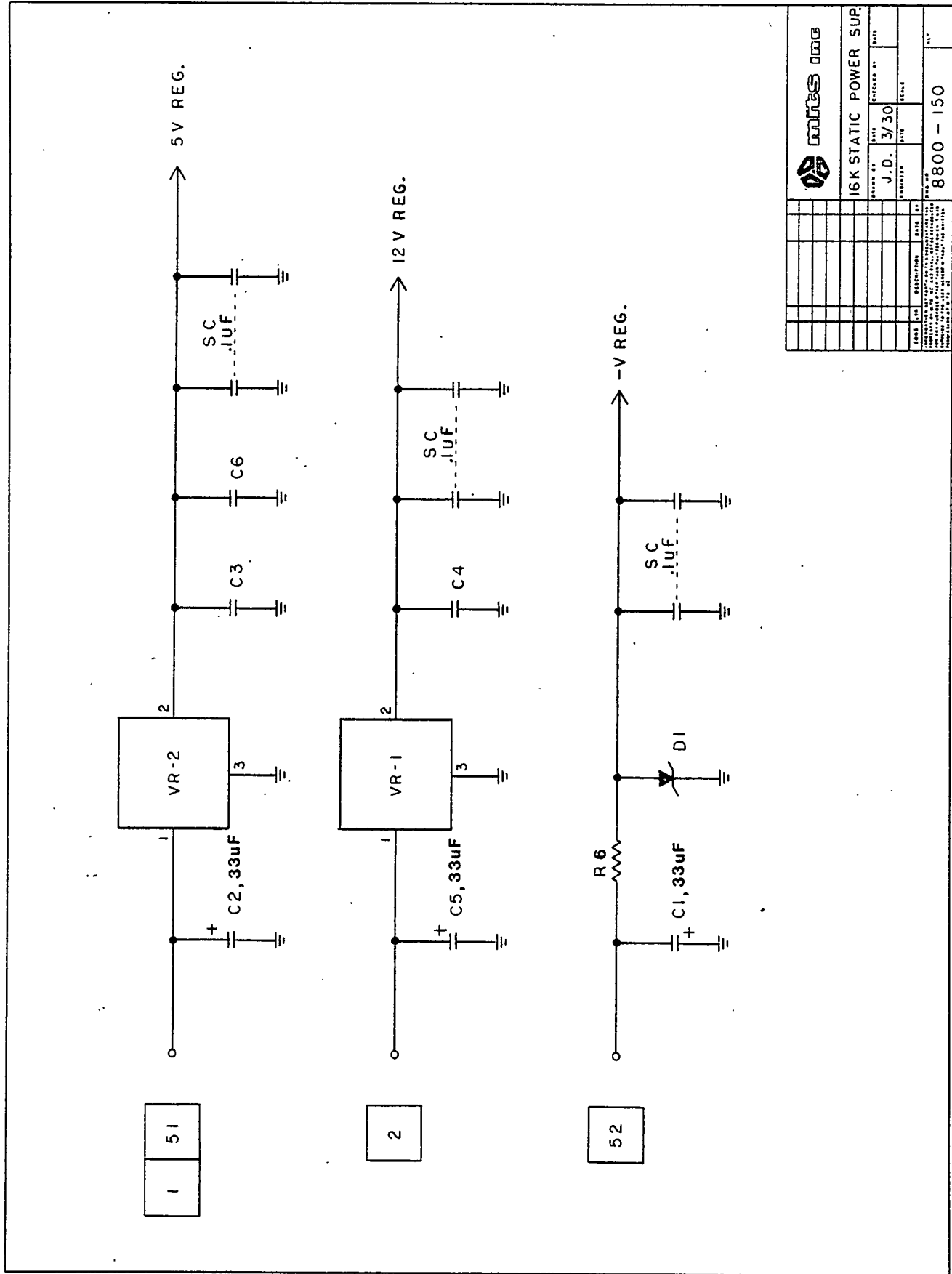APPROXIMATLY 500 NANOSECONDS

3

88-16MCS Layout (Top)

MITS 16K STATIC

4

88-16MCS Layout (Bottom)

5 V REG.

12 V REG.

−V REG.

S C
.IuF

S C
.IuF

S C
.IuF

C6

C3

C4

VR-2

VR-1

2

3

2

3

C2, 33uF

C5, 33uF

R6

D1

C1, 33uF

51

1

2

52

mites inc

16K STATIC POWER SUP.

J.D.   3/30

8800 − 150

BRUNING 44-132 28440

88-16MCS Schematic

QTY	TYPE	VCC	GND	VDD	VBB
A-D	4200	11	22	18	1
E	7406	14	7		
F	74L02	14	7		
G	74L139 9321	16	8		
	74L04	14	7		
K	74L574	14	7		
M	74LS22	14	7		
N	7402	14	7		
S	8212	24	12		
V,W	8T97	16	8		

16K STATIC

J.D.

8800-150

4200 RAMS
AØ-7
BØ-7
CØ-7
DØ-7
SEE 8800-152
FOR DETAILS

DATA OUT

ADDRESS IN

DATA IN

DØØ DØ1 DØ2 DØ3 DØ4 DØ5 DØ6 DØ7

DIØ DI1 DI2 DI3 DI4 DI5 DI6 DI7

AØ A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11

A12 A13 A14 A15

PSYNC
Ø1
MWRITE
SMEMR
PDBIN

CSD CSC CSB CSA R/W

TP1 TP2 TP3 TP4

SW-1

R/W +5V
R5

88-16MCS Scehmatic

INTEGRATED CIRCUITS (IC's) CAN COME WITH ANY ONE OF, OR A COMBINATION OF, SEVERAL DIFFERENT MARKINGS. THESE MARKINGS ARE VERY IMPORTANT IN DETERMINING THE CORRECT ORIENTATION FOR THE IC's WHEN THEY ARE PLACED ON THE PRINTED CIRCUIT BOARDS. REFER TO THE ABOVE DRAWING TO LOCATE PIN 1 OF THE IC's, THEN USE THIS INFORMATION IN CONJUNCTION WITH THE INFORMATION BELOW TO PROPERLY ORIENT EACH IC FOR INSTALLATION.

WARNING: INCORRECTLY ORIENTED IC's MAY CAUSE PERMANENT DAMAGE!
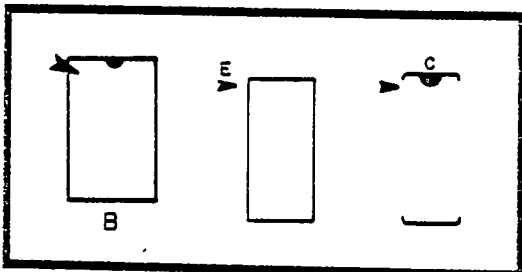
THE DRAWING ON THE LEFT INDICATES VARIOUS METHODS USED TO SHOW THE POSITION OF IC's ON THE PRINTED CIRCUIT BOARDS. THESE ARE SILK-SCREENED DIRECTLY ON THE BOARD. THE ARROWHEAD INDICATES THE POSITION FOR PIN 1 WHEN THE IC IS INSTALLED.

9A

PRINTED CIRCUIT BOARD VISUAL INSPECTION

It is recommended that a visual inspection of the PC Board(s) in your kit be made before beginning the assembly procedures.

Look for etching "bridges" or etching "opens" in the printed circuit lands, as shown in the drawings below:

Example of an
Etching "Bridge"

Example of an
Etching "Open"
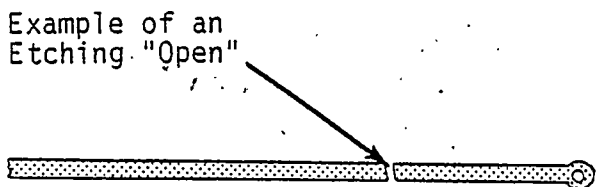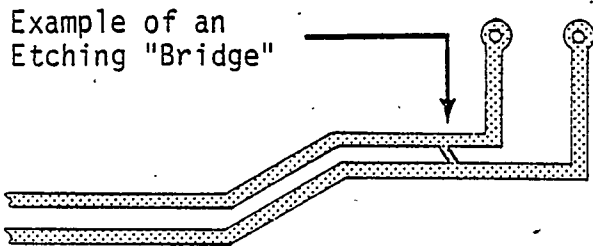
This could also appear as a "hairline" cut.

A thorough visual inspection will eliminate one possibility for errors, should the board not operate properly after it is assembled. Troubleshooting efforts may then be concentrated elsewhere.

88-16K
STATIC
RAM
CARD

(88-16MCS)

assembly procedure

SOCKET AND IC INSTALLATION

There are 32 22-pin sockets to be
installed on the 88-16MCS. Refer-
ring to the component layout on
this page, note rows A, B, C and
D. Install sockets AØ-A7, BØ-B7,
CØ-C7 and DØ-D7 according to the
following instructions.

1. Be certain that the socket
    pins are straight. If any
    of the pins are bent, CARE-
    FULLY straighten them with
    the tip of a small screw-
    driver.

2. Set the socket into place and
    secure it with a piece of
    masking tape.

3. Turn the board over and sol-
    der each pin to the foil pat-
    tern on the back of the board.
    Be sure that EACH pin is sol-
   dered, and be careful not to
    leave any solder bridges.

4. Turn the board over again, and
    remove the masking tape.

SOCKETS	PINS
AØ-A7	22
BØ-B7	22
CØ-C7	22
DØ-D7	22

IC SOCKET

PC BOARD
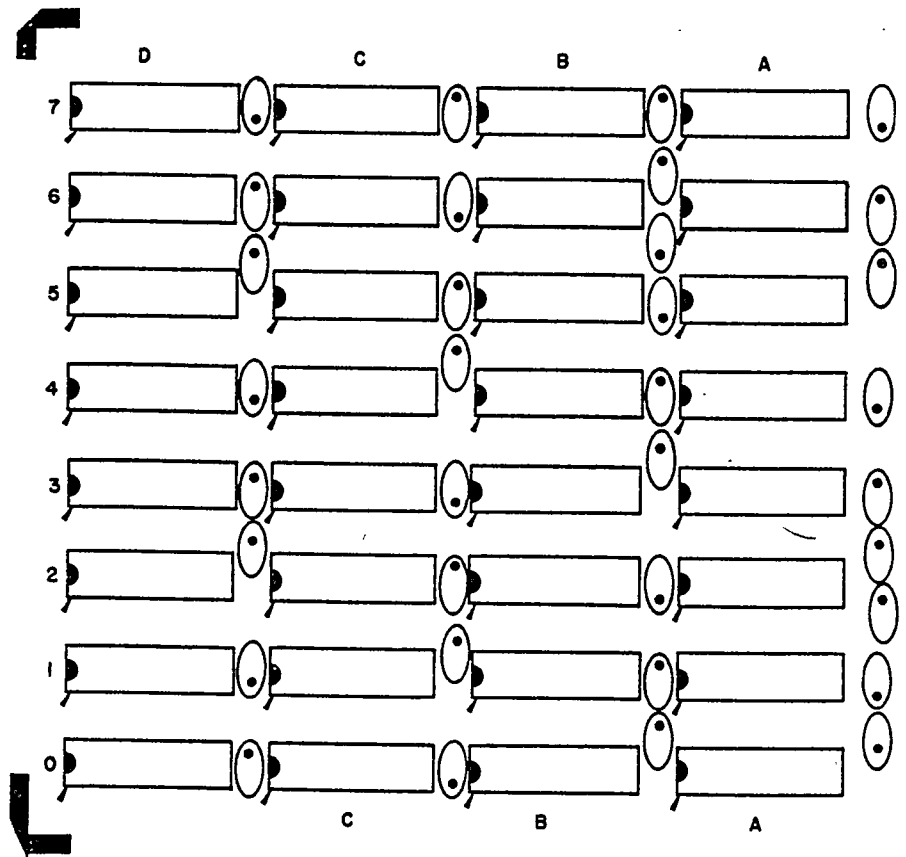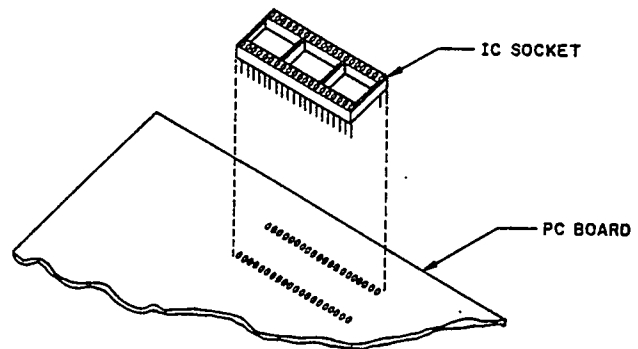
There is one 24-pin socket to be
installed on the other half of the
88-16MCS. Referring to the compo-
nent layout and parts chart below,
install socket "S" according to the
instructions (steps 1-4) on the
preceding page.

SOCKET	PINS
S	24
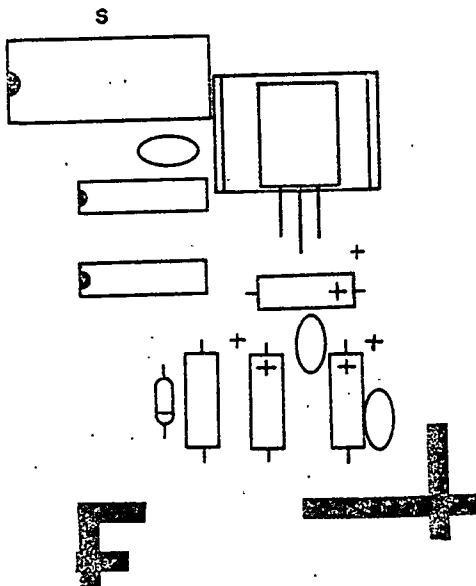
Thirteen ICs (E, F, G, H, K, L, M
N, R, T, U, V, W) will be soldered
directly to the board.

To prepare the ICs for installation:

Referring to the component layout
on the next page, remove the IC with
the correct part number from its holder.
If there are any bent pins, straighten
them with a needle-nose pliers. Ensure
that you choose the IC with the correct
part number as you install each one.

Install the ICs according to the fol-
lowing procedure:

1. After the IC is correctly oriented,
    start the pins on one side of the
    IC into their respective holes on
    the silk-screened side of the PC
    board. DO NOT PUSH THE PINS IN ALL
    THE WAY. If you have difficulty
    getting the pins into the holes,
    use the tip of a small screwdriver
    to guide them.

2. Start the pins on the other side
    of the IC into their holes in the
    same manner. When all of the pins
    have been started, set the IC into
    place by gently rocking it back and
    forth until it rests as closely as
    possible to the board. After you
    are certain that the IC is perfectly
    straight, tape it in place with a
    piece of masking tape.

3. Turn the board over and solder
    each pin to the foil pattern
    on the back side of the board.
    Be sure to solder EACH pin, and be
    careful not to leave any solder
    bridges.

4. Turn the board over again, and
    remove the piece of masking tape.

5. After each IC is installed, check
    the corresponding part off of the
    list provided on the next page.

ICs		
	Designation	Number
( )	E	7406
( )	F	74L02
( )	G	74LS139 or 93L21
( )	H	74L04
( )	K	74LS74
( )	L	74L04
( )	M	74LS27
( )	N	7402
( )	R	74L04
( )	T	74L04
( )	U	74L04
( )	V*	8T97
( )	W*	8T97

*Note that ICs "V" and "W", 8T97 may be substituted with a 74367 or 8097 chip.
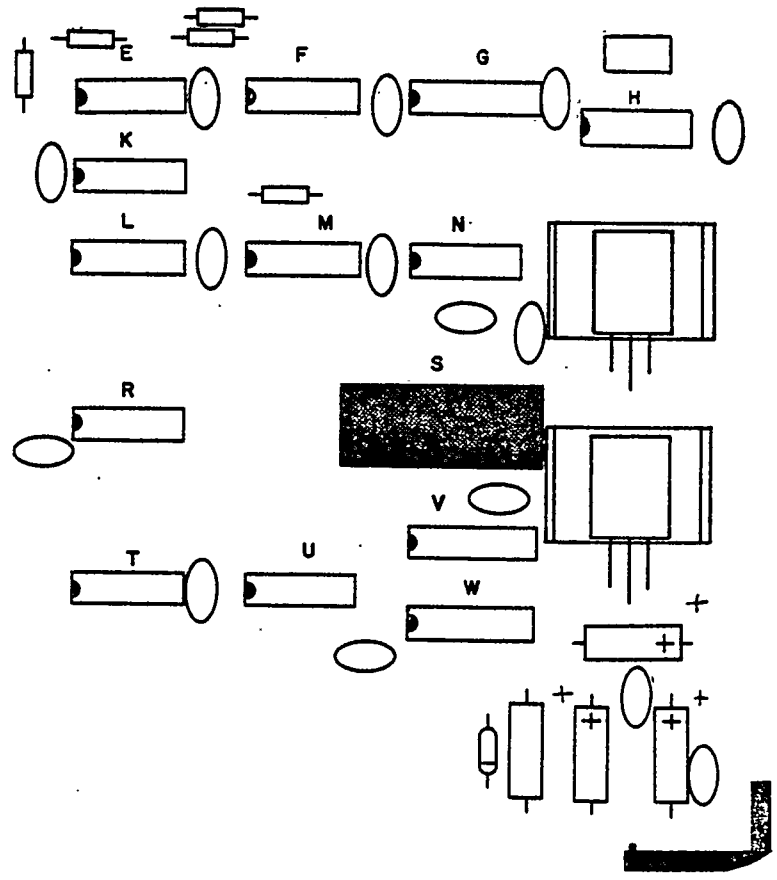
There are six resistors (R1, R2, R3, R4, R5, R6) to be installed on the 88-16MCD.


NOTE

Resistors are color-coded according to their value. The resistors in your kit will have four bands of color. The fourth band in both cases will be gold or silver, indicating the tolerance. In the following instructions, only the 3 bands of color to one side of the gold or silver band are significant. Be sure to match these three bands of color with those called for in the instructions as you install each resistor.

Refer to the component layout and the parts list on this page, and install the resistors according to the following procedure:

1. Match the color bands designated on the parts chart with the resistor position indicated by the component layout.

2. Using needle-nose pliers, bend the leads of the resistor at right angles to match their respective holes on the board.

3. Insert the resistor into the correct holes from the silk-screened side of the board. Push the resistor down until it touches the foil pattern.

4. Holding the resistor in place, turn the board over and bend the leads slightly outward.

5. Solder the two leads to the foil pattern on the back side of the board. Clip off any excess lead lengths, and save them for hard-wire connections to be made later.

6. After making sure that there are no solder bridges, check the resistor off of the parts list.
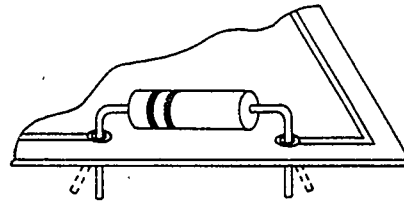
RESISTOR

| RESISTORS |
|---|
| ( ) R1, orange-orange-brown, 1/4 or 1/2W |
| ( ) R2, orange-orange-brown, 1/4 or 1/2W |
| ( ) R3, orange-orange-brown, 1/4 or 1/2W |
| ( ) R4, orange-orange-brown, 1/4 or 1/2W |
| ( ) R5, orange-orange-brown, 1/4 or 1/2W |
| ( ) R6, brown-black-brown, 2W |
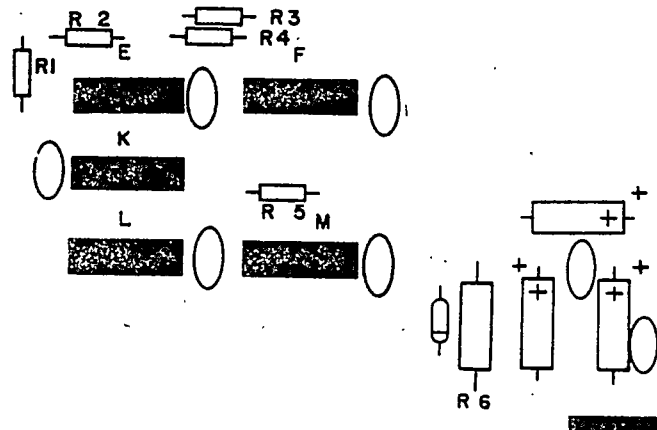
CAPACITOR INSTALLATION

There arc 34 .1 mf ceramic disk capacitors to be installed on the left-hand side of the PC board. The silk screen designations appear on the board as follows: ⬭ * These capacitors are not numbered. Referring to the component layout on this page, install the ceramic disk capacitors according to the instructions below:

1. Using needle-nose pliers, straighten the two leads as necessary to fit their respective holes on the board.

 * Ignore dots that appear on silk-screen designation.

2. Insert the capacitor into the correct holes from the silk-screened side of the board. Push the capacitor down until the ceramic insulation almost touches the foil pattern.

3. Holding the capacitor in place, turn the board over and bend the two leads slightly outward. Solder the leads to the foil pattern and clip off any excess lead lengths.
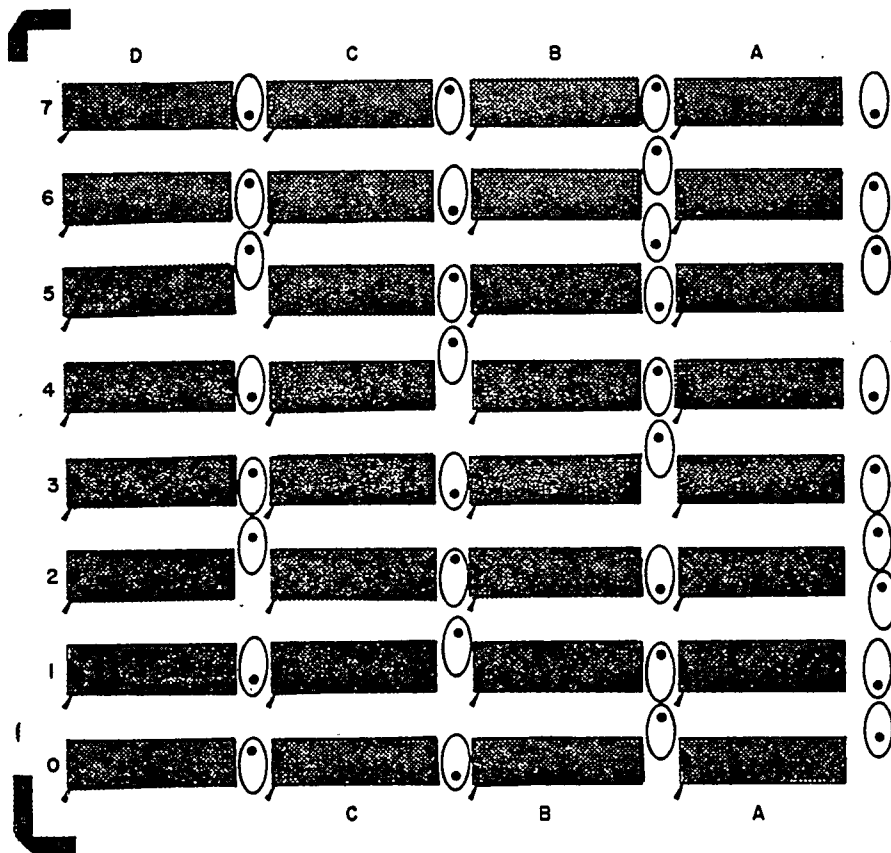
There are 15 .1 mf ceramic disk capacitors to be installed on the 88-16MCS. Three of the ceramic disk capacitors are numbered, C3, C4 and C6. The other twelve capacitors are marked only by the following designation: ⊂⊃

Referring to the component layout on this page, install the ceramic disk capacitors according to the instructions (steps 1, 2 and 3) on the preceding page.
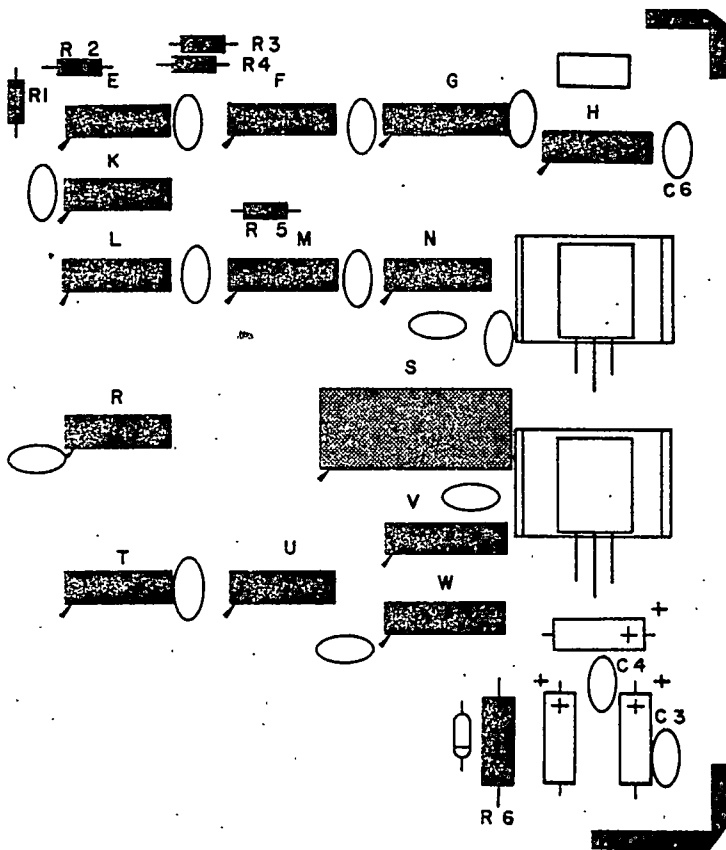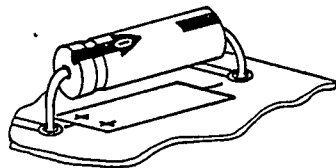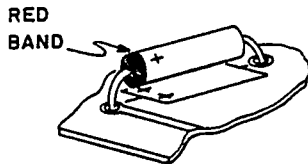
There are three 33 mf electrolytic ca-
pacitors to be installed on the 88-16MCS.

The polarity markings of each electro-
lytic capacitor will appear as one of
the following types:

ELECTROLYTIC
CAPACITOR


ELECTROLYTIC
CAPACITOR

RED
BAND
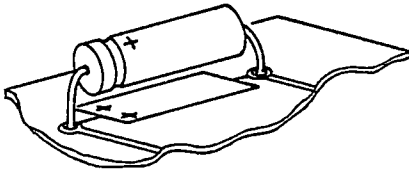
If the marking is the arrow type, a
negative sign will appear in the tip
of the arrow. Orient the capacitor
so that the arrow points to the nega-
tive polarity side. If the marking
is one of the other two types, orient
the capacitor so that the positive
signs match the positive polarity
side. Polarity is designated on the
silk-screened side of the board.

Referring to the component layout
and the parts chart on this page,
install each electrolytic capacitor
as follows:

1. Bend the two leads of the capa-
   citor at right angles to match
   their respective holes on the
   board. Insert the capacitor
   into the holes on the silk-
   screened side of the board.
   Be sure to orient the capacitor
   correctly.

2. Holding the capacitor in place,
   turn the board over and bend the
   two leads slightly outward. Sol-
   der the two leads to the foil pat-
   tern, and clip off any excess
   lead lengths.

3. After making sure that there are
   no solder bridges, check each
   electrolytic capacitor off of the
   parts list as you install it.

| ELECTROLYTIC CAPACITORS |
| --- |
| ( ) C1, 33mf at 16V |
| ( ) C2, 33mf at 16V |
| ( ) C5, 33mf at 16V |
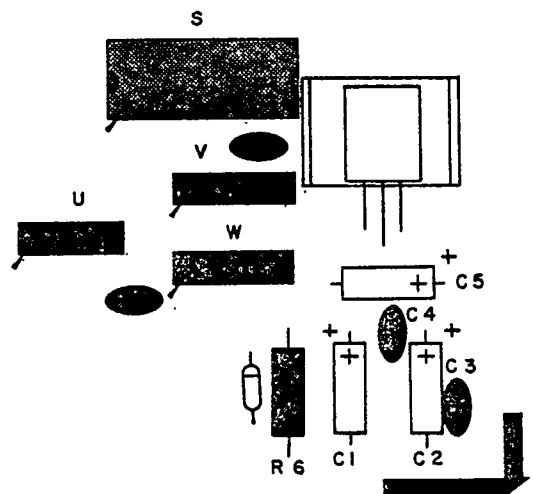
DIODE INSTALLATION

There is one 5-volt zener diode (silk-screen designation, D1) to be installed on the 88-16MCS.

> **NOTE**
>
> Diodes are marked with a band to indicate the cathode end. The diode must be oriented so that the banded end corresponds with the band printed on the 88-16MCS. Failure to orient diodes correctly may result in permanent damage to your unit.
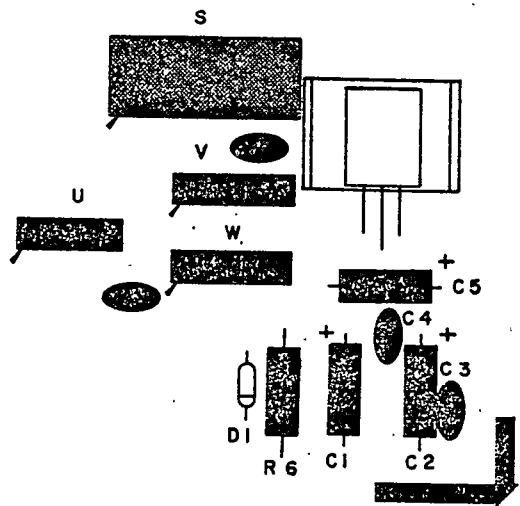
Referring to the component layout on this page, install the 5-volt zener diode according to the following instructions.

1. Bend the leads of the diode at right angles to match the correct holes on the board.

2. Be certain that the banded end of the diode matches the band on the silk-screened side of the board.
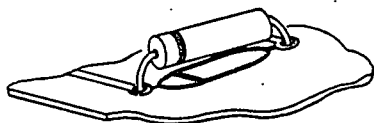
DIODE

3. Insert the diode into the correct holes from the silk-screened side of the board. Turn the board over, and bend the leads slightly outward.

4. Solder the two leads to the foil pattern on the back side of the board. Clip off any excess lead lengths.

S
V
U
W
+ C5
C4
+
D1
C3
R6 C1 C2

VOLTAGE REGULATOR INSTALLATION

There are two voltage regulators to be installed on the 88-16MCS.

Referring to the parts chart and the component layout on this page, install the voltage regulator according to the following instructions.

1. Set the voltage regulator in place on the board and align the mounting holes. (See drawing below.)

HEAT SINK

#6-32 x ¼"

MC 7805
OR 7812

#6-32
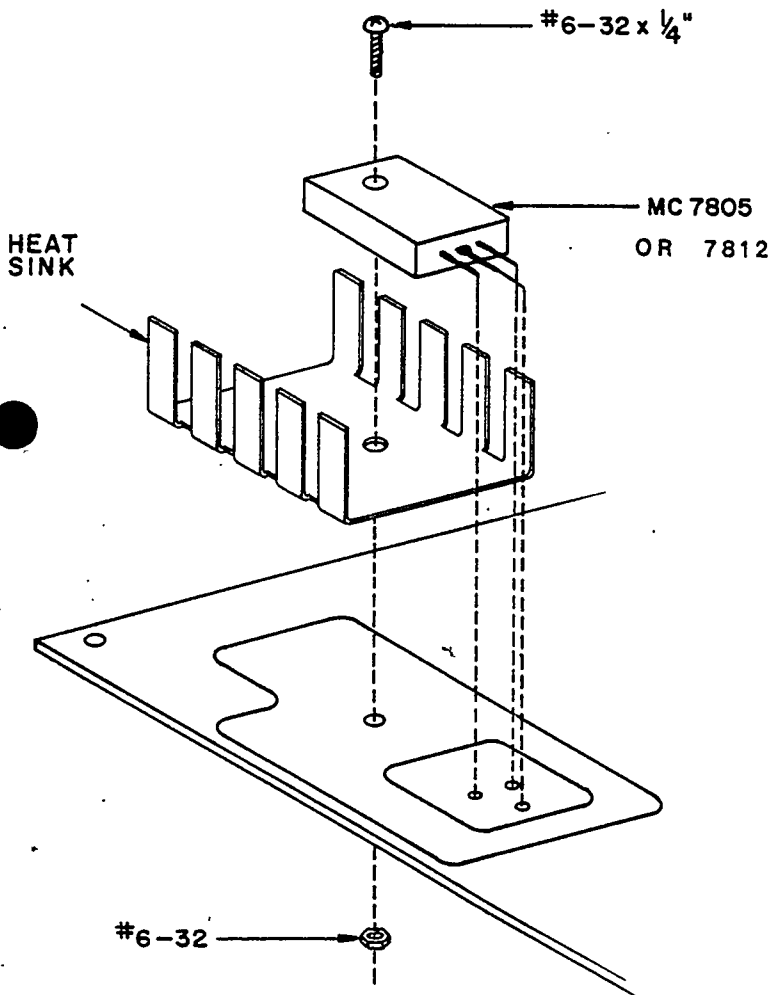
2. Use a pencil to mark the point on each of the three leads where they line up with their respective holes on the board.

3. Using needle-nose pliers, bend each of the three leads at a right angle at the points where you made the pencil marks.

> **NOTE**
> Use heat-sink grease when when installing this component. Apply the grease to all surfaces which come in contact with each other.

4. Referring to the preceding drawing, set the regulator and heat sink in place on the silk-screened side of the board. Secure the regulator and heat-sink as shown by the drawing, holding the regulator in place as you tighten the nut.

5. Turn the board over and solder the three leads to the foil pattern on the back side of the board. Be sure not to leave any solder bridges.

6. Clip off any excess lead lengths.

| VOLTAGE REGULATORS |
| --- |
| ( ) VR1, 12 volts, 7812 |
| ( ) VR2, 5 volts, 7805 |

18
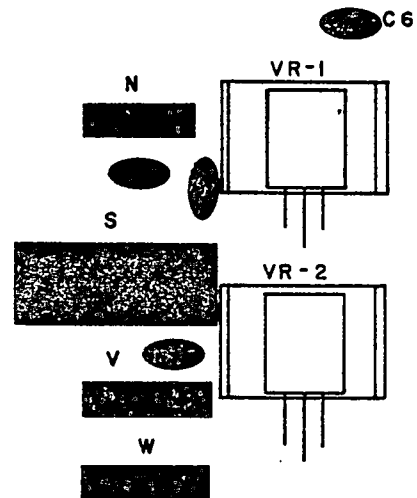
ADDRESS SWITCH INSTALLATION

There is one address line switch to be installed on the 88-16MCS.

Referring to the component layout on this page, install the address switch according to the following procedure.

1. Remove the switch from its holder. If there are any bent pins, straighten them with a needle-nose pliers.

2. Orient the switch so that the numbers 1, 2, 3 and 4 on the switch line up directly under the corresponding 1, 2, 3 and 4 printed on on the board silk-screen. Note the following illustration.
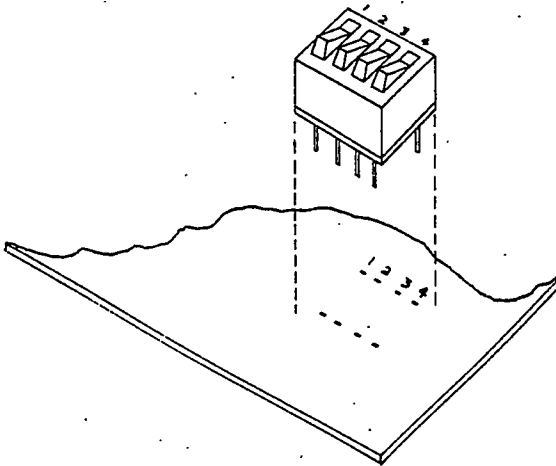
3. Start the pins on one side of the switch into their respective holes on the silk-screened side of the board. DO NOT PUSH THE PINS IN ALL THE WAY. If you have difficulty getting the pins into the holes use the tip of a small screwdriver to guide them.

4. Start the pins on the other side of the switch into their holes in the same manner. When all of the pins have been started, set the IC into place by gently rocking it back and forth until it rests as closely to the board as possible. After you are certain that the switch is straight, tape it in place with a piece of masking tape.

5. Turn the board over and solder each pin to the foil pattern on the back side of the board. Be sure to solder EACH pin, and be careful not to leave any solder bridges.

6. Turn the board over again, and remove the piece of masking tape.

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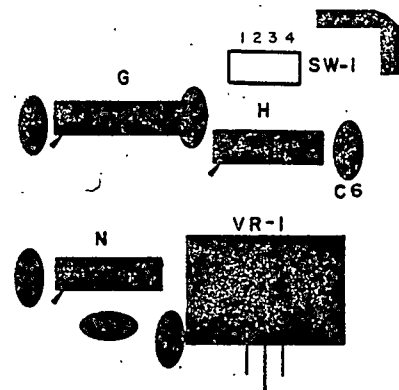
IC AND BOARD INSTALLATION

ICs A∅-A7, B∅-B7, C∅-C7, D∅-D7
and S should be installed now.

1. Review the "MOS IC Special Han-
    dling Procedures" on page 5 of
    the ALTAIR 8800 Assembly Manual.
    Note, failure to carefully follow
    the instructions of the "MOS Spe-
    cial Handling Procedures" may
    result in permanent damage to
    static-sensitive ICs.

2. Insert the ICs into their sockets
    on the 88-16MCS. Handle the ICs
    carefully, and use as little pres-
    sure as possible when inserting the
    ICs. Note that ICs A∅-A7, B∅-B7,
    C∅-C7 and D∅-D7 are 4200s and that
    the number for IC S is 8212.

Install the edge connector provided
with the board according to the pro-
cedure described on page 64 in the
assembly manual "EXPANDER BOARD
8800 M/BD ASSEMBLY".

Press the 88-16MCS into the edge con-
nector. The board should be oriented
so that the silk-screened side faces
the right side of the unit viewed from
the front panel.

BOARD SELECTION

Note that the total amount of memory
for the 8800 is obtained with four
88-16MCS boards. The four-position
switch identifies board selection.
Only one of the four switches is
used to select a board. The following
chart indicates which board to select
for the memory location you want.

4-Position Switch	Memory Location
1	0-15K
2	16-31K
3	32-47K
4	48-64K

mits

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