4K DYNAMIC RAM BOARD

ASSEMBLY PROCEDURE

MITS INC.

4K MEMORY BOARD ERRATA — Oct. 21, '75

ADDITION TO REV. 0.2

THE FOLLOWING APPLIES TO PAGE 3 OF THE ASSEMBLY MANUAL:

This is a corrected list of the integrated circuits to be installed on all REVISION 0.2 4K Memory Boards.

( ) IC's A & R are 74L04's

( ) IC B is a 74LS04

( ) IC D is a 74193

( ) IC's F & E are 74L193's

( ) IC's G & T are 7473's

( ) IC's H & I are AM26L123's

( ) IC J is a 74L20

( ) IC M is a 74L02

( ) IC N is an 8212

( ) IC's O, P, Q & S are 8T97's

( ) IC K is a 74L00

( ) IC L is a 74LS00

( ) IC Z is a 7406

NOTE: There are several errors in reference to this material, including the current Parts & BAG lists. Disregard all other instructions and references to these IC's.

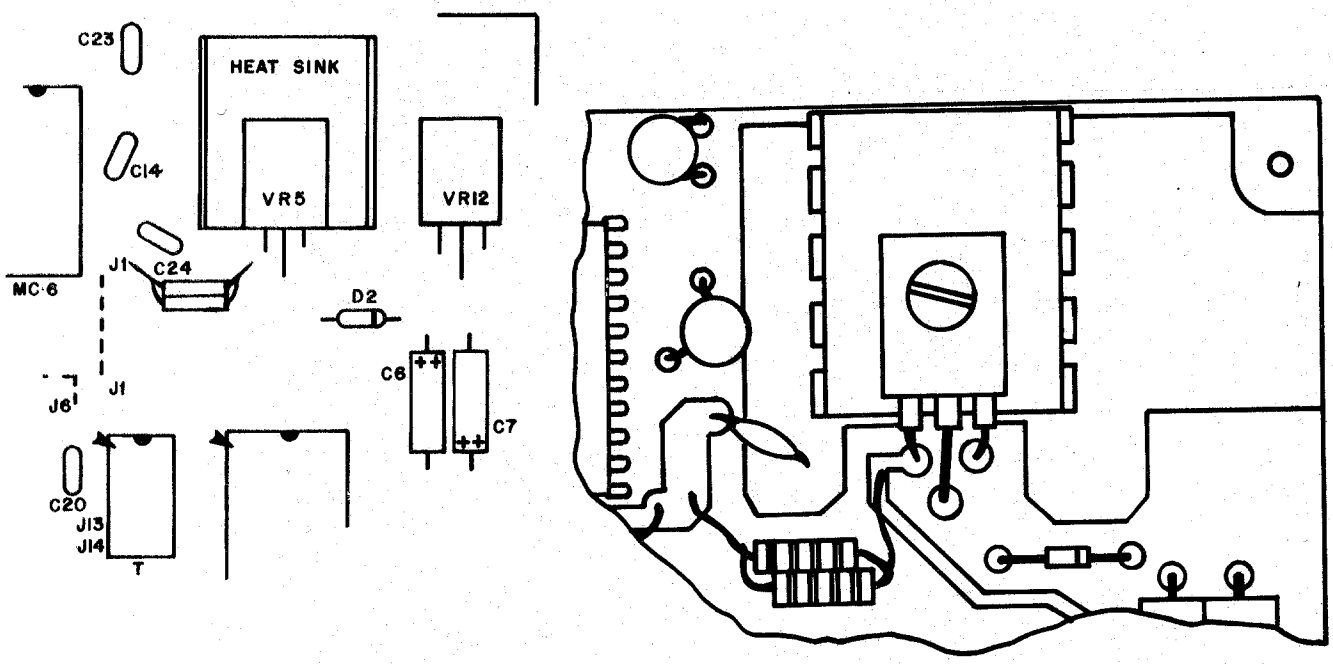
4K RAM BOARD POWER SUPPLY
**** MODIFICATION ****

THE FOLLOWING MODIFICATION MUST BE PERFORMED ON THE 5 VOLT SUPPLY REGULATION CIRCUITRY.

( ) Solder two 20-ohm resistors (red-black-black) together. Make the connection so that the two are as close as possible to each other. (see drawing below)

( ) Referring to the drawing, place a piece of electrical tape over the area on the board where the resistors will rest.

( ) Solder the resistors in place directly to the PC lands. One side will go to the 7805 lead closest to the IC labeled MC-6. The other side goes to the land connecting one side of C24 and the top pad for jumper J1. (see drawing and component layout below)



4K DYNAMIC RAM BOARD ASSEMBLY

Integrated Circuit Installation

There is a total of 28 integrated circuits (IC's) to be installed on the 8800 4K RAM Board (88-4MCD). The eight memory IC's will be installed later in the assembly procedure. The other 20 IC's should be installed at this time, according to the following procedure.

( ) Referring to the component layout, remove the IC with the correct part number from its holder. If there are any bent pins, straighten these using needle-nose pliers. Ensure that you choose the IC with the correct part number.

( ) Orient the IC so that its notched end corresponds with the notch printed on the board, and pin 1 of the IC corresponds with the arrowhead printed on the board.

NOTE: If the IC does not have a notch on one end, refer to the IC Orientation Chart included in your manual for the identification of pin 1.

( ) When you have the correct orientation, 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.

( ) Start the pins on the other side of the IC into their respective 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 close as possible to the board. Make sure that the IC is perfectly straight and as close to the board as possible; then tape it in place with a piece of masking tape.

( ) Turn the board over and solder each pin of the IC 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.

( ) Turn the board over again and remove the piece of masking tape.

Use the same procedure to install each of the IC's. Be sure that you have the correct part number and the correct orientation as you install each one.

(✓) IC's A, B & R are 74L04's

(✓) IC D is a 74193

( ) IC's F & E are 74L193's

(✓) IC's G & T are 7473's

(✓) IC's H & I are AM26L123's

(✓) IC J is a ~~7420~~

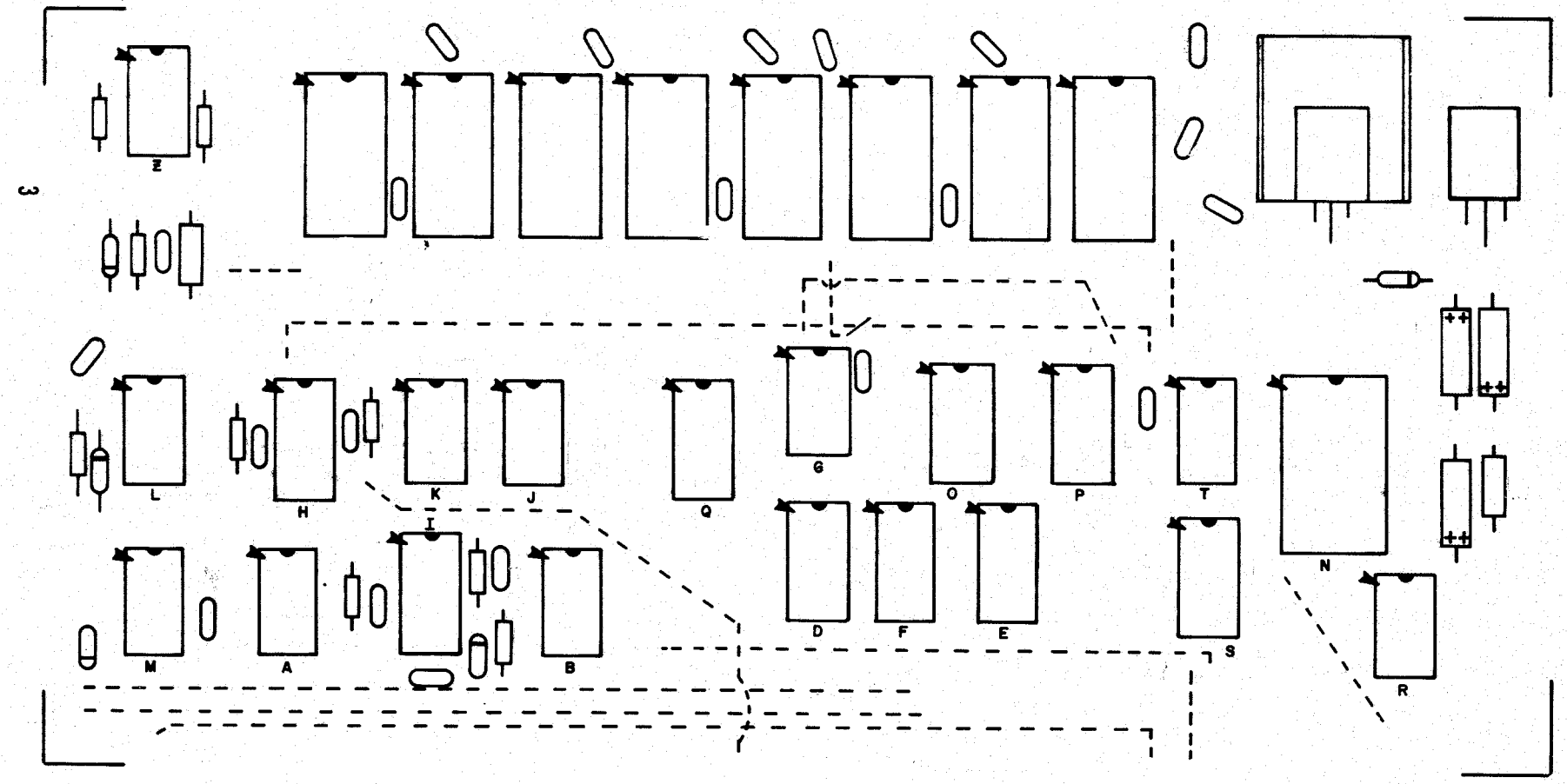
(✓) IC M is a 74L02

(✓) IC N is an 8212

(✓) IC's O, P, Q & S are 8T97's

(✓) IC's L & K are ~~7400's~~

(✓) IC Z is a 7406



Resistor Installation

There are 11 resistors to be installed on the 8800 4K RAM Board.

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

Using needle-nose pliers, bend the leads of the following resistors at right angles to match their respective holes on the PC board. (see component layout)

NOTE: All resistors on the 4K RAM Board may be either 1/4 or 1/2 Watt; except resistor R9, which must be 1/2 Watt.

( ) Install resistor R1 (100-ohm, brown-black-brown) into the correct holes on the silk-screened side of the PC board.

( ) Holding the resistor in place with one hand, turn the board over and bend the two leads slightly outward.

( ) Solder the leads to the foil pattern on the back side of the board; then clip off any excess lead lengths.

Referring to the component layout, install the remaining resistors in the same manner. Be sure you have the correct color-coding for each one as you install them.

NOTE: Save the component leads that you clip off for use later in the assembly procedure.

(✓) R11 is 100-ohms, brown-black-brown

( ) R2, R7 & R8 are 1K-ohms, brown-black-red

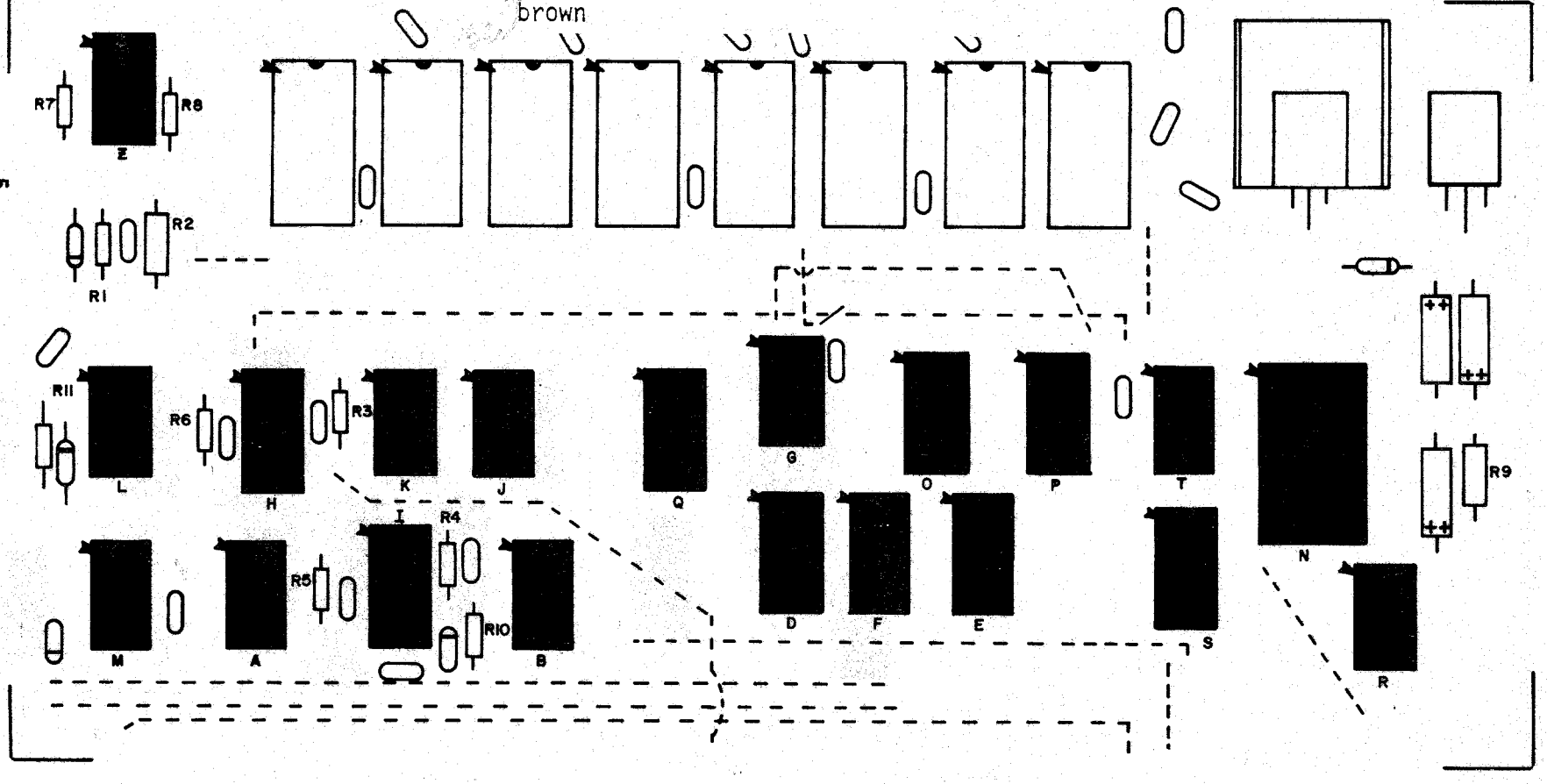
(✓) R3 is 22K-ohms, red-red-orange

(✓) R4 is 27K-ohms, red-violet-orange

(✓) R5 is 20K-ohms, red-orange

(✓) R6 is 43K-ohms, yellow-orange-orange

(✓) R9 & R10 are 470-ohms, yellow-violet-brown



Capacitor Installation

There are 21 ceramic disk capacitors and 3 electrolytic capacitors to be installed on the 8800 4K RAM Board.

Refer to the component layout and install the ceramic disk capacitors according to the following procedure.

( ) Choose the capacitor with the correct value as called for in the instructions. Straighten the two leads as necessary and bend them to fit their respective holes on the PC board.

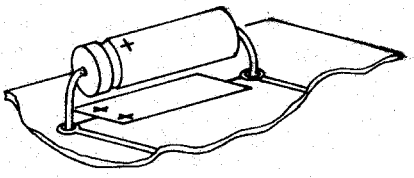
( ) Insert the capacitor into the correct holes from the silk-screened side of the board. Push the capacitor down until the ceramic insulation almost touches the foil pattern.

( ) Holding the capacitor in place, turn the board over and bend the two leads slightly outward.

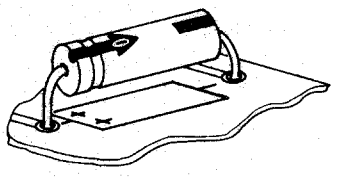
( ) Solder the two leads to the foil pattern on the back side of the board; then clip off any excess lead lengths.

Install all of the ceramic disk capacitors in this manner. Be sure that you have the correct value capacitor as you install each one.

The three electrolytic capacitors for the 4K RAM Board have polarity requirements which must be noted before installation. Those contained in your kit may have one or possibly two of three types of polarity markings. To determine the correct orientation, look for the following: (see drawing above right)



ELECTROLYTIC CAPACITOR



One type will have plus (+) signs on the positive end; another will have a band or a groove around the positive side in addition to the plus signs. The third type will have an arrow on it; in the tip of the arrow there is a negative (-) sign and the capacitor must be oriented so the arrow points to the negative polarity side.

Referring to the component layout, install the electrolytic capacitors on the board.

( ) Bend the two leads of the capacitor with the correct value 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 align the positive polarity side with the "+" signs printed on the board.

( ) 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.

( ) Install the remaining electrolytic capacitors in the same manner.

(✓) C1 & C22 are .001uf

( ) C2 is 470pf

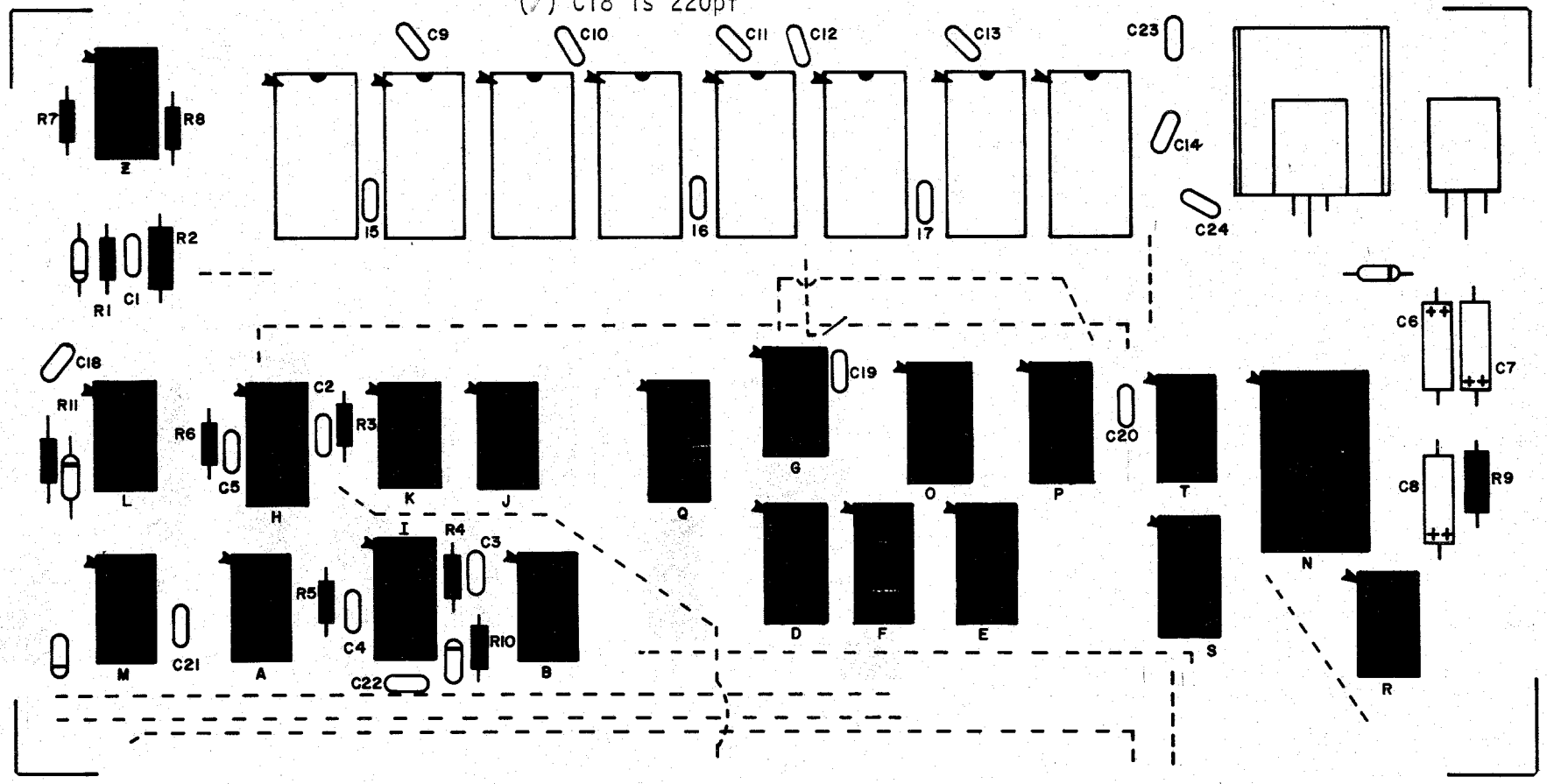
(✓) C3 & C5 are 20pf

(✓) C4 is 100pf

(✓) C6, C7 & C8 are 35uf

(✓) C9 through C17, C19 through C21, and C23 & C24 are .1uf

(✓) C18 is 220pf

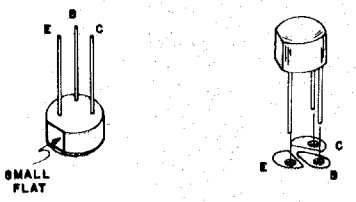


Transistor Installation

There is 1 PNP, EN2907 transistor to be installed on the 8800 4K RAM Board.

NOTE: When installing this transistor, ensure that you check the part number before soldering it into place. Some transistors are identical in physical appearance but differ in electrical characteristics. If the part number on the transistor does not match the number called for in the instructions, it may be that you have substitutions. In this case refer to the Transistor Identification Chart included with your manual.

( ) This transistor is rounded and has a flat edge near one of the leads. The lead nearest this flat edge is called the emitter. The hole for the emitter is marked with an "E" on the board, next to the transistor Q1 designation. If the emitter lead is placed into this hole, the other two leads should fit into their holes with little or no bending and should not cross over each other. (see drawing below)



( ) Orient Q1 so that the lead nearest the flat edge aligns with the correct hole on the board. Insert the transistor into the holes from the silk-screened side of the board.

( ) Holding the transistor in place, turn the board over and bend the three leads slightly outward.

( ) Solder the leads to the foil pattern on the back side of the board; then clip off any excess lead lengths.

Diode Installation

There are four 1N914 diodes and one 3.3v (1N746A) zener diode to be installed on the 8800 4K RAM Board.

NOTE: Diodes are marked with a band on one end indicating the cathode end. The diode must be oriented so that the end with the band is towards the band printed on the board when being installed.

( ) Referring to the component layout, bend the leads of diode D1 (1N914) at right angles to match the correct holes on the board.

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

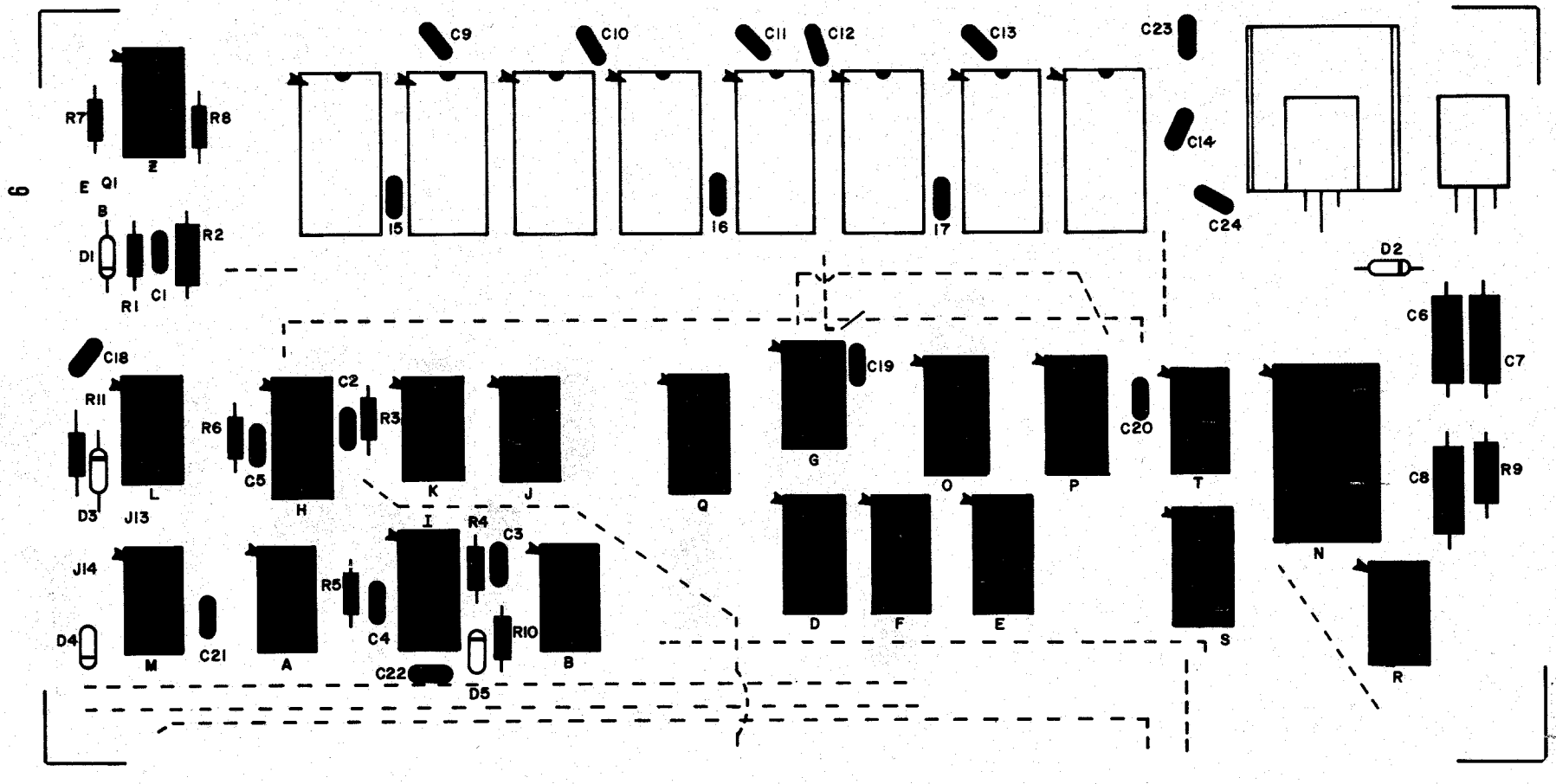
( ) Solder the leads to the foil pattern on the back side of the board; then clip off any excess lead lengths.

Install zener diode D2 and the remaining 1N914 diodes, D3, D4 & D5, in the same manner. Be sure that the band on the diode is aligned with the band printed on the board as you install them. Failure to orient these diodes correctly may result in permanent damage to your unit.

(✓) Q1 is an EN2907

(✓) D1, D3, D4 & D5 are 1N914's

(✓) D2 is a ~~1N746A~~



PC Jumper Wire Connections

There are 17 hardwire jumper connections to be made on the 8800 4K RAM Board.

These jumpers are indicated on the PC board in two manners. The first twelve are indicated by the two pads to be connected having the same designation and shown connected by a broken line printed on the board. The remaining five are indicated simply by the two pads to be connected having the same designation.

Cut the wire for each jumper to the correct length for each connection allowing an extra 1/2 inch. Strip 1/4 inch of insulation from both ends of each wire and tin them by applying a thin coat of solder to the uninsulated portion.

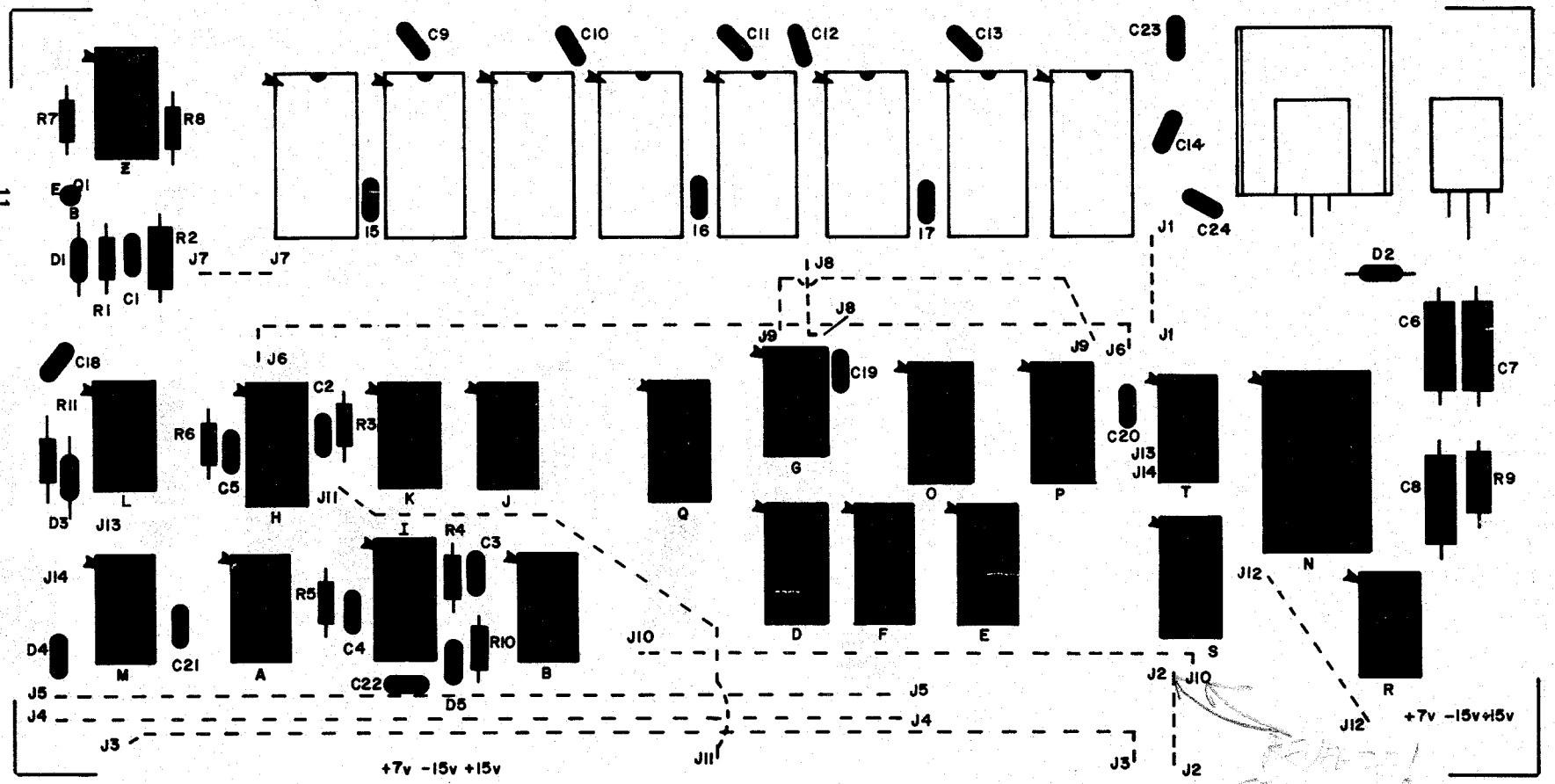
NOTE: It is very important for the operational performance of this board to keep the length of these jumper wires as short as possible. Any excess wire lengths may create "noise" and influence critical timing operations.

Make each of the following connections by inserting the wires from the silk-screened side of the board and soldering them to the foil pattern on the back side. Be sure to clip off any excess lead lengths as you install each jumper.

NOTE: Jumpers J1, J7, J8 & J12 should be made using the heavier guage wire included with your kit.

( ) Connect J1 to J1
( ) Connect J2 to J2
( ) Connect J3 to J3
( ) Connect J4 to J4
( ) Connect J5 to J5
( ) Connect J6 to J6
( ) Connect J7 to J7
( ) Connect J8 to J8
( ) Connect J9 to J9
( ) Connect J10 to J10
( ) Connect J11 to J11
( ) Connect J12 to J12
( ) Connect J13 to J13
( ) Connect J14 to J14
( ) Connect +7v to +7v
( ) Connect -15v to -15v
( ) Connect +15v to +15v

(✓) Install all 17 jumpers as per the instructions.



Voltage Regulator Installation

There is one 7805 5-volt regulator and one 7812 12-volt regulator to be installed on the 8800 4K RAM Board.

( ) Set the 7805 (VR5) in place on the board and align the mounting holes. (see drawing)

( ) Use a pencil to mark the point on each of the three leads where they line up with their respective holes on the board.

( ) Use needle-nose pliers to bend each of the three leads at a right angle on the points where you made the pencil marks.

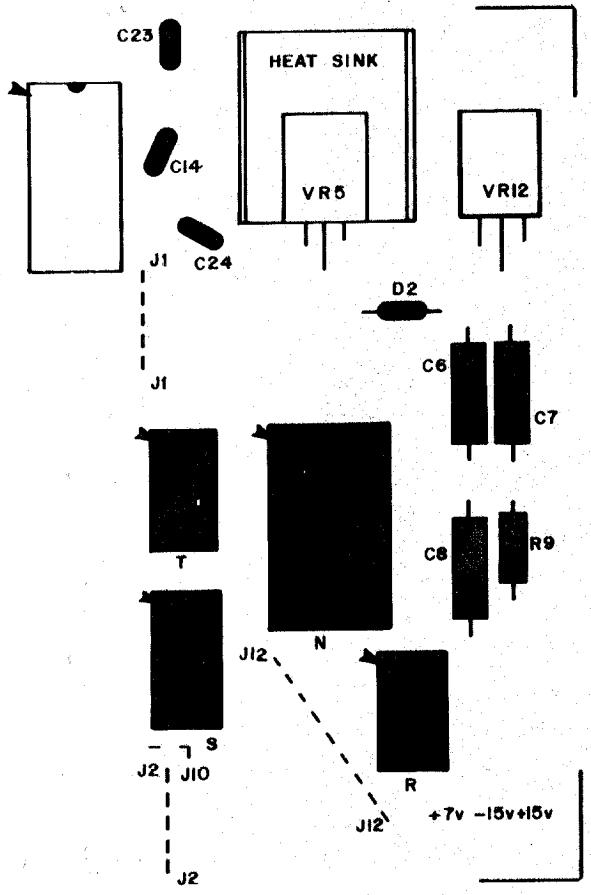
NOTE: Use heat-sink grease when installing these components. Apply the grease to all surfaces which come in contact with each other.

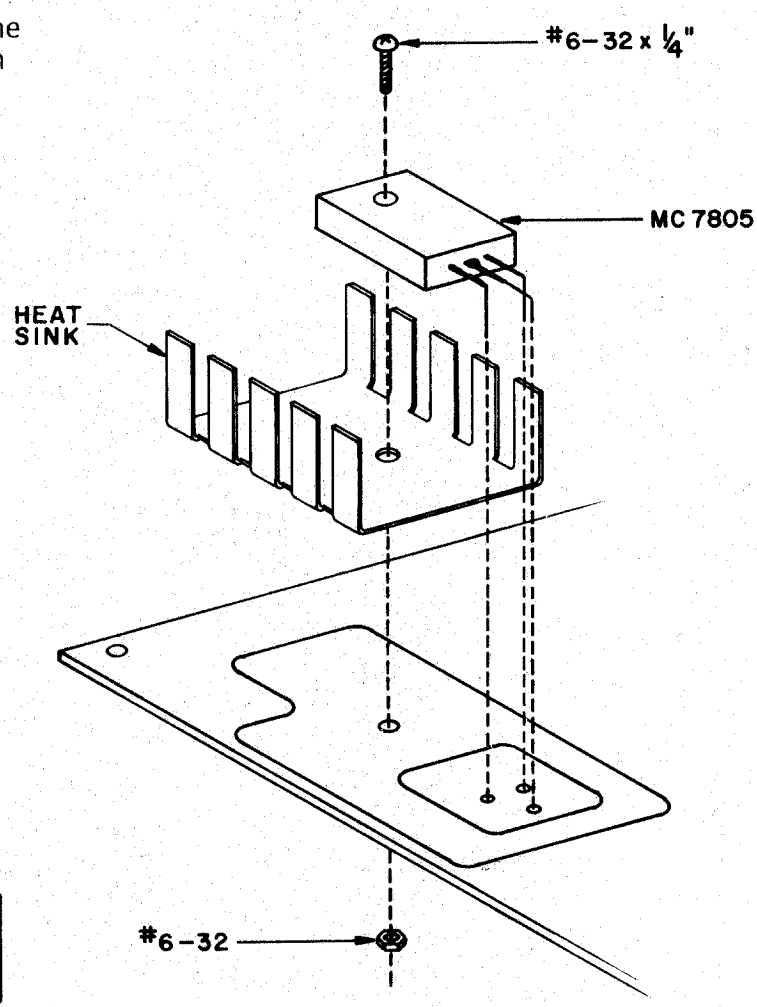
( ) Referring to the drawing, set the regulator and heat sink in place on the silk-screened side of the board. Secure them as shown, holding the regulator in place as you tighten the nut to keep from twisting the leads.

( ) 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.

( ) Clip off any excess lead lengths.

( ) Install the 7812 (VR12) in the same manner; except there is no heat sink to be installed with this regulator.





MOS Integrated Circuit Installation

There are eight MOS Integrated Circuits (IC's) to be installed on the 8800 4K RAM Board.

These IC's are very sensitive to static electricity and transient voltages. In order to prevent damage to these components review the information contained in the MOS IC SPECIAL HANDLING PRECAUTIONS included with your manual.

( ) Referring to the component layout, remove the IC with the correct part number from its holder. If there are any bent pins, straighten these using needle-nose pliers. Ensure that you choose the IC with the correct part number.

( ) Orient the IC so that its notched end corresponds with the notch printed on the board, and pin 1 of the IC corresponds with the arrowhead printed on the board.

NOTE: If the IC does not have a notch on one end, refer to the IC Orientation Chart included in your manual for the identification of pin 1.

( ) When you have the correct orientation, 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.

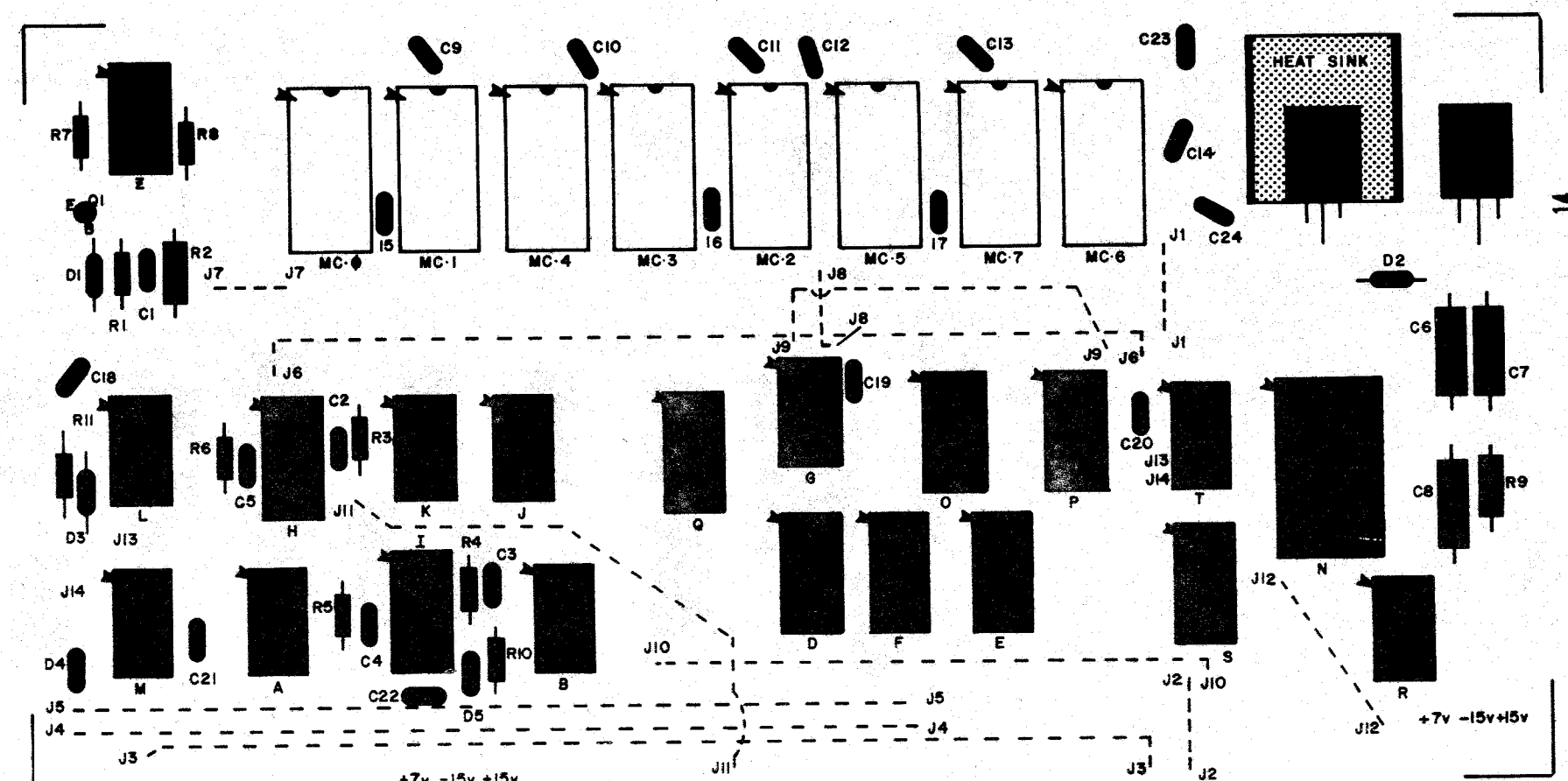
( ) Start the pins on the other side of the IC into their respective holes in the same manner. When all of the pins have been started, set the IC into place by gently rocking it back and forth until it rests as close as possible to the board. Make sure that the IC is perfectly straight and as close to the board as possible; then tape it in place with a piece of masking tape.

( ) Turn the board over and solder each pin of the IC 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.

( ) Turn the board over again and remove the piece of masking tape.

Use the same procedure to install each of the IC's. Be sure that you have the correct part number and the correct orientation as you install each one.

( ) IC's MC0 through MC7 are TMS 4030's or C2107A's



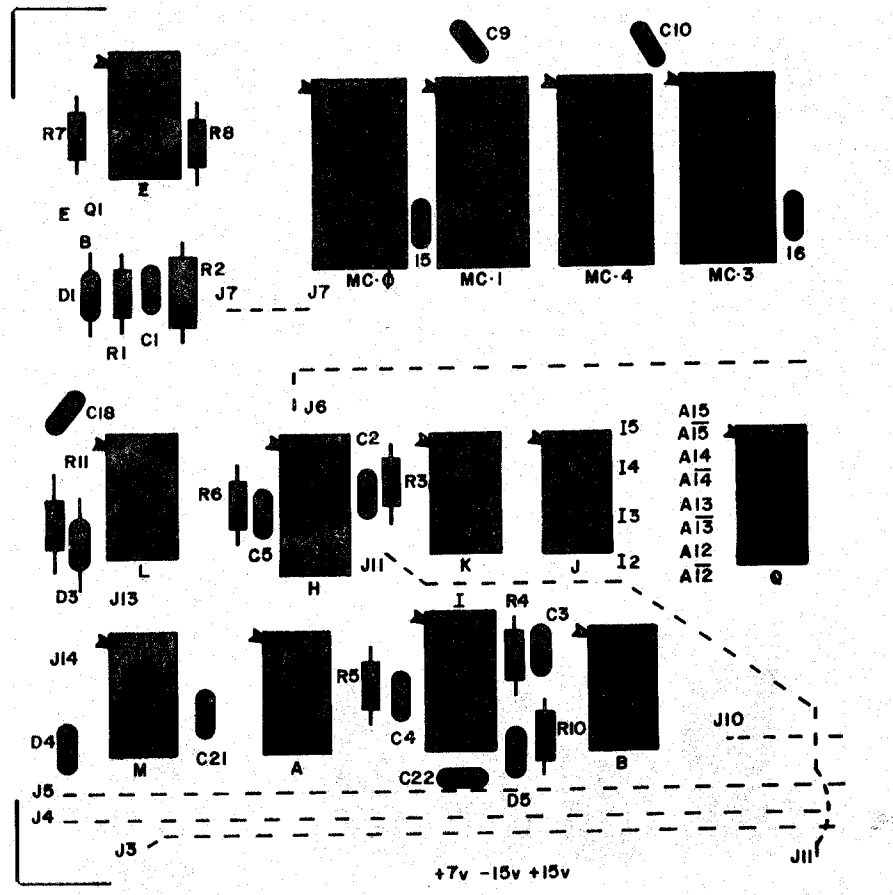
Address Hardwire Connections

There are four hardwire connections to be made on the 8800 4K RAM Board which set the starting address for the particular board being wired.

The address choosen for each memory board must be correlated with the rest of the system in which it is to be used. Refer to the MEMORY ADDRESS SELECTION section of your manual for the necessary information to determine these connections.

These four connections are to be made using the component leads saved from earlier in the assembly procedure. Bend the leads as necessary to fit the correct holes on the board, and insert them from the silk-screened side. Solder the leads to the foil pattern on the back side of the board; then clip off any excess lead lengths.

Be careful not to leave any solder bridges.



The board should be installed with the same orientation as the other boards in your 8800.

MEMORY ADDRESS SELECTION

There are several hardwire connections to be made on the 8800 memory boards for selecting the starting address for each board.

The starting address for each individual board is entirely optional within a few limitations. With only a single memory board in your system there is no problem, as long as the starting address selected in noted and taken into account when programming.

When more than one memory board is in the system, the sequence of starting addresses becomes critical. This is especially true when combining 1K and 4K boards in the same system. The important aspect in this case is to be sure that the individual blocks of memory on each board follow each other sequentially. There should be no gaps between the last address of one board and the starting address of the next.

The best example of this situation would be a system containing a 1K board with only 256 words of static memory together with a full 4K dynamic memory board. As may be noted from the "MEMORY ADDRESS SELECTION CHART", the starting address of the 1K boards may be selected with minimum increments of 1024 words. For the 4K board the minimum increment is 4096 words.

NOTE: Those addresses marked with an asterisk (*) in the chart are the possible address selections for the 4K boards, I1 & I0 being dropped for this board. Any address listed may be selected for the 1K boards.

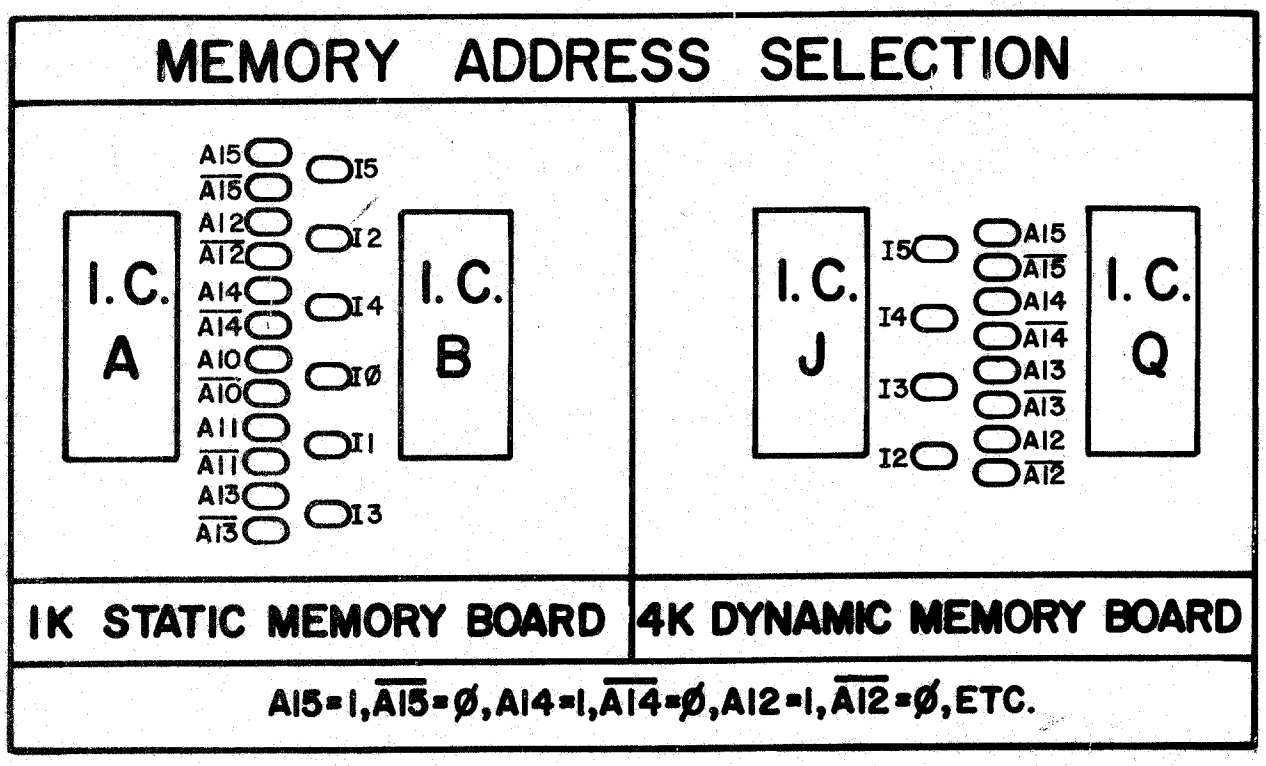
As may be seen from studying the chart, in the example above if the 1K board is placed at an address "before" the 4K board there will be a gap of 3840 words of memory between the boards. Even with the 1K board expanded to its full 1024 words, there would still be a gap of 3072 words of memory.

In this example the 4K board address must be placed "before" the 1K board address in order to keep all possible addresses sequential. (i.e.--place the 4K board at octal address 0 and the 1K board at octal address 10 000)

The same would hold true for two 1K boards, one fully expanded and the other with only 256 words of memory. The full board must be placed first and the second board must be placed so that it follows immediately in sequence.

The chart below illustrates the address selection pads for both the 1K and the 4K memory boards. The "I" prefixed pads correspond to the "I" prefixed headings on the "MEMORY ADDRESS SELECTION CHART". The "A" prefixed pads correspond to the 1's and 0's on the "MEMORY ADDRESS SELECTION CHART" as indicated at the bottom of the chart below. The last number of the pad should always correspond in each connection. (i.e.--pad I5 must go to either A15 or $\overline{A15}$, pad I1 must go to either A11 or $\overline{A11}$)

PROM MEMORY CARD (88-PMC) The 2K PROM Board uses exactly the same addressing format as the 1K and 4K memory boards. The only difference is that five jumpers are used (I1 through I5), and the memory increments in 2K blocks. All of the information in this section applies to the PROM board just as with the other memory boards. The possible addresses for the PROM board are marked " † " on the MEMORY ADDRESS SELECTION CHART.



MEMORY ADDRESS SELECTION CHART

ADDRESS LINES						ADDRESS SELECTED	
I5	I4	I3	I2	I1	I0	DECIMAL ADDRESS	OCTAL ADDRESS
0	0	0	0	0	0	0	0 * †
0	0	0	0	0	1	1,024	2 000
0	0	0	0	1	0	2,048	4 000 †
0	0	0	0	1	1	3,072	6 000
0	0	0	1	0	0	4,096	10 000 * †
0	0	0	1	0	1	5,120	12 000
0	0	0	1	1	0	6,144	14 000 †
0	0	0	1	1	1	7,168	16 000
0	0	1	0	0	0	8,192	20 000 * †
0	0	1	0	0	1	9,216	22 000
0	0	1	0	1	0	10,240	24 000 †
0	0	1	0	1	1	11,264	26 000
0	0	1	1	0	0	12,288	30 000 * †
0	0	1	1	0	1	13,312	32 000
0	0	1	1	1	0	14,336	34 000 †
0	0	1	1	1	1	15,360	36 000
0	1	0	0	0	0	16,384	40 000 * †
0	1	0	0	0	1	17,408	42 000
0	1	0	0	1	0	18,432	44 000 †
0	1	0	0	1	1	19,456	46 000
0	1	0	1	0	0	20,480	50 000 * †
0	1	0	1	0	1	21,504	52 000

ADDRESS LINES						ADDRESS SELECTED		
I5	I4	I3	I2	I1	I0	DECIMAL ADDRESS	OCTAL ADDRESS	
0	1	0	1	1	0	22,528	54 000	†
0	1	0	1	1	1	23,552	56 000	
0	1	1	0	0	0	24,576	60 000	* †
0	1	1	0	0	1	25,600	62 000	
0	1	1	0	1	0	26,624	64 000	†
0	1	1	0	1	1	27,648	66 000	
0	1	1	1	0	0	28,672	70 000	* †
0	1	1	1	0	1	29,696	72 000	
0	1	1	1	1	0	30,720	74 000	†
0	1	1	1	1	1	31,744	76 000	
1	0	0	0	0	0	32,768	100 000	* †
1	0	0	0	0	1	33,792	102 000	
1	0	0	0	1	0	34,816	104 000	†
1	0	0	0	1	1	35,840	106 000	
1	0	0	1	0	0	36,864	110 000	* †
1	0	0	1	0	1	37,888	112 000	
1	0	0	1	1	0	38,912	114 000	†
1	0	0	1	1	1	39,936	116 000	
1	0	1	0	0	0	40,960	120 000	* †
1	0	1	0	0	1	41,984	122 000	
1	0	1	0	1	0	43,008	124 000	†
1	0	1	0	1	1	44,032	126 000	
1	0	1	1	0	0	45,056	130 000	* †
1	0	1	1	0	1	46,080	132 000	

ADDRESS LINES						ADDRESS SELECTED		
I5	I4	I3	I2	I1	I0	DECIMAL ADDRESS	OCTAL ADDRESS	
1	0	1	1	1	0	47,104	134 000	†
1	0	1	1	1	1	48,128	136 000	
1	1	0	0	0	0	49,152	140 000	* †
1	1	0	0	0	1	50,176	142 000	
1	1	0	0	1	0	51,200	144 000	†
1	1	0	0	1	1	52,224	146 000	
1	1	0	1	0	0	53,248	150 000	* †
1	1	0	1	0	1	54,272	152 000	
1	1	0	1	1	0	55,296	154 000	†
1	1	0	1	1	1	56,320	156 000	
1	1	1	0	0	0	57,344	160 000	* †
1	1	1	0	0	1	58,368	162 000	
1	1	1	0	1	0	59,392	164 000	†
1	1	1	0	1	1	60,416	166 000	
1	1	1	1	0	0	61,440	170 000	* †
1	1	1	1	0	1	62,464	172 000	
1	1	1	1	1	0	63,488	174 000	†
1	1	1	1	1	1	64,512	176 000	
Highest Directly Addressable Memory Location ⟶						65,535	177 777	

*4K Dynamic Memory Board Selections

† PROM MEMORY CARD SELECTIONS

88-4MCD
(4K Dynamic RAM)
Parts List
Sept. 1975

BAG 1

1	MC7805	101074
1	MC7812	101085
2	26L123	101066
1	74L00	101080
1	SN74L02	101072
1	74LS04	101042
1	SN7406	101054
1	74L20	101039
2	7473	101027
2	SN74L193	101087
1	SN74193	101037
4	N8T97	101040
2	74L04	101073
1	74LS00	101069

BAG 2

1	8212	101071
8	TI4060-2	101094
8	22 pin sockets	102108
1	24 pin socket	102105

BAG 3

2	.001mF 12v cer	100328
2	470pF 10v cer	100316
3	33mF 16v elec	100326
2	20pF 12v cer	100334
1	100pF 12v cer	100361
1	220pF 12v cer	100314
1	.01 16v	100321

BAG 4

17	.1mF 12v cer	100348

BAG 5

2	#6-32 nut	100933
2	6-32 lockwasher	100942
2	#6-32x1/2" screw	100918
1	Heat sink	101870
1	24" 20-gauge wire	103063
3	36" 26-gauge wire	103060
1	Edge connector	101864
2	Card guides	101714

BAG 6

1	EN2907	102804
5	IN914	100705
1	5.1v zener	100721

BAG 7

2	100 ohm 1/2w	101924
3	1K ohm 1/2w	101928
1	22K ohm 1/2w	101933
1	20K ohm 1/2w	101940
1	27K ohm 1/2w	101989
1	43K ohm 1/2w	101988
2	470 ohm 1/2w	101927
2	20 ohm 1/2w	102048
1	330 ohm 1/2w	101926

MISCELLANEOUS

1	PC board	100100
	Manuals	101549