S-100 MPA

USER

MANUAL

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S-100 MPA INSTRUCTION MANUAL - PRELIMINARY

INTRODUCTION

THIS INSTRUCTION MANUAL IS DIVIDED INTO MANY SEPERATE PARTS. THEY ARE:

INTRODUCTION
ASSEMBLY INSTRUCTIONS
OPTION SELECTION
INSTALLATION
THEORY OF OPERATION
PARTS LIST
DRAWINGS

IF YOU PURCHASED YOUR S-100 MPA ASSEMBLED AND TESTED SKIP THE ASSEMBLY INSTRUCTIONS AND PROCEED DIRECTLY TO THE OPTION SELECTION SECTION. IF YOU PURCHASED THE S-100 MPA AS A KIT, PROCEED TO THE ASSEMBLY INSTRUCTIONS.

ASSEMBLY INSTRUCIONS

1. BEFORE ASSEMBLING THIS KIT, READ THE ENTIRE SECTION FIRST! WE WILL ASSUME THAT YOU HAVE ALL THE NECESSARY TOOLS TO SUCCESSFULLY ASSEMBLE THIS KIT. THE NECESSARY TOOLS ARE:

NEEDLE-NOSE PLIERS
WIRE CUTTERS AND STRIPPERS
A GOOD PHILLIPS SCREWDRIVER
25 WATT SOLDERING IRON - NOTE: DO NOT UNDER ANY CIRCUMSTANCES USE A SOLDERING IRON RATED ABOVE 40 WATTS!! WE HAVE FOUND THE WELLER WP-25 IRON TO BE AN EXCELLENT CHOICE.
ROSIN CORE SOLDER - SOLDER IS PROVIDED WITH THIS KIT. BE SURE TO USE IT OR ANY HIGH QUALITY ROSIN CORE SOLDER. DO NOT USE ACID CORE SOLDER. USE OF ACID CORE SOLDER WILL NOT ONLY IMMEDIATELY VOID YOUR WARRANTY, BUT IT WILL RUIN YOUR KIT!

2. WE WILL ALSO ASSUME THAT YOU KNOW HOW TO SOLDER WELL AND ARE GENERALLY FAMILIAR WITH STANDARD TERMINOLOGY. WE WILL ALSO ASSUME THAT YOU KNOW A RESISTOR FROM A CAPACITOR ETC., AND THAT YOU CAN TELL ONE IC FROM ANOTHER.

ALTHOUGH THIS IS BY NO MEANS A DIFFICULT KIT TO ASSEMBLE, IT IS ALSO DEFINITELY NOT SUITABLE FOR A BEGINNER'S FIRST PROJECT.

CAREFULLY READ THE ASSEMBLY INSTRUCTIONS AND IF YOU DOUBT YOUR ABILITY TO ASSEMBLE THIS KIT WITHOUT PROBLEMS, WE STRONGLY SUGGEST YOU RETURN THIS KIT AND EXCHANGE IT FOR AN ASSEMBLED UNIT. TO THOSE WHO ARE EXPERIENCED AT PUTTING THINGS TOGETHER THIS MAY SOUND A BIT INSULTING, BUT WE WANT EVERYBODY TO HAVE A WORKING SYSTEM THE FIRST TIME.

3. BEGIN BY EXAMINING THE S-100 MPA BOARD. YOU WILL NOTICE THAT ONE SIDE HAS A COMPONENT PLACEMENT LEGEND SILK-SCREENED ONTO IT. THIS WE SHALL CALL THE COMPONENT SIDE. THE REVERSE SIDE WILL BE REFERRED TO AS THE SOLDER SIDE OF THE BOARD. ALL COMPONENTS ARE INSERTED FROM THE COMPONENT SIDE AND SOLDERED ON THE SOLDER SIDE.

ALSO PROVIDED WITH THE S-100 MPA IS A SMALL BOARD WITH NO SOLDER MASK (THE GREEN GOOP) OR LEGEND ON IT. HOWEVER YOU WILL NOTICE THAT IT HAS FOIL "TRACES" ON ONE SIDE ONLY. THIS IS THE SOLDER SIDE OF THAT BOARD. OBVIOUSLY THE OTHER SIDE IS THE COMPONENT SIDE. THIS IS CALLED THE TRANSISTION BOARD.

4. IF YOU HAVEN'T ALREADY DONE SO, NOW IS THE TIME TO CHECK THE PARTS LIST TO SEE IF ANY ARE MISSING. IF THERE HAPPEN TO BE ANY MISSING, REPORT THE DISCREPANCY TO US OR YOUR DEALER IMMEDIATELY. YOUR DEALER CAN USUALLY PROVIDE YOU WITH REPLACEMENT PARTS FASTER THAN WE CAN AT THE FACTORY.

5. NOW WE CAN BEGIN THE ACTUAL ASSEMBLY OF YOUR S-100 MPA. BEGIN BY INSTALLING THE IC SOCKETS. THREE SIZES OF SOCKETS ARE PROVIDED WITH YOUR S-100 MPA KIT - 20 PIN, 16 PIN AND 14 PIN. TAKE A LOOK AT FIGURE #1 WHILE EXAMINING AN IC SOCKET. NOTE HOW PIN ONE OF THE SOCKET IS DESIGNATED. WHEN INSTALLING ALL SOCKETS MAKE SURE THAT THEIR PIN ONE DESIGNATION POINTS UPWARD.

HERE'S HOW TO INSTALL A SOCKET: INSERT THE SOCKET FROM THE COMPONENT SIDE OF THE BOARD UNTIL IT'S PLASTIC BODY IS FLUSH WITH THE BOARD. WHILE HOLDING THE SOCKET IN PLACE, INVERT THE BOARD AND BEND TWO LEADS ON OPPOSITE CORNERS OUTWARD AT A 45 DEGREE ANGLE TO HOLD THE SOCKET IN PLACE. SET THE BOARD COMPONENT SIDE DOWN ON YOUR WORK TABLE AND THEN SOLDER THE OTHER TWO LEADS ON OPPOSITE CORNERS TO PERMANENTLY FIX THE SOCKET IN PLACE. IF FOR SOME REASON THE SOCKET IS NOT FLUSH WITH THE BOARD, NOW IS THE TIME TO REPOSISTION IT. DO THIS BY REHEATING THE SOLDERED LEAD WHILE APPLYING PRESSURE TO THE SOCKET FROM THE COMPONENT SIDE. REPEAT FOR THE OTHER LEAD. THEN REBEND THE OTHER TWO LEADS (BENT EARLIER) TO THEIR ORIGINAL UPRIGHT POSISTION AND SOLDER ALL OF THE REMAINING LEADS.

THERE ARE OTHER METHODS OF SOLDERING SOCKETS IN PLACE, AND IF YOU KNOW OF ONE THAT YOU LIKE BETTER FEEL FREE TO USE IT - AS LONG AS IT WORKS SATISFACTORILY!

SOLDER IN THE 20 PIN SOCKETS FIRST. THESE ARE AT IC LOCATIONS 12,13,23,24 AND 25.

NEXT DO THE 16 PIN SOCKETS. THESE ARE LOCATED AT IC LOCATIONS 4,5,9,10,11,22 AND 26. BE CAREFUL NOT TO INSTALL SOCKETS IN THE TWO SPARE LOCATIONS JUST ABOVE IC4 AND JUST TO THE RIGHT OF IC16.

LASTLY INSTALL THE 14 PIN SOCKETS. THESE ARE LOCATED AT IC LOCATIONS 1,2,6,7,8,14,15,16,18,19,21,27 AND 28. AGAIN BE CAREFUL TO AVOID THE SPARE IC LOCATIONS.

6. NEXT INSTALL THE RESISTORS. DO THIS BY BENDING THE RESISTOR LEADS AT RIGHT ANGLES TO THE RESISTOR AND INSERTING THE RESISTOR LEADS THROUGH THEIR PROPER MOUNTING HOLES. PULL THE RESISTOR FLUSH TO THE BOARD BY GRASPING THE LEADS ON THE SOLDER SIDE. BE SURE TO BEND THE LEADS TO THE PROPER SPACING FOR THOSE WITH LEAD BENDERS (RECOMMENDED HIGHLY) ALL THE RESISTORS ON THE S-100 MPA ARE .4 INCHES SPACING.

ONCE THE RESISTOR IS PULLED FLUSH TO THE BOARD, SOLDER IT'S LEADS ON THE SOLDER SIDE AND THEN TRIM THEM AS CLOSE TO THE BOARD AS POSSIBLE.

YOU MAY WISH TO INSERT TEN OR SO RESISTORS AT ONE TIME AND THEN SOLDER THEM ALL AT ONCE. THIS IS PERFECTLY OK.

MOST OF THE RESISTORS ON THE S-100 MPA ARE 1K OHMS (BROWN/BLACK/RED). INSTALL THESE FIRST.

1K RESISTORS (BROWN/BLACK/RED) GO IN LOCATIONS R1 THROUGH R9, R11, R12, R13, R15, R16, R23 THROUGH R27, R29, R30, AND R32 THROUGH R36.

THE REMAINING RESISTORS ARE ASSORTED VALUES AND ARE INSTALLED IN ACCORDANCE WITH THE FOLLOWING TABLE:

R#	VALUE	COLOR CODE
R14	20K	RED/BLACK/ORANGE
R17	1.5K	BROWN/GREEN/RED
R18	7.5K	VIOLET/GREEN/RED
R19	3.9K	ORANGE/WHITE/RED
R20	750 OHMS	VIOLET/GREEN/BROWN
R21	470 OHMS	YELLOW/VIOLET/BROWN
R22	6.8K	BLUE/GRAY/RED
R28	750 OHMS	VIOLET/GREEN/BROWN
R31	100 OHMS	BROWN/BLACK/BROWN
R37	270 OHMS	RED/VIOLET/BROWN
R38	180 OHMS	BROWN/GRAY/BROWN
R39	10K	BROWN/BLACK/ORANGE

NOTE THAT R10 IS NOT INSTALLED UNLESS YOU HAVE THE STAND ALONE OPTION, IN WHICH CASE IT WILL BE INSTALLED LATER.

7. NEXT WE WILL INSTALL THE ZENER DIODE D3. IT IS A 1N751A AND IT GOES IN THE LOWER LEFT-HAND CORNER OF THE BOARD. LOOK AT THE DIODE AND NOTE THE BAND AT ONE END. WHEN INSTALLING THE DIODE MAKE SURE THIS BAND IS TOWARD THE RIGHT. A SIMILAR BAND IS SHOWN ON THE COMPONENT LEGEND.

THE DIODE INSTALLS VERY SIMILAR TO A RESISTOR. SOLDER THE DIODE AND TRIM IT'S LEADS AS CLOSE TO THE BOARD AS POSSIBLE.

8. NEXT ARE THE CAPACITORS. THERE ARE THREE TYPES OF CAPACITORS INCLUDED WITH YOUR S-100 MPA. THESE ARE DISC CERAMIC, DISC SILVER MICA, AND TANTALUM ELECTROLYTICS. WE WILL INSTALL EACH TYPE SEPERATELY.

FIRST LOCATE THE 36 PF SILVER MICA DISC CAPACITOR. THIS CAPACITOR IS DISTINGUISHED BY IT'S DEEP BROWN, SHINY CERAMIC CASE. THERE IS ONLY ONE OF THESE IN THE ENTIRE KIT.

INSTALL THIS CAPACITOR IN LOCATION C8. NOTE THAT THERE IS NO VALUE SHOWN ON THE LEGEND. DON'T WORRY, IT'S 36 PF. C8 IS LOCATED TO THE RIGHT OF IC5.

INSERT THE LEADS THROUGH THE PROPER HOLES AND PULL THE CAPACITOR SO THAT IT'S CASE BOTTOM IS FLUSH WITH THE BOARD. BEND THE LEADS AT 45 DEGREE ANGLES TO THE BOARD TO HOLD THE CAPACITOR IN PLACE. THEN SOLDER AND TRIM THE LEADS AS CLOSE TO THE BOARD AS POSSIBLE.

IN A SIMILAR MANNER INSTALL THE CERAMIC DISC CAPACITORS. THE MAJORITY OF THESE ARE .047 MF. THESE CAN BE MARKED EITHER .047 OR 473. INSTALL THESE AT LOCATIONS C2,C6, AND C12 THROUGH C22. THE REST OF THE CERAMIC DISC CAPACITORS ARE ASSORTED VALUES AND ARE INSTALLED ACCORDING TO THE FOLLOWING TABLE:

C#	Value	MARKINGS	
C3	.0047 mfd	.0047 or 472	NOTE: THE LEGEND IS MARKED
C4	.0047 mfd	.0047 or 472	.005 FOR THESE TWO CAPACITORS
C5	.047 mfd	.047 or 473	NOTE: LEGEND MARKED 100
C7	.1 mfd	.1	
C10	.1 mfd	.1	
C11	.047 mfd	.047 or 473	NOTE: LEGEND MARKED 100

NOTE THAT C1 AND C9 ARE NOT INSTALLED.

FINALLY INSTALL THE THREE DIPPED TANTALUM ELECTROLYTIC CAPACITORS. NOTE THAT THESE DEVICES ARE POLARITY SENSITIVE. THE POSITIVE LEAD WILL BE DESIGNATED EITHER WITH A '+' OR WITH A COLORED DOT. BE SURE TO INSTALL THE + END IN THE HOLE MARKED + ON THE COMPONENT LEGEND.

THESE THREE CAPACITORS ARE 10 MF AND ARE LOCATED AT C23, C24, AND C25. C23 AND C24 ARE NEAR THE BOTTOM LEFT-HAND CORNER OF THE BOARD AND ARE INSTALLED WITH THE + LEAD TOWARDS THE RIGHT. C25 IS NEAR THE BOTTOM RIGHT-HAND CORNER OF THE BOARD AND IS INSTALLED WITH THE + LEAD TOWARDS THE LEFT. NOTE - C23 IS ERRONEOUSLY MARKED '1' ON THE LEGEND.

SOLDER THE LEADS AND TRIM AS CLOSE TO THE BOARD AS POSSIBLE. DOUBLE CHECK THE POLARITY!!!

9. NEXT WE WILL INSTALL IC17 AND IT'S HEATSINK. IC 17 IS A DEVICE WITH THREE LEADS AND A MOUNTING TAB. IT IS A 7805 REGULATOR. IT MAY ALSO BE MARKED LM340T-5 OR SIMILAR.

HOLDING IC17 IN POSISTION AT THE LOWER LEFT-HAND CORNER OF THE BOARD, OBSERVE HOW IT'S LEADS MUST BE BENT IN ORDER TO MOUNT IT. BEND THE LEADS ACCORDINGLY. CHECK TO MAKE SURE THEY ARE BENT OK.

NOW POSISTION THE HEATSINK SO THAT IT LINES UP WITH THE MOUNTING HOLE. HOLDING IT IN PLACE, INSTALL IC17 SO THAT THE HEATSINK IS SANDWICHED BETWEEN THE BOARD AND THE MOUNTING TAB OF IC17. INSTALL THE SCREW FROM THE BACK/SOLDER SIDE OF THE BOARD THROUGH THE BOARD, HEATSINK AND THE MOUNTING TAB. INSTALL THE LOCKWASHER ONTO THE SCREW AND THEN THE NUT. TIGHTEN THE WHOLE ASSEMBLY DOWN SECURELY.

NOW INVERT THE BOARD AND SOLDER THE LEADS OF IC17 AND TRIM THEM OFF AS CLOSE TO THE BOARD AS POSSIBLE.

10. NEXT WE WILL INSTALL THE TRANSISTOR. IT IS A 2N3904 AND IS LOCATED NEAR THE LOWER RIGHT-HAND CORNER OF THE BOARD. NOTE THAT IT'S SHAPE IS SIMILAR TO THE SHAPE ON THE COMPONENT LEGEND. ORIENT THE TRANSISTOR SO THAT IT'S SHAPE MATCHES THAT ON THE LEGEND AND INSERT IT'S THREE LEADS INTO THE HOLES THAT THEY WOULD NATURALLY FIT INTO. PUSH THE TRANSISTOR DOWNWARDS UNTIL IT'S ABOUT 1/4 INCH ABOVE THE BOARD AND BEND IT'S LEADS ON THE SOLDER SIDE TO HOLD IT IN PLACE. INVERT THE BOARD AND SOLDER THE LEADS. TRIM AS CLOSE TO THE BOARD AS POSSIBLE.

11. NEXT INSTALL THE 8 POSISTION DIP SWITCH IN THE UPPER LEFT-HAND CORNER OF THE BOARD. ORIENT IT SO THAT THE NUMBERS ON THE SWITCH ARE AT THE TOP AND THE 'ON ARROW' POINTS UPWARD. THE DIP SWITCH IS INSTALLED SIMILAR TO AN IC SOCKET. SOLDER ALL THE LEADS.

12. FINALLY INSTALL THE 50 PIN RIGHT ANGLE CABLE HEADER. THIS GOES APPROXIMATELY IN THE MIDDLE OF THE BOARD AT THE TOP. NOTICE THAT THE HEADER HAS STRAIGHT PINS AND BENT PINS. INSERT THE BENT PINS, FROM THE COMPONENT SIDE, INTO THE HOLES IN THE BOARD SO THAT THE STRAIGHT PINS POINT TOWARDS THE TOP OF THE BOARD. MAKE SURE THAT THE HEADER IS FIRMLY SEATED, INVERT THE BOARD AND SOLDER ALL 50 PINS. TAKE CARE NOT TO CREATE SOLDER BRIDGES BETWEEN THEM.

13. ALL THAT REMAINS IS TO PLUG THE IC'S IN THEIR SOCKETS. NOTE THE END NOTCH OR SIMILAR DESIGNATION FOR PIN ONE ON EACH IC. WHEN PLUGGING THE IC'S IN THEIR SOCKETS, MAKE DOUBLY SURE THAT PIN ONE GOES IN THE UPPER LEFT OF EACH SOCKET!!

THE IC'S ARE INSTALLED ACCORDING TO THE FOLLOWING TABLE:

IC#	DESIGNATION
IC1	74LS136
IC2	74LS136
IC4	74LS193
IC5	XR-215
IC6	74LS74
IC7	74LS20
IC8	74LS08
IC9	74148 OR 74LS148
IC10	74LS157
IC11	74LS157
IC12	81LS97 OR 81LS95
IC13	81LS97
IC14	74LS08
IC15	74LS08
IC16	74LS04
IC18	74LS74
IC19	74LS02
IC20	74LS00
IC21	74LS04
IC22	74367 OR 8097 OR 8T97
IC23	81LS97 OR 81LS95
IC24	81LS97
IC25	81LS97 OR 81LS95
IC26	74367 OR 8097 OR 8T97
IC27	74LS02
IC28	74LS74

THIS COMPLETES ASSEMBLY OF YOUR S-100 MPA KIT.

NOTE: DUE TO COMPONENT AVAILABILITY YOUR S-100 MPA MAY BE SUPPLIED WITH 81LS95'S SUBSTITUTED FOR 81LS97'S FOR IC'S 12, 23 & 25. DO NOT SUBSTITUTE THEM FOR IC'S 13 OR 24!!!!!!!!! AGAIN - 81LS95'S CAN GO IN IC LOCATIONS 12, 23 & 25 ONLY!!!!

ASSEMBLY OF THE TRANSISTION BOARD

1. THIS IS THE SMALL PC BOARD THAT HAS A 40/80 PIN CONNECTOR TACK-SOLDERED TO IT - NOTE THAT THIS CONNECTOR IS ONLY TACKED ON - BE CAREFUL NOT TO STRESS IT OR IT MAY BE DAMAGED.
THE FUNCTION OF THIS BOARD IS TO ADAPT THE 40/80 PIN CONNECTOR WHICH PLUGS ONTO THE MEMORY EXPANSION CONNECTOR ON THE PET TO THE 50 PIN FLAT-CABLE HEADER. WE DID THIS SO YOU WOULDN'T HAVE TO STRIP, SEPERATE AND SOLDER 50 INDIVIDUAL CONNECTIONS.

2. IF YOU EXAMINE THIS BOARD YOU WILL NOTICE THAT ONLY ONE SIDE HAS FOIL 'TRACES' ON IT. THIS IS THE SOLDER SIDE AND OBVIOUSLY THE OTHER SIDE IS THE COMPONENT SIDE.

3. THE 40/80 PIN CONNECTOR HAS ALREADY BEEN TACK-SOLDERED IN PLACE FOR YOUR CONVENIENCE. SET THE BOARD COMPONENT SIDE DOWN ON YOUR WORK TABLE AND FINISH SOLDERING THE LEADS OF THE CONNECTOR TO THE FINGERS ON THE PC BOARD IN A MANNER SIMILAR TO WHAT HAS ALREADY BEEN DONE. TAKE CARE NOT TO CREATE SOLDER BRIDGES BETWEEN THE PINS.

4. LOCATE THE REMAINING 50 PIN RIGHT ANGLE HEADER. NOTICE THAT IT HAS BOTH STRAIGHT PINS AND BENT PINS. INSERT THE BENT PINS, FROM THE COMPONENT SIDE, THROUGH THE HOLES IN THE BOARD SO THAT THE STRAIGHT PINS POINT AWAY FROM THE 40/80 PIN CONNECTOR. INVERT THE BOARD AND SOLDER ALL 50 OF THE PINS TAKING CARE NOT TO CREATE SOLDER BRIDGES BETWEEN THEM.

5. FIND TWO LENGTHS OF RESISTOR LEAD YOU TRIMMED OFF DURING ASSEMBLY OF THE MAIN BOARD. INSERT ONE OF THE LEADS THROUGH ONE OF THE HOLES MARKED 'G' AT EITHER END OF THE BOARD SO THAT AT LEAST 3/4 OF AN INCH PROTRUDES FROM THE COMPONENT SIDE. SOLDER THE LEAD IN PLACE. TRIM OFF ANY EXCESS ON THE SOLDER SIDE. AFTER IT HAS COOLED, BEND THE LEAD OVER TOWARDS THE UN-CONNECTED PINS OF THE 40/80 PIN CONNECTOR UNTIL IT TOUCHES THE ONE ON THE END. SOLDER THE WIRE LEAD AND THE CONNECTOR PIN TOGETHER AND TRIM ANY EXCESS AWAY. REPEAT THE PROCEEDURE FOR THE OTHER END OF THE BOARD.

THIS COMPLETES ASSEMBLY OF YOUR TRANSISTION BOARD.

VERY CAREFULLY INSPECT THIS BOARD FOR SOLDER BRIDGES AND SHORTS!!

These are most likely to occur between the pins of the right angle header where traces pass through the pins.

Stand Alone Option Instructions S-100 MPA

1. Once you have completed assembly of the S-100 MPA you will need to install some extra components to get the S-100 MPA to function as a stand alone CPU board. These extra components are contained in their own seperate bag and should consist of a 6502 chip, a 40 pin socket, a 10 pf capacitor, a 330K resistor (orange/orange/yellow), a 1 Mhz crystal and two 1N914 diodes.

2. Begin by installing the 40 pin IC socket. It goes in the space marked IC 3. Note that it's pin 1 designation goes toward the left side of the board. Invert the board and solder all the pins taking care not to create solder bridges between them.

3. Next install the 330K resistor (orange/orange/yellow) in the posistion marked R10. Invert the board and solder both leads and trim them off as close to the board as possible.

4. Next install the two 1N914 diodes in the posistions marked D1 and D2. Note that these are polarity sensitive! Make sure the banded end on the diode matches the band on the component legend. (D1 band towards the left and D2 band towards the right.) Invert the board and solder the leads, then trim.

5. Install the 10 pf capacitor in the location marked C1. Invert the board, solder and trim.

6. Lastly install the 1Mhz crystal. Posistion the crystal over the large pad just to the left of the IC3 socket so that the crystal's leads point upward. Note where they must be bent to go through the two holes at the top of the pad. Bend the leads accordingly. Insert the crystal's leads through the holes and push the crystal downwards until it lies flush to the board. Using a spare piece of component lead, strap the crystal down to the pad by soldering a U shaped lead over the crystal into the two holes at the left and right sides of the pad.

7. Plug the 6502 IC into the socket at IC3. Note that this is a MOS device and is static sensitive! When performing this operation avoid as much movement as possible and wear all cotton clothing. Be sure to orient the 6502 so that it's pin one designation is at the left.

8. The last thing to do is to remove IC7 (74LS20) and IC9 (74148). Carefully remove them from their sockets and save them in a safe place. Next, using spare piece of component lead, istall a jumper between the two pads labeled CLOCK. These are located just above IC26. Note that if you wish to go back to the PET/S-100 configuraion it will be necessary to remove this jumper and to reinstall IC's 7 and 9 and to remove the 6502,IC3.

OPTION SELECTION

1. There are only a few options that need to be selected on the S-100 MPA. One is for the I/O address page select. One is if you have a 4K PET. The last is the address mirror enable.

2. The I/O address select is done via the DIP switch in the upper left-hand corner of the S-100 MPA. Since the 6502 processor does not have any I/O instructions, it must use memory locations as I/O addresses. The 8080 processor however has 256 unique I/O addresses. To simulate the 8080 type I/O, the S-100 MPA decodes 1 256 byte block of memory and makes it look like 8080 I/O addresses to the S-100 Bus. The DIP switch selects which 256 byte block is decoded.

The highest address decoded from the PET by the S-100 MPA is BFFF hex. The highest 256 byte block is therefore BF00 hex. This is the block that we reccommend you choose for the I/O page. Any software we may provide in the future will assume this block.

To set the DIP switch for the 'standard' block, all that is needed is to set all the switches to the up posistion (on) except switch #2. This is also marked with a 6 on the component legend but is switch #2 on the switch itself.

If you wish to set up for a differrent block, then the switches would represent the 8 highest address lines with switch #1 (marked 7 on the legend) representing A15 and switch #8 (marked 0 on the legend) representing A8. The on posistion is a 1 for that address line and the off posistion is a 0. So if you wanted block A9 for example, you would set switches 1,3,5 and 8 on and switches 2,4,6 and 7 off.

Note that for use with the PET only address blocks 9 through B are available due to the PET design.

3. If you have a 4K PET you will need to install a jumper at the place marked 4k on the S-100 MPA circuit board. This is located just above IC8. If you have an 8K PET, nothing need be done.

4. The normal 8080 I/O address mode is to put it's unique 8 bit I/O address out onto the lower 8 address lines and the same address on the upper 8 address lines. The S-100 incorporates an address mirror circuit to simulate the 8080 I/O instruction more faithfully.

If for some reason you do not desire this address mirror to be active, you can defeat it by cutting the trace on the solder side of the board betwwen AM and ON and installing a jumper between AM and OFF. The location of this jumper is just above IC9.

This completes the option selections of your S-100 MPA.

S-100 MPA INSTALLATION - PET

NOTE:BE SURE THAT THE POWER TO THE PET AND TO YOUR MAINFRAME ARE BOTH OFF BEFORE PROCEEDING!!!!!

1. First make sure you have a proper mainframe to use with the S-100 MPA. This means either a chassis, power supply and motherboard package such as an IMSAI, Vector Graphics, TEI, or Integrand or similar. Alternatively you can have a motherboard and power supply of your own design, but be sure it works and you know what you are doing. In any case be sure to verify that your system is operating properly before proceeding.

2. Now you must decide whether or not you want your system to have DMA (Direct Memory Access) and wait state capability. If you do, you will need to install two jumpers inside the PET computer. Proceed immediately to the section on modifying the PET. If you don't need wait states and DMA - most users probably don't - then you do not need to modify your PET. Anyway, you can do it any time in the future you wish.

3. Begin by attatching the ribbon cable to the Transistion Board. If you examine the cable you will notice that it has a red stripe down one side. This identifies pin one of the cable assembly. Holding the Transistion Board so that the solder side is facing downwards and the right angle header is on the top, plug the ribbon cable onto the header so that the cable exits it's socket downward. This should posistion the red stripe nearest the "1" on the solder side of the board. Make sure that all the pins mate and that you have not skewed the connector by any pin posistions.

4. Next plug the Transistion Board assembly onto the Memory Expansion connector on the right side of the PET. Make sure the solder side of the transistion board faces down. This should leave the red stripe on the ribbon cable facing towards the front of the PET..

5. Plug the S-100 MPA into the front slot of your chassis or motherboard. It helps to have the chassis assembly sitting just to the right of the PET.

Then plug the remaining end of the ribbon cable onto the right angle header at the top of the S-100 MPA board. The cable stripe should be on the same side as the arrow silk-screened onto the board. Again check to make sure that all the pins mate and that you have not skewed the connector by any pin posistions.

6. This completes installation of your S-100 MPA. All that remains is to apply power to the chassis and then to the PET, of course after installing any memory boards or peripherals into your S-100 mainframe. Note: unless you have a RESET switch on your mainframe (recommended) always power-up the mainframe first, then the PET. Otherwise the PET won't know what's out there.

NOTE: BE SURE THE PET IS UNPLUGGED BEFORE PROCEEDING!!!!

1. You should be at this section if you desire your PET/S-100 system to have DMA and wait states. If you do not need these functions then you don't need to modify your PET.

2. Begin by opening up the PET chassis. Do this by removing the 4 large Phillips head screws located under the upper chassis lip of the PET near the front. We suggest you use a good quality Phillips head screwdriver to do this. If you use an inferior screwdriver you may strip the screws, ruining the serviceability of your PET.

Once you have the four screws removed, open up the PET and prop it up using the "dip-stick" attatched to the left side of the upper chassis.

3. Examine Figure 2 in the Drawings section of this manual. Note the approximate posistions of the Keyboard connector, Tape Deck connector, Power Supply connector and CRT connector.

Taking careful notes on paper of the orientation of each of these connectors (use the individual wire colors as a guide) carefully remove the connectors from the PET PC board by gently pulling them upward.

4. Again examining Figure 2, note that the PET PC board is secured by three nylon mounting pins, two sheet metal screws and one machine screw.

Using a good quality Phillips head screwdriver, remove the two sheet metal screws and the one machine screw. Put them in a safe place where they won't get lost. While removing the screws, note the differences between them. It will be necessary to put them back in the proper places later.

Next, while providing a gentle upward pressure to the PC board, push in the tab on the nylon mounting pin so that the PC board is freed. Repeat for the other two mounting pins.

Your PC board should now simply lift out of the chassis.

5. Turn the PET PC board upside down and orient it as in Figure 3. Using the figure as a guide, find the pins of the 6502 IC and the pins of the 10 k (brown/black/orange) resistor.

Using the figure as a guide, install the two jumpers shown using #28 hook-up wire. Do this by first putting some extra solder on the connection points. Be sure not to create solder bridges between the traces. Also apply a small amount of solder to the very tip of the memory expansion connector fingers where it is shown on the figure (pins 31 and 32).

Then, using the wire, measure the distance between the hook-up points plus a little slack and cut the wire to the proper length. Strip about 1/8 th of an inch of insulation from either end of the wire and solder it in place. Take extreme precaution not to create solder bridges between anything.

Repeat this procedure for the other jumper.

6. Reinstall the PET PC board into it's chassis by posistioning it over the nylon mounting pins and gently pressing downward on the board until it snaps in place.

Then reinstall the two sheet metal screws and the one machine screw in their proper places. Be sure not to interchange the machine screw with a sheet metal screw or vice versa! Also be careful not to over-tighten these screws.

Finally, using your notes and figure 2 as a guide, reinstall the cables that you removed in step 3. Be extremely careful not to skew any of the connectors by any posistions - especially the power supply connector!

Double check that your cables are correctly reinstalled.

Lower the cover and reinstall the four screws that secure the cover. Be careful not to over-tighten these screws.

This completes the modification of your PET Computer.

S-100 MPA Theory of Operation

The S-100 MPA has two basic functions. 1. A PET to S-100 bus adapter and 2. A 6502 CPU board for the S-100 bus. In this section we will describe how it performs both those functions. First we will deal with the PET to S-100 bus configuration.

A bit of background on the PET is in order. The PET's memory expansion bus consists of mainly the basic processor signals - the bidirectional data bus, the address bus and the miscellaneous CPU control lines like R/W, IRQ and Ø2. (referring to a 6502 hardware manual will be helpful in understanding the function of these lines.)

Although the basic processor signals are brought out to the memory expansion bus, there are a few important exceptions.

The address bus normally consists of 16 bits, however the PET only brings out the lower twelve bits. The upper four bits are decoded inside the PET to 16 "address selects" (using a 74154) one for each 4k byte page of memory. Of the 16 possible selects only 10 are brought out to the epansion bus. This is Commodore's way of "protecting" those pages from user use.

The R/W line is gated by several things inside the PET so it is not really normal.

RDY and SYNC are not brought out to the bus (nor are they used internally), but RDY is necessary for DMA and wait states. We have you modify your PET to bring these lines out if you want DMA and wait states. SYNC is just a status signal, but while you're in there we have you bring it out too.

A chart of the memory expansion bus and how it translates to the 50 conductor ribbon cable system used by the MPA is in the appendix.

Now that we understand what comes out of the PET we can begin the explanation of what the S-100 MPA does with those signals.

First we'll begin with the clock section. Ø2 from the PET is running at 1 Mhz. In order to maintain IEEE specs for the S-100 bus, Ø1 and Ø2 on the S-100 bus have to run at 4 Mhz, not 1 Mhz. This is because the 6502 does an equivalent amount of work at 1 Mhz compared to an 8080 or Z-80 at 4 Mhz. Therefore the clock had to be "dummied up" to make the 6502 look like an 8080 on the bus.

IC5, an XR-215 is a high frequency phase-locked-loop (PLL) with a free running frequency determined by C8 to be 8 Mhz. One of the inputs to the PLL is Ø2 from the PET at 1 Mhz. The output of the PLL is not TTL compatible so it goes through one section of IC15, an AND gate wired as a schmitt trigger with R21 and R22. The output of the schmitt trigger goes to IC4 a 74LS193 4 bit binary counter. This divides the 8 Mhz input to 4,2,1, and .5 Mhz. The 1 Mhz output (pin 6) feeds the other input to the PLL. The PLL then "locks" itself to the Ø2 signal from the PET. This configuration is known as a frequency synthesizer because we are synthesizing an 8 Mhz signal from a 1 Mhz signal. All the resultant frequencies are then "phase locked" to the PET's Ø2.

The 4 Mhz output from IC4 is buffered and becomes the S-100 Ø2. It is gated with 8 Mhz through a section of IC27, buffered and this becomes Ø1.

The S-100 bus always wants to see 2 Mhz at pin 49 (CLOCK) regardless of the processor speed and the 2 Mhz counter output provides this function.

Next we'll describe the address bus. The first task is to take the decoded upper address bits (SEL lines) and re-encode them. This is accomplished by IC's 7,8 and 9. IC8 a 74148 8 line to 3 line encoder does the bulk of the work. Basically when any input goes low a corresponding bit pattern is generated at the three outputs. Also, the EO line (pin 15) goes high when any input is active. This IC only encodes three out of the four lines we need so IC's 7 and 9 help it out. The output of IC7 becomes A15. It is normally low but if SEL9, A or B goes low then the output will go high. SEL9, $\bar{A}$ and $\bar{B}$ also go through sections of IC9 to select the proper three bit pattern for A12,13 and 14 and also trigger the enable output (EO). The EO line then tells us when any SEL line is active, and therefore we can distinguish between internal and external PET operations. This is necessary in later circuitry. Now we have are four re-encoded address bits, A12 -15.

Before the 16 address lines get to the S-100 bus however, they must go throygh some further processing. The 8080 and Z80 decode 256 addresses for I/O instructions. The 6502 has no such internal decode, but uses memory locations for I/O addresses. In order to simulate 8080 type I/O we use a block of 256 bytes of memory addresses and convert them to I/O addresses. There are 256 possible 256 byte blocks in the memory map. IC's 1 and 2 form an 8 bit comparator that compares the upper 8 address lines to the setting on the dip switch. When they are equal (actually the complement of equal) the output of the array will go high. This signal then tells us when we are doing an I/O instruction - actually a read or write to a location in the specified block.

During an I/O instruction the 8080 outputs the port address on the lower 8 address lines and <u>also</u> on the upper 8 lines. The upper 8 address lines in the S-100 MPA are routed through IC's 10 and 11, 74LS157's. These are quad 2 input multiplexers with a select line (pin 1) telling the output to follow either the A or B input. Normally the select line is low allowing the upper 8 address lines to proceed to the output. However during an I/O instruction the select line will go high selecting the lower 8 address lines as input. This "mirrors" the lower 8 bits in the upper 8 bits to the bus simulating 8080 type I/O. This feature can be disabled by permanently grounding the select line by cutting the trace connecting AM to ON and installing a jumper from AM to OFF.

The thus processed 16 bit address bus is then buffered by IC's 12 and 23 and goes out to the S-100 bus. The buffers can be tri-stated by the ADR DISABLE line.

Next we will discuss the data bus. The 6502 and PET both have a bidirectional data bus. This means that data can flow both ways on the same lines. The S-100 bus has a seperate bus for data outputted from the CPU (DO bus) and data inputted to the CPU (DI bus). IC's 13 and 24 are used to buffer these busses. When the PET or 6502 is writing data, the DO buffers are turned on and the DI buffers are tri-stated. The converse is obvious. The signal that controls the buffer states a function of R/W and the EO line described in the address section. The PET R/W line is "anded" with PET Ø2 by a section of IC20 after being inverted by a section of IC16. That output is then "anded" with the EO signal. This becomes the PDBIN signal and it goes high during a processor read. This is then inverted by a section of IC19 and applied to the tri-state controls of the DI buffers.

This turns them on during a read and off during a write. The same signal is then re-inverted by a section of IC20 and applied to the tri-state controls of the DO buffers. This turns them off during a read and on during a write. If DO DISABLE is low, the DO buffers will always be disabled.

Now let's examine the Command Control bus logic. First is PSYNC. This signal on the 8080 signifies the begining of a machine cycle. This happens only once for every three to five cycles on an 8080. The 6502 however does an equivalent amount of work in only one cycle. Therefore every cycle is a machine cycle - except during a wait cycle or a DMA cycle. IC's 28,27 and 16 generate the PSYNC signal at precisely the right time related to the S-100 bus Ø2. PSYNC will be inhibited by either a PHLDA (signifying DMA) or PWAIT(signifying a wait cycle). These two signals are "ored" by a section of IC27 and applied to the reset input of IC28.

XRDY and PRDY are the two wait request signals to the CPU. They are "anded" together by a section of IC20. The resulting output is applied to the clock input of 1/2 of IC18. When either RDY is asserted a one is clocked into IC18. This goes through a section of IC19 and into the PET or 6502. This stops the processor if it is in a read cycle. On the next rising edge of PET Ø2 this signal is clocked into the second section of IC18. The output becomes the PWAIT signal. This signal "unsets" IC6 and on the second rising edge of PET Ø2 clocks a zero into it. The output then resets the entire network and it is then ready for the next RDY request.

The PHOLD signal requests a DMA from the processor. It is inverted by a section of IC19 and is applied to the D input of a section of IC6. When PET Ø2 rises it is transferred to the Q output. This signal then goes through another section of IC19 and then to the RDY line of the 6502. This is also "anded" with R/W in a section of IC15 and applied to the D input of a section of IC28. On the next PET Ø2 rising edge it is clocked to the Q output and this is the PHLDA signal signifying that the 6502 has stopped and is ready for a DMA.

The PDBIN signal generation was described earlier in the data bus section.

$\overline{\text{PWR}}$ is the signal which says the CPU is writing. It is a function of PET Ø2, R/W and the EO line. Basically, PWR is low (active) when PET Ø2 is high, R/W is low and the EO line is high, meaning it's a write to the S-100 bus.

PINTE is not synthesized by the S-100 MPA but it is tied high through a section of IC22 and then to the bus.

The entire Command Control bus word is bufferred by IC22 and can be tri-stated by the CC DISABLE signal.

The last section is the status word. SM1 is an 8080 signal signifying an OP Code fetch cycle. The 6502 SYNC signal is exactly the same thing, so it will do nicely as SM1.

The SOUT signal signifies a write to an I/O port. This is a function of the I/O address comparator (described under the address line section) output and R/W. A section of IC14 "ands" the two signals and the output is SOUT.

The SINP signal is the opposite of SOUT so it is a function of an I/O request and the opposite state of the R/W line. IC14 also provides this function.

SWO is exactly the same signal as PWR except that it is not gated by PET Ø2.

SMEMR signifies a memory read cycle. The I/O request signal is inverted and "anded" with R/W making the output high when it's not an I/O request and it is a read. IC14 does the job here too.

SINTA, SHLTA, and SSTACK are not implemented by the S-100 MPA but they are tied low through IC25 and applied to the bus.

The entire Status Word is buffered through IC25 and may be tri-stated by the STATUS DISABLE line.

For use as a stand-alone 6502 CPU, the 6502 chip replaces the PET signals as far as operation of the logic is concerned. No address re-encoding is required so IC6s 7 and 9 are removed or the jumpers labeled A12 - A15 are cut. The clock components are installed along with the CLOCK jumper. This replaces the PET clock.

The S-100 bus reset line is "anded" with the POC line and applied to the 6502 reset line. This insures a clean power-on reset. The 6502 will do a normal jump to it's reset vectors in high memory so you must have the starting address of your routines stored in ROM or PROM up there.

PET Memory Expansion Connector

Pin #	Signal
(Bottom)	
1	AØ
2	A1
3	A2
4	A3
5	A4
6	A5
7	A6
8	A7
9	A8
10	A9
11	A1Ø
12	A11
13	N/C
14	N/C
15	N/C
16	SEL1
17	SEL2
18	SEL3
19	SEL4
20	SEL5
21	SEL6
22	SEL7
23	SEL9
24	SELA
25	SELB
26	N/C
27	RES
28	IRQ
29	BØ2
30	R/W
31	RDY*
32	SYNC*
33	BDØ
34	BD1
35	BD2
36	BD3
37	BD4
38	BD5
39	BD6
40	BD7
(Top)	
1-40	GND

*If jumpered, otherwise N/C.

HUH Electronics 50 pin Cable

Pin #	Signal
1	GND
2	AØ
3	A1
4	A2
5	GND
6	A3
7	A4
8	A5
9	GND
10	A6
11	A7
12	A8
13	GND
14	A9
15	A1Ø
16	A11
17	GND
18	SEL1
19	SEL2
20	SEL3
21	GND
22	SEL4
23	SEL5
24	SEL6
25	GND
26	SEL7
27	SEL9
28	SELA
29	GND
30	SELB
31	RES
32	IRQ
33	GND
34	BØ2
35	GND
36	R/W
37	RDY*
38	SYNC*
39	GND
40	BDØ
41	BD1
42	BD2
43	GND
44	BD3
45	BD4
46	BD5
47	GND
48	BD6
49	BD7
50	GND

Parts List

Qty.	Description
1	IC, 74LS00
2	IC, 74LS02
2	IC, 74LS04
3	IC, 74LS08
1	IC, 74LS20
3	IC, 74LS74
2	IC, 74LS136
1	IC, 74148 or 74LS148
2	IC, 74LS157
1	IC, 74LS193
2	IC, 74367 or 8097 or 8T97
5	IC, 81LS97
1	IC, XR 215-36
1	IC, 7805 or LM340T-5
1	Transistor, 2N3904
1	Zener Diode, 1N751A
26	Resistor, 1k (brn/blk/red)
1	Resistor, 100 ohms (brn/blk/brn)
1	Resistor, 180 ohms (brn/gray/brn)
1	Resistor, 270 ohms (red/violet/brn)
1	Resistor, 470 ohms (yellow/violet/brn)
2	Resistor, 750 ohms (violet/grn/brn)
1	Resistor, 1.5K (brn/grn/red)
1	Resistor, 3.9K (ong/wht/red)
1	Resistor, 6.8K (blue/gray/red)
1	Resistor, 7.5K (violet/grn/red)
1	Resistor, 10k (brn/blk/orng)
1	Resistor, 20K (red/blk/orng)
1	Capacitor, Silver Mica, 36 pf
2	Capacitor, Disc, .0047 mfd
15	Capacitor, Disc, .047 mfd
2	Capacitor, Disc, .1 mfd
3	Capacitor, Dipped Tantalum, 10 mfd
14	IC Sockets, 14 pin
7	IC Sockets, 16 pin
5	IC Sockets, 20 pin
1	Dip Switch, 8 posistion
1	Heatsink
1	Set of hardware - screw,nut and lockwasher
1	50 conductor ribbon cable
1	40/80 pin PC Edge connector
2	50 pin right angle cable headers
1	S-100 MPA Main PC Board
1	Transistion PC Board
1	Instruction Manual
1	Warranty Form
1	Hank of Solder

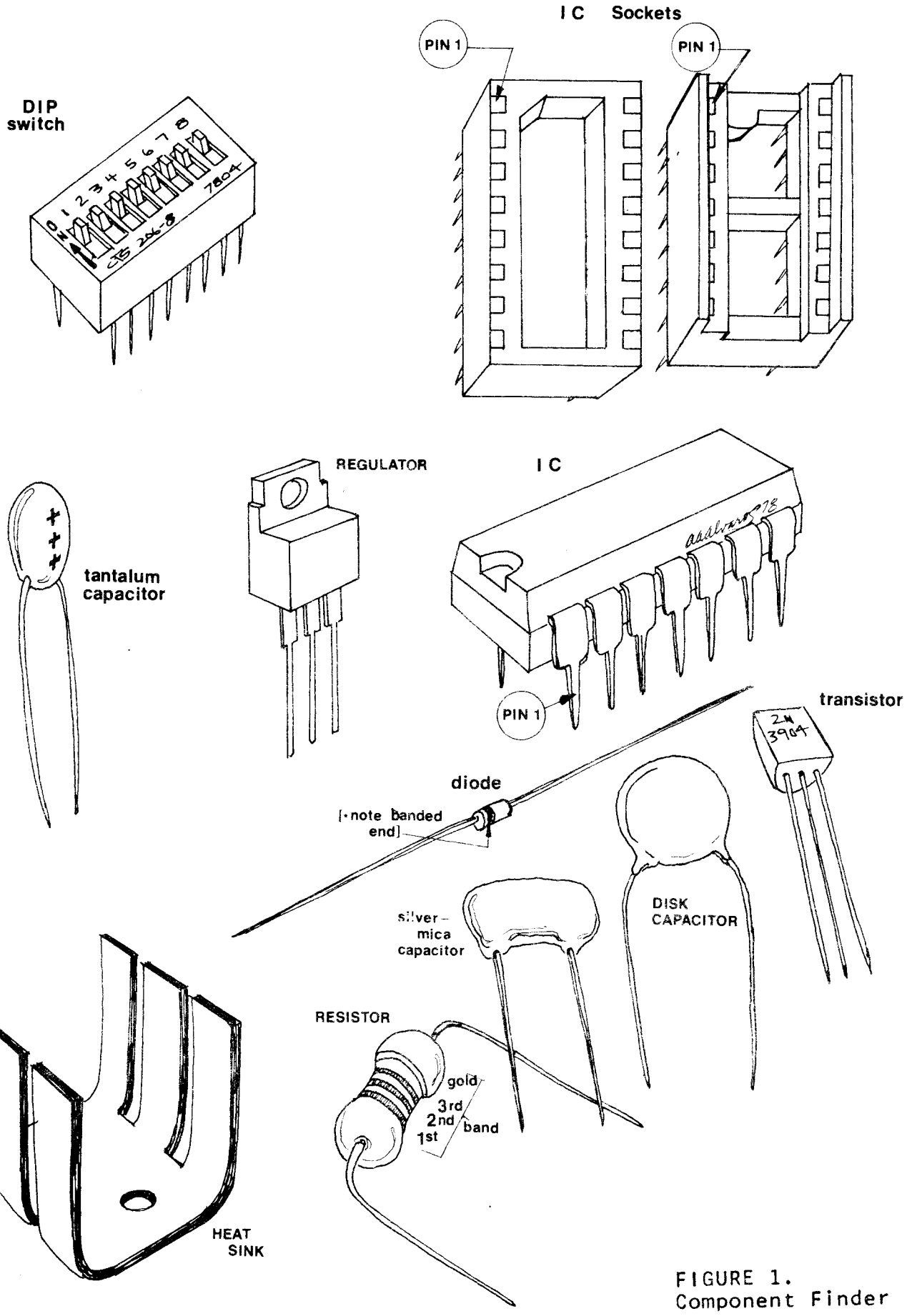


FIGURE 1.
Component Finder

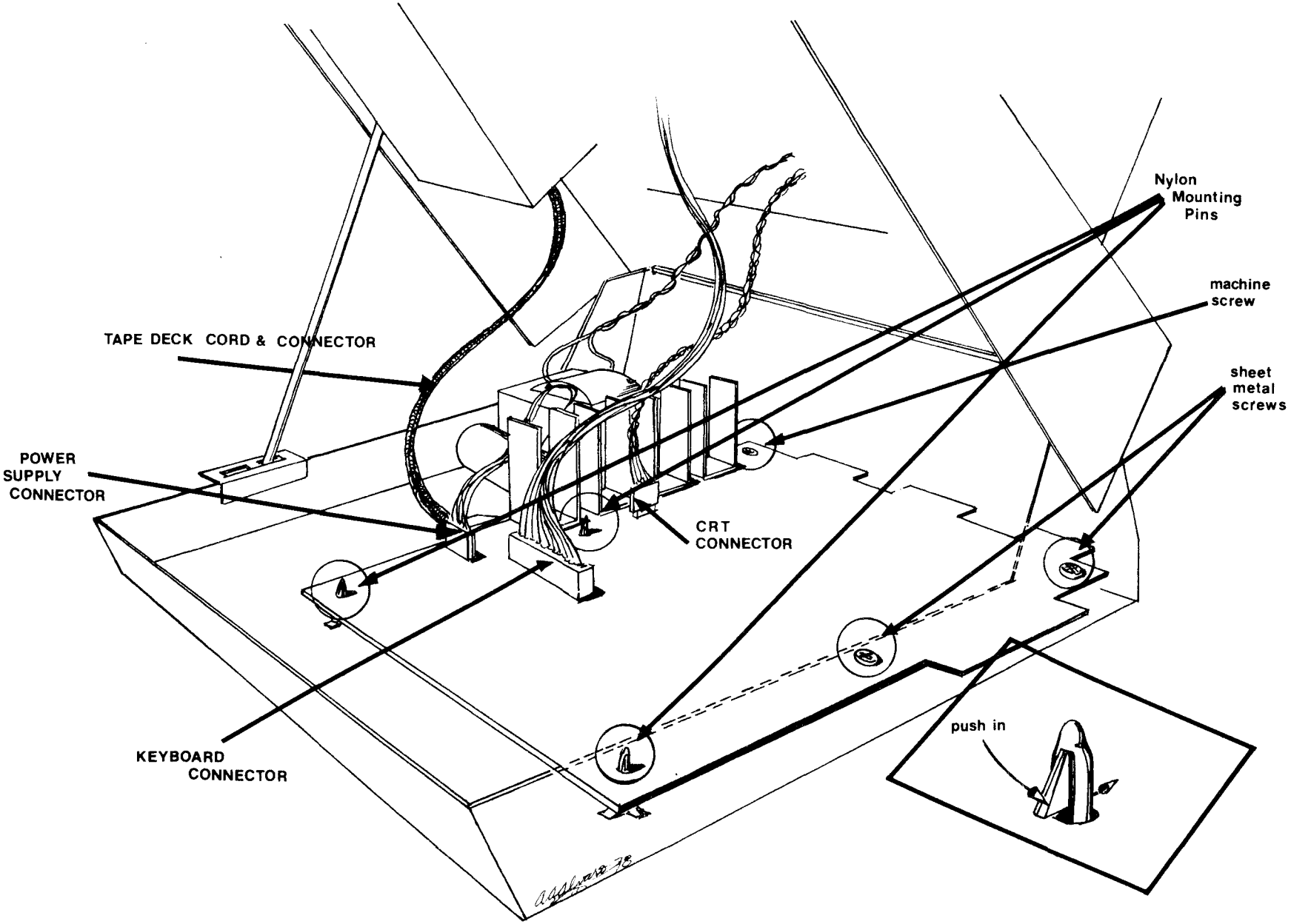
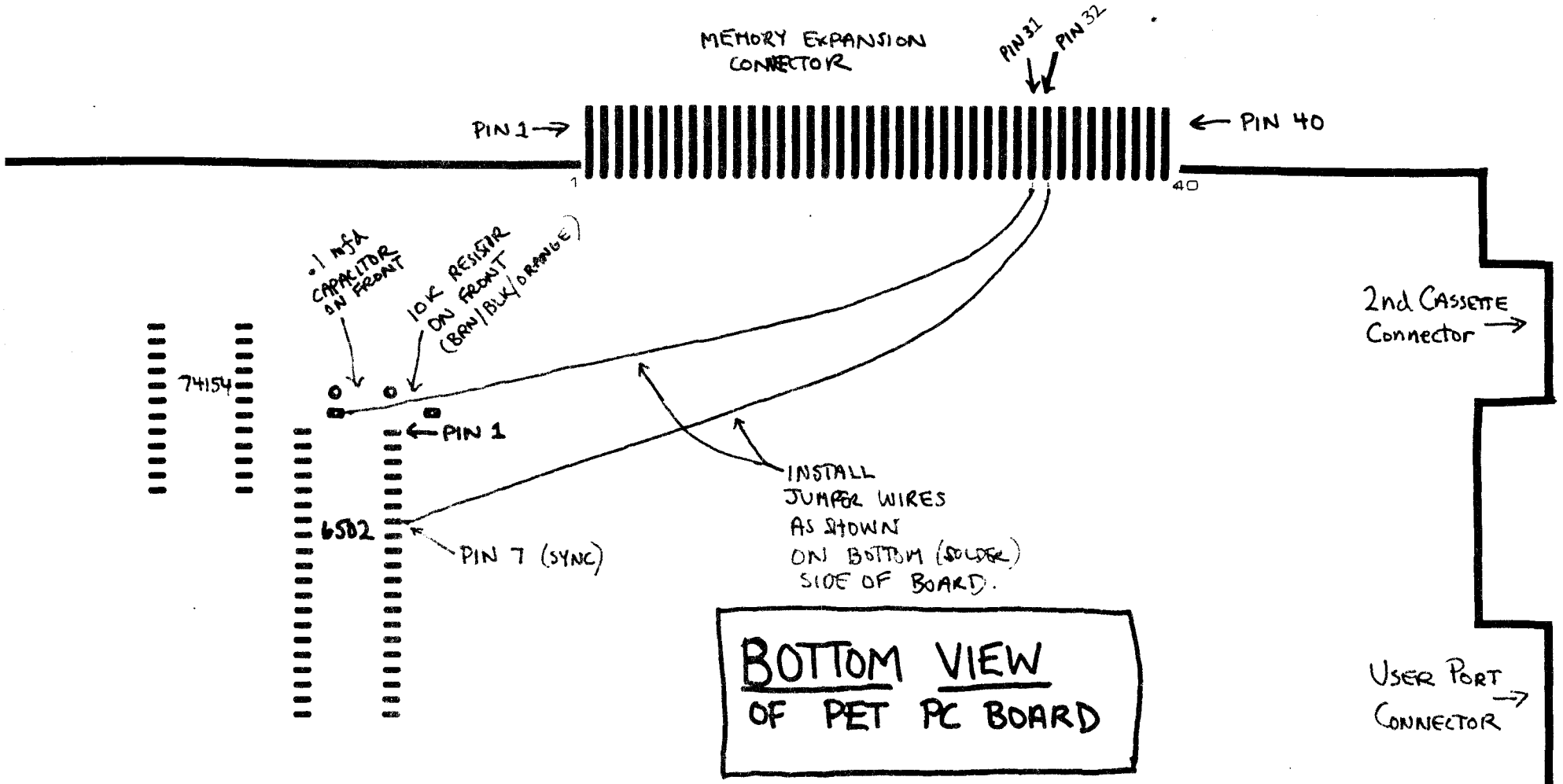
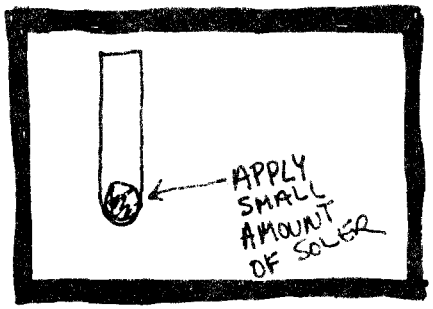

Nylon
Mounting
Pins
machine
screw
sheet
metal
screws
TAPE DECK CORD & CONNECTOR
POWER
SUPPLY
CONNECTOR
CRT
CONNECTOR
KEYBOARD
CONNECTOR
push in

FIGURE 2.





DETAIL OF PC EDGE CONNECTOR PRIOR TO INSTALLING JUMPERS

FIGURE 3.

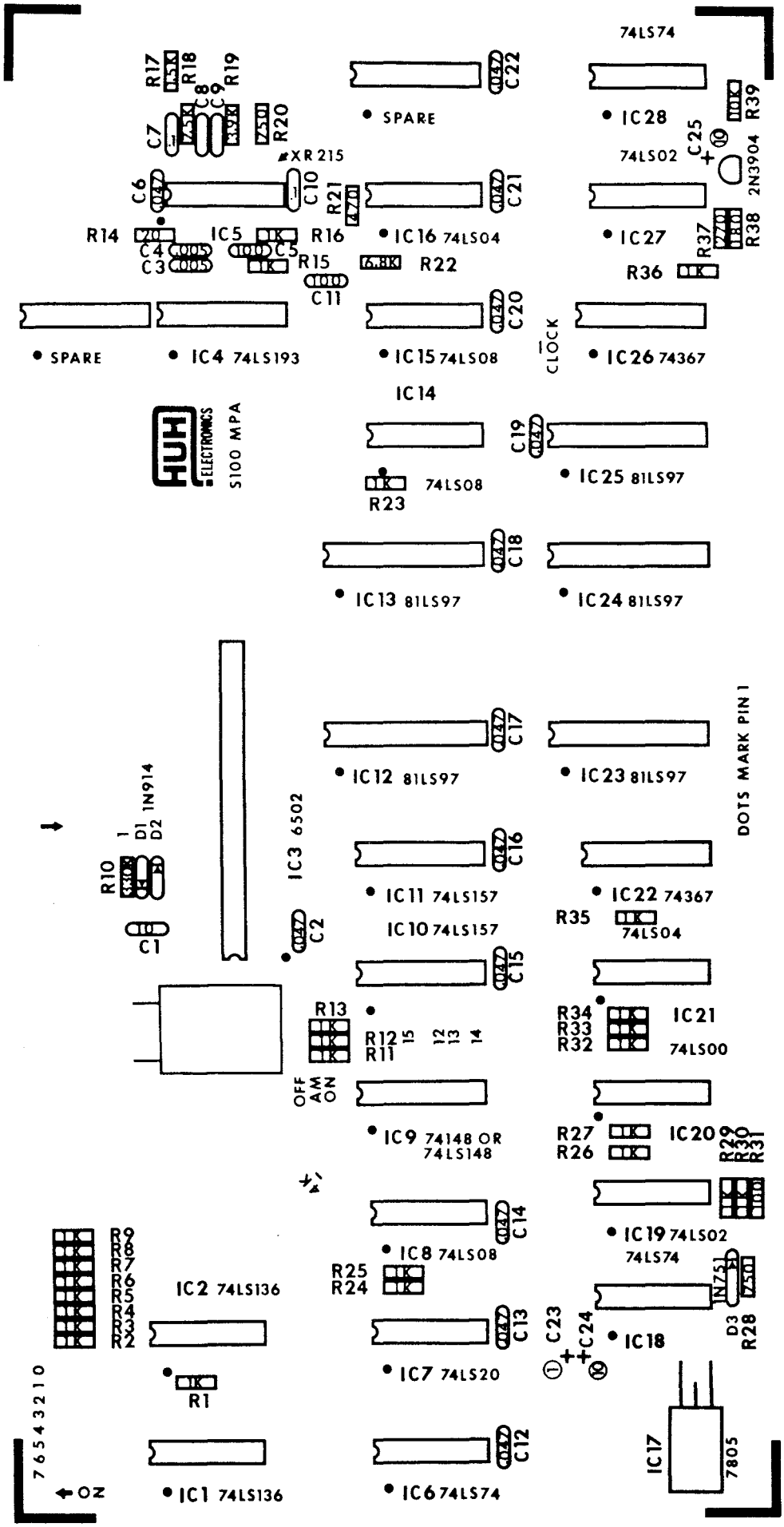


Figure 4.
Component Placement

LEGEND
4X

NOTES