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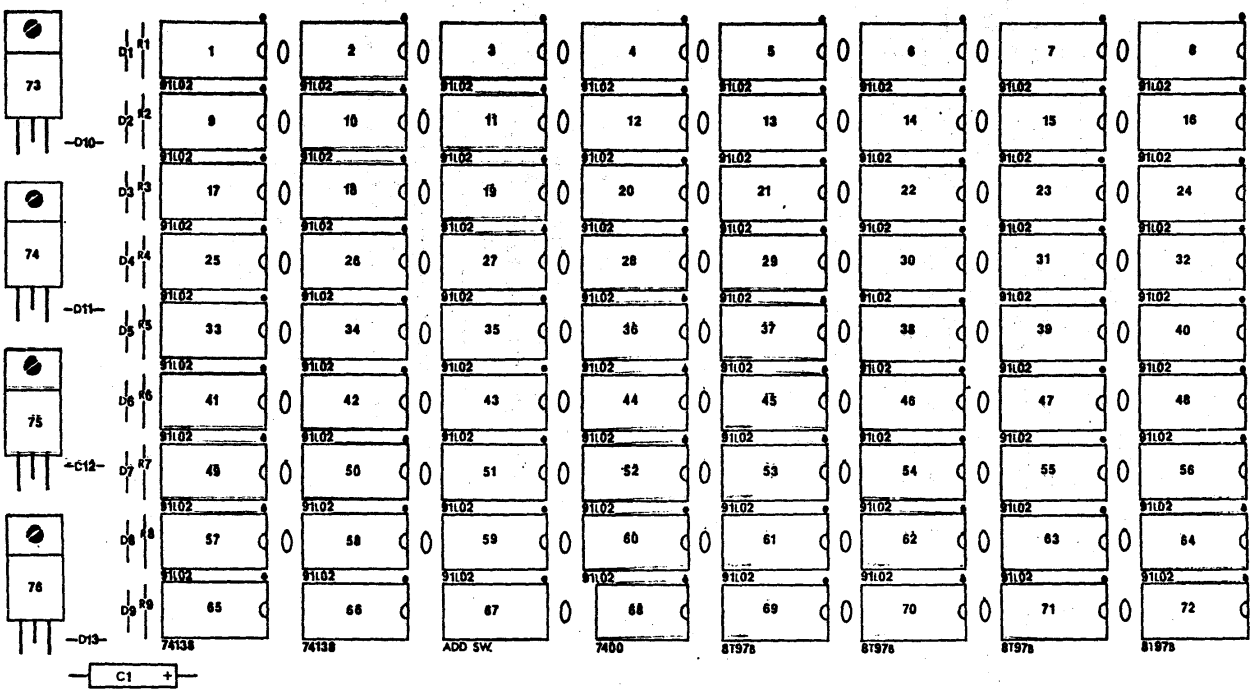

Figure 1. Screening on Component Side of Printed Circuit.

8K SC PRINTED CIRCUIT ASSEMBLY

Figure 1 is a layout of the board that is screened onto the component side of the printed circuit. Each integrated circuit location, and also that for an address switch assembly, are identified with location numbers, 1 through 76. The diodes, resistor, and large filter capacitor locations are shown by reference designator numbers (D1 through D13, R1 through R9, and C1). In addition there are 60 smaller filter capacitors that will be installed between the integrated circuit locations; their positions on the finished printed circuit are indicated with small ovals and no attempt has been made to identify them with component numbers because they all have the same value, 0.1 μF.

The components have been furnished in four numbered bags. The components in bag #1 should all be assembled to the board before those in bag #2, etc. However, it is a good idea to open each bag and check to see that it includes all of the components that are supposed to be included in the shipment. After checking to see that all components have been included, return them carefully to the bag to prevent loss, damage, or mixup with those that are in the other bags.

Bag 1 contains:	9 resistors.	Each is 1K, 1/4 W and is color-coded brown, black, red, and a 4th band that indicates tolerance.
	13 diodes.	Each is a type 1N4004 and has a band to identify the cathode end.
	4 heat sinks.	Each includes a mounting screw, a lockwasher, and a nut for assembly.
	4 IC packages.	Each is a type 7805 with a mounting tab on the back and 3 contact leads.
	1 capacitor.	100 μF electrolytic, with the positive end marked "+" on the case.
Bag 2 contains:	1 switch assy.	8 miniature toggle switches (DIP package)
	1 IC socket.	14-pin socket for an integrated circuit.
	70 IC sockets.	16-pin sockets for integrated circuits.
Bag 3 contains:	60 capacitors.	Each is 0.1 μF, disk type.
Bag 4 contains:	1 IC package.	Type 7400, 14-pin.
	2 IC packages.	Type 74138, 16-pin.
	4 IC packages.	Type 8T97B, 16-pin.
	64 IC packages.	Type 91L02, 16-pin (for 8K SC kit) or Type 2102LHPC, 16-pin (for 8K SC-Z kit).

Note: These instructions and the screening on the printed circuit refer to the basic kit, 8K SC, using 91L02 integrated circuits for the memory; this unit has an access time of less than 500 ns. By substituting the 2102LHPC integrated circuits in place of the 91L02 packages, the 8K SC-Z kit provides an access time of 250 ns. All of the remaining information is the same for both kits.

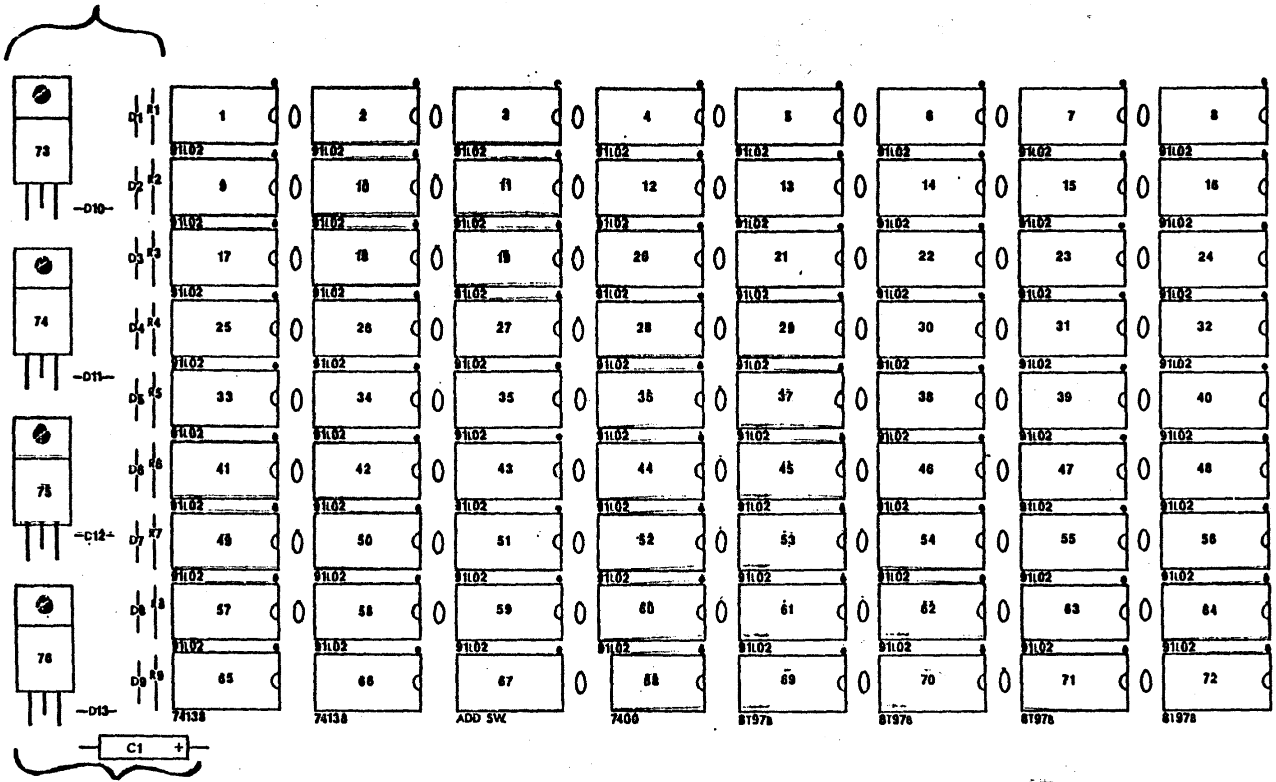

Figure 2. Location of Components Included in Bag #1.

ASSEMBLY OF COMPONENTS IN BAG #1

( ) <u>Resistors</u> Obtain the nine 1K resistors from the bag. Use a needle-nose pliers to bend the leads at right angles to match the hole spacing on the board. Insert each resistor into the correct holes from the screened side of the board and hold it while you turn the board over and bend the leads out at a slight angle to hold the resistor on the board. Solder both leads to the foil pattern on the back side of the board. Then clip off any excess lead lengths. Assemble and solder one resistor at a time to ensure that each one is secure both mechanically and electrically.

( ) <u>Diodes</u> Obtain nine of the 13 type 1N4004 diodes from the bag. Use a needle-nose pliers to bend the leads at right angles to match the hole spacing on the board for D1 through D9. Orient each diode with its banded end (cathode) at the top and insert it into the correct holes from the screened side of the board. Hold it in position while you turn the board over and bend each lead outward slightly to hold it in position on the board. Solder both leads to the foil pattern on the back side of the board. Then clip off any excess lead lengths. Assemble and solder one diode at a time to ensure that each one is secure both mechanically and electrically.

> NOTE: Be sure the cathode-end of each diode, D1 through D9, points UP on the board; failing to observe proper diode orientation can result in permanent damage.

( ) <u>Diodes</u> Obtain the remaining four type 1N4004 diodes from the bag. Use the same assembly procedure to install them at locations D10 through D13. The cathode-end of each diode must be at the left for each of these diodes.

( ) <u>Heat Sinks and Integrated Circuits</u> Select one heat sink, one type 7805 integrated circuit, one screw, a lockwasher, and a nut for the assembly to the board at each of four locations (73, 74, 75, and 76). Use a needle-nose pliers to bend each of the 3 IC leads at right angles to match the hole spacing on the board; the tab on the side opposite the 3 leads will be attached to the heat sink and the board with the screw (through the top) and the lockwasher and nut (on the back of the board. Solder all three leads to the foil pattern on the back of the board. Then clip off any excess lead lengths.

( ) <u>Capacitor</u> Obtain the 100 μF capacitor from the bag. Note that it is marked "+" at one end; this end is to be located at the right when the capacitor is installed on the board. This is an electrolytic capacitor and will be damaged if voltage is applied to it with the wrong polarity, so proper orientation is important. Use a needle-nose pliers to bend the leads at right angles to fit the hole spacing on the board at the C1 location. Using the proper orientation, insert the leads in the holes from the screened side of the board. Hold the capacitor in position while you bend the leads slightly outward on the back of the board. Then solder each lead to its foil pattern on the back of the board and clip off any excess lead lengths.

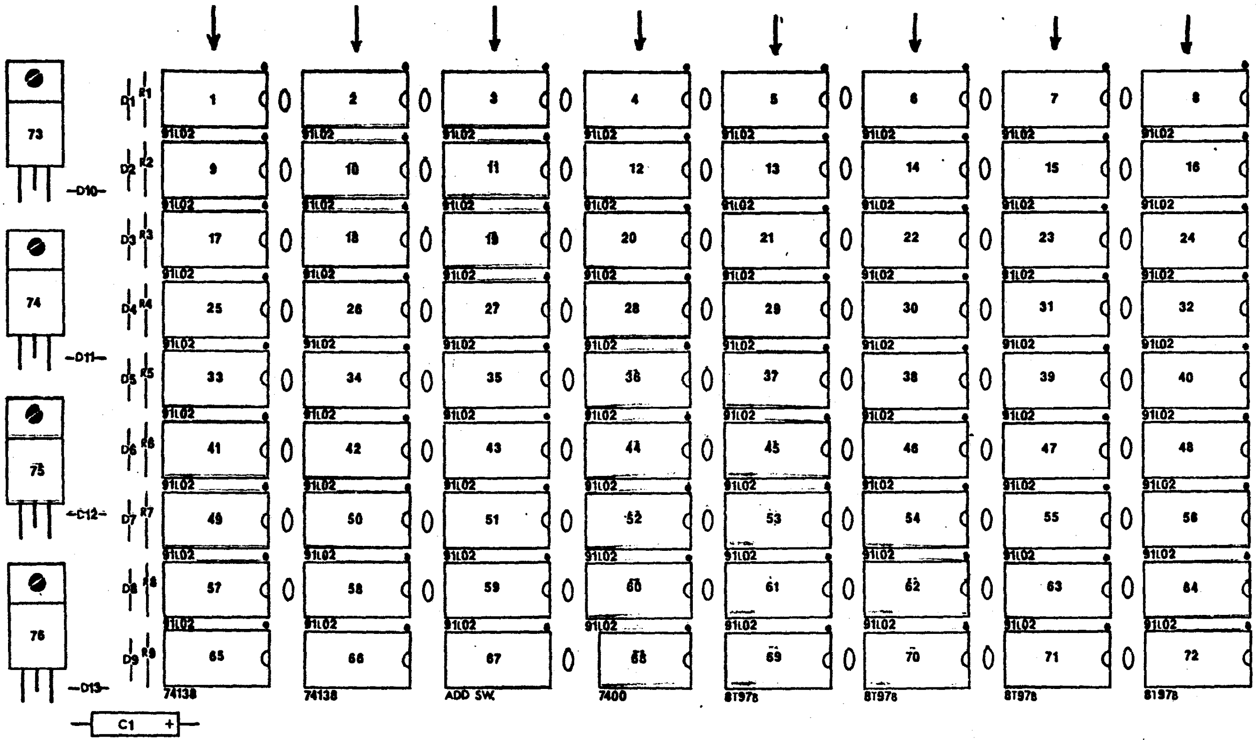

Figure 3. Location of Components Included in Bag #2.

ASSEMBLY OF COMPONENTS IN BAG #2

( ) Switch Assembly The switch assembly includes 8 miniature SPST switches, numbered 1 through 8 at the top and OFF at the bottom. Obtain the assembly from the bag and check the 16 leads (8 across the top and the other 8 across the bottom). Straighten these leads as necessary, using a needle-nose pliers, to install the entire assembly at location 67 on the printed circuit. Orient the assembly so that the switch numbers are across the top. Hold the assembly in position with a short length of masking tape. Turn the board over and solder each of the 16 leads to its contact in the foil pattern. Start with the leads across the top of the assembly; practice making solder connections without bridging between leads while you solder these 8 leads (they are all shorted together so solder bridges will not matter here, but this gives you a chance to improve your technique). Then solder each of the 8 leads across the bottom of the assembly, and be careful to prevent shorting between adjacent leads with solder bridges, since these must remain as separate circuits. Remove the masking tape and set switch 1 at ON, switches 2 through 8 at OFF.

( ) 14-pin Integrated Circuit Socket Obtain the 14-pin socket from the bag. This will be installed at location 68 on the board. Straighten all 14 of its leads as necessary with a needle-nose pliers and insert it through the screened side of the board. There is no orientation to be considered for the socket; there will be for the integrated circuit that gets inserted into it later. If desired, hold the socket in position with a short piece of masking tape while the 14 pins are soldered to their contacts in the foil pattern. Be very careful to prevent solder bridges. Remove the masking tape and cut off any excess lead lengths.

( ) 16-pin Integrated Circuit Sockets Each of the remaining IC sockets in the bag is a 16-pin socket that will be installed at one of the remaining locations on the board, 1 through 66 and 69 through 72. Straighten all 16 of its leads as necessary with a needle-nose pliers and insert it through the screened side of the board at one of the designated locations. There is no orientation to be considered for the socket. If desired, hold the socket in position with a short piece of masking tape while the 16 pins are soldered to their contacts in the foil pattern. Be very careful to prevent solder bridges. Remove the masking tape and cut off any excess lead length after each socket has been assembled to the board and its leads have been properly soledered.

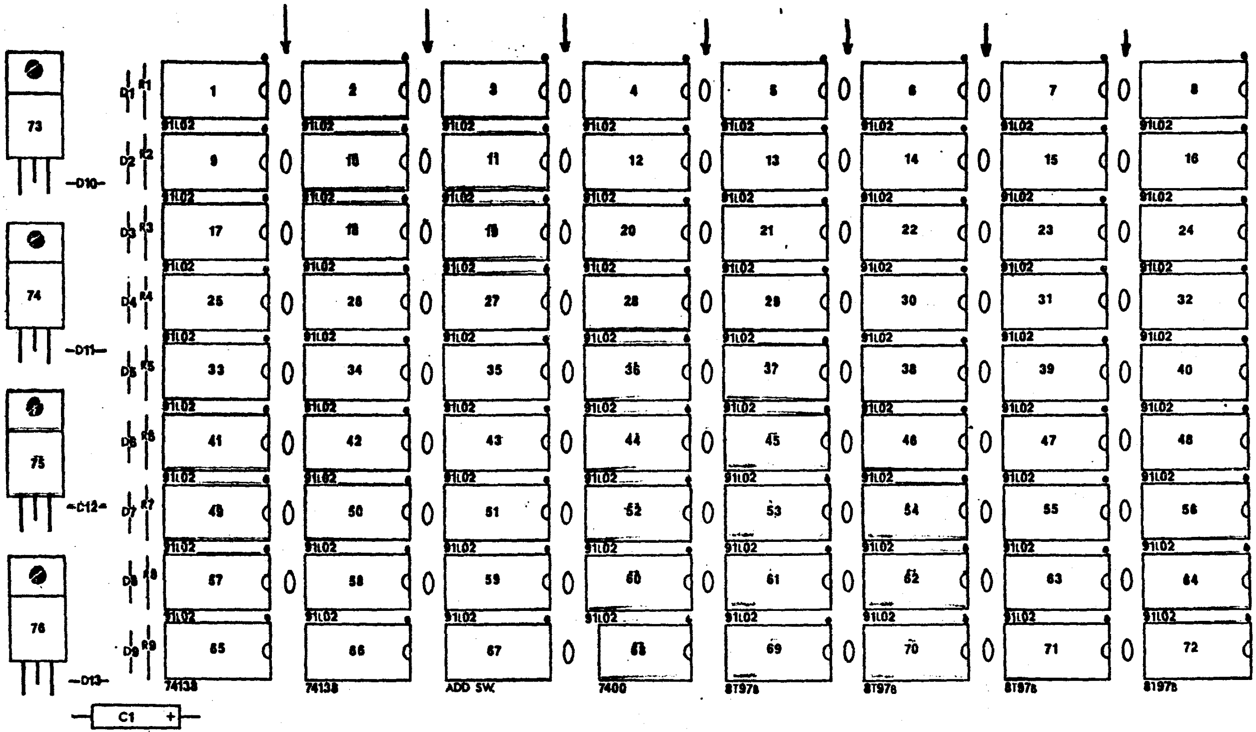

Figure 4. Location of Components Included in Bag #3.

ASSEMBLY OF COMPONENTS IN BAG #3

( ) Capacitors There are 60 capacitors in bag #3 and they all have the same value, 0.1 μF. Their locations are not numbered, since all are similar. Figure 4 indicates where they are to be installed in rows on the printed circuit; each capacitor is located between two of the integrated circuit packages as shown in the screening. Disk capacitors are not subject to orientation and can be installed by pushing the two leads through the pair of contacts provided at each location on the board. Then bend the leads outward slightly at the back of the board, solder each lead to the foil pattern, and clip off any excess lead lengths.

On the schematic diagram for the 8K-SC board, these 60 capacitors are in a filter circuit for V_{CC} and are all in parallel electrically. They are shown as two capacitors in the power supply, at the lower left corner of the schematic, that are shown without either part number or value. The collective value is 6.0 μF and their distribution through all circuits in the active matrix filters out the transients that might otherwise cause crosstalk or other erratic response in the memory circuits.

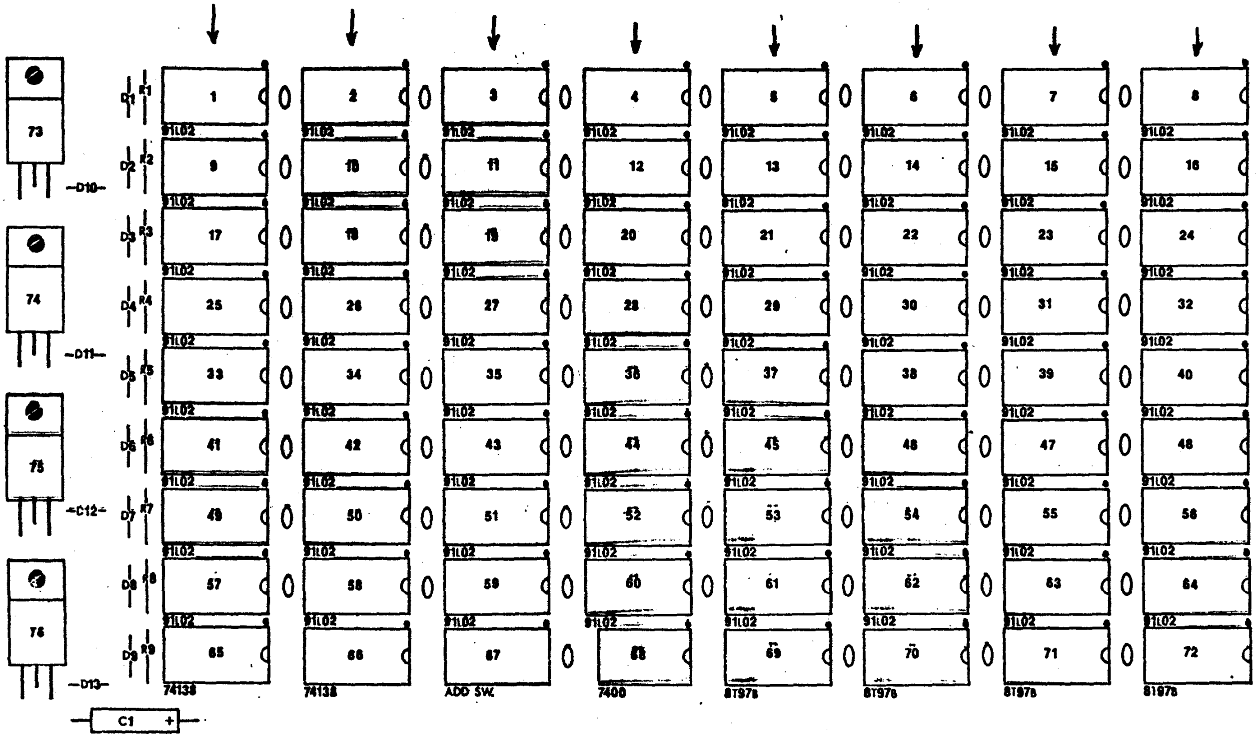

Figure 5. Locations of Components Included in Bag #4.

ASSEMBLY OF COMPONENTS IN BAG #4

( ) Type 7400 Integrated Circuit Select the 14-pin integrated circuit, type 7400, from the bag. Use a needle-nose pliers to straighten all 14 leads as necessary to prepare it for insertion into the socket at location 68. Orient the IC so that its notched end is at the right and its pin 1 contact is at the top right as indicated on the screening on the board. When you have the proper orientation, start the contacts across the top of the integrated circuit into the 7 matching holes in the socket but do not push the pins in all the way; align the contacts that are across the bottom of the package with their 7 holes in the socket and start them into the holes. Then, when all 14 contacts are started in their proper holes in the socket, press the package down firmly into the socket.

( ) Type 74138 Integrated Circuits Select the two type 74138 packages from the bag. Use a needle-nose pliers to straighten all 16 leads as necessary. One of these will be installed at location 65 and the other at location 66, using the same technique as outlined above for the 14-pin package. The notch and pin 1 location for each package is at the right, as indicated on the screening on the board.

( ) Type 8T97B Integrated Circuits Select all four type 8T97B packages from the bag. Use a needle-nose pliers to straighten all 16 leads as necessary. These integrated circuits will be installed at locations 69 through 72, using the same technique as outlined above for the 14-pin package. The notch and pin 1 location for each package is at the right, as indicated on the screening on the board.

( ) Type 91L02 Integrated Circuits All of the remaining 64 integrated circuit packages in the bag should be type 91L02 and will be installed at locations 1 through 64. Straighten all 16 leads on each package as necessary and install it at one of the locations, using the same technique as outlined above for the 14-pin package. The notch and pin 1 location for each package is at the right, as indicated on the screening on the board.

WARRANTY

Seals Electronics warrants its equipment for a period of ninety (90) days from the date of shipment to be free from defects in workmanship and materials, provided that the equipment has been used in a proper manner as described in this set of instructions. Seals Electronics cannot be responsible for nor assume any liability for problems that are encountered with methods of installation or with installation results.

After the warranty period, or for any condition that is not covered by the warranty, Seals Electronics will repair or replace, at its option, any part or parts that are found to be defective. This service will be performed within a reasonable time for a service fee of $20.00 per board plus parts. Shipping costs are the responsibility of the purchaser of the board and/or the repair service.

No other warranty is expressed or implied by Seals Electronics.

INSTALLATION

1. Check to see that a power source of +8 V is furnished through the circuit using pins 1 and 51, and that ground is furnished through pins 50 and 100 before plugging the board into the computer. These power input connections should be standard in ALTAIR or IMSAI systems.

2. On the 8K SC board, one and only one of the eight switches in the switch assembly at location 67 is to be set at On; all of the other 7 switches must be set at Off. Select the switch that identifies the sequential assignment of this board in a multi-board system. The address switches permit the use of up to 8 boards for a capacity of 64K memory addresses, using this system to decode input bits A13, A14, and A15. Where only one board is used, for an 8K memory, set switch 1 at On and all other switches, 2 through 8, at Off.

3. Plug the board into the computer at any unused connector on the motherboard. All connections are made in parallel between the boards and have been allocated properly to be compatible with the basic standard interconnections furnished between boards.

4. If a battery backup is desired, this can be furnished by a source of +2 to +4 V through pin 14 of the motherboard (pins 50 and 100 are ground reference). The current required by each board from the battery backup is nominally 600 mA. A battery backup card is available from Seals Electronics to provide this service for all 8K SC cards in the computer. The purpose for a battery backup is to retain the data bit configuration that is stored in the memory during interruptions of input power.

THEORY OF OPERATION

The 8K SC Memory is a fast static-type memory card that can be plugged in and used immediately with an Altair, Imsai, or any 8080 based computer system. It includes 8192 memory words of 8 bits each that are fully buffered. The standard access time is limited to less than 500 ns and the memory does not contribute to any wait state because no refresh cycles are required for its operation.

For an installation in which the memory capacity needs to exceed 8192 words (8K = 8192), additional 8K SC cards can be installed in the computer. A convenient DIP switch assembly on each card has 8 toggle switches; one switch on each card must be turned On and the other seven switches turned Off, and each card then serves one of eight 8K segments of addresses up to a maximum of 64K. Use the switches according to the following table:

Address Range	Switch Settings							
	1	2	3	4	5	6	7	8
0 to 8K	On	Off	Off	Off	Off	Off	Off	Off
8K to 16K	Off	On	Off	Off	Off	Off	Off	Off
16K to 24K	Off	Off	On	Off	Off	Off	Off	Off
24K to 32K	Off	Off	Off	On	Off	Off	Off	Off
32K to 40K	Off	Off	Off	Off	On	Off	Off	Off
40K to 48K	Off	Off	Off	Off	Off	On	Off	Off
48K to 56K	Off	Off	Off	Off	Off	Off	On	Off
56K to 64K	Off	Off	Off	Off	Off	Off	Off	On

The schematic, included at the back of these instructions, shows the matrix of 64 memory-chip integrated circuits (only four of the eight rows are drawn; the remaining four rows are connected in an identical manner). These are type 93L02 chips, and each has a capacity of one bit at each of 1024 addresses (1K). They are organized, both on the board and in the schematic, so that the top horizontal row of chips serves the first 1K of addresses on the board, the next row serves the second 1K, the third row serves the third 1K, etc. Thus IC's 57 through 64 serve the eighth 1K in the card. Reading from left to right, the first chip in each row serves the first of eight data bits and the last chip serves the eighth data bit. When an address is identified on the input address lines AØ through A12, the eight data bits that are stored for that address are furnished through the eight common data bus lines to output buffers in IC71 and IC72, from which they can be strobed to the CPU by an SMEMR signal. Since there is always an address input identification (the address is zero unless some address bit in the group AØ through A12 is high), there is always some data bit configuration present at the input to the buffers. However, the data word cannot be strobed out to the CPU unless the SMEMR signal is furnished and the internal board select circuit is also satisfied.

The board select circuit uses IC66 and the eight board address switches in the switch assembly at location 67. IC66 decodes the address lines A13, A14, and A15 to provide a low output through one of eight lines according to the table on page 14. For the addresses on the first card, A13, A14, and A15 are all low and the output signal from IC66 through pin 15 is connected through (closed) switch 1 to enable IC65 and to also enable the NAND gate in IC68 that permits the SMEMR signal to be accepted. Unless the signal level at pins 4 and 5 of IC65 and at pins 4 and 5 of IC68 is low, this board cannot write input data and it cannot read stored data out through the buffer, so it is an inactive board. When this signal level does go low, it selects this board as the active memory segment (even if it is the only one).

The computer can furnish either a high or a low on the $R/\overline{W}$ line through pin 68. This signal is normally high, and is driven low to write a bit configuration into the memory at an address that has been selected. The bit configuration to be written is furnished from the CPU on the DOØ through DO7 lines. (DO means "data out" and refers to the relation between the CPU card and the common lines; DI means "data in" and again refers to the relation between the CPU card and the common lines; thus for the memory card, the identity of the input and output lines is reversed from their logical functions.) However, when the $R/\overline{W}$ line goes low to provide a write command, the only board on which this will be effective is the board that is selected by the combination of A13, A14, and A15 address bits and the switch selection.

When IC65 is enabled by a low signal to its pins 4 and 5, it decodes the address bits that are furnished as A10, A11, and A12 and generates a chip-select signal to enable one of the eight horizontal rows of memory chips. When these address bits are ØØØ, IC65 generates CSØ at pin 15 and furnishes this as an enable signal to pin 3 on chips IC1 through IC8. When these address bits are ØØ1, the output from IC65 is CS1 at pin 14 and this enables IC9 through IC16. This logic is continued through the eight possible input address configurations for these three lines. Note that, if the board select signal is not present, none of the eight CS signals is generated, so none of the 64 chips in the memory are enabled.

When a row of memory chips is enabled by a $\overline{CS}$ line, an address is then identified in the chip by the AØ through A9 input bit configuration, and this is the active address for read and/or write operation. While the input at its pin 3 is high, for Read, the bit stored at the selected address is furnished out through pin 12 to its respective data output buffer in IC71 or IC72. When the input at its pin 3 goes low, for Write, the chip will replace its previous content at the selected address with the bit that is furnished to its pin 11, and this comes from one of the data input lines, DOØ through DO7.

To read the eight data bits that are furnished to output buffers IC71 and IC72 during the quiescent Read time, the computer furnishes a high signal through the SMEMR line on pin 47. The low board select signal, inverted through a section in IC68, allows response to SMEMR in the memory board that is identified by A13, A14, and A15 only. This combination enables the gates in IC71 and IC72 and furnishes their input data bit configuration to the common lines, DIØ through DI7, for return to the CPU card.

For low-temperature operation of the power supply, the V_{CC} for integrated circuits IC1 through IC72 is divided into four groups. One 7805 regulator serves each group according to the legend shown in the lower left portion of the schematic. If a battery backup is furnished, an input level of +2 to +4 V is accepted through pin 14 and furnished as V_{CC} when the computer power is turned off or interrupted. As long as the V_{cc} level remains at a minimum of +2 V, all data bits that have been stored in the 64 memory chips are maintained. If the level drops below +2 V, the data bit configuration will be random when power is applied again.

GENERAL INFORMATION

There are several different types of components that will be assembled onto the printed circuit. All are mounted on the same side of the printed circuit, where the location guide is screened onto the board surface. Most are held in place by having their contact leads soldered onto the back side of the board, so the soldering is very important for two reasons; one reason is to hold the component in position on the board and the other is to complete the electrical contact necessary for its operation in the circuit. Always use rosin-core solder only (never use acid-core). Use as little solder and heat as necessary at each connection so that you get a smooth, shiny connection that does not spread out and short the connection to any other adjacent contact point. Excess heat can damage some of the electronic components, so a small low-wattage soldering tool must be used, rather than a large and cumbersome iron that would overheat and damage the components and the board circuits.

The resistors, diodes, and capacitors are all components that are held in position by their two contact leads, soldered to the places where they connect to the foil pattern on the back of the board. Before each of these components is soldered in place, it should be held just off the front surface of the board (about 1/32" should be enough clearance for most, although the disk capacitors may require a little more). After soldering the component in place, test it's security by pressing gently against the mounting and be sure it is secure before proceeding to the next component.

The multi-pin integrated circuit packages have been protected against overheating by adding them into the plug-in sockets after all other parts, including the sockets, have been soldered into position on the board. No further soldering should be required after the integrated circuit packages have been installed.

All of the components, including the printed circuit board, are of the highest quality obtainable. Careful assembly and handling will maintain this quality as you complete the following steps and create the operating circuit that you will appreciate using for a long time to come. Although some of the steps may seem tedious, the extra care and patient procedure by you to complete each step precisely as described will pay you dividends of long-term useful operation afterward. But a careless mistake could destroy the quality and usefulness that can be yours otherwise.