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Thank you for purchasing the INTERNAL MEMORY(TM) from HOLMES ENGINEERING! The following material describes installation and operation of both the 32K IM-1B and the 48K IM-2 boards. Installation is accomplished without soldering or trace cutting, and does not require a great deal of skill or electronics knowledge. PLEASE READ THE INSTRUCTIONS CAREFULLY! TAKE YOUR TIME AND HANDLE EVERYTHING WITH CARE, AND YOU WILL BE SURPRISED AT HOW EASY IT WILL BE TO INSTALL YOUR INTERNAL MEMORY AND HAVE IT WORK THE FIRST TIME YOU TRY IT!

The IM boards can only be used with a Model I TRS-80 (Note: TRS-80 is a registered trademark of Tandy Corporation), LEVEL I or LEVEL II. Both the IM-1B and the IM-2 require that the keyboard unit be programmed for 16K RAM chips.

If you have a 16K keyboard unit, read on. If your keyboard unit is presently set up for 4K RAM, you will need to upgrade it to 16K before continuing. Contact HOLMES ENGINEERING if you need instructions for upgrading from 4K to 16K.

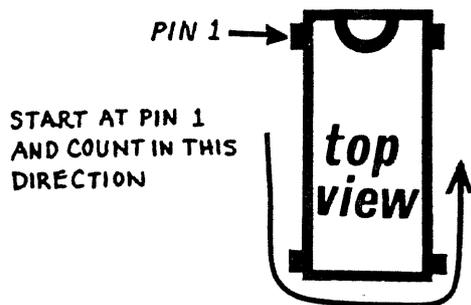
If you ever feel lost or confused at any time, go back to the point in the instructions where everything is very clear and start from there. As you well know, computers do not forgive mistakes easily! Everything must be perfect or it just won't work.

You will need to know how to handle MOS dynamic RAM chips, how to "read" I.C. pin numbers, and how to remove I.C.'s from sockets in order to successfully install your IM. Even if you know ALL ABOUT these things, please read through this material anyway, just to be sure.

\*\*\*\*\*

MOS I.C.'s, including dynamic RAM's, can be damaged by the static electricity which can be generated in normal everyday movements. Several thousand volts can be generated by simply walking across a rug on a dry day! Most MOS I.C.'s now being manufactured have some built-in protection against static damage, but it is a good idea to observe a couple of rules whenever handling MOS I.C.'s. (1) Whenever you move MOS I.C.'s from one location to another, always wrap them in foil, or put them in or on some type of conductive material, to protect them from any static built up while they are being moved. (2) ALWAYS touch a socket with one hand before inserting or removing an MOS I.C. with the other hand; this will equalize the potential between you and the I.C. and prevent any charge from flowing into the I.C. to damage it. (3) Hold the I.C. by the body; touch the pins as little as possible.

All of the I.C.'s used in the TRS-80 and the IM use the same pin numbering scheme. Looking at the I.C. from the top (pins facing away from you), notice that one end of the I.C. has a square or half-round notch, a small dimple, or some other prominent marking distinguishing one end from the other. If you turn the I.C. so that the notch or dimple is facing upward, pin one of the I.C. will be in the upper left-hand corner, and the pins will be numbered counter-clockwise around the I.C. like this:

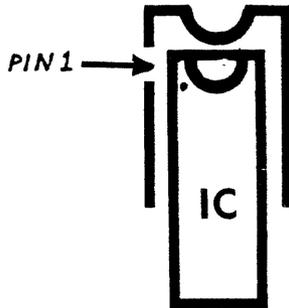


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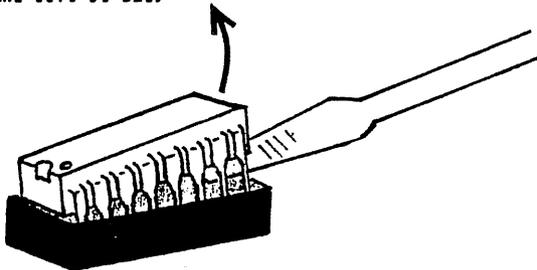
IM-2/IM-1B  
INTERNAL MEMORY  
INSTALLATION INSTRUCTIONS

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Larry Holmes

I.C. sockets have a notch of some kind at one end to indicate where pin 1 of the I.C. goes. When installing an I.C., always place the notched end of the I.C. at the notched end of the socket (that makes sense!). In addition, the IM boards have I.C. outlines painted on the board to help you get the I.C.'s in right. Match the notch on the I.C. with the notch painted on the board:



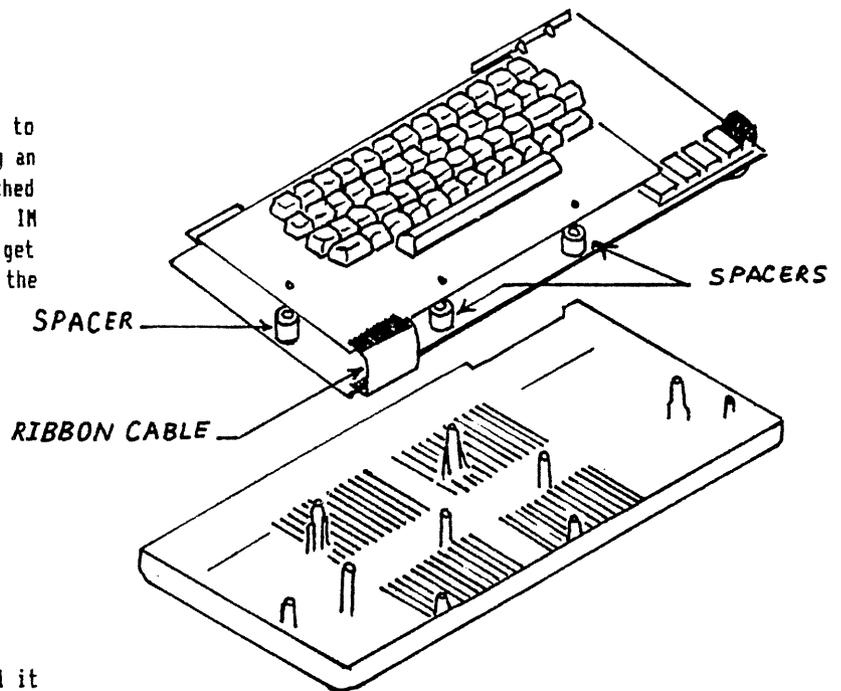
When removing an I.C. from a socket, DO NOT try to pull it out with your fingers; it will "pop" out suddenly, bending the pins and/or sticking them into your fingers (ouch!). If you have an I.C. removal tool, use it. If not, use a small screwdriver or similar object to pry the I.C. out of its socket, as shown. Pry up one end of the I.C., then pry up the other end and lift it out.



Now you are ready to install your IM! You will need a Phillips screwdriver, a soft towel and good lighting. (1) Remove the power supply, video and cassette cables from your KU (keyboard unit). Disconnect anything connected to the expansion connector. (2) Lay the KU face down on the towel, with the front facing toward you. (3) Loosen and remove the six screws in the bottom of the KU. Note where they go (they are not all the same length) and put them aside. (4) Hold the KU together and turn the KU "right side up", being careful to keep everything in place. (5) There are several different versions of the TRS-80, with varying amounts of hardware inside. Make a mental note or drawing of what is in your KU so you can put it all back together properly.

-----CAUTION-----

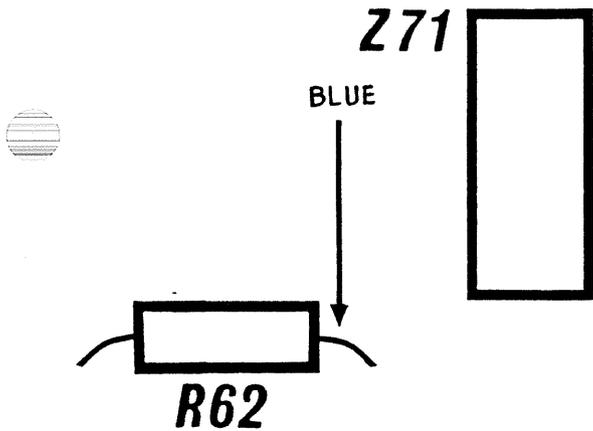
There is a flat ribbon cable connecting the keyboard to the main board. This cable is very fragile and must not be strained during the next steps! Excessive flexing of this cable will cause improper operation of the keyboard.



(6) Very carefully lift up the keyboard and note that there are several plastic spacers holding the keyboard up off the main board. Make a note of where they go, then remove them and put them aside. (7) Lift both the main board and the keyboard, as a unit, out of the case bottom, and set the cage aside. (8) Open up the keyboard and main board like a "clamshell", and lay them down on the towel, with the writing on the main board "right side up". Be careful not to break any wires which may be attached to the main board; position any cables or "piggy-back" boards (such as the 3-chip ROM board or the cassette fix board) so they will not be damaged in the next steps.

(9) Remove the RAM IC from socket Z13 on the main board (remember the instructions for removing I.C.'s), and plug it into socket M1 on the IM board. MAKE SURE YOU POSITION THE IC SO THE NOTCHED END MATCHES THE OUTLINE ON THE IM BOARD, OR YOU MAY DAMAGE THE IC WHEN YOU APPLY POWER LATER ON! (10) Remove Z14 from the main board and plug it into socket M2 on the IM board. (11) In the same manner, remove Z15, Z16, Z17, Z18, Z19 and Z20 from the main board and install them in M3, M4, M5, M6, M7 and M8 on the IM board. (12) If you did not purchase RAM with your IM, install 4116 type RAM chips (200 ns. or better) in the remaining sockets on the IM board. Sockets M9 through M16 correspond to the first 16K bank of added RAM; M17 through M24 to the second bank of added RAM (IM-2 only).

Examine the bottom of the IM board and notice that sockets M1 through M8 have pins connected to them. These pins will be plugged into the now empty RAM sockets (Z13 through Z20) on the TRS-80 main board, and will provide the power, data and multiplexed address connections to the IM board. THESE PINS MUST ALL BE PROPERLY INSERTED OR THE IM (and your TRS-80) WON'T WORK! Take a moment to study the pins, and see how they fit into the RAM sockets, before actually attempting to install the IM; installation is quite simple once you know how it is



(23) Position the wires away from the holes in the TRS-80 $\ddagger$  main board so they will not get pinched by the cabinet posts when you put the case back together. Tape or glue them down if necessary to keep them out of the way.

Your INTERNAL MEMORY is now installed and connected! Double check everything; make sure that all wires are connected to their proper points, and that the pins are correctly inserted into the RAM sockets. Also, look at the back side of the main board and see if there are any wires there. During the process of pushing the IM into the RAM sockets, any wires present on the back of the main board may have been pressed onto the sharp pins protruding from the board, causing the pins to pierce the plastic insulation on the wires and short to the wire inside. Just to be safe, lift all wires away from the board to make certain they have not been pierced.

-----NOTE-----

There are two pads on the IM marked "sw". A SPST switch may be soldered to these points (via a pair of wires) to allow you to turn off the added memory in your keyboard unit, in case you should want to occasionally use an unmodified expansion interface. When the switch is closed, only the lower 16K of RAM on your IM will operate. When the switch is open, the IM will operate at full capacity.

(24) Now it is time to reassemble your KU. (If you wish to check out your TRS-80 $\ddagger$ /IM combination before putting it back into the case, keep in mind that the main board is "upside down" in its present position. If you connect anything to the expansion connector, the connector should be attached upside down also. In addition, make sure that you plug the power connector into the spot closest to the power switch.) In some cases, you may need to trim the cabinet support posts of the TRS-80 $\ddagger$  so they will not hit against the IM board when the case is reassembled. (23) Fold the main board and keyboard back together, just as they were when you removed them from the case. (REMEMBER, the cable connecting the main board and keyboard must not be stressed!) (24) Place the entire assembly back into the case bottom (you probably had a plastic spacer which fit over the post at the right of the case bottom—make sure it is in place.) CAREFULLY lift the keyboard up and push the main board over the cabinet posts, starting with the taller posts toward the rear of the cabinet bottom. If you cannot get the main board to go over these posts, you may need to trim away a little plastic as previously mentioned, to prevent the posts from binding against the IM board. (25) Once you have the main board pushed down into place, put the soft plastic spacers back

into position on the posts between the keyboard and main board. If you don't remember where they go, just put them in positions which best support the keyboard itself. (26) Place the top of the case back on, making sure you get the power LED properly positioned. (27) You may wish to tape the keyboard halves together to make it easier to screw them back together. Place the keyboard face down on the soft towel and put the screws back in. The shortest screws go closest to the front, the medium screws go in the middle, and the longest screws go toward the back. Make sure the screws are properly threaded into the plastic before you tighten them down, and do not overtighten them! It is hard to put the plastic back if you strip the threads! You are now finished with the installation, and are ready to check out your system!!!

-----SYSTEM CHECKOUT-----

(1) Connect the power supply, video and any other cables you normally use to your TRS-80 $\ddagger$ . Wish yourself good luck, and turn on the power. You should immediately see the familiar MEMORY SIZE (or MEM SIZE) prompt on the screen. If you get "garbage", a blank screen, or a pattern of letters and/or signs on the screen, TURN YOUR SYSTEM OFF AND IMMEDIATELY PROCEED TO THE "IN CASE OF DIFFICULTY" SECTION OF THIS MANUAL.

(2) Press 'ENTER' in response to the MEMORY SIZE prompt; in a couple of seconds, you should get the familiar >READY prompt. It will take longer for the >READY to come up with more than 16K of RAM; the TRS-80 $\ddagger$  takes longer to find the top of memory.

(3) Once you get the >READY prompt, type 'PRINT MEM'. You should get 31956 (31954) for a 32K system, or 48340 (48338) for a 48K system. (Values in parenthesis are for those systems which normally give a 15570 memory size w/16K of RAM.) If you don't get these values, go to the "IN CASE OF DIFFICULTY" section. (4) You are almost finished! All that remains to be done is to verify that all memory locations are good. If you have a memory test program you are familiar with, use it to test your system. If not, use the simple program listed here. This is not an exhaustive test by any means, but it will indicate whether or not all memory locations can store and recall properly in BASIC. Type in the following program, and store it on tape or whatever you prefer:

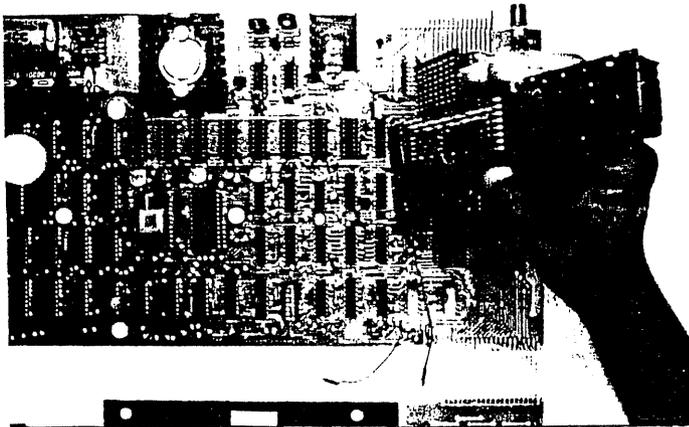
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10 CLEAR 0:CLS:PRINT"INTERNAL MEMORY RAM TEST"
20 INPUT"ENTER START ADDRESS";A
30 IF A>32767 THEN A=A-65536
40 INPUT"ENTER END ADDRESS";B
50 IF B>32767 THEN B=B-65536
60 PRINT"TESTING...."
70 IF A<0 GOTO 160
80 IF B>0 THEN C=B ELSE C=32767
90 FOR X=A TO C
100 POKE X,0
110 IF PEEK(X)<>0 GOSUB 230
120 POKE X,255
130 IF PEEK(X)<>255 GOSUB 230
140 NEXT
150 A=-32767:IF B>0 GOTO 220
160 FOR X=A TO B
170 POKE X,0
180 IF PEEK(X)<>0 GOSUB 230
190 POKE X,255

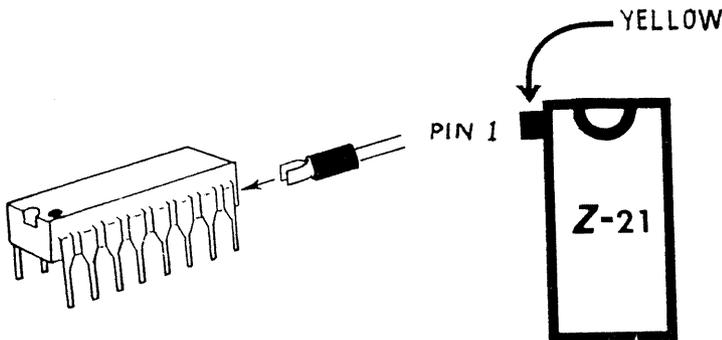
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SUPPOSED to be done! NOTE: The pins should be exactly perpendicular to the board. If any are bent, straighten them so they form a 90 degree angle with the board.

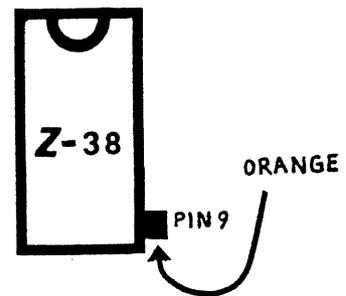
(13) There are a number of brown ceramic capacitors "poking up" around the RAM sockets, which if left in position will prevent the IM board from being inserted into the RAM sockets. Starting with C12, bend each capacitor down so it is even with the tops of the RAM sockets. Be careful not to short a capacitor lead to a circuit board trace or I.C. pin, (be especially careful with C22). Don't be concerned if some of the brown outside coating crumbles off the capacitors; it won't affect their performance. Even if you should break some of the capacitors, you will not affect the performance of the IM board, as it has enough capacitors on it to operate even with most of the TRS-80 capacitors broken! (14) Looking at the TRS-80 main board with the writing "right side up", position the IM board over the RAM sockets with the "skinny end" pointing to your left. (15) Stand the IM on end, with the end closest to M8 resting between Z22 and Z23 on the TRS-80 main board. You are now going to connect two of the wires to points which will be underneath the IM board once it is installed.



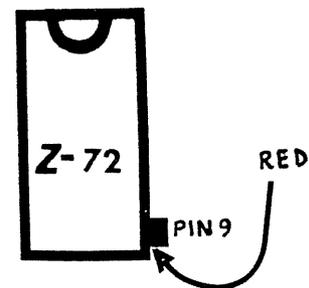
(16) Connect the YELLOW wire to pin one of Z21 on the TRS-80 main board, by slipping the solderless clip onto the I.C. pin as illustrated below. You may wish to tape or glue the wire in place to make it more secure; BE CAREFUL NOT TO GET ANY GLUE ON THE I.C. PIN OR THE CONNECTOR!!



(17) In the same manner, connect the ORANGE wire to pin 9 of Z38 on the TRS-80 main board



(18) Place the IM back on top of the RAM sockets, then look under the IM and make sure the pins are all properly positioned for insertion. Pin 1 of M1 should go into position 1 of the socket at Z13; pin 1 of M8 should go into position 1 of the socket at Z20, and so on. TAKE THE TIME TO CHECK PIN ALIGNMENT CAREFULLY NOW!! IF A PIN IS IMPROPERLY POSITIONED, IT WILL PROBABLY BREAK OFF IN THE NEXT STEP AND RENDER YOUR IM INOPERATIVE!! (19) Once you have all the IM pins properly lined up, push gently on the top of the IM board and start the pins into the RAM sockets. If you feel hard resistance to your light hand pressure, stop and check pin alignment again. Slight variations in the spacing of TRS-80 RAM sockets may require you to reposition a pin or two for proper alignment. The sockets used in the TRS-80 have large openings for the pins to enter, which will allow you to move the IM board around a little while attempting to line up the pins. ALL YOU NEED TO DO AT THIS POINT IS TO GET THE PINS INTO THE CORRECT SOCKET OPENINGS; the pins will "bend" slightly to assume their final positions in the next step. (20) Press the IM board firmly into place until the black plastic "rings" on the pins are close to or are touching the tops of the RAM sockets. If you can't get the board pressed down all the way, go back and check to see if one of the capacitors is interfering with installation of the IM board. (21) Now connect the RED wire to Z72 pin 9 in the same way you connected the orange and yellow wires.



(22) With the TRS-80 main board positioned with the writing right side up, find the socket labeled Z71 (it will have a "DIP shunt" plugged into it). Look just off the lower left corner of Z-71 and find a 4.7K ohm resistor labeled R62. Attach the BLUE wire to R62, on the end closest to Z71.

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200 IF PEEK(X)<> 255 GOSUB 230
210 NEXT
220 CLS:PRINT"END OF TEST"
225 PRINT E;"ERRORS DETECTED":END
230 PRINT"ERROR AT ADDRESS";X:E=E+1
240 FOR Y=0 TO 300:NEXT
250 RETURN

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(5) Once you have saved the program, turn off your TRS-80, turn it back on, and answer 17801 to the MEMORY SIZE question. (6) Load the program and RUN it. The first testable location is now at 17801; if you try to test below that address, you will wipe out the test program! The first 16K of RAM ends at 32767, and is contained in RAM's M1 through M8 on the IM board. The second 16K of RAM starts at 32768 and ends at 49151, and is contained in RAM's M9 through M16 on the IM board. The upper 16K (IM-2 only) starts at 49152 and ends at 65535, and is contained in RAM's M17 through M24 on the IM board. Thus, test a 32K system from 17801 to 49151, and a 48K system from 17801 to 65535. (NOTE: If you are using a Stringy Floppy, do not test the top 4 bytes of RAM. The SF uses the top 4 bytes, and your system will crash if you test them with this program.) This is a BASIC program, and will take quite a while to run. If you have a printer, you may wish to change the PRINT statements in lines 60-230 to LPRINT, to get a listing of the test results.

Once you have tested the RAM in your KU, all that is left to do is to use it! RAM in your IM "looks" just like RAM in an expansion interface; use it exactly the same way. The only "trick" needed to use the IM is not related to the IM at all, but is brought about by the fact that the TRS-80 cannot handle integers greater than 32767. Thus, in order to use PEEK and POKE commands with addresses above 32767, you must use a negative number derived from the formula: desired address-65536=PEEK or POKE address. This is explained in section 8 of the TRS-80 LEVEL II BASIC REFERENCE MANUAL.

-----IN CASE OF DIFFICULTY-----

The following information is intended only to provide suggestions for solving relatively simple difficulties. No attempt is made to teach how to repair the TRS-80, as that is best covered in the Technical Reference Manual available from Radio Shack. There are several common problems which can occur when installing an IM board, involving malfunctions of the TRS-80 (caused by broken wires) or malfunctions/incorrect installation of the IM or RAM chips. Answer four questions before proceeding: (1) Are all the RAM chips inserted with the notched end matching the outline on the IM board? (2) Are any RAM pins bent up under the chip body, preventing the pin from being properly inserted into the socket--lift up each chip to check, as bent pins can "hide" very effectively. (3) Are the red, blue, yellow, and orange wires connected to the correct points on the main board? Are they touching adjacent IC pins or PC traces? (4) Do you have the correct type of RAM chip installed (4116)? Are the chips good?

You must know that the TRS-80 is functioning properly before you can look for other problems. If you can operate your TRS-80 SAFELY out of the case, follow these steps. (Otherwise, go to the next paragraph.) Remove the RAM chips

from the IM sockets, and turn on the TRS-80. If you get a pattern of "@S's" on the screen (or sometimes just large @ signs), you probably have a problem with one of the RAM chips you had installed in the IM. If you don't get "@S's", disconnect the four wires and unplug the IM from the sockets. If you get "@S's" now, check to see if a pin on the IM was bent, broken, or improperly inserted in a socket (sometimes one of the single pins can get bent over into the next socket position, i.e., pin 2 can get pushed over and inserted into position 3 of the socket). If you can't see anything wrong with the IM or the way it was installed, you will need to contact HOLMES ENGINEERING for assistance. If you don't get "@S's" with the IM removed and the RAM sockets empty, you probably have a problem with your TRS-80. Place your original RAM chips back in the sockets and see if it works at 16K. If not, contact us or your dealer for assistance.

The following is a list of symptoms, printed in CAPITALS and preceded by an arrow (-->), followed by suggestions for solving the indicated problem:

--->SCREEN IS BLANK THE INSTANT THE TRS-80 IS TURNED ON: The +5 volt supply is current limiting. You probably have a RAM chip installed backwards; the chips do not all go in the same direction! Check to make sure the notches in the chips match the outlines on the IM board. You could also have one of the brown capacitors bent down so its lead is touching a trace on the PC board, shorting the +5 volt power supply.

--->DISPLAY JITTERS. The video sync section of the TRS-80 is unstable to begin with. After adding an INTERNAL MEMORY to the system, it seems to be even worse! The easiest way to cure the "video jitters" is to swap the RAM chips around on the IM board until the jitter goes away; i.e., swap the chips in sockets M14 and M22, etc. A more effective way requires a bit of soldering and a "trial and error" approach: Solder a 20-500 pf capacitor from pin 10 to pin 11 of Z57 on the TRS-80 main board. Solder another 20-500 pf capacitor from pin 12 to pin 13 of Z57. (The values are not critical; use as much capacitance as your TRS-80 can handle without moving the display off the screen!) After you have added these capacitors, the jitter should disappear. If not, try using larger capacitors until it does. When you are finished, your display will probably be off center. Adjust variable resistors R20 and R21 (next to the cassette connector on the TRS-80 main board) to center the display on the screen.

--->SCREEN SHOWS GARBAGE FOR AN INSTANT, THEN GOES BLANK OR SHOWS RANDOM CHARACTERS AT A FEW LOCATIONS. The RAM address lines are not all functioning properly. Check for bent-under RAM pins, improperly installed chips in M1 through M8, capacitors pushed down and shorting against the pc board, wires on the back of the board pierced by the sharp pins.

--->SCREEN FILLS WITH BLINKING PATTERN OF "@S's" (or large @'s"). A ROM or the ROM cable is unplugged, or a wire from the ROM board to the main board is broken loose. You will need to refer to a RS manual, or contact us for help.

--->IMMEDIATELY AFTER MEMORY SIZE APPEARS, OTHER CHARACTERS APPEAR AND/OR ERROR MESSAGES SCROLL UNCONTROLLABLY DOWN THE SCREEN. One or more connections inside the ribbon cable connecting the keyboard to the main board are broken. Measure the cable with an ohm-meter and attach jumper wires across any broken conductors; flex the cable while measuring to reveal any

intermittant connections.

--->SCREEN FILLS WITH GARBAGE. Make sure you have gone through the steps at the beginning of this section. You must know that your TRS-80 is OK before proceeding! Remove the RAM chips from the IM. If you get a pattern of "@" signs and letters on the screen, you probably had a bad or improperly installed RAM in M1-M8. If you don't get a pattern of "@" signs, disconnect the 4 wires and remove your IM board. If you now get the pattern, you have a bad or improperly installed RAM on the IM, a bent or broken pin, or a defective board. If you still get garbage with the RAM sockets empty, something is probably wrong with your TRS-80. Contact us for assistance. (First, check to see if any wires on the back of the TRS-80 main board have been pressed onto the sharp pins protruding from the board.)

--->IM WORKS, BUT NOT AT FULL CAPACITY. If you only get 16K of RAM, check the blue wire. Make sure it is making good contact on R62-there could be some solder flux on the connector or the resistor preventing proper contact from occurring. If you get more than 16K but less than full capacity, you have a defective or improperly installed RAM chip in M9 through M24 on the IM board.

--->NONE OF THE ABOVE STEPS HELP. You have exhausted all the simple tests. Go over everything again, and maybe again, but stop just before you are ready to send the IM down the garbage disposal! Contact your local dealer if possible; he can most conveniently assist you. If you purchased your IM from HOLMES ENGINEERING, call or write and we will assist you. The IM does work; hundreds of them are in operation right now! One way or another, we will help you get it up and running. If you wish to send your keyboard unit to us, we will install your IM board for \$20.00 including return UPS shipping; we usually ship systems back out 48 hours after receiving them if they are pre-paid or COD. We can also repair your TRS-80 for a reasonable fee; contact us for details.

-----USING AN INTERNAL MEMORY WITH AN EXPANSION INTERFACE-----

If you plan to use an expansion interface with no memory installed (a OK interface), you will need to modify it so that its memory circuits do not interfere with the operation of the INTERNAL MEMORY. This modification will only affect the memory portion of the interface; it will not alter the function of any other section. There are two basic versions of the expansion interface (EI). You won't know which one you have until you open it up. (1) Remove the screws on the bottom of the expansion interface (2) remove the case bottom to reveal the printed circuit board. (3) Look for Z19 and Z21. If these are 74LS367's, you have an "old style" expansion interface; continue with these instructions. If Z19 is not a 74LS367, you have a "new style" interface; skip to the next paragraph. (4) Remove the PC board from your EI (5) Cut the traces connecting to Z19 pin 1 and Z21 pin 1, so that pin 1 of Z19 and Z21 is not connected to anything (6) Now connect pin 1 of Z19 to pin 1 of Z21 (7) Connect a 1k-10k resistor (value not critical) from pin 1 of Z19 or Z21 to pin 16 of Z19 or Z21 (+5 volts). The RAM output buffers are now "tri-stated" (floating) permanently and cannot interfere with the INTERNAL MEMORY. To return your EI to original operation, simply connect a wire from pin 1 of Z19 or Z21 to Z20 pin 3. Skip the next paragraph.

MODIFYING THE "NEW STYLE" EXPANSION INTERFACE. If Z29 and Z31 are 74LS244's, you have a "new style" EI. Since you should already have it opened up, (1) make sure Z29 and Z31 are 74LS244's. IF THEY ARE NOT, contact HOLMES ENGINEERING before proceeding. If they are, find Z28, a 74LS00 I.C. (2) Find the trace running between pins 8 and 9 of Z28. (3) Cut the trace running between pins 8 and 9 of Z28, just past the point where it "feeds through" the hole in the circuit board. (4) connect a 1k-10k resistor (value not critical) from the feed-through hole in the circuit board to the heavy trace connected to pin 16 of Z28. You have now connected pin 19 of Z29 and Z31 to +5 volts, which "tri-states" (floats) the RAM output buffers and prevents them from interfering with the operation of the INTERNAL MEMORY. To restore your EI to original configuration, simply repair the cut trace.

-----WARRANTY-----

HOLMES ENGINEERING guarantees the INTERNAL MEMORY to be free from defects in material and workmanship for a period of one year from date of purchase under normal use and operation. This warranty does not include the cost of any inconvenience, liability, loss or damage to the customer or any other party caused or alleged to be caused by installation or failure of the INTERNAL MEMORY, nor does it cover damage caused by misuse, abuse or alteration. REPAIRS AND/OR TROUBLESHOOTING DONE TO INTERNAL MEMORY BOARDS USING RAM CHIPS NOT PURCHASED FROM HOLMES ENGINEERING ARE EXCLUDED FROM WARRANTY COVERAGE, AND WILL ONLY BE DONE AT CUSTOMER EXPENSE! Returned INTERNAL MEMORY boards must be shipped pre-paid to HOLMES ENGINEERING, to be repaired or replaced at HOLMES option at no charge within the warranty period. There are no other warranties granted, expressed or implied.

# MERCHANDISE RETURN POLICY

In order to return merchandise to Holmes Engineering, you must first write or call ahead and receive an RMA (Return Merchandise Authorization) number. HOLMES ENGINEERING WILL NOT ACCEPT RETURNED MERCHANDISE WHICH DOES NOT HAVE AN RMA NUMBER CLEARLY VISIBLE ON THE OUTSIDE OF THE PACKAGE!!!!

Merchandise which is shipped in error or defective prior to shipment will be replaced without additional charge. The RMA number will be coded to show this, and will indicate to our shipping department that the package should be accepted.

MERCHANDISE DAMAGED DURING SHIPMENT WILL NOT BE ACCEPTED FOR RETURN BY HOLMES ENGINEERING. To meet insurance requirements, report shipping damage to the shipping carrier immediately. Keep the original shipping container, packing material and any papers, cards or other literature which may have been included. The carrier will not honor a claim if any of the shipping material is missing!

BE SURE TO REPORT SHIPPING DAMAGE PROMPTLY! THERE IS A TIME LIMIT ON ANY SHIPPING DAMAGE CLAIM.

To return any merchandise for any reason, call (801) 261-5652 between the hours of 9a.m. and 5p.m. MST, and ask for the CUSTOMER SERVICE department. (If you cannot call, send a letter explaining the problem in detail). You will be issued an RMA number according to the circumstances. In addition, returned merchandise is subject to the following conditions:

- \* Merchandise must be properly shipped in original packaging. All documentation, registration cards, other literature and accessories must be included.
- \* Merchandise may not be damaged, marred or otherwise made unfit for resale, prior to return to HOLMES ENGINEERING.
- \* If a refund is requested, it will be made within 30 days if the above conditions are met. Shipping and handling charges will not be refunded. In addition, we will deduct a re-stocking charge of \$5.00 or 15% of the amount returned (whichever is greater). The re-stocking charge will be waived if you apply the refund toward another purchase at the time of the return. If you paid with a check, we will send you a refund check. If you paid with a credit card, we will credit your account.
- \* HOLMES ENGINEERING reserves the right to refuse a refund or exchange for any item it determines has been misused, altered or otherwise rendered unfit for re-sale. Such products will be returned to the customer freight collect.
- \* If you request replacement of the merchandise, we will send the replacement as soon as it is in stock.



Thank you for purchasing the INTERNAL MEMORY(TM) from HOLMES ENGINEERING! The following material describes installation and operation of both the 32K IM-1B and the 48K IM-2 boards. Installation is accomplished without soldering or trace cutting, and does not require a great deal of skill or electronics knowledge. PLEASE READ THE INSTRUCTIONS CAREFULLY! TAKE YOUR TIME AND HANDLE EVERYTHING WITH CARE, AND YOU WILL BE SURPRISED AT HOW EASY IT WILL BE TO INSTALL YOUR INTERNAL MEMORY AND HAVE IT WORK THE FIRST TIME YOU TRY IT!

The IM boards can only be used with a Model I TRS-80 (Note: TRS-80 is a registered trademark of Tandy Corporation), LEVEL I or LEVEL II. Both the IM-1B and the IM-2 require that the keyboard unit be programmed for 16K RAM chips.

If you have a 16K keyboard unit, read on. If your keyboard unit is presently set up for 4K RAM, you will need to upgrade it to 16K before continuing. Contact HOLMES ENGINEERING if you need instructions for upgrading from 4K to 16K.

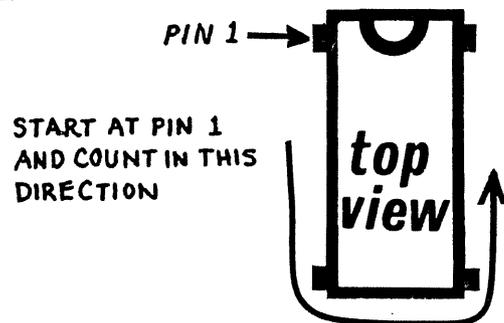
If you ever feel lost or confused at any time, go back to the point in the instructions where everything is very clear and start from there. As you well know, computers do not forgive mistakes easily! Everything must be perfect or it just won't work.

You will need to know how to handle MOS dynamic RAM chips, how to "read" I.C. pin numbers, and how to remove I.C.'s from sockets in order to successfully install your IM. Even if you know ALL ABOUT these things, please read through this material anyway, just to be sure.

\*\*\*\*\*

MOS I.C.'s, including dynamic RAM's, can be damaged by the static electricity which can be generated in normal everyday movements. Several thousand volts can be generated by simply walking across a rug on a dry day! Most MOS I.C.'s now being manufactured have some built-in protection against static damage, but it is a good idea to observe a couple of rules whenever handling MOS I.C.'s. (1) Whenever you move MOS I.C.'s from one location to another, always wrap them in foil, or put them in or on some type of conductive material, to protect them from any static built up while they are being moved. (2) ALWAYS touch a socket with one hand before inserting or removing an MOS I.C. with the other hand; this will equalize the potential between you and the I.C. and prevent any charge from flowing into the I.C. to damage it. (3) Hold the I.C. by the body; touch the pins as little as possible.

All of the I.C.'s used in the TRS-80 and the IM use the same pin numbering scheme. Looking at the I.C. from the top (pins facing away from you), notice that one end of the I.C. has a square or half-round notch, a small dimple, or some other prominent marking distinguishing one end from the other. If you turn the I.C. so that the notch or dimple is facing upward, pin one of the I.C. will be in the upper left-hand corner, and the pins will be numbered counter-clockwise around the I.C. like this:

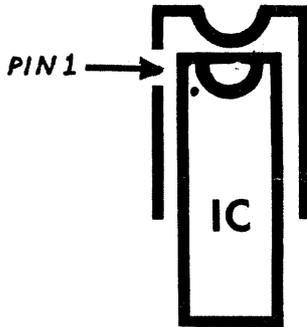


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3555 South 3200 West  
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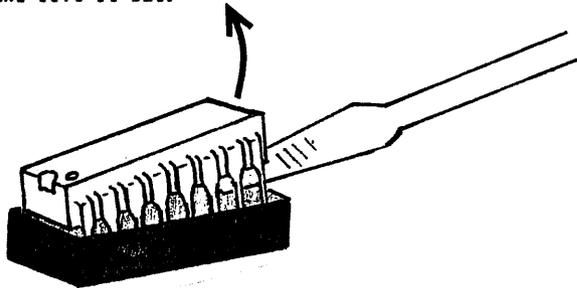
IM-2/IM-1B  
INTERNAL MEMORY  
INSTALLATION INSTRUCTIONS

Copyright 1981  
Larry Holmes

I.C. sockets have a notch of some kind at one end to indicate where pin 1 of the I.C. goes. When installing an I.C., always place the notched end of the I.C. at the notched end of the socket (that makes sense!). In addition, the IM boards have I.C. outlines painted on the board to help you get the I.C.'s in right. Match the notch on the I.C. with the notch painted on the board:



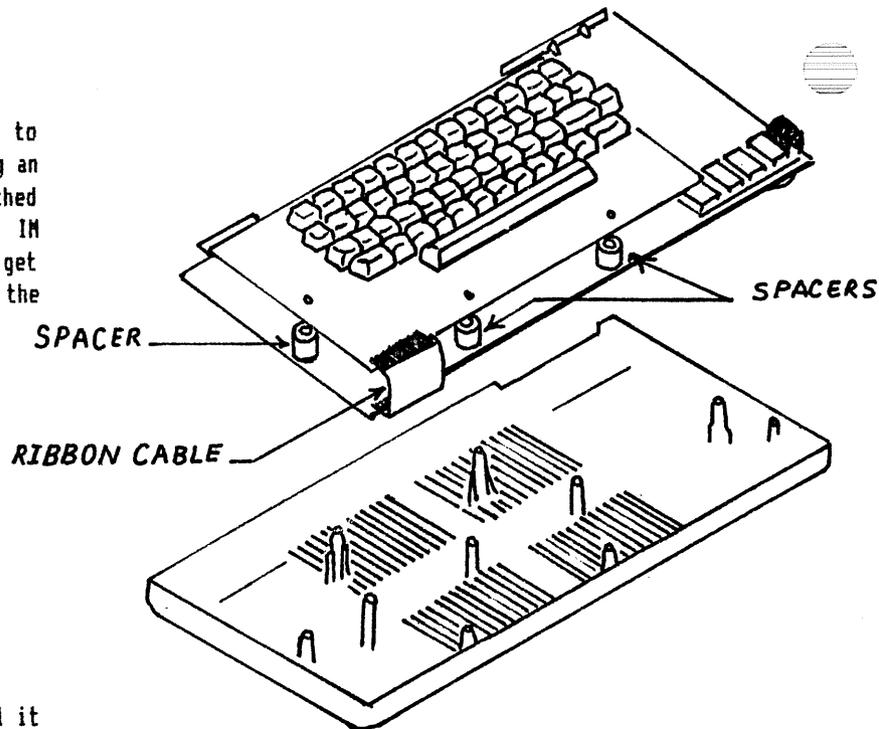
When removing an I.C. from a socket, DO NOT try to pull it out with your fingers; it will "pop" out suddenly, bending the pins and/or sticking them into your fingers (ouch!). If you have an I.C. removal tool, use it. If not, use a small screwdriver or similar object to pry the I.C. out of its socket, as shown. Pry up one end of the I.C., then pry up the other end and lift it out.



Now you are ready to install your IM! You will need a Phillips screwdriver, a soft towel and good lighting. (1) Remove the power supply, video and cassette cables from your KU (keyboard unit). Disconnect anything connected to the expansion connector. (2) Lay the KU face down on the towel, with the front facing toward you. (3) Loosen and remove the six screws in the bottom of the KU. Note where they go (they are not all the same length) and put them aside. (4) Hold the KU together and turn the KU "right side up", being careful to keep everything in place. (5) There are several different versions of the TRS-80, with varying amounts of hardware inside. Make a mental note or drawing of what is in your KU so you can put it all back together properly.

-----CAUTION-----

There is a flat ribbon cable connecting the keyboard to the main board. This cable is very fragile and must not be strained during the next steps! Excessive flexing of this cable will cause improper operation of the keyboard.



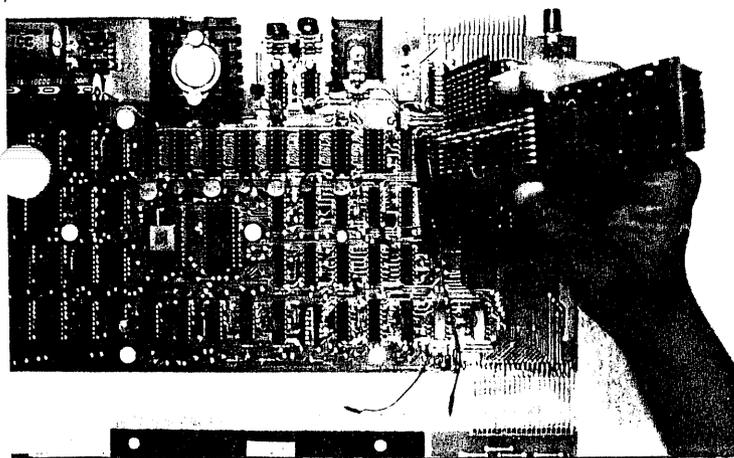
(6) Very carefully lift up the keyboard and note that there are several plastic spacers holding the keyboard up off the main board. Make a note of where they go, then remove them and put them aside. (7) Lift both the main board and the keyboard, as a unit, out of the case bottom, and set the unit aside. (8) Open up the keyboard and main board like a "clamshell", and lay them down on the towel, with the writing on the main board "right side up". Be careful not to break any wires which may be attached to the main board; position any cables or "piggy-back" boards (such as the 3-chip ROM board or the cassette fix board) so they will not be damaged in the next steps.

(9) Remove the RAM IC from socket Z13 on the main board (remember the instructions for removing I.C.'s), and plug it into socket M1 on the IM board. MAKE SURE YOU POSITION THE IC SO THE NOTCHED END MATCHES THE OUTLINE ON THE IM BOARD, OR YOU MAY DAMAGE THE IC WHEN YOU APPLY POWER LATER ON! (10) Remove Z14 from the main board and plug it into socket M2 on the IM board. (11) In the same manner, remove Z15, Z16, Z17, Z18, Z19 and Z20 from the main board and install them in M3, M4, M5, M6, M7 and M8 on the IM board. (12) If you did not purchase RAM with your IM, install 4116 type RAM chips (200 ns. or better) in the remaining sockets on the IM board. Sockets M9 through M16 correspond to the first 16K bank of added RAM; M17 through M24 to the second bank of added RAM (IM-2 only).

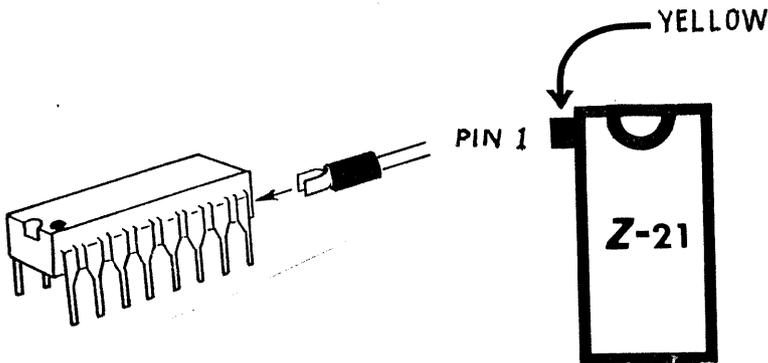
Examine the bottom of the IM board and notice that sockets M1 through M8 have pins connected to them. These pins will be plugged into the now empty RAM sockets (Z13 through Z20) on the TRS-80 main board, and will provide the power, data and multiplexed address connections to the IM board. THESE PINS MUST ALL BE PROPERLY INSERTED OR THE IM (and your TRS-80) WON'T WORK! Take a moment to study the pins, and see how they fit into the RAM sockets, before actually attempting to install the IM; installation is quite simple once you know how it is

SUPPOSED to be done! NOTE: The pins should be exactly perpendicular to the board. If any are bent, straighten them so they form a 90 degree angle with the board.

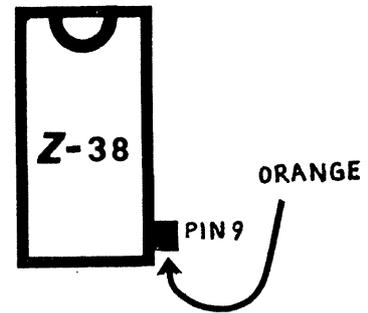
(13) There are a number of brown ceramic capacitors "poking up" around the RAM sockets, which if left in position will prevent the IM board from being inserted into the RAM sockets. Starting with C12, bend each capacitor down so it is even with the tops of the RAM sockets. Be careful not to short a capacitor lead to a circuit board trace or I.C. pin, (be especially careful with C22). Don't be concerned if some of the brown outside coating crumbles off the capacitors; it won't affect their performance. Even if you should break some of the capacitors, you will not affect the performance of the IM board, as it has enough capacitors on it to operate even with most of the TRS-80's capacitors broken! (14) Looking at the TRS-80's main board with the writing "right side up", position the IM board over the RAM sockets with the "skinny end" pointing to your left. (15) Stand the IM on end, with the end closest to M8 resting between Z22 and Z23 on the TRS-80's main board. You are now going to connect two of the wires to points which will be underneath the IM board once it is installed.



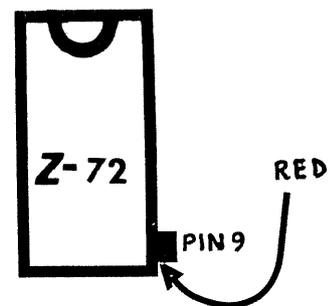
(16) Connect the YELLOW wire to pin one of Z21 on the TRS-80's main board, by slipping the solderless clip onto the I.C. pin as illustrated below. You may wish to tape or glue the wire in place to make it more secure; BE CAREFUL NOT TO GET ANY GLUE ON THE I.C. PIN OR THE CONNECTOR!!



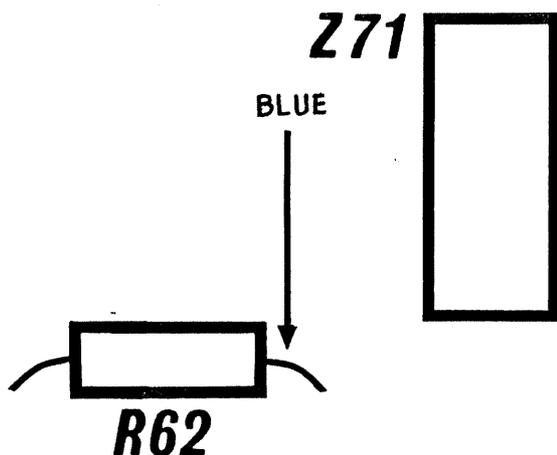
(17) In the same manner, connect the ORANGE wire to pin 9 of Z38 on the TRS-80's main board



(18) Place the IM back on top of the RAM sockets, then look under the IM and make sure the pins are all properly positioned for insertion. Pin 1 of M1 should go into position 1 of the socket at Z13; pin 1 of M8 should go into position 1 of the socket at Z20, and so on. TAKE THE TIME TO CHECK PIN ALIGNMENT CAREFULLY NOW!! IF A PIN IS IMPROPERLY POSITIONED, IT WILL PROBABLY BREAK OFF IN THE NEXT STEP AND RENDER YOUR IM INOPERATIVE!! (19) Once you have all the IM pins properly lined up, push gently on the top of the IM board and start the pins into the RAM sockets. If you feel hard resistance to your light hand pressure, stop and check pin alignment again. Slight variations in the spacing of TRS-80's RAM sockets may require you to reposition a pin or two for proper alignment. The sockets used in the TRS-80's have large openings for the pins to enter, which will allow you to move the IM board around a little while attempting to line up the pins. ALL YOU NEED TO DO AT THIS POINT IS TO GET THE PINS INTO THE CORRECT SOCKET OPENINGS; the pins will "bend" slightly to assume their final positions in the next step. (20) Press the IM board firmly into place until the black plastic "rings" on the pins are close to or are touching the tops of the RAM sockets. If you can't get the board pressed down all the way, go back and check to see if one of the capacitors is interfering with installation of the IM board. (21) Now connect the RED wire to Z72 pin 9 in the same way you connected the orange and yellow wires.



(22) With the TRS-80's main board positioned with the writing right side up, find the socket labeled Z71 (it will have a "DIP shunt" plugged into it). Look just off the lower left corner of Z-71 and find a 4.7K ohm resistor labeled "R62". Attach the BLUE wire to R62, on the end closest to Z71.



(23) Position the wires away from the holes in the TRS-80<sup>+</sup> main board so they will not get pinched by the cabinet posts when you put the case back together. Tape or glue them down if necessary to keep them out of the way.

Your INTERNAL MEMORY is now installed and connected! Double check everything; make sure that all wires are connected to their proper points, and that the pins are correctly inserted into the RAM sockets. Also, look at the back side of the main board and see if there are any wires there. During the process of pushing the IM into the RAM sockets, any wires present on the back of the main board may have been pressed onto the sharp pins protruding from the board, causing the pins to pierce the plastic insulation on the wires and short to the wire inside. Just to be safe, lift all wires away from the main board to make certain they have not been peirced.

-----NOTE-----

There are two pads on the IM marked "sw". A SPST switch may be soldered to these points (via a pair of wires) to allow you to turn off the added memory in your keyboard unit, in case you should want to occasionally use an unmodified expansion interface. When the switch is closed, only the lower 16K of RAM on your IM will operate. When the switch is open, the IM will operate at full capacity.

(24) Now it is time to reassemble your KU. (If you wish to check out your TRS-80<sup>+</sup>/IM combination before putting it back into the case, keep in mind that the main board is "upside down" in its present position. If you connect anything to the expansion connector, the connector should be attached upside down also. In addition, make sure that you plug the power connector into the spot closest to the power switch.) In some cases, you may need to trim the cabinet support posts of the TRS-80<sup>+</sup> so they will not hit against the IM board when the case is reassembled. (23) Fold the main board and keyboard back together, just as they were when you removed them from the case. (REMEMBER, the cable connecting the main board and keyboard must not be stressed!) (24) Place the entire assembly back into the case bottom (you probably had a plastic spacer which fit over the post at the right of the case bottom—make sure it is in place.) CAREFULLY lift the keyboard up and push the main board over the cabinet posts, starting with the taller posts toward the rear of the cabinet bottom. If you cannot get the board to go over these posts, you may need to trim away a little plastic as previously mentioned, to prevent the posts from binding against the IM board. (25) Once you have the main board pushed down into place, put the soft plastic spacers back

into position on the posts between the keyboard and main board. If you don't remember where they go, just put them in positions which best support the keyboard itself. (26) Place the top of the case back on, making sure you get the power LED properly positioned. (27) You may wish to tape the keyboard halves together to make it easier to screw them back together. Place the keyboard face down on the soft towel and put the screws back in. The shortest screws go closest to the front, the medium screws go in the middle, and the longest screws go toward the back. Make sure the screws are properly threaded into the plastic before you tighten them down, and do not overtighten them! It is hard to put the plastic back if you strip the threads! You are now finished with the installation, and are ready to check out your system!!

-----SYSTEM CHECKOUT-----

(1) Connect the power supply, video and any other cables you normally use to your TRS-80<sup>+</sup>. Wish yourself good luck, and turn on the power. You should immediately see the familiar MEMORY SIZE (or MEM SIZE) prompt on the screen. If you get "garbage", a blank screen, or a pattern of letters and/or signs on the screen, TURN YOUR SYSTEM OFF AND IMMEDIATELY PROCEED TO THE "IN CASE OF DIFFICULTY" SECTION OF THIS MANUAL.

(2) Press 'ENTER' in response to the MEMORY SIZE prompt; in a couple of seconds, you should get the familiar >READY prompt. It will take longer for the >READY to come up with more than 16K of RAM; the TRS-80<sup>+</sup> takes longer to find the top of memory.

(3) Once you get the >READY prompt, type 'PRINT MEM'. You should get 31956 (31954) for a 32K system, or 48340 (48338) for a 48K system. (Values in parenthesis are for those systems which normally give a 15570 memory size w/16K of RAM.) If you don't get these values, go to the "IN CASE OF DIFFICULTY" section. (4) You are almost finished! All that remains to be done is to verify that all memory locations are good. If you have a memory test program you are familiar with, use it to test your system. If not, use the simple program listed here. This is not an exhaustive test by any means, but it will indicate whether or not all memory locations can store and recall properly in BASIC. Type in the following program, and store it on tape or whatever you prefer:

```

10 CLEAR 0:CLS:PRINT"INTERNAL MEMORY RAM TEST"
20 INPUT"ENTER START ADDRESS";A
30 IF A>32767 THEN A=A-65536
40 INPUT"ENTER END ADDRESS";B
50 IF B>32767 THEN B=B-65536
60 PRINT"TESTING...."
70 IF A<0 GOTO 160
80 IF B>0 THEN C=B ELSE C=32767
90 FOR X=A TO C
100 POKE X,0
110 IF PEEK(X)<>0 GOSUB 230
120 POKE X,255
130 IF PEEK(X)<>255 GOSUB 230
140 NEXT
150 A=-32767:IF B=0 GOTO 220
160 FOR X=A TO B
170 POKE X,0
180 IF PEEK(X)<>0 GOSUB 230
190 POKE X,255

```

```

200 IF PEEK(X)<> 255 GOSUB 230
210 NEXT
220 CLS:PRINT"END OF TEST"
225 PRINT E;"ERRORS DETECTED":END
230 PRINT"ERROR AT ADDRESS";X;E=E+1
240 FOR Y=0 TO 300:NEXT
250 RETURN

```

(5) Once you have saved the program, turn off your TRS-80, turn it back on, and answer 17800 to the MEMORY SIZE question. (6) Load the program and RUN it. The first testable location is now at 17801; if you try to test below that address, you will wipe out the test program! The first 16K of RAM ends at 32767, and is contained in RAM's M1 through M8 on the IM board. The second 16K of RAM starts at 32768 and ends at 49151, and is contained in RAM's M9 through M16 on the IM board. The upper 16K (IM-2 only) starts at 49152 and ends at 65535, and is contained in RAM's M17 through M24 on the IM board. Thus, test a 32K system from 17801 to 49151, and a 48K system from 17801 to 65535. (NOTE: If you are using a Stringy Floppy, do not test the top 4 bytes of RAM. The SF uses the top 4 bytes, and your system will crash if you test them with this program.) This is a BASIC program, and will take quite a while to run. If you have a printer, you may wish to change the PRINT statements in lines 60-230 to LPRINT, to get a listing of the test results.

Once you have tested the RAM in your KU, all that is left to do is to use it! RAM in your IM "looks" just like RAM in an expansion interface; use it exactly the same way. The only "trick" needed to use the IM is not related to the IM at all, but is brought about by the fact that the TRS-80 cannot handle integers greater than 32767. Thus, in order to use PEEK and POKE commands with addresses above 32767, you must use a negative number derived from the formula: desired address - 65536 = PEEK or POKE address. This is explained in section 8 of the TRS-80 LEVEL II BASIC REFERENCE MANUAL.

-----IN CASE OF DIFFICULTY-----

The following information is intended only to provide suggestions for solving relatively simple difficulties. No attempt is made to teach how to repair the TRS-80, as that is best covered in the Technical Reference Manual available from Radio Shack. There are several common problems which can occur when installing an IM board, involving malfunctions of the TRS-80 (caused by broken wires) or malfunctions/incorrect installation of the IM or RAM chips. Answer four questions before proceeding: (1) Are all the RAM chips inserted with the notched end matching the outline on the IM board? (2) Are any RAM pins bent up under the chip body, preventing the pin from being properly inserted into the socket--lift up each chip to check, as bent pins can "hide" very effectively. (3) Are the red, blue, yellow, and orange wires connected to the correct points on the main board? Are they touching adjacent IC pins or PC traces? (4) Do you have the correct type of RAM chip installed (4116)? Are the chips good?

You must know that the TRS-80 is functioning properly before you can look for other problems. If you can operate your TRS-80 SAFELY out of the case, follow these steps. (Otherwise, go to the next paragraph.) Remove the RAM chips

from the IM sockets, and turn on the TRS-80. If you get a pattern of "@S's" on the screen (or sometimes just large @ signs), you probably have a problem with one of the RAM chips you had installed in the IM. If you don't get "@S's", disconnect the four wires and unplug the IM from the sockets. If you get "@S's" now, check to see if a pin on the IM was bent, broken, or improperly inserted in a socket (sometimes one of the single pins can get bent over into the next socket position, i.e., pin 2 can get pushed over and inserted into position 3 of the socket). If you can't see anything wrong with the IM or the way it was installed, you will need to contact HOLMES ENGINEERING for assistance. If you don't get "@S's" with the IM removed and the RAM sockets empty, you probably have a problem with your TRS-80. Place your original RAM chips back in the sockets and see if it works at 16K. If not, contact us or your dealer for assistance.

The following is a list of symptoms, printed in CAPITALS and preceded by an arrow (-->), followed by suggestions for solving the indicated problem:

-->SCREEN IS BLANK THE INSTANT THE TRS-80 IS TURNED ON: The +5 volt supply is current limiting. You probably have a RAM chip installed backwards; the chips do not all go in the same direction! Check to make sure the notches in the chips match the outlines on the IM board. You could also have one of the brown capacitors bent down so its lead is touching a trace on the PC board, shorting the +5 volt power supply.

-->DISPLAY JITTERS. The video sync section of the TRS-80 is unstable to begin with. After adding an INTERNAL MEMORY to the system, it seems to be even worse! The easiest way to cure the "video jitters" is to swap the RAM chips around on the IM board until the jitter goes away; i.e., swap the chips in sockets M14 and M22, etc. A more effective way requires a bit of soldering and a "trial and error" approach: Solder a 20-500 pf capacitor from pin 10 to pin 11 of Z57 on the TRS-80 main board. Solder another 20-500 pf capacitor from pin 12 to pin 13 of Z57. (The values are not critical; use as much capacitance as your TRS-80 can handle without moving the display off the screen!) After you have added these capacitors, the jitter should disappear. If not, try using larger capacitors until it does. When you are finished, your display will probably be off center. Adjust variable resistors R20 and R21 (next to the cassette connector on the TRS-80 main board) to center the display on the screen.

-->SCREEN SHOWS GARBAGE FOR AN INSTANT, THEN GOES BLANK OR SHOWS RANDOM CHARACTERS AT A FEW LOCATIONS. The RAM address lines are not all functioning properly. Check for bent-under RAM pins, improperly installed chips in M1 through M8, capacitors pushed down and shorting against the pc board, wires on the back of the board pierced by the sharp pins.

-->SCREEN FILLS WITH BLINKING PATTERN OF "@9's" (or large @'s"). A ROM or the ROM cable is unplugged, or a wire from the ROM board to the main board is broken loose. You will need to refer to a RS manual, or contact us for help.

-->IMMEDIATELY AFTER MEMORY SIZE APPEARS, OTHER CHARACTERS APPEAR AND/OR ERROR MESSAGES SCROLL UNCONTROLLABLY DOWN THE SCREEN. One or more connections inside the ribbon cable connecting the keyboard to the main board are broken. Measure the cable with an ohm-meter and attach jumper wires across any broken conductors; flex the cable while measuring to reveal any

intermittant connections.

--->SCREEN FILLS WITH GARBAGE. Make sure you have gone through the steps at the beginning of this section. You must know that your TRS-80 is OK before proceeding! Remove the RAM chips from the IM. If you get a pattern of "@" signs and letters on the screen, you probably had a bad or improperly installed RAM in M1-M8. If you don't get a pattern of "@" signs, disconnect the 4 wires and remove your IM board. If you now get the pattern, you have a bad or improperly installed RAM on the IM, a bent or broken pin, or a defective board. If you still get garbage with the RAM sockets empty, something is probably wrong with your TRS-80. Contact us for assistance. (First, check to see if any wires on the back of the TRS-80 main board have been pressed onto the sharp pins protruding from the board.)

--->IM WORKS, BUT NOT AT FULL CAPACITY. If you only get 16K of RAM, check the blue wire. Make sure it is making good contact on R62—there could be some solder flux on the connector or the resistor preventing proper contact from occurring. If you get more than 16K but less than full capacity, you have a defective or improperly installed RAM chip in M9 through M24 on the IM board.

--->NONE OF THE ABOVE STEPS HELP. You have exhausted all the simple tests. Go over everything again, and maybe again, but stop just before you are ready to send the IM down the garbage disposal! Contact your local dealer if possible; he can most conveniently assist you. If you purchased your IM from HOLMES ENGINEERING, call or write and we will assist you. The IM does work; hundreds of them are in operation right now! One way or another, we will help you get it up and running. If you wish to send your keyboard unit to us, we will install your IM board for \$20.00 including return UPS shipping; we usually ship systems back out 48 hours after receiving them if they are pre-paid or COD. We can also repair your TRS-80 for a reasonable fee; contact us for details.

#### -----USING AN INTERNAL MEMORY WITH AN EXPANSION INTERFACE-----

If you plan to use an expansion interface with no memory installed (a OK interface), you will need to modify it so that its memory circuits do not interfere with the operation of the INTERNAL MEMORY. This modification will only affect the memory portion of the interface; it will not alter the function of any other section. There are two basic versions of the expansion interface (EI). You won't know which one you have until you open it up. (1) Remove the screws on the bottom of the expansion interface (2) remove the case bottom to reveal the printed circuit board. (3) Look for Z19 and Z21. If these are 74LS367's, you have an "old style" expansion interface; continue with these instructions. If Z19 is not a 74LS367, you have a "new style" interface; skip to the next paragraph. (4) Remove the PC board from your EI (5) Cut the traces connecting to Z19 pin 1 and Z21 pin 1, so that pin 1 of Z19 and Z21 is not connected to anything (6) Now connect pin 1 of Z19 to pin 1 of Z21 (7) Connect a 1k-10k resistor (value not critical) from pin 1 of Z19 or Z21 to pin 16 of Z19 or Z21 (+5 volts). The RAM output buffers are now "tri-stated" (floating) permanently and cannot interfere with the INTERNAL MEMORY. To return your EI to original operation, simply connect a wire from pin 1 of Z19 or Z21 to Z20 pin 3. Skip the next paragraph.

MODIFYING THE "NEW STYLE" EXPANSION INTERFACE. If Z29 and Z31 are 74LS244's, you have a "new style" EI. Since you should already have it opened up, (1) make sure Z29 and Z31 are 74LS244's. IF THEY ARE NOT, contact HOLMES ENGINEERING before proceeding. If they are, find Z28, a 74LS00 I.C. (2) Find the trace running between pins 8 and 9 of Z28. (3) Cut the trace running between pins 8 and 9 of Z28, just past the point where it "feeds through" the hole in the circuit board. (4) connect a 1k-10k resistor (value not critical) from the feed-through hole in the circuit board to the heavy trace connected to pin 16 of Z28. You have now connected pin 19 of Z29 and Z31 to +5 volts, which "tri-states" (floats) the RAM output buffers and prevents them from interfering with the operation of the INTERNAL MEMORY. To restore your EI to original configuration, simply repair the cut trace.

#### -----WARRANTY-----

HOLMES ENGINEERING guarantees the INTERNAL MEMORY to be free from defects in material and workmanship for a period of one year from date of purchase under normal use and operation. This warranty does not include the cost of any inconvenience, liability, loss or damage to the customer or any other party caused or alleged to be caused by installation or failure of the INTERNAL MEMORY, nor does it cover damage caused by misuse, abuse or alteration. REPAIRS AND/OR TROUBLESHOOTING DONE TO INTERNAL MEMORY BOARDS USING RAM CHIPS NOT PURCHASED FROM HOLMES ENGINEERING ARE EXCLUDED FROM WARRANTY COVERAGE, AND WILL ONLY BE DONE AT CUSTOMER EXPENSE! Returned INTERNAL MEMORY boards must be shipped pre-paid to HOLMES ENGINEERING, to be repaired or replaced at HOLMES option at no charge within the warranty period. There are no other warranties granted, expressed or implied.

# MERCHANDISE RETURN POLICY

In order to return merchandise to Holmes Engineering, you must first write or call ahead and receive an RMA (Return Merchandise Authorization) number. HOLMES ENGINEERING WILL NOT ACCEPT RETURNED MERCHANDISE WHICH DOES NOT HAVE AN RMA NUMBER CLEARLY VISIBLE ON THE OUTSIDE OF THE PACKAGE!!!!

Merchandise which is shipped in error or defective prior to shipment will be replaced without additional charge. The RMA number will be coded to show this, and will indicate to our shipping department that the package should be accepted.

MERCHANDISE DAMAGED DURING SHIPMENT WILL NOT BE ACCEPTED FOR RETURN BY HOLMES ENGINEERING. To meet insurance requirements, report shipping damage to the shipping carrier immediately. Keep the original shipping container, packing material and any papers, cards or other literature which may have been included. The carrier will not honor a claim if any of the shipping material is missing!

BE SURE TO REPORT SHIPPING DAMAGE PROMPTLY! THERE IS A TIME LIMIT ON ANY SHIPPING DAMAGE CLAIM.

To return any merchandise for any reason, call (801) 261-5652 between the hours of 9a.m. and 5p.m. MST, and ask for the CUSTOMER SERVICE department. (If you cannot call, send a letter explaining the problem in detail). You will be issued an RMA number according to the circumstances. In addition, returned merchandise is subject to the following conditions:

- \* Merchandise must be properly shipped in original packaging. All documentation, registration cards, other literature and accessories must be included.
- \* Merchandise may not be damaged, marred or otherwise made unfit for resale, prior to return to HOLMES ENGINEERING.
- \* If a refund is requested, it will be made within 30 days if the above conditions are met. Shipping and handling charges will not be refunded. In addition, we will deduct a re-stocking charge of \$5.00 or 15% of the amount returned (whichever is greater). The re-stocking charge will be waived if you apply the refund toward another purchase at the time of the return. If you paid with a check, we will send you a refund check. If you paid with a credit card, we will credit your account.
- \* HOLMES ENGINEERING reserves the right to refuse a refund or exchange for any item it determines has been misused, altered or otherwise rendered unfit for re-sale. Such products will be returned to the customer freight collect.
- \* If you request replacement of the merchandise, we will send the replacement as soon as it is in stock.

