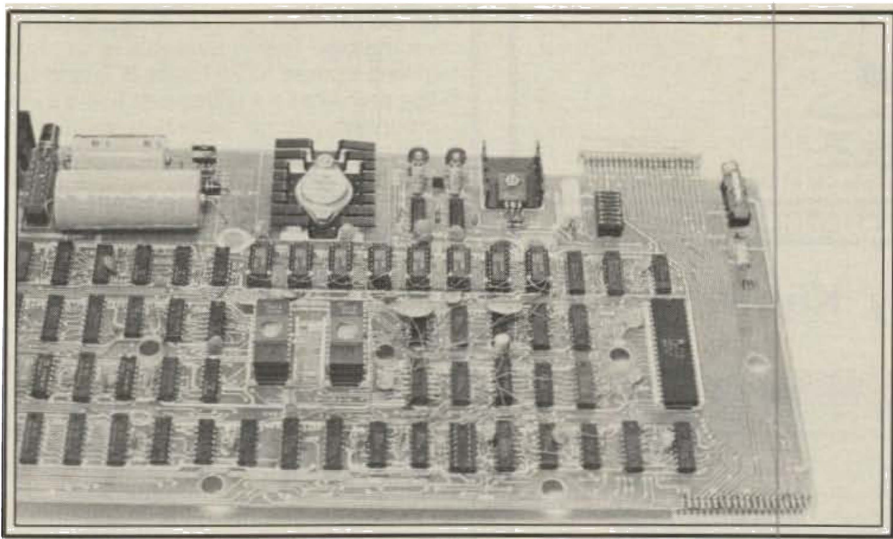


**With a little effort and not much money you can increase the memory of your TRS-80® Model I to include RTTY and other sophisticated modes of communication in its repertoire.**

# Updating The TRS-80® Model I To 48K Memory With 64K Chips

BY LEW MCCOY\*, W1ICP, AND FRED TREASURE\*\*, KA5NJY



*This photo shows the 64K chips installed and wired into the circuit. As mentioned in the text, the ROMs shown bear no resemblance to the original TRS-80®. (TRS-80 is a registered trademark of Radio Shack.)*

**T**here are many reasons why the owner of a TRS-80® Model I might want to install full memory in the computer proper (not in the interface). With the recent drop in prices on 4164 dynamic RAMs (about \$50 for a complete set of 8) it becomes very attractive to add memory to your Model I. The 64K chips will bring your system up to the full 48K of RAM it is capable of running. Keep in mind that the bottom 16K is reserved for ROM, which holds BASIC, operating systems, etc.

One of the advantages of using the 4164 is that it requires much less power (cooler operation). In fact, the heat reduction is dramatic. Before making the modification, the power supply pass transistor got very hot. Now it runs so cool, that it is hard to detect that it is actually operating.

Another advantage in the modification is that it cuts down on reboots from memory errors. There is a lot less chance of glitches with only 8 memory chips versus 24. And most important, the modification eliminates the memory problems so common with the interface units. This is particularly true of the earlier interface models, although the memory problem can exist with the newer interfaces.

We were lucky enough to obtain some factory rejects of interface boards, and almost invariably the problems with the boards were memory problems. By installing the 64K, 4164 dynamic RAM chips on the computer board itself, memory errors common to using the interface vanished.

## 4164 Variations—Watch Out!

The pin numbering on the 4164s is different from the existing RAMS used in the Model I. However, no socket changes are necessary to make the modifications. All

that is required is to lift certain pins on the new RAMS (pins 8 and 9) so that the pins do not make contact with the sockets. These pins which were lifted or bent up will be wire-wrapped for their new connections. With some types of 64K RAMs, a few manufacturers require that pin 1 be connected to +5 volts. Be careful here because on the existing sockets on the TRS-80® Model I board, pin 1 is -5 volts. In our modification, such types of the 64K RAMs must have the pin lifted so that it is not engaged in the socket. They must be lifted and then strung together and connected to the +5 volt line. (The OKI chips we used do not have pin 1 connected internally and pin 1 is not connected to +5 volts, so this was not a problem in the modification shown in the photo.) Of course it would be remiss on our part if we tell you to be careful of the manufacturer and then not tell you where we got our chips. Here is the supplier: Microprocessors Unlimited, P.O. Box 8080, Beggs, Oklahoma 74421, phone 918-267-4796. The chips are designated 220 ns, OKI, plastic 64K dynamic RAMs. When we got ours, they were about \$5.00 each.

## Required Modifications

We could do the modifications in a step-by-step manner, but the changes are really simple. The project just requires some care. It is assumed that anyone desiring to make this change has long since voided the warranty by opening his or her computer to make changes. However, the changes should be clear so that any amateur with even basic soldering knowledge can make the mods required. First, please observe all the usual warnings and precautions about handling the 4164s. They are sensitive to static electricity and can be ruined through careless handling.

After removing the computer case, carefully remove the existing RAMs, Z13 through Z20. They are all in a line togeth-

\*200 Idaho St., Silver City, NM 88061

\*\*Route 8, Box 28E2, Silver City, NM 88061

er on the top row just below the large power-supply pass transistor. Next, carefully bend pins 8 and 9 on each of the new chips to slightly more than 90 degrees, enough so that you will be able to wire-wrap the pins. (If your 4164s have the pin 1 connected as mentioned above, you will need to lift these pins also.) Now carefully insert all the RAMs into the sockets, making sure that all pins make good connections into the sockets. Pin 8 on the new RAMs requires 5 volts, so these pins should be wire-wrapped, daisy-chained, and then connected to the 5 volt bus. In order to reduce noise pick-up, both ends of the line were connected to 5 volt points. Z20, pin 8 is connected to Z39, pin 16 (5 volt point), and Z13, pin 8 is con-

nected to Z31, pin 16 (5 volt point). (Be careful to check your wire-wrapping to make sure that none of pins 8 are shorted to pins 9.)

In order to address this new memory we need to create a new line, **MA7** (Memory Address 7). Fortunately, this is extremely simple. Z51, a 74LS157, is an address multiplexer, and if you examine it, you will find that pins 12, 13, and 14 are not connected to anything. These pins will be used to create our new line **MA7**. First, daisy-chain all the pins 9 together on the memory chips using your wire-wrap wire; then connect a lead from pin 9 of Z20 to pin 12 of Z51. We routed the wire through the large hole between Z51 and the ROM socket Z34 to make the con-

nection to pin 12 of Z51 on the bottom side of the board. Be sure when making any of these connections to use a minimum of solder and heat. Naturally, one should check any new solder joint to make sure that it isn't shorting to any adjacent line or connection. Make a connection between Z51, pin 13 to Z38, pin 11. This is address line 14 and is needed for addressing the new memory. Likewise, connect Z51, pin 14 to Z38, pin 9, which is address line 15.

If your chips require pin 1 to have +5 volts, they must be wired together and connected to the +5 volt line. It is probably a good idea to connect both ends of the string to the 5 volt line as you did with pin 8.

One last modification is required. It is necessary to enable the memory locations above 32K by activating the signal **MEM\***. We can do this by inverting A15 using a spare gate. This modification is a little trickier if we want to use the spare inverting gate that is available to us. This gate is located on Z37, pins 8, 9, and 10. The problem here is that pins 8 and 9 are grounded, and the ground connection is under the chip. We used a desoldering tool to clean out the pin holes. A small prod was used to lift the two pins from the board so we could get at them. You could get another 74LS02 and mount it piggyback and then wire it for +5 volts and ground rather than unsolder the existing pins, but that is up to you. Next connect pins 8 and 9 together and connect them to Z38, pin 9 (address line 15). Last, connect a signal diode such as a 1N4148 with the cathode (bar) to pin 10 of Z37. The anode end (arrow) is connected to pin 10 of Z74. That completes the modifications. There are no other modifications required to complete the project.

### Some Conclusions

It is important to keep in mind that the first 16K of memory is reserved by the ROMs in the TRS-80® Model I. We understand that there are other operating systems available (in ROM), but presently we have no further information. In the photograph of the unit shown here, the ROMs used are a special program dedicated to various amateur radio functions such as RTTY, code copying, slow-scan, etc. But that is another story that may never be written—the system is always in a state of flux!

One last item: Those people who have interfaces with memory in them must remove the memory chips in the interface. This prevents memory contention between the two sets of memory.

We have modified three computers so far. The first took several hours of study and work. The last one took about two hours to modify using this article as a guide.

Is the work and expense worth the effort? We think it is. Getting rid of the heat and memory glitches was well worth it. 