

# RAM/ROM Upgrade Roundup

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There have been many words written on how to upgrade the various models of the Color Computer and TDP System 100 to get more memory and Extended Color BASIC. With the presence of at least four different versions of the CoCo's main circuit board (each changing various aspects of memory expansion), it's easy to get confused trying to find out how to do the job. At the *Rainbow* editorial office, we've kept a two-page sheet around that tells how to do a number of different mods. When I found out how different the Color Computer 2 was from the earlier models, I decided it was time for an update to put all the upgrade information together in one place.

### What's The Difference?

When Radio Shack first introduced the Color Computer in 1980, it started not with version A, as one might expect, but with a board identified as version D. This circuit board was designed to accept either 4K or 16K of RAM and either 8K or 16K of ROM. The first 8K was for Color BASIC with the second 8K reserved for future use, but by the time the CoCo was actually announced Radio Shack had decided to offer Extended Color BASIC. (Fortunately, they did not repeat the earlier mistake on the Model I where they set up the unit for 4K of ROM and had to go to an extender board for the 12K Level II BASIC.) In 1981 Radio Shack decided to offer the CoCo with 32K RAM; to do it Tandy modified the board to use half of the capacity of a set of 64K RAM chips. Since the modification was rather complex and hard to do in production, they went to the version E board which could accept 4K, 16K or 64K RAMs.

In 1982, as the TDP Electronics division prepared to enter the personal computer market with the System 100, Tandy developed what it calls the NC board (which is often referred to as the 285 or F board). This board was designed to meet slightly relaxed FCC specifications, and used either 16K or 64K RAM chips. The NC board was designed to make available the all-RAM mode that all CoCos had the potential for, but which had not been implemented in the earlier designs. The NC board went into all TDP System 100 units; when Radio Shack dropped the 4K CoCo, the NC board began to appear in their units late that year.

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Because the CoCo was priced quite a bit higher than its close competition, Tandy decided to redesign the entire machine into a unit that would cost much less to manufacture. The assignment, making a computer that was much cheaper than the existing CoCo but did exactly the same things, would appear difficult to anyone who is familiar with the CoCo's already efficient design. But the engineers in Fort Worth were able to do it, partly by getting rid of the regulated +12V, -12V and -5V power supplies with the use of new single-supply RAM chips in the 16K models of the new Color Computer 2. This was at about the same time that Radio Shack decided to offer OS-9 and an improved keyboard for the CoCo; the CoCo 2 was initially sold in 16K versions only and the regular CoCo (which was equipped for 64K, but advertised as 32K) was given the new keyboard and a white case and renamed the 64K Color Computer.

If you have a Color Computer with a black border around the keyboard and a RAM size button on top, you have either a D or E board. If you have a CoCo with a gray border around the keyboard and a model number ending in A (or if you have a TDP System 100), you have an NC board; if it has Radio Shack's "32K" RAM then you already have 64K. If you have the Color Computer 2, it's a whole new ballgame.

### A Few Precautions

1) *Unplug the computer* before you start making any of these modifications. Even though the machine is turned off,



there may still be a small current flowing in the CoCo's circuitry, which could cause damage when you start plugging and unplugging chips; there will definitely be 120 volts present on the power transformer, and you could get a very nasty (not to mention dangerous) shock if you make contact with it!

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2) The RAM chips (and, to a lesser extent, the other integrated circuits in the computer) can be damaged by static electricity. The new chips you will be installing will usually be on a black conductive foam pad. Just before you install them, touch the pad to either the shield (if any) over the circuit board or to the RF modulator unit's metal case. (Use the pad to hold the old RAM chips you took out, so they will be protected until you install them in something else.)

3) Use a soldering iron (not a gun) rated at around 40 watts or less. The components and circuit board can take the

heat needed for soldering, but the heat of the bigger irons and guns (designed for radio/TV repair work) can easily damage them. A grounded iron (with a three-prong plug) is helpful, but not really necessary; if you have a cordless soldering iron, it would be ideally suited for this work.

## 4K to 16K

To install 16K RAM in a 4K CoCo (D or E board), you need only a set of eight 4116 RAM chips. These should be rated at 200 nanoseconds or faster (which most are these days). When you open the case and remove the shield, you will find the 4K chips in sockets U20-U27. Remove them one at a time by gently prying them out with a small screwdriver or nail file; insert a 16K chip in place of each one, with the notch on one end in the same direction. Now locate two jumpers marked 4K on one side and 16K on the other; one is next to the 6883 SAM chip (U10) and the other is between the two 6821 PIA chips. Change each of them to the 16K position. With Color BASIC, you should now get a response of 14631 to *PRINT MEM*.

## All The Way to 64K

To upgrade a 4K or 16K CoCo to 64K, you will need a set of eight 4164 64K RAM chips, as well as a few feet of thin insulated wire (wire-wrap wire is normally used, but you can also use wire taken out of telephone cable). The D and E board upgrades take a bit of wiring to get 64K (the D version has to be rewired even to get 32K); the NC board is not particularly difficult, and the Color Computer 2 is the easiest of all. On a D or E board, I would first install the chips and get the computer going as a 32K unit before doing the 64K modification. (If you have the D or E board, check the Color BASIC ROM's copyright date; if it's marked (C) '80 you will need to replace it. See BASIC ROM Upgrades below.)

**D Board:** This board has only the two jumpers that I mentioned in the 16K upgrade instructions. After removing the shield cover, check to see that the jumper next to the 6883 SAM chip (marked U10) is in the 16K position and remove the jumper between the two PIA chips. To change the power connections to the RAM chips, bend up pins 1, 8 and 9 of each chip. (With the notched end of the chip facing away from you, pin 1 is at the upper left, pin 8 is at the lower left and pin 9 is on the lower right.) After inserting the RAM chips in place of the old 16K chips, wire pins 1 and 8 of each RAM chip to pin 9 of that chip's socket. Wire the pin 9s on all the chips together and connect them to pin 35 (the sixth pin from the top on the right side) of the SAM chip. Connect pin 12 of U4 to pin 16 of U8. Check to make sure that none of the bent-up pins are touching anything, and that all the pins are well below the edge of the shield wall. (Skip the next paragraph.)

**E Board:** There are five jumpers in this board and two more jumper locations that don't have jumper plugs on them. Move the jumper located between U8 and U4 and the three jumpers next to the keyboard connector to the 32K position, and check to see that the jumper just below C44 is set to the 16K/32K position. Solder the two pins next to C44 together; find the three pins (marked LOW and HIGH) next to U29 and solder the LOW pin to the center pin. Cut off one

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side of each of the capacitors C61, C31, C64, C35, C67, C45, C70 and C48. Replace each of the 16K RAMs with the 64K chips.

With 32K RAM, you should get a response of 31015 to *PRINT MEM* (24871 with Extended Color BASIC). If all is well, unplug the computer again. Pull U29 (74LS02) and U11 (74LS138) from their sockets, bend up pins 4, 5 and 6 of U29 and pin 5 of U11 and reinsert them. Connect pins 6 and 8 of U29 together (pin 8 was not bent up), connect pin 4 of U29 to pin 5 of U11, and connect pin 5 of U29 to the pin marked TP1 on the board. The computer should work the same under BASIC as it did before you took out the two chips. (To try the other half of the RAM, you will need to run some program that uses 64K, such as OS-9 or *Telewriter-64*, and see if it works as expected.)

**Radio Shack 32K:** If your D or E board CoCo was purchased with 32K RAM (or upgraded by Radio Shack), you most likely have a good set of 64K RAMs in place and you will only need to perform the 64K addressing modification above. If the LOW-HIGH jumper (on an E board) is set to HIGH, or if the connections to U4, U8 and/or U10 (on a D board) are different from those given here, you will probably have to put in new 64K chips because the ones you have are good in the high half only. If you put in new RAMs, move the jumper to LOW (on an E board) or change the wiring (on D).

**NC Board:** The RFI shield is held in place by lugs under the board. Pry down the two lugs near the left edge of the board, then pry the shield loose from the top of the board. Clip out capacitors C58, C60, C62, C64, C66, C68, C70 and C72 (these are the nearest of the two capacitors next to each RAM socket). Change the two jumpers next to U21 and one

above U28 to the 64K position. Solder the two jumper pins next to U17 together. Replace the 16K RAMs with the 64K chips. When you put the shield back on, bend those tabs you can reach back into place.

**Color Computer 2:** Unplug the keyboard cable and set the keyboard aside. Replace the 16K RAMs with the new 64K chips. Locate the two adjacent holes at W1 next to the IIA chip (MC6822P) and connect them together. Plug the keyboard back in.

With 64K RAM, you should get a response of 31015 to *PRINT MEM* (24871 with Extended Color BASIC). Unless something very odd is wrong with your machine, the 64K mode should now work. Color Computer 2 users should note that the 16K chips that came out of the CoCo 2 are *not* 4116s; they are 2118s, which use a single +5V power supply and *will not work* in earlier CoCos (either as replacements or for "piggyback" RAM expansion). In the same way, the 4116 RAMs cannot be used in the CoCo 2.

## BASIC ROM Upgrades

**Extended Color BASIC:** The upgrade kit (Radio Shack catalog number 26-3018) consists of the ECB ROM chip and the *Going Ahead with Extended Color BASIC* manual. Any Radio Shack store or dealer can get it for you, though some sales people may not know that they can sell it without installation or may be unwilling to do it. The only thing you have to do is insert the ROM chip in the empty socket next to the Color BASIC ROM. (ECB does require at least 16K of RAM to operate.)

**Color BASIC Revisions:** Tandy has released three different versions of the Color BASIC ROM, all of which carry the part number 8040364. Version 1.0's major characteristics were that it used a 7-bit format for printer output (and therefore could not use bit-image graphics on Radio Shack printers) and that it worked only with 4K and 16K RAMs (not 64Ks). Version 1.1 (8040364A) allowed the use of 64K RAM chips and used an 8-bit printer format. Version 1.2 (8040364B) cleaned up a few bugs in the Color BASIC math functions, and the extensively rewritten interpreter runs faster than earlier versions did. As with Extended Color BASIC, installing the new ROM only involves putting it in its socket (in this case, replacing the old ROM chip). Socket numbers vary, but the Color BASIC ROM will always be in the lower-numbered position of the two 24-pin sockets (Extended Color BASIC will be in the higher-numbered socket).

## Color Computer 2 Cartridge Port

The Color Computer 2, as mentioned above, uses single-supply 16K and 64K RAMs. Because of this, Tandy left out the regulated +12V supply, which the disk controller and X-Pad depended on for power, so the CoCo 2 normally can't use them (unless you have the Multi-Pak Interface). An unregulated +12V source *is* available, and it's easy enough to put it on the edge connector where it can do some good. Locate the four diodes (CR1-4) next to the power transformer. Run a wire from the cathode (banded end) of either of the two larger diodes (CR3 or CR4) to pin 2 of the edge connector. This pin is clearly marked, and is on the end at the back of the unit.

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