Custom Color

by Dennis Kitsz



illustration by Rod McCormick

AN ICE STORM rages outside while a solar storm creates beautiful auroras in the sky above, Northern lights which aren't visible. For me, the only way to lift this storm-inspired depression is to upgrade several Color Computers for friends — more memory, better Basic, clearer video.

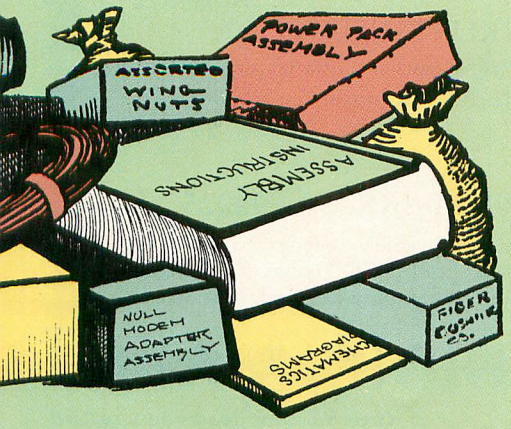
For less than a hundred dollars, plus some time, you can expand your Color Computer from the $299 special — 16K Color Basic — to a 32K Extended Color Basic machine with direct video output. In the process, you will discover how the inside of the machine is organized and learn a great deal about how it works. First glance through the photos accompanying this article to get an idea of what your computer looks like and what will be involved. Then, before getting started, make a trip to Radio Shack and purchase their excellent *Color Computer Technical Reference Manual*, Cat. No. 26-3193, $14.95.

This first edition of Custom Color is down-n-dirty practical, and I'll save the theory for later. For now, we'll just get your machine in shape.

I recommend a static-free workbench with a solid metal surface, for this project and some pads of conductive foam (Radio Shack Cat. No. 276-2400), or a static-free workbench pad (#WS-9010, $15 plus shipping from Wescorp, 1155 Terra Bella Ave., Mountain View, CA 94043).

Opening the Computer

This will be the single hardest step for the first-timer to take. If you do not have Extended Basic, turn the machine on and mark down the Color Basic sign-on message revision number (1.0 or 1.1 at this writing). Now unplug the computer, and turn the machine over on a soft towel to avoid scratching the silver-grey paint. Removing the first six screws takes only a Phillips-type screwdriver (see Photo 1), but the final screw is located underneath a label with the warning message: "Opening case will void warranty. See owner's manual for warranty information."



You should know that Radio Shack has relaxed some of its firm rules regarding warranty voiding, but you should also be aware that making modifications remains your responsibility. Wait until the warranty period is over, and then make all changes neatly and always keep a detailed record of any changes you have made. This will come in handy if you ever have to return the computer to Radio Shack for repairs.

You can now confidently punch through the warning label and remove the seventh screw. Hold the case together tightly and flip it upright. Slide your fingernails under the front lip, and lift the top up and back (Photo 2). The inside is shown in Photo 3.

Before continuing, identify your "board revision" (Photo 4). Most stan-

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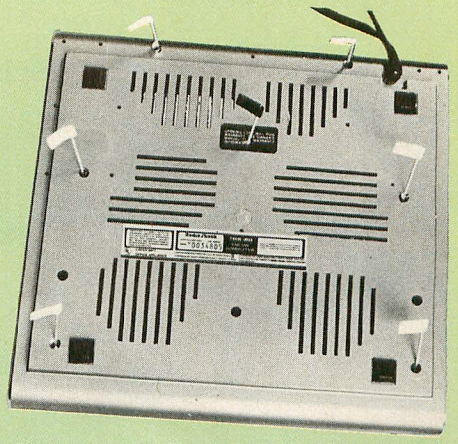


Photo 1. *Here's where to find the Color Computer's screws. The white flags identify the six holes where Phillips-type screws are located. The seventh screw, black flag, is located under the warranty label.*

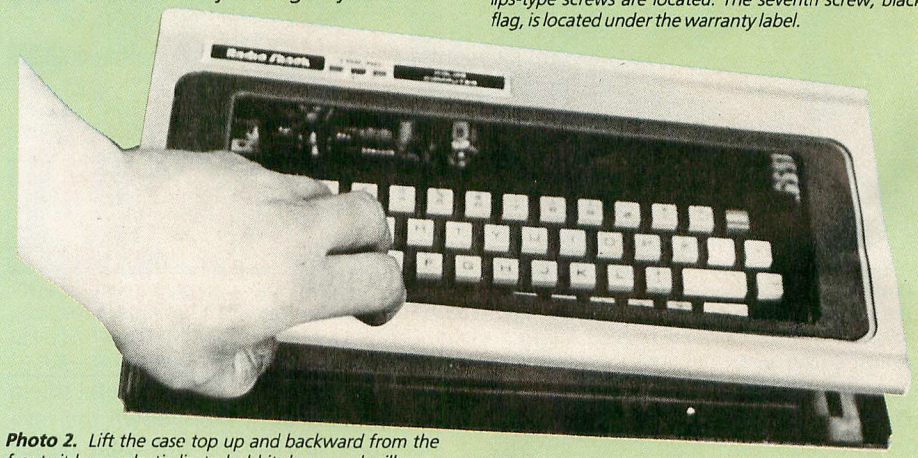


Photo 2. *Lift the case top up and backward from the front; it has a plastic lip to hold it down and will snap up when enough pressure is applied.*

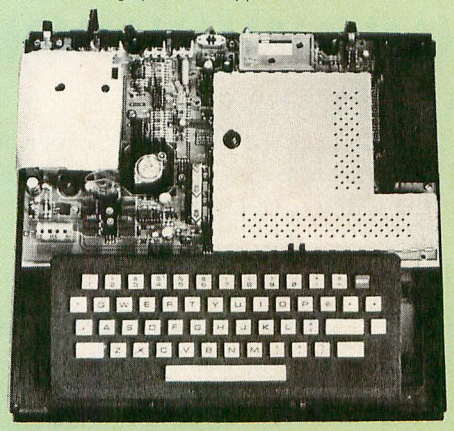


Photo 3. *Inside the computer, left to right: transformer and AC power supply under an insulating shield; +5, −5 and +12 regulated power supplies (including heat sinks); cassette and joystick circuitry (at back); RF modulator (metal box at back); interference shield (large metal cover); and cartridge slot.*

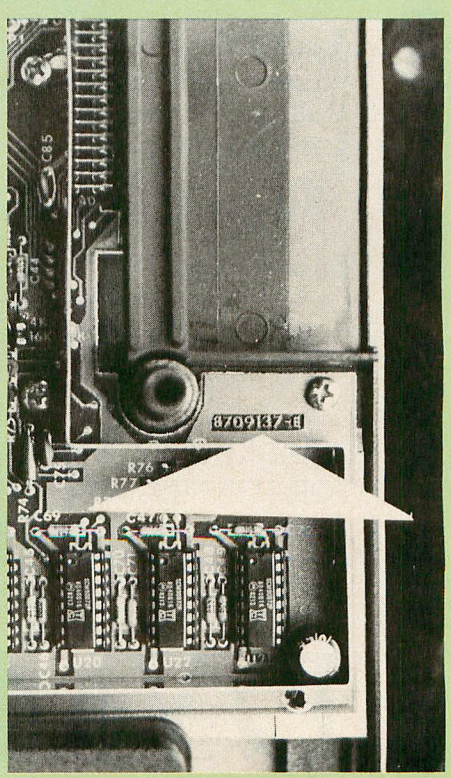


Photo 4. *Your board revision is identified by a number just below the cartridge slot (white arrow points to identification number). This is revision E, the first board in which 64K RAMs could be used easily.*

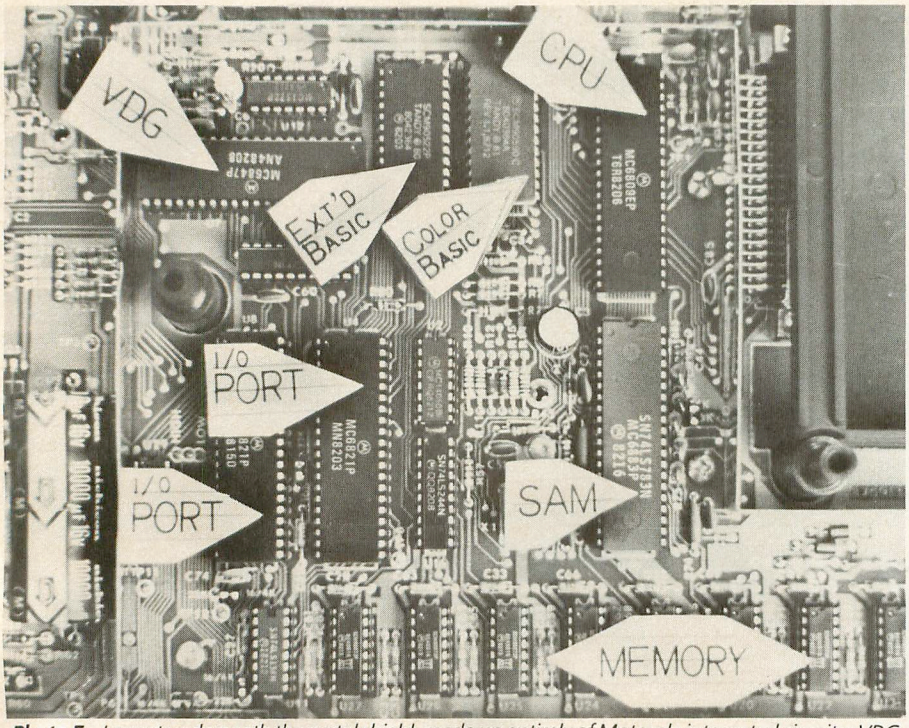


Photo 5. *Layout underneath the metal shield, made up entirely of Motorola integrated circuits: VDG is the type 6847 video display generator; CPU is a 6809E; Basic ICs are both 68A364 industrial ROMs; I/O ports are 6821; memory consists of eight standard 4027 (4K), 4116 (16K), or 4164 (64K) dynamic RAMs; SAM is the synchronous address multiplexer, Motorola type 6883 (or generic type 74LS783).*

Continued from page 41

dard Color Computers are D and E revisions, though I have seen a few C boards. The new white-case TDP computers have an F revision with a smaller metal shield covering the guts. Mark down the revision code. Identify the two white plastic straps holding down the large metal shield; clip them with snips and pull them out with pliers. Lift the metal shield straight up, slowly sliding the sides upward until the dozens of metal fingers slip off the frame below. The heart of the computer is under this shield, as you can see in Photo 5.

4K to 16K

To make any reasonable computer upgrades, you will need at least 16K of memory. At this point, you have several options: 1) obtain eight 4116, 250 nS dynamic memories (under $10 these days) for a straightforward 16K upgrade; 2) obtain sixteen 4116 dynamic memories for a piggyback-type 32K memory upgrade; 3) obtain eight 4164 dynamic memories (about $48 a set) for an immediate 32K upgrade and future 64K upgrade. Both 32K upgrades will be covered later in this article; for now, you'll probably want at least the 16K. Leave the memories you have purchased in their packaging.

Under the metal shield, toward the keyboard, are eight identical integrated circuits: U27, U26, U25, U24, U23, U20, U22, and U21. These are the memories. Notice that each contains a rounded notch in one end pointing toward the back of the machine. Now refer to Photo

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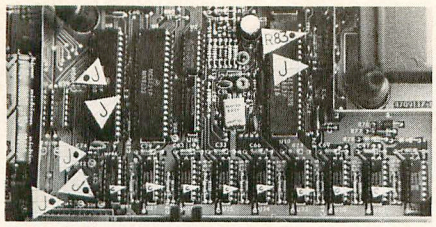


Photo 6. *Upgrading from 4K to 16K, and 16K to 32K, the Radio Shack way. Only two jumpers are changed to upgrade to 16K; an additional four must be moved, and a resistor added, for the official 32K upgrade. The C labels indicate the integrated curcuits.* See text before performing any upgrades!

6; the J's are jumpers. You will need to locate the two J's not marked with black dots in the photo. Move both jumpers from the 4K pair of upright posts to the 16K (or 16K/32K) position. The center post is common to both.

Remove the 4K memories by sliding a small screwdriver, dentist tool, or other small implement between each memory chip and its socket. Rock slowly from each end, alternately until the memories come loose; don't rush. Wrap them in aluminum foil and give them to your favorite hacker, or send them to a school, college, or prison electronics shop (used prices for these are 10 cents or less each, so don't expect to make any money by selling them).

Cut a square of aluminum foil or black static-free foam, and set it down on your work area. Open the package of 16K dynamic memories and slide them, pins down, onto the foil or foam. Each chip has a notch on one end. When in place, this notch should point to the back of the computer, just as the 4K memories did. Using an IC inserter (Radio Shack Cat. No. 276-1574, $6.95), press each memory into place. If you don't use an inserter, you must squeeze the pins of each memory chip together slightly when pushing them into the sockets. Handle the ICs with a small piece of foil around all the pins when inserting by hand.

When all eight chips are in place, check that no tool or debris is left in the computer, and temporarily set the grey cover back in place. Hook up the machine, restore power, and type: PRINT MEM. A Color Basic machine will read 14631. If the machine reads 2343, you have probably not moved the jumpers. If the machine reads greater than 2343 but less than 14631, you probably have installed at least one defective memory chip. If the machine hangs up, or crashes quickly, you have probably bent a pin underneath or outside of the socket.

If all is well, you're ready to continue with the upgrades. Disconnect the power and remove the cover again.

Basic Upgrades

Upgrading to Extended Color Basic is physically an easy task. You must first obtain the Extended Color Basic Kit (Catalog #26-3018, $99) or the Extended Color Basic ROM alone (Catalog #AXX-3054, $64.16, from Radio Shack National Parts). Please do not hassle your local Radio Shack store for the AXX-3054 part; they can't get it. Only Computer Centers can obtain the ROM alone. If you feel capable of following installation instructions, go to your nearest computer center and order ROMs for all the Color Computers in your family. If you must upgrade three machines to Extended Color Basic, the savings are over $100. But remember, you will not receive any documentation, help, or the Extended Color Basic manual (Cat. No. 26-3192, $5.95). Only the ROM. *Once you recieve your Extended Color Basic ROM, do not open the package until you have read the following instructions.*

Using Photo 5, identify the position of the Extended Color Basic ROM (U28). Presently, it will be an empty socket toward the back of the shielded area. At this point, mark down all the information found on top of the Color Basic ROM (U3) already in the machine; a "Rev 1.1" will be helpful later.

Cut a square of aluminum foil or black static-free foam, and set it down on your

Please turn the page

Sugar Software

AUTO RUN

Auto Run is a utility program for the TRS-80* Extended Basic Color Computer. It is used to add convenience and professionalism to your software.

Auto Run will help you create your title screen with the graphics editor. The graphics editor allows you to choose a background color and border style. Using the arrow keys and several other commands you can draw pictures, block letters and also include text.

Auto Run will generate a machine language loader program to preceed your program on the tape. Then, to start up your program, simply type CLOADM to load in the Auto Run loader program, which will then automatically start itself up, display your title screen, load your program and then RUN or EXEC it.

Also you may record a vocal or musical introduction preceding your program. The Auto Run loader will control the audio on/off.

Basic programs can be set to load anywhere in memory above $600 (the PCLEAR 0 page).

Software authors: The Auto Run prefix may be appended to your software products.

Auto Run is **$14.95** and includes complete documentation and an assembly source listing. Requires 16K Extended Basic.

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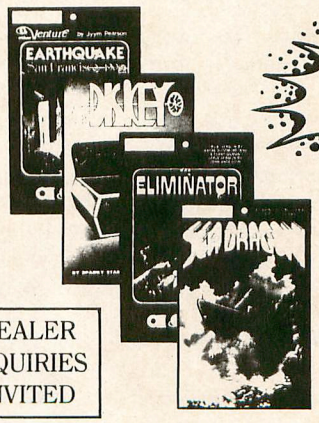
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work area. Open the plastic tube (or whatever the Extended Color Basic ROM came packaged in), and slide the ROM, pins down, onto the foil or foam. One end of the ROM will have a notch; this will face in the same direction as the Color Basic part. Lift the ROM from the foam by its ends, and set it on socket U28. If the pins are a bit too wide to fit directly into the socket, place the ROM back on the foam and "roll" it slightly so the pins come together. Try again, and when the pins are exactly right, press the ROM into its socket.

Check again for any debris or tool you may have left in the computer, temporarily set the grey cover back on (you can leave the metal shield off, and hook up the video screen. Power up; after a short pause you should now receive the message:

```
EXTENDED COLOR BASIC 1.0
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```

There is little you can do incorrectly making this upgrade, but should the message not appear, turn the machine off immediately. You may have inserted the ROM upside down; bent one or more pins underneath the part when inserting it in the socket; not completely inserted it in the socket; or damaged the ROM. These ROMs are electronically stable, and if you have followed the instructions carefully, the upgrade will work immediately.

Now type PRINT MEM. You will be surprised to see 8487, only about half of 16K. Since Extended Basic has many graphics functions, it automatically grabs some of the memory for itself. To retrieve part of it (if you don't plan to use high-resolution graphics), enter: PMODE0: PCLEAR1. Your Print Memory command will reveal 13095, which is the best you can get (for the moment — more at a later time).

Memory Upgrades

Newer Color Computers can be simply upgraded to 32K, with 64K possible through modification (see Bob Rosen's TDP-100 review in this issue). If you already have Extended Color Basic, check the top of the Color Basic ROM (U3) for the revision number, and mark this down. Now open the machine, remove the Extended Color Basic ROM (U28), and set it on a piece of foil or non-static foam. Re-cover and reconnect the machine, and mark down the Color Basic sign-on message revision. The purpose of this redundancy is that some Color Computers are reported to have ROMs stamped 1.1, whose sign-on message reads 1.0, or which are stamped 1.0 and whose sign-on message reads 1.1. Someone goofed on a batch of these, but if either reads 1.1, you've got the new revision. Chances are you have the 1.1 ROM if you have an E revision board. Now disconnect the power, open the case, and replace the Extended Color Basic ROM (remember the notch points toward the back).

To do the piggyback-style 32K upgrade, you will need eight more 4116 dynamic RAMs and a single 33-ohm resistor (¼ watt, 5%; Radio Shack Cat. No. 271-007 is ½ watt, 10%, which is fine).

For the Radio Shack-style 32K upgrade, which can be modified further for 64K use, you will need an E revision board, a version 1.1 Color Basic (not 1.1 Extended Basic), a 33-ohm resistor, and eight 4164 dynamic RAMs. If you do not have the E-board or the 1.1 Color Basic, hold off on this modification. At your nearest Shack computer center, trade in your 1.0 Color Basic ROM for a version 1.1 (there is a charge for this). I'll cover the D-board modification details in a later issue of *The Color Computer Magazine*.

Piggybacks First

The single cheapest way to upgrade your 16K Color Computer is by piggybacking a second set of 16K dynamic RAMs atop the first. It can cost only $8, and the process is simple and dull; but don't try any shortcuts.

1.) Remove the new set of 4116 dynamic RAMs from their packaging; set them on aluminum foil or conductive foam.

2.) Locate the notch at one end of a RAM integrated circuit. Count down along the left side to pin 4.

3.) With a small screwdriver, lift pin 4 straight out, bending it at the body of the IC.

4.) Unplug and open the computer, remove the metal shield, and identify the 16K RAMs (see Photo 5).

5.) Remove each RAM with a thin screwdriver, using a gentle rocking motion on each end.

6.) Place the old RAMs on the foil or conductive foam, pins down.

7.) Squeeze the pins of the new RAMs gently together so the pins point straight down.

8.) Place each new RAM on top of each old RAM (both pointing in the same direction), with each pin of the top RAM touching the matching pin on the bottom.

9.) With a 25-watt soldering iron (Radio Shack Cat. No. 64-2070 or Weller WTCP) and fine solder (Radio Shack Cat. No. 64-005), solder each pin to the one below. Solder with the pins still touching the foil or foam. Use very little solder; this is very important! Also, if the RAM gets too hot to hold comfortably while soldering, stop and let it cool off.

10.) When all 17 pins are soldered (all but pin 4), you will have a double-decker RAM. Insert this memory back in its socket, with the notch pointing toward the back.

11.) Complete the remaining memory chips, and insert each into its socket.

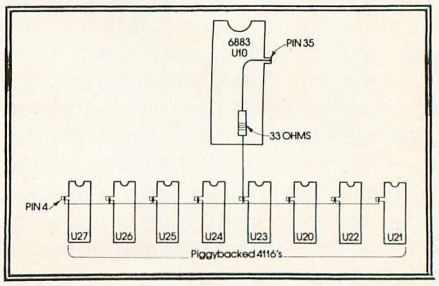


Figure 1. *32K piggyback upgrade. Bus wire connects all pin 4s together on the second bank of 4116 RAMs.*

12.) Loop a piece of thin bus wire (such as Radio Shack Cat. No. 278-1341) around each pin 4, connecting them together in a line (see Figure 1). Solder the loops to each pin 4.

13.) Very gently (!) lift the notched end of the 6883 chip (U10) up from its socket about ⅛ inch.

14.) The first pin to the right of the notch is pin 40. Count down to pin 35, and solder one end of the 33-ohm resistor to this pin 35.

15.) Press U10 back into its socket; bend the resistor sharply about ¼ inch above U10, and angle it back toward the RAMs.

17.) Solder the free end of U10 to the nearest point on the bus wire (see Figure 1).

18.) Check that neither the resistor nor the bus wire is shorted to any other point; check that the RAMs are in their sockets and no pins are bent underneath; check that U10 is properly pressed back into its socket; check that all RAMs are inserted in the correct direction.

19.) Check for leftover bits of wire or solder, close the case, restore power and type: PRINT MEM. 24871 should be the response with Extended Color Basic, 31015 with Color Basic.

Potential problems:

■ Still get only 8487 as response to the Print Memory command? Check for an

unsoldered pin in the piggybacking; check that the resistor is the correct value and is soldered properly; check that the piggybacked RAM is not turned around.

■ Get between 8487 and 24871? Check for proper soldering of all pins; check that the resistor is the correct value and soldered properly; a RAM may be bad.

■ Machine crash after sign-on message? Check for proper soldering of all pins; check for good connection to pin 4 on all RAMs; a RAM may be bad.

■ Machine lock up from the start? Check that no pins bend underneath or go into the sockets; check for a solder short between pins; check that no pins slide outside of the sockets; make sure RAMs are turned in the right directions.

Radio Shack-Style 32K

Refer to the jumpers in Photo 6. If your machine is already 16K, then the 16K jumpers (not marked with dots in the photo) should be in the 16K/32K positions. If not, move them from 4K to 16K/32K. The remaining four jumpers must now be moved from the 4K/16K positions to the 32K position.

Locate the jumper marked R83. Take a 33-ohm resistor and loop its ends, one on each jumper pin (see Figure 2). For security, solder it in place. Next locate the jumper marked HI/LO. Wind a small piece

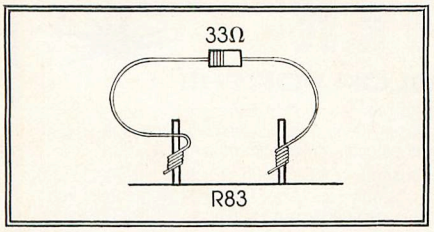


Figure 2. Mounting a 33-ohm resistor on the posts labeled R83.

of bus wire around the center pin and *either* the left or right pins (not both). Solder for security. Finally, identify the capacitors (shown in Photo 6) marked C31, C35, C45, C48, C61, C64, C67, and C70. Cut these out with sharp diagonal cutters.

Check for bits of wire, etc., restore the case and power. You should have 24871 bytes of memory in Extended Basic, 31015 in Color Basic.

Clearing Up the Video

I don't like television. Even if the Color Computer had the greatest RF (Radio Frequency) output there could be, I still wouldn't like it. Fortunately, I have an excuse to change it because the results are

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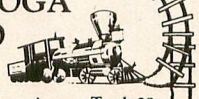
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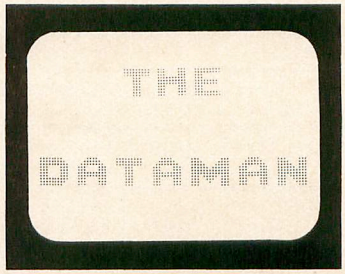
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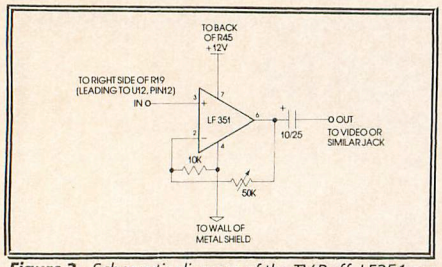


Figure 3. *Schematic diagram of the TV Buff. LF351 can be substituted by TL071, TL081, or TL091.*

so dramatic; I call it the tiny video buffer —TV Buff.

Figure 3 contains the schematic of a small circuit that will give standard NTSC video output for virtually any monitor on the market. The picture is crisp, and the level is variable to match the varying sensitivities of new and surplus monitors. I think you'll like it better than TV any day.

You can pick up all the parts at Radio Shack. The 10K resistor is 271-1335, the 50K variable is 271-219, the electrolytic capacitor is 272-1013, and the integrated circuit is 276-1716 or 276-1745. The circuit board is pictured in Figure 4, and the parts layout is shown in Figure 5. A complete unit or a kit of parts for the TV Buff is available at low cost from World Electronics, 177 27th St., Brooklyn, NY 11232.

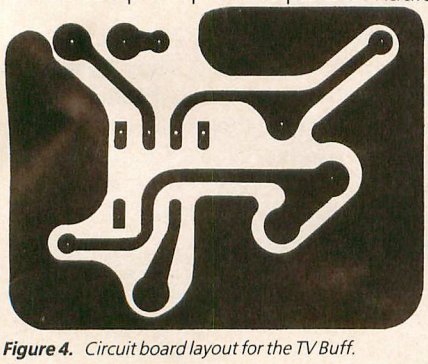


Figure 4. *Circuit board layout for the TV Buff.*

The TV Buff is easy to build using the PC board pattern, on perfboard, or just point-to-point on terminal strips; it can be mounted with double-face tape atop the RF modulator box at the back of the computer (see Figure 6 and Photo 7). No special construction is needed, but watch the polarity of the electrolytic capacitor. Attach the TV Buff input to the right side of R19; +12 volts is found at the back of R45; ground can be any point on the metal shield wall; and the output is fed to a jack of your choice (Photo 8). I used ordinary phono jacks, which are compatible with my monitor input, and 75-ohm cable (Radio Shack Cat. No. 15-1535 is a 6-foot assembly, 278-1324 is sold by the foot for longer lengths). Be sure to ground the outside (shield) of the jack. The plastic case is soft and can be cut easily with a fine coping

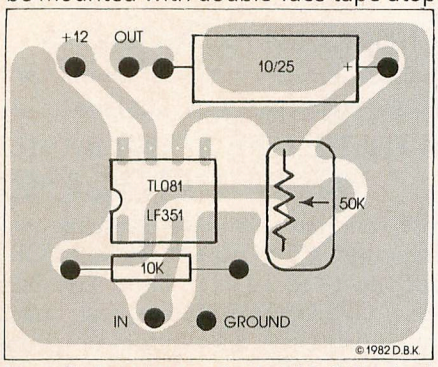


Figure 5. *Parts placement for the TV Buff. The view is from the top of the board.*

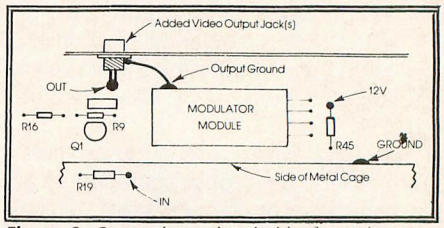


Figure 6. *Connection points inside the Color Computer for the TV Buff. A phono jack can be added to the case for video output.*

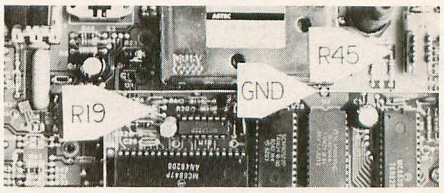


Photo 7. *The video buffer installed. It is mounted with double-faced tape on the RF modulator. Be careful to use thick tape so the buffer bottom is not shorted on the metal case.*

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saw blade, and filed smooth.

Clean any debris from the computer, connect the monitor, restore the power, and adjust the 50K variable resistor for an ideal picture. Be sure you use a TL071/081/091 or LF351 integrated circuit; a slower speed (741 or equivalent) will give you a smeared, contrastless image.

All the modifications are now complete, and should look something like Photo 9. Also visible in the photo is a piggyback board — something for the future.

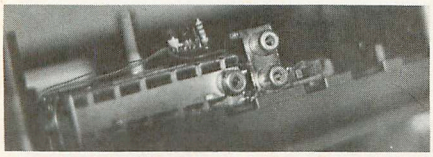


Photo 8. *Extra video jacks can be installed at the back of the computer; use coax jacks or phono jacks (shown here).*

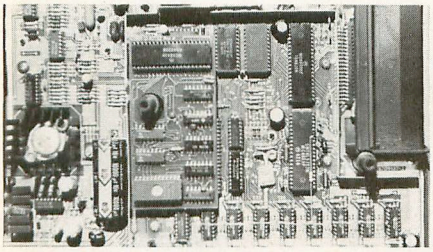


Photo 9. *Changes in place: 32K modification with strap wire and 33-ohm resistors, and video buffer. Also installed is a lowercase generator, the subject for the future.*

Coming Up

In this next year, here's what you can expect from Custom Color Applications: coming up next month, an input/output port totally transparent to disk drive operation; then a rundown for the Lowerkit II, a true lowercase character generator project; an EPROM programmer and ROM/RAM pack; tips and pointers on the care and feeding of you Color Computer; and — yes, you heard it here first — 1 megabit bubble memory.

If you have problems with these mods, you may write to me in care of *The Color Computer Magazine*. Please enclose a self-addressed stamped envelope. Till next time. ■■■

Article Specs:
Hardware
4K to 16K upgrade
16K to 32K upgrade (two methods)
Color Basic to Extended Color Basic upgrade
NTSC Output Modification

Parts and Equipment required:
For 16K upgrade:
Color Computer Technical Reference Manual R.S. Cat. No. 26–3193 $14.95
Conductive foam pads for static-free solid metal work surface workbench or
Static-free workbench pad #WS–9010 $15 plus shipping from Wescorp, 1155 Terra Bella Ave., Mountain View, CA 94043
Phillips-type screwdriver
Eight 4116, 250 nS dynamic memories Under $10
snips
Aluminum foil or black static-free foam
IC inserter Radio Shack Cat. No. 276-1574 $6.95
Extended Color Basic Kit R.S. Cat. #26-3018 $99 or Extended Color Basic ROM Cat. #AXX-3054 $64.16 From Radio Shack National Parts through Computer Centers only.

For 32K upgrades:
Piggyback:
Eight 4116 dynamic RAMs
One 33-ohm resistor (¼ Watt, 5% : R.S. Cat. No. 271-007, ½W, 10% is ok)
25 Watt soldering iron R.S. Cat. No. 64-2070 or Weller WTCP
fine solder R.S. Cat. No. 64-005
thin bus wire R.S. Cat. No. 278-1341

R.S.-Style upgrade:
E Revision Board
Version 1.1 Color Basic
33-ohm Resistor
Eight 4164 Dynamic RAMs $48
sharp diagonal cutters
For the TV Buff:
10K Resistor R.S. Cat. No. 271-1335
50K Variable R.S. Cat. No. 271-219
Electrolytic Capacitor R.S. Cat. No. 272-1013
Integrated Circuit: TL071/081/091 R. S. Cat. No. 276-1716 or 276-1745 or LF351 or, complete kit of parts (or unit) from World Electronics, 177 27th St., Brooklyn, NY 11232 (212) 499-5400
75-ohm cable R.S. Cat. No. 15-1535 or 278-1324
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