Upgrading TIMEX-SINCLAIR VIDEO

Modification provides direct video output for crisper characters and white-on-black display for reduced eyestrain

By Steve Pence

OWNERS of the Timex/Sinclair 1000 or ZX-81 computers sacrifice many features for the benefit of low price. Two in particular are direct video output and a white-on-black video screen format. With this project, you can modify your computer to obtain both of these features.

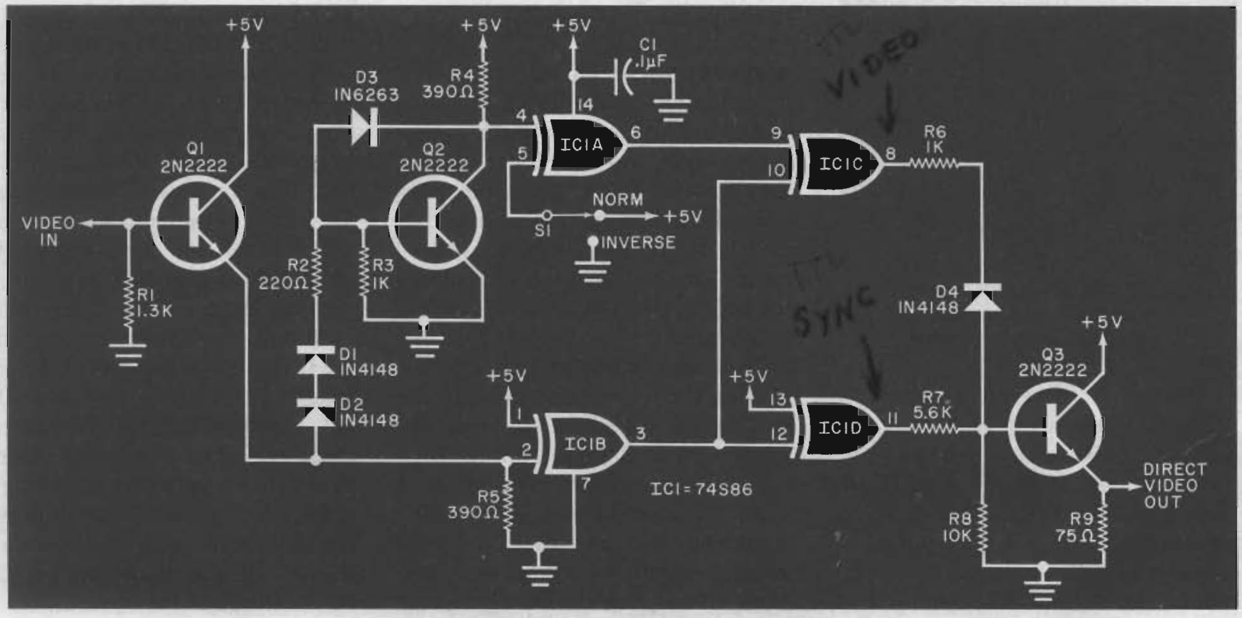
If direct video output were the only requirement, implementation would be simple since it only would be necessary to add an emitter-follower stage to buffer the signal already being fed to the computer's r-f modulator. Inverting the video is a little tricky, however. It is not acceptable to simply invert the entire signal as this would also invert the

Fig. 1. Switch S1 determines whether the output is normal or inverse. In this circuit, only the video portion is inverted.

PARTS LIST

C1—0.1-µF, 50-V ceramic disc capacitor
D1,D2,D4—1N4148 diode
D3—1N6263 diode
IC1—74S86 Exclusive OR
Q1,Q2,Q3—2N2222 transistor
The following are ¼-W, 5% carbon resistors:
R1—1.3 kilohms
R2—220 ohms
R3,R6—1 kilohm
R4,R5—390 ohms
R7—5.6 kilohms
R8—10 kilohms
R9—75 ohms
S1—Spdt miniature switch
Misc.—RG174U coax (36"), RCA phono plug, 4-40 × ½ machine screw (2), 4-40 hex nut (2), #4 fiber washer (4), pc board, etc.

Note: The following is available from Random Access, Box 41770P, Phoenix, AZ 85080: complete kit of parts (DVC-2) for $18.95 plus $1.50 shipping and handling. Also available separately is the printed circuit board (DVC-2B) for $5.95. Arizona residents add 4% sales tax.



sync pulses, making it impossible for the monitor's sync separator to operate properly.

To do the job right the two components of the composite video signal must be separated, and only the video portion inverted, leaving the sync pulses as they are. Next the proper ratio of sync pulse amplitude to video amplitude must be maintained. Finally the correct peak-to-peak amplitude and output impedance suitable to drive a standard video monitor must be provided.

Circuit Description. As shown in Fig. 1, the first stage, *Q1*, is a buffer amplifier that has a low output impedance capable of driving the stages that follow. The input impedance is controlled by *R1*.

The composite video signal from *Q1* is applied to pin 2 of *IC1B*, a 74S86 Exclusive OR chip. This gate actually performs two functions. First it acts as a simple inverter, providing an output that is 180° out of phase with the input. Second, it acts as a comparator to separate the sync pulses from the video. Each sync pulse brings pin 2 to ground potential. The video, however, never drops below 2 V. This means that as far as the gate is concerned the input is always high except during sync pulse time. The output at pin 3 is therefore an inverted version of composite sync containing no video.

Transistor *Q2* converts the composite video signal into a logic compatible format in which both sync pulses and video information are the same amplitude. This is done by dropping most of the sync pulse voltage across diodes *D1* and *D2*. As a result *Q2* will not begin to conduct until the signal voltage reaches a level of approximately 2.1 V (three diode drops). Since the video voltage is active at 2 V, *Q2* switches for both video and sync voltage.

Diode *D3* is a Schottky type with a forward drop of 0.3 to 0.4 V. Its purpose is to increase the switching speed of *Q2* so that full video bandwidth will be obtained. It does this by preventing *Q2* from saturating, thus eliminating the long storage time that would otherwise occur. As *Q2* turns on and attempts to saturate, *D3* becomes forward-biased and begins to bleed off base drive. The collector of *Q2* can never get any lower in potential than the difference between its forward V_{be} drop and the forward drop of *D3* (about 300 mV). This effectively prevents saturation and eliminates storage time.

The logic level signal at the collector of *Q2* next goes to pin 4 of *IC1A*, which is configured as a programmable buffer. With *S1* in the NORM position, *IC1A* acts as an inverter, but with *S1* in the INVERSE position it performs as a noninverting buffer.

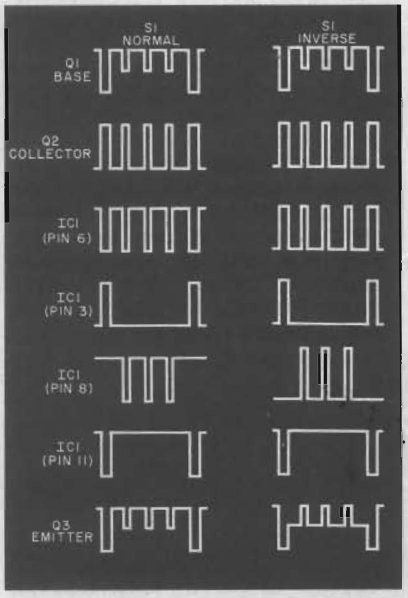


Fig. 2. Waveforms for the direct and inverse signals at various points in the circuit.

Pin 9 of *IC1C* receives a composite signal consisting of both video and sync pulses. Pin 10 sees only the inverted sync from pin 3 of *IC1B.* The Exclusive OR action of *IC1C* cancels out the two sync pulses at the input leaving only the video signal at the output. The sync pulses are inverted for the second and last time by *IC1D.*

The two outputs from *IC1C* and *IC1D* are combined by the scaling network consisting of *R6, R7, R8,* and *D4.* This network provides the proper ratio of sync pulse to video and applies the result to the base of *Q3*, a high-input-impedance, emitter-follower stage. Transistor *Q3* has a 75-ohm resistor in its emitter leg to provide the proper impedance for driving a standard video coax and monitor. Waveforms for this process are shown in Fig. 2.

Construction. The direct video converter is best built using a printed circuit board. The foil pattern is shown full size in Fig. 3. with the component guide given in Fig. 4. Be sure to orient *IC1* properly. Also, mount the three transistors as close to the pc board as possible.

Installation. Begin the computer modification by drilling a ¼" hole in the side of the computer's case (upper right, top half) for miniature toggle switch *S1.* Next, on the opposite side, drill a #32 hole approximately ⅝" to the right of the indentation for the 9-V connector. Drill the hole in the center where the two halves meet.

Disassemble the computer by removing the five screws holding the two halves together (three of the screws are under the rubber feet). Pull the bottom half off and set it aside. Remove the two screws holding the pc board and lift it up. Be extremely careful working with the loose circuit board. The flex print connecting the keyboard to the computer is very fragile and easily damaged. Do not attempt to remove it from its connector, as this will increase the likelihood of damage.

Referring to Fig. 5 remove *R31, R32,* and *D9* from the computer's circuit board. This network is used to scale the video voltage applied to the r-f modulator and is no longer needed. The video signal from the conversion board is already scaled properly and is applied directly to the modulator input. Next, install four wires, each at least 8" in length by soldering them to the four feedthrough holes indicated. One of the holes, the input to the modulator, is accessible as a result of the removal of *R31.*

Position the completed video circuit board as shown in Fig. 6. Mark the inside of the case through the mounting holes of the pc board, and drill two #32 holes at these marks.

Now the wires can be connected as shown. Use RG174U coax for the direct video output as this type is only about $^{1}/_{10}$" in diameter and therefore very easy to work with. Tie a knot in the cable at the point at which it will exit the computer (the #32 hole you drilled near the 9-V connector) to act as a strain relief.

Mount the conversion board to the inside of the top half of the computer's cover using two #4-40 × ½" machine screws. Be sure and place two fiber insulating washers over each screw before installing the conversion board. This will prevent the bottom of the board from being shorted by the aluminized coating on the inside of the cover.

Using the Computer. After reassembling the computer, you are ready to connect it to your video monitor. If you are using a black-and-white TV that has been modified for direct video, you will obtain the best results with the contrast control set nearly fully counter-

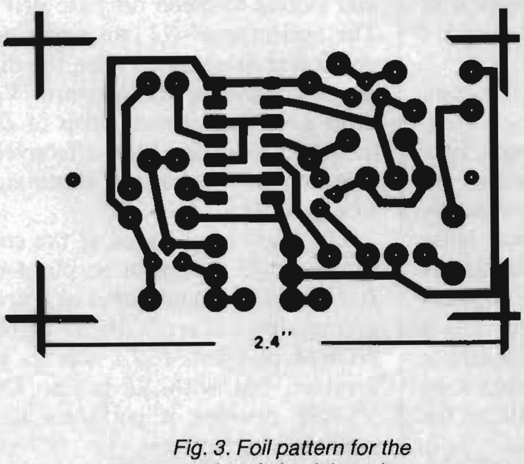


Fig. 3. Foil pattern for the printed circuit board.

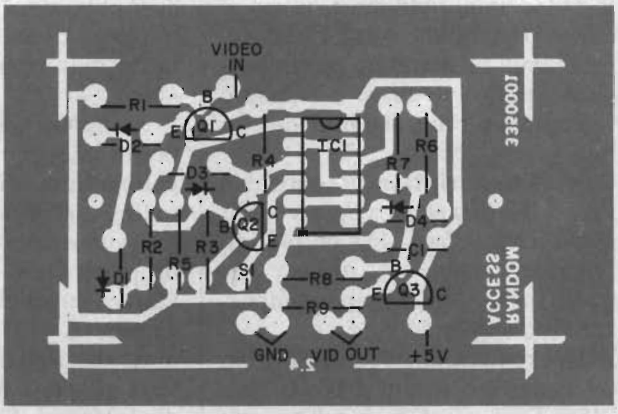


Fig. 4. Follow this diagram to lay out the components on the pc board.

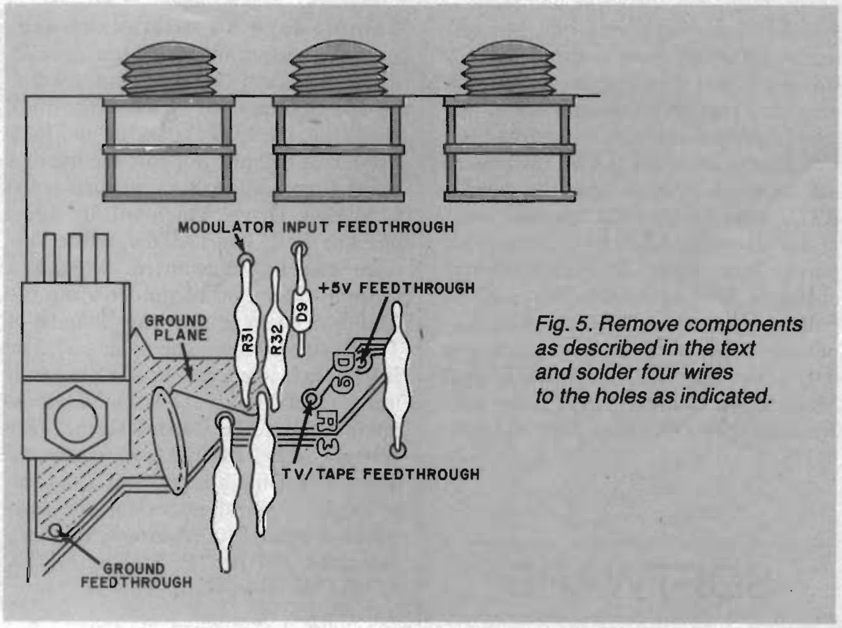


Fig. 5. Remove components as described in the text and solder four wires to the holes as indicated.

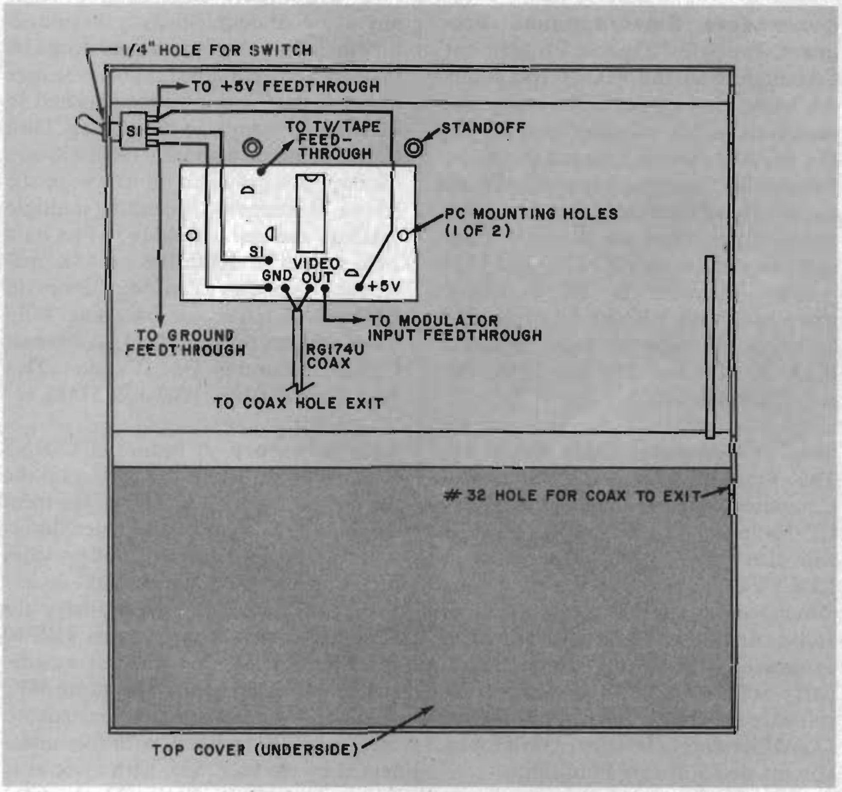


Fig. 6. Position the circuit board and connect the wires as shown here.

clockwise (minimum video amplifier gain) and the brightness control set a little bit lower than normal. If your monitor does not employ dc restoration (most do not), you will have to readjust the brightness control each time you switch from normal to inverse video or vice versa.

As a final note, you may find it interesting and useful that the size of the pixels that make up the characters can be controlled to some extent by varying the values of resistors *R1* or *R2*. Resistor *R1* can be adjusted between 1 and 2 kilohms and *R2* varied from 75 ohms to 1 kilohm or so. What this does is change the dc bias point and thus modify the amount of time that *Q2* has to react to the video voltage. ◇