

# BUILD THIS

**Part 2** IN THE FIRST PART OF this article we showed you how to build the video test generator. However, due to space limitations, we could not show you Figs. 6-11; As promised, those appear this month. Now it's time to check out the unit and learn how to use it.

## Checkout and alignment

Once you're sure that all the circuit connections are OK and that there are no inadvertent shorts to the chassis, you can apply power. Check the power-supply voltages and verify proper outputs. If the voltages are not correct, be sure to rectify the problem before proceeding.

Set S1 to the EXT position. Connect an oscilloscope to TP1 and trigger the scope

from TP9 (or the horizontal-rate output from J4 on the front panel). Adjust the scope until the display shows approximately one line of video as depicted in Fig. 12. Be sure that the scope is DC-coupled, because you want to adjust R2 and R3 until the blanking level is at zero volts, and the peak-to-peak amplitude of the signal is two volts. Now set S1 to the UP/DOWN STEP position, and adjust R5 until the blanking level is again at zero.

At this point you should verify that the up/down-step and the gray-level signals resemble those shown in Fig. 1. The gray level should be selectable (8 levels) by momentarily pushing S2. When S2 is held closed, the generator should "walk through" the gray levels successively.

The next step is to align the multiburst

generator. To do that, set S1 to the MULTIBURST position. Put the scope probe on test-point TP1, and trigger the scope from TP6. Adjust R34 until the signal on the scope is about 500 kHz. Then, trigger the scope from TP5 and adjust R36 for 1 MHz. Continue in a similar manner with the other test points, adjusting for the frequencies (at TP1) shown in Table 1.

Leave the probe on TP1 and trigger from the HORIZONTAL RATE jack (or TP9) again. Verify that the multiburst signal looks like the one shown in Fig. 1. Next, place the scope probe on TP7 (with the scope set to trigger internally). Adjust R52 for the best-looking sinewave.

You are now ready to align the RF section. Using 75-ohm coaxial cable, connect a TV to J2 (RF OUT). Be sure to use

*Build this low-cost, general-purpose video test generator and service TV receivers, video amplifiers, monitors, VCR's, and other video equipment.*

GENE ROSETH



# VIDEO TEST GENERATOR

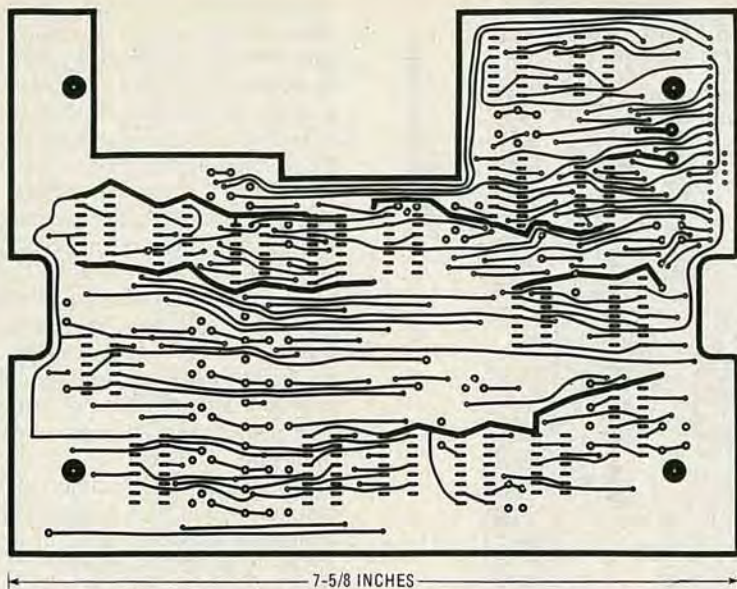


FIG. 6—THE BOARD B component-side foil pattern is shown here reduced 50 percent.

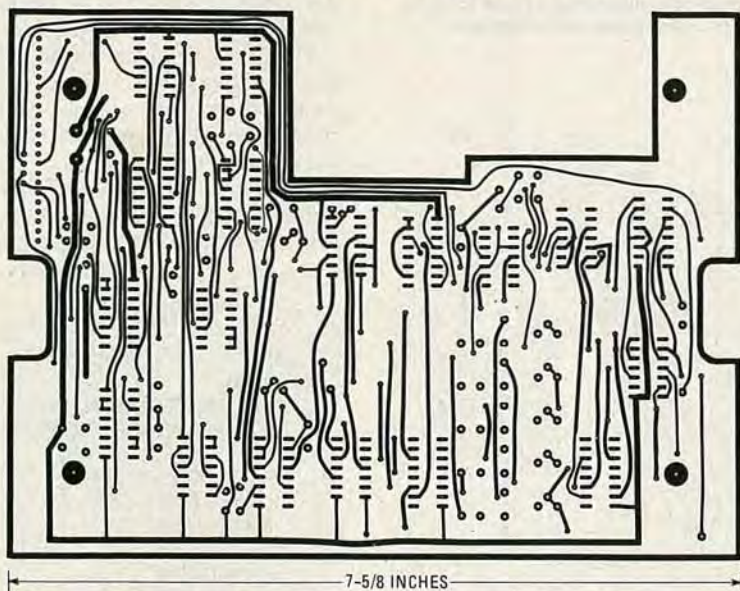


FIG. 7—THE BOARD B solder-side foil pattern is shown here, also reduced 50 percent.

the 75-ohm input of the TV or use a balun for impedance matching, if necessary. Set the TV tuner to channel 3, put the fine tuning at mid-range, and disable the AFT if possible. Adjust coil L1 (with a nonconductive tool) until the best display appears. Rotate S1 through 6 positions (don't worry about the EXT position) and check all signals for proper display. At this point, don't be concerned if there is no color on the color-bar display. Place S3 in the INTERNAL-audio position and adjust

L2 until the 1500-Hz tone is heard.

The last step is to accurately adjust the frequency of the master oscillator. The best way to do that is to use a frequency counter at TP14, and adjust C22 until the counter reads 3.579545 MHz. Alternatively, you can adjust C22 by using the TV; Set S1 to the CLR BARS position and turn C22 until the color locks in. That method is less accurate than using a frequency counter. Whether that is acceptable depends on your application.

#### Using the video test generator

The video test generator is used, in general, as the source of video reference signals. The output of the generator is connected to the device or system under test, and the output from that device or system is observed on an oscilloscope. By knowing what the system's output *should*

be, and then comparing that to the actual output for any deviations, you can locate the causes of many problems.

In this section, we'll first discuss some of the problems and distortions commonly found in video equipment and systems and how they can be identified using one or more test signal(s). Some of the problems are peculiar to a particular class of equipment (receivers, for example), and some may be found in most or all types of video gear, including receivers, videocassette recorders (VCR's), distribution amps, repeaters, switches, routing systems, etc. After we look at some of the common problems, we'll address the subject of interfacing for the purpose of gen-locking and, finally, we'll look at the external digital video input.

To begin, let's consider poor frequency response: That is a general class of distortions which we must break up into different cases for closer examination. We'll start by saying that the video signal has a wide bandwidth (from DC to 4 MHz) and all that spectrum plays an important part.

Low-frequency distortions usually show up as gradual picture-shading changes, typically right after an abrupt scene change. The problem can be caused by a poor DC-restoration circuit somewhere in the video chain. Power-line hum can also cause a similar, gradual shading change. To test for that situation, do the following: Place the test generator in either the up/down-step or the gray-level mode. Depress and hold S2, the auto-step button; That sends gray-level changes to the system under test at a 1-Hz rate. Trigger your oscilloscope from the vertical-rate jack and observe the system output (DC coupled). If the blanking level changes, then low-frequency distortion exists. A good companion check for problems in this part of the spectrum is to use the gray-level mode at its highest level (maximum white). Observe the system output on a DC-coupled oscilloscope at a sweep rate of about 30-Hz, so that two or three fields are visible. Distortion will cause a tilt to the signal such that the sync tips within the vertical-blanking interval are not at the same level as those during the active portion of the picture. And the entire scope display will have a sawtooth component to it. That problem is most frequently caused by insufficiently sized coupling capacitors between stages of a video chain or between stages of individual amplifiers.

Mid- and high-frequency distortions cause problems ranging from simple left/right shading changes to loss of picture detail or image ringing. To test for that problem use the multiburst signal. Observe the output of the system under test at the horizontal rate. If the white-flag portion of the multiburst test signal is tilted, mid-frequency distortion is indicated. Higher-frequency problems show up as

TABLE 1

| Scope trigger | Adjustment | Frequency (at TP1) |
|---------------|------------|--------------------|
| TP6           | R34        | 500 kHz            |
| TP5           | R36        | 1 MHz              |
| TP4           | R38        | 2 MHz              |
| TP3           | R40        | 3 MHz              |
| TP2           | R42        | 3.58 MHz           |

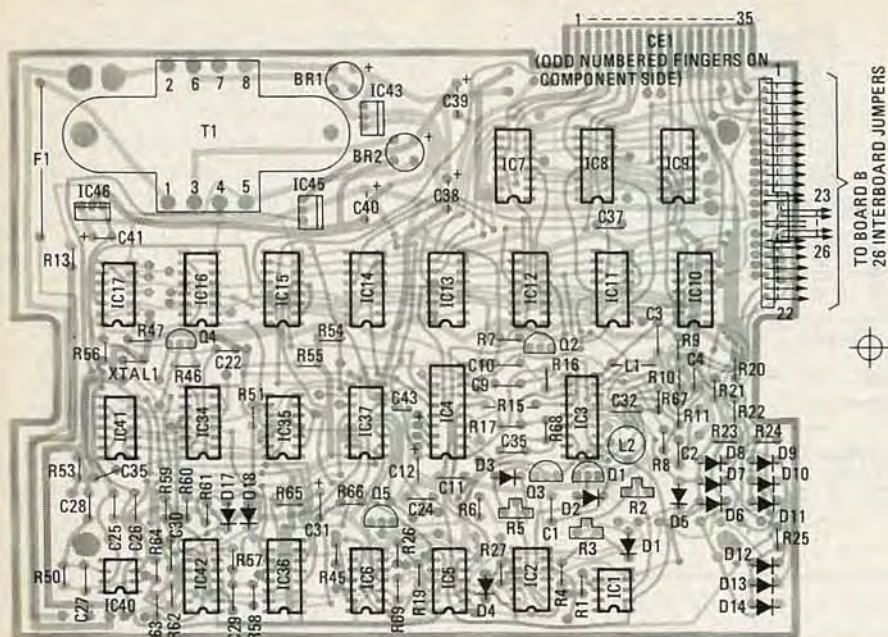


FIG. 8—BOARD A: ON-BOARD PARTS-PLACEMENT. When installing components, be sure to watch the polarity of the diodes, transistors, electrolytic capacitors, and other polarized components.

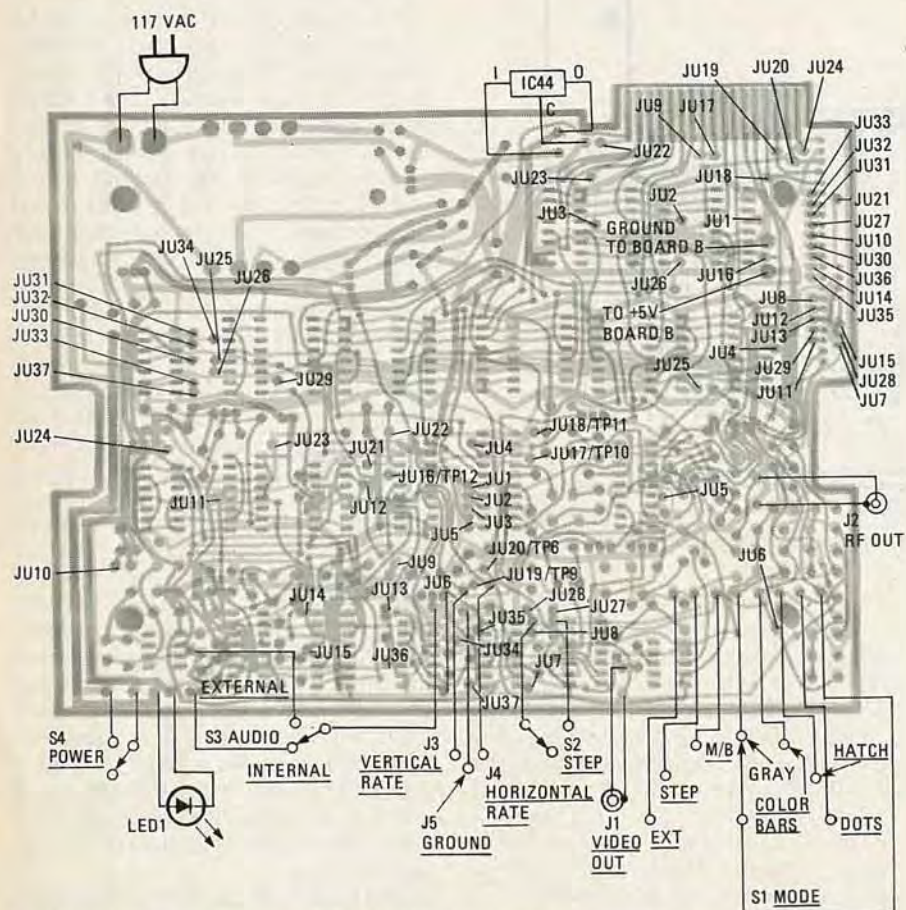


FIG. 9—BOARD A: OFF-BOARD PARTS PLACEMENT and jumper diagram. Note that besides the 37 on-board jumpers, there are also 26 inter-board signal jumpers as well as +5V and ground inter-board jumpers.

amplified or attenuated burst packets. The multiburst test signal is versatile and convenient. It will give a quick indication of system performance. An interesting exercise is to apply this signal to a properly

adjusted VCR. The output signal from the VCR may surprise you—it is a result of the various compromises that are made in its design.

Amplifier non-linearity is another com-

mon distortion in video systems. It is characterized by loss of detail at some gray levels. To test for that condition, use the up/down step test signal and verify that all steps are of equal magnitude in both ascending and descending directions. Increase the vertical gain of your scope when doing this test. Also, check the step transitions for overshoot or round corners.

Scan non-linearity in receivers and monitors is best tested using the hatch-and-dot-pattern signals. Equidistant spacing within each axis as viewed on the screen indicates proper scanning. Those two signals also serve well for color-convergence adjustments; of course, the alignment should attempt to achieve all white dots and lines.

While we are on the subject of receiver/monitor alignment it is worthwhile mentioning the use of the up/down step signal again. A properly operating receiver or monitor should easily resolve all eight of the gray-level steps contained in the signal. That's a quick check and should indicate if further testing is called for.

The color-bars signal provides the standard six colors (three primary and three complementary) in order of ascending luminance level (blue, red, magenta, green, cyan, yellow). That signal is primarily used for subjective system evaluation, as well as for adjustment of receivers. But if you have access to a vectorscope, the

*continued on page 139*

TABLE 2

| Card-edge pin | Function                       |
|---------------|--------------------------------|
| 1             | GREEN LSB IN (2 <sup>0</sup> ) |
| 2             | VERT RESET CONTROL IN          |
| 3             | BLUE MSB IN (2 <sup>2</sup> )  |
| 4             | HORIZ RESET IN                 |
| 5             | GREEN MSB IN (2 <sup>2</sup> ) |
| 6             | GROUND                         |
| 7             | GREEN 2 <sup>1</sup> IN        |
| 8             | GROUND                         |
| 9             | BLUE 2 <sup>1</sup> IN         |
| 10            | GROUND                         |
| 11            | RED LSB IN (2 <sup>0</sup> )   |
| 12            | GROUND                         |
| 13            | RED 2 <sup>1</sup> IN          |
| 14            | GROUND                         |
| 15            | EXT AUDIO IN                   |
| 16            | GROUND                         |
| 17            | COMPOSITE SYNC OUT             |
| 18            | GROUND                         |
| 19            | BLUE LSB IN (2 <sup>0</sup> )  |
| 20            | GROUND                         |
| 21            | RED MSB IN (2 <sup>2</sup> )   |
| 22            | GROUND                         |
| 23            | BURST GATE OUT                 |
| 24            | GROUND                         |
| 25            | + 5 VDC (10 mA) OUT            |
| 26            | GROUND                         |
| 27            | BLANKING OUT                   |
| 28            | GROUND                         |
| 29            | HORIZ DRIVE OUT                |
| 30            | GROUND                         |
| 31            | VERT DRIVE OUT                 |
| 32            | GROUND                         |
| 33            | VERT RESET IN                  |
| 34            | GROUND                         |

## PARTS LIST

### All resistors 1/4-watt, 5%, unless noted

R1—68 ohms  
 R2, R5, R36, R38, R40, R42, R52—5000 ohms, trimmer potentiometer  
 R3—200 ohms, trimmer potentiometer  
 R4, R12, R14, R39, R41, R53—1000 ohms  
 R6, R23, R37—3300 ohms  
 R7, R15, R18, R48—4700 ohms  
 R8—75 ohms  
 R9, R10—220 ohms  
 R11—100 ohms  
 R13, R47—470 ohms  
 R16—27,000 ohms  
 R17—2200 ohms  
 R19, R20—R22, R24—R27, R29—R31, R33, R43, R45, R50, R51, R54—R56, R63, R65, R69—10,000 ohms  
 R28—1 megohm  
 R32, R62—47,000 ohms  
 R34—10,000 ohms, trimmer potentiometer  
 R35—68,000 ohms  
 R44—50,000 ohms, trimmer potentiometer  
 R46, R61, R66—100,000 ohms  
 R49, R67, R68—15,000 ohms  
 R57, R58, R60, R64—33,000 ohms  
 R59—22,000 ohms

### Capacitors

C1—0.002  $\mu$ F, ceramic disc  
 C2, C4—0.001  $\mu$ F, ceramic disc  
 C3—75 pF, mica  
 C5, C8, C24—C26, C29—0.1  $\mu$ F, ceramic disc  
 C6, C7—47 pF, ceramic disc  
 C9, C10, C15, C16, C32—100 pF, ceramic disc  
 C11, C28, C30, C34—C37, C42—0.1  $\mu$ F, ceramic disc  
 C12, C31, C41, C43—1  $\mu$ F, 16 volts, tantalum  
 C13—0.2  $\mu$ F, ceramic disc  
 C14—330 pF, ceramic disc  
 C17, C33—22 pF, ceramic disc  
 C18, C19, C21—10 pF, ceramic disc  
 C20—470 pF, ceramic disc

C22—5–40 pF, trimmer capacitor  
 C23—10 pF, ceramic disc  
 C27—5 pF, ceramic disc  
 C38, C39—4700  $\mu$ F, 16 volts, electrolytic  
 C40—1000  $\mu$ F, 16 volts, electrolytic

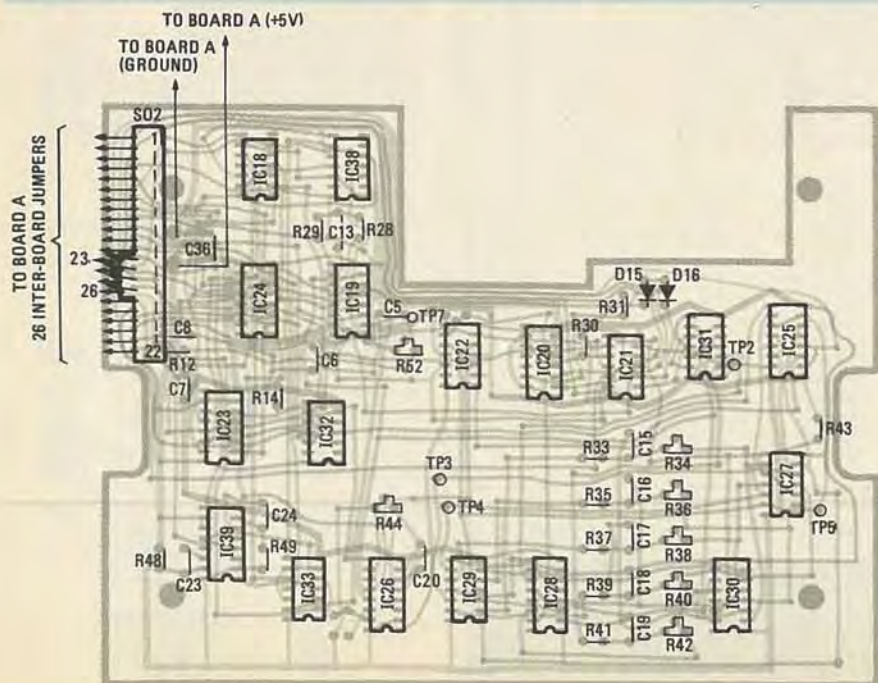
### Semiconductors

IC1—LH0002CN current amplifier (National)  
 IC2, IC21, IC27—4066 quad bilateral switch  
 IC3—LM1889 TV video modulator  
 IC4—LM1886 TV video matrix D/A converter  
 IC5—74LS32 quad OR gates  
 IC6—74LS03 quad NAND gates  
 IC7—IC15—74LS151 one-of-eight selector/multiplexer  
 IC16, IC23, IC24—74LS161 synchronous 4-bit counter  
 IC17—74LS00 quad NAND gates  
 IC18—74LS20 dual 4-input NAND gate  
 IC19, IC28, IC30, IC42—4049 hex inverting buffer  
 IC20—74LS191 synchronous up/dwn counter  
 IC22—74LS73 dual J-K flip-flop  
 IC25—74LS174 hex D-type flip-flop  
 IC26, IC39—74LS123 dual retriggerable monostable multivibrator  
 IC29, IC31—74C00 quad NAND gates  
 IC32—74LS30 8-input NAND gates  
 IC33—7402 quad NOR gate  
 IC34—74LS169 4-bit synchronous up/down counter  
 IC35—7473 dual J-K flip-flop  
 IC36—MM5321 TV camera sync generator (National)  
 IC37—74LS365 hex bus driver  
 IC38—74LS93 4-bit binary counter  
 IC40—LM318 op-amp  
 IC41—74LS08 quad AND gate  
 IC43—LM340T5 5-volt regulator, TO-220 case  
 IC44—LM340K5 5-volt regulator, TO-3 case

IC45—LM340T12 12-volt regulator, TO-220 case  
 IC46—LM320T12 12-volt negative regulator, TO-220 case  
 Q1, Q4—2N2222A  
 Q2, Q3—MPS918  
 Q5—MPSA05  
 D1, D3—D18—1N914 or 4148  
 D2—1N746A  
 S1—7-position rotary switch (Allied 7471001 or similar)  
 S2—pushbutton switch, normally closed  
 S3—SPDT toggle switch  
 S4—SPST toggle switch  
 LED1—standard red  
 T1—Transformer (Triad F-166XP or similar), primary: 117 volts; secondary: 24 volts, center-tapped, .125 amps; 9 volts, center-tapped .5A  
 BR1, BR2—bridge rectifier, 1.5 amps  
 L1—0.071–0.082 mH adjustable coil (J.W. Miller 48A778MPC or similar)  
 L2—7–12  $\mu$ H adjustable coil (J.W. Miller 23A105RPC or similar)  
 XTAL1—14.31818 MHz crystal  
 F1—fuse, 1 amp, pigtail leads  
 J1—BNC jack  
 J2—type N jack  
 J3–J5—standard tip jacks

**Miscellaneous**—Heat sinks, cabinet (Pactec CM86-225), power cord, strain relief, T0-3 mounting kit, IC sockets, etc.

The following are available from Jengco, 3232 San Mateo, Suite 75, Albuquerque, NM, 87110: Complete kit including PC boards, all components, cabinet (no IC sockets), \$295; Etched, drilled, and silkscreened PC boards (boards A and B), \$49.50; Complete test generator, assembled and tested, \$395. Please add 5% for postage and handling, New Mexico residents add 4.25% sales tax, allow 6–8 weeks for delivery.



color-bars signal can also be used to check chroma demodulators.

### Interfacing the generator

A standard 34-pin card edge is available at the back of the unit. Refer to Table 2 for the pinout configuration. Numerous sync-family signals are provided as TTL level outputs (horizontal drive, vertical drive, composite sync, composite blanking, and colorburst gate). Those signals are useful in a variety of applications such as driving switches. The vertical-drive and horizontal-drive signals are handy for driving two or three video cameras (for example: in a security system), thereby synchronizing them for input to a simple switcher or VCR. That avoids the loss of sync which usually causes picture roll. A composite sync at video levels can also be derived from the generator by using the gray-level signal adjusted for blanking (gray level = 0) and taking the output from the front-panel BNC VIDEO OUT connector.

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## VIDEO GENERATOR

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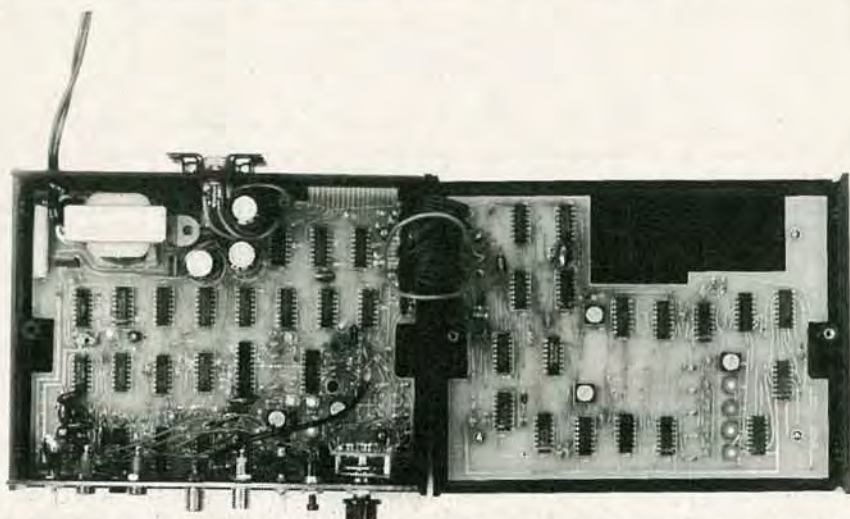


FIG. 11—SUGGESTED MOUNTING METHOD of the two boards is shown here in a photograph of the author's prototype.

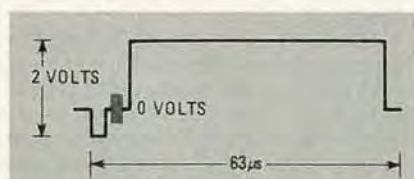


FIG. 12—ONE HORIZONTAL LINE of video should be seen at TP1 when the test generator is in the EXT mode.

The inputs are connected via the same 34 pin edge connector and consist of the audio input, three sync inputs for gen-locking, and nine RGB digital video inputs. The audio input is used only for the RF-modulated output and can replace the generator's internal 1500-Hz oscillator.

There are various ways you might gen-lock the unit using the three sync inputs. The vertical and horizontal reset can be driven separately (you must use pulses of less than 800 ns duration). If you do that with the vertical-reset control high (or not connected) then the vertical timing is reset to the beginning of each field. If the vertical-reset control is "low" then the vertical timing is reset to the fifth vertical separa-

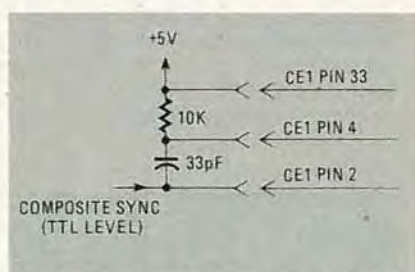


FIG. 13—THIS CIRCUIT can be used to allow gen-locking from a source of composite sync (LS-TTL level).

tion pulse. That allows it to act like a conventional integrated sync-separator circuit.

Another possibility is to use a circuit such as shown in Fig. 13. That allows gen-locking from a source of composite sync (at LS-TTL levels). It should be noted that those schemes will lock the scanning timing but not the chrominance oscillator: color can still be produced, however.

One of the more intriguing capabilities of the test generator is its ability to accept digital RGB data, format the data with the proper sync signals, and then output the

TABLE 3

| Color out     | Red inputs |    |    | Green inputs |   |   | Blue inputs |   |    |
|---------------|------------|----|----|--------------|---|---|-------------|---|----|
| Card-edge pin | 21         | 13 | 11 | 5            | 7 | 1 | 3           | 9 | 19 |
| WHITE         | 1          | 1  | 1  | 1            | 1 | 1 | 1           | 1 | 1  |
| LIGHT GRAY    | 1          | 0  | 1  | 1            | 0 | 1 | 1           | 0 | 1  |
| DARK GREY     | 0          | 1  | 1  | 0            | 1 | 1 | 0           | 1 | 1  |
| BLACK         | 0          | 0  | 0  | 0            | 0 | 0 | 0           | 0 | 0  |
| BRIGHT RED    | 1          | 1  | 1  | 0            | 0 | 0 | 0           | 0 | 0  |
| PALE RED      | 0          | 1  | 0  | 0            | 0 | 0 | 0           | 0 | 0  |
| BRIGHT GREEN  | 0          | 0  | 0  | 1            | 1 | 1 | 0           | 0 | 0  |
| BRIGHT BLUE   | 0          | 0  | 0  | 0            | 0 | 0 | 1           | 1 | 1  |
| BRIGHT YELLOW | 1          | 1  | 1  | 1            | 1 | 1 | 0           | 0 | 0  |
| ORANGE        | 1          | 1  | 1  | 1            | 0 | 0 | 0           | 0 | 0  |
| FLESH         | 1          | 1  | 1  | 1            | 1 | 0 | 1           | 0 | 1  |

data. The possibilities range from the creation of other simple test patterns, to interfacing with a microcomputer for the production of dynamic video color imagery for computer games, interactive learning, etc.

Table 3 lists the digital inputs that can be used to produce blank rasters for several colors. Note that each primary color (red, green, and blue) has three inputs, and thus,  $2^3 = 8$  input levels. Other colors (a total of 512) are possible.

As a simple example, suppose you wish to have the signal generator provide a solid red raster (perhaps for adjusting receiver purity). Simply connect the three red inputs (RLSB, R, RMSB) high, and the six green and blue inputs low. Now when the generator is in the EXT mode, it supplies a composite-video signal with a constant red image.

For complicated applications involving computer control you must choose between two general approaches. In the first method, the signal generator acts as the master timing source and the computer software synchronizes to the vertical- and horizontal- drive signals. In the second approach, the computer is the master clock and provides sync and reset signals to the signal generator in addition to the RGB data.