VIDEO EFFECTS GENERATOR

Color correction, deliberate distortion, artistic picture control. Our video palette puts it all at your fingertips.

RUDOLF F. GRAF AND WILLIAM SHEETS

Part 2 THE VIDEO PALETTE IS built on two printed-circuit boards: a "main" board and a "special-effects" board. The main board contains the video-signal splitting and recombination (summing amplifier) circuits. The special-effects board contains the circuits for the solarizer, posterizer, inverter, and the power supply.

Circuit Description

Refer to Fig. 10, the schematic of the main board, and Fig. 11, the schematic of the effects board. Transformer T1, diodes D5 and D6, and capacitors C52 through C55 form two half-wave rectifiers supplying +8-volts DC to regulator IC12, and −8-volts DC to regulator IC13.

A 1-volt peak-to-peak negative-sync video signal at input jack J1 is coupled through C1 to the video amplifier consisting of R2, R3, R78, IC1, and C2. Switch S4 can bypass C1 if DC coupling is necessary. Terminating-resistor R1 can be switched across the input by switch S1 to provide a 75 ohm termination. Trimmer potentiometer R78 sets the amplifier's output level.

At least 0.5-volt peak-to-peak video is necessary for proper operation. IC1 is an LM318, a video op-amp. Resistor R3 provides feedback and C2 provides frequency compensation for IC1. Resistors R18 and R19, together with capacitors C3 and C4, provide ±5 volts to IC1 and serve as decoupling networks, reducing video cross-talk through the power-supply wiring. About 2 to 3 volts of inverted (positive sync) composite video appears at IC1 pin 6.

Inverted composite video is fed directly from IC1 to IC2, an analog switch, and through R4, C5, and Q1 to the sync-separator system. Transistor Q1 is normally non-conducting, because bias generated across R5 keeps Q1 cut off except during positive sync tips. Negative sync pulses appear at Q1's collector. Resistor R6 provides a collector pull-up for Q1. Resistors R7 and R8 couple the sync pulses to Q2. Resistor R9 is the collector load for Q2. Resistors R10 and R11, and capacitors C6 and C7 form an integrator network that extracts vertical timing pulses from the composite sync at the collector of Q2. Capacitor C8 couples the timing pulses to Q3, which squares and shapes the timing pulses. The negative-going vertical sync pulses are used to trigger dual-multivibrator IC4.

Pulses at the collector of Q1 trigger dual-multivibrator IC3; the two sections of IC3 are connected as two cascaded monostable multivibrators. Resistors R79 and R14, and capacitor C9 determine the pulse width of the first section—about 53 microseconds. Resistor R80 and R15, and capacitor C10 determine the pulse width of the second section—about 10 microseconds. A positive-going pulse appears at IC3 pin 10. By proper adjustment of R80, the pulse can be made coincident to, and the same width as, the horizontal-blanking pulse. It's the same with the vertical-sync pulses at the collector of Q3 trigger IC4. Both sections of IC4 function identically to IC3. Resistors R81 and R16, and capacitor C12, determine the pulse width of the first section—nominally 16 milliseconds. Resistors R82 and R17, and capacitor C13, determine the pulse width of the second section. By proper adjustment of R81 and R82, the pulse appearing at IC4 pin 10 can be made coincident with the vertical-sync interval of the video-input signal. A negative pulse at IC4 pin 9 cuts off IC3 (horizontal gating) during vertical-retrace intervals. The horizontal and vertical gating pulses are summed across R20. Diodes D1 and D2 DC-isolate IC3's and IC4's outputs from each other. The pulse across R20 is nominally +5 volts; it is low during line scan and high during sync intervals. It is fed to pin 9, the control lead, of video switch IC2.

Since IC2 pin 9 is low, during line scan intervals the normal video containing luminance and chroma from IC2 pin 4 appears at pin 5. Inductor L1, and capacitors C16 and C17 form a lowpass filter, while C15, R22, and L2 form a highpass filter. Resistors R23 and R24 terminate the

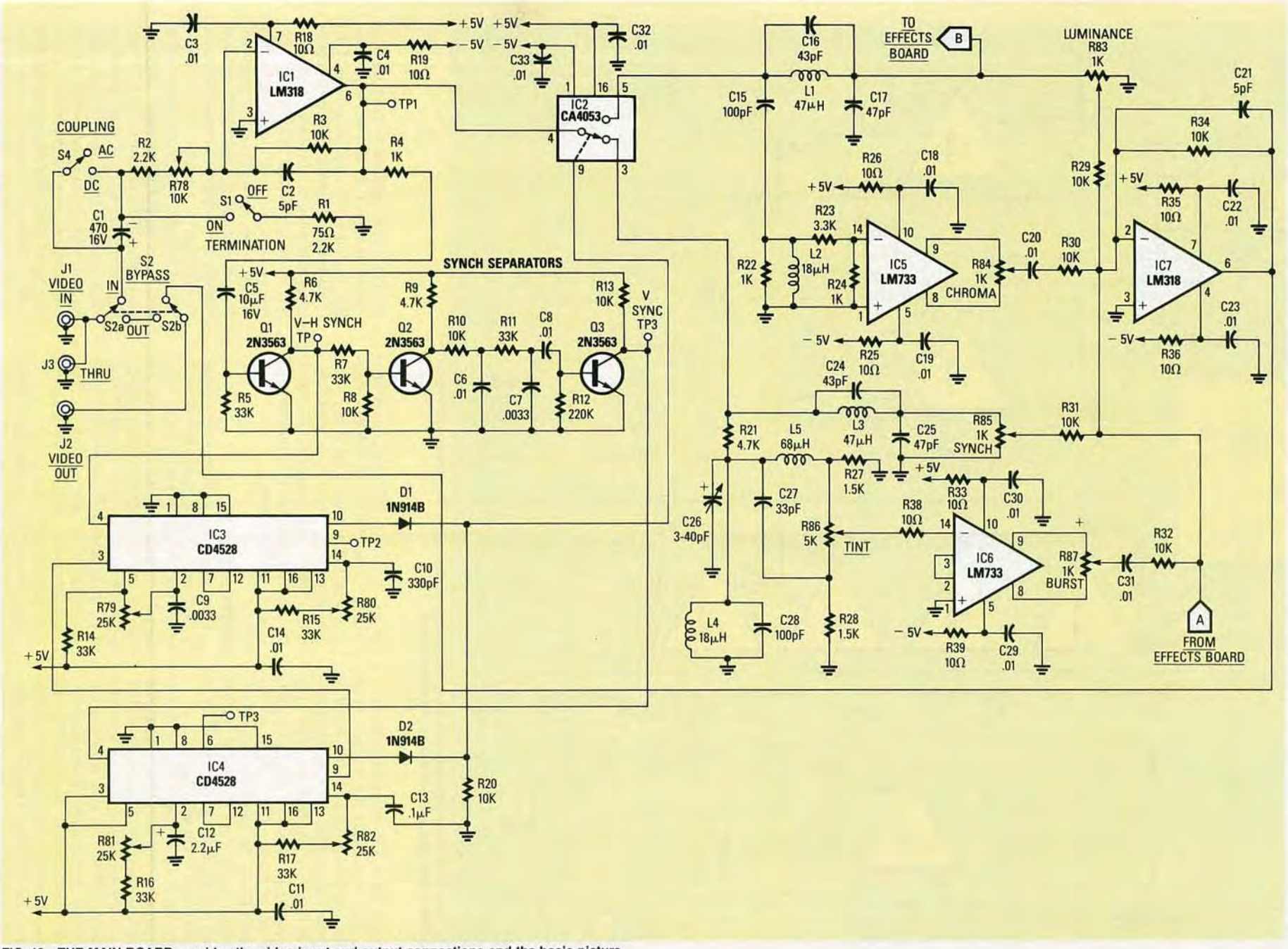


FIG. 10—THE MAIN BOARD provides the video input and output connections and the basic picture processing. Analog switch IC2 separates the sync from the chroma and luminance components.

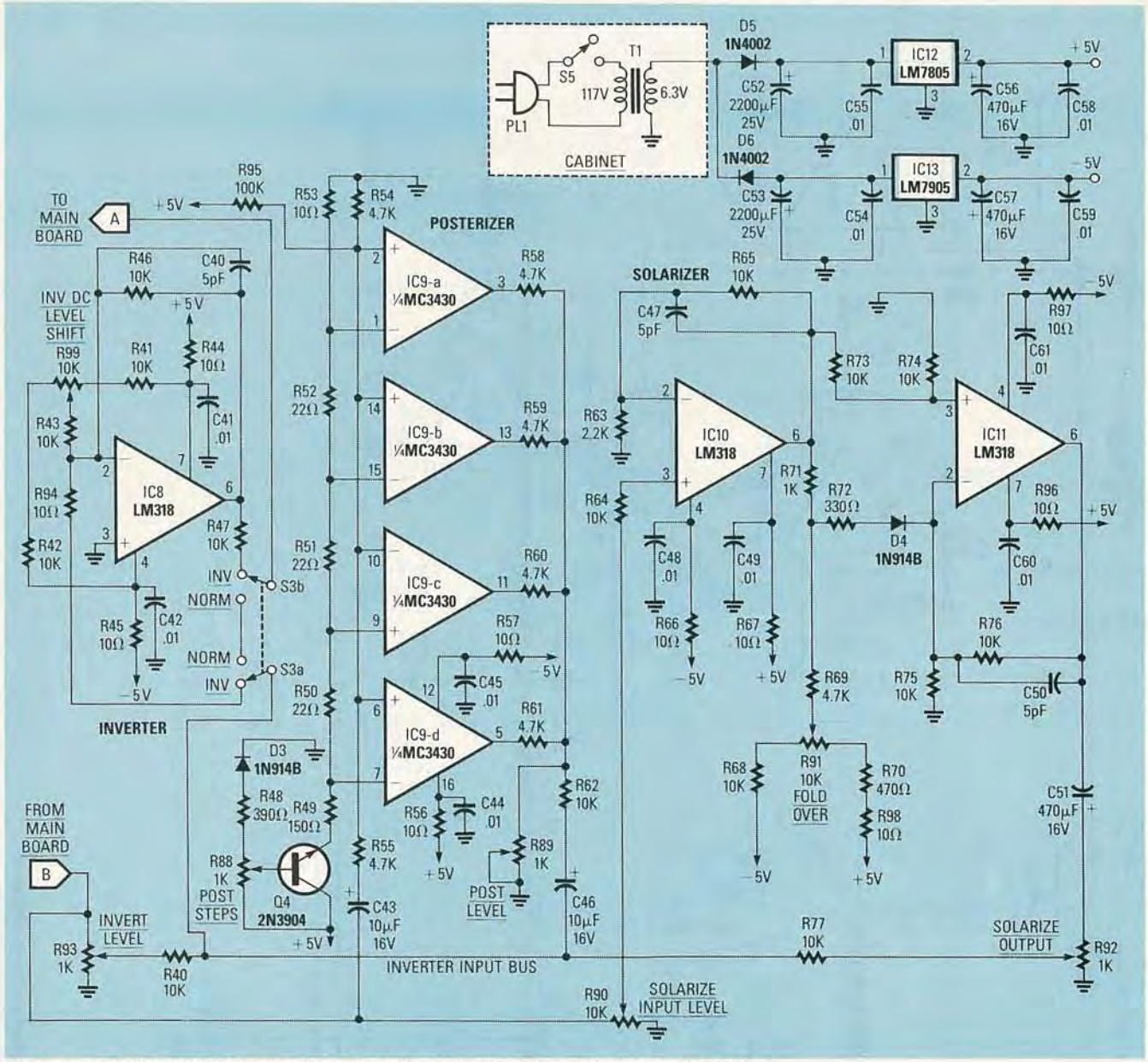


FIG. 11—THE EFFECTS BOARD provides the analog effects: posterization, solarization, and inverted video. The power supply is also built on the effects board.

highpass filter. The luminance gain control, R83, terminates the lowpass filter. Video from R83's wiper goes through R29 to summing amplifier IC7. Chroma amplifier IC5 has a nominal gain of 10. (The chroma signal appears at an equal level, 180° out of phase, at IC5 pins 8 and 9.) Resistor R84 is the chroma-level control. Depending on R84's setting, either positive or negative chroma signal can be supplied to IC7 through R30.

During sync intervals, IC2 pin 9 is high, so sync, burst, and blanking appear at pin 3. Capacitors C24, and C25, and L3 form a lowpass filter, feeding sync and blanking to R85, the sync-level control. The wiper of R85 feeds summing amplifier IC7 through R31. Resistor R21, capacitors C26 and C28, and L4 are used as a burst take-off filter. Trimmer capacitor C26 is adjusted so that the tint-control circuit—L5, C27, R27, R28, and R86—produces correct tints when R86's wiper is centered. The burst from R86's wiper goes to burst amplifier IC6, which has a gain of 100 to compensate for the loss in the tint control circuit. Potentiometer R87 controls the burst level.

Adding effects

Processed video from the effects board is fed to summing amplifier IC7 at pin 2. In addition to summing the various video-signal components, IC7 re-inverts the video so that it appears as 1-volt peak-to-peak with negative sync (nominal NTSC) at video output jack J2. Depending on the settings of the the palette's controls, up to 2 volts of video is available when the unit is terminated by 75 ohms.

As shown in Fig. 11, the effects board receives its video input across R93. Video (luminance) is applied to the posterizer circuit through C43 and R55. Resistor R54 provides a ground return for IC9's comparators. Transistor Q4 provides an adjustable reference bias for the posterizer. Resistor R48 and diode D3 provide temperature compensation of the reference voltage. The comparator outputs are summed across level control R89 and flow through the inverter input bus to S3-a, the INVERT-NORMAL switch.

The solarizer, which was discussed in Part 1 (see **Radio-Electronics**, page 41, September 1987), consists of IC10 and IC11. Amplifier IC10 has a gain of four; its input signal is taken from R90's wiper through R64. The output, which has an amplitude of up to 4-volts peak-to-peak, appears at IC10 pin 6. Potentiometer R91 is the "foldover" control; resistors R68 and R71 limit R91's effective range for

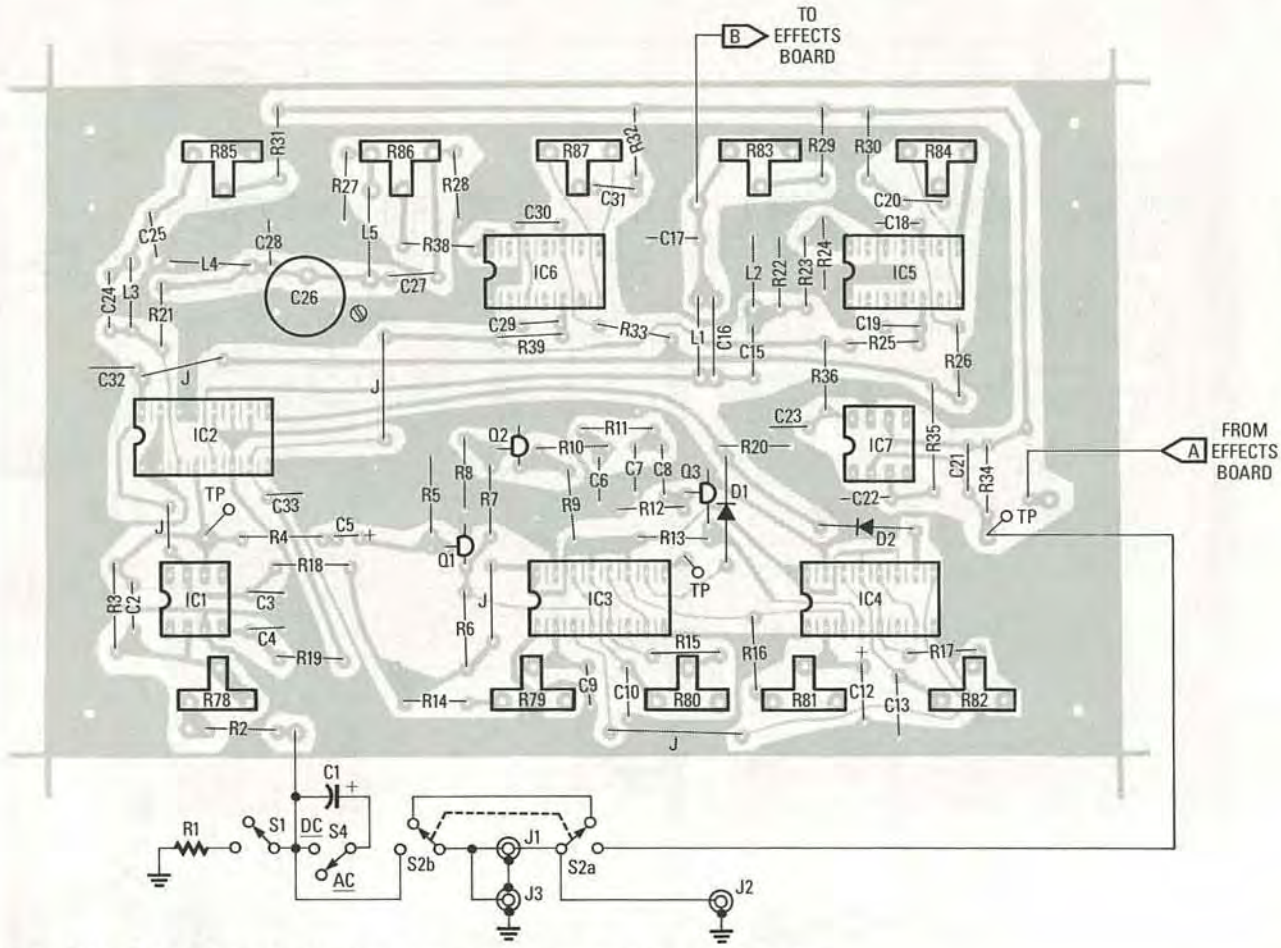


FIG. 12—INSTALL THE MAIN BOARD COMPONENTS in the order given in the text. While IC sockets aren't specified, their use is suggested. They make troubleshooting easier if you have any problems.

PARTS LIST—MAIN BOARD

All resistors are ¼-watt, 5% unless otherwise noted
R1—75 ohms
R2—2200 ohms
R3, R8, R10, R13, R20, R29–R32, R34—10,000 ohms
R4, R22, R24—1000 ohms
R5, R7, R11, R14–R17—33,000 ohms
R6, R9, R21—4700 ohms
R12—220,000 ohms
R18, R19, R25, R26, R33, R35, R36, R38, R39—10 ohms
R23—3300 ohms
R27, R28—1500 ohms
R37—not used
R78—10,000-ohm trimmer potentiometer
R79–R82—25,000-ohm trimmer potentiometer
R83, R84, R85, R87—1000-ohm potentiometer
R86—5000-ohm potentiometer

Capacitors
C1—470 µF, 16 volts, electrolytic
C2, C21—5 pF, silver mica
C3, C4, C6, C8, C11, C14, C18, C19, C20, C22, C23, C29–C33—0.01 µF, ceramic disc
C5—10 µF, 16 volts, electrolytic
C7, C9—0.0033 µF, Mylar
C10—330 pF, silver mica or NPO ceramic disc
C12—2.2 µF, 10 volts, Tantalum
C13—0.1 µF, Mylar
C15, C28—100 pF, silver mica
C16, C24—43 pF, silver mica
C17, C25—47 pF, silver mica
C26—3–40-pF trimmer
C27—33 pF, silver mica
C34–C39—Not used

Semiconductors
IC1, IC7—LM318 wideband op-amp
IC2—CD4053 analog multiplexer/demultiplexer
IC3, IC4—CD4528 dual monostable multivibrator
IC5, IC6—LM733 differential video amplifier
Q1, Q2, Q3—2N3565 NPN transistor
D1, D2—1N914B small-signal diode

Other components
J1, J2, J3—Coaxial jacks, see text
L1, L3—47 µH
L2, L4—18 µH
L5—68 µH
PL1—Power plug
S1, S4, S5—SPST switch
S2, S3—DPDT switch
T1—6.3 volts, 300 mA

Miscellaneous—Wire, solder, cabinet, mounting hardware, knobs, etc.

easier operation. Solarized video is fed through C51 to solarizer output level control R92, whose wiper feeds the inverter input bus through R77. Unprocessed video luminance is also fed to the bus from inverter level control R93.

Similar circuits

Switch S3-a selects the inverter circuit consisting of IC8 and its peripheral components. You may have noticed by now that the circuits using the LM318 are all very similar; hence we are not discussing them in detail except where significant differences are encountered. Resistors R87, R41, R42, and R53 feed an adjustable DC bias to IC8 to maintain correct DC-baseline levels when inversion is used. Resistor R47 feeds inverted output through S3-a to summing amplifier IC7, which is located on the main board. As in the other amplifier circuits using the LM318, a 10,000-ohm feedback resistor (R46) and a 5-pF shunt capacitor (C40) are used to set the gain and provide frequency compensation.

Construction

You can build the video palette from scratch using the PC-board patterns provided in PC Service. Also, a kit of

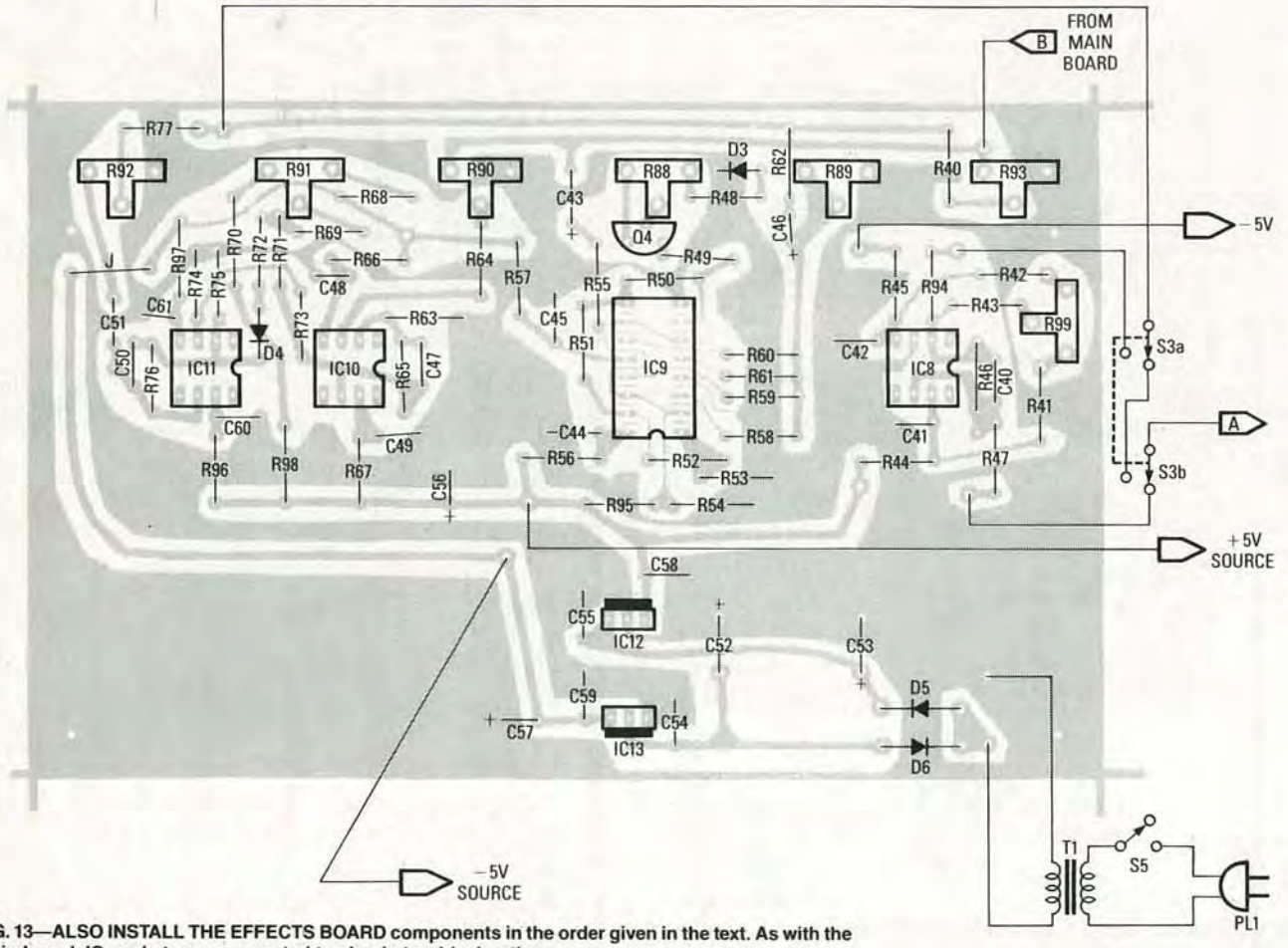


FIG. 13—ALSO INSTALL THE EFFECTS BOARD components in the order given in the text. As with the main board, IC sockets are suggested to simply troubleshooting.

PARTS LIST—EFFECTS BOARD

All resistors are ¼-watt, 5% unless otherwise noted

R40–R43, R46, R47, R62, R64, R65, R68, R73–R77—10,000 ohms
R44, R45, R53, R56, R57, R66, R67, R94, R96–R98—10 ohms
R48—390 ohms
R49—150 ohms
R50–R52—22 ohms
R54, R55, R58–R61, R69—4700 ohms
R63—2200 ohms
R70—470 ohms
R71—1000 ohms
R72—330 ohms
R95—100,000 ohms
R99—10,000-ohm trimmer potentiometer
R88, R89, R92, R93—1000-ohm potentiometer
R90, R91—10,000-ohm potentiometer

Capacitors

C40, C47, C50—5 pF, silver mica
C41, C42, C44, C45, C48, C49, C54, C55, C58, C59, C60, C61—0.01 μF, ceramic disc
C43, C46—10 μF, 16 volts, electrolytic
C51, C56, C57—470 μF, 16 volts, electrolytic
C52, C53—2200 μF, 25 volts, electrolytic

Semiconductors

IC8, IC10, IC11—LM318 wideband op-amp
IC9—MC3430 high-speed comparator
IC12—LM7805 +5-volt regulator
IC13—LM7905 –5-volt regulator
Q4—2N3904, NPN transistor
D3, D4—1N914B small-signal diode
D5, D6—1N4002 silicon rectifier

Note: The following items are available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804: Main PC board $12.50; main and effects PC boards $25.00; main PC board and all parts that mount on the board $49.95; main and effects PC boards and all parts that mount on the boards $84.95. (The effects board is sold only in conjunction with the main board.) Add $2.50 for postage and handling per total order. NY State residents add appropriate sales tax.

parts that includes the PC boards and all board-mounted parts is available from the source listed in the parts list. Knobs, switches, jacks, plugs, case, etc., are not supplied with the parts kit. A suitable cabinet is the Radio-Shack *270-274*.

If you decide to etch your own boards, use single-sided .031 or .062 phenolic material, or fiberglass-epoxy G-10 (preferred). Figures 12 and 13 show the parts placement for the boards.

Stuff the PC boards in this order: resistors, inductors, capacitors, controls, transistors, IC's. The lengths of the interconnecting wires aren't critical, but they should be as direct as possible. The palette's input and output connections should be coax when possible. To reduce both stray capacitance and induced 60- or 120-Hz pickup, the leads carrying video signals to and from the effects board should be dressed away from grounded metal and the power-supply leads.

The shafts for all the front-panel controls should be strain relieved. That can be done by passing them through holes in the front of the cabinet that are about .005″ larger than the shaft diameter, which is nominally ¼″. If desired, bushings can be used around the shafts.

The front panel has eleven controls, a pilot light (if installed), and three switches; don't crowd its layout or it will be hard to use unless you have very small hands. RCA-phono, HF, BNC, or F-type video connectors are suggested for the external connections. Switches can be of the mini-

ature type which use a ¼" mounting hole. At this point, check your wiring and PC boards for correct component insertion and pin orientations, unwanted solder bridges, and completeness. If any wiring or assembly errors exist, correct them before proceeding farther.

Alignment

Alignment is simple. If possible, use an oscilloscope having a bandwidth greater than 5-MHz. While a scope does make the initial alignment easier, do not let the lack of a scope discourage you, because final "tweaking" will be found easiest to do by watching the picture. If a scope isn't available, simply observe the effects of your adjustments on a TV monitor; we'll tell you what to look for.

Prepare the video palette for alignment by setting R78, R79, R80, R81, R82, and R99 so that they are in the center of their range (midway). Then connect the video palette as shown in Fig. 14.

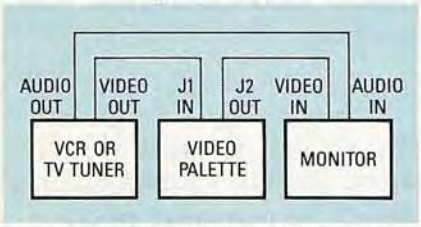


FIG. 14—USE THIS KIND OF HOOKUP for checking and aligning the video palette. A TV-tuner signal source can originate in the VCR, or use an integral TV-tuner device.

Next, connect the ground lead of a 20,000-ohm/volt (or higher) VOM that is set to read about 10-volts full scale to the main board's ground foil; then apply power to the video palette. *Very quickly* check the voltages across C56 and C57—they each should be 5 volts (C56 has its negative lead grounded, and C57 has its positive lead grounded). Then *very quickly* check for the following voltages on the indicated pins of IC1, IC7, IC8, IC10, and IC11:

Pin 6: 0-volts (±0.5 volts OK)
Pin 7: +5 volts
Pin 4: –5 volts

Make the following checks on IC5 and IC6:

Pin 5: +5 volts
Pin 6: +5 volts
Pin 8: 0 volts (± 1 volt OK)
Pin 9: 0 volts (± 1-volt O K)

Then, with no signal input to J1 or J3, check IC1, IC3, and IC4 for:

Pin 10: 0 volts
Pin 9: +5V volts
Pin 16: +5 volts
Pin 8: 0 volts

Also check IC2 for:

Pin 7: −5 volts
Pin 16: +5 volts

Check IC9 for:

Pin 16: +5 volts
Pin 12: −5 volts

Check Q1 for:

Collector: +5 volts
Base: 0 volts

Check Q2 for:

Collector: 0 volts
Base: +0.6 volts

Check Q3 for:

Collector: +5 volts
Base: 0 volts

Check Q4 for:

Collector: +5 volts
Base: +2–5 volts (depends on setting of R88)
Emitter: 0.6 volt less than base

Nothing should get hot—if anything does, there is a problem that must be corrected before proceeding any farther.

If the test signal is provided by a VCR that can output a tuner signal instead of a tape signal, use the tuner signal because it has better stability.

The main board

If an oscilloscope is available, you can check your adjustments using the photographs shown in Figs. 15 through 26 as a general—not an exact—reference. Each figure shows the vertical sensitivity and sweep rate used to obtain the trace.

Apply a 1-volt peak-to-peak negative-sync NTSC video signal to J1 (Fig. 15). Close S1 to provide a 75-ohm termination for the video source. Open S4 so that the video source is AC-coupled to the palette. Set S2 to its IN position. Adjust R78 for 3-volts peak-to-peak at IC1 pin 6 (Fig. 16). Notice that the signal at pin 6 is inverted. Check Q1's collector for negative-going pulses (Fig. 17). Transistor Q3's collector should also show negative-going pulses (Fig. 18), although because of their short duration they may be hard to see on a scope with screen brightness.

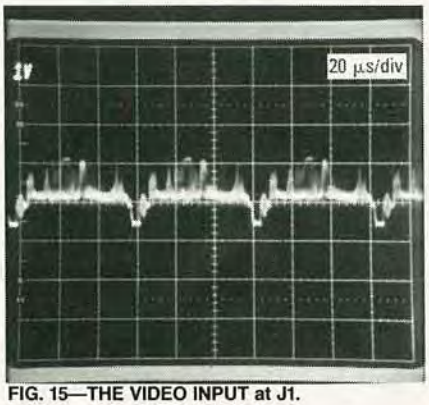


FIG. 15—THE VIDEO INPUT at J1.

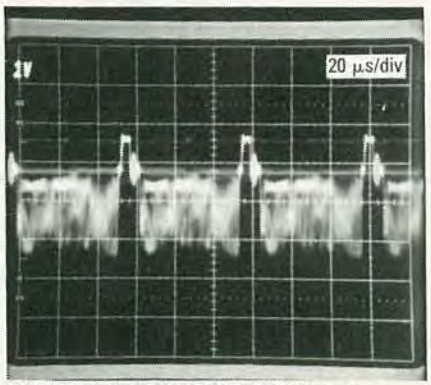


FIG. 16—INVERTED VIDEO AT IC1, pin 6.

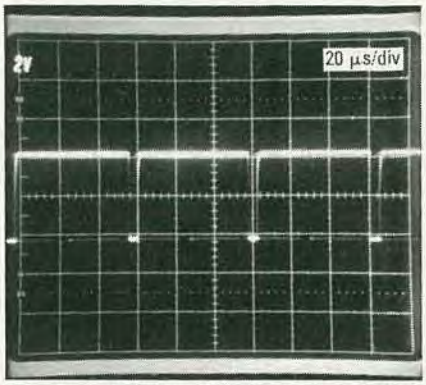


FIG. 17—NEGATIVE PULSES at Q1's collector.

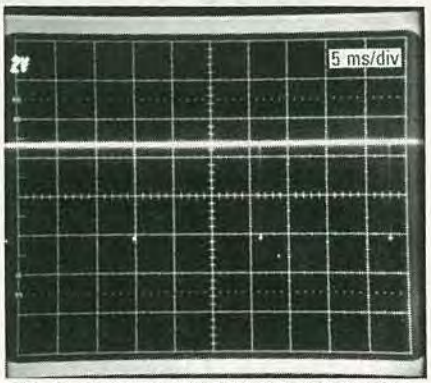


FIG. 18—THE NEGATIVE PULSES at Q3's collector might be difficult to observe.

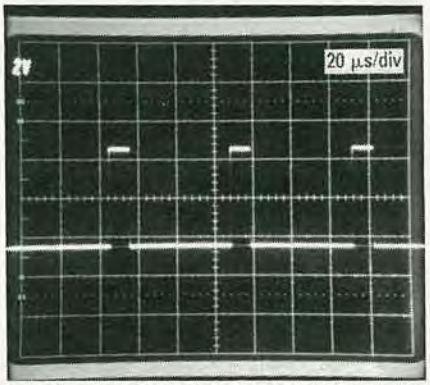


FIG. 19—THE SCOPE DISPLAY should resemble this at IC3 pin 7.

Adjust R79 for a nominal 53-microsecond negative-going pulse at IC3 pin 7 (Fig. 19). Then set R80 for a nominal 10-microsecond positive-going pulse at IC3 pin 10 (Fig. 20). Next, adjust R81 for a negative-going 16-millisecond pulse at IC4 pin 7 (Fig. 21). Then adjust R82 for an approximate 600-microsecond positive-going pulse at IC4 pin 10. If there is no pulse, tweak R81 until a narrower pulse is obtained (Fig. 22). Note that a 600-microsecond pulse will not be generated if the 16-millisecond multivibrator is set for too long a pulse.

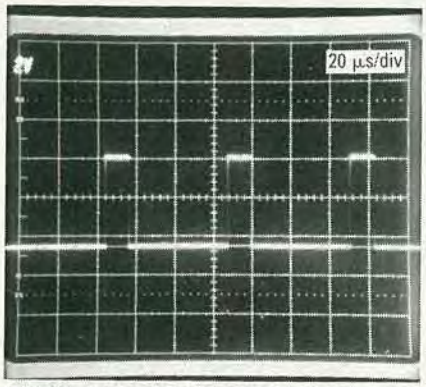


FIG. 20—THE SCOPE DISPLAY AT IC3, pin 10 resembles the display at pin 7.

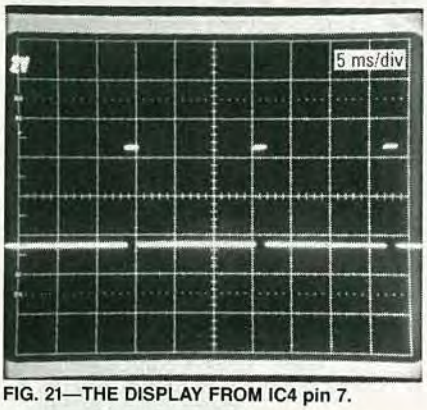


FIG. 21—THE DISPLAY FROM IC4 pin 7.

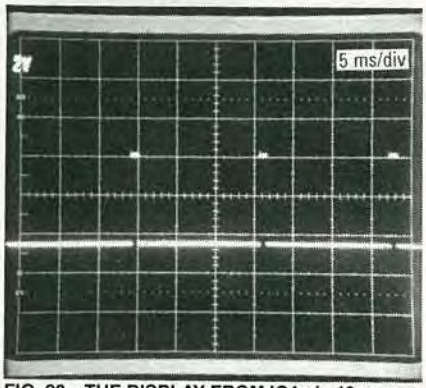


FIG. 22—THE DISPLAY FROM IC4 pin 10 resembles that of pin 7.

Aligning by monitor

If a scope isn't available, make the following adjustments and use a TV monitor to observe their effect.

1. Set R83, R85, R86, and R87 to their mid position. You should see a black-and-white, or a weak color image on the monitor. Set all the effects-board controls for minimum resistance (*off*).

2. Adjust R79—you will see a "transition" on the right and/or left side of the screen. That is caused by IC2 switching the video through the sync channels. If instability is noticed on the monitor, adjust R85 for maximum stability. Adjust R79 and R80 to move the transitions just off the right and left edges of the screen so they are unseen during normal viewing. The picture may roll vertically—that is OK for now.

3. Adjust R81 and R82 for a stable, vertically-locked picture. When those controls are properly set there should be no "transitions" at the top or bottom of the picture.

4. With all effects controls still set for minimum resistance, set S2 to OUT to bypass the video palette and adjust the TV monitor for a normal picture. Then set S2 to the IN position and check that each control does what it's supposed to do.

- Resistor R83 should vary the picture contrast (luminance).
- Resistor R85 should vary the picture brightness. (When R85 is toward minimum, the picture should lose its sync.)
- Resistor R87 may vary the color saturation and reverse the colors (burst).
- Resistor R84 should operate in a similar manner to R87 (chroma).
- Resistor R86 should vary the tint. Adjust C26 to produce normal tint when R86 is set to its mid position.

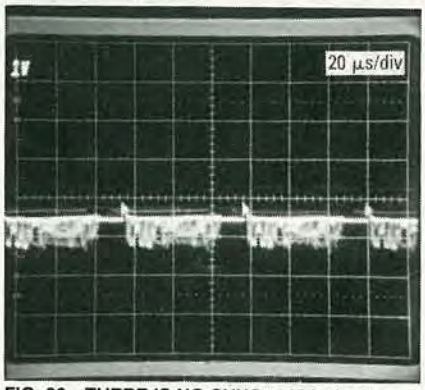


FIG. 23—THERE IS NO SYNC at IC2 pin 5.

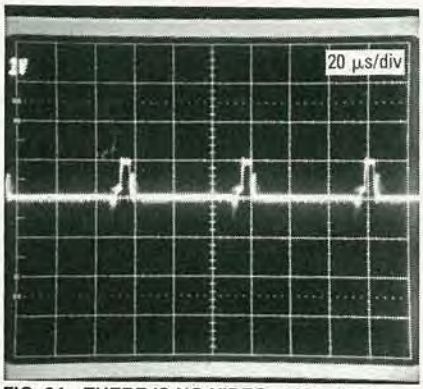


FIG. 24—THERE IS NO VIDEO at IC2 pin 3.

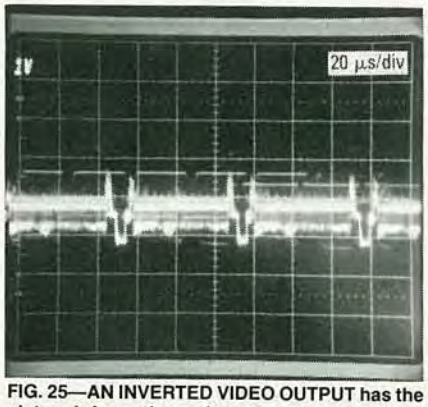


FIG. 25—AN INVERTED VIDEO OUTPUT has the picture information going negative.

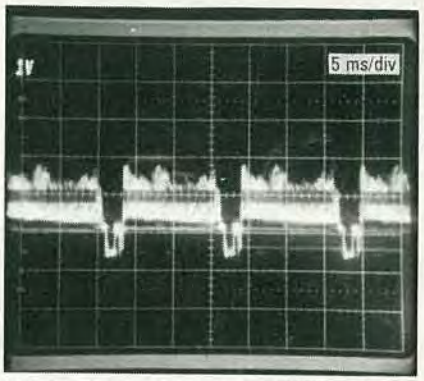


FIG. 26—A NORMAL VIDEO OUTPUT looks like this on your scope.

If you are using a scope, you can place the scope on IC7 pin 6 and observe the effect of each control on the video signal.

5. Set up R83 through R86 for a normal TV picture. Then set R83 to minimum. (All effects-board controls should be at zero again.) You should see a plain raster with only splotches of color, or on a black and white monitor, just a raster with only a very weak, faded picture.

6. Set inverter switch S3 to NORMAL. The picture should return as you adjust R93 clockwise.

7. Set S3 to its INVERT position. A negative picture should be seen.

8. Adjust R99 for a satisfactory negative picture. (You may have to touch-up R85 on the main board first.) When R99 is properly adjusted, R85 can be left alone. Now set S3 to its NORMAL position.

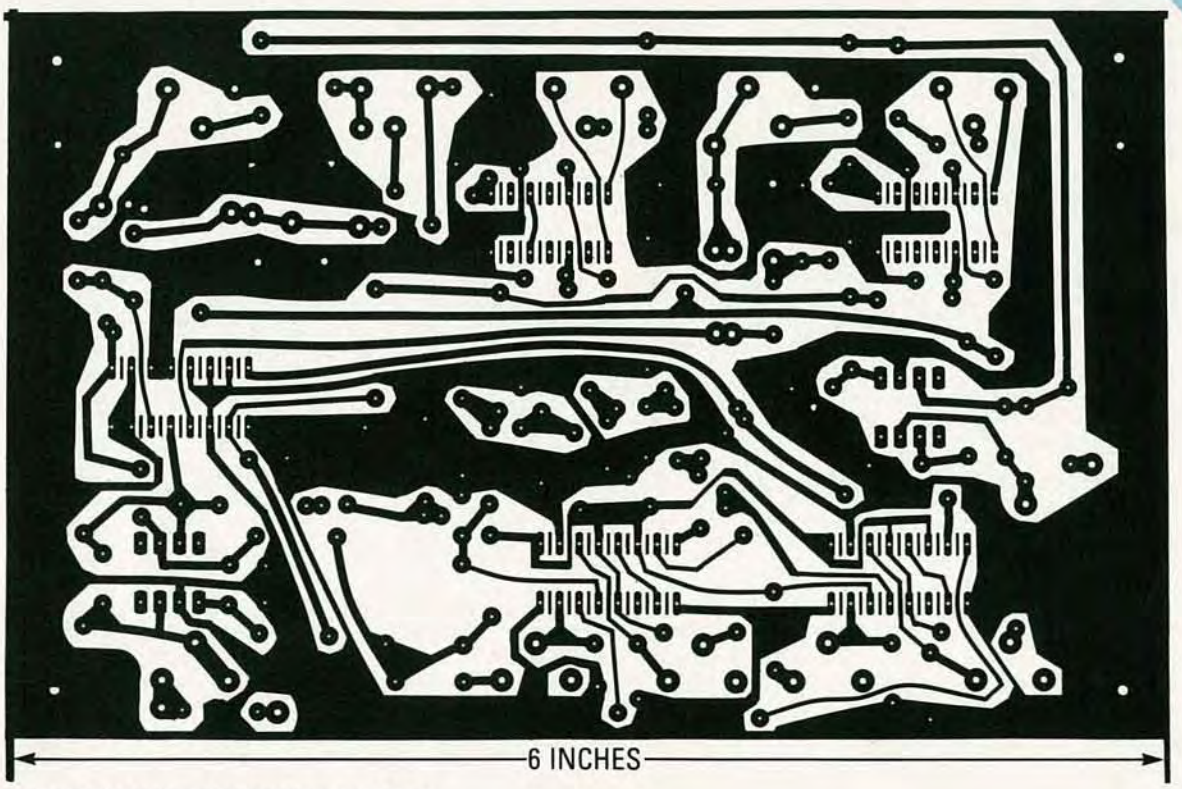
9. Rotate R93 fully counter-clockwise. Set R88 and R89 to their mid position. Observe the effect on the TV picture. You should see a posterized image—it will be obvious. Then adjust R88 and R89 and take note of their effect on the picture. Finally, return R88 and R89 to zero (full counter-clockwise).

10. Set R90 and R92 to approximately their mid position and then slowly adjust R91—you will see the solarization effect. Adjust R90 and R92 for the best or the desired effect, although R85 may have to be readjusted at some settings.

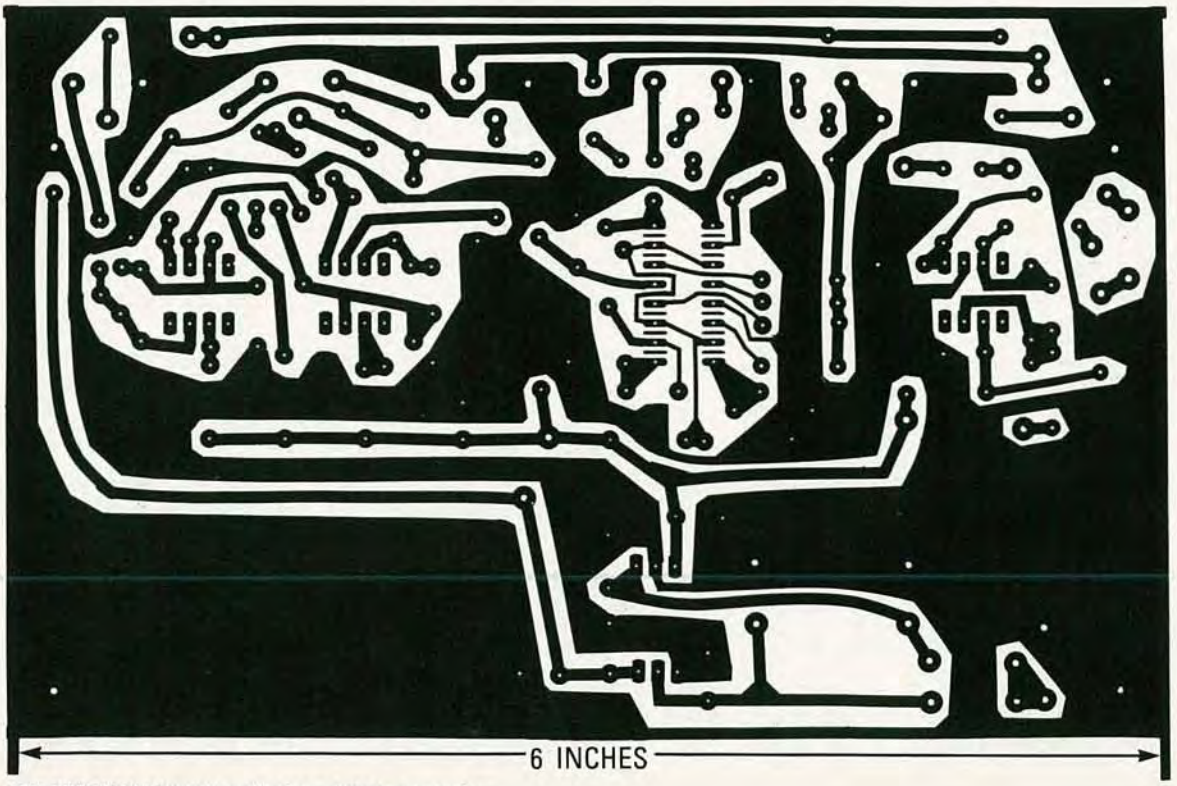
11. Set S3 to both its NORMAL and INVERT positions and observe the solarization effect (as in step 10).

If you have some form of instability or an undesired effect that we haven't mentioned, the following scope checks will help your track down the problem. Check for *video only* at IC2 pin 5 (Fig. 23); *sync only* at IC2 pin 3 (Fig. 24); *normal video* at output jack J2 when S3 is set to NORMAL (Fig. 25); *inverted video* at J2 when S3 is set to INVERT (Fig. 26).

That completes the alignment and checkout. The rest is up to you. A few hours of just plain experimentation is the best way to learn what the video palette can do. **R-E**



THE VIDEO-EFFECTS GENERATOR main board.



THE EFFECTS BOARD for the video-effects generator.