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Servicing & Technology

DECEMBER 1985/$2.25

INDEX !!

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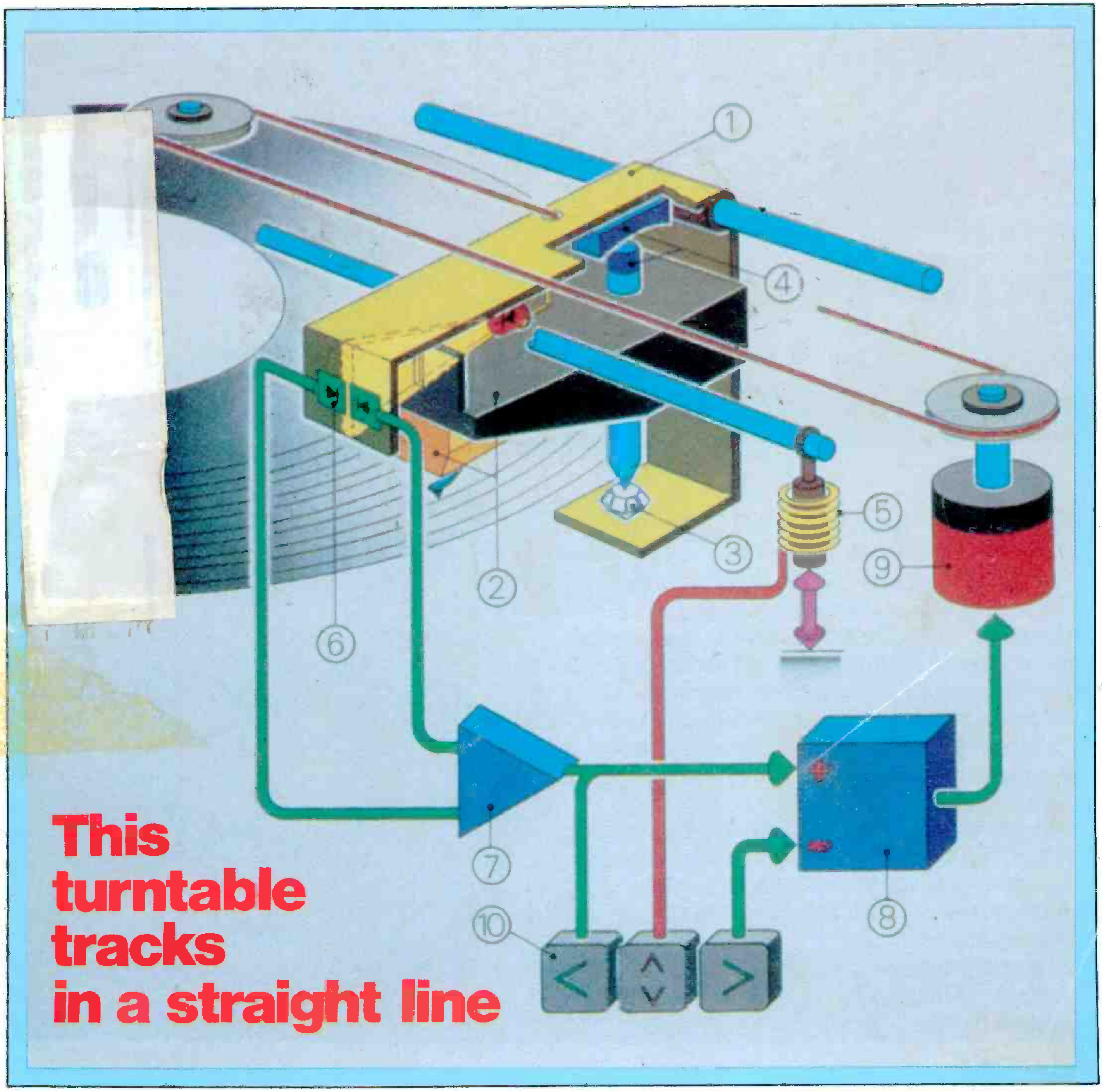
Microcomputer troubleshooting • Computer-generated test patterns



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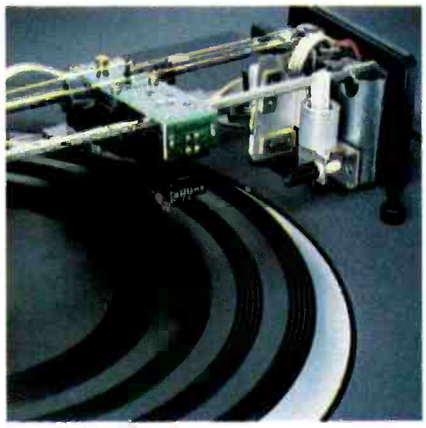
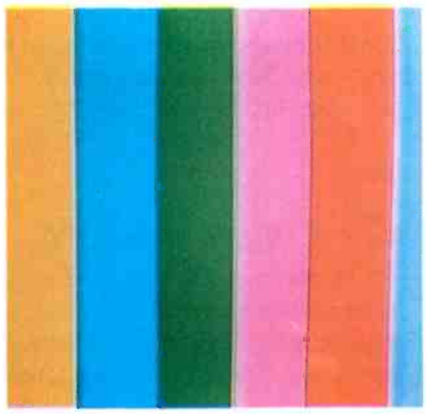


Promising superior sound reproduction and long-term stability, this tonearm is a feature of the linear-tracking turntable depicted schematically on this month's **ES&T** cover. See the Technology article, beginning on page 4, for a detailed explanation. *(Graphics courtesy of Studer Revox.)*



Color bar test patterns can be programmed on certain home computers. The article begins on page 40.

Editorial

Computers as TV servicing tools

Before the 1970s, the only computers were large mainframe or minicomputers, found in climate-controlled rooms and operated by *Data Processing Specialists*. In the 1970s, the microcomputer was developed and as soon as industry had grasped its potential, the race was on to use the microcomputer to its fullest potential. Manufacturers began to design microcomputers into existing products; at first, commercial products such as gas pumps and industrial equipment, where the cost, which at that time was still fairly high, could be absorbed.

As the cost of microcomputers and the software to make them work plummeted, the applications of microcomputers multiplied. Personal computers began to appear on the market. Consumer products such as microwave ovens began to boast the inclusion of microcomputers.

Ultimately, as soon as microcomputers and their software became inexpensive enough, microcomputers found their way into almost every kind of consumer electronic product: VCRs, digital audio compact disc players and stereo receivers. If you look closely at the electronic systems of most cars produced today, you'll probably find several microcomputers.

You really don't have to look very far to find out why microcomputers virtually have taken over. Computers possess a characteristic not associated with any other kind of circuit. They are programmable. That means that one general-purpose circuit can be programmed to perform one series of operations in one system, then reprogrammed to perform another series of operations in another system. You don't have to unsolder a single connection. You don't have to replace a single component. You don't have to design a new circuit board. All you have to do is give the device a new set of instructions and it will perform a completely new set of tasks.

In the past several years, the versatility of the personal computer has been demonstrated again and again, then expanded, and demonstrated yet again. At first, it was a curiosity. People would say "It's neat, but what good is it?" Then software was developed to make it into a spreadsheet tool. Another capability that has attracted previously reluctant buyers is the personal computer's capability to become a word processor, composing and editing prose, without the need ever to print a word onto a piece of paper until it is perfect.

In addition to those capabilities, today's personal computers can act as personal communications terminals, allowing people to receive electronic "mail" almost instantaneously. Add to that the capability to control home appliances from a single central location, to get today's stock market situation immediately on your own terminal, and dozens of other similar capabilities.

With the right software, a personal computer even can become a superb TV servicing tool. Because of this potential application of computers as TV diagnostic tools, we're including an article in this issue showing how valuable a personal computer can be in TV servicing. The particular programs shown may not be applicable to every computer, but the general principles demonstrated can be related to a large number of the computers owned by **ES&T** readers.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

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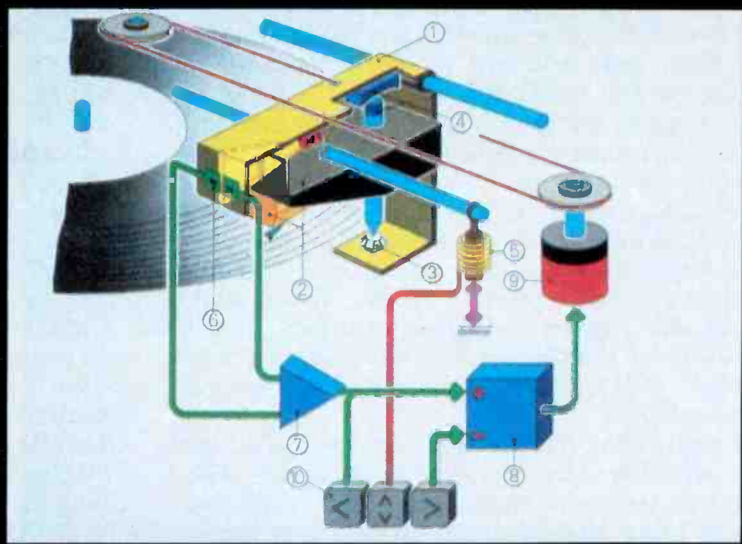
Technology

This turntable's tonearm tracks in a straight line

All phonograph records are manufactured using a disc-cutting lathe that cuts the groove in the master disc using a tangential path; that is, the cutting tool travels from the outside edge of the master disc to the center in a perfectly straight line (see Figure 1). The result is a disc in which there is no angular error.

On most playback turntables, the disc is played back by a stylus that is connected to a tonearm which pivots at the end opposite the stylus, and thus moves from the outside edge of the record toward the center in an arc, not in a straight line (see Figure 2). A record cut tangentially played back with a pivoting arm introduces errors that are undesirable in the playback of the music.



This schematic representation of the linear-tracking turntable illustrates some of its features.

1. The tonearm carriage moves along one radius of the record with the stylus always at the tangent to the groove.
2. The short, low-mass tonearm tracks the record groove well.
3. The tonearm pivots in a watchmaker's jewel bearings.
4. The magnetic guidance system allows the arm to pivot fore and aft and swivel horizontally, but prohibits lateral motion.
5. An electronically controlled electromagnet lowers and raises the tonearm.
6. An LED/photodiode system transmits information about the position of the stylus relative to the groove back to the microcomputer that controls the tonearm carriage servomotor.
7. The signals are received by a pre-amplifier and routed to the servopower circuit.
8. The servomotor power amplifier controls the tonearm motor.
9. The servomotor and drive gear drive the tonearm.
10. Operator keys provide for rapid forward-and-reverse movement of the tonearm.

One way to eliminate this problem is to use a turntable with a tonearm that travels across the record tangentially, just as the cutting tool did in cutting the record master. Studer Revox Company of Switzerland has designed and manufactured such a system in its B791 and B795 linear tracking turntables.

What Revox has done, in essence, is to create a short, low-mass tonearm that rides on rails like an overhead crane trolley, tracking tangentially, reproducing the motion of the tool used to cut the record master. The box shows a schematic representation of the construction of this linear tracking system. The tonearm, ②, is mounted in a carriage using a low-friction pivot, called a *unipivot*, ③. The carriage, fabricated of a very

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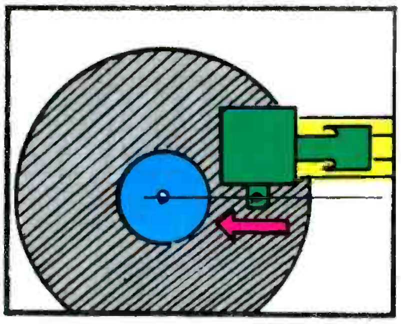


Figure 1.

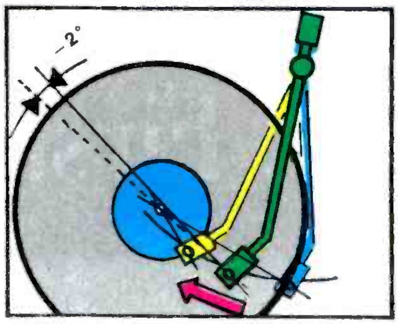


Figure 2.

Figure 1. The cutting tool on a record-cutting lathe travels in a straight line, cutting the groove tangentially. For best sound reproduction, the playback stylus should track tangentially.

Figure 2. On a standard turntable, the tone arm pivots at one end, so the stylus describes an arc as it tracks the groove across the record.

Figure 3. Records may exhibit any of a number of manufacturing defects, such as shown here. The lower the mass of the tonearm, the more readily it will track the groove of a record exhibiting one of these problems.

Figure 4. The tonearm on the linear tracking turntable pivots horizontally and in the fore-and-aft dimension of the arm, but the magnetic guidance system prohibits lateral motion without introducing friction.

Figure 5. The linear-tracking turntable is directly driven by a servo-controlled Hall-effect motor.

The tonearm rides on rails like an overhead crane trolley.

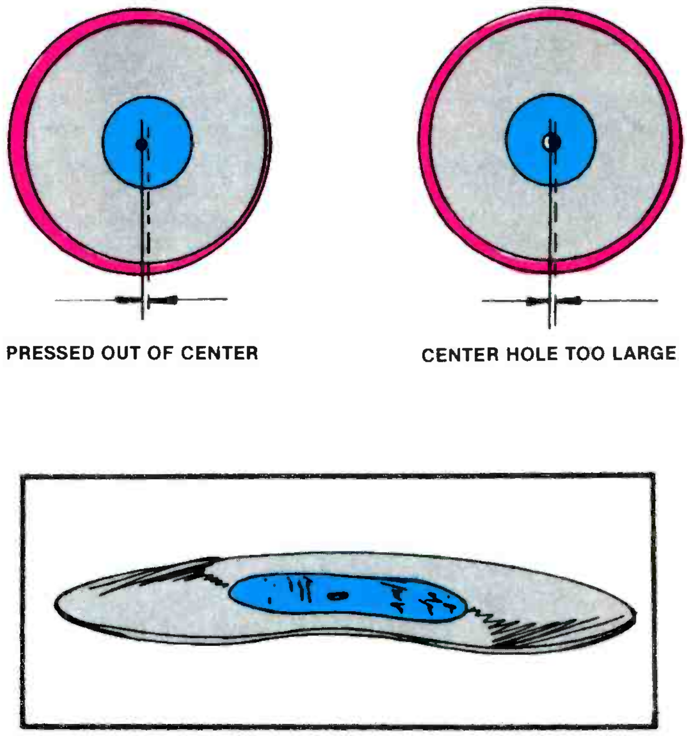


Figure 3.

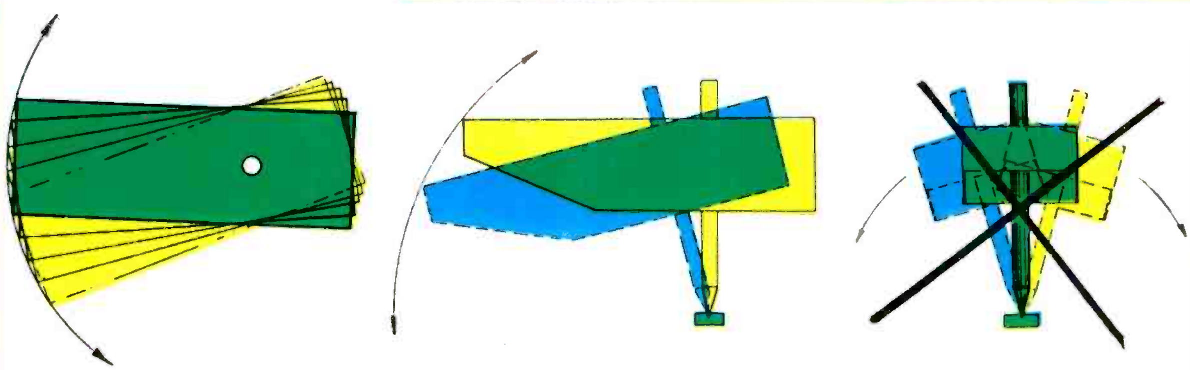


Figure 4.

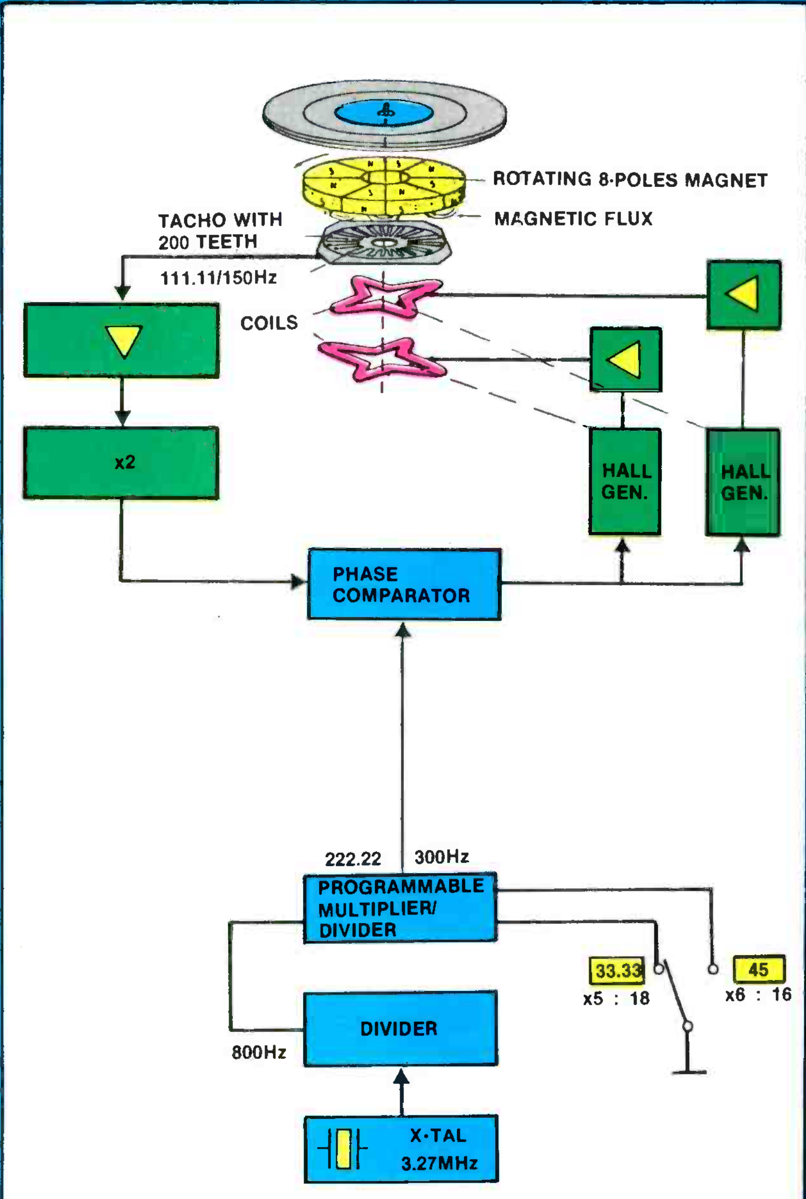
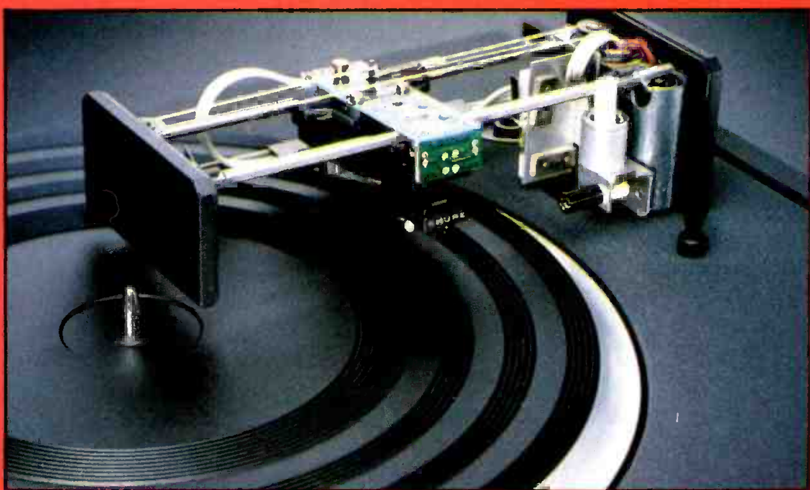


Figure 5.



slippery polymer material, glides over the surface of the record, propelled by a pulley-driven cord. The motion is provided by a microcomputer-controlled servomotor.

The unipivot mounting of the tonearm allows it to pivot in any direction. Free pivoting horizontally and pivoting vertically in the fore-and-aft plane of the tonearm are desirable for good reproduction of music. Lateral tilting, however, would produce distortions in the output, as well as causing channel separation problems. The designers eliminated this lateral movement without introducing friction by using a magnetic guidance system to stabilize the tonearm laterally. A small permanent magnet is affixed to the upper end of the tonearm pivot shaft. Above this magnet, on the carriage, another magnet is placed. This magnet is oriented to allow the tonearm to swivel horizontally or pivot in the vertical plane, but to prevent it from tilting laterally.

In the groove

On a standard, pivoting-arm turntable, the stylus simply follows the groove and pulls the tonearm along with it. That approach in a linear-tracking turntable would defeat part of its purpose, which is to keep the mass of the tonearm as low as possible. In the linear-tracking turntable, the tonearm carriage is driven across the record by a servomotor. An LED scanning system, located at the front end of the tonearm for highest resolution, tracks the disc. Variations in groove spacing sensed by this tracking system are reported to a microcomputer, increasing or decreasing the speed of the carriage drive servomotor.

Direct drive

The turntable features a high precision drive. The quartz-referenced Hall effect direct-drive slow-speed motor gives smooth running and eliminates pole hunting or cogging, according to the manufacturer. The absence of drive belts, couplings, and mechanical speed selector contributes to long term stability. The drive motor is of the 12-pole type (6 coils) equipped with a separate 100-pole tachogenerator and efficient electronic servosystem. ES&T

Diagnosing and correcting shutdown problems

By Homer W. Davidson

In late model color receivers, the present generation of safety systems has sophisticated *shutdown* circuits that monitor either the flyback-pulse amplitude or the amplitude of flyback pulses vs. the picture-tube current. The intensity of X-rays emitted by a picture tube varies according to the high voltage and the CRT current, with higher voltage and/or higher current generating increased radiation. Therefore, conditions of excessive high voltage and excessive CRT current simultaneously are the most dangerous. Many of these new circuits monitor both conditions, eliminating sound, picture, raster and most dc-voltage supplies in the chassis when *shutdown* is triggered.

Another complicating factor in new color receivers these past few years is the *start-up temporary dc voltages* that power the horizontal oscillator and driver stages long enough for the horizontal-sweep system to *begin* full-power operation. This is necessary because all stages (except the horizontal-output stage) operate from dc power rectified from horizontal-sweep power, usually from the flyback. In these models, *any interruption* long enough to bleed the filter capacitors results in a total shutdown of all functions, even when the shutdown circuit is not activated. The overvoltage/overcurrent shutdown circuits in those models can be fairly simple, because any temporary interruption of the horizontal-sweep operation will stop all functions.

Other models do not have start-up voltage supplies for the horizontal oscillator and driver stages. Therefore, the shutdown mode must eliminate the horizontal operation more permanently. This is done often by two transistors that are connected as a regenerative switch. When either transistor is triggered by an overload, the transistors bias each other to saturation current and then remain that way until the television is turned *off* and back *on* again later. While both *shutdown* transistors are conducting, the near short-circuit collector-to-emitter path of one eliminates the horizontal signal at the base of the horizontal-driver transistor.

When presented with a dead color-TV receiver, a technician has several basic possibilities in addition to the conventional one of a defective horizontal-sweep system. Perhaps start-up did not occur. Perhaps start-up was successful but was followed instantly by shutdown.

To make analysis more difficult, a failure to start up might be caused by a defective start-up circuit. Or it might be caused by a defective horizontal circuit. The same applies to shutdown: Is the trouble source in the shutdown voltage or current sensor circuits? Or is a chassis defect producing abnormal current or voltage that is correctly triggering shutdown?

Before wasting time in aimless troubleshooting, a technician should examine carefully the complete schematic, tracing the start-up and shutdown circuits. Many of these circuits for several models have been explained thoroughly in past issues of **ES&T**. Check the article index of the previous year's articles. This year, the index has been published in the December issue.

Dynamic symptoms

Switch on the receiver's power and notice all sound and raster symptoms. If the picture appears to be normal but then collapses to a thin horizontal line, it is likely the vertical stages are causing shutdown, perhaps by loading down a power supply with excessive current. If the raster has no picture but becomes much brighter before shutdown occurs, a picture-tube short circuit or a video circuit overload is indicated. When the picture has only one dominant color, a shorted picture tube or a leaking spark gap on the CRT socket is a possibility.

When sound comes on loud for less than a second then stops with the chassis in shutdown, the problem usually is in the horizontal-output and high-voltage circuits.

Excessive arcing followed by shutdown might be caused by a defective flyback or tripler. If the picture cannot be locked horizontally, check the high voltage. Remember, early solid-state chassis sometimes had shutdown circuits that prevented power horizontal locking when the high voltage was excessive.

Most shutdown circuits can be activated for tests by shorting together two test points. Check the service data. Be sure to check shutdown operation after any repairs are made.

General test methods

Preliminary checks to show whether shutdown has been caused by excessive high voltage or by component defects in the chassis should be made at different line voltages. Of course, all hot-chassis receivers should be supplied ac power via an isolation transformer. Also use a variable-voltage transformer to supply ac power between zero and 130Vac.

Before switching on the television, adjust the ac transformer for about 75V. Switch on the receiver and notice if there is picture and sound. Most newer receivers will operate (perhaps with a narrow picture) at 75Vac. At least there should be high voltage. Monitor this high voltage and the ac voltage as you increase the input ac voltage slowly. If excessive high voltage is causing the shutdown, the HV might measure 29kV or higher at 80Vac, and shutdown consequently will be activated at some voltage between 80Vac and 100 Vac. In such cases, the shutdown circuit merely is doing its intended job of protecting the receiver and the viewers; the problem is excessive high voltage.

Alternatively, a 100W incandescent light bulb can be connected across the terminals of an open line fuse or circuit breaker. As described in previous articles, this limits the current to approximately 1A while providing a visual indication (by the bulb's brightness) of the amount of current flowing. Usually, a receiver with excessive high voltage that has triggered shutdown at 120Vac line voltage will not go into shutdown when the bulb is used to limit the current during the time that the high voltage is measured.

With remote-equipped receivers, a clip lead must be attached temporarily across the 120Vac relay contacts. Otherwise, the remote control power supply might not have sufficient B+ voltage to activate the relay at low line voltages. Thus, the receiver would be dead.

Absolute proof whether or not the shutdown circuit is eliminating the sound and picture can be obtained easily by disconnecting the shutdown circuit. This must be done carefully, otherwise damage can be done to the receiver. Most shutdown sensor circuits have diodes for pulse rectifiers or for voltage barriers (Figure 1). Because diodes are easy to locate on a schematic, unsolder one end of a diode that will disconnect the shutdown operation from the horizontal sweep. Connect your HV probe and ground to the CRT anode and CRT ground, plug in the power cable or switch on the receiver power for just a few seconds – just long enough to obtain a valid HV reading. Then, unplug it immediately.

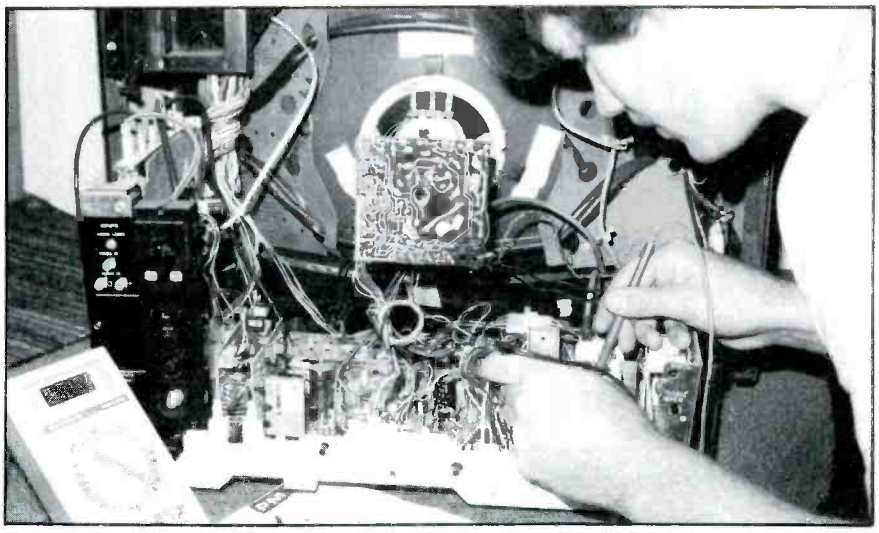
If the HV was excessive, the shutdown circuit probably is normal, but the horizontal-output stage has a defect that must be repaired.

If the HV was normal, the shutdown circuit might be defective, indicating excessive high voltage when there is none. Therefore, the shutdown circuit must be tested and repaired before the diode is resoldered and the receiver is given final tests.

Excessive high voltage can be caused by two general conditions: Excessive dc voltage is applied to the flyback winding that connects to the horizontal-output collector; there is insufficient retrace-tuning capacitance between the horizontal-output collector and emitter.

Many newer receivers have

A DMM with a diode-junction voltage-drop test should be used for in-circuit checks of diodes and transistors, such as these tests being conducted on JC Penney model PM.



Shutdown history

Over the years, the safety circuits in color TV receivers have become more effective; they have at the same time increased in complexity. More than 15 years ago, for example, the simple safety circuits only slightly reduced the excessive high voltage that resulted from loss of HV regulation. RCA CTC21 and CTC24 chassis televisions added a sample of negative voltage (produced by rectification of horizontal pulses by the blanker-tube grid) to the 6JE6 control grid.

If the 6BK4 high-voltage regulation was not operating to limit the flyback-pulse amplitudes (including blanker-grid and HV pulses), a larger negative voltage from the blanker grid was fed to the 6JE6 control grid, thus limiting the maximum 6JE6 plate current and reducing the high voltage somewhat. Although this simple circuit was ignored by many technicians, it reduced a possible 50kV HV reading to about 33kV when the 6BK4 regulator was not operating. An improved circuit in the RCA CTC38 rectified horizontal pulses with a diode and distributed the negative dc voltage via a varistor to the 6LQ6 control grid. Perhaps these safety circuits should have been called *hold-down* systems because they did not regulate the HV or stop all operation, but, rather, limited the HV to values that usually do not cause receiver damage by arcing.

The next generation of safety circuits monitored flyback-pulse amplitude (as equivalent to monitoring the high voltage) and, as long as an excessive pulse voltage was found, changed the horizontal-oscillator frequency so severely that hold-control adjustments could not restore the locking. The change of oscillator frequency was in the direction that reduced the high voltage somewhat, and the nuisance of out-of-lock stripes replacing the picture was supposed to force the customer to have the receiver repaired before any damage could occur.

Finally, there is the present generation of safety systems.

regulated dc voltage supplied to the horizontal-output collector; therefore, a common cause of excessive high voltage and shutdown is a failure in the low-voltage regulator. Leakage in a regulator transistor or SCR raises the output voltage above the norm. An erratic or improperly adjusted regulator control potentiometer also can increase the regulated supply voltage.

The next suspect is an open safety retrace-tuning capacitor (Figure 2). These special capacitors are rated at 1.2kV and are constructed to pass heavy pulse currents without excessive heating. *Do not use ordinary replacement types for this application.* Replace either with an original-type capacitor or an exact universal replacement. Some retrace-tuning capacitors are manufactured inside a ceramic wrapper and have a tendency to break at the ends, opening the capacitance and producing excessive high voltage.

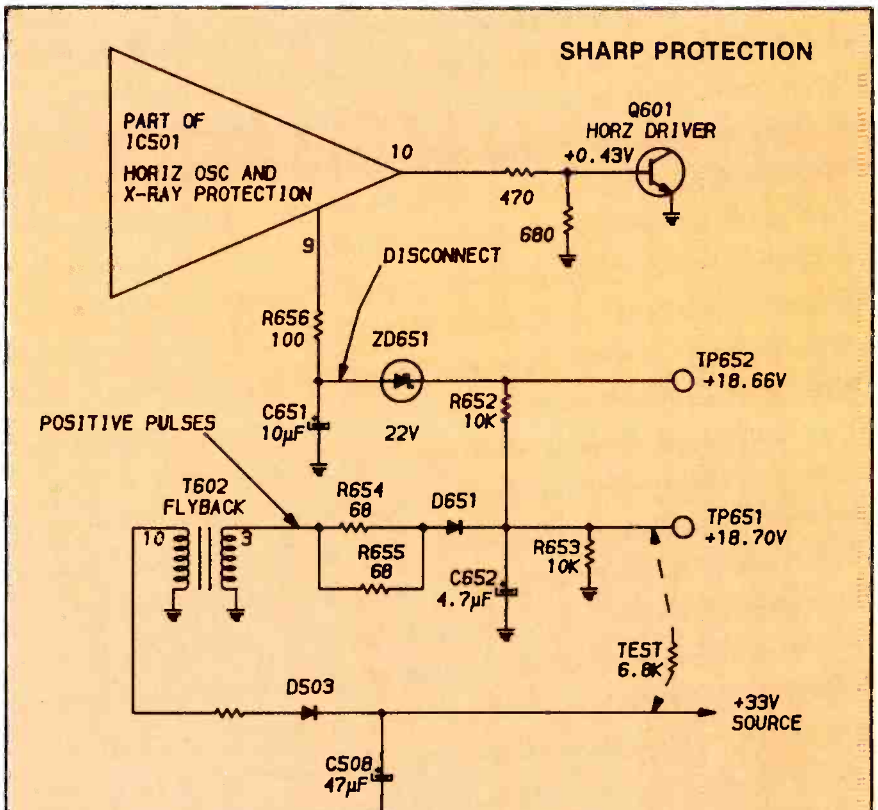


Figure 1.

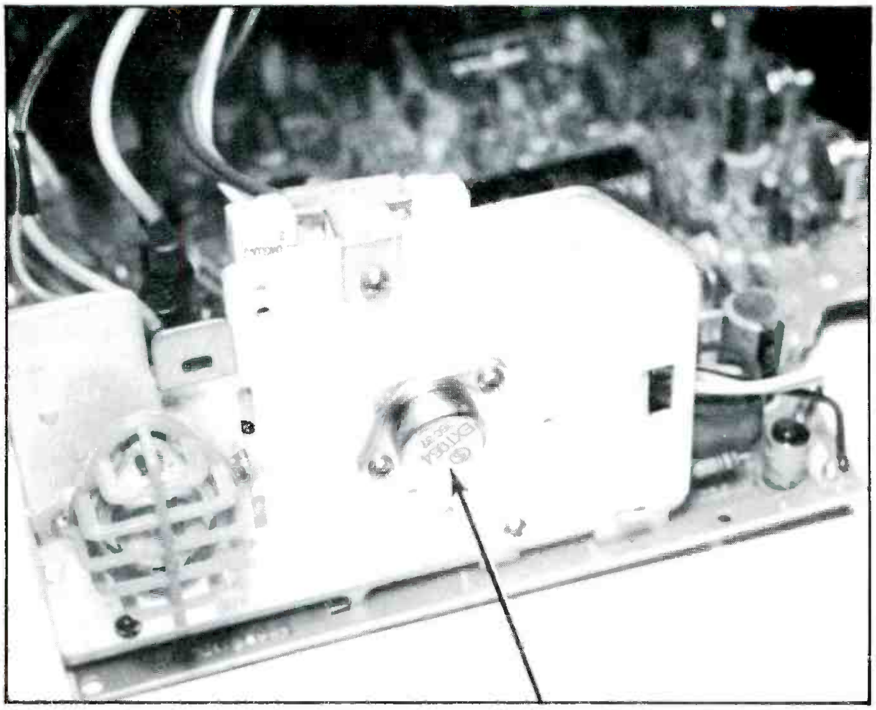
RCA with start-up then shutdown

With the HV probe in place, I applied 120Vac to the receiver, measuring +38kV for a few seconds as a whining noise could be heard from the flyback of this RCA with a CTC108A chassis. A careful visual inspection of the flyback showed several raised bubbles, perhaps from the heat of internal arcing. I replaced the flyback, which gave normal operation without shutdown.

A burst of sound and shutdown

With one RCA CTC97 chassis (Photofact 1931-2), the sound burst on immediately at power-on but then the sound disappeared

Figure 1. Excessive amplitude of pulses from the flyback of a 13F22 Sharp (Photofact 2045-2) triggers the safety circuit inside IC501, which then eliminates the horizontal oscillator output signal. Without a drive signal to the Q601 horizontal-driver transistor, the horizontal-sweep circuit cannot operate. To disconnect the safety circuit during short tests, unsolder the ZD651 anode lead. After all repairs and adjustments have been made, temporarily connect a 6.8k resistor between testpoint TP651 and the +33V source at the D503 cathode. Instantly, the receiver should become dead (in shutdown). Turn *off* the power for a minute, remove the 6.8k resistor, and then switch it *on* again. The receiver now should operate. Don't consider the test completed until the receiver's safety-circuit operation has been checked and found to be correct.



Collector-to-emitter leakage in the series-pass regulator transistor (on the heat sink at the right) increases the B+ at the horizontal-output transistor. This is a common cause of instant shutdown at turn-on.

and the chassis went instantly into shutdown. In an effort to determine whether or not excessive high voltage was responsible, I unsoldered the collector terminal of Q38 (Figure 3) from the circuit board. However, power-on was followed by a short burst of sound before shutdown again removed all sound, high voltage and raster, thus proving excessive high voltage was not the cause of the shutdowns.

Replacement of a leaky SCR101 regulator SCR and the Q101 horizontal-output transistor did not change the symptoms. I disconnected the receiver and felt Q101. Although the chassis power had been applied for only a few seconds, the horizontal-output transistor felt quite warm (photo, lower left). These symptoms pointed to a massive overload, such as a shorted T101 flyback. Installation of a new flyback restored normal operation. I resoldered the Q38 collector wire to reactivate the safety shutdown circuit.

In some cases, scope waveforms will indicate whether an overload exists around the flyback. Using a variable-voltage transformer for line voltage, begin at a low voltage, perhaps 75V or 80V and increase the voltage slowly and smoothly until shutdown occurs. If, for example, shutdown is triggered at 87V, begin again at a low voltage but stop at about 84Vac, before shutdown. Examine the base and collector waveforms of Q101, the horizontal-output transistor. If the base waveform is badly distorted, test the driver and oscillator stages. If the collector waveform shows typical high-amplitude positive pulses with nothing except the base line between, there is no overload. If the retrace pulses have reduced amplitude and one or two smaller distorted pulses are located midway between them, a severe overload is indicated. A yoke or flyback with shorted turns can give these symptoms. Another possibility is a shorted rectifier diode or filter capacitor in one of the voltage supplies produced by rectification of flyback signals. Check all these with an ohmmeter first, and replace any that are found to be defective. If none are found by resistance tests, disconnect one rectifier diode at a time and scope the Q101 collector waveform again, still using low ac voltage.

Out of horizontal lock

As shown in Figure 4 for the RCA CTC46A receiver, test first those components that are identified by arrows when the picture is out of horizontal lock and the hold control cannot lock it. Some borderline cases have a stable locked picture when the brightness is turned high, but the picture becomes diagonal stripes when the brightness is reduced. This is the same problem, but the condition is not so severe.

First, attempt to adjust the high voltage to the value specified in the service data. If a resistor value in the regulator has changed with age, but the specified HV can be obtained, the stripes should disappear. However, the aging component should be found and replaced before it changes again.

If the specified HV cannot be obtained by regulator adjustment

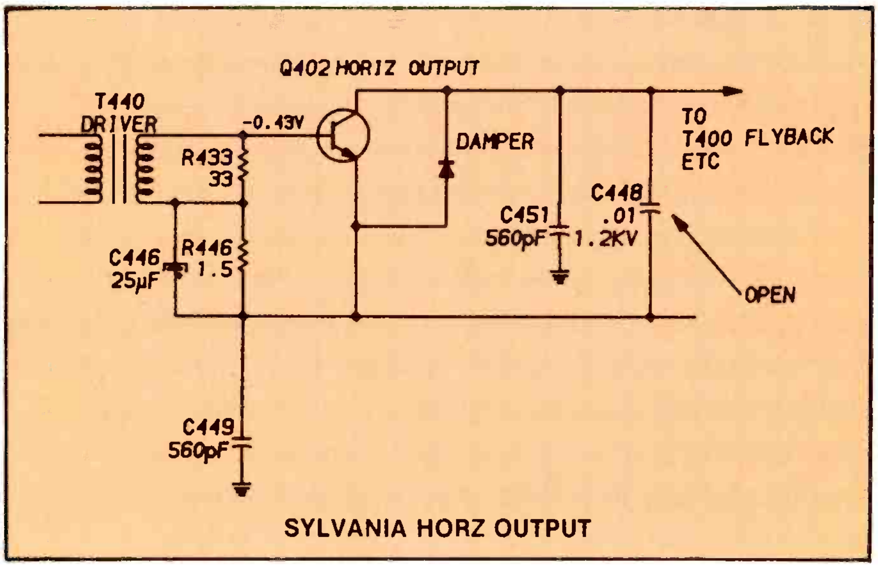


Figure 2. Retrace-tuning capacitors, such as C448 in Photofact 1836-1, play a large part in determining the level of high voltage. Remember, the Q402 output transistor conducts during part of the cycle, the damper diode conducts during another part, and the HV pulses are developed during the small remaining time of each horizontal cycle. It is during retrace time that the yoke/flyback circuit is not grounded by transistor or damper so resonant ringing can begin. In this ringing, as with all other ringing, a smaller capacitance value increases the peak amplitude while reducing the time of a cycle. In TV receivers, therefore, an open C448 will increase all flyback-pulse amplitudes, including those that are rectified to form the high voltage. Incidentally, these retrace-tuning capacitors must be capable of passing pulsed high currents and withstanding large voltages without failures. This E24-chassis Sylvania has a shutdown circuit with flyback-voltage and CRT-current sensors. Turning *off* the ac power for a minute resets the shutdown.

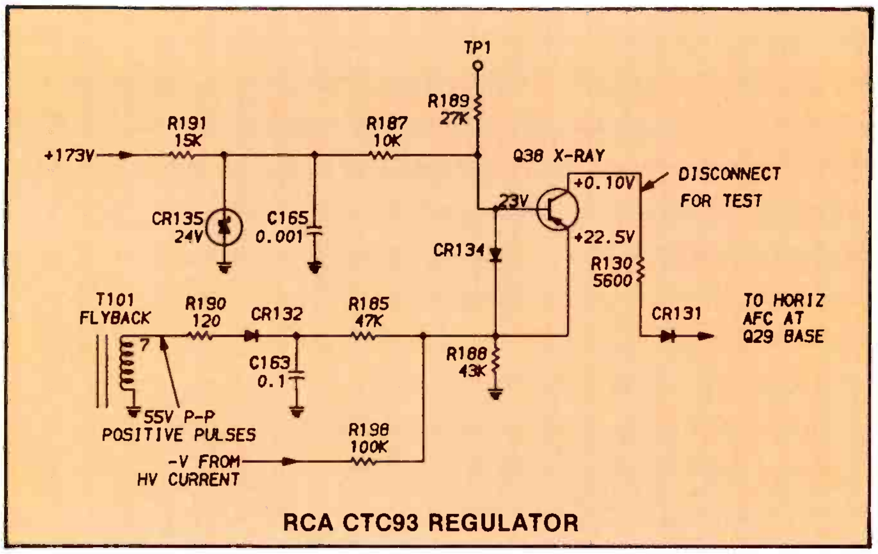


Figure 3. For testing the high voltage in an RCA CTC97 (Photofact 1931-2) without the shutdown circuit for a few seconds, you should unsolder the Q38 collector lead. After the test and any necessary repairs have been made, resolder the Q38 collector lead. Test the shutdown during normal operation by grounding test point TP1. The picture should become diagonal stripes that cannot be corrected by the horizontal-hold control. If the correct response is observed, remove the temporary TP1 ground and lock the picture. This chassis has flyback-voltage and CRT-current sensors for the shutdown circuit, which does not stop the receiver operations when activated but instead prevents horizontal locking so long as the excessive voltage or current condition exists.

and the HV measures too high (almost a certainty because the safety circuit has been triggered), check all components of the regulator circuit, particularly those with arrows.

Incidentally, this type of regulator is unique. Voltage drop across C10 from the horizontal yoke current is monitored as an indicator of high voltage. Increased HV causes Q1 to draw increased collector current that *decreases* the inductance of T2. And T2 is paralleled across T1, which is in the anode circuit of SCR102, the retrace SCR. Indirectly, the amount of high voltage is determined by the peak voltage at the SCR102 anode when SCR102 is triggered into conduction. Therefore, a decreased T1/T2 inductance causes the SCR102-anode signal to reach maximum more quickly and go to a lower voltage by the time SCR102 conducts. Reduced T2 current increases the T2/T1 total inductance, slowing the rise and fall of the SCR102 anode signal so it has a higher voltage when SCR102 begins conduction.

The circuit board has been prone to intermittent problems at the soldered pins of the larger transformers and other components. Check them carefully before spending an excessive amount of time in instrument tests.

Shutdown with tic-tic

No raster or sound came from the RCA CTC85. And only a slow *tic-tic-tic* noise could be heard coming from the flyback. Preliminary tests were made on the horizontal-oscillator, horizontal-driver and horizontal-output circuits, without any answers. Unfortunately, shutdown with tic-tic occurred after the ac power was reduced with a variable transformer.

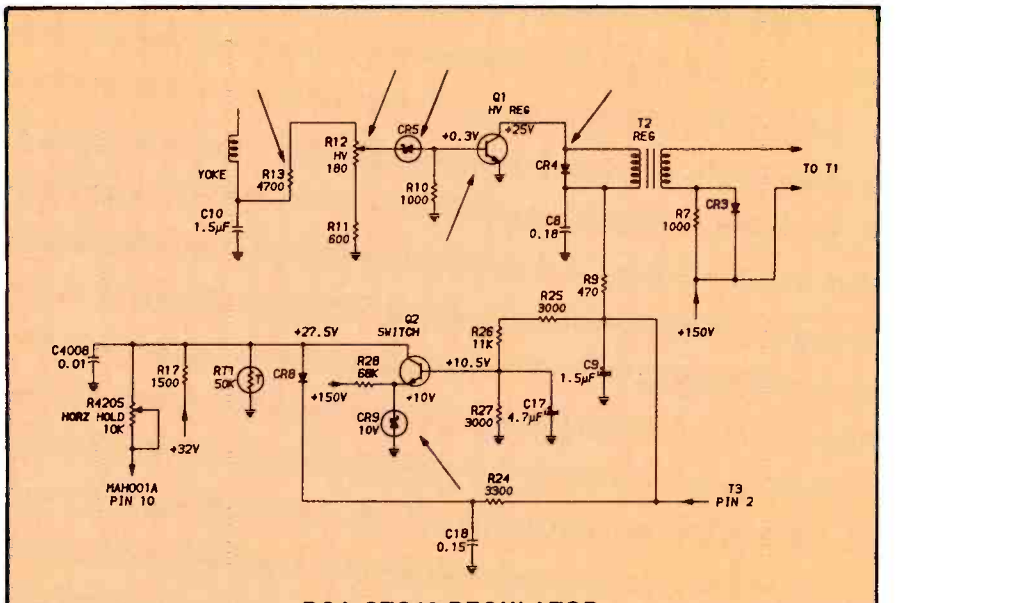
I disconnected various rectifiers connected to the flyback, one by one, but found no improvement. Finally, I removed the vertical module from the chassis and the horizontal/high-voltage system began to operate as it should. Replacing the vertical module with a new one solved the shutdown problem.

This symptom of an audible tic-tic-tic sound from the flyback windings usually means the horizontal-sweep section is normal, but the regulator has applied excessive dc voltage to the horizontal-output transistor, thus triggering shutdown. The tic-tic results from a vain attempt by the SCR-regulator circuit to regulate a supply voltage when the current is zero because of shutdown and when there are no horizontal pulses for synchronizing the regulator oscillator or for turning off the SCR conduction.

Shutdown after a few minutes

After an hour or so of operation, the RCA CTC93 chassis would go into shutdown. Usually this means that there is a defect in the horizontal-sweep circuit, because excessive high voltage would have caused instant shutdown.

A new horizontal-output transistor did not change the symptoms. We were considering replacement of the yoke, but decided to replace the SCR600 regulator SCR first. Surprisingly, the new SCR600 repaired the problem. Probably, the old SCR opened from internal heat after an hour of operation.



RCA CTC46 REGULATOR

Figure 4. Arrows point to the components most likely to produce excessive high voltage in RCA CTC46A chassis (Photofact 1278-3). Suspect R13, R12, CR5, CR4, Q1 and T2 if the high voltage cannot be adjusted. Or, check Q2 and CR9 if the HV can be adjusted correctly, but the horizontal hold cannot be locked. In this older model, excessive HV or a shutdown-circuit defect changes the horizontal frequency so much that the hold control cannot lock the picture.

Suspect shorted turns in the flyback transformer when the receiver shuts down quickly and the horizontal-output transistor case feels warm, indicating that it has been carrying excessive current. Often this indicates damage to the transistor as well. Once you have installed a new horizontal-output transistor, use a variable-voltage transformer to operate the receive at lower ac line voltage while you identify and correct the problems.

Intermittent shutdown

Intermittent shutdown at random times can occur from a defect either in the horizontal-sweep or in the shutdown circuit itself. Sometimes increasing or decreasing the line voltage during a time test will force such erratic problems to occur more often. Warming the chassis until the intermittent starts and then spraying suspected solid-state components with canned coolant often will identify which components are sensitive to heat changes. Watch for visible changes (such as a narrowing picture or a change of brightness) just prior to the intermittent action.

With this General Electric YME chassis, the screen had foldover in the center and narrow width on the right side just before shutdown. Replacement of the horizontal-driver transistor (center foldover usually indicates drive problems at the horizontal-output transistor base) gave no improvement. When the red/yellow yoke lead was disconnected from the flyback, the screen gradually showed shutdown.

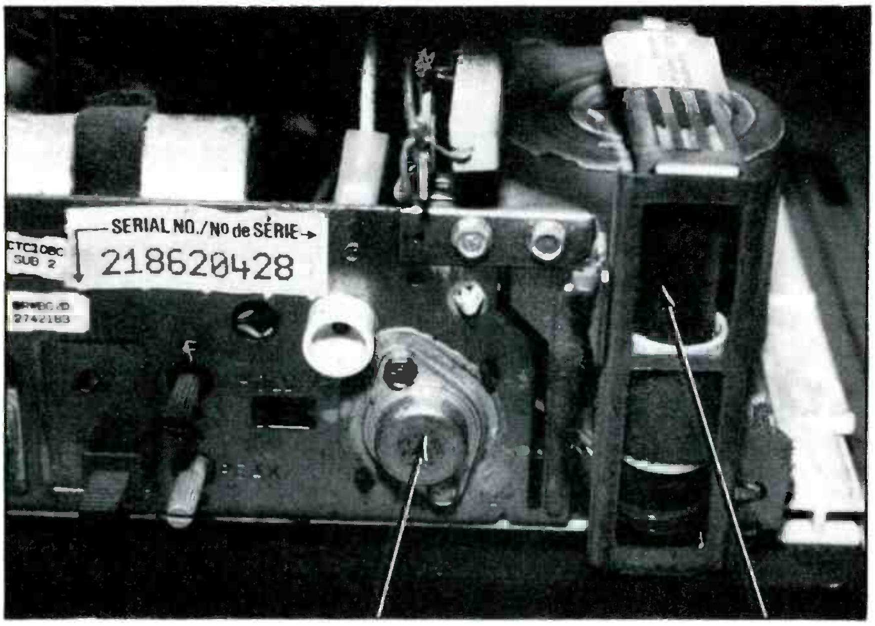
After the T710 output transformer (flyback) and the C702 retrace-tuning capacitor were replaced, normal operation returned permanently.

Arcing and shutdown

Flyback internal arcing with buzzing and sometimes smoke can trigger *current* shutdown. Often, the fuse is blown and the horizontal-output transistor is ruined by the overload. Most new-type flybacks have three or four HV diode rectifiers located inside. Defective diodes make flyback replacement necessary.

In one RCA CTC109A, the high voltage came up, the picture became visible and then the raster faded away as the sound of arcing

Continued on page 63



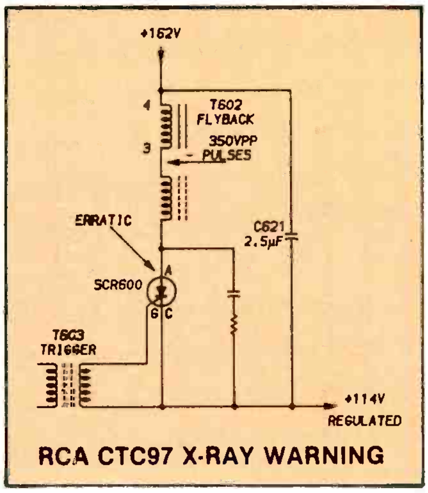


Figure 5. In one RCA CTC93 (Photofact 1810-2), the SCR600 SCR regulator apparently opened after the receiver temperature reached a certain critical level, causing shutdown of all functions. Two protective circuits are provided. One has sensors for flyback-voltage and CRT-current. It is tested by shorting together test points X1 and X2, which forces the horizontal out of lock (the same action that is caused by excessive voltage and/or current). The other circuit uses a single SCR that monitors the +27.5V supply through a 33V zener diode. When the SCR conducts, its anode shorts the horizontal-drive signal to ground. Of course, the SCR does not unlatch until the receiver is turned *off* for a time and then is switched *on* again. This demonstrates why schematics are necessary for servicing shutdown problems.

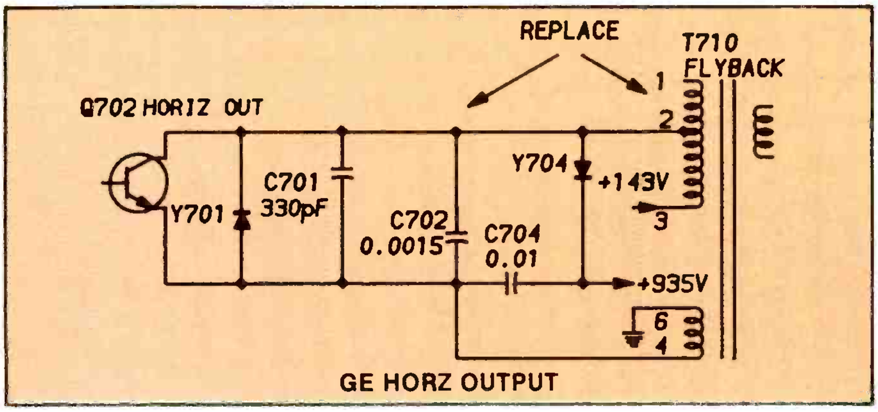
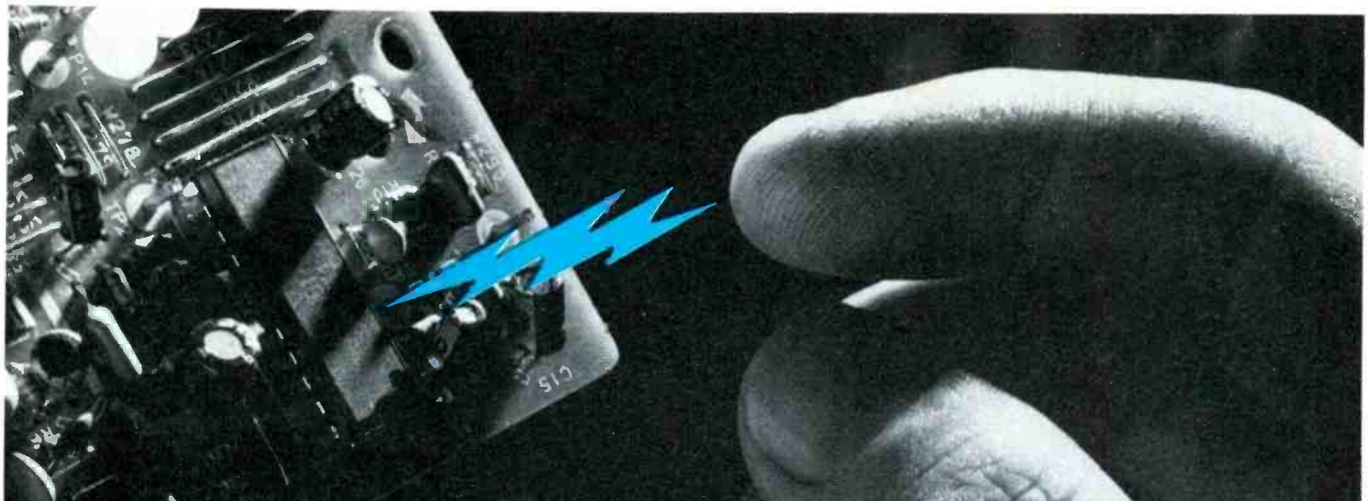


Figure 6. Replacement of the T710 flyback and the C702 retrace-tuning capacitor eliminated the problems of foldover in the center followed by loss of picture. This model uses a regulated power transformer, so it does not require a regulated power supply nor a start-up supply. Neither does it have a recognizable shutdown circuit.



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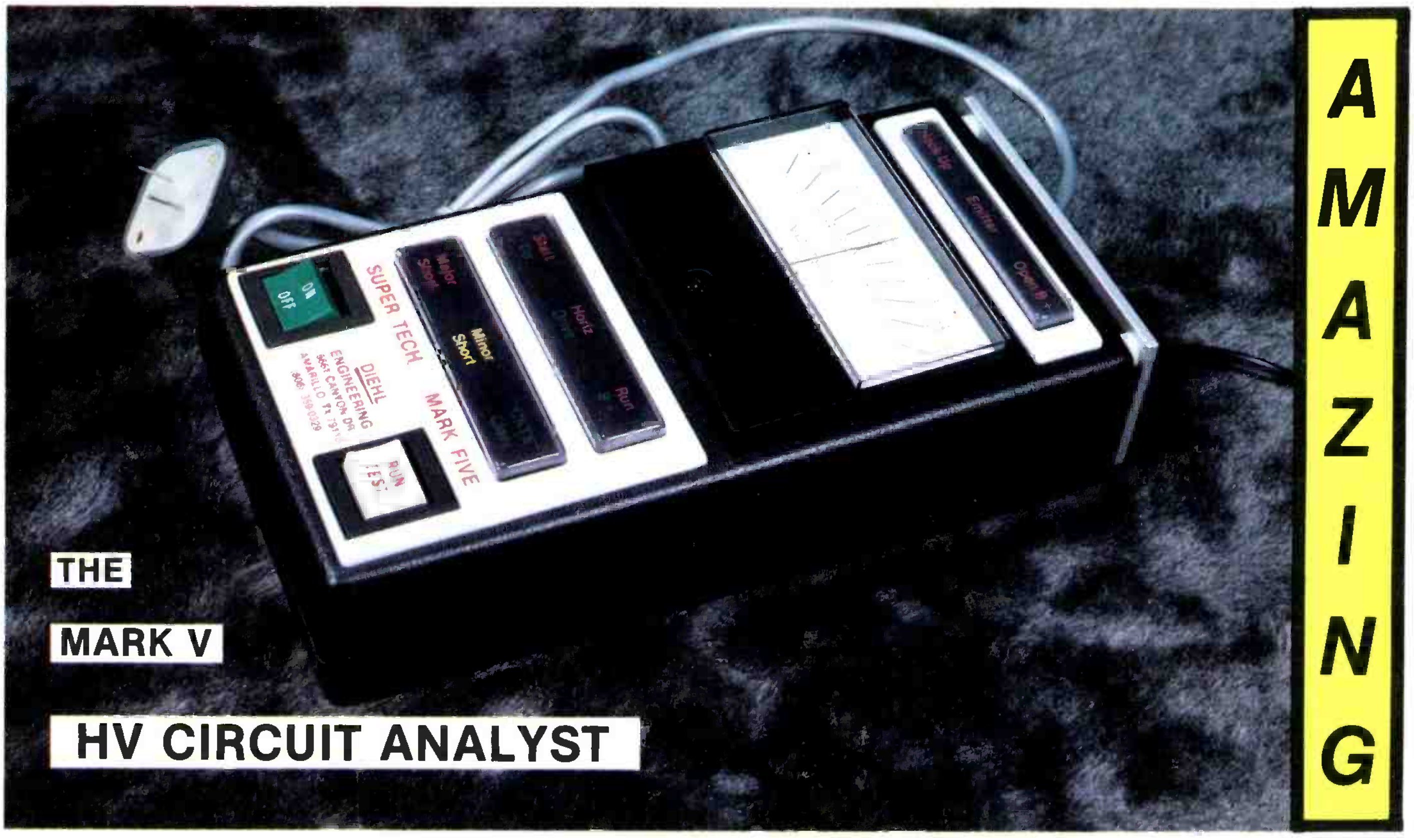

- ★ Checks the horiz output stage for opens / shorts,
- ★ Checks flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B + sources,
- ★ Checks for open safety capacitors
- ★ Checks for open ground path for horiz output stage
- ★ Checks for open primary LV supply,
- ★ Checks for error in interface connections,
- ★ Checks for proper LV regulation,
- ★ Checks for proper start up circuit operation,
- ★ Checks for shorted horiz driver transistor,
- ★ Checks the operation of the horiz osc / driver circuits,
- ★ Checks B + "run" supply for the horiz osc / driver circuits,
- ★ Checks all circuits in the TV set that rely on scan derived B +,
- ★ Automatically circumvents all start up circuits and horiz drive related shut down circuits.

HOOK UP: (Identical to Mark III)

OPERATION: Turn the Mark V on, turn the TV set on, then, simply look at the lights.

RED "HOOK UP" LIGHT means that you have made an error in hook up. No damage has been done, correct the problem then continue.

RED "EMITTER" LIGHT means that the ground path for horiz output stage is open. Correct the problem then continue.

RED "B + OPEN" LIGHT means that the primary LV supply in the TV set is open. Correct the problem then continue.

No "top row lights" equals normal.

Look at the middle row of lights

RED "START UP" LIGHT means that the start up circuit in the TV set is not working (no start up pulse).

GREEN "START UP" LIGHT means the start up circuit in the TV set is working normally. Yes, it is 100% accurate. Even on Zenith's single pulse start up circuit !

RED "HORIZ DRIVE" LIGHT with a green start up light means that the horiz driver transistor in the TV is shorted (E to C).

GREEN HORIZ DRIVE LIGHT means that the horiz oscillator and driver circuits are operational.

READ THE DC VOLTAGE METER THEN,

PUSH THE TEST BUTTON

If the meter comes up to, or, falls back to, factory specified DC collector voltage, the LV regulator circuit is working. If it fails to do so, it is not working!

RED "B + RUN" LIGHT means that the B + source that normally keeps the horiz osc / driver circuits running after the start up B + pulse has been consumed has become open.

GREEN "B + RUN" LIGHT means that the B + resupply voltage (scan derived) is being provided. All is normal if all three lights are now green.

The scan circuit short detector in the Mark V is identical in all ways to that which is used in the Mark III. Operation is also identical. Both units are virtually indestructable when simple directions are followed. Both units carry a full year's warranty against defects in materials and workmanship (parts and labor). Either unit can be easily repaired by almost any technician in his own shop.

If the green "circuits clear" light is now lit

It is now safe to push the "run" button and examine the symptoms that appear on the CRT screen, for the purpose of isolating any "open" circuits.

Except for hook up and CRT filament warm up time, this test can easily be completed in two to five seconds!

The Mark V sells for only $995[00]

Stop losing money on start up / shut down scan derived B + problems; order your Mark V today!

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Compiled by Warren G. Parker, Metairie, LA

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TROUBLESHOOTING TIPS

ES&T

News

EIA's 1985 edition of Replacement Parts Source Book

An updated, easy-to-use directory listing sources for replacement parts and technical service literature is now available through the Electronic Industries Association's Consumer Electronics Group (EIA/CEG).

Prepared by EIA/CEG's Product Services Committee, "The Consumer Electronics Replacement Parts Source Book" may be ordered by writing: EIA/Consumer Electronics Group, Product Services Department, 2001 Eye Street N.W., Washington, DC 20006. Enclose one dollar for postage and handling.

According to CEG Product Services Director Don Hatton, "Our committee has undertaken the task of preparing this publication in an effort to advise servicers, and interested consumers, on how and where replacement parts and technical service literature can be obtained, to help them service consumer electronics products."

UL desires input concerning proposed ANSI standards revision

Underwriters Laboratories Inc. (UL) is proposing the updated Standard for Safety for Low-Voltage Video Products without Cathode-Ray-Tube Displays, UL 1409, for recognition as an American National Standard.

UL 1409 covers video products intended for household or commercial use on supply circuits as defined in the National Electrical Code. The products receive their signals (1) off the air, (2) through a CATV/MATV cable system, (3) from a video-recorded medium, or (4) from image-producing units such as vidicons.

Such products include videotape recorders, video-receiving, -processing, -recording, -producing and -amplification equipment, TV cameras without cathode-ray-tube viewfinders, TV-antenna amplifiers, cable television (CATV) converters, picture-tube degaussers and similar video equipment operating at 2500V peak or less.

The scope also covers tape-head demagnetizers or bulk tape erasers intended for use with video products only and auxiliary equipment and accessories rated for use with low-voltage video products.

UL 1409 does not cover any product classed as a TV receiver, regardless of video-display type.

The proposed standard is a revised version of ANSI/UL 1409-1981, which is presently recognized as an American National Standard. UL is seeking review and comment from interested individuals and organizations to help develop a consensus.

Anyone interested should contact Mavis Whitehead at UL, 333 Pfingsten Road, Northbrook, IL 60062; 312-272-8800, ext. 2988, and request a free copy of UL 1409-NR. Those interested should request their copy immediately so that comments can be considered in time to meet the ANSI deadline of Dec. 21 for this standard. ES&T

Part 2

Introduction to microcomputer troubleshooting

Troubleshooting the basic personal computer system

Photo courtesy Apple Computer, Inc.

This is part two of a 3-part series

By Bud Izen, CET/CSM

In the first article in this series (**ES&T**, November 1985), the subject was hardware. When a computer system ceases to function properly, however, it is sometimes less than obvious what is causing the problem. More often than not, when a system fails, it is doing something useful at the time. Computers are only useful when they are doing *something useful*, such as running a statistical analysis, printing a word-processed letter or pitting the user against an onslaught of asteroids or antagonistic galactic beings. When the report stops displaying, the letter stops printing halfway through, or the galactic beings turn into a random display of gibberish, you know you have a problem.

Your first step is to find out as much as possible about what was happening when the system failed. Next, you must determine if it is a software or a hardware problem. Start by going through exactly what happened in terms of which program was running, if the printer was on, what you were trying to do, if you had ever done it before, and so forth.

Basic troubleshooting procedure

Once you have the computer set up, you should perform the following steps in order to isolate the problem. The order you perform these steps will vary, depending upon the exact symptom and upon your experience and knowledge of the machine in question.

- With the power cord removed from the computer, disconnect and/or remove all peripheral connections to the computer. Unplug and remove all peripheral cards from their slots.
- Connect the video output to your test monitor. Use of a monitor when possible is better than using a receiver, because the modulator is eliminated as a problem source.
- With just the monitor connected and turned on, turn on the computer. At this point, one of several items will happen. If the nature of the problem is related to a peripheral device, the computer should work properly, displaying a prompt indicator (cursor) on the screen. If not, the computer is likely to exhibit one of the following symptoms:

A.) Pilot light does not light, and

In several places in this article, the author mentions removing or otherwise dealing with interface cards on the computer. This applies to Apple and other computers that are constructed with expansion slots that may or may not have interface cards in them. In the case of Commodore and some other computers, there are no pluggable circuit cards.

There may be other differences in procedures between those given here and those applicable to a specific computer you may be working on. For that reason, apply these procedures and suggestions with care and caution.

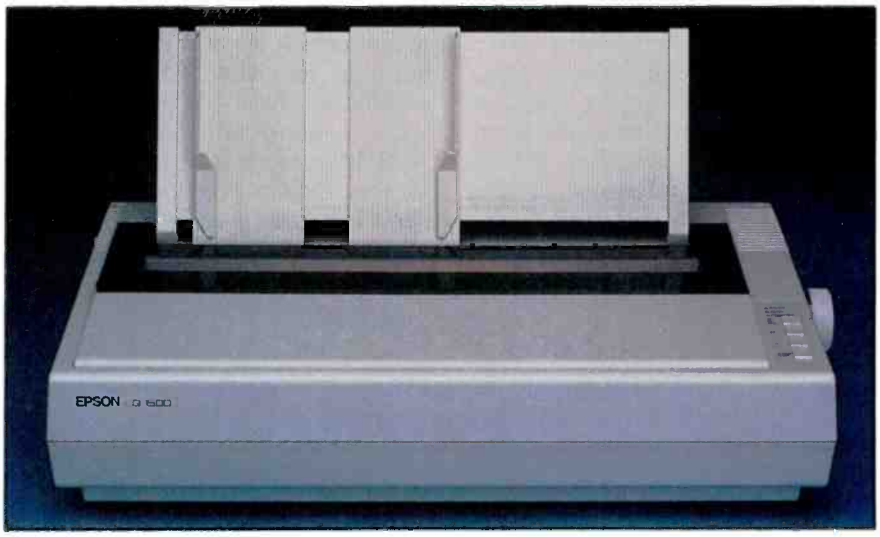


Photo courtesy Epson

Photo courtesy Apple Computer, Inc.

there is no display (completely dead).
B.) Pilot light lights, but there is no prompt on the screen.
C.) Computer displays nonsense.

Computer appears dead

If symptom A appears, there definitely is a power-suply related problem. Most computers use switching power supplies that generally are high reliability items. Therefore, you first might suspect more mundane sources of the problem, such as a defective *on/off* switch or an open power cord. In general, switching-power supplies are treated as black boxes, often factory sealed with rivets, which makes repair of such items difficult. If such a power supply is proved defective, get a new one.

Some of these power supplies have built-in shutdown circuits that turn the supply *off* if there is either an excessive load or an open circuit on one or more outputs. If the power supply makes a rapid *tick-tick-tick* noise, it is probable that the source of the problem is a load (either open or shorted), not the supply itself. The noise you hear is the power supply turning *on* and turning *off* in the absence of a proper load. If such is the case, you can still check the supply if you have a fast-responding meter (either digital or analog) or an oscilloscope. Switch *off* the power, disconnect the supply from the computer (they often plug in), turn the power back *on* and connect the leads of your meter or scope between the output of each supply and common (ground), one at a time. You should observe the supply swinging between its rated output (or slightly higher) and zero. If one or more of the supplies does not do this, it is defective.

Pilot light but no cursor

If symptom B appears, this is not likely to be a power supply problem. All computers need two basic requirements to function. The first is power, and the second is a master system clock. The requirement of the first is obvious. The second is needed in order to time all the events and cycles of the computer system. Also, most systems also require the presence of various other pulses, but because these can't be discussed without getting machine-specific, they won't be covered here.

In order to further localize symptom B, first measure the output of all the power supplies *on the board itself* to make sure they are all properly within tolerance. If they are, take your scope and find a convenient location to measure the system clock. Most micros run on a clock of less than 6MHz, so any wideband scope will do. (A scope with a legitimate bandwidth of 35MHz or more is ordinarily satisfactory for most computer troubleshooting tasks.)

Miscellaneous troubleshooting hints and suggestions

• *Connections can corrode.* If you are encountering intermittent symptoms relating to one or more peripheral devices, inspect the card edge connectors. First, turn off the computer and disconnect the power cord. Remove the case to gain access to the peripheral cards. Taking care to observe which cards are located in which slots, remove the cards one at a time. Unless the connectors look spotlessly clean and shiny, take a clean pencil eraser and rub the edge connectors on both sides of the board until they are all clean. Visually inspect the connectors in the slots themselves. If they also need cleaning (a good idea in any case), use a good sprayer to clean them thoroughly before reinserting the cards.

This same process of inspecting and cleaning connectors should extend to any leads that are used to interconnect various sections of multiboard computers.

• *Dust can be a culprit.* Computers that use conventional keyboards having switch contacts below the keys (as opposed to the newer, cheaper membrane keyboards) can collect dust that can cause intermittent or complete failure of one or more keys. The best way to fix this problem is to turn the unit off, remove the power cord, dismantle the unit, and remove the keyboard assembly from its housing. Then, using air from a compressor, the dust can be forcibly evicted from underneath and between the key switches. Save future expense and aggravation by purchasing, then using a dust cover.

• *Magnetism is destructive.* Although much has been written elsewhere about the adverse effects of magnetism, it is well worth mentioning again. Never leave floppy disks or cassettes containing valuable programs near any device containing a permanent magnet (like an external speaker) or an electromagnet (like a monitor, TV receiver or telephone ringer). Such stray magnetic fields can cause irreparable damage to the programs, in some cases causing total failure, while in other cases it will just cause the programs to do weird things.

Be sure to keep all the master copies of your (expensive) diagnostic disks in a safe place, and make two or three back-up copies of them. In a shop setting, it is all too easy to lay a magnetized screwdriver on top of an important piece of software!

• *Heat can be fatal to most microcomputers.* If an IC fails, it will usually short, rather than open. When it does, it may not draw enough power to affect the power supply adversely, but programs will not run correctly. *Do not use freeze spray* as a diagnostic procedure because the little particles can develop several thousand volts of static charge as they accelerate through the thin plastic nozzle, enough to destroy a MOS IC. Instead, gently touch each memory chip (taking care to ground yourself first with a wrist strap as per standard MOS safety procedures). If you feel any chip that is very hot to the touch or significantly warmer than its fellows, you have found the culprit. Keep checking; there may be more than one. Be sure to turn off all power and disconnect the power cord before changing the chip. Also be sure to replace it with *exactly* the same type of chip to ensure compatibility. Recommend installation of a fan. Such devices, available at low cost (about $22 and up), are worth the price in terms of lengthening the life of the equipment.

If the power supply and system clock are both all right, what comes next depends on what the specific machine is. If the machine has built-in diagnostics in ROM, then you can use those from the start of the process. (The Zenith Z-100 family is an excellent example of what can be done at the factory to make servicing easier. Its built-in ROM-level diagnostic routines can test every operation and every section of memory and ensure, upon successful completion, that the motherboard is completely sound.) If the machine does not have built-in diagnostics, you must then rely on the service information provided by the manufacturer. If the power supply and system clock are all right, the source of the problem will relate directly to the CPU.

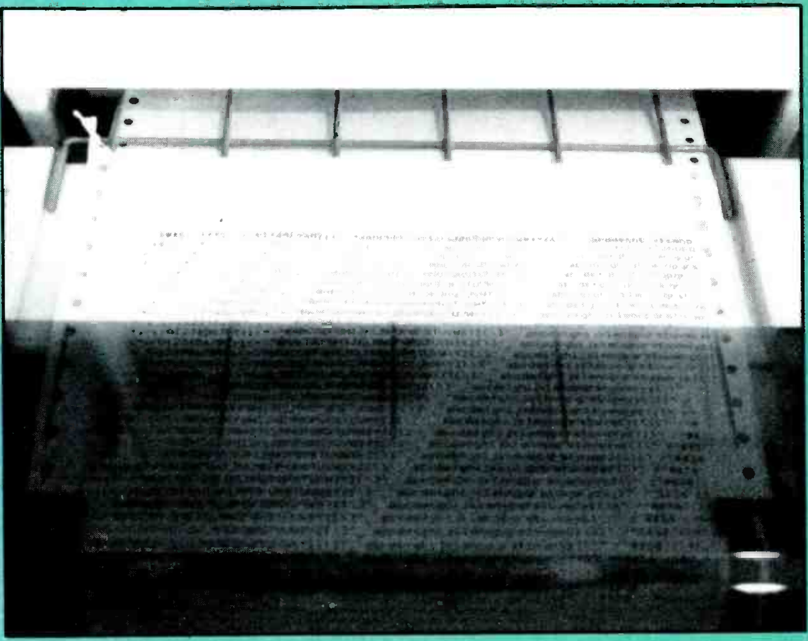
Again, it is important to remember that there always can be mundane solutions to the most awful and expensive-looking problems. If the ICs plug into the motherboard, one or more of them may have come slightly loose or have corroded connections. *Be sure to observe the safe handling procedures for MOS devices whenever you work with the CPU, ROM, RAM and other related ICs.*

Meaningless display

If you are troubleshooting symptom C, you must take care to be sure that this is not a symptom of normal operation. Some computers will display a screen full of meaningless information when you turn them *on* without certain peripherals attached. For example, certain (earlier) models of the Apple II will do this. If you observe this symptom, press the system reset button before doing any further troubleshooting. If the screen clears and the prompt appears, then all is well. If not, there is a problem that relates directly to the CPU. Again, to troubleshoot this symptom further requires access to the manufacturer's service data.

Once the problem has been remedied, you can proceed to the next step in troubleshooting.

• If you have reached this step, the problem is localized to a peripheral device or its interface. Because of space limitations, this



Most printers feature a test switch that prints a line or two of characters when pressed. This confirms that the printer itself is operating when the printer in a personal computer system won't print.
(Photo courtesy Mark Anthony Computers, Fairfield, CA)

article will discuss troubleshooting only disk drives and printers, which are the most common sources of problems.

Check out the disk drive

Disconnect all power. Connect the disk drive according to the operator's instructions. Note that many computers are designed for the first disk drive to be placed in a specific slot. The main exception to this is the S-100 bus system wherein the slots themselves have no meaning – the address of each peripheral device is hardware-selectable.

Place a piece of software, preferably a known-good one, into the disk drive. If you have a diagnostic disk designed for the machine, so much the better. *Under no circumstances should you use any software generated on the computer being serviced.* It may be the source of the problem. Also, you do not want to take a chance on damaging it due to certain types of system defects. Turn the system *on* and attempt to load the disk software. If the system will not load the software, turn it *off* and try at least two more disks that are known to be good. If all three fail to load, it is pretty clear that there is a problem with the disk drive and/or its controller. How to go about isolating the symptom further will be covered in a separate article, using the Apple II disk drive as an example.

If the system does load on disks that are known to be good, and seems to run properly, try it with the disk that was being used when the problem occurred. If it does not perform properly, you have located the source of the problem.

• It is now time to test the printer. There are many types of printer-related failures. This article will only deal with localizing the source of the problem. An entire article could be devoted to actual printer repair. But before you start working on the printer, you must make sure it is broken.

Trying to get a non-functioning printer to work is one of the most frustrating obstacles to a user. Here's why. The user buys a computer made by one manufacturer, buys a printer made by another manufacturer, buys an interface card from a third manufacturer and software from a fourth manufacturer. Then when the four items fail to work together, it is difficult to find any help, unless the user bought all four pieces from the same place. If the *same place* is a mail-order house, it may still be difficult for the user to obtain meaningful assistance. This does not always happen, but it happens often enough.

Suspect printer? Check software

First, check the software. Connect the printer and monitor to the computer and turn the system *on*. Press the system reset button. At this point, you should see the prompt on the screen, hear the printer motor, but nothing else should be happening.

Next, you need to enter the command that sends information directly from the keyboard to the printer. This takes the form of a direct BASIC command that you type in at the keyboard. You do *not* need to know how to program in order to do this. What you do need to do is to consult the appropriate user manual or command summary of the particular machine to find the correct command. This may be either a LINEPRINT, LPRINT, pr#S (where S is the number of the slot in which is located the printer interface card) or a similar command. After you find and type in the correct command, everything you enter at the keyboard will be sent directly to the printer; it is likely that one of three things will happen. If all is normal, then whatever you type at the keyboard should appear on the printer. If not, then either nothing will happen (in which case the system may hang up), or the printer may print gibberish.

What you have done is zero in on the software. If the printer did not work under software control but does work when commanded to do so directly from the keyboard (called hardware control), then the problem has to do with how the particular piece of software relates to the printer. Just about every worthwhile piece of software designed to be used with a printer contains some option whereby it is initialized to work with whatever printer and interface card is installed. It could be that this initialization program is not correctly set up. It needs to be reset.

To pinpoint printer problems

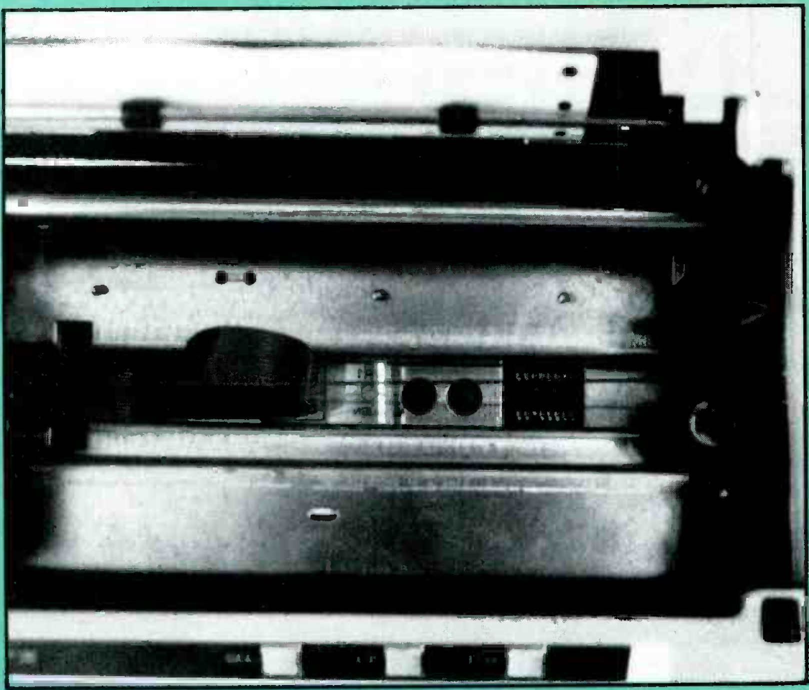
On the other hand, if it is clear that the computer is not communicating with the printer correctly, there are certain things you can do to localize the source of the problem. First, take the printer off-line by pressing the appropriate switch. If the printer already was off-line, you have probably discovered the heart of the problem, in which case, you can try to print out again. Once the printer is off-line, locate and press the test switch that most printers have. If the mechanism is all right, a line or two of characters will be printed. This shows the unit is capable of printing.

Next, turn off the computer and unplug the power cord. Unplug or otherwise disconnect and remove the printer interface card. Observe from which slot you took it. Make sure that if the system requires the printer interface to be located in a certain slot, that it is so located. If the interface is a serial RS-232 type, check the little DIP switches for baud rate. This is the rate at which the interface card sends information to the printer. You will need the owner's manual for the interface unit to interpret the switch settings.

Turn off the printer, and remove any access covers so that you can get to the DIP switches that set the printer's baud rate. Check with the printer user's manual to make sure that the baud rate is set correctly and that it is set to exactly the same setting as the interface card. If the printer is printing gibberish, it is likely that one or the other baud rates has been inadvertently changed in the setup process or during a move or perhaps even when installing an adjoining peripheral card inside the computer.

Interface may be ineffective

If the printer never worked with the computer, it is possible that its RS-232 lines are wired incorrectly. This is likely to be the case if the system hung up and the printer refused to print anything, when the user was running a program. Some printers and interface units use different lines for *handshaking* (when the printer needs to let the interface know it is busy or has a full buffer and cannot accept more data). If the interface is looking for the handshake signal on a different line than the printer is sending, or if the handshake signal is of a different polarity than expected, the interface card will be



Most printers have DIP switches (shown here at center right of the photo) that select the baud rate at which the printer will receive from the computer.

(Photo courtesy Mark Anthony Computers)

confused into thinking that the printer is permanently busy. The only way to check this out is to physically inspect the wiring and measure it for continuity if it appears normal.

Often an extensive amount of time must be spent in checking these connections. Sometimes the only thing *standard* about the RS-232 connections between some printers and interface devices is the fact that they both have the standard 25 pin *D* connectors attached. If all else seems to be failing, get out both user manuals for printer and interface, and check each wire for correctness. Then, when all seems well, turn on the system and check the voltage levels for correct amplitude and polarity. Sometimes this time-consuming method is the only way to get the system on-line.

In order to check the interface card, it is likely that test routines can be obtained from the manufacturer of the interface card, if not given in the user's manual. California Computer Systems, as an example, includes quite a thorough explanation in the user manual of how to diagnose its interface boards, along with instructions on how to make a test adapter. In a matter of minutes, you can determine whether the board is working properly.

Centronics-type parallel interface devices can be checked in essentially the same manner as above. The main difference is that the data is sent in parallel, and that there is no baud rate adjustment.

Check user-adjustable settings

In either case, it is important that all user-adjustable settings on the printer be set compatibly with the instructions accompanying the interface device. This includes line and form feed hardware switches, on-line/off-line switch, parity (even, odd, none) switch and so forth. To make sure these various settings are correct, it is necessary to obtain the user's manuals for both the printer and the interface unit.

Once you have found that the interface card is in the correct slot, that both baud rate switches are set to the same value and to one which the printer can accept, that all the wires are correct and are carrying the right signal with the correct polarity, and that all the printer front panel controls are set correctly, you have done essentially all you can to ensure that it is not a setup problem. What remains for you to do is check that the actual information is reaching the printer.

Retest with known-good program

Set up a program that you know works with other printers. Word processing programs are especially useful for this test. Follow the instructions for the program to set it up for the particular interface device and printer you are working on. Load in a test file and set the program so that it will send the information to the printer. Monitor the data-input line to the printer with a scope, so that you can readily see the amplitude and polarity of the signal. Compare this with what the printer needs to receive. As data is being sent, measure the voltage on the handshake line(s) to make certain that it is present and of the correct polarity. If all is well here, the printer is at fault and must be repaired. Refer to the manufacturer's service manual for the exact troubleshooting procedure required.

If you have followed the above procedures, your scope reading should confirm that the correct signals are reaching the printer and that the handshake lines are working properly. If not, it could be that the computer is not sending the interface card any information. Again, if you have done everything indicated so far, this would seem to be the fault of the software itself, as you should have already checked out the interface card. To be doubly sure, scope the input line(s) to the interface card as the program indicates that it is supposedly sending information to the printer. By performing these tests, you should have pinpointed the source of the problem. ES&T

What do you know about electronics?

Surface-mount components

By Sam Wilson

There is no doubt that the circuit boards of the future will have surface-mounted components. They are usually called *chips* or chip-mounted components. There are many advantages to this method of fabrication, but there are also a few disadvantages. Figure 1 compares the surface-mounted component with one that is mounted with its leads through the board.

Good news and bad news

Let's start with the disadvantages first. The boards will be harder to work with. One reason is that they are smaller. In one example, a circuit board was reduced more than 50% in size by converting it from a through-the-board construction to surface mount.

The smaller boards are the result of much smaller components. A resistor, for example, is only 3.2 millimeters long. Even the familiar dual in-line plastic IC packages (DIPs) are smaller.

Another reason the boards will be harder to work with is that components will be mounted on both sides of the board. You may be tracing signals from one side to the other. Because the components are much smaller, and closer together, you will have to be careful not to short circuit neighboring component connections accidentally.

The floor space required for making surface-mounted components is much smaller, which gives manufacturers the incentive to go into this type of board fabrication. For that reason alone, you can be sure of seeing these boards in all of the future equipment design.

Add to that the lower cost of *making* the boards if you are looking for reasons that you will be working with them in the future.

The components won't look the same as you can see in the example of Figure 1. The leads will be flat against the board instead of protruding through holes in the boards. You've already seen examples of this in dedicated microprocessors. To get one of them free from the board, you have to unsolder the leads one at a time and bend them away from the solder connection.

With a twist of the wrist

During the manufacturing process, the components are mounted on the board with a tiny glob of epoxy. After you have unsoldered the leads on the surface-mounted components, you have to *twist* the component off the board because of that epoxy. The epoxy is formulated to shatter when it is twisted. *Do not try to lift the component straight up off the board. Twist it off. If you try to lift it, then you can damage the board.*

Mounting the components closer to the board means less inductance and distributed capacity, so there will be better performance. There also will be smaller soldering irons. RCA recommends a 40W iron with temperature controlled at 500° to 600°F.

Get a well-made set of tweezers. When you are removing a resistor from a board, hold it with the tweezers, move the iron back and forth between the connections until both are melted at the same time. Then, *twist* the component off the board.

Figure 2 shows a handy soldering tip for removing these com-

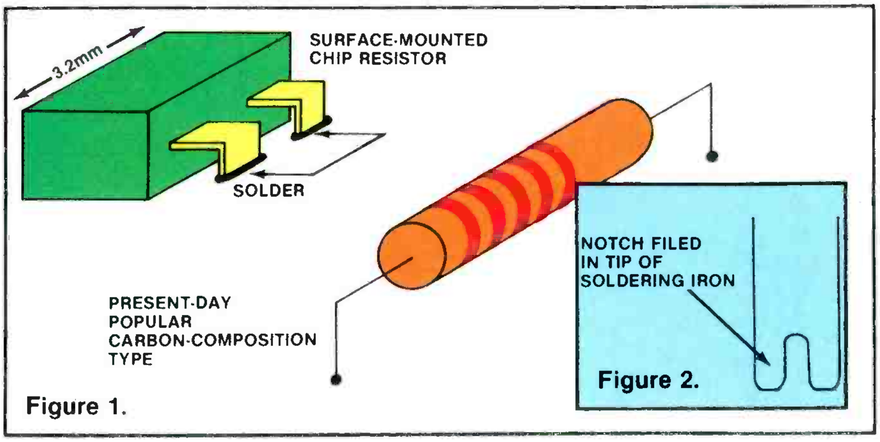


Figure 1.

Figure 2.

Many thanks to RCA for providing most of the material on surface mounting.

What do you know about electronics?

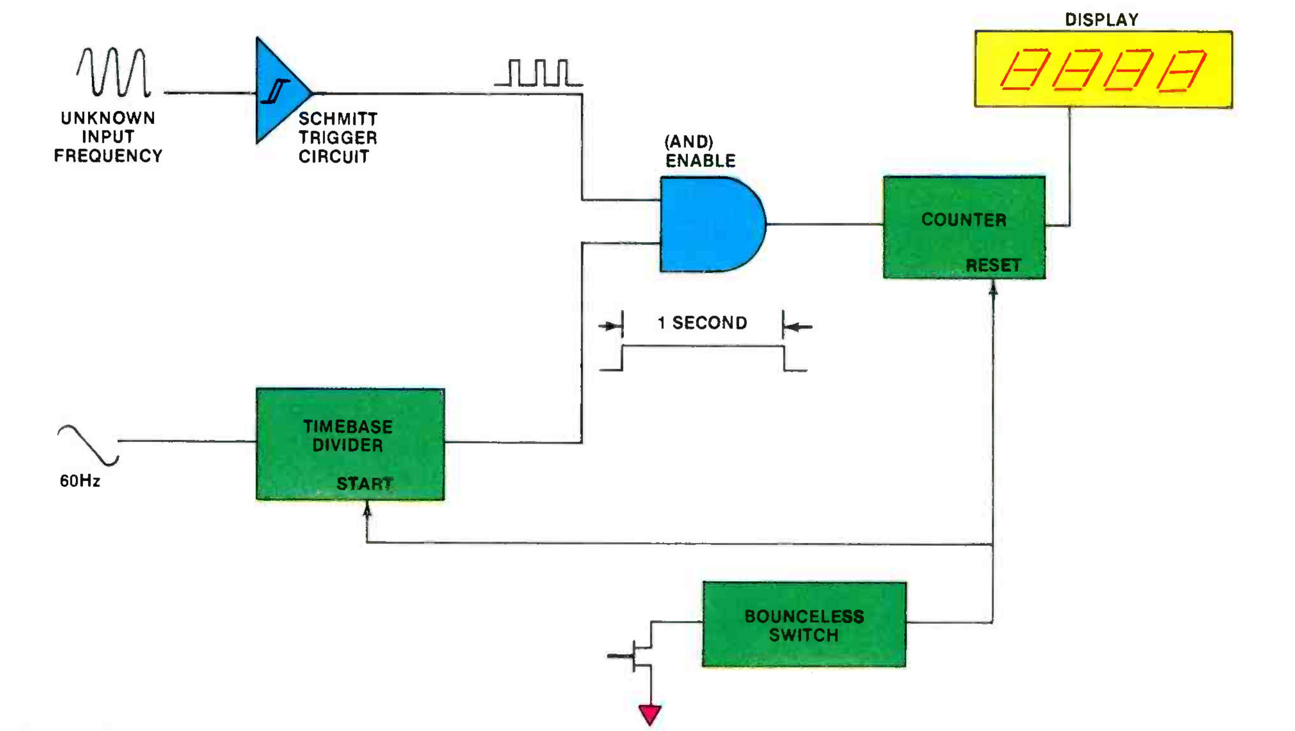


Figure 3.

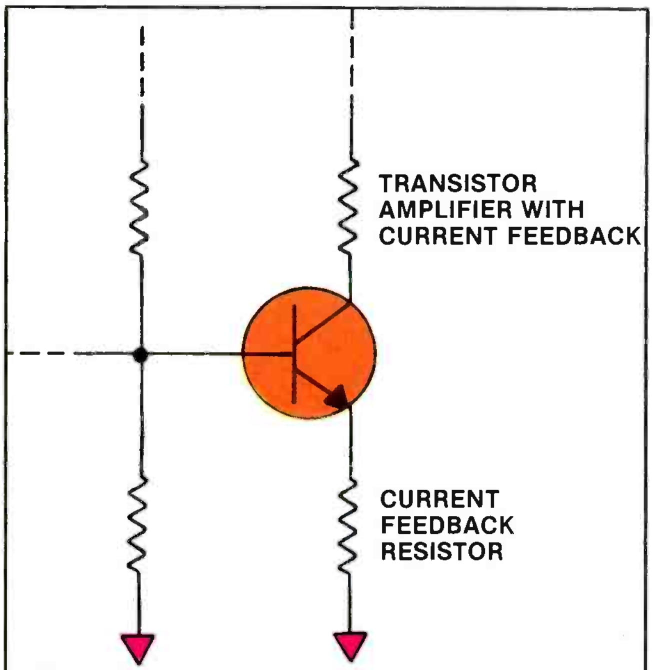


Figure 4A.

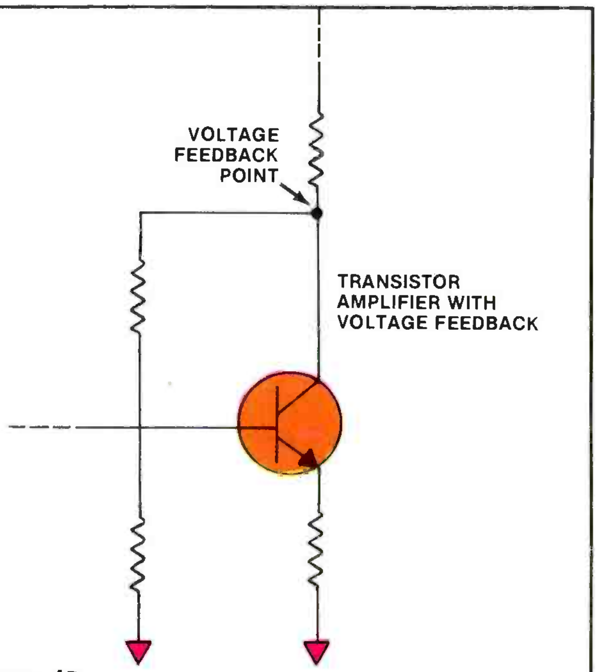


Figure 4B.

ponents. Most of the chip's components are 3.2 millimeters in length; you're talking about a *tiny* tip. No doubt, by the time you read this, there will be tips available from soldering iron manufacturers.

If you are removing a chip resistor or capacitor, *don't try to save it!* It has surely been damaged by the removal procedure.

The resistive and capacitive values of the chip components depend upon the material on their surface. *Don't wipe, rub or scrape the new one before you install it.* To do so can change its value. Use those tweezers.

The epoxy was used as a manufacturing procedure. You don't need to use it when replacing a component.

Obviously, you will want to inspect the new (replacement) component before you solder it into place. Any scratches, chips or other signs of mishandling can mean the component value has been changed. Don't take a chance, throw it away.

Identification codes

Chip resistors have a 3-number identification that you read like the color code. Read the first two numbers as the first two digits of the resistance value. The third number tells the number of zeros to add.

Examples: 332 would mean 3,300Ω and, 223 would be 22K. For capacity values below 100pF, the value is printed in the body. For values over 100pF, there is a letter/number code. The letters represent the first two digits and the number is the multiplier.

A different code uses the chip color to identify the range of the capacity value, and a letter printed on the chip tells the specific value.

They can't squeeze the identification number of a transistor onto the new small package, so they use a letter to tell the type of transistor and a number to indicate its grade.

You may need a good magnifying glass. I like the large ones that are mounted on lamps.

A useful project

Audio-signal generators with an analog-frequency selector are difficult to tune for a specific output frequency. A few years ago, I assigned lab students the job of making a digital readout for an audio generator. This would permit the generator to be used for a specific frequency – say 1,000Hz with an accurate frequency adjustment. Figure 3 shows a block diagram of the circuit as it appeared on the assignment sheet. Whether or not you decide to design and build the circuit, it serves as a good way of looking at a frequency counter.

The input signal with the unknown frequency is delivered to the Schmitt trigger. (This is the signal generator output.) The Schmitt trigger circuit converts the unknown (signal generator) frequency into pulses that can operate the frequency counter. These pulses are delivered to the enable circuit. The unknown frequency pulses cannot pass through the enable until the other lead is made positive. The time base divider provides an exact 1-second output pulse when it receives an input from the bounceless switch.

It is the trailing edge of the pulse from the bounceless switch that starts the 1-second pulse from the time base divider. That 1-second pulse holds the enable open for the unknown pulses to pass through. So, the number of pulses that get through is the number of *cycles-per-second* (Hz) of the unknown frequency.

The bounceless switch resets the counter at the instant the 1-second pulse opens the enable. The counter then counts the number of cycles for the second. This number is displayed.

The count is displayed every time the reset button is released after it has been pushed.

Comparison of negative current and negative voltage feedback

Positive feedback was used in early bipolar transistor circuits for RF and IF amplification. The junction capacity in the early transistors made it difficult to get any appreciable gain without the help of regenerative feedback. Positive feedback isn't needed for most of today's transistor circuit designs.

Negative feedback is used in low-frequency amplifiers to broaden the frequency response. It is accomplished in two ways: *current feedback* and *voltage feedback.* Figure 4 shows the two types of circuits. Although they accomplish the same result in terms of frequency response, there are slightly different characteristics for the two circuits. They are listed here.

Characteristics of current feedback

- Slightly reduced current gain (Ai),
- Slight reduction of voltage gain,
- *Increased* input and output impedance.

Characteristics of voltage feedback

- Reduction of voltage gain, but less reduction than for current feedback,
- Slight current gain reduction, but the current gain is less dependent upon circuit parameters,
- *Decreased* input and output impedance.

Comput

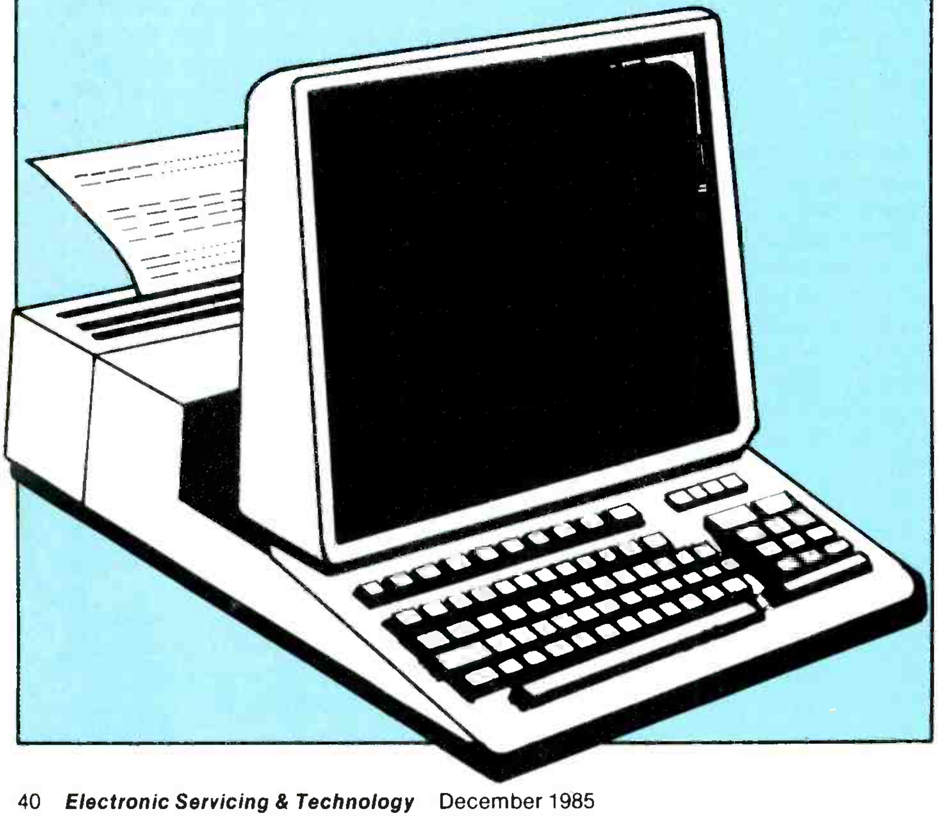
Editor's Note:

The personal computer has proved to be a versatile tool in the office and in the home. Because it's such a general-purpose device, and because it's designed to use a television as its primary display medium, the personal computer is a natural for producing on-screen patterns for performing diagnoses, or for convergence and other adjustments.

The computer won't replace other pattern-generating test equipment in the busy shop, but for occasional use where the purchase of dedicated signal generators doesn't make economic sense, it's a helpful tool.

The TI99/4A and the Timex Sinclair 1000 and ZX81 are not the most popular of personal computers, but the point of publishing this article is not necessarily to give specific program listings to produce specific patterns on specific computers. It is, rather, intended to make readers aware of the potential for use of a personal computer to generate signals. These principles can be adapted to any personal computer.

*And for those of you out there who are saying to yourselves, "Sure, another article on computers!" please be assured that **ES&T** is in no danger of becoming "another computer magazine." The computer is, however, a piece of home electronics equipment that occasionally needs servicing. And it is a general-purpose device capable of generating signals that are useful in diagnosing other items of home electronics equipment. For these reasons, it warrants a share of attention in **ES&T**.*



By Victor Meeldijk

A video test-pattern generator is a useful piece of electronic equipment to have in servicing video equipment. Someone whose use of one of these devices is limited might not, however, want to invest in this specialized piece of test gear. A home computer can be used to generate various displays including bar, dot, cross hair and color bars. This article shows you how to develop computer programs to generate test patterns using the (TI) Texas Instruments 99/4A and Timex Sinclair 1000, or ZX81 (TS).

Color bars

Because the Texas Instruments 99/4A (TI) computer can display 13 colors, as well as black, white and transparent, color bar displays can be generated including a pseudo NTSC (National Television Standards Committee) broadcast color pattern. This pattern also is commonly known as the Standard Electronic Industries Association (EIA) standard test pattern. The NTSC color bar pattern discussed here is a pseudo one, because there is no wideband orange-cyan *I*, inphase signal or the narrowband magenta-green *Q*, quadrature signal. Figure 1 shows the pseudo NTSC pattern with the top 75% colors of gray, light yellow, cyan, medium green, magenta, dark red and light blue. The lower 25% colors are dark green, white, dark blue and two black sections.

To assign the various colors on the TI computer, *CALL COLOR* statements are used. For example, the statement CALL COLOR (1, 12, 12) has assigned the character set number 1 a foreground and background color of light yellow (12). Set number 1 refers to ASCII

er-generated test patterns

character codes 32 to 39. These standard characters are:

32	(space)
33	! exclamation point
34	" quote
35	# number or pound sign
36	$ dollar
37	% percent
38	& ampersand
39	' apostrophe

In the CALL COLOR statement above, because both the foreground and backgrounds are specified to be light yellow, a yellow character square will be displayed if any character from 32 to 39 is called out. To display the light yellow character square either a *CALL VCHAR* (vertical character) or a *CALL HCHAR* (horizontal character) statement is used. For example, the statement CALL VCHAR (1, 1, 35, 18) will result in yellow squares, on the screen, starting at row 1, in column 1, going vertically downward to row 18. The last number, 18, is the number of times, in the vertical direction, that the yellow square is repeated. Figure 2 is the row and column layout of the video screen.

You could use a separate CALL VCHAR statement for every vertical line you wish to display on the screen but this is not necessary. If the following statements are used, columns 1 through 10 will be yellow.

```
10  A = 1
20  FOR I = 1 TO 10
30  CALL VCHAR (1, A,
     35, 18)
40  A = A + 1
50  NEXT I
```

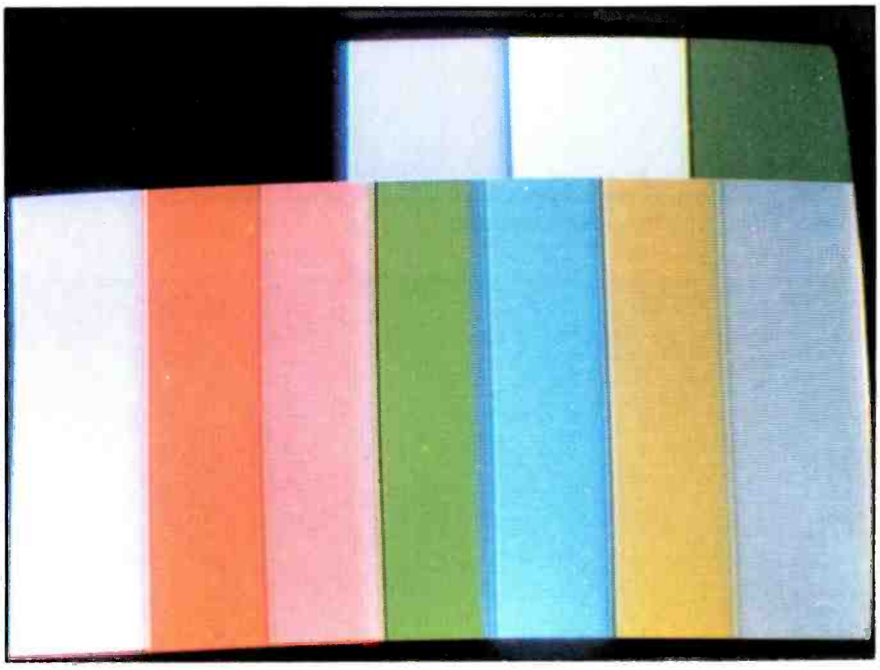


Figure 1. Pseudo NTSC broadcast pattern

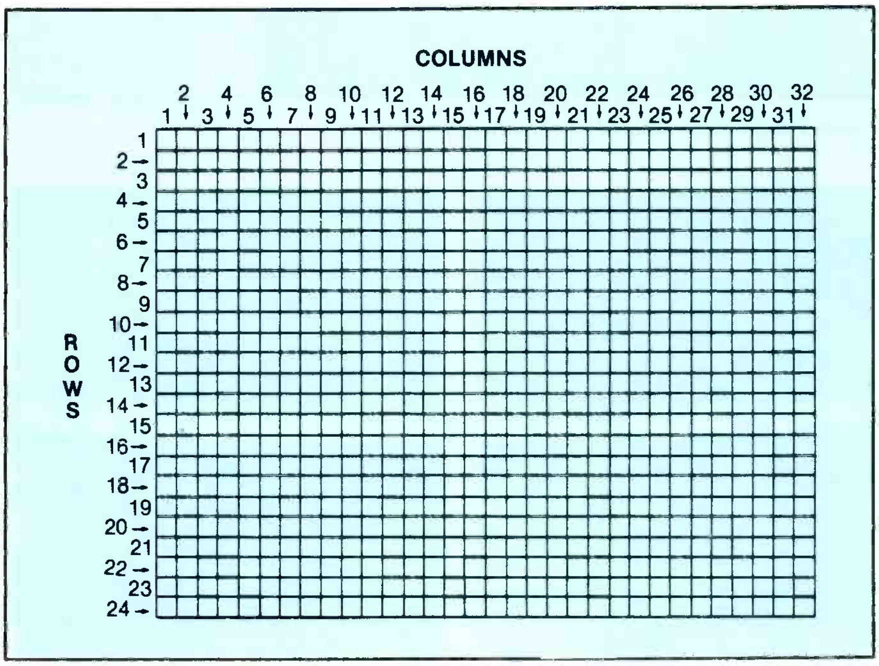


Figure 2. Row and column layout of the TI 99/4A video screen

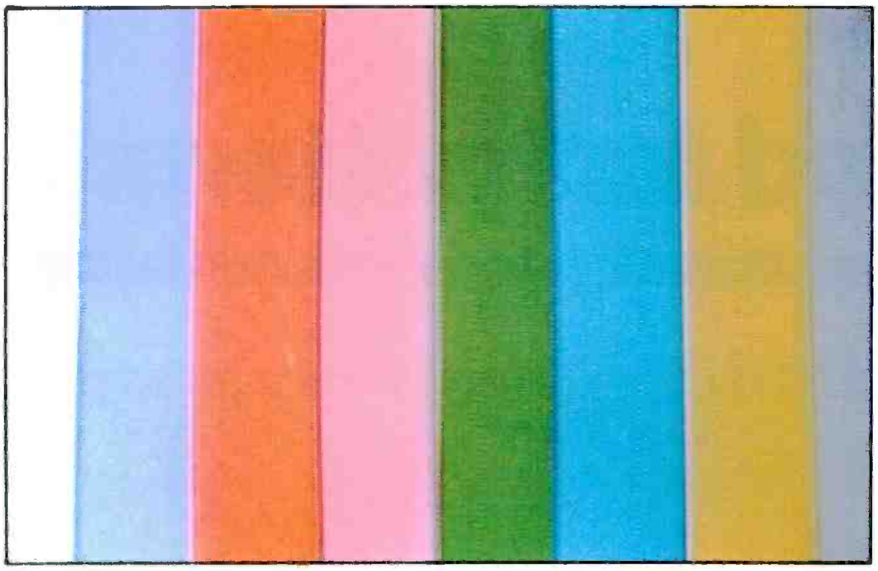


Figure 3. Eight-color bar pattern display

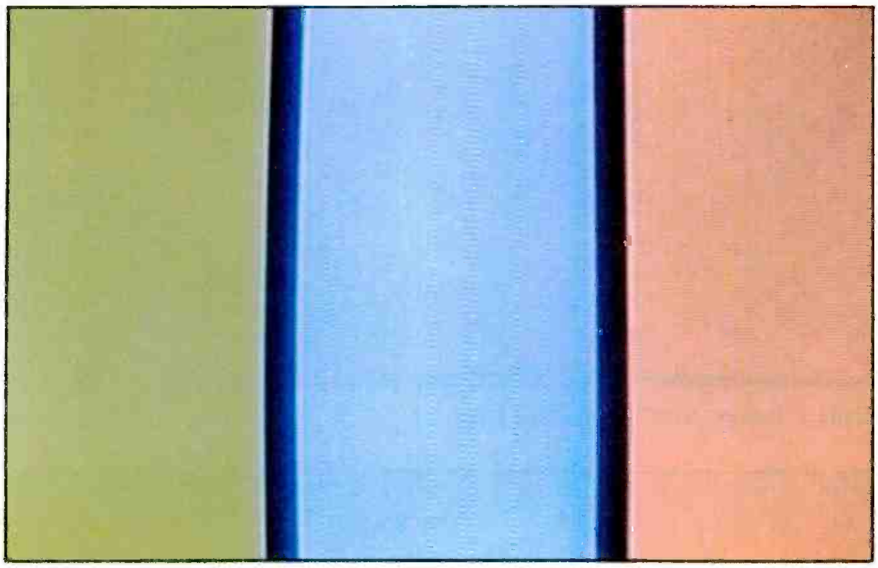


Figure 4. Dark red, dark blue and dark green display

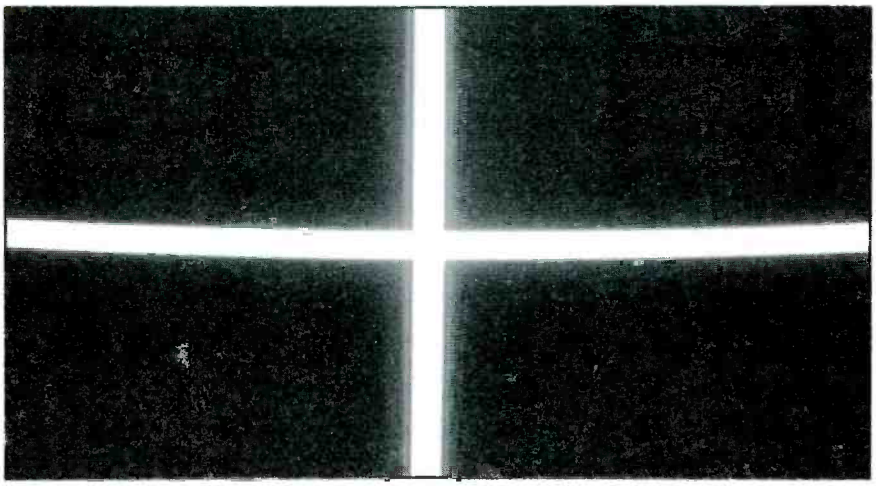


Figure 5. TI center cross display

Figure 3 shows an 8-color bar pattern, consisting of gray, light yellow, cyan, medium green, magenta, medium red, light blue and white sections. The colors gray, yellow, cyan, green, magenta, red and blue are in order of descending luminance. Figure 4 is a 3-color pattern of dark red, dark blue and dark green colors.

These test patterns are used for subjective receiver evaluation and to check the chroma demodulators when a vectorscope is used. The vectorscope would be used to adjust the colors within FCC compliance. The user should be aware that adjustments based on these test patterns alone may result in a picture with some colors appearing excessively bright and dazzling. It is left to the viewer to adjust the set for the proper combination of color (hue), lightness (for example, light or dark values) and saturation (for example, chroma, which categorizes vivid vs. dull colors).

Center dot, center cross or cross hairs

These displays are used to center video signals on the screen. For the TI display, a white indicator on a black background can be displayed easily while for the TS computer, a black indicator on a white background is easier to generate.

Referencing Figure 2, to display properly a center dot or cross on the TI computer, rows 12 and 13 and columns 13 and 14 are used. The center cross, as shown in Figure 5, is therefore made up of four types of special character squares. The squares have either a white left, right, top or bottom section. For the vertical line, the two characters are:

```
CALL CHAR
(98,"OFOFOFOFOFOFOFOF")
CALL CHAR
(99,"FOFOFOFOFOFOFOFO")
```

Character 98 now is a special character with a white right half, for use in a CALL VCHAR (1, 16, 98, 24) statement, which prints one-half of the white vertical line in column 16. Character 99 is the other half of the vertical line, placed in column 17 using CALL VCHAR(1, 17, 99, 24). The horizontal line is done in a similar manner using special characters 96 and 97:

```
CALL CHAR
(96,"OOOOOOOOFFFFFFFF")
CALL CHAR
(97,"FFFFFFFFOOOOOOOO")
```

If you run the program using a black background, for example, CALL SCREEN (2), there will be a gap where the horizontal and vertical lines intersect. This gap can be filled using four more specially defined characters:

```
CALL CHAR
(100,"OFOFOFOFFFFFFFFF")
CALL CHAR
(101,"FOFOFOFOFFFFFFFF")
CALL CHAR
(102,"FFFFFFFFOFOFOFOF")
CALL CHAR
(103,"FFFFFFFFFOFOFOFO")
```

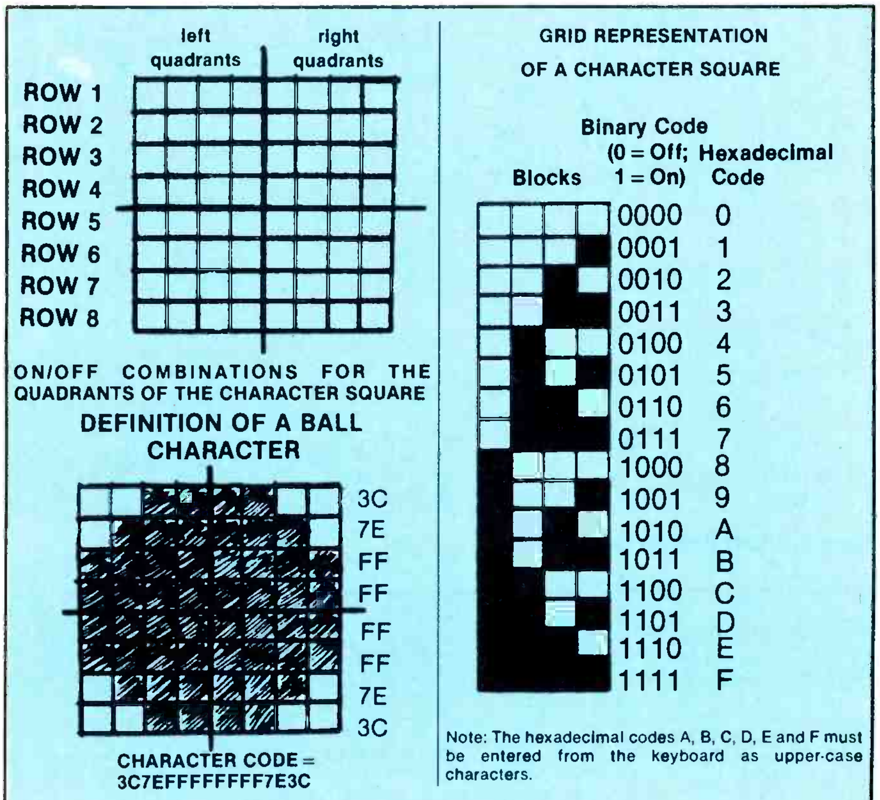


Figure 6. Special character generation

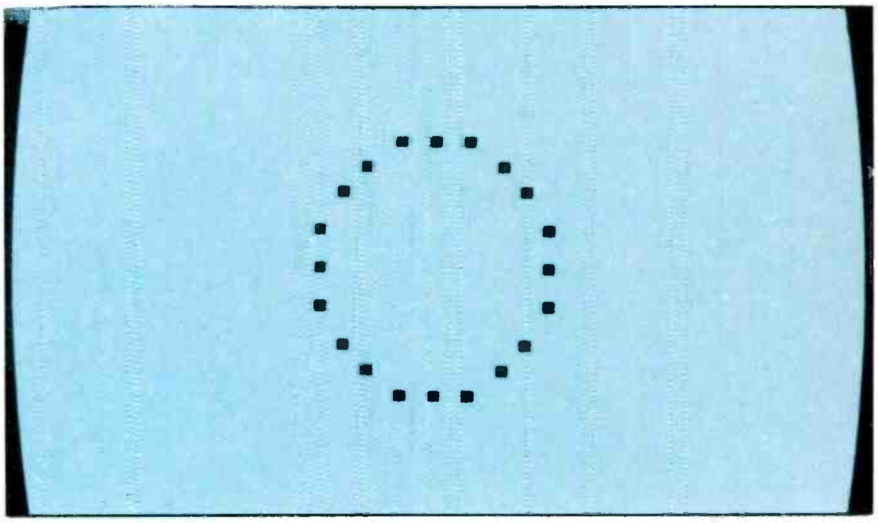


Figure 7. Timex Sinclair circle

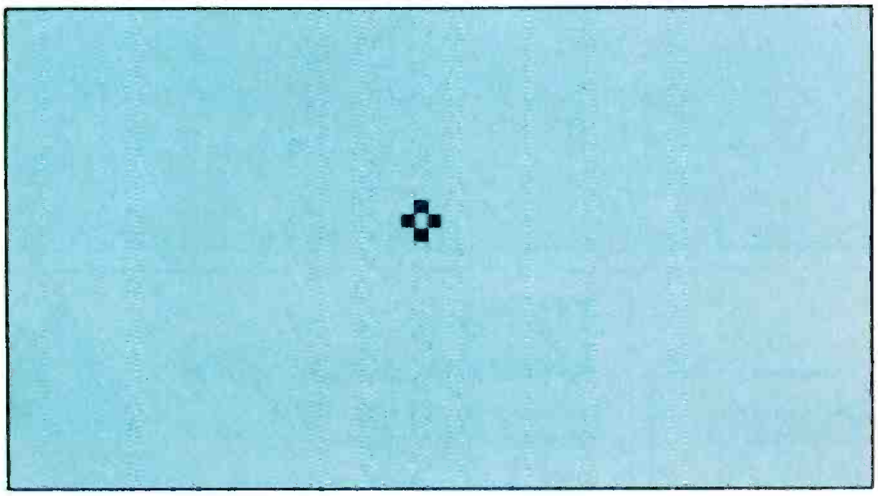


Figure 8. Timex Sinclair center cross

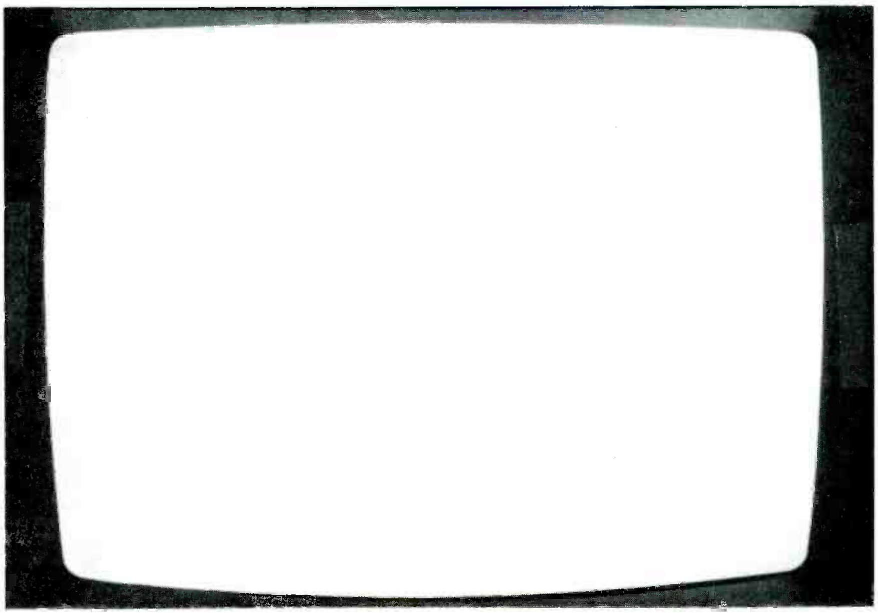


Figure 9. White screen

Figure 6 shows the 4-quadrant grid representation of a character square on the TI computer. To create a new character, specify which blocks within the character square are *on* (filled in) or *off* (left blank). The table in Figure 6 contains all the possible *on/off* combinations for the quadrants of the character square. The associated hexadecimal code numbers and letters are used to develop the code that specifies the new character. The new character code is the string of numbers or letters starting with the left quadrant, row 1, then the right quadrant, row 1, followed by the left quadrant, row 2, until the right quadrant, row 8 is reached. A ball pattern is shown in Figure 6.

To create a center cross on the TS computer is easier because a *PLOT* statement can be used. The following statements result in a circle appearing on the screen (Figure 7):

```
10 FOR I = 0 TO 2
* PI STEP PI/2

20 PLOT 27 + 1
* COSI, 18 + 1 * SINI

30 NEXT I
```

If the program is modified so the circle collapses, a center cross is created (Figure 8). The statements for the center cross become:

```
10 FOR I = 0 TO 2
*PI STEP PI/10

20 PLOT 27 + 10
*COSI, 18 + 10 * SINI

30 NEXT I
```

Although the values shown above are optimum, screen placement may vary for each TS computer. Positioning of the center cross can be accomplished by increasing or decreasing the 27 value to move the cross right or left. The 18 value can be modified for up/down positioning.

White/red screens

The white screen, Figure 9, is

used to adjust the color circuits to produce a white screen on a color television. It also is used to check the display for hot spots. The white screen represents a maximum load and this uniform display permits the detection of undesired brightness or modulation in the picture.

The red screen, Figure 10, for the TI computer only, is used in adjusting color purity. If the screen shows other colors around the edges, the set should be degaussed, or the color purity magnets adjusted.

Screen color on the TI computer is set by the CALL SCREEN (X) statement. X is a number corresponding to the color screen desired. For a white screen X = 16, for a dark screen X = 7. Because the screen is normally white for the TS computer, a simple *GO TO* statement such as 100 GO TO 100 will keep the screen blank until a *BREAK* command is entered.

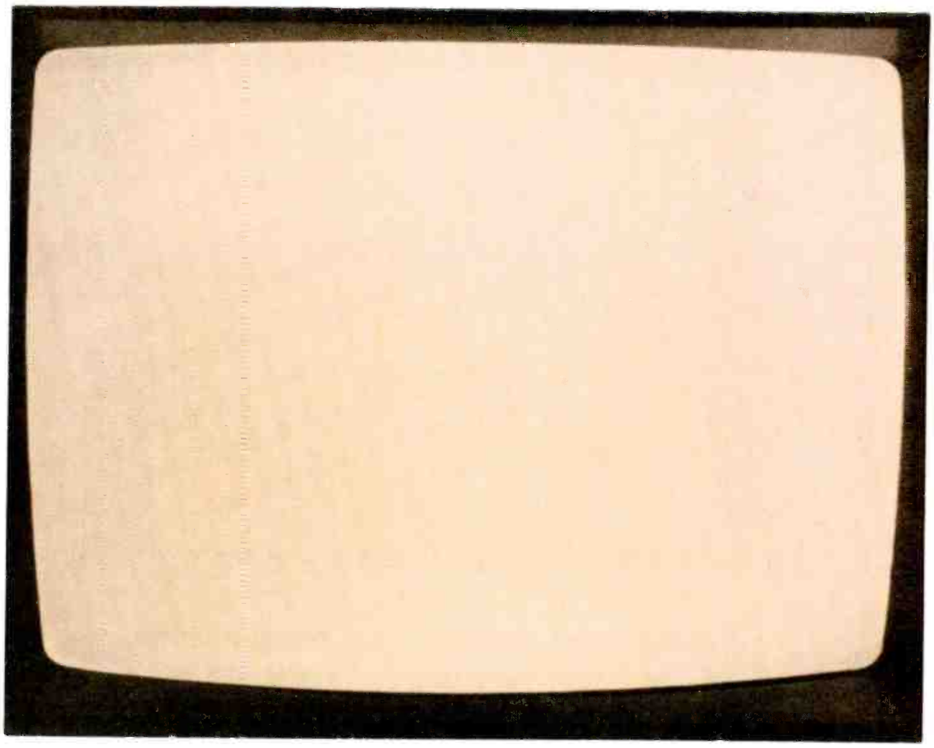
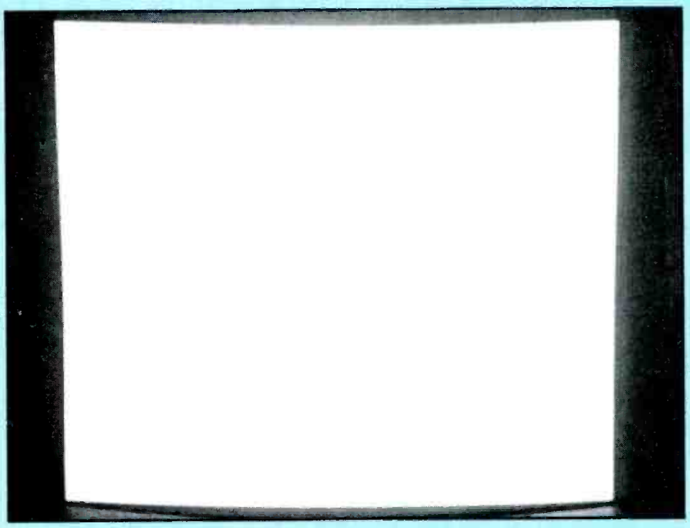


Figure 10. Red screen



T1 white square

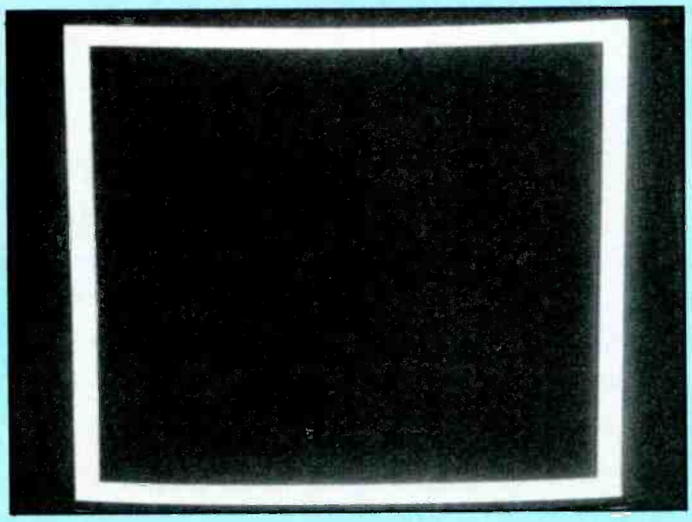


Figure 11. TI square outline

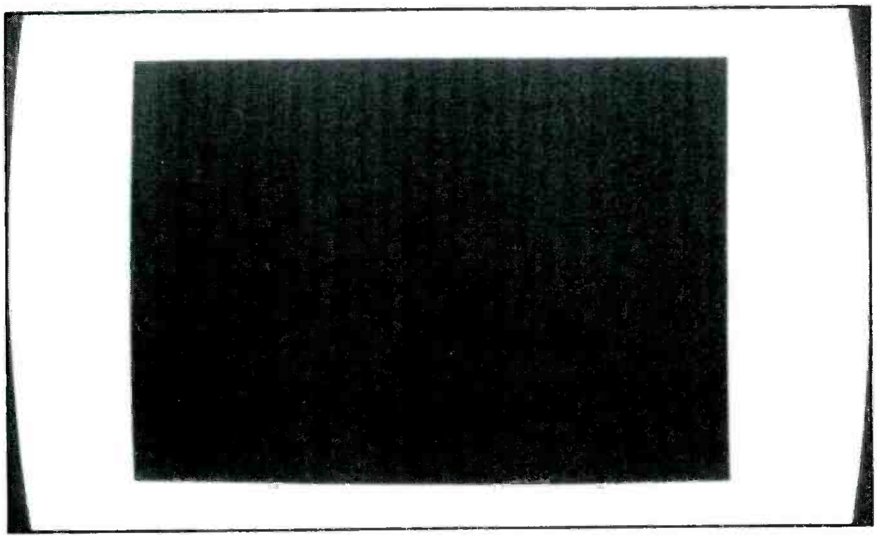


Figure 12. Timex Sinclair black square

White/black square

The TI white square, Figure 11, top, is formed by HCHAR and *FOR-NEXT* statements, for example:

```
20030  X = 1
20040  FOR I = 1 TO 24
20050  CALL HCHAR
       (X, 5, 42, 24)
20060  X + X + 1
20070  NEXT I
```

Using separate VCHAR and HCHAR statements, similar to those already discussed in the section on cross hairs, can create a large square outline, such as the one shown in Figure 11, lower.

A black square on the TS computer, Figure 12, is created using a graphics character string A$ and FOR-NEXT statements. As an example:

```
   100  LET  A$="XXXXXX-
XXXXXXXXXXXXXXXXXXX"
   200  FOR I = 1 TO 17
   300  PRINT A$
   400  NEXT I
```

where X is the graphics symbol ■. Use either *PRINT* or FOR-NEXT statements at the beginning of the program for vertical centering and spaces between the " and the first graphics symbol in line 100 for horizontal centering.

These *window* patterns are low duty-cycle tests that provide an evaluation of low-frequency response and allow for analysis of system transient response by examination of the square's horizontal edges. If the background appears gray at the edges, the dc coupling or dc restoration between the video amplifier and the picture tube is not functioning in correct fashion. Gradual changes in picture shading, after an abrupt scene change, is indicative of low-frequency distortions.

Lines/grid patterns/dots

The accepted method of checking scan linearity and geometry is a grid pattern of horizontal and vertical lines. Equidistant spacing between the lines indicates proper scanning.

A 4x3 grid display can be produced on the TI computer using the VCHAR and HCHAR statements. For proper screen centering, as done for the cross hair display, the vertical lines are defined as half lines:

```
CALL CHAR
(98,"OFOFOFOFOFOFOFOF")
CALL CHAR
(99,"FOFOFOFOFOFOFOFO")
```

The left and right halves of the vertical lines are displayed in columns 2/3, 9/10, 16/17, 23/24 and 30/31 (column 2, for example, has special character 98 and column 3 has special character 99).

Horizontal lines are generated using a HCHAR statement such as CALL HCHAR (X, 3, 42, 28). The X variable is used so a FOR-NEXT loop with an X = X + & statement can generate multiple horizontal lines. By using the FOR-NEXT loops, the grid pattern program can be written as:

```
10  Y = 2
20  FOR I = 1 TO 5
30  Z = Y + 1
40  CALL VCHAR
    (2, Y, 98, 22)
50  CALL VCHAR
    (2, Z, 99, 22)
60  Y = Y + 7
70  NEXT I
80  X = 2
90  FOR I = 1 TO 4
100 CALL HCHAR
    (X, 3, 42, 28)
110 X = X + 7
120 NEXT I
```

Figure 13 shows the grid pattern.

Horizontal or vertical line patterns, such as the ones shown in Figures 14 and 15, can be made using the same CALL HCHAR, CALL VCHAR and FOR-NEXT loops employed in the grid pattern program.

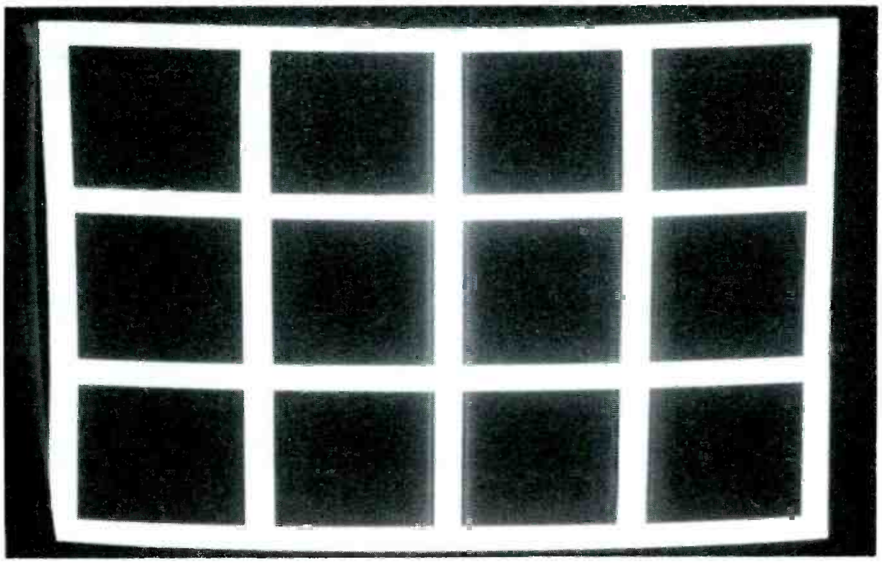


Figure 13. TI 4x3 grid pattern

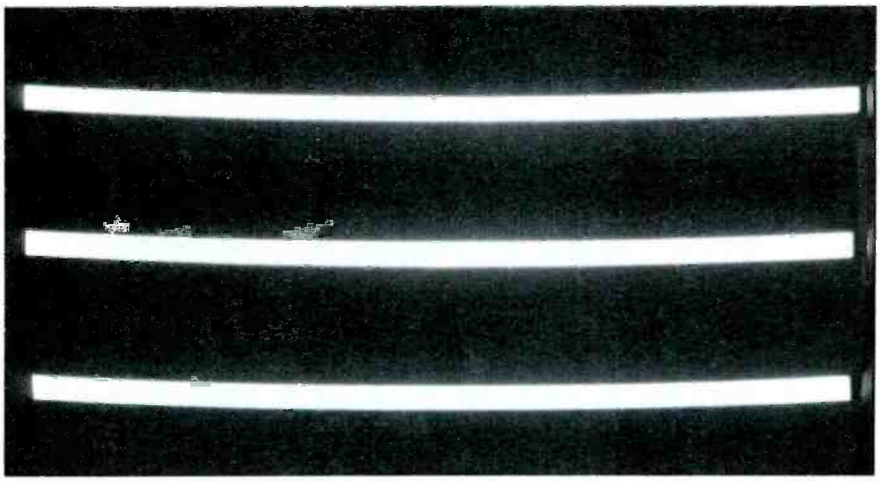


Figure 14. TI horizontal lines

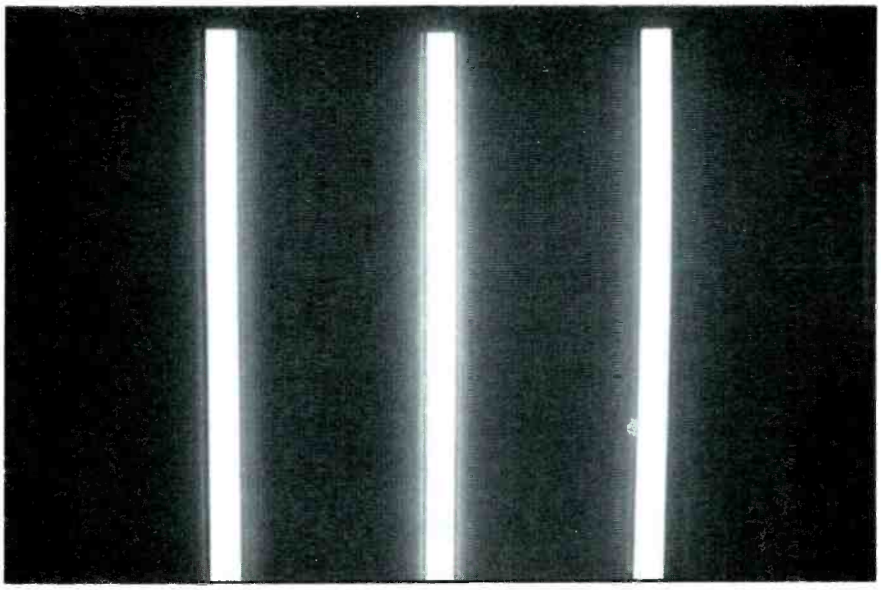


Figure 15. TI vertical lines

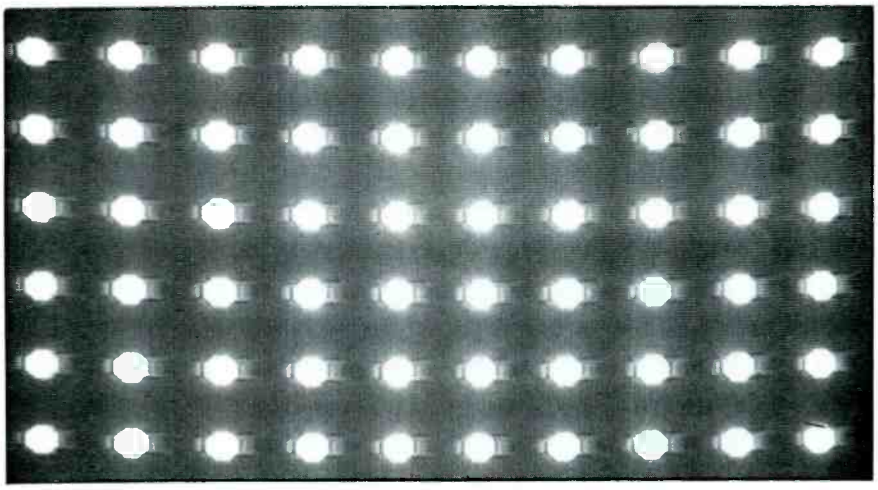


Figure 16. TI 10x8 dot pattern

To create a series of dots in a 10x8 pattern on the TI computer, a combination of a FOR-NEXT loop and a subroutine can be employed. In the portion of a typical program shown below, the initial FOR-NEXT loop FOR I=1 TO 10 results in 10 vertical columns of equidistantly spaced dots. The subroutine produces the 8-dot vertical columns using FOR-NEXT and HCHAR statements (note that a VCHAR statement could have been used just as easily without the FOR-NEXT loop).

```
10030  X = 2
10040  Y = 3
10050  CALL CHAR
       (96,"3C7EFFFF-
       FFFF7E3C")
10051  CALL COLOR
       (9, 16, 2)
10060  FOR I = 1 TO 10
10080  GOSUB 10500
10090  Y = Y + 3
10100  NEXT I
10500  FOR J = 1 TO 8
10510  CALL HCHAR
       (X, Y, 96)
10520  X = X + 3
10530  NEXT J
10540  X = 2
10550  RETURN
```

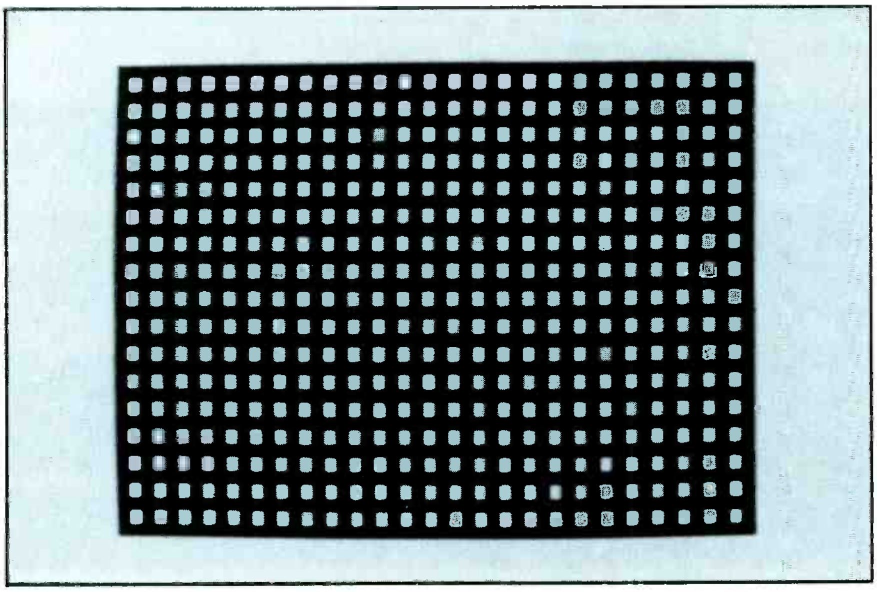


Figure 17. Timex Sinclair 25x17 grid

The CALL CHAR statement creates the dot used in the program, see Figure 6, which shows how the dot was made. Figure 16 shows the 10x8 dot pattern.

As already noted, it is easier to create patterns on the TS computer because of the specialized graphics keys. To display a 25x17 box grid, a graphics character string, print statement and a FOR-NEXT loop is used. For example:

```
  10 LET A$="PPPPP-
PPPPPPPPPPPPPPPPPPPPI"
  20 FOR I = 1 TO 17
  30 PRINT A$
  40 NEXT I
```

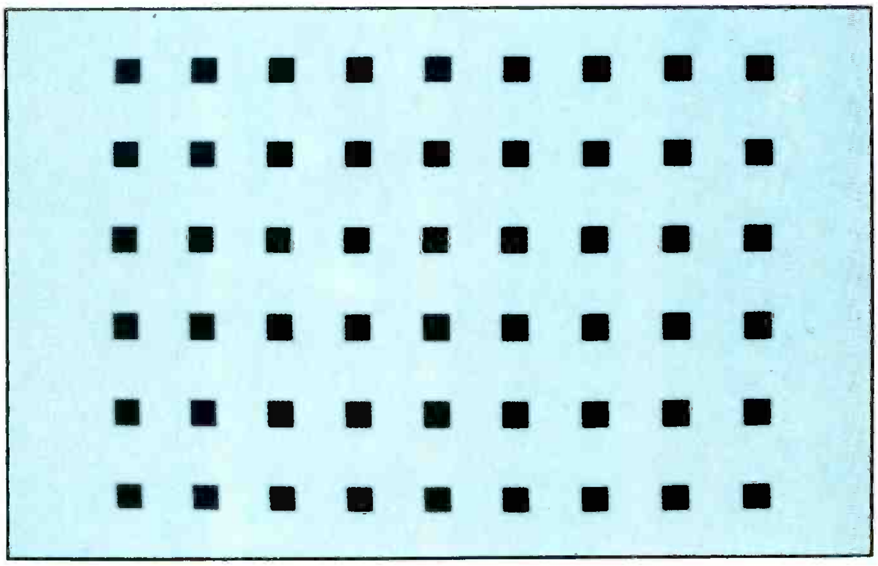


Figure 18. Timex Sinclair 9x6 small squares pattern

Where P is the graphics character ■, and I is ■. The bottom of the grid, however, is not closed. The following statements that use the PLOT command can be used to close the grid:

```
50  LET X = 2
60  FOR I = 1 TO 51
70  PLOT X,1
80  LET X = X + 1
90  NEXT I
```

Figure 17 shows the display, which has been centered on the screen by the use of four blank PRINT statements at the beginning of the program.

Vertical and horizontal line displays and a 9x6 pattern of small squares are as easily written using other graphics keys. A small square pattern, such as the one shown in Figure 18, results from the following:

```
10  FOR I = 1 TO 16
20  PRINT "XXXXXXXXX"
30  PRINT
40  PRINT
50  NEXT I
```

X is the graphics key ■. As with the previous programs PRINT statements used at the beginning of the program are used to center the display. Figures 19 and 20 show typical horizontal and vertical line patterns.

The bar patterns are useful in aligning convergence on a color television. The bars should appear completely white on a black background, for the TI display, or completely black on a white background, for the TS display. An incorrect display is indicative of smearing or fading of the video signal.

The dot, small square patterns, also are used to check color convergence adjustments. When used in conjunction with the other grid and line patterns, they aid in identifying such abnormalities as size, aspect ratio and geometric distortions (linearity, skew, pincushion and barrel effects).

Putting it all together

It is inconvenient to have a lot of small individual programs each of which would have to be loaded into the computer whenever a particular display is desired. The programs can be combined for easy computer loading and access. Memory space can be conserved, necessary when using an unexpanded Timex Sinclair computer, by putting many repetitive FOR-NEXT loops and PRINT statements in subroutines.

For the TI programs, the individual test pattern programs can be assigned statement numbers in groups of 1,000. For example, the pseudo NTSC color bar pattern could start with statement 1000, a multicolor bar pattern would start with 2000, 3-color bars would start with 3000, and so on. With the use of CALL KEY statements, each test pattern display could be run with just the push of a single key. The statement CALL KEY (1, K1, S) scans the left side of the console keyboard. If 1 is pressed the computer recognizes this as a function key code of 19. Therefore, if the statement IF K1 = 19 THEN 1000 is used in a GO TO loop that causes the computer continually to perform the IF K1 = 19 THEN 1000 instruction pressing the 1 key at any time will result in the computer running the 1000, or pseudo NTSC color bar pattern program. Similar statements are used to cause the computer to branch to each individual (sub)program. Pages II-88 and II-89 of the TI "User's Reference Guide" illustrate the various keyboard scans that are available.

Before branching to various (sub)programs however, the CALL COLOR statements must be returned to their standard computer assignments. This is due to the fact that if a specific CALL COLOR statement is used in one (sub)program it will still be in effect should another (sub)program be called out that uses the standard computer color assignments. This would result in some test patterns varying because of the dif-

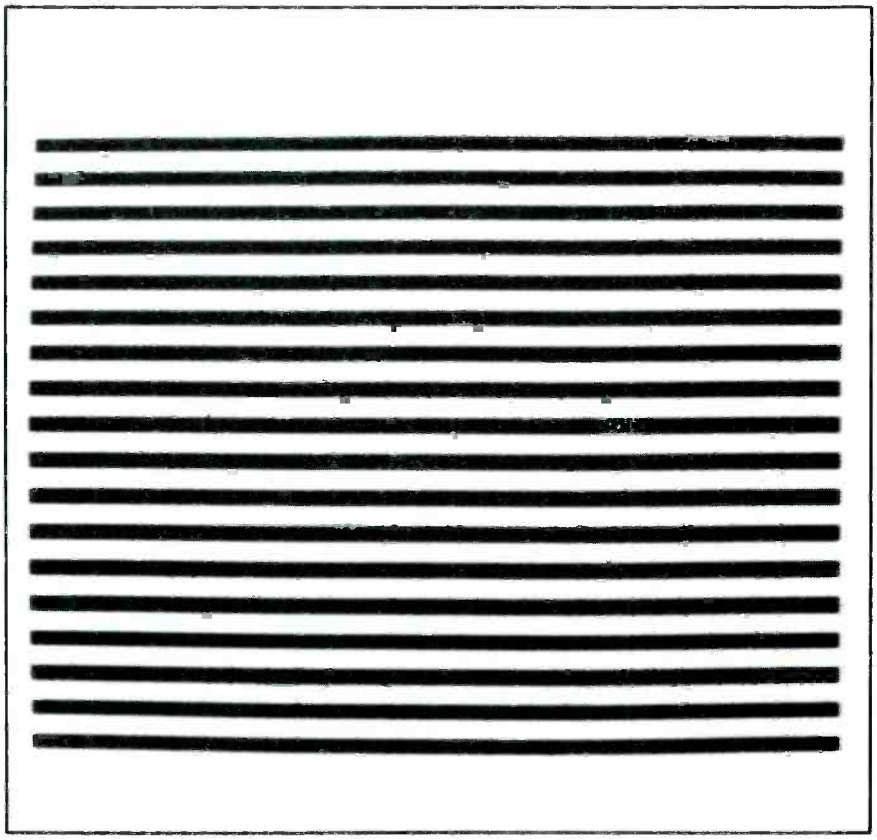


Figure 19. Timex Sinclair horizontal lines

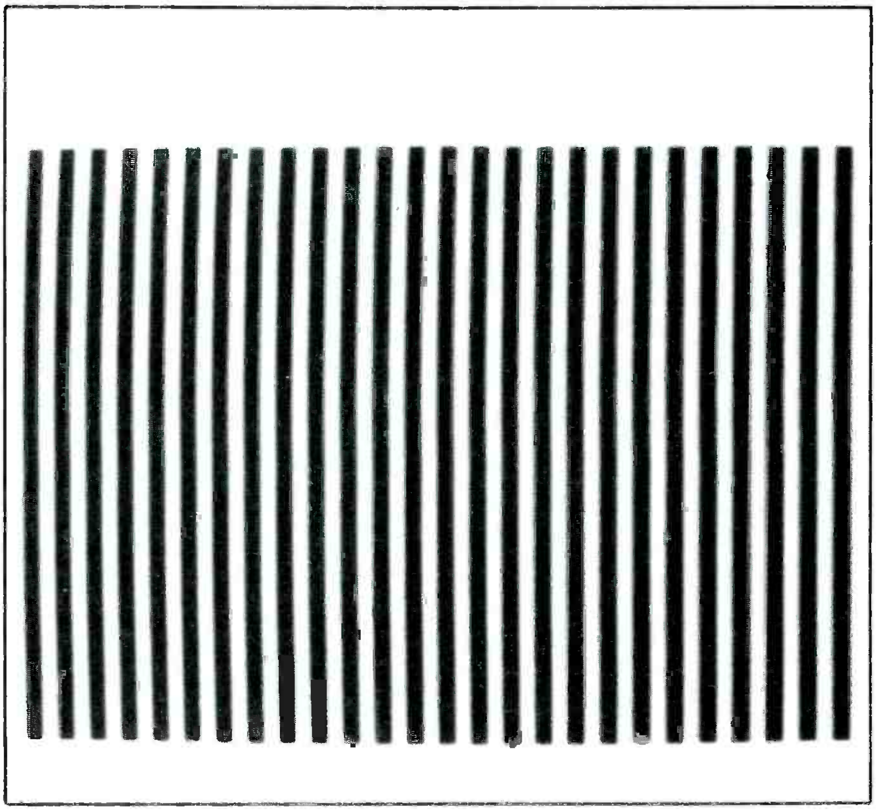


Figure 20. Timex Sinclair vertical lines

ferent sequence in which they were run. It is therefore necessary that at the beginning of every (sub)program a subroutine, such as the one below, be referenced:

```
CALL COLOR (1, 2, 1)
CALL COLOR (2, 2, 1)
CALL COLOR (3, 2, 1)
CALL COLOR (4, 2, 1)
CALL COLOR (5, 2, 1)
CALL COLOR (6, 2, 1)
CALL COLOR (7, 2, 1)
CALL COLOR (8, 2, 1)
CALL COLOR (9, 2, 1)
CALL COLOR (10, 2, 1)
```

At the end of each (sub)program, the computer should be instructed to return to the CALL KEY statements to scan the keyboard again for different test pattern selection.

In the case of the unexpanded TS computer, there is little memory space available for any special keyboard scans. Therefore, after as much memory space as possible is conserved by the use of subroutines, each (sub)program is ended by a statement that goes to itself, such as 650 GO TO 650. The various displays are then called out by pressing the BREAK key and then running (*RUN*) the desired (sub)program. ES&T

The author has available, for a fee, a cassette tape and instruction booklet, "Video Test Pattern Generator-Computer Program," containing the Texas Instruments 99/4A and Timex Sinclair 1000 programs that were used to generate the test patterns shown in this article. If you're interested, you may contact him at the following address:

Victor Meeldijk
2165 Bolton St.
Bronx, NY 10462

Test your electronic knowledge

By Sam Wilson

1. Which of the following components might be used for *X* in Figure 1 if its purpose is to protect the speaker from being overdriven?
A.) Esaki diode
B.) Hall device
C.) Coil with ferrite core
D.) VDR

2. The network comprised of *R* and *C* in Figure 2 is used for
A.) Decoupling.
B.) Improving transient response.
C.) Low-frequency compensation.
D.) (Cannot answer.)

3. Which of the following is used to broaden the response of an audio amplifier?
A.) Regenerative feedback
B.) Degenerative feedback

4. The pilot in an FM stereo broadcast is used to accomplish
A.) Carrier elimination.
B.) Carrier centering.
C.) Carrier reinsertion.
D.) Carrier reduction.

5. A phase-locked loop might be used
A.) To control the speed of a turntable motor.
B.) To demodulate an FM signal.
C.) To lock the local oscillator onto its required frequency.
D.) (All choices are correct.)

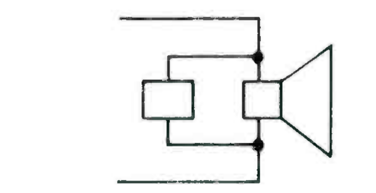


Figure 1.

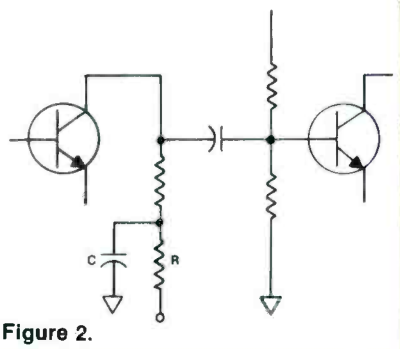


Figure 2.

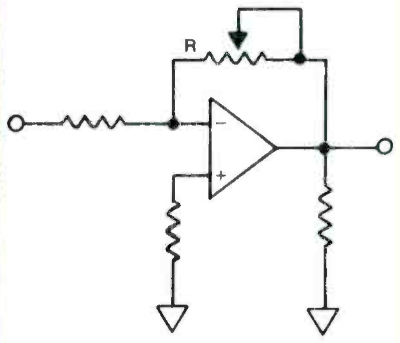


Figure 3.

6. The third harmonic of a 1,000Hz pure sine wave is
A.) 2,000Hz.
B.) 3,000Hz.
C.) 4,000Hz.
D.) (None of the choices is correct.)

7. There should be no partition noise in
A.) A tetrode.
B.) A bipolar transistor.
C.) A MOSFET.
D.) Any of the above choices.

8. In the audio op-amp circuit of Figure 3, the frequency response (bandwidth) will be increased by
A.) Increasing the resistance of r.
B.) Decreasing the resistance of r.
C.) (Neither choice is correct because the frequency response is not affected by the resistance of r.)

9. Commercially prepared cassettes have a poor high-frequency response when played on a certain cassette player. A possible cause is
A.) Capstan speed.
B.) Azimuth adjust.

10. Pink noise has
A.) More low-frequency energy than high-frequency energy.
B.) More high-frequency energy than low-frequency energy.
C.) Equal high- and low-frequency energy.

Answers are on page 60

Repairing the consumer color video camera

By Neil Heller

The advent of home videotape recorders only filled half the needs of consumers. They could control their viewing habits, but still desired the ability to create their own programming. This need was filled by the development and introduction of the consumer video color camera. Since this introduction in the early 1980s, consumer color cameras have become commonplace. Eventually, many cameras will require servicing.

Servicing of color cameras requires the use of some specialized test equipment. Because every adjustment made to a color camera is dependent on every other adjustment, it is necessary to complete each step correctly before proceeding on to the next one. Color cameras are unforgiving in their adjustment procedures. The key items of test equipment required to repair color cameras are:

• *Waveform Monitor*–When repairing a color camera, it is necessary to view a stable representation of both the horizontal and vertical waveforms. The waveform monitor provides such an output along with a faceplate graticule that allows for precise level and pulse-width adjustments. It is possible to use an oscilloscope in place of a waveform monitor, but it requires particular attention to level and an external sync source. The operation of test equipment will be detailed in future articles in this series.

• *Vectorscope*–Although the waveform monitor measures pulse levels and widths, it cannot signal phase differences such as the phase relationship between burst and chroma. This measurement must be properly set up so that the camera produces the correct hues.

• *A set of quartz-iodine lights*–Color cameras are designed to operate under various lighting conditions, which emit various hues, but the setup of color cameras requires a fixed amount of light that is predetermined by the manufacturer, and a hue emitted by a 3200°K light source. This type of light source is commonly a quartz-iodine light.

• *A good quality color monitor with cross pulse and underscan*–The repair of color cameras requires that many of the automatic color circuits commonly found on TV sets, or low-end monitors, be turned *off* in order to give a true representation of the camera's output. Cross pulse and underscan are required because the entire active scan of the camera output must be viewed, and because distortions such as discoloration usually will begin in the corner areas of the scan.

• *A set of manufacturer-recommended test charts*–Because the camera views images under reflected light, it is necessary that these objects yield specific camera output levels. For this reason, test charts such as a gray scale are required. As with the vectorscope and waveform monitor, we will cover the specific usage of test charts in a later article.

• *Spare shop space*–The repair of color cameras requires that the camera view the test charts from a distance of 6 to 10 feet. This often means that with a properly equipped work station, the total space needed could be as much as 15 to 20 feet, or the space that could be used for two or three regular work stations. Because the work area cannot be contaminated by external lighting, it also must be separated from windows and overhead fluorescent lighting.

The theory and operation of the single-tube color camera.

The single-tube color camera is one of the greatest advances in the field of television. Not only did it significantly reduce the size and weight of the color camera, but for the first time, the reduction in cost put a color camera within the reach of the consumer. Earlier attempts to create a scaled down 3-tube color camera led to the development of the 2-tube camera, which combined the luminance and green signals on one tube, and the red and blue signals on the other. These cameras did not meet the requirements for small size and low cost. The use of multiple tubes still required a complex registration process in order that the individual tubes could *see* in an identical manner.

To understand the single-tube camera, you first must recognize

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that the pickup tube (vidicon or other device that converts a light image into an electrical signal) is color blind. For this reason, the process of creating a red, blue and green signal must be done by some external component. This is the function of a component of the camera called the stripe filter (See Figure 1) that separates the incident light into its red, green and blue frequency components. After passing through the optical stripe filter, the resulting signal can be separated electronically into the red, green, and blue primary colors, and processed in the same method used for 3-tube cameras.

The basics of color separation

Start with white containing the three primary colors. If we pass the light through clear glass, the light maintains all its color content. When we place a yellow filter in front of the clear glass only, the red and green frequencies are passed. The blue light is absorbed by the filter. If we replace the yellow filter with cyan-colored glass, the red frequencies are blocked, and the blue and green frequencies are passed.

By striping the faceplate of the tube with cyan and yellow filters, we can create an optical encoder. Stripes of the same color are set parallel to each other and are scanned by the horizontal movement of the electron beam as it scans the faceplate (see Figure 2 for scanning action). If the stripes are the same width, then as a result of the horizontal scan, they will modulate the electron beam at the same frequency. This would present a problem, as it would be impossible for the electronics to determine which frequency was a result of the cyan filter and which was a result of the yellow filter. To prevent this condition, the cyan and yellow stripes are positioned at different angles to the vertical plane. This has two advantages. First, at some point, the filters will cross each other. The combination of the cyan and yellow filters blocks both red and blue frequencies, allowing only green to pass. Second, the physical positioning of the stripes at different angles

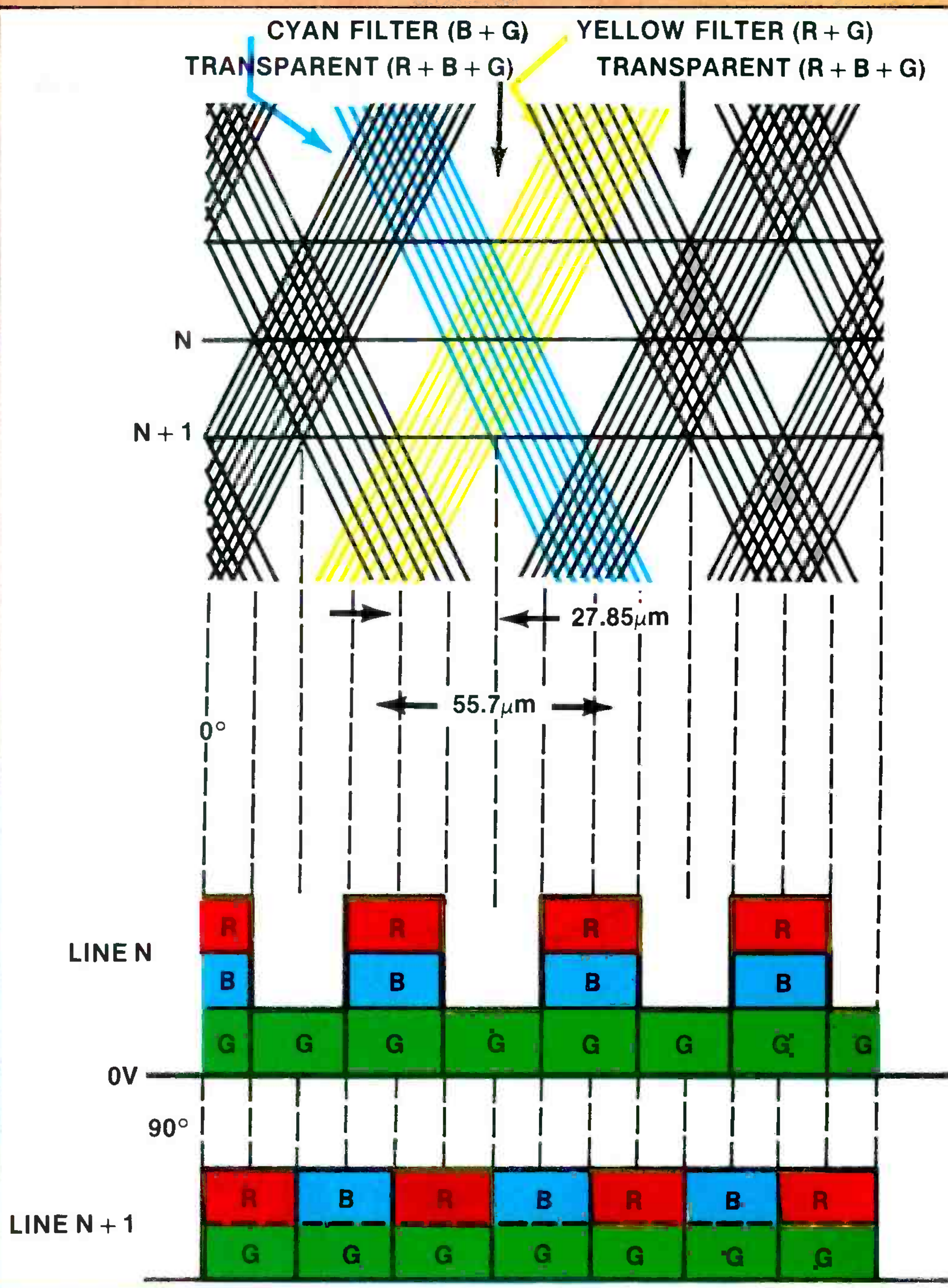


Figure 1. In some single-tube color video cameras, the light reflected from the subject is broken down into its primary-color components by means of a color-striped filter. Because the stripes (dyed-gel filters) cross at an angle, the electrical signal output of the beam will change from one line in the raster to the next. This change contains the color information.

Key items you will need

- Waveform monitor
- Vector
- Set of quartz-iodine lights
- Color monitor (good quality) with cross pulse and underscan

results in a frequency offset between the outputs of the cyan frequency and the yellow frequency.

Assume that the single-tube color camera contains a left-running yellow stripe and a right-running cyan stripe. Both stripes are positioned at a 25° angle from the vertical axis. (The actual angle between the color-striped filters and the vertical axis is determined by the following formula: Phase angle = arctan 1.55f, where f equals the modulating frequency of the carriers in MHz.)

Each color stripe is then separated from the next by a clear stripe. We can pick any point on the active horizontal scan and determine what color or colors are blocked or passed. For example, follow the horizontal path of one line of scanning of the electron beam. Call this scan line N. It begins by sensing light that is passing through the yellow filter, which yields a red and green (yellow) signal. Next, it senses the light passing through the cyan filter, producing a blue-green (cyan) signal. This pattern continues for the rest of this horizontal scan line. On the next horizontal line, call this N+1, the beam senses light passing through alternating clear glass, and the red, green and blue, and the combined cyan and blue filters, which only passes green. The green frequency serves as the carrier for the red and blue light components.

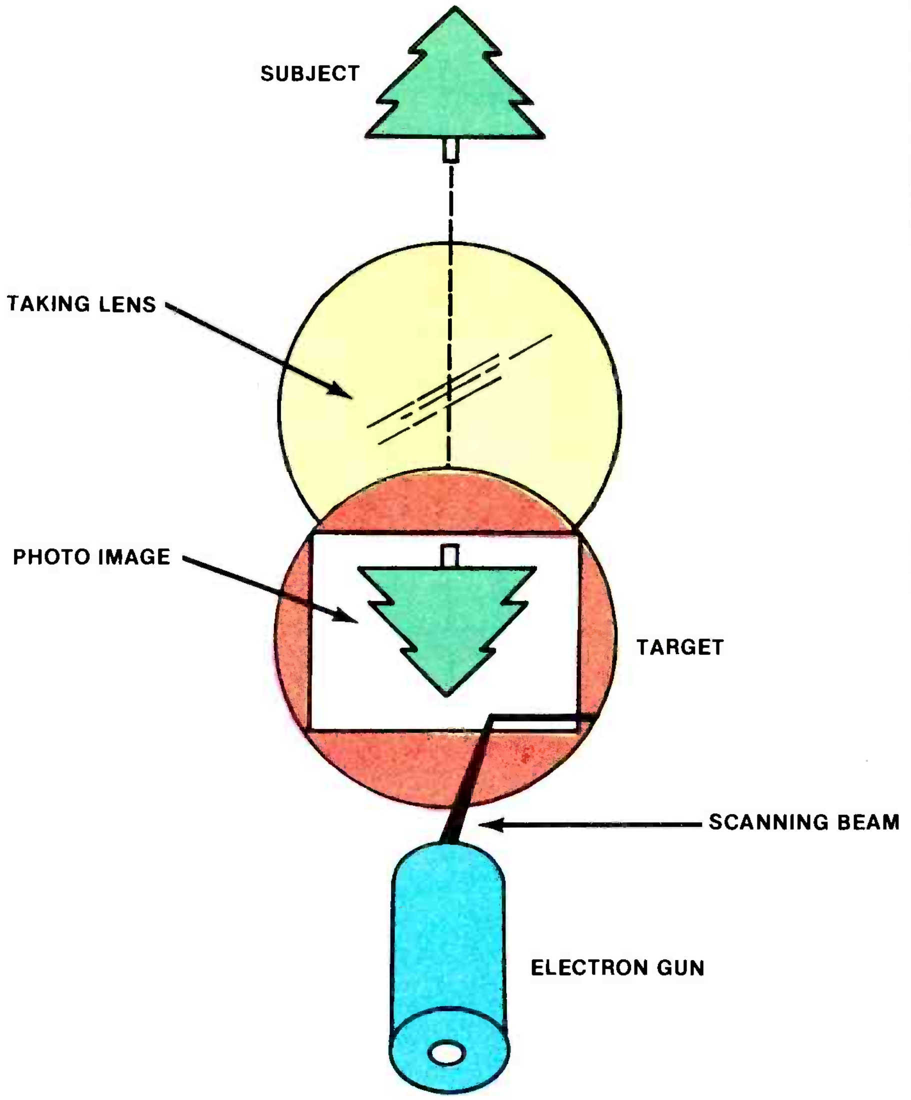


Figure 2. The process of turning a visual image into an electrical signal is essentially the inverse of creating a picture on the picture-tube faceplate. The method of creating the signal is also similar, using a scanned electron beam to create a raster signal.

Now, look at lines N and N+1 in terms of their color output. The physical offset that exists because the filter lines are diagonal results in a 90° phase difference between the peaks of the blue and red signals. This offset can be used to separate the common frequency into these individual colors. By positioning this specific chroma carrier frequency above the wider band of the green carrier, we can separate the two groups by using a low-pass filter (green) and a bandpass filter (red, blue). Also, the bandwidth of the green signal allows it to contain the luminance (detail) information.

The major drawback of this optic system occurs when the subject matter cannot meet the minimum operating conditions of the optical stripe. The first drawback is the light requirements. All color reproduced by the single-tube camera is dependent upon the capability of the tube to see the stripe filter. When light conditions are too low, the details of the stripe are lost. When light conditions are too high, the beam saturates due to excessive beam transmissions, and the stripe is washed out. In either case, the loss of the stripe means the loss of the capability of producing red and blue. The resulting output of the system is the carrier frequency: green. To avoid this condition, most single-tube color cameras contain a chroma chip circuit that eliminates any chroma information under extreme low and high light conditions.

The second problem depends on the shape of the object being viewed. Sharp contrasts result in creating high-frequency transitions on the target faceplate. When these frequencies approach the frequency of the stripe filter, the camera will interpret them as being color information generated by the stripe filter. To avoid this condition, high-frequency luminance signals must be attenuated. A simple but unacceptable method would be to defocus the lens. Another, much better method is to place a lens in front of the target that will roll off high frequencies without affecting the transitions created by the stripe filter.

The subject of overall resolution is another drawback of the single-tube color camera. In the frequency-modulated system, the frequency of the luminance signal cannot exceed that of the color carrier, as this would result in interference between the two. One solution is to raise the frequency of the color carrier. This is easier said than done. The carrier frequency is a complex relationship that can be expressed by the following equation:

$$F = W(mm)/P(\mu m) \times T(\mu s) \times 10^3 \text{ (MHz)}$$

where:

F = The color carrier frequency, expressed in MHz.

P = Color stripe pitch expressed in micrometers.

W = Effective horizontal scanning width of the pickup tube, expressed in millimeters.

T = Effective horizontal scanning period of the pickup tube expressed in microseconds.

By increasing the horizontal scanning width and lowering the pitch, higher carrier frequencies can be achieved. Frequency modulated stripe-filter systems have seen carrier increases from 3.6MHz in first-generation cameras introduced in 1973, to 4.3MHz carriers found in today's *highband* tubes. This increase in carrier frequency has yielded an effective increase in luminance resolution from approximately 250 horizontal lines to 300 horizontal lines. This discussion has centered on one particular method for producing color from a single tube. This method was created from a system called interplexing, which was developed in the early 1970s by Siemen's AG of Germany, and introduced in the United States in the first color camera available to the consumer. Today, the frequency multiplex system is used most widely for consumer and industrial color cameras.

How the single-tube color camera works

In understanding how a single-tube camera can reproduce the three primary colors of red, green and blue from the stripe filter, it is necessary to divide the camera into the three major sections that are responsible for its operation. The first is the deflection system that in a single-tube camera has the dual function of beam scanning and creating the color carrier.

Second are the video processing circuits. These circuits include a series of filters that separate the color carrier into red, blue, YL and YH (see Figure 3). The YH represents a high-frequency component that the camera uses for resolution. The YL is separated from the YH signal by means of a low pass filter. This lower frequency component signal is used by the camera to make green. After the three primary colors are separated from the carrier and individually amplified, they are mixed or matrixed to create the complete range of colors. Matrixing is the third major process of the color camera (see Figure 4).

Troubleshooting considerations

Optics are not considered to be a concern during troubleshooting of a single-tube video camera as the stripe filter is fixed to the faceplate of the tube. As a result, the key to color reproduction for the single-tube camera is the ability of the circuits responsible for beam transmission to scan the stripe filter accurately. Only when this occurs will the scanning beam produce the center-frequency that in turn is used to create color. Any distortions in resolving the stripe filter will lead to a loss of proper color reproduction. These distortions can be divided into two categories. First are those that concern beam transmissions such as target, beam and focus. Any misadjustment in this area will af-

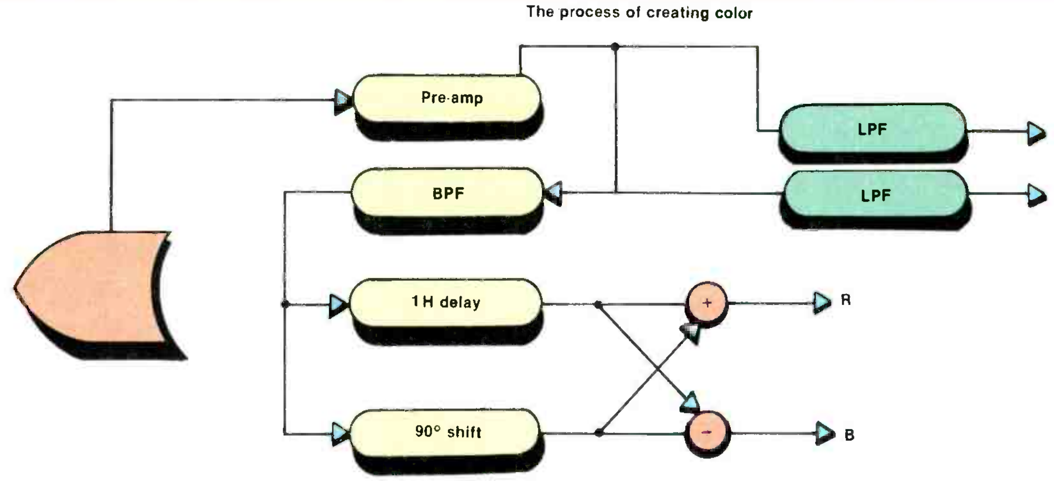
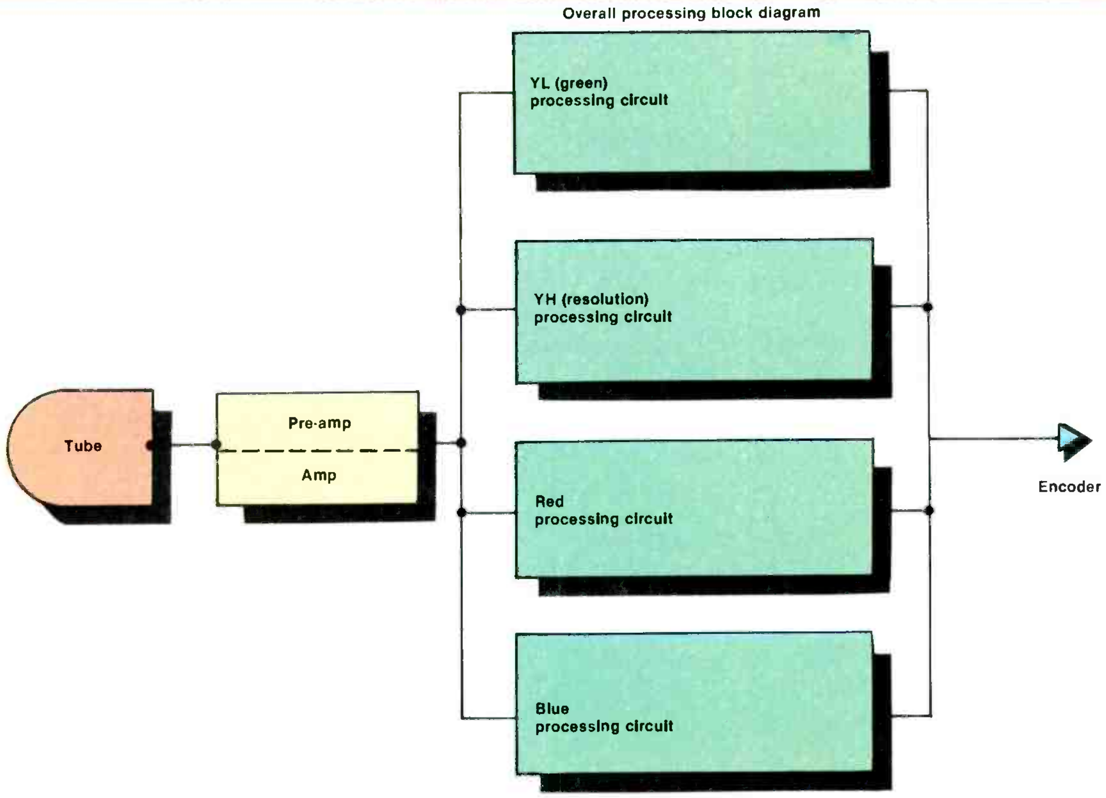


Figure 3. The camera electronics performs amplification, filtering, delay and frequency shift to convert the output signal from the scanning process into color, luminance and resolution information components.

Figure 4. The color components are matrixed to create the complete range of colors.

fect the ability of the camera to see the filter. In addition, beam transmission problems are not always uniform across the tube faceplate. Sometimes the lack of proper color reproduction can be limited to certain areas of the raster such as the center or the edges of the screen.

Deflection distortions are the second type of problem encountered in color cameras. Even if the beam can properly *see* the stripe filter, it must scan it at a rate that results in the characteristic center-frequency. This is the frequency that the camera uses to create red and blue. Problems in horizontal deflection such as size and lineari-



ty will have the greatest effect on color reproduction. Problems in vertical deflection cause a frequency shift within the vertical scan. This frequency shift beats against the characteristic center frequency, which in turn causes a visual beat in the picture.

In both of these cases, the loss of the center frequency results in the loss of red and blue, as the signal required to produce these colors is no longer present. The only remaining frequencies are those that exist in a wideband below the center frequency. These are the frequencies that are used to produce green. As a result, any distortion in the reading of the stripe filter will cause the output picture to turn green.

All of these adjustments are critical to the performance of the color camera. Even minor misadjustments or distortions can result in a low blue signal, which is hardest for the single-tube color camera to reproduce. The resulting output picture lacks the unity of red, blue and green signals that is required for proper color reproduction.

Signal processing and color matrixing

The signals coming off of the target faceplate are a wide range of frequencies that result from both the colored and clear portions of the stripe filter. The modulated signal is passed through a bandpass filter to separate the center carrier for blue and red, and a lowpass filter for separating the luminance components used for resolution and green.

The red, blue path

The phase angle created by the yellow and cyan stripes results in a 90° difference between the red and blue signals during scanning of alternate horizontal lines. The band-passed signal is then routed through two paths. The first shifts the signal by an additional 90°, while the second delays the signal one horizontal line. The red signal will result by taking the sum of the delayed and phased shifted signals, while the blue will be the result of the difference.

Resolution and green signals

The YH signal is taken from the stripe filter via a low-pass filter that cuts off frequencies approximately 0.5MHz below the carrier used for red and blue. The resulting signal is processed and used to set the luminance, or brightness level. Besides being used for camera brightness, the YH signal passes through an additional low-pass filter with a cutoff of approximately 0.5MHz. The result is the YL signal used to produce green.

The matrix process

The output of the process circuits yields red, blue and green in the form of YL and YH. Alone, these components only represent the three primary colors, along with white, which is the mixture of equal amounts of the primary colors, and black, which is the absence of color. In order to create the full range of colors, it is necessary to have primary as well as secondary components, such as yellow, cyan and magenta. This process depends not only on the proper amounts of the three primary colors, but also the addition of combinations of blue and green, and red and green. In terms of camera signals, these color combinations are know as R-YL and B-YL. Any color produced by the camera is dependent on the three primaries and the combinations of R-YL and B-YL. Matrixing is the system that mixes red and blue with YL to create R-YL and B-YL.

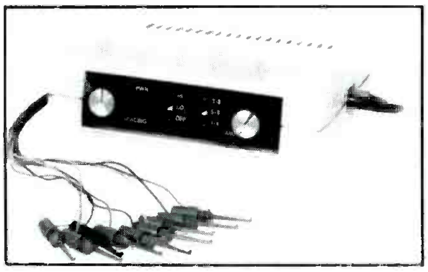
Theory: the method behind the repair

As with videotape recorders, regardless of model or manufacturer the theory behind the basic circuits that are responsible for creating color is the same. By understanding how the system works, it is possible to troubleshoot from point to point, using the adjustment procedure as a guide. In future articles, we will develop complete troubleshooting and alignment procedures based on the theory presented in this article. In addition, we will review in greater depth the use of test equipment and test charts required to effect the repair. ES&T

Products

MX-8 scope multiplexer

Global Specialties has announced the MX-8 scope multiplexer, which can be used with any single-or dual-channel oscilloscope to monitor eight different digital or analog circuits simultaneously.

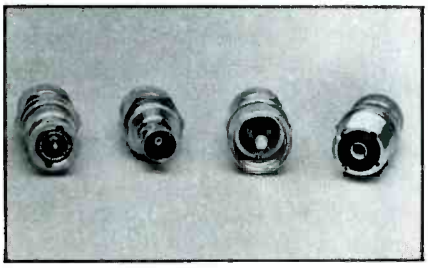


MX-8 features include: a frequency range to 5MHz; 40Vpp input range; analog and digital compatibility, including CMOS and overvoltage protection to 100V. It comes with an ac adapter, and nine E-Z-HOOK probes for quick and simple positive connections.

Circle (75) on Reply Card

Toolless coaxial connectors

A recently introduced line of coaxial connectors from *AMP* requires no special tooling, and can be reused at least 25 times.

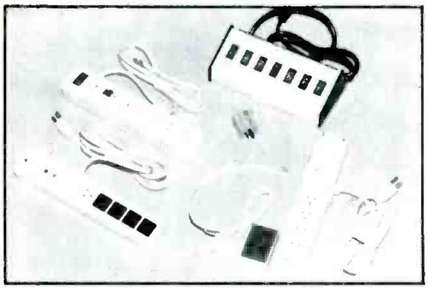


These connectors accommodate popular cable sizes such as RG58, RG59 and RG62 up to RG6U. Solid, foam and air dielectric cables can be used. The center contact has a spring member that accepts the variation in conductor sizes. Maximum jacket size acceptable is about 0.275, depending on the cable braid thickness because the braid is folded back over the jacket before insertion of the cable into the connector.

Circle (76) on Reply Card

For power distribution

Four power distribution devices that provide surge protection and EMI/RFI filtering have been introduced by *GC Electronics*. These include a desk top power console, ac/remote power tap, (APU) automatic power up, and an economy surge protector.

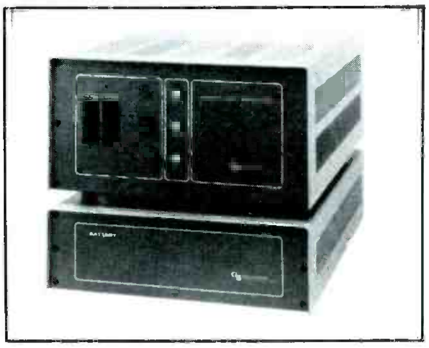


The desk top power console contains seven ac outlets. Six are controlled by a master switch and have lighted switches for each outlet. The seventh outlet is for constant use and never needs to be turned *off*. Surge and RFI/EMI circuitry adds protection against the failure of microchips in expensive equipment.

Circle (77) on Reply Card

Portable 1.0kVA UPS

A compact electronic 1kVA UPS (uninterruptible power system) featuring CSA approval is offered by *Sola*, a unit of *General Signal*. The portable UPS is designed to incorporate an improved input power factor, reduced input noise and greater operating efficiency at a lower cost. It is available in both 60Hz and 50Hz models to protect sensitive electronics from common ac-power problems, including



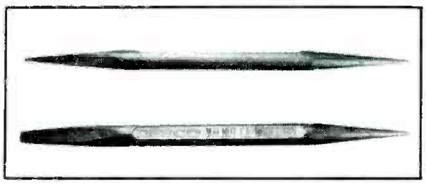
blackouts. The unit is designed for shelf or 19-inch cabinet mounting and uses two separate dc power supplies to power the inverter and charge the battery.

Circle (78) on Reply Card

Multiuse spudger tool

Desco Industries has developed a molded spudger tool for use in electronic assembly or field service. The glass-filled nylon tool offers economy and long life, and will not damage wire or delicate surfaces, according to the manufacturer.

The Spudger originally was introduced by telephone companies for probing and pushing wires and



connectors around central office and field switching blocks. Since then it has found many additional uses as a wiring aid.

Circle (79) on Reply Card

Spike and noise suppressor

Tripp Lite has announced its SpikeBlok. This unit plugs directly into an existing outlet and converts the twin outlet receptable into six outlets with full noise and spike suppression. The SpikeBlok has two indicator lights: one to show that power is present; the other to show that the protection circuitry is working.

Circle (80) on Reply Card

Digital probe multimeter

A.W. Sperry Instruments has introduced the AWS DM-6590 Electro-Probe autoranging, digital probe multimeter.

At $6\frac{3}{8}$"x$11\frac{1}{8}$"x$\frac{3}{4}$", the DM-6590 is a miniaturized instrument that fits comfortably in the hand and contains a built-in probe tip for one-hand operation. It is designed for reading ac voltage, dc voltage and resistance in tight, hard-to-reach areas such as crowded circuit boards.

Circle (81) on Reply Card

Floppy disk alignment program

Computer Options has released FDAP – a utility designed to aid in floppy disk drive alignment. Programmed for use with Dysan's model 208-10 Analog Alignment Diskette or equivalent, FDAP allows the use of an Apple or compatible computer to control Apple-compatible 5¼-inch disk drives (Shugart SA390 or equivalent).

Written in assembly language, FDAP provides a means for positioning the heads to any desired track, while keeping the drive in read mode. Features included are: single-keypress command, track-zero recalibration, 40-track capability, drive one or two operation, decimal and hexadecimal displays, a hysteresis detection aid, and a reference index to Dysan's Analog Alignment Diskette.

Circle (82) on Reply Card

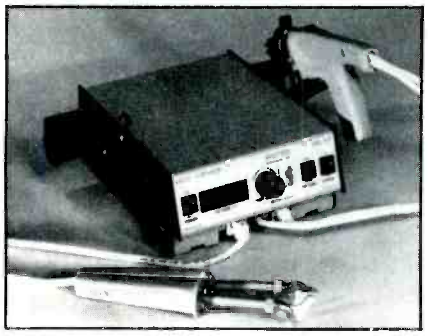
Focal finder for buttonhook feeds

Precision Satellite Systems announces a different type of focal finder for buttonhook antennas. With the offset design of this focal finder (model PS-504), all buttonhooks can be quickly and easily checked for accuracy.

Circle (83) on Reply Card

Repair printed circuit boards

Repair of printed circuit boards containing SMD components and

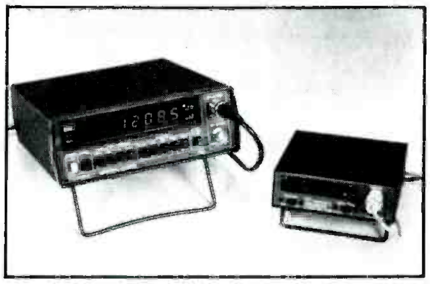


conventional leaded components can be accomplished with the *Plato* V-250. Combining the technology of Plato's pulsed vacuum with the Hot Grips (hot tweezer tool), the kit is designed for quick, safe component removal, according to the manufacturer. A selection of interchangeable tools is available to desolder chips, SOICs, SOTs and quad-packs, as well as all conventional components. Regulated temperature, ergonomically designed hand piece, rapid heat-up and spike-free operation are features of the repair kit.

Circle (84) on Reply Card

Frequency counters

Models 7700, 7500 and 7200 frequency counters from *Triplett Corporation (a Penril Company)* provide a selection of economy, accuracy and versatility. The model 7200 is a compact 111mm(w)x 36mm(h)x125mm(d), an economical counter capable of 5Hz to 160MHz measurements with a variable gate time for improved resolution. It features a 7-segment



LED display.

The model 7500 (10Hz to 150MHz) and model 7700 (dual channel – Channel A: 10Hz to 100MHz; Channel B: 50MHz to 550MHz) counters feature period and rpm measurement and are suited for highly accurate R&D, experimental and production line usage. All of these units feature an 8-segment LED display and include TCXO for enhanced accuracy.

The model 7500 and model 7700 counters have a floating decimal point, leading zero blanking and overflow indication. A self-check test circuit may be used to verify proper counting function.

Circle (85) on Reply Card

Satellite pole support

T-bar Pole Supports manufactured by *Versa-Mount Industries* are constructed of 1½-inch tubular steel, in several gauges, with pre-welded leg plates, pole brackets and pre-drilled installation holes. They are built to accommodate pole sizes from 2⅜-inches OD to 4½-inches OD.

With these supports, earth station antenna mounting positions may be selected on earth, wood decking, cement patio and flat or pitched roofs. Pole plumb problems caused by continuous earth movement may be resolved with adjustable leg levelers. Stable 3-point support for dish sizes up to 10-foot diameter may be achieved, according to the manufacturer.

Circle (86) on Reply Card

Cable tester

The Instrumentation Products Division of *Beckman Industrial Corporation* has added the RS-232C Easy CableTester to its communications product line. It is intended for identifying cable con-

figurations and testing new cables.

Designated the model 715, this hand-held test instrument enables the technician installing data transmission systems to verify that the cable is configured properly *before* installation. With a special feature, using the optional remote indicator, the cable also can be tested after installation, even if each end is in a different location.

Circle (87) on Reply Card

General-purpose wiper

A general-purpose wiper designed for precision industrial and scientific cleaning needs has been developed by *The Texwipe Company.*

Called Omni-Wipe, the wipers combine the strength and absorbency of low particulating natural fibers with the durability and solvent compatibility of polypropylene. The result is a wiper that, according to the manufacturer, will not degrade when used with acids or strong solvents, can be used on rough surfaces without linting or abrading, and features low particle generation, low extractables and high absorbency.

This optimum blend of wiper characteristics has been achieved through a technique called *heat entanglement* – a process that intimately bonds two types of fiber to act as a single, new fiber.

Circle (88) on Reply Card

Surface-mount Grabber

ITT Pomona Electronics has introduced a test clip that adapts to the 0.05-inch centers of surface-mounted devices. The SMD Grabber test clip, model 5243, features gold plated stainless steel contacts. The contacts are designed so that the clips can fit side by side either on gull wing or *J* leaded devices such as SOIC, SOJ, SOT and PCC/PLCC chip carriers.

The nylon plastic body of this test clip comes in 10 colors, facilitating simultaneous testing of different points on the circuit board.

Designed without wire attached for do-it-yourself flexibility, the device also will be available on patch cords, cable assemblies and cable breakouts.

Circle (89) on Reply Card

Pocket inspection microscope

SAT Inc. (a Spirig company) presents self-illuminated pocket microscopes about the size of a long and slender pack of cigarettes. They weigh 4½ ounces and provide a clear 30-power magnification with the Spirig-30, or a 100-power magnification with the Spirig-100 model

Circle (90) on Reply Card

Anti-static solder pump

Oryx has released an anti-static solder pump.

The unit was developed in response to the specific requirements of an electronics manufacturer. Requirements were for low resistance between the desoldering tip and the operator to ensure static-free operation. The simple mechanical design uses advanced materials, with a carbon loaded PTFE tip and aluminum body with conductive plating. This enables a typical resistance of 10kΩ between tip and operator.

Circle (91) on Reply Card ES&T

Answers to the Quiz

See questions, page 51

1. D. When the voltage goes up the resistance of the VDR goes down. The low resistance of the VDR protects the speaker.

2. D. A decoupling filter and a low frequency compensating network have the same configuration. To answer the question you would have to know the values of the components. You would look for a low value of resistance (about 100Ω) if it is a decoupling filter.

3. B. Remember that gain and bandwidth are tradeoffs. A degenerative feedback reduces the gain, so it increases the bandwidth.

4. C. The pilot signal is sent from the station. Its frequency is doubled and the resulting signal is reinserted so that demodulation of the L - R signal can take place.

5. D.

6. D. There is no harmonic content in a pure sine wave.

7. C. Partition noise occurs whenever a charge carrier has a choice of two paths as it moves through an amplifying component. There is no choice of paths in a MOSFET.

8. B. The gain is lowered and the bandwidth is increased when the feedback resistance is lowered.

9. A. Both high and low frequencies would be affected by an incorrect capstan speed.

10. A. This is one way to define pink noise.

Photofact

The Photofact folders for TV receivers and other equipment have been released by Howard W. Sams & Company since the last report in ES&T.

JVC	
C-2055, C-2065	2363-1
JCPenney	
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JCPenney	
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CT-9012/A, CT-9022/A	2365-1
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TR-5046R	2367-1
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TOSHIBA	
CHASSIS TAC8311, TAC8312, TAC8371	2368-2

Computerfact	
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1550BCD	CP14
IBM	
PC jr. 4860	CSCS8

Troubleshooting Tips Wanted

Electronic Servicing and Technology needs additional consumer-product Troubleshooting Tips. Most types of case histories are suitable, especially those with unique, puzzling or misleading symptoms.

List the brand, model and Photofact number followed by a narrative telling the original conditions or symptoms, the various troubleshooting steps, and the components replaced to restore the original performance. Please include a simple hand-drawn schematic of the stage that has a defect.

$10 will be paid for each Troubleshooting Tips published. Your name and city will be listed, unless you ask to remain anonymous.

Send all Troubleshooting Tips to:

Troubleshooting Tips Department
Electronic Servicing and Technology
P.O. Box 12901
Overland Park, KS 66212

Readers' Exchange

For Sale: Sencore equipment – TF 30 Super Cricket transistor checker; CG169 deluxe color generator; CR161 cathode ray tube tester; TF17A transistor FET checker; FS134 field strength meter; CB41 CB Automatic Performance tester; Sams Photofact folders, 1781 to 1810. *Call 201-231-1760 and ask for George.*

For Sale: Canadian RCLs, 187 to 238, in binders, excellent condition; Tekfax schematics 1549 to present; Tekfax manuals, 112 to 115; assorted service manuals – Electrohome, CGE, RCA, Zenith; all, $400 plus shipping, or best offer. *Tom Bundros, 3545 Godfrey, Gilroy, CA 95020; 408-848-2602.*

For Sale: (Closing TV-CB shop) – Sencore VA48, used three times, purchased new, $700; Lampkin 107c, used very little, purchased new, $1500; CB42 analyzer, $700. Send s.a.s.e. for list of other equipment. All excellent condition: CB and television AR and TR, MHF Sams Photofacts. *Vic Veselka, 3212 Cholla Way, Orlando, FL 32808; 305-298-4107.*

Wanted: UHF/VHF tuner subber, ac/dc, working condition, fair price. **For Sale:** Sams Photofact folders 601 to 879, 60 cents each, you pay postage. *David M. Muratore, 27 Clark View Road, New Windsor, NY 12550; 914-562-2805.*

Wanted: Complete remote control system (transmitter and receiver with manuals) for Heathkit color television GR-2001. Will pick up if near Los Angeles area. *James L. Young, 5922 Lorelei Ave., Lakewood, CA 90712; 213-925-5802.*

For Sale: B&K 1077B analyst, B&K 1460 oscilloscope, Sencore FC-45 with PR47 and NE206, $150 each, or $400 for all. New TV tubes, 500 for $450. *J.R. Young, Box 243, Greenlawn, NY 11740.*

Wanted: For VCR servicing – tape tension and spindle gauge, video test tape, VHS or Beta. Also Panasonic 12-inch picture tube No. A26JAS31X. *Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Wanted: Two books – "Modern CB Radio Servicing," by Marvin Hobbs; "Transistor Radio Servicing Made Easy," by Wayne Lemons. Mint condition only; will pay any reasonable price. *John L. Wingfield, Box 685, 210 N 5th, Cedaredge, CO 81413; 303-856-6341.*

Wanted: Old radio advertising material, especially RCA metal signs, neon signs and clocks. *Jeff Lendaro, 5516 E. Fjord, Indianapolis, IN 46250.*

For Sale: ET-3200 digital trainer with digital techniques course, in two binders, $75, plus shipping; **Wanted:** EICO signal tracer, model 150 or model 147. Also bench-type DMM. Send prices and condition. *Calvin Logue Jr., 171 Washington Lane, Westminister, MD 21157.*

Wanted: NRI TV/video servicing courses and equipment; NRI computer, microprocessor course and equipment. Reasonably priced. *Joseph Wegner Jr., P.O. Box 262, Glendale, CA 91209.*

For Sale: Teletype model 33, clean and in perfect condition, includes box of paper and box of tape. Best offer. *R. Garcia, 2784 Fairway Drive, Kelseyville, CA 95451; 707-279-1938.*

For Sale: B&K TV analyst, 1077B with manual and cords, mint condition, $325; ***Electronic Servicing & Technology***, August 1970 to August 1984; *Electronic Technician/Dealer* March 1976 to March 1982, make offer; serviceable modules for all makes of televisions, $2 each. *A. Orjias, 1650 Airport Road, Montrose, CO 81401; 303-249-4995.*

Wanted: Sams AR manuals – 1 to 18, 21, 22, 24, 26 to 29, 31, 32, 34, 38 to 40, 42 to 47, 50, 51, 53 to 64, 66 to 78, 80 to 89, 105 to 114, 116 to 121, 123 to 140, 142 to 147, 149 to 154, 156 through present. *Jerry Keelin, 409 S. Oklahoma St., Shamrock, TX 79079.*

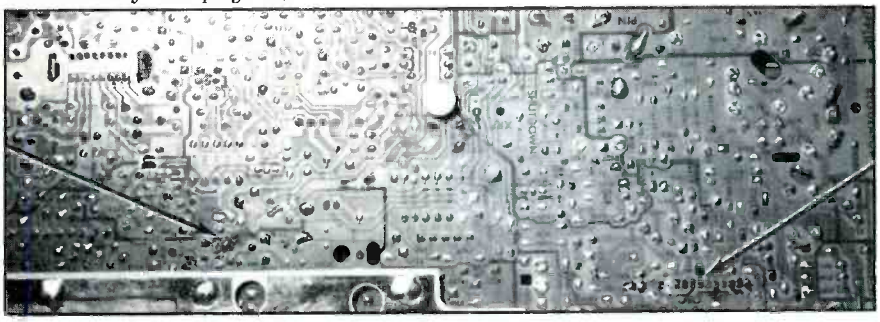
Wanted: Model 11SP22 picture tube, new or used. Also Don Bosco stethotracer and/or accessories. *Murray's Repair Service, 8842 Grange Hill Road, Sauquoit, NY 13456; 315-737-7192.*

Needed: Hickock model 661 color bar generator. *J.G. Shoemaker, 600 First St., Leechburg, PA 15656.*

For Sale: Radio and TV tubes – very old, old and recent types. Send list of tubes needed for quote; minimum shipment, $10. *Ted Youngman, 2225 Vigo St., Lake Station, IN 46405.*

ES&T

Continued from page 14



Melted wiring and burned areas of the circuit board are common after lightning has reached a TV receiver via the power line or antenna lead. Check all circuit boards carefully for such damage.

could be heard. However, the flyback was not responsible in this case. Instead, the focus lead to the picture tube was arcing against a small metal shield.

Other kinds of arcing and current leakage can occur following lightning damage to a circuit board as shown, above left, that might remove some of the copper wiring or splatter carbon across the board to cause shorts. It is wise to examine these circuit boards for any signs of lightning damage, and make repairs before it causes multiplied problems.

Tripler problems

A leaky tripler-rectifier unit can load the flyback enough to cause shutdown in those models that monitor the flyback/CRT current. Sometimes the line fuse will blow or the breaker will trip simultaneously with the shutdown. Tripler arcing can be erratic: At times, the arcing will be strong enough to be heard inside the tripler but not severe enough to activate shutdown. This will help locate the arc.

A partial check of a tripler can be made by disconnecting the tripler's input wire (that connects to the flyback HV winding). Then, by holding the plastic screwdriver's well-insulated handle, touch with the metal blade the HV wire from the flyback. Expect at least a ¼-inch arc. Alternatively, the receiver should go into shutdown if the defect proves not to be the tripler.

Some defective triplers arc through the plastic case to chassis ground. That is reason enough for replacement. After several minutes of operation, turn off the power and feel the temperature of the tripler case. A normal tripler operates cool; a leaky tripler often becomes warm. Replace any triplers that operate warm or hot.

The various suggestions for test sequences should be sufficient to locate any shutdown problems or horizontal problems that imitate shutdown. Of special importance are the two suggestions to reduce the line voltage for tests and to study the complete schematic to find unexpected interconnections between the usual circuits and start-up or shutdown systems. ES&T

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BOOTLEGGERS BIBLE for CB Modification $12.95, CB Radio Repair $10.95. Linear Amplifier Planbook $14.95, kits, etc. Catalog $1.00 refundable—APS, POB 263 Newport, R.I. 02840 401-846-5627. 12-84-tfn

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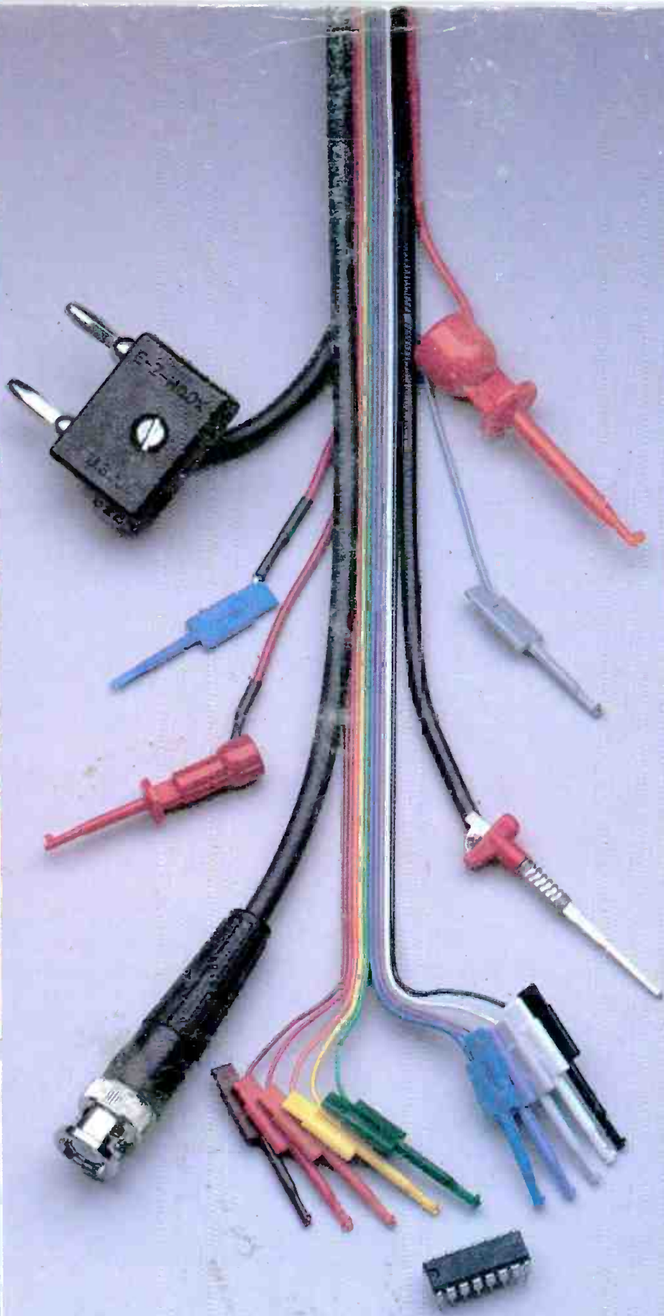
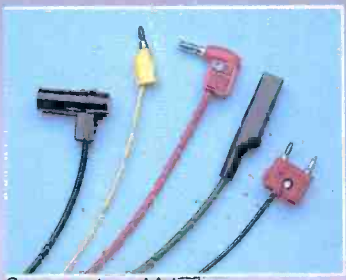
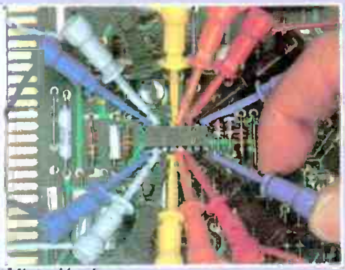


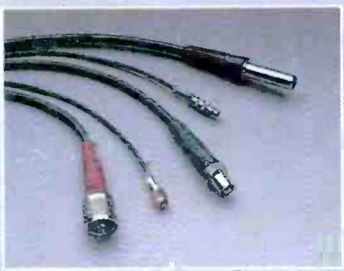


Components and Adaptors

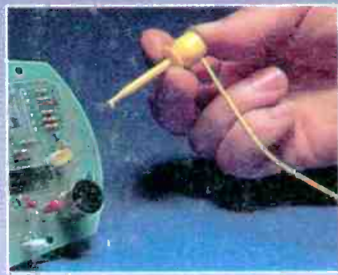
P-25 Plug-On Pico Hook



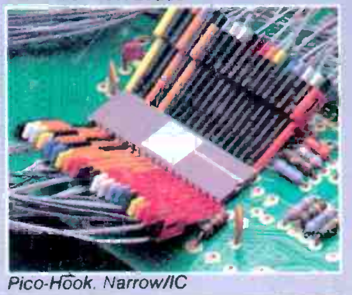
Micro-Hook



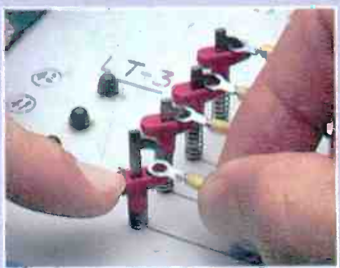
Coax Cable/Patch Cord Assemblies



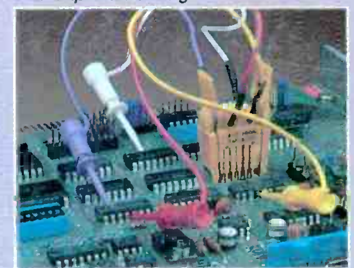
Mini-Hook Test Leads



Pico-Hook, Narrow/IC



Nail-Clip, Harnessing



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