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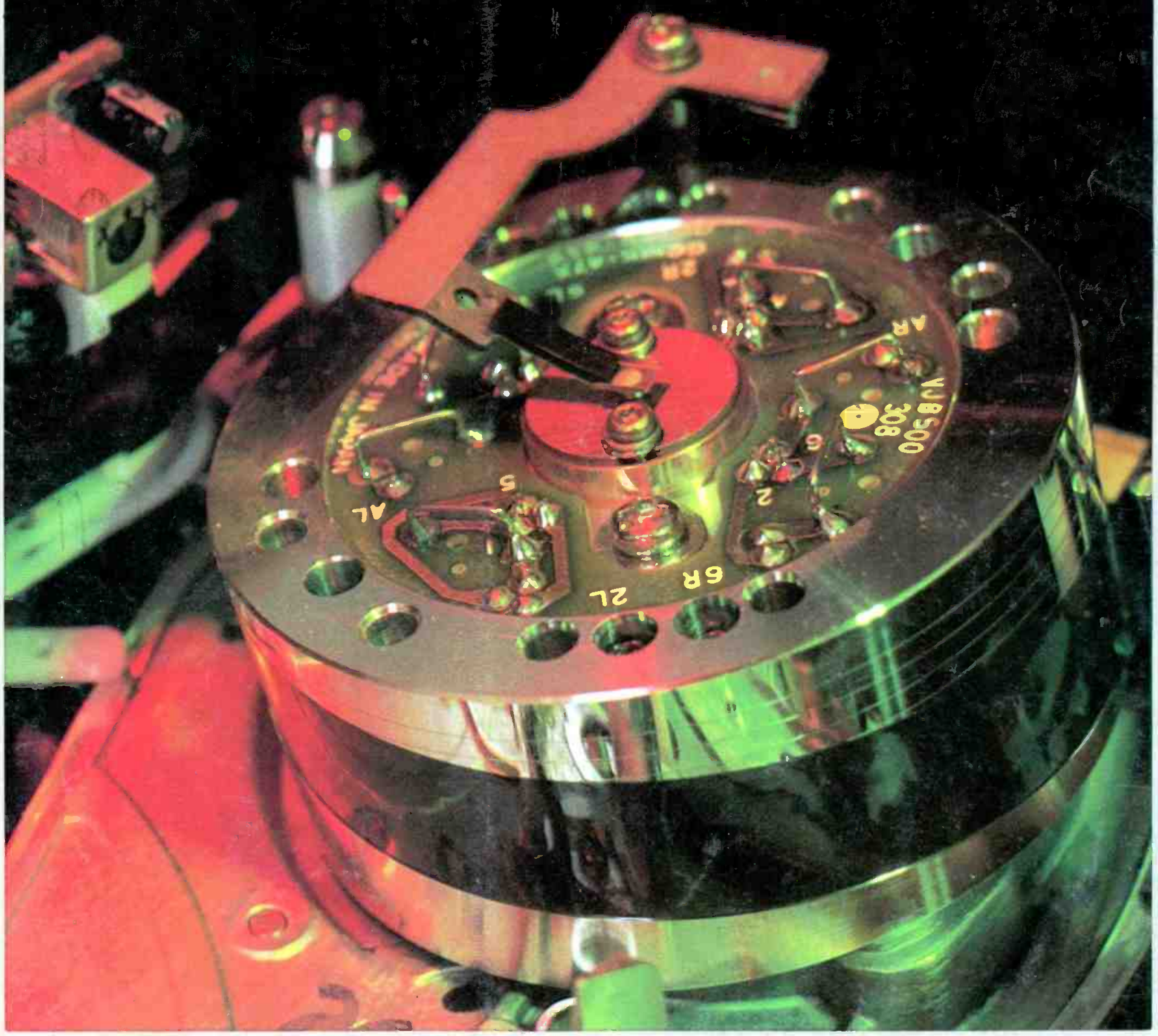
Sylvania Superset II—part 2 • The video connection—part 3

What do you know about electronics?—tuned circuits

VCR troubleshooting hints



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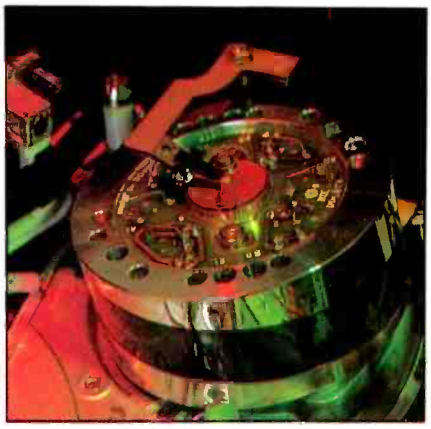
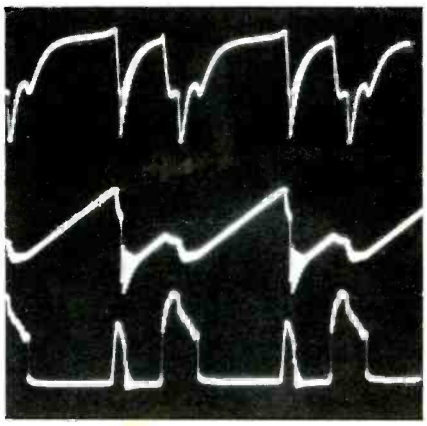
ELECTRONIC
Servicing & Technology

Volume 5, No. 5 May 1985



Troubleshooting the VCR, page 20.
Photo: courtesy of the General Electric Company.



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It all happened so fast

It all started just a few years ago. A videocassette recorder (VCR) inexpensive enough and easy enough to operate for home use was introduced. Then a trickle of video products began showing up on the shelves of a few higher-priced electronics stores. Then a short time later the floodgates opened and millions of people in the United States were buying VCRs.

At the same time, the manufacturers were busily improving the products even as they were shipping them out the door by the truckload. A list of the innovations that have taken place in video products is impressive. A few of them in no particular order are:

- Stereo hi-fi sound.
- Remote control electronic tuning.
- Freeze-frame/slow motion.
- High-speed search.
- Multi-day/multi-event programming (as far in advance as one year).

Much of the circuitry to achieve the performance exhibited by these wonderful machines represents a major change in the circuitry encountered in home entertainment electronic systems. Open one of these up and you find servo motors, microcomputers and other unfamiliar components and circuits.

All of this new circuitry represents something of a challenge to someone whose experience is limited to television and audio. An entirely new approach to servicing is required. In many cases, when one of these VCRs quits working, you check out the logic circuits first. The article "VCR Troubleshooting" in this issue deals with some of this new VCR circuitry, suggesting a logical, methodical approach to isolating problem areas.

And more to come

New technologies are "building blocks" whose eventual impact will depend upon what subsequently is designed and constructed with them. According to Professor Nathan Rosenberg of the Economics Department of Stanford University, what happens with new technology is not simply a matter of improved technical performance, but rather how they are put to use. There are a number of difficulties in predicting what the impact of such technological changes will be, he added. For example, Rosenberg said to nearly 200 people at a symposium on Economics and Technology sponsored by the National Academy of Engineering, the Stanford Center for Economic Policy Research and the Stanford Departments of Chemistry and Chemical Engineering, "Marconi understood the basis for wireless communication, but never foresaw the possibilities for a vast new entertainment broadcasting industry, reaching into every household and automobile."

The difficulty in predicting the future impact of technology being developed today can indeed be considered a problem if so august a body as this expresses concern with it. But people involved in electronics technology are well aware of it; they face it every day. We may be unable to predict what impact a given technology will have in the future, but **ES&T** will continue to keep readers alert to developments in electronics technology so that you can make your own evaluations.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

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Technology

Development of high-definition TV continues in Japan

Recently developed transmitting and receiving equipment for the high-definition color television (HDTV) system can produce pictures better than those projected on motion picture theater screens from 35-millimeter film.

The equipment, developed by Toshiba Corporation in cooperation with the Japan Broadcasting Corporation (NHK), consists of: a high-definition color TV camera, a high-definition videotape recorder (VTR), and high-definition *MUSE* transmitting equipment, all of which are to be used at broadcasting stations. Home-use equipment developed for the same system includes a high-definition 40-inch color display and a high-definition MUSE receiver.

HDTV is expected to be a key element in a next-generation broadcasting system that will make possible much finer pictures on a wide screen and better sounds than those on a conventional TV system, through utilizing a broadcasting satellite or a cable television system with large-capacity optical fiber. Conventional equipment, including TV cameras, VTRs, TV sets, and transmitting equipment, cannot be used for the HDTV system.

NHK has been developing a system that uses 1125 scanning lines per frame because the higher the number, the better the picture resolution. In contrast, current TV systems use 525 or 625 lines. Moreover, the system has the expanded aspect ratio (the ratio between screen width and height) of 5 to 3 from the conventional 4 to 3.

NHK plans to start high-definition broadcasting by using Japan's *BS-3* broadcasting satellite scheduled to be launched in 1989. Japanese manufacturers have long been developing necessary equipment for the HDTV system.

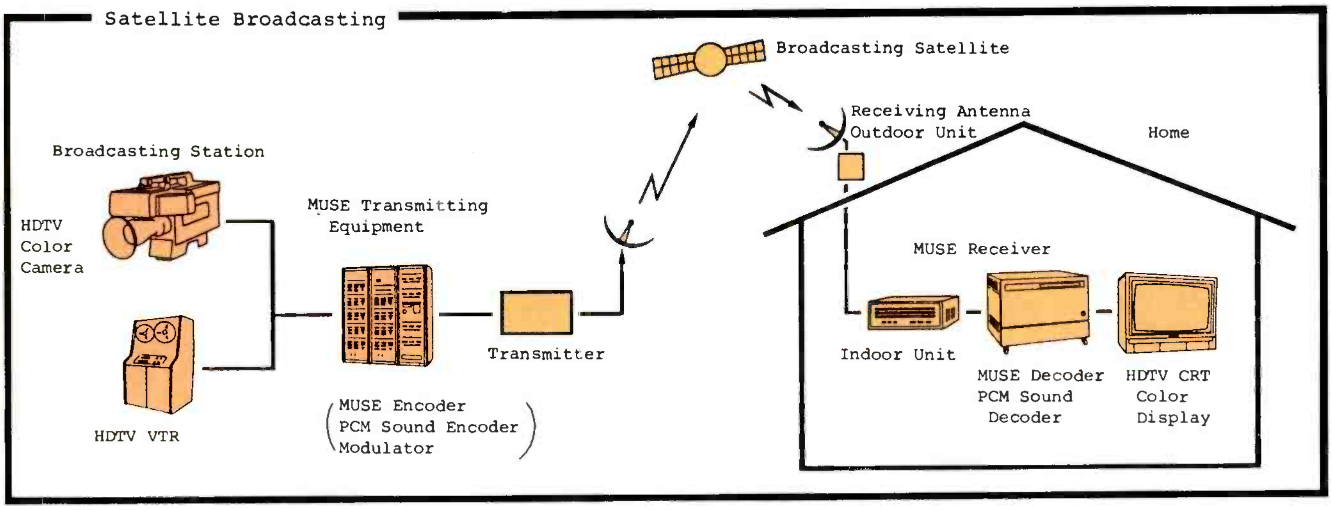
Details of the new Toshiba Equipment follow:

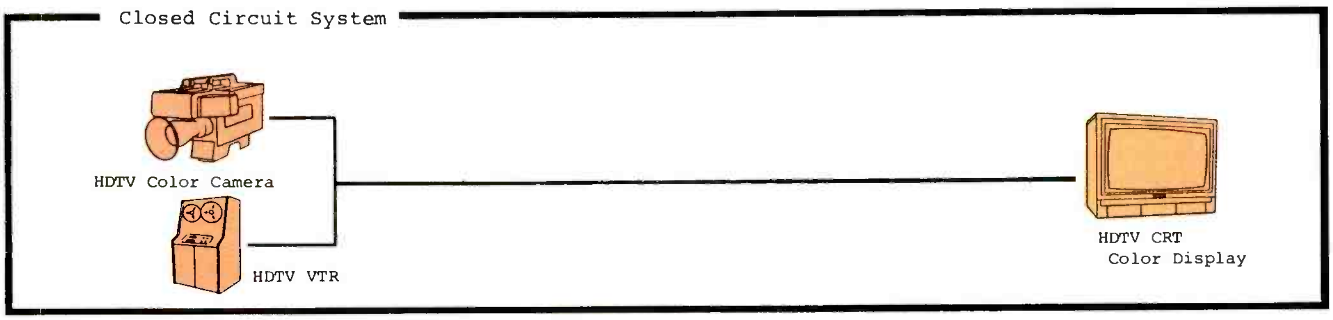
High-definition color TV camera

The new color TV camera for HDTV incorporates small, ⅔-inch, pick-up tubes ("Saticon") and is very compact (46cm long, 14cm wide and 28cm high). It is suitable for outdoor picture-taking because it operates on only 12V of battery power. It adopts a high quality zoom lens and a new circuit that corrects color mis-registration and nonuniformity.

High-definition VTR

A 1-inch high-definition VTR for studio use can record and replay 90-minute HDTV programs by utilizing four recording heads. Equipped with a high performance tape transport and microprocessors, it easily can edit a program. It can use both barium ferrite perpendicular magnetic tapes





for high-density recording, as well as conventional (cobalt gamma ferric oxide) tapes.

High-definition 40-inch color display

A 40-inch screen display has 1125 scanning lines per frame and an aspect ratio of 5 to 3, as previously mentioned, so that it can produce picture images surpassing 35mm movie films in vividness, brilliance and clarity.

New developments for the display include: a new dynamic focusing circuit that ensures sharp focusing on the entire screen; and a digital convergence circuit to automatically adjust the color registration.

To create a picture tube for such a large-screen color TV display, Toshiba developed a new large-caliber (12mm) electronic gun that reduces the diameter of electronic beams to approximately one-half the size of those produced by conventional (9.5mm) guns–thereby considerably improving TV image focus.

High-definition MUSE transmitting equipment

NHK has developed a new method of band compression called MUSE (Multiple Subnyquist Sampling Encoding). In the system, a picture is divided into some two million picture elements. One-fourth of these are transmitted to the satellite at one time, therefore four transmissions produce one picture. Image memory devices incorporated in the receiving equipment recombine the four parts to constitute a picture.

The information volume at a single transmission is relatively small, and signal bandwidth can be limited to be within one satellite TV channel. (The larger the information volume, the wider the signal bandwidth.) It was previously thought that more than two channels would be required for HDTV satellite broadcasting because of the huge, overall volume of information. The advance represented by the MUSE system is said to have opened the way to practical HDTV broadcasting.

Toshiba has developed the HDTV transmission equipment, which includes: a MUSE encoder that compresses the bandwidth to a single satellite TV channel; a PCM (pulse code modulation) encoder to transmit high-quality sound; and a modulator. The company has delivered the equipment to NHK, to be used for experimental HDTV transmission utilizing the BS-2 broadcasting satellite.

High-definition MUSE receiver

The receiver consists of: a parabolic antenna and an outdoor unit of a satellite receiver; a satellite receiver indoor unit; a MUSE decoder to reconstitute the high definition picture; and a PCM decoder to reproduce high-quality sound.

News

Power co-ops compete with satellite retailers

The entry of public electric companies into the sales of satellite dishes is strongly opposed by the National Electronics Sales and Service Dealers Association's (NESDA) Legislative Committee and the Georgia Electronics Sales and Service Dealers Association (GESDA).

According to Cliff Shaw, chairman of NESDA's Legislative Committee, "If a bill prohibiting public utility companies from selling and installing satellite stations is not passed, the situation would constitute a killing blow to independent dealers. There is no way they could compete successfully."

"Public electric companies are subsidized by the government through federally guaranteed loans and were originally created as non-profit companies formed for the distribution of electricity. The electric companies involved in selling satellite stations arrange bank financing for buyers and add the charge to their monthly electric bill," according to Dan Mundy, president of GESDA.

For more information, contact Wallace Harrison, Director of Communications for NESDA, 2708 West Berry Street, Fort Worth, TX 76109; 817-921-9061.

Servicers to receive 5 percent parts discount

Members of NASD (National Association of Service Dealers) will be able to cut parts cost by 5 percent when buying qualified parts from participating wholesalers through a new association program.

The Parts Discount Program (PDP) will be initially available only in the Midwest through Garron's Distributing, which has two outlets in Milwaukee, WI, two in Iowa and one in Chicago.

To qualify for the 5 percent parts discount from participating wholesalers, service dealers must be members of NASD or NARDA and meet simple conditions on ordering required by authorized parts dealer.

For more information on PDP and NASD membership, contact NASD, 2 N. Riverside Plaza, Chicago, IL 60606.

CEG announces formation of Telephone Subdivision

The Electronic Industries Association's Consumer Electronics Group (EIA/CEG), Washington, DC, has formed a Telephone Subdivision that held its first meeting during the EIA Spring Conference in Washington.

Under an agreement reached between CEG and EIA's Information and Telecommunications Group (ITG), and approved by the EIA Board of Governors, CEG will coordinate state legislative activity, conduct consumer affairs programs, gather and disseminate certain sales data on the retail telephone market, and continue to provide what has become the essential marketplace for the industry, the International Winter and Summer Consumer Electronics Shows (CES). ITG, for its part, will have responsibility for engineering standards, relations with the Federal Communications Commission (FCC), liaison with Underwriters Laboratories, and marketing services related to the EIA statistical program covering telephones.

To ensure that EIA telephone members are most effectively served, a Telephone Coordinating Committee has been established.

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PART TWO

Analyzing the Sylvania Superset Two

By Carl Babcoke, CET

General layout, unusual features, adjustments and precautions for the Sylvania model RX-S198WA TV receiver with its 19C4-03AA chassis were given in our February issue. A few of the many interesting features include a sophisticated decoder that produces two stereo audio channels when the TV program audio is in stereo, and a jack panel for connecting stereo audio inputs and outputs plus a video input and output. Direct video connections produce sharper pictures than RF modulators do. Twin audio amplifiers with tone controls and two external speaker cabinets complete the stereo system. This receiver can be called a TV receiver/monitor.

Before these circuits can be explored, it is necessary to describe many details of the power supplies and TV circuits. TV power systems no longer are simple brute-force rectifier/filter circuits with high-wattage voltage dividers to supply lower voltages. Many of these new dc-power supplies equal the horizontal-sweep systems in circuit complexity. Start-up and shut-down systems add to the complications and make troubleshooting more difficult. If you're planning on tackling a set such as this, you must have a working knowledge of all these circuits and how to troubleshoot them, unless you are content to limit your servicing to changing entire circuit boards. General knowledge no longer is sufficient because of major differences in circuitry between various models and brands.

General information

Figure 1 shows the Sylvania 19C4 chassis, picture tube and cabinet from the rear with the back removed. Notice the white plastic framework at the bottom. This is the frame that holds the two large circuit boards in place. The frame also acts as a base for metal brackets that support the tuners, tuner-control board, stereo-audio decoder board and other circuit boards.

In general, there are three sections. The power-supply/horizontal-deflection and high-voltage board is at the extreme lower right (Figure 2). Near the center and below (Figure 1) is a large board for the IFs, horiz/vert oscillators and the vertical-deflection system. At the extreme left are the boxes for RF switching, tuners, tuner-control and stereo decoder. Any of these three sections can be removed completely, but with some difficulty because of the many plugs and cables.

The white-plastic framework can be removed from the cabinet (along with all attached boards and shielded boxes) by removing one metal screw at the extreme right and another at the extreme left side. Then the whole thing can be slid backward an inch or so (to disengage the three plastic hooks that slide under and grasp metal brackets in three shallow holes) before lifting up the assembly and sliding it backward to remove it. Some cables must be unplugged to remove the assembly. Or, the assembly can be moved backward a couple of inches, allowing Q601 horiz output to be removed, without unplugging any cables.

Reinstallation of the *chassis* assembly is done in reverse, however be careful to place the three hooks (at the lower front edge) inside the shallow holes *before* the assembly is moved toward the receiver's front. Otherwise, the hooks will not engage and the plastic frame can be left warped without proper support at the front, even when the side screws are installed.

There is no metal chassis as used in older models.

A single diode (D500 in the schematic titled "Basic Rectification") rectifies the 120Vac line power in the 19C4. (A 4-diode bridge is used in the 25C4 version to provide slightly higher dc

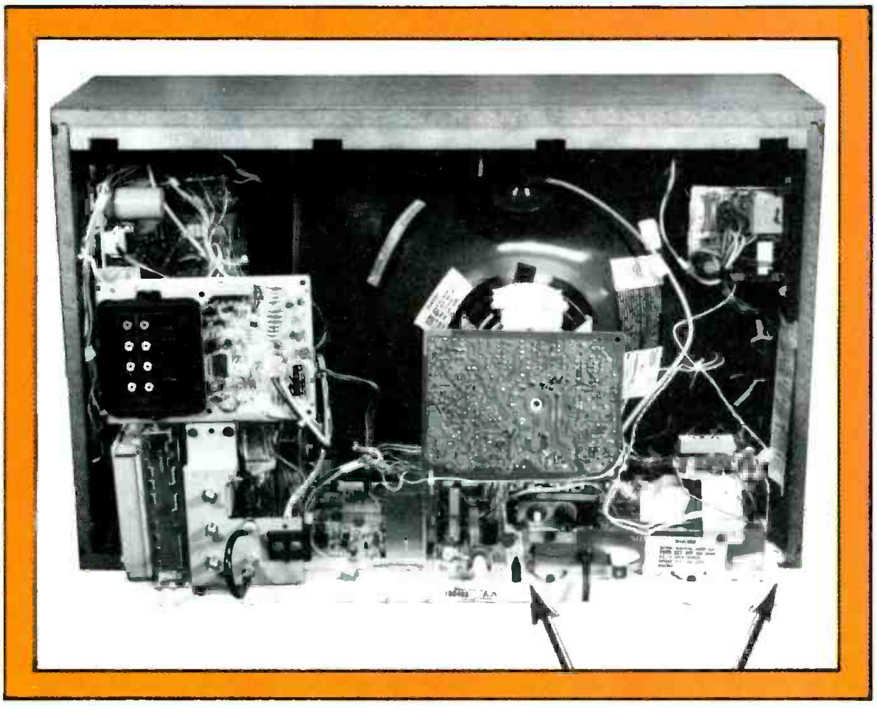

Figure 1. Little unused space is found inside a Sylvania TV model RXS198WA with a 19C4-03AA chassis. In this rear view with the back removed, the two horizontally mounted boards are visible at the bottom inside a white plastic frame. At the right, arrows indicate the power-supply/horiz-sweep board that includes the voltage-regulator circuit.

voltage.) Notice that the current flows from D500 through surge resistor R501 and the primary winding of T500 start-up transformer before reaching the input filter capacitor C502. See photographs in Figure 3, Figure 4 and Figure 5 for location and appearance of these components. The unregulated source at C502 measures between +149V and +150V according to picture brightness, which changes the load current. The ripple is 60Hz sawteeth of slightly more than 8VPP.

Also, the schematic in Basic Rectification includes part of the start-up circuit, including T500 (Figure 5), D503 and C503. Partial wiring is shown for the distribution of start-up dc voltage to the oscillator IC, the horizontal-predriver transistor and the horizontal-driver transistor. Output Q601 (not shown) receives dc power from the +110V regulated source. During start-up, a pulse of dc voltage from D503 (stored briefly in C503) allows the oscillator, predriver and driver stages to operate weakly and drive the Q601 input. The horizontal-deflection system increases in power rapidly until it reaches maximum and the +24V scan-rectified supply takes over the load as D503 is reverse biased to disconnect the start-up circuit.

Hot and cold grounds

Two completely separate grounds are employed in the Sylvania 19C4 chassis. As shown on page 14, one side of the input power goes through a winding of L500 to the *hot* ground, which serves as a common ground for the +150V and +110V supplies. Notice the *cold* ground symbol at the secondary winding of T500 start-up transformer. This cold ground must be connected to other cold grounds of several voltage sources that are produced by rectification of horizontal-deflection power from the flyback.

Figure 3 identifies two metal panels that can be used conveniently for *most* waveform and dc-voltage tests involving hot or cold grounds. Although the ac plug on the power cable has one wide prong that theoretically connects hot grounds to the line-power external ground, do not depend on this partial safeguard when connecting test equipment to the receiver. *Always use an isolation transformer* to eliminate possible damage to the receiver or the test equipment, and to prevent shocks.

In summary, the *hot* ground is used for the +150V and +110V power supplies, the Q601 horizontal-output stage, the flyback primary's ac ground and the horizontal yoke's ac ground. All other stages are referenced to *cold*

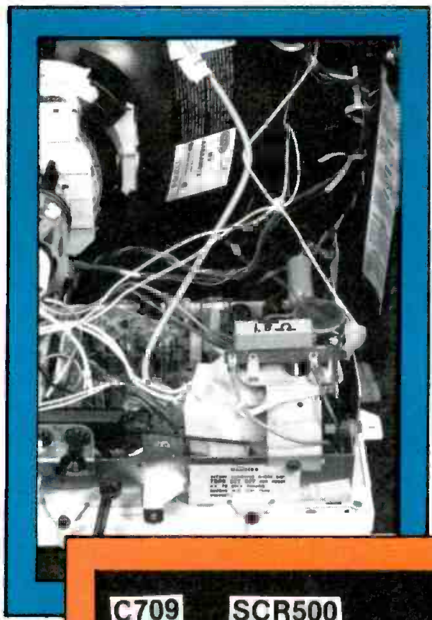

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Figure 2. The power/regulator/horizontal board; the large white mass on the board is the T700 flyback. Two variable controls at the left are the screen (or G2) control and the focus control.

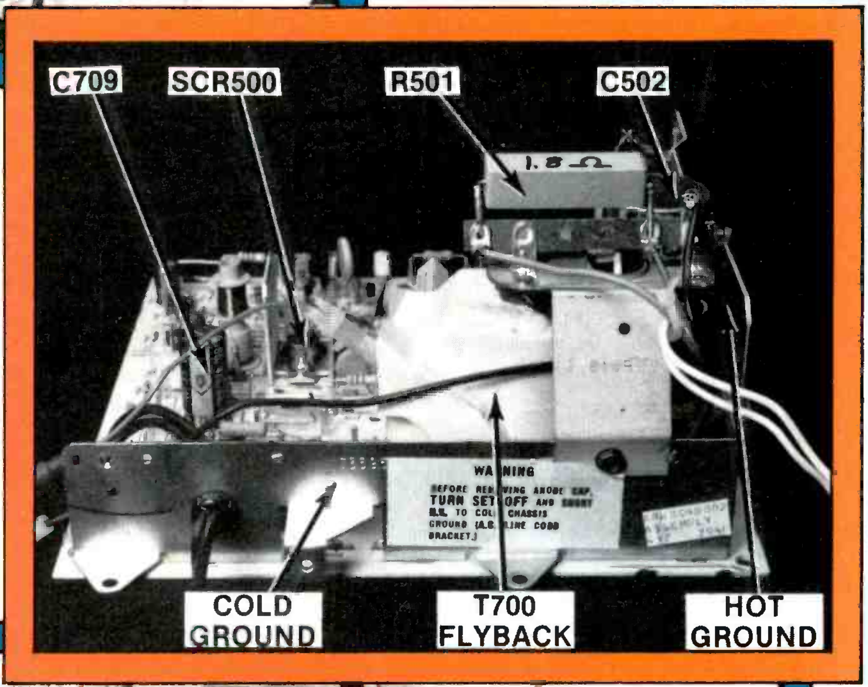

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Figure 3. Arrows point to two metal panels that serve as hot and cold ground for the power/horizontal board (shown in the receiver as viewed from the rear). Other arrows point to locations of other important components.

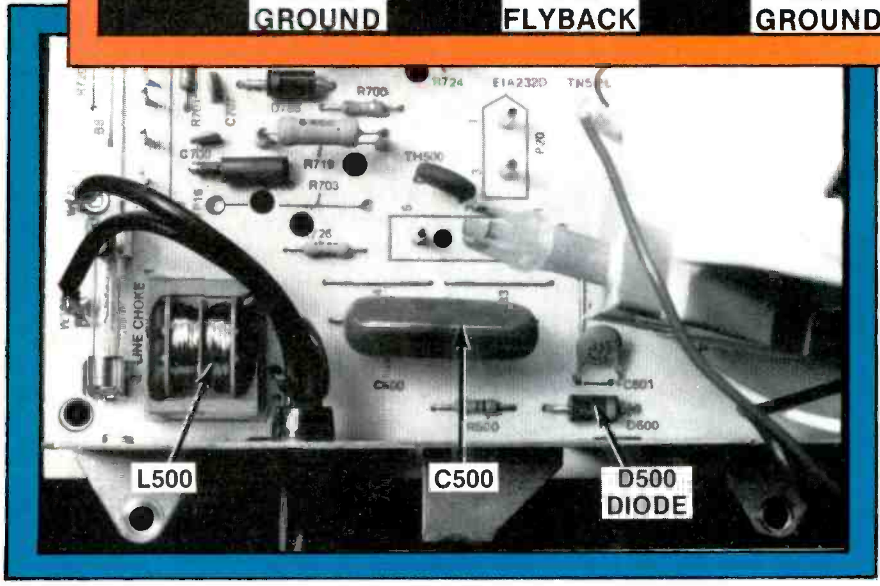

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Figure 4. Important power-supply components are identified by three arrows.

ground that has no continuity to hot ground or the 120Vac input voltage.

Regulation by integrating dc pulses

Regulation of the +110V source that powers the horizontal-output stage is effected by varying the duty cycle of dc-voltage pulses. These pulses are subsequently smoothed by a low-pass filter into pure dc voltage of a value equal to the *average* voltage of the pulses before filtering.

Before the circuitry is examined, several proofs that this is a valid method are described and illustrated in "Proving dc pulse integration," page 16.

A highly simplified schematic of the 19C4 basic regulator is given in Figure 6A which shows SCR500 as a manually operated switch. (In the actual circuit, the SCR switch is placed after R513 and L501. But placing them as shown makes the low-pass-filter action clear, without compromising the operation.)

The block diagram of the entire rectifier-and-regulator system (Figure 6B) shows the purposes of various major components and how they are connected. Study this diagram and the explanation until the operation becomes clear. That knowledge will help you understand the complete circuit presented next.

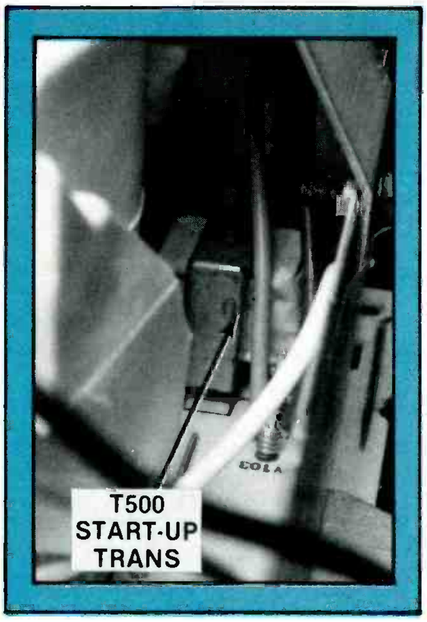

Figure 5. T500 start-up transformer is almost hidden behind the flyback in a corner of the power/horizontal board between hot- and cold-ground panels.

19C4 SCR regulation

Briefly stated, the +110V regulated source is monitored by three transistors that adjust the exact time during each horizontal cycle that the SCR500 regulator is gated into conduction. "The SCR-Regulator Circuit," page 19. This conduction applies some of the +150V source to C512 and the horizontal-output stage, and the conduction continues until stopped by the next negative-going horizontal pulse (from a separate winding on the flyback) that reaches the SCR anode. Shorter conduction times during each horizontal cycle decrease the regulated voltage, while a longer conduction time increases the regulated +110V source. Therefore, the circuit compensates for line-voltage variations as well as for changes of load on the horizontal-deflection system.

Details of the regulator circuit are provided on page 19, along with waveforms and circuit operations. Voltage variations of the +110V source change the conduction current of Q500, thus varying the C507 voltage charge. When the C507 voltage increases to a critical value, it triggers Q501 and Q502 into a regenerative latching mode where each forward biases the other until both are saturated and C507 is discharged by one large pulse of current through Q502. This Q502 collector current flows through switching diode D504 and the T501 primary, with the T501 secondary winding inducing a single positive voltage pulse at the SCR500 gate. This, in turn, triggers the SCR into conduction to replenish the +110V source at C512. SCR conduction and the resulting gradual increase of C512 voltage continue until the next horizontal pulse arrives at the SCR500 anode to stop the conduction. A detailed explanation is given on page 12, while Figure 7 identifies many regulator and safety-circuit components.

Regulation efficiency

Regulation in the Sylvania 19C4 chassis operated very well, as shown by the following measurements taken at different line voltages of the +150V TP9 source vs. the TP24 +110V regulated source:

LINE	TP9	TP24
125.2Vac	+156V	+111.3V
120.3Vac	+149.2V	+111.0V
110.2Vac	+134.2V	+109.7V
100.2Vac	+119.1V	+107.6V
90.6Vac	+105.5V	+103.8V
85.0Vac	+ 97.1V	+ 92.7V
80.4Vac	+ 90.6V	+ 86.3V

When the line voltage was varied, the picture size changed slightly, although the picture covered the entire screen down to about 90Vac. Reliable start-up was possible down to 90Vac, also. When the ac voltage was slowly reduced to less than 85Vac, the picture began to brighten noticeably. Unless the brightness control was turned down to darken the screen, the brightness and the CRT current became excessive, triggering the CRT-current section of the shut-down safety circuit so the *on/off* relay clicked and all power to the receiver was lost (except for the remote-control receiver).

Is the theory correct?

Waveforms of the SCR500 anode voltage and current (Figure 8) show changes of the SCR conduction times to be totally inadequate for good regulation, yet the dc voltage readings prove the regulation is good. At the normal 120.3Vac line voltage, for example, the waveforms showed SCR500 conduction for 31 percent of each horizontal cycle. But 31 percent of +150V is only +46.5V, although the 31 percent conduction produced +111V. Calculated the other way, +111V divided by +150V yields 74 percent conduction. Why is the conduction time so short, and what accounts for the extra 64.5V?

When the brightness was increased to maximum and the line voltage reduced to 100.3Vac, waveforms in Figure 8B showed conduction of slightly more than 49 percent of each cycle with a supply voltage of +119.1V and a regulated voltage of +107.6V. But 49 percent of +119.1V is only +58.4V, although the measured voltage was +107.6V. Also, 107.6V divided by 119.1V equals an expected conduction time of 90 percent. How can the short conduction time produce such a high

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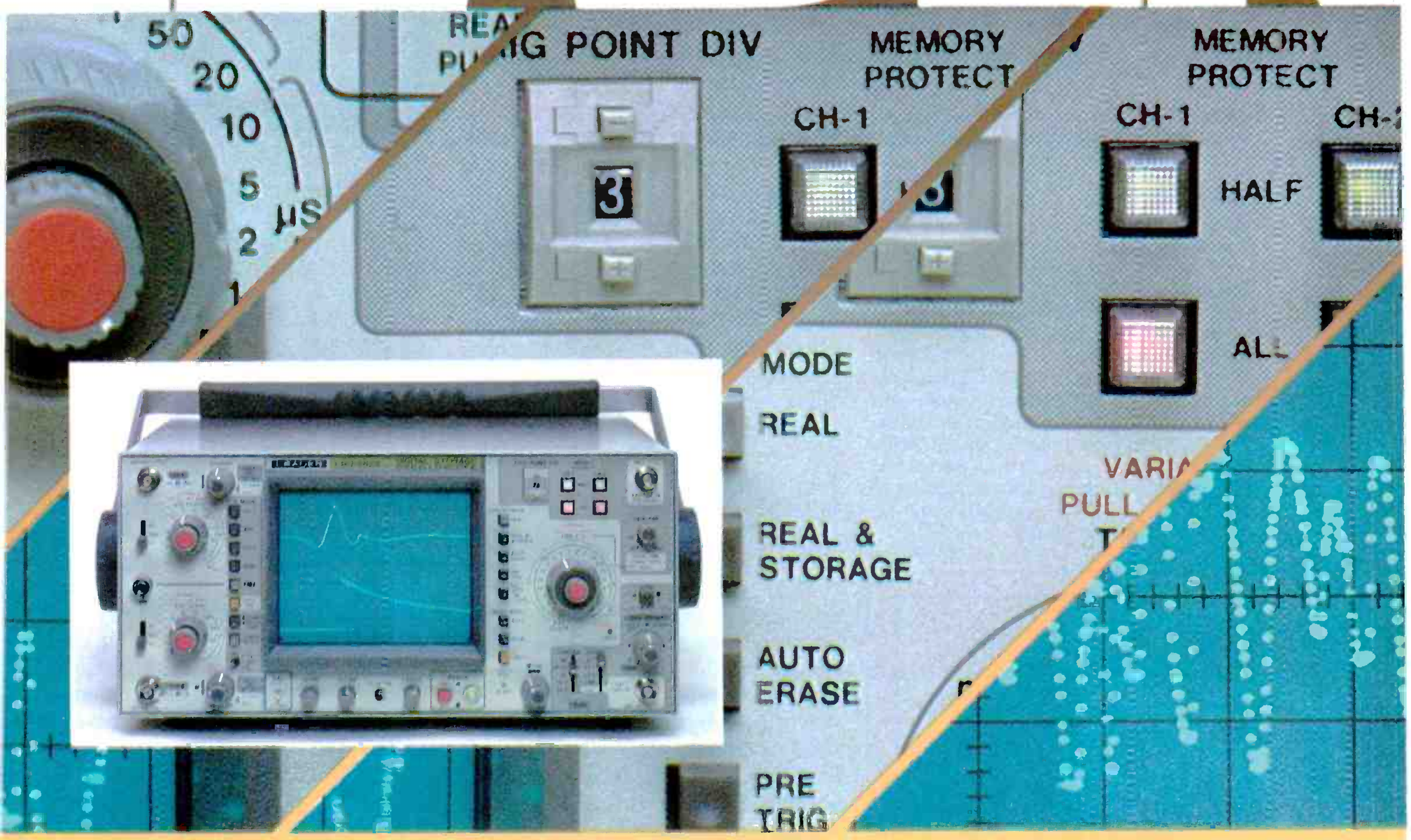

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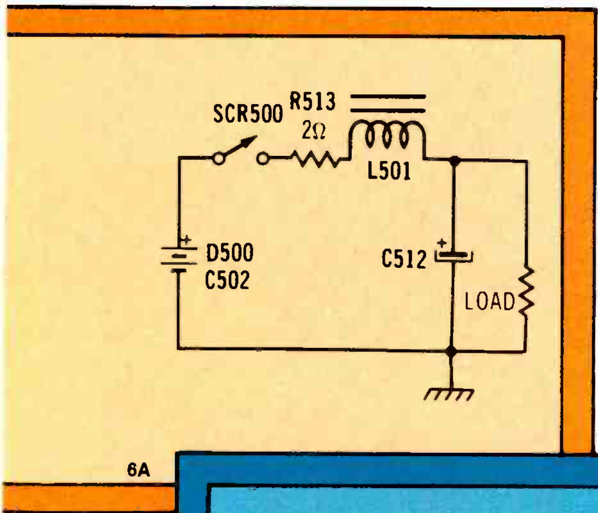
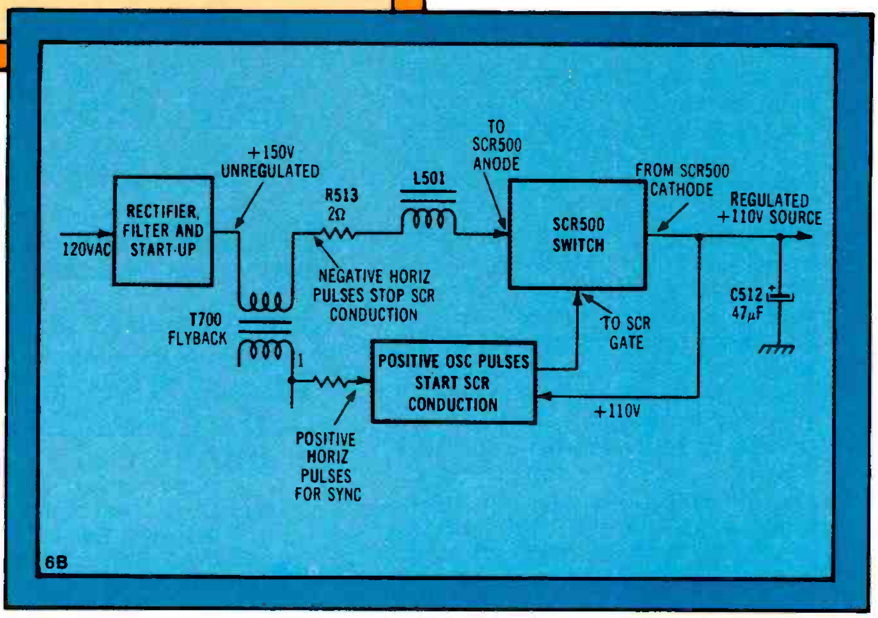
Figure 6. Regulation of the +110V source in the Sylvania 19C4 is accomplished by changing the amount of time (during each horizontal cycle) that the +150V supply replenishes the +110V supply. The theory is identical to the filtering of variable-duty-cycle dc-voltage pulses previously discussed. (A) Greatly simplified, the +150V supply (shown as batteries) is switched by SCR500, while R513 and L501 prevent the current from increasing too rapidly into C512, the smoothing filter capacitor. Without R513 and L501, the circuit would have been peak reading, and different duty cycles of SCR500 current would produce the same +150V output. In other words, there would be no regulation. Notice that R513 and L501 together form the resistive leg of a low-pass filter, with C512 as the capacitive leg. (SCR500 was drawn on the opposite side of R513 and L501 to make clear the filter configuration.) (B) This block diagram shows the major components and the general connections of the +150V unregulated supply and the +110V regulated source. Three transistors determine when SCR500 conducts, with two of them operating in a type of relaxation oscillator that gates on SCR500. Notice that a sample of horizontal sweep also is sent to this oscillator to discharge the C507 oscillator during horizontal retrace, also.





regulated voltage? Where did the additional +49.2V come from?

These figures do not prove the principle of integrated dc pulses is in error. Instead, the additional voltage comes from a second source: *rectification of the pulse waveform at the SCR500 anode.* You may disagree at first with that statement. They will reply that the pulses are negative-going, and a diode (such as SCR500 when conducting) cannot rectify or conduct when its anode is negative relative to its own cathode. That statement certainly is true, but notice that the +150V unregulated supply is added to those negative-going pulses, moving the zero-voltage line far down on the pulses. All areas of the waveform that are above the zero line are positive. Therefore, they are rectified and their dc voltage added to the pulses of dc voltage from the +150V supply. Both signals are filtered by the L501/R513 vs. C512 low-pass filter, and both contribute to the +110V regulated-supply voltage.

Most of the regulator circuit operations can be viewed and analyzed by scope waveforms, particularly when the various important dc levels are added to the waveforms by the scope. But some vital areas are hidden by the SCR conduction itself. When an SCR conducts, there is only a small voltage drop (about 1V) between anode and cathode; for most practical purposes, the SCR is a dead short when conducting. Therefore, during conduction times, the

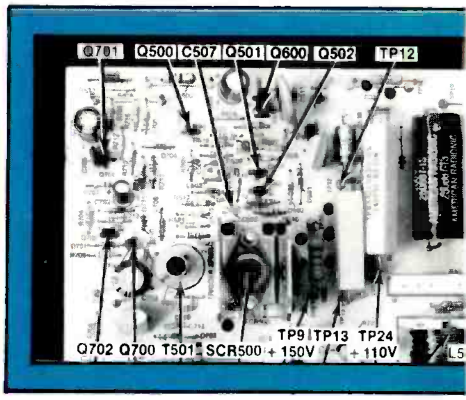


Figure 7. Regulator components and test points are identified on the power/horizontal circuit board.

anode dc and ac voltages are identical to the cathode dc and ac voltages. In other words, the bottom of the notch in the SCR500 anode waveform is the +110V source during the same time period.

Rectifying the waveform

Previously, it was stated that L501 and R513 were added in series between the ac/dc input signals and the SCR500 anode as current limiters. That is only one of their three functions. First, without them, SCR500 and C512 would produce peak-reading rectification that would prevent pulse-width regulation. Second, without L501 and R513, the 460VPP pulses from the flyback winding would be connected directly to C512 during SCR conduction. At the horizontal frequency, C512 is nearly a dead short, so the flyback winding would be excessively loaded with an ac dead short. Obviously, the horizontal-deflection system cannot operate with such an overload. Finally, L501 and R513 act as the resistive leg and C512 acts as the capacitive leg of a low-pass filter that is required to integrate the dc pulses, giving an average reading.

During SCR500 conduction, however, this low-pass filter appears to remove all the pulse waveform from the SCR500 anode. It is easy to mistakenly assume that the pulse waveform has been eliminated, while the +150V dc voltage is unchanged by the low-pass filter, and that the pulse waveform cannot play any part in increasing the dc voltage at C512 or reducing the conduction time. It seems logical to assume

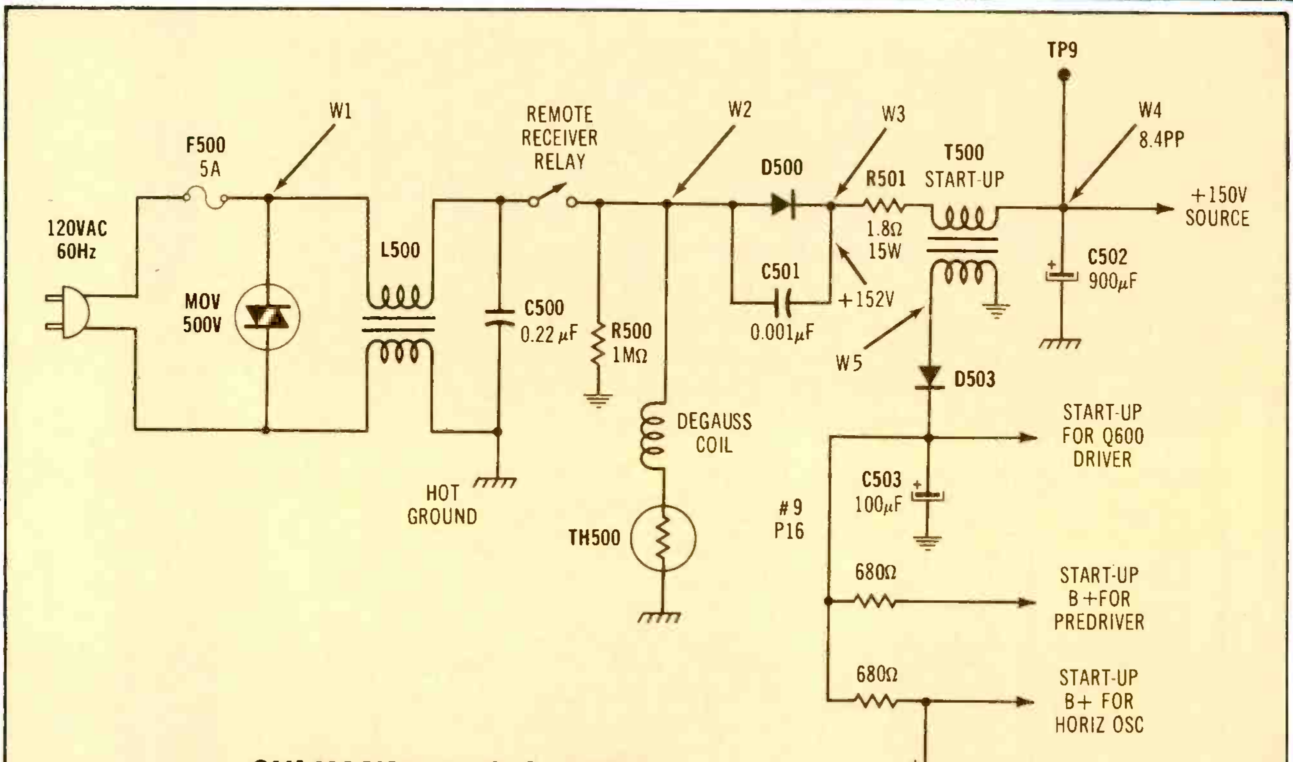
Basic Rectification—One diode (D500) rectifies the 120Vac line voltage, while C502 is the peak-reading input filter capacitor. R501 limits the inrush of current when power is switched on. Start-up transformer T500 is left connected at all times, but it only does something useful immediately after power is switched on and during the time when C502 is acquiring its voltage charge.

Remember, an uncharged capacitor is much like a short circuit (it accepts a high current and has virtually zero voltage drop across it). Therefore, if the power is switched on when the incoming line voltage is at the tip of the first positive peak, a huge current (limited mostly by R501) flows into C502, beginning to charge C502.

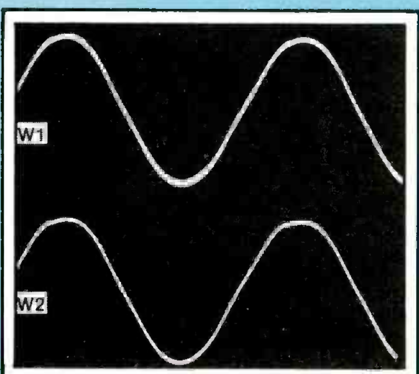
The next few rectified positive peaks produce progressively smaller currents as C502 begins to build up a voltage charge. These pulses of dc current flow through the primary winding of start-up transformer T500. Consequently, the large current pulses at first produce large voltage pulses in the secondary winding.

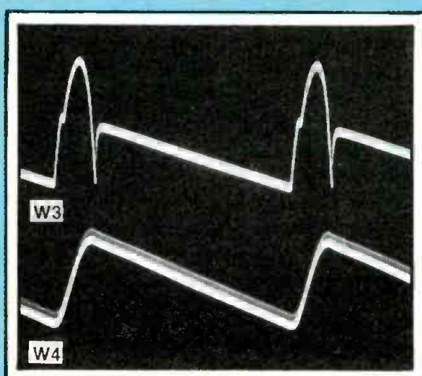
These voltage pulses are rectified by diode D503 and stored in filter C503 before the resulting dc voltage is sent to the horizontal oscillator, predriver and driver stages. The fourth stage (Q601 output) already has dc voltage from the +110V supply, so the horizontal system begins to operate but at this time it only operates weakly. Now, it operates at a fraction of its full output.

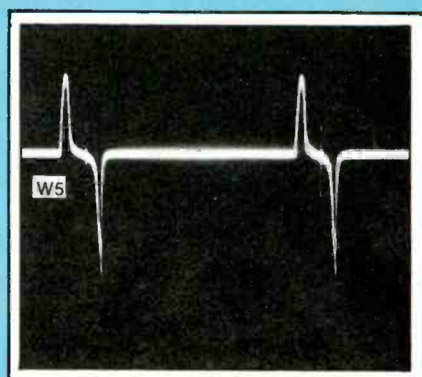
When the scan-rectified supplies build up, the horizontal system gradually but rapidly acquires stronger operation and in a fraction of a second, the horizontal system has full power. The +24V scan-rectified source is increasing in voltage while the start-up voltage is decreasing. When the +24V supply voltage exceeds the start-up voltage, diode D503 is reverse-biased, and it becomes an open circuit, disconnecting the start-up dc voltage from the +24V supply. At this time of *normal* operation of the receiver, T500 continues to develop voltages from the pulses of +150V-supply current, but the amplitude is low enough so only a small conduction at the tip of the pulses (Waveform 3) causes minor clipping of the pulse waveform.



SYLVANIA BASIC POWER







Proving dc-pulse integration—The theory of integration of dc pulses can be proved by a pulse generator, a good dc scope, a DMM and a few components. (1) Check the generator by using dc coupling in the scope. When the desired pulses are obtained, move the ac/ground/dc switch from dc to ground. The resulting horizontal scope line will be located exactly where the pulse's base line previously had been, *if the pulses are dc*. This line marks 0V. However, if the pulses are ac type (without any dc component), the line will be at the average-voltage point (which moves up and down with the duty cycle). If the pulses are ac, add positive dc voltage from a variable supply through a large value resistor to the pulse waveform and adjust the dc voltage so changing from dc to ground places the 0-voltage line on the base line. When the same pulse pattern is displayed using the scope's ac-coupling mode and the switch then changed to ground, the resulting horizontal line will mark the *average* voltage (top trace).

Measure with the scope's calibrations the voltage from the zero base line to the average-voltage line and compare it with the total height. Alternatively, measure the duty cycle (time of one complete cycle vs. the time of one pulse). With the top trace in Figure A, about 15 percent is obtained in both cases. If the scope doesn't drift, and the scoping is done carefully, the answer should be the same as that given by a DMM's dc-voltage function. You will find, of course, the meter reading is more accurate.

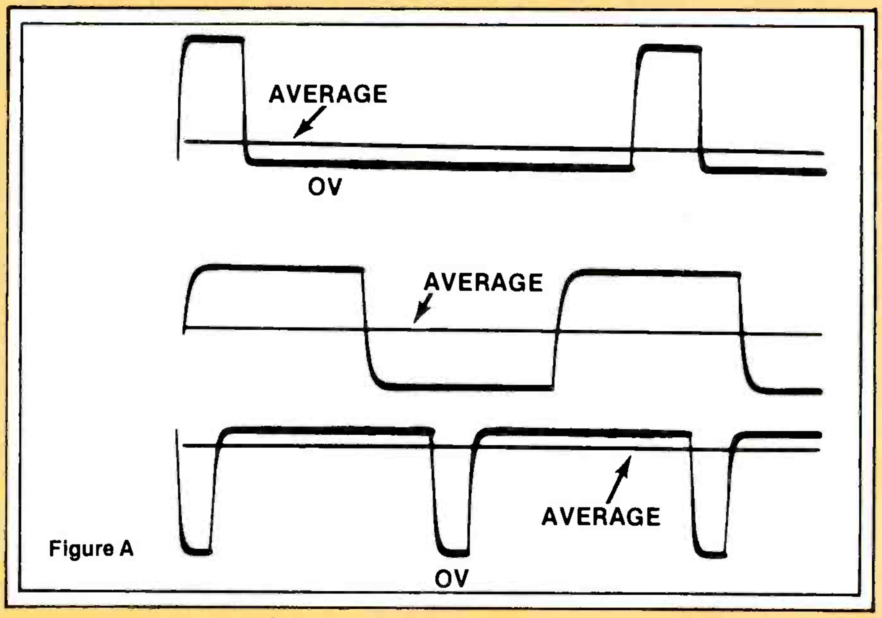
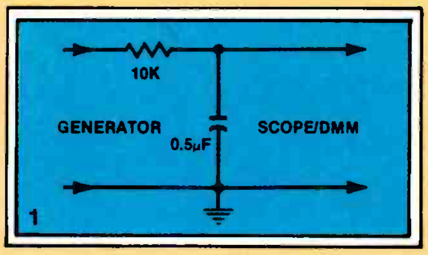
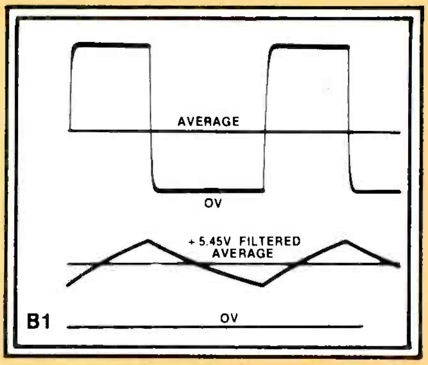
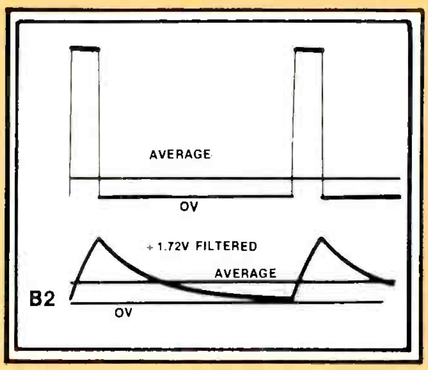


Figure A



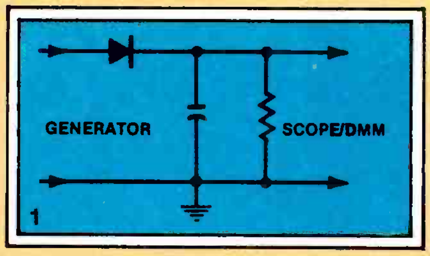


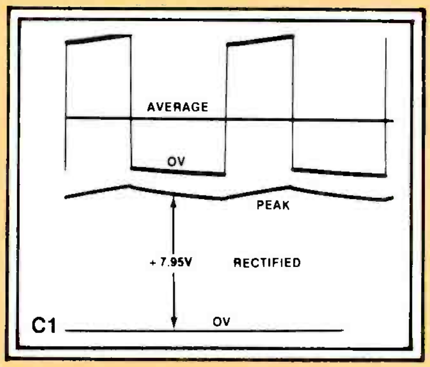


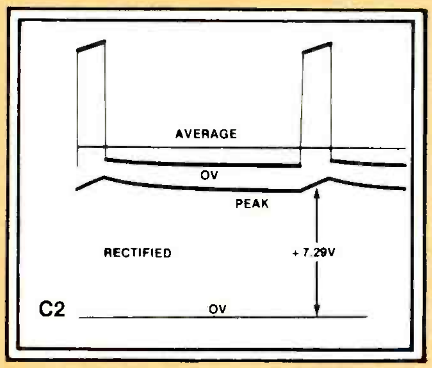
And remember that a *good* DMM integrates all pure-dc and pulsed-dc components, thus giving accurate voltage readings with dc pulses. An average-voltage line just slightly below half the pulse height (center scope trace) indicates a duty cycle of about 48 percent (to verify: measure one cycle vs. one pulse).

As shown by the bottom scope trace, higher-duty cycles have the average-voltage line (the voltage between it and zero at the baseline is the average positive voltage of the waveform) nearer the maximum pulse amplitude. This one measured about 83 percent by average-voltage-line and duty-cycle methods, and the DMM verified the figure. (B1) Scope and DMM measurements both prove the dc voltage of the top waveform (40 percent duty cycle approximately) is the same before the filter or after passing through an R/C low-pass filter. The DMM readout was +5.45V for input and output waveforms (top photograph). Similarly, the shorter duty-cycle waveforms in photograph (B2) measured the same +1.72V filtered and unfiltered (that is, the filter did not change the average dc voltage). *Note:* The unfiltered pulses have average-voltage lines added by the scope, while the filtered waveforms have an average-voltage line through the waveform and a true 0-voltage line below. Notice that the distance between the base line and the average voltage line of the unfiltered (top) waveform is equal to the distance from the filtered waveform's average-voltage line and the true 0-voltage line below. This indicates the dc voltages are equal. (C) The results are vastly different when the dc pulses of various duty cycles are *peak rectified*. When all test conditions remain the same, *variations of pulse width do not change the dc-voltage output.*

Average dc-voltage lines have been added by the scope to the unfiltered waveforms in photograph C1, showing the pulses' average dc voltages were very different. Arrows point between the ripple waveforms and each rectified waveform's 0-voltage line a long distance below. The dc voltage is between the average-voltage line of the ripple (not shown because of crowding) and the 0-voltage line. Notice that the distance between those lines is approximately the same (indicating nearly equal rectified voltages), although the originating pulses had greatly different duty cycles and measured average dc voltages. (The 40 percent duty-cycle pulses had a rectified output of +7.95V, and the short duty-cycle pulses produced +7.29V. As explained before, these voltages would have been identical if the repetition rates had been identical.)







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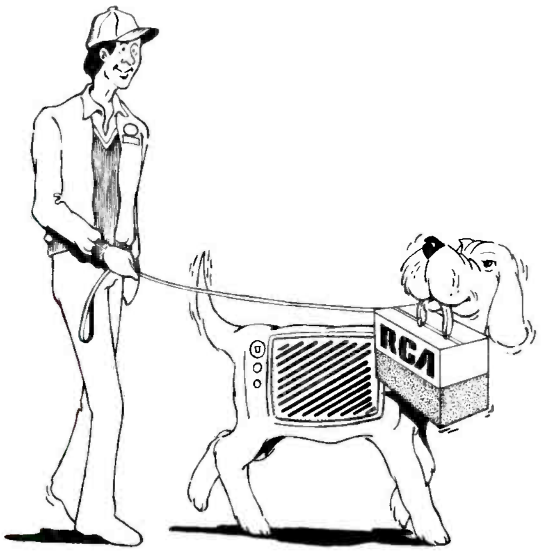

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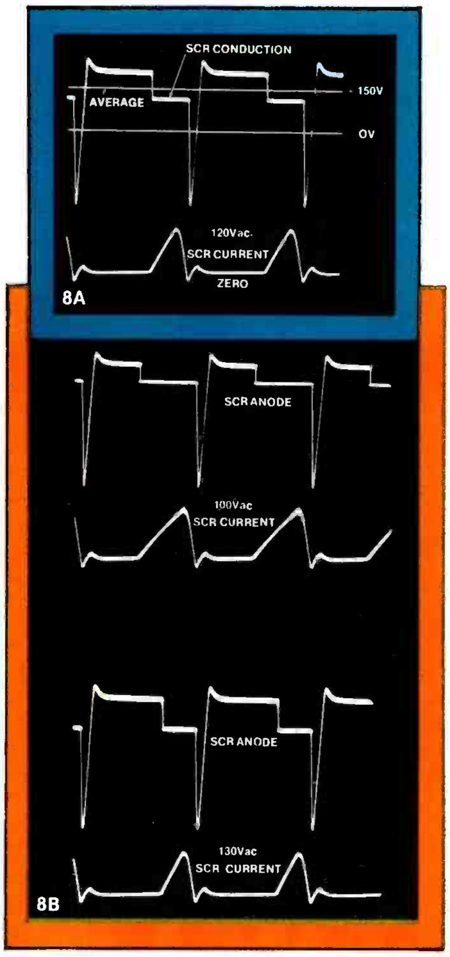


Figure 8. Rectification by SCR500 of all positive parts of the anode waveform during the conduction time produces dc voltage that is added to the gated +150V dc pulses, and both dc voltages are averaged by C512, becoming the +110V source at TP24. (See text.)

that the pulse waveform does nothing useful except turn off the SCR. It's logical, but incorrect.

The important missing point is that *the regulation actually operates by varying the dc current into the C512 capacitor.* Then the load pulls dc current from C512 as needed. As shown in the Figure 8 waveforms, the SCR current flows for a longer time and with increased amplitude (more milliamperes) when the +110V regulated-source voltage drops and the SCR current replenishes the voltage in C512. Notice the sawtooth or ramp waveform of the current flow in all cases. (Perhaps we should state one fundamental about capacitors: an uncharged capacitor has zero current and zero voltage. When current flows into the capacitor, the voltage starts at zero and increases as the current decreases until a fully charged capacitor will have maximum voltage and zero current. Disconnect the input voltage and connect a resistor across the charged capacitor. The capacitor voltage goes down as the current from the capacitor flows into the resistor, beginning with maximum current and ending with zero current and zero voltage.) So C512 acts as a storage device, receiving current to increase its voltage and delivering current to decrease its voltage.

Notice that the amplitude of the input waveform in any R/C type of low-pass filter determines the current flow into the filter's capacitor. The ac voltage or signal ripple across the capacitor does not determine the capacitor's current flow. Essentially the same thing is true for a series rectifier circuit. When the rectifier is a silicon diode, the voltage drop across the diode is only about 1V. So the diode will have almost zero voltage (about 1V) between anode and cathode during diode conduction, because of the low internal voltage drop and the large-capacitance filter capacitor at the cathode. Therefore, *the input ac voltage is connected to the filter capacitor during times of diode conduction.* A current-limiting surge resistor or the winding of a power transformer must be used to supply the anode voltage to limit the peak currents that can damage some components. There is a noticeable resemblance to the SCR500 circuit.

During SCR500 conduction time, there will be virtually no ac from the pulse waveform or dc voltage from the +150V supply at the SCR anode. That is not important to the regulation. Remember it is the input voltage during SCR conduction that is important.

Until SCR500 begins to conduct during each horizontal cycle, the SCR anode waveform is identical to the incoming pulse waveform from the flyback. Notice in Figure 9 that this base line (at top of pulse, because the pulse is negative-going) is *not* 0V of the waveform. If the +150V source had not been connected, the average-voltage line (top horizontal line) of the pulse waveform would have been 0V. Because the +150V source *is* connected, the waveform's average-voltage line represents +150V. And the base line is 50VPP more positive, so it is at +200V above the true zero line (the bottom horizontal line).

Therefore, when SCR500 conducts previous to the negative pulse, the SCR is gating +200V and not merely the +150V supply, as we might otherwise assume. That fact illustrates the major reason why actual conduction times are shorter than calculated conduction times: *Rectification of the waveform was not considered before.* Dc power from waveform rectification by SCR500 is added to the +150V source, making the actual input voltage much higher than it originally appeared. According to scope measurements, the addition of the +150V supply to the voltage from the waveform's base line produces +200V, which is the basic supply voltage available between the beginning of conduction and the start of the next negative-going pulse.

The Figure 9 waveforms show other important facts about the SCR current. Notice that the current increased linearly from the point where SCR conduction began, and it reached maximum at the start of the input's negative pulse. During this time, the +150V supply voltage and the

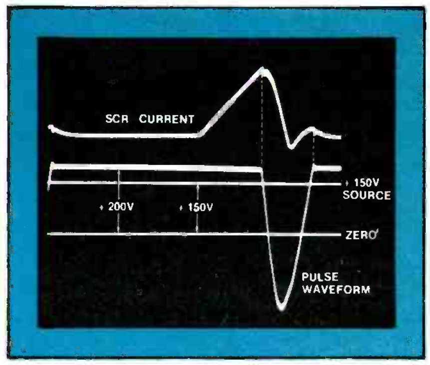
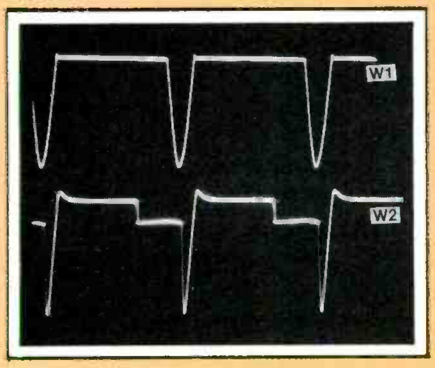
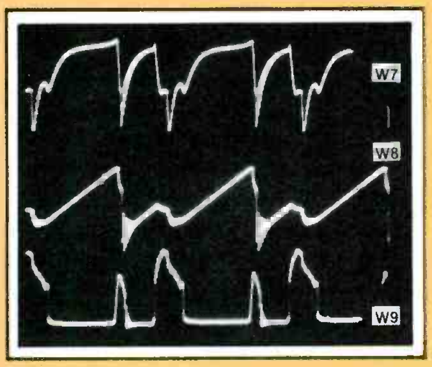


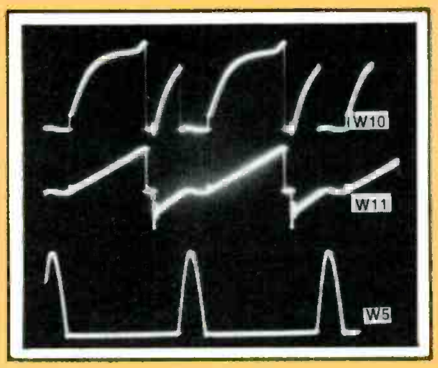
Figure 9. The top waveform is the SCR anode current, and the negative-going input pulses below have the 0-voltage line added by the dc scope. During the ascending-ramp current waveform, the input at SCR500's anode consists of the +150V supply and the negative-going-pulse waveform. Therefore, the input is not merely +150V but +150V plus the positive peak of the wavefqrm (a sum of about +200V). When the input waveform (shown here) begins its negative plunge, the current decreases in step, with zero current occurring at approximately the time of each pulse's tip. (The slight discrepancy will be explained later.) Remember that all parts of the waveform above the zero line are positive, and all below are negative. Also, the gradual *current* changes are produced by inductance L501, and to a lesser degree, by R513.

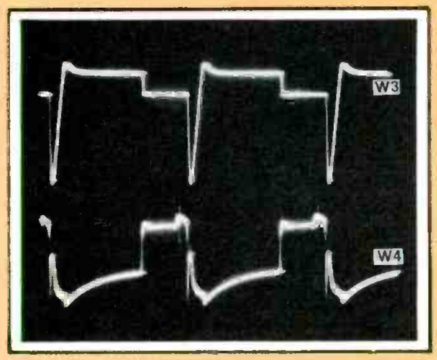
The SCR-regulator circuit—Q500 continuously monitors the +110V source voltage through a fixed voltage divider (R523/R521/R519/R517 for the high side and R522/R520/R518/R516 for the low resistance). Several resistors are arranged in parallel so one or more of the high-value resistors can be cut out of the circuit if it becomes necessary in the future to change the regulated output voltage. Output of this fixed voltage divider determines the forward bias of Q500 (PNP) because its emitter is stabilized by zener diode Z500. Q500's collector current flows through limiting resistor R509 and charges capacitor C507. Therefore, the exact voltage at the +110V source determines how rapidly C507 is charged to a critical voltage where a relaxation-type of oscillation occurs between Q501 and Q502. Consider that the receiver has been in normal operation for some time, and at this time, SCR500 is conducting (allowing some +150V-supply current to flow through the flyback winding, L501 and R513 to the SCR and on to C512 and the +110V source). Two kinds of horizontal pulses from the flyback are required during horizontal-retrace time. The pin-5 end of one flyback winding produces a negative-going horizontal pulse of 460VPP which eventually reaches the SCR500 anode where it stops the SCR from conducting. This will be covered in detail later. At the same time, a 1040VPP positive pulse from the Q601 output device is reduced in amplitude by two 56K resistors, and is coupled through C508 and R510 to the Q502 base, forcing Q502 into saturated C/E conduction. Positive voltage from C507 passes through the primary of T501 triggering transformer, through diode D504 (now forward biased) and through Q502 to its grounded emitter. (*Note:* This is not electron flow.) Therefore, the voltage charge in C507 is reduced nearly to zero, thus the circuit is reset and ready for the next step. Q500 collector current again begins to charge C507. Notice that the C507 voltage is coupled through a small RF choke to the Q501 emitter. Also, when D504 is forward biased, the C507 voltage passes through the T501 primary and D504 directly to the Q502 collector and through R515 to the Q501 base. If D504 is shorted, the circuit will not oscillate because essentially the same voltage (from C507) would be applied to Q501 base and emitter.

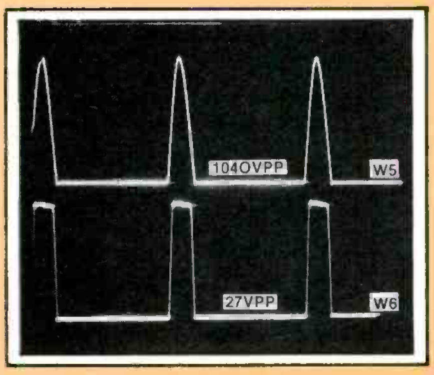
As the C507 voltage rises, the PNP Q501 B/E bias is increased (base voltage is unchanged, emitter voltage is more positive) from reversed bias to a small amount of forward bias. Remember that reversed bias permits no C/E current, while a small bias allows only a small collector current. Eventually, the rising emitter voltage creates enough forward bias to produce significant collector current. Because the Q501 collector is connected to the Q502 base, this means Q502 is given some forward bias. When Q502 begins to draw collector current, the current reduces the Q501 base voltage (R515 connects the Q502 collector and the Q501 base), which further increases the forward bias. This is a regenerative condition that almost instantly ends with both Q501 and Q502 drawing saturation current. The Q501 emitter takes current from C507 and applies it to the Q502 base. However, most of the C507 current goes through the T501 primary winding, D504 (which now is forward biased) and the C/E path of Q502 to ground. The short intense burst of current through T501 produces a secondary positive pulse at the SCR500 gate (relative to its cathode) that starts the SCR conduction (which will continue until turned off by a negative pulse at the anode). When the +110V source voltage drops too low, the circuit gates-on SCR500 earlier in each horizontal cycle until the shortage is relieved. When the +110V source voltage becomes too high, the circuit gates-on SCR500 later in each horizontal cycle until the excess is relieved. Correction for the +110V source variation is extremely rapid, because it occurs at the horizontal-sweep frequency.

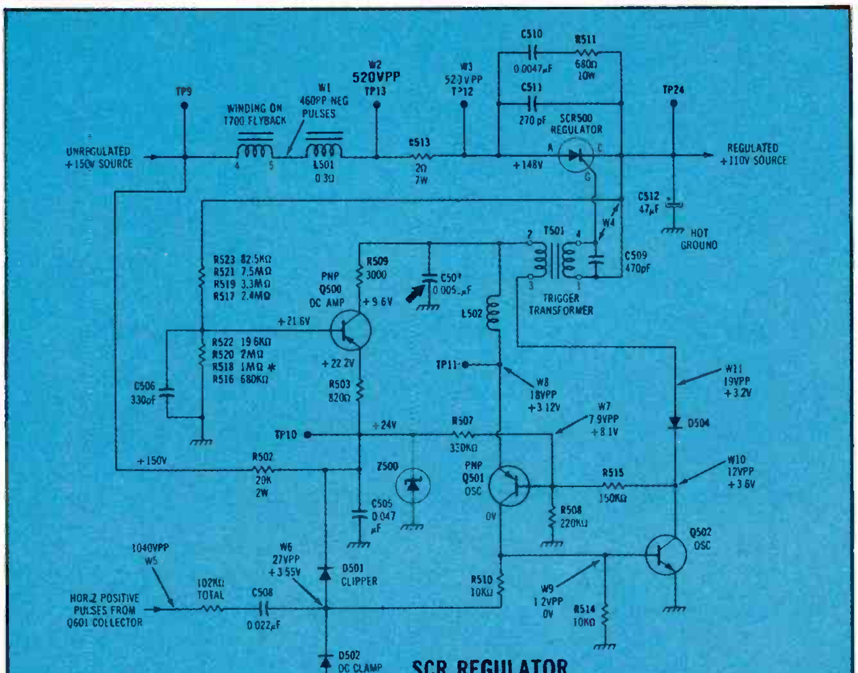






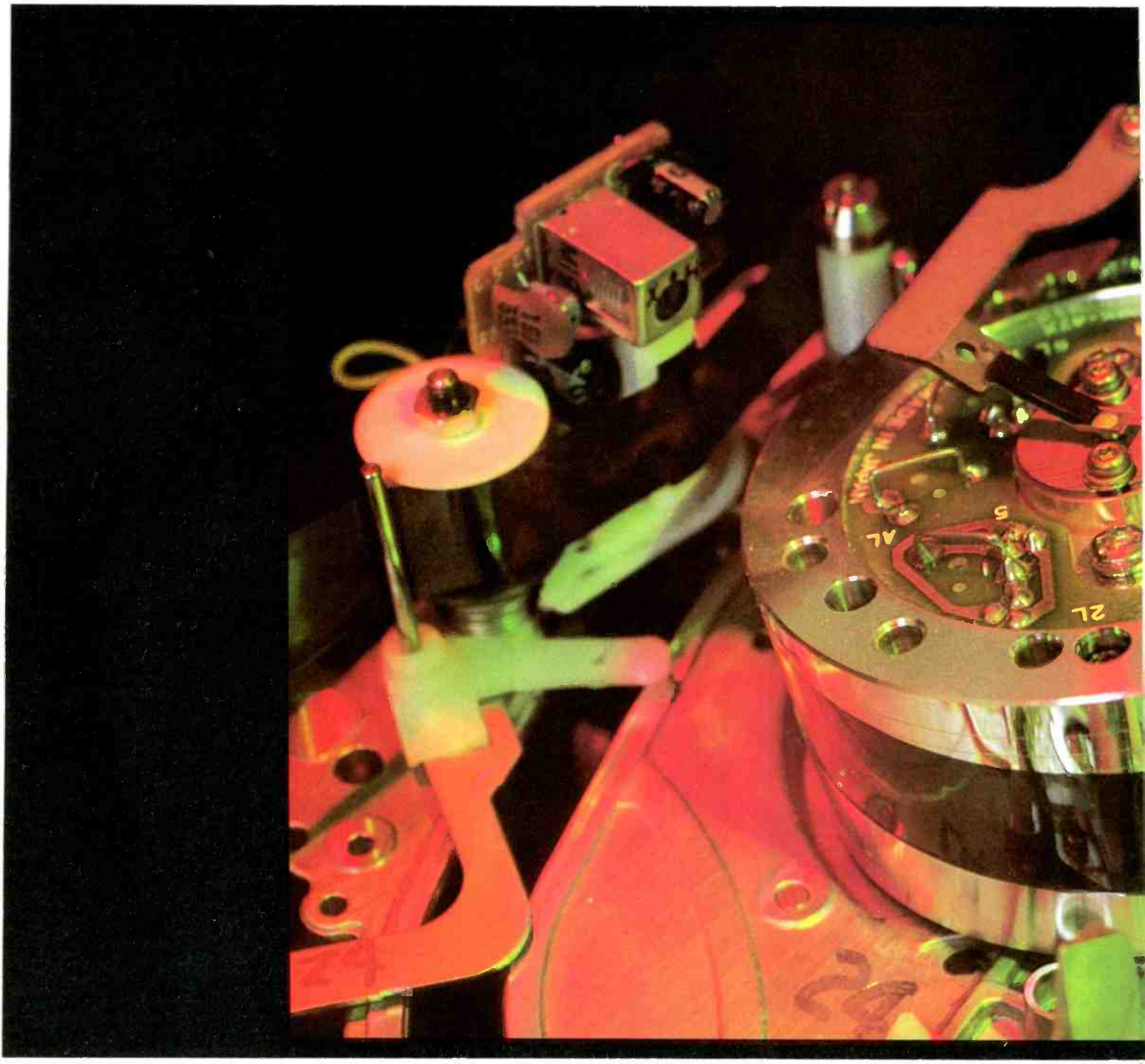






SCR REGULATOR

continued on page 60



VCR Troubleshooting

Use new information, established techniques to diagnose video equipment

One of the most valuable tools someone can have when troubleshooting a product is a good fundamental knowledge of the unit's operation, and how the functional subsystems operate and interact. Televisions, radios and stereos have been around for enough years now that almost anyone with an interest in home entertainment electronics equipment has a pretty good idea of how they work and how to approach a diagnosis in the case of a malfunctioning unit.

Home video equipment is a different story. Products such as VCRs represent a giant leap ahead in technology, and introduce components and circuits not seen before in home entertainment products. Lack of familiarity with these innovations can make diagnosis difficult.

In recent issues, **ES&T** has presented articles that examine in-depth operation of some of the circuits in VCRs. Such articles will continue in the future. This article, adapted from the Technical Training Manual for VCRs and video cameras, published by General Electric Company, Television Business Division, Portsmouth, VA, will examine VCR operation from a functional block point of view, and discuss troubleshooting of the overall system, as well as focusing on the system control stages in particular.

The overall functional diagram

Figure 1 is the overall block diagram of a basic, theoretical VCR. A first step in diagnosing

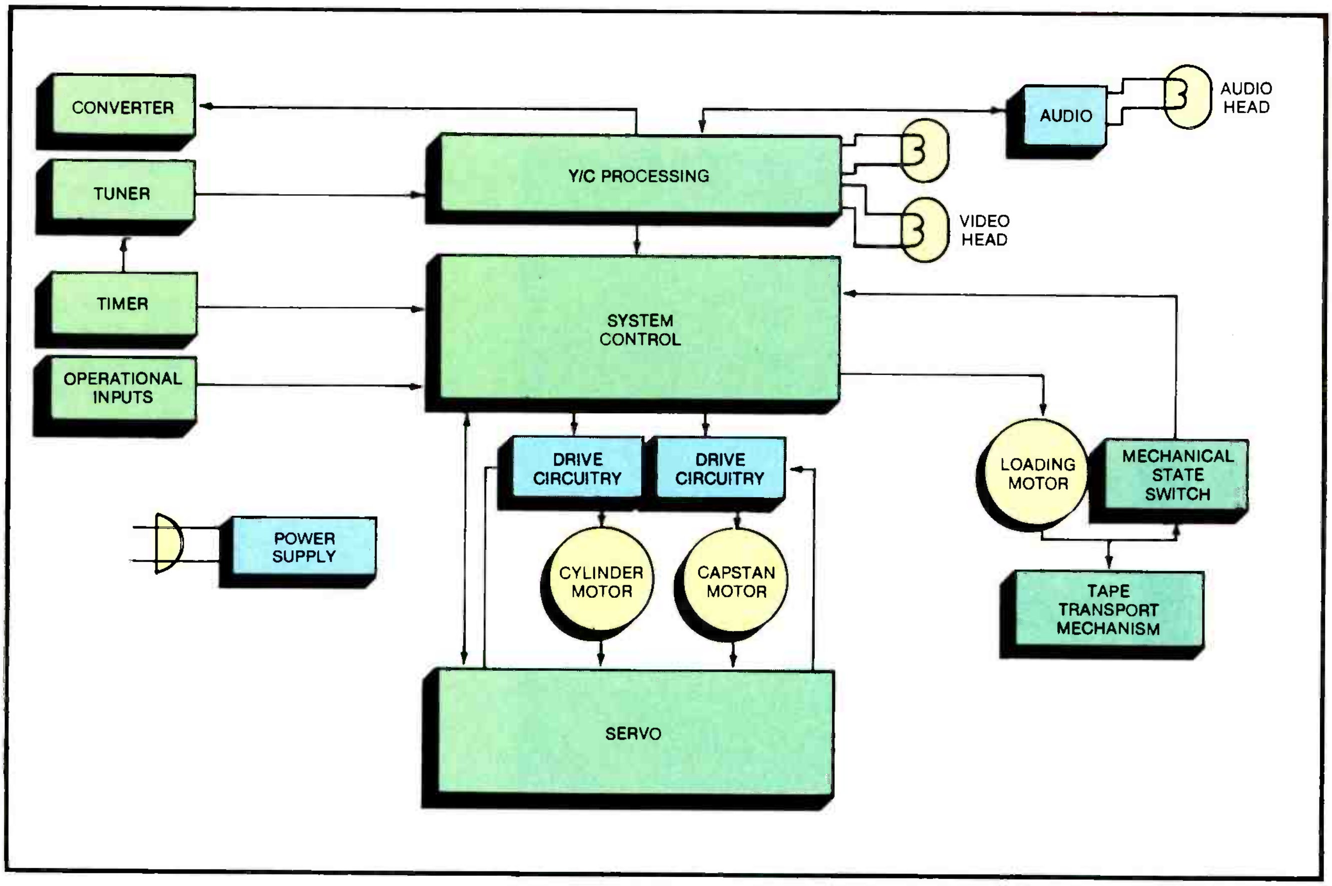


Figure 1. A glance at the block diagram of a table-model VCR suggests that troubleshooting a malfunctioning unit requires a new fund of knowledge, assumptions and approaches. (Chart, courtesy of General Electric)

the problems with a faulty unit is to go through the steps in Figure 2 to isolate the problem to a specific block or set of blocks. As you gain familiarity and experience with VCR troubleshooting, you'll find shortcuts and higher level logic processes that can be applied to the troubleshooting chart. For example, the confirmation of proper Tuner, IF and RF converter operation can be determined by using the signal input/output jacks to bypass these stages in most VCRs.

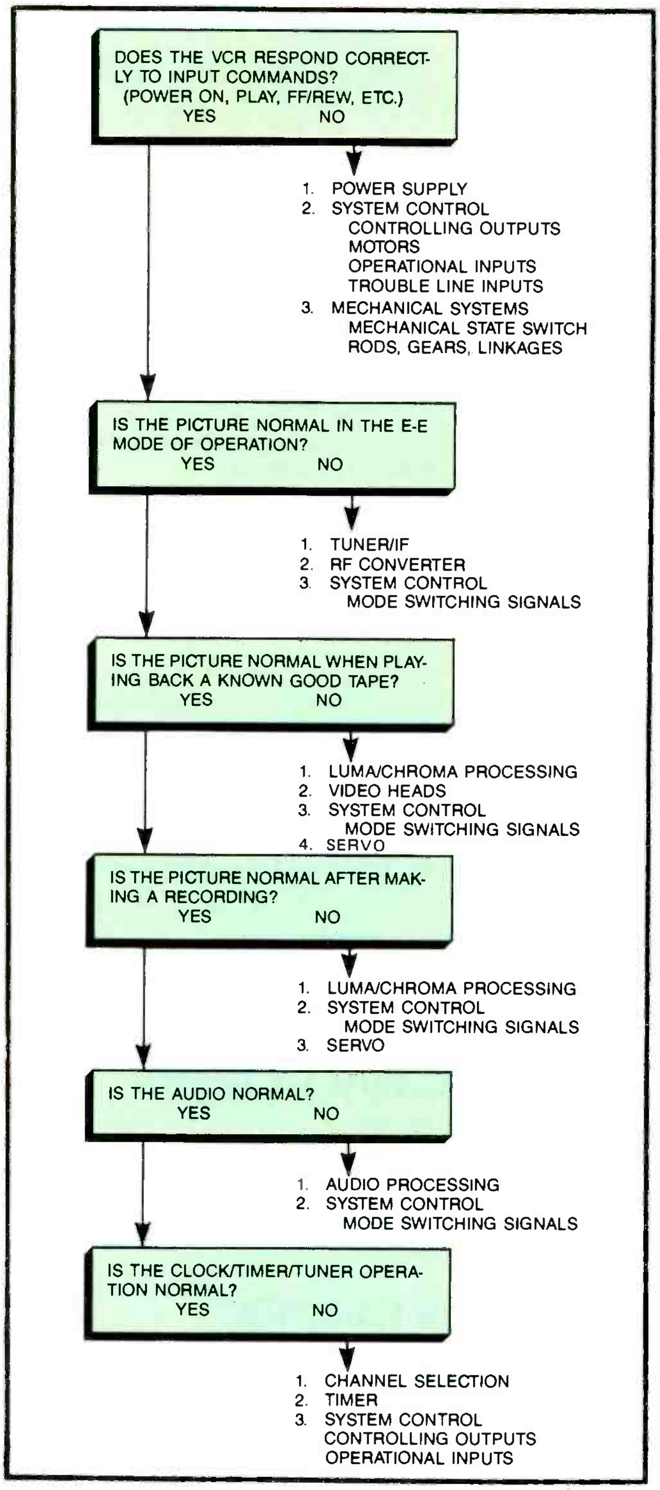
As a rule, the servo system also can be analyzed further before dynamic troubleshooting begins. Malfunctions in the cylinder servo system will affect only the picture, while the capstan servo stages (which pull the tape through its transport path) will affect both picture and sound. An exception to this rule might be a recorder that has helical scan recorded audio capability. Also, it is possible for both servo systems to fail or lose a common reference input at the same time.

Troubleshooting equipment required

Equipment necessary to troubleshoot VCRs includes a good quality signal generator, dual trace (at least 20MHz) oscilloscope, digital voltmeter, and a frequency counter (at least 20 MHz). And don't forget that an isolation transformer (preferably with variable ac input) is essential for many VCRs.

Servicing the system control stages

The system control stages of table model VCR's present special challenges to the servicing technician, especially when dealing with the "time shared" inputs to the microprocessors. Voltmeter readings and oscilloscope waveforms can be particularly confusing in this area of system control.



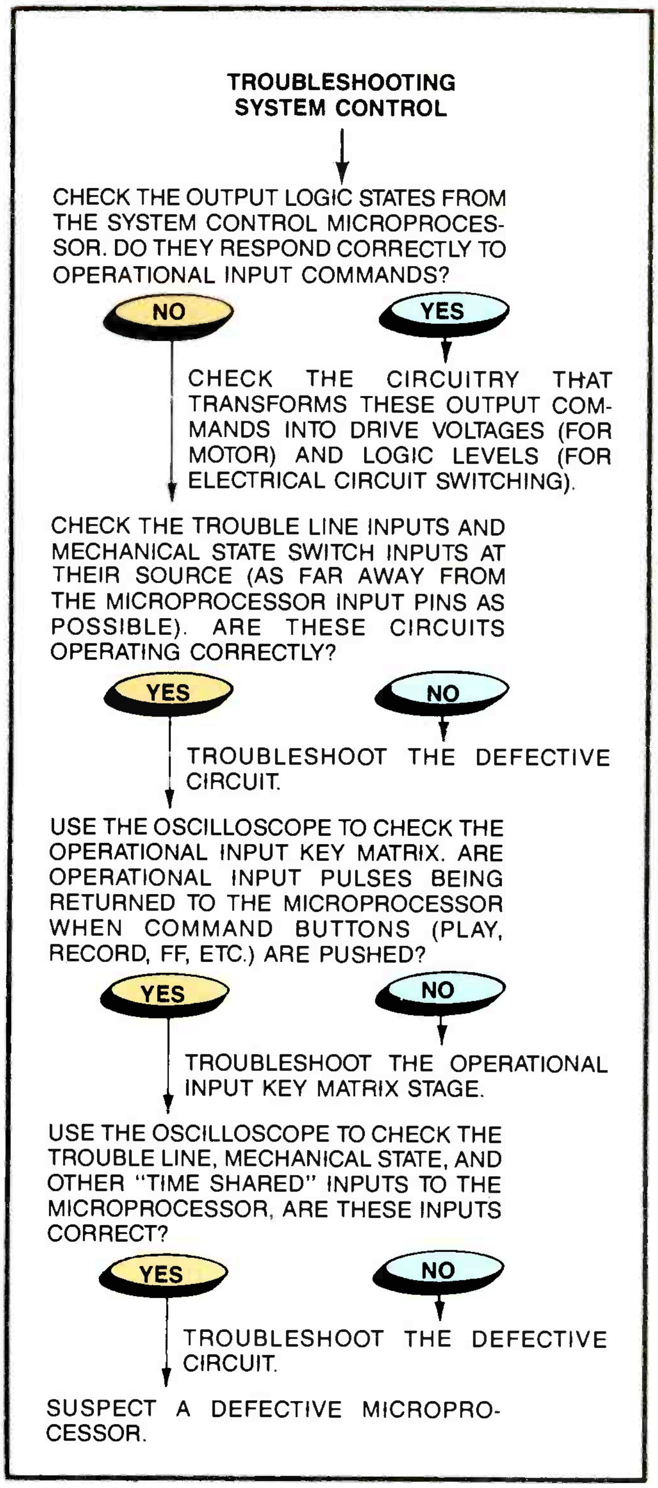


Figure 2. The cause of a VCR malfunction can be isolated to a functional block by using a system of logic such as this.

Figure 3. When the problem has been isolated to the system control block, follow a procedure like this

(Chart, courtesy of General Electric)

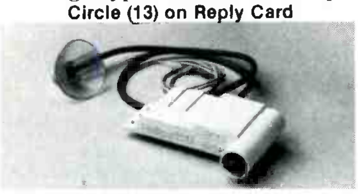
ECG® LED Lamps

Philips ECG has LED lamps in shapes and sizes for virtually any application. They're available in round, rectangular, triangular and square shapes. They come in red, yellow, green, or even in two colors. And there's a choice of clear and diffused reds. Some have jewelled lenses. And some are even available as flashing LEDs with the flasher circuit built in.

In addition, long-life, shock-resistant, vibration-resistant, LED replacements for incandescent cartridge indicator lamps are also available in red, yellow or green.

Common applications: All LED indicator applications. LED cartridges are ideal replacements for cartridge-type incandescent lamps.

Circle (13) on Reply Card



ECG® High-Voltage Rectifier and Voltage Divider Network

Philips ECG's ECG568 is a high-voltage rectifier used in Sanyo and Sears TV sets to supply high voltage to the picture tube. It also contains a voltage divider network which supplies focus voltage to the picture tube.

Common applications: For use in television service and repair.

Circle (14) on Reply Card

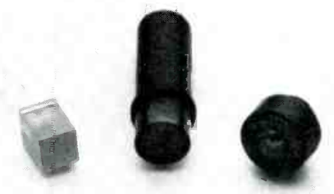
EMF® Transient Voltage and RF Interference Suppressors

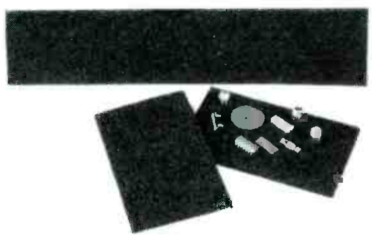
EMF transient voltage surge suppressors by Philips ECG clamp voltage spikes on 120 VAC line to levels safe for all electronic equipment. They can handle up to 40% greater surge current than other suppressors. Single outlet suppressors are available in both two- and three-prong versions.

The multiple outlet EMF315 incorporates both a spike suppressor and a PI filter to suppress RF interference on the AC line. RF interference causes audio and video degradation and causes digital equipment to function imperfectly.

Common applications: Electronic equipment such as hi-fi and television, stereo, computers or other line-operated electronic equipment subject to voltage surges and radio frequency interference from the AC line.

Circle (15) on Reply Card





ECG® A-STAT Material

Philips ECG has two sizes of anti-static foam that will prevent damage to semiconductors from static electricity. The A-STAT 12 measures 12" x 12" and is perfect for bench use. The A-STAT 2 measures 3" x 5" and can be carried in the tool box. When semiconductors are kept in A-STAT foam, static electricity is shunted through the foam instead of into the semiconductor, where it could have caused damage.

Common applications: Essential for semiconductor protection on the workbench or in the field.

Circle (16) on Reply Card

The one thing we make that you have to replace every year.

The new and expanded ECG® Semiconductors Master Guide.

Your new Master Guide will be looking as dog-eared as the old one before long. Because this year the Master Guide has been expanded to include more than 400 new products and almost 25,000 new cross references. The Master Replacement Guide for 1985, 656 pages. Over 3,500 different ECG devices that provide replacement coverage for more than 227,000 industry types. And everything in the book is cross-referenced so you can find what you're looking for fast, and be sure it fits. Plus, everything we make meets or exceeds the original JEDEC or application specs. So it works. It's the only book you'll need. But you'll need a new one every year.

To get a copy of the new Master Guide, go to your nearest Philips ECG distributor. For his name and location, just call: 1-800-225-8326 (in Mass., 617-890-6107).

If it's ECG, it fits. And it works.

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Circle (17) on Reply Card

To isolate problems, check microprocessors first

This block diagram shows the complex interrelationship among the three microprocessors used to control the functions of GE's videocassette recorder model 1VCR5018; ICs 5601, 6001, 7502. The Input/Output (I/O) pin matrix for IC 6001, the System Control Circuit IC is also shown. This circuit produces the logic levels that control the motors and switch the electrical modes of the VCR. It also receives mechanism-position data from the mechanical state switch, and scans the trouble line inputs.

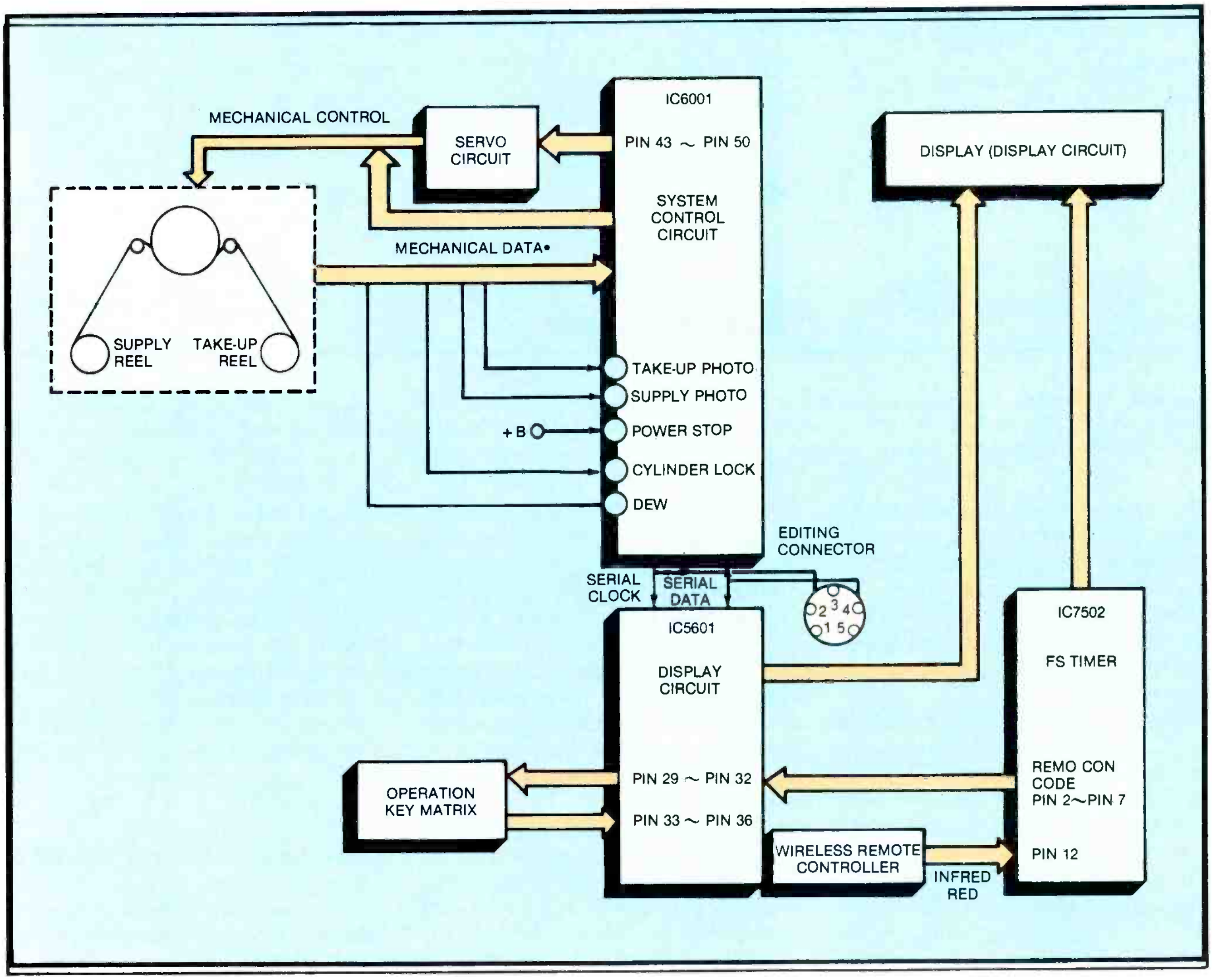
PIN	I/O	NAME/OPERATION
1	I	Vss (GND)
2	I	S. TAB, POS
3	I	T. SET, INDEX IN
4	I	T. REC, CS, SW A
5	I	T. INDEX, CS, SW B
6	O	M. CTL
7	O	×3
8	O	NC
9	O	SCK
10	O	NC
11	I	SIRQ Power Off Interrupt
12	I	IRQ Power Off Interrupt
13	I	SBT (SERIAL CLOCK)
14	O	SBO (8 Bit Serial Data Output)
15	I	SBI (8 Bit Serial Date Input)
16	I	RESET (L)
17	I	V. A. REF
18	I	T. PHOTO
19	I	S. PHOTO
20	I	T. REEL PULSE
21	I	S. REEL PULSE
22	I	V. B. REF
23	I	2/4/6/, CYLINDER LOCK
24	I	POS I, DEW
25	I	OFF/INDEX/MEMO
26	I	C.P.S./OFF/SV
27	O	LOAD (L)
28	O	UNLOAD (L)
29	O	CASSETTE DOWN (H)
30	O	CASSETTE UP (H)
31	O	REEL SOLENOID (L)
32	O	MR HEAD (L)

PIN	I/O	NAME/OPERATION
33	O	INDEX REC (L)
34	O	+12 V ON (L)
35	O	CURRENT EMPHASIS (L)
36	O	VIDEO EE (H)
37	O	AUDIO EE (H)
38	O	AUDIO MUTE (H)
39	O	SENSOR LED (L)
40	O	A-D-REC (L)
41	O	D-REC (L)
42	O	FULL ERASE (L)
43	O	S-REEL MOTOR (L)
44	O	T-REEL MOTOR (L)
45	O	R0
46	O	R1
47	O	⊖ SLOW ⊖ PLAY
48	O	CAPSTAN REV (H)/STOP (M)/FWD (L)
49	O	S0
50	O	S1
51	O	$S\text{-}2^0$
52	O	$S\text{-}2^1$
53	O	$S\text{-}2^2$
54	O	$S\text{-}2^3$
55	O	F-ADV (H)
56	O	S-SELECT (H)
57	O	S-MEMORY (L)
58	O	INSERT (L)
59	O	CYLINDER MOTOR (L)
60	O	REC (L)
61	O	−1/×3/CUE/REVIEW (H)
62	I	OSC 2
63	I	OSC 1
64	I	V_{DD}

In the I/O diagram, the pin numbers of IC6001 are identified in the leftmost column. The second column, marked I/O, indicates whether that pin has an input applied to it, or if it is used as an output to control some function. At the risk of stating the obvious, an "I" in the "I/O" column indicates an input, and an "O" indicates an output.

As explained in the text, isolation of a problem can be accomplished by checking the static dc outputs from the microprocessors. If a problem exists and these voltages check out, the problem is in the motor drive of electrical switching circuitry. Absence of one or more outputs indicates a need for further checking, as described in the text.

(Diagram, courtesy of General Electric)



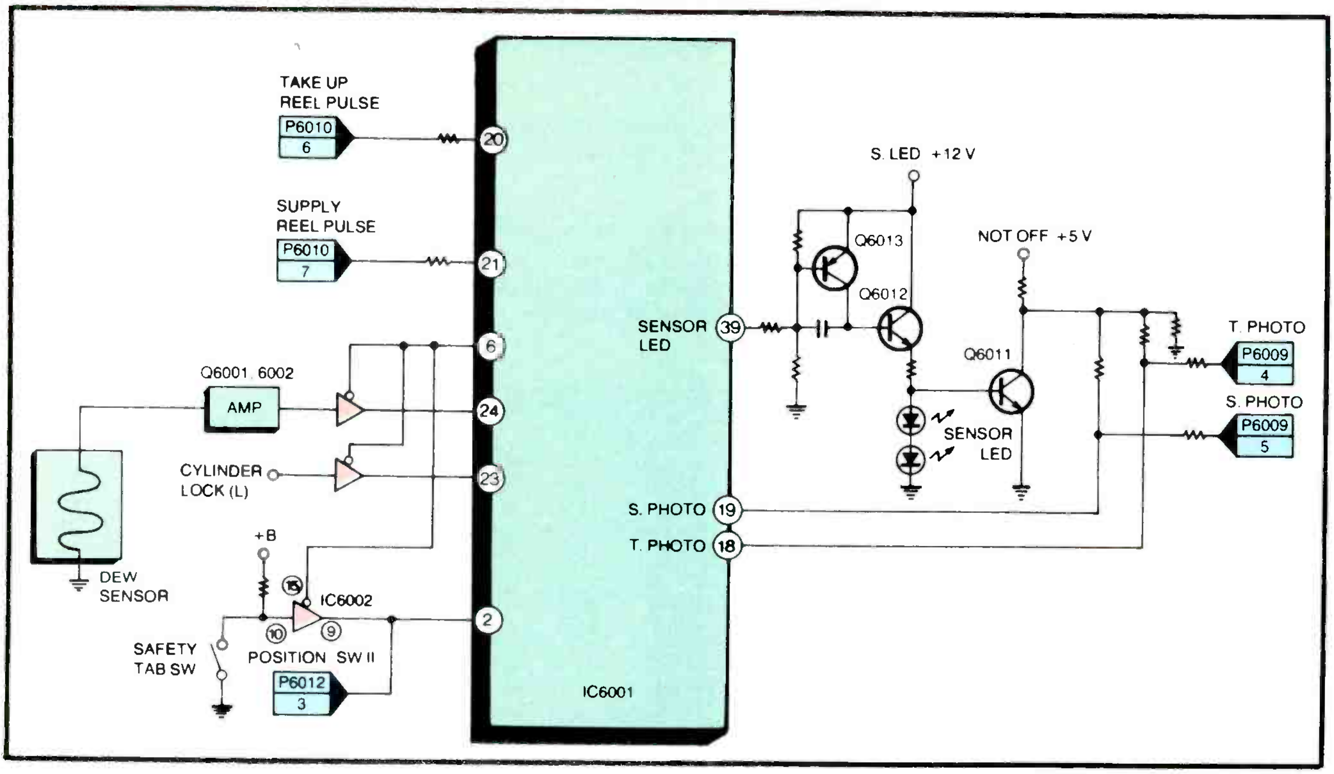


Figure 4. The system-control section of the VCR includes safeguards such that certain undesirable conditions shut down some or all functions. These "trouble lines," such as the dew sensor and safety tab switch should be checked if a microprocessor output is incorrect or absent. (Diagram, courtesy of General Electric)

Therefore, when a symptom has been determined to be caused by system control, a logical troubleshooting procedure like that shown in Figure 3 will leave these measurements for last; and easier, more meaningful steps will be taken first.

The easiest measurements to make on the system control stages are the static dc outputs from the microprocessors. If these respond correctly to operational inputs, then the microprocessor and all of its inputs, trouble lines, and mechanical state data are correct and troubleshooting can advance into the motor drive and electrical switching circuitry.

If no output, or an incorrect output is found, then the trouble lines (see Figure 4) and mechanical state switch can be checked at their sources; as far away from the microprocessor's inputs as possible and while they are still dc levels and have not yet been integrated into a "time shared" input circuit. (Note: trouble lines are inputs into the microprocessor that cause system shutdown when problems occur.) If these circuits are normal, then use the oscilloscope to see that scan pulse outputs are being returned to data inputs when an operational command button *(play, record, FF)* is pushed.

If the problem still has not been located, the inputs to the microprocessor should be scoped. If there is doubt about a reading or waveform, then it usually will be helpful to make something happen that will confirm or deny the correctness of circuit operation. For example, the tape and sensors can be observed in active and inactive conditions by inserting a tape and alternately raising and lowering the cassette tray. Other circuits usually can be activated and deactivated by similar methods, including disconnection of the numerous plugs in the VCR.

Finally, only after carefully eliminating all peripheral circuits, suspect the microprocessor itself of malfunction.

A new troubleshooting approach

The new crop of digitally controlled electronic products is very different from an older generation of equipment. Only by studying how the new equipment operates and by developing new troubleshooting methods will it be possible to diagnose and service it. ES&T

Photofact

These Photofact folders for TV receivers have been released by Howard W. Sams since the last report in ES&T.

CAPEHART
8050AR 2323-1
3320AR 2325-1

GENERAL ELECTRIC
Chassis 19PM-A 2321-1

KMC
1944RG 2324-1

PHILCO
Chassis E32-36, E32-37 2322-1

SEARS
564.42440451, 564.42460450, 564.42460451 . . . 2322-2
564.40540450 2323-2

SHARP
20J580 2320-1

SONY
Chassis SCC-470T-A 2320-2
Chassis SCC-470R-A,S-A 2321-2

QUASAR
Chassis ANDC110 2325-2
Chassis AEDC110 2326-1

ZENITH
V4552NK3, Z2500W/W3/4K/4K3/8P/8P3/10PN,10PN3/
82NK/82NK3 2324-2
S1906C/C1 2325-3
Z1908W2, Z1926W 2326-2

See Troubleshooting Tips on page 56

Do you miss the Troubleshooting Tips column when it doesn't appear? In those months, we miss bringing it to you. We need more Troubleshooting Tips – if you have any tips for our readers, please send them in! For writing guidelines to submit T-Tips, write to:
Conrad Persson, Editor
Electronic Servicing & Technology
P.O. Box 12901
Overland Park, KS 66212

What do you know about electronics?

Tuned Circuits

By Sam Wilson

A surprising number of technicians have difficulty understanding how resistance affects a parallel-tuned circuit. This confusion precipitated the second greatest amount of mail I have received, representing one of the most prolonged arguments in which I have become embroiled in the electronics field.

Figure 1 shows two sets of parallel-tuned circuits. The resonant frequency of the circuit in Figure 1A is given by the equation:

$$f_r = 1/2\pi\sqrt{LC}$$

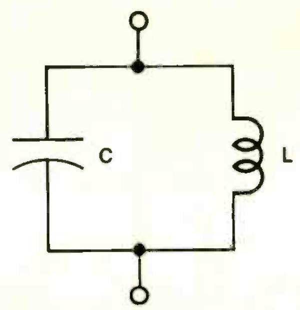


Figure 1A.

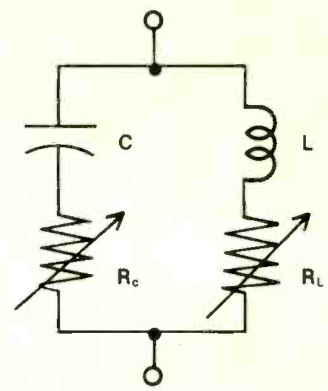


Figure 1B.

This is the same equation as used for series-tuned circuits.

When there is resistance in either (or both) of the branches – as shown in Figure 1B – the above equation is no longer valid! The resistance in the branches affects the resonant frequency, and the equation for f_r is:

$$f_r = (1/2\pi\sqrt{LC})\ R_L^2\ C - L/R_c^2C - L$$

- *f in hertz*
- *L in henries*
- *C in farads*
- *L in henries*
- *R in ohms*

This equation is based upon the concept that at resonance the currents in the two branches are equal.

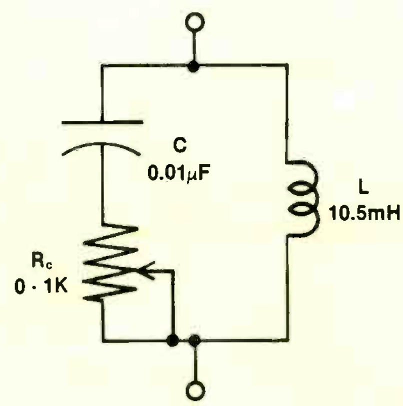


Figure 2.

To get some insight into why this concept seems so hard to understand, I recently questioned an experienced technician. He believes that the resistance does affect the resonant frequency. But he also believes that the effect is so small that it could be disregarded. Wrong!

Figure 2 shows a tuned circuit that was actually used in a TV receiver years ago. The circuit was tuned to resonance by R_c. The values in the original circuit have been forgotten, so I chose some new values.

Because $R_L = 0$, this equation can be simplified to

$$f_r = (1/2\pi)\ \ LC\ \ \ L/L - R_c^2C$$

Table 1 shows values of f_r as R_L is varied

TABLE 1

$R_L\Omega$	f_r(kHz)
0	15.5
250	16.5
500	17.8
750	22.8
900	32.5
950	41.4
1000	71.2

Figure 3 shows a graph based on the calculated values in Table I. As you can see, the effect of R_C is not negligible.

I once had my students build the circuit and verify the curve. The result is that the curve based upon measured values is not as steep. At higher frequencies, the distributed capacitance and other factors take their toll. However, the effect of R_C could not be ignored.

For a series RLC circuit there is a resonant frequency for all values of components. By contrast, a parallel–tuned circuit may have no resonant frequency. For example, in the circuit of Figure 2, the resonant frequency will be infinitely high if:

$$L = R_c^{2c}$$

In other words, there is no resonant frequency.

Current events

Speaking of controversy, one of the oldest arguments in the history of electricity involves this question: does the current go from + to −, or does it go from − to +?

Here's an interesting viewpoint to consider. I will take the argument that electricity is *not* simply a flow of electrons.

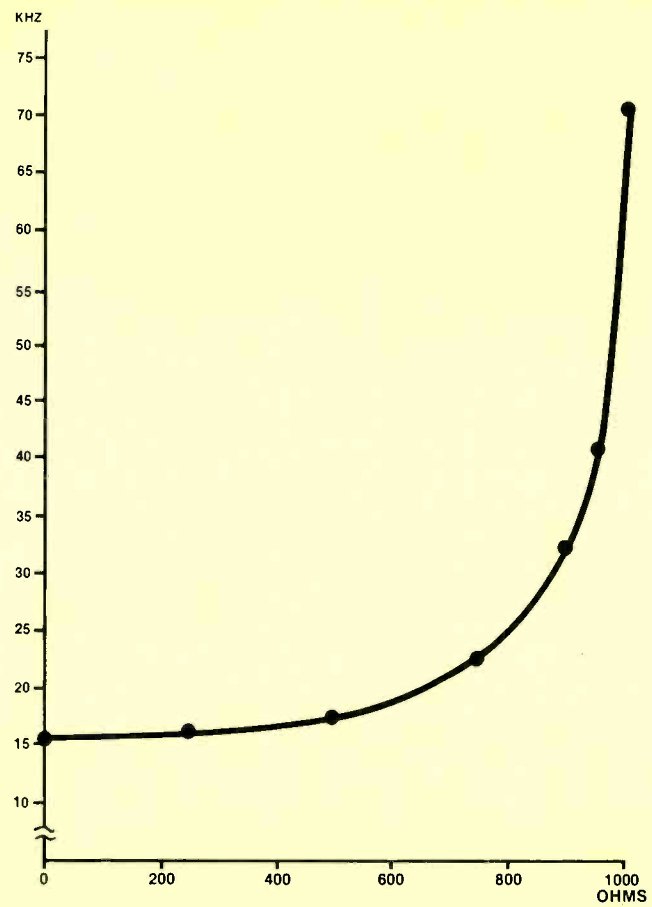


Figure 3.

A cubic centimeter of pure germanium has about 44,000,000,000,000,000,000,000 atoms. In plain words, that is forty-four thousand million million million atoms. At room temperature the resistance of a cubic centimeter of germanium is about 50Ω between opposite faces. That cube has about 25,000,000,000,000 free electrons. Read that number as twenty-five million million free electrons. In powers of 10 that number is 2.5×10^{13}.

The reason current flows in the cube of germanium is that it has those free electrons–right?

Now, assume the germanium material is lightly doped with acceptor atoms. To be specific, we will use 3.66×10^{14} acceptor atoms. What we have made is P-type material.

Now, there are only 1.7×10^{12} free electrons. In other words, there is only about one-fifteenth as many free electrons as there are in the pure germanium. So, if electricity is simply a flow of electrons, it should be harder to get current to flow through the germanium that has been doped with acceptor atoms.

But, the P-type germanium has only about 10Ω resistance.

Let's summarize that in another way. *Pure germanium has fifteen times more free electrons than P-type germanium, but the resistance of the pure germanium is five times greater.*

If electricity is a flow of electrons, then why does the material with more free electrons have a higher resistance?

The name "P-type material" is not a good choice. It *sounds* like the material has a positive charge. Likewise, it *sounds* like N-type material should have a negative charge. Actually, there is no electric charge associated with either. The names are supposed to convey the idea that P-type has positive charge carrier holes available for current flow, and N-type has negative (electron) charge carriers that are available for current.

Coming in...

JUNE

Analysis of Sylvania Superset Two: Part 3—Carl Babcoke, ES&T's Consumer Servicing Consultant, continues his guided tour of this technologically advanced television. Featured in this segment are the operation of the horizontal-sweep circuits from the oscillator to the flyback and examination of the shutdown safety circuit.

Personal computer system maintenance tips—Personal computers are rugged, reliable devices designed to operate in the environment found in the typical home or office. Trouble-free operation can be extended by following a program of regular cleaning, and by paying attention to contaminants brought into the area. This article provides some hints and tips for keeping a personal computer in shape.

What do you know about electronics?—Lack of care in selecting replacement fasteners for electronic circuits can cause galvanic corrosion. Capacitors exhibit something called dielectic absorption, which may cause them to retain a charge even after they have been short-circuited. In this installment, Sam Wilson examines these and several other interesting electronics phenomena.

Servicing computers?—Here are some sources for parts and information. Once an electronic product type has been on the market long enough, information is generated about servicing it, and parts are in ready supply. Because personal computers have not been on the market very long, information and parts may not be readily available. In this article, David McLanahan explores some of the component types found in computers and suggests sources of computer components and literature.

If you connected a voltmeter between a block of P-type and N-type materials, as shown in Figure 4, there would be no voltage measured. Likewise, there would not be a momentary current. This demonstrates that the materials are electrically neutral.

Tube current

The argument that electricity is a flow of electrons is often based upon current flow in a vacuum tube. Electrons flow from the cathode area to the plate. So, it is argued, if nothing is flowing from plate to cathode, it follows that the current is electron flow.

However, an electron could not go to the plate if there was not a "hole" there. Furthermore, when the electron fills the hole at the plate, a hole appears at the cathode. So, the hole goes from plate to cathode.

The idea of hole flow is difficult for some technicians to believe in. "A hole is nothing, and you can't describe a current on the basis of nothing." At least, that is a common argument against hole flow. A person who really believes that has never driven downtown and tried to find a parking space. That's funny, because he left one in the garage when he left home.

Did you ever watch an attendant on a small parking lot? He moves the cars around so that the parking spaces are in front. He actually is not moving the cars – he is moving the parking spaces. After all, that is what he rents. So, there is no use to write to me and try to convince me that it is really electrons moving in P-type material to make the current. You have to move what you've *got*.

The truth is that there is a current in both directions. The arrows on semiconductor symbols point toward N-type material, or in the direction of conventional current flow.

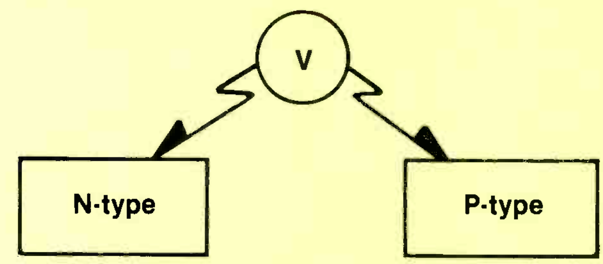


Figure 4.

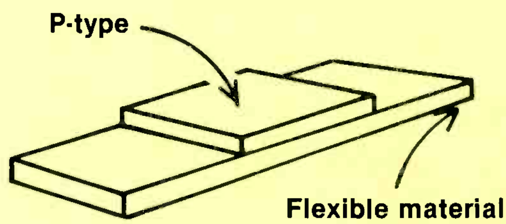


Figure 5.

When is a strain gauge a stress gauge?!

In the scientific meaning of the word, *stress* is the amount of force-per-unit area that is exerted on a body. *Strain* is a measure of how much a body is deformed when under stress.

If you want to measure the amount of force at some point you use a strain gauge. In other words, you use a strain gauge when you want to measure stress! The strain gauge has an output that is proportional to how much it is deformed.

Hooke's law says that the strain is directly proportional to the stress if you don't go beyond the elastic limit of the material being strained. That is what makes it possible to use a strain gauge to measure stress.

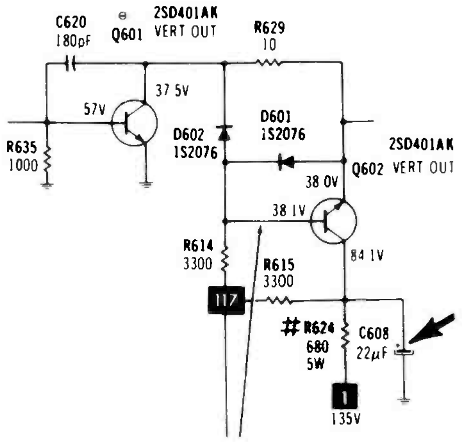
Strain gauges are *active* if they generate a voltage in response to a stress. They are passive if they change a parameter – such as resistance – in response to a stress.

Figure 5 shows an example of an active strain gauge. It consists of a thin layer of P-type material mounted on a flexible material. When that material is flexed it causes crowding of atoms at one end of the P crystal. That, in turn, generates a voltage in accordance with the piezoelectric effect. It is the same effect that results in a voltage being generated in any other crystaline material such as quartz or barium titanate. ES&T

Troubleshooting Tips

Black bar in picture
Hitachi CT1910
(Photofact 2200-1)

A horizontal black bar about 1½ inches high and 2 inches from the screen's top was present in the pictures from all TV stations. Horizontal lines and bars either originate in the vertical-sweep system or they have the same repetition rate as the vertical scanning. First I checked dc voltages and waveforms of IC701, the deflection integrated circuit. Finding nothing suspicious there, I proceeded to the two vertical-output transistors. Installation of two new output transistors produced no change.



It seemed time to be more critical of the measurements, so I checked the dc voltages again with more care used around the output transistors. The Q602 output-transistor measurements showed the collector voltage was about 2V low. Scoping the collector showed the vertical-signal amplitude was varying. C608 was suspected, and it was replaced as a test. While replacing the capacitor, I noticed the original was only 10μF, while the Photofact called for 22μF. To be on the safe side, I used a 22μF replacement. *Afterwards the picture was normal without the black bar.*

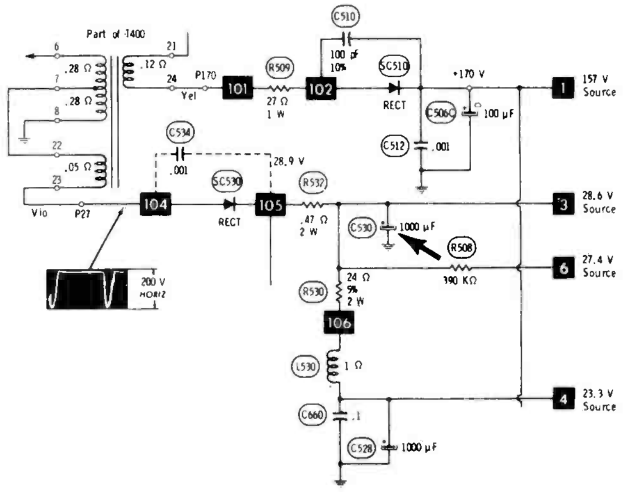
Michael L. Bare
Thurmont, MD

Black shadow and horizontal lines
Philco E-21-5
(Photofact 1585-2)

A combination of unlikely picture symptoms were visible on the screen. First, the height was insufficient, with bad foldover at the bottom. Also, the picture was unstable, wanting to roll. When held in vertical locking by careful adjustment of the hold control, it had a fuzzy double picture. There was a bright hoizontal line across the center of the picture, and other less-prominent horizontal lines across the bottom half of the picture. Worst of all was a dark area, about three inches across, in the upper right corner. This had the appearance of a shadow cast by some element inside the picture tube. The sound and other functions appeared to be normal.

Of all the many symptoms, the most obvious were problems with the vertical sweep. The horizontal line across the center had the appearance of foldover caused by incorrect transfer of the vertical sweep from the Q302 top-output transistor to the Q300 bottom-output transistor (perhaps an extreme case of *notch* distortion). However, replacement of those two transistors produced no improvement. No change was noted after the IC302 vertical driver was replaced. Adjustment of the pincushion controls changed the size and shape of the dark shadow, but did not eliminate it.

After the most obvious suspects had been replaced without success, I began to scope the vertical circuit. A normal waveform was found at the Q302 base, but a high-frequency envelope was almost obscuring the Q300 base waveform. In fact, the high-frequency oscillation had an amplitude much higher than the vertical waveform. The oscillation was proved to occur at horizontal frequency, and was traced back eventually to filter capacitor C530, a 100μF electrolytic. A temporary paralleling of a smaller value across C530 removed most of the symptoms, and replacing C530 eliminated all the previous problems.



C530 is the peak-reading input filter capacitor for the +28.6V scan-rectified supply; so when it opens, horizontal pulses are distributed to vertical oscillator/driver IC302 and Q300 bottom vertical output. Vertical blanking from IC302 contains the horizontal pulses that are fed into the video stages, causing the dark shadow in the upper right corner. Of course, the open C530 also reduces the +28.6V source voltage, thus producing the vertical foldover.

This repair taught me an important lesson: When the symptoms are many and mysterious, check all electrolytic capacitors (especially those filtering scan-rectified supplies) before wasting time trying to analyze individual symptoms.

George P. McKnight
St. Marys, PA

PART THREE

The VIDEO CONNECTION

By Martin Clifford

A typical indoor TV antenna has a pair of telescoping arms for VHF and a circular non-extendable type for UHF. Using such an antenna does not eliminate the possibility of wiring a VCR into the system. Generally, the leads from such an antenna are a pair of 300Ω 2-wire lines as indicated in Figure 1. Usually an installation of this kind requires at least one balun, often two, depending on the input and output signal arrangements on the VCR and on the input setup at the antenna terminal block on the television.

Separate antennas and the VCR

Although it is now customary to use a single antenna for VHF and UHF pickup, there are still many older installations using separate antennas for these signal sources. This means, as shown in Figure 2, there will be two separate downleads from the antennas. The UHF antenna generally uses 300Ω twinlead while the VHF antenna is either 300Ω lead or 75Ω coax. Again, the number of baluns needed for both of these lines will be determined by the types of inputs at the VCR.

The drawing also shows the connections to the TV receiver. The connecting links will be either 300Ω line or coax, but several baluns may be needed, depending on the impedance outputs of the VCR and the impedance inputs of the TV set.

Single antenna and the VCR

The advantage of the single antenna for VHF and UHF pickup is that it uses just one downlead, and this can be either 300Ω twinlead or 75Ω coax. Both possibilities are shown in Figure 3, but in either case a VHF/UHF band splitter will be required. This drawing is a composite to indicate the two different arrangements. The outputs of the band splitters are connected to baluns (also known as adapters or matching transformers) and from these units the leads are wired to the input terminals of the VCR. The outputs of the VCR will be connected to the antenna block of the TV set. The drawing shows a single balun at the TV set, but again the possibilities are no baluns, or one, or perhaps two.

In the connections shown in Figures 1 through 3, note that the VCR is wired in series between the signal source, an antenna in this case, and the TV set – that is, the VCR is on line. Also note that any connections previously made to the antenna terminals of the set must be removed. This also could be the case if an indoor antenna such as rabbit ears had been used, and now replaced by an outside antenna.

Connecting the VCR to multiple TV sets

The VCR can be connected to two or more TV sets following the arrangement shown in Figure 4. To simplify the drawing, the antenna input to the VCR isn't included but the wiring is the same as that indicated in the preceding illustrations.

Note the use of the accessory identified as a *band combiner* connected to the outputs of the VCR. This is a device that combines the UHF and VHF signal outputs of the VCR. Originally, in a single downlead setup, the signals brought down from the antenna are in combined form, a composite of VHF and UHF (plus FM). At the output of the VCR, these signals are separated, forming a pair. What we now need is not one, but two pairs of signals, one set of each (VHF and UHF) for the two TV receivers. The combined signals are then fed, via coax, to the two TV sets. This connecting link of coax can be considered in the same category as an antenna downlead.

Because two TV sets are to be driven, the combined VHF/UHF signals must be split into two parts, accomplished by a pair of band separators, one for each of the TV sets.

The same technique can be used to drive three or four televisions as indicated in Figure 5. The coax line from the band combiner is fed into a 3-way or a 4-way splitter. These devices have a single input and three or four outputs. These outputs are then used to input the required number of band separators.

Need for more signal

The output of the VCR isn't an inexhaustible signal supply. With four TV sets, the original signal supplied by the VCR is divided into four parts. Actually this is an optimistic estimate because each of the accessories, the band combiner, the signal splitters and the band separators are all passive devices, meaning they introduce some signal loss. As a result, you may have to use an RF preamplifier. This is a solid-state device and can be mounted directly at the antenna. This is its best signal-to-noise position but it can also be put on line anywhere along the single downlead before connection to the VCR. The pre-amp also requires connection to the ac power line, drawing so little current it can remain permanently on.

The independent television

The problem with the multiple TV set connections described thus far is that none of the sets is independent of the VCR. Figure 6 shows a hookup in which one television is VCR controlled; the other independent. The combined VHF and UHF signals are first brought into a splitter, dividing the overall signal into two approximately equal parts. One half is fed into a band separator with the VHF and UHF outputs then brought into one of the two TV sets. The other half of the combined signal also is brought into another band separator with the output used to drive the VCR. The VCR, in turn, works as the signal source for TV 1. With this setup, one of the TV sets can be used to watch a VCR taped program; the other for watching network television.

Switchers

You can have a greater operational flexibility by using switchers. Of these, the simplest is the *A/B* type shown in Figure 7. As shown in the drawing, the switcher is supplied with a pair of inputs, in this instance, cable or an antenna, and a VCR. Depending on the switching position, the single television can receive either of the signals. However, there are other video connections that make use of the switcher.

The *A/B* switcher can be used in a multiple TV receiver application as shown in Figure 8. The basic input signal can be either that supplied by a TV antenna or cable. The signals are first divided by a 2-way splitter, with half furnished to the input of a VCR and the other half delivered to the B terminal of the *A/B* switcher. When the switcher is in its *A* position the signals are routed through the VCR and then to a number of TV sets, possibly as many as four. With the switcher in its *B* setting, the VCR is bypassed and the effect is as though the TV sets were directly connected to the antenna or cable input. *A/B* switchers are available with various input and output impedances so they are not only used for switching but for impedance matching. (Figure 9.)

VCR hookup variations

There are various ways of connecting a VCR depending entirely on what the user wants. Thus, the connections in Figure 10 permit recording channels 2 to 84 while watching channels 2 through 13, with the *A/B* switch in one position. When the *A/B* switch is set to its second position, it is possible to watch videotapes and channels 2 through 84 and record either channels 2 through 13, or 14 to 84 separately.

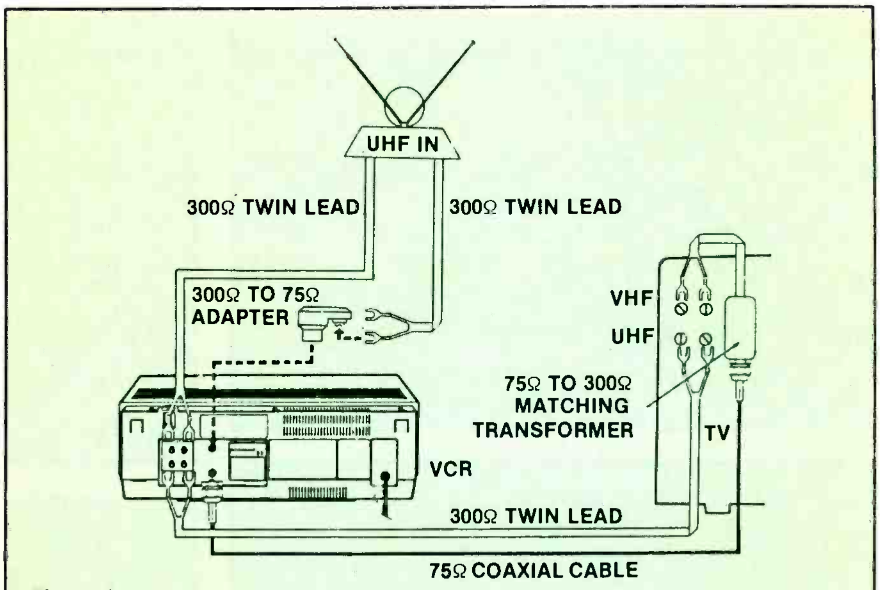


Figure 1.

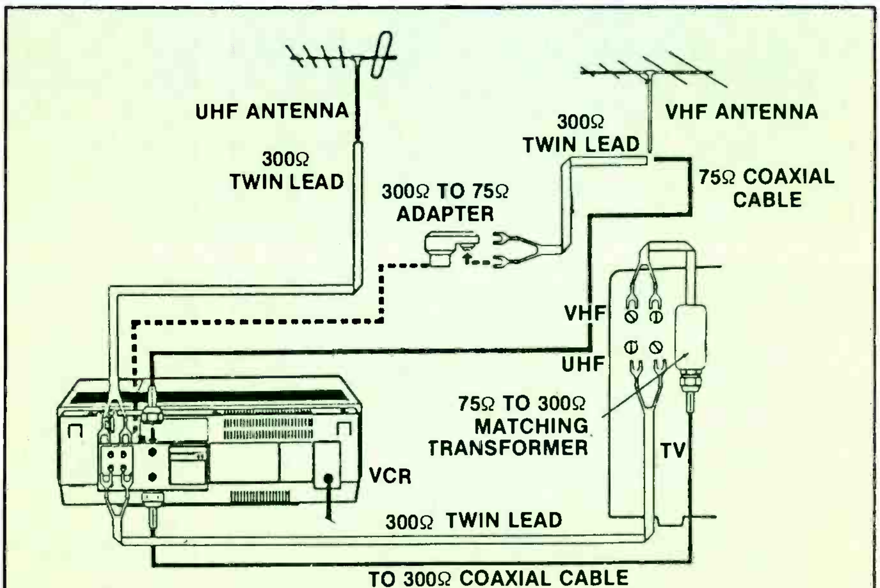


Figure 2.

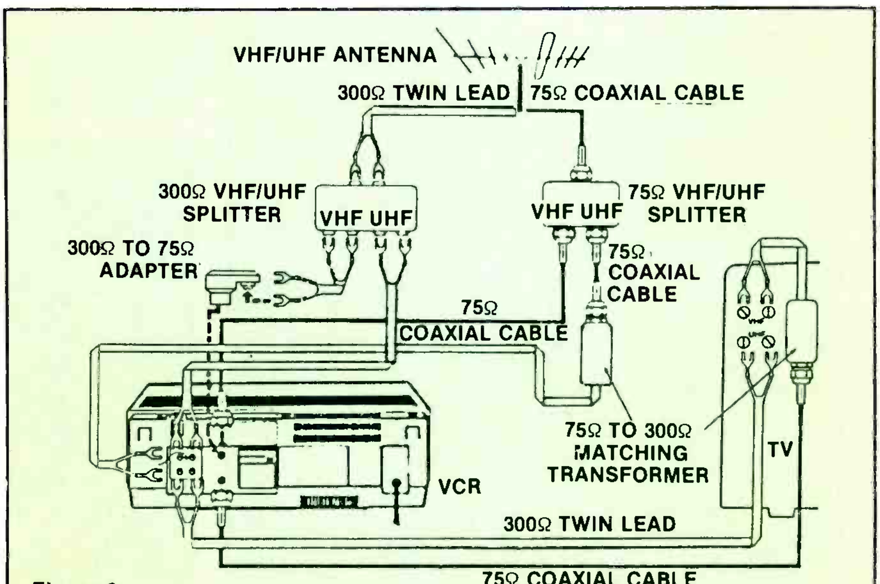


Figure 3.

Figure 1. Method of connecting a rabbit ears antenna to a VCR. (Courtesy Sharp Electronics.)

Figure 2. VCR connections for separate UHF and VHF antennas. (Courtesy Sharp Electronics.)

Figure 3. Methods of connecting a single antenna to a VCR. (Courtesy Sharp Electronics.)

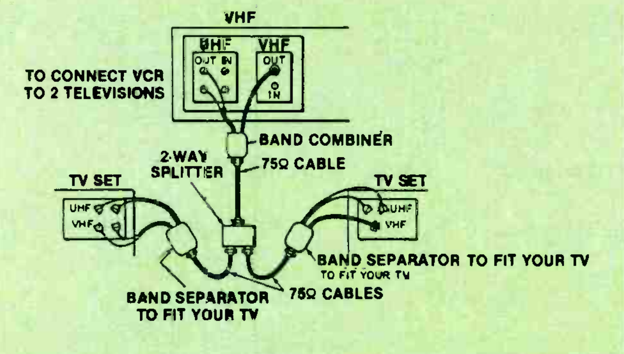


Figure 4.

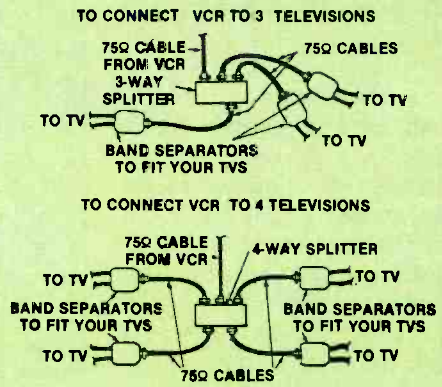


Figure 5.

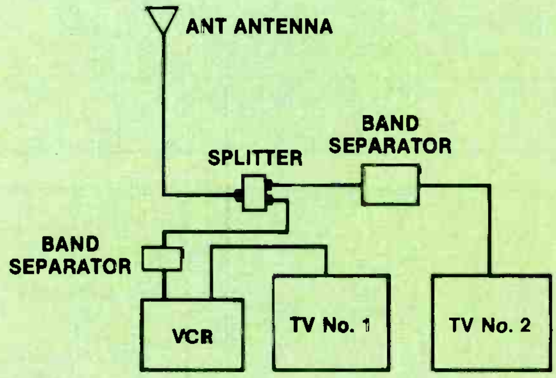


Figure 6.

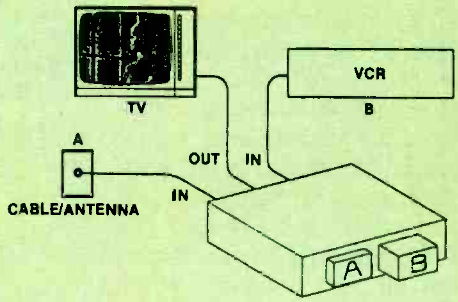


Figure 7.

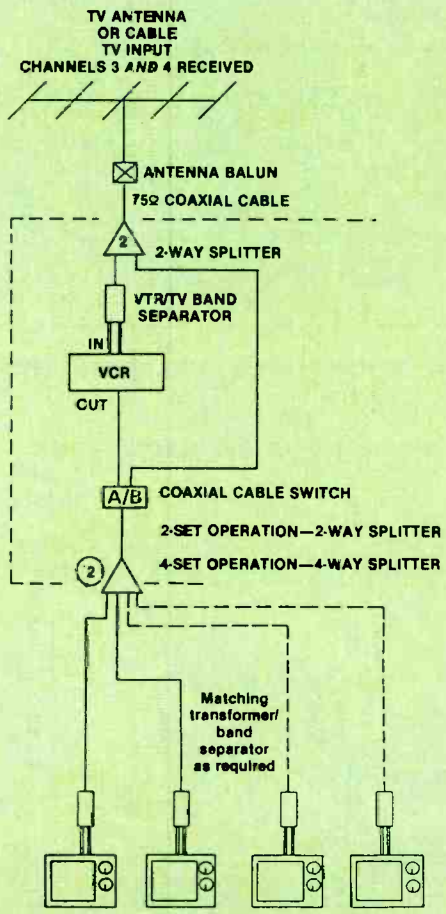


Figure 8.

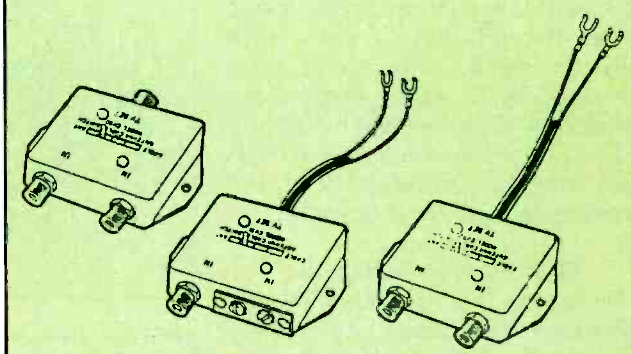


Figure 9.

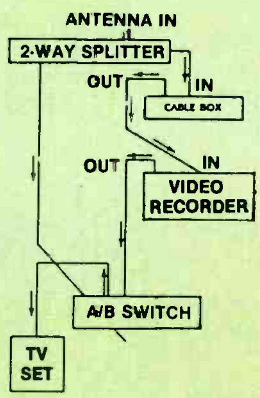


Figure 10.

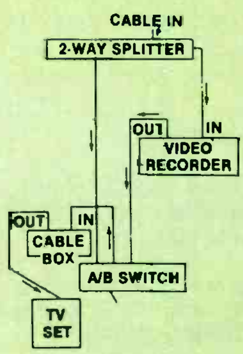


Figure 11.

Figure 4. Method of connecting VCR to a pair of TV sets. (Courtesy Gemini Industries.)

Figure 5. VCR connected to three TV sets, A; to four TV sets, B. (Courtesy Gemini Industries.)

Figure 6. Two-set operation with the televisions independent of each other. Baluns are omitted, but may be required.

Figure 7. *A/B* switcher. (Courtesy GC Electronics.)

Figure 8. TV sets connected like this can use VCR signal or switch to a signal supplied by TV antenna or cable. (Courtesy Channel Master, division of Avnet.)

Figure 9. Types of *A/B* switchers. Left: 75Ω in; 75Ω out. Center: 75Ω and 300Ω in; 300Ω out. Right: 75Ω in; 300Ω out. *A/B* switchers have two inputs; one output. (Courtesy Gemini Industries.)

Figure 10. *A/B* switch permits flexibility in watching and recording. (Courtesy Recton Corporation.)

Figure 11. Alternate wiring of arrangement in Figure 9. (Courtesy Recton Corporation.)

By using the same equipment but rearranging the wiring (Figure 11), it becomes possible to record channels 2 through 13 and watch channels 2 to 84 on television. With the switch set to its alternate position, it becomes possible to watch videotapes and record or view channels 2 through 13 simultaneously.

Game switches

A game switch (Figure 12) gives the user a choice of watching a TV program or using a video game or a personal computer. It also allows the recording of a program while using a video game or computer.

A typical game switch will have a 300Ω input for connection to twinlead downlead from an antenna or, through the use of a balun, for connection to 75Ω downlead coax. Connection to a home computer or a video game, requires an input using an RCA plug. Its output to the TV set is a short length of 300Ω line terminating in spade lugs. Note, in the wiring arrangement of Figure 13, that both *A/B* switches and game switches are required. Although this is an economical setup, you may regard it as inconvenient.

The cable TV connection

Cable TV still is another possible signal source; it supplements broadcast television. Quite often a viewer will want access to both. One possible arrangement is shown in Figure 14. The VCR hasn't been included but it can be inserted on the line between the band splitter and the inputs to the TV set. Note that a 2-way switch is used to permit independent selection of either of the two signal sources.

Video control centers

The *A/B* switch is useful but it does have its limitations. The tendency today is to use TV receivers for a number of signal sources. It is true a pair of *A/B* switchers could be used but this concept complicates the wiring and burdens the user with recalling which switch does what.

A better arrangement is to use a multiple switcher such as the component shown in Figure 15. It can deliver any of the signal sources

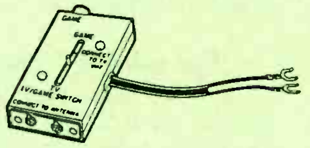
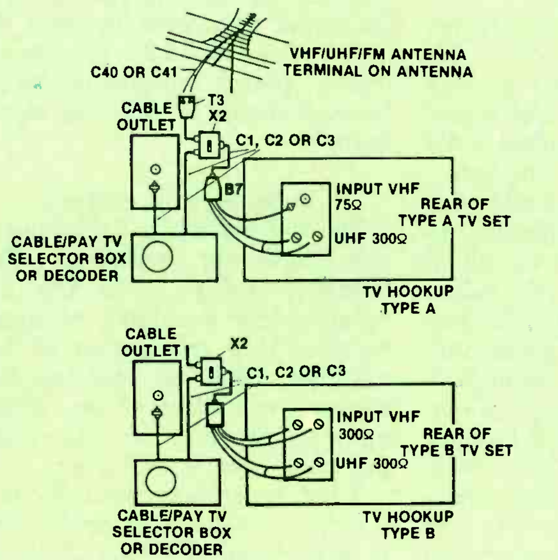


Figure 12.



QUANTITY	CODE	COMPONENTS REQUIRED
1	B7	75Ω TO 75/300Ω TRANSFORMER (BALUN) AND VHF/UHF BAND SPLITTER
1	C40 OR C41	50-ft. OR 75-ft. BULK 300Ω FOAM-FILLED TWIN-LEAD DOWNLEAD CABLE
3	C1, C2 OR C3	3-ft., 6-ft. OR 12-ft. 75Ω COAXIAL CABLES WITH F-TYPE PLUGS ON BOTH ENDS
1	T3	300Ω TO 75Ω MATCHING TRANSFORMER
1	X2	2-WAY 75Ω ANTENNA SWITCH

QUANTITY	CODE	COMPONENTS REQUIRED
1	B1	75Ω TO 300Ω TRANSFORMER (BALUN) AND VHF/UHF BAND SEPARATOR
1	C40 OR C41	50-ft. OR 75-ft. BULK 300Ω FOAM-FILLED TWIN-LEAD DOWNLEAD CABLE
3	C1, C2 OR C3	3-ft., 6-ft. OR 12-ft. 75Ω COAXIAL CABLES WITH F-TYPE PLUGS ON BOTH ENDS
1	T3	300Ω TO 75Ω MATCHING TRANSFORMER
1	X2	2-WAY 75Ω ANTENNA SWITCH

Figure 14.

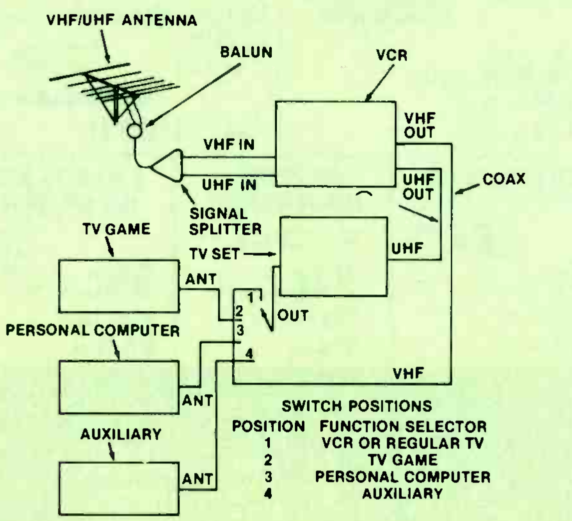
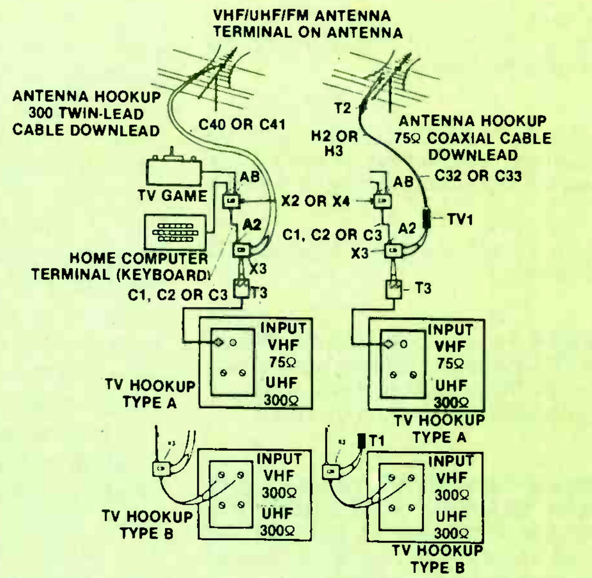


Figure 16.



300Ω ANTENNA HOOKUP

QUANTITY	CODE	COMPONENTS REQUIRED
1	A2	ADAPTER, F-TYPE JACK TO PHONO (RCA-TYPE) PLUG
2	A8	ADAPTER, PHONO (RCA-TYPE) JACK TO F-TYPE PLUG
1	C40 OR C41	50-ft. OR 75-ft. BULK 300Ω FOAM-FILLED TWIN-LEAD DOWNLEAD CABLE
1	C1, C2 OR C3	3-ft., 6-ft. OR 12-ft. 75Ω COAXIAL CABLES WITH F-TYPE PLUGS ON BOTH ENDS
1*	T3	300Ω TO 75Ω MATCHING TRANSFORMER
1	X2 OR X4	2-WAY 75Ω ANTENNA SWITCH
1	X3	TV/VIDEO GAME SWITCH

75ΩANTENNA HOOKUP

QUANTITY	CODE	COMPONENTS REQUIRED
1	A2	ADAPTER, F-TYPE JACK TO PHONO (RCA-TYPE) PLUG
2	A8	ADAPTER, PHONO (RCA-TYPE) JACK TO F-TYPE PLUG
1	C32 OR C33	25-ft. OR 50-ft. BULK 75Ω COAXIAL CABLE DOWNLEAD (WITHOUT CONNECTORS)
1	C1, C2 OR C3	3-ft., 6-ft. OR 12-ft. 75Ω COAXIAL CABLES WITH F-TYPE PLUGS ON BOTH ENDS
2	H2	F-TYPE CRIMP-ON CONNECTORS
OR		
2	H3	F-TYPE TWIST-ON CONNECTORS
1	T1	75Ω TO 300Ω INDOOR MATCHING TRANSFORMER
1	T2	75Ω TO 300Ω OUTDOOR MATCHING TRANSFORMER
1*	T3	300Ω TO 75Ω MATCHING TRANSFORMER
1	X2 OR X4	2-Way 75 Ω ANTENNA SWITCH
1	X3	TV/VIDEO GAME SWITCH

* Required for type A TV hookup

Figure 13.

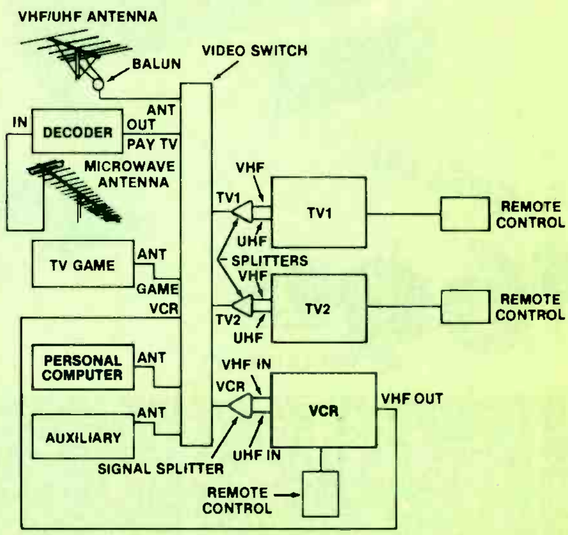


Figure 17.

shown to a pair of TV sets, driving these sets simultaneously. It is possible to regard one channel while watching another. Any one of the components can be switched in or out of the line and so it is possible, for example, to drive the TV set (or sets) with a video game and to have it recorded on a VCR, if desired.

Video switchers can range from the simple *A/B* to the more sophisticated unit of Figure 15, and there are some that are just intermediate such as the one in Figure 16. This really is a ganged *A/B* type but it does eliminate the need for connecting and disconnecting cables. It can control four signal sources, including a TV antenna, TV game, personal computer and an auxiliary such as a videodisc player. However, only the antenna is fed through the VCR, with the other components brought directly into the TV set.

A much more elaborate switching arrangement appears in Figure 17. Not only does it have provision for five inputs, but any input can drive any output. Further, it can operate two TV sets. As a result, it becomes possible to tape a program, watch a program on one TV set and watch a videodisc on the second television.

Figure 12. TV game switch. (Courtesy Gemini Industries.)

Figure 13. Three possible signal sources to TV requires use of two switches. (Courtesy, GC Electronics.)

Figure 14. Hookups for cable television and broadcast television. (Courtesy GC Electronics.)

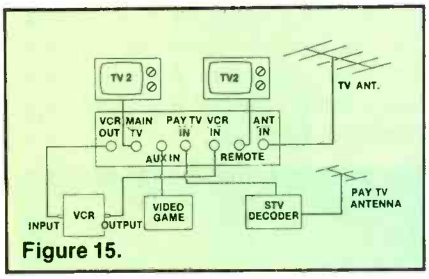


Figure 15.

Figure 15. Video control center. (Courtesy Channel Master, division of Avnet.)

Figure 16. Multiple video switcher replaces several *A/B* types.

Figure 17. Versatile switcher permits number of operating conditions.

With an eye to the future

Most consumers start in video with nothing more than a single TV set, quite frequently using an indoor antenna. In time, the antenna moves outdoors (if possible), the TV receiver is supplemented by a second set, followed by a VCR and then a video game, with the consumer also beginning to think about videodiscs. About this time, there is some thought about adding a personal computer, using the TV screen for viewing. And satellite TV also becomes an intriguing possibility.

What this is, then, is a move toward a video home center. The result is that the rear of the system can become a wiring maze. To avoid connecting and disconnecting cables, a switcher of some kind is essential. Ideally, the switcher should be such that there is no cross leakage from one signal input to another. Also, the switcher should have as many input ports as possible, with at least one that is vacant to allow for the inclusion of one more video device, some time in the future. ES&T

Products

Sams VCR data now in Photofact

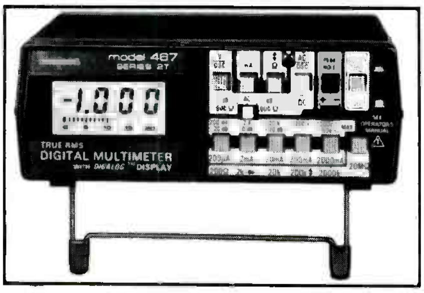
Howard W. Sams, Indianapolis, has repackaged its VCR servicing information and added it to the company's regular line of Photofact consumer electronic service data.

Formerly available only as a 100-page-plus softcover book, Sams VCR service information now is issued quarterly as a set of folders packed in a file jacket and priced at $9.45. It is shipped automatically each quarter to Sams Photofact-Of-The-Month subscribers.

Circle (75) on Reply Card

DMM for telecom testing

Simpson Electric, Elgin, IL, has announced a digital multimeter specifically designed for telecommunications servicing. The model 467-2T is a 3½-digit instrument with direct-reading dB ranges (switchable 600Ω and 900Ω references) for both new and old telecommunications systems. It also has a built-in 1004Hz tone generator for line checking and signal tracing.



The 467-2T has Simpson's Digalog (digital and analog) LCD readout with pulse, continuity and low-battery indicators. The DMM has true RMS ac capability. Twenty-nine ranges are optimized for telecommunications testing.

Other 467-2T functions include audible/visual continuity indications, logic level detection up to 35 V, diode test and differential peak hold. A 9V battery provides up to 100 hours of continuous operation.

The 467-2T measures 2" x 5.63" x 4.6" and weighs 1.5 lbs. Test leads and 1004Hz output cable have alligator clips.

Circle (76) on Reply Card

Universal testing device

Philips ECG Distributor and Special Markets Division, Waltham, MA, has introduced a remote control transmitter tester designated RCT 5501. The tester verifies remote control transmitting functions for both infrared and ultrasonic units used with television sets, video cassette recorders and cable converters. The compact, self-contained tester also provides a determination of the transmitter's useful operation range.

Designed around a sensitive hybrid circuit, the RCT 5501 is useful to technicians both in the shop and on field service calls.

Circle (77) on Reply Card

Wide range counter

An 8-digit, wide range, 100MHz universal counter that has applications ranging from simple event counting, audio and computer servicing to FM receiver repair and cordless telephone repair has been added to the Circuitmate product line by the *Instrumentation Products Division* of the *Beckman Industrial Corporation,* Brea, CA.

Key features of the UC10 include push-button function, gate time, attenuator, frequency range and reset, and self-check functions. Four gate times range from 0.1 second to 10.0 seconds. The 14 LED indicators provide visual feedback as well as an audible signal indicating positive contact was made. Because there are two inputs, the counter also can measure frequency ratios and time intervals.

Circle (78) on Reply Card

Auto-ranging, probe-type DMM

A probe type digital multimeter featuring auto-ranging on all functions, audible continuity test, data hold and ABS plastic case construction with RFI/EMI shielding has been introduced by *B&K-Precision,* Industrial Electronic Products Group of Dynascan Corporation, Chicago.

Model 2802 measures dc voltage in five ranges – 200mV to 500 Vac voltages in four ranges – 2000mV to 500V, and resistance in six ranges – 200Ω to 20MΩ. When the *data hold* switch is depressed, the meter "holds" the reading and allows the probe tip to be removed from the point of measurement. The data hold feature is selectable for all measurements.

Model 2802 includes two interchangeable probe tips – short and long for tight, hard-to-reach measurement points.

Circle (79) on Reply Card

Portable floppy drive tester

Applied Data Communications, Tustin, CA, has added model PT-350 floppy drive tester to its product line. The portable PT-350 weighs 12 pounds, and is acceptable as airline carry-on luggage with an optional built-in plain paper strip printer for hard copy results in the field.

Offering two overlapping test techniques, the PT-350 tests and characterizes all types of floppy disk drives: 8", 5¼", 3½" and 3", FM or MFM encoded.

Circle (80) on Reply Card

Snap-around volt-ohm-ammeter

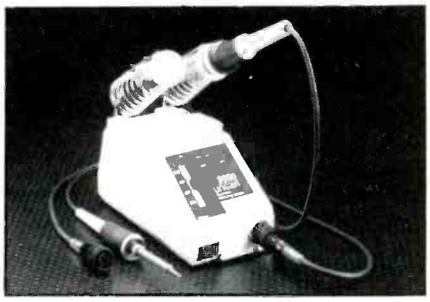
A. W. Sperry Instruments, Hauppauge, NY, announces introduction of the AWS Snap 7 model SDC-701 dc rotary scale snap-around volt-ohm-ammeter. It features an integral unit with all instrument functions contained in a hand-sized housing, and a stable Hall Element circuitry design.

Other features include: continuous duty; self-contained battery power supply; ohm-probe fuse and battery attachment with 600V safety rated fuse; insulated jaws; ABS shock resistant plastic housings; large full-view optically clear window; twist-and-lock safety test leads; accessible front panel controls; new meter design; safety swivel strap; LED pilot light *battery replace* warning; continuous battery check switch; broad, meaningful range spectrum; 1.575 inch diameter jaw opening. Dimensions are 10.04" x 2.835" x 1.575" x 3.425" across jaws (250x72x87mm). Weight: 23 ozs. (650G.)

Circle (81) on Reply Card

Variable-temperature soldering

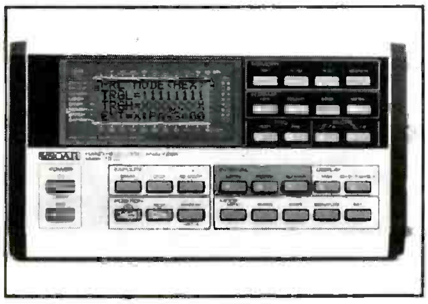
A compact electronically controlled, variable-temperature soldering system with all features needed for electronic production or service has been introduced by the *Ungar Division of Eldon*



Industries, Compton, CA. The model 9900 Electronic Soldering System measures only 3.8 inches wide by 7 inches deep. Either a micro-sized or macro-sized soldering iron can be plugged into a quick-lock plug on the front.

A front-panel switch calibrates a single temperature controller for either size iron, making interchange quick and easy. Twelve standard Ungar tips are available for each iron. Temperature can be set at any point between 450 to 850 degrees F. An optional snap-in lock allows the temperature control to be locked in any of nine positions in 50-degree increments. Three models are available.

Circle (82) on Reply Card



Logic analyzer

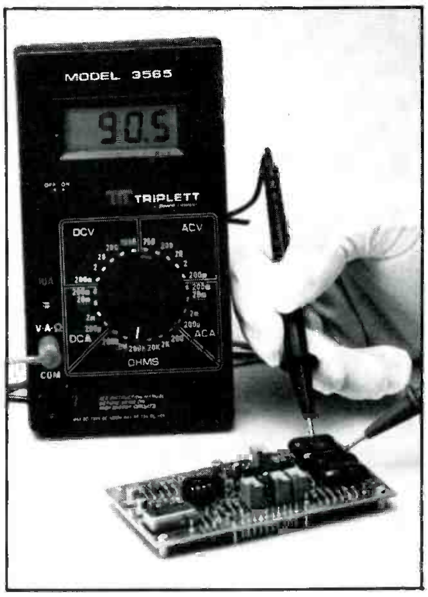
Soar Corporation, Cherry Hill, NJ, presents models 1310 and 1320 logic analyzers capable of performing logic timing, logic state and signature analysis. They are small size hand-held battery portable machines designed for a wide range of applications including field service. The large LCD display unit (2688 pixels) provides a clear picture and the LCD contrast can be adjusted for best viewing in varied light ambience.

Circle (83) on Reply Card

Super-slim multi-tester

Model 3565 digital multi-tester introduced by *Triplett Corporation,* Bluffton, OH, features 5-function, 26-range capability with a 200μA to 10A current range for in-field testing. The tester has recessed jacks, plus overload protection on all ranges with "no-nuisance" fuse outages on the voltage & resistance ranges. Ranges include: 0-1000 Vdc or Vac in five ranges, 0-10A dc or ac in five ranges, 0-20MΩ resistance in six ranges. All ranges are selectable with a single function switch.

Circle (84) on Reply Card



Digital capacitance meter

A low-cost digital capacitance meter specifically designed for hand-held battery operation has been introduced by *Global Specialties,* New Haven, CT, an Interplex Electronics Company. Designated model 3000, this test instrument offers 3½-digit resolution, accuracy to 0.2 percent of reading, capacitance measurement from 1pF to 2,000μF and switch selection of capacitance range. The 0.5 inch numeral LCD display has a maximum reading of 1999 and has annunciators to indicate low battery and excessive compensation of stray capacitance. A *zero adjust* control permits nulling of stray and incidental capacitance.

Circle (85) on Reply Card

Triple output power supply series

A series of compact, laboratory/bench Triple Output Power Supplies has been introduced by *Electronic Measurements,* Neptune, NJ. Designed for both digital and linear applications, each model provides a 5V output that is screwdriver-adjustable over a 3- to 7V range. Model TOS 40405 offers 20Vdc at 2.5A on output 2 and 40Vac at 1.25A on output 3. Model TOS 2025 provides two outputs of 20Vdc at 2.5A.

The current limit is set with single-turn potentiometers that select constant current limits between 0 and 100 percent of maximum rating, thereby providing the constant current output for the power supply and overload protection on outputs 2 and 3. All outputs are completely isolated from each other and from the case and may be connected in series in any polarity. Current limited outputs also may be paralleled. Other specifications include: input/output isolation of 2500Vac; response time, 100 percent step at 5A/μs, is

50μs, with 0.2V p-p overshoot; output is 100MV peak to peak, with two and/or three at 3MV, all in less than 0.4 sq. ft.

Circle (86) on Reply Card

DMMM Add-a-Function

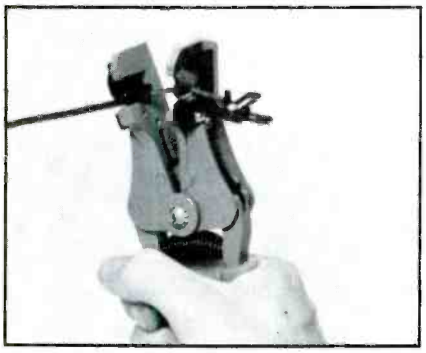
AEMC's Multi-Multimeter now has 18 compatible modules that provide for a wide range of measurement and simulation capabilities. By using the various plug-in modules in place of the standard plug-in lead block, it is possible to measure temperature, air flow, air velocity, relative humidity, a wider range of ac and dc currents, frequency, fiber optic power, capacitance and resistance. Other add-a-function modules can be used to measure light intensity, sound level and magnetic flux den-

sity, as well as simulate RTDs, thermocouples and process signals.

Circle (87) on Reply Card

Wire and cable stripper

Rush Wire Strippers, Syracuse, NY, announces a new die blade, automatic hand-held wire and cable stripper, the model D, designed for stripping the insulation from stranded and solid twin



conductor cables to 0.059-inch and 0.071-inch. Most insulation types can be severed and stripped with this tool, including PVC, polyethylene, nylon and some PTFE and teflon-type insulations.

Hardened steel position ground die blades are activated by a single squeeze of the tool handles. The blades automatically cut the insulation and the slug is removed. Both wires of a twin cable are cut and stripped in one single operation. An adjustable strip length stop is standard equipment to obtain repeatable strip length in critical applications.

Circle (88) on Reply Card

Reference card

From *Micro Logic Corporation* of Hackensack, NJ, comes the Micro Chart No. 10 entitled "Active Electronic Components." This two-sided two-color 8½" x 11" plastic card gets right to the basic workings of everything from op-amps to programmable unijunction transistors without having to go through theory, fabrication methods, or advanced terminology, according to the publisher.

Non-digital functions readily available in a single monolithic package are covered including 13 diode types, 6 types of transistors, 5 families of thyristors, 4 types of light emitters, 9 types of light receivers, plus the analogue switch, A/D & D/A, comparator, multiplier, one-shot, op-amp, optocoupler, PLL, bridge rectifier, sample and hold, Schmitt trigger, tone decoder, varistor, VCO, voltage follower, voltage regulator and more. Typical descriptions cover: names of part, signal names, detailed operation, and examples of key specification parameters.

Circle (89) on Reply Card

Portable soldering iron kit

An industrial grade soldering iron that operates from any 12V battery for emergency repairs almost anywhere is available from *M.M. Newman Corporation,* Marblehead, MA. The Antex MLX-12 repair kit features an in-

dustrial grade 25W soldering iron with a 15-ft. cord and heavy-duty alligator clips that connect to any 12V battery. For emergencies, it heats up to 800 degrees F in less than two minutes.

Supplied with a vinyl carrying pouch and solder, the Antex MLX-12 repair kit fits into a glove box or tool case. The soldering iron has an 8-inch non-charring plastic handle that stays cool and uses replaceable, slide-on tips.

Circle (90) on Reply Card

Power console

PMC Industries, San Diego, CA, has a power console designed for use with personal and small business computers. Model 062 Noise/Surge Buster is built to protect personal and small business computers (and their data) from ac line noise, transients and high voltage surges.

The model 062 features a master *on/off* lighted rocker switch, two surge and spike protected outlets, and the added feature of a two stage RFI/EMI filter to attenuate data-scrambling common and differential mode noise. The Noise

Buster eliminates RFI/EMI noise to 55dB and common and differential mode high voltage and high energy spikes to 70 joules (6500A, 780,000W). This unit is designed for direct plug-in use to any 120Vac line.

Circle (91) on Reply Card

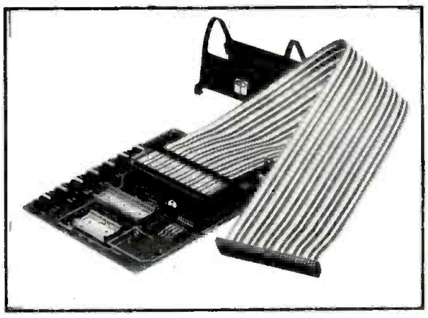
Marker for thin wires, multiconductor cables

Thin wires can be marked with Flexy-Marker, a wire and cable marker introduced by *Datak Corporation,* Guttenberg, NJ. Jet-black OCR-B standard characters are permanently fused into an elastic and flexible 0.003-inch white vinyl film. Characters are clear and legible on wire sizes down to 0.040-inch diameter without flagging the marker. The adhesive is impervious to most oils and hydraulic fluids.

Circle (92) on Reply Card

The low-profile connection

A P Products, Mentor, OH, has introduced a test clip that fits between closely stacked PC boards to simplify the testing of integrated circuits. The Low Profile Logical Connection systems eliminate the need for extender boards or umbilical-type connectors which are required by standard test clips.



With this test clip, ICs can be tested on boards side by side. The height of the Low Profile Logical Connection systems is .33 inches, which allows for the testing of ICs with board spacings down to 0.5 inches.

Circle (93) on Reply Card

Hot air soldering/desoldering

Edsyn, Van Nuys, CA, presents model 1036 Hot Air Soldering and Desoldering Station, designed for manual operation without endangering sensitive components. Particularly useful for surface mount devices, the hot air tool does not have to make physical contact with the joint being soldered or desoldered.

Several benefits of this technology cited by the manufacturer include the fact that the effect of the hot air on the solder is always visible, permitting more precise control of dwell time.

Circle (94) on Reply Card

Ground outlet tester

A small, lightweight testmeter originally designed for hospital safety is being used by office personnel to detect unsafe grounds in electrical wiring. The Veri/Test-500 TM electrical ground outlet tester, from *Verité,* Harbor City, CA, plugs into any standard outlet to identify faulty grounding.

The Veri/Test-500 shows readings for both the neutral line and the third (U) ground wire of a 3-wire line. The user checks each wire in turn by flicking a switch on the front panel. A zero voltage reading indicates reverse wiring polarity.

The Veri/Test-500 indicates which is the hot wire and verifies that 115 volts are actually being supplied in the correct polarity. The 2-pound device is claimed to detect and indicate resistances as low as 0.1Ω.

Circle (95) on Reply Card

Cleans, preserves, lubricates

Cramolin is an anti-oxidizing solution that cleans, preserves and lubricates all metal surfaces, including gold.

When Cramolin, product of *CAIG Laboratories,* Escondido, CA, is applied to metal contacts and connectors, it removes resistive oxides. Cramolin forms a protective molecular layer that adheres to the metal surfaces and maintains maximum electrical conductivity thus discouraging future contamination. Use on: switches, potentiometers, relays, PCB connectors, batteries, faders, interconnecting cables, plugs, jacks etc.

Circle (96) on Reply Card

Shirt pocket-size tester

Network Technologies, Chagrin Falls, OH, announces the Montest-C15, a small portable test instrument. It is compatible with the IBM PC color monitor and tests RGB video drive and intensifica-

tion. Montest-C15 can display a 6 by 7 cross hatch pattern or a full raster in any of the 15 possible colors. Monitor connection is made via a 9 pin D. Because of its small size and battery operation, it is suited for production, inspection or service applications. Test and calibration can be done at the user's work area.

Circle (97) on Reply Card

Test your electronic knowledge

By Sam Wilson

This is the age of the supertechnician. In order to understand the wide variety of components, circuits and systems used in today's technology, it is necessary to know both analog and digital theory. It also is important to have a basic understanding of other fields of knowledge such as physics, chemistry and mathematics. This test is for the supertech.

1. For the circuit in Figure 1, +5V is *logic 1* and 0V is *logic 0*. When the switch is in the position shown, the output at Q is
A.) logic 1.
B.) logic 0.

2. A series of instructions for solving a problem is called
A.) a code.
B.) an algorithm.
C.) a decode index.
D.) an instruction set.

3. Which of the following is the speed of sound in air?
A.) 212 miles per hour.
B.) 1120 miles per hour.
C.) 186,000 miles per hour.
D.) None of the above choices is correct.

4. A certain power supply has an output of 28 volts when it is not delivering current. The full-load voltage of the supply is 26.5 volts. The percent regulation of this supply is
A.) 5.66 percent.
B.) 5.357 percent.
C.) 4.44 percent.
D.) 4.137 percent.

5. Assuming the capacitors in the circuit of Figure 2 are fully charged, the voltage across C_1 should be ________________V.

6. Which of the constant-current diode symbols in Figure 3 is properly labeled?
A.) the one marked 'a.'
B.) the one marked 'b.'

7. The R-C circuit in Figure 4 is called a *false bass tone* control. To increase the treble sound, move the arm of the variable toward
A.) point a.
B.) point b.

8. Everyone knows that a strain gauge measures strain. Or, does it? As a high-quality technician you are very careful not to confuse the terms *stress* and *strain* as they are used in science. You know that
A.) stress is the force that produces strain.
B.) strain is the force that produces stress.

9. Another name for a pulse stretcher is
A.) monostable multivibrator.
B.) bistable multivibrator.
C.) astable multivibrator.
D.) voltage-controlled oscillator.

10. Which of the following can be made into a constant-current device with a single wire?
A.) UJT.
B.) PUT.
C.) FET.
D.) CCD.

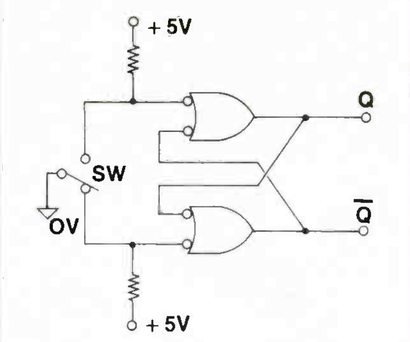


Figure 1.

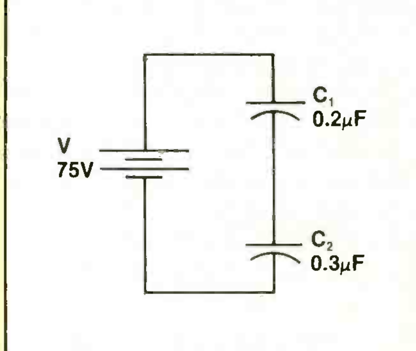


Figure 2.

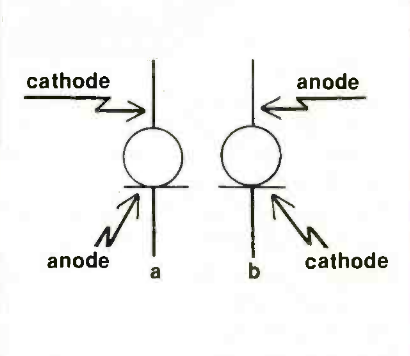


Figure 3.

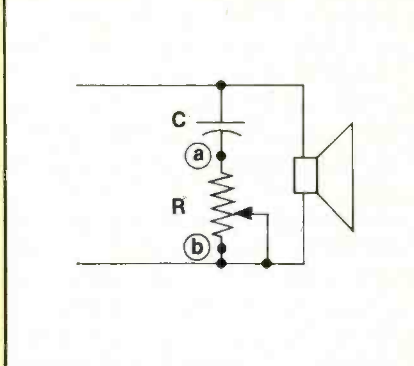


Figure 4.

Answers to quiz

1. B. An OR gate with inverted inputs is equivalent to a NAND gate. So, the circuit of Figure 1 behaves like a NAND flip flop.

2. B.

3. D. If you selected choice B, you may be a careless reader. If so, train yourself to read questions very carefully.

4. A. The equations, and the solution:
Percent Regulation =
$$\frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$
(Where V_{NL} is the no-load voltage and V_{FL} is the full-load voltage) so:
Percent Regulation =
$$\frac{28 - 26.5}{26.5} \times 100$$
$$= 5.66\%$$

5. 45 V.
The voltage across each capacitor can be calculated by using the following equations:
voltage across $C_1 = V_1 =$
$$V \left(\frac{C_2}{C_1 + C_2}\right)$$
voltage across $C_2 = V_2 =$
$$V \left(\frac{C_1}{C_1 + C_2}\right)$$
(C_1 and C_2 are in the same units)
For question 5:
$$V_1 + 75 \left(\frac{0.3}{0.2 + 0.3}\right) \; 45V$$

6. B.

7. B. By increasing the impedance of the R–C circuit, you reduce the amount of high-frequency audio that bypasses the speaker.

8. A. A strain gauge actually measures the deformity that is produced by a stress. The reason the terminology is confusing is that you normally couldn't care less about the amount of strain. What you really want to measure is the force (stress) that produces the strain. See also the discussion on strain gauges in the article titled "What Do You Know About Components?"

9. A. A short input pulse produces a long output pulse.

10. C. See Figure A.

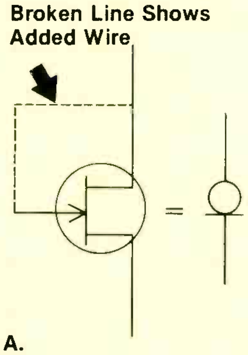
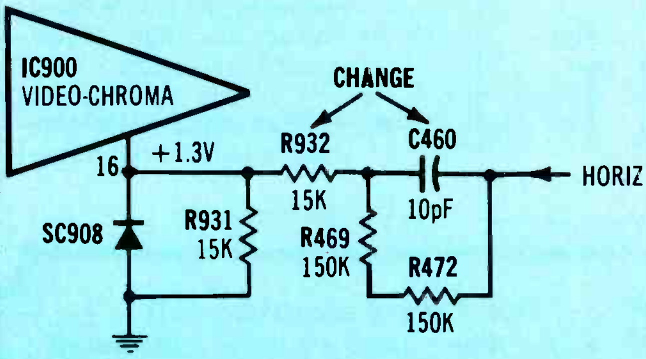


Figure A.

Symcure

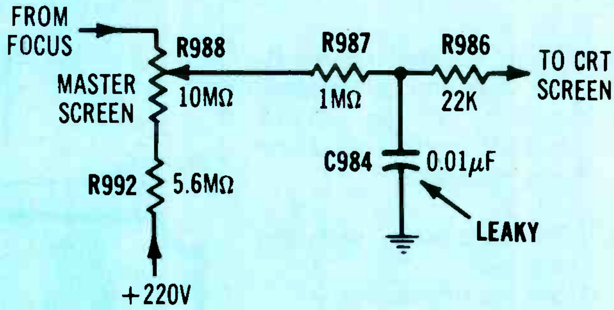
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Sylvania E-32 series 1
PHOTOFACT—2034-1 and others



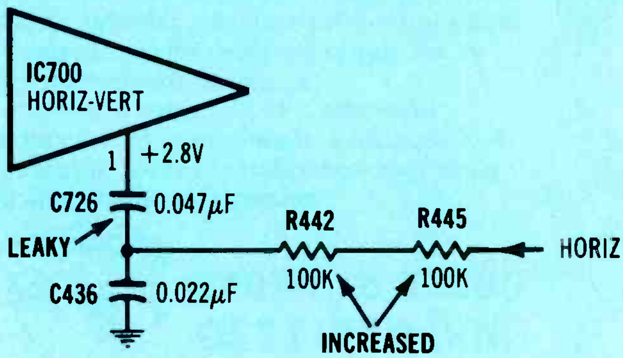
SYMPTOM—Black hole or black horizontal line when channels are changed
Cure—Remove R932 and replace with a 47pF capacitor; also remove C460 and discard

Chassis—Sylvania E-32 series 2
PHOTOFACT—2034-1



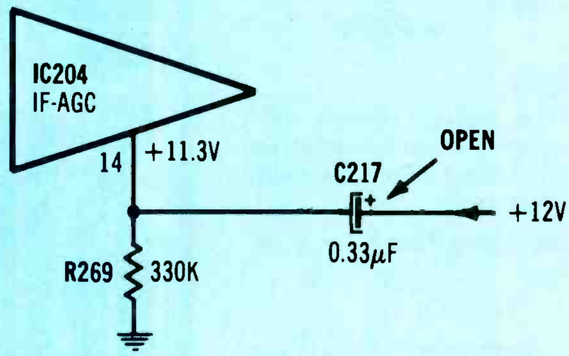
Symptom—Low brightness, similar to a weak CRT
CURE—Check capacitor C984, and replace it if leaky

Chassis—Sylvania E-32 series 3
PHOTOFACT—2034-1



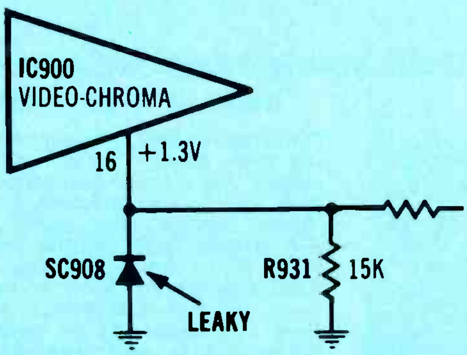
Symptom—No horizontal locking, or erratic locking
Cure—Check C726, R442 and R445, and replace the capacitor if leaky and the resistors if increased in value

Chassis—Sylvania E-32 series 4
PHOTOFACT—2034-1



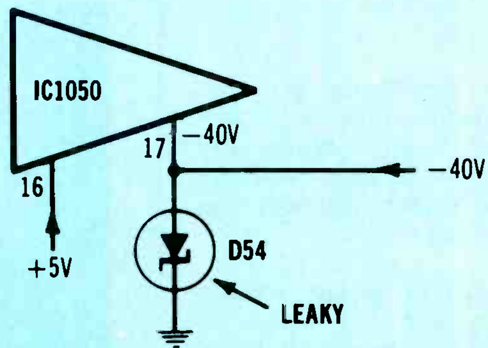
Symptom—Horizontal pulling or tearing
Cure—Check capacitor C217, and replace it if open or leaky

Chassis—Sylvania E-32 series 5
PHOTOFACT—2034-1



Symptom—No color or intermittent color
Cure—Check diode SC908, and replace it if leaky

Chassis—Sylvania E-32 1984 6
PHOTOFACT—2110-2



Symptom—Loses channel memory after it is addressed
Cure—Check zener diode D54, and replace it if leaky

Literature

A colorful spring catalog showing 347 computer, electronic and other technical titles by 214 well-known authors has been released by **Howard W. Sams and Company.**

Displaying Sams entire line of books and software, the 48-page catalog describes technical subject matter including robotics, digital electronics, video, satellite communication, security, electronic design, service and reference data, plus all phases of business and personal microcomputing.

Circle (100) on Reply Card

The NEDA Battery Cross-Reference Guide has been published with 276 different battery numbers cross-referenced to designations from the 10 participating manufacturer/sponsors. Published annually by the **National Electronic Distributors Association,** Park Ridge, IL, for more than 30 years, the 1985 NEDA Battery Guide lists interchangeable battery numbers from the different manufacturers.

The most popular and commonly used battery models are published in this 12-page guide. In addition to the listing of non-rechargeable and rechargeable batteries, the guide also has an expanded number of lithium batteries and includes zinc air batteries for the first time.

Circle (101) on Reply Card

Electronic Specialists is offering Catalog 851, a 40-page color catalog describing power line problems such as noise and high voltage spikes. Damaging and disruptive effects on various types of hi-tech equipment are described. Typical laboratory, commercial and office problems and suggested solutions are included; protective and interference cure products are described.

Circle (102) on Reply Card

Bishop Graphics announces publication of its newly revised 220-page technical manual and catalog. The publication is called "Bishop Graphics Printed Circuit Drafting Technical Manual & Catalog 107A." It is divided into two segments: an expanded product catalog and an updated technical manual.

Circle (103) on Reply Card

Now available from **VIZ Test Equipment,** a division of VIZ Manufacturing Company, is a 20-page short-form catalog describing over 50 test instruments, including digital and analog meters, isolated ac power sources, signal generators, dc power supplies and universal counters.

This 1985 multicolor catalog introduces new instruments and gives technical specifications. The catalog gives a direct *800* number for ordering information.

Circle (104) on Reply Card

Books

Editor's note: *Periodically **Electronic Servicing & Technology** features books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given, rather than to us.*

Apple II Plus/IIe Troubleshooting and Repair Guide, by Robert C. Brenner, Howard W. Sams & Co., $19.95.

Apple II Plus/IIe Troubleshooting and Repair Guide takes users step by step through proper II+/IIe diagnostic techniques and lists specific malfunctions in trouble charts organized by computer subsystem. Brenner calls this book "...an all meat and potatoes manual" intended for 95 percent of those circumstances where knowledge and a good reference are enough to let a user find and repair a failure.

Illustrated chapters include coverage of periodic preventive maintenance. There also is information for heavy-repair of the remaining 5 percent of failures, including advice on developing some custom diagnostic tools in both hardware and software form.

Howard W. Sams and Company, 4300 W. 62nd St., Indianapolis, IN 46268

Color and Black & White—Television Theory and Servicing, second edition, by Alvin A. Liff, Prentice-Hall, $29.95.

The author designed this book to help aspiring and practicing electronic technicians become proficient in the expanding field of video electronics. This second edition is a newly updated examination of the theory and practice of color and black & white television receivers.

Among the features of this practical guide: the television receiver system and circuits are presented easily and logically; a new chapter on the video cassette recorders has been added; each chapter begins with a block diagram in which the circuit being discussed is shaded to show the position of the circuit as it relates to the overall system; modern television circuits, including cable and satellite TV systems are discussed. Chapters are profusely illustrated, and end with questions to test reader's understanding of the material.

Prentice-Hall, Inc., Englewood Cliffs, NJ 07632

Basic Transistor Course—2nd Edition, by Stan Gibilisco, Tab Books, $12.95 paperback.

Anyone new to electronics practice, or needing a quick brush-up on the new developments in solid-state technology will find this a thorough, easy-to-use guide. Here, in a revised and updated second edition of the classic transistor sourcebook, are all the practical facts and hands-on guidance for understanding transistor technology and using these devices in practical applications.

The author, Stan Gibilisco, is currently involved in engineering, tutoring and technical writing. He also has written Tab's *Understanding Einstein's Theories of Relativity: Man's New Perspective on the Cosmos.*

Tab Books, Blue Ridge Summit, PA 17214

How to Design Op Amp Circuits, with Projects and Experiments, by Delton T. Horn, Tab Books, $15.45 paperback.

Versatile and readily available at low cost (some surplus op amps cost no more than $1 per dozen; new chips, 50 to 60 cents) operational amplifier integrated circuits lend themselves to countless applications in the workshop. This handbook provides over-the-shoulder guidance for using op amps in designing digital or analog circuits ranging from active filters, signal generators and pulse circuits to power supply, detector, metering and digital circuit applications.

Writing in interesting, informal style, the author leads readers through all the fundamentals of op amp characteristics and applications, reinforcing each principle with hands-on experiments. Descriptions are clear of various types of op amps, and of reasons why these circuits have become increasingly important in all areas of electronics practice.

Tab Books, Blue Ridge Summit, PA 17214

Second Book of Easy-to-Build Electronic Projects, by the Editors of *Elementary Electronics*, Tab Books, $12.95 paperback.

Build-your-own electronic devices – from an apartment antenna, a rhythm and blues synthesizer box and novelty digital dice to power supplies and test equipment – are described with the necessary how-to information in this second of a series of project guides. The volume includes a total of 33 plans for projects that are entertaining or that can be used for practical home and hobby applications.

A complete parts list is included for each project, along with building instructions, detailed drawings and schematics and tips on using perf-board and point-to-point wiring as an alternative to printed-circuit boards.

Tab Books, Blue Ridge Summit, PA 17214

The 1985 ARRL Handbook for the Radio Amateur, by the American Radio Relay League, $15.00 paperback in U.S., $16.00 Canada and elsewhere.

This year's Handbook has new typesetting throughout, new outline, new title, new construction projects and a circuit board etching pattern section that is also new.

The 1985 edition totals 1024 pages, 376 more than last year, and there are 17 additional chapters. More than 1700 circuit diagrams and illustrations are provided.

The American Radio League, Inc., Newington, CT 06111

29 Electronic Projects for Your Home, Car and Workshop, by Myles H. Marks, Tab Books, $18.95 hardbound only.

The practical projects included in this guide include a simple, but effective, home intrusion alarm system, an intermittent feature for car windshield wipers, a power saver for use on ac induction motors (the type used in refrigerators, air-conditioning compressors and pool filters), a 0 to 35V regulated variable power supply to power devices requiring up to 1.5A, an automatic headlight shutoff delay, an automatic garage door closer...the list goes on!

Marks is a graduate of Cleveland Institute of Electronics and is currently technical director for WPXI-TV in Pittsburgh.

Tab Books, Blue Ridge Summit, PA 17214

A Beginner's Guide to Making Electronic Gadgets – 2nd Edition, by R.H. Waring, Tab Books, $8.95 paperback.

Here is hands-on guidance in the principles of successful electronics practice, put to practical purpose as the reader is directed, step-by-step through numbers of functional projects. Build power switches, thermostat controlled heaters, a simple field-strength meter, low-cost test instruments... even an electronic organ.

Beginners may find this the key to an expanding and productive hobby that could lead – with requisite training – to a career in electronics.

Tab Books, Blue Ridge Summit, PA 17214

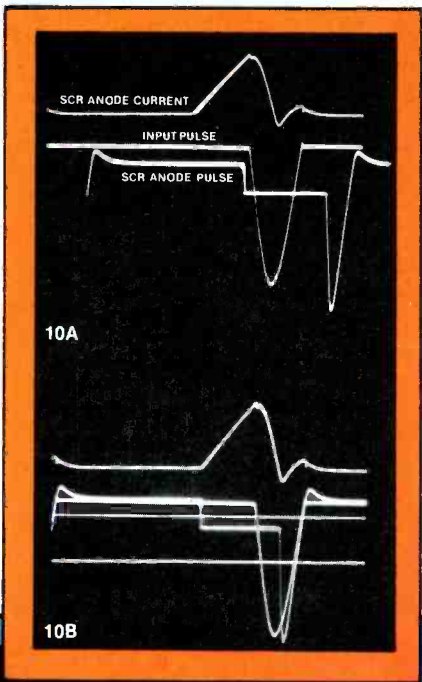
The Understanding Series, auspices of Gerald Luecke, Texas Instruments, $14.95, paperback.

Texas Instruments announces the expansion of this series of books designed for people interested in learning about today's science and technology. Written and edited by experts in science and electronics in a style that makes these subjects interesting and understandable, the books in this series have a fresh, inviting format highlighted by numerous illustrations.

Ten titles have been issued in 1985 and plans are underway to increase the number to 36. The following books comprise those published during this year's first quarter:

- *Understanding Automation Systems*
- *Understanding Automation Electronics*
- *Understanding Communications Systems*
- *Understanding Computer Science*
- *Understanding Data Communications*
- *Understanding Digital Electronics*
- *Understanding Digital Troubleshooting*
- *Understanding Microprocessors*
- *Understanding Solid-State Electronics*
- *Understanding Telephone Electronics*

Texas Instruments, Inc., P.O. Box 225474, MS 8218, Dallas, TX 75265



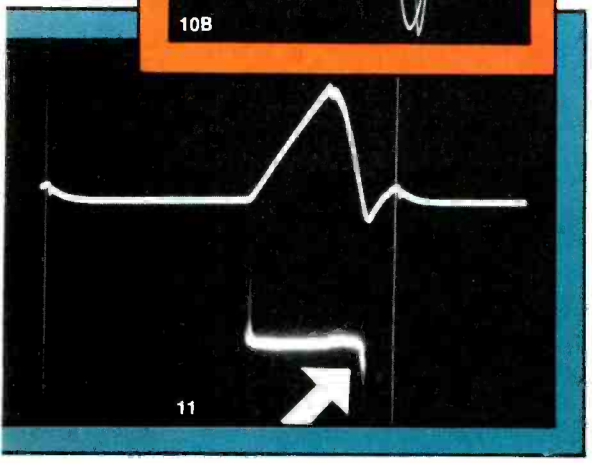


Figure 10. The current waveform (at top) and the input pulse waveform (center) are in the correct phase relationship, but the SCR anode waveform has been moved to the right and below the input waveform so both waveforms will be unobscured. 10B is an unretouched multiple exposure of the same waveforms with correct phase also +150V and 0-voltage (bottom) lines added by the scope. The faint line going down from the end of conduction (in the SCR-anode waveform) is faint because the beam was traveling very rapidly. Notice that the tip of the SCR-anode waveform is moved to the right of the input-pulse tip and has greater amplitude. Those effects and the overshoot where the line joins the pulse base line are produced by the tuned-circuit effect of several components in the circuit.

Figure 11. This photograph is a dual-trace combination of the sawtooth current waveform (at the top) and the SCR-anode waveform greatly expanded vertically to show details of the turn-off operation at the end of SCR conduction. The bright vertical part of the turn-off corner has an amplitude of only about 2VPP. Two dim narrow vertical lines at the edges are the rising right sides of the half-pulses in the SCR-anode waveform.

An analysis

...continued from page 19

waveform's base-line voltage did not change. The increase was the inductive action of L501, which opposes rapid changes of current. When the input pulse first began its negative movement, the SCR current began to decrease, because the pulse voltage (while still positive) was decreasing rapidly. Zero current did not occur until the tip of the input pulse was at the SCR500 anode (there is phase shift here, to be explained later). SCR500 then was non-conductive and remained that way until gated-on by the two oscillator transistors in the control circuitry.

Turning-off, phase shift and overshoot

As explained before, the normal 460VPP input pulse amplitude becomes only a fraction of a volt at the SCR500 anode during SCR conduction. Essentially the same reduction of the +150V supply occurs, also. Except, the anode becomes about +1V relative to the cathode voltage of 110V.

This huge reduction of dc and ac voltages at the SCR500 anode is the reason why the negative-going pulses must have very high amplitudes in order to turn off the SCR and stop its conduction. The requirements are simple: The anode must be slightly more negative than the cathode. However, the conduction vertically compresses the pulses; thus an input of several hundred volts PP is required to produce the required volt or two. Compare waveforms W2 and W3 in The SCR-Regulator Circuit. Because it was scoped at TP13 on the other side of R513, W2 shows a definite downturn at the right end of the horizontal line that represents the −110V source, but W3 taken at TP12 (SCR500 anode) shows very little curve before the turn-off. Figure 11 shows the current waveform for reference and a small section of the SCR500 anode waveform greatly expanded vertically by use of the 5V/div range. The corner is easy to see in Figure 10, but the curve drops only about 2VPP before turn-off is complete and the beam moves downward with great speed.

Figure 10 proves that the SCR current stops after the tip of the input pulse has already passed. Also, the half-pulse at the SCR anode has its tip to the right of the input pulse's tip. This is the result of lagging phase shift produced by one or more of the incidental tuned circuits. During conduction, the most prominent tuned circuit is the low-pass filter composed of L501 and capacitor C512. But the one that moves the anode tip half-pulse to the right operates during non-conduction, and it is made up of L501 vs. C510/C511, which are bypassed to ground by C512.

The pulse tilting by tuned circuits makes the analysis more difficult, but the evidence strongly suggests that almost the entire 460VPP is needed for dependable turn-off of SCR500. Another conclusion is that three voltages contribute to the +110V regulated supply. First, of course, is the +150V supply. Second is the extra voltage supplied by the base line of the 460VPP pulses. This voltage is steady during the time the SCR current is increasing. Third and last is the smaller voltage added by the rectification of the left side of the horizontal pulses. A comparison of the calculated voltages from averaging of dc pulses vs. the actual circuit showed about 64V out of +111V with line voltage of 120Vac were added by the extra rectification, while about 49V out of 107V were added by rectification at 100Vac line voltage.

At first thought, this extra bonus voltage reminds one of perpetual motion, or of someone pulling himself up by his own bootstraps. After all, horizontal deflection produces the negative pulses that increase the +110V source, while the +110V source supplies dc power to the horizontal-output stage that produces horizontal deflection. However, *all* power originally comes from the +150V supply, so no laws of physics are broken.

Next article

Is the horizontal-output solid-state device a gate-controlled switch (GCS) or a transistor with internal resistors added? These and other questions will be discussed plus a detailed examination of the 19C4 horizontal-deflection and high-voltage system. ES&T

Readers' Exchange

For Sale: Retiree from Radio-TV-Appliance business wishes to dispose of all repair parts, equipment and even the store. Will consider exchange for equal value. *Allen G. Jolly, Engelhard (Hyde Country), NC 27824; 919-925-2621.*

For Sale: FC45 frequency counter, $250; Sencore PS163 scope, $200; Sencore VA48 (updated and calibrated), $800; EICO 633 CRT tester w/adapters, $80. Sencore CB41 tester, $100. Other items. *Bill Bechtold, 7429 Frederick, Omaha, NE 68124; 402-397-2461.*

Wanted: Knight 83YX123 RF sweep generator, Knight 83Y125 VTVM manual, B&K 2801 DVMs, and Supremes TV 1, 2, 11, 12 and 15, 16 manuals. *C.T. Huth, 130 Hunter St., Tiffin, OH 44883.*

For Sale: Sencore VA48, excellent condition and all manuals, etc., $800; Sencore CR31A super mack CRT tester and beam builder, excellent condition and all manuals with 21 sockets, $400. *Larry R. Bell, 5506 Mesa Ridge Lane, Columbus, OH 43229; 614-882-8055.*

For Sale: Supreme service manuals R-1 through 27, AU-1, TV-1 through 29 (except TV-19), C-69, C-70, UHF-1 and master index. Shipped prepaid within U.S.A. for highest bid received during month following this ad (complete set only). Original cost, $250. *C.E. Maupin, 2124 SW 68, Oklahoma City, OK 73159.*

For Sale: Circuit boards, tubes, tuners, knobs and other TV parts for older Motorola models Wu870EWB, Wu918Gu, WL922GP, Wu819GW, 21K39R, other makes and models. Send large s.a.s.e. for complete list, prices. *Randy's Radio & TV Service, R.R. 1, Arcadia, IA 51430; 712-658-2442, 9-5 EST.*

For Sale: Lifetime base-mount antenna mount, increases range of mobile CBs. Build from easy plans, $15. *M.G. Scott, Box 349, Sandstone, MN 55037.*

For Sale: Large collection (2000 plus) of original factory-service books, schematics and service notes. Want to sell all. *Alvin Sydnor, 806 Meetinghouse Road, Boothwyn, PA 19061; 215-477-9100.*

For Sale: Sencore VA48, $475; Heath IM-2264 RMS digital multimeter, $175; Heath IT-3121 curve tracer, $75; Heath IB-1102 frequency counter, $50. *D. Valencia, 7241 Tuolumne Drive, Goleta, CA 93117.*

For Sale: B&K Precision model 1477, dc to 15MHz dual trace oscilloscope, includes accessories, 3 months old, $295 or best offer. Global Specialties model 333 Tri-mode comparator, model 2001 function generator, model 6001 5Hz to 650MHz frequency counter, model 3001 capacitance meter, model 5001 universal timer/counter, model 4401 frequency standard. All bench-top units sold in complete set only. All, like new and include all accessories. $1195 or best offer. *Tim Valczack, P.O. Box 2680, Des Plaines, IL 60018; 312-298-6335, days.*

For Sale: Sencore VA48, used slightly more than one year, $950; Hickok 515 solid-state 15MHz single trace oscilloscope, very good condition, $225. *Al's TV, P.O. Box 1388, Prescott, AZ 86302; 602-778-3194.*

For Sale: Service manuals: Admiral, Emerson, G.E., Magnavox, Philco, RCA, Westinghouse, covering radio, b&w television, color television, record changers, stereo MX, radio-phono comb, tuners, transistor radios, tape recorders, CB, etc., 1950-1973. Six bound volumes of 1467 manuals, $150 plus shipping. *M. Seligsohn, 1455 55th St., Brooklyn, NY 11219.*

Wanted: Schematic for Electronic Associates color monitor model E.V.-2114. Will pay for the copy and postage. *R.J. Warwick, 5096 Eucalyptus Circle, Cypress, CA 90630.*

For Sale: Sams Photofact folders 101 to 180 in eight volumes (80 sets); 399 to 1502, $2 per set, minimum 30 sets, or $1,200 for all. Also Zenith and RCA manuals, test equipment and modules. Send s.a.s.e. for complete listing. Will ship Best Way or UPS with $50 deposit, balance C.O.D. *Mack Kunzman, Jamke TV-Radio, 1051 Bale Lane, Calistoga, CA 94515; 707-942-4724.*

For Sale: Radio and color TV course by Bell and Howell, used by the DeVry Institute of Technology; 10 volumes on *Basic Theory to Color TV Troubleshooting*, $100 plus shipping. *Mark Fowlds, Frontier TV, Box 10A, Palisade, MN 56469; 218-845-2156.*

For Sale: Sencore PS148 oscilloscope, $125; B&K model 607 tube tester and 453 new tubes, $500, 400 Sams Photofact folders No. 600 to 1600, plus Zenith TV manuals, $400. *Ezra Hodgson, Route 5, Box 148D, Berryville, AR 72616; 501-423-2642.*

For Sale: B&K 1077B analyzer, $300; B&K 290 multimeter, $125; NRI professional VCR servicing course, $90. *Stan Hayman, 19707 Turnberry Way, N. Miami Beach, FL 33180; 305-944-5674.*

Needed: Owner's manual and service manual for open reel Dokorder model 7050, series 7000, and for open reel tape recorder Sony TC-270. Will pay for copies and postage. *John S. Boczar, 42 Edwards St., New Haven, CT 06511.*

Wanted: VCRs (older models) for parts purposes, VHS/Beta, *Scott's TV & Electronic Service, RD3-3186, Pottsville, PA 17901. No phone calls, please.*

Needed: Circuit diagram for Trio amplifier model KW-200G, and Armstrong receiver model 626. Will copy and return or will pay. *Richard Rozon, Les Services Audio-Visuel Un á Un, 9 février 1985, Westmount, Québec, Canada H3Z-1W9.*

For Sale: Lampkin frequency meter, $500; Bird wattmeter with one element, $100; B&K TV alignment generator, $250. *Alvin Jacobson, 416 W. 2nd St., Williston, ND 58801; 701-572-5712.*

Wanted: Analab model 1100 or 1120 oscilloscope mainframe in good condition. *Steve Senk, 1214 Hickory Ave., Waldorf, MD 20601; 301-645-1475.*

For Sale: RCA 10J106A test jig with 38 adapters and focus supply, $400; B&K 501 semiconductor curve tracer, $100; VIZ 510A Master-VoltOhmyst, $100. All like-new condition. *John Fisher, 832 Hanover Road, Deland, FL 32724; 904-734-9226 after 6:00.*

For Sale: Heath microprocessor trainer model ET-3400, like-new condition, complete with manual and parts for experiments, $125; Sencore CG141 color bar generator, $35. *Lloyd R. Settle, RR 1, Ina, IL 62846; 618-437-5618.*

Wanted: VHF/UHF tuner knob set for GE model SF2100AM, 21-SF chassis, 1973. *Vito Cascio, 325 Menahan St., Brooklyn, NY 11237.*

Wanted: *Practical CB Radio Troubleshooting and Repair*, by David F. Norman (TAB Books); *Modern CB Radio Servicing*, by Marvin Hobbs (Hayden Book Company). Both out-of-print. Will gladly pay reasonable price for these books in mint condition. *John L. Wingfield, P.O. Box 685, Cedaredge, CO 81413; 303-856-6341.*

Needed: Schematic for Minneapolis Honeywell electronic panel model MD74000. Will copy or pay, collect calls accepted. *August Aubert, Box 700, Connell, WA 99326; 509-234-2471.*

For Sale: Hameg oscilloscope HM-203/5N 20 MHz dual trace with built-in component tester and long-persistance phospher, $570. Three months old, original price $625 w/o probes. Two-year warranty. *Antonio Moreno Sp5. Box 2019, APO New York, NY 09035.*

Wanted: Service manual, schematic and alignment procedure for Hallicrafter's amatuer receiver model S77A. *T.A. Naeem, P.O. Box 959, Deep River, Ontario, Canada KOJ 1P0.*

For Sale: Sencore VA48 video analyzer, Updated, like new, $700. *Duane Conger, 4321 Herrick Lane, Madison, WI 53711; 608-238-4629.*

For Sale: Sencore SG165, excellent like-new condition, $995, will pay shipping. Have retired. *Al Nikora Sr., 5298 Argyle Ct., Sterling Hgts., MI 48078; 313-268-6938.*

Wanted: TV sweep/marker alignment generator, preferably like EICO model 369, used. Kit acceptable. NY-NJ area, write with make and model, condition and price. *Jack Lionel, P.O. Box 604, Bloomfield, NJ 07003.*

For Sale: Sencore VA48, Z meter, field strength meter and other equipment, Sams Photofact folders 37-2214, tubes, parts RCA Mag. Factory TV and VCR manuals. Send s.a.s.e. for complete price list. *R. Williams, 106½ N. Main, Box 278, Arlington, OH 45814; 419-365-5065.*

For Sale: Tektronix service and instruction manual for type-545B oscilloscope, includes complete schematic, $7.50 plus shipping. *Robert Shultz, 2091 Hillslake Drive, El Cajon, CA 92020.*

Wanted: Motorola flyback transformer No. 24P65174A25 or its replacement No. 2465174A43. Component of Motorola chassis E16TS-929, F18TS-929/-929Q. Also need schematic or service information for Precision Apparatus Company tube tester model No. 612. *Steven Shevach, RD #7, Altamont Drive, Kingston, NY 12401; 914-385-1342.*

Needed: Plug-in modules for Tectronix 560 series scope. State price and condition. *R.W. Frier, P.O. Box 1081, Sausalito, CA 94965.*

Wanted: Sams book No. 21517 (*Advanced Color TV Servicing*). Will pay reasonable price and postage. *Wes McKeever, 8882 Storch Woods Drive, Savage, MD 20763; 301-776-5767.*

For Sale: Antique tubes and literature, 800 new radio-TV tubes, 225 service magazines, parts and filing cabinets, assorted used tubes, transistors and modules. All for $750 plus shipping. *Herbert Schneider, 405 Oakland Ave., Cedarhurst, NY 11516.*

Wanted: NRI model 11 VTVM, NRI model 44 multitester and NRI 7RK radio. *William P. Jarvis, 1214 Fifth Ave., Beaver Falls, PA 15010.*

For Sale: B&K 3010 function generator with manual, in original box. Two years old, excellent condition, $100; EICO model 944 flyback and yoke tester with leads and instruction/construction manuals, $35. *Jim Davis, RD #1, Box 1269, Pottsville, PA 17901.*

For Sale: Sams Auto Radio service manuals 19 through 339, and TSM manuals 46 through 146, like new, $3 each, or best offer. Will ship. *Milton Kitchens, 21908 W. 11th St., Sand Springs, OK 74063; 918-245-4174.*

For Sale: Heathkit model EF-1 and model EF-3 Technical Application series: "How to Understand and Use Your Vacuum Tube Voltmeter and Signal Generator." Includes manuals, test parts, power supply and test chassis, $50 or best offer. Heathkit vacuum tube voltmeter IM-11 and RF signal generator model IG-102, with manuals, $50 or best offer. Excellent condition. *Thomas Walker Kennedy, 5926 Amberwood Lane, Amarillo, TX 79106; 806-358-4326.*

Wanted: Parts for 1958 Philco Predicta b&w television model H3412GL, chassis 10L43. Especially need horizontal output transformer No. 32-8899-1, or information concerning substitute. Also need contrast and channel knobs for this set. *Leonard J. Riscile, 3256 Youngstown-Lockport Road, Ransomville, NY 14131; 716-791-4577.*

For Sale: Sencore SC61 waveform analyst, two years old, like new, $2000 (includes optional accessories). *Marlin D. Repine, P.O. Box 60, Capon Bridge, WV 26711; 304-856-3764, no collect calls, please.*

For Sale: New sweep marker generator, B&K model 415, $165; Tektronic 10MHz scope type 514AD (pick-up), $100; CRT rejuvenator/tester, $25. *Leonard Duschenchuk, Chuck's TV Service, 255 Stewart Ave., Bethpage, NY 11714.*

For Sale: Two Hewlett-Packard model 1332 X-Y displays with the following options: 326, 330, 570 and 611. Manuals are available. *Toren R. True, P.O. Box 193, Bedford, WY 83112.*

Wanted: Vertical output transformer for Curtis-Mathis chassis 52M504, transformer No. Sanyo T-W39. Send information to *C.D. French, P.O. Box 412, Ridgeland, MS 39158.*

For Sale: Heath *Digital Techniques* course and trainer, EE3201A and ET3200B, $125. *G. Guthrie, 609 S. Third Ave., Kissimmee, FL 32741.*

For Sale: Sencore VA48, excellent condition, with all leads, extra adapters and isolation transformer, manuals and all bulletins, $750 including shipping. *Nate's Radio & TV, 135 E. Broad St., Quakertown, PA 18951; 215-536-7191.*

Needed: Ryder's manuals, volumes 1, 2, 3, 9, 10, 13, 14, 15, 16, 18, 21, 22, 23; Supreme manuals, 1949, 1955, 1957; Supreme manuals, *Postwar Record Changers;* Supreme manual, *Pre-war Record Players and Recorders.* EICO 680 transistor and circuit tester. *Paul M. Williams, R.D. #2, Box 55, New Providence, PA 17560.*

For Sale: 1924 5-tube radio, restored; Motorola 7-inch television, "Golden View," made in the '40s. Both clean and working. *George Robinson, 7155 Walden Road, Newburgh, IN 47630.*

For Sale: Oscilloscope, 5-inch RCA model WO91A, good condition, $130; radio and TV tubes, 6AU6s, 12AU7s, etc., 50 cents each, some used; electronic magazines, E.T.D., 1979 through 1984, $25. *Nicholas Morrone, 117 N. 61st, Philadelphia, PA 19139, 215-748-1068.*

Wanted: Sencore CB42 analyzer. *Ray Mackie, Box 1155, Kodiak, Alaska 99615; 907-486-5334.*

For Sale: Sencore VA48, $750; Sencore CB42, $500, all equipment like new. Disabled owner wishes to sell; please send for complete listing. *John Dandurand, 26446 Langford Ave., New Prague, MN 56071; 612-758-3698.*

For Sale: Heathkit RF oscillator model IG-5280, with manual, never used; Heathkit audio generator model IG-5282, with manual; Heathkit signal tracer model IT-5283, with manual, never used. $90 for all, or $35 each. No personal checks. *M. Torgan, 269 Harrison Ave., Warwick, RI 02888; 401-781-5789.*

For Sale: Sencore dual trace solid-state scope model PS163, $250; brand-new Sony CRT 470BEB22, $100, including shipping. *HY TV Service, 911 E. 15th St., Brooklyn, NY 11230; 718-258-4877.*

For Sale: Test equipment, RCA WV98C senior VoltOhmyst, $50; RCA WV77E VoltOhmyst, $25; WV500B VoltOhmyst, $50; WR538A super color bar, $65; WR508B mini color bar, $35. *Ralph E. Dorough, 117 Pecan St., Terrell, TX 75160; 214-563-7105.*

Wanted: Schematic for Mayfair model AD495 AM/FM/8-track stereo and tape recorder. Not listed in any Sams index. Will pay any reasonable price. *James A. Herb, 23 E. Pine St., Selinsgrove, PA 17870.*

For Sale: Surplus radio and TV test equipment. Send large s.a.s.e. for price list, tube price list will be included. **Needed:** Service information for field strength meter FSP3 made by Benco Television Associates of Toronto; RCA geiger counter model WV8T. Will copy and return or pay for copy. *Maurer TV Sales & Service, 29 S. 4th St., Lebanon, PA 17042; 717-272-2481.*

For Sale: Sams Photofacts folders, assortment of 40 complete sets. Send for list. $90 for all. *Douglas Haustein, 94 Winanis Ave., Cranford, NJ 07016.*

For Sale: Precision E410C sweep generator and marker adder, best offer. **Needed:** Precision EV10A VTVM. Quote best price in first letter. *Forest Altland, 972 Washington St., Wooster, OH 44691.*

For Sale: Heathkit IT-5230 CRT tester and rejuvenator, mint condition, $100. **Wanted:** Speed change lever, part No. 224 805, for a dual 1229 turntable. *Ed L. Williams, 3504 Heritage Valley Road, SW, Atlanta, GA 30331.*

For Sale: EICO tube tester model 667 with roll chart and update books, includes universal picture tube tester adapter, $150; tube tester, Precision Tube Master series 10 to 12 with roll chart, in wooden dovetail box, $125, shipping extra. Also 6 VTVMs, various makes, $15 each and up, shipping extra. Send s.a.s.e. for information. *Ed Barlow, Box 29, Tweed, Ontario, Canada K0K 3J0.*

For Sale: Complete RCA VCR and Disc Service literature, both through 1984. Parts and discs, school tape (video), harness, special tools, etc. My cost, $1800. Asking $1200. *Dan Murphy, Murphy's TV Service, Route 1, Grove Meadow Road, Taylors, SC 29678; 803-895-3410.*

Needed: Operations manual, tube charts and schematics for Accurate Instruments model 257 tube tester. Will pay for copies and postage, or will copy and return. *Duane Weisshaar, 605 N. Elmwood, #301, Sioux Falls, SD 57104.*

For Sale: B&K 1077 TV analyst, $200; RCA ICT5 color jig, $75; Conar capacitance/ resistor analyzer, $35; RCA WT501A transistor tester, $35. *George C. Pullen, 6722 Botetourt Drive, Ft. Washington, MD 20744; 301-449-7348.*

Wanted: Two each NDC-40013 ICs; two each MM-5799NBR ICs for SBE console VI CB XCVR. Advise price including postage and handling. *A. Kohlberg, Communications Service Company, 5706 84th Ave., New Carrollton, MD 20784; 301-577-2023.*

For Sale: B&K analyst model 1076, $150. *Terrace TV, 1809 Grant St., Aliquippa, PA 15001; 412-375-5223.*

For Sale: HD-100 Beckman hand-held digital multimeter, 22M input impedance, $150 or best offer. Six months old. Fluke 8024-B DMM with peak-hold ac or dc, conductance function and many other features, $200 or best offer. One month old. *Stanley Todorow, G8468 Belle Bluff Drive, Grand Blanc, MI 48439.*

For Sale: Cimron digital volt-ratio meter No. 7631, mV-ac-dc to 10005, cost $5500 new. Best offer. *Landers, 156 Shore Road, Port Washington, NY 11050; 516-674-4470.*

For Sale: B&K model 1471B dual trace scope with two probes and manual, like new, $250; B&K model 1465 scope with probe and manual, like new, $150; RCA model WR-89A crystal calibrated marker generator with cable and manual, excellent condition, $75; Precise model 630 RF-AF and TV marker generator with cable and manual, $20. *Frank N. Sachs, 6803 Navajo Drive, Baltimore, MD 21209.*

For Sale: Thordarson flybacks, tubes, antennas, etc. Owner retiring, selling stock below cost. Send s.a.s.e. for list of items. *Joe Racanelli, 30-65 48th St., Astoria, NY 11103; 718-545-9258.*

Wanted: B&K CB RF generator model 2040. **For Sale:** HP8640B RF generator and Cushman FM-AM communications monitor model CE46A. $8500 each or make offer. *Bob Eichman, 1500 Executive Drive, Elgin, IL 60120; 312-888-7200.*

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