ELECTRONIC™

Servicing & Technology

JANUARY 1985/$2.25

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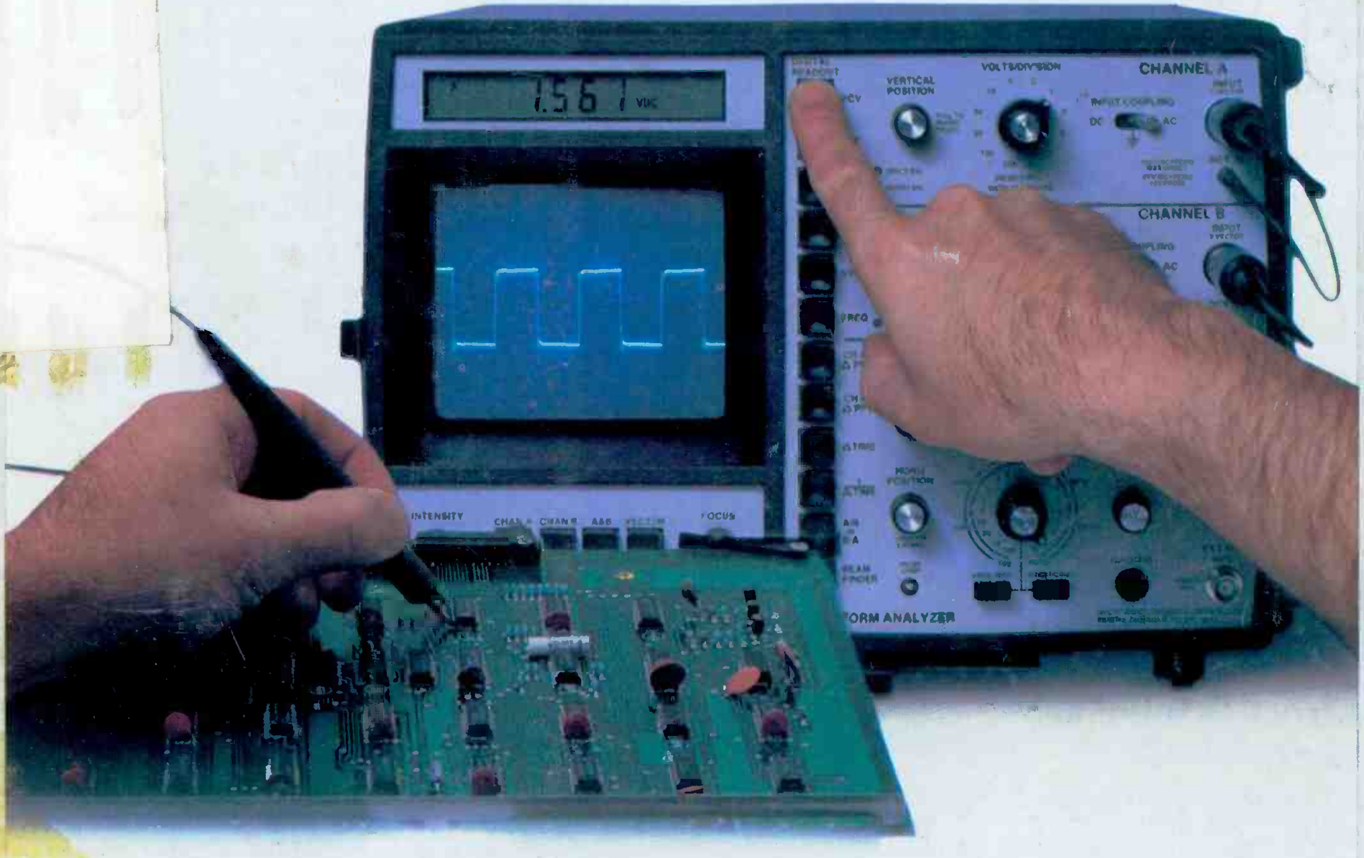

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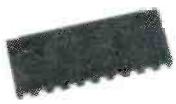

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Circle (4) on Reply Card

The how-to magazine of electronics...

ELECTRONIC Servicing & Technology

Volume 5, No. 1 January 1985

Departments :

Troubleshooting in electronics equipment is greatly simplified with the use of an oscilloscope. Sometimes, a scope is an indispensable tool. For testing methods using your scope, see the article beginning on page 20, *Waveform tests in the horizontal-sweep section*. (Photo courtesy of Sencore)

Page 6

A new start

The start of a new year is truly nothing more than a convenient way to mark the return of the earth to an arbitrary starting point in its yearly travel around the sun. Many years ago, a day during the coldest, darkest part of the year was chosen to be the start of the new year. It would have been just as valid to choose a day in summer or spring or fall as the "first day of the new year."

Even though the start of a new year is an arbitrary event, it provides us with a psychological break. On December 31, we close the books on the old year, and on Jan. 1, we start with a fresh new year. It's a time of renewed hope and promise. If last year was lousy, that's behind us now. This new year gives an opportunity for better times. If last year was good, this year can be even better.

And most of us see the new year as an opportunity to improve ourselves. Who can resist the temptation to make at least one resolution. And if we don't manage to keep our resolutions faithfully, what does it matter. The point is we tried, and really, sincerely planned to do it. And that makes us just a little better, doesn't it?

There has been so much innovation in electronics technology recently that some of us might feel a little left behind. If you're still trying to decide what kind of resolution to take for 1985, a good one might be to take one kind of circuit or product technology and resolve to learn everything you can about it.

For our part, we at **Electronic Servicing & Technology** have resolved to work even harder to bring information about new electronic circuitry to you. For example, in the February issue of **ES&T**, you'll find an article about the drive/pickup systems in the compact digital audio disc player (CD). Future issues will cover other aspects of CDs. Also in February, the first in a series of articles will discuss disturbances on the ac power line, how these disturbances can damage electronics equipment and what you can do to prevent such damage.

A particularly exciting project is being evaluated behind the doors of the **ES&T** test lab. We have on loan from one of the major manufacturers a TV set with stereo sound and second-language program capability, comb filters and scan velocity modulation to name a few of its features. Soon we'll be bringing you articles on how this circuitry works and how to fix it.

We'll be bringing you all of this and a lot more in 1985.

Happy New Year.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

Editorial, advertising and circulation correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664.

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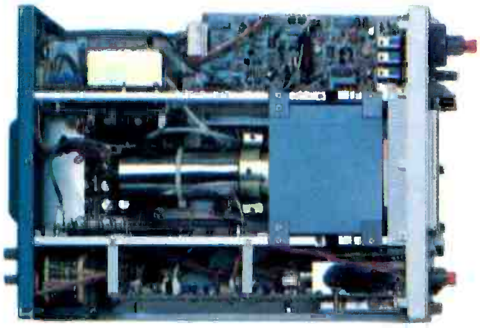

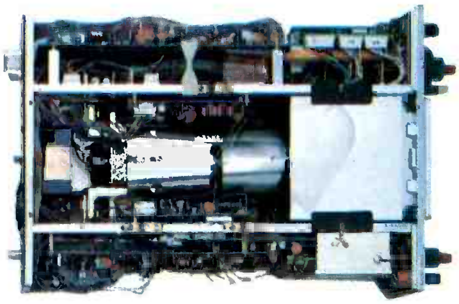

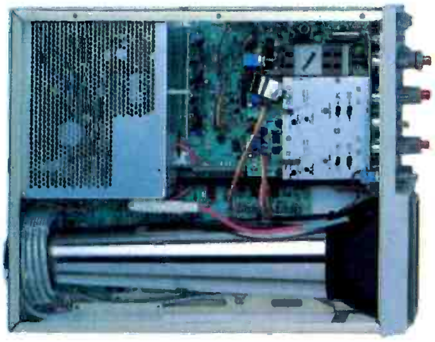

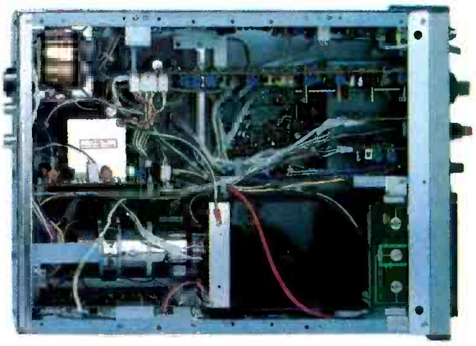

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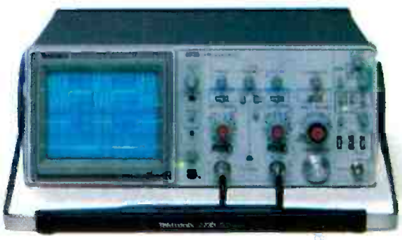

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Circle (6) on Reply Card

Phone device for hearing-impaired

Let your fingers do the talking

Hearing-impaired persons soon will be able to use a telephone anywhere they go–thanks to a new portable electronic device. The battery-powered device, known as the Echo 2000, attaches to a handicapped person's telephone. Equipped with a liquid-crystal screen, it displays written messages tapped out by callers on the keys of their push-button phones.

The varying tones generated by the caller's push-buttons are translated by special decoder circuits into letters that flow across the device's display window in ticker-tape fashion for the hearing-impaired person to read.

A patent covering the technology was awarded to the General Electric Company earlier this year in the name of inventor Edwin Underkoffler, a computer specialist at the GE Research and Development Center. He developed a device similar to the Echo 2000 to help a colleague communicate with his deaf son. Underkoffler has been involved with a number of local projects with the hearing-impaired in recent years. Under terms of a recent agreement, GE has licensed Palmetto Technologies, of Duncan, SC, to manufacture and market its version of the device, the Echo 2000.

The innovative device complements the teletype keyboard printers currently used by the hearing-impaired to communicate via telephone. Because it is portable, it can be hooked up to a phone anywhere–even in a telephone booth. Also, only the hearing-impaired person needs a device, whereas teletype keyboard printers must be located at both ends of the line.

The key to the device is an integrated circuit capable of decoding the various frequencies produced by push-button telephones. "I realized that the signals generated by this microchip could be employed to activate the appropriate letters of an electronic display. All that was needed was a code and the circuitry to make it work," Underkoffler said.

While Underkoffler was busy

The battery-powered Echo 2000 enables hearing-impaired persons to use a telephone anywhere. Varying tones generated by the caller's push buttons are translated by special decoder circuits into letters that flow across the device's LCD window in ticker-tape fashion.

developing the device, an electrical engineer named Stephen Fowler of Duncan, SC, was also trying to develop a communications tool that would enable him to be understood on the telephone by his hearing-impaired mother.

"When my father was alive, I had no problem communicating with my mother on the telephone because my father would simply answer the phone and relay whatever I wanted to say to my mother, who is an excellent lip-reader," Fowler said. "But after my father died, I was faced with a tremendous communications problem. I could communicate with my mother only in person – not on the phone."

Fowler developed a device similar to Underkoffler's and then discovered that Underkoffler already held the patent. When Fowler called GE to ascertain its plans, he learned that the company was hoping to license the technology. For a nominal fee, Fowler then purchased the commercial rights to the innovation, which the company he founded (Palmetto Technologies) is now marketing.

The Echo 2000 is compact (7"x4"x1"), portable (weighing 10 ounces) and powered by four rechargeable batteries that allow at least six hours of continuous operation between recharges.

To *talk* to a hearing-impaired person, the callers must depress two telephone buttons for each letter – the first being the key on which the letter is located, the second being the number key (either 1, 2 or 3) to indicate the position of the letter on the key initially depressed. For example, to transmit the letter A, the user taps the middle key in the top row (which contains the letters A, B and C), followed by the *1* key to indicate it's the first letter in the series. To transmit the letter B, the user would first hit the same middle key and then the *2* key, and so on.

To transmit a number, a caller simply strikes the desired number key and then the pound (#) key. Also, there are abbreviated, 2-button codes for some of the most frequently used words. For example, *00* denotes *hello* and **0* indicates *goodbye*.

Computer drive memory uses compact disc format

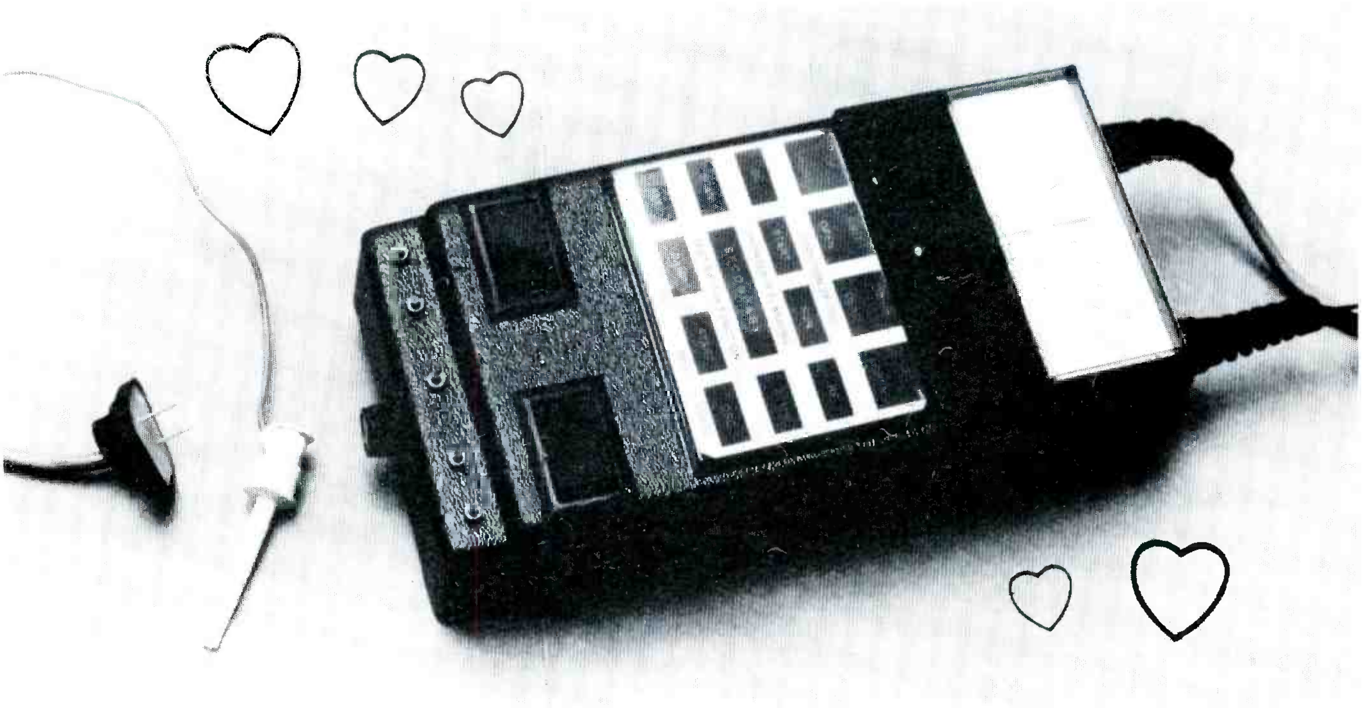
The CD-ROM allows the advanced information storage technology of the compact disc to be applied to a very high capacity read-only memory (ROM) storage system for personal computers.

A non-audio application of the compact disc format has recently been achieved by Nippon Columbia of Kawasaki, Japan, parent company of Denon. The advanced information storage technology of the compact disc has been applied to a *very* high capacity read-only memory (ROM) storage system for personal computers. Dubbed the CD-ROM, this disc has the same compact dimensions (120mm or 4¾-inch) and uses the same type of laser-pickup *player* mechanism as the audio CD.

The primary advantage of the CD-ROM, this disc has the same 550-megabyte storage capacity on one side; this is the equivalent memory potential of 500 to 1000 conventional 5¼-inch floppy disks. This density is achieved without degradation of access time or data-transfer rate. Also, the interface circuitry built into the CD-ROM drive mechanism allows connection to most current personal computers. And all the application software a computer could use (including the necessary documentation) could fit on one CD-ROM.

According to the manufacturer, the ruggedness and reliability of the optical CD-ROM disc and its drive mechanism exceeds that of conventional magnetic memory media. Aside from its freedom from magnetic mishaps and head/-drive problems, the CD-ROM has a unique built-in error-detection/correction system. This system supplements the normal audio-CD correction system and improves it by a factor of 100. The shape of the information-carrying *pits* on the ROM disc also can be simplified during mastering to reduce the chance of moulding defects during manufacture.

The CD-ROM's enormous storage capacity (the equivalent of more than 275,000 pages of text) provides the opportunity to include sophisticated, high-resolution graphics to accompany the text. Among the potential candidates for CD-ROM storages are all manner of reference works, directories, professional journals and catalogs.



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- Short Across the Horiz Yokes Discharge Capacitor.
- Short across the Fail Safe, Shut Down or X-Ray Protect Transistor or Zener (E to C or A to K).
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- Short out a Vertical Output Transistor.
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Tapoffs, drop taps and directional taps in MATV

By James E. Kluge, Technical Editor, Winegard Company

The quality of a TV picture depends greatly on the quality of the signal reaching the antenna terminals of the television. The quality of that signal, in turn, depends on the quality of the transmission medium.

Whether you ever plan to become involved in installing a master antenna TV (MATV) system, or if you are ever called upon to diagnose problems and service a TV set that receives its signal from an MATV system, or if you just have your own television connected to a master antenna or other cable system, this article will enhance your understanding of how these systems are constructed and provide some clues as to what might cause signal degradation.

Tapoffs, droptaps and directional taps

A large MATV system involves a large number of taps. Besides initial cost, performance, insertion loss, isolation, future system expansion and ease of installation must all be considered in choosing taps for an MATV system.

Most MATV manufacturers offer a wide variety of tapoff devices that meet every requirement for jobs large and small, home and commercial. There are tapoffs, drop taps and wall outlets; flush or surface mounted; 300Ω or 75Ω input and output; brown or ivory; fixed, selectable or variable isolation; VHF or UHF; directional or non-directional. Nearly any variety you could need is available, and of course, capable of passing all 82 TV channels plus all the CATV channel frequencies.

There are three basic types of taps: 1) the line tapoff (type used in loop-to-loop systems), which is the most common; 2) the drop tap, which is least understood; and 3) the pressure tap, which probably isn't even available any more. Let's take them one at a time, see what makes them different, and learn how they can best be applied.

Line tapoffs

Line tapoffs derive their name from the way they are connected to a long trunkline. By cutting the trunkline and connecting the center conductor of each end to a common screw on the tap, a small portion of trunkline voltage is tapped off through an isolation resistor and appears at the tap output. An independent short section of coaxial cable then delivers this voltage to the antenna terminals of the TV set. The trunkline is thus routed from one tap location to the next.

Before the tapoffs are installed, the trunkline cable is drawn out of the wall through the roughed-in opening, to form a loop. The loop is cut and cable ends are connected to the tap. A serrated clamp holds the cable securely and pierces the jacket to make electrical contact with the shield. The excess cable is then pushed back into the wall, the tapoff mounted in the opening, and finished cover plate installed over the tapoff.

Each tapoff connected to the trunkline cable causes some insertion loss; i.e. it drops the signal level on the trunkline at that point. The insertion loss is somewhat dependent on frequency and the amount of isolation desired. With many taps connected into a long trunkline, the total voltage drop accumulates as you add tapoffs along the trunkline moving toward the last tap. At some point, the signal voltage level will drop below a certain minimum. It will then be necessary to insert a line amplifier to restore (i.e. raise) the trunkline signal level.

However, higher values of isolation are not only desirable, but they also produce lower values of insertion loss. Isolation shows up as a voltage drop across the impedance existing between the trunkline and the TV set. A rule of thumb prescribes using the highest value of isolation possible commensurate with the existing signal voltage on the trunkline.

The voltage available to the TV set, (at the tap output) should be $1000\mu V$ (0dBmV) or more. With 10dB isolation, at least +10dBmV will have to be on the trunkline at the tap. With +15dB isolation, there will have to be +15dBmV or more and, likewise, with 20dB isolation, +20dBmV needs to be on the trunkline.

Almost all taps offer either fixed, selectable or variable isolation. Fixed isolation means the tap is manufactured with a fixed value of isolation that cannot be changed conveniently. These taps are manufactured with either 10, 15, or 20dB of isolation. The principal disadvantage of fixed-isolation taps is an inventory of three different taps is required.

Selectable isolation means one tap can offer three values selectable in the field. For example, the Winegard SLT series provides either 12dB, 15dB or 20dB of isolation by merely clipping out one or two of the three installed fixed, parallel resistors. This tap solves the problem of multiple inventory, but once the resistors have been clipped out, you cannot easily change the isolation value back again to a lower value without soldering new resistors in their place, usually done in the shop.

The variable isolation tap provides a continuously variable amount of isolation. In the Winegard VTF series, the adjustment is easily accessible underneath the wall cover plate. With this adjustment, you can vary the isolation anywhere between 10 and 25dB. It can be set to exactly the value needed and then changed to a new value whenever it becomes necessary to readjust part of the system, to add taps or to upgrade the system. Accomplishing any of these procedures will produce changes in voltage levels at the taps which, in turn, may require resetting their isolation values.

One more type of tapoff deserves mention: the directional line tapoff. Although a bit more costly than the others, it has a number of advantages that can make it cost effective. The line tapoffs we've discussed previously have employed resistive voltage-divider networks to achieve the necessary isolation. In addition to the resistive isolation networks, the directional line tapoff employs transformer action to isolate the TV set from extraneous signals originating farther down the trunkline.

In other words, directional tapoffs are designed to pass signals only from the signal source (e.g. headend) to the tap output. Extraneous signals and reflections generated downstream on the

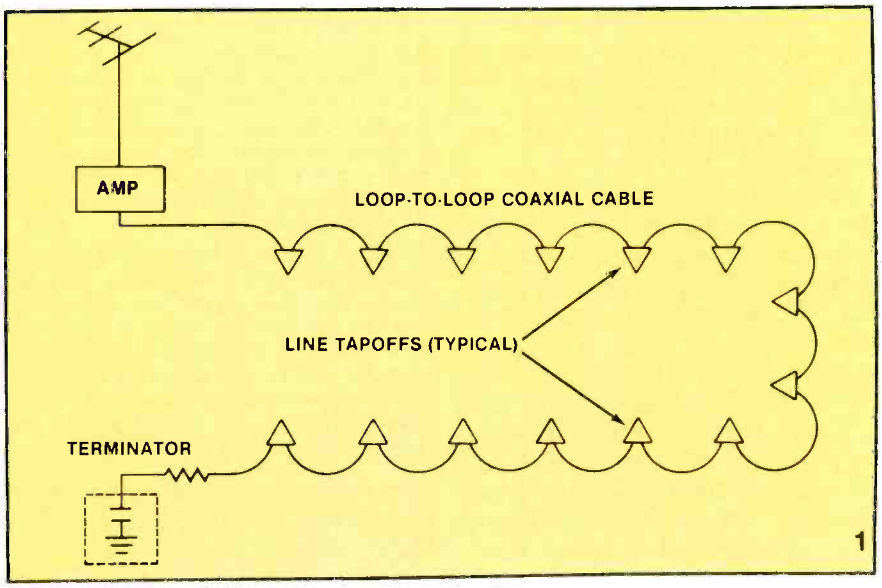


Figure 1. Simplified diagram of MATV system shows tapoffs connected to main trunkline by looping from tap to tap at various locations.

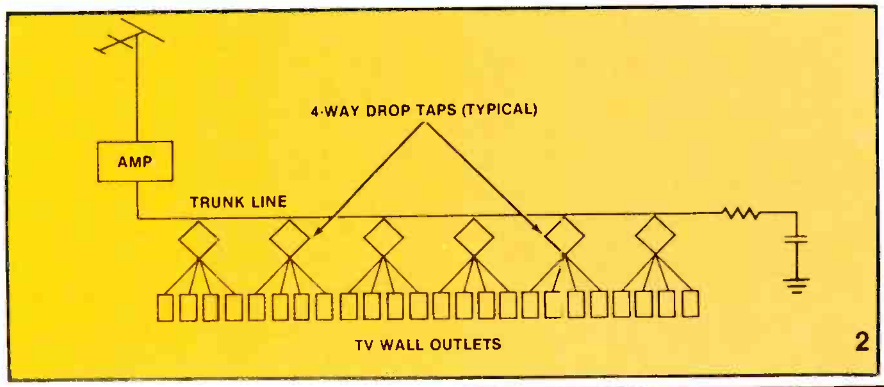


Figure 2. Simplified diagram illustrates drop-tap hookups in an MATV system. Drop taps typically are available with one, two or four outlets each connected, via drop (feeder) cables, to wall outlets. Drop taps also offer control of signal level, ensuring each TV receiver a sufficient signal, while limiting excessive feed-thru loss. Drop-tap isolation reduces interaction between TV sets connected to the system. Trunkline can follow long horizontal corridors or vertical elevator and ventilaton shafts while permitting short cable runs to the wall outlets in building units.

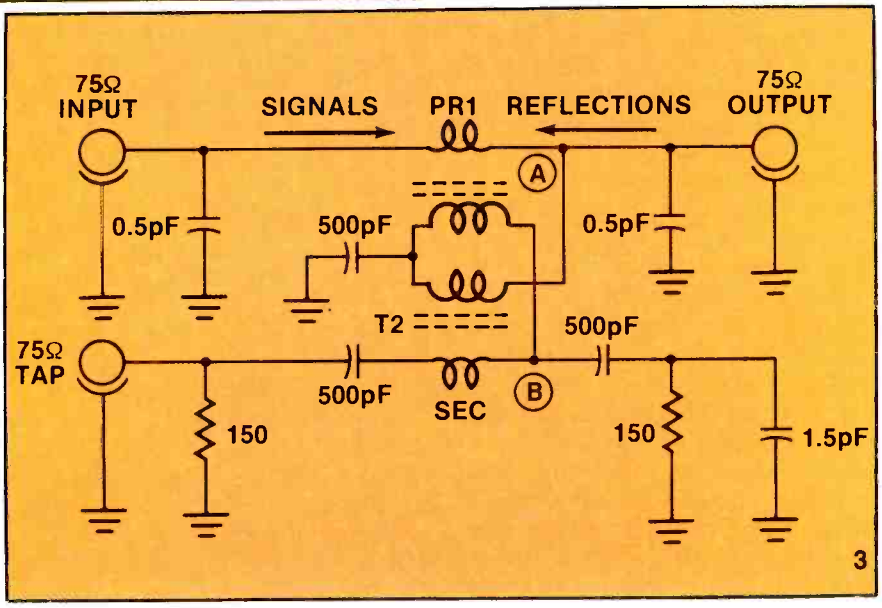


Figure 3. Directional drop tap employs transformer action in T1 and T2 to impart directional properties to signal paths inside the tap. T1 primary, in series with trunkline, senses phase of reflections as being opposite to that of incident signals. T2 primary, connected between trunkline and ground cannot sense direction. Signals and/or reflections on the trunkline appearing at point A induce a voltage into T2 secondary that appears between point B and ground. Trunkline signals and/or reflections incident upon T1 also induce voltage into T2 secondary that appears between point B and ground. Signal voltages at point B are in phase and reinforce each other. Reflected voltage at point B are out of phase and tend to cancel each other. Reactance of ac/dc blocking-capacitor (500pF) is considered negligible at frequencies above 5MHz. Small capacitors and resistors provide a proper impedance match at input/output and tap output.

cable are prevented from reaching the tap or trunkline-input connector (via the trunkline output connector) by as much as 25dB of built-in 1-way attenuation plus the isolation impedance of the tap.

This directional characteristic prevents reflections and extraneous signals, usually generated in TV sets and other devices farther down the trunkline, from getting to the tap outlets (and thus the TV sets) of those taps connected to the trunkline ahead of the disturbances.

Furthermore, this tap has little effect on the trunkline signal when connected in series with it. It has a trunkline voltage standing-wave ratio (VWSR) of 1.1:1 and a return loss of at least 26dB. The backmatch, which the TV set *sees* looking back into the tap, is also low (typically 1.3:1), thus eliminating the possibility of generating standing waves at the TV set terminals. Standing waves caused by an impedance mismatch, are a common cause of multiple ghosts and picture smear.

The result of all this is a cleaner, clearer, sharper picture devoid of smears and ghosts usually caused by the undesirable signals and reflections many conventional tapoffs cannot completely discriminate against.

TV wall outlets—The non-tap

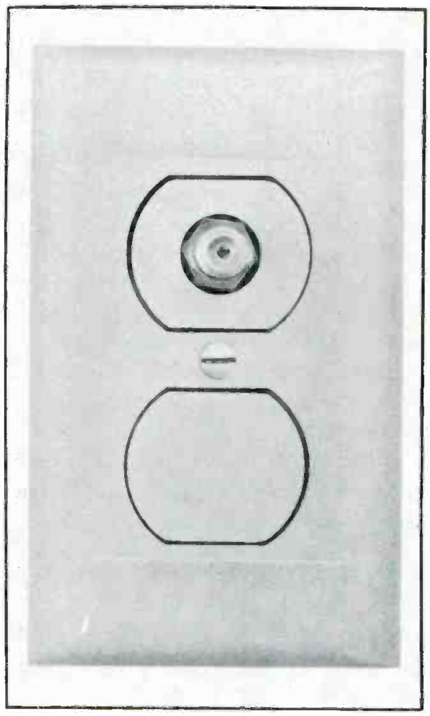
Another group of devices, called TV wall outlets, cannot be classified as taps but bear a close resemblance to them, at least in outward physical appearance. TV wall outlets come in a variety of configurations. They are available in two colors—brown and ivory—to match the room decor or the color of the ac power receptacles.

They mount in any standard electrical box or wall cutout for a flush mounting, or in a compact, plastic, low-profile box, for surface mounting. The latter type is commonly used where wire or cable must be run on the surface of the wall or along the baseboard and/or where it is not possible to cut holes in walls (such as concrete) to run cable and install flush boxes.

Both tapoffs and outlets are available with either 300Ω or 75Ω input/output connections: no-strip, screw-type terminals for 300Ω and F-type coaxial connector for 75Ω impedance. Trunkline connections on 75Ω tapoffs are accomplished easily with a handy clamp-and-screw attachment on the backside of the tap.

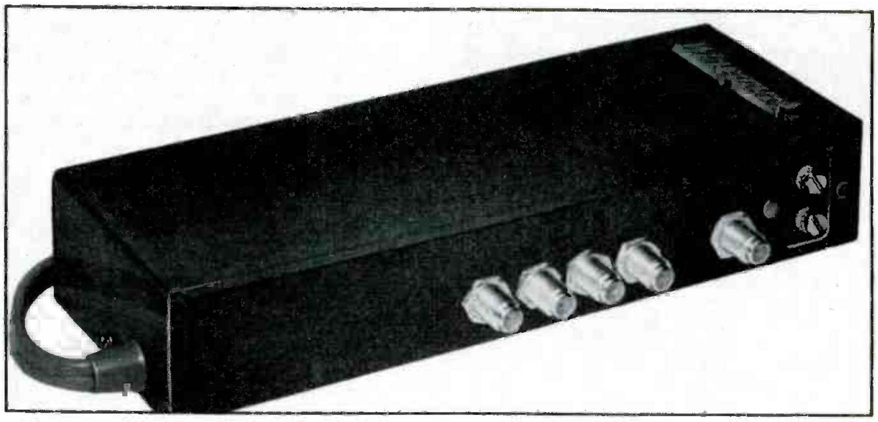
Drop taps

A drop tap serves as a junction box for several coaxial feeder cables radiating outward from it. Each feeder cable terminates in a wall outlet or passes directly through a wall plate on its way to a TV set.

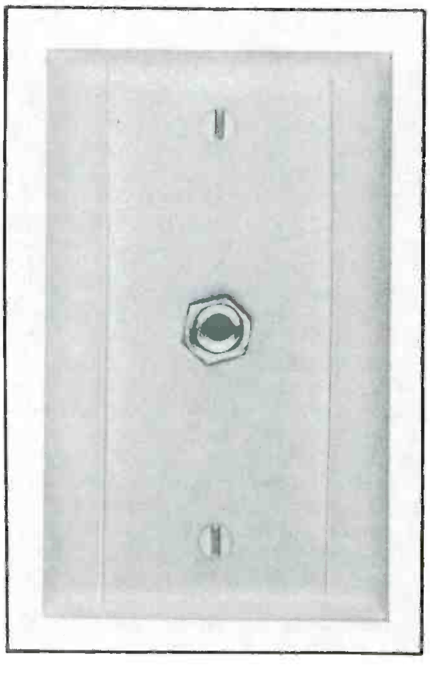


The SLT-77 82-channel tapoff offers selectable isolation. By clipping out one or two of three equal-valued resistors, the isolation value can be selected in discrete steps of approximately 10, 15 and 20dB.

Similar in appearance, the VTF-77 82-channel tapoff, features variable-isolation and employs RC components that are effective but non-directional. Tapoff cannot distinguish between incident signals arriving at the trunkline input and reflections returning to the trunkline output. Isolation adjustment can be made from the front by removing the wall cover plate. A variable resistor controls the portion of trunkline signal delivered to TV set and, at the same time the impedance (isolation) between the TV set and trunkline.



Booster Coupler (BC-274) combines a 4-way splitter with a distribution amp. It divides the input signal four ways and provides 6dB gain between the input and at each of the 75Ω outputs. The high-level input spec (0.2V) avoids overload and allows it to operate as an amplified 4-way splitter. It can supply signals to four TV sets, usually via wall outlets.



TV wall outlets have no isolation and, consequently, are fed from only set couplers, booster couplers and/or drop taps, each of which provide the necessary isolation between their outputs. T-77A Wall Outlet consists of wall plate and double-ended F connector to bring cable neatly through the wall.

A drop tap consists of a metal box having several connectors, and is commonly installed in a concealed, out-of-the-way, but reasonably accessible location, such as a utility-service area, a basement or the attic of a building. Electrically, a drop tap is connected in series with a trunkline and may have one, two or four separately isolated outputs feeding signals, via feeder lines, to wall outlets or through a wall plate directly to the antenna terminals of the TV sets.

The advantage of using drop taps instead of wall tapoffs is the typically large, low-loss trunkline cable does not have to run the additional distance to each individual tapoff location and suffer the attendant loop loss and the resulting feed-thru and cable losses. Instead, the trunkline can be run in an approximately straight line, such as horizontally over a corridor or vertically in an elevator or ventilation shaft, with the smaller feeder lines radiating outward in short runs to carry the signal to the individual room outlets. This simplifies the installation, reduces the cost and requires only simple, inexpensive wall outlets instead of tapoffs.

The required isolation is built into the drop tap and is selected by removing or installing a jumper underneath a snap out plastic cover. And, as an additional benefit, the feeder line may be connected or disconnected without having to enter a private apartment or some other restricted or otherwise inaccessible area.

Drop taps are especially handy in applications in which there are several outlets close together, as in a dealers' showroom, a service shop, a mobile-home park or in garden apartments. Where cable must be exposed or run along a wall surface, drop taps eliminate the necessity of cable loops which must go to and return from a wall outlet or tapoff.

Directional drop taps

Directional drop taps are designed to pass the trunkline signal in only one direction – forward. Extraneous signals generated downstream and returning back toward the source are severely attenuated when they attempt to enter the directional drop tap in a reverse direction.

Any unwanted signal appearing on the trunkline after the tap, such as reflections or spurious signals generated by other equipment downstream, are isolated from the drop tap by its directional properties. Likewise, the individual tap outputs have selectable resistive isolation, thus minimizing any interaction between TV sets connected to the drop taps. The high reverse isolation between the tap and the continuing trunkline allows VHF and UHF signals to be tapped off the trunkline with little change in the trunkline VSWR. And, because the backmatch (VSWR looking back at the tap from the TV set or the wall outlet) is less than 1.3:1, standing waves on the drop line are virtually eliminated.

Directional drop taps give the system designer and installer the additional flexibility often needed to solve layout and installation problems in MATV systems and still provide acceptable pictures on every set at minimum cost. Useful applications include systems in which subscriber's taps must be remotely serviced (i.e. connected, disconnected and reconnected) as tenants move in and out.

This device combines an inherent 30dB reverse isolation attributable to the directional properties of the tap and 15dB resistive forward isolation with the option to bring it up to 23dB by merely unplugging a resistive jumper located inside the box and accessible underneath a snap-out plastic cover. The 2- and 4-output taps simply incorporate 2- and 4-way line splitters respectively at the output. Be sure to properly terminate all unused outputs.

Booster couplers

Booster couplers are little more than line splitters preceeded by a built-in voltage amplifier. The amplifiers are designed to offset the splitter loss and line losses. Although splitters and booster couplers do not fall in the same category as taps, they are mentioned because they frequently are employed like a drop tap; i.e., their output signals are fed through a wall outlet directly to the antenna terminals of TV receivers.

Again, unused taps and outputs should be properly terminated to avoid reflected signals and resulting smear. Even if the change (terminated vs. nonterminated) is not perceptible, a small system modification could aggravate the condition, causing it to become noticeable. If, in a small system, you don't need the gain provided by booster couplers, use drop taps.

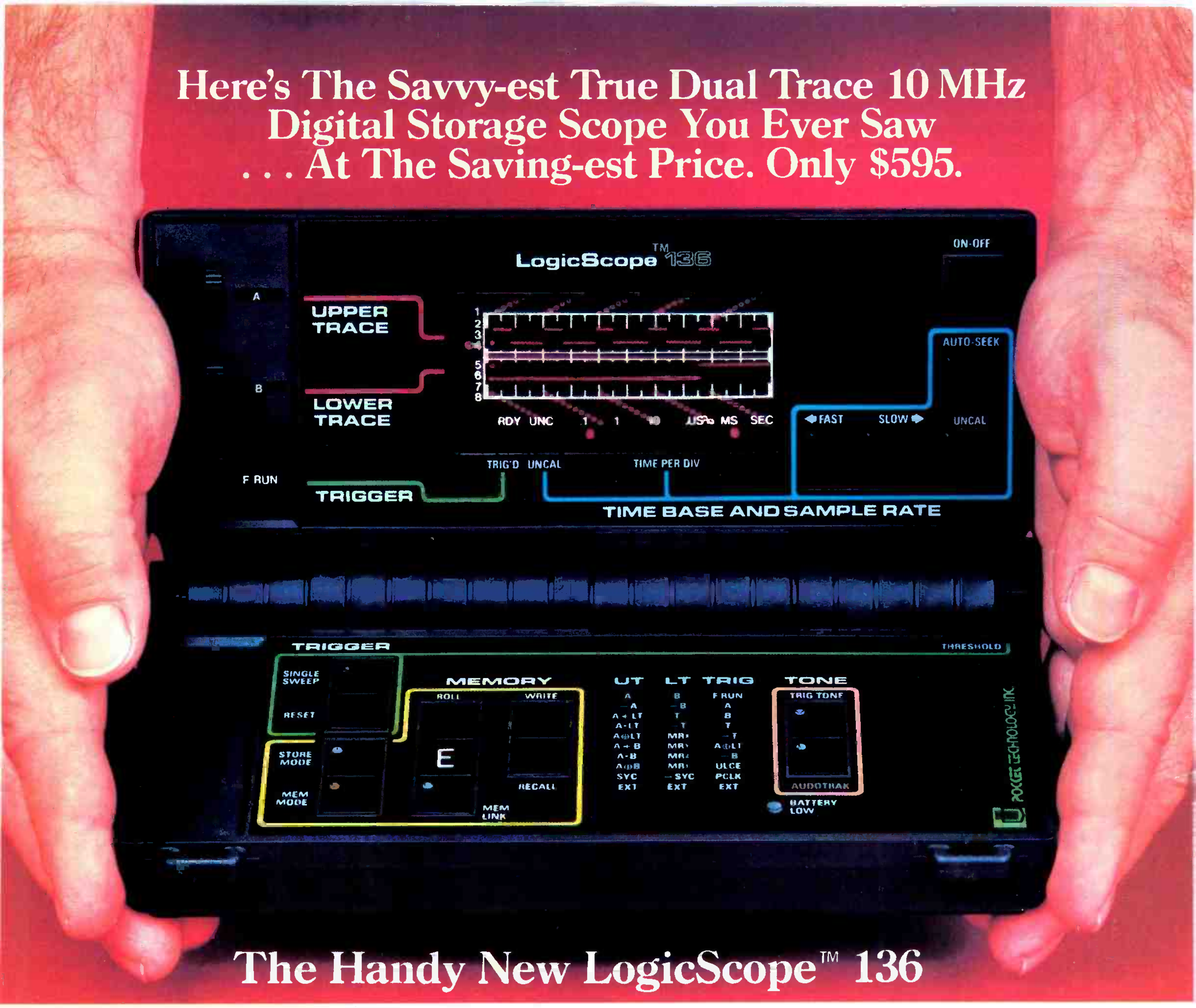
Pressure taps

Pressure taps are used in outdoor applications. You'll typically find them installed in older mobile-home parks where they serve as house drops from an aerial or pole-line cable, as in mini-cable systems. There are three types of pressure taps, and the difference between the three involves the method by which they achieve isolation. One uses transformer action, another uses resistor networks and the third employs capacitive coupling. Those using transformer action or resistor networks are capable of handling all 82 channels, while the type that uses capacitive coupling is good only through VHF (at UHF frequencies, the capacitive reactance becomes so small that there is little, if any, isolation).

Even at VHF frequencies, the capacitive isolation is reduced substantially between channel 7 and channel 13. Isolation provided by transformer action or resistor networks remains relatively constant over all 82 channels.

The pressure tap gets its name from the way it makes contact with the conductors of the trunkline or feeder-line cable. The other jacket, the shield and dielectric of the cable are pierced with a coring tool so the pressure-tap inner conductor (called a stinger) may extend into the feeder cable and make a pressure contact with the center conductor. The tap then is clamped around the outer jacket.

Pressure taps may be attached anywhere on a feeder cable, and the cable need not be severed. Their big advantage is they may be attached to the cable in the middle



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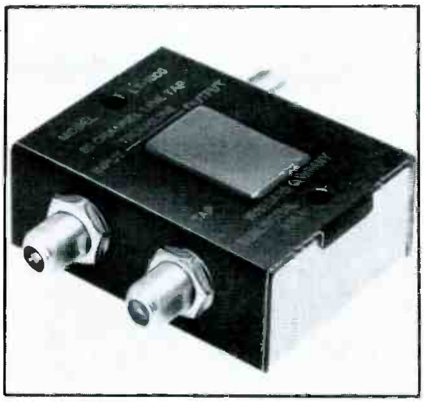
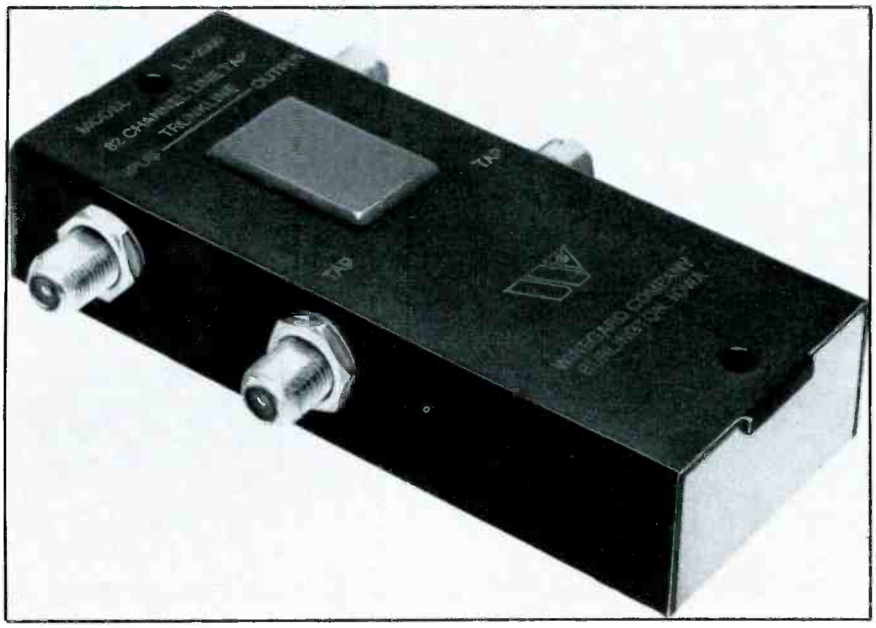
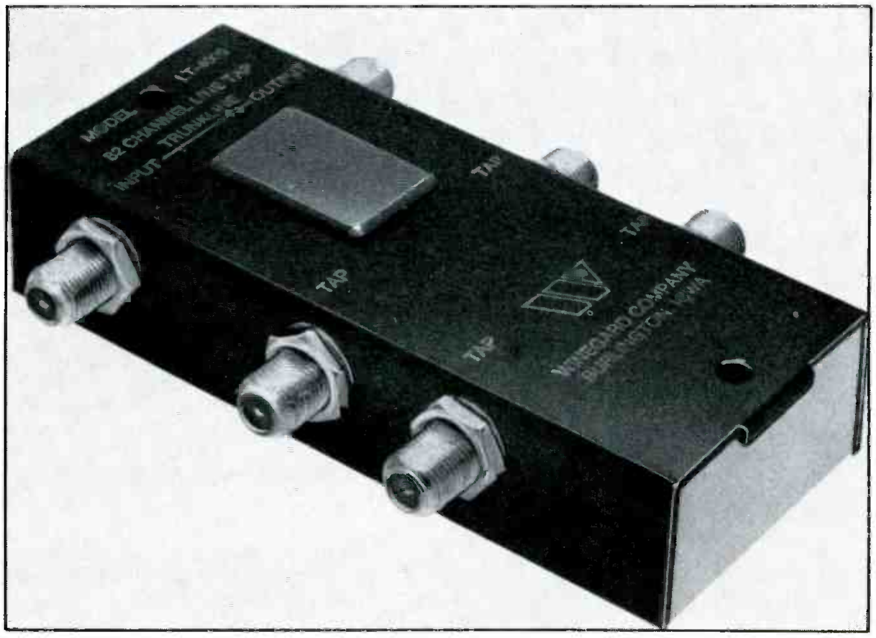
of a span. Most pressure taps are equipped with a strain relief for the drop cable and include a provision for clamping the strain relief to an available steel messenger wire that will remove any strain otherwise applied to the feeder cable.

As you might expect, moisture and other elements may enter the feeder cable where the outer jacket has been pierced; and the pressure contact at the inner conductor leaves something to be desired in terms of the reliability and the integrity of the pressure connection that passes the signal. Pressure taps are no longer available, and, for obvious reasons, are not recommended for new MATV applications. Many pressure taps still are in service, however.



Directional line-drop taps allow VHF and UHF signals to be taped off the trunkline with virtually no change in trunkline VSWR. Designed to pass only *upstream* signals to the outputs, unwanted or undesirable signals generated or reflected from any point *downstream* (i.e. beyond the line drop tap) are attenuated an average of 30dB as they attempt to reach the tap outputs. Units are available with single (LT-1000), double (LT-2000) or 4-way (LT-4000) outputs to provide signals to feeder lines or wall outlets. Isolation is selectable between 18 and 23dB by changing a jumper under the snap-out cover on top of unit.





Tap evaluation guideline

Anyone laying out a MATV system should look carefully at the type of taps available and ask if the tap is the most efficient kind to use in terms of:

1) Cost of the taps vs. total system materials cost?
2) Cable routing versatility?
3) Installation ease (labor cost)?
4) Future system expansion?
5) Integrity of the signals?
6) Compatible with present and future MATV requirements?

Many tradeoffs should be considered when choosing the proper tap for the job.

MATV design assistance

MATV systems-layout service is offered by some antenna system manufacturers.

Whether the system is a hospital, school, mobile-home park, apartment or hotel, a complete layout and design of the system is available to the installer by the Winegard Company for a nominal fee.

Learn MATV design

One way to learn about MATV design is to attend a seminar. The Winegard Company offers their MATV Home and Commercial Seminars throughout the United States several times a year. These often are 3-day seminars covering all aspects of MATV design and are arranged to assist the novice as well as the experienced installer. For more information, contact Winegard Company by writing to 3000 Kirkwood, Burlington, IA 52601.

WAVEFORM TESTS

in the horizontal-sweep section

A standard SCR horizontal-deflection circuit has two silicon controlled rectifiers (SCRs) which act as bidirectional switches in combination with diodes, as shown in Figure 1. Note there is normally a peak power of 1200VA in the yoke, as indicated in Figure 2.

Troubleshooting the SCR horizontal-sweep system

With reference to Figure 1, the trace-switch SCR, SCR_T, and diode X_T switch the deflection current through the yoke winding L_Y during the forward-trace interval. On the other hand, the retrace switch SCR or commutating SCR, SCR_C and diode X_C provide commutating-switch action for the flyback interval. At the beginning of the forward scan, trace-switch diode X_T conducts the yoke current that was stored as a magnetic field during the latter half of the previous scanning interval. This trace-switch diode conducts a linearly decreasing current ramp; as the current falls to zero the first half of the forward-scan interval is completed.

Just before the ramp reaches zero, the trace-switch SCR, SCR_T, is readied for conduction by the application of a positive pulse to its gate from resistor R_G. The yoke-current ramp then crosses the zero level from negative to positive, whereupon the circuit current transfers from trace-switch diode X_T to trace-switch SCR, SCR_T, as shown in Figure 3. Then capacitor C_Y begins to discharge via SCR_T to drive yoke current through winding L_Y during the second half of the forward-scan interval.

In normal operation, the voltage across C_Y changes but slightly during the forward-scan/retrace sequence. This constant-voltage source drives a linearly rising current through the yoke winding.

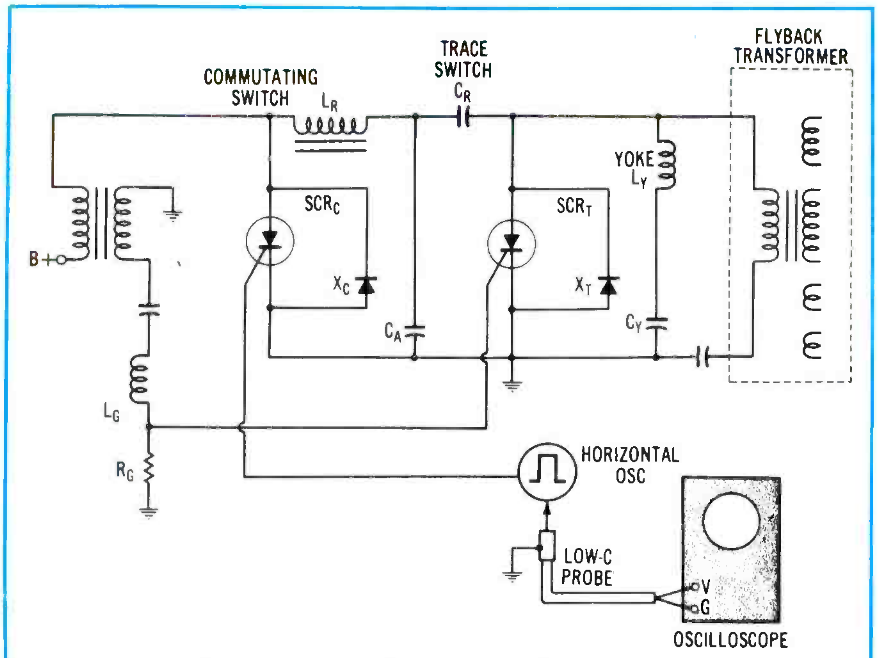


Figure 1. Basic SCR horizontal-deflection circuit.

Commutating-switch action

As the end of the forward scan is approached, the commutating-switch SCR, SCR_C, is gated into conduction by a pulse from the horizontal oscillator. At this time, capacitor C_R is enabled to discharge a current pulse through L_R via the trace and commutating SCRs. This discharge current is termed the *commutating pulse;* its peak-to-peak value increases until it is greater than the yoke current, whereupon trace diode X_T starts to conduct. This conduction by X_T reverse biases the trace SCR long enough that it cuts off. *Normal oscilloscope waveforms that accompany this sequence of circuit actions are shown in Figure 4.*

Editor's note: An oscilloscope is a valuable tool in the troubleshooting of electronics equipment. In many cases, a good scope is indispensable. This article, reprinted with permission from the book *Troubleshooting with the oscilloscope* by Robert G. Middleton, Copyright 1980 by Howard W. Sams and Company, Indianapolis, IN, describes some procedures for using an oscilloscope to troubleshoot the horizontal sweep section of a television.

As the commutating pulse falls to a value lower than the amplitude of the yoke current, X_T starts to conduct; thereby the magnetic energy stored in the yoke winding produces a current which charges retrace capacitors C_A and C_R over the first half of the forward-scanning interval.

This charge *rings* back into the yoke over the second half of the forward-scanning interval (see Figure 2B). The ringing circuit is completed via X_C, and an adequate time lapse is provided for SCR_C to cut off. Then, as the current through the yoke reaches its peak value in the negative direction, SCR_T begins to conduct and the forward-scan interval starts.

Observe that while the commutating switch is closed, input in-

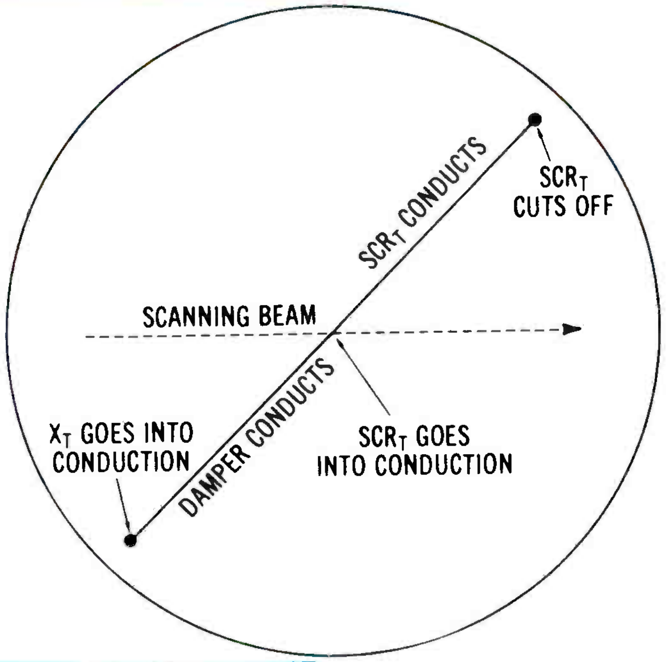
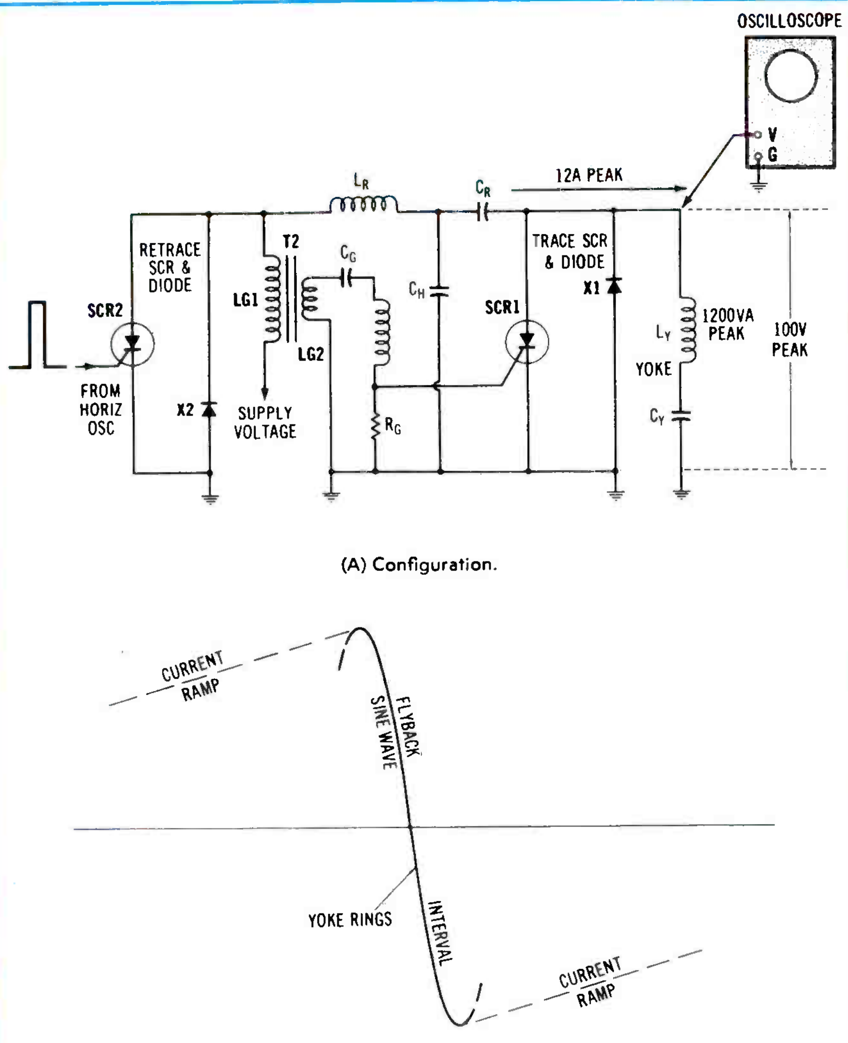


Figure 3. Sequence of circuit events during the forward scanning interval.



(A) Configuration.

(B) Retrace interval is one-half of a 70-kHz sine wave.

Figure 2. SCR horizontal-sweep arrangement.

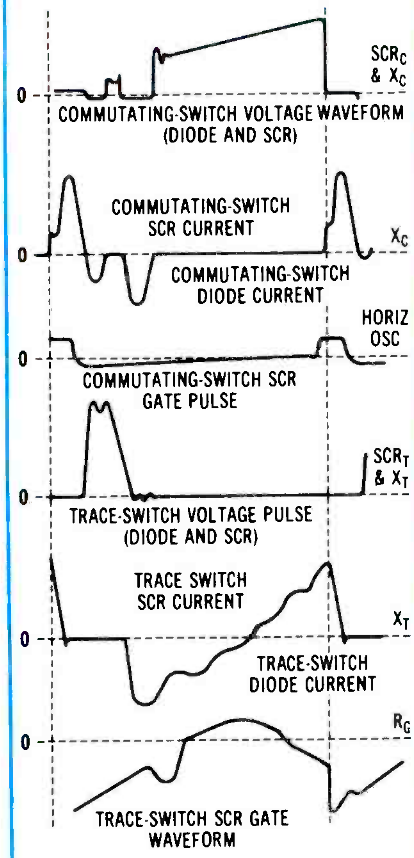


Figure 4. Normal voltage and current waveforms in the SCR horizontal-sweep system.

ductor L_G is automatically switched across the supply-voltage source. Accordingly, magnetic energy stores up in the inductor. This stored magnetic energy serves to charge up the flyback capacitors C_A and C_R, replenishing the I^2R loss in the circuit.

Transistor horizontal-output arrangement

A standard horizontal-output configuration that uses a pnp power-type transistor is shown in Figure 5. Transistor Q102 operates in a grounded-collector (emitter-follower) circuit. The load for the emitter consists of the high-voltage transformer, T102, the yoke winding, and the damper X105. The output stage starts to conduct at approximately the center point of the forward scanning interval, and it produces a linear current rise for the remainder of the forward scan.

Then, at the end of the current rise, Q102 is suddenly cut off by the input waveform from the driver stage. At this time, the flyback pulse is generated; the flyback produces retrace and drives damper X105 into conduction. Damper conduction continues for the first half of the forward-scanning interval, and decays to zero at approximately the center of the scanning interval. The cycle then repeats. Figure 6 shows the waveforms involved in this horizontal-output circuit action.

To protect the output transistor from excessive current, a current-limiter transistor (Q108 in Figure 5) is included. Also, diode X107 protects the current-limiter transistor from breakdown due to spike voltages. The picture width is adjusted by means of the width coil L107, which is connected in series with the horizontal-yoke windings.

The adjustment of L107 also affects the efficiency of yoke operation. High-voltage pulses are generated as a result of the flyback pulse that occurs during retrace time. This flyback pulse is stepped up by autotransformer T102 and is then rectified by rectifier tube V106. A +13kV potential is obtained, which is used as accelerating voltage for the picture tube. (It is assumed that a 12-inch picture tube is being used in this example.)

Note the flyback pulse at the emitter of the output transistor is also rectified and filtered. Diode X508 rectifies the flyback pulse and supplies approximately +240Vdc for the accelerating anode in the picture tube. The horizontal-output transformer also supplies a reference pulse for the afc comparison circuit and a keying pulse for the keyed-agc circuit.

Horizontal-output configuration with pincushion transformer

Many modern horizontal-output circuits include a pincushion transformer for correction of curvature in raster edges. A widely used form of transistor horizontal-output circuit with a pincushion transformer is shown in Figure 7A. The output transistor, Q702, functions as a switch; it is turned on to deflect the electron beam in the picture tube from the center to the right-hand side of the screen, and is then cut off for the reminder of the scanning cycle. Damper diode X701 conducts and the resulting current deflects the picture-tube beam from the left-hand side of the screen to center. Boost diode X704 also conducts on retrace pulses; it supplies about 800Vdc to the picture-tube screen-grid circuits.

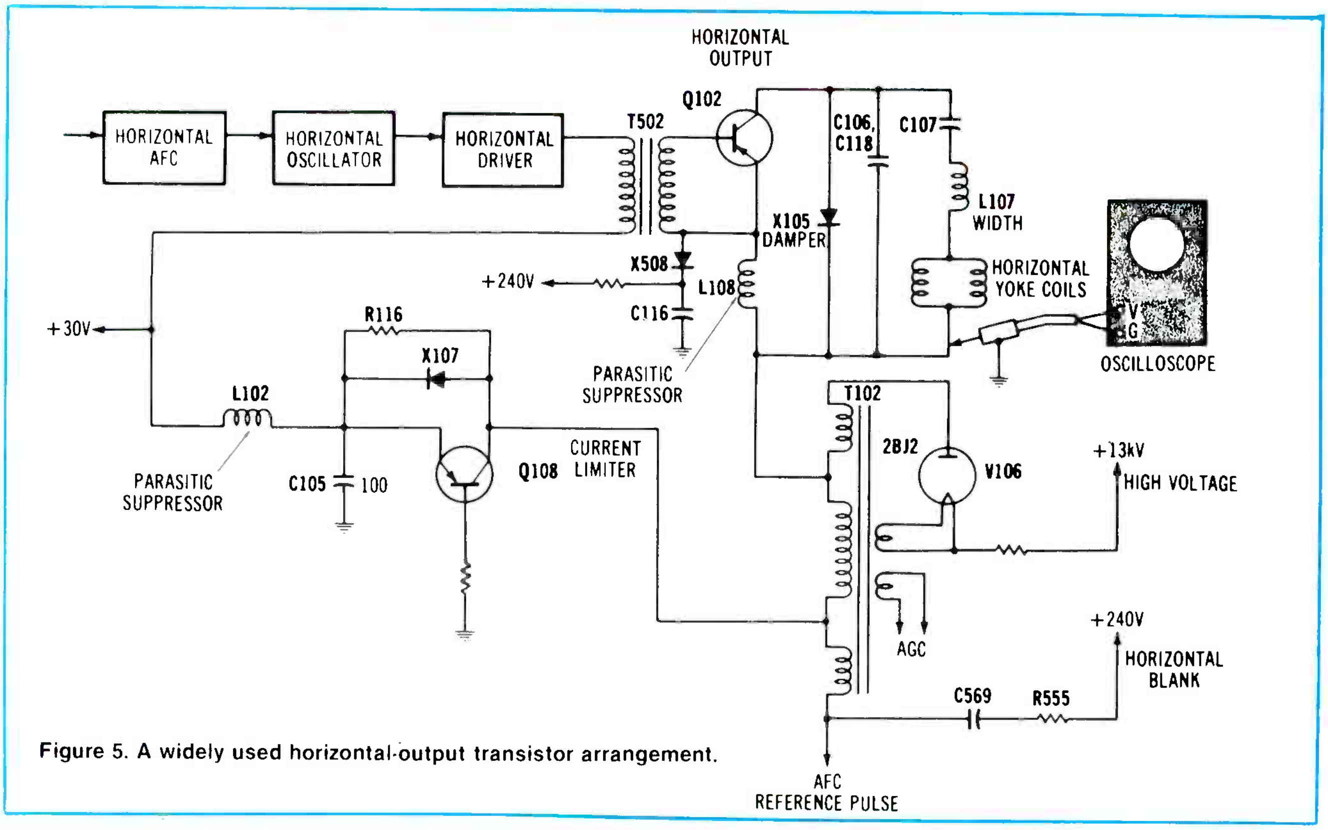


Figure 5. A widely used horizontal-output transistor arrangement.

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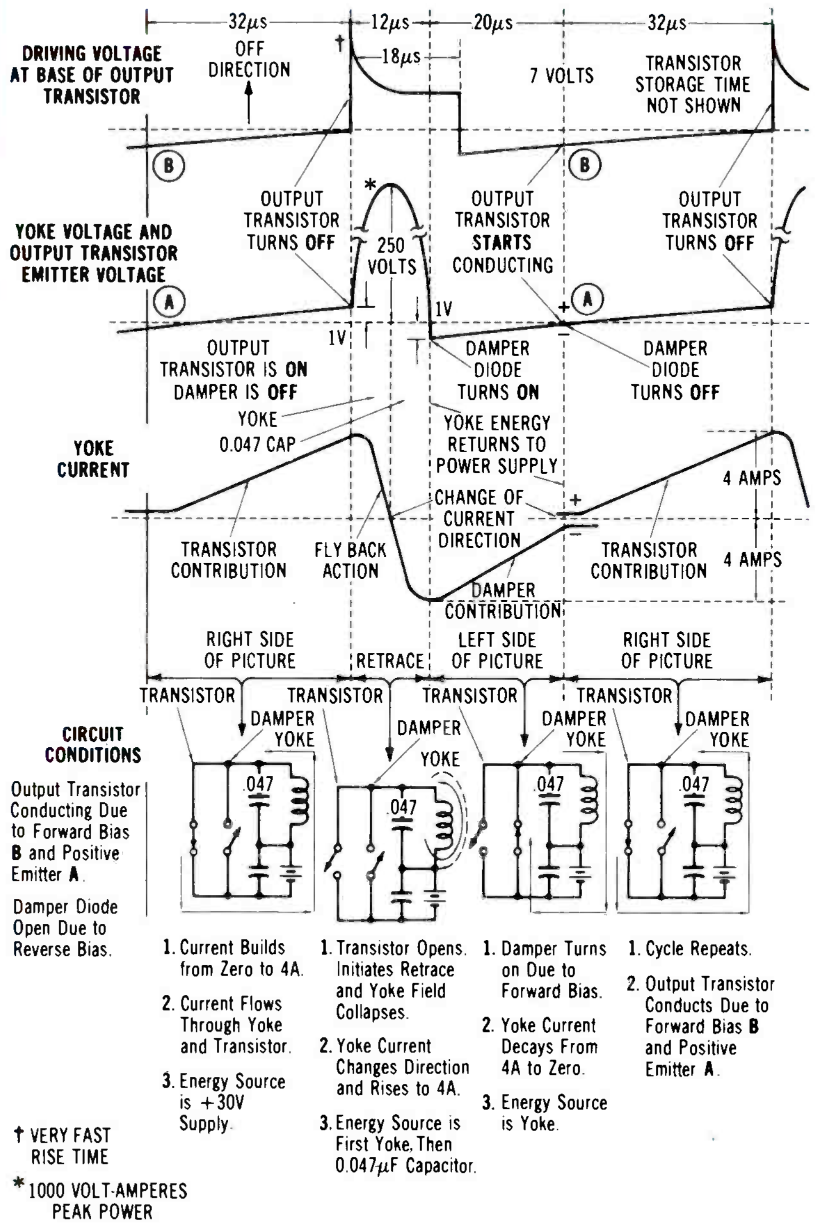

Figure 6. Normal waveforms for the configuration of Figure 5.

In this arrangement, the deflection yoke must be operated so the horizontal-pulse voltage is balanced with respect to ground. The center of the horizontal-yoke winding is effectively at ground potential in normal operation. This balance is required to keep the pulse voltage between layers and between wires in the yoke winding within ratings, and to avoid yoke breakdown.

Observe the primary winding of the high-voltage transformer in Figure 7A is split into two equal halves. That is, T710 is divided, with one winding being driven from the collector, and the other winding driven from the emitter of Q702. The collector winding is tapped at about five turns from the collector input terminal in order to provide a correct match to the yoke inductance. The supply voltage is applied to the other end of the winding; this terminal is at ac ground potential.

Capacitor C721 couples the emitter pulse to the yoke via T815, and also provides pincushion correction for the horizontal sweep. Pincushion correction involves a waveshaping action whereby edge curvature is corrected by increasing the sawtooth current in the horizontal-yoke winding as the scanning beam moves down the screen from top to center. Then the sawtooth current is decreased as the scanning beam moves down the screen from center to bottom. An analogous vertical waveshaping factor is used to correct top and bottom pincushioning.

When Q702 conducts, terminal 4 of the yoke *sees* a negative-going pulse, while at the same time terminal 10 *sees* a positive-going pulse. Although the voltage from terminal 4 to terminal 10 is nearly 1kV at one instant, the voltage from any point in the yoke to chassis ground is less than 500V. The emitter winding in T710 is bifilar, and the secondary side of this winding, connected to pins 5 and 7, is used to provide a path for the centering current. As in the case of the previous transistor horizontal-output arrangement, it is essential that the driving pulse to Q702 have a rapid rise. A slow-rise driving pulse results in lowered efficiency and in overheating of the power transistor.

Transistor horizontal-output arrangement with high-voltage diode stack

The transistor horizontal-output and high-voltage system shown in Figure 8 is an all-solid-state design; the high-voltage rectifier section uses a diode voltage-multiplier network with three subsections. The damper diode X20 is a pnp transistor with the emitter terminal *floating*. As in the arrangement of Figure 5, the horizontal-yoke windings are connected in parallel. The yoke, however, is returned to ground in the configuration of Figure 8, whereas both ends of the yoke operate above ground in the design of Figure 7A. Observe the Q19 emitter waveform in Figure 8 has a normal peak-to-peak amplitude of 90V, whereas the supply voltage is only 11.9V.

This voltage magnification is the result of the inductive kickback from T7. The base drive voltage to Q19 normally has a higher peak-to-peak voltage than the emitter waveform (95V p-p vs. 90V p-p). Thus, somewhat greater voltage magnification is in the base circuit than in the emitter circuit. The horizontal-output transistor oper-

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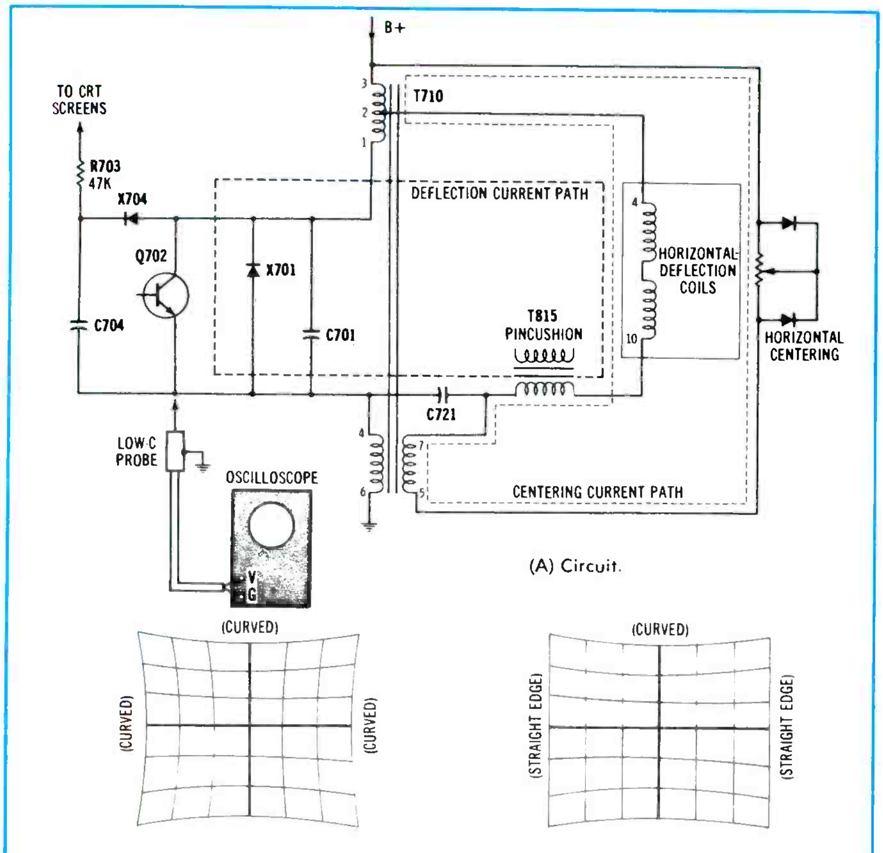

(A) Circuit.

(B) Top-bottom and side pincushioning.

(C) Top and bottom pincushioning.

Figure 7.
Horizontal-output transistor circuit that includes a pincushion transformer.

ates basically as a current amplifier; because its output voltage is almost equal to its input voltage, the transistor functions also as a power amplifier.

High-voltage ripple and filtering

The output from a high-voltage rectifier-filter system is never pure dc; ripple voltage (Figure 9), however, can be disregarded unless its amplitude is sufficient to impair picture shading. In a simple high-voltage system, the ripple frequency is 15,750Hz, and the ripple *pulses* are comparatively narrow.

The ripple voltage tends to increase in amplitude as the *brightness* control is advanced; the ripple pulse also increases in width. If the output filter capacitor is open, the ripple may be accompanied by high-voltage ringing. Or, if the output filter capacitor becomes leaky, the ripple is likely to include a sawtooth (exponential) component. Ripple waveforms can be checked and their peak-to-peak voltage measured with a high-voltage capacitance-divider probe. However, these specialized probes are seldom available except in TV labs.

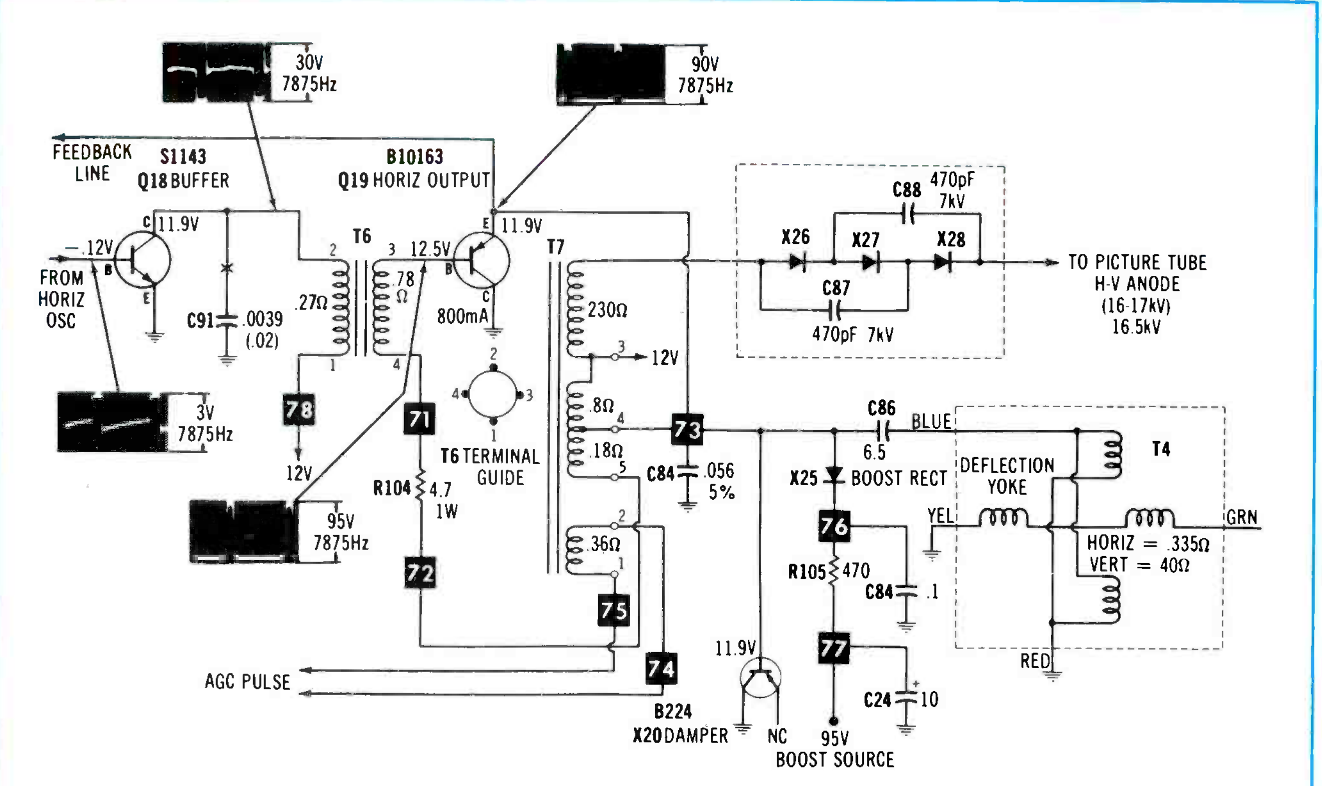

Figure 8. Horizontal-output transistor arrangement with high-voltage diode-multiplier section.

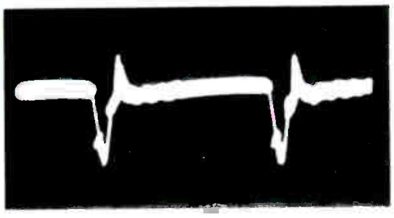

Figure 9. Typical high-voltage ripple waveform.

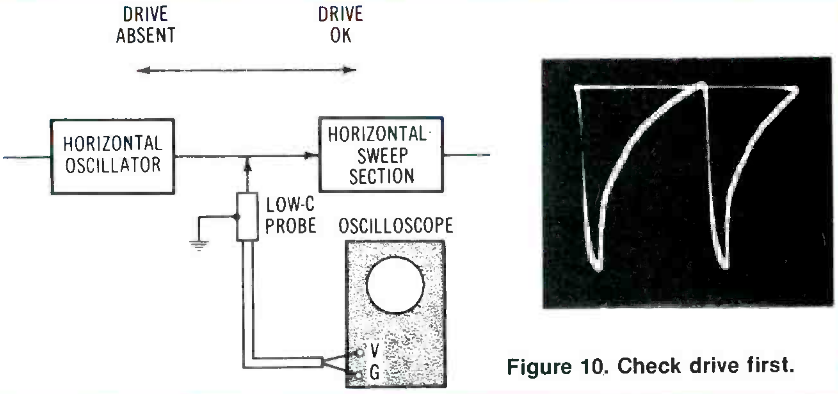

Figure 10. Check drive first.

Troubleshooting tube-type horizontal-sweep circuitry

TV technicians are often confronted by horizontal-sweep trouble symptoms in tube-type receivers. Although this receiver section has earned a tough-dog reputation, troubleshooting procedures may often be facilitated by oscilloscope tests. With reference to Figure 10, it is good practice to check the drive waveform to the horizontal-output tube routinely. The waveform at this point will usually sectionalize a horizontal-sweep trouble symptom. Thus, if the drive waveform is weak or absent, the trouble is almost certainly to be found in the horizontal-oscillator section.

On the other hand, a normal drive waveform points to trouble within the horizontal-sweep system. One exception to this general rule is as follows: If the horizontal oscillator happens to obtain its plate-supply voltage from the B+ boost circuit, a weak drive waveform can result from sweep-circuit defects which reduce the boost voltage. In this situation, check the B+ boost voltage. If the boost voltage is subnormal, a bench power supply can be used to restore normal supply voltage while you are checking out the sweep circuitry.

Troubleshooting procedures

Referring to Figure 11, the widely used autotransformer arrangement is exemplified. The autotransformer (flyback transformer) functions to match the plate resistance of the 6DN6 output tube to the deflection-coil impedance for maximum power transfer (maximum circuit efficiency). The transformer also steps up the flyback pulse voltage for processing by the high-voltage power supply.

The center-tapped yoke in this example has a 4700Ω damping resistor included to minimize waveform ringing. The voltage and current waveforms in the horizontal-sweep network have different waveshapes because the load circuit is reactive (inductive). Although a complex voltage waveform will drive the same complex current waveform through a resistive load, a reactive load will characteristically modify the voltage waveshape in development of the current waveform, as depicted in Figure 12. Although voltage waveforms are generally used in troubleshooting horizontal-sweep systems, current waveforms may be occasionally cross-checked. As an illustration, an oscilloscope check of the waveform across resistor R5 in Figure 11 shows the amplitude and waveshape of the unbalanced current in the yoke circuit.

The drive waveform to the grid of the horizontal-output tube is a voltage waveform. It is checked at point *A* in Figure 11, and it has the typical waveshape shown in Figure 10. Coupling capacitor C1 has a value of 4000pF and therefore has appreciable reactance (2500Ω) at the 15,759Hz scanning frequency. Whereas the horizontal oscillator supplies 90V p-p to the coupling capacitor, only 75V p-p are applied to the grid of the output tube. This voltage drop across the coupling capacitor is normal. However, if less than 75V p-p were found at the grid of the output tube, the coupling capacitor would fall under suspicion – unless, of course, the horizontal oscillator was not supplying normal drive voltage.

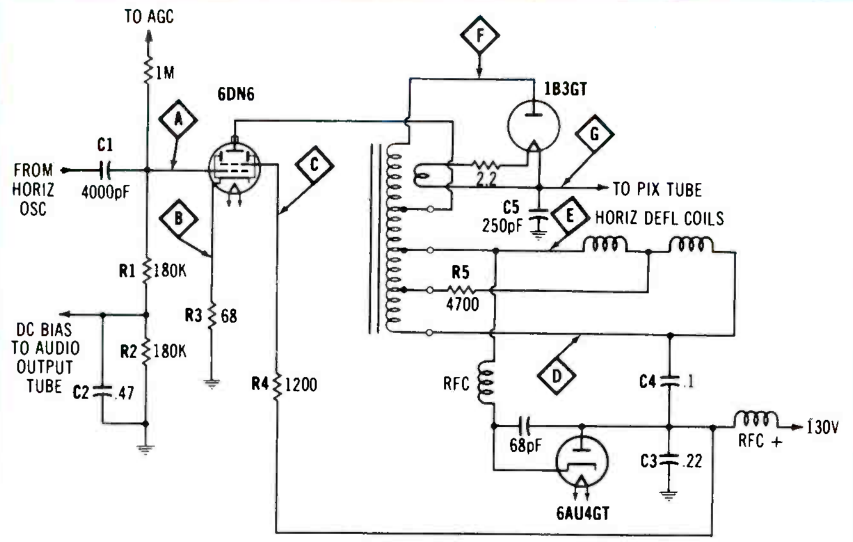

Figure 11. Typical horizontal-sweep configuration.

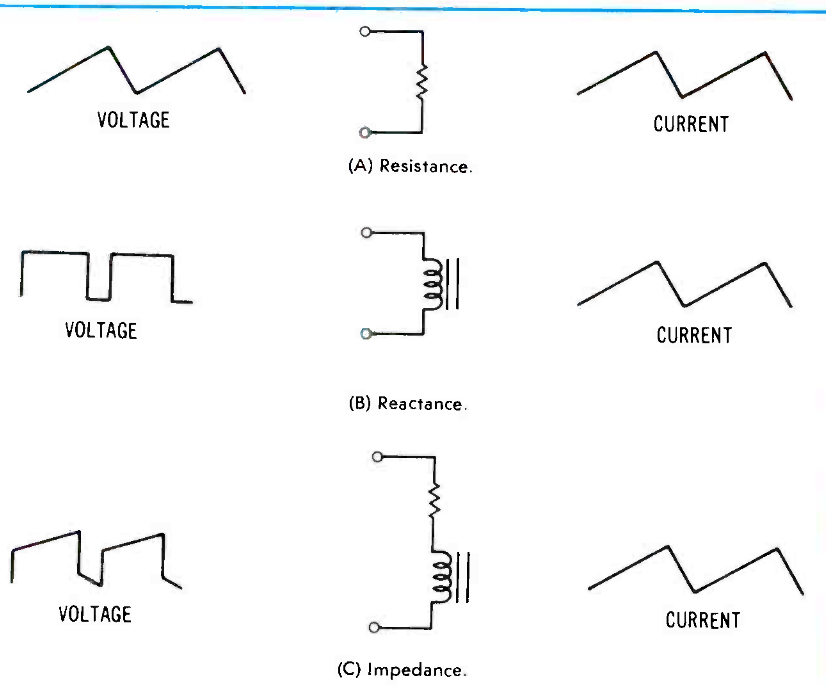

Figure 12. Voltage waveforms needed for a sawtooth current.

When the capacitance of C1 is subnormal, the drive waveform at the grid not only has reduced amplitude, but also becomes distorted as a result of severe clipping of its positive peak. If C1 is completely open, no drive voltage reaches the grid of the output tube and the picture-tube screen is dark.

Low-drive trouble symptoms

When the drive voltage to the horizontal-output tube is subnormal, the deflection current through the yoke is also subnormal and results in a narrow picture. Also, the high-voltage output is reduced, dimming the picture. If the *brightness* control is advanced in this situation, the picture tends to bloom. When the oscilloscope is connected across R3 in Figure 11, the cathode-current waveform is displayed. The normal cathode waveform is shown in Figure 13A. When C1 becomes leaky, the cathode waveform is distorted as in Figure 13B.

The cathode-current waveform reflects several system faults because it is the sum of plate, screen and grid currents in the horizontal-output tube. Leakage in C1 produces a narrow picture, due to reduction of grid bias for the output tube and consequent clipping of the drive waveform.

Next, the normal screen-grid waveform for this configuration is shown in Figure 14A, and a distorted waveform resulting from an increase in screen-resistor value is shown in Figure 14B. When the resistance of R4 is too high, the picture shrinks horizontally. Two causes are effective in this situation: First, too high a screen

Continued on page 38

Photofact

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

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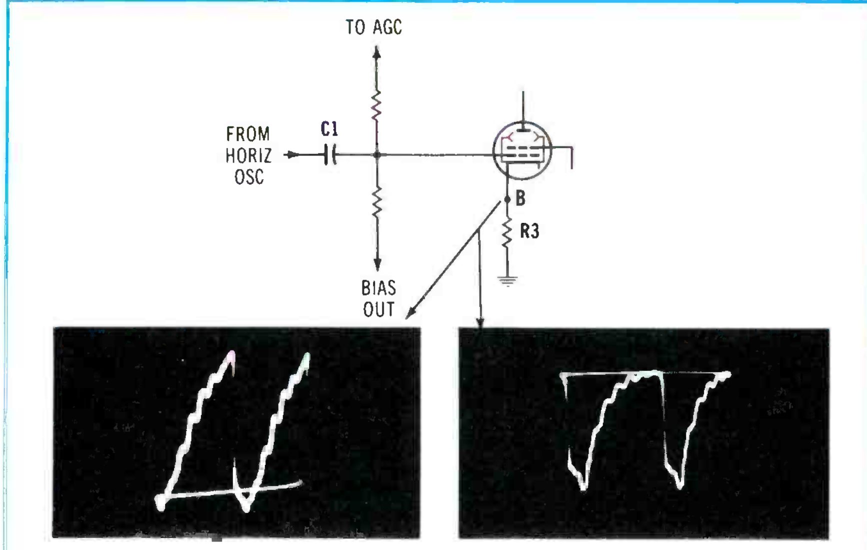
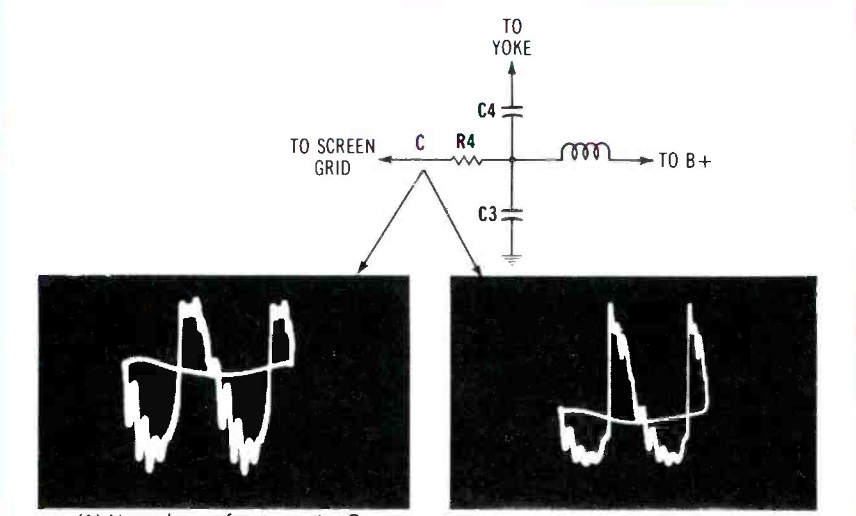


Figure 13. Normal and abnormal waveforms at point B of Figure 11.



(A) Normal waveform at point C.

Figure 14. Normal and abnormal waveforms at point C of Figure 11.

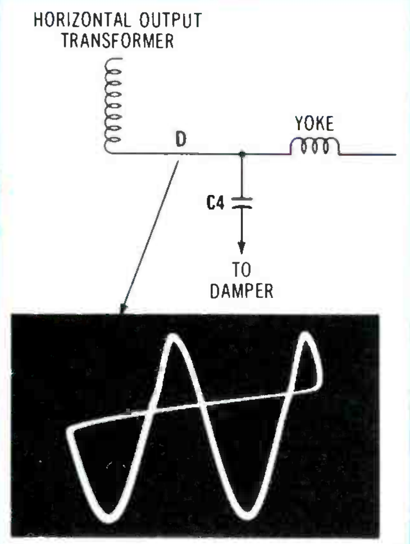


Figure 15. Normal waveform at point D of Figure 11.

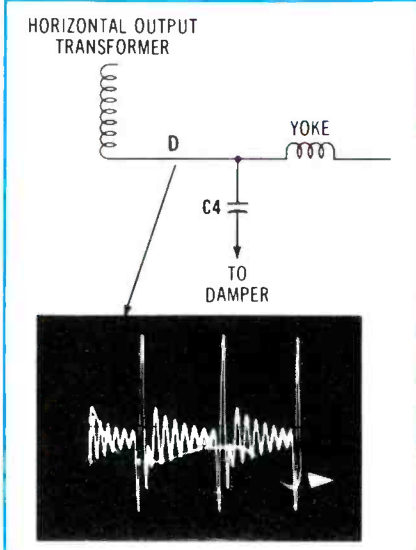


Figure 16. Distorted waveform at point D when C4 is open.

resistance reduces the dc voltage at the screen grid, which limits the power output from the tube; and, second, an unbypassed screen resistor is used in this configuration. Thus, when the screen resistor increases in value, the signal amplitude at the screen resistor increases, although the dc voltage decreases. In turn, the screen-grid circuit operates as a triode plate-load circuit.

When the load resistance increases, the output signal voltage increases. In a beam-power tube, however, the useful power is not supplied by the screen grid but by the plate. The screen-grid signal is 180 degrees out of phase with the control-grid signal, and opposes control-grid action.

The screen grid in a beam-power tube has a lower amplification factor than the control grid, but it nevertheless has an effect on the plate current. An increase in screen-grid signal amplitude reduces the power output in the plate circuit.

Technically, the screen grid has a degenerative action when the screen resistor is unbypassed. Compare this action with the cathode signal (point *B* in Figure 11). Here the cathode signal voltage is in phase with the control-grid signal voltage. Nevertheless, a degenerative circuit action is present in the cathode circuit because a positive-going signal at the control grid increases the plate current.

Narrow picture analysis

With reference to Figure 11, the normal waveform at point *D* is shown in Figure 15. If C4 opens up, a narrow picture results and the waveform at point *D* becomes highly distorted, as shown in Figure 16. Or, if C4 becomes leaky, the waveform amplitude is reduced although the waveshape does not change greatly, because the picture width is reduced. These examples show that for a technician who is familiar with the abnormal waveforms in a horizontal-deflection circuit, defective components can often be pinpointed. A narrow-picture symptom can be caused by more than one component defect, and the oscilloscope is often the most useful instrument to find the fault. ES&T

What do you know about components?

Another look at transformers

By Sam Wilson

For the power supply of Figure 1, the regulator section is designed to hold the output voltage (or current) at a constant value. Some of the factors that can produce undesired changes in power supply voltage are shown in Figure 1.

- A) Changes in the line voltage can produce undesired changes in power supply output. These changes can be momentary, or they can appear over a long period of time.
- B) Transformers are not necessarily linear devices. They have a dc resistance (called copper resistance) that can produce undesired changes in voltage when the supply load current changes.
- C) The resistance of the power supply connectors can cause variations in the output voltage. In many regulated supplies, these changes in voltage are not compensated for by the supply regulator.
- D) Changes in load resistance – especially momentary changes – can cause undesired changes in the supply output.

The regulator section of the supply is designed to take care of the problems just cited, but there is a limit to the regulator's capability.

Figure 1. High-quality power supplies often use a specially designed transformer to provide preregulation.

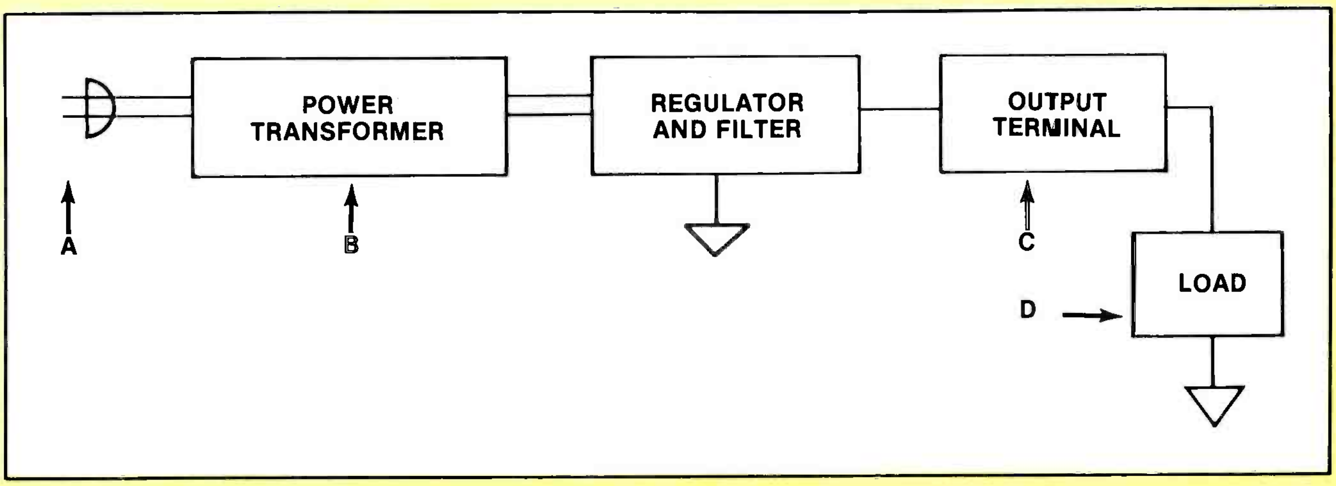


Figure 2. One method of automatically changing a transformer's turns ratio is to use a motorized tap changer.

Figure 3. A self-saturating transformer is designed to saturate before the primary voltage reaches its peak value.

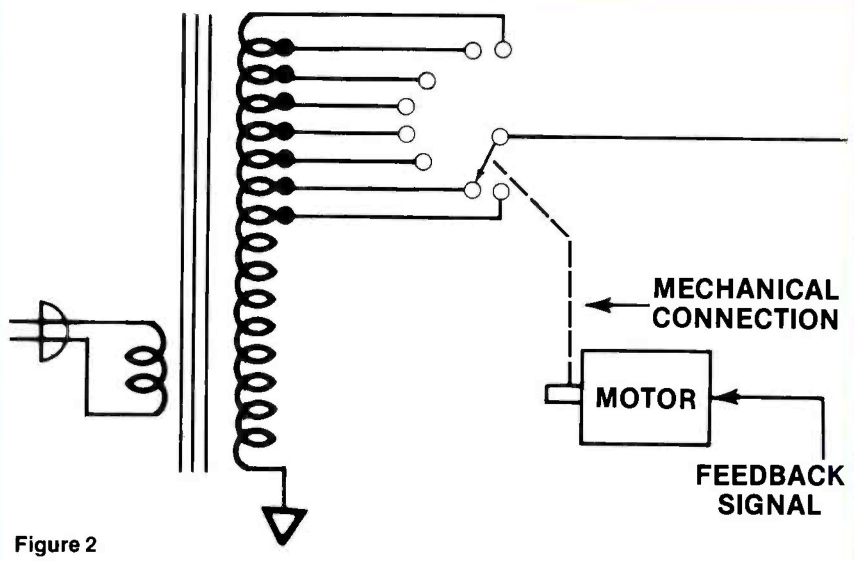


Figure 2

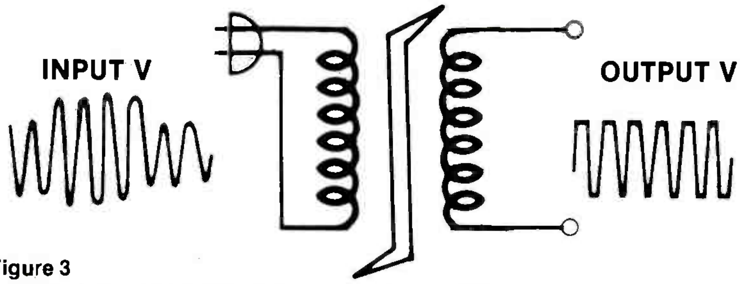


Figure 3

In some cases, the supply can take care of gradual changes in voltage, but cannot compensate for any rapid change. An important rating of regulated supplies is the amount of time it takes to respond to a rapid change in input or output voltage. During the time the supply is responding to a rapid change, the output is unregulated.

If the input voltage to the regulator can be held constant, the supply can be designed to give better regulation against output changes. For that reason, high-quality supplies often incorporate a *preregulator*. This may be in the form of an electronic regulator, but companies that manufacture laboratory-quality supplies often use a special transformer design to accomplish preregulation. A few of these transformers will be discussed here.

Motor-driven transformers

If I had put this idea into a suggestion box, I know I would have received a suggestion in my pay envelope. Mine would have been on pink paper.

In the simplified version of Figure 2, there is a motor-driven switch that selects the amount of secondary voltage. A feedback voltage from the supply output controls the amount and direction of motor rotation.

If the output is too high, as determined by a sense circuit, the motor switches the secondary to a lower number of turns. On the other hand, if the output of the supply is too low, the motor will turn the switch to select a higher number of turns.

Stepping switches and stepping motors work well in this application. In practice, there may be many more switch contacts.

Self-saturating transformers

Figure 3 shows the symbol for a self-saturating transformer. You will remember the core of a transformer is saturated when an increase in primary current does not produce a significant increase in the core's magnetic flux. Once saturation occurs, there is no further increase in the secondary output voltage, even though there is an increase in the primary voltage. (In this discussion, it is assumed that an increase in primary voltage produces an increase in primary current.)

The transformer in Figure 3 is designed to saturate before the primary voltage reaches its peak value. That produces the squared tops on the output at the secondary. Note that the output amplitude remains constant even tough the amplitude of the input voltage varies. The reason is because the transformer always saturates at the same point regardless of any further increase in primary voltage.

Of course, if the input voltage falls *below* the value required to produce saturation, the transformer output becomes unregulated. If the transformer is well designed, it will work within the range of input voltage amplitudes expected.

Ferroresonant transformers

Ferroresonant transformers also work on the principle of saturation. An example of this device is shown in Figure 4. In other versions, the resonating capacitor is connected across parts of the secondary winding. In this case, a separate winding (L) and capacitor (C) are used to oscillate at the line frequency.

The flux due to the oscillating current combines in the core with the flux generated by the primary current. The combined fluxes drive the transformer well into satura-

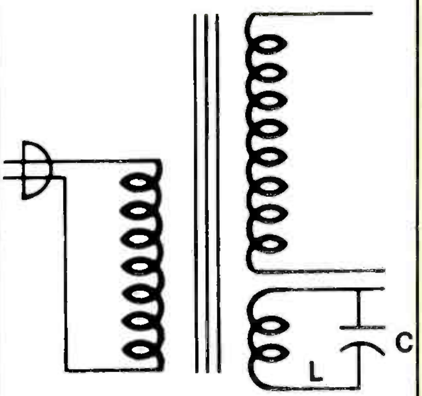


Figure 4

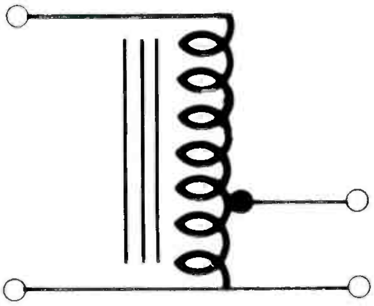


Figure 6

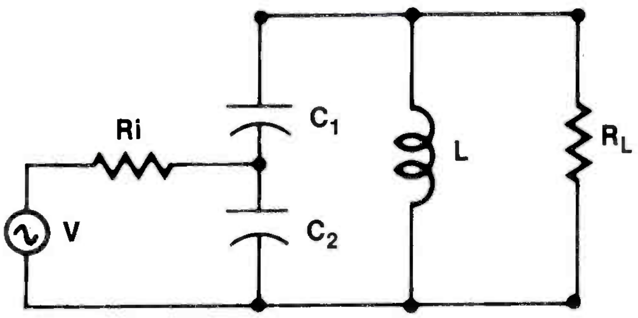


Figure 5

Figure 4. In a ferroresonant transformer, the additional flux provided by the resonance of the L/C circuit makes it less likely for the transformer to go out of regulation when the input voltage is low.

Figure 5. In an autotransformer, the input and output are not isolated from one another.

Figure 6. This unlikely-looking circuit performs the functions of a transformer.

tion of each half cycle of input power.

Because of the additional flux produced by the oscillating circuit, there is less likelihood of the transformer going out of regulation when the input voltage is low. The output voltage looks the same as for the output of the self-saturating transformer.

Autotransformers

In its basic form, a transformer consists of two windings that are coupled, or linked, by an electromagnetic flux. Isolation transformers have two separate windings to prevent a technician from accidentally getting across the hot side of the power line and ground.

At one time, there was a CET test question about using an autotransformer as an isolation transformer. As shown by its schematic symbol in Figure 5, a physical connection exists between the primary and secondary windings, so they should never be used as isolation transformers!

A Variac is an autotransformer with an adjustable secondary winding. Because it has a physically connected primary and secondary, it should never be used as an isolation transformer.

When is a coil not a transformer?

One easy answer to that question is: when it is the coil in an automobile ignition system. The so-called coil in that system is actually an autotransformer that converts the pulsations of current from the breaker points to a high voltage for firing the plugs.

Would you believe the coil circuit of Figure 6 is another example? I found this circuit in an ARRL Electronics Data Book when I was looking for something else. At first I thought it was a mistake, but the operation of the circuit gives it the same characteristics as a transformer.

The *transformer* actually consists of C_1, C_2 and L. The input signal source is represented by V and the internal impedance R_i. The output impedance is represented by R_L.

The low impedance of the source is matched to the higher impedance of the load by the capacitive divider. Looking from the generator you see the reactance of C_1; and, looking from the load side you see the reactance of both capacitors. So, the circuit performs one of the functions of a transformer: *impedance matching.*

Any dc that might accompany the input signal is prevented from reaching the output by the capacitor action. So, the circuit performs the second function of a transformer: *pass the a-c signal but not the accompanying dc.*

Because the L-C circuit will be resonant to a single frequency or narrow range of frequencies, the circuit performs the job of an r-f or i-f transformer: *tuning.* In practice, the coil will be made adjustable so the circuit can be aligned, and that is also a feature that makes it behave like a transformer.

If it looks (electrically) like a transformer, and it acts like a transformer, and it smells like a transformer, then I guess it *is* a transformer.

You will see versions of this device between transistor amplifiers in r-f and i-f amplifiers. I've been calling this an impedance coupling network, but I like transformer better. ES&T

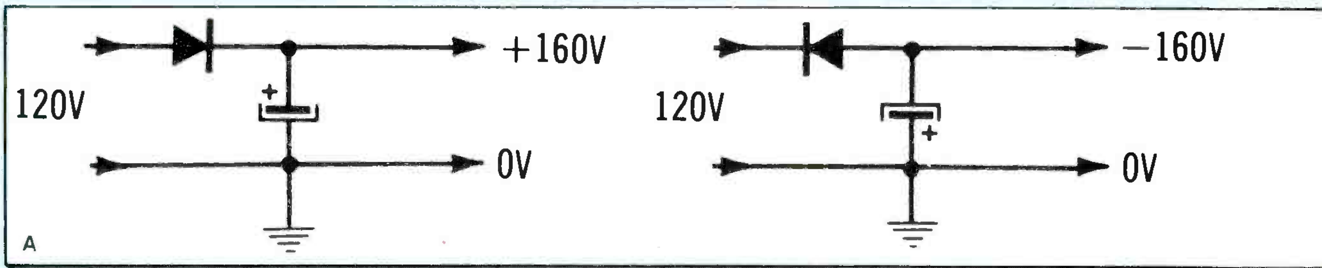
TROUBLESHOOTING
the Sony KV 1722

By Michael Steele

An experienced Sony technician takes the mystery out of the color receivers that experience multiple failures of components for unknown reasons. In addition to explanations of power-supply and sweep functions, complete static and dynamic tests are detailed for the Sony KV1722 and its gate-control-switch circuits.

Sony pioneered the pulse-width-modulated (PWM) power supply for TV receivers in 1973. At the same time, Sony introduced a gate-controlled switch, a unique type of SCR for use in the power-supply circuit and the horizontal-output stage. This 4-layer device operates much like a power transistor, because the anode current is controlled solely by gate current without any need for unlatching by reversed anode voltage or current. However, the rapid switching characteristics are similar to those of a standard SCR. One color receiver that included several GCSs was the Sony KV1722 (Photofact 1432-2). My suggestions for troubleshooting these GCS circuits will be illustrated by this model.

After more than 10 years in the field, these KV1722 receivers are experiencing component failures more frequently. Most will have one or more GCS devices ruined as well as several other components. This situation has created some unusual problems, however, Sony soon advanced to different circuits, making it difficult to find accurate and detailed explanations for these older circuits. The re-



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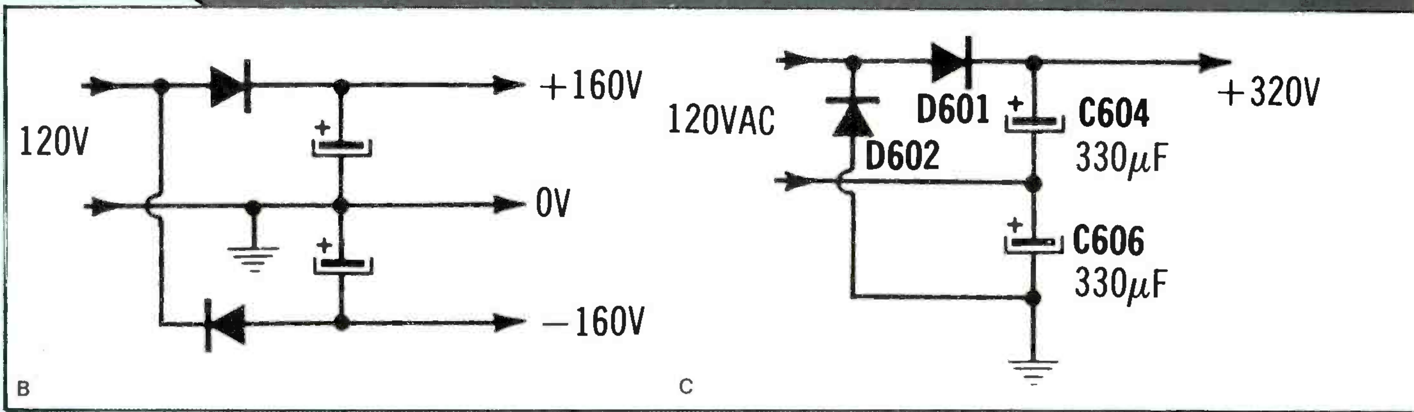


B

C

ceivers operated so long without repairs that few technicians acquired sufficient personal experience to establish their own troubleshooting procedures for this critical electronic-circuit design.

Many people, therefore, attempt one repair before becoming dismayed by the complexity of the PWM circuitry, and then refuse to try again. Further, some believe the circuit is impossible to repair, except perhaps by a genius or someone with incredibly good luck.

For example, one technician told me he ruined *nine* of the expensive little SG613s (Sony's replacement for the original SG608s used in this model), as well as several horizontal drivers, a couple of 2W 820Ω resistors, one smaller start-up GCS, both error-amplifier transistors, several diodes and one expensive filter capacitor. Finally, he gave up and admitted defeat.

Actually, his experience was somewhat typical of the problems that arise when the circuits and the test methods are not thoroughly understood. Despite horror stories about similar repairs, these receivers are worthy of all the trouble and work. They are excellent receivers, without quality being sacrificed for economy or simplicity. And they are designed with circuit boards that can be tilted downward for easy access. After repairs, each should give another 10 years or so of dependable operation.

But, more to the point, *repairs to these formidable color receivers need not be that difficult or expensive for someone who knows the correct method.* The repairs probably will require slightly more time than does the average, however, so don't rush by omitting some of the steps. Observe every detail carefully. Finally, do not attempt the repairs without the following test equipment:

- DMM or VTVM of sufficient accuracy.
- A zero-140Vac supply with 1:1 isolation transformer.
- 10Aac and 10Adc meters.
- A zero-19Vdc 2A supply.
- A scope of adequate bandwidth and gain.
- An audio generator with square waves.
- One 4A circuit breaker.
- One 220Ω, 150W wire-wound power resistor.

Doubler, regulator and start-up

Most of the explanations about these circuits and functions will be found accompanying the illustrations, while this text will cover important generalities and side issues. Figure 1 shows the Sony voltage doubler to be nothing more than a combination of a negative-voltage half-wave rectifier and a positive-voltage half-wave rectifier. Together they form a full-wave-voltage and ripple-frequency doubler with a 120Hz ripple frequency. It is not a shunt type (or negative clamping) stage followed

Figure 1. Active components of the horizontal oscillator are inside IC501. Output at pin 16 divides with one path going through L515 to Q410 shut-down transistor on the PR board, and the other path feeding Q508 and Q509 (which are connected as a Darlington amplifier). Q509 drives the gate of GCS Q510 through driver transformer T502. In this circuit, Q510 acts much as a power transistor, but with better bandwidth and other characteristics. C552, C542 and C550 tune the flyback resonant point during retrace time. Therefore, one being open (and particularly C542) increases the high voltage. Notice T501 flyback is not used to develop high voltage. Instead, horizontal pulses from Q510 are coupled through L753 and C755 to high-voltage transformer T801, and T801 supplies DC801 multiplier rectifier. Four major low voltage sources are provided by rectification of flyback power. D510 rectifies the pulses at Q510's anode, producing +900V. D514 powers the +17.5V source, after start-up is over. Also, a resistor and zener D513 produces +11.2V from +17.5V. D515 provides +18V, and from it a regulator transistor produces +12V. Horizontal power to D516 is augmented by +130Vdc source, thus producing +200V for the color amplifiers. Notice the path of the horizontal-yoke coil is through a flyback winding, a 0.01μF coupling capacitor, and the pincushion-elimination circuit to ground.

by a series type rectifier, as used in many older sets. That type gives a 60Hz ripple frequency.

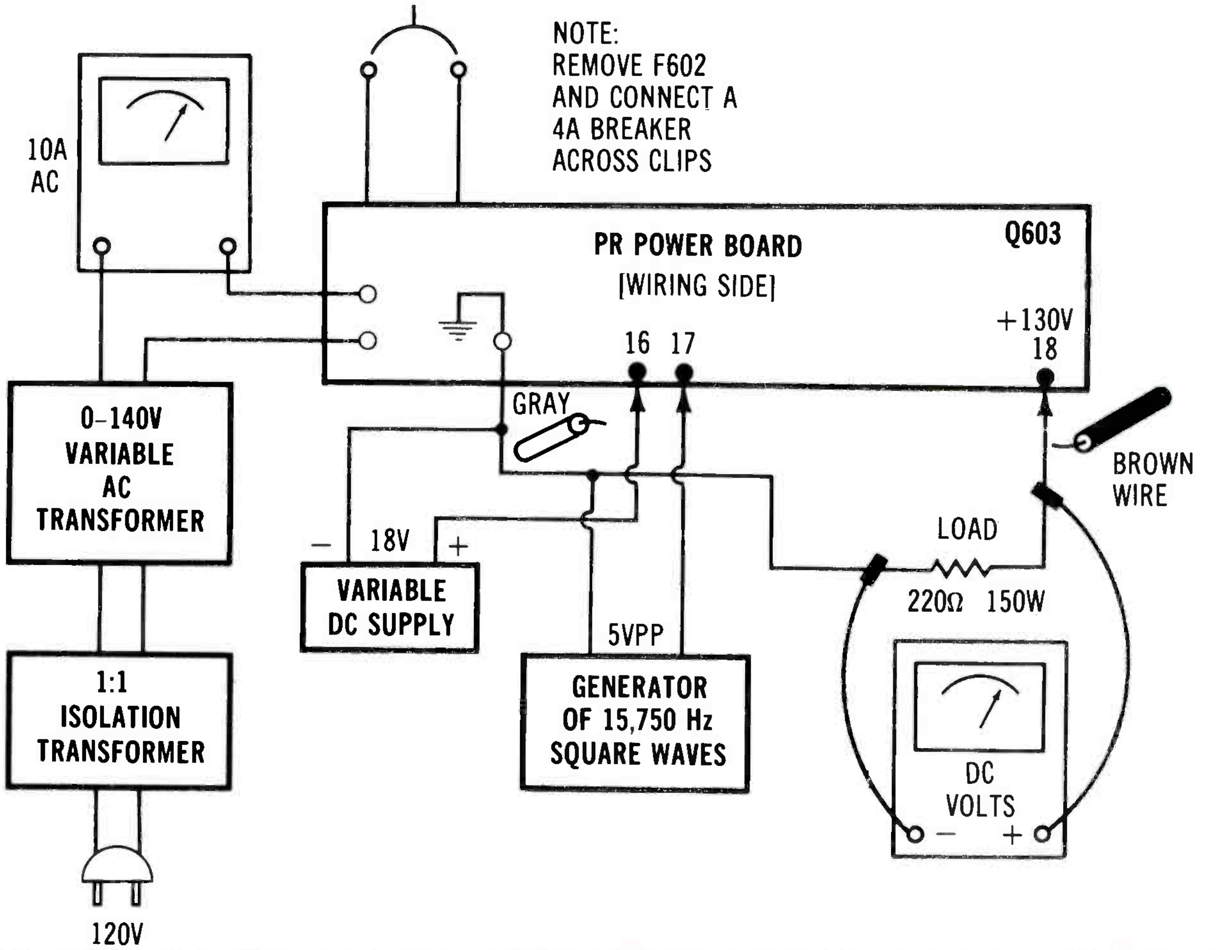
Older Sony receivers incorporate all of today's start-up, shutdown and regulator circuits even though they were manufactured as early as 1973. A schematic showing the complete regulator circuit, the shut-down circuit and three paths of the start-up voltage is featured in a related article at the end of this text.

As is true of most new receivers, a failure of the start-up circuit gives symptoms of no sound and no raster. Of course, a successful start-up followed by instant shutdown also will provide no sound and no raster. In both cases, rectified line voltage will be the only dc supply that continues to operate.

After you have studied the Sony regulated voltage schematic and its explanation, remember the following important items of information:

- No TV stages obtain power directly from the doubler.
- One regulated +130V supply is the only voltage obtained from the doubler power.
- Q510 (the horizontal-output GCS) and the sound-output transistor are the only two stages that obtain power directly from the regulated +130V source.
- All other stages operate from power produced by rectification of horizontal-sweep power from the flyback. This includes the horizontal-oscillator and driver stages.
- In other words, the horizontal-oscillator and horizontal-driver stages operate from dc voltages rectified from horizontal signals they have helped generate. This is a special type of positive feedback,

Figure 2. Connecting the power-supply PR board as shown will allow the doubler and regulator circuits to be tested with high accuracy. However, the start-up function is not tested. If the PR board tests perfect with instruments, but the start-up does not occur when the PR board is connected to the HV board, some component in the start-up circuit probably is defective.



so breaking the signal at any point stops the whole thing.

• For example, an intermittent condition inside IC501 that stopped the horizontal oscillator for a short time (perhaps a half to one second) would stop the horizontal sweep and all other functions. Most (but not all) of the start-up functions would attempt to restart the voltage sources. GCS Q602 would be gated into conduction to supply start-up dc voltage to the +17.5V source. But the temporary loss of horizontal drive would prevent start-up because C605 would remain charged and not furnish the current pulse necessary to force a pulse from the chopper drive to the Q603 gate.

If the power was turned off long enough for C605 to discharge and the receiver then switched on, the receiver would achieve start-up and normal operation (assuming the oscillator started) until the next intermittent.

• Remember that a normal receiver will not go through the start-up sequence and begin normal operations unless C605 has discharged sufficiently. Usually a wait of two or three minutes after the power has been removed is sufficient for start-up when the receiver is next switched on.

A typical failure

Now that normal operation has been explained, it is time to consider the causes of the catastrophic failures so common with this model. The chain reaction (of one failure ruining another component and so on) can begin at many points. We chose one and will follow it to the logical conclusion.

Assume that Q603 regulator GCS begins to leak, allowing the +130V source at its cathode to rise above the normal level. Positive voltage at the Q609 emitter also increases, which increases the Q609 forward bias and producing a positive voltage at the Q609 collector. The Q609-collector positive voltage provides saturation bias to shut-down Q610, and its saturation collector-to-emitter conduction will ground the horizontal-rate square waves. This removes all drive from the horizontal system, so it stops (shut-down).

Also, the horizontal pulses for operation of the pulse-width modulator (PWM) circuit are eliminated. Indirectly, this removes all gate pulses from Q603 and stops the regulator action. However, the +130V supply would have some positive dc voltage from the Q603 leakage, and the leakage with resulting heat probably will cause a thermal runaway in Q603 that ends with a dead short.

Furthermore, the +17.5V source will not be totally eliminated, although the horizontal sweep system is dead and D514 no longer is rectifying. When voltage from the D514 cathode stops and the source voltage drops, zener D610 stops conduction, turning off Q601 conduction.

Resistors R605 and R606 bring forward bias to the Q602 (GCS) gate and Q602 conducts current from the +320V doubler output through R608 and D605 to the CircuiTrace-3 +17.5V source. Also, the +130V source has increased to almost +320V because of the light load and the Q603 short, so current flows from that source through R642 and D604 (now forward biased) to the Q602 anode. Therefore, the +17.5V source voltage begins climbing toward +320V, but transistors or filter capactors usually short before that level is reached.

Long before the +17.5V source reaches +320V, the greatly increased Q509 driver bias (through R577 and Q508) and the higher-than-rating source voltage have shorted Q509 driver. Transients from that Q509 destruction probably will apply excessive pulses to the Q510 gate (the anode already has B+) and Q510 will short also. After Q509 shorts, R608 is overloaded and begins to smoke. Usually, R642 does the same thing.

All the previous actions perhaps happen in a few milliseconds. The 4A fuse blows immediately after Q510 shorts.

Other sequences of failure can occur, but usually these defects remain: a blown F602 4A fuse, a shorted Q603 GCS regulator, a shorted Q510 GCs horizontal-output device, a shortened Q509 horizontal-driver transistor and a burned R608.

All too often, also, another unseen problem exists; either the original defect or another component is ruined by the original failure. Therefore, if the components known to be defective are replaced and the receiver powered with full voltage, the result–all too often–is another sequence of massive failures.

The following 3-part method will stop this repeated waste of components:

1. Disconnect the PR power-supply board, check it statically, repair all defects found and finally use test equipment to operate the board by itself.
2. Disconnect the dc sources from the VH deflection board, operate it from an external power supply while using scope and meter to find defects during low-power operation. Replace all defective components.
3. Connect the two boards to the receiver, but operate at low line voltages until normal operation is verified, then apply full power for a heat run.

Checking the PR board

Disconnect the gray wire (for the +17.5V source) from pin 16 on the PR power-supply board. Also, disconnect the brown wire (output of the +130V regulated source) at pin 18, as shown in Figure 2.

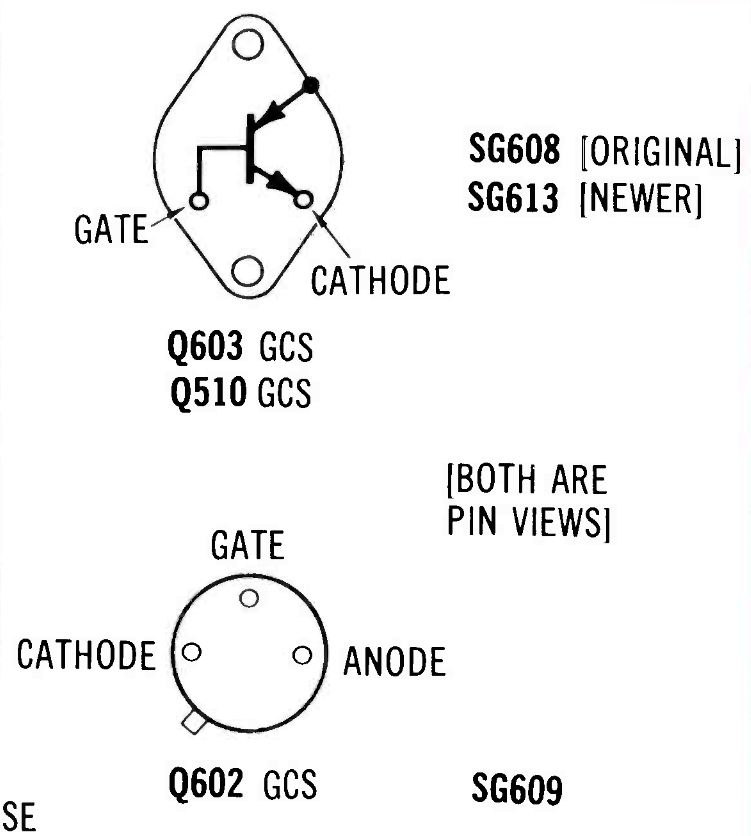
Remove the regulator chopper GCS Q603 and check it for opens and leakages (see Figure 3). Check the F602 4A fuse. If it has been blown, it is likely Q603 has been under extreme overload, which

Figure 3. The two gate-controlled switch (GCS) devices operate much like power transistors, although each has four semiconductor layers inside where transistors have three. Notice the extra arrow in the symbol. Actually, a GCS is a special type of SCR, which gives GCSs the high-speed switching characteristics of SCRs. The defects in most GCS devices can be identified by resistance tests out-of-circuit. Use a digital multimeter that has a high-power type of resistance function, a VOM or a VTVM to test the Q603 and Q510 GCSs according to the following chart:

OHMMETER CONNECTIONS TO SG608

Anode	NC	NC	–	+	–	+
Gate Pin	+	–	+	–	NC	+
Cathode Pin	–	+	NC	NC	+	–
Meter Range	R1	R10K	R10K	R10K	R10K	R10K
Normal Reading	15	INF.	15K	10M	INF.	0

Note: the smaller Q602 (SG609) tests about the same, except no conduction should be found between anode and gate.



ANODE IS CONNECTED TO THE CASE

sometimes produces a defect that will not show up in a resistance or other static test. Therefore, replace Q603 if there is a possibility of a dynamic defect.

When replacing Q603 or Q510, always use only Sony's SG613 replacement part. I have tried at least three different universal replacements, and each failed immediately or within a few weeks. There is a secret the universal manufacturers haven't learned yet–probably careful selection based on exactly standards (which might explain the high price).

On the other hand, there is no need to accept the rumor that all replacement components must be Sony originals. I have used ECG replacements for almost all other semiconductors on the PR and VH boards with no adverse results. One other part should be replaced by a Sony original: the Q509 (2SC1475) horizontal-driver transistor. Perhaps the reason is the critical waveshape of the collector signal it must generate.

Inspect the board visually, especially R608 and R642. Push back the asbestos sleeve to allow an examination. If either shows signs of being overheated, replace it, using flameproof resistors.

Install and resolder Q603. Then check resistance with positive lead to the Q603 cathode and negative lead to ground. A reading of 20KΩ or higher is satisfactory. If a lower reading is obtained, check the reason and correct it. At PR-board pin 16 (+17.5V source), the resistance should be 200Ω or higher.

Q602 can be tested in-circuit on the ohmmeter's RX1 range. Either polarity of test leads between cathode and anode should read infinity. Also check Q608, Q609 and Q610 on the RX1 range. If any readings seem out of line, disconnect the associated components and recheck them separately.

Dynamic operation

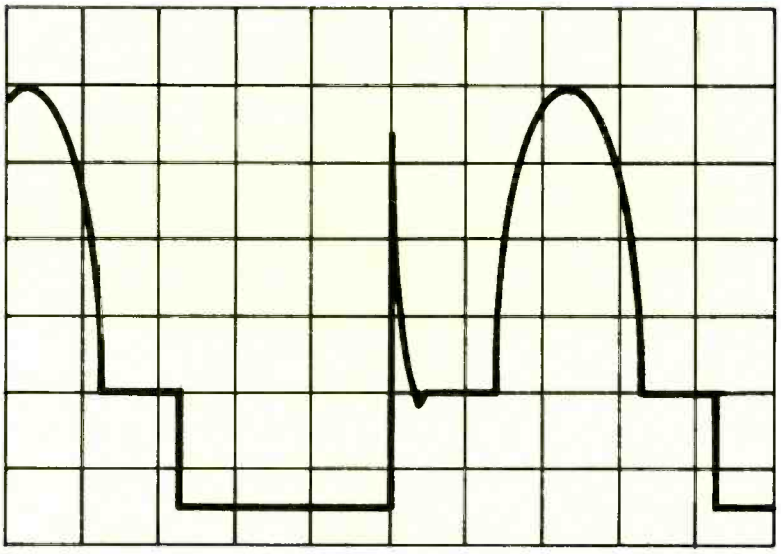
After all obvious problems on the PR board have been repaired, it is time to start powered dynamic operation. Connect an external 4A circuit breaker across the open F602. Connect a 220Ω 150W wirewound resistor from PR board pin 18 to ground. Insert 15,750Hz square waves 5VPP from a generator at pin 17 and ground. Monitor the dc voltage at pin 18 with a dc voltmeter. Connect the ac ammeter in series with the variable-voltage transformer and the isolation transformer (as shown in Figure 2), turn the variable transformer to 0V and plug the set into it.

While carefully watching the ac-input current and the dc voltage reading at pin 18, begin advancing the transformer voltage. An initial surge of up to about 2Aac is permissible, but when the receiver line voltage reaches 90Vac, the ac ammeter should show less than 1A (load of the 220Ω dummy load). Also at 90Vac input, the pin 18 +130V source voltage should read +130V. Slight adjustments of VR601 should produce +130V somewhere near midrange of rotation. Further increases of ac voltage up to 130V should not change the +130V reading.

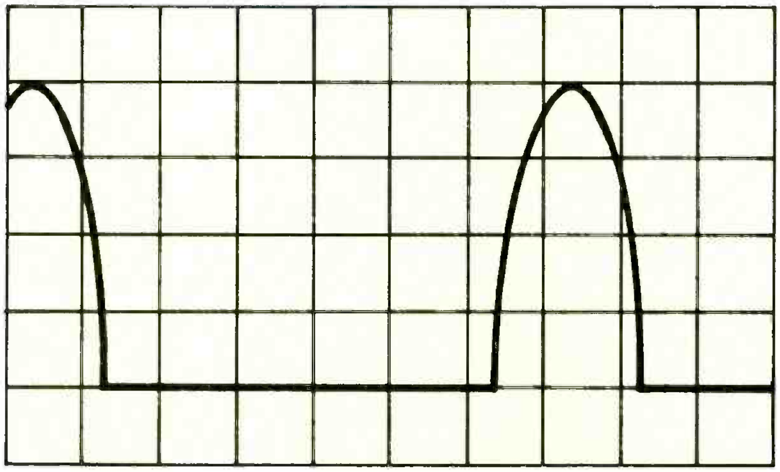
After everything checks as intended, operate the PR board for about 10 minutes to show any heat-related problems or any components that are running too hot. If any problems show up, they must be repaired and time tested before you go to the next step. Disconnect the variable-voltage transformer and all temporary connections.

Checking the sweep board

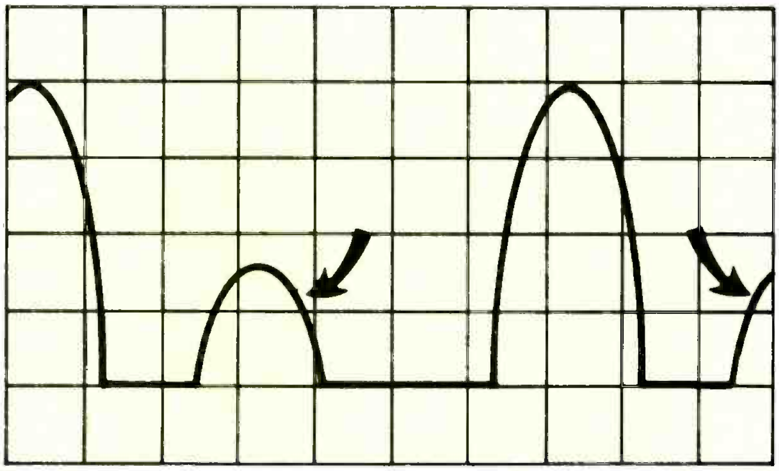
Remove GCS Q510 from the vertical-horizontal (VH) board and check it (Figure 3). If there is any doubt about its condition, remember substitution is the only certain solution. Test horizontal-driver transistors Q508 and Q509. Check the D517 damper diode. It should read infinity on the highest resistance range. Any resistance reading indicates unacceptable leakage, and the damper should be replaced. Check +17.5V-source D514, and verify continuity from the D514 cathode to pin 16 on the VH board. Incidentally, the gray wire formerly at pin 16 and the brown wire previously removed from pin 18 on the PR board both remain disconnected.



4A



4B



4C

With your ohmmeter, check for shorts at the cathodes of D515, D516 and D510. When the meter positive lead is connected to the Q510 anode, check the resistance to ground. Less than 20kΩ is reason for suspicion. Carefully inspect the VH board for loose connections or burned resistors.

After the VH board passes these tests, it is ready for controlled operation with power.

Dynamic operation

Adjust the 18V external power supply to zero and connect it in series with the dc ammeter and the gray wire that is hanging loose near pin 16 of the PR board. Connect the scope probe to the Q509 collector. Watch the current as you advance the dc voltage to +18V. Current of more than 400mA indicates trouble.

Figure 4. (A) This is the desired 80VPP waveform at the Q509 collector. (B) The Q510 anode waveform is conventional, although the amplitude will be small when operating temporarily from the +18V test supply. (C) "Glitches" between the normal flyback pulses indicate serious overloads. A shorted D516 causes the glitch to have this appearance.

If the current is moderate at the test +18V, compare the Q509 collector waveform and amplitude with Figure 4A. The amplitude must be 80VPP and the waveform as shown. If not, make repairs. Substitute Q509 first (remember to use a genuine Sony transistor). Try a new Q508 if Q509 does not help. The T502 driver transformer seldom fails, but it or something in the output circuit might cause the incorrect waveform. IC501 might be at fault, but that is not likely.

Up until now, Q510 has had no anode dc voltage. After the proper driving waveform is obtained, jumper the brown wire (hanging loose near PR pin 18) to the same external +18V supply that already is connected to the gray wire formerly at PR pin 16. (Remember both wires remain disconnected from the PR board.) Q510 now is operating with only +18V of supply voltage. The Q510 anode waveform should be correct as shown in Figure 4B. If the waveform is distorted, the problem must be in Q510 itself or in the output circuit, for the performance was good up to the Q510 gate.

Many defects that cause an excessive load on the horizontal-output transformer (flyback) add extra distorted pulses between the normal flyback pulses (Figure 4). However, *some problems do not produce these distortions at low B+ voltages.*

If the output pulse waveforms looks healthy, and nothing operates too warm, disconnect all the test equipment and prepare for a test with both boards connected.

Cautious powered tests

At the PR power-supply board, reconnect the gray wire to pin 16, and reconnect the brown wire to pin 18. Using the ac ammeter, connect the variable-voltage transformer to the receiver but start with 0V. Position the scope probe near the Q510 case so the expected 800VPP pulses can be viewed without risk to the scope or the GCS.

Advance the line voltage and watch for any glitches to appear between the pulses on the waveform. If none appear, stop at 90Vac and allow it to operate for a minute or so. When all is well, a normal picture will be obtained.

If glitches appear at the Q510 anode, remove the ac power quickly and troubleshoot the cause before continuing. Common failures occur in D514, D510 and D517. Occasionally, leakage might be found in C755 which feeds horizontal power to the high-voltage transformer T801. Or the DC801 HV multiplier might be defective. Check L752 for damage or for burned windings.

After all repairs and adjustments have been made, and the output waveforms are correct, operate the receiver with 90Vac for about 10 minutes. Observe everything about the receiver during this heat run.

After the heat run has been successful, remove the test equipment, solder in a new 4A fuse, apply normal line voltage and operate the receiver for about two hours. After all these precautions, there is little possibility of a callback.

Comments

One peculiarity of the pulse-width regulator should be emphasized. If horizontal pulses to the PWM circuit are lost while GCS Q603 is not conducting, the regulator probably will merely stop operations, and the +130V source will go to zero. On the other hand, if the pulses stop *while Q603 is conducting,* there is no provision for turning off Q603. Therefore, Q603 remains a virtual short circuit, and the +130V source rapidly equals the line-rectified doubler voltage.

Of course, many components (as described before) immediately are ruined, the 4A fuse blows and all receiver operations cease. Essentially the same sequence happens when Q603 shorts. This action resembles that of a crow-bar circuit used to *protect* a power supply from overload by applying a short circuit across the load and tripping the breaker. Perhaps this is the one shortcoming of an otherwise excellent circuit that was included in Sony receivers only a short time.

Because of this peculiarity of the GCS pulse-width-modulator regulator, the recommended sequence of static and powered tests should be followed carefully. If the instructions are followed, few additional components should be ruined during troubleshooting of KV1722 Sony color receivers. The testing sequence also should virtually eliminate the call-backs where the same trail of previously installed components are found to be defective again.

Start-up and shut-down circuitry

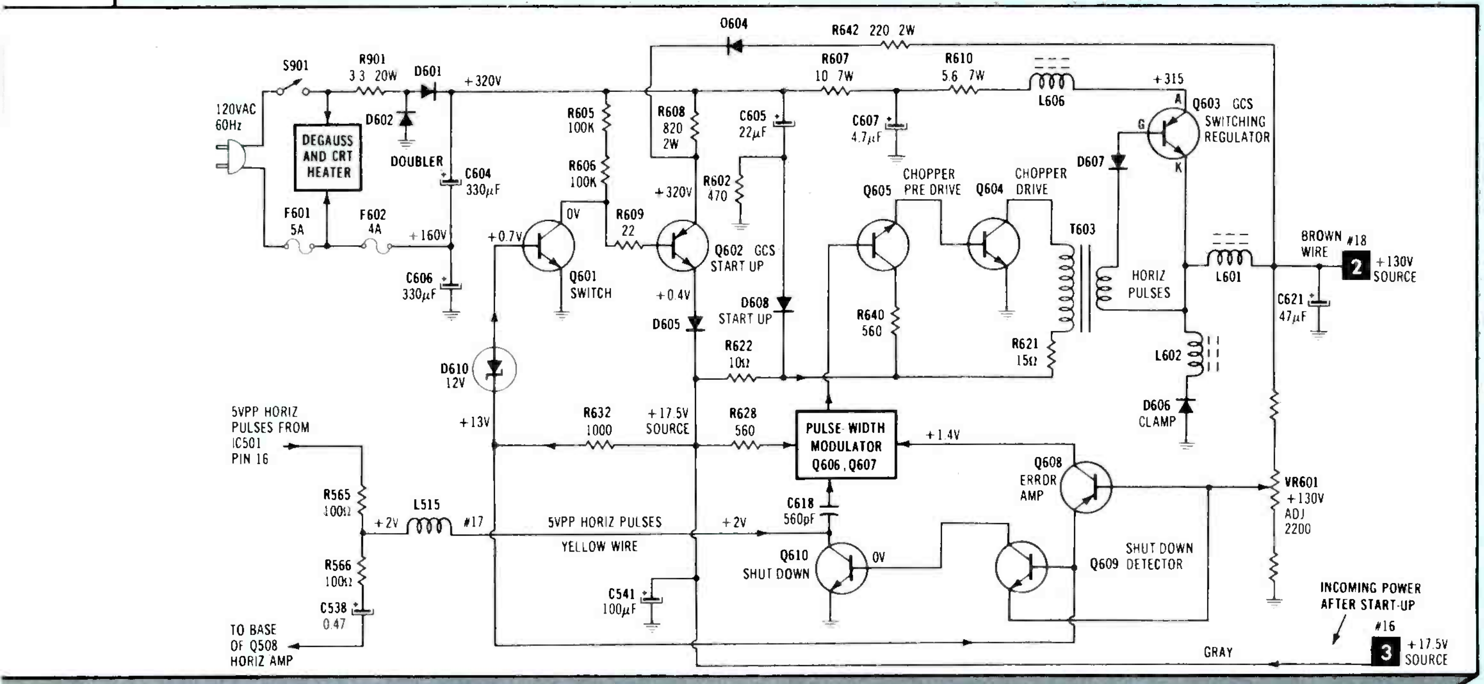
In addition to the dc-voltage previously described in *Troubleshooting Sony KV1722 and a voltage regulator circuit, the Sony KV1722 power-supply PR board (Figure 1) also contains the start-up voltage supply and a simple type of shut-down circuit. Components are shown for all sections except two: the chopper-drive transistor stages; and the two pulse-width-modulator transistor stages. Repairs are seldom needed for those two areas, so no details are provided except input signals, output signals and B+.* As shown in Figure 2, the horizontal-output transistor is powered by the regulated +130V supply, while the oscillator and horizontal-driver stages receive power from voltage produced by rectification of horizontal power. Therefore, a start-up circuit must temporarily provide supply voltages to the oscillator and driver stages each time the receiver power is switched on.

When the doubler output begins to climb toward +320V, capacitor C605 charges, producing a pulse of charging current that is sufficient for the chopper-drive transistors Q605 and Q604 to produce a pulse that keys Q603 into brief conduction that places some voltage on the +130V source (for the horizontal-output GCS). This same pulse of current is applied to the +17.5 source, but it is not strong enough to power the large load during start-up. That is the function of small GCS Q602 and switching diode D605. But Q602 must be turned on at the correct time, and that is the function of Q601 switching transistor and zener diode D610.

Positive voltage for the Q602 GCS gate is available through R605, R606 and R609 anytime the voltage doubler has +320V, except when Q601 grounds the Q602 gate. The D610 zener cathode receives voltage from the +17.5V source has insufficient voltage to pass through the 12V zener. Therefore, at the beginning of start-up, the base of Q601 has zero dc volts, and GCS Q602 has positive gate bias. Power therefore flows through R608, Q602, D605 (now forward biased) and to the +17.5V source (CircuiTrace 3).

The partial voltage on the 17.5V source allows the horizontal oscillator and driver stages to operate. As previously explained, output GCS Q510 has some anode dc positive voltage, so the horizontal-deflection system begins to operate weakly. As the Q603 switching regulator begins to operate, the voltage of the +130V supply begins to rise. When the voltage exceeds that at the Q602 anode, D604 is forward biased and additional current is available through R642 to supply the heavier load during the latter part of start-up.

In a series of small steps, the sweep becomes stronger until the +17.5V source is supplied *only* by diode D514 which rectifies power from the T501 flyback, as shown in Figure 2. The deflection system now is operating at 100 percent power, and it is time the start-up system should be disconnected. Zener diode D610 has sufficient cathode voltage that it conducts, supplying forward bias to the Q601 base. Q601 now conducts, and its C/E path grounds the Q602 gate bias at the junction of R606 and R609. Without positive gate voltage, Q602 GCS ceases to conduct, and in turn D605 is reverse biased so it becomes an open circuit, disconnecting the +17.5V source from Q602. At the Q602 anode, the dc voltage rises to +320V which reverse biases D604 so it becomes an open circuit, thus disconnecting R642, which otherwise would connect the +320V and +130V levels. Start-up now is completed, the voltages should be as shown on the schematic, and all deflection-rectified supplies should be

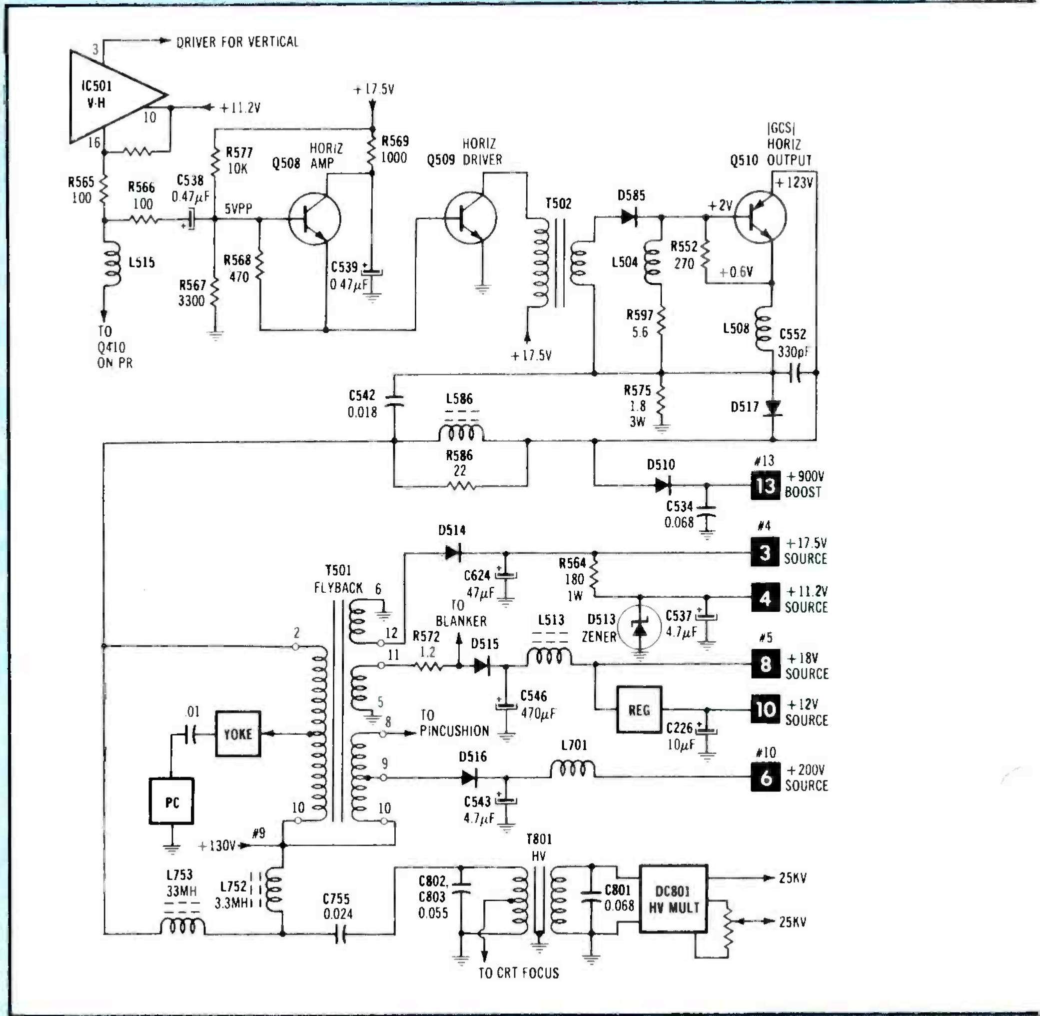


operating correctly. Start-up can be repeated anytime C605 has been completely discharged before the receiver is switched on.

Regulation

Regulation of the +130V supply should begin just before the supply voltages stabilize following start-up. *Remember that regulation is accomplished by the integration of dc pulses.* Specifically, the pulse-width modulator (PWM) and chopper-drive circuits produce variable-width pulses that determine when during each horizontal cycle the Q603 gate-controlled switch (GCS) feeds through L601 to C621, where it is smoothed to the average voltage determined by the pulse's duty cycles.

If Q603 conducts continuously (ignoring the damage that would result), the duty cycle is 100 percent with the same voltage at regulator input and output. If the duty cycle is 33 percent, the filtered regulator output will be approximately 105V. When the line voltage goes down or the load on the +130V regulated supply increases, the output voltage would decrease. However, the circuit lengthens the time during each horizontal cycle whe Q603 passes power to the +130V source, and this restores the correct voltage. Conversely, if the line voltage goes up or the load current decreases, the PWM and chopper circuits shorten the time during each horizontal cycle that Q603 passes power to the +130V source. Thus, excellent voltage regulation is produced.



Error-amplifier Q608 continuously monitors the +130V source through several resistors (not all are shown here) and the VR601 control. The Q608 varying collector voltage is applied to the PWM circuit as one step of the regulation. Notice both Q608 and Q609 are PNP types. Base and emitter of shut-down detecter Q609 parallel emitter and base of Q608, so they are controlled by VR601 adjustments and voltages. But notice that the Q608 base is connected to the Q609 emitter, and the Q608 emitter is connected to the Q609 base. Thus, one transistor forward bias is increased and the other decreased by each voltage change.

In normal operation, Q608 has a moderate negative forward bias and a moderate C/E current, while Q609 is reverse biased and without collector current. If the +130V supply voltage increases significantly, the decreased Q608 current attempts (through narrowed pulse width) to correct the increase. But when that correction is not possible (perhaps Q603 is leaky), Q609 is forward biased by a more positive emitter voltage, causing a positive collector voltage which is applied to the Q610 base, and the Q610 C/E resistance becomes very low, shorting to ground the horizontal pulses that are essential for PWM operation and for horizontal drive (Figure 2). Of course, loss of pulses for the horizontal-driver base stops the sweep instantly (shut-down).

When Q603 is leaking heavily, a series of component failures is produced, as explained in the text. When Q603 is not leaking or shorted, loss of pulses to the PWM circuit stops Q603's conduction of variable-width pulses, and this either eliminates the +130V source or increases it to the doubler's dc voltage, depending on the state of Q603's conduction at the time the pulses were lost.

Finally, remember this about start-up: Start-up cannot occur unless C605 has been discharged first. But turning off the receiver for several minutes allows C605 to discharge, and this permits an attempt at start-up when power is applied next time. If the cause of the excessive regulator-output voltage was temporary, or has been repaired, the next start-up should be successful.

Index of 1984 articles

Compiled by
Warren G. Parker,
Metairie, LA

Titles of Articles

TECHNOLOGY

BOOK REVIEWS

SYMCURE

Titles of Articles

Symcures Wanted

Electronic Servicing and Technology needs a broader variety of television Symcures. Especially needed are reports of Quasar, General Electric, Sylvania (or Philco), Sony Sears and Magnavox.

Symcures are, by definition, solutions to problems that have been encountered during the repair of *more than one* television set of the same make and model, and that may reasonably be expected to be a source of *recurrent* failure.

Please give the brand, model number, Photofact number, a brief description of the symptoms, a rough hand-drawn schematic of the area containing the defect, and a short description of the cure (including whether the defective component was open, leaky, shorted or intermittent).

ES&T editors will adapt the material to the Symcure format and have Photofact-style schematics prepared.

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P.O. Box 12901
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Test your electronic knowledge

By Sam Wilson

1. The first four bands on a certain resistor are colored RED, RED, RED, RED. By an accurate bridge measurement, the resistance of the resistor is found to be 2.7K. Which of the following statements is correct?
(A) The resistance is out of tolerance.
(B) The resistance is in tolerance.

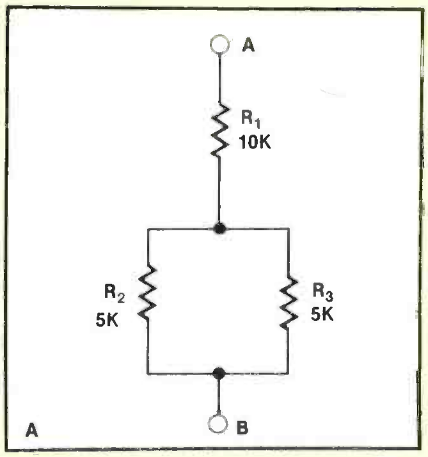
2. The inductance of an air-core solenoid does *not* depend upon:
(A) its shape.
(B) the number of turns.
(C) the coil current.
(D) the distance between the turns.

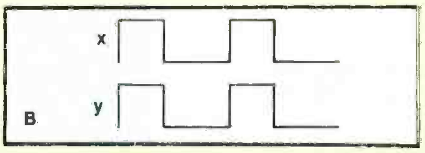
3. Select the correct statement.
(A) Electrolytic capacitors might have a Faraday shield, but power transformers do not.
(B) A power transformer might have a Faraday shield, but electrolytic capacitors do not.
(C) A Faraday shield is likely to be found in electrolytic capacitors and power transformers.
(D) None of the above statements is correct.

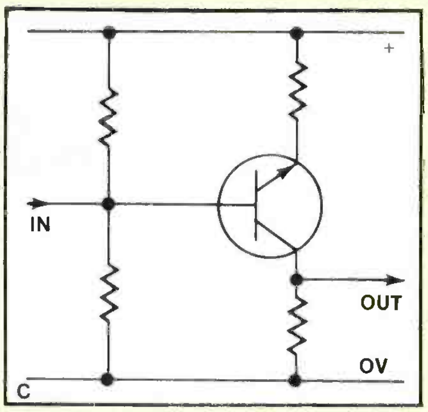
4. The isolation resistance of an optical coupler would be better expressed in:
(A) terraohms.
(B) picoohms.

5. There are a few shorted turns in the primary of an isolation transformer. This will cause the secondary voltage to be:
(A) slightly higher than expected.
(B) slightly lower than expected.

6. A certain TTL logic circuit is intermittent. By raising the power supply voltage from 5V to 10V you can:
(A) locate the intermittent IC because it will be hotter than the others.
(B) sometimes eliminate the intermittent by causing a higher current to flow through it.
(C) find the intermittent by turning off the lights and looking for an arc.
(D) eliminate the intermittent by destroying all of the TTL integrated circuits.







7. In the circuit of Figure A, the resistance is accurately measured between A and B and found to be 15kΩ. You would:
(A) consider this circuit to be OK.
(B) suspect that R_1 is out of tolerance.
(C) suspect that one of the parallel resistors is bad.

8. The reciprocal of reactance is:
(A) conductance.
(B) measured in Darafs.
(C) both (A) and (B) are correct.
(D) neither (A) nor (B) is correct.

9. Figure B shows the dual-trace oscilloscope display of two pulse signals taken at two different points in a system. You know for certain that signal y is 360 degrees behind signal x. Which of the following is correct?
(A) The display is wrong. Most likely the scope is not properly synchronized.
(B) It wouldn't make any difference in the circuit because the rise times occur at the same instant.
(C) The display is correct as shown. However, you should use some other technique to determine if the phase is correct.

10. Regarding the transistor circuit of Figure C:
(A) it is an example of a common emitter amplifier.
(B) the amplifier is being operated Class B.
(C) the amplifier is being operated Class C.
(D) it won't work.

Answers to quiz

1. (A) The tolerance band is red, so it is a resistor with a ± 2 percent tolerance. The highest value it could have and still be within tolerance is 2.244K, so it is out of tolerance.

2. (C) The coil current might influence the inductance if the coil was wound on an iron core. Excessive current would saturate the iron and thereby limit the inductance.

3. (B) The electrostatic (Faraday) shield is used to prevent capacitive coupling between the windings.

4. (A)

5. (A) The reduced number of turns in the primary causes it to act like a step-up transformer. If more than a few turns are shorted, the inductance (and inductive reactance) will be decreased. That, in turn, will cause excessive heating due to the increased primary current.

6. (D) This test procedure would be ridiculous.

7. (C) It is likely that one of the parallel resistors is open. If you short across the parallel branch and the resistance goes to 10K, you will know the problem is in the parallel branch.

8. (D) The reciprocal of reactance is *susceptance*. Conductance is the reciprocal of resistance. The reciprocal of capacity is called elastance and it is measured in darafs – which is farad spelled backwards.

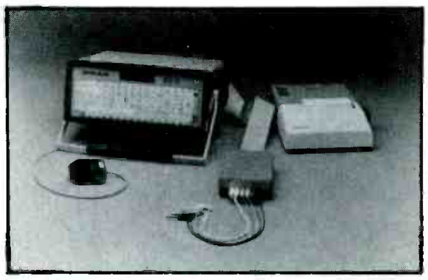
9. (C) Even though the pulses appear to be starting at the same time, they may be 360 degrees apart. That means the y pulse is late. In some systems, that may prevent correct operation.

10. (D) The polarity of the supply is wrong. If the polarity was reversed, then choice (A) would be correct.

Products

Automated disk alignment tool

Quicklign 123 automated flexible disk drive alignment station, manufactured by *Brian Instruments*, Fullerton, CA, is designed for field or factory use with disk drives ranging from three to eight inches, including high-speed 5¼-inch drives. The automation level of the Quicklign 123 also provides on-line audit with an optional local printer that documents all final adjustments.



Six test procedures can be stored for operator call-up. Test sequence flexibility allows user to jump out of a test procedure and re-enter at a different point, perform each test on a stand-alone basis independent of the linked procedure, and to step backward and forward through the procedure.

Circle (75) on Reply Card

Variable isolated ac power source

VIZ Test Equipment, Philadelphia, PA, offers a new variable output isolated ac power source, model WP-30. The WP-30, with isolated ac output variable from 0V to 150Vac, 60Hz, is designed to provide continuous 0A to 5A output current to a maximum of 650VA. The output curent can be set to the maximum output desired; beyond this point, a latching relay will open the circuit and reduce output volts and amps to zero. Two parallel, three prong ac sockets are also provided, so the unit may be used for more than one load.

This isolated voltage source is equipped with a power line leakage tester to measure ac leakage in electrical equipment. It has two 3½-inch meters; one monitors output voltage and the other can display output current or leakage. Accuracy is ± 2 percent.

Circle (76) on Reply Card

250MHz frequency counter

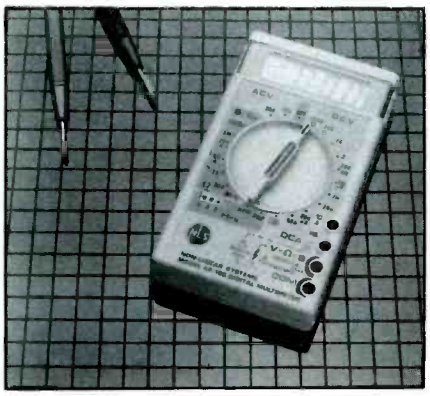
An economically priced 250MHz frequency counter has been introduced by *Global Specialties*, New Haven, CT. MAX-250 provides accuracy of 5PPM, making it suitable for laboratory calibration purposes and also for hobbyists, technicians and educational institutions.

MAX-250 has an 8-digit, 7-segment LED readout with a decimal indicating MHz position. Other features include 20mV to 320mV sensitivity range, ±1-count accuracy, switchable 0.1 second and 1.0 second gate times and switchable input frequency ranges of 5Hz to 100MHz and 30MHz to 250MHz. MAX-250 works in a variety of applications, including signal processing, measuring transmitter frequencies, measuring audio signals and time base calibration.

Circle (77) on Reply Card

Pocket-size multimeter

Non-Linear Systems, Solano Beach, CA, announces the AP-105, a low-cost, 3½-digit (2000 counts) DMM. Features of the AP-105 include ac and dc voltage measurement, dc current, conductance, resistance, NPN and PNP transistor diode and battery test. A single rotary switch selects on-off power function and 23 different ranges.



The AP-105 measures 4.8"L x 2.8"W x 0.9"H and weighs seven ounces. Automatic polarity an overload indication are included. The DMM is powered by a 9V battery with a life of 300 hours and features a low power indicator.

Circle (78) on Reply Card

Large cable stripper

Rush Wire Strippers, Syracuse, NY, announces the availability of model RW-1 large cable stripper for removing the insulation from the ends of wires and cables used in the electrical and electronics industries. Model RW-1 is a compact, bench-mounted, hand-operated device designed for wires and cables with diameters up to 0.625 inches.

Circle (79) on Reply Card

Digital VOM

Triplett Corporation, Bluffton, OH, introduces model 3560 handheld, digital VOM. It features a 200mA to 10A current range and 2000 hour battery life. A 20Ω resistance range and audible continuity tone makes the 5-function, 29-range suitable for in-field measurements on industrial, commercial, communications and consumer electronic equipment.

Measuring 6.7" x 3.4" x 1.65", the VOM has a 3½ digit, ½-inch high LCD display. Autopolarity and overrange indication are provided. Ranges include 0-1000Vdc in five ranges; 0-750Vac in five ranges; 0-10A ac/dc current in six ranges; 0-20M resistance in six ranges. Powered by a 9V battery, model 3560 offers lo-batt indication and battery fuse access.

Circle (81) on Reply Card

Electronic chemical aerosol products

Philips ECG introduces a comprehensive line of electronic chemical aerosol products for commercial, industrial and high-technology applications. This line of products includes a variety of cleaning, lubricating, shielding and testing agents. Eighteen different products are available in aerosol can sizes and three-bulk packages for larger applications.

Circle (82) on Reply Card

Literature

Simpson Electric Company, Elgin, IL, offers its new test equipment catalog 5500-TE. Organized into different product and subclasses, all digital type instruments are in one location, followed by analog test equipment which is separated by product class – general-purpose, sound level and environmental. The catalog features large 4-color illustrations, complete engineering specifications and prices.

Circle (121) on Reply Card

A 12-page, 4-color brochure from **BBC-Metrawatt/Goerz,** Broomfield, CO, features their full line of digital and analog multimeters. A complete description of each model's measurement capabilities and full specifications are included. BBC multimeters are available in bench/portable, compact hand-held and unique folding designs. BBC's line of multimeter accessories is also described in detail. This includes high voltage and RF probes, current transformers, temperature probes, current shunts and carrying cases. A compatibility chart shows which accessories are suited for each BBC multimeter.

Circle (120) on Reply Card

More than 7000 electron tube types are listed in a catalog issued by **Unity Electronics,** Elizabeth, NJ. Tube types listed include special-purpose industrial tubes, receiving tubes, transmitting tubes, magnetrons, klystrons, traveling wave tubes, ballasts and many other tube types. All receiving tubes are shown with net pricing; all other tubes are indicated with list pricing.

The catalog also contains four pages of ICs and solid-state devices available including digital ICs Schottky devices, diodes, transistors, triacs, varactors, rectifiers, microprocessor components, voltage regulators and many other solid-state devices. Unity has included four pages of conversion charts allowing the user to substitute similar tube types when the exact tube number required is not available. The conversion charts include: U.S. service type to commercial, foreign numbers to U.S. numbers, Jedec number to manufacturer's number and manufacturer to manufacturer.

Circle (122) on Reply Card

Precision Satellite Systems, Clearwater, FL, has a new catalog available for satellite dealers. The catalog features more than 400 items with competitive prices and convenient fast shipping.

Circle (123) on Reply Card

Non-Linear Systems, Solano Beach, CA, introduces their 88-page product catalog for 1984-85. It includes descriptions of the 58 basic instruments, which with variations make up the more than 2000 NLS products. The catalog features miniature portable test instruments, oscilloscopes, DMMs, frequency and temperature meters, along with digital panel meters in three case styles: industrial, low profile and short depth. The functions of these meters include: ac and dc voltage and current, ohms, line frequency, event counting, frequency, time interval, period and frequency ratio.

Circle (124) on Reply Card

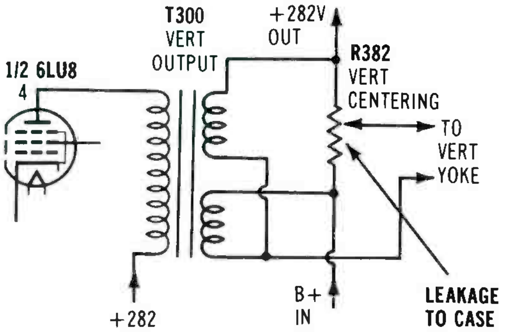
Miller-Stephenson, Danbury, CT, offers specific techniques for solving 70 cleaning and maintenance problems in a products applications guide, based on the MS family of high-purity aerosol cleaners. The fold-out guide has been designed for workplace use, to be mounted on bulletin board or wall for immediate reference, or kept in desk or worktable drawer. Applications and recommendations cover communications equipment, electronic components, printed circuits, semiconductors, glass products, instrument and metering devices, electrical and non-electrical machinery, medical/pharmaceutical apparatus,

Continued on page 61

Symcure

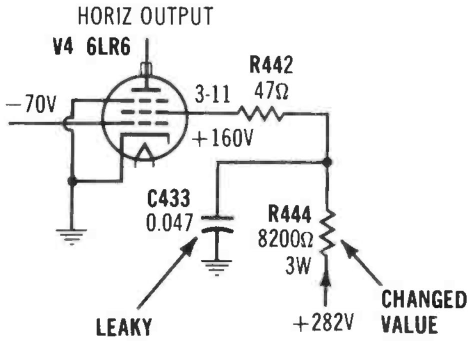
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Sylvania D16 1
PHOTOFACT—1178-3



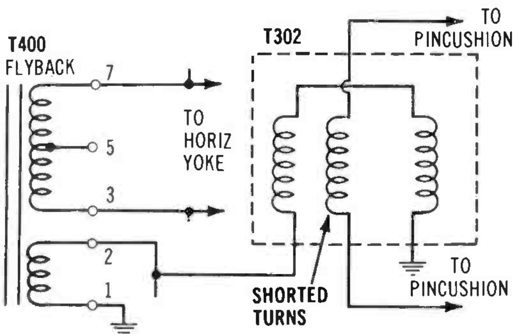
Symptom—Severe overload trips breaker, but filters and diodes are not shorted
Cure—Disconnect R382 vertical-centering control and test for internal leakage to its case. Replace control, if shorted.

Chassis—Sylvania D16 2
PHOTOFACT—1178-3



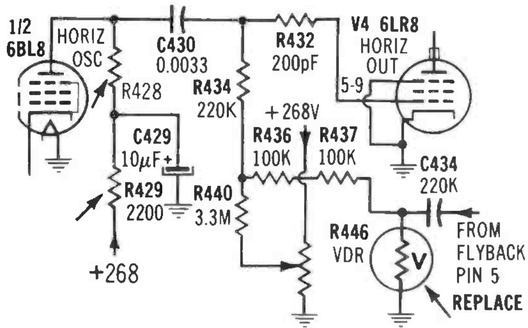
Symptom—HV is too low, and the 6LR6 operates less warm
Cure—Check C433 and R444, and replace both if C433 is leaky and R444 has changed value from heat and overload.

Chassis—Sylvania D-16-10 3
PHOTOFACT—1325-2



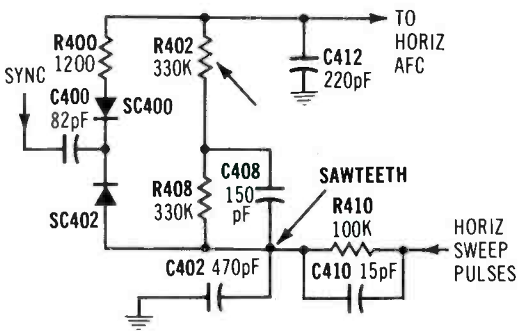
Symptom—No HV and the 6LR6 runs red, although its drive is normal
Cure—Disconnect the T302 wire at T400 pin 2. If the HV returns, replace T302 pincushion-correction transformer (it has shorted turns).

Chassis—Sylvania D16-10 4
PHOTOFACT—1325-2



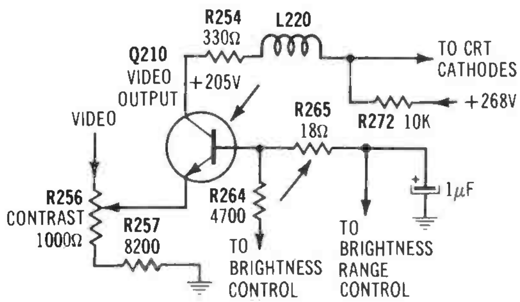
Symptom—HV cannot be adjusted higher than 23kV; regulation is poor
Cure—Check R429 and R428, and replace them if the values have changed from heat. Also, replace varistor R446 as a test.

Chassis—Sylvania D16-10 5
PHOTOFACT—1325-2



Symptom—Horizontal cannot be locked when receiver is cold
Cure—Replace AFC diodes SC400 and SC402 as a test. Check R402, and replace it if the value has changed.

Chassis—Sylvania D16-10 6
PHOTOFACT—1325-2



Symptom—Excessive brightness and extreme blooming
Cure—Check video-output transistor Q210, and replace it if shorted. Also, check R265 and replace it if the value is out of tolerance.

Continued from page 59
metal cleaning, and plastic and rubber goods. Specific equipment is listed, along with problem areas, suggested remedy, and recommended aerosol product.

Circle (125) on Reply Card

Osborne/McGraw-Hill announced the availability of their fall 1984 catalog featuring *Helpware,* the accurate, easy-to-use microcomputer books.

All Osborne/McGraw-Hill books, including 20 new titles are pictured in this 35-page color brochure. The entire *Helpware* product line is described, and order information is provided. General interest and enterment books, user guides to hardware, software, operating systems, programming languages, assembly languages, techincal reference titles, and ready-to-use program books are all featured in this catalog.

Circle (126) on Reply Card

Books

Handbook for Electronics Engineering Technicians, by Milton Kaufman and Arthur H. Seidman; McGraw-Hill Book Company; $39 hardbound.

Electrical engineering technicians will find this comprehensive handbook will not require an extensive background in high-level engineering principles and techniques. It was written to meet the day-to-day needs of electronics technicians. This handbook covers topics in discrete circuits and analog and digital ICs from a practical applications point-of-view. Each topic is illustrated with practical, numerical worked-out examples that can be applied to the reader's own particular problems.

Twenty-four in-depth sections are arranged in the same format, breaking down each topic as follows: definition of terms and parameters; types and characteristics of components; analysis of the basic and special functions; detailed practical problems and clearly worked out solutions; clarifying charts tables, nomographs and illustrations.

Seven new chapters, each written by a recognized authority in the field, were added to update the readers with state-of-the-art theoretical and practical applications.

Published by McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

The CET Study Guide, by Sam Wilson; Tab Books, Inc. $11.95 paperback.

For those of you interested in or planning to take the CET exam, this book will be a great help in your preparation. It reviews the information you will need to know for the exam – theory and practical workbench techniques dealing with TV, radio, VCR, stereo, microcomputer and other electronics equipment.

Arranged in sections, the study guide provides the latest technology on antennas and transmission lines, digital circuits, linear circuits, test equipment and troubleshooting. There is a 75-question practice exam, with questions similar to those asked on the actual CET exam. Answers to every question in this book are also provided. Plus, the author gives tips on how to avoid careless mistakes while taking the CET exam.

As an **ES&T** reader, you are probably familiar with the monthly quizes Sam Wilson writes for the magazine. The questions in his study guide are similar to the ones he asked on his quizzes, but the book is a much more comprehensive study guide. Wilson is an expert in his field, and possesses 20 years of experience as an electronics teacher and 15 years experience as a technician and engineer. Currently, Wilson is the director of the International Society of Certified Electronic Technicians.

Published by Tab Books, Blue Ridge Summit, PA 17214.

Readers' Exchange

For Sale: Sams Photofact folders 1-1000 with file cabinets. Make offer. *David McKnight, Butternut Lane, Norwalk, CT 06851; 203-847-9254.*

For Sale: Leader LBO-508A dual trace oscilloscope, $500. Sylvania CK 3000 jig with 38 adapters, $350. B&K 470 picture tube tester with adapters, $200. Sencore TF 40 transistor FET tester, $50. *Henry Price, 640 Cambrain Court, Sacramento, CA 95825; 916-481-2418.*

For Sale: ETA 3400 Heathkit microprocessor trainer accessory with optional 3k memory chips, assembled with manual, $125. *Calvin S. Logue Jr., 17 J Washington Lane, Westminster, MD 21157.*

For Sale: Sams Photofact folders 299 to 2066 with or without six steel filing cabinets. Test equipment, tubes, parts, send s.a.s.e. for price lists. *Mack Kunzman, Jamke TV-Radio, 1051 Bale Lane, Calistoga, CA 94515.*

Wanted: RCA Industrial vacuum tube manual. *John Vartanian, 2019 Jackson St., Hopewell, VA 23860.*

For Sale: Simpson model 463 DMM with carrying case, in mint condition. $125 or best offer or trade. *Stanley Todorow, G3398 S. Grand Tranverse, Burton, MI 48529.*

Needed: High-voltage trippler for TV NTC 1300, model No. 1300 CL, type No. ECX-B0085C, manufacturer part No. 2459-002-010, Sams 1777, item No. D509. *Ed's TV, 30 Longmeadow Road, Chelmsford, MA 01824; 617-256-3878.*

Wanted to buy: How to understand and use your Heathkit oscilloscope, model EF-2 for using 5-inch Heathkit laboratory oscilloscope model 10-18. Will pay $25 for complete kit. *Philip Butler, Box 581, West Brookfield, MA 01585.*

For Sale: 27 Sams Photofact folders, from 804-1644, $65 or best offer on all or part. Send s.a.s.e. for complete list. *Ray Brumbaugh, 118 Kaywood Drive, Statesville, NC 28677; 704-872-5742.*

For Sale: B&K 1076 TV analyst, $85. B&K CRT rejuvenator tester, model 440, $40. All include manual, shipping costs extra. *Spencer Cromwell, 33815 133rd Ave. SE. Auburn, WA, 98002; 206-833-7298.*

For Sale: Used Sencore Super Mack, good condition, $400. Leader dual trace scope, new, $1450. Excellent GND, $600. *Dwayne Burge, Electrical Services, 1112 Main, Sturgis, SD 57785; 605-347-4243.*

For Sale: MTI 2-way radio course, complete, $175. *A. Hawker, 372 Circuit Drive, Roseville, CA 95678.*

Needed: Schematic for a Standel amplifier, model 83115V, will copy and return or will pay. *T.F. Gratkowski, 5 Gross Lane, Easthampton, MA 01027.*

For Sale: B&K 1077B TV analyst, $285. Leader LV77 multimeter, $60. Leader RF generator, $85. All excellent condition. *Scott Tanenbaum, 4 Jarvis Court, Erial, NJ 08081; 609-627-3606.*

For Sale: War surplus aircraft amplifiers, converters, relays and tubes. Send s.a.s.e. *Page Bledsoe, Route 11, Hill Road, Knoxville, TN 37938.*

For Sale: Sams Photofact folders 1-2100, with three filing cabinets. *Calvin Boddie, 660 E. Yucca Street, Oxnard, CA 93030; 805-487-3170.*

For Sale: RCA transistors Vdc power supply, type WP-704B, $2500. Simpson model 311 VTVM (22 MΩ imped.) with HV and RF probes, $35. Two EIMAC transmitting tubes, type 8875.50.00 $100 each. *W.D. Shevtchuk, 1 Lois Ave., Clifton, NJ 07014; 201-471-3798.*

Needed: Tuner mounting bracket, complete, including VHF and UHF tuners, control switch, knobs and all cables, for a Silvertone color television, model 528.43513303. *Steve's Radio Service, P.O. Box 168, Wickes, AR 71973.*

Needed: Schematic for VM 20241/1497-1, need dial cord information. Also need motor for a Keystone projector K109. *Robert De Haan, Osceola Electronics, 226 S. M66 Highway, Marion, MI 49665.*

Needed: Schematics and technical information for Bally/Astrocade Company's Arcade home video game and computer. *R. Van Den Bussche, Vandy's Electronic Sales and Service, 5306 N. Magnet Ave., Chicago, IL 60630.*

For Sale: B&K model 177 vacuum tube voltmeter, $85. Sencore model SS-137 sweep circuit analyzer, model TE-46, $75. Lafayette capacitance resistance analyzer, $35. *Angelo Alessi, 29 Cross St., New Windsor, NY 12550; 914-562-9152.*

Needed: Good working 16 VBMP22 picture tube, could be used part. *John Pekar, 24 Flax Road, Fairfield, CT 06430; 203-259-9730.*

For Sale: Sencore picture tube checker, model CR143, $50. Sams Photofact folders TSM, AR, buy one or all, make offer. Assortment of old receiving tubes, make offer. For complete list send s.a.s.e. to *Bill Curry, 422 N. 5th, Marshall, MN 56258.*

For Sale: Sams Photofacts, miscellaneous numbers from 2067 and down, any quantity. Digital capacitance module, operates with any DMM to measure capacitance, $25. *M.B. Danish, P.O. Box 217, Aberdeen Proving Ground, MD 21005; 301-272-4984.*

Needed: Vertical output transformer for Philco-Ford color chassis 3CR40, 3CR41, part No. 32-10167-1. Reference Photofact 1366-1, page 20, T3. *Jeffery Blackmon, J-Tronic Electronics, 2107 Turnbull Road, Beavercreek, OH 45431; 513-426-0232 (after 5 p.m. EST).*

Needed: CRT for a Tektronics type 422 scope or a type 422 scope for parts or a good, used type 422 scope. Call or write: *Wyatt TV Shop, Route 5, Box 107, Searcy, AR 72143; 501-268-1909.*

For Sale: More than 10,000 wire jumpers, plug jumpers and connectors for IBM computer boards. Best offer. Send large s.a.s.e. for samples. *Mitchell Electronics, 4 Golf Ave., Maywood, NJ 07607.*

Wanted: UHF/VHF TV field strength meter. Excess audio or test equipment service manuals. *J. Allen Call, 1876 E. 2990 S., Salt Lake City, UT 84106.*

For Sale or Swap: Winegard amp DA-825B, DA-2150. Will sell or swap: DA-830 VHF/UHF amp, DA-405 UHF amp, three TC-48 UHF tilt and two CS-775 separators. *Elsea TV and Appliances, 117 S. Main, Fostoria, OH 44830; 419-435-5505.*

Needed: Sams Book, *Industrial Process Control Systems* by Patrick and Fardo, No. 21625. Also recently used Heathkit electronic courses and back issues of ES&T, 1980-82. *Fred Washington, 4004 Prospect, Kansas City, MO 64130.*

For Sale: Complete TV service shop, more than $4000 worth of equipment, literature and parts, including 400 Sams, Zenith, and TV service manuals, scope, CRT rejuvenator, 200 new tubes, tube checker, new and used modules, plus much more. Best offer over $2000. *Ezra Hodgson, Ezra's Electronic Service, Route 5, Box 148D, Berryville, AR 72616; 501-423-2642.*

Needed: Schematic and instruction manual for Century in-circuit capacitor checker, model CT-1. **For Sale:** B&K CRT testers and rejuvenator, model 400 and 440, both for $75 plus shipping. Supreme oscilloscope, model 546, $35 plus shipping, no manual. *John Brouzakis, Route 3, Box 602B, Charleroi, PA 15022; 412-483-3072.*

For Sale: Leader LBO-515 oscilloscope, $750. Bell and Howell ABR-917 microfiche reader, $195. Sencore DVM 32 digital meter, $100. All items like new. *Glen H. Bryant, 211 N. Maple, Hoisington, KS 67544.*

Needed: Channel selector switch for a Pearce Simpson Lynx 23 or Super Lynx 23 CB transceiver. P/N: SR-046 and SR-005. *Thomas Norton, 10201 S. Cedar Lake Road #109, Minnetonka, MN 55343; 612-941-6860 (work).*

Needed: New or good used b&w picture tubes No. 16BP4, 17BP4, 10BP4, 12UP4. Also looking for Zenith 11-inch porthole table model (sold under the name Mayflower). *Michael Warshaw, c/o Eaton Financial Corporation, P.O. Box 71, South Station, Framingham, MA 01701; 617-620-0099.*

Wanted: Complete remote control kit for Heath TV model GRD-900. *G.W. Davenport, Box 204, Trenton, NC 28585; 919-448-4561.*

For Sale: Sencore TF 17 transistor FET tester, as new, $40. *T.W. Benson, 204 Riverside Ave., Tallassee, AL 36078; 205-283-4266.*

For Sale: B&K model 970 transistor equipment analyst, P/S signal generator transistor tester VOM, $100. RCA WR99A marker generator, $40. Conar #280 signal generator, $40. Conar #230 signal tracer, $20. *Charles TV, Route 210 and Poplar Lane, Indian Head, MD 20640; 301-743-7777.*

Wanted: S-meter for a Hallicrafter, model SX-28 in good condition. *Paul Capito, 637 W. 21st. St., Erie, PA 16502.*

Coming in...

FEBRUARY

Are you ready for surface-mounted components? — One of the many rapid developments in circuit construction is surface mounting, which places interconnections between components on a PC board on the same side that the components are mounted. It probably won't be long before consumer electronics products manufacturers will adopt this technology on a large scale, meaning servicers will need to know how to effectively remove and replace surface-mounted components when they fail. Next month's cover story will describe surface mounting technology from the manufacturers point of view: why and how it is being done.

Don't let power line disturbances damage your electronics equipment — Power line disturbances can cause a great amount of damage to your electronic equipment unless you have prepared and protected your equipment. This article describes typical power line disturbances and gives tips for protecting your equipment against them.

What do you know about components? More about resistors and diodes — Continuing his examination of components, Sam Wilson takes another look at resistors and diodes, offering information which was not included in his first discussion of these components.

Understanding the compact audio disc player — The increasingly popular compact audio disc players are being used by more and more consumers today. While they may be the preferred audio instrument among consumers, servicers of CD players will find they are complex, sophisticated digital instruments. To learn about the circuitry involved in CD players, watch for next month's article.

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HELP WANTED

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WANTED: To buy well established TV-video repair shop in Brooklyn or Manhattan Boroughs of New York City. For offer please call: 336-9573. 1-85-1t

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The Sencore VA48 TV Analyzer, introduced in 1976, quickly became the industry standard for video service. It is now used by more than 22,000 technicians nationwide who have averaged an overall 54% reduction in service time, according to a recent survey of VA48 owners.

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