THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

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Servicing & Technology

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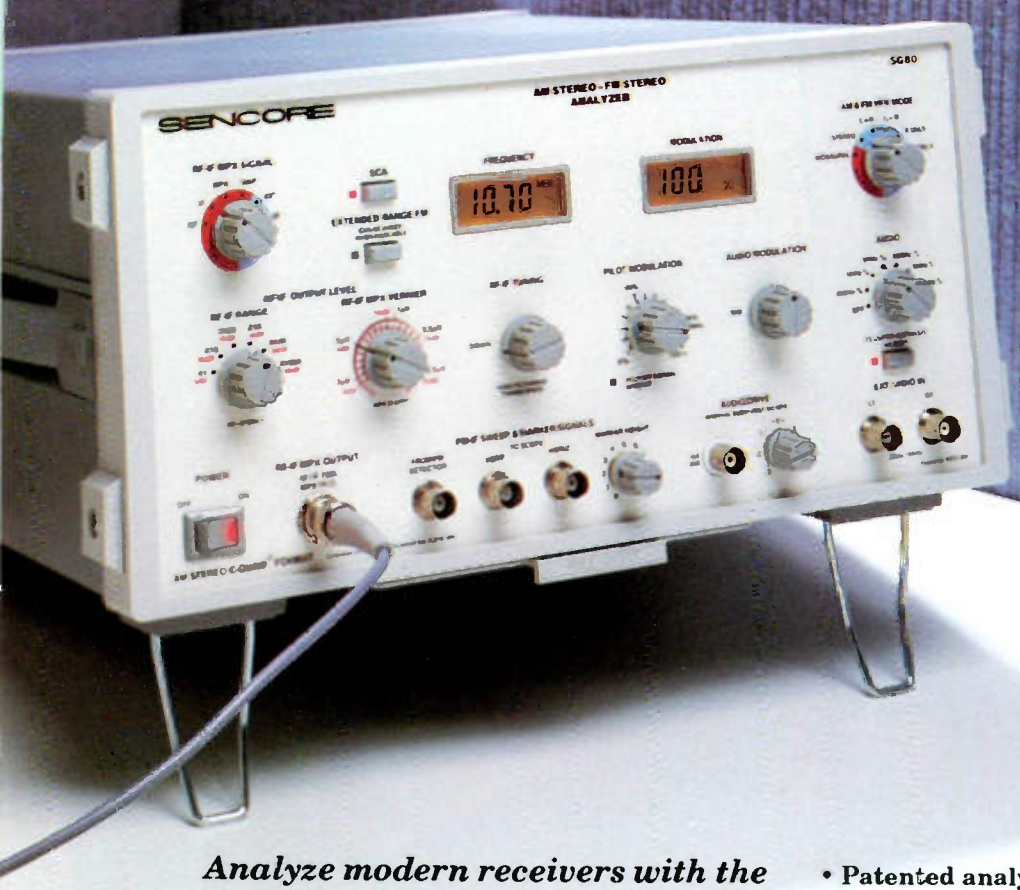

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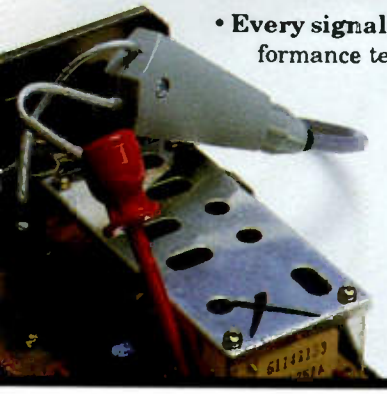

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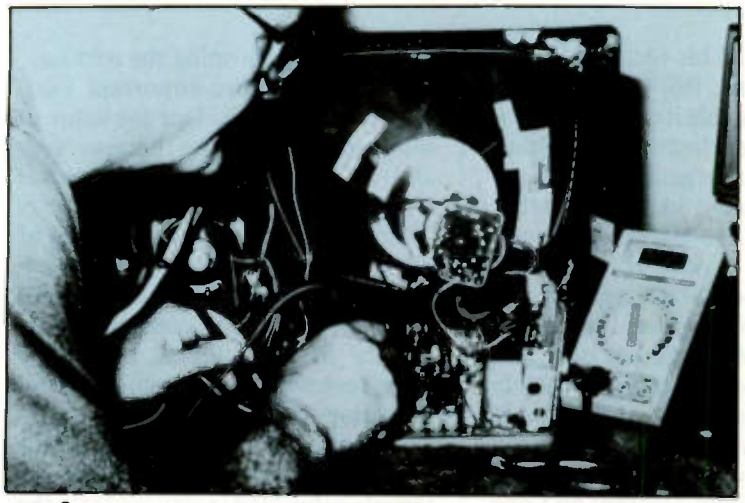

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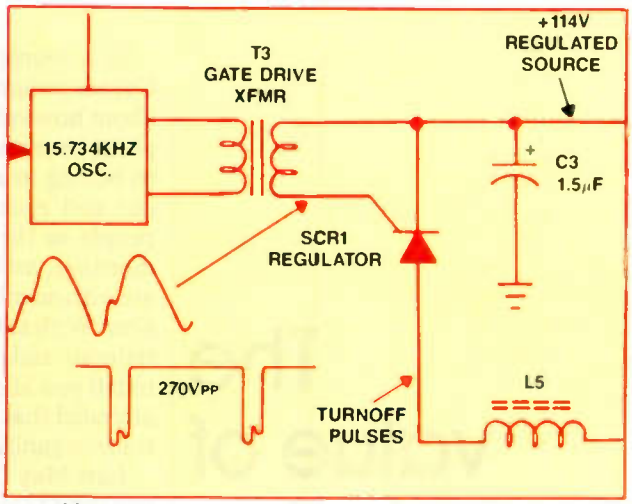

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DEPARTMENTS

ON THE COVER

Static electricity is an accumulation of electric charge. Electrostatic discharge occurs whenever a static electric build-up finds a convenient discharge path. In a thunderstorm this discharge happens in a big way; in the service facility it happens in a small way, but if ESD-sensitive components happen to be in the discharge path, the result may be a destroyed component. Simple precautions during servicing will eliminate ESD problems. *(Photo courtesy HMC, Canton MA).*

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ELECTRONIC
Servicing & Technology

The value of association

In a couple of his recent Business Corner columns, Bill Lynott talked about how valuable it can be for people in consumer electronics servicing to belong to an organization, to get out and exchange ideas with other people in the profession, to attend meetings, and in general just associate with members of the same profession. With this editorial, I wanted to reiterate and reinforce that view, and to tell you about a meeting I recently attended that made clear the value of trade organizations.

Last May I was visiting headquarters of CQ Communications on Long Island, and so it was convenient for me to attend the second annual Greater New York Regional Manufacturers and Service Dealers Conference. The conference was sponsored by the Television and Electronic Servicers Association (TESA) of Long Island, METSDA (metropolitan Service Dealers Association) and the NESDA chapter of New York State. The primary purpose of the conference is to keep the lines of communication between service centers, parts distributors and manufacturers of consumer electronics open.

The first conference in 1989 proved to everyone that by openly discussing mutual problems this can be accomplished. Since that time, according to the people who planned and coordinated that first conference, many improvements have been made.

Present at this year's conference were national and regional representatives from parts distributors, representatives of New York City and Nassau and Suffolk County Departments of consumer affairs and representatives from service centers throughout New York State. I had hoped that the meeting would be worthwhile attending. It was more successful and valuable than I could have imagined. For starters, the night before the meeting, the groups held a hospitality suite in the hotel, where members got together to relax and chat. In the space of a few hours I met a dozen competent, intelligent, gracious electronic servicing people. Besides just enjoying their company, I was able to ask them about their businesses, and learned a great deal that would be valuable to any servicing organization.

It was at the meeting the next day, though, where the important business was transacted that the value of meetings such as this became very clear. The president of NESDA made a trip across the country to be there. There were officers and members of all of the sponsoring groups in attendance. There were representatives of most of the major consumer electronics manufacturers, and there were representatives from the local regulatory agencies.

A major part of the agenda consisted of questions that had been previously submitted in writing from the memberships. Most of the questions were aimed at the service representatives of the manufacturers.

It was obvious that many of the problems that were mentioned by both the service centers and the manufacturers were caused in part by miscommunication and misunderstanding—a normal course of events in any business. This forum allowed many of these misunderstandings to be discussed from both sides, and a mutually agreeable resolution was settled on.

Another important part of the proceedings was an exchange of ideas between the groups and the local government regulatory agencies. The servicing organizations not only made it clear that they agree that regulation is needed, they even suggested areas where regulation of the consumer electronics servicing profession would be valuable to the community and offered their technical expertise to the regulators.

As important as every other aspect of the meeting was the professional manner in which it was conducted. Every key servicecenter representative on the stage made it clear by the way they conducted themselves that they consider themselves members of a profession that they're proud of, and expect to be treated as professionals. And every business owner and technician in attendance projected a professional attitude.

If you're not a member of an organization such as this, you should be.

Nils Conrad Persson

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For Demonstration Circle (16) on Reply Card

Consensus being developed as a base for ANSI

The proposed standard is a revised version of ANSI/UL 923-1981, which is presently recognized as an American National Standard. UL is seeking review and comment from interested individuals and organizations to help develop a consensus upon which continued recognition of UL 923 by the American National Standards Institute (ANSI) can be based. ANSI is a clearinghouse for information on standards and coordinates development of national consensus standards through voluntary action.

Anyone interested should contact Joe Freeman at UL, 333 Pfingsten Road, Northbrook, Illinois 60062 and request a free copy of UL 923-NR. Those interested should request their copy now so that all comments can be considered in time to meet the ANSI deadline for this standard.

Underwriters laboratories proposing safety for microwave cooking appliances

Underwriters Laboratories Inc. is proposing the updated standard for safety for microwave cooking appliances, for recognition as an American National Standard.

UL 923 covers household and commercial appliances operated in the Industrial, Scientific and Medical (ISM) bands of 915 ± 25 and 2450 ± 50 MHz, for use in ordinary locations in accordance with the National Electrical Code, ASI/NFPA 70, and rated not more than 600V. In addition to appliances for counter-top use, the standard also covers those intended for built-in installation, side-by-side mounting, stacking, wall mounting and installation over ranges. The microwave cooking portion of a household electric range is covered as well.

Electronic and computer parts catalog

A new catalog of electronic, electro-mechanical, and computer-related parts and components at below factory-outlet prices is available from *American Design Components.*

Geared to meet the needs of hobbyists, computer buffs, small manufacturers, large OEMs, universities, and R&D facilities, this 40-page, fully-illustrated catalog is chock full of components and peripherals such as integrated circuits, switches and connectors, power supplies, rechargeable batteries, fans, blowers, and more. It also features a large assortment of computer products such as monitors, disk drives, add-on boards, mice, modems and complete computer systems. All material is available for "off-the-shelf" delivery.

HRRC calls DAT suit short-sighted confident consumer interest will triumph

The Home Recording Rights Coalition today called the copyright suit filed against Sony Corporation short-sighted and without merit, and expressed confidence that the right to sell digital audio tapes (DAT) recorders to American consumers will be left unchanged. The suit, supported by the National Publishers Association (NMPA), was filed in Federal Court in New York.

Gary Shapiro, HRRC Chairman and Group vice president of the Electronics Industries Association's Consumer Electronics Group said that it is ironic for this suit to be filed so soon after a long-awaited study by Congress's office of Technology Assessment found there to be no evidence to confirm that home audio taping hurts record sales. Rather, the OTA found that most consumers tape from albums they already own. The reason given most often was portability—making tapes for car tape players, personal stereos, "boom boxes" etc. The OTA also found that most instances of home taping do not even involve recorded music.

Shapiro said that the DAT is the latest in a line of consumer electronics innovations , such as the VCR, that have created opportunities for the entertainment industry as well. "Rather than hurt the music business the tape recorder has opened up vast new markets for everyone involved in music," said Shapiro.

Digital audio tape recorders have been available in the United States since 1987, through importers independent of the recorder manufacturers. In June, Sony became the first manufacturer to offer consumer model DATs for retail sale. These models contain the "Serial Copy Management System,"or SCMS, a new international standard that addresses recording industry concerns over making digital copies of prerecorded material.

The HRRC has defended the right of consumers to purchase and use audio and video recording products since October of 1981. Most recently, HRRC has joined with the Recording Industry Association of America to endorse legislation (S. 2358/H.R. 4096) to mandate the SCMS standard in all consumer DATs.

HRRC continues to oppose as unfair and unwarranted any and all proposals for legislated royalty taxes on home audio and video recorders and blank tapes. HRRC has emphasized that noncommercial home taping for private purposes embraces basic rights of American consumers. HRRC has helped defeat, in the Congress, repeated attempts to enact royalty taxes that would infringe on such rights. Today, Shapiro pointed out that obtaining such royalty tax legislation appears to be the real goal of the anti-DAT suit. ■

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Literature

New application note

BMI's new application note #216 explains power monitoring for field service engineers and managers. The 5-page application note answers common questions about power quality, describes power disturbances, that disrupt personal computers and other electronic devices, and reveals what causes these disturbances. Two case studies illustrate how power disturbances can be tracked down and solved.

Circle (80) on Reply Card

Color Test Equipment catalog

New from *Leader Instruments Corp.*, is their full line catalog which contains 96 pages and more than 200 full color photographs of their expanded line of test equipment. The catalog contains "A Guide to Basic Needs,"which describes the different stages of electronic testing and the instruments that are used. In addition, applications for various instruments, including digital and analog oscilloscopes, audio and video products, signal generators, frequency counters, and power supplies are found throughout the catalog.

Two new products featured in this catalog are the Model 2100R, 100 MHz CRT Readout Oscilloscope and the Model 408, NTSC Video Sync/ Test Generator.

Circle (81) on Reply Card

Identification product bulletin

A special bulletin, featuring a complete line of labeling, identification and bar code products, is currently available from *Tyton Corporation*. The 19 page bulletin provides detailed descriptions of Tyton's three labeling and bar coding software programs-Tagprint, Tagprint Plus and Tagprint Plus Graphics, as well as their accompanying labels and accessories.

In addition, the bulletin offers information on Tyton's complete line of wire and cable identification and marking products, including Shrink-Tag, Flex-Tag Markers and Tag-Mate.

Circle (82) on Reply Card

Updated brochure outlines new ESD, EFT and surge tests

Keytek Instrument Corp. announces the availability of a new, 16-page brochure outlining the requirements for Pulsed EMI testing to various standards, with emphasis on both ANSI/IEEE Standards and their international counterparts, the IEC 801 series of tests that will be mandatory starting in 1992. Also included are descriptions of the company's latest, relevant Pulsed EMI test equipment, including simulators for ESD (electrostatic discharge), EFT (electrical fast transient) and SURGE (on both power and I/O lines).

The new brochure includes extensive tables comparing U.S. standards for ESD, EFT and SURGE with their forthcoming mandatory IEC counterparts. Organizations in addition to the IEEE, ANSI and the IEC whose key Pulsed EMI standards are included are UL, FCC, CCITT and Bellcore.

Circle (83) on Reply Card

New PERX 1990 catalog

PERX has released their 1990 catalog of popular software and hardware for engineers and scientists. The 1990 edition offers a wide selection of products from industry leaders in data acquisition and control, test and measurement instrumentation and design automation, (CAE/CAD).

The data acquisition section of PERX's catalog offers one of the broadest selection of PC plug-in boards that can be found from any one source. By offering the products from several companies such as Data Translation, Metrabyte, Analog Devices, Strawberry Tree, National Instruments and many others, PERX feels it can provide an unbiased recommendation as to which product is best suited for most applications. Coupled together with data acquisition software such as Labtech Notebook, Asyst, Global Lab and Codas, an engineer can satisfy most of his acquisition needs with one call.

Perx's product offering is rounded out with other popular engineering products such as graphics and data analysis software, signal analysis and processing software, image and voice digitized boards and PC enhancement products such as AT expansion chassis that take 8- and 16- bit cards.

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THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC Servicing & Technology

Electronic Servicing & Technology is edited for servicing professionals who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts who repair and maintain audio, video, computer and other consumer electronics equipment.

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Servicing Samsung high-low TV circuits

By Homer Davidson

Most portable TV problems can be traced to the low voltage power supply and horizontal output circuits. In many early TV chassis, low voltage regulation was accomplished with a fixed regulator. Often, replacements for ac voltage regulators were available only from the manufacturer (Figure 1.) Today, replacements for these same regulators can in many cases be obtained as universal replacements from RCA and Sylvania.

Sometimes locating the integrated circuit low voltage regulator in a modern TV is something of a challenge because it may resemble other components. For example, the 125V regulator found in the portable Samsung chassis may look like a horizontal output transistor or IC component. The STR 382 regulator found in the Samsung CT-333KA, CT-3409VE and K20 models, resembles a horizontal output transistor, while the STR 3125, found in Samsung K20 and CT-3409 sets looks like a stereo power output IC component. The STR 382 regulator may be replaced with a universal RCA SK 7646 or SK 7720 regulator (Figure 2.)

Davidson is a TV servicing consultant for **ES&T**.

Low voltage power source

Power to Samsung's CT-33KA model and 20K20 chassis is switched using a manual on/off switch, while the K20 and CT-3409 VE model feature remote control. When one of these remote-control units won't power up, place a clip lead across terminals 82 and 83. This bypasses the remote control circuits, and connects ac voltage directly to the low voltage rectifier (D802). Always plug the ac chassis into an isolation transformer when making tests.

D802 is a half-wave silicon diode providing 155Vdc to regulator Q801 through R802, R804, and fuse F802. Take note that there's a 3A fuse (F801) in the ac power circuit in series with a 1.2A fuse (F802) (Figure 3). Suspect a leaky regulator or horizontal output transistor when both fuses are blown.

If you find R802, F802 and R804 all open, suspect a shorted low-voltage regulator (Q801) or lightning damage. After replacing these components, if the regulator voltage remains lower than normal, suspect a defective regulator or overloading on the 125V dc source. Remove one end of R423 (1Ω) or Q404 from the circuit and the regulated voltage should rise above the 125V source.

Most of the low-voltage power supply components may be replaced with universal replacement parts. Very seldom does R808 open. It should be replaced with original component, or a standard 200Ωand 10Ωresistor (each rated at 20W). In other Samsung portable chassis, R808 is a 300Ω10W resistor.

Keeps blowing fuses

In many cases when lightning strikes the TV, D802 and R802, as well as both fuses, must be replaced. Heavy lightning damage may destroy R804, R506, and Q801 in addition to the above components (Figure 4). A leaky voltage regulator may blow both fuses and R804 and R802. If exact replacements aren't available for R802 and R804, they may be replaced with a 2Ω10W resistor without any problems.

When the fuse continues to blow, check not only components within

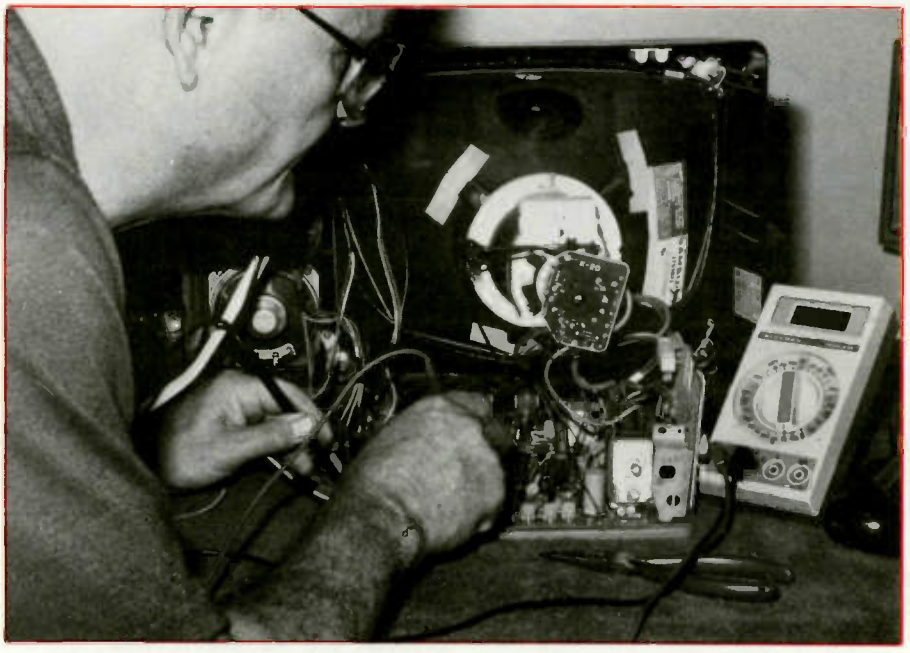

Figure 1. Resistance measurements In the low voltage power supply of a Samung CT-334 KA portable can reveal a considerable amount about the condition of the set.

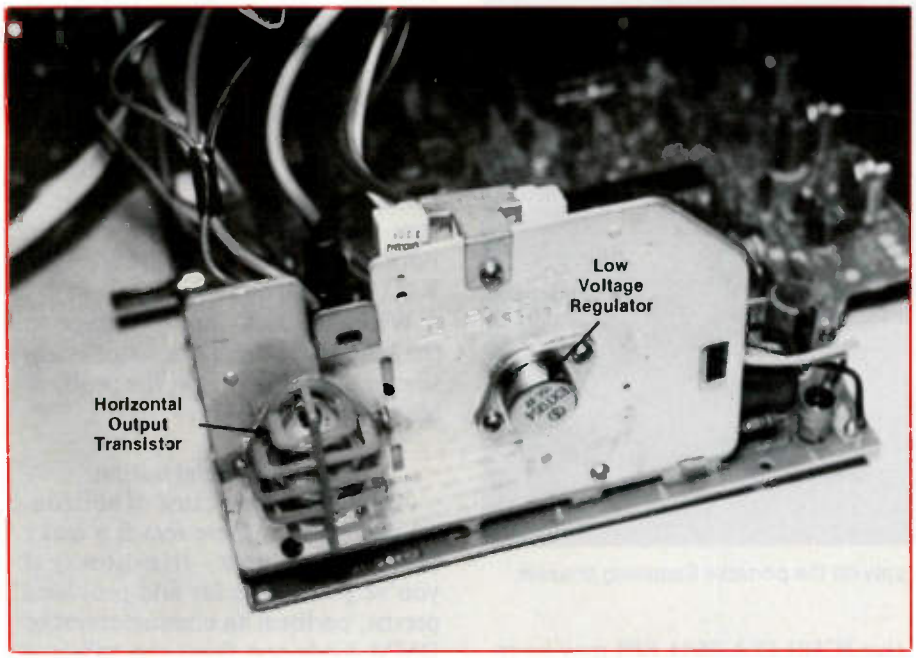

Figure 2. The low voltage regulator IC resembles an ordinary horizontal output transistor (STR 382).

the low-voltage power supply, but the PWB section, on/off switch, R428 (1KΩ), Q403 starter, horizontal output transistor Q404 and IC 501 as well. After replacing damaged parts in the power supply, if the chassis keeps blowing fuses check Q404 and R423. Suspect trouble in the start-up and horizontal circuits when the fuse blows but the positive 125V source is normal at the power supply.

Defective horizontal drive IC

The horizontal circuits must be operating before the scan-derived voltage sources are available to the horizontal oscillator section in IC501. IC501 combines video, chroma, vertical and horizontal deflection circuits in one large IC. It's possible that some of the horizontal circuits may not function even though the horizontal deflection circuits within IC501 are normal. On the other hand, a leaky IC501 may prevent any circuits from operating.

When there is no horizontal deflection, suspect a leaky IC501 or the absence of supply voltage at pin 3 of IC501. The 12V source applied to pin 12 is taken from the 16.5V source through resistor R225 (47Ω).

A 12V external source may be injected at pin 12 with the power cord pulled, to determine if IC501 and horizontal oscillator circuits are operating normally. With the 12V

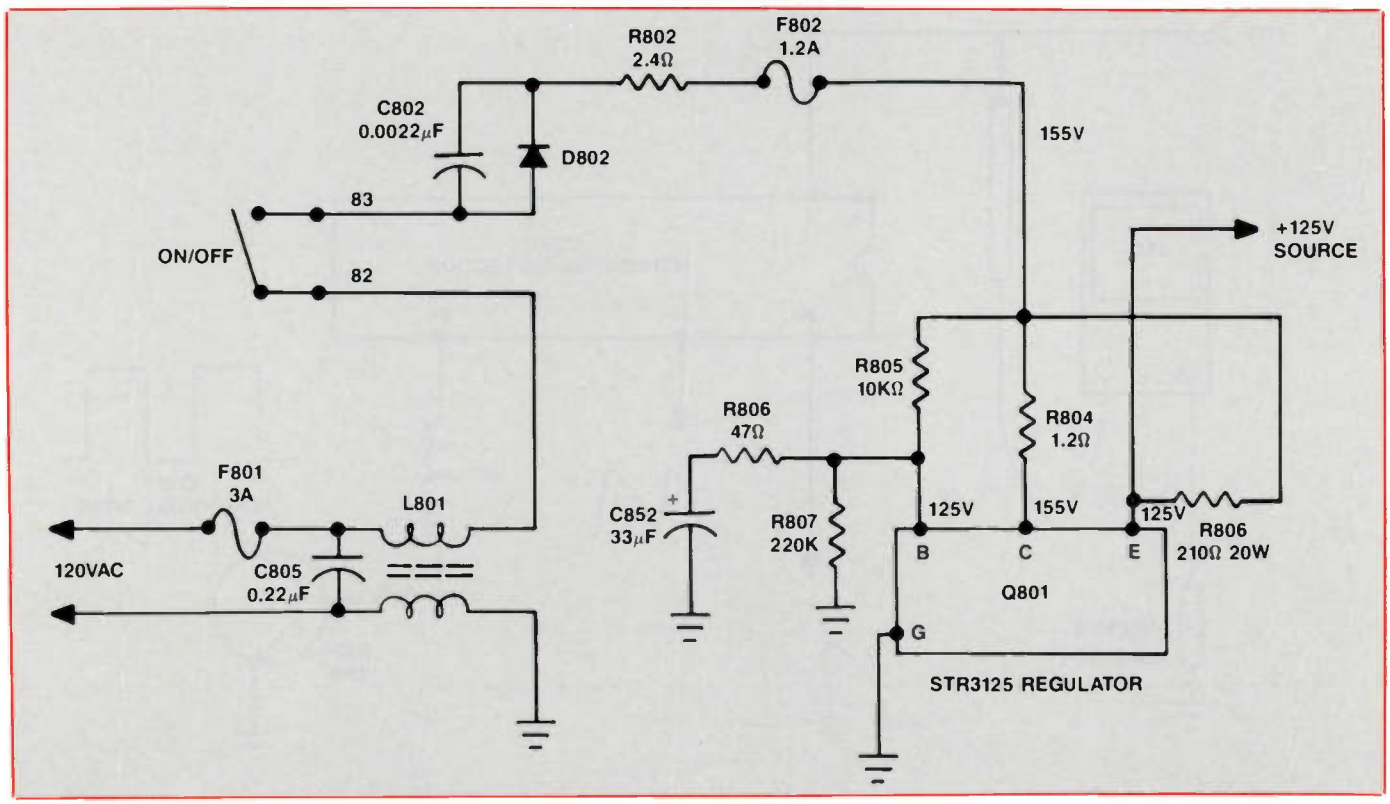

Figure 3. Problems in the low voltage regulated power supply of this defective Samsung 20K10 set may be caused by a number of components within or outside the power supply.

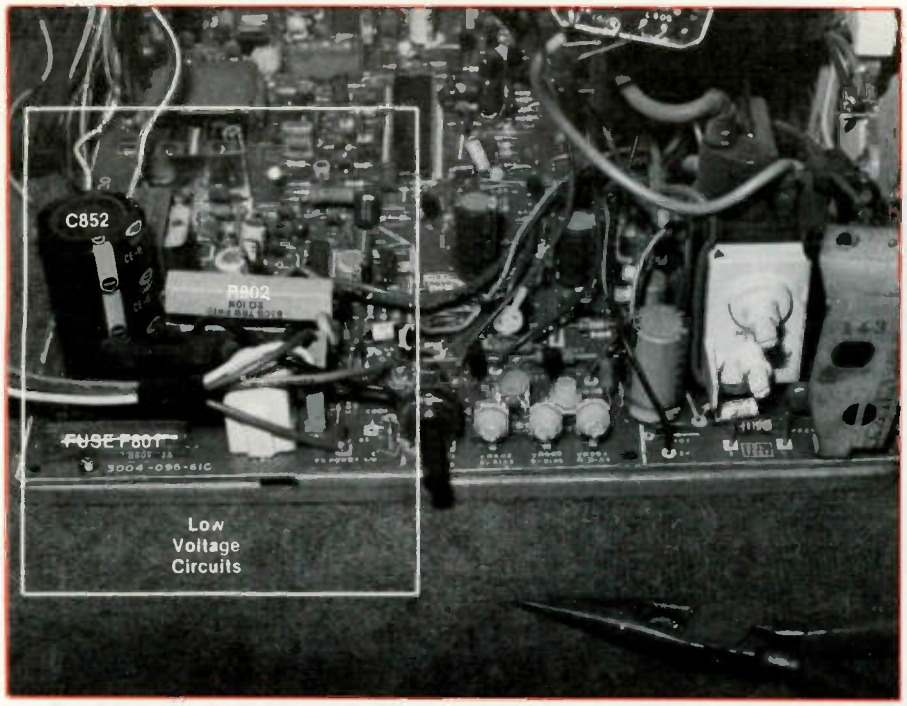

Figure 4. Location of the low voltage power supply on the portable Samsung chassis.

source applied, scope terminals 34 and 36 of IC501 for saw tooth wave forms indicating the horizontal circuits are normal. Scope pin 24 for a horizontal drive waveform applied to the base of driver transistor Q402 (Figure 5). If these signals are absent, IC 501 is defective. The defective IC501 (TA 7644 BP) may be replaced with universal RCA SK 7676 replacement.

Overheated driver

The horizontal drive output voltage is fed to Q402 from pin 24 of IC501. This drive wave form is not present in the event of a defective IC501 or horizontal output circuits. The horizontal driver amplifies the square wave and applies it to T401. The kick start voltage is supplied by Q403 from the 125Vdc source, as shown in Figure 6. Don't be alarmed if the horizontal driver transistor runs warm when the horizontal circuits are not operating. In the event of a defective drive transistor, or insufficient drive voltage, Q402 may run warm. The collector voltage, normally 11.7V, will be lower. Also, R411 may run quite warm.

When the kick supply voltage to the horizontal drive transistor is absent or abnormally low, the problem may be an open R428.

Leaky horizontal output

Another possible cause of horizontal problems in these sets is a leaky horizontal output transistor. If you've gotten this far and problems persist, perform an ohmmeter test or DMM diode test from the collector terminal (metal case) to chassis ground. An extremely low resistance reading indicates a leaky output transistor. The normal DMM diode resistance reading should be from 0.550Ω to 0.695Ω. Take this measurement after you have disconnected the power

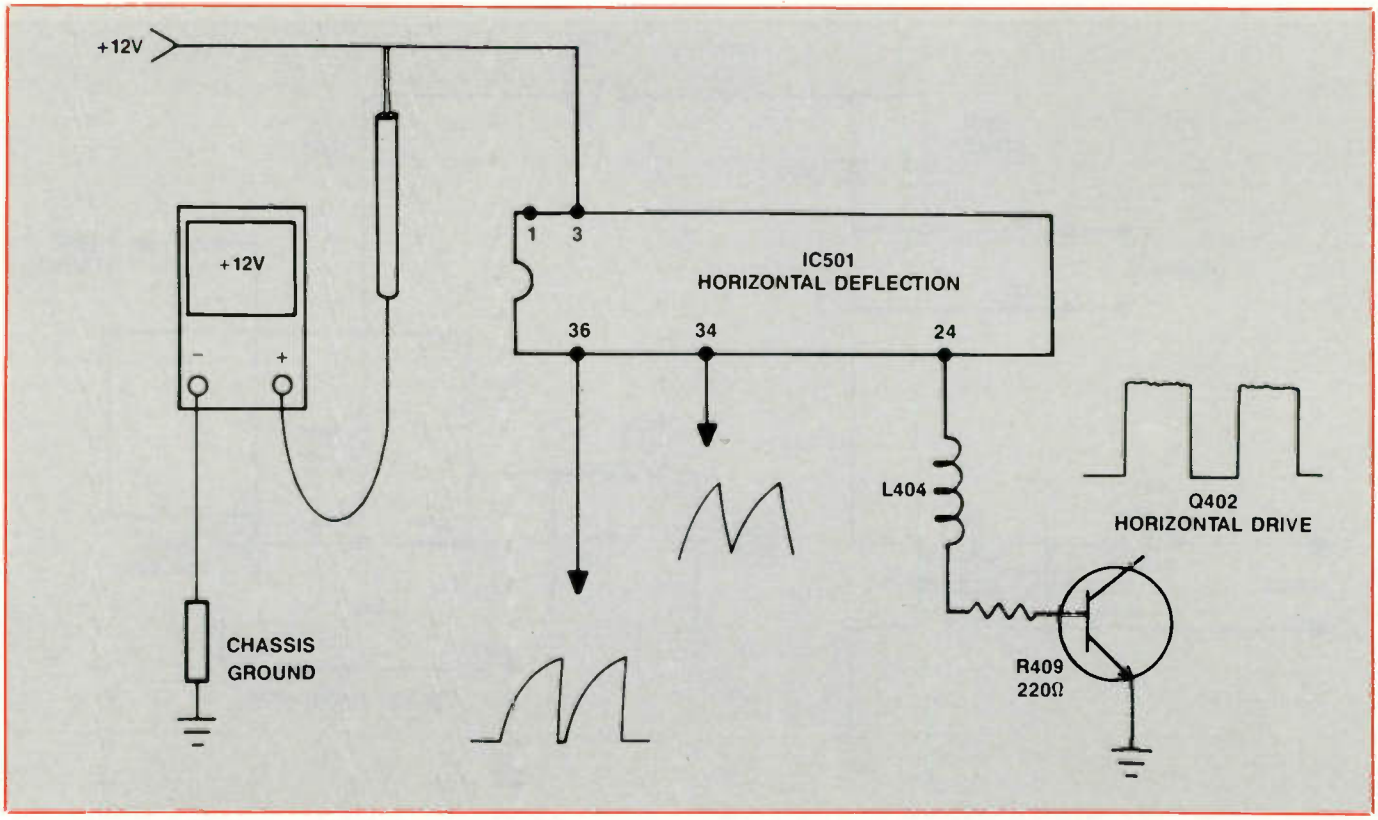

Figure 5. Inject a 12V power source to determine if IC501 horizontal and deflection circuits are operating. Monitor horizontal waveform with scope at pins 34, 36, and 24 of IC501.

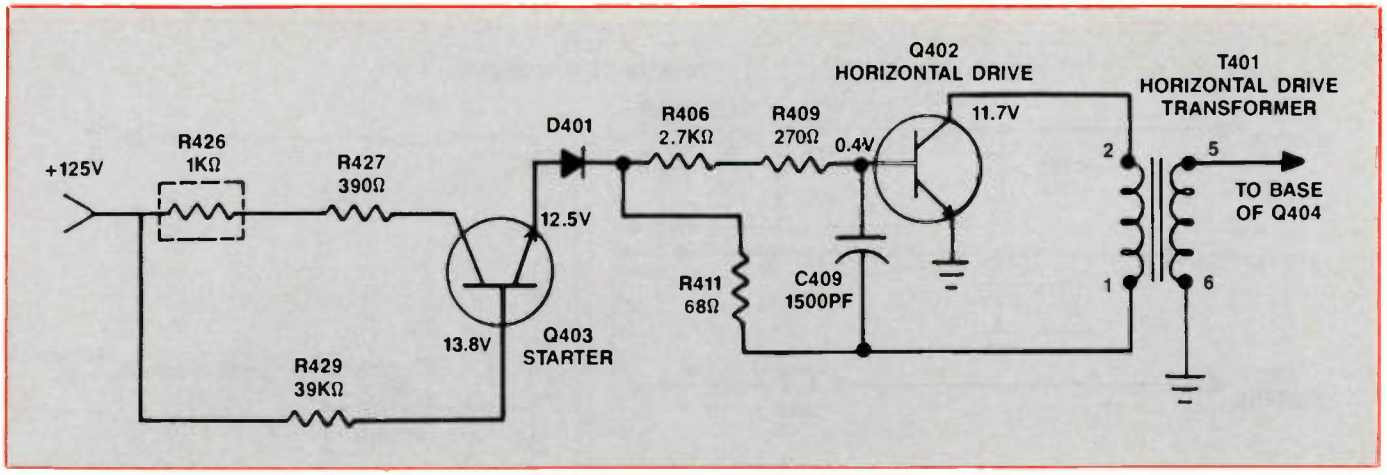

Figure 6. Overheated Q402 may result from leaky transistor or no drive waveform at the base terminal.

cord and discharged the metal base of Q404 to chassis ground.

In these sets, the damper diode is mounted within the case of the horizontal output transistor, rather than externally. It's good practice to always check the location of the damper diode before replacing the horizontal output transistor. If Q404 were replaced with a regular high voltage horizontal output transistor, it would be destroyed. Horizontal output transistor 25D 1398 and 25D 870 may be replaced with an RCA SK 9422 and SK 9119, respectively.

If the horizontal output transistor, Q404, becomes leaky, it may destroy fuse 802 and resistor R423. This fuse may open when the drive voltage at the base of Q404 is incorrect. If the +125V supply source is higher than normal, suspect an open Q404. It is best to disconnect the base terminal of Q404 to make accurate tests, because the secondary winding of T401 and resistor R412 are in parallel with the base terminal. Remove Q404 from the circuit if in doubt.

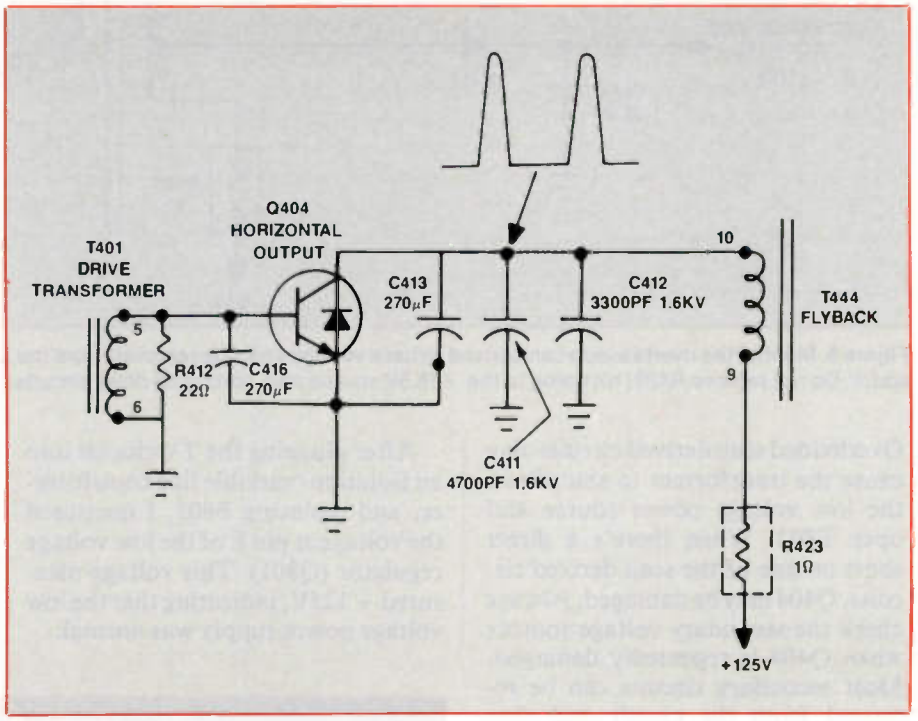

Figure 7. Q404 in the Samsung K20 Chassis has a damper diode inside the transistor from collector to emitter.

Keeps knocking out Q404

Suspect improper drive voltage or a defective flyback when a replacement horizontal output transformer is damaged immediately after replacement. When loud popping and cracking noises occur, followed by shutdown, suspect that C411 or C412 may be open. Before replacing Q404 once again, make certain that the 125V source is present, that horizontal oscillator circuits (IC 501) are operating by injecting external dc and checking the output waveform with a scope, and that the driver circuits are normal.

If all of these procedures check out, connect a variable isolation transformer to the chassis and slowly increase the voltage. Monitor the voltage at the collector of Q404, and monitor the base waveform with the scope. If Q404 starts to become warm at 65Vac, suspect a defective flyback transformer.

Make sure C411 and C412 are normal. Remove the red horizontal yoke lead. If the dc voltage comes up and horizontal waveforms begin to appear, suspect a shorted yoke assembly. Replace the flyback transformer in the case of an overheated output transistor and improper drive voltage.

Flyback scan voltages

There are many different circuits powered by the scan-derived flyback voltages. The +24V source provides vertical output voltage through R420 and D404 (Figure 8). The +16.5V source feeds the tuner, audio IF and amp, IF stages, video, chroma and vertical-horizontal deflection, video amp and bias for color amp circuits through R408 and D408. The color output and CRT circuits are powered via D407 (+120V). The picture tube high voltage, screen and focus voltages are taken from the secondary HV circuits of T444. The heater voltage for the CRT is taken from a separate winding on pins 3 and 6.

When you find that one of the fusible secondary resistors is open or burned, check that circuit for a damaged diode and overloaded circuit.

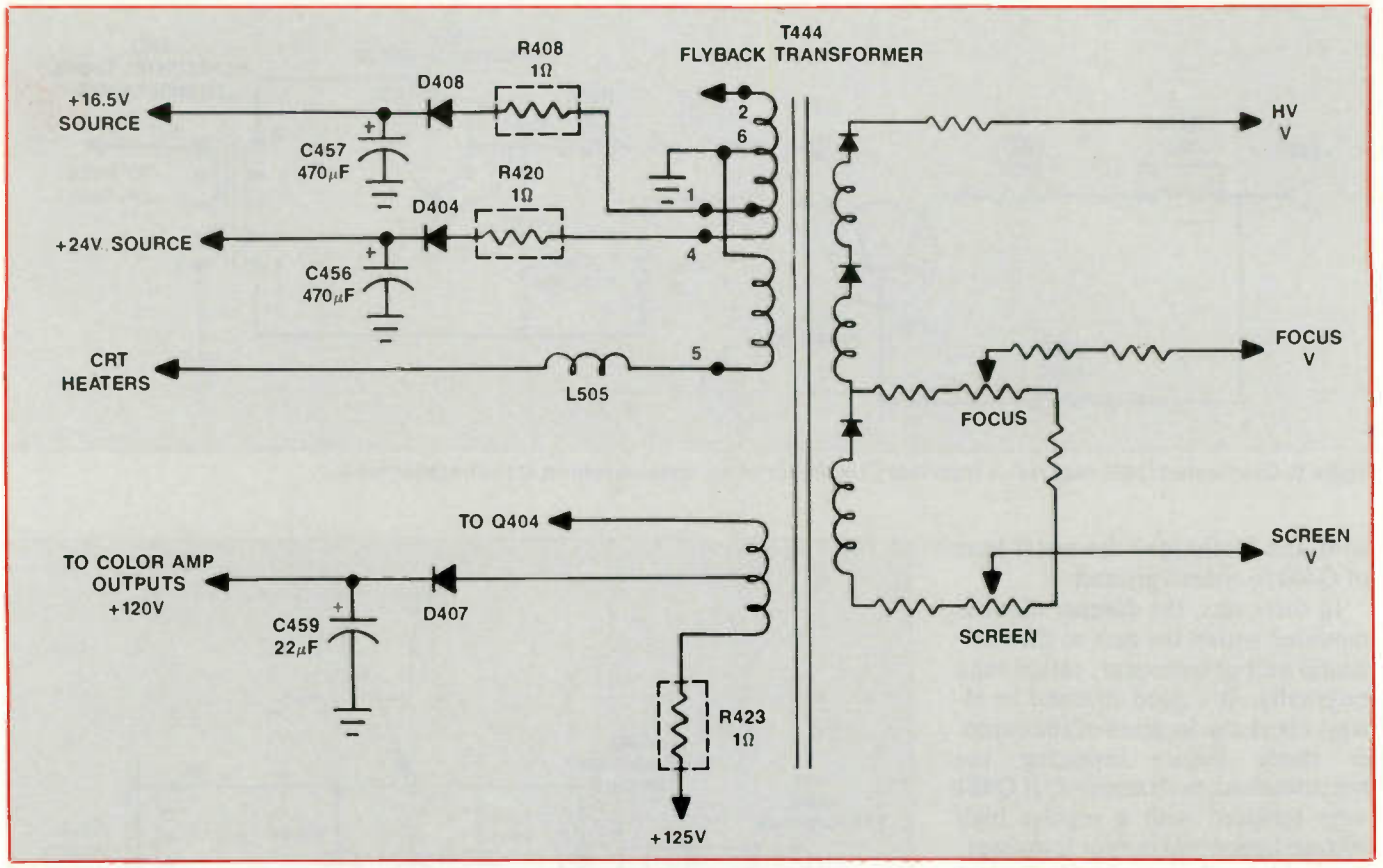

Figure 8. Most of the overloaded scan derived flyback voltages can be removed from the circuit by removing one end of the fusible resistor. Do not remove R420 (1Ω) going to the +16.5V source and horizontal drive circuits.

Overloaded scan derived circuits may cause the transformer to shut down the low voltage power source and open F802. When there's a direct short on one of the scan derived circuits, Q404 may be damaged. Always check the secondary voltage sources when Q404 is repeatedly damaged. Most secondary circuits can be removed from the circuit and thus eliminated from suspicion by removing one end of each fusible resistor except the +16.5V source feeding the deflection circuits.

Dead K20 chassis

The Samsung K20 portable came in with a blown F802 fuse. The replacement fuse opened as soon as the power was turned back on. The remote control had no effect on the dead chassis. Since the +16.6V source powers the remote control and this problem caused that voltage to be absent, I connected a fuse clip across terminals 82 and 83 going to the PWB, bypassing the remote control circuits. A resistance check from the collector (metal) terminal of Q404 to chassis ground appeared normal (Figure 9). One end of R423 (1Ω) was removed, isolating the horizontal and high voltage circuits.

After plugging the TV chassis into an isolation/variable line transformer, and replacing F802, I measured the voltage at pin E of the low voltage regulator (Q801). This voltage measured +125V, indicating that the low voltage power supply was normal.

I pulled the chassis back and checked the resistances of Q403 and Q402. These checked normal in circuit. The readings for Q404 seemed to be normal until it occurred to me that the damper diode was located inside Q404. That being the case, a pro-

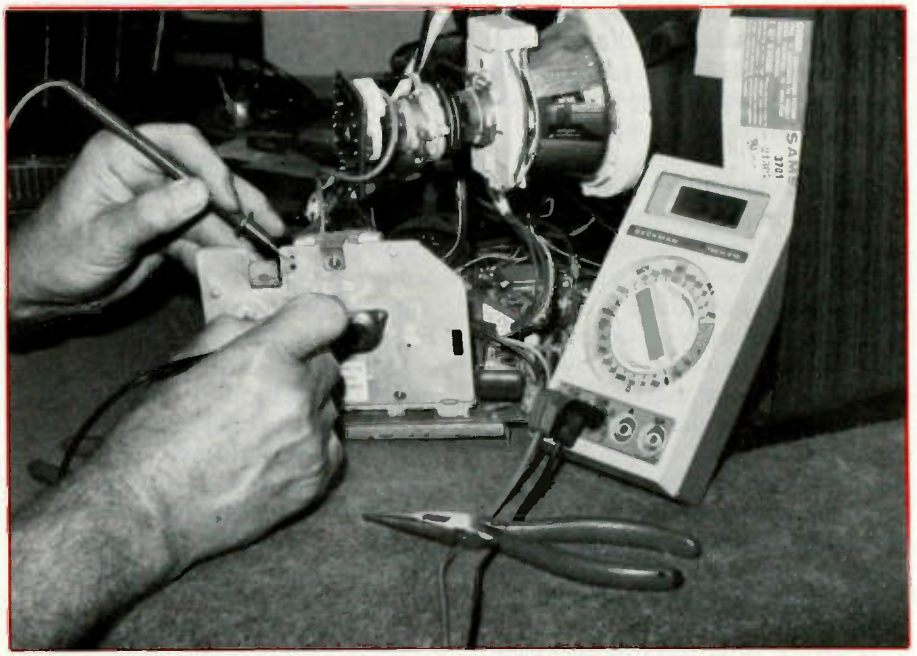

Figure 9. Check from collector (metal) of Q404 to chassis ground for leakage, with the diode test of the DMM.

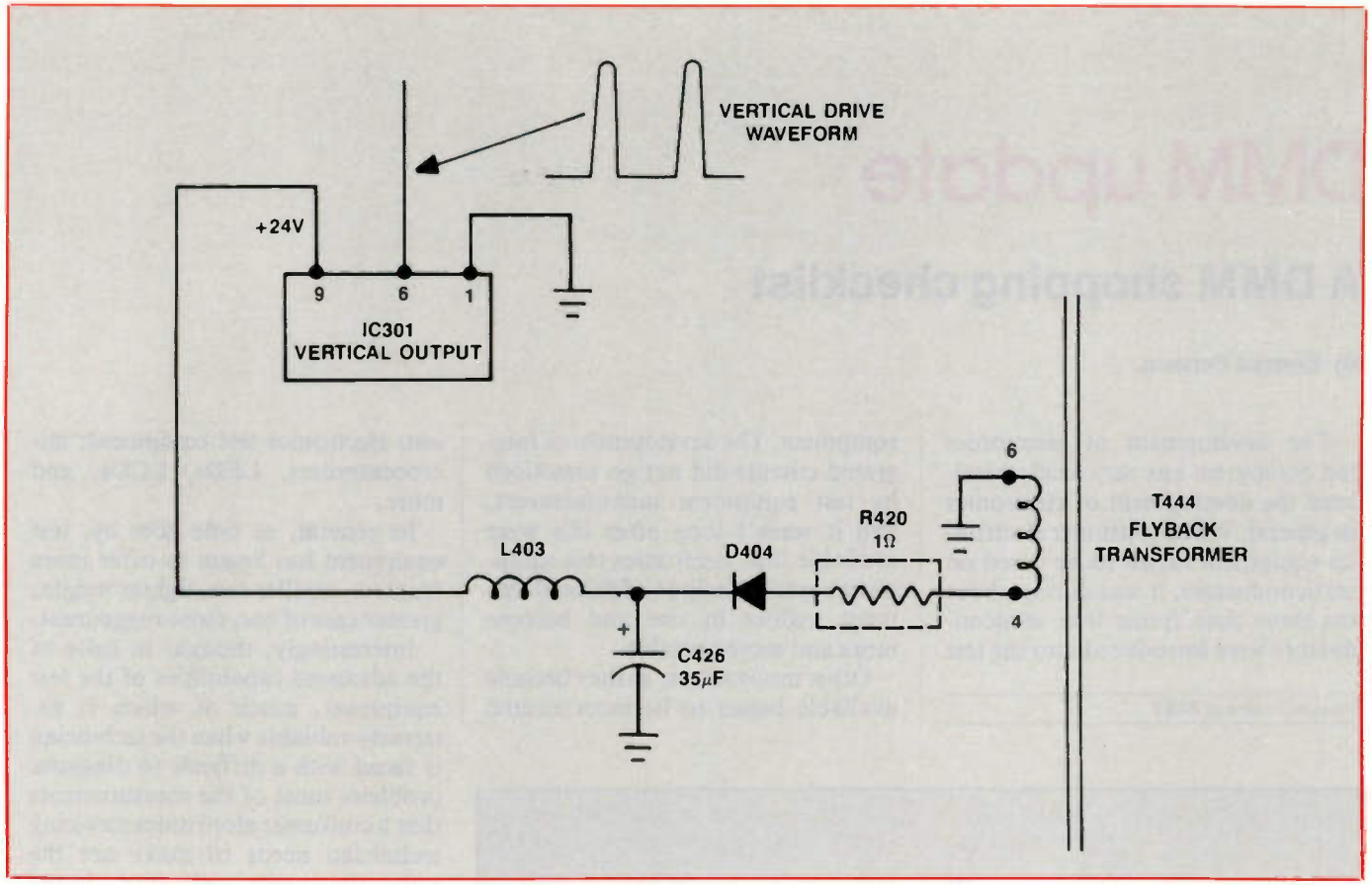

Figure 10. The + 24V scan derived flyback voltage was absent at pin 9 of IC301 as a result of a defective IC301 and open R420.

blem was indicated. Although the base terminal gave a low resistance reading in circuit, it was found to be open when tested out of circuit. No doubt the base junction was internally open. Replacing F802 and Q404 and soldering up resistor terminal R423 solved the dead K20 chassis.

Horizontal white line CT-333KA

In this defective set, an absence of vertical deflection pointed toward vertical trouble. Further checks revealed that the problem was related to the secondary scan voltage. A voltage check on pin 9 of IC301 indicated no voltage (Figure 10). R420 (1Ω) fusible resistor was open, but D404 appeared normal. No doubt, IC301 was leaky and opened R420.

Pin 9 of IC301 was checked for leakage to common ground with a fairly high measurement. Scoping pin 26 of IC501 and pin 6 of IC301 indicated normal vertical drive voltage. All components around IC301 appeared normal. When R420 was replaced, the picture was good for a few seconds, then collapsed to a vertical line.

IC301 had to be defective, but it showed no signs of leakage. Replacing the vertical output IC 301 and R420 solved the horizontal white line. No doubt the drive signal inside IC301 was defective, causing the vertical output circuits to overload to + 24V scan derived voltage source.

Conclusion

Always power the ac chassis through an isolation transformer before connecting test equipment. Isolate the low voltage circuits from the other circuits to determine if power supply or horizontal circuits are overloading the power source. On remote chassis, eliminate remote power by clipping across pins 82 and 83 going to the PWB. Isolate overloading secondary voltage sources by removing one end of the fusible resistor.

Inject an external 12V source at pin 3 of IC501 to determine if deflection circuits are functioning. Scope pins 34,36, and 24 for horizontal drive waveforms with power cord pulled. Suspect F801, F812, R802, R804, Q801, R428, Q403, Q402, R423, and Q404 for no start-up. For intermittent shutdown, monitor + 125V source and waveform at collector of Q404. Remember, the horizontal circuits must perform before a scan derived voltage source is fed to the other circuits. ■

DMM update

A DMM shopping checklist

By Conrad Persson

The development of electronics test equipment has very nicely paralleled the development of electronics in general. When consumer electronics equipment began to be based on semiconductors, it was during about the same time frame that semiconductors were introduced into the test equipment. The development of integrated circuits did not go unnoticed by test equipment manufacturers, and it wasn't long after ICs were available that electronics test equipment began to include additional features, reduce in size and become more and more portable.

Other innovations, as they became available began to be incorporated into electronics test equipment: microcomputers, LEDs, LCDs, and more.

In general, as time goes by, test equipment has begun to offer more features, smaller size, lighter weight, greater ease of use, more ruggedness.

Interestingly, though, in spite of the advanced capabilities of the test equipment, much of which is extremely valuable when the technician is faced with a difficult to diagnose problem, most of the measurements that a consumer electronics servicing technician needs to make are the same old ones: resistance, impedance, voltage, capacitance, diode drop, waveshape. Checks such as these point to the source of the problem in a large percentage of the malfunctions, so even though there will be more and more occasions to use modern, sophisticated general-purpose and special-purpose test equipment, the multimeter will continue to be the first instrument brought to bear on most consumer electronics problems.

Persson is editor of **ES&T**

Figure 1. One thing to look for in today's DMM's is their degree of ruggedness. Some meters, such as this one, are designed to withstand harsh environments.

Features

There was a time when a VOM or DMM measured precisely those parameters: volts, ohms and milliamperes and no more. Not only that but when the meter was measuring alternating current, the reading was accurate only if the waveform of the ac was a sine wave. Today, many other features have been added to multimeters. To such an extent, that if you're considering purchasing a new meter, it might be a good idea to consider carefully which features you want in a meter.

Backlighting: Some of today's digital multimeters have a backlit display. This allows the user to take readings in situations where the display might otherwise not be readable.

Continuity: This is the function that allows the user to learn immedi-

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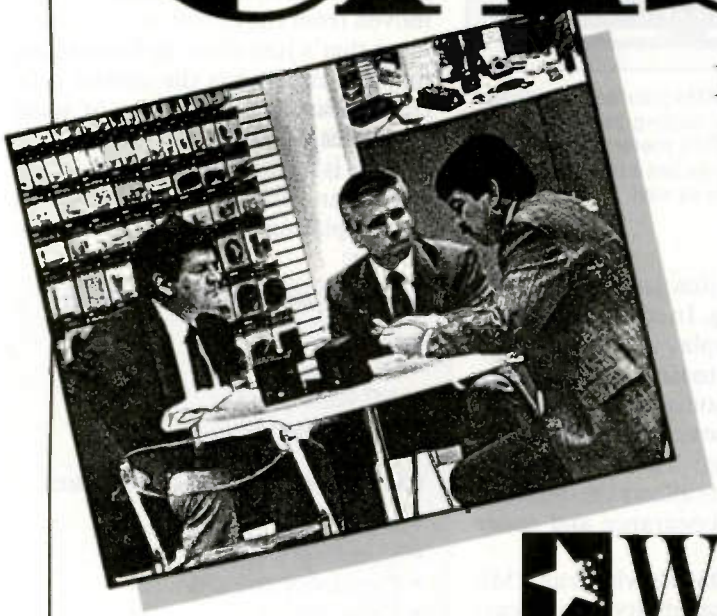

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ately if there's an electrical connection between two points without having to wait for the meter display to settle down. Because this function is usually audible, it's not even necessary to look at the meter face. The technician can move the probes about quickly and listen for the beep.

Diode test: This is frequently combined with the continuity function. This function forces a preset value of current through the diode to forward bias it, and provides an indication of the forward voltage drop.

Display Technology: Recent improvements in LCD technology include better response over wider ambient temperature ranges. Some of today's meters have a backlit display to make it easier to read the value of what's being measured.

Durability: Heavy duty DMM models are designed with an impact-resistant, environmentally sealed casing to withstand harsh environments, and the bangs and jolts of being thrown into the tool case and being toted around.

Capacitance measurement: Some of the DMMs available today have been provided with the ability to measure capacitance, thus extending the range of useful measurements that a DMM can perform.

Frequency measurement: Although the range of frequency measurement for DMMs so equipped is usually not very broad, even the limited range of frequency measurements available can sometimes reveal some critical frequency information about the circuit under test when an oscilloscope or frequency counter is not available.

Input protection: This may take the form of a device such as the metal oxide varistor (MOV) for high voltage protection. The traditional way to protect current ranges is with fuses. Fuses are becoming smaller with higher voltage ratings available. Some DMMs now offer special positive temperature coefficient (PTC) resistors. In series with the input, the PTC resistor reacts to a current overload by heating up, which in turn causes its resistance to increase rapidly.

Analog display: Some newer DMM models include some kind of analog display that supplements the numeric reading. In some cases this is a bar sort of display in which a series of bars appears to simulate an analog reading, or in some cases, an actual analog meter movement is included.

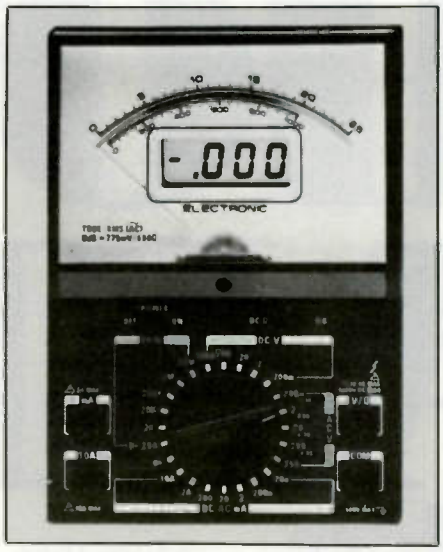

Figure 2. Some DMMs provide trend types of information by adding an LCD graph type of display. This meter features not only a digital display, but a traditional mirrored analog scale as well.

Auto-Ranging: The auto-ranging feature in DMMs allows the device to be simpler in appearance and easier to use.

True RMS: DMMs with true RMS measurement capability can accurately measure the RMS value of ac signals, virtually regardless of their waveform or distortion.

Automatic Shut-Off: Some DMMs shift into a low drain state, and some will turn themselves off after a period of unattended operation. It's important to know which of these you're buying if you want to conserve battery life.

Minimum/maximum recording capability: Min/max capability allows you to leave the meter unattended for long periods of time during which the meter can measure and store the highest and lowest values sensed. Some auto-ranging DMMs can auto-range when in min/max recording mode.

Reading hold: A number of new DMMs allow the user to make a measurement when it's not possible to observe the display, and then observe the display when it is convenient or safe to do so.

Relative mode: This function allows the user to take a reading and then use that reading as a reference point for taking further readings.

Resolution: This characteristic of a meter determines the smallest numeric value that can be read on the display. The number of digits displayed and the number of ranges available for each function determine this value.

Transistor beta: In many cases it's important to determine whether the gain of a transistor that has been removed from the circuit, or a replacement that's just about to be installed into the circuit has the correct gain characteristic. This feature of some DMMs can give this indication.

Here is a checklist of things that a technician should consider when contemplating the purchase of a multimeter:

Standard multimeter functions

- Ohms
- DC volts
- AC volts
- DC milliamps

Enhancements to special features

- Diode junction test
- Continuity
- Frequency counter
- Capacitance
- Audible continuity test
- Backlit display
- Program function
- Reading hold
- Analog meter
- Autoranging
- Transistor beta
- Temperature measurement
- True rms measurement
- Automatic shut off
- Minimum/maximum hold
- Relative mode

Physical attributes

- Heavy duty
- Protective holster
- Provision to hang meter up

Electronic attributes

- Number of digits
- Resolution
- Accuracy ■

Preventing electrostatic discharge damage

By Rick Lucas

Electrostatic discharge (ESD) is defined as: "a transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field." Static electricity occurs whenever two substances are rubbed together, brought together then separated, or flow relative to one another (such as gas or liquid over a solid). People are perhaps the biggest generators of static electricity and, depending on the type of clothing worn, a person may build up a charge of over 35,000 volts. It takes a discharge of far less than this value to destroy some semiconductor devices.

When a semiconductor device happens to be in the path of an electrostatic discharge, the energy released by the discharge may cause damage to the very thin layers of material, or even totally destroy the device.

ESD is a significant cause of semiconductor device failure at all stages of device and equipment production and handling. Industry experts estimate that ESD is costing the industry over $1 billion per year. From component to end product, the possibility of ESD damage is ever present. The commercial industry estimates that for every ESD related defect found in manufacturing, there are two to five walking wounded (latent defects) in the field. S. Russell Craig of Teradyne has observed that, if static is allowed to degrade just 5 percent of the devices going through an assembly area and average of 20 devices are installed per board, the potential board failure is 10 percent. With five boards per typical system, the likelihood of premature failure reaches 40 percent.

The same kind of analysis might be made for electronics servicing. If a service facility that services products based on static-sensitive devices, and nowadays that's just about every one, does not take precautions to avoid ESD damage, some replacement components, and perhaps some good components on the faulty product being serviced will be damaged by ESD. If the technician is lucky the component will fail completely and the product will not work until it's replaced. If the technnician is not so lucky, the product will work fine long enough for it to pass the burn in stage and be picked up by the customer, and fail some time during the warranty period of the repair. The result will be a call back that will cost time, money and aggravation.

Lucas is Manager, Semiconductor Technical Support, of Thomson Consumer Electronics. The series of articles was originally published in a newsletter that Thomson sends to its distributors.

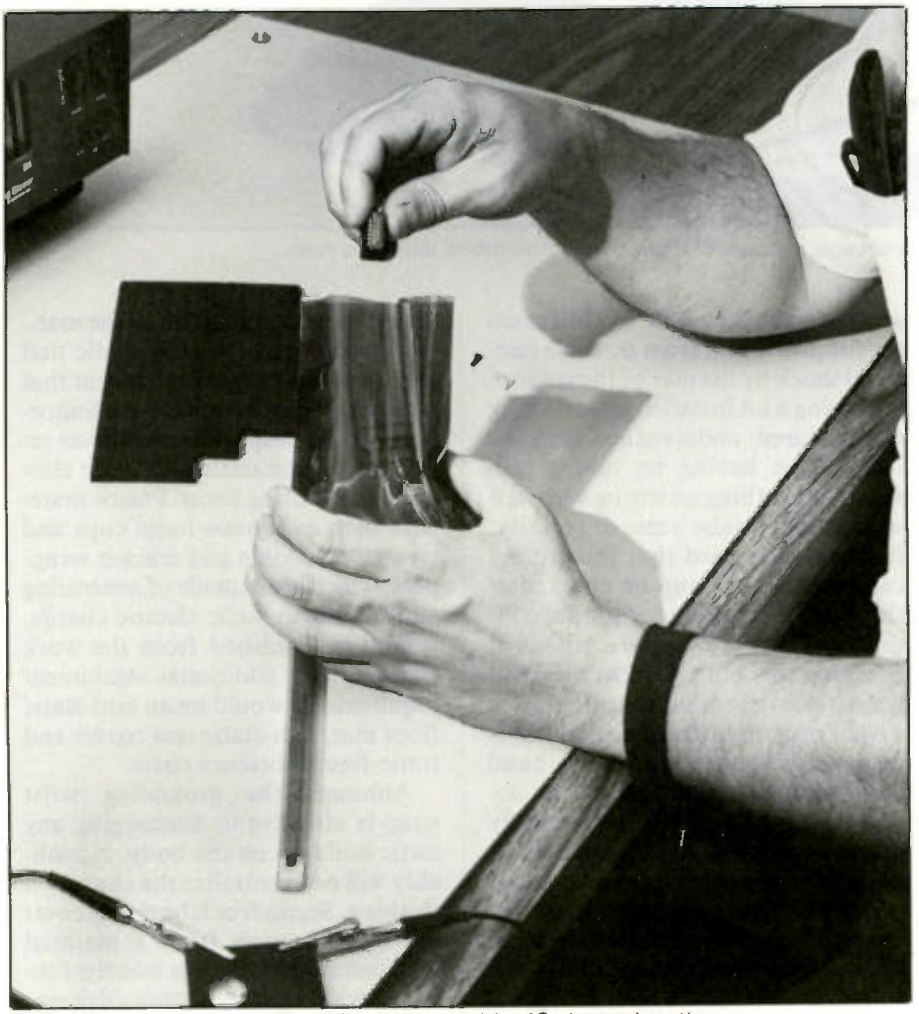

Figure 1. The correct handling of a static sensitive IC at a workstation.

The work station

The key to avoiding electrostatic discharge damage is a static free

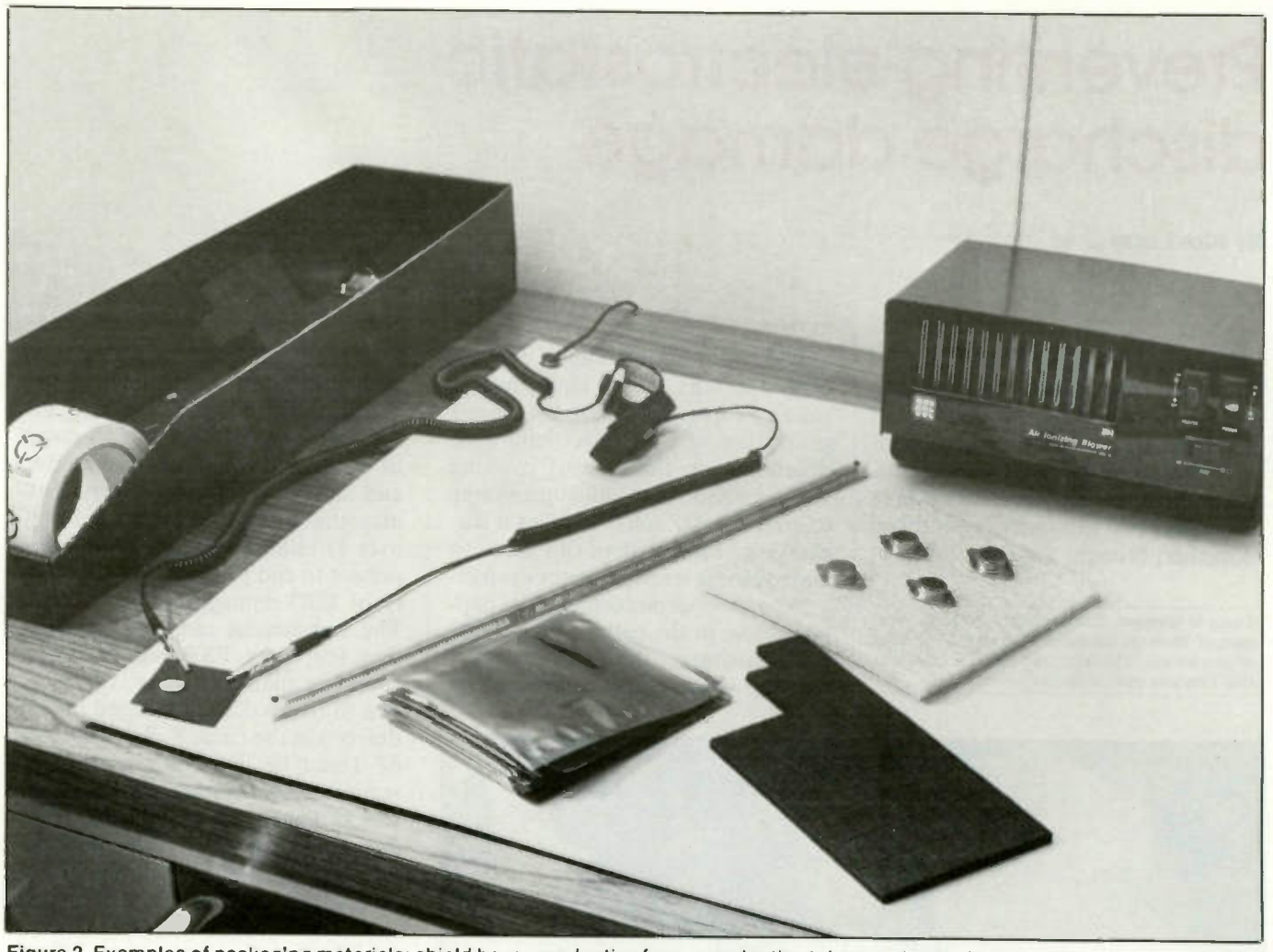

Figure 2. Examples of packaging materials: shield bags, conductive foam, conductive tubes, antistatic foam.

work environment. A static free work station should consist of the following items to meet minimum requirements:

1. Anti-static table mat and accessories.
2. Grounding cords and protective resistors.
3. Anti-static floor covering.
4. A drawer for labels, pouches, bags, etc.
5. Anti-static seat covers for all chairs.
6. Static-free laboratory coats (optional).
7. Air ionizers.

An Anti-static mat kit should consist of a static dissipative type mat, a wrist strap and a grounding cable that safely drains electrostatic charges to ground. The grounding cable should be connected to a good ground and have a built in 1MΩ resistor for protection from possible electrical shock by the user of the station.

Having a kit installed and ignoring the required maintenance may be worse than having no mat at all; should something go wrong with it, it will provide a false sense of security. It is recommended that the ground cable and wrist strap be checked at the start of each day for proper continuity. There are several methods of checking this but the most effective way to assure continuity at all times is a wrist strap monitor. The monitor is connected between the wrist band and the mat. Depending on the design, the tester will either constantly monitor or randomly test the continuity of the wrist strap and ground cord. The mat should be kept free from dirt and should be cleaned regularly with a good topical anti-static solution. Household detergents should not be used to clean the mat.

In addition to the anti-static mat and wrist strap, an environment that minimizes static electricity is important. To accomplish this involves removing or minimizing all static electricity generating items. Plastic materials such as styrene-foam cups and cigarettes, cookie and cracker wrappers, which are capable of generating and holding a static electric charge, should be banished from the work station. The additional equipment requirements would be an anti-static floor mat, anti-static seat covers and static-free laboratory coats.

Although the grounding wrist strap is effective in discharging any static build up on the body, it probably will not neutralize the charge on clothing. Static-free laboratory coats are usually made from a material with metal fibers woven into the fabric to create a pseudo-conductive ma-

terial. This material will minimize the generation of static electricity.

Because the fabric is pseudo conductive, it can easily be neutralized with an air ionizer. The Anti-static seat covers are based on the same principle. An air ionizer will also help neutralize any statically charged items (boxes, shipping trays, etc.) that may come in close contact with the static sensitive device.

Neutralization is accomplished by flooding the work area with positive and negative ions. These ions are continuously generated to replenish those that have recombined. A charged surface in the work area attracts the ions of opposite polarity. These ions then neutralize the static charge on the surface. The anti-static floor mat should be connected to the same grounding point that the mat and wrist strap are connected to, and also have a built in 1 MΩresistor in the grounding cord to ensure the safety of the worker from electrical shock.

ESD-safe packaging

The use of antistatic protective packaging is essential in protecting semiconductors during packing and shipping. Antistatic materials are those that resist static electric charging and produce minimal static charge when separated from the same or other materials. It should be remembered that a material's antistatic property is not necessarily proportional to its resistivity.

Antistatic materials dissipate static charge either by conduction or acting as a shield against electrostatic fields. Conductive materials are either surface or volume conductive. Volume conductive materials can be metal or some material impregnated with metal, carbon particles or other conductive substances, while surface conductive materials are materials whose surfaces have been treated with such substances through a process of lacquering, plating, metallizing or printing. Not all conductive materials are antistatic.

Electrostatic shield materials are those capable of reducing the strength of an electrostatic field, so that its effects do not reach the device. Combining the two dissipative methods into one conductive static shielding material can be accomplished by:

1. A multilayered material consisting of an electrostatic field shielding exterior layer, an insulative intermediate layer and an antistatic inner layer.
2. A multilayered material consisting of an antistatic exterior layer, a conductive electrostatic field shielding intermediate layer and an antistatic inner layer.

Examples of acceptable conductive electrostatic shielding materials are:

1. Conductive tubes (rails) with dissipative plugs or pins at both ends of the tube.
2. Antistatic bags.
3. Foil wrapped or foil lined containers.
4. Conductive foam of the high density noncorrosive type.

If dunnage is required in shipping ESD sensitive devices, it must be in

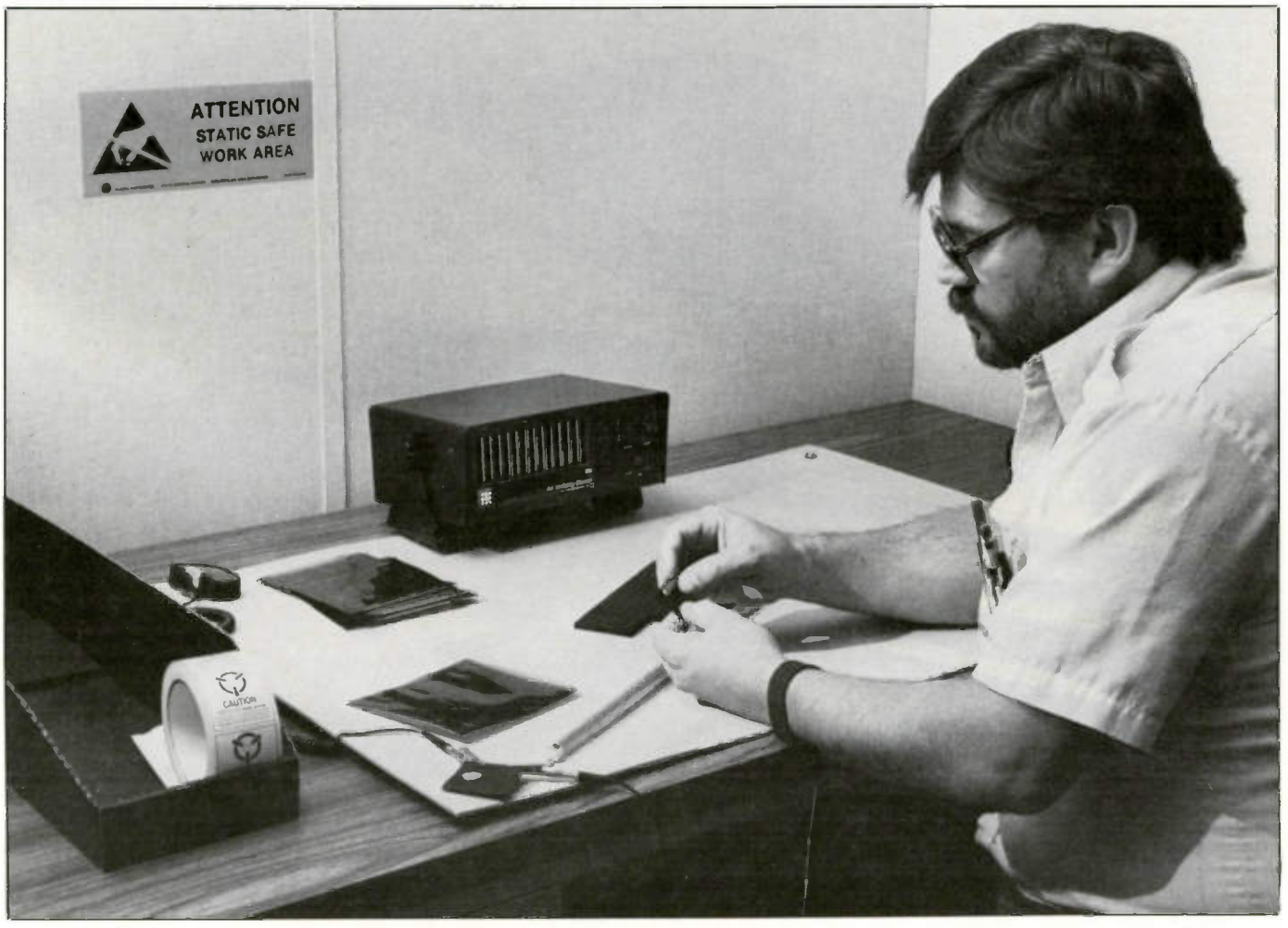

Figure 3. Warning sign alerting employees that static procedures should be followed.

the form of antistatic material that complies with the static decay test requirements of MIL-B-81705B. In addition to being antistatic the packing material used must maintain its antistatic properties during storage, shipment distribution and use. The additives or antistatic agents (antistats) that provide the dissipative properties for foam, bags, IC tubes, etc. have a limited shelf-life that varies according to the manufacturer's process. If the shelf life is exceeded, the material can actually become a static generator.

The use of these antistatic packing materials could be undermined by sealing boxes, bags, etc. with anything other than antistatic tape. Because some sort of relative motion is necessary to create a static generator, the pulling of regular tape from the dispenser or the surface of the container it seals is a potential hazard. All static shielding bags and any other antistatic container must be labeled with an ESD caution label. The exterior of all shipping containers should also be labeled.

Safe handling procedures

Four rules must be remembered when handling semiconductors:

1. Assume all electronic components are sensitive to ESD damage.
2. Do not touch a sensitive component unless properly grounded.
3. Do not transport store or handle sensitive components except in a "static free" environment.
4. Test static sensitive components only in ESD protected areas.

All semiconductors are susceptible to some degree to ESD. To be on the safe side, it should be assumed that every device that a technician handles is ESD sensitive. ESD damage can be caused by just opening an antistatic container when not in the proper environment. Dry weather tends to greatly increase the accumulation of static charges on any surface. Conversely, higher humidity levels reduce the magnitude of the static voltage generated. In a low humidity environment the handling rules listed above take on added importance and should be adhered to without exception.

Typical handling guidelines for receiving semiconductors

Devices should not be removed from their conductive or antistatic carriers until they are going to be connected into the circuit. The parts should be counted without removing them from their containers. If the product is not received in conductive or antistatic packing material, they should be returned to the supplier.

Storage

All devices should remain in their carriers. Even a partial removal of semiconductors from carriers should only be done by a grounded operator at an antistatic work station.

Transportation

All devices should be transported in the original protective packaging. If this cannot be done, they must be placed inside a tray or container that is formed of conductive or antistatic plastic. Common plastic bags, card-

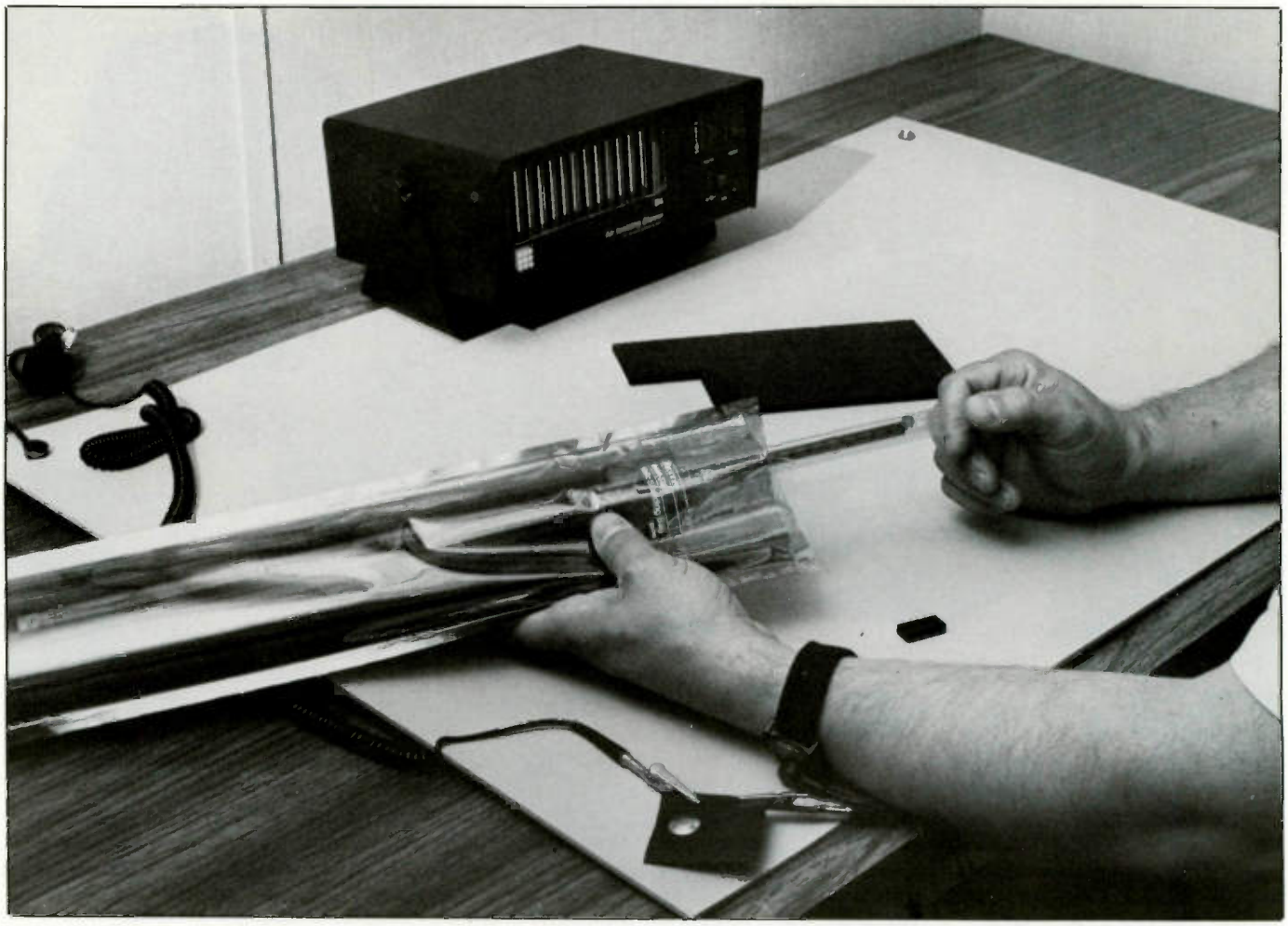

Figure 4. Sensitive IC's packaged in Anti Static Shielding bags and conductive tubes.

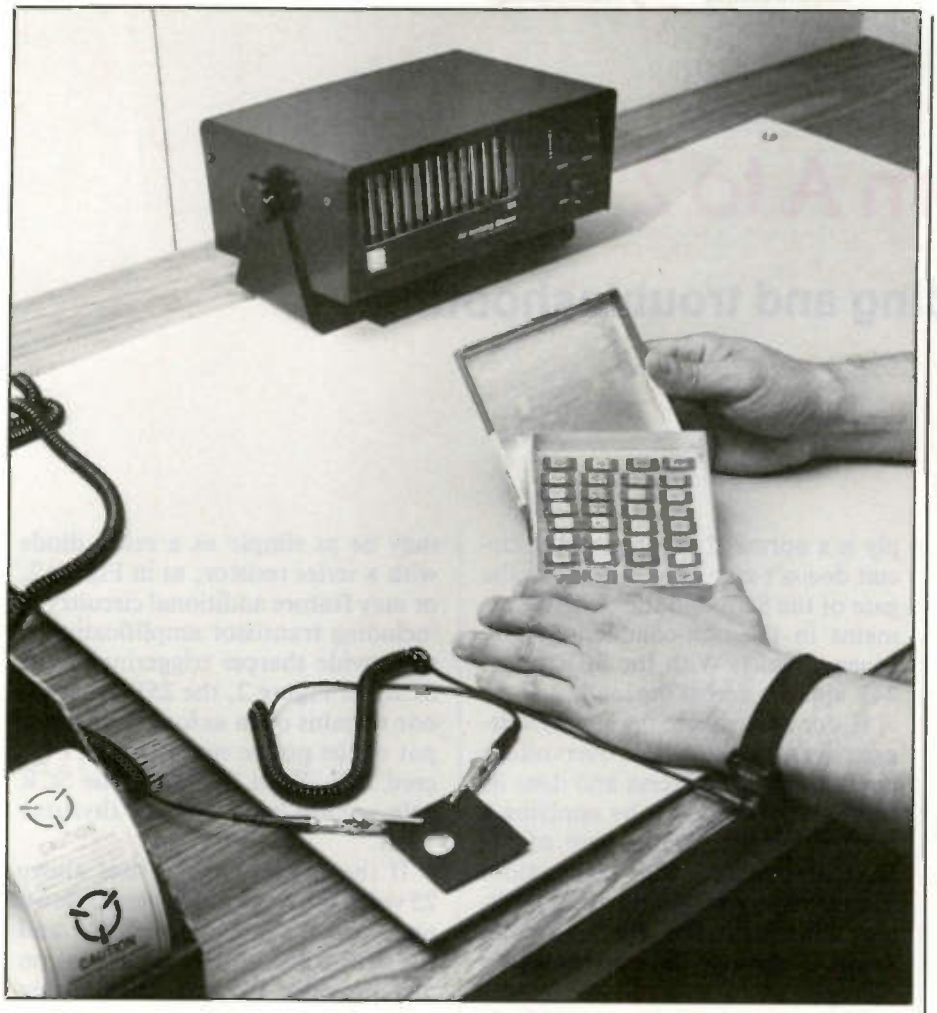

Figure 5. Foil lined box.

board or plastic containers and foam must not be used. Carts used to transport the carriers must have a static discharge strap in contact with the floor. People carrying the devices should wear a conductive heel and toe strap which provides a continuous ground path with the floor. The heel and toe strap should have an intrinsic 1MΩresistance for protection against shock just like the wrist strap.

Electrical testing and troubleshooting

All testing and troubleshooting should be performed by a grounded technician. Don't use canned coolant for fault isolation, except those that are specifically formulated to be antistatic. Ground the ESD protective package containing the replacement device prior to opening it. This will dissipate any accumulated charge on the package. All test equipment and leads must be grounded to avoid damage when touching the terminals of a device. Also the soldering system used should be grounded for the same reason.

Avoid touching the ESD sensitive device with other parts, circuitry and other items that could possibly accumulate a charge. When testing is complete, reinsert the device into the conductive carrier. Educate technicians about the ESD hazard, and augment this with written procedures for each area of a facility. This will aid employees in correctly following ESD procedures. Review the procedures for each area periodically to see if they still apply. Periodically explain the procedures to all personnel to insure that everyone understands what is expected of them.

ESD is a very serious problem that faces all semiconductor handlers from the manufacturer, the distributor, the OEM to the servicer. At present there is no simple way to eliminate ESD. This article along with the many others that have been written on the subject, may seem repetitive. This is often necessary when treating a problem which cannot easily be seen by the average worker. We need constant reminders of the problem and the damage it can cause. ■

Thyristors from A to Z

Part IV: Understanding and troubleshooting SCR circuits in TV

By Bert Huneault, CET

Articles in past issues (February 1990 - Silicon controlled rectifiers; April 1990 - SCRs, diacs and Shockley diodes; July 1990 - The unijunction transistor) discussed the principles of SCRs, examined a few dc and ac applications, and looked at companion devices such as diacs, Shockley diodes and unijunction transistors.

This installment examines some specific SCR applications in the field of consumer electronics and also introduces an optoelectronic thyristor: the light activated silicon controlled rectifier (LASCR).

SCR crowbar

Our first application features an SCR used as a crowbar to protect a load against excessive voltage from a power supply. The crowbar principle is illustrated in Figure 1 which shows an SCR connected in parallel with the load, and an overvoltage sensing circuit driving the gate of the thyristor.

When the output of the power supply is a normal 24V, the sensing circuit doesn't apply any voltage to the gate of the SCR and the thyristor remains in the non-conducting state (open circuit). With the SCR open, 24V appears across the load.

If, for any reason, the supply voltage rises above 24V, the overvoltage circuit senses the excess and does its thing, i.e. it responds by applying a positive voltage to the gate of the SCR, triggering it into conduction. The thyristor shorts out the load voltage, thus protecting the load from possible damage due to excessive voltage.

This action is similar to suddenly slapping a crowbar right across the load terminals. Obviously the power supply needs current limiting to prevent excessive current when the SCR latches on.

The very fast turn-on of the thyristor (e.g. one or two microseconds) makes the SCR crowbar an ideal protection device in digital integrated circuits, because these ICs usually can't tolerate much overvoltage, not even for brief periods.

The overvoltage sensing circuit may be as simple as a zener diode with a series resistor, as in Figure 2, or may feature additional circuitry—including transistor amplification—to provide sharper triggering of the SCR. In Figure 2, the 25V zener diode remains open as long as the output of the power supply doesn't exceed 24V. With D1 open, the SCR gate voltage is 0V and the thyristor is off.

If the supply voltage rises above 25 volts, the zener diode breaks down and current flows through R1 and the SCR's gate. SCR1 thus turns on and provides R2 with crowbarring protection.

SCR regulator

Besides being used as crowbars in shutdown circuits, SCRs find other uses in many TV receivers; a couple of examples being B+ regulation and horizontal output switching.

In typical voltage regulator applications, the SCR is essentially a switch that quickly and repeatedly turns on and off the B+ supplied to the loads that require regulation. Switching regulators are much more efficient than conventional series pass transistor regulators because, unlike the transistors which operate continuously as linear amplifiers and therefore waste a lot of power and require large heat sinks, SCRs operate as electronic switches which are either off or on, with no in-between states; therefore, they waste less power and tend to run much cooler.

An interesting example is the SCR switching regulator featured in a number of RCA TV chassis, including the CTC87. In this circuit, the thyristor switches the dc supplied to the horizontal output stage, thereby regulating it to a constant +114

Huneault is an electronics instructor and head of the REE Department at St. Clair College of Applied Arts & Technology in Ontario, Canada.

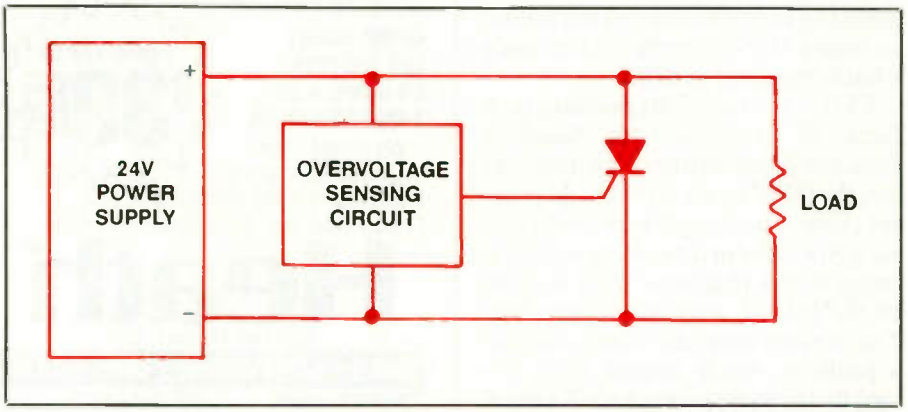

Figure 1. A crowbar circuit places a short circuit across the load terminals in the event of excessive voltage at the output of the power supply.

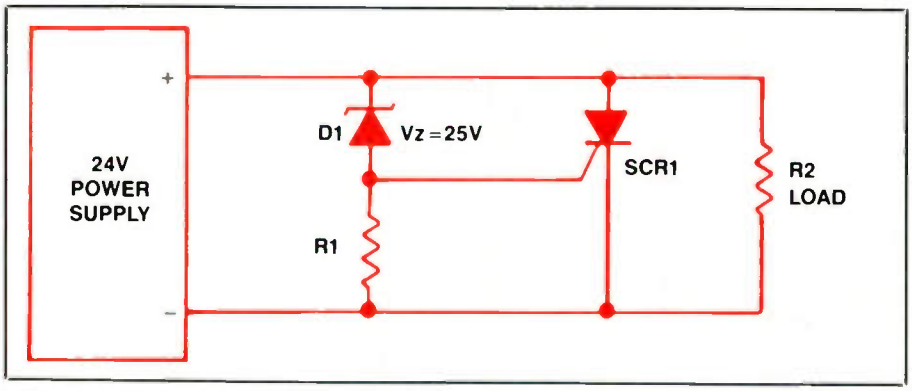

Figure 2. A zener diode can be used as a voltage reference for a crowbar circuit.

volts. The principle is illustrated by the simplified circuitry of Figure 4.

The system features a closed loop (phase locked loop) encompassing the regulator SCR, an error amplifier, a phase control transistor, and an oscillator synchronized to the horizontal deflection frequency. Power for the SCR and control circuitry is supplied from an unregulated +150V source (low voltage power supply).

SCR regulation in detail

Here's how the system works: SCR1 is switched on by a positive pulse applied to its gate shortly after the beginning of horizontal trace. This gating waveform comes from the oscillator, via gate drive transformer T3. Once the SCR turns on, C3 begins storing energy; it charges toward +150V through the SCR, choke L5, flyback winding L4 and resistor R2. The time constant of this charging circuit is mainly determined by the values of C3 and L5, but the amount of time actually available for charge during each cycle depends on just when the SCR switches on during horizontal trace. During retrace, winding L4 supplies a negative pulse to the SCR anode, turning the thyristor off.

The SCR is indeed an electronic switch that gets closed by a gate turn-on pulse and opened by an anode turn-off pulse. The longer the SCR switch is closed, the more energy gets stored in C3; therefore the higher the regulated voltage. In actual operation, this voltage is maintained constant by virtue of the feedback loop, which sends a sample of the regulated voltage back to the control circuitry via voltage divider network R4-R5. The resistance of R5 is carefully selected during manufacturing to produce the normal +114V regulated voltage.

The error amplifier compares this sample voltage with a 33V zener-regulated reference voltage, and outputs an error voltage to the control transistor. The latter functions as a variable resistance in the R-C network of the oscillator and thus varies its timing.

Note that although the oscillator is synchronized to the 15.734kHz horizontal scanning frequency (by means of sync reset pulses derived from

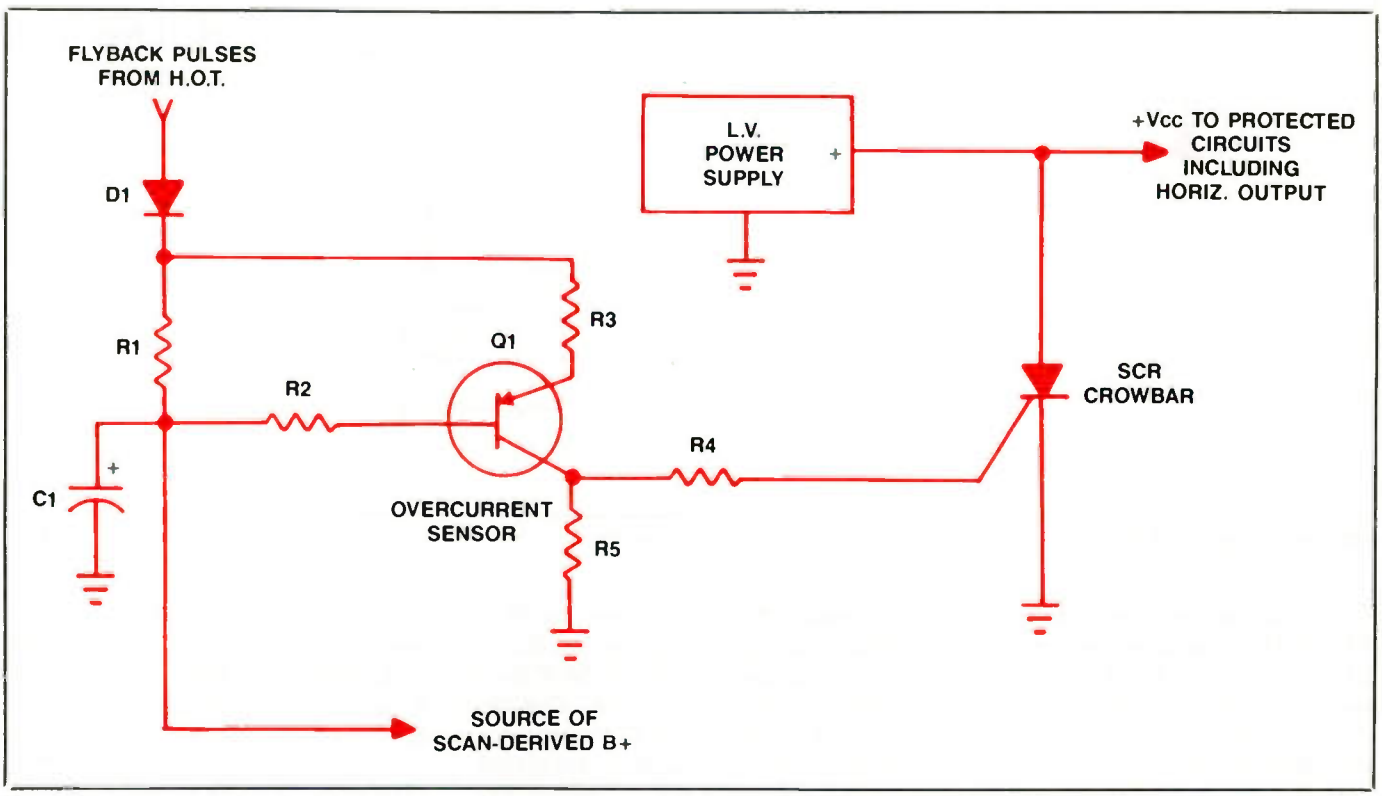

Figure 3. In some crowbar circuits, a transistor is used as the sensing element.

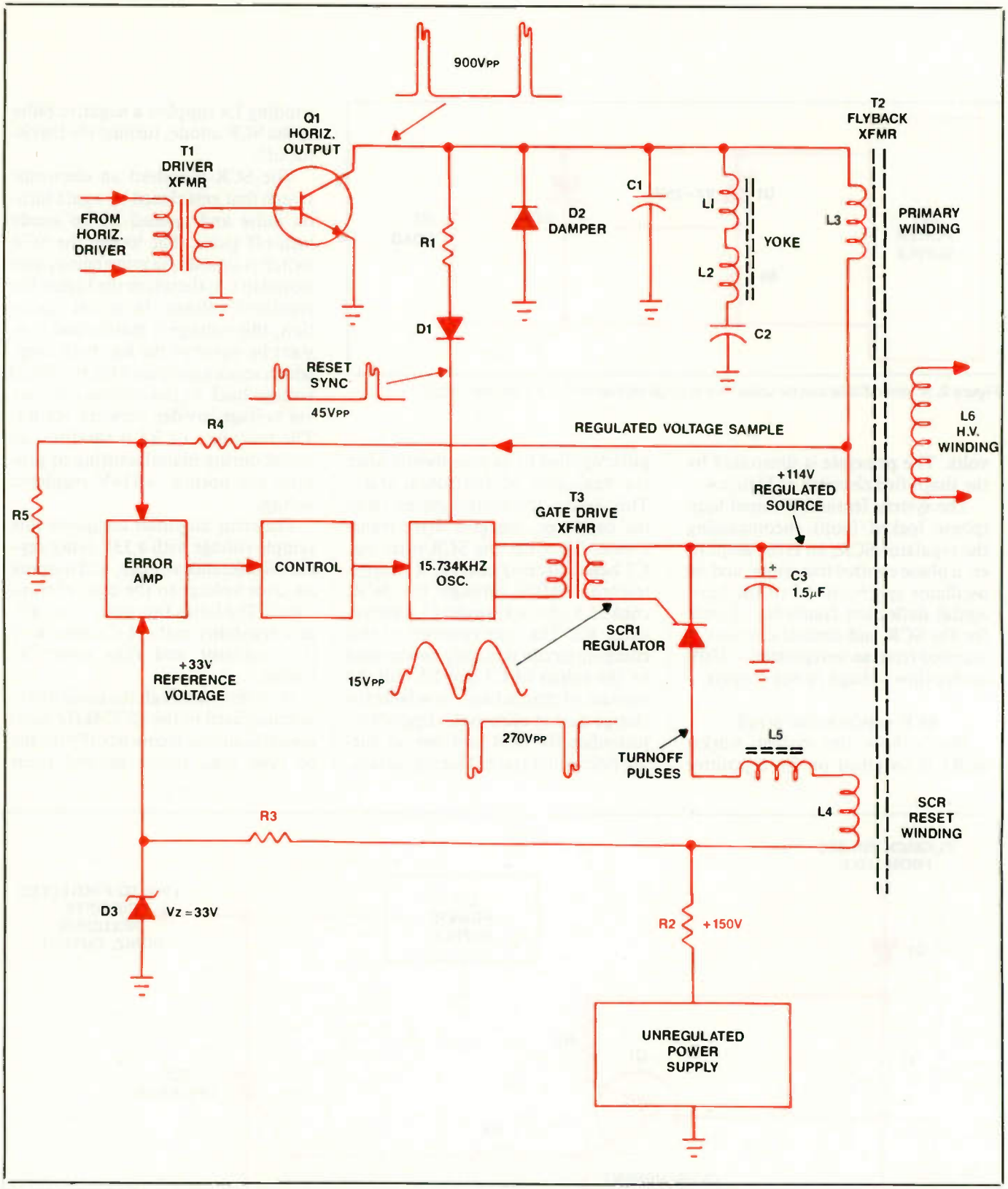

Figure 4. The SCR has been used as a voltage regulator element in some TVs.

Q1's collector and applied through R1 & D1), the precise moment when its output waveform is positive enough to fire the SCR is controlled by the action of the phase locked loop just described.

If the regulated voltage tends to rise above 114V—for example during reception of a dark image—the PLL delays the phase of the oscillator waveform. As a result, the SCR fires later in the trace interval. This reduction in SCR duty cycle causes a corresponding reduction in regulated output voltage at the cathode of the thyristor.

Incidentally, note that although the energy reservoir C3 is returned to ground in Figure 4 (for simplicity), it is actually returned to the +150V B+ line in the RCA chassis; but its action remains the same. It acts as a filter and allows its stored energy to

(Continued on page 37)

ES&T Manufacturers' schematics **PROFAX**

September 1990

Profax Number

RCA/GE
CTC156 Color TV 3068

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ES&T Manufacturers' schematics **PROFAX**

TUNER (TAHQ)

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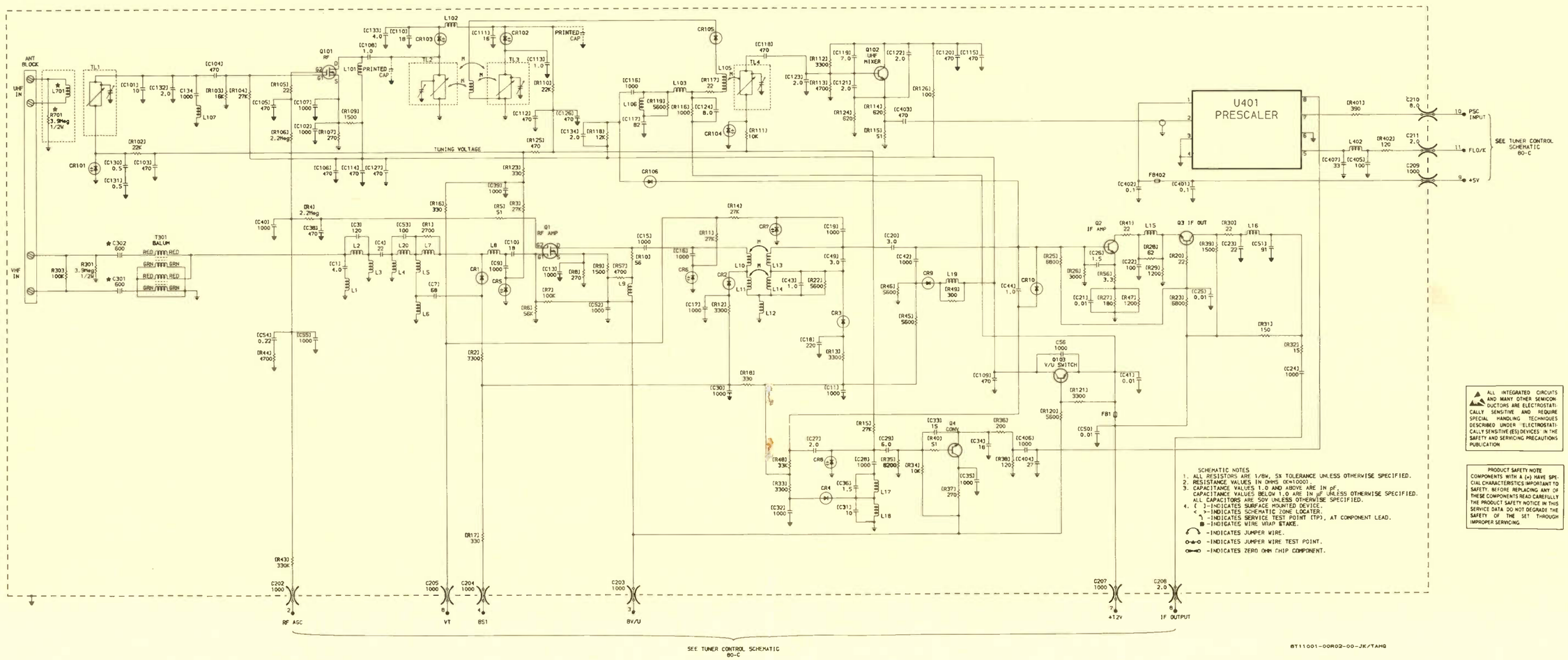
1-M1 1-M2 1-M3 1-M4

TUNER (TAHQ) SCHEMATIC



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3068

PROFAX

Manufacturers schematics

SEPTEMBER 1990

RCA/GE
COLOR TV

TUNER (TCCR/TCHR)

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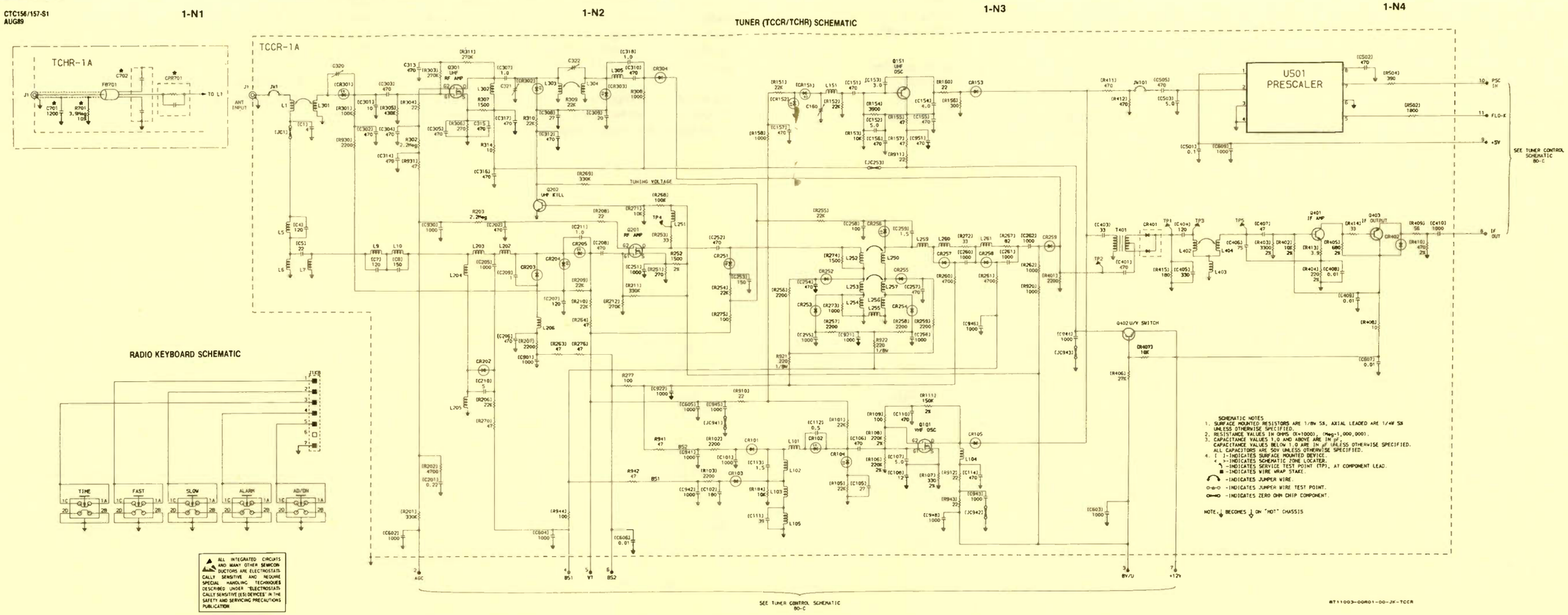
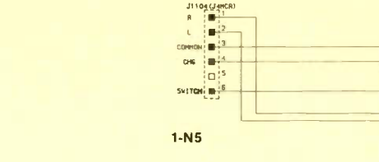
CTC156/157-S1
AUG89

1-N1 1-N2 1-N3 1-N4

TUNER (TCCR/TCHR) SCHEMATIC



RADIO KEYBOARD SCHEMATIC



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PRODUCT SAFETY NOTE: COMPONENTS WITH A (▲) HAVE SPECIAL CHARACTERISTICS IMPORTANT TO SAFETY. BEFORE REPLACING ANY OF THESE COMPONENTS READ CAREFULLY THE PRODUCT SAFETY NOTICE IN THIS SERVICE DATA. DO NOT DEGRADE THE SAFETY OF THE SET THROUGH IMPROPER SERVICING.

MCR027 SCHEMATIC

1-N5 1-N6 1-N7 1-N8

SIGNAL/MONO AUDIO

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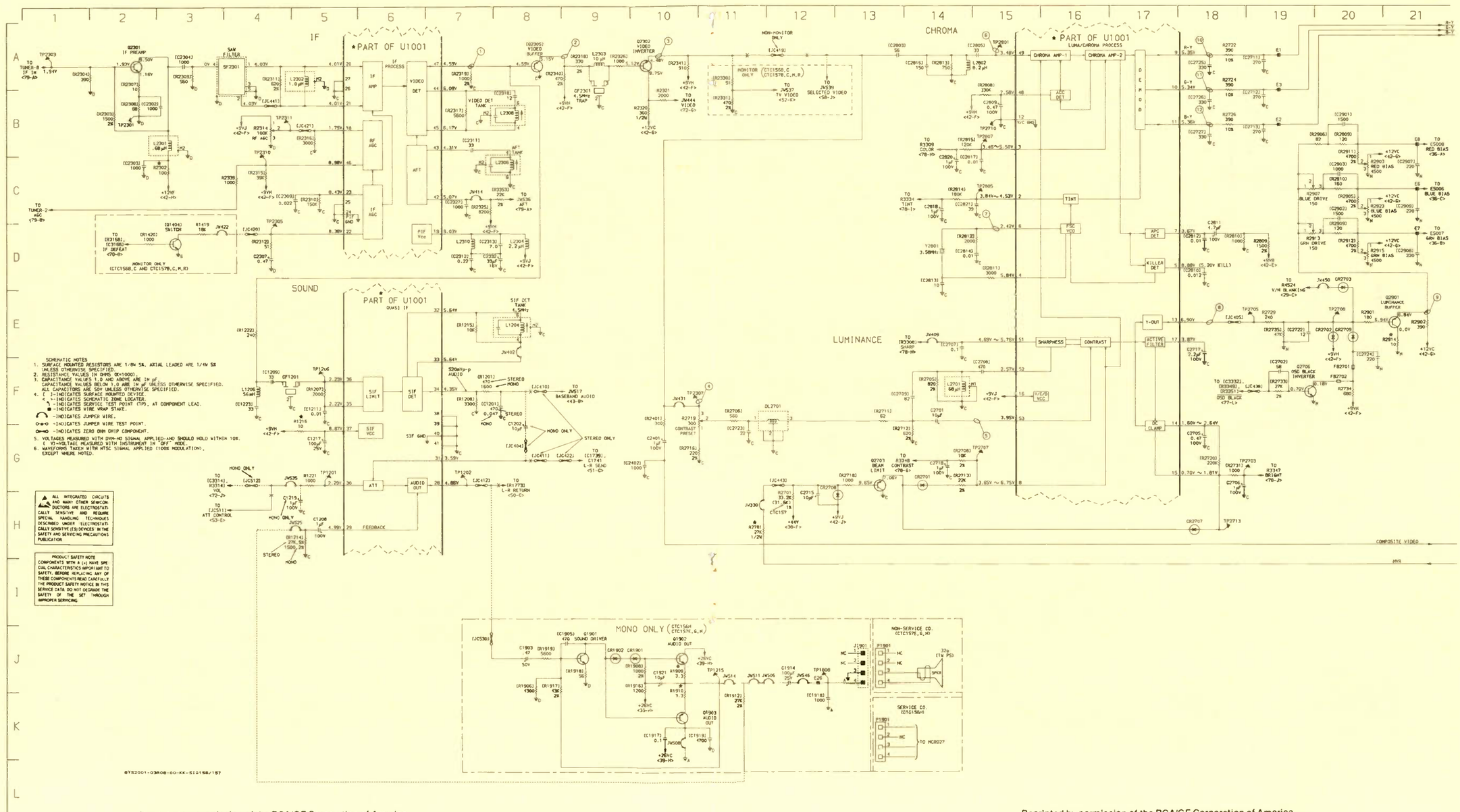
SIGNAL/MONO AUDIO SCHEMATIC



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DEFLECTION/POWER SUPPLY/KINE DRIVER

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Manufacturers' schematics PROFAX 3068

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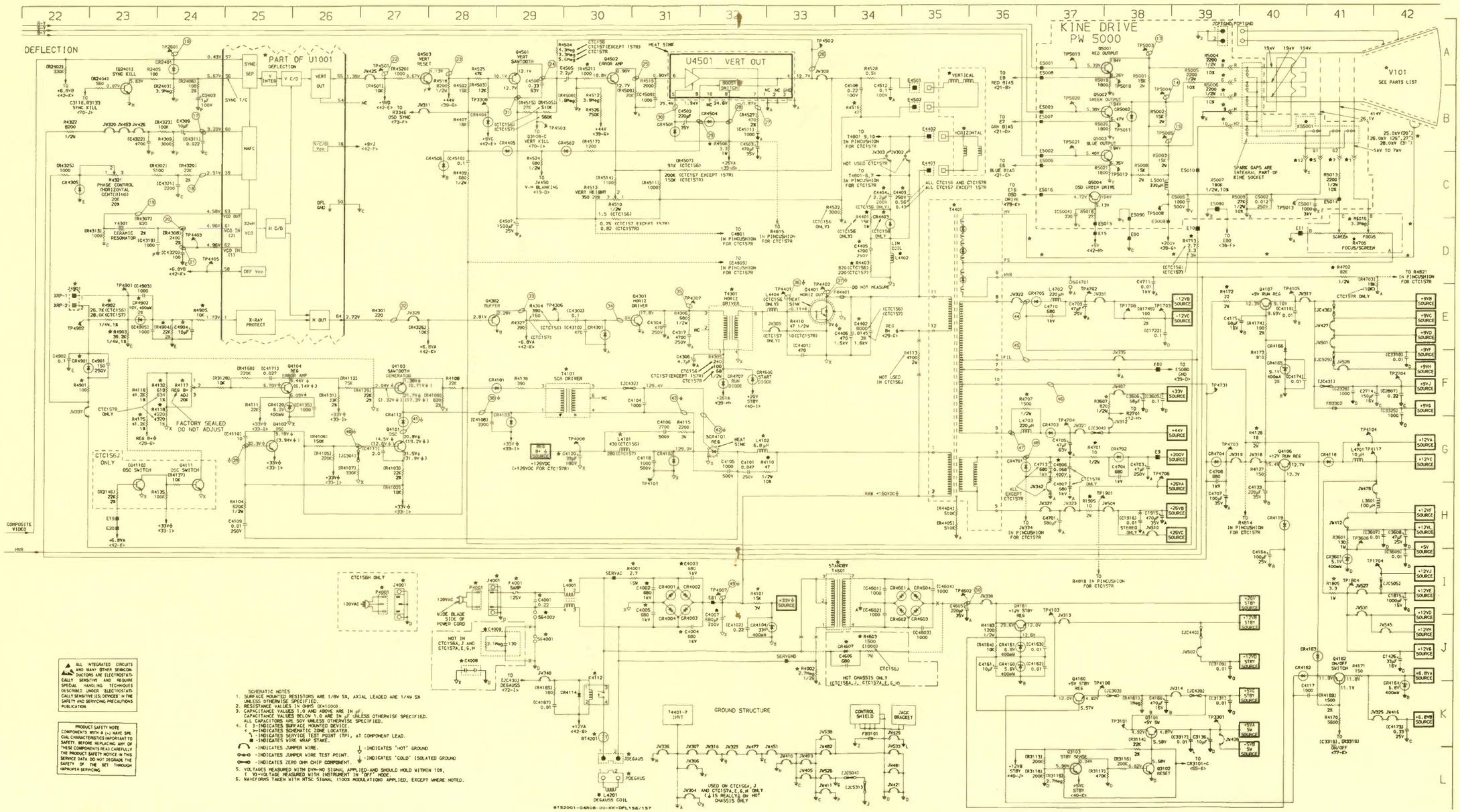
DEFLECTION/POWER SUPPLY/KINE DRIVER SCHEMATIC



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(from page 24)

be discharged into the load (horiz. output stage) at a constant rate.

Servicing the little rascals

Modern TV sets which feature scan-derived B+, shutdown circuits and regulators that control the horizontal output's Vcc supply can be tricky to troubleshoot because they are likely to be totally inoperative (dead set symptoms) regardless of whether the fault is in the horizontal oscillator, horizontal output, regulator, control, shutdown or startup circuits, or the main power supply.

In the circuit of Figure 4, if prolonged operation is necessary (under no-raster conditions) in order to make a number of checks, it may be wise to connect a clip lead across the secondary winding of the gate drive transformer, shorting out the SCR gating pulses. This disables the SCR and provides maximum component protection.

If preliminary checks indicate that the fault is in the regulator oscillator and control circuitry, RCA suggests the following procedure:

First, use an isolation transformer and a variable transformer. Remove power. Connect a jumper from anode to cathode of the SCR (thus bypassing the regulator) and a dc voltmeter between the SCR cathode and ground. Apply power and adjust the variable transformer for +114V dc. Then perform the following series of checks:

1. Check 33V B+ at D3.
2. Check reset waveform at SCR anode.
3. Check SCR gate waveform.
4. Check sync waveform at R1-D1 junction.
5. Check waveforms in the 15.734 KHz oscillator.
6. Check dc voltages on oscillator, control and error amplifier transistors.

One or more of the above checks should give you the clue(s) you're looking for.

Horizontal output SCRs

The basic objective of all horizontal electromagnetic deflection circuits is to cause a nearly linear current to flow through the yoke windings, thereby producing linear beam deflection from left to right across the screen, followed by a quick reversal, i.e., fast retrace from right to left.

Because the inductors and capacitors in the horizontal output circuitry can store energy and resonate naturally, the linear trace and fast retrace currents can be provided by accurately timed switching of the LC circuits. This switching function is normally produced by a horizontal output transistor in most TV sets (e.g. Q1 in Figure 4), and it's important to remind ourselves that this transistor really does function like a switch, not like a linear amplifier such as the audio output transistor.

However, recalling that SCRs are very effective electronic switches, it's not surprising to find that the horizontal output switching function is provided by SCRs instead of transistors in some TV Sets. As a matter of fact, some years ago the majority of RCA color receivers—as well as some other brands—featured SCR horizontal output stages. In recent years, however, the pendulum has swung the other way and most TV receiver designs now feature horizontal output transistors. For this reason we won't devote much space to horizontal output SCRs in this article; but a brief discussion of a simplified schematic diagram may be useful to some technicians.

The circuit, shown in Figure 5, features two SCRs, each paralleled with a fast recovery diode. SCR1 and D1 provide the switching action that controls yoke current during horizontal retrace, while SCR2 and D2 switch the yoke current during the trace period.

Circuit action is fairly complex, but a good way to start is to point out that when power is first turned on,

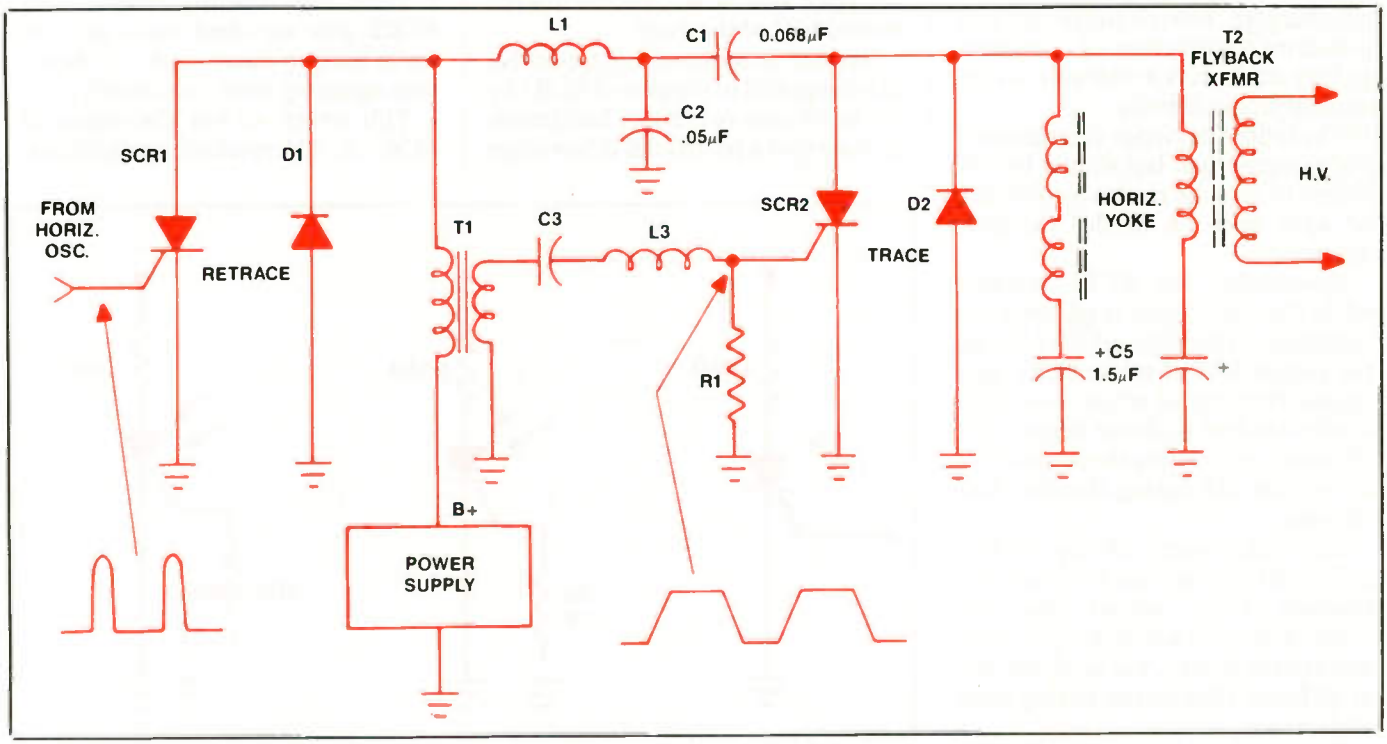


Figure 5. SCRs and diodes work together in this horizontal output circuit to provide trace and retrace intervals.

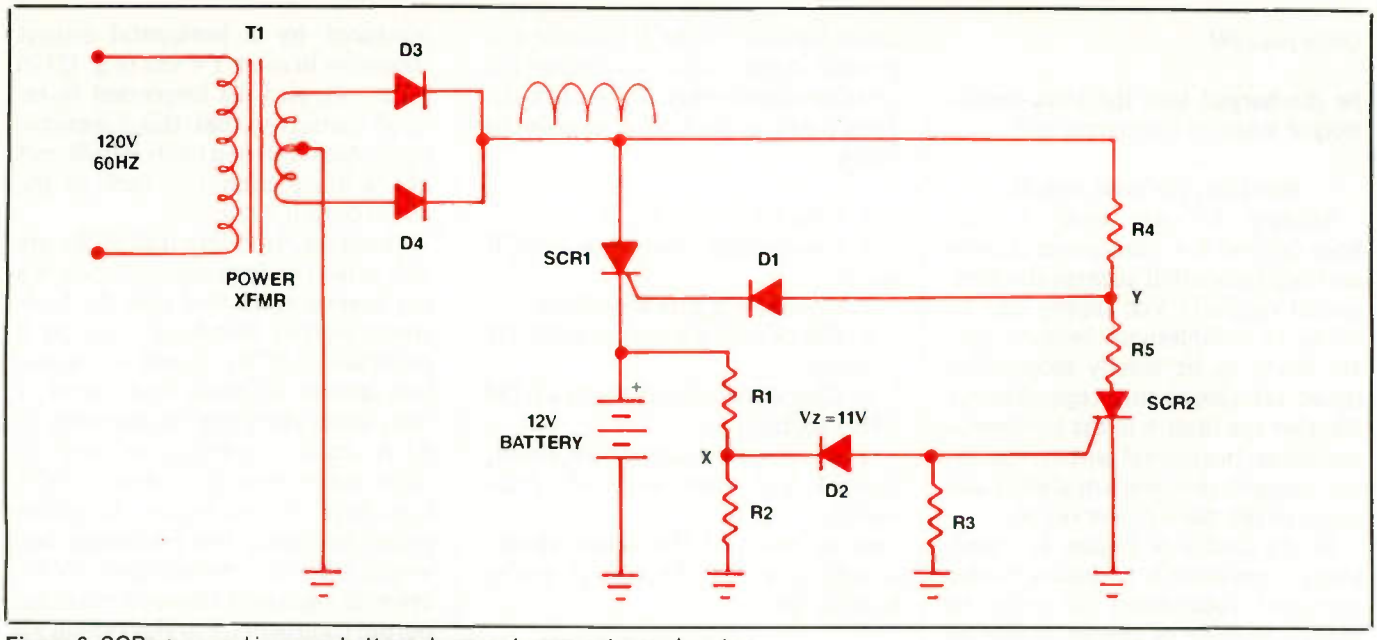


Figure 6. SCRs are used in some battery chargers to prevent overcharging.

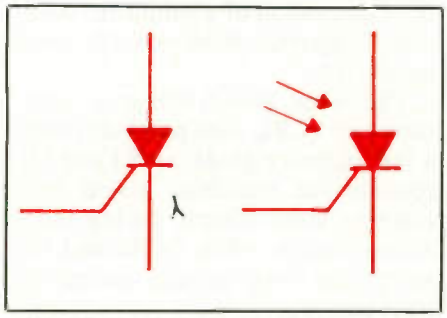


Figure 7. Symbols for the light-activated SCR.

capacitors C1, C2, C4 and C5 all begin charging through the primary of gate drive transformer T1. The energy they store plays a vital role in subsequent circuit activity.

The following circuit description is highly simplified, but should be sufficient to give the reader a good idea of what goes on in this thyristor application.

Essentially, the SCRs conduct while the CRT beam is painting the right side of the raster—SCR2 during the second half of trace, SCR1 during the first half of retrace—and the diodes conduct while the beam is left of center—D1 during the second half of retrace, D2 during the first half of trace.

The inductances of the various coils and transformers and the capacitances of the various capacitors form LC circuits which not only store and release energy, but also resonate at different frequencies during trace and retrace.

The yoke and large energy storing capacitor C5 in series with it resonate at a relatively low frequency, producing the gradual horizontal trace. The resonant current flows one way through D2 during the first (left) half of the trace, and the opposite way through SCR2 during the second (right) half. When the CRT beam is in about mid-trace (near center), SCR2 gets switched on by a gating signal induced into the secondary of T1 by circuit action; C3, L3 and R1 shape and delay this gating waveform for correct timing of SCR2 triggering. C5 then discharges through the yoke and SCR2, producing the second half of the trace.

Retrace is initiated by a positive pulse supplied to the gate of SCR1 by the horizontal oscillator. Incidentally, note that a horizontal driver stage is not necessary in this type of deflection circuit. The resonant circuit active during retrace includes inductor L1 and relatively small capacitor C1 in addition to C5 and the yoke inductance. The smaller series capacitance results in a higher resonant frequency and faster retrace. Timely switching from SCR1 to its parallel diode D1 is accomplished by a reversal in voltage polarity resulting from resonance during retrace.

Following retrace, D2 conducts while the collapsing magnetic field in the yoke moves the CRT beam from extreme left towards center; then SCR2 gets switched back on and we're back to square one . . . the action repeating itself indefinitely.

This wraps up our discussion of SCRs in TV receiver applications.

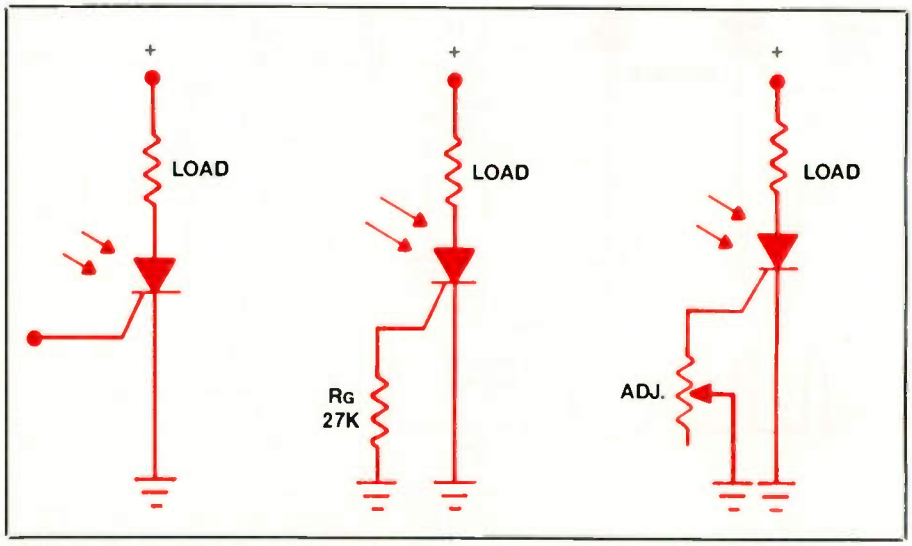


Figure 8. The resistance placed in a LASCR's gate circuit affects its sensitivity to light.

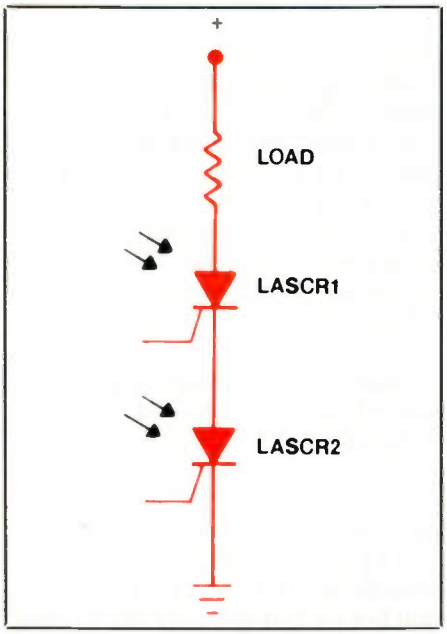


Figure 9. LASCRs can be used to construct simple logic circuits, as in this AND gate, for which both LASCRs must be illuminated in order for current to flow.

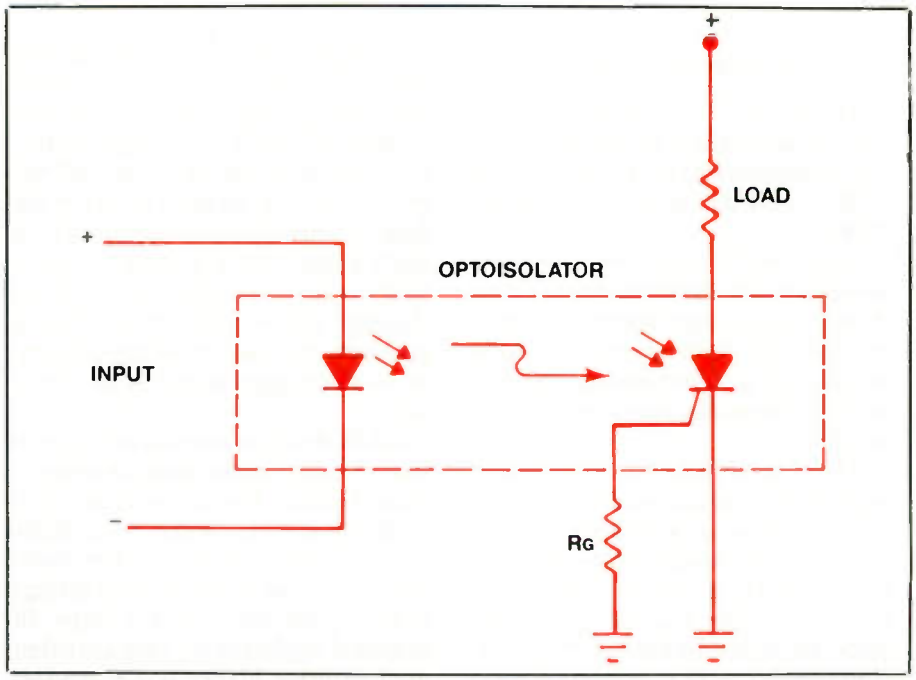


Figure 10. This LED/LASCR combination provides a latching relay that provides electrical isolation between the input and output.

But before leaving the field of consumer electronics, let's take a quick look at one more popular SCR application.

SCR battery charger

The switching properties of SCRs are ideally suited to battery chargers. Figure 6 shows a battery charging regulator featuring a couple of SCRs. SCR1 is in series with the battery, across the unfiltered output of a full-wave rectifier. When SCR1 conducts, charging current flows through the 12V battery. Circuit operation is as follows:

When the battery is low, the voltage at the junction of the R1-R2 divider network (point X) is too low to force the zener diode into conduction. Therefore SCR2 is in the off state in the absence of gate current. With no current flowing through SCR2 and R5, the SCR1-D1-R4 circuit functions just like the static switch circuit discussed earlier in this series (Figure 1, Part II, April 1990).

When the unfiltered positive voltage at the output of the D3-D4 rectifier is sufficiently high, gate current switches SCR1 into conduction and the battery begins charging through the thyristor. The SCR switches off at the end of each alternation, i.e., when anode voltage drops down to zero, because anode current falls below the minimum holding value; but it soon switches back on as the positive voltage rises again in the next alternation. Thus full-wave rectified current flows through the battery, gradually charging it.

When the battery is sufficiently charged, the voltage at point X becomes high enough to turn on the zener diode, allowing gate current to flow in SCR2; the thyristor switches on. We now have a voltage divider consisting of SCR2, R5 and R4 in series, across the output of the power supply. The current flowing through this divider causes the voltage at point Y (R4-R5 junction) to drop so much that there is now insufficient gate voltage for SCR1 to turn on. The thyristor thus fails to switch back on during the next ripple of input voltage, and battery charging ceases. Thus the regulator prevents overcharging. Later, when battery voltage drops, the zener diode stops conducting and the SCR2 will drop out, allowing SCR1 to switch back on and begin recharging the battery.

Light activated SCR

The last PNPN devices we'll discuss in association with silicon controlled rectifiers is the light-activated SCR (LASCR), also called photo-SCR.

This optoelectronic thyristor operates essentially the same way as an ordinary SCR, except that it can also be triggered by light energy. In other words, it's a photosensor. Figure 7 shows commonly accepted LASCR symbols.

The photo-SCR features a case with a transparent window that allows light to enter and reach a photosensitive part (depletion region of a p-n junction) of the semiconductor pellet, releasing free electrons. The photoelectrons initiate a regeneration (similar to that in conventional SCRs) and the thyristor switches into conduction; it remains latched on even when the light is removed. In dc applications, LASCRs can be turned off (reset) by momentarily interrupting anode current, while in ac applications anode voltage polarity reversals take care of that automatically.

Note that most LASCRs also feature a gate lead for conventional electrical triggering. LASCRs are most sensitive to light when the gate terminal is left open, as in Figure 8(a), but a resistor can be connected between gate and cathode to lower the light sensitivity, as in Figure 8(b). In applications where adjustable sensitivity to incoming light is desirable, a rheostat can be connected between gate and cathode, allowing the user to set the trigger point, as in Figure 8(c).

LASCRs are somewhat sensitive to heat. An increase in junction temperature reduces the intensity of light needed to activate the device. LASCRs are relatively low power thyristors, with maximum anode current ratings generally limited to 2 or 3 amps. In practical applications, they are often used to drive higher power devices such as electromechanical relays or conventional SCRs.

Photo-SCRs can be used in a wide variety of control applications ranging from domestic uses such as automatic lawn lanterns, door openers, light activated alarms and remote triggering of slave photoflash units, to industrial applications such as relays, motor control, optical tachometers and flame detectors; and computer applications such as punched card readers and light activated logic gates. An example of the latter is shown in Figure 9.

In this circuit, the load is powered only when light falls on LASCR1 and LASCR2. A parallel arrangement of photo-SCRs would produce an OR gate.

Some photon couplers (optoisolators) combine an LED with an LASCR within a sealed package, such as in Figure 10.

With voltage applied to the light emitting diode input, the light emitted by the LED triggers the LASCR into conduction. The photothyristor latches on and can only be switched off by interrupting anode current or reducing it below its minimum holding value i, H. Note that in this latching relay the LED input circuit is completely isolated (electronically) from the output load circuit.

This wraps up our discussion of silicon controlled rectifiers. In the next installment, we'll look at other types of thyristors, including the popular triac. ■

Special report: Advances in consumer electronics technology

- Fuzzy logic focusing systems
- Artificial intelligence comes to consumer products

By Carl Babcoke

To a computer-repair technician the phrase fuzzy logic brings instant thoughts of fuzzy numbers and pictures on the computer readout, either from a bad CRT or a board defect. Or perhaps the fuzzy characters are smeared and rounded by degraded frequency response or power-supply problems that mix the signals.

However, a new meaning for the words fuzzy logic now is created with the news from Japan of the excitement in many engineering departments of a new way of helping internal calculators/computers perform with fewer errors when handling unpredictable analog signals. Where fuzzy thinking in a human causes errors, "fuzzy thinking" in an analog-to-digital converter reduces errors.

This fuzzy-logic concept is particularly well suited for television receivers, VCRs, TV cameras and camcorders, as explained in this preliminary report.

Fuzzy logic provides advanced camcorders such as this with a way to "decide" the most logical object on which to focus. This creates an accurate, human-like focusing system.

Sony's ASC feature

An early TV application of fuzzy logic appears in two new Sony color receiver/monitors—model number DV-27X BR50 (apparently a 27-inch picture) and its larger twin with a 32-inch screen.

In the 27XBR50, a variety of perfect-condition scenes is stored for comparison against the incoming program scenes. At 60 times per second, the Active Signal Correction (ASC) circuit samples 248 points of the output video for contrast, brightness, sharpness, color and noise. After the ASC compares the video image with the most-similar stored frame, the fuzzy logic circuitry aids in the decision to correct the picture quality or make no changes. If correction is needed, the ASC changes the dc voltages of the normal contrast, brightness, hue and color saturation circuits. Also, excessive picture noise activates the noise-reduction circuits.

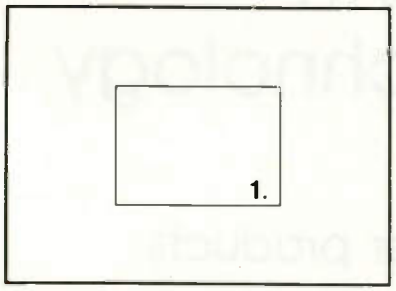
In most cases, the fuzzy logic operation is said to produce more natural, or more pleasing pictures. However, a switch is provided to turn off the ASC system and its fuzzy logic operation if you desire.

Fuzzy logic in cameras

Because fuzzy logic is a form of artificial intelligence, fuzzy-logic circuits are an important part of some new film cameras and camcorders. These circuits replace the computer chips used in other cameras to control the automatic exposure or automatic focusing adjustments of the lens. Because both the computer chips used formerly, and the new fuzzy logic do essentially the same func-

Babcoke is the consumer servicing consultant for **ES&T**.

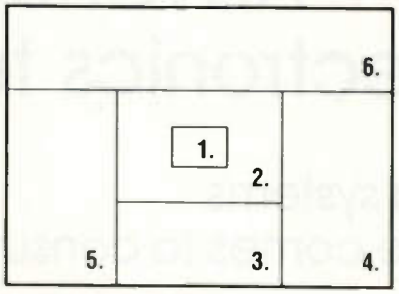
The following is adapted from information supplied by Fisher, describes how the fuzzy logic principle is implemented in one of their new camcorders.



DIGITAL I

Standard digital autofocus

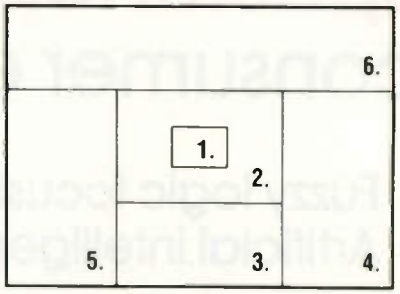
Digital evaluation of focus is made on one center-weighted portion of the CCD (charge coupled element). Objects off-center are impossible to focus on automatically, and moving objects go out of focus once they move off center.



DIGITAL II (FVC-720)

Six-active-zone autofocus

In this autofocus system, used in the FVC-720 camcorder, the CCD is electrically "divided" into six active segments. By "active" is meant that the output signal strength of each segment is independent of the other segments. While this allows for quick response and better focusing than simple center-weighted designs, two off-center objects at different distances may cause some oscillation between focusing (as with the standard digital).



DIGITAL III FVC-880

Fuzzy logic

Fuzzy logic (as featured in the FVC-880 camcorder), allows the signal output from each of the six segments to be evaluated instantly. The strongest signal from any segment is quickly put into steady focus regardless of its movement off center. No other focus system can adapt to off-center or moving objects in the same way that a camera equipped with fuzzy logic can.

tions, it is helpful to show the simplified operation of the old and the new separately.

Computer chip

As with all computers, a camera computer makes all decisions via logic voltages which are high or low, but never at any point between. These highs and lows are the equivalent of yes or no.

Typically, the chip computer is programmed for one specific desired answer (the amount of light that's required to expose the film) for each combination of film speed and open-shutter time (yes). When the computer finds the light level is higher than specified for the combination (no) it will reduce the light level a small preset amount by closing the lens aperture slightly. If the light level is still too high, the camera reduces it again by that same preset amount. This same sequence is repeated over and over very rapidly until the light level is correct (yes) and the computer rests. All is ready for a picture to be taken.

With sufficient computer power, this system can be very satisfactory, except for a few conditions. Rapidly varying light levels require the operator to wait long enough to determine when the exposure is made and locked. However, the worst offenses occur with camcorders because the time delay of the exposure mechanism is added to the delay of the imaging device, causing very noticeable changes of picture brightness until the camera is looking steadily at a scene.

Fuzzy logic for exposure

Fuzzy logic operates differently, of course. Instead of moving the light intensity up and down in tiny steps, as the conventional computer chip does, the fuzzy-logic computer might ask electronically, "On a scale of bright-to-dark, where is the present reading?" This reading is judged against the previous reading, and if it is approximately the same, the fuzzy computer is likely to take no corrective action (which is racheting up or down as needed). Therefore, in this case the aperture will not be disturbed.

This provides several advantages. Consecutive pictures should have identical exposures with reduced minimum time between each. Also, the exposure should be more even (especially with camcorders) if the main subject moves rapidly or is removed from view.

Traditional autofocusing

Any autofocus system should produce a higher percentage of correctly focused pictures, if that camera could find out quickly (with a minimum of mistakes) which object or person is the principal subject of each scene—the one the photographer himself would select with manual focusing—and then focus on it.

Traditional autofocusing systems must operate by a rigid set of rules when selecting the point of focus. With a single autofocus sensor, the camera always focuses on the center of each picture. This is simple, and it's used in most point-and-shoot lower-price autofocusing models. However, the system has one disturbing problem. What to do if you want to focus somewhere else? For example, assume two people are standing about three feet apart. To see them

both, the camera focuses on the space between, and the wall behind them is in good focus, but both people are badly blurred. Obviously, this is not the best answer for an expensive camera.

Traditional logic for focusing demands more than one or even two sensor areas. Therefore, the logic must select the most likely reading from three (minimum) horizontally-arrayed auto-focus light sensors and adjust the focus to that distance. Which of the three readings should be used? Logic comes to the rescue.

Most simple of the situations is that some cameras arrange for focusing on the nearest of the three distance readings. Some (as explained) are programmed for the center reading. A more complex system is based on examples from the Canon company.

Here are the most simple conditions of a three-zone system:

- When the left distance is shortest, the principal subject is assumed to be at the left, and receives the best focus.
- When the center distance is shortest, the subject is assumed to be at the center, and the camera is focused there.
- When the right distance is shortest, the subject is assumed to be on the right, and the camera is focused there.

There are many more similar but more complex rules for actual operation of a good camera using traditional logic.

Fuzzy autofocusing

Fuzzy logic might use rules similar to the preceding ones, but the solution is stated as a probability. In effect, the fuzzy-logic system assigns a value that is proportional to the extent that the data meets the rule. For example:

- When the left distance reading is shortest, the probability is high that the desired subject is at the left.
- When the center distance is shortest, the probability is high that the desired subject is in the center.
- When the right distance is shortest, the probability is high that the desired subject is at the right.
- When the left/center/right measure far/medium/near, the probability is high that the desired focus subject is at the center.
- When the left/center/right measure near/medium/far, the probability is high that the desired object for focusing is at the center.

What's the future of fuzzy logic?

With these breakthroughs of fuzzy logic and its type of artificial intelligence in more cameras and electronic products, we expect cameras (for example) that perform many computer-like functions and appear to be thinking like a human photographer, but faster and more accurately. One writer speculates about a future camera that, when confronted with an unsolvable choice between two focus points, checks for the possibility that depth of field would cover both. If it would not, the camera checks the amount of film remaining. Then, if there's enough film, the computer makes two exposures automatically, one for each focus point.

Based on present trends in the industry, fuzzy logic will soon be inside many top-of-the-line cameras, camcorders and color television receivers.

Books

Industrial Electronics For Technicians, by Sam Wilson; Tab Books; 350 Pages; $24.95.

This hands-on reference explains the theory and applications of industrial hardware from the technician's perspective. According to the publisher, it contains tests, measurements and troubleshooting procedures; theory and applications of transducers; analysis of closed-loop systems; applications and concepts of robotics; and techniques of automation, including CAD, CAE, and CAM.

Tab Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138. Also available from ISCET, 2708 West Berry St., Fort Worth, TX 76109; 817-921-9101.

Telecommunications, by Warren Hioki; Prentice Hall; 428 pages; $45.80.

The intent of this book is to provide the reader with the technical aspects and background material on the subject of telecommunications, one of the fastest growing industries in the world. A broad range of topics is covered without the intricate details of mathematical derivations and proofs. Instead, fundamental principles are emphasized in a simplified, yet comprehensive and practical manner. To achieve this, numerous sketches with detailed explanations are included throughout, all of which are aimed at providing the reader with the practical knowledge deemed necessary for today's telecommunications engineer and technician. Intended primarily for use as a college text, the book covers such subjects as transmission codes, terminals, serial interfaces, the telephone and the telephone network, modems, data communications protocols, local area networks, noise and fiber optics.

Prentice Hall, Englewood Cliffs, NJ 07632; 201-767-5937.

Electricity and Electronics: A Survey - Second Edition, by Dale R. Patrick and Stephen W. Fardo; Prentice Hall; 564 pages; $39.60.

Electricity and Electronics is an introductory text that explores many aspects of electricity and electronics in a very basic and easy-to-understand way. According to the authors, the key concepts presented in this book are discussed using a "big picture" or "systems" approach that greatly enhances learning. Many applications, testing procedures, and operational aspects of equipment and devices are discussed in this comprehensive textbook. The use of math is kept to a minimum and discussed clearly through applications and illustrations. The book is divided into two sections, one dealing with the basics of electricity and the other providing an overview of electronics.

Prentice Hall, Englewood Cliffs, NJ 07632; 201-767-5937.

Industrial Electronics CET Exam Study Guide, by Sam Wilson; Tab Books; 366 Pages; $24.95.

Sample questions, practice tests, programmed reviews and valuable hints are designed to help the reader use study time efficiently in studying for the Industrial Electronics CET Exam. Provides a review of the topics found on the certification exam, and a 75-question section that's designed to simulate the actual certification exam.

Tab Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138. Also available from ISCET, 2708 West Berry St., Fort Worth, TX 76109; 817-921-9101.

Photofact

GE
2760-1 ..... 26GC10OCO1, 2GC4OOKO1, 26GC4O1KO1, 26GC48OKO1, 2GC481KO1, 2GC482KO1, 26GT44OFO1, 26GT441FO1, (CH. CTC149C/G/H)

MITSUBISHI
2757-1 ..... CS-261OR, CS-2611R

PANASONIC
2758-1. CTL-2053R (CH. ADP165)

QUASAR
2759-1 ..... SP275ODK (CH. AEDC166/GL7SI)

RCA
2754-1 ..... F2612OWNFO1, F26121DGFO1, F26122MKFO1, F2716OWNFO1, F2717ODGFO1, F27171CPFO1, F27172MKFO1, F3122OWNNO1, G2635OTNPO1, G26351TNPO1, G26352TKPO1, G26359HPMO1, G27331TNMO1, G27335TKPO1, G27339HPMO1, G27339HPPO1, G27371TNMO1, G27371TNPO1, G27372TNPO1, G27373CPPO1, G3112OTNNO1 (CH. CTC159B/M/S)

SANYO
2758-2 ..... 52C1OOA (CH. A7G-1OOAO)

SAMSUNG
2754-2 ..... TC254OS

SEARS
2755-1 ..... 564.42313950/51
2756-1 ..... TC9820S, TC9823S

SONY
2757-2 ..... KV-27TW70 (CH. SCC-C7OD-A)

SYLVANIA
2759-1 ..... RKJ178WAO1, RKJ19OWAO1, RKJ195CHO1, (CH. 2OF1O1/1O5/109)
2760-1 ..... RAJ147WAO1, (CH. 13A3O4)

ZENITH
2755-2 ..... D1914W, SD1914W, SD19155S/W

Test your electronics knowledge

By Sam Wilson, CET

Each of the answers in this test is either an abbreviation or an acronym used in electronics.

1. Design with the help of a computer_____.

2. Method of delivering information directly to memory without going through the microprocessor _____.

3. Another name for IEEE-488 _____.

4. Chemical symbol for lead_____.

Wilson is the electronics theory consultant for ES&T.

5. An SCR that is turned on with light_____.

6. Abbreviation for multiplexer _____.

7. Motorola's abbreviation for their UART_____.

8. Chemical abbreviation for silicon _____.

9. Interference in the radio frequency spectrum _____.

10. Field effect transistor that can be used as a power amplifier _____.

11. Modulation system in which data is converted to binary digits _____.

12. Terminal on a RAM IC used to determine whether data is going in or coming out_____.

13. Acronym for an electronic system that permits a telephone/computer link_____.

14. A manufacturer that supplies parts and equipment for manufacturing _____.

15. The fastest logic family_____.

(Continued on page 58)

Resonance-with a little help from Norma

By Sam Wilson

Jump ahead for a moment and look at the circuit in Figure 3. That is where this discussion is heading.

It all started years ago when RCA put a parallel-tuned circuit in one of its systems. I got several letters from technicians asking how the resistor in that circuit was able to tune the resonant frequency.

I explained it as well as I could without using math. Then, since I was writing all of the CET tests at that time I put a question in about the circuit of Figure 3. All I asked was: Can the circuit be tuned with one of the resistors? Since my explanation had been in the Technical Notebook it only went to CET's. No one taking the CET test had seen it. So, I printed a form letter with the explanation and sent it to anyone interested enough to ask.

Later, I made a heroic effort to explain it (again without math) in a national publication. It went over like an iron dirigible.

Not long ago I put the question in *Test Your Electronics Knowledge* in this publication. That brought on another surge of letters.

I was talking to my wife (Norma) about this:

Sam: I can't understand why this is such a mystery?

Norma: Maybe you aren't explaining it well enough.

I gave that some serious consideration and I have made an important decision. I'm not going to talk to her about these things any more. That will be enough of that!

Wilson is the electronics theory consultant for ES&T

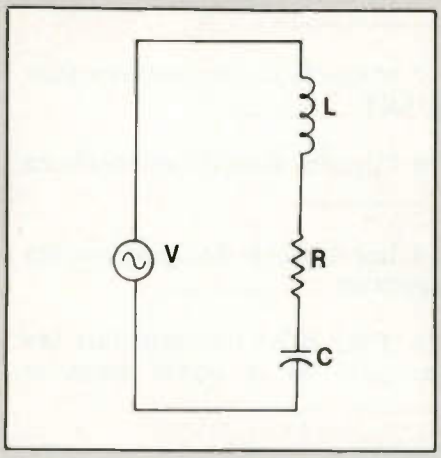


Figure 1.

This month I will try a different attack. I will use some of the basic math that I have been sidestepping. The math is not especially difficult, and, I believe it will be helpful for getting a better understanding of parallel resonance. At least, the result will be helpful. Fasten your seatbelts!

Why Johnny can't understand parallel tuned circuits

I want to make it clear that I am not referring to my friend Johnny in Warren, Ohio. When I wrote *Why Johnny Can't Understand Capacitors* some people got the idea that I was poking fun. Actually, the title is a takeoff on a very good book titled *Why Johnny Can't Read*. I think the author of that book gave the same reason as I have been giving.

The study of tuned circuits usually starts with a explanation of the series-resonant circuit of Figure 1. By one definition, resonance in a series circuit occurs when the voltage across the inductor equals the voltage across the capacitor:

$$IX_L = IX_C$$

Dividing both sides of the equation by I:

$$X_L = X_C$$

or:

$$2\pi fL = 1/2\pi fC$$

If you solve this equation for f you get the resonant frequency [f_r]:

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

So far so good. For the simple parallel-tuned circuit of Figure 2. resonance occurs when the current through the inductive branch equals the current through the capacitive branch:

$$I_L = I_C$$

or:

$$V/X_L = V/X_C$$

Dividing both sides of the equation by V gives:

$$1/X_L = 1/X_C$$

If you substitute $2\pi fL$ for X_L and $1/2\pi fC$, and solve for f, you get the same equation for the resonant frequency [$f = 1/2\pi\sqrt{LC}$].

There is no resistance in either branch, so, there is no resistance in the resonant-frequency equation for the parallel circuit of Figure 2.

Unfortunately, this is where technical training often stops. That is the reason the circuit of Figure 3 isn't being understood.

Parallel-tuned circuits with resistive branches

Now consider the circuit of Figure 3. The resistors affect the current in each branch. Therefore, the resistance does affect the resonant frequency!

Before I go any further, I want to define some very important terms used in circuits.

Conductance - is a measure of the ease with which a current can flow through a resistive circuit. The sym-

bol for conductance is G. Conductance is the reciprocal of resistance. So, $G = 1/R$.

Susceptance - is a measure of the ease with which current can flow through a reactance. The symbol for susceptance is B. Susceptance is the reciprocal of reactance. So, $B = 1/X$ where $X = X_L$ or X_C.

Admittance - is a measure of the ease with which a current can flow through a circuit. The symbol for admittance is Y. Admittance is the reciprocal of impedance. So, $Y = 1/Z$.

The usual procedure for determining the resonant frequency is to set the admittance of the R-L branch equal to the admittance of the R-C branch.

One way is to start by setting the currents in the two branches equal:

$$I_L = I_C$$

The currents in the branches are equal to the voltage across the branch divided by the branch impedance:

$$V/Z_L = V/Z_C$$

The voltage can be divided from both sides:

$$1/Z_L = 1/Z_C$$

You should recognize that as being the same as setting the admittances equal. In other words, $Y_L = Y_C$.

The admittances equations for the branches are given here:

$$Y_L = X_L/(R_L^2 + X_L^2) \text{ and } Y_C = X_C/(R_C^2 + X_C^2)$$

These admittances are obtained by taking the reciprocal of the impedance for each branch (written with j operators) or, $[R_L + jX_L$ and $R_C - jX_C]$.

From this point I will give you the main steps in developing the equation for resonant frequency. If you are into math you will not have any trouble going from step-to-step.

If you are a bit rusty, you will need a more detailed explanation of how each step is obtained. I will gladly send you the complete detailed step-by-step procedure if you will send a self addressed, stamped business envelope. There is no charge.

If you are one of those who just can't tolerate any math in your life, jump ahead to the equation for f_r and be sure to read the explanation of what that equation means.

Start here:

$$X_L/(R_L^2 + X_L^2) = X_C/(R_C^2 + X_C^2)$$

To solve the admittance equations for f_r, start by setting the product of the means equal to the product of the extremes. In slang: "cross multiply". The result is:

$$(X_L)(R_C^2 + X_C^2) = (X_C)(R_L^2 + X_L^2)$$

Replace X_L with $2\pi fL$ and X_C with $1/2\pi fc$.

$$(2\pi fL)[R_C^2 + 1/(4\pi^2 f^2 C^2] =$$
$$(1/2\pi fC)[R_L^2 + (R_L^2 + 4\pi^2 f^2 L^2)]$$

Solve for f^2. You will get:

$$f^2 = [1/(4\pi^2 LC)]$$
$$[CR_L^2 - L)/(CR_C^2 - L]$$

Take the square root of each side of the equation to get f. That is actually f_r. In order to get your equation into the form shown here it may be necessary to multiply the numerator and denominator of the fraction by -1.

$$fr = [1/2\pi\sqrt{LC}]$$
$$[\sqrt{(CR_L^2 - L)/(CR_C^2 - L)}]$$

What does this equation tell about the circuit?

As you can see, the resonant frequency depends upon the values π, L, C, R_L and R_C. The resonant frequency can be changed by changing R_L and or R_C. Another way of saying that is: If R_L or R_C is a variable resistor it can be used to tune the circuit.

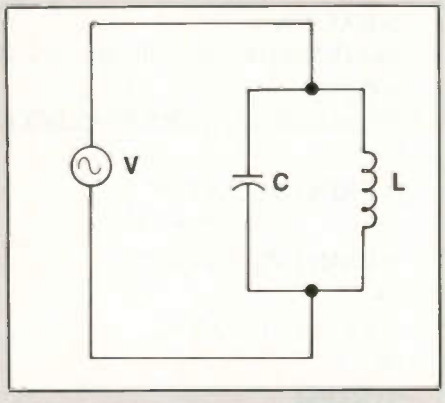


Figure 2.

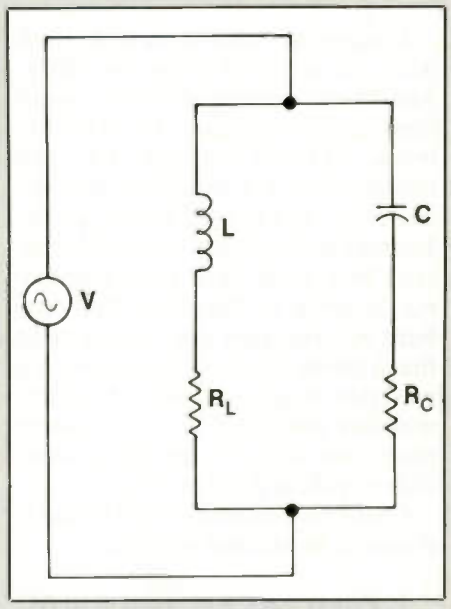


Figure 3.

The equation also tells some other important facts about the circuit.

- The value under the radical can be negative for certain values of resistance, capacitance, and inductance. When the value is negative there is no resonant frequency because you cannot find the square root of a negative number. Compare that with the circuits in Figures 1 and 2 which always have a resonant frequency when the values of the components are known.
- If the numerator under the radical is equal to zero then f_r is equal to zero. I would suppose that would mean the circuit is resonant too but, I'm not sure you could call a resonant frequency.
- If the denominator under the radical is zero the resonant frequency would be infinitely high. If you can get me an oscillator with an infinitely-high output frequency I will build the circuit and prove it is resonant.

In the next issue I will write about some unusual facts concerning resonant circuits. ■

Servicing modems

By Glenn R. Patsch

Modems are now commonly used with the personal computer (PC). Just like everything else they sometimes require servicing. There are external types of modems. External modems are in a small box that attaches to the PC with a serial cable. Internal modems are on an adapter card that plugs into the computer bus. Internal modems have their own built in serial port and require only that a phone line be connected with a modular telephone jack. External modems also have a small power pack that connects to the modem with a cable and connector.

Check the following when troubleshooting an external modem:

1. Power pack is plugged in to AC power and cable is connected to modem. Use a voltmeter to check that power pack is working.

2. Power switch on modem is ON. Not all modems have a power switch. One or more modem lights should be on to indicate that the power is on. Hayes Smartmodems have a MR (modem ready) light that indicates the power is on. The HS (high speed) light will normally be on indicating the modem is set to work at its highest speed.

3. Serial cable is securely attached to both the modem and the PC. Check that the cable is plugged into a SERIAL port on the PC. The serial port on the PC is a 9 or 25 pin male connector. For testing use a straight thru 25 wire cable.

4. Some modems have configuration switches behind the front panel. These should only have to be checked if the modem is being set up for the first time.

5. Telephone cable is attached to the modem and the telephone jack. Make sure the telephone line is working by checking for a dial tone with a telephone. Some modems have two modular jacks on them. Usually it makes no difference which one you use, but sometimes one is for a telephone and it is disconnected when the modem is in use. The two jacks are normally labeled LINE and PHONE. Be sure to connect the LINE jack to the telephone line. Modular connecting cables go bad so have a spare cable and use it to make sure the cable is good. The little tabs that lock the cable often break and the cable is not firmly held in the jack.

6. Adjust the volume control knob on the modem. Some modems allow the volume of the speaker to be controlled only by software commands.

Check the following for an internal modem:

7. There is a DIP switch or jumper that controls the serial port used by the modem. Modems for the IBM PS/2 set the serial port in the configuration program. Since most PCs have at least one built in serial port usually set the modem for COM2. If you suspect a conflict with another card that has a serial port, try removing the other adapter card and test the modem. Serial ports will have 9 or 25 pin male jacks. Be sure to power off the PC before removing or inserting a card.

8. Modem card is correctly seated in PC bus. Remove the modem card and reinsert it. Be sure to power off the PC before removing or inserting a card.

Assuming you have the following at this point:

- Working telephone line with a known good modular cable.
- Working serial port and known good serial cable for an external modem. Non-conflicting serial port selected for an internal modem.
- Power to the external modem with one or more lights on.

Try to isolate which one of the above three items is the problem. Next check the modem to see if it is working.

You will need some communications software to test the modem. I use PROCOM software by Datastorm Technologies. It is easy to use and will emulate several different terminal types and support almost all the file transfer protocols. If you do not have any modem software you can use BASICA or GWBASIC which came with DOS. If you are using IBM PC-DOS you have BASICA and if you are using MS-DOS you always have GWBASIC. Enter GWBASIC or BASICA at the DOS command prompt. When using BASIC the ok indicates the command was accepted with no errors:

```
>MODE COM2:1200                    set serial port 2 to 1200 baud
com2:1200,e7,1,-                   PC responds with
>BASICA                            start BASICA
The IBM Personal Computer BASIC
>OPEN
"Com2:1200,e,7,1,RS,CDO,DSO"       TR light on
ok
>PRINT #1, "AT"                    RD and SD modem lights flash
ok
>PRINT #1, "ATDT"                  dial tone, OH light on
ok
>PRINT #1, "AT"                    hang up, no dial tone
ok
SYSTEM                             return to DOS, TR light off
```

Patsch is a consultant specializing in the selection, evaluation, and installation of IBM personal computer and compatible hardware and software.

Almost all modems now use the Hayes command set. The commands below are for Hayes and compatible modems. The modem test commands:

AT-attention, modem ready to receive commands. SD (send) and RD (receive) lights flash.
ATDT-dial touch-tone, should hear dial tone OH (off hook) light should be on.
AT-send AT or just press enter key. Cancel dial tone, OH light off.
ATM1-turn on speaker.

Some modems have the speaker switched off with software so to listen for the dial tone, use ATM1 command to turn on the speaker, then ATDT.

No dial tone

If you cannot get a dial tone, but do see the RD (receive data) and SD (send data) lights flash, suspect the phone line jack. In many cases the small fingers that contact the jack are bent or broken. Try carefully rebending the fingers or bypassing the jack with jumper cables to confirm the jack is the problem.

No lights flashing on modem

If nothing seems to be getting to the modem, suspect the 25 pin connector on the modem. In many cases the jack has separated from the PC board inside the modem or some of the pins have been broken. Its much easier to fix an external modem since the serial cable may be bad. This is easy to test if you have a serial cable you know works.

When all else fails

If everything seems to be working, then its time to open up the modem and take a look inside. Most of the time there is a tiny crack in the PC board (modem was dropped) or one of the connectors (phone, power, or serial) is not attached.

Most modem repairs are pretty straightforward and the challenge is to isolate the problem. Remember modems need power, telephone and a serial port. Isolate which one of these is not working. Now you can test a modem and fix many of the common problems. ■

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Using a function generator to troubleshoot audio problems

By the ES&T Staff

One of the most common methods of troubleshooting defective audio equipment is to inject a signal from a function generator at the input of the device under test. An oscilloscope is then used to check the output at each stage, starting nearest the input and moving toward the output. The stage which has no output or a distorted output is presumed to be defective. A typical application is presented in Figure 1. The input signal is usually a sine wave of low enough amplitude so as not to produce undesired clipping in later stages. Also, there is usually no dc offset present, although, as shown in the figure, most amplifiers incorporate an input capacitor to block any dc component.

The technique is equally applicable to non-audio equipment. Most function generators can produce signals up to 1MHz, with some models capable of 5MHz or higher.

Troubleshooting by signal substitution

A variation on the signal tracing technique is to inject an audio signal at various points in the circuit under test, to substitute for the normal signal. In this technique, the signal is first injected nearest the speaker and is moved toward the audio input one stage at a time until no sound is heard from the speaker. The stage that produces no sound is presumed to be defective.

One precaution: make sure that the dc offset matches the normal operating voltage at each point of signal injection. Improper dc offset could bias a normally operating stage to cutoff and make it appear defective. It could also damage the circuit under test. A coupling capacitor may be used to block the dc offset and allow the signal to float at the dc level of the point of injection if desired.

The signal amplitude should simulate the normal signal levels used in the circuit where signal is being injected.

This technique is also applicable to non-audio equipment. In this case, the output will not be audible, as in the case of an audio circuit so for an output you can sense, connect an os-

This article is based on "B&K Precision's Guidebook to Function Generator's," published by B&K Precision, Chicago, IL.

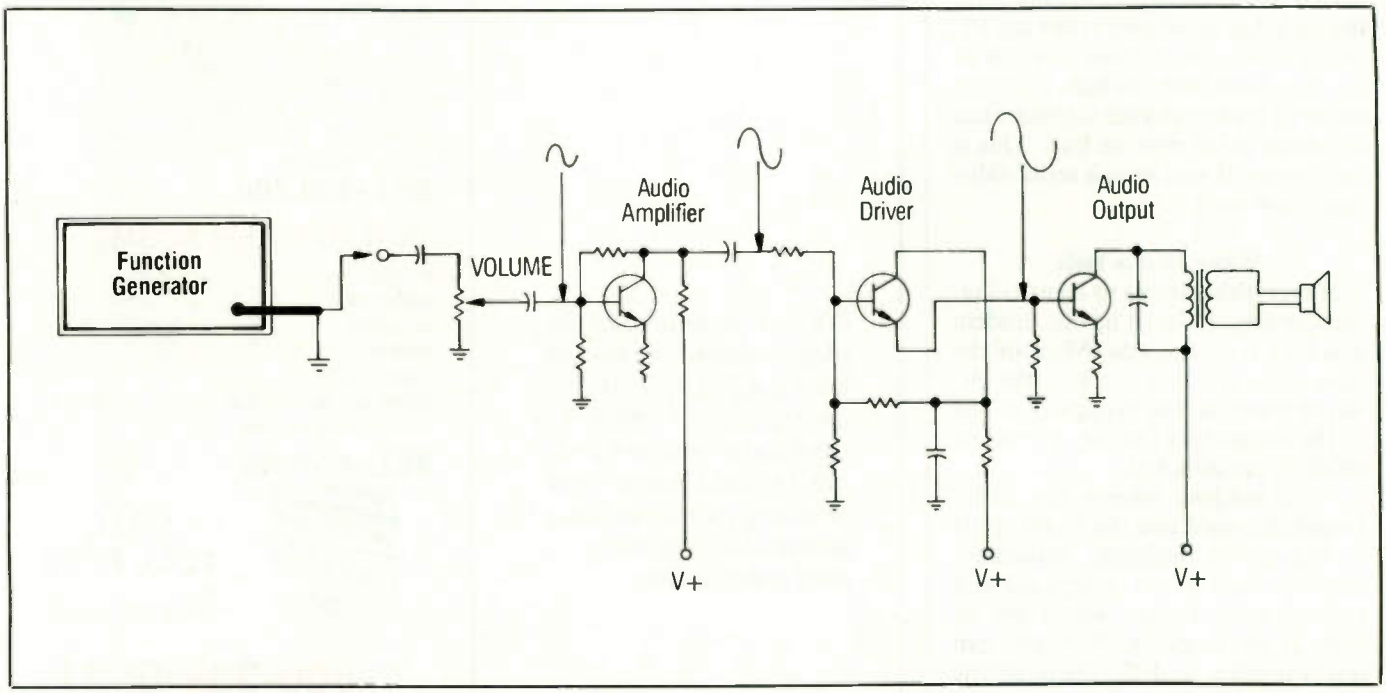


Figure 1. Possible signal tracing points in a simple amplifier.

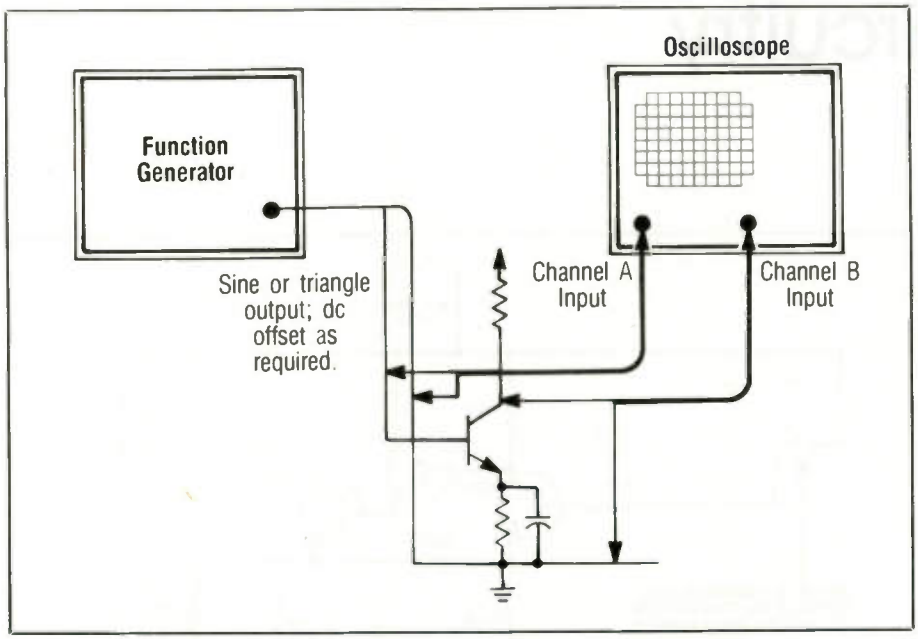


Figure 2. Use of a function generator as combined bias supply and signal source.

cilloscope, voltmeter, or any other device which will indicate the presence or absence of output.

If the equipment under test is already handling one or more signals that could be confused with the test signal, use sweep or tone burst operation on the function generator to produce unique sounds or signals. These should be easily distinguishable from any other signals that may be present.

Using a function generator as a bias and signal source

Most modern function generators are able to superimpose a dc offset voltage on their ac signal output. A shown in Figure 2., this capability can be used to bias a transistor amplifier under test as well as to furnish the ac component of the input signal. By observing the amplifier output of an oscilloscope, the amplitude and bias of the transistor can be optimized for maximum undistorted output. By varying the dc offset, the effects of various types of bias (class Class A, B and C) can be determined.

Amplifier overload characteristics

The overload point for some amplifiers is difficult to determine using a sine wave input. The triangle waveform is ideal for this type of test because any departure from absolute linearity is readily detectable. Using the triangle output, the peak overload condition for an amplifier can be easily determined. This overload condition is shown in Figure 3. ■

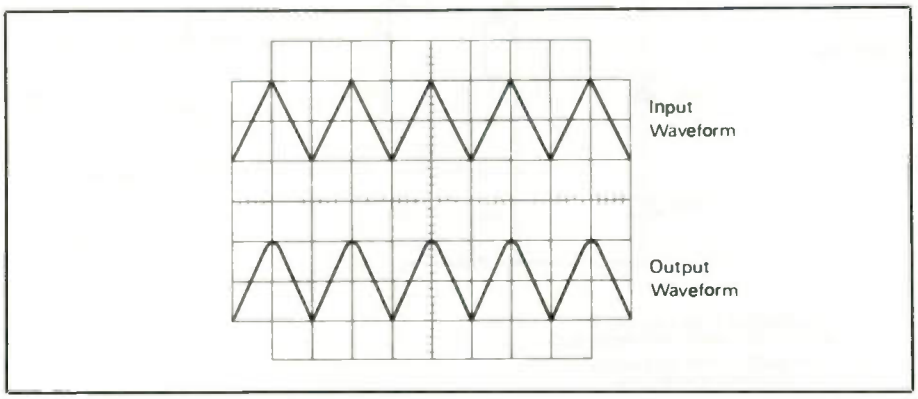


Figure 3. Amplifier overload characteristics.

Reel servo circuitry

By Stephen J. Miller

Have you ever had on of those weeks where every other VCR was a tough dog or a strange failure? Well, I sure have. Late one muggy Friday afternoon, after struggling through just such a week, I found that my final job would be a Sharp VC-584U that was eating tapes. I was grinning from ear to ear as I started what I thought would be an easy idler replacement. Finally! An easy one to finish out a tough week.

On the test bench, my smiles quickly turned to frowns. This job was not going to be a simple idler replacement. Fast forward was sluggish, which is normal with a worn idler. However, when in play, I did not hear the characteristic whine of the reel motor as it spins against the hard, glazed surface of a worn idler. In fact, the reel motor made no noise at all because it wasn't even running! Instead of an easy idler replacement, I was about to embark on a journey through the murky, forgotten areas of reel servos and reel drive circuitry.

Reel servo and reel motor drive circuitry is necessary in all VCRs employing a separate reel motor. Some VCR designs drive the reels from the capstan motor via a belt and clutch assembly, while other designs eliminate the belt and clutch and replace them with a separate reel motor. Either method has its advantages and disadvantages. Using the belt and clutch method complicates the capstan motor control circuitry. By employing a separate reel motor, the capstan circuitry is simplified, but an additional reel motor circuit must be added. Over the years, most manufacturers have produced both types of machines. Often the very high end equipment will employ a separate reel motor to allow precise reel rotation during editing and special effects functions.

Miller is a senior bench technician for a Lancaster, PA based repair company

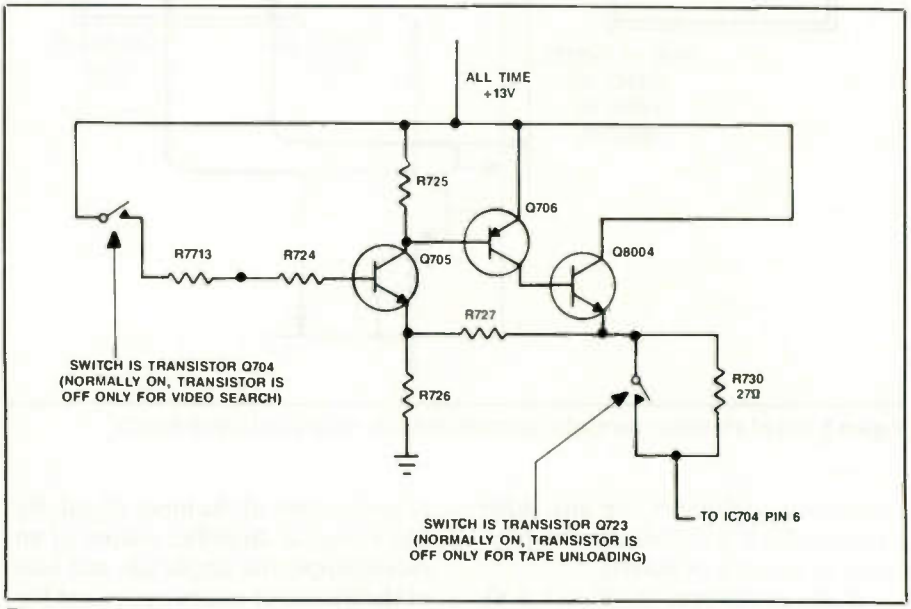


Figure 1.

The Sharp VC-584U employs a separate reel motor and a rubber tire idler to produce reel rotation. Both the motor's speed and torque vary in direct proportion to the applied motor drive voltage. Thus an increase or decrease in the motor drive voltage signifies a corresponding change in both the motor's speed and torque. B+ power is sent to the reel motor

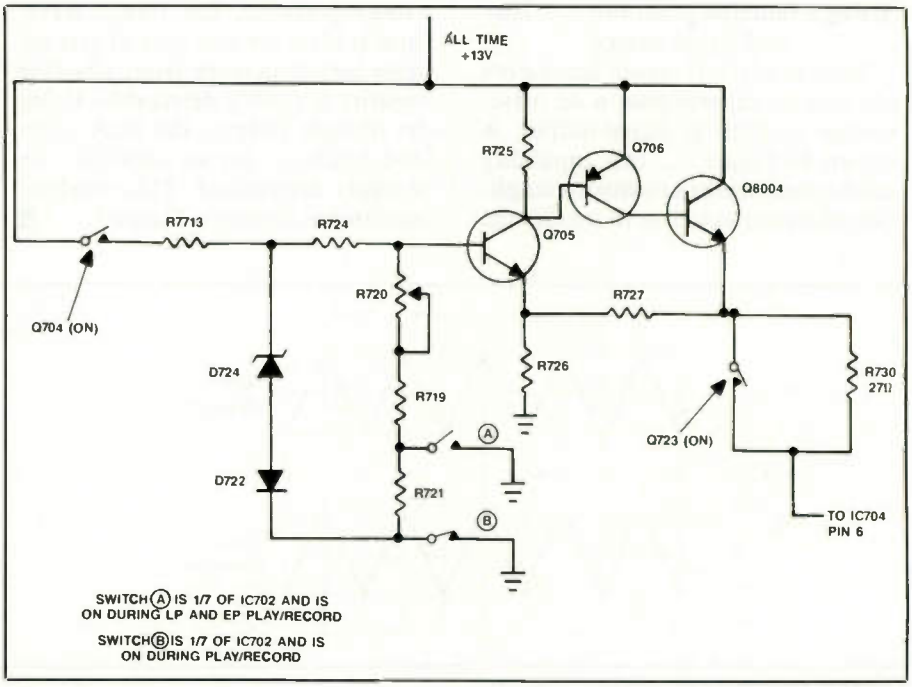


Figure 2.

via IC704, a TA7267P. This IC is only a switching chip and does not produce or regulate the reel motor voltage. IC 704 can be thought of as an electrically operated double-pole, double-throw (DPDT) switch. This type of switch enables the VCR to reverse the motor terminals for the rewind operation. A detailed analysis of this IC is given in the accompanying sidebar. Keep this information handy as many other manufacturers, such as GE, Toshiba, and MGA, have employed this IC in a variety of different circuits.

The reel servo in this Sharp VCR must produce four different levels of controlled reel torque:

1. Fast forward and rewind torque.
2. Play or record torque (varies with tape speed).
3. Video search torque.
4. Limited tape take-up torque during tape unloading.

Each of these voltages of torque requires a different reel motor drive voltage. The system control circuit employs a variety of switching IC's and transistors to perform all these modes. Other models of VCR's can have even more reel modes depending on the VCR's features. We will concentrate on these four types, as they are common to most machines. Because of the complexity of the circuit, we will show a simplified diagram for each type of reel torque. The simplified diagram will show only the components which are active in that mode.

Q705, Q706, and Q8004 form a non-inverting voltage regulator for the reel motor (see Figure 1). Q8004 is located off-board on a heavy metal part of the chassis. The emitter of Q8004 is the regulator's output terminal and is maintained at approximately 0.1V less than the base of Q705. Therefore varying the base of Q705 will vary the regulator output voltage and both the motor's speed and torque.

Figure 1 shows the diagram of the fast forward and rewind modes. In this mode, Q704 is turned on and the base of Q705 is connected to the +13V supply via R7713 and R724. This produces approximately +12V at the regulator's output. This +12V

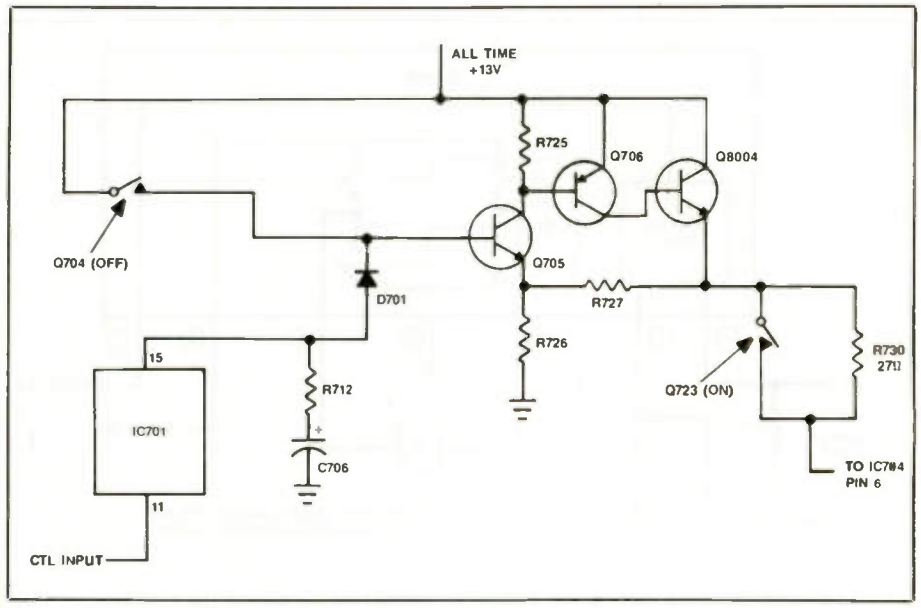


Figure 3.

is passed through Q723 which is normally on and is applied to the motor switch IC, IC704.

In the play or record modes, reel torque must be reduced (see Figure 2). Also, in this mode, the reel torque must be varied as the tape speed changes. This Sharp machine uses two different play/record reel torques, one higher torque for the SP mode and a lower torque level used in both the LP and SLP modes. Proper reel torque is very important in either play or record. Too much torque will stretch and damage the tape, while too little torque will not take up slack tape fast enough, producing tape spillage and damage.

Providing this precise reel torque is accomplished by applying a tightly regulated voltage to the base of Q705. D724 and D722 produce a regulated +9V supply from the +13V supply. This +9V is applied to R724, R720, R719, and R721, a voltage divider network. The output of this adjustable voltage divider network is applied to the base of Q705. By switching resistors into and out of this voltage divider network, the base

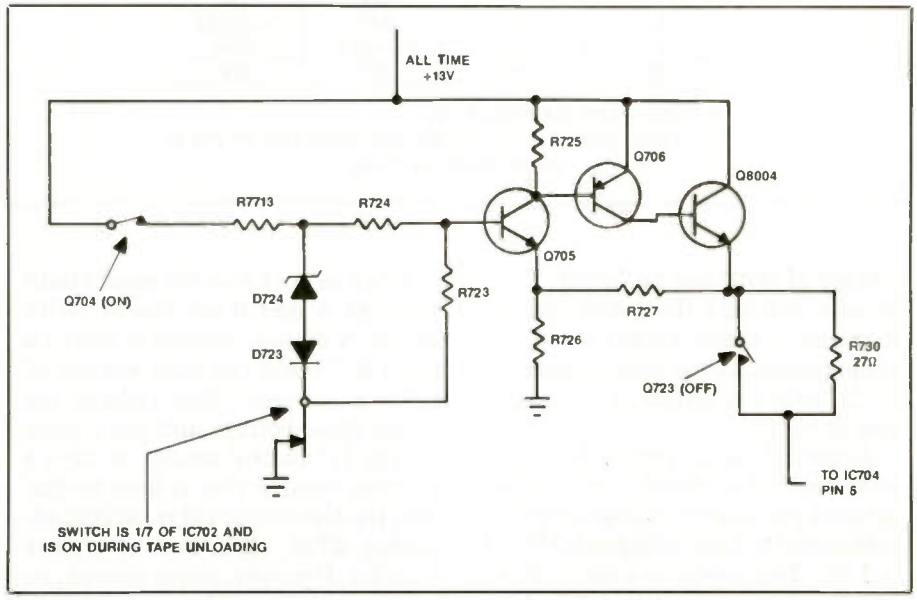
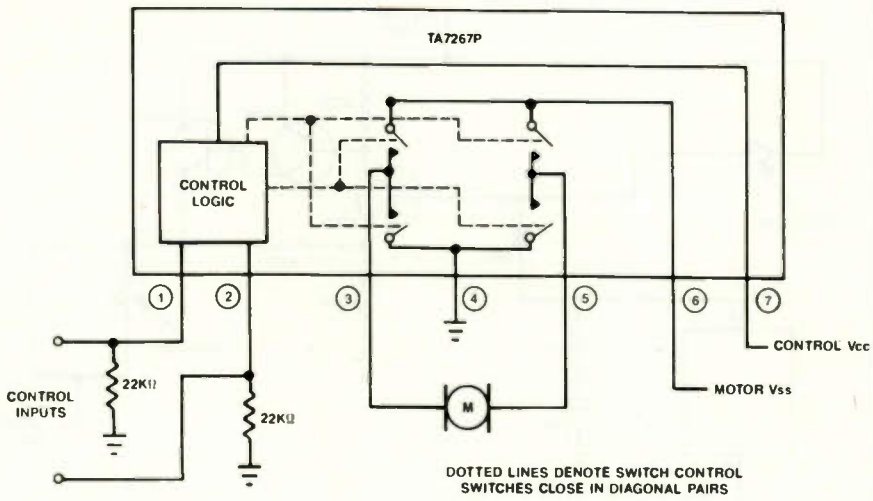


Figure 4.



In troubleshooting reel motor problems, start at IC704, the switching IC. First verify both the power control supply voltage on pin 7 and the motor drive supply voltage on pin 6. If these are present, check the control logic on pins 1 and 2. Correct control logic and power supplies, but no output voltages on pins 3 and 5, means IC704 is defective. Should the motor drive supply be missing on pin 6, check the reel drive voltage regulator (Q705, Q706, Q8004 and zener D724). If these components are ok, test the VCR in all four reel torque modes. By noting which modes work and the voltages in the defective modes, you can isolate the portion of the reel servo that is causing the problem.

Finally, don't forget that the rubber idler is the most likely component to fail. It should be replaced every 500 to 750 hours. Often, idlers on the verge of failing will exhibit intermittent symptoms. In machines like this Sharp, the video search mode can be used to help locate marginal idlers. Remember that in video search the reel motor alone pulls the tape through the transport, and a good quality idler is needed to accomplish this. Therefore, if the reels stall out in video search, yet the reel motor can be heard running, then a marginal idler is indicated.

CONTROL LOGIC		MOTOR OUTPUT	
PIN 1	PIN 2	PIN 3	PIN 5
L	L	OV	OV
L	H	0.6V	Vss-0.6V
H	L	Vss-0.6V	0.6V
H	H	OV	OV

L = LOGIC LOW (TYPICALLY OV)
H = LOGIC HIGH (TYPICALLY GREATER THAN 60% OF PIN 7)
(9V IN SHARP VC-584U)

voltage of Q705 can be varied. This, in turn, will vary the motor torque. Remember, motor torque is directly proportional to the base voltage of Q723, which is turned on, and then sent to IC704.

In the SP mode, switch A is open and switch B is closed. The resistor network produces a voltage drop that maintains the base voltage of Q705 at +2.6V. This produces a motor drive voltage of approximately +2.5 which develops the correct reel torque.

When in the LP or EP modes both switches A and B are closed. With switch A closed, current is diverted from R721 and the base voltage of Q705 is lowered. This reduces the motor drive voltage and reel torque for the LP and EP modes. R720 is a variable resistor that is used to fine tune the reel torque value. Before adjusting R720, clean and/or replace the idler. If proper torque returns, no adjustment of R720 is necessary. Should adjustment be necessary, closely follow the procedure in the service manual.

In the video search mode, the pinch roller is retracted from the capstan and the capstan motor is turned off. Now the reel motor alone controls the tape movement through the VCR. While in the video search modes, the reel motor voltage regulator is controlled by IC701, a video search servo IC. IC 701 drives the base of Q705 via D701 (see Figure 3). By monitoring the playback CTL pulses, IC701 adjusts the base voltage of Q705 to produce the proper 5X video search speed. Again in this mode, Q723 is turned on and supplies the drive voltage directly to IC704.

In the tape unloading mode, sufficient take-up torque must be provided to rewind all the slack tape back into the cassette. Yet, too much torque will stretch or snap the tape. To control the reel drive voltage, a regulated voltage is supplied to the base of Q705 via a voltage divider network of R724 and R723 (see Figure 4). This is the same method used to regulate the play/record reel torque, only different voltage divider resistors are used. To further limit the unloading torque, Q723 is turned off in this mode. With Q723 off, all reel motor current must go through R 730, a 27Ω resistor. This limits the maximum reel torque.

Having covered the four modes of reel torque, let's return to the broken Sharp machine. In play, the motor terminal voltage was less than 0.75v (normally, it is approximately +18v). However the voltage at the emitter of Q8004 was correct at +25v. In addition, R730 appeared to be discolored from overheating. By now, the rest of you are probablly way ahead of me in troubleshooting this VCR. It took me a few additional minutes and some more voltage checks to realize that Q723 was electrically open! With Q723 open, R730 was never switched out of the circuit and the reel motor current was passing through this resistor in all modes, overheating it. This defect caused fast forward and rewind to be sluggish. When in play, this limited motor current couldn't even start up the motor. Replacing Q723, R730 and the drive idler put this VCR back into perfect working order. ■

Products

Uninterruptible power systems

Perma Power Electronics, Inc. has introduced local area network compatible uninterruptible power systems (UPS). The new UPS units are Novell-tested and approved and are compatible with other major LAN systems, including 3-Com and Ethernet, and with UNIX and XENIX, as

well as the MS-DOS, operating systems.

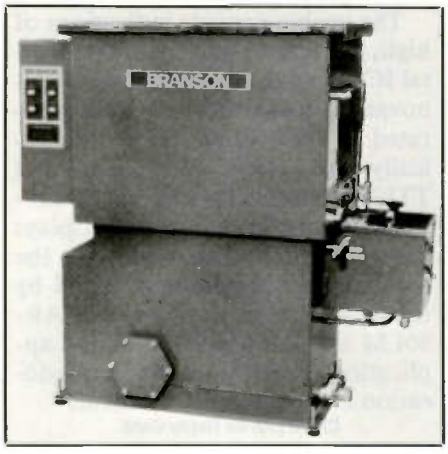
These models are designed to signal the loss or disruption of commerciai power, power restoration and power shutdown conditions. Many network and multi-user systems are equipped with a software program that can communicate messages to users and effect an orderly shutdown of the server upon receipt of the UPS signals, directly or through an optional monitor board or software interface program.

Perma Power offers separate interface cables to meet the specifications of the most popular LAN systems.

Circle (44) on Reply Card

Low-hazard degreasing operation

Ohmite Manufacturing Co., presents their new low-hazard degreasing operation which uses a special degreasing unit installed in 1989, that has reduced toxic air emissions, conserved energy, reduced water usage and lowered employee exposure to fumes. In addition, the new degreaser guards against potentially hazardous decomposition of solvent by protecting against low liquid levels.



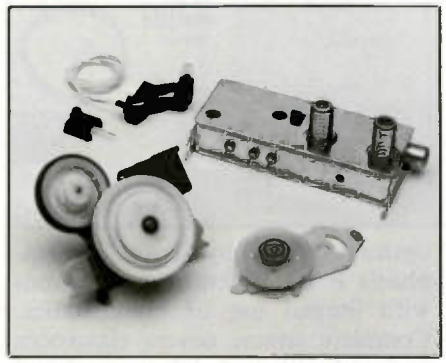
This unit uses a noncontributing solvent and has reduced toxic air emissions during degreasing by more than 50%. In addition, the solvent has a low boiling point which enables Ohmite to significantly reduce energy usage degreasing operations.

The new system also uses an automatic transport to lower parts into and out of the tank. This system reduces disruption of the tank's vapor blanket and eliminates the need for manual loading, which can expose personnel to fumes.

Circle (45) on Reply Card

Replacement VCR modulators

Philips ECG introduces nine new replacement VCR modulators, further expanding the Audio/Video product line. The modulators are described in an illustrated brochure containing comprehensive information which cross references the equivalent ECG



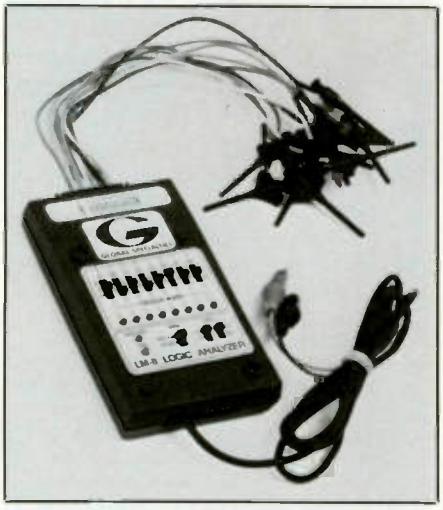
replacement to the original OEM part by VCR brand name and individual part numbers.

Consisting of quality components and accessories, the ECG audio/video product line is designed to meet the diverse needs of audio/video technicians. The product line includes audio test cassettes, demagnetizer and cleaning cassettes, video tension cassettes for VHS and Beta systems, VHS and Beta Video head assemblies, precision adjustment tools and test jigs, lubrication and cleaning kits, sensor lamps and photo-sensitive transistors.

Circle (46) on Reply Card

LM-8 hand held logic analyzer

Global Specialties announces the LM-8, a very low cost hand-held TTL logic analyzer that will replace multiple logic probes. Ideally suited for troubleshooting 8, 16, and 32 bit



microprocessor circuits, the unit has trigger word recognition allowing it to be substituted for more complex logic analyzers.

The unit has 8 input channels, an external clock input, and an oscilloscope trigger output. The captured data can be displayed by the built-in LEDs or on an oscilloscope. The number of channels can be expanded up to 32 by linking 4 probes together, and triggering from a 32 bit trigger word if desired.

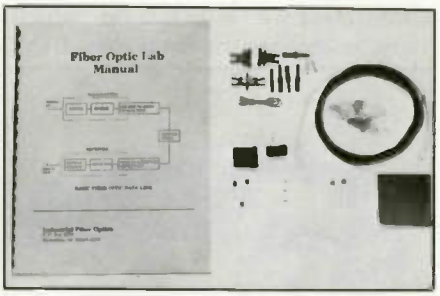
Each channel's trigger can be set to 0,1 or don't care. The logic status of each channel is continuously displayed on the LED's. Pulse stretching enables high frequency or short duration pulses to be viewed. The maximum clock frequency is 25 MHz, with pulses as narrow as 10M sec wide being captured and displayed.

The unit is circuit powered, and supplied complete with grabber leads for each data channel.

Circle (47) on Reply Card

Fiber optic course

A new 15 week course that fills the needs of vocational schools and universities or industrial training in fiber

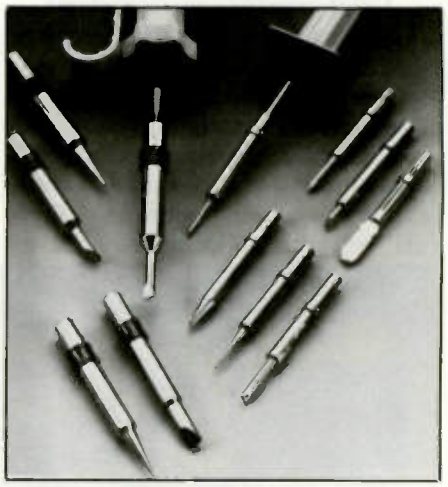


optics is offered by *Sintec*. The emphasis is on practical applications with limited use of mathematics. Complete course covers classroom and pad with text, lab manual and kit. Course has three main parts. Part one covers fiber optics theory as a transmission line and its advantages. Part two covers, fibers, sources, detectors, connectors, and splices. Part three details fiber optic systems, link system analysis, installation and hardware, applications and equipment.

Circle (48) on Reply Card

Soldering iron tips

A full line of soldering iron tips designed for all electronic and industrial assembly and field service soldering is available from *M.M. Newman*



Corp. Newman's series 140,180 and 50 tips come in a wide variety of styles including spade, chisel, needlepoint, cone, pyramid and hot knife shapes and different lengths to accommodate any type of soldering. Made from a special copper alloy for maximum strength and conductivity, they are nickel plated for easy wetting.

Designed for Antex miniature (.135" shaft diameter) and standard size (.178" shaft diameter) soldering irons, these tips slide-on over the heating element which is directly under the tip for optimum thermal efficiency. Totally interchangeable, these tips have no threads to bind or screws to freeze.

Circle (49) on Reply Card

High speed logic probe

Mare/American Reliance Inc., has released a pair of new, high-speed, Logic probes. The AR-80LM is a 20MHz model while the AR-85HLM is a 40MHz version. Each is a functional equivalent to 16 probes in a single unit.

The probes provide indications of high, low and pulsing inputs for digital ICs of up to 16 pins. Do to the innovative, custom IC design incorporated in these units, they automatically detect power and ground, and TTL and CMOS logic levels. A handy latch function detects and displays short-duration pulses and holds the indication until manually tested by the technician or engineer. The AR-80LM and the AR-85HLM find applications in R&D production, education and service environments.

Circle (50) on Reply Card

Should there be a computer in your business?

By William J. Lynott

A personal computer can help with many functions in a small electronics service business. Among the more obvious are such things as technician productivity analyses, maintenance of customer records, and of course, accounting.

Putting your books on a computer can give you more accurate records, better management information, and tighter financial control. A computer can also print out your invoices, work orders, P&L statements, checks, even W-2 forms. Most important, a good accounting program will forever eliminate the drudgery of manual entries on ledger cards or in one of those "one-write" accounting systems. In addition to all of this, a computerized accounting system will save your accountant time and will look more professional to everyone including your banker.

There are yet more advantages to computerized accounting, too numerous to even mention in this limited space. So, every electronics service dealer should be on computerized accounting. Right?

Not necessarily. Properly handled, a desktop computer can be put to good use in virtually every service business, no matter how small. Things like productivity records and customer histories are easy computerizing projects that can pay rich dividends. When it comes to accounting, however, computerizing is not the best solution for everyone.

If your business is very small—say only yourself and one or two other employees—don't bother to computerize your accounting at all; it will be more trouble and expense than it's worth.

I know it's a lot of trouble to keep up with those manual payroll records even for a couple of employees, but maintaining a tiny payroll account on personal computer is even more trouble. Its almost humorous to see a small service dealer meticulously threading his payroll checks into a printer in order to print out two or three more checks. I know a number of very small service dealers who soon came to recognize that the whole accounting job was easier when they did it by hand.

If your business is larger, though, with a minimum of four or five employees and annual revenues of say, $200,000 or more, computerized accounting may be well worth your consideration. If you do decide to switch, it is important to plan carefully, set specific goals, and manage the switchover with great care.

Here is a brief checklist of points that we provide to our consulting clients who are computerizing their accounting for the first time:

- First and perhaps most important, recognize the absolute necessity of unswerving dedication to backup and security for your electronic accounting records. If you have any experience at all with computers, you already know the damage that can be done when a hard disk "crashes" or a simple computer failure zaps your current project. To maintain your motivation on this, just ask yourself what you would do if your accounting records were wiped out and there was no backup copy. And be sure to keep one backup copy at an off-site storage location such as your home or an employee's home.
- Be certain that more than one person is trained to operate your computerized accounting. A vacation, sudden illness, or the loss of a key employee could leave you in a mess if no one else knows how to punch in today's data or print out an invoice.
- Don't computerize everything all at once. Just because you buy an accounting package capable of handling every conceivable accounting requirement, don't think you have to use it all. Some small service dealers get discouraged with computerized accounting because they take too big of a bite all at once. Start out with just the general ledger for reporting income and expenses. Add such functions, as accounts receivable and accounts payable one at a time as you become comfortable with the system. Add payroll last, after you've had at least six months experience with the rest of the accounting package.
- Run "parallel" systems for the first three months. That is, maintain both your old manual system and the new computer system as a cross-check and learning process.
- Bring your accountant into the picture during the planning stage. If he's not happy with what you've done, it's only going to cost you in the end. On a more positive note, your accountant can ensure that your system provides an audit-trail that will satisfy his and IRS requirements.
- Don't attempt to computerize your accounting without an adequate hardware system. A hard disk with at least 40 MB of storage space is a must. No accounting package worth its salt will function with only floppy disks.
- Plan your startup date carefully, and allow plenty of time for your employees to get used to the idea. Most people are wary of change, and switching from manual to computerized accounting is a big step. And remember, when you transfer records to the computer, you will need to know the exact balance and the current status of every account in your system. Things you normally think about only once a year such as the balance for every depreciable asset must be recorded to the penny.

There are an almost endless variety of accounting programs that you can buy off-the-shelf for computerizing the records in your small service business. Next month, we'll discuss some of those packages and I'll give you my recommendations. ■

Lynott is president of W.J. Lynott, Associates, a management consulting firm specializing in profitable service management and customer satisfaction research.

Test your electronics knowledge

Answers to the quiz

(from page 45)

1. CAD (Computer-Aided Design)
2. DMA (Direct Memory Access)
3. GPIB (General-Purpose Interface Bus)
4. Pb
5. LASCR (Light Activated SCR)
6. MUX
7. PIA (Peripheral Interface Adaptor)
8. Si
9. RFI (Radio Frequency Interference)
10. VFET
11. PCM (Pulse Code Modulation)
12. R/W (Read/Write)
13. MODEM (Modulate/Demodulate)
14. OEM (Original Equipment Manufacturer)
15. ECL (Emitter-Coupled Logic)

Note to reader: If you would like to see any of these subjects discussed in What Do You Know About Electronics please drop me a line.

Classified

Classified advertising is available by-the-word or per column inch. By-the-word $1.65 per word, per insertion. Initials and abbreviations count as full words. Blind ads (replies sent to ES&T for fowarding) are $40 additional. Minimum charge: $35 per insertion.

Per Column Inch (Classified Display): $235 per column inch, per insertion, with frequency discounts available. 1" minimum, billed at ¼" increments after that. 10" maximum per ad. Blind ads are $40 additional. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.)

Optional color (determined by magazine) $150 additional per insertion. No agency discounts are allowed for classified advertising.

Contact Jeff Uschok, 516-681-2922, for information on frequency and pre-payment discounts, or to place your classified ad. Or send your order and materials to Jeff Uschok, Electronic Servicing & Technology, 76 North Broadway, Hicksville, NY 11801.

FOR SALE

TELEVISION AND MONITOR TROUBLESHOOTING BOOKS: 336 Problems/Solutions, $12.00, 35 Steps to Easier Television Repairs, $15.00 Add $1.50 shipping. Refunds if not satisfied. Fred Jones, 407 Morningbird, Niceville, FL 32578. 12-89-tfn

REDUCED 85%, Diehl Mark 111 scanner $89. Diehl Mark V scanner $219. New. Restore remote control keypads with our conductive coating $8.99 ppd. WEEC, 2805 University Ave., Madison, WI 53705. 608-238-4629. 608-233-9741. 6-90-tfn

INVENTORY LIQUIDATION: of Consumer Electronics Repair Shop. Test equipment for 10 complete video/camera repair stations and 2 audio test stations. Equipment is of recent manufacture (less than 4 years in service). Contains oscilloscopes 20, 35, and 100mhz bandwidths. VCR/TV analyzers. Audio test equipment: distortion analyzers FM generators, dual channel milli voltmeters, generators. Power supplies (AC variable & dc high current) frequency counters, function generators, wow/flutter meters, component checkers. All generic Japanese series represented in quantity. Worth $150,000 at retail prices $60,000 at 100 unit prices. We are selling at 0.2 on the dollar. If both lots are purchased as one unit, thousands of dollars in service literature will be included. IMC 5368 Forbes Ave, Pitt., PA, 15217 (412) 521-6816.

TV TOUGH DOGS: 300 symptoms and cures. Send $9.95 to DAVIS TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 10-87-tfn

VHS-VCR Repair Solutions Sets I,II,III,IV,V. Each contains 150 symptoms and cures, cross reference chart, free assistance, $11.95 each all five $49.95. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 12-89-tfn

COMPUTER AIDED TV/VCR REPAIR: 3,500 solutions. 37 manufacturers. Printout or IBM compatible hard drive, 5 1/4 disk, time saver. Quick scan by model, chassis, and stage. Send $90 to Electronic Solutions, 407 West Avenue "N", San Angelo, Texas 76903. 7-90-tfn

CASE HISTORIES: Over 700 TV symptoms and cures. Professionally prepared, satisfaction assured, $18. Mike's Repair Service P.O. Box 217, Aberdeen Proving Ground, MD 21005. 7-90-3t

COBRA PORTABLE PHONE: Parts and literature. Phone or write for info-best offer. Boulevard Radio & TV Service, 1431 Robinson Avenue, Havertown, PA 19083. (215) 446-4519. 9-90-1t

TV/VCR REPAIR SOLUTIONS: Printout or IBM compatible with hard drive. 3,400 solutions. time saver, quick scan by make, model chassis or stage $90.00. Post paid to electronics Solutions 407 W. Ave "N", San Angelo, TX, 76903. 7-90-tfn

COMPUTERIZE: with the Service Manager. COD and warranty service, NARDA Forms, Inventory and Accounting. The Service Manager does it all. See our demo or video before purchasing any software (from $495). CMI Computer Systems (516) 584-8188. 3-90-3t

EQUIPMENT WANTED

TUBES WANTED: We buy receiving and transmitting tubes. Send your list for bid. New tubes in original boxes only. Also need radio. I.F. XFMRS. Antique Electronic Supply, 688 West First St., Tempe, AZ 8528[illegible]. Phone 602-894-9503, Fax 602-894-0124. 3-90-tfn

TAPE SHEET: needed for GD/67-90 for Quasar Chassis. Buspar 10tld for volume control for model SA4OE. Paul Cohen 1760 Bertha Rd, Jeddsville, Tenn. 9-90-1t

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LARGE AUDIO/VIDEO SERVICE BUSINESS: In sunny S.W. city. Established 20 yrs. Well equipped. Price and terms negotiable. (602) 298-8827, Eves. 8-89-tfn

TV REPAIR SHOP: Shop for sale. Write 5005 Menaul Blvd, N.E. Allbequerque, N.M. 87110. 9-90-1t

AUDIO, VIDEO, SERVICE BUSINESS: In Kingston, NY, 100 miles north of New York City. Factory authorized service for over 70 brands. Fully equipped and well established in community. Turn key operation. Days 914-331-2812, Eves 914-339-5251. 9-90-1t

Readers' Exchange

Back by popular demand - FREE Reader's Exchange

Readers' Exchange has been reinstated as a free service, effective with the February issue.

The following restrictions apply to Readers' Exchange:

- Only individual readers may use Readers' Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropriate place for your message is in a paid advertisement, not Readers' Exchange.
- Readers' Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).

Send your Readers' Exchange submissions to:

Reader's Exchange
Electronic Servicing & Technology
76 N. Broadway
Hicksville, NY 11801

WANTED

Flyback-24D72686-AO4, for Quasar chassis -TS-942A. *Mark Weber, 4415 So. Kings Highway, Mo.*

Tentel VCR Test Accessories and Sencore VA62. *Debbie-212-264-2147.*

Color Television Training Video tapes or a training course with the instructions on the latest television theory and servicing technology. Contact *Lou Carpinone 6 Hickory Ave, Shalimar, Fl 32579, (904) 651-6440.*

Schematic or Zerox copy of one for Amiga color monitor -1080. Will pay $10.00. *Augustines TV, 530 N. 9th Street, Reading Pennsylvannia 19604. 212-372-5438.*

Volume Control Pot for realistic model SAF40D tube amp. Schematics for Akai digital tuner model ATVO4 and Yamaha model CR400 receiver. Would like to trade something I have for something you need for Pot or prints or will pay reasonable price. *DMC Electronics P.O. Box 123, 704 North Hwy. 259, Oregon CIty, Texas 75683, 214-968-6080.*

Good used tube type 6E5. Heathkit Cop Checker IT-28. Heathkit Part -58-10 Pole piece assy for GR-370. *Joseph Baker, 3141 Victor St, Aurora, CO 80011, 303-366-0345.*

Service Manual or Sams Photofact or just schematic for Admiral TV model no. 25L101, chassis no. 1M3O12-5. *Rey Flores, 2017 Hinton Dr., Oxford, AL 36203; 205-835-1372.*

BSM plugs, or cables with same on end, and BSM/BNC adapters (to connect to Dumont/Fairchild scope plug-ins). *Cecil Grace, Box 5127, Asheville NC 28813.*

FOR SALE

Tandy 1400 Laptop computer with dual 3½" floppy drives. Excellent condition. $700.00 - *Paul Carlson; 219-264-2147.*

Riders Radio Manuals, Vol -1-11. Good condition - $200.00 plus shipping. *Merk TV, 1503 N. Norwood Ave. Tulsa, OK. 74115; 914-836-0037.*

Leader LCG-396, Wow & Flutter - $575; B&K 1035 NTSC Generator $800; complete shop contents. Write or call *P. Delman, 5812 W. 17 St, Greeley, CO 80634, 303-330-3334.*

Sencore CR31A Super Mack CRT tester/restorer with Dandy Dapter, $275. Sencore MU 150 tube tester, $125. Tektronix 465B 100mhz dual-trace scope, w/probes; manuals, $850. A1 condition. *Bob Hendrickson, 5116 Hutchins St., Winston-Salem, NC 2106; 919-922-4571*

Used, reasonably priced wow and flutter meter; RF generator and audio test tapes. *M. Kostaris 48 W. James St. Lancaster Pa. 17603; 717-393-5115*

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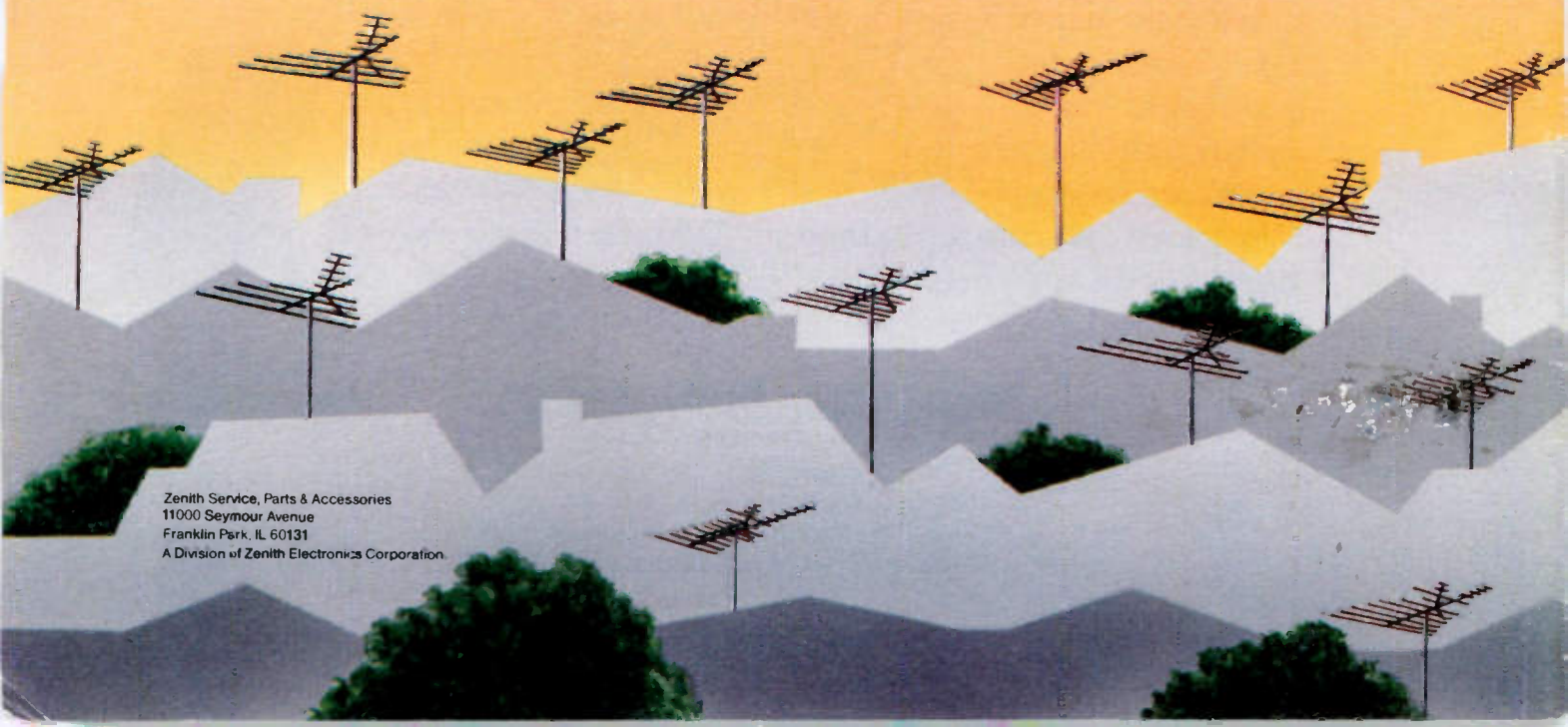

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