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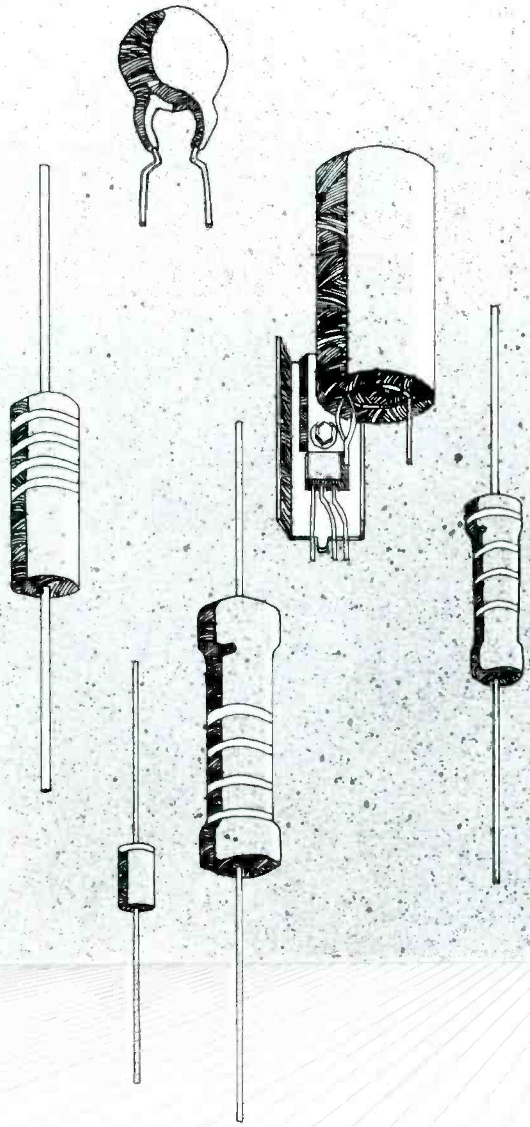

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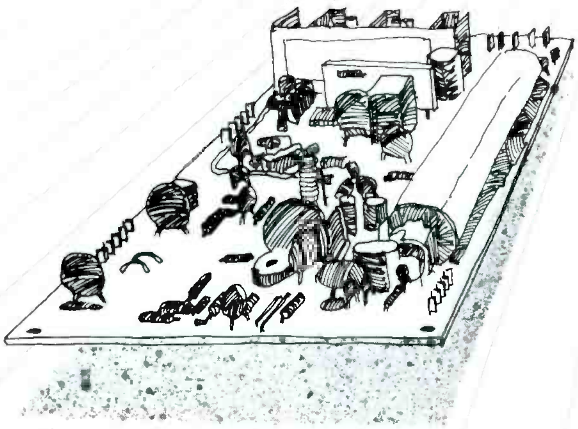

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ELECTRONIC SERVICING & TECHNOLOGY is the "how-to" magazine of electronics. It is edited for electronic professionals and enthusiasts who are interested in buying, building, installing and repairing home-entertainment electronic equipment (audio, video, microcomputers, electronic games, etc.).

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CALENDAR OF EVENTS

January

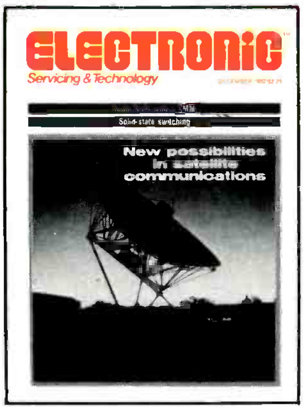
6-9
International Winter Consumer Electronics Show, Las Vegas. Contact Consumer Electronics Shows, Two Illinois Center, Suite 1607, 233 North Michigan Ave., Chicago, IL 60601; 1-312-861-1040.

18-20
Southcon/83 High-Technology Electronics Exhibition and Convention, Georgia World Congress Center, Atlanta. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245, 1-800-421-6186 (in California, 1-213-772-2965).

The how-to magazine of electronics...

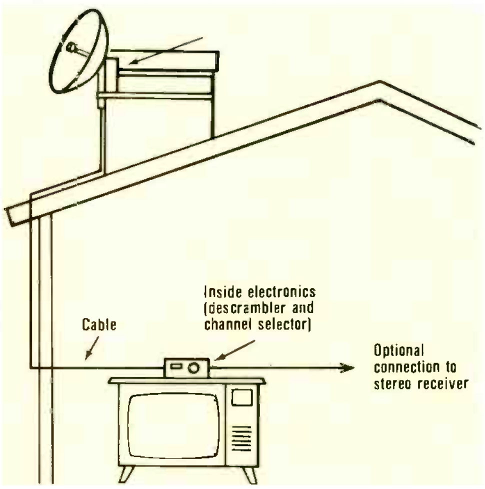
ELECTRONIC
Servicing & Technology

December 1982
Volume 2, No. 12

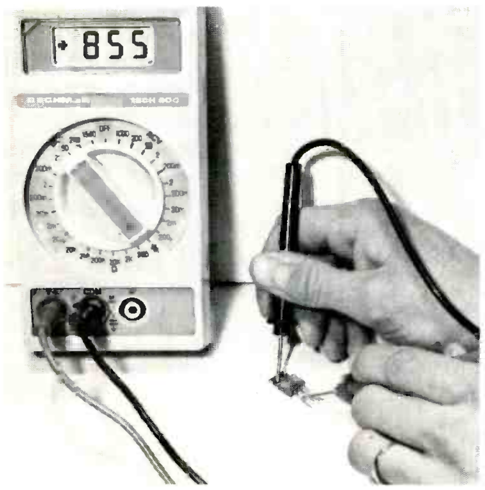


This 10-meter satellite receiving antenna is just one example of the new possibilities for satellite communications. See related articles on pages 18 and 50. *(Photo courtesy of Andrew Antenna.)*

Page 10



Page 18



Page 22

Departments

Next month...

A new department. *Technology* will premiere in our January issue. Each month, this department will report on new technological advancements that will keep technicians and hobbyists up to date on the ever-changing electronics field.

These reports will alert readers to new basic technology, new devices, new equipment and even new trends that we anticipate having an effect on the application of electronics equipment and the way it is constructed and serviced.

EDITORIAL

Television today: Too much of a good thing?

The other night as I was watching television, a commercial came on announcing a new tortilla chip. Not a new and improved chip, or a chip in a new, improved, easy-open, reclosable package, but a brand new chip.

This must have been at least the third or fourth such product introduction this year. Here's just what we need: another tortilla chip. There were already about a half-dozen brands, each offering plain chips in at least two sizes, taco-flavored chips, nacho-flavored chips, extra light, extra thin and extra crispy.

But in addition to all of this reconstituted cornmeal, the grocers' shelves are groaning under the weight of other snack foods: potatoes, for example, treated and mistreated in any number of ways, and carefully sealed in practically impregnable plastic bags. And there are countless other chips, crackers and other snacks. Is it possible that this is too much of a good thing?

In much the same way, TV sources and programs have proliferated, most of them offering little more substance than snack food. For years the viewing public got along with VHF channels. Then the development of UHF increased that capability several fold. More recently, cable television came along, and, if the sources and programs were available, the viewer would be able to choose from more than 100 offerings.

People who have a few thousand dollars to spare can broaden their horizons even further and have their own TVRO dish in the yard, soaking up shows from not only U.S. but Canadian satellites. And videotape and videodisc add yet another viewing dimension for those able to afford it.

Now, looming over the horizon, are several more new technologies that are destined to swell the volume of programs available for television yet more. One of these new technologies is direct-broadcast satellite (DBS). Inside the magazine is an article that details the current status of DBS technologically and politically.

The technology is exciting: satellites floating above the earth in geosynchronous orbit, much like today's communications satellites, but handling TV signals originated on earth and beamed to the satellite with the sole purpose of being rebroadcast directly to home antennas. The service is expected to be a subscriber-pay service with a cost that's on a par with today's cable cost. Some of the possibilities being speculated for DBS include high-definition television and stereo-audio television.

The implications of DBS for both the public and for electronic servicers are good. For servicers, DBS represents an opportunity for business in the installation of the dish antennas and the frequency conversion system, as well as service for this equipment when it fails. For the public, DBS could mean a new source of original programs and information.

The potential is there for DBS to be a valuable service to subscribers. Let's hope it doesn't turn out to be just another video snack food.

Nils Conrad Persson

ELECTRONIC SCANNER

GE opens 24-hour, toll-free answer center

General Electric has implemented a toll-free hotline (1-800-626-2000) to serve GE video customers and servicers. Consumer information specialists will answer questions about GE replacement parts, service literature, owners manuals and training meetings, as well as other information. Service technicians and retailers can also provide customers with the number so they can get answers to questions they may have.

Electronics Industries Association elects 1983 officers

The Electronic Industries Association (EIA) Board of Governors has elected Glenn E. Ronk (General Signal) chairman, William E. Boss (RCA) vice chairman and C. Travis Marshall (Motorola) treasurer, effective Jan. 1, 1983.

Ronk, as vice president and group executive for General Signal, has been a member of EIA's Board of Governors since 1966; Boss, division vice president for RCA's Consumer Electronic Division, has served as industry vice president for EIA's Consumer Electronic Group (CEG) since 1975; and Marshall, vice president and director of Corporate Government Relations for Motorola, was first elected treasurer of the Association in June 1981.

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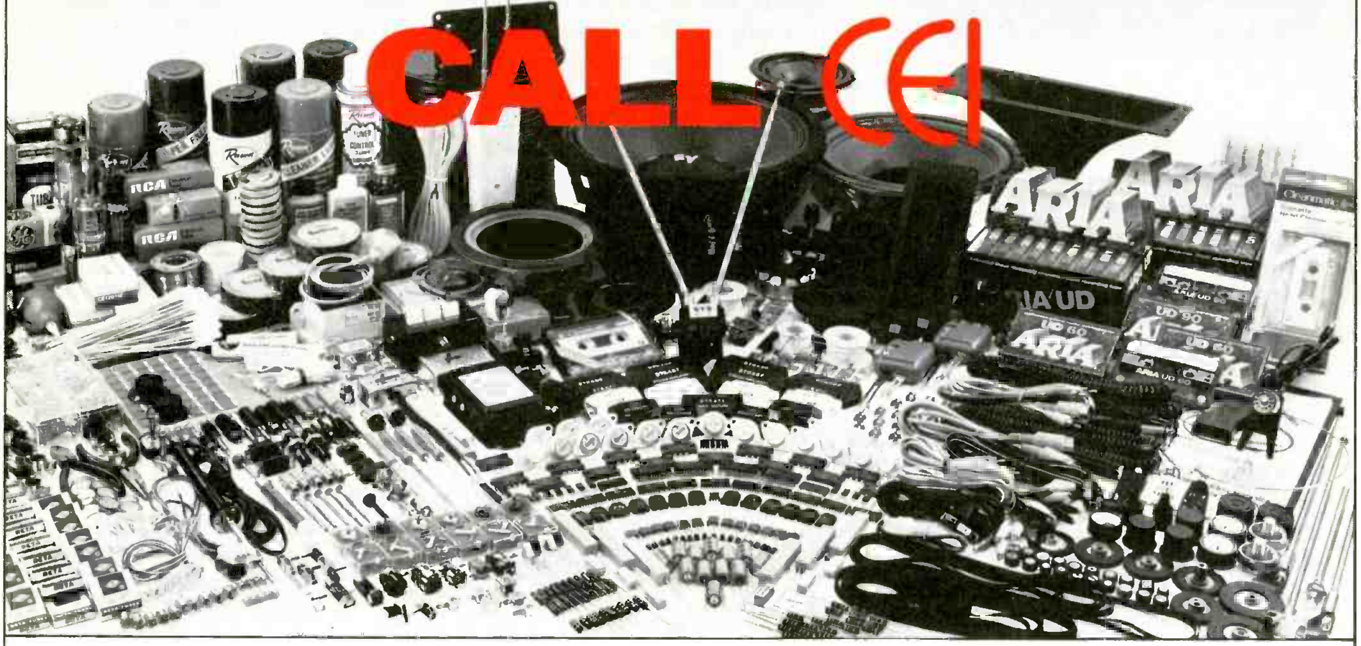

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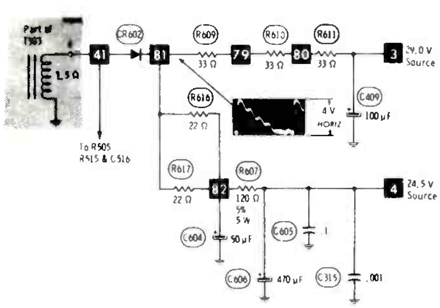
TROUBLE-SHOOTING TIPS

Lack of vertical deflection
Admiral b&w T1L7
(Photofact 1741-1)

A bright, narrow line across the center of the screen proved the loss of all vertical deflection. Many times a visual inspection will locate burned or defective components in just a few seconds that might have required hours of testing with instruments. When I carefully examined the main circuit board, I noticed discoloration of resistors R609, R610 and R611 in the power supply. Seldom are discolored resistors the cause of a problem but usually they are overheated by the defect. Because these resistors supply dc-voltage power to the vertical stage, the discoloration seemed to indicate excessive current in the vertical circuit.

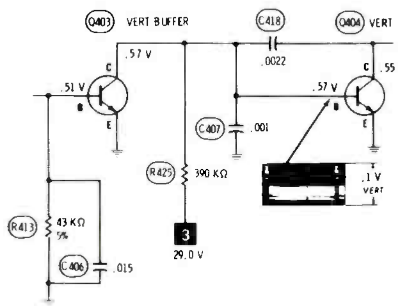
First, Q402, Q403, Q404 and Q405, the four transistors before the output stage, were removed and tested externally for shorts and opens. None was defective. New output transistors were installed, but there was no change. Yoke continuity tested normal. The +29V rectifier (CR602) and the filters for the +29V and +24.5V supplies also were not defective.

Finally, I decided to monitor the +29V supply with a VTVM. When the television first was turned on, the VTVM showed +29V. However, within a few seconds, the voltage dropped rapidly to about +5V, and smoke began rising from those three power-supply resistors. Undoubtedly, the vertical-sweep circuit was drawing excessive current because of a defect.



I tested every component in the vertical-output and feedback circuits, but found nothing abnormal. A new Q402 oscillator transistor, installed as a test, brought no change.

Then I decided to make resistance readings on all vertical stages, although I never have had much faith in that technique. All readings agreed with the Photofact figures until I reached the Q403 collector. The reading was



infinity. Even after I removed R425 from the circuit, it tested completely open.

Replacement of R425 and adjustment of the vertical-height control restored normal vertical height. Also, I replaced R609, R610 and R611, and then monitored the +29V supply. No variation of the +29V reading was noticed, and the three new resistors remained cool.

Apparently, the open resistor forced the output transistors into heavy conduction, which overloaded the +29V supply, causing it to decrease drastically.

George M. Marechek Jr.
Cheverly, MD

Editor's Note: Any electronic test that produces a correct answer is valuable. However, another dc-voltage test might have pointed to the malfunctioning area a bit quicker. That method involves measuring the dc voltage from the signal-output point (emitters of Q406 and Q407 in this case). When the output signal is capacity-coupled (C413), the dc voltage should be slightly more than half of the supply voltage. The Admiral supply voltage is +29V, and the schematic calls for +17.5V at the two emitters. Probably this point was just a few volts when R425 was open. The dc-voltage tests backward through previous stages would have located R425 quickly. We suggest you add this dc-output-voltage test to the others.

Erratic brightness
Zenith 19JC48 color chassis
(Photofact 1738-2)

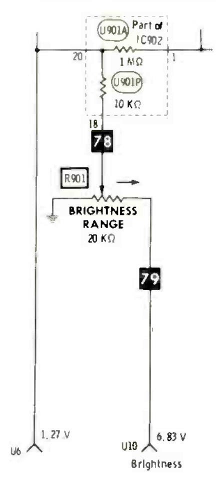
After three years of normal operation, this television suddenly lost most of its brightness, with the picture showing dim, moving shadows. The sound was good, but the front-panel brightness control caused no picture change.

After the chassis was pulled, I located luminance module 9-88-03 and checked all dc voltages at IC901 pins. These readings appeared to be within normal tolerance.

While checking the schematic, I noticed R901, a rotary trim pot that limits the range of the front-panel brightness control. As an experiment, I gently rotated the trim pot slightly. The picture brightness returned permanently.

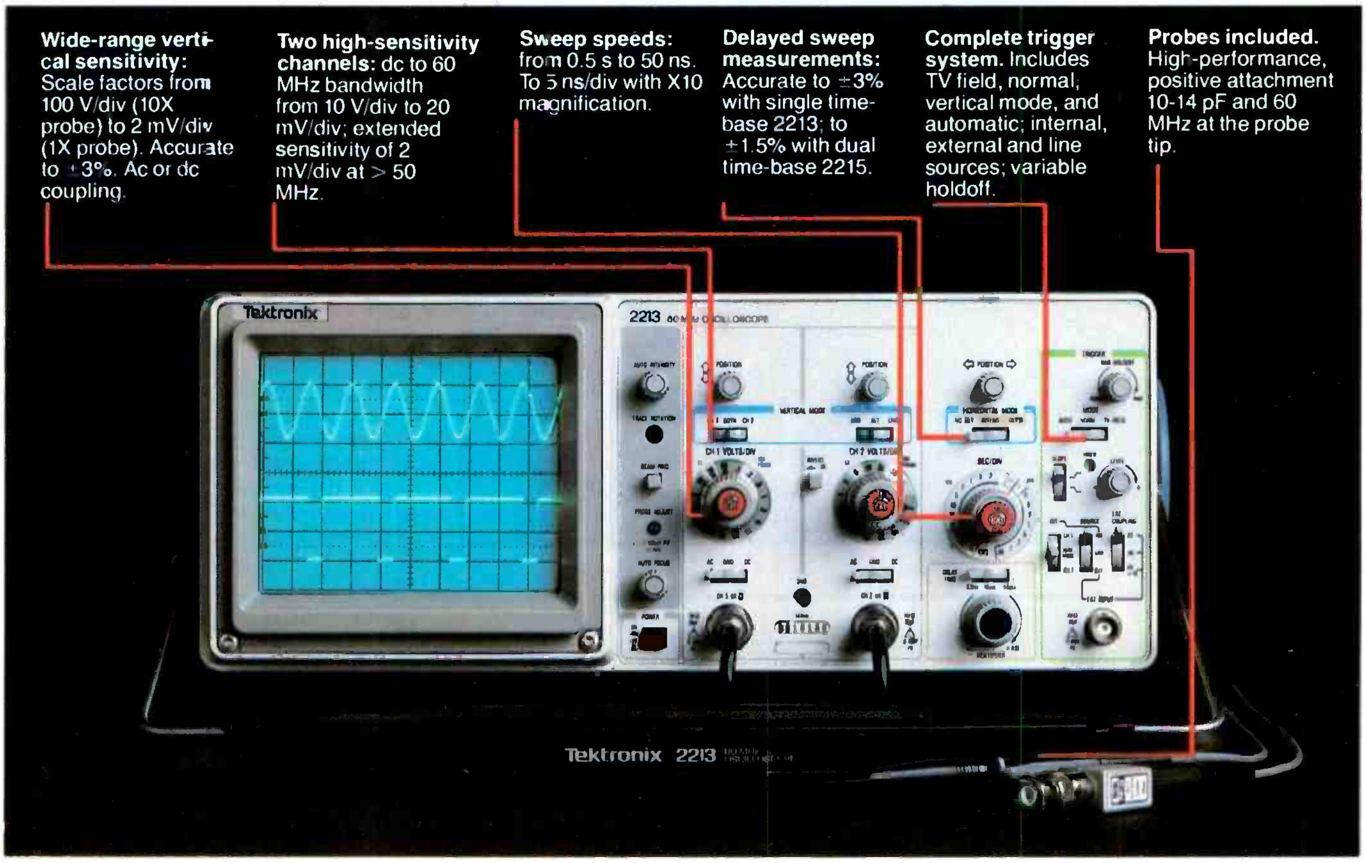
A new rotary control was installed to be certain the problem was elimiated. No brightness problems have been reported since then.

This television was operated near the kitchen, and I theorize that vapors from cooking settled on the carbon element of the trim pot, eventually causing an open circuit between the wiper and the element.



Karl Young Jr.
Roxbury, CT

Tek's most successful scope series ever: At $1200-$1450, it's easy to see why!



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The cost: $1200* for the 2213. $1450* for the dual time base 2215. You can order, or obtain more information, through the Tektronix National Marketing Center, where technical personnel can answer your questions and expedite delivery. Your direct order includes probes, operating manuals, 15-day return policy and full Tektronix warranty.

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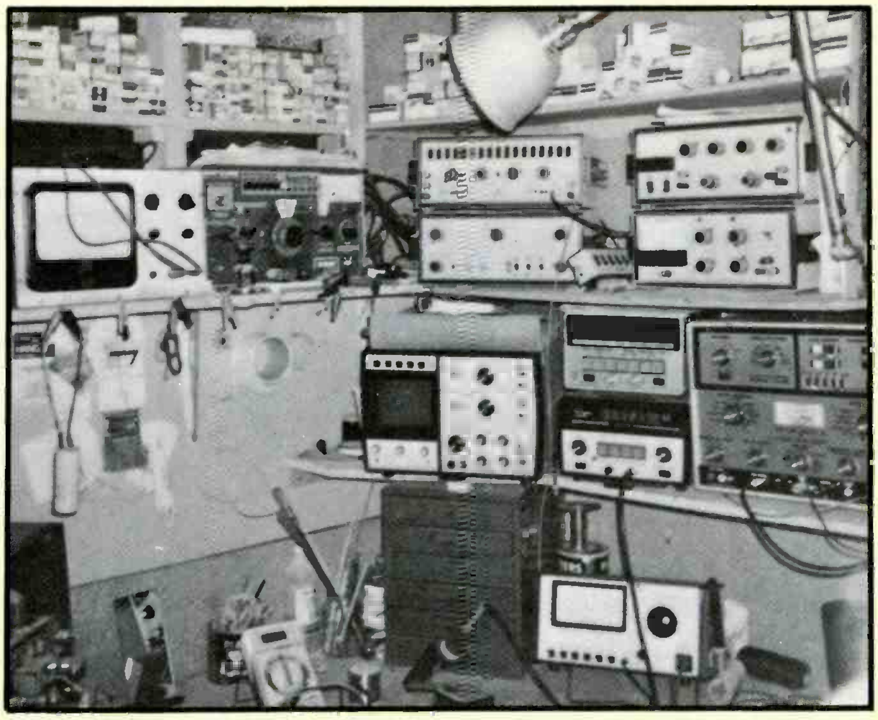

C.A. Honey's main work bench is "L" shaped, with major test equipment at the right, on the short side of the "L." The arrangement allows convenient access to the equipment controls without test leads and cables resting on the televisions and other items under repair.

C.A. Honey operates an unusual shop in Ontario, CA. His only customers are other service dealers who bring "dog" TV receivers, many that have been tested unsuccessfully. A flat-rate labor charge is made for each, plus replacement components at regular net. All brands are serviced, with solid-state and foreign sets a specialty.

For many years, I have had almost daily encounters with difficult repairs of TV and audio equipment brought to me by established dealers. Many of the sets have been examined by other technicians who failed to find the defects. I confine my repair work to these tough jobs because of the personal satisfaction that results from successfully solving unusual problems.

This type of business has given me opportunities to observe what inadequacies prevented technicians from finding the defects within a reasonable time. Also, I have had to discover (for my own profit and satisfaction) the most efficient and error-free troubleshooting methods plus accurate and time-saving test equipment.

Shops need updated equipment

As a former field engineer for a major TV manufacturer, I have noticed one major deficiency in about 90% of the electronic shops I visited several years ago. These shop technicians were trying to diagnose color TV receivers by using a 20,000Ω/V VOM and a tube tester, both often obsolete. To a large degree, the same inadequacies are found in many of the shops that bring me their difficult-to-diagnose repairs.

Technicians need updated training

Although few of the repairs I make would be considered routine, I have finished some repairs in less than an hour, after the submitting dealer had expended many man-hours without success. I am not a "super-tech," but the difference between my approach and that of the average technician can be stated this way:

- As a professional technician, I

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continually update my knowledge of how electronic circuits are supposed to operate.

- I attend every available seminar and buy the latest new books about my field.
- I read articles in **Electronic Servicing & Technology**, especially those that explain how the new circuits operate.
- I try to use the latest in test equipment and to understand the applications of this equipment that will help me find defects rapidly. (In comparison, I vividly remember visiting one shop where the "old-timer" technician was attempting to do FM-stereo alignment *by ear* without a generator or a scope.)

Scopes

A 10MHz scope, with or without triggered sweep, is standard equipment for nearly all shops that have scopes. Unfortunately, such scopes are almost useless for troubleshooting many of the new TV circuits.

For example, the Magnavox STAR TV tuning system has a crystal-controlled oscillator with a 24MHz frequency. The 24MHz is divided down to 12MHz, 6MHz and finally to 1MHz. With a 10MHz scope, no trace of the oscillator signal can be seen on the screen. And even the 6MHz square wave signal appears as a very weak near-sinewave. By comparison, a good 50MHz or 60MHz scope will show 24MHz square waves with only a small amount of rounding.

Even a 35MHz scope does not have enough bandwidth to reproduce videocassette and microprocessor-tuner waveforms with sufficient accuracy. This can be verified by looking at a known fast-rise-time 10MHz square wave with a 35MHz scope. The square waves will have rounded corners and slowed rise times, because the upper harmonics are not being reproduced.

Video-signals generator

A generator of signals for TV and video troubleshooting is absolutely essential. Because no other manufacturer I know of offers a similar generator, I recommend the Sencore VA-48 video analyzer. This generator is directly responsible for most of my "supertech" ability. For example, if a color receiver is normal except for weak color saturation, I can tell you in just a few seconds if the problem originates in the tuner, the video IF circuit or the chroma stages. In just a few more seconds, I can determine which stage in the video IF or the chroma IF is responsible for the weak color.

By choosing appropriate test equipment, I can find most other TV or videocassette malfunctioning stages just as quickly.

Digital multimeter

The old-fashioned method of making voltage measurements in tube-equipped TV receivers was to use a vacuum-tube voltmeter (VTVM) or a 20,000 Ω/V VOM. With the advent of solid-state equipment, those two meters were not adequate for many measurements. Normal voltages at some IC pins are only a few millivolts, and analog meters will not reveal the small differences between good and bad operation.

Most digital-multimeter (DMM) models solve the resolution problem but retain another: *excessive loading*. VOMs have so much loading that they are almost useless for measuring most solid-state circuits.

A 1000-to-1 loss probe increases the dc resistance to several megohms.

Of course, this loading of the circuits is produced by separate dc and ac (capacitive) loading. The dc loading adds resistance to the circuit, which can drive transistor biases out of tolerance and thus reduce transistor gains.

When dc voltages are measured in wide-bandwidth or tuned circuits, the stray capacitances added to the circuits by the meter wiring and the test-lead hot wire are even more serious. A better solution was included in the probes for older VTVMs that had a 2-position switch that connected a 1M resistor in series with the signal path during dc-voltage measurements. This minimized the probe's capacitive loading. Also, the lead wire was shielded to prevent pickup of unwanted external signals, such as hum. Of course, the trade-off was the additional capacitance during ac-voltage measurements. A few DMMs have a similar switchable probe; many more *should* offer it as an option.

One of my solutions is to use a DMM with an input impedance of 22MΩ. For some more-critical measurements, I add a 1000-to-1 loss probe, which increases the dc resistance to several megohms, while it also greatly reduces the stray capacitance at the probe tip.

Capacitor/inductor analyzer

Because I am not aware of a direct equivalent, I must tell you about the Sencore model LC53, which can test capacitances between 1pF and 200,000μF. It also applies dc voltages up to 600V for leakage tests. A digital readout displays the leakage currents in microamperes and the direct capacitance values. Inductors from 1μH to 10H can be measured, and ringing tests can be made on inductors from 10μH to 1H.

Long ago, I learned that an ohmmeter is not trustworthy for checking the leakage of a capacitor or the operation of an IF coil. Ohmmeters apply between 1.5V and perhaps 6V to capacitors. But leakage is often non-linear, with excessive leakage occuring at higher dc voltages but not at low dc voltages.

Of course, any inductor could have shorted turns that would not change the dc resistance very much, while the inductive impedance would be greatly reduced.

Recently I was checking a color receiver that had no color because the burst was missing. The burst-transformer windings checked normal with an ohmmeter, but the LC53 showed shorted turns. The coil would not ring. Without the unsoldering of a single joint, the problem was identified as the burst transformer.

In another case, an RCA CTC17 displayed jumping vertical lock for the first visible 30s of operation from a cold start. After some testing, the defect was identified as the *new* 0.0068μF capacitor at the 6GF7 grid. A previous technician had installed the capacitor to cure a case of slow downward roll. When tested by an older capacitor analyzer, both the capacitance and leakage appeared normal, but the LC-53 showed it was bad. The display locked up with a 1---.8 reading with the last digit flashing. When the capacitor was replaced by another new one *that the LC-53 showed was normal,* the vertical jumping was eliminated. Later examinations of the bad capacitor showed it had excessive *dielectric absorption.* No bridge can measure dielectric absorption.

Tube tester

Another essential for working on older televisions is a good picture-tube tester. The tests should include emission and contrast range of each gun, short detection, tests for emission tracking (preferably without calculations) and a method of reactivating or rejuvenating weak-emission tubes. Several brands and models on the market will fulfill those specifications.

Transistor tester

For rapid servicing, an in-circuit transistor tester is necessary, and it should identify the three leads automatically before checking gain and leakage. Several models fulfill the specifications.

Also, an older model transistor tester that measures dc beta is excellent for verifying defects after the transistor has been removed from the circuit.

Leakage tester/isolation transformer

A Sencore PR-57 Powermaster enables me to fulfill the new California law requiring a safety check on every television serviced in the state. This law is enforced by an investigator who walks into a shop with a PR-57 in his hands.

Several functions are performed by this unit:

- It can monitor and measure the 120Vac line voltage.
- It is an isolation transformer with a metered 0-to-140V variable output.
- Power for the monitored outlet socket is measured by two wattage ranges.
- A meter accurately shows leakages to either side of the incoming 120V line.
- The variable voltages are recommended for troubleshooting start-up and shut-down problems and for reducing the possibility of ruining a new audio-output or horizontal-output transistor in case the original defect has not been found.

Miscellaneous test equipment

The following instruments are useful for servicing older radios and televisions using tubes:

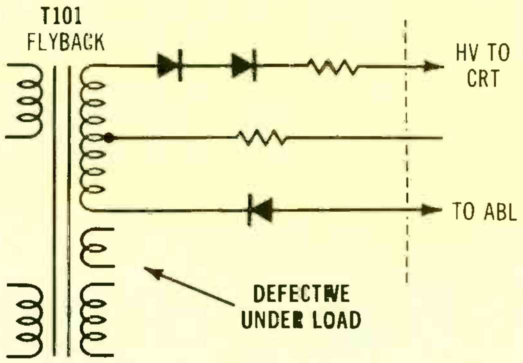
- a receiving-tube tester, preferably a transconductance type;
- a VTVM for varying readings and for time-testing critical voltages;
- a radio or TV signal generator for various jobs;
- a 10MHz scope for a second bench, for time-testing televisions, or for repairing audio equipment.

ES&T

SYMCURE

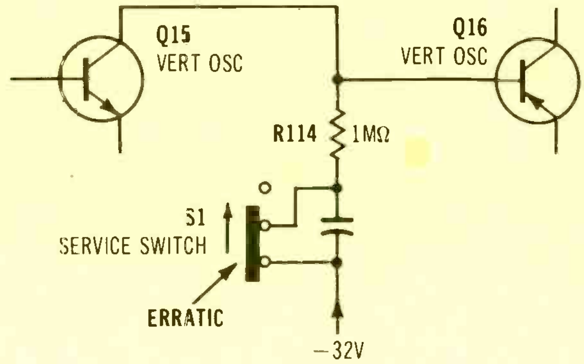
Symptoms and cures compiled from field reports of recurring troubles

Chassis – RCA CTC87 1
PHOTOFACT – 1778-2



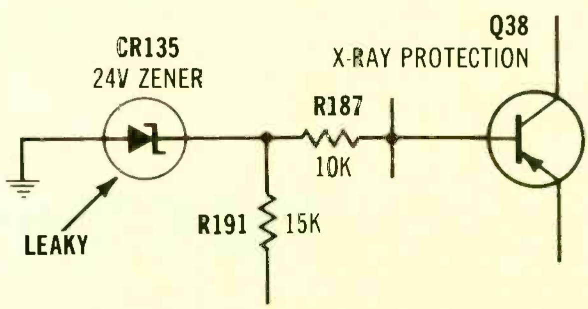
Symptom – Slow recurrent blooming with ticking sound
Cure – If symptoms vary with brightness, replace T101 flyback that includes HV rectifiers

Chassis – RCA CTC87 (CTC88, CTC96 and CTC97) 2
PHOTOFACT – 1778-2 (1787-1, 1870-2 and 1862-1)



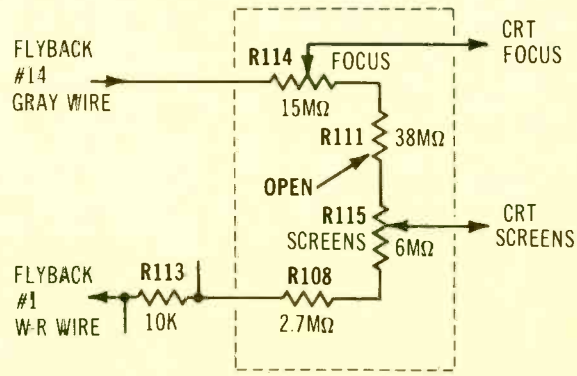
Symptom – Erratic vertical roll or loss of height
Cure – Check S1 service switch and replace it if contacts are erratic

Chassis – RCA CTC97 3
PHOTOFACT – 1862-1



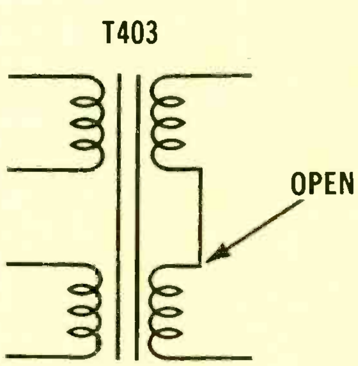
Symptom – Shutdown at 120V line voltage, but not at 100Vac
Cure – Check zener diode CR135 and replace it if leaky

Chassis – RCA CTC97 4
PHOTOFACT – 1862-1



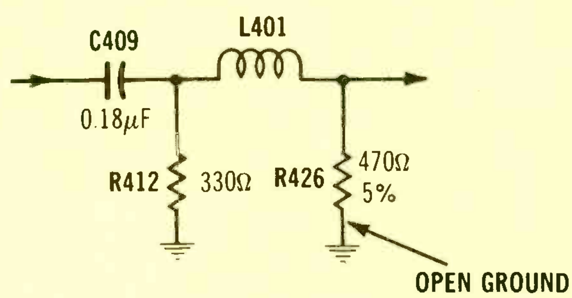
Symptom – Dark picture, with no control over focus or screen adjustments
Cure – Check resistor R111 and replace it if open or increased in value

Chassis – RCA CTC76 5
PHOTOFACT – 1468-2



Symptom – Bright 1-inch vertical line in picture at center
Cure – Check for open connection at pin 4 of T403 (T/B pincushion); repair open

Chassis – RCA CTC72 6
PHOTOFACT – 1622-2



Symptom – Intermittent narrowing of picture with flashing lines
Cure – Check for an open PW400 ground stake at R426 (CR306 and R326 also might be ruined by overload)

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MEST-122

Dictaphone
A Pitney Bowes Company

Circle (8) on Reply Card

PHOTOFACTS™

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

Coming in

ELECTRONIC
Servicing & Technology

Servicing Atari video games. A typical repair takes about 15 minutes for a technician experienced in video-game servicing. This article describes actual field failures and repairs.

Methods of equalizing tape recording. Circuits that use capacitors and resistors to increase or decrease the frequency response at specific frequencies are described.

BOOKS

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

Complete TV Servicing Handbook, by Walter H. Buchsbaum; Prentice-Hall; 251 pages; $19.50.

This book shows the reader how to service any device that has a TV screen, including computer CRT terminals. It is written by an expert for readers who understand the basics of electronics.

The book begins with a quick, reliable way to diagnose most TV defects by using only the TV screen and the readily accessible controls. Then, without getting into complicated mathematics or theoretical physics, the following "how-to-do-it" chapters cover topics such as how TV receivers and monitors work; how color television works; color TV picture tubes; TV tuners and IF circuits; sync, deflection and high-voltage circuits; color circuits and audio and power supply circuits.

More than 120 illustrations and 17 color pictures of actual TV screen symptoms help explain the latest information needed to service all types of monitors.

Prentice-Hall, Business and Professional Books Division, Englewood Cliffs, NJ 07632.

Basic Solid-State Electronics, Volume I, by Van Valenburgh, Nooger and Neville, Inc.; Hayden Book Company; $6.95 (set of volumes 1-5 $33.75 paper and $27.95 cloth).

This is the first of a 5-volume course that presents solid-state electronics in terms of the overall information management system. The course begins by explaining discrete components and discrete circuits, then examines ICs and system-level microtechnology.

This series, a course on basic electronics for beginners, is a revised edition of "Basic Electronics," the civilian version of the U.S. Navy COMMON-CORE Training Program. More than 100,000 Naval technicians were trained under this program.

All information on the latest applications of basic solid-state electronics is covered in detail. Features of this revision include extensive review sections, numerous illustrations and experiment/applications.

Each volume covers a specific area of solid-state electronics that explains the configuration and management of information systems. Volume I, #0885, covers Information System Building Blocks; Volume 2, #0886, Audio Information Systems; Volume 3, #0887, Information Transmission; Volume 4, #0888, Information Reception; and Volume 5, #0889, Information Management.

Hayden Book Company, 50 Essex St., Rochelle Park, NJ 07662. ES&T

DBS: Opening up the satellite earth station market

By Elaine Cole, publications editor, Winegard Company

With the unanimous approval of interim rules for licensing and operating direct broadcast satellites (DBS), the Federal Communications Commission gave official sanction to a potentially explosive new technology.

The FCC approved the rules on June 23, nearly three years after DBS was first proposed by Comsat's Satellite Television Corporation. Comsat is one of nine companies whose DBS applications have already been accepted for filing by the FCC. The other eight are: RCA Americom, CBS, U.S. Satellite Broadcasting Company, Graphic Scanning Corporation, Video Satellite Systems, Focus Broadcast Satellite Company, Western Union and Direct Broadcast Satellite Corporation.

Direct broadcast satellites have been heralded by proponents of the new technology as a way to bring quality and variety of programming to rural and non-cabled areas where TV reception is limited.

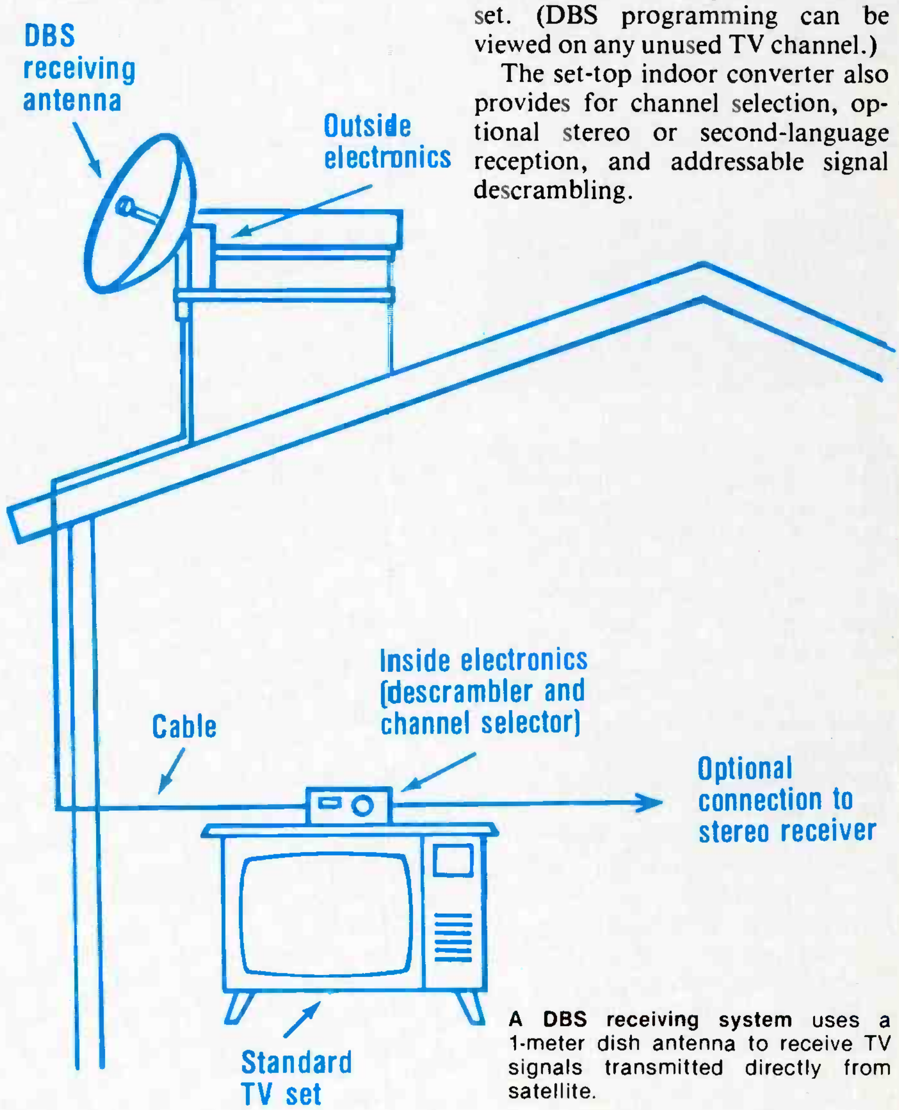
DBS programming will be transmitted via a new breed of high-powered satellites, broadcasting with some 200W of power per transponder and tentatively scheduled for launch in mid to late 1985.

These high-powered satellites will allow the use of small, relatively inexpensive dish antennas that can be stationed on a homeowner's roof or aimed out an apartment dweller's window.

DBS equipment

The three basic components of a DBS home system are the dish antenna, the amplifier/downconverter and the indoor tuner.

The parabolic dish antenna (no more than 2 to 3 feet in diameter), with feed horn, is mounted on a roof, facing generally south, or directly inside a window with a southern exposure.



A DBS receiving system uses a 1-meter dish antenna to receive TV signals transmitted directly from satellite.

Affixed at the rear of the antenna is a small amplifier/downconverter, which converts the 12GHz signal to a lower frequency. The signal is then transmitted through standard coax cable to an indoor converter, which completes FM demodulation and remodulates it for input into the TV set. (DBS programming can be viewed on any unused TV channel.)

The set-top indoor converter also provides for channel selection, optional stereo or second-language reception, and addressable signal descrambling.

Reprinted with permission from Winegard Company.

The basic customer cost for DBS receiving equipment has been estimated at $400, although some proposed systems allow for rental options.

In establishing interim rules for the new broadcast technology, the FCC said that the benefits of authorizing DBS service outweighed any negative impact it might have on current spectrum users or on traditional terrestrial broadcast services.

Rules remain flexible

Attempting to avoid any regulations that might inhibit the growth of the fledgling technology, the FCC commissioners purposely left the interim rules flexible.

DBS bandwidth set aside by the commission—500MHz in the 12.2 to 12.7GHz band for downlinks and 500MHz in the 17.3 to 17.8GHz band for uplinks—hinges on final approval to be given at RARC '83 (the Regional Administrative Radio Conference). RARC '83 will open in Geneva in July 1983 to allocate frequencies and orbital positions for DBS satellites in the Western Hemisphere.

The FCC's interim rules give DBS operators a lot of latitude in deciding what types of services they will offer.

The commissioners didn't set any restrictions on DBS ownership or on the number of channels an individual operator can control, stating that current applicants comprise sufficient competition. Also, no technical standards were imposed, except those requiring compliance with international agreements.

DBS operators who come under the FCC's definition of a common carrier or broadcaster will be subject to appropriate existing FCC regulations. Under the new FCC rules, licenses will be granted for five years.

To spur introduction of DBS services, the commission will require applicants to start construction, or complete construction contracting, within a year after construction permits are granted. DBS applicants are also required to start operations within six years after construction permits are granted.

The commission stressed that the interim rules are clearly meant to be only that; the staff plans to address DBS in the future (possibly after the first generation of DBS satellites have run their course in about seven years) to adopt permanent rules.

The adoption of the 12GHz band for DBS means that nearly all terrestrial microwave operators currently using the 12.2 to 12.7GHz band will have to move to other frequencies. Those operators will be allowed five years to relocate after a study of the problem, due September 1983, is completed by the FCC's Office of Science and Technology.

Some 1800 microwave links currently exist in the spectrum now reserved for DBS. Some 50% to 80% could be moved to 18GHz or higher frequencies, which would call for all new equipment. Services that can't be moved to that bandwidth will be located in the 12.7 to 13.25GHz band or the 6GHz range.

The impending financial burdens imposed on the affected terrestial operators may be eased by agreements with DBS services. Comsat's Satellite Television Corporation has said it will help compensate nonprofit organizations whose microwave transmissions must be relocated.

Proposed DBS service ranges from scrambled pay-TV signals to advertising-supported, unscrambled programs.

Although the vote favoring DBS was unanimous, several commissioners voiced concern about the possible adverse effect the new services could have on local TV broadcasting.

Several opponents of the FCC decision feel that DBS authorization isn't in the public interest because it will undoubtedly steal some of the audience of local broadcasters.

However, in the report on DBS prepared by FCC staffers, the staff said it didn't feel that the commission had to consider those staff said it didn't feel that the commission had to consider those objections in its rule making.

Even though DBS might usurp some of the local broadcasters' viewers, the FCC has traditionally given weight to a new service's effect on an existing service only if the new service results in a "net decrease in service," the FCC staff said.

Instead of decreasing service, the staff said, DBS would spur a "great expansion" of TV service, providing programming to outlying areas that are currently underserved by other broadcasters.

The type of DBS service proposed by the nine companies applying for FCC permits range from scrambled pay-TV signals to free advertiser-supported, unscrambled services. Assuming there are no major changes in bandwidth allocation at the Geneva conference next summer, DBS service could offer close to 40 channels of programming. (Most services currently planned call for a start-up of three operating channels.)

U.S. Satellite Broadcasting of St. Paul, MN, is planning a 3-channel, free service for its DBS offering.

One channel would offer 24-hour-a-day "traditional" news, sports, weather, entertainment and public affairs. Another around-the-clock channel would focus on news, sports and special interest programming. Company officials have declined to outline the third channel for competitive reasons.

U.S. Satellite's service would be available at no charge to any customer purchasing receiving equipment. Programming would be retransmitted via selected local TV stations through traditional over-the-air transmission.

These selected local stations would become both part owner and member stations and would also originate programming services to be offered throughout the entire satellite system.

Comsat's Satellite Television Corporation, based in Washington, D.C., plans to take a different approach to DBS.

The company's 3-channel system is to be offered nationwide using a 4-satellite system. Subscribers would receive, via scrambled signal, advertising-free programming.

The service would include a

24-hour-a-day entertainment channel with two 15-hour-a-day specialty programming channels. The service would cost subscribers $16 to $18 a month.

According to a company spokesman, Comsat is aiming at the nearly 25 million U.S. households, many in rural areas, where cable TV will never be offered. The company is forecasting a long-range goal of 7 to 8 million customers.

A secondary market for Comsat might be cable companies, who could rebroadcast DBS programming to their cable viewers.

Yet another approach to DBS programming, and probably the most innovative, has been dealt a blow by the adopted interim rules. CBS, which has been actively supporting the development of HDTV (High Definition Television), was unsuccessful in its attempt to get the FCC to restrict the new DBS frequencies to HDTV transmisisons.

HDTV setback

Although the commissioners' new rules allow HDTV DBS broadcasts as long as they don't interfere with conventional transmissions, the commissioners rejected CBS' lobbying to dedicate the entire spectrum to high-definition broadcasts. The commission also refused CBS' request to set aside part of DBS' 12GHz spectrum so that terrestrial broadcasters could retransmit one HDTV channel from the CBS system.

HDTV technology, still under experimental development in Japan, has been championed in the United States by CBS.

The technology significantly improves the traditional TV signal quality, utilizing 1125 scanning lines instead of the current 525 and using a 5:3 aspect ratio versus the existing 4:3 ratio. HDTV reception quality has been favorably compared to the clarity of a color photograph.

However, because of the advanced technology inherent in HDTV, current TV sets used in the United States wouldn't be able to receive HDTV signals without addition of a decoder or converter. In essence, every American who wanted to view this new technology would have to buy a new TV set.

HDTV also occupies more spectrum space than American TV channels. (You can fit two traditional channels into the bandwidth required for one HDTV channel.)

Because CBS' plans were based on the FCC reserving the entire DBS spectrum for HDTV, the company now is reconsidering its future in DBS.

DBS in your future

DBS will spawn an estimated $10-billion to $12-billion market for receiving equipment (including dish antennas, decoders and signal conversion equipment). Manufacturers and retailers of current 4GHz satellite receiving technology feel that DBS can be a boost to their market as well.

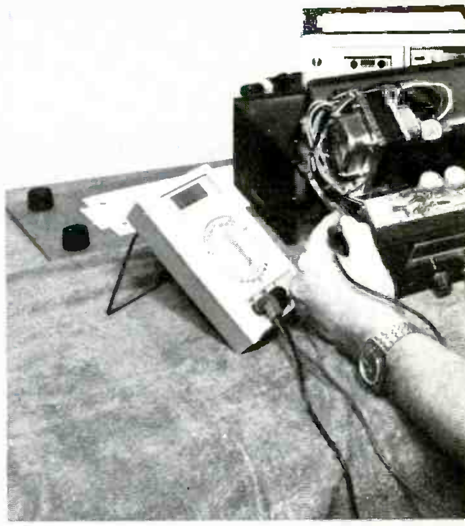
Once viewers in rural areas and urban areas not served by cable receive three satellite-quality signals from a DBS service, they will be hungry for the 70-plus channels they can receive with traditional satellite receiving equipment.

Dealers should view the emerging DBS market and other satellite technologies as new centers of profit opportunities. ES&T

Audio tests with DMMs

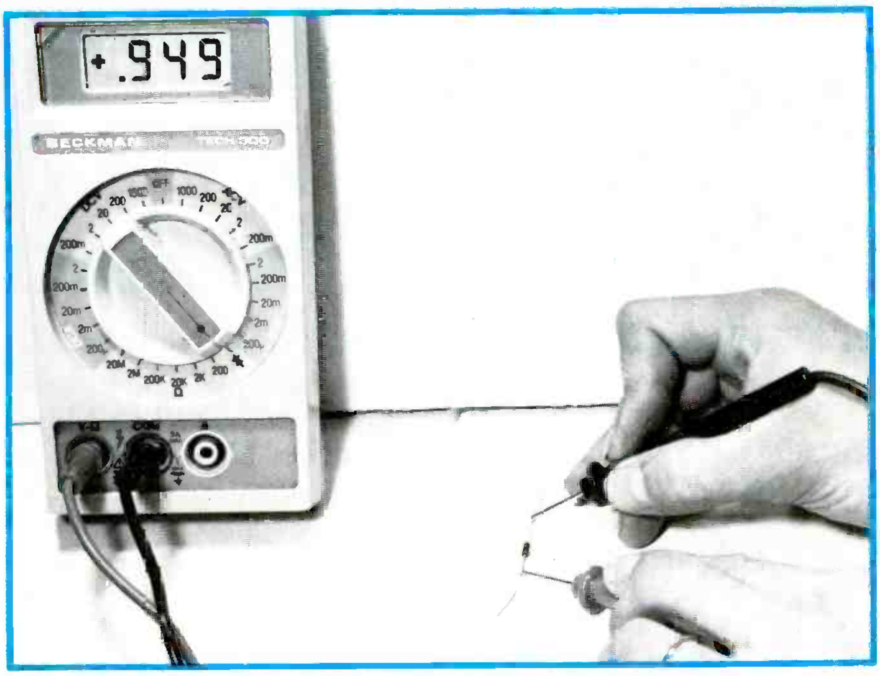
By Homer A. Davidson

Many audio measurements formerly made by VTVMs now can be made more efficiently and accurately by digital multimeters. Recommended procedures are described, along with other measurements that often are not effective.



DMMs are recommended for testing the audio stages in AM/FM/stereo radio receivers, especially those meters that have a constant-current voltage-drop type of diode test.

A large variety of digital multimeters (DMMs) is available now with the functions needed for audio amplifier repairs. Previously, VOMs and VTVMs were used, although the accuracies left much to be desired. Audio circuits can be tested satisfactorily by DMM dc-voltage and current functions, with their improved accuracies. However, the resistance and ac-voltage functions of some DMMs cannot be trusted completely for *all* audio measurements.



When the DMM has a voltage-drop diode test, connect the positive-voltage test probe to the diode anode and the negative-voltage test probe to the diode cathode. As shown here, the Beckman Tech 300 series DMMs have a diode test that is identified by a diode symbol. A constant dc current is passed through a forward-biased diode, producing a voltage drop that is displayed on the 2Vdc range. Reversal of the probes applies reverse bias, and a normal diode should have little current flow, which activates the meter overrange display.

Diode problems

The problems with resistance readings are old ones that came with the advent of solid-state components.

Many different readings. A diode or transistor junction attempts to stabilize the *forward-bias voltage* across itself. This stabilization operates by the diode changing its internal resistance according to the applied voltage, and the change in resistance in turn changes the diode current. The voltage vs. current relationship is highly non-linear. Therefore, the diode resistance (as measured by an ohmmeter) varies depending upon:

- which ohmmeter range is selected;
- what dc voltage is applied by the ohmmeter to the diode;
- the amount of ohmmeter current (often determined by range and voltage); and
- condition of the diode (open, leaky, shorted or normal).

Obviously, there can be a multitude of readings for each individual diode, and that situation can be very confusing, even under ideal conditions. No specific resistance can be assigned to any diode, and this complicates ohmmeter readings.

In-circuit resistance errors. When ohmmeter measurements are made on resistors in typical circuits, the partial conduction of transistor junctions and diodes (from the ohmmeter dc voltages) can produce huge errors. The percentage of error varies with polarity of the test probes, the range used and the resistance values being measured, so the accuracy cannot be improved by applying a correction formula.

Many of today's DMMs attempt to solve the diode-conduction problems by including *two* ohmmeter functions. One usually is called *high power* because it has higher dc voltages that produce conduction through transistor junctions and diodes. The other ohmmeter function is labeled *low power* because the maximum dc voltage between the probes is maintained below the voltage that causes diode conduction. With lower-power operation, the probe voltage should not exceed about 0.2V for any reading not activating the overrange. High-power mode should be used when the forward-bias conduction of a diode is being measured. When the ohmmeter is operated to test circuit resistances (and diode conduction would give erroneous readings), low-power ohms mode should be selected.

The errors caused by diode conduction can be illustrated by making each resistance reading twice, once with high-power and again with low-power mode. Any significant difference between the two tests is produced by diode or transistor conduction.

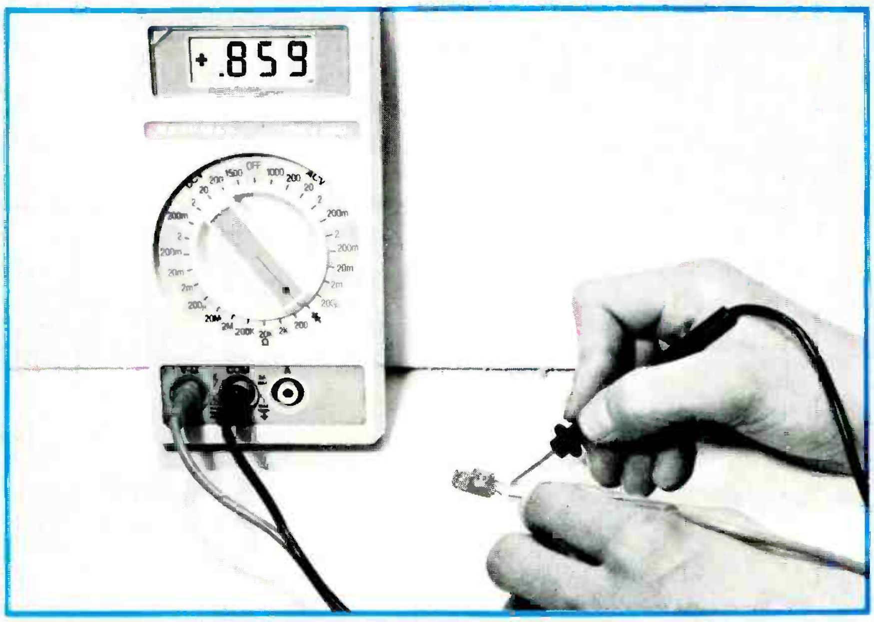
Unfortunately, the use of high-power and low-power ohmmeter modes does not solve all problems. Conduction in the high-power mode is not sufficient for accurate analysis of diode conditions when the circuit also has low-value resistors. Also, some DMMs have too high a voltage in the low-power mode, so excessive conduction can occur with *germanium* transistors and diodes.

Diode and resistor tests

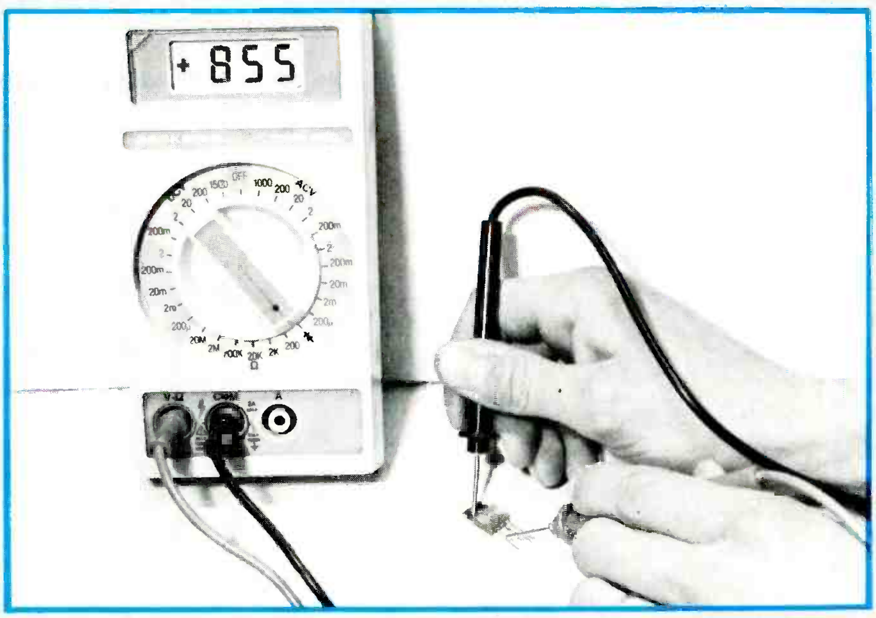
A few DMMs solve the diode-conduction problems more satisfactorily. First, all ohmmeter ranges are the low-power type that minimizes errors due to diode-conduction.

For solid-state tests, a 1-range test is provided. This one range checks all single diodes. A regulated constant dc current (1mA to 5mA, according to model) of forward-bias polarity is forced through any normal diode that is being checked. The current produces a characteristic voltage drop: a different voltage for different types of diode. This voltage drop is measured by the DMM's 2Vdc range and displayed on the digital readout.

Dependable diode-forward-conduction readings can be made by all DMM models, regardless of brand, that have a voltage-drop test. Of course, a model that applies 1mA of dc current to a diode junction will show a slightly lower reading than another that has 5mA, but the differences probably will be less than 0.05V. Therefore, the voltage-drop test will give one reading (not dozens) for each individual transistor junction or diode.



To test an NPN power transistor by the voltage-drop method, connect the positive-voltage test probe to the transistor base, then connect the negative-voltage test probe to the transistor emitter. A normal silicon transistor should show a readout between 0.65V to 0.80V.



The second step for testing an NPN power transistor is to leave the positive test probe at the transistor base while connecting the negative probe to the transistor collector. This forward-bias reading and the one in the first step should be approximately the same.

Precise readings cannot be forecast for all diodes because of several variables. Of course, silicon junctions will produce about double the voltage of germanium. This is helpful because the characteristic voltage will differentiate silicon devices from germanium devices. High-power transistors usually have a lower voltage drop than low-power ones have. Other unpredictable readings probably are caused by differences in manufacturing techniques or variations of impurities in the silicon.

With the Beckman meter I use, small germanium transistors have B/E and B/C junctions that measure about 0.30V to 0.33V, while germanium power transistors have readouts between 0.165V and 0.207V. Many small silicon transistors check about 0.70V to 0.75V per junction. Silicon power transistors usually check lower. Several top-hat-type 60Hz supply diodes tested in the 0.63V to 0.65V range, but low-voltage-bridge diodes checked lower (in the 0.57V to 0.59V range).

Zener diodes can be tested for forward-bias operation. A zener showing normal forward-bias voltage drop without excessive reverse-bias leakage usually has proper zener operation. Always be prepared, of course, for intermittent or heat-triggered defects.

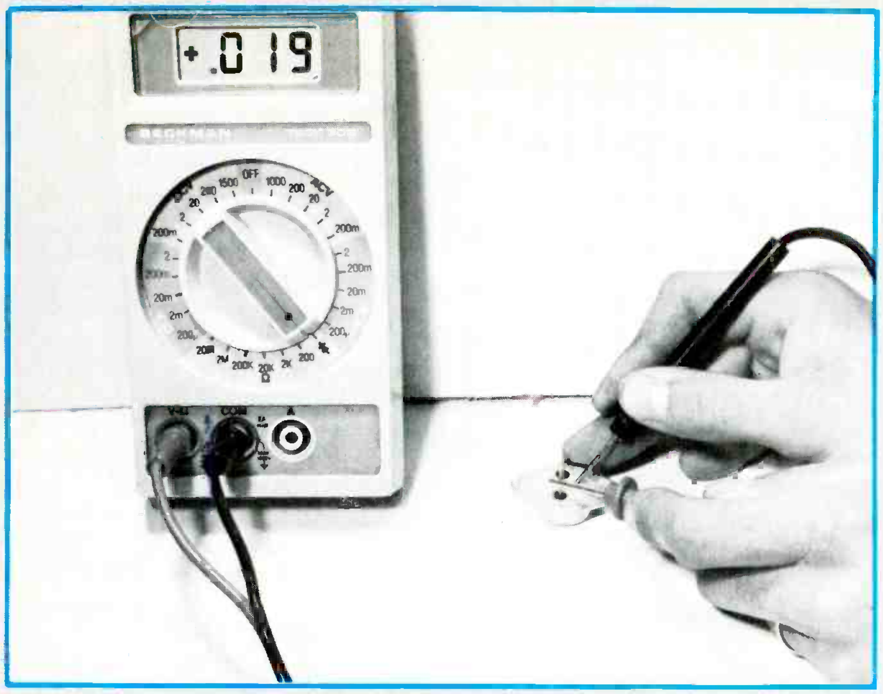
Experience in testing many transistor junctions and diodes by the voltage-drop method will show you rapidly the *range* of readings for the various kinds of junctions.

Remember also that these tests cannot measure switching times. Therefore, this method can not identify which diodes are suitable for horizontal-blanking circuits or rectification of horizontal pulses.

Testing transistors

Use the following steps when testing transistor junctions and diodes by the voltage-drop method.

- Place the positive-voltage meter probe against the diode anode (or base of an NPN transistor and the negative-voltage probe against the diode cathode (or the NPN transistor emitter). Take



Silicon power transistors should not produce a conductive reading regardless of the polarity of the meter probes with respect to collector and emitter. Some large germanium transistors might show some conduction with one polarity. However, when a low reading (as shown) is obtained with both polarities, the transistor has a collector-to-emitter short.

the reading.

- If the device is an NPN transistor, transfer the negative test probe to the collector. Evaluate the reading.
- If the device is a transistor, connect the test probes between collector and emitter. Notice the readout, then reverse the test probes and look at the readout. Both tests should show overrange (a few high-power germanium types might show a reading with *one* polarity – this probably is normal). If both polarities show a low readout, the transistor has a collector-to-emitter short.
- Any lower-than-normal readings during the preceding tests indicate a leaky or shorted junction.
- To test PNP transistors, reverse the test-probe polarities. For example, the negative-voltage probe connects to the base, with the positive-voltage probe alternated between emitter and collector. When that is done, the PNP and NPN readings can be evaluated by the same standards.
- Excessive leakage can be identified by testing the forward-bias conduction and then reversing the test probes to give a leakage check. However, a leakage resistance below about 400Ω is needed to bring the reading out

Circle (12) on Reply Card

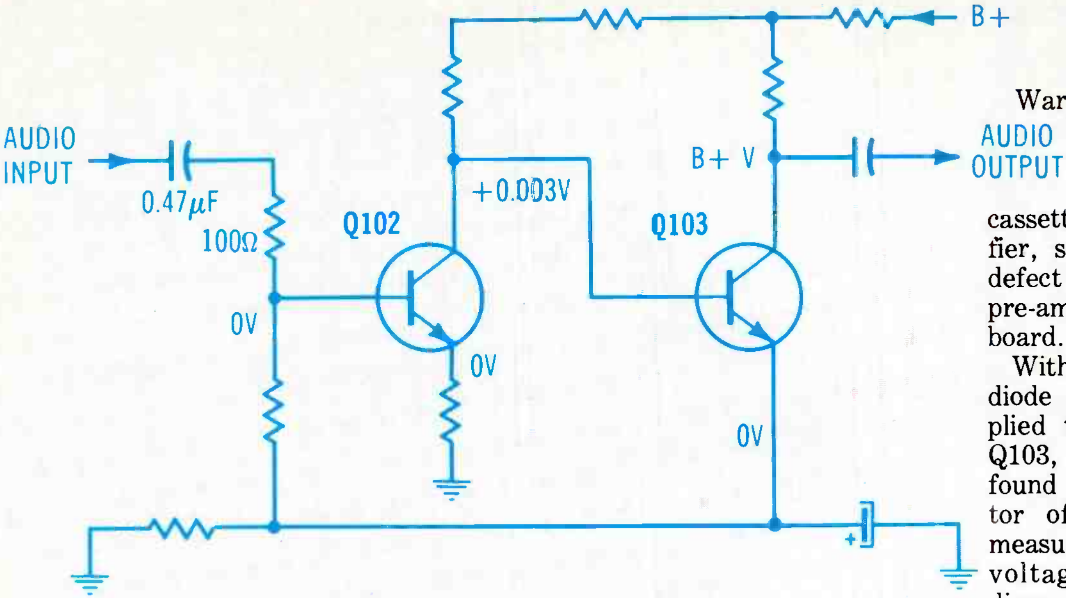


Figure 1 These voltage readings in a Montgomery Ward's tape player proved transistor Q102 had collector-to-emitter leakage.

Montgomery Ward cassette machine

The radio function of a Ward's model 3989 played normally, but no sound could be heard from the cassette player. Both radio and cassette use the same main amplifier, so it was obvious that the defect was located on the cassette pre-amplifier part of the circuit board.

With the DMM switched for diode tests, the probes were applied to the leads of Q102 and Q103, and a high leakage was found between emitter and collector of Q102. Accurate voltage measurements with the DMM dc-voltage ranges verified the diagnosis (Figure 1), because the emitter had zero volts and the collector only slightly higher. The Q102 base also measured zero because its dc voltage came from the Q103 emitter, but Q103 was cut off because the Q102 short reduced the Q103 base voltage to almost zero.

If the Q102 base had received its dc forward bias through a resistor from a B+ source, the base would have measured only slightly lower than usual (perhaps +0.60V rather than +0.67V).

of overrange, so some diodes or transistors might require removal from the circuit for conventional ohmmeter reverse-bias leakage tests.

- Darlington transistors (an emitter follower connected internally to a second transistor) can be identified by the higher base/emitter voltage. For example, one Darlington tested 1.19V between base and emitter, while the B/C junction measured 0.69V.

In summary, the voltage-drop type of transistor-junction and diode test can reveal which lead is the base; opens between base and collector or emitter; whether the diode or transistor is germanium or silicon; shorts or excessive leakages across the junctions; all large unbalances between B/E and B/C; and if a transistor is a Darlington or not.

Most of these tests can be performed in-circuit. A paralleling resistance must be 500Ω or less to reduce a junction or diode reading significantly. And leakages below 100Ω are required before the tests become questionable. Rapid and accurate conduction tests can be made on bridge-rectifier circuits, for example.

Problems of interpretation arise occasionally in circuits that connect several transistors together in direct-coupled mode. But these cases are rare. The voltage-drop method is relatively free from complications.

Power supply testing

Leaky or shorted power-supply diodes are a common cause of blown fuses or tripped circuit breakers. Two diodes are used in transformer-type full-wave rectification, while four are necessary for any bridge circuit (whether or not a power transformer is used). These open or shorted diodes can be tested easily in-circuit by the voltage-drop diode measurement.

First, you must know which meter probe is positive during these tests. If there is any doubt, measure the dc voltage between the two probes by using a second meter on its low dc-voltage range.

Quicker tests of ICs

Removal of integrated circuits is difficult if damage to the IC and the circuit board is to be avoided. Also, considerable time is required for IC replacement. Therefore,

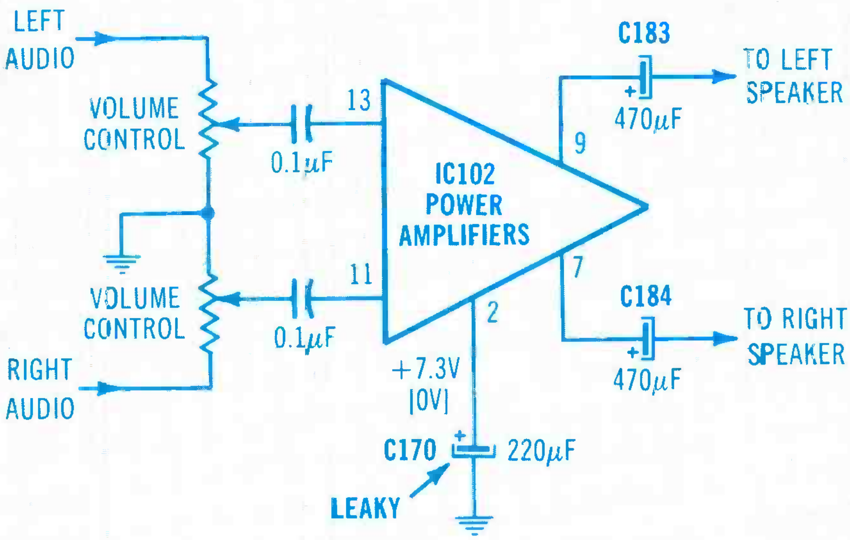


Figure 2 The dual-channel power-amplifier IC was not defective in a Soundesign machine, but the loss of all volume was caused by a leaky C170 capacitor.

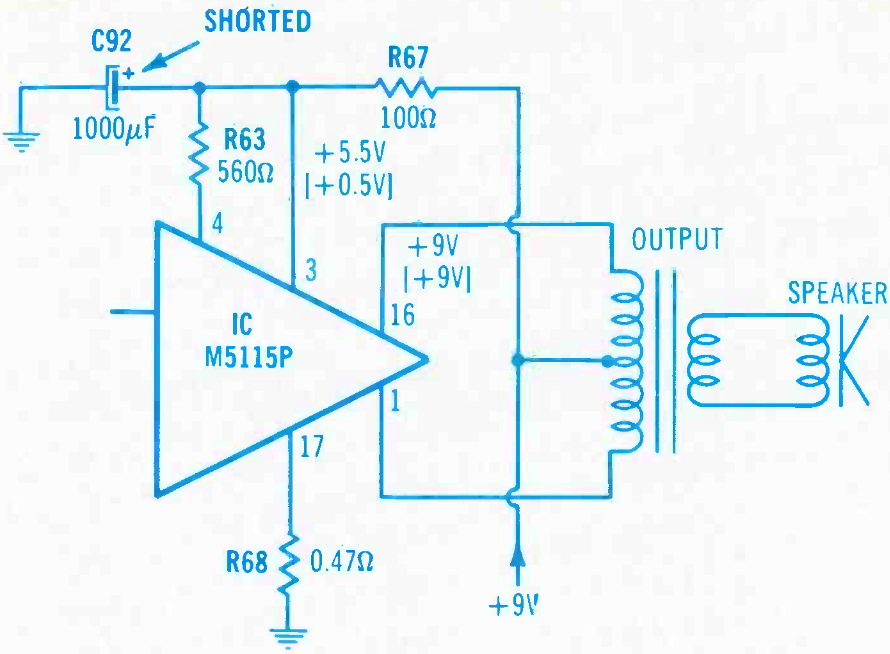


Figure 3 A shorted decoupling capacitor (C92) in a Panasonic left some dc voltages unchanged while it eliminated all sound at the speaker.

tests should be made to prove the IC is actually defective, and not inactive because of a bad component or wrong voltage connected to it. Before any IC is replaced, you should perform accurate voltage and resistance tests of each pin, plus making scope checks for input and output-signal waveforms.

Both audio channels were dead in a Soundesign model 2200. As is often the case, one IC (IC102) contains both stereo power-output stages. The dc-voltage tests located zero voltage at pin 2, but the schematic called for +7.3V. Either the IC or C170 must be shorted. C170 was easier to remove, and it was found to have a low-resistance short (Figure 2). Replacement of C170 restored normal volume in both channels. Replacement of IC102 because of suspicion would have been costly and futile.

Panasonic without sound

The only sound from a model RQ-483S Panasonic radio/cassette machine was a click when power was applied. Scope waveforms proved sound was coming to the IC-M5115P power-output integrated circuit, but no audio was coming out of it.

The dc-voltage tests at the #1 and #16 pins that drive the speaker were normal, so the IC was replaced, but the machine remained silent. Either the new IC was defective or excessive heat from the installation might have ruined it.

When the dc voltages were measured at each pin (Figure 3), pins 3 and 4 had only about 0.5V

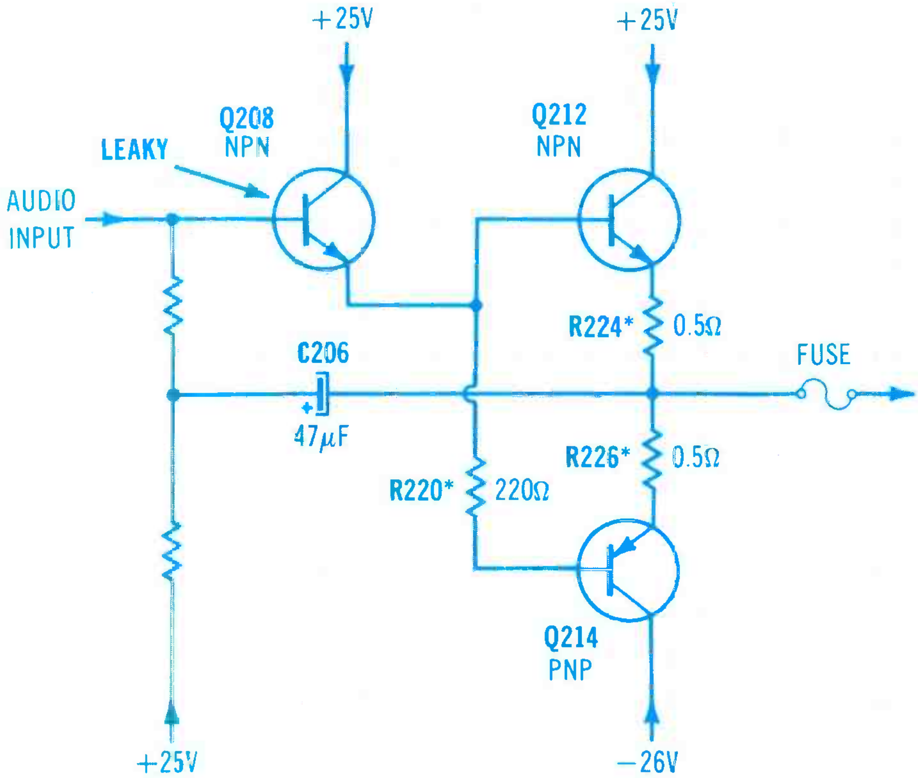


Figure 4 Transistor Q208 probably failed first, with the resulting overload ruining Q212 and three bias resistors in one Pilot radio.

instead of +5.5V as specified. Ohmmeter readings showed less than 20Ω from pin to ground. Evidently the IC or C92 was shorted, but the IC had been replaced, so C92 was removed for testing externally, where it was found to have excessive leakage. After it was replaced, the audio stage performed correctly.

Distortion in a Pilot

Most cases of distortion in audio amplifiers originate in the output stages. Check first for leaky or open output transistors when excessive distortion is heard at low volume. If only one of the output pair is bad, it is advisable to replace both. Also, check all low-resistance bias and limiting resistors (at the bases or emitters usually). Disconnect one end of each suspect before measuring the resistance.

A Pilot model 1500 deluxe AM/FM/stereo had low-volume distortion in the right stereo channel. When tested by the voltage-drop method, driver transistor Q208 and output transistor Q212 were leaky (Figure 4), while Q214 output transistor had not been damaged. (It is likely that Q208 failed first, which then overloaded Q212 and Q214 before the fuse blew.)

After Q208 and Q212 were removed, all resistors of the output stage were measured. R220 and R224 were out of tolerance from the previous overload. R226 was checked, but it had not been damaged. Normal volume and minimum distortion were obtained following replacement of two resistors and two transistors.

Distortion in a Soundesign

A small amount of distortion was the complaint against a Soundesign model 4485 AM/FM/stereo radio. Of course, it is often much more difficult to locate such a moderate distortion. Check first all transistors and resistors in the driver and output stages. And don't overlook the bias diodes.

In this case, the preliminary tests found nothing wrong until bias diodes D12 and D13 were tested by the DMM diode function. Diode D12 tested shorted, which applied an incorrect bias to Q22. This problem is called crossover distortion because it affects the point where Q20 and Q22 stop and start conduction during each cycle (Figure 5). Borderline symptoms can be located much more easily if the voltages, signals and components of the bad channel are compared against those of the good channel.

Signal tracing

Audio signal tracing usually is accomplished by scoping the stages. However, the sensitive ac-voltage ranges of most DMMs allow faster signal tracing with much better accuracy.

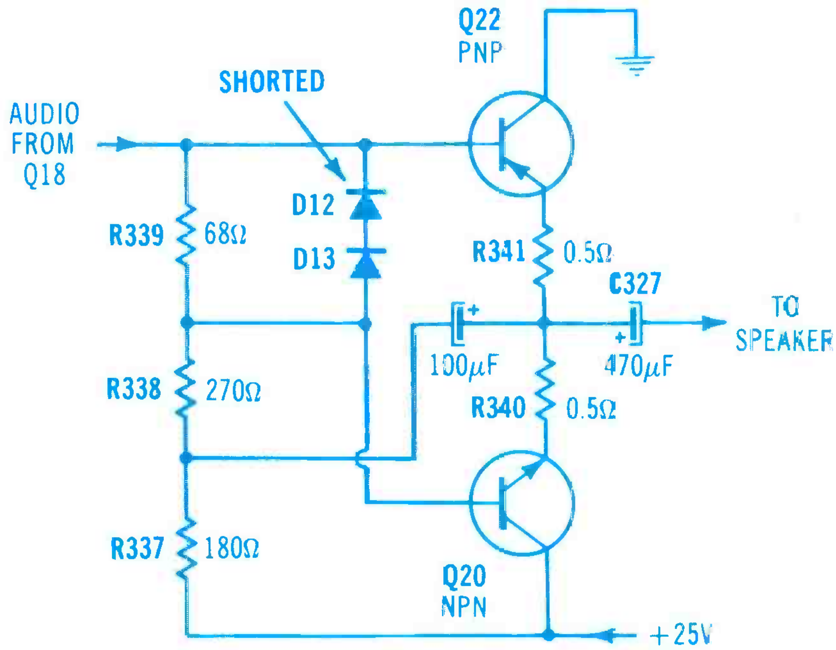


Figure 5 The bias offset between two complementary power output transistors is very critical if distortion is to be minimized. A shorted D12 bias diode in a Soundesign stereo radio produced a moderate amount of crossover distortion at lower volume levels.

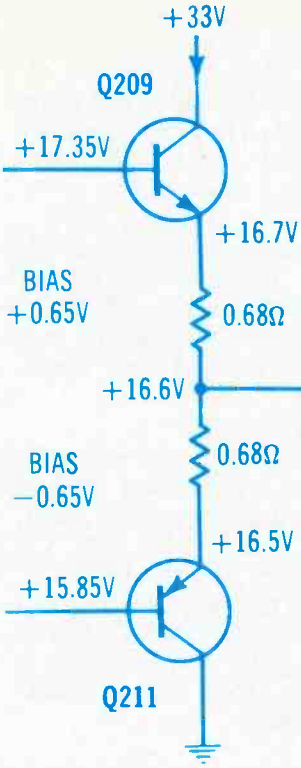


Figure 6 The base/to-emitter bias of a Q209 NPN output transistor should equal the B/E bias of a Q211 PNP output transistor. Also, dc voltage at the output emitter resistors should be about half of the supply voltage. Always check resistances of the emitter resistors after any overload.

If the most-sensitive DMM ac-voltage range is 2V (actually, 1.999Vac), a DMM will measure ac signals accurately down to about 10mV. Relative indications are possible down to about 2mV. Although transistorized preamplifiers might have lower levels, all other normal stages should have more than sufficient signal strength to be measured by a DMM.

There are two limitations. Digital meters are not practical unless the signal being measured has a constant amplitude. Therefore, an audio oscillator should be used for the signal source as the DMM traces the levels down stage by stage. Feed the same signal into each stereo channel, and the good channel can be the standard for the bad channel.

The other possible problem is ac frequency response. Many digital multimeters have flat response only to 400Hz or 500Hz. Also, the frequency response often is wildly different for various acV ranges. If you do many frequency-response measurements, it is advisable to obtain a DMM that is flat over the 20Hz to 20kHz audio range. There are a few, but not many. If you are interested only in gain, then use a low frequency such as 400Hz for signal-tracing tests.

Comments

Figure 4 shows several critical voltages of typical audio-output stages that should be tested carefully during each repair.

Complementary output stages that operate from a single power supply typically have about half the supply voltage at the signal output (C219 here). With the gain reduced to give weak volume, the base-to-emitter forward biases of the two complementary transistors should be almost identical (except, of course, one will have negative and the other positive bias).

The first measurements made during each troubleshooting session should include these voltages plus all bias resistors and diodes of the output stage. ES&T

READERS' EXCHANGE

Needed: Schematics and/or operator's manuals for B&K model 1070 Dyna-sweep circuit analyzer. *Roy L. Marcum Jr., 2132 Eleanor, Springfield, IL 62702, 1-217-544-4187.*

Needed: The following "recently out-of-print" Sams books at reasonable prices: 23800, Small Engine Maintenance and Repair; 21148, ABCs of Calculus; and 20784, Collected Basic Circuits. *Shannon O. Sellers, 7308 Franklin Drive, Rock Creek, Bessemer, AL 35023.*

Needed: New or good used flyback transformer, part #AM-WM-20, for Crown color television, model 13 CX-1. *Joe Kurata, 377 Santa Ana Ave., San Francisco, CA 94127.*

Needed: Calibration information on a model 209 A Hickok VTVM. Willing to pay copy costs and shipping, or will buy manual if necessary. *Howard Adams, 209 W. Shadywood Drive, Midwest City, OK 73110.*

Needed: Replacement record-playback (one or two) heads for a Realistic TR-101 reversing reel-to-reel recorder, catalog #14-901. Could use hubs if they are available. Any help would be appreciated. *Don Graham, 125 Cedar Hill Road, Baltimore, MD 21225.*

Needed: Sencore TF 54 pocket Cricket, reasonable. Instruction manual and schematic. State price and condition. *I. Anchia, 615 S. Louise St., Glendale, CA 91205.*

Needed: TEK/HP/GR test equipment catalogs; TEK 3L5 p/i. Send SASE for electronic list. *J. Allen Call, 1876 E. 2990 South, Salt Lake City, UT 84106.*

Needed: EMC model 802 signal tracer/generator, Heath model 1G-5237 FM generator and B&K model 1640 regulated power supply or similar models. *Caswell Davis Jr., 601 Delmar, Apt. 2, San Antonio, TX 78210.*

Needed: Schematic and part list for model 20585 Lemart stereo multiplex receiver with 8-track cartridge player, or information on where to get same. *David Hurlbert, 43 Koster St., Wallington, NJ 07057.*

Needed: Picture tube #13VAMP22 for 13JC10 model Zenith color portable, tuner control module for Zenith model 17GC45 color portable and remote control (transmitter and receiver) for Heathkit GR-2001 color television, GRA-2001-6. *Call James L. Young, 1-213-420-9832, Long Beach, CA.*

Needed: Schematic and part list for any of the following metal detectors: Garrett "Coinhunter" BLF/TR featherweight, D-tex "Coin King" CK30, or Whites Coinmaster 5000D GEB. Will buy or copy and return. *G. Leediker, 1705 Althea Drive, Houston, TX 77018.*

Needed: Used service monitor, signal generator for 2-way FM radios and Bird wattmeters. *Robert Haley, Route 3, Box 378K, Longview, TX 75603, 1-214-643-2236.*

Needed: RF probe, leads and manual for a Sylvania polymeter, model 221-Z; manual for RCA TV sweep generator, model WR-59-A; and a manual for a Tektronics 555 oscilloscope. *Ken Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

Needed: Will pay $500 for RCA color television, model CT-100 (CTC-2) from 1954. Also need 15GP22 kines. *Jeff Lendaro, c/o Morris TV, 1 Padanaram Road, Danbury, CT 06810.*

Needed: Sencore VA48, B&K 520B, schematics for Funai F-067, Dynaco A-431 and Philmore FS-1. *Fred Washington, 4004 Prospect, Kansas City, MO 64130.*

Needed: Schematic for Panasonic recorder, model RS-760S. *Tom Hamilton Audio, 2409 Gates Ave., Redondo Beach, CA 90278, 1-213-371-5984.*

Needed: Quasar flyback transformer #24P65171A49. *Bedford TV, 662 Broadway, Bedford, OH 44146.*

Needed: Operating manual or copy of Sony TC 580; advise charges. *George Bleeker, 271 Emporia, San Antonio, TX 78209.*

Needed: Schematic for Toshiba car radio, model 7CN-15T, 12V, 7 transistor. Also parts list if possible. *Louis A. Loos, 1112 N. Lafayette, Bremerton, WA 98312.*

Needed: Sams Photofacts from 1473 and newer; Sams MHF series; back issues of ES&T and ETD for the last 10 years. *Rich Clark, Route 1, Belmond, IA 50421, 1-515-444-3171 after 6 p.m.*

Needed: Reward of $50 will be paid for the first schematic or service manual on a Craig CCTV camera, model 6107. *Joe Wagner, Mid-Co TV Systems, 646 Mendelssohn Ave. North, Minneapolis, MN 55427, 1-612-544-3375.*

Needed: Sencore VA48 in first-class condition with all cables and manual; will pay to $700. *M.E. Baker*

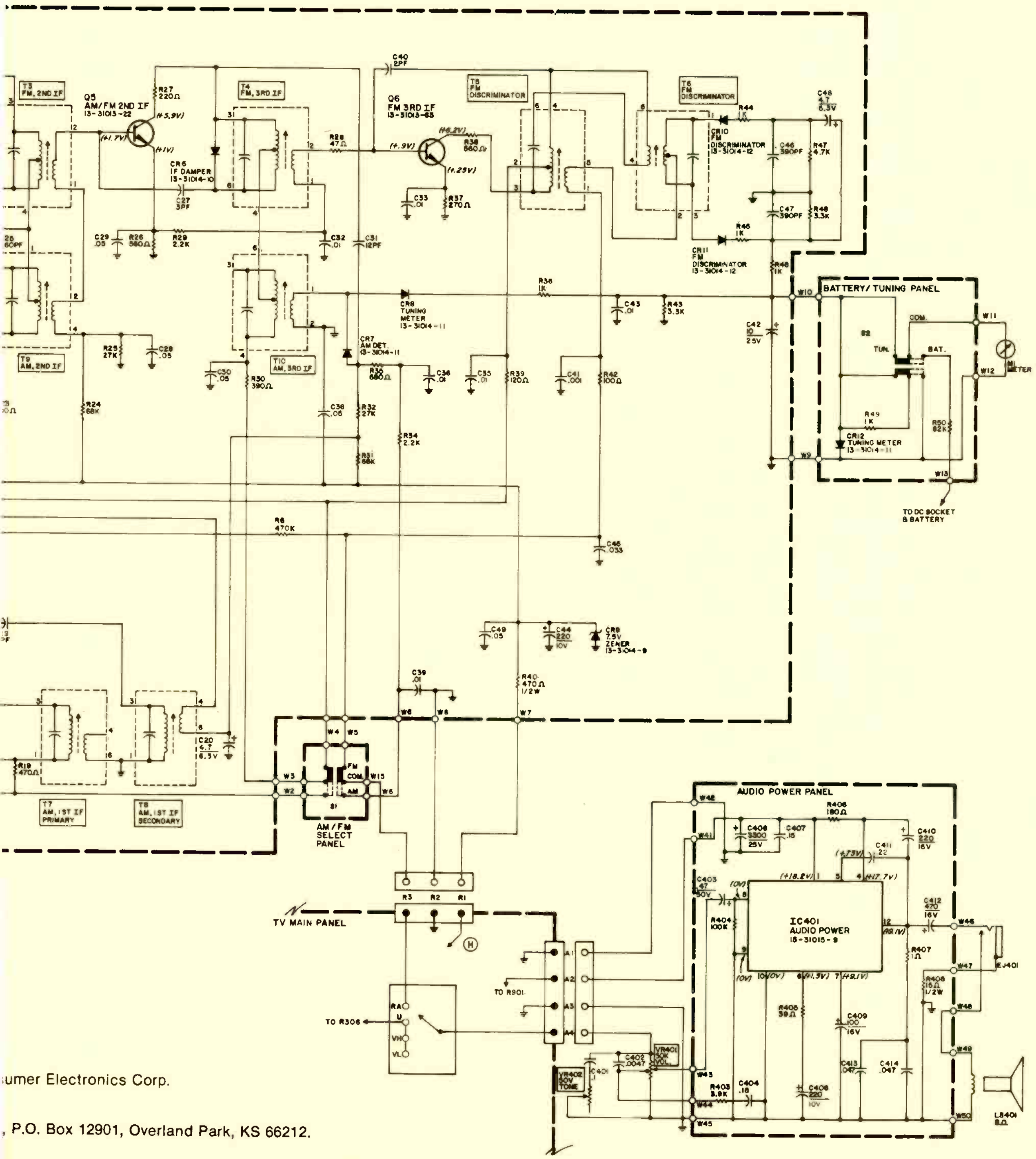
ES&T Manufacturers' schematics **PROFAX**

2006

NAP
B&W TV
Model MQA014GY

DECEMBER 1982

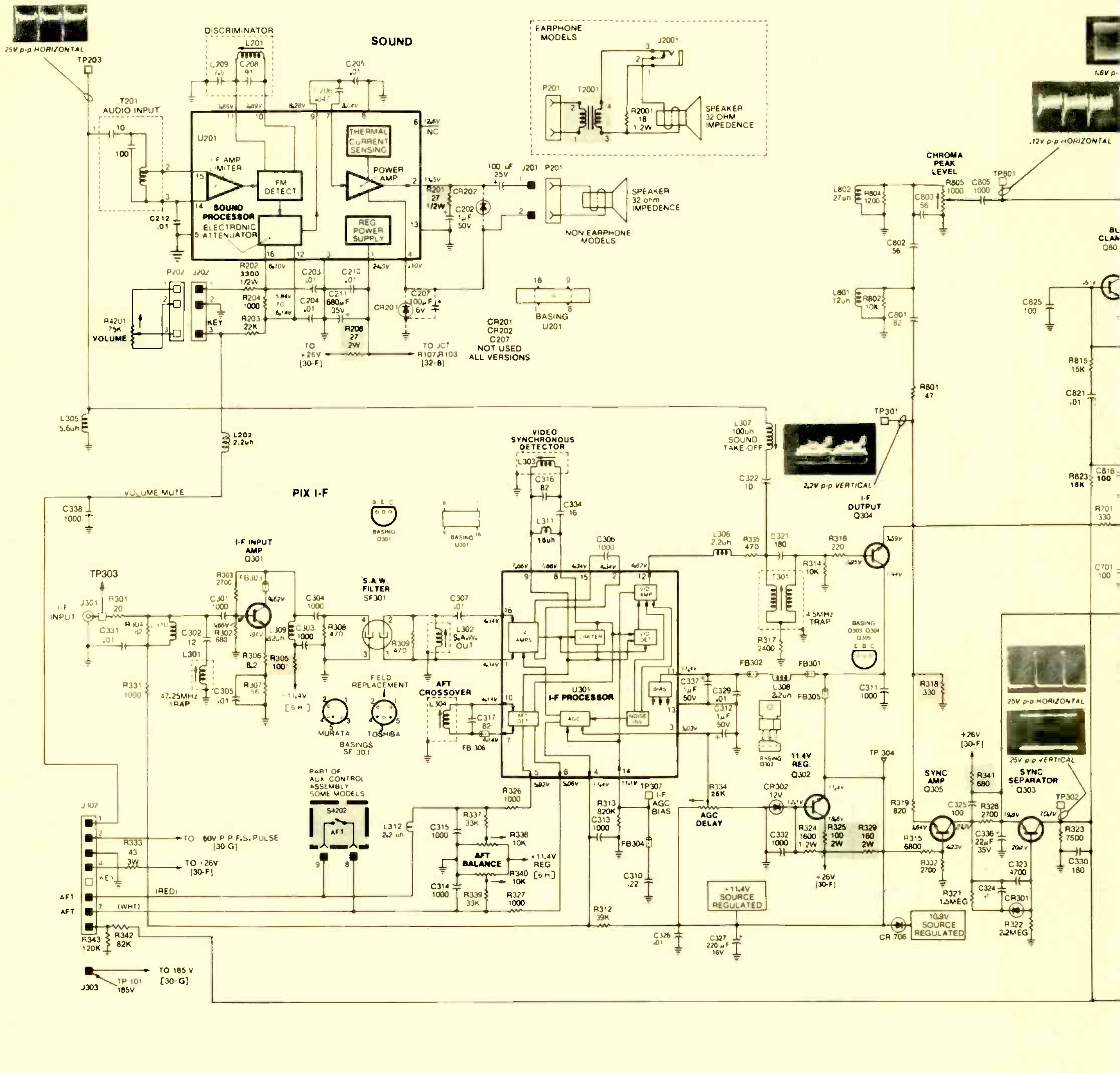
EMATIC



umer Electronics Corp.

, P.O. Box 12901, Overland Park, KS 66212.

When this *Profax* pull-out section is removed from the magazine and horizontally aligned with the other RCA schematic, the entire chassis circuitry of the color unit may be viewed.



This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

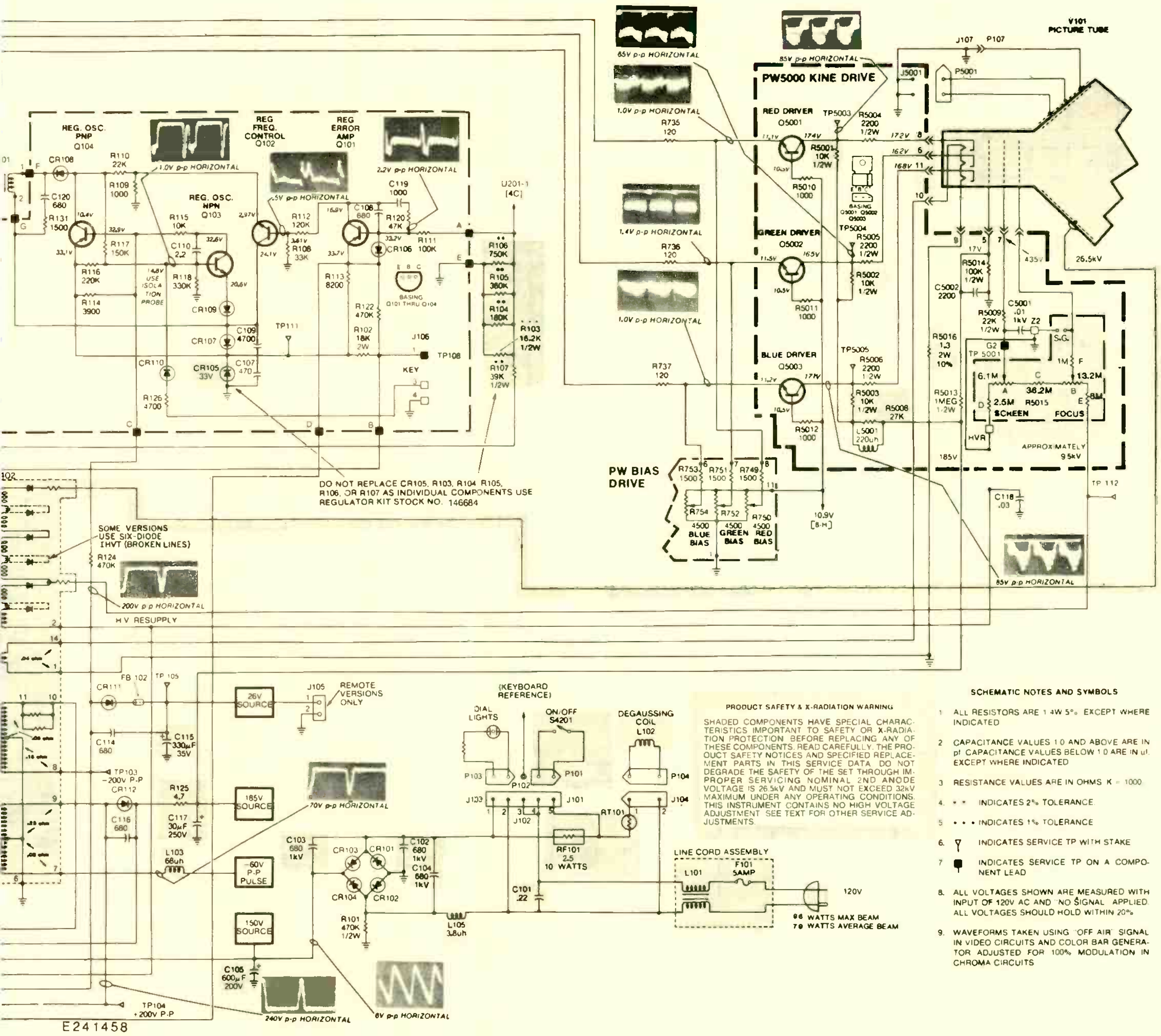
Reprinted from RCA

ES&T Manufacturers' schematics **PROFAX**

2007

RCA
Color TV
Chassis CTC 108

DECEMBER 1982



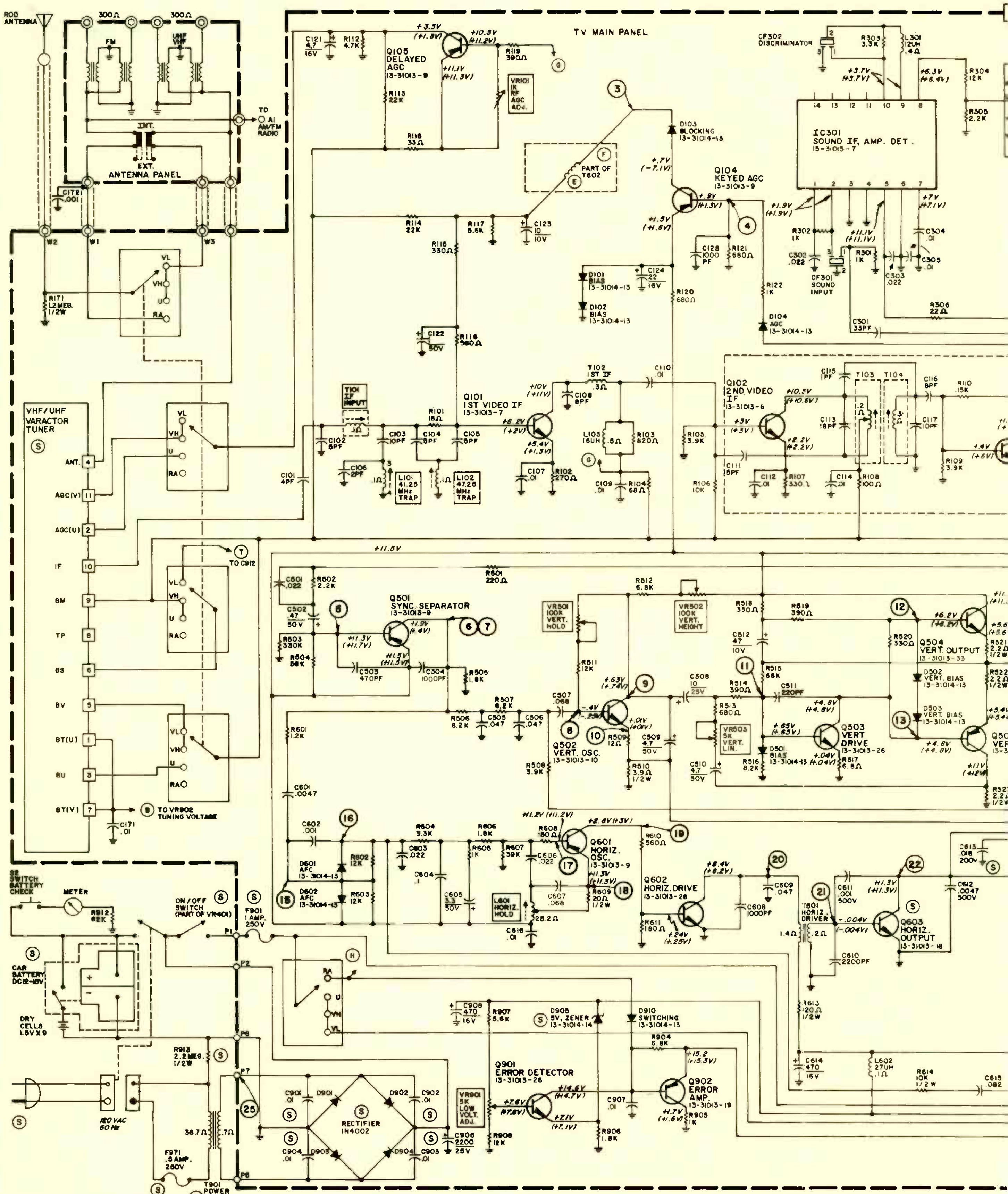
PRODUCT SAFETY & X-RADIATION WARNING

SHADED COMPONENTS HAVE SPECIAL CHARACTERISTICS IMPORTANT TO SAFETY OR X-RADIATION PROTECTION. BEFORE REPLACING ANY OF THESE COMPONENTS, READ CAREFULLY THE PRODUCT SAFETY NOTICES AND SPECIFIED REPLACEMENT PARTS IN THIS SERVICE DATA. DO NOT DEGRADE THE SAFETY OF THE SET THROUGH IMPROPER SERVICING. NOMINAL 2ND ANODE VOLTAGE IS 26.5kV AND MUST NOT EXCEED 32kV MAXIMUM UNDER ANY OPERATING CONDITIONS. THIS INSTRUMENT CONTAINS NO HIGH VOLTAGE ADJUSTMENT. SEE TEXT FOR OTHER SERVICE ADJUSTMENTS.

SCHEMATIC NOTES AND SYMBOLS

1. ALL RESISTORS ARE 1/4W 5% EXCEPT WHERE INDICATED
2. CAPACITANCE VALUES 1.0 AND ABOVE ARE IN pf. CAPACITANCE VALUES BELOW 1.0 ARE IN uf. EXCEPT WHERE INDICATED
3. RESISTANCE VALUES ARE IN OHMS. K = 1000
4. • • INDICATES 2% TOLERANCE.
5. • • • INDICATES 1% TOLERANCE.
6. INDICATES SERVICE TP WITH STAKE
7. INDICATES SERVICE TP ON A COMPONENT LEAD
8. ALL VOLTAGES SHOWN ARE MEASURED WITH INPUT OF 120V AC AND "NO SIGNAL" APPLIED. ALL VOLTAGES SHOULD HOLD WITHIN 20%.
9. WAVEFORMS TAKEN USING "OFF AIR" SIGNAL IN VIDEO CIRCUITS AND COLOR BAR GENERATOR ADJUSTED FOR 100% MODULATION IN CHROMA CIRCUITS

TELEVISIC



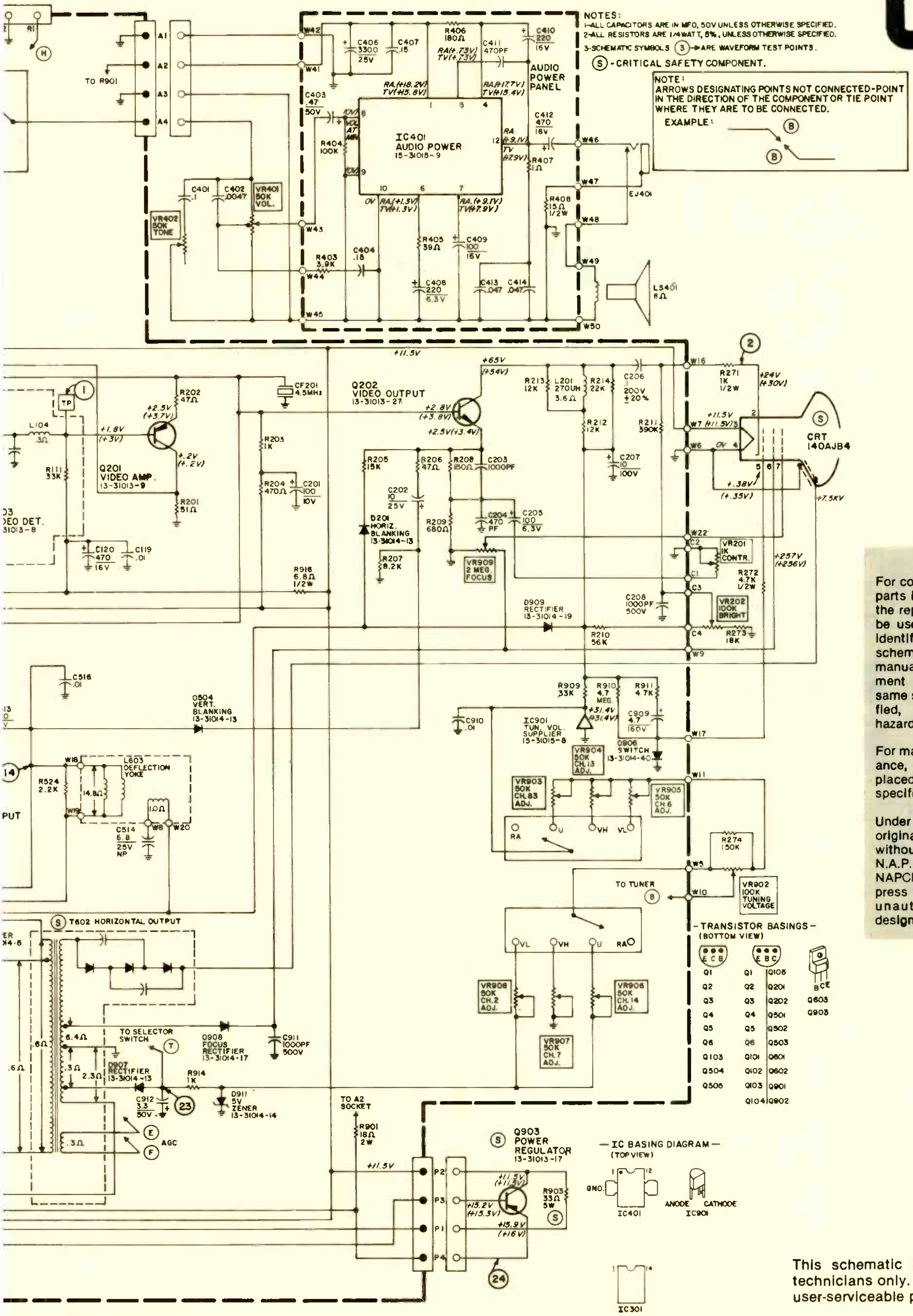
ROD ANTENNA
300Ω
300Ω
FM
UHF VHF
INT.
EXT.
ANTENNA PANEL
TO AM/FM RADIO
TV MAIN PANEL
Q105 DELAYED AGC 13-31013-9
VR101 1K RF AGC ADJ.
PART OF T602
D103 BLOCKING 13-31014-13
Q104 KEYED AGC 13-31013-9
D101 BIAS 13-31014-13
D102 BIAS 13-31014-13
D104 AGC 13-31014-13
CF302 DISCRIMINATOR
IC301 SOUND IF, AMP. DET. 15-31015-7
CF301 SOUND INPUT
VHF/UHF VARACTOR TUNER
ANT.
AGC(V)
AGC(U)
IF
BM
TP
BS
BV
BT(U)
BU
BT(V)
TO VR902 TUNING VOLTAGE
TO C912
T101 IF INPUT
L101 41.25 MHz TRAP
L102 47.25 MHz TRAP
Q101 1ST VIDEO IF 13-31013-7
T102 1ST IF
Q102 2ND VIDEO IF 13-31013-6
+11.5V
Q501 SYNC. SEPARATOR 13-31013-9
VR501 100K VERT. HOLD
VR502 100K VERT. HEIGHT
Q502 VERT. OSC. 13-31013-10
VR503 5K VERT. LIN.
Q503 VERT DRIVE 13-31013-26
Q504 VERT. OUTPUT 13-31013-33
D502 VERT. BIAS 13-31014-13
D503 VERT. BIAS 13-31014-13
D501 BIAS 13-31014-13
D601 AFC 13-31014-13
D602 AFC 13-31014-13
L601 HORIZ. HOLD
Q601 HORIZ. OSC. 13-31013-9
Q602 HORIZ. DRIVE 13-31013-28
T601 HORIZ. DRIVER
Q603 HORIZ. OUTPUT 13-31013-18
S2 SWITCH BATTERY CHECK
METER
ON/OFF SWITCH (PART OF VR401)
F901 1 AMP. 250V
CAR BATTERY DC12-16V
DRY CELLS 1.5V X 9
120 VAC 60 Hz
F971 .5 AMP. 250V
T901 POWER
RECTIFIER IN4002
VR901 5K LOW VOLT. ADJ.
Q901 ERROR DETECTOR 13-31013-26
D905 5V, ZENER 13-31014-14
D910 SWITCHING 13-31014-13
Q902 ERROR AMP. 13-31013-19

2006

NAP
B&W TV
Model MQA014GY

DECEMBER 1982

:CHEMATIC



WARNING

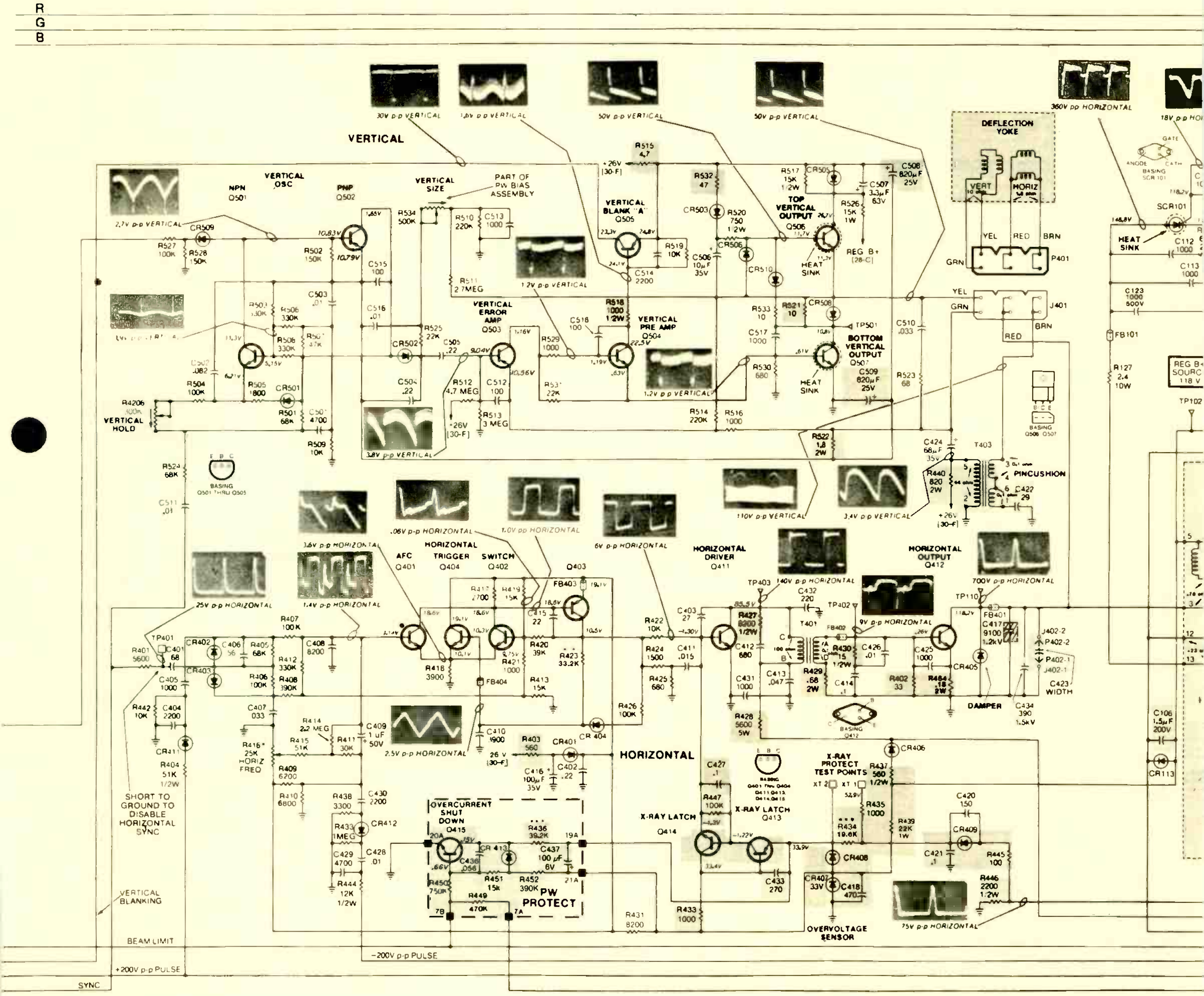
For continued safety of this product, parts identified with an **S** preceding the replacement part number should be used as replacements for those identified in the shaded areas of the schematic diagrams of the service manual. Use of substitute replacement parts which do not have the same safety characteristics as specified, may create shock, or fire hazards.

For maximum reliability and performance, all other parts should be replaced by those having identical specifications.

Under no circumstances should the original design be modified or altered without written permission from the N.A.P. Consumer Electronics Corp. NAPCEC assumes no liability, express or implied, arising out of any unauthorized modifications of design.

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

When this *Profax* pull-out section is removed from the magazine and horizontally aligned with the other RCA schematic, the entire chassis circuitry of the color unit may be viewed.



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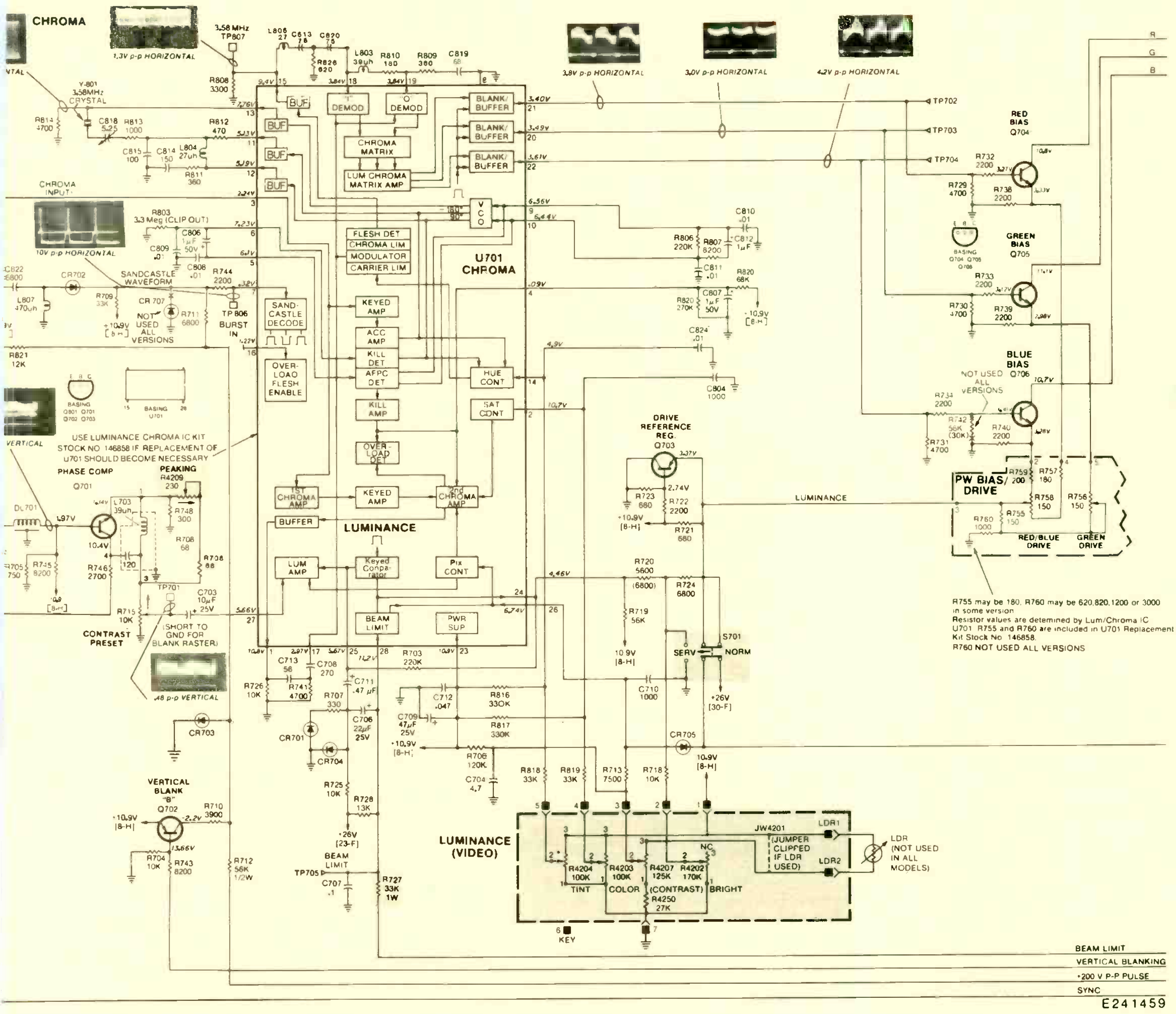
ES&T Manufacturers' schematics **PROFAX**

2007

RCA
Color TV
Chassis CTC 108

DECEMBER 1982



ce Data File 1982 CTC 108.

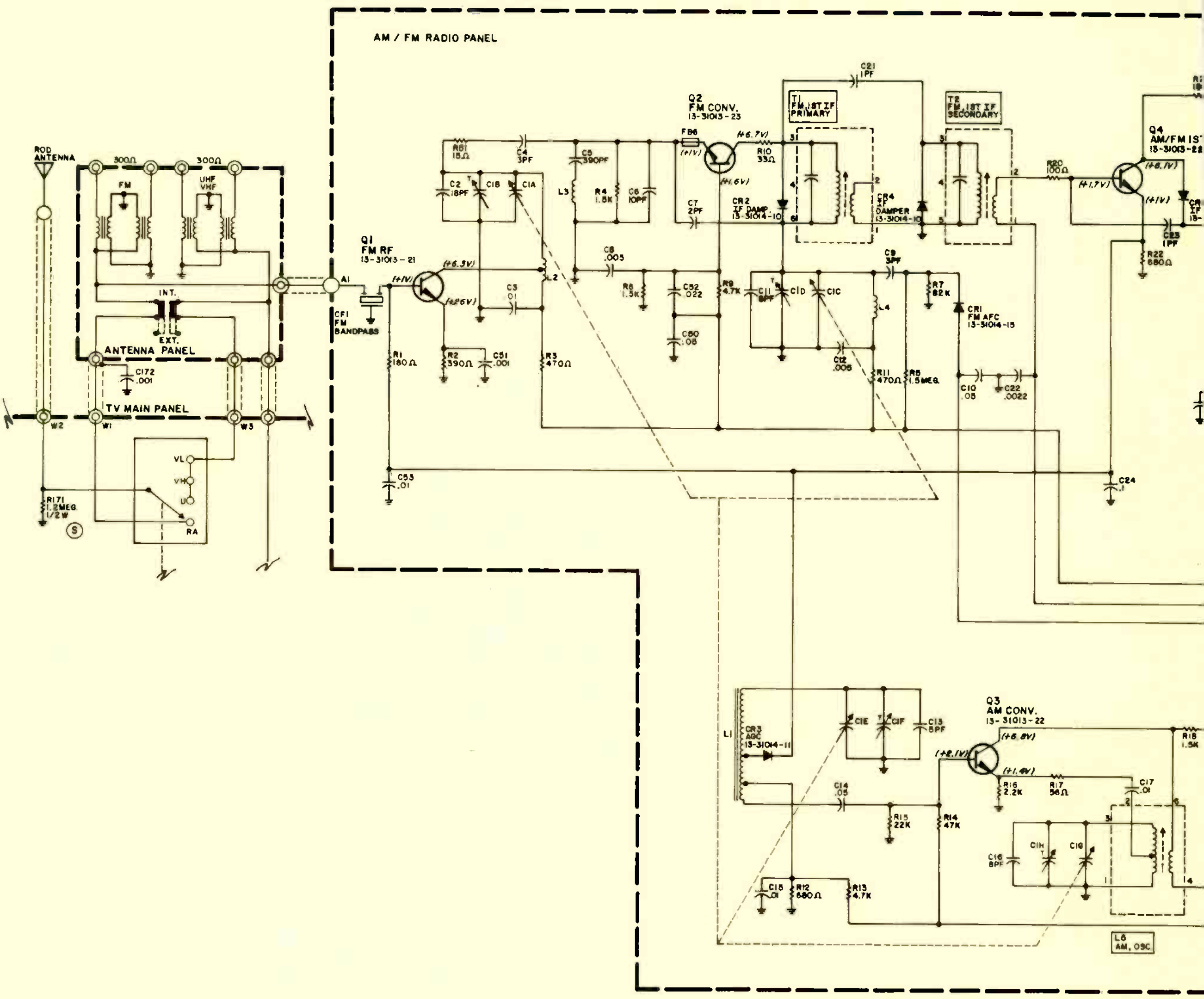
logy, P.O. Box 12901, Overland Park, KS 66212.

ES&T PROFAX

Manufacturers' schematics

	Schematic No.
NAP	
B&W TV model MQA014GY (With radio)	2006
RCA	
Color TV chassis CTC 108	2007

RADIO S



NOTES:
1. ALL CAPACITORS ARE IN MFD, 50V UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE 1/4 WATT, 5% UNLESS OTHERWISE SPECIFIED.
3. VOLTAGES TAKEN WITH SPEAKER CONNECTED.
4. MAINTAIN LINE VOLTAGE AT 120VAC, 60Hz.
5. ALL VOLTAGES TAKEN UNDER NO SIGNAL CONDITIONS, WITH SELECTOR SWITCH ON RADIO AND AM/FM SWITCH SET TO THE APPROPRIATE POSITION.
6. VOLUME CONTROL MUST BE SET AT MINIMUM

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

Reprinted courtesy of NAP

Sr., 1200 78th St., Newport News, VA 23605, 1-804-826-5394.*

Needed: Sencore VA-48, SC-61, PR-47, DMV-56A, SG-165 and/or DMV-37. *Rod Wells, 4528 N. Dearing St., Fresno, CA 93726, 1-209-291-5071.*

For sale: Oldie Sams from 275 to 675 and antique RCA television, model 630TS. *Mike's Repair Service, P.O. Box 217, Aberdeen Proving Ground, MD 21005, 1-301-272-4984 after 6 p.m.*

For sale: Heath IM-2215 DMM, new and complete, $100. *George Lazoryszak, George's TV, 4432 N. Chadwick St., Philadelphia, PA 19140.*

For sale: National Radio Institute Discovery Lab, assembled, $65; Conar frequency counter, model 202, $30. Shipping prepaid. *William Shevtchuk, 1 Lois Ave., Clifton, NJ 07014, 1-201-471-3798.*

For sale: "TV Field & Bench Service Handbook," "Solid-state Servicing Guide," "Servicing Transistor Equipment" and "Study Guide for CET Exams," $3.50 each, post paid. *P. Valer, 428 W. Roosevelt Blvd., Philadelphia, PA 19120.*

For sale: ET/D and predecessors back to 1954. Also Tekfax from same years. *Russell Scarpelli, 5727 W. Becker Lane, Glendale, AZ 85304.*

For sale: Sams Photofact folders 1 to 1000, good condition, 99% complete, many never used, original file cabinets; $1500, FOB, Norwalk, CT. *David McKnight, A-OK TV & Audio, 520 West Ave., Norwalk, CT 06850, 1-203-847-3676 or 1-203-847-9254 after 5 p.m.*

For sale: B&K Precision model 1077-B TV analyst, ser. #18-06009, new in original carton, never been used, $290; Sears-Penske automotive analyzer, model 244-21033, made in USA, like new, all test leads with unit, $40; Sears-Penske timing light, model 244-2115, like new, $22.50. Instruction books with all three units. Will sell separately or together. Cashier's check or money order, will ship UPS. *James K. Sattgast, Wholesale Service Co., P.O. Box 308, Mar-Ken Acres, Warrenton, MO 63383.*

For sale: Tube tester, $75; alignment generator, $35; Pix tube tester/restorer, $190. *WSEP, 318 S.K., Sparta, WI 54656, 1-608-269-2392.*

For Sale: RCA RF signal generator, type WR-50B, $50; RCA dc constant voltage power supply, type WP-704B, $30; RCA master color-bar generator,

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type 515A, $125. *William Shevtchuk, 1 Lois Ave., Clifton, NJ 07014, 1-201-471-3798.*

For sale: Sears 15-inch color portable chassis, model 528-4064-302. In perfect condition, with cabinet, less CRT. Make an offer. Also a Heathkit IG5257 post-mark/sweep generator, new, $175. *Ron's TV & Stereo, Box 365, Highland, KS 66035, 1-913-442-5580.*

For Sale: Old Sams from #275 to #765, plus some scattered older ones; best reasonable offer. Also old RCA TV, model 630TS (KCS 20A); best offer. *Mike Danish, P.O. Box 217, Aberdeen Proving Ground, MD 21005, 1-301-272-4984 (after 6 p.m.).*

For sale: Sencore PS163 dual-trace scope in excellent condition, $550; 3-month-old Sencore FC61 1GHz frequency counter, $650. Both have complete manuals and leads included: $1100 for the pair or make an offer. *Hefner Electronics, 111 E. Broadway, Coleridge, NE 68727, 1-402-283-4333.*

For sale: Hewlett Packard model 202A low-frequency function generator, $65; approved Electronic Instruments Corp. A-460 TV field strength meter, $25; CRTs for Tektronix scopes 535, 515A, RM15, 310 series, $25. I'll pay all shipping costs. *Frederick Jones, 407 Morningbird Court, Niceville, FL 32578.*

For sale: Fully equipped service shop and service van. Includes state-of-the-art Sencore equipment, tools, racks, parts, literature and more. For list, send SASE. *Mike Adams, Able TV & Electronics, Route 4, Box 764, Panama City, FL 32405.*

For sale: Conar Oscilloscope (Capitol Radio Engineering Institute), DC-5MHz, single trace, triggered for general purpose use. Instrument is brand new with instructions and original box. Asking $150 or best offer. Might consider a trade for a good curve tracer or CRT checker or rejuvenator. Postage paid. *Edward E. Ramsey, 816 N.E. 79th Ave., Portland, OR 97213, 1-503-254-0154.*

For sale: To be sold as entire lot only, to the best offer over $995: 50 new RCA and Zenith modules, 650 new Westinghouse tubes, used B&K CRT checker, B&K CRT restorer, B&K tube checker, Sencore 13-channel color generator and new FSR meter. *Economy TV, 158 South Anacapa, #D, Ventura, CA 93001, 1-805-653-7440.*

For Sale: Sencore VA48 video analyzer, $800; B&K 467 CRT restorer/analyzer, $250; B&K 747B GM tube tester, $200; or all three for $1150 (if purchased new, $2340). All in mint condition, includes manuals and accessories. *Leo Mosby, 323 David Lane, Brighton, IL 62012.*

For sale: Hundreds of tubes, 80% off and more, some antiques: Tab books; Tekfax #106, 107, 109, 110, 111, 113; 125 Sams from #70 to 1600. $50 plus shipping. *Kay TV, 644 Lincoln Ave., Maywood, NJ 07607.*

For sale: B&K 1077B, $450; B&K 1472C dual-trace oscilloscope, $550; Sencore SG165 AM-FM MX analyst, $500. *Al Dolgins, 1905 N. Woodley St., Arlington, VA 22207, 1-703-524-2493.*

For sale: Fordham radio BP DVM-532 3½-digit autoranging multimeter, not used, still in original carton, $59.95 new or make an offer. *Gerald L. McKouen, 534 Pacific Ave., Lansing, MI 48910, 1-517-372-2479 after 5 p.m.*

For sale: EIC0 scope, 460-S, new, still in box, with probes, $200. Also have 800 tubes and 700 Sams; make an offer. *Pete Soroka, 6323 Jack St., Finleyville, PA 15332.*

For sale: Riders radio manuals, volumes 1-14 complete. Also volumes 8, 13 and 14. Best offer. *Barry Evans, 5028 Downey Ave., Independence, MO 64055.*

For sale: New Heathkit #4540 oscilloscope kit, $185; Heathkit cap checker, IT-28, $65; Heathkit RF signal generator, IG-102, $65. All have manuals and leads. *Richard L. Bednarcik, 28 Steele Ave., Lincoln Park, NJ 07035, 1-201-694-6374 in evenings.*

For sale: B&K 415 sweep marker generator, excellent condition, $200; Sencore Little Henry multimeter, $50. *Larry Poffen, Route 5, Box 282, Broken Arrow, OK 74012, 1-918-455-1041.*

For sale: Sams Photofact folders 1-100; very good condition, 99% complete, many never used, original file cabinets; $1200 FOB, Norwalk, Ct. *David McKnight, A-OK TV & Audio, 520 West Ave., Norwalk, Ct 06850, 1-203-847-3676, 847-9254 after 5 p.m.*

For sale: Heathkit sweep generator/post market, model IG-57A, $100; EICO CRT tester and rejuvenator, model 663, $75; Conar oscillocope, (tube type), recurrent sweep, model 250, $60. Schematics, cables and manuals included. *Henry H. Perry, 37 Grand View Ave., Lynn, MA 01904, 1-617-595-2855.*

For sale: Heathkit ignition analyzer, CO-1015, complete with 12V inverter, $105; Heathkit vectorscope/color generator, 10-4101, $75; Sencore VA-48 TV-MATV, VTR video analyzer, new condition, first $950. *Richard Sanderford, 6400 Andy Drive, Raleigh, NC 27610, 1-919-834-3504.*

Readers' Exchange items are listed for free, but may contain only three items. "For sale" items must consist of used equipment, parts, etc., owned by individuals and not new items for sale by companies or manufacturers. If you can help with a request, please write directly to the reader, not to ES&T.

ES&T

SWD-1 VIDEO CONVERTER

FOR CABLE TV

The SWD-1 Video Converter is utilized on cable TV systems to remove the KHz's signal from a distorted video (channel 3 in/out) and also pass thru the normal undistorted/detected audio signal. Rocker switch selects operating mode to remove KHz's distortion from the video or pass all other channels normally. Simple to assemble—less than 30 minutes. Pre-tuned. Input/output Channel 3. Impedance 75 ohms. 117VAC.

SWD-1 Video Converter Kit **$69.95**

VTR ACCESSORIES

SIMPLE SIMON VIDEO STABILIZER

Simple Simon Video Stabilizer, Model VS-125, eliminates the vertical roll and jitter from "copy guard" video tapes when playing through large screen projectors or on another VTR. Simple to use, just adjust the lock control for a stable picture. Once the control is set, the tape will play all the way through without further adjustments. Includes 12V power supply.

VS-125 Video Stabilizer, wired **$54.95**

SIMPLE SIMON VIDEO SWITCHING BOX

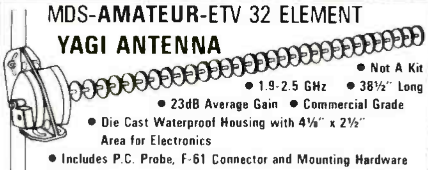
The Affordable Video Control Center

Excellent in isolation and no loss routing system. Simple Simons VSB-300 Video Switching Box enables you to bring a variety of video components together for easy viewing/dubbing. Also you gain the ability to record one channel while viewing another. Unit includes two F-type quick connector ended cables.

VSB-300 Video Switching Box, wired **$19.95**

UHF ANTENNAS and ACCESSORIES

MDS-AMATEUR-ETV 32 ELEMENT YAGI ANTENNA



- Not A Kit
- 1.9-2.5 GHz
- 38½" Long
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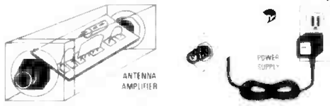

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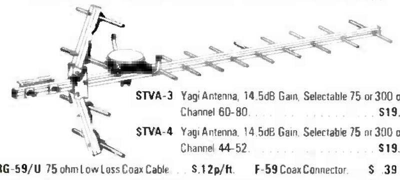

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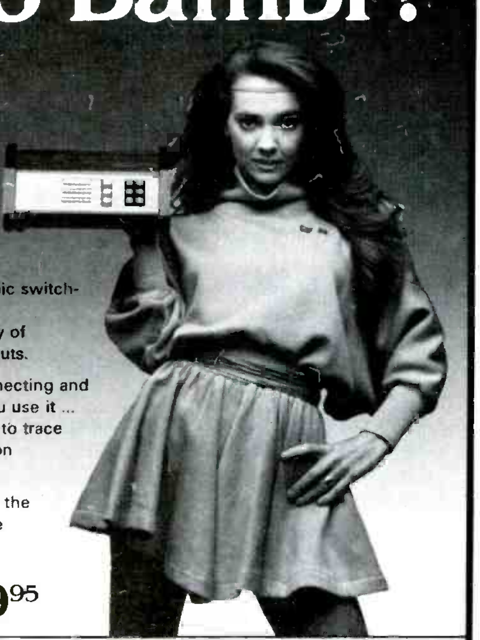

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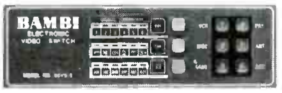

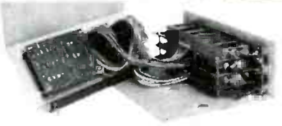

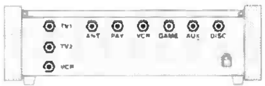

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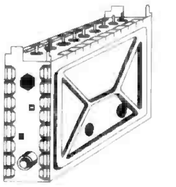

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Solid-state switching

By Bernard Daien

Solid-state switches handle millivolt signals, and kilowatts of power, from direct current to high frequencies. They can be locally controlled or remotely controlled. They have no contacts to wear, arc or bounce. They are explosion-proof and can be used in any atmosphere. They can be mounted in any position and are relatively immune to vibration. They can be more sensitive than the most sensitive magnetic relay. Finally, they have an indefinite life and operate faster than any other switch or relay.

With a few simple additions to their internal circuitry, solid-state switches can be set up to close or open as the ac power source goes through the zero crossing point, which greatly reduces radio frequency interference.

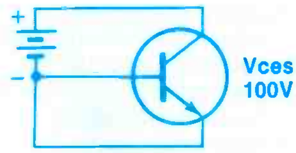
Solid-state switching is used in such diverse applications as telephone switchboards, switching-type power supplies, "choppers" in precision instrumentation, photo-optic relays, digital flip-flops and power switches in electrical appliances.

Solid-state switches and relays

Solid-state switches have been with us since the advent of the germanium diode because diodes can be used for switching and switching matrixes (witness the use of diodes in solid-state TV tuners, where they are used for band switching).

With the coming of the transistor, solid-state switches were provided with power gain. The silicon-controlled rectifier ushered in very high-power solid-state switches. It might be of interest to note that some power transmission is now being done with direct current, which avoids the radiation losses inherent in ac transmission lines running at hundreds of thousands of volts, over thousands of miles. The dc is chopped back into ac at the receiving end with the use of series SCRs, each of which handles a thousand or so volts, at hundreds of amps. One hundred SCRs in series will handle 100,000 reverse volts, with about 200V forward drop—a loss of 0.2%. The power savings on long transmission lines is appreciable, and with today's energy costs, amount to large dollar and oil savings.

The emphasis of this article will be upon transistor switches, because SCRs are latching devices and must have some form of turn-off circuitry when used on direct current. SCRs are especially effective for alternating current use when the load is primarily resistive, because inductive (reactive) loads result in a phase shift between voltage and current, which makes it difficult to turn off the SCR, even on ac. The main advantage of the SCR is that it is essentially regenerative internally: Once you hit the gate with a positive-going pulse of sufficient amplitude, the SCR turns on and stays on *in a fully saturated state.* This means that the internal voltage drop is at a minimum and remains that way. In contrast, it is possible to partially turn on a transistor (not fully saturated) and have it remain in that state due to insufficient base drive. Then the combination of high current and appreciable voltage drop in the transistor results in high heat generation, which soon destroys the transistor. Also, the SCR will fully turn on if it is subjected to overvoltage, and thus protect itself, while the transistor will be "punched through."



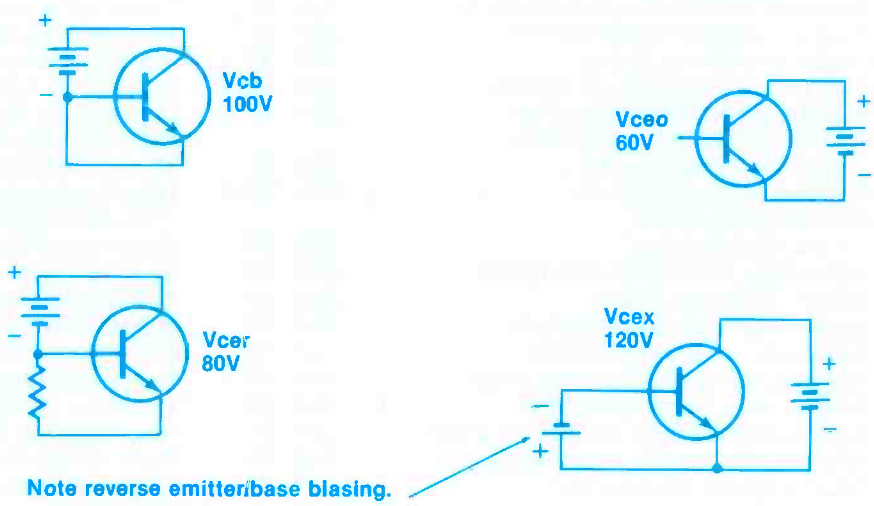


Figure 1. Transistor voltage ratings are established by connecting the transistor in a number of different configurations. It is important to exercise care in interpreting these values in light of the intended application.

As you can see, the SCR is a more rugged device due to the above considerations and is therefore attractive as a high-power but comparatively slow (relative to a transistor) switch. It does well on 50- and 60-cycle power systems, and at 400 cycles, but not in the new trend toward 20kHz and 40kHz systems, where transistors really shine. Because SCRs latch on, extra electronic circuitry is required to turn off the SCR, which increases direct current switching complexity. Because of this, it would require a separate article to do justice to the SCR. We are, therefore, concentrating on the use of transistors for solid-state switching in this article.

Transistor power switches and relays

Most texts spend a great deal of time discussing the transistor switch from the viewpoints of internal construction and solid-state physics. We are not going to do that, because the subject has been beaten to death in past and current literature. You should be aware of a couple of simple facts, however. First, you must specify a transistor capable of the switching speed required. Because turn-on and turn-off waveforms are not sinusoidal, but approximate a square wave with fast rise and fall times, you must choose a transistor characterized for the use intended. For example, if you are going to use the device in a TV horizontal-sweep output stage, you will need a transistor designed for such service. Second, transistor voltage ratings are specified in several different ways, and what you think you see is not necessarily what you are going to get.

The usual voltage ratings are V_{cb}, V_{ces}, V_{cer}, V_{cex} and V_{ceo} (See Figure 1). V_{cb} is the rating for the collector-to-base junction only, as a diode. It is usually a high voltage, but unfortunately not useful because you don't use a transistor as a diode. V_{ces} is the collector-to-emitter voltage rating, with the base shorted to the emitter, which again makes the transistor into a 2-terminal (diode) device. It is also a high voltage rating and not very useful. V_{cer} is usually lower than V_{cb} or V_{ces} and is the voltage rating between collector and emitter with the base tied to the emitter by means of a specified value of resistor. This approximates the way a transistor is really used, and is therefore a useful rating, *providing a realistic value of resistor is specified.* (If a low value of resistor is specified, it could be approaching a short between emitter and base, which is the same as V_{ces}.

V_{ceo} is the best way to judge a transistor, because it is the voltage rating between collector and emitter, with the base open (i.e., an infinite resistance between base and emitter). This is the worst case and results in the lowest voltage, but it is the acid test for a good-quality device.

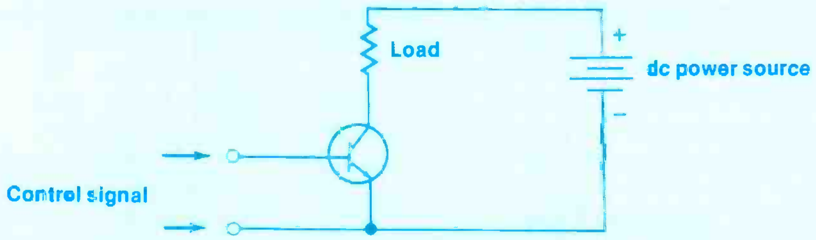


Figure 2. Depending upon the application, the transistor may experience ac or dc.

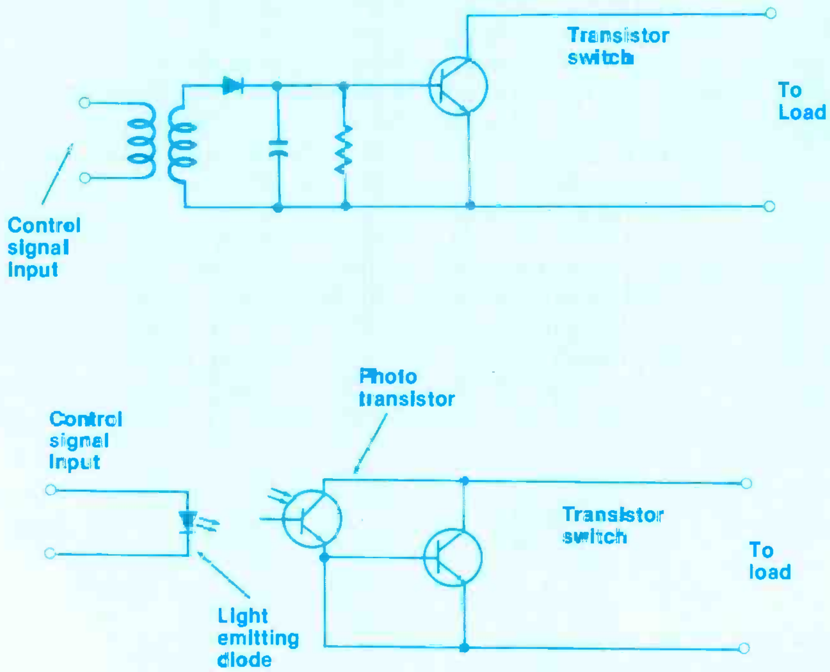
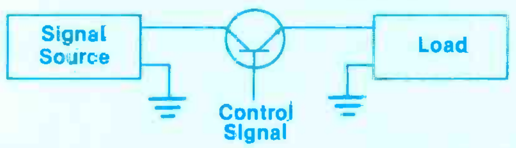


Figure 3. There are two methods of isolating the input of a solid-state switch. One uses a transistor, rectifier and filter to provide turn-on bias for the transistor switch; the second method uses opto-coupling.

Figure 4. Analog switches may be used in either series (A), or shunt (B) configuration.



V_{cex} is the voltage rating between collector and emitter, *with a specified value of reverse bias* applied to the base. It is useful only in certain applications and results in a very high voltage rating. It is rather a dangerous way to fly, because if the reverse bias is lost for even a fraction of a microsecond with voltage applied, the transistor will break down, usually destroying itself. Reverse bias has been used in some high power switch circuits, which explains why some switching transistors pop unless everything in the drive circuit is working properly.

Unfortunately, the higher the voltage rating, the more than transistor costs. High-current transistors, in contrast, cost little more than lower-current transistors. Don't be misled by attempts to economize on high voltage transistors; it just doesn't work. The cheaper units simply use V_{cb}, or V_{ces} ratings, which are misleading. Figure 1 shows the different configurations for the ratings discussed, along with the relative voltages of a typical (but mythical) transistor.

Now that we have put these two little ratings details to rest, we can proceed with the transistor switch circuitry. Figure 2 shows how a transistor can be used to switch direct currents, or alternating currents. Note that by using the transistor as an active device inside a full wave bridge rectifier configuration, the load sees ac, *but the transistor handles only dc.*

Isolating inputs and outputs

The circuits of Figure 2 are useful only when there is no need for isolation between the input and the output of the solid-state switch (hereafter referred to as the "SS switch"). Figure 3 shows two methods of isolating the input. One way (Figure 3A) is to use a small transformer, rectifier and filter to provide turn-on bias for the transistor switch. If the signal is an audio frequency of a few kilohertz, response is fast and the filter capacitor required is small. If the power transistor is a Darlington, or if a small transistor is used as an amplifier ahead of the power transistor, input current requirement becomes small and the isolation signal transformer becomes tiny and inexpensive. (Alternatively, the control signal can be a radio frequency with the same circuit.)

Another method, shown in Figure 3B, is the use of electronic opto devices (opto-couplers). An LED provides excitation for a phototransistor, which controls the base drive to the switching transistor. These opto devices are fast and can have thousands of volts of insulation between the elements.

No doubt other methods of providing isolation will occur to you; as one example, a Hall effect generator, which changes resistance (or current through it) with the presence of a magnetic field, can be used for isolation.

Signal switches

SS switches can be used for signal switching, as well as for power switching. A more descriptive name is "analog switching," to differentiate between digital switching and the kind of signal switching we are talking about. Digital signal levels, (1s and 0s) are fairly large dc levels. Analog levels, on the other hand, can be anything from microvolts, in communications, to volts, in audio amplifiers.

When dealing with low-level analog signals, the switch cannot be noisy. Because bipolar transistors have two semiconductor junctions, emitter/base and collector/base, and because current flowing through such a junction creates noise, the bipolar transistor is not the best choice for analog switching. The field-effect transistor has no junctions between the source and drain and therefore is a lower noise device. The FET has a much higher "off" resistance than the bipolar transistor, which makes it a more effective switch due to the better on/off ratio.

Analog switches can be used in either the series or shunt configuration, as shown in Figure 4. Unfortunately, the effectiveness of a series switch depends greatly upon the load into which the switch works, as shown by the equivalent series switch circuit in Figure 4A. The effectiveness of the shunt switch depends upon the source resistance.

To eliminate these dependencies, two switches are often used, one in series and one in shunt, synchronized so that when one is open the other is closed. This makes a very effective switch (Figure 5).

Because the bipolar transistor has semiconductor junctions in the current flow path, and because a semiconductor junction requires forward biasing in order to conduct (about 0.6V for silicon), it follows that there is going to be a voltage drop in the transistor. This drop can be minimized by driving the transistor into deep saturation. The drop can be reduced to tens of millivolts by using the transistor inverted, as shown in the shunt switch schematic (Figure 4B). With 1mA drive, the switch will bring the dc small signal level down to within 20mV of ground potential. The FET, on the other hand, has no junctions and will bring the dc level down to within microvolts of ground level. (This small voltage is termed the "offset" voltage.)

As you probably already know, switching a semiconductor on and off produces transients in the output due to the steep rise and fall times and the capacitance inherent

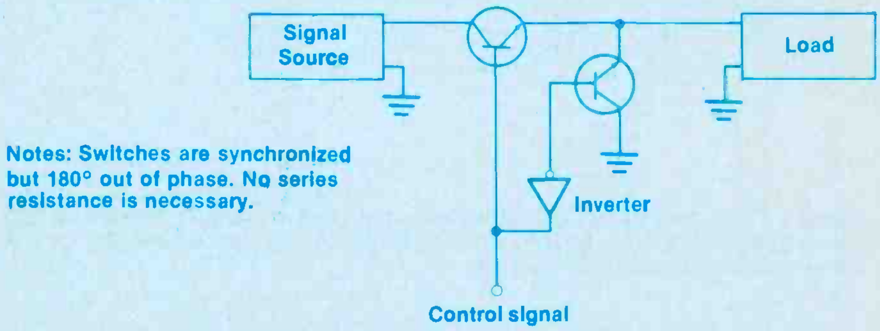


Figure 5. Series/shunt solid-state switch eliminates source and load dependencies inherent with series or shunt switch.

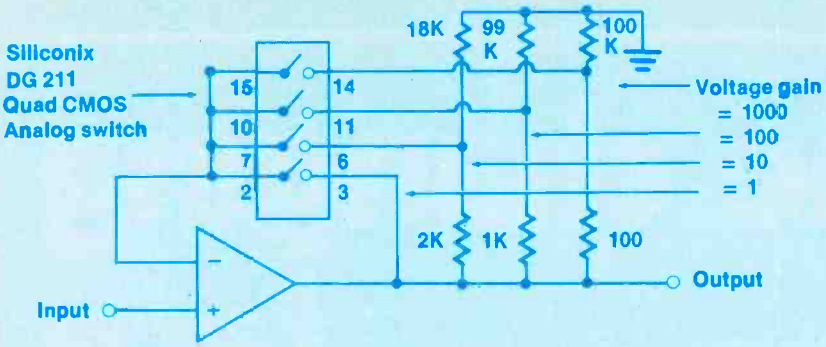


Figure 6. A solid-state switch can be used to program the gain of an op amp.

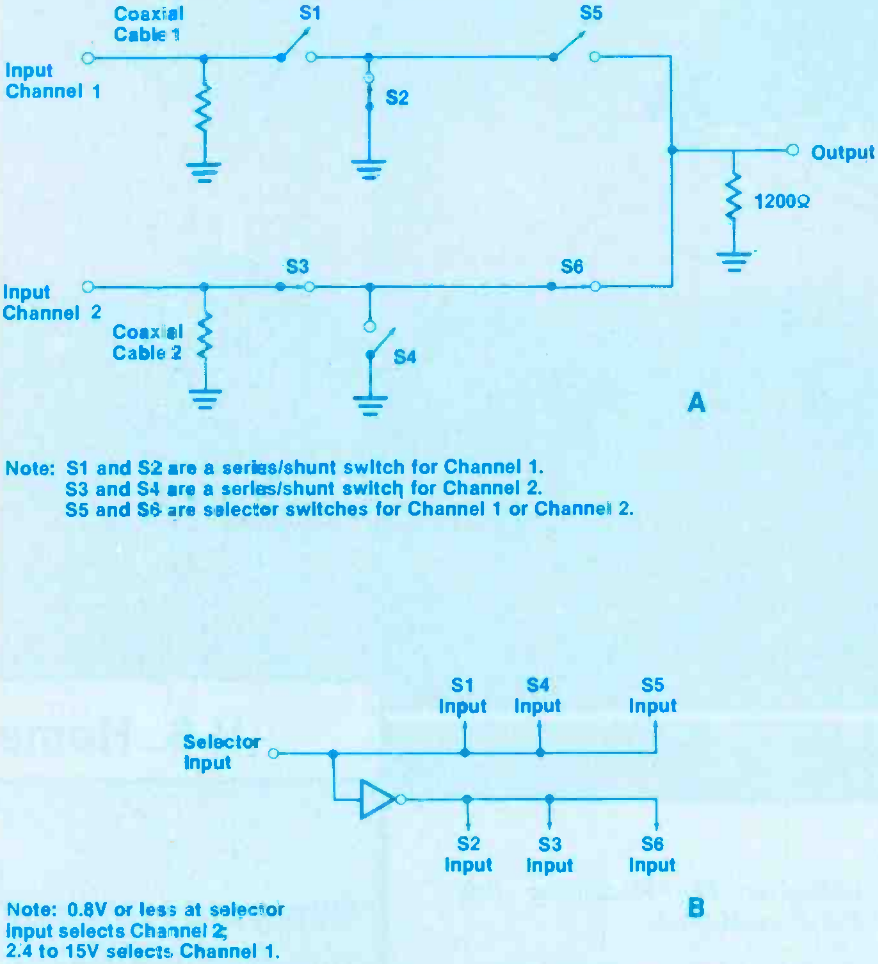


Figure 7. A 2-channel analog switcher uses both shunt and series switching to achieve over 90dB of isolation up through video frequencies (A). The logic for inputs to analog switches is shown in (B).

in the switch. (This also happens with vacuum tubes for the same reason, but the semiconductor is worse because of the stored charge in the junction, in the case of the bipolar transistor.) With FETs we can use a little trick to reduce these transients. FETs come in two "polarities", N channel and P channel (N MOS and P MOS in the case of MOSFETs). By using two of these devices together in the now-common CMOS, the output signal transients are of opposite polarity and partially cancel each other, thus reducing the transients. By using two discrete devices, selected carefully, the cancellation can be very effective. That's one trick you can't do with vacuum tubes!

Driving the solid-state switch

The SS switch can be driven from a simple mechanical switch, of course, but this is not practical because of switch bounce, slow operating time and other undesirable conditions. More often, we want to drive the SS switch from some other circuitry (TTL logic, ECL logic or perhaps CMOS). These popular logic families all have different voltage levels. Sometimes it's necessary to drive the switch from a high impedance, other times from a low impedance, or from a slow (low-frequency) or fast (high-frequency) source.

These factors are understood, and semiconductor manufacturers now make switches, complete with drivers, for various purposes in one IC. In fact, you can buy a package with several such complete switches, just like buying quad logic gates, so you don't need to do any designing.

Figure 6 shows how a commercial SS switch can be used to program the gain of an op amp. As you should know by now, op amps have very high open loop gains. The gain is adjusted by means of external feedback resistors. The SS switch is used to select the desired resistors (closed loop gain) electronically. This makes a useful instrumentation amplifier).

Figure 7A is a 2-channel signal switcher, using both shunt and series switching to achieve more than 90dB of isolation up through video (6mHz) frequencies. That's good enough for audio, broadcast and video uses on standard transmission lines.

By now you must be thinking of many other uses for these SS switches, which are small, fast and lightweight. They come in a wide variety, categorized by use, so you pay only for what you need. The switches designed for low frequencies, for example, cost less than the high-frequency devices. The more stringent the specifications, the higher the cost. On the average, SS switches cost less than conventional small relays when you consider the lack of maintenance, long life expectancy, and other pertinent factors.

ES&T

The changing face of video

By the end of this decade, more than 15 million homes in the United States will have direct broadcast satellite (DBS) antennas sprouting from their roofs, and consumers will continue to demonstrate their preference for pay television over home video.

Those are predictions by International Resource Development, of Norwalk, CT, a market-research and product-planning firm, in two related research reports: *DBS Systems,* and *Telepay vs. Videodisc – The Exploding Pay-Per-View Market.*

Article and charts courtesy of International Resource Development, Norwalk, CT, (Photo courtesy of Andrew Antenna)

Direct broadcast satellite

The rooftop home earth stations intended for DBS reception will be made up of the following segments: three million from rural homes with fewer than three regular TV channels, three million from rural homes with more than three TV channels, three million additional homes in areas not served by cable, three million homes that are passed by cable but are not subscribers, and three million from cable subscriber

U.S. Home Ea

Backyard terminals
Unit sales (thousands)
Installed base (thousands)
Revenues ($ millions)
Rooftop terminals
Unit sales (thousands)
Installed base (thousands)
Revenues ($ millions)

homes. The 187-page report predicts that the rooftop terminals, which are designed for Ku-band frequencies, will make the present day backyard terminals, which operate on C band frequencies, all but obsolete. The installed base of backyard terminals by 1990 is only expected to be slightly more than 600,000.

The takeover by the rooftop segment will occur gradually over the course of this decade, according to the study. In the pre-1986 time period, rooftop earth stations will be approximately 2m to 3m in size and will be used primarily by apartment buildings to receive low-power Ku-band broadcasts. The post-1985 market will be spurred by the launch of the high-power DBS satellites, (14/12GHz), which will enable the rooftop terminal to be reduced in size to 0.75 to 1.25m. These smaller dishes will be far more attractive to single-family users, and combined with significant reductions in price ($350 to $500 by 1990), will substantially boost market growth.

One group, however, will hold off from switching to the rooftop version until the late '80s, IRD has predicted. Because the cable networks and operators already have their system set up to receive programming on the C-band frequency, there is no incentive for them to move over to the Ku band – at least not until near the end of the decade, when they will be motivated to switch by the advent of high-definition TV (HDTV) broadcasts on the Ku band.

Small companies will be squeezed out by the larger ones in the DBS rooftop terminal business, according to IRD. Only those companies with substantial capital, adequate production facilities and the necessary marketing capabilities will be able to survive the economies-of-scale game, as prices decline from the present $5000 to $8000 level to $350 to $500 by 1990. Companies expected to participate include Andrew Corporation, Harris, Hughes, Microwave, M/A-Com, Microdyne, NEC, Alcoa, Scientific-Atlanta, Amplica, General Instrument, RCA, SatCom and SED. Partnerships are already being explored in anticipation; NEC and Alcoa have established a working partnership, RCA and Comtech Telecommunications are reported to have had joint venture negotiations, and Scientific-Atlanta and SatCom have both announced that they are looking for partners.

th Station Sales

1982	1984	1987	1990
25	75	120	5
41	161	506	611
175	375	360	15
.....	216	2000	5000
.....	290	3582	15582
.....	650	1420	2270

Likely winners in DBS systems

In another section of the report, IRD observed that prospects are good for STC, RCA, Western Union and CBS, but only fair to poor for the other DBS system applicants. This outlook is based on the belief that the pre-1990 market (i.e., the subscriber base) will not be able to support more than four or five dedicated DBS systems. The carriers (e.g., RCA and Western Union), will be in an excellent position because they will probably be able to accommodate programming that was initially intended for those systems that are not implemented or that subsequently fail in operation. IRD has predicted that only two out of the present six broadcast applicants will have a good chance of success – Satellite Television Corporation (subsidiary of Comsat) and CBS. The others may have to revise their plans and end up "piggybacking" on one of the common carrier satellites.

Pay television

Pay television is expected to increase its share of viewer revenues from 63% in 1982 to 82% of the total pay TV/home video software market in 1990, according to a 280-page report from the same company.

"The continuing wide lead of pay television over home video is based on the far greater convenience, value and freshness/aliveness/sharability factors of pay television," according to the report.

It argues that consumers value the ability to share their viewing experiences with others the next day, as well as the convenience of turning on the television rather than going to the local video store to rent or buy videocassettes or videodiscs. Thus VCRs will continue to be used primarily for timeshifting and X-rated material, and videodiscs will penetrate less than 7% of TV homes by the end of the decade.

Market-by-market competition

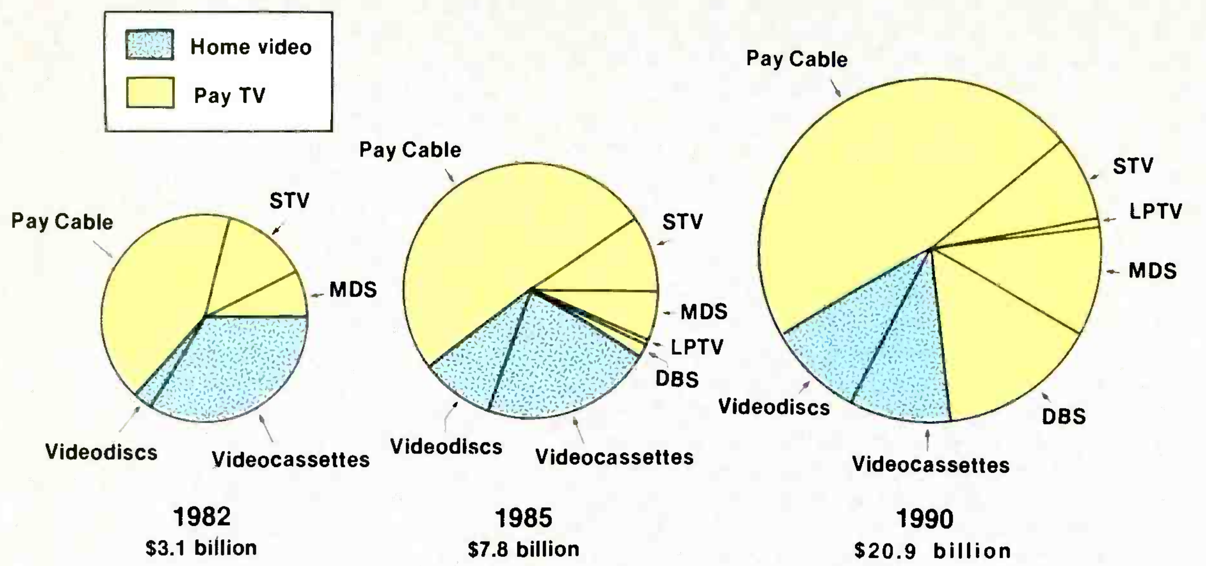
Competition between the various forms of pay television is becoming fierce in many of the top markets. IRD has taken the 25 markets projected to be largest in TV household population in 1990, and has analyzed each of these in terms of present and future competition. Many of these markets do not presently have cable; this will create a race between over-the-air pay television and pay cable to see who can get there first.

As would be expected, a large number of the top markets that do not have cable have a higher-than-average VCR penetration.

"In areas where cable has not yet arrived," added IRD staffer Joan de Regt, "the other pay television forms, such as STV, MDS, LPTV and DBS, have a good chance of survival. Where cable has made it there first, they haven't got much of a prayer."

Interactive discs

According to this study, the videodisc industry has the potential to make present-day video games obsolete through the development of "full-video" interactive game discs. If developed, the game discs could be a significant chunk of the projected $1.4 billion revenues for interactive discs in 1990. These discs would be superior to the current videogames for two reasons: First, the screen would show in full video pictures real-life action instead of



pure animation, and second, the viewer's choices would determine how the action developed.

"In light of slow videodisc sales and the booming videogames market, it is surprising that the videodisc industry has not pounced on this opportunity to obsolete the current state-of-the-art video games," according to the report.

At present, only the laser optical videodisc system developed by Philips is capable of playing this type of disc because of interactive capabilities. The VHD grooveless capacitance system is also interactive but its U.S. introduction has once again been delayed, this time to the summer of 1983. It's possible that the system may never arrive on the market. RCA's grooved capacitance CED system does not have interactive capabilities as yet, but has promised them "sometime in the future."

"There is an excellent opportunity here for the laser camp to end their slump and bring out a truly exciting product," de Regt said, "although it would require working closely with the program producers to develop these discs. While the initial market may be small because of the high equipment costs (a videodisc player hooked up to a personal computer or smart terminal), the long term potential is mouthwatering for both players and discs." It won't be until the late '80s that this market really begins to develop, however.

Telesoftware

The advent of "telesoftware" could dramatically change the distribution of videocassettes, says the report. Telesoftware is essentially scrambled over-the-air transmission of programming low-rate hours intended to be recorded by home VCRs. These VCRs must be equipped with decoders to unscramble the signals and to automatically turn the machines on and off.

Over-the-air delivery of software may be more convenient than shopping for tapes or discs in the store.

"Consumers will find that over-the-air delivery of software, to be received by their VCR or videodisc player (when VDPs become recordable), may be far more convenient than shopping for tapes or discs in the store," the report stated. High-speed recording is likely to be the next development in this area, whereby several programs could be transmitted via fast-forward in the time it now takes to transmit one.

Taping-at-home controversy

The report also addresses the controversy concerning the taping-at-home of copyrighted materials, and predicts that it will eventually be solved by Vertical Blanking Interval (VBI) coding. According to the report, VBI is a continuous subliminal code that would be placed on all video masters and their copies for identification purposes. A non-removable meter, which would be built into the VCR, would keep track of the titles copied and would relay this information back to central computers during unused telephone time. Program copiers would then be billed through a central clearinghouse.

Cable challenges Bell by 1990

The report predicts that by 1990, fiber optics will have replaced coaxial cable, which will allow the carriage of over 200 full video channels. Some of these channels will be able to feed full video upstream from home video cameras. IRD suggests that cable subscribers will be able to circumvent AT&T by use of fiber-optic multipoint-to-multipoint transmission, and could even use home cameras to see each other during conversations. "While cable will obviously not replace the Bell system, it could be a very viable alternative to phone conversations within a particular cable system," de Regt added. ES&T

How to edit videocassettes

Reprinted courtesy of 3M Company.

Everyone has some unbelievable scenes of good friend Paula learning to water ski or a classic Steve Martin monologue in the middle of an otherwise re-usable videocassette. Ultimately, most VCR owners want to do some serious editing of their cassette collection.

It takes two machines, a television and a little time, but almost anyone can do a reasonable editing job himself. There's no need to cut and splice like film; in fact, cutting is an absolute no-no. If there's a goof, no harm has been done. Just start over. That's one of the great advantages of video vs. celluloid–videocassettes can be used over and over again.

The easiest way to edit videocassettes is by using a uniform radio frequency (RF) channel, 3 or 4, to switch the RF output from the *player* VCR into the tuner section of the *recorder* VCR. (For best results, use your own machine as the recorder unit.) This type of editing is as simple as A, B, C.

A. Connect the VHF (RF) output of the *player* VCR to the VHF input of the *recorder* VCR with a 75Ω coaxial cable.

B. To monitor the editing, another cable is needed to connect the VHF output to the *recorder* VCR and the television.

C. To edit the material you've selected, simply push the play button on the *player* VCR and the record button on the *recorder* VCR during the appropriate segments. Voilá! You're an editor.

Be sure the *recorder* VCR has been fine-tuned to the RF channel so the copy is as picture perfect as possible. Use the television as a monitor. There are two problems that can come up using the RF technique The first is annoying noise from either or both of the RF converters. The second is that the lower signal-to-noise ratio of this method may not meet your expectations of picture clarity. However, you won't know until you try.

If your machines are too sensitive for the first technique, here's another idea. This method is a bit more complicated, but produces a slightly more professional look. It involves direct dubbing between the *player* VCR and *recorder* VCR using both the audio and the video lines. Again, use your own VCR as the *recorder* for best playback.

A. Use patch cords or dubbing cables to connect the two machines. Hook-up is simple. Audio output of the *player* to audio input of the *recorder*, video output of the *player* to video input of the *recorder*. The difficult part is getting the correct set of cables. Machine hook-up varies, so take your instruction booklet with you when buying cables.

B. For a VCR with an input source selector switch, the *recorder* VCR should be set in "camera" or "aux" position, not in "tuner" position. If your VCR doesn't have this switch, don't worry about it.

C. To double-check your wiring, hook up the VHF (RF) of the *recorder* to the TV monitor. What you see is what you get.

D. Depending on the circuitry of your VCR(s) you may have to use TV monitors from the *player* as well as the *recorder*. The television connected to the *player* can be used to watch the playback picture and to locate scenes to copy. The television connected to the *recorder* can be used to check overall picture quality and content.

E. When you find the piece you want to add to your permanent cassette, start the *player* up a few inches *before* the piece you selected begins. These few seconds of warm-up let the *recorder* unit focus in on the signal and stabilize. When the segment starts, release the pause key on the *recorder*.

You'll be pleased to know that the two machines used for editing can be, but don't have to be, the same format. This is one time, Beta, VHS and U-matic all work together. Electronic editing is just a matter of transferring a signal from the *player* VCR to a *recorder* VCR, and the electronic makeup of the signals is the same on all formats.

If you use unlike-format machines, yours will be the *player* and the other will be the *recorder*. When the editing is complete, the new program will be on the "other" format and you must make a copy compatible with your VCR. Just reconnect the VCRs so the other VCR becomes the *player* and plays back the newly edited master while your VCR is the *recorder*. The only drawback with this technique is that there will be some overall loss of picture quality since the final copy is one generation removed from the edited master.

Post-production

Remember that both the *player* and *recorder* must be operating up to speed to produce a quality copy. Where the videotape speed varies, the result will be distortions to the picture (glitches) as well as the sound. Once glitches become recorded, they'll remain until the tape is erased/recorded over.

Editing is a great time to add titles and audio to dress up home productions. Adding new audio background to edited material will help cover up some of the glitches that are bound to happen in any at-home electronic editing.

Keep in mind that the better the recording, the better the edited material can be reproduced. Every time a tape is reproduced (dubbed) the reproduction loses some quality from the original. For direct dubbing, a low-cost black-and-white portable television works fine as the monitor.

Probably most of the time you spend as editor will involve finding the tape segments you want to preserve. So it's important that before editing you watch the tape and tape counter and note the cues of where to begin and end each segment. (Keep in mind that some tape counters have a way of slipping slightly.) Also, be sure you use the proper length of blank tape. There's nothing worse than short-changing yourself by losing those last precious scenes.

ES&T

Using a TDR

By Joseph J. Carr, CET

A TDR, or *time domain reflectometer,* is one of the most useful tools for working with any type of transmission line. Keep in mind that transmission lines are not just wires that connect antennas to 2-way radios; they are also the cable used by cable-TV systems, master antenna systems and many other areas of electronics.

The transmission line is not always a coaxial cable, but it is usually made of coax in modern systems. A TDR unit will allow you to test a transmission line, whether coax, open-ladder line, twin-lead or the twisted pairs used in many intercom and telephone systems. In fact, a "twisted pair" of wires is often recognized as a transmission line with a characteristic impedance (Z_O) of approximately 70 to 80Ω. The TDR unit will use the properties of the transmission line that give rise to SWR and other phenomena to test the line for proper match to its load, open circuits and short circuits. It is interesting to note that the TDR provides quantitative information about the line and will allow you to find a fault in the line to within a couple of feet, *without leaving the head end.*

A classic case of TDR usefulness occurred in a community antenna system operating in the mountains west of Shenandoah, VA. A master antenna on a mountain top picked up TV and FM-radio signals, amplified them and then forced them down a 4-mile coaxial cable to a secondary amplifier at the foot of the mountain. The signal was then amplified again and distributed to the homes in the community with just a little snow.

Then one day, the snow increased dramatically, and the picture disappeared. The local technician went to the head end (at the top of the mountain) and found the antenna and amplifier working—there was a cable break somewhere in that four miles of coaxial cable. This *could* mean a painstaking search along the entire line; and because there is no guarantee that the break would be *visible,* it could also mean climbing poles every few hundred yards until the break was isolated by loss of the signal on the down-slope side of the line.

There had to be a better way. This technician used his head and came up with a test method that eliminated the grueling physical search. He had a portable oscilloscope with him, and it formed the basis of a test method that allowed him to predict the location of the break (in a few seconds) to within a few yards of its actual location.

Transmission lines revisited

Technicians engaged in com-

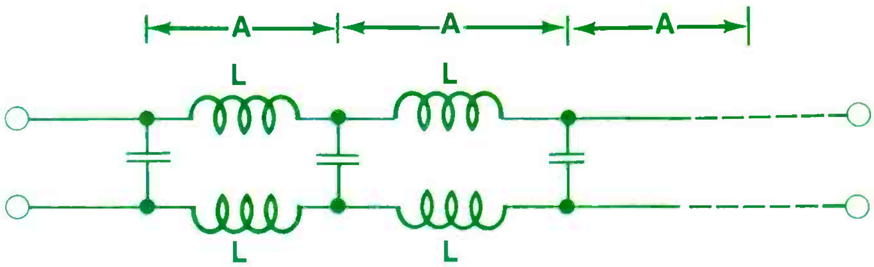


Figure 1. A transmission line can be viewed as having distributed capacitance and inductance.

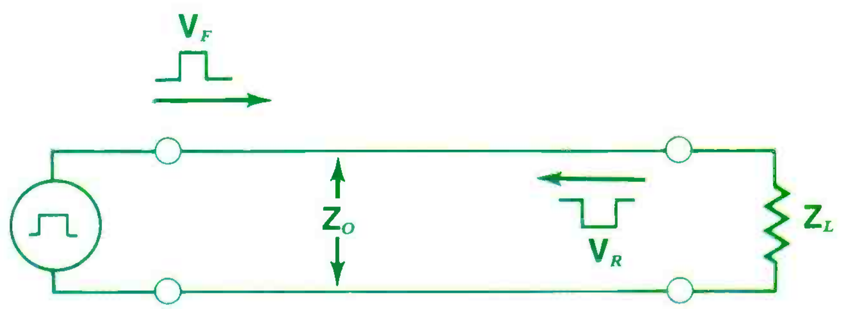


Figure 2. If the load impedance (Z_L) does not match the characteristic impedance of transmission line (Z_O), a portion of a transmitted signal will be reflected back to the source.

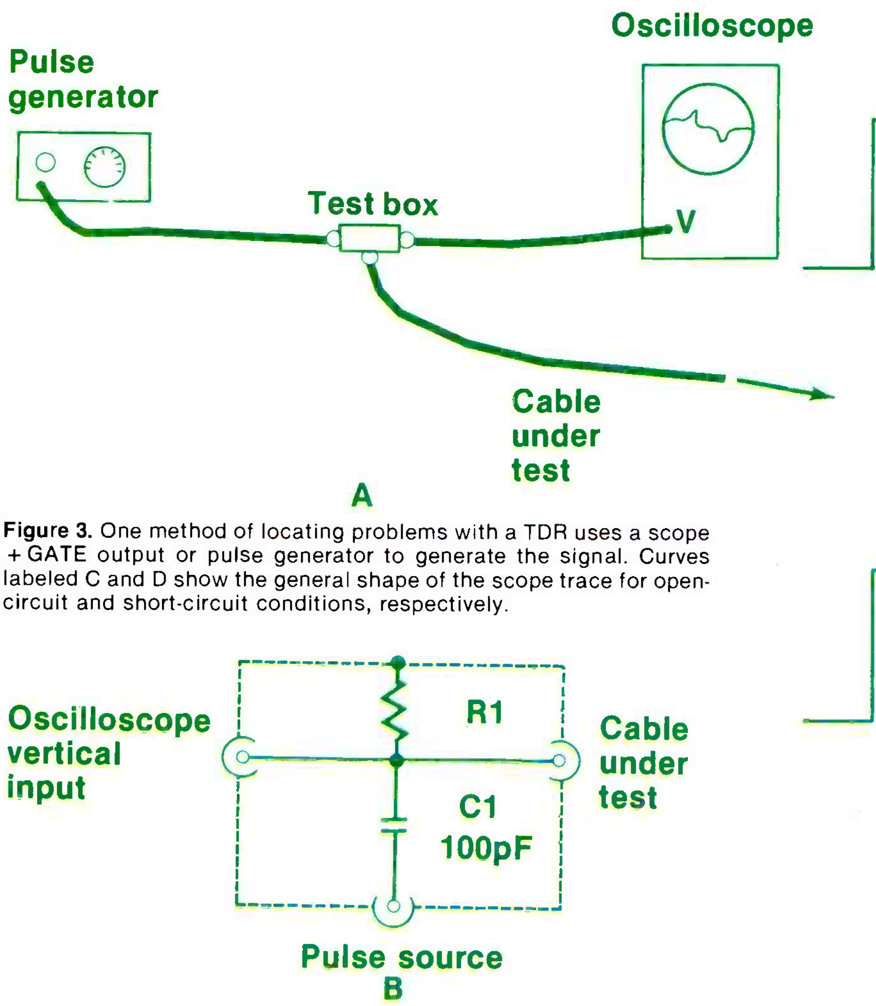
munications regularly refer to antenna cable as transmission line. Similarly, people in the MATV business will use the term transmission line for the downlead. But cable-TV people, intercom and communications (telephone) people and others also use what are in fact transmission lines. For example, the computer technician who finds a length of RG-59/U carrying analog data signals up to the A/D converter card inside of the computer is dealing with transmission lines.

A transmission line can be viewed as having distributed capacitance (C) and inductance (L). The capacitance is due to the mutual proximity of the conductors, either side-by-side as in twisted pairs and twin lead, or concentrically as in coaxial cable. The inductance comes from the natural inductance of the conductors in the cable. Figure 1 is a model of a transmission line. If we take dimension A as a unit of length (i.e. foot, meter, etc), then L is the inductance per unit of length and C is the capacitance per unit of length.

Transmission lines have a property called *characteristic impedance,* also called *surge impedance,* generally symbolized by Z_O. Simply stated, the surge impedance is the square root of the ratio L to C [$Z_0 = (L/C)^{1/2}$]. We can best understand the operation of a transmission line with some examples. Suppose that as in Figure 2, we connect a pulse generator to one end of a transmission line that has a characteristic impedance of Z_O. The other end of the transmission line is terminated in a load impedance. What happens? When the load impedance Z_L is equal to the characteristic impedance Z_O, the engineers tell us that the transmission line will act as if it were infinitely long. In simpler terms, this means that the load will dissipate the entire amount of pulse energy. If we were to impose a pulse onto the line at the head end, then we would never see it again...it would travel to the load and be dissipated.

What happens when the load impedance is *not* equal to Z_O? In that case, some of the pulse energy is reflected back toward the source. Pulse V_f in Figure 2 is the forward pulse, and is sent from the generator. When it hits the load, some of it is absorbed and some of it is reflected (V_r). Note that the phase of the pulse is reversed, it is now upside down. Radio technicians will recognize this as the phenomenon that brings on *standing waves,* but we can use it to test coaxial lines.

Radio waves travel down a transmission line at a known velocity and so do pulses. This velocity will be some fraction of the speed of light. If we know the velocity and can time the interval between the transmission of the incident pulse and the arrival of the reflected pulse, then we can tell the length of the line. If the line is shorted, or open, then the length calculated will be the distance from the test point and the fault.



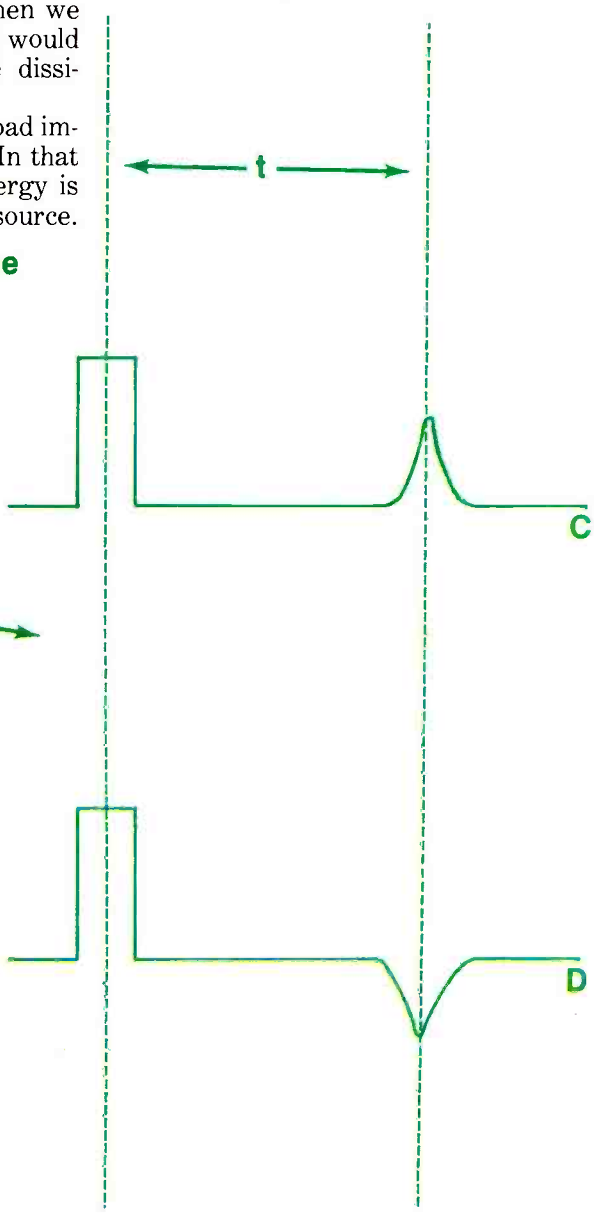


Figure 3. One method of locating problems with a TDR uses a scope +GATE output or pulse generator to generate the signal. Curves labeled C and D show the general shape of the scope trace for open-circuit and short-circuit conditions, respectively.

Now you can see how the technician on that mountain top managed to use his portable Tektronix scope to find the distance to the cable break. The model oscilloscope that he toted to that mountain top has a +GATE output that generates a pulse every time the sweep is triggered. In the auto-trigger or free-run mode, there will be a stream of narrow pulses from that output. The technician sent them down the cable and then timed the return pulse on the scope screen.

Two methods

There are actually two related, but slightly different, approaches that you can take to making a TDR test on any good oscilloscope. I have successfully used both on color-TV-grade oscilloscopes.

The first method is shown in Figure 3A. Connect a pulse generator (or the oscilloscope +GATE output) to the input of the test box (Figure 3B). The outputs of the test box go to the vertical input of the oscilloscope and to the cable being tested. The test box (Figure 3B) consists of a 100pF capacitor connected to the coaxial line. The line is terminated in a resistor, R1, that has a value equal to the characteristic impedance of the cable (52Ω for communications, 75Ω for MATV/cable/twisted-pair, etc). In some cases, we might also want to trigger the oscilloscope sweep from the pulse generator, but most of the time free-running sweep is adequate.

The problem on the line will be shown by the polarity of the reflected pulse, while the distance to the fault is given by the spacing between incident and reflected pulses. Figures 3C and 3D show the general shape of the scope trace for the open-circuit and short-circuit conditions, respectively. Note that the incident pulse is usually sharper than the reflected pulse, and will have a greater amplitude because line losses will attenuate the reflected pulse. The distance to the fault is determined by measuring the time difference, t. This measurement is determined by observing the number of divisions between peaks and the time/div setting of the oscilloscope. The formula for the length is

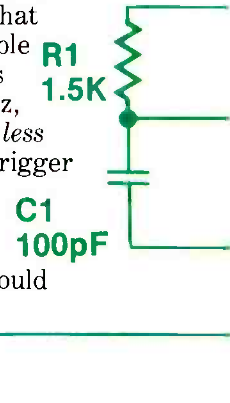
$$L = 983.5\ Vt/2 \qquad (1)$$

Where L is the distance to the fault in feet, t is the time between pulses in microseconds (μs), measured on a scope, and V is the velocity factor of the cable under test. V is 0.8 for foam coax and 0.66 for regular coax (check catalog for other types). 983.5 is the number of feet light travels in 1 microsecond.

Let's look at an example in which a 500-foot section of RG-59/U foam coax is to be tested for a fault. We make a measurement of the time between the incident pulse and the *inverted* reflected pulse (Inverted! Aha, the line is shorted!) and find that the time for return is 0.85μs. How far down the line is the short located? L = (983.5) (0.8) (0.85)/2 = 334.4 feet. In an actual case, we would find the fault approximately 334 feet from the measurement point. In this case, the cable was part of a long run to input analog data to a computer, and a carpenter hanging a shelf had driven a long nail right into the coaxial cable.

The scope used for this application should have a sweep speed of at least 0.1μs/div, which will work with cables as short as approximately 40 to 50 feet. Shorter cables have the incident and reflected pulses on top of each other. This problem can be overcome by placing a delay line in series with the cable under test. If you do not have a pulse delay line, you can make one with a length of coaxial cable. Insert a value of t into equation (1) that is equal to the desired delay (several tenths of a microsecond) to find the length of cable needed. Try to use a type of cable that is the same as the cable under test. Also, when connecting together the equipment, try to use as short a length of cable as possible. This is especially critical of the cable to the scope.

If you lack a pulse generator, or +GATE output on your oscilloscope, try building a pulse generator such as the one shown in Figure 4. This circuit is a monostable multivibrator based on the 74121 TTL One Shot. The timing of this circuit is set for approximately 0.1 μs, but could be longer if desired. Some circuits have C1 variable so that a variable pulse width is obtained. The combination of R1/C1 sets the pulse duration. The pulse repetition rate can be set with your squarewave generator, provided that it has a TTL-compatible output. Because 0.1μs corresponds to 10MHz, we want a frequency *less* than 10MHz for the trigger source.



Be careful when building this type of circuit. The layout should be consistent with good high-frequency practice, and the power supply bypass capacitor (C2) sould hug close to the body of IC1.

Some improvement in the performance of this circuit can be expected if it is built right into the box of Figure 3B. Pomona Electronics makes a line of blue boxes that can be obtained without connectors, or with the three BNC jacks already mounted. If you use this approach, bring the two power supply lines into the box via a pair of wires through a grommet in the side of the box.

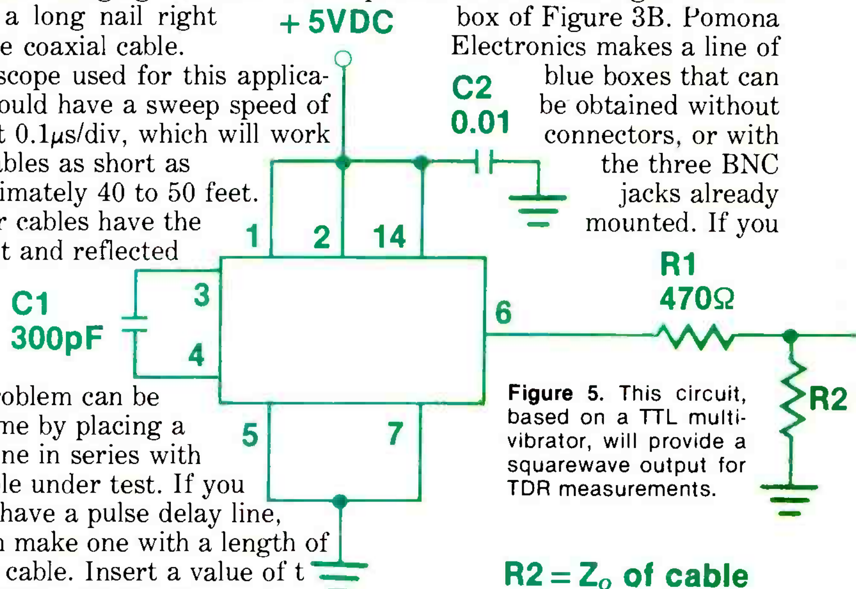


Figure 5. This circuit, based on a TTL multivibrator, will provide a squarewave output for TDR measurements.

You can also use a squarewave to make the TDR measurement, an approach that is particularly useful for those who already have a good quality squarewave or function generator. The primary requirement of the function generator is a fast rise time of the leading edge. If your generator lacks a fast risetime (as is often the case), then pass the output through a TTL Schmitt trigger (7413 or 7414 devices). Alternatively, you may build a TTL

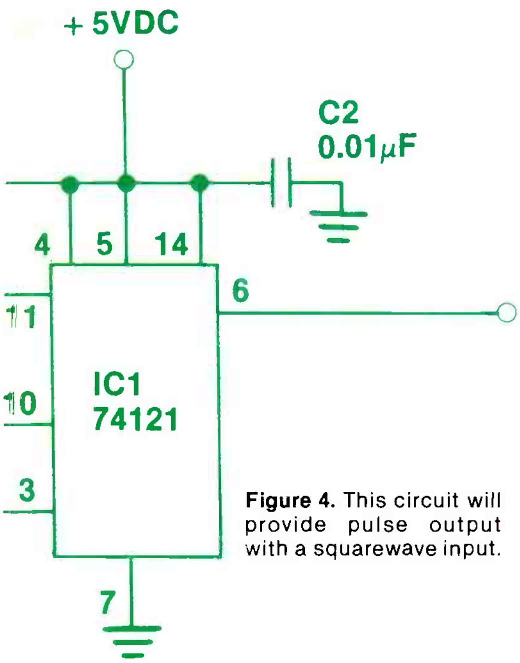
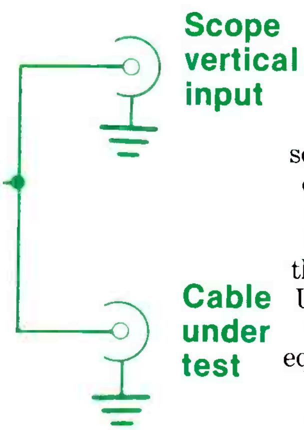


Figure 4. This circuit will provide pulse output with a squarewave input.

astable multivibrator that will output a chain of high-frequency squarewaves (Figure 5). The MC4024 device is NOT a CMOS device, but a TTL voltage-controlled oscillator made by Motorola. It is widely available through hobbyist electronics outlets.



If you use a squarewave or function generator to create the 1mHz squarewave, then connect it to the oscilloscope and cable under test through a coaxial UHF or BNC (as needed for your equipment) T-connector. If you build the circuit shown in Figure 5, build it inside of the shielded Pomona boxes described earlier. The two connectors can then be mounted right on the box.

Making the measurements

The oscilloscope sweep controls are adjusted to display only the top portion of the forward wave. We want to pick a time base setting that is calibrated and will allow display of most of the top edge of the waveform (see Figure 6). The idea is to allow the reflected pulse to be superimposed on the top of the forward pulse. If the load impedance is greater than the characteristic impedance of the line ($Z_L > Z_O$), the scope trace will appear as in Figure 6A. If the load impedance is less than the characteristic impedance of the line ($Z_L < Z_O$), the reflected wave is flipped upside down and will subtract from the forward wave. This results in the shape shown in Figure 6B. The time *t* needed for equation (1) is found by measuring the interval between the leading edge of the squarewave and the return. On most common scopes, the risetimes will appear slanted on the CRT, so pick points halfwave up the slope for the reckoning of time.

The TDR set-up shown here can also be used to measure both VSWR and the velocity factor of a known length of coaxial cable. Let's look at VSWR first. The relationship for VSWR in any transmission line is

$$VSWR = (V_f + V_r)/(V_f - V_r) \quad (2)$$

Where V_f and V_r are the forward and reverse voltages, respectively, as defined in Figure 6.

A sample VSWR calculation

We observe that the forward voltage V_f displays 4.2cm on the scope CRT face. The reverse voltage V_r occupies 1.2cm. What is the VSWR?

$$VSWR = (4.2 + 1.2)/(4.2 - 1.2)$$
$$VSWR = 5.4/3 = 1.8{:}1$$

The velocity factor of a line can

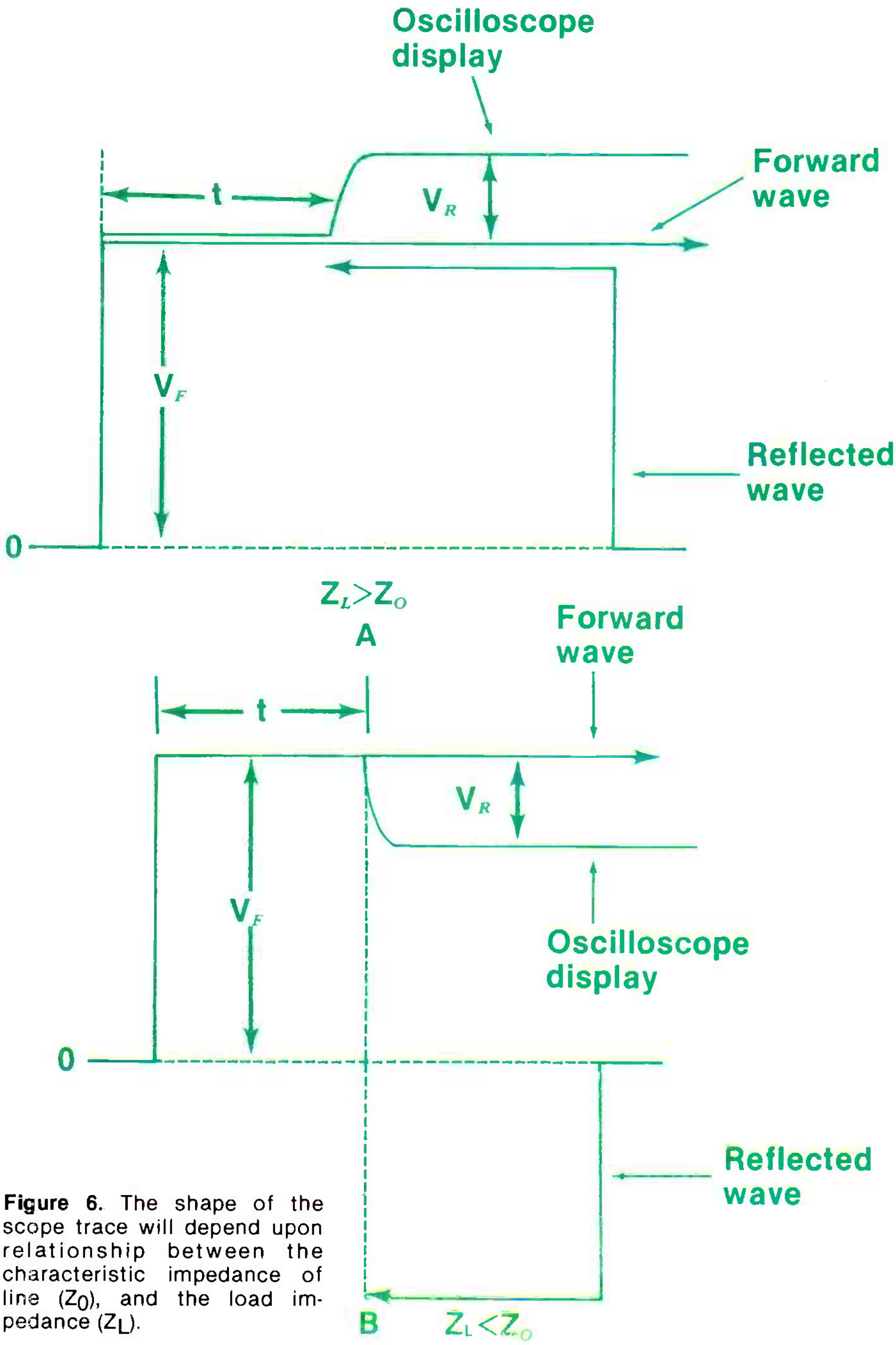


Figure 6. The shape of the scope trace will depend upon relationship between the characteristic impedance of line (Z_O), and the load impedance (Z_L).

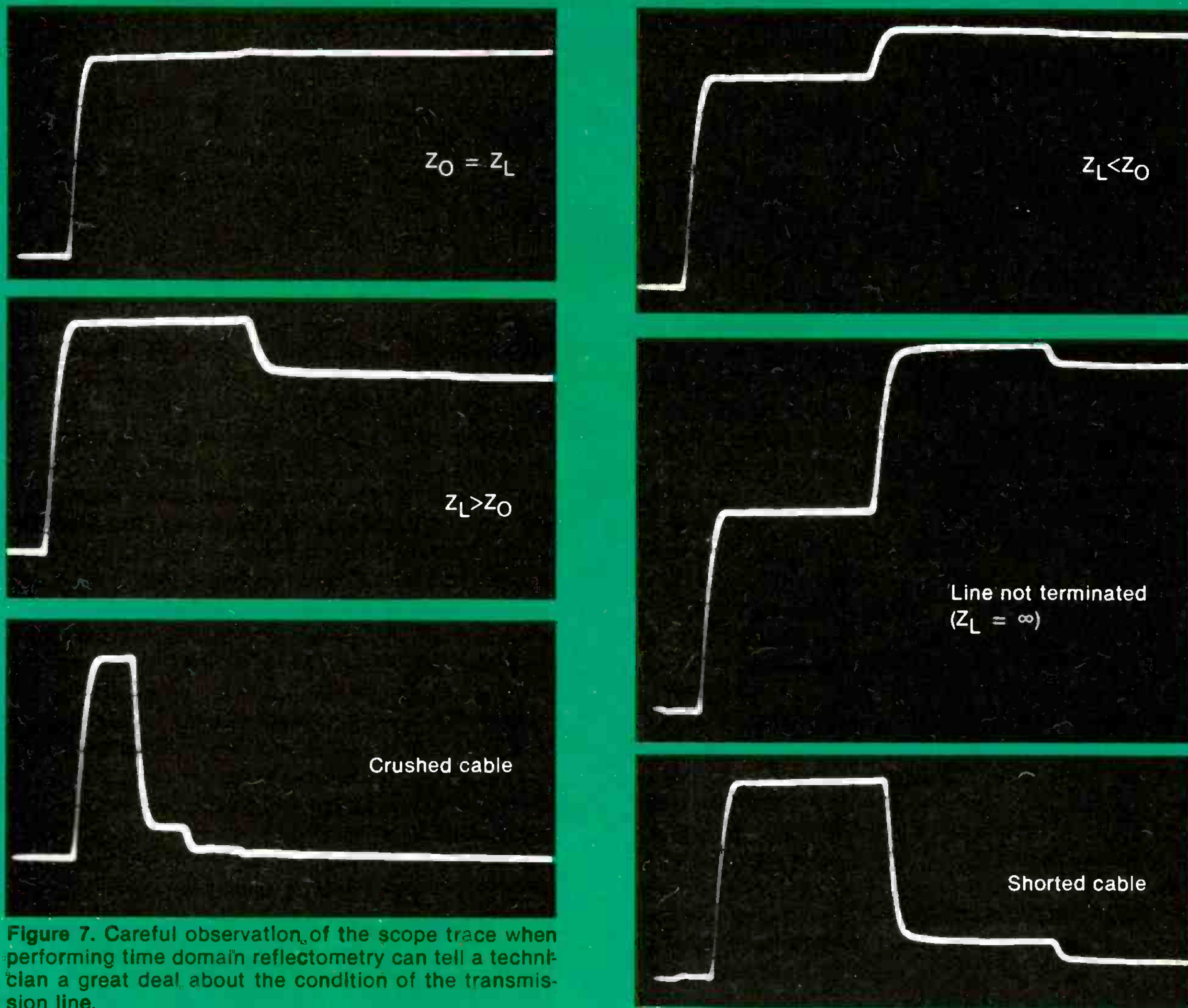


Figure 7. Careful observation of the scope trace when performing time domain reflectometry can tell a technician a great deal about the condition of the transmission line.

be measured with this setup, provided we know the actual length of the line. After all, the velocity factor is defined as the fraction of the speed of light that an electrical signal is propagated along the line. We know the speed of light as 983.5 ft/μs, and we have equation (1). If we solve equation (1) for V, then we obtain a means for measuring velocity factor:

$$V = 2L/983.5t \qquad (3)$$

Calculating velocity factor (v)

We have a 200-foot length of coaxial cable. It is observed that the transition time on the TDR (either method) is 0.67μs. Find the velocity factor of this unknown line.

$$V = 2L/983.5t$$
$$V = (2)(200)/(983.5)(0.67)$$
$$V = 400/658.95 = 0.61$$

While preparing this article, I wanted to retest some of the procedures. Using the second test method, and a 66-foot length of RG-59/U polyfoam coaxial cable (MATV cable), a number of oscilloscope waveforms were taken. The results are shown in Figure 7.

The example in Figure 7A shows the situation when the load impedance is equal to the characteristic impedance. The forward wave is fully absorbed by the load (the line appears to have infinite length), so no bump appears in the scope trace (actually there is a small bump; I couldn't find an exact 75Ω resistor). The situation discussed earlier where the load impedance is greater than and less than the characteristic impedance is shown in Figures 7B and 7C respectively.

For a troubleshooter, it is sometimes handy to know what kind of fault exists on the line. Figure 7D shows the result of an open line (66 feet). This is an extreme version of the $Z_L > Z_O$ tracing shown above. In Figure 7E, we see the result of an anomaly in the line, located 19.5 feet from the test end. I tried to simulate a pinched line by crushing the coaxial cable with a pair of long-nose pliers. The anomaly was enough to send the VSWR up and would foul up a MATV or cable TV system, as well as a radio transmitter. After the anomaly photo was taken, I finished the job by causing a short circuit at the same point (20 feet into a 66 foot cable). The short was caused by a pin through the coaxial cable. The tracing is shown in Figure 7F. Note that the cable was still continuous to the end, where it was terminated in the correct impedance. The short occurred between the transmitter end and the load.

Whether you buy a ready-made TDR unit, or make one of your own from an ordinary bench oscilloscope, the use of this technique is well worth the trouble for the technician involved in radio communications, MATV, cable-television or any other technology that uses long runs of coaxial cable or twisted pairs. ES&T

NEW PRODUCTS

The 16-piece system consists of color-coded (red and black) pairs of 48-inch long test leads, test lead extenders, probe-type test prods for general purpose testing, and 6-inch spring tip hook-on probes for no-slip connections.

Circle (69) on Reply Card

Soldering and desoldering system

Pace's new Micro provides a self-contained power desoldering and soldering system that can be used anywhere electronic equipment needs to be repaired.

The unit operates on ac and 12Vdc sources. Desoldering and soldering are accomplished with a single handpiece with a finger-activated vacuum. The Micro provides spike-free MOS safe operation and precise tip temperature control.

Circle (67) on Reply Card

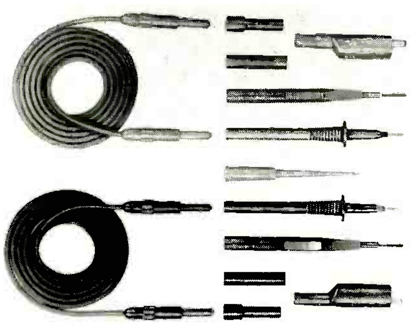
Volt-ohm ammeters

A.W. Sperry Instruments has announced the development of a new series of volt-ohm-ammeter snap-arounds. Called the Slim-Snap series 60, model TD-6 features a 600Vac-rated, fast-acting, high-interrupting capacity fuse in its Ohmprobe. Another important innovation is a low-mass meter movement, which provides maximum protection against damage from shock.

Circle (68) on Reply Card

Universal test lead system

Simpson Electric has introduced a new universal test lead system that expands the measuring capabilities of all Simpson or any other brand VOMs and DMMs with standard or reverse-type banana jacks.



Digital pulser kit

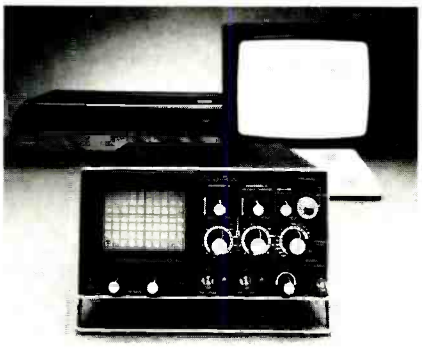
The DPK-1, a new digital pulser kit, designed for use as a pulse injector in stimulus/response testing of digital circuitry, has been introduced by *Global Specialties Corporation.*

This pulse generator is an affordable, sophisticated, portable test instrument that is easy to build and easy to use. The DPK-1 features multi logic family compatibility and operates on both TTL and CMOS circuits.

Circle (55) on Reply Card

Oscilloscope

The *Scopex* 14D-10V, with TV line selector, offers features to trigger onto a video color waveform via an active TV sync separator, selecting any line on the



waveform to enable easy and accurate alignment of VCR, VHS, BETA and videodisc recorders. By pushing two buttons, the instrument automatically triggers the TV line, enabling the operator to select each individual line of the TV waveform to be investigated on the CRT display.

Circle (60) on Reply Card

Capacitor kit

The NAC-400 general-purpose capacitor kit, from *Century Electronics Corporation,* features 62 values of the most popular

aluminum electrolytic, ceramic disc, polyester film and metalized film at a total of 400 pieces. It is designed for circuit designers, laboratories, R & D departments, technical schools, universities and repairmen.

Circle (61) on Reply Card

Soldering tool

Edsyn's new Idle-Rest soldering tool Pod comes in two versions (IP288 or IP289), each designed for specific Edsyn, soldering tools.

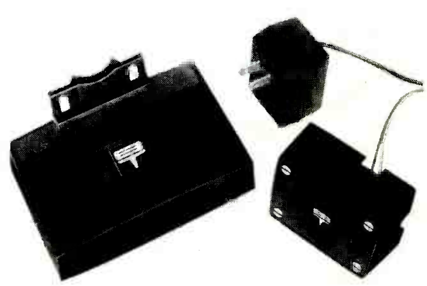
The IP288 is designed for the Loner model 940 or 950 temperature-controlled soldering instrument, while the IP289 is designed for the Ersa Tip 16 (an uncontrolled temperature soldering tool).

Circle (62) on Reply Card

Preamplifiers

Blonder-Tongue Laboratories has announced the availability of a complete new line of mast-mounted preamplifiers for home installations. The 16 models allows an installer or home owner to meet any TV signal amplification requirement. All UHF models are operational through Channel 83.

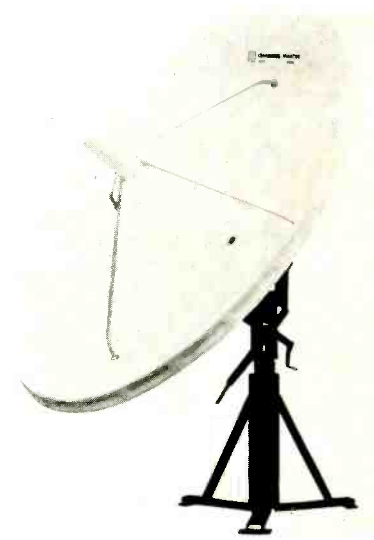
All Galaxy III preamplifiers are designed with a low noise figure for a snow-free TV picture. The Galaxy III power supply consists of an all new transformer/power adder, simplifying hook-up and mounting and improving reliability. Each dual model Galaxy III unit has a built-in splitter, making it easy to feed two TV sets from one preamplifier with no degradation of the picture, and is protected from lightning and power line surges.



Circle (59) on Reply Card

Home earth stations

A new generation of satellite earth stations from *Channel Master* offers a high level of performance combined with simplified and convenient operation.



Each system includes a 10- or 12-foot parabolic dish, motorized or manual polar mount, 100° or 120° LNA (low noise amplifier), scaler feed with automatic polarizer, full-feature 24-channel receiver/downconverter, built-in modulator and all necessary cables and connectors.

Circle (63) on Reply Card

Junction box for security

Junction boxes for use in security system wiring applications are now available from *Sentrol.* Designated as the 1990 series, they are available both with and without tamper switches installed and in mahogany brown, off-white

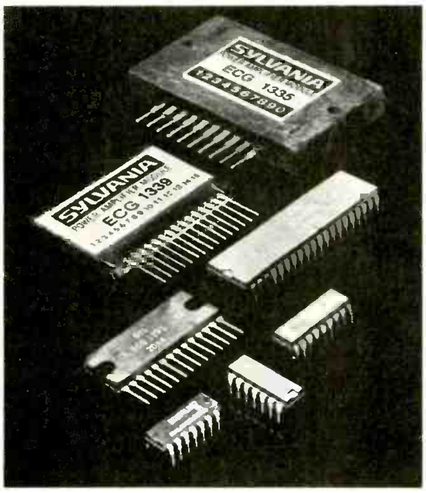
or gray to adapt to any environmental need.

Each box has four screw terminals with protective barrier strips to prevent accidental shorts. Special clamping washers eliminate the need to hook wires around the screws. Built-in wire clamps keep wires dressed properly and built-in clamps hold armored cable in place when used.

Circle (56) on Reply Card

ICs and modules

The Distributor & Special Markets Division of *Philips ECG* has announced the addition of 50



new ICs and modules to the Sylvania ECG semiconductor line.

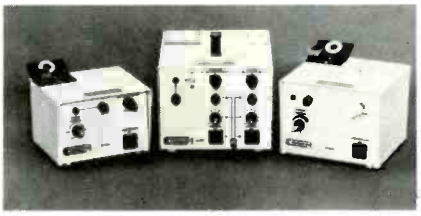
The replacement devices are grouped as 17 entertainment/consumer, 7 AF modules and 26 industrial.

Circle (57) on Reply Card

Desoldering tools

Automated Production Equipment's models EX-500, EX-550 and EX-525 are now available for desoldering printed circuit boards.

Models EX-500 and EX-525 are



self-contained and use a rotary and piston pump, respectively. Model EX-550 is pneumatically operated, using a transducer to obtain vacuum. The air supply is controlled via a solenoid.

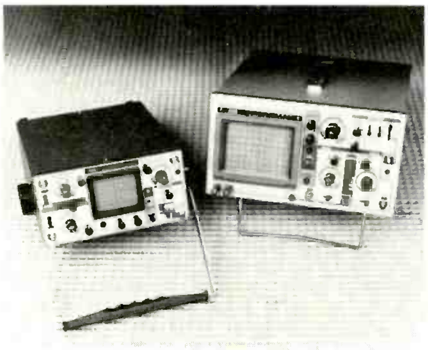
All three units come complete with APE model EX-1000 desoldering handpiece with new improved heater and SCR controller. Vacuum flow is foot-pedal operated on all units, leaving the operator's hands free.

Circle (58) on Reply Card

Oscilloscopes

A. W. Sperry Instruments has announced their line of easy-service oscilloscopes: the AWS 315P and the AWS620C.

Model 315P is a portable ac/dc, 15MHz, dual-trace oscilloscope with a built-in battery pack. Major features include ease of servicibility (three circuit boards and minimal hard wiring); automatic battery recharge; high sensitivity (2mV/div); high intensity, rectangular CRT with internal grati-



cule; front-panel trace rotation adjustment; TV (video) sync separator and X-Y display modes.

Model 620C is a 20MHz, dual-trace oscilloscope with built-in component checker for use on resistors, capacitors, diodes, digital circuits and more.

Circle (98) on Reply Card

ES&T

Circle (19) on Reply Card

Circle (21) on Reply Card

Circle (20) on Reply Card

NEW LITERATURE

A new, comprehensive cyanoacrylate adhesive selector guide has recently been compiled and published by **Oneida Electronics Manufacturing.**

The guide, which has been color coded, makes it fast and simple to determine the most appropriate formula of Oneida Instant-Weld Adhesive to handle your particular bonding requirements.

The new literature gives detailed specifications on the 10 different types of Instant-Weld, giving setting time, viscosity, softening point, melting point and weatherability, as well as examples of the various formula's bonding (tensile) strength on similar and dissimilar materials.

Circle (84) on Reply Card

The Engineering Department of the **Electronic Industries Association** has announced the availability of RS-198-B-3A, "Detail specifications B/22 and B/23," (Single and multiple layer, encapsulated ceramic dielectric, 2-pin dual-in-line capacitors, style CC2810 and style CC2820; revision of RS-198-B-3.

The major changes in this revised recommended standard are the minimum thickness dimensions. The document also contains changes in the recommended plastic shipping slides for the 2-pin dual-in-line capacitor.

Copies of RS-198-B-3A are available for $6 each.

Circle (83) on Reply Card

Mountain West Alarm Supply has recently released their new *1983 Security Catalog,* which contains more than 2000 items, as well as technical information and color photos. Diagrams and detailed descriptions make this catalog an asset to everyone from

THE MARKETPLACE

Circle (23) on Reply Card

security and alarm professionals to the advanced do-it-yourselfer.

Circle (97) on Reply Card

Sprague-Goodman Electronics has a new series of miniature single-turn, air-dielectric, parallel-plate trimmer capacitors. The trimmers feature rotors and stators machined from solid brass stock.

Complete information on this product line is given in Sprague-Goodman Engineering Bulletin SG-600, available from the Technical Literature Service, Sprague-Goodman Electronics, 134 Fulton Ave., Garden City Park, NY 11040.

Circle (90) on Reply Card

The new 32-page Stabiline Automatic Voltage Control Bulletin SVC1281 describes **Superior Electric's** complete line plus a reference of power-line disturbances and solutions. There is also a glossary of electronic and voltage-control terms.

Circle (94) on Reply Card

A line of precision tweezers with specialized applications in the scientific, electronic, research and quality control laboratories fields has been introduced by **Grobet File Company of America.**

Developed specifically for the professional market, the Grobet tweezer line includes nearly 100

types, shapes and sizes of tweezers. The unusually varied line has been given the trade name "Arrow," and the new 12-page catalog #982 is now available to help distributors and users become familiar with the many tweezers available.

Circle (81) on Reply Card

A new catalog of hard-to-find tools for electronic assembly and

precision mechanics is free from Jensen Tools. The catalog features more than 2000 products and introduces several new kits. The contents include tools of interest to field engineers, technicians, instrument mechanics and electronic hobbyists.

Circle (82) on Reply Card

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USED RADIO-TELEVISION TUBES. All types. Working condition. 30 for $10.00 postpaid. Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 10-82-3t

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TUBES FOR TV AND RADIO—35¢ ea. Washington TV Service, 1330 E. Florence Ave., Los Angeles, CA 90001. 12-82-12t

FOR SALE: NEW B.K. 1077B and 415 acquired through delinquent accounts. For information or to reply with bid write, MGC Inc. 490D Rd. #1 Macungie, Pa. 18062, Best offer over $390 each. 12-82-1t

HEATH IG-5257 Sweep Marker Generator, excellent condition $135.00. 804-384-0240 Virginia. 12-82-1t

COMPLETE TV, STEREO & COMPUTER SERVICE SHOP. Equipment and service manuals from warranty service center retiree. Includes latest equipment, complete Sams, Zenith, RCA, Kenwood, Litton, etc. parts and factory manuals. At 20% of dealer cost. 1-303-641-4678. 12-82-1t

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TV TECHNICIAN, Gill's TV, St. Joseph, Mo., 525 So. 39th, contract wage $60 per set average bench, Call Myrt 816-232-2750. 12-82-1t

MAGNAVOX 703744-, 704208, $13.99 exchange; 703646-$14.95 exchange. Send your duds with order, 12 month warranty. Module Exchange, 930C S. Cedar Ridge Rd., Duncanville, TX 75137. 12-82-1t

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NORWALK, CALIFORNIA ESTABLISHED TV AND STEREO SERVICE AND SALES very busy money maker, excellent location, low rent, very good lease, 2300 square feet, 10 minutes to beaches and Los Angeles. $40,000 includes inventory, large enough for living quarters, owner retiring, phone 213-863-1919. 11-82-tfn

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with a line of VCR and Video Disc Player accessories as strong as its name.

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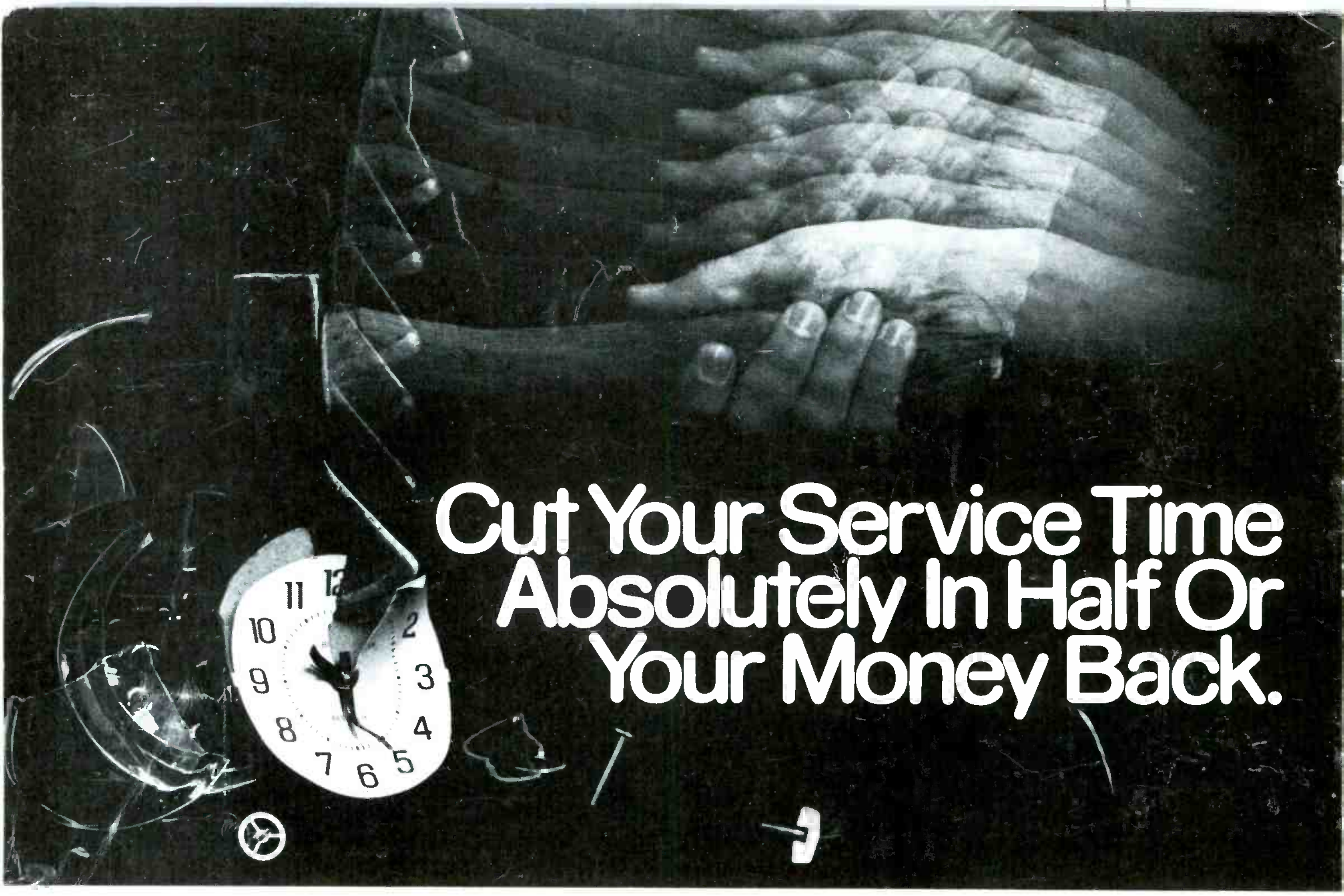

If you use a general purpose oscilloscope for troubleshooting we can cut your present service time in half with the SC61 Waveform Analyzer. That claim may sound a little bold, but SC61 customers around the country tell us it's happening every day in service shops just like yours. That's why, in less than one year, the SC61 Waveform Analyzer has become the biggest selling instrument in our 31 year history.

It's ten times faster—ten times more accurate: The SC61 is the first and only instrument to integrate the speed and accuracy of a digital readout with the viewing capability of a high performance 60 MHz scope. Connect only one probe and you can view any waveform to 60 MHz. Then, just push a button to read DCV, PPV, frequency and time.

There are no graticules to count or calculations to make so every measurement is 10 to 100 times faster than before.

The digital readout is 10 to 10,000 times more accurate than conventional scopes for measurements you can trust in today's high precision circuits.

Plus having everything you want to know about a test point, at the push of a button, eliminates guesswork and backtracking which speeds troubleshooting tremendously.

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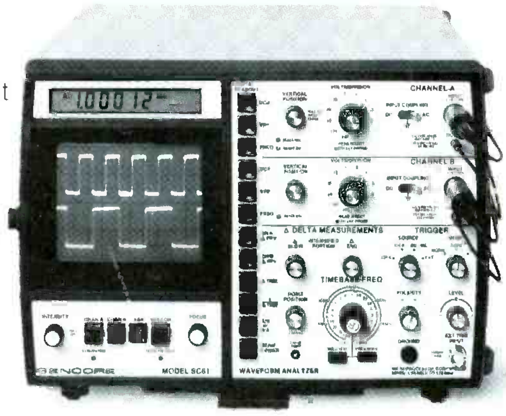
And it's neat: What's it worth to permanently clean up your work bench? No more tangled leads, piles of probes or dangling cords. The SC61 is an entire bench in one unit. You can't get neater than that.



Guaranteed to cut your service time in half: When we say the SC61 will double your productivity, we're being conservative. We've seen cases of three, four, even ten time increases in productivity with this first-of-its-kind, automated oscilloscope. Every situation is different, however, so try an SC61 and judge for yourself. Here's our offer.

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