October, 1979 □ $2.25

Electronic Servicing®

Testing thyristors

Association conventions

Repairing old TVs

Electronic Servicing

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INTERTEC PUBLISHING CORP.

In November

Electronic Servicing

Test equipment roundup; features of RCA CTC99 chassis; servicing horizontal sweep; and repairing medical oscillographs.

October, 1979 □
Volume 29, No. 10

Electronic Servicing®

Departments

About the cover

Symbols of SCR and TRIAC thyristors illustrate the *Quick tests of thyristor controls article.* Graphic design by Linda Franzblau.

electronicscanner

news of the industry

Liaison, a professional conference planning company, is planning two 1-day workshops on VTR Servo-mechanisms. The workshops, to be held in St. Louis November 10 and 17, will be conducted by Forest Belt, **Electronic Servicing** author and well known authority on electronics servicing. Fee is $150 and includes workshop, materials, beverage breaks and lunch. Seats must be reserved before November 1 by contacting Liaison via Western Union or Special Delivery mail with payment in full. Enrollments cannot be accepted after this date. For more information contact Marti McPherson. Liaison, P.O. Box 40821, Indianapolis, IN 46240.

Two electronics upgrading workshops are scheduled to be held in St. Louis. The first 3-day workshop (November 7-9) is for consumer or dealer service technicians. Wednesday features a *Triggered Oscilloscope Hands-On Workshop* conducted by Forest Belt, CET. Thursday's is conducted by Wayne Lemons and deals with *Solid-State Update*. Friday covers *Digital Electronics for Technicians*. James R. Manery and Forest Belt will team up for this presentation where attendees will learn about gates, how they work in logic circuits, steady-state and pulsed digital signals and how to trace troubles through complex digital-electronic systems with ordinary electronic testing equipment and with new digital testers. The second week, November 14-16 brings basically the same 3-day session this time geared to the industrial maintenance technician. Both Belt and Lemons are contributing **Electronic Servicing** authors. Look for their features in the industrial maintenance section of this month's **ES**. The fee for the consumer electronics technician session is $750. Fee for the industrial maintenance session is $850. For further details contact Marti McPherson, Liaison, P.O. Box 40821, Indianapolis, IN 46240. Telephone (317) 253-7822.

Texas Instruments has introduced a unique electronic digital thermostat for home use. The thermostat offers digital display of time and room temperature, and it can be adjusted easily for a wide range of set-back temperatures. For example, it might be set for an increase to 70°F before rising time in the morning, a decrease to 60° at 8 AM, an increase to 70° at 5 PM, and a decrease to 65° at 11 PM for comfortable sleeping all night. The retail price is said to be $125.

Mattel has licensed General Telephone & Electronics (GTE) to market Mattel Intellivision under the Sylvania name. When Intellivision is connected to a TV receiver for audio and picture, preprogrammed cartridges provide a choice of games and educational programs. The basic system consists of a 16-bit microprocessor master component with two hand-held controllers. Addition of a keyboard (early 1980) will allow the system to function as an interactive computer.

Sales of color TVs are expected to remain strong despite the predicted economic dip this year, according to Jack K. Sauter, vice president and general manager of the RCA Consumer Electronics Products division. Sauter said RCA's 1979 color TV sales were higher than last year, and that RCA will be spending 23% more for advertising in the second half of 1979 compared to the same period last year.

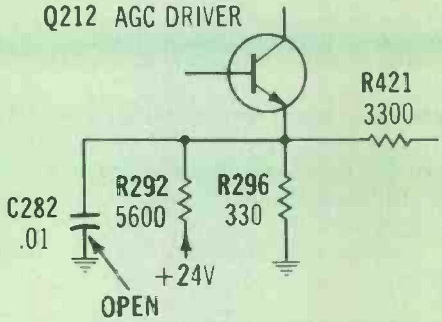
Omni Electronic Tuning for a new 13-inch color TV was introduced by Zenith in early August. All channels are available by rotation of one flywheel-type tuning knob, and no setup adjustments are required. Zenith also unveiled a top-of-the-line direct-drive turntable and stereo radio in the component line.

Total TV sales to dealers for the first 30 weeks of 1979 were 1.9% higher than for the same period last year. Auto radio sales were 5.1% higher, but all other radio types suffered reduced volume. Home videotape recorder sales increased by 25.3% during the same period.

symcure

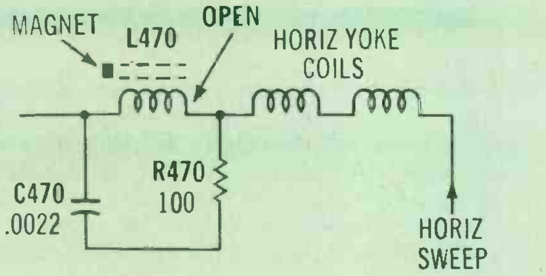
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Sylvania E21
PHOTOFACT—1587-1



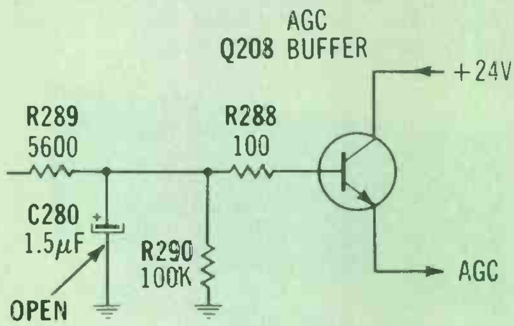
Symptom—AGC overload with horiz tearing
Cure—Check C282, and replace it if shorted or leaking

Chassis—Sylvania E21
PHOTOFACT—1587-1



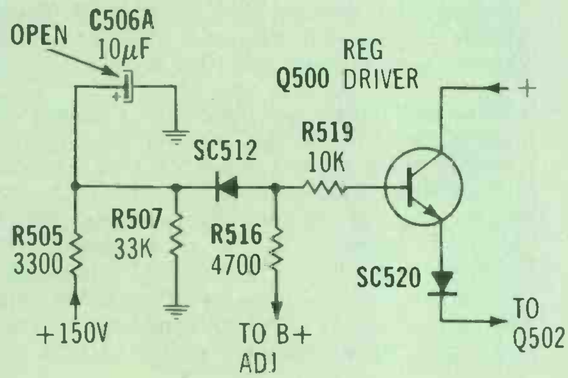
Symptom—No HV, no raster
Cure—Check linearity coil L470, and replace it if open

Chassis—Sylvania E21
PHOTOFACT—1587-1



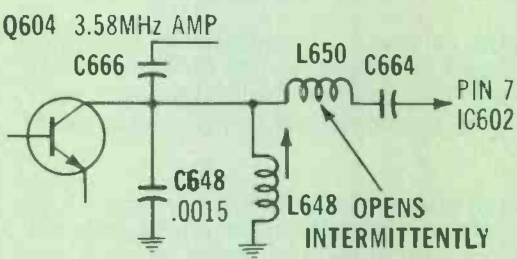
Symptom—Horizontal tearing and instability
Cure—Check AGC capacitor C280, and replace it if open

Chassis—Sylvania E21
PHOTOFACT—1587



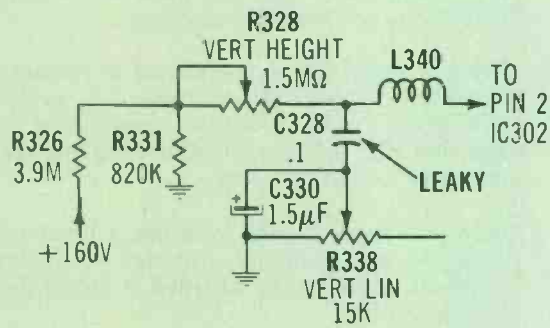
Symptom—Excessive B+ and HV causing shut-down
Cure—Check supply capacitor C506A, and replace it if open

Chassis—Sylvania E21
PHOTOFACT—1587-1



Symptom—Erratic skin tint
Cure—Check for open L650, or replace as a test

Chassis—Sylvania E21
PHOTOFACT—1587-1



Symptom—No height
Cure—Check capacitor C328, and replace it if leaky

Hot Shot.

Our heat gun is light, tough and very easy to control. You get easier handling with precise hot air direction and built-in durability.

Weighing only 13 ounces, including its 3-wire cord, the heat gun sits comfortably in your hand. Its handle stays cool even during long hours on the job.

You can put the hot air stream exactly where you want it because the nozzle is smaller. And the four baffles that are included with the gun adapt it for a wide variety of uses.

There's a 3-way trigger switch with hot and cool positions. The nozzle temperature reaches 750° 800°F in seconds. And you can get our optional stand to hold the heat gun securely in several work positions.

In its high impact, heat resistant molded case, the heat gun can withstand the rigors of industrial, service shop or laboratory use.

Try our versatile, economical heat gun for everything from shrink tubing, to reflow soldering, to repairing plastics. You'll see why half of our heat guns are bought by or on the recommendation of a satisfied user.

For our new catalog, write to Ungar, Division of Eldon Industries, Inc., P.O. Box 6005, Compton, CA 90220.

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The Heat Gun. For Precise Control Of Hot Air.

Asbestos-Free!

Circle (7) on Reply Card

reader's exchange

There is no charge for a listing in *Reader's Exchange*, but we reserve the right to edit all copy. Due to the limited amount of space for this department, ads must show no more than *five* items. If you can help with a request, write directly to the reader, not to **Electronic Servicing.**

Needed: New or good-used record-playback head for model EP-2207-1 Webcor. Webcor part number is 65P160; Nortronics part number is 1000. Advise price. *John Osborne, Winthrop Electronics, Town Hall Lane, Winthrop, ME 04364.*

Needed: One filament transformer for a Sencore tube tester model #MU140, new or used. Voltage output .8, 1.25, 1.8, 2.4, 3, 3.8, 4.9, 6.2, 8, 10, 12.5, 16, 21, 28, 37, 48, 60. *Herzings Radio & TV Service, 2242 Frederick Ave., Baltimore, MD 21223.*

For Sale: TV tubes, good, boxed, assortment of 30 for $12. SK3054 vertical-output transistors, 7 for $2, postpaid. Send stamped-addressed envelope. *S. Valer, 428 W. Roosevelt Blvd., Philadelphia, PA 19120.*

Needed: Operating manuals or schematics for R&D Instruments models 1715 and 1715BR square wave generators. *J. Morgan, 3008 Ozark Rd., Chattanooga, TN 37415.*

For Sale: RCA model WR-514A alignment generator with RF, IF, video and Chromalign sweep signals, $225; Aerovox LC checker, model 97, $50. Both have all manuals, cables and connections; used only once; best offer. *Mitchell Electronics, 1009 Delmar Drive, Mobile, AL 36606.*

For Sale: New Sencore YF33 Ringer (yoke and flyback tester), $150, list price, $225 (bought Sencore's VA48 Video Analyzer which has built-in Ringer.) *Leo Mosby, 323 David Lane, Brighton, IL 62012.*

For Sale: Conar tuned signal tracer with manual, $35; Hickok 288-X signal generator, $35; Superior C/R bridge and signal tracer (no manual), $20; Radio City Products model 704 signal generator, $20; Hickok video generator model 650 C (needs some repair), $15; Heathkit IT-17 tube tester, $65. *Ken Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

For Sale: B&K Precision CB test equipment 1403A scope; 1040 CB Servicemaster; and 1801 frequency counter with PR25 probe. All with manuals and probes in original cartons, used a few hours. Send

SASE. *Michael Harlinski, 180 Cherokee Drive, Springfield, MA 01109.*

Needed: Books or schematics for older US Government radio gear including 1 General Television & Radio GN-45-B generator, Series 27048; 1 Hubbell & Miller BC-1335-A (10273-Phila-49) radio receiver-transmitter, Series 492; 1 Crosley BC-654-A Series 55581 radio receiver and transmitter; 1 Russel Electric type 530-D3-DB, Series 58833 Balentine Dynamotor; 1 Crosley power unit PE103A, Series 53887 1 PE-104-A power converter unit, Series 67956. *David T. Schmidt, 821 Manor Drive, Lake Havasu City, AZ 86403.*

Needed: Information on polarized possibly tantalum-type circuit boards, ½-inch long and 3/16-inch in diameter. Markings are Kemet T110—TS2—CS13B—F225K and 2R2 uF 35V. *George J. Damm, 376 Tidd Drive, Galion, OH 44833.*

Needed: Convergence assembly for Sylvania D12 or D13 chassis. State price and condition. *John DeLuco, 435 Ocean Blvd., Cliffwood Beach, NJ 07735.*

Needed: Manuals and schematics for Hewlett-Packard 500B frequency meter, Ballantine ac VTVM model 300 and V-M Tape-O-Matic model 711/TR-1. Latter is available in Sam's Photofacts 349, no longer in print. Will buy or pay to copy and return. *Unitronix, P.O. Box 247, Galveston, TX 77553.*

For Sale: TV service shop equipment, all types, send self-addressed stamped envelope for list. Wanted: Two 9.6V "C" size Nicad cells (like Gulton 8VO 180) for telephone dialer; first class FCC course in good condition. *Don Setliff, 1038 Tenth Ave., R., Huntington, WV 25701.*

For Sale: 50 assorted BW tuners; 50 assorted flybacks; 50 assorted yokes; Rider's manuals radio 6-19, and TV manuals 1-23; Polaroid cameras, make offers. *Troch's 290 Main St., Spotswood, NJ 08884.*

For Sale: Sencore SS105 sweep circuit tester, $30; Precision model 230 multi-bias supply, $30 and 1000 tubes for old radios and B&W TV sets $200. *Al Crispo, 159-30-90 St., Howard Beach, NY 11414.*

people in the news

PTS "Man of the Month" is Ed Arraya. Arraya, a native of Bolivia, worked his way through technical school. After several jobs, he became a technician at the PTS Philadelphia branch. After two years, he was promoted to manager.

Richard "Dick" Mentzinger has been appointed director of sales for the Quasar Company. Previously, Mentzinger was with Beatrice Foods, RCA and General Electric.

Shure Brothers has promoted **Bernhard W. Jakobs** to the post of vice president, engineering. A 20-year veteran with Shure, Jakobs is considered one of the world authorities on phono-cartridge design.

Gould Electronics announces these promotions: **David Blecki** to vice president of marketing; **Roy Tottingham** to vice president; **L. Briggs Dunn** to operations manager of scopes; and **Robert Kerzman** to director of marketing communications for the Gould instruments division.

Philips Test & Measuring Instruments company has named **Dan Lippman** to the position of sales manager—manufacturers' representatives. Expansion of the marketing organization is linked to the upcoming manufacturing of scopes in the United States.

ELECTRONICS UPGRADING Seminars

at ST. LOUIS, MO.

CONSUMER/DEALER TECHNICIANS
NOVEMBER 7 - 9, 1979

INDUSTRIAL MAINTENANCE TECHNICIANS
NOVEMBER 14 - 16, 1979

SPECIAL OPTION - VTR Servomechanism Servicing
NOVEMBER 10 or 17, 1979

Consumer or industrial electronics upgrading made easy.
Unique, concise tell-and-show methods, plus hands-on experience,
place new electronics technology at your fingertips.

So VITAL that no electronics servicer should miss it!

SUMMARY OF THREE-DAY SEMINAR

DAY 1 - TRIGGERED SCOPES
Hands-On Workshop

Learn to manipulate modern scopes wisely and knowledgeably. Speed up troubleshooting of even the most complex equipment. This familiarization program explains controls for CRT, vertical input, time base, and triggering...plus advanced scope techniques. Scope displays become easy to analyze after this day-long session, with Forest Belt instructing.

DAY 2 - SOLID-STATE UPGRADING
and Updating

Gain unexpected insight into new and established solid-state devices and technology. Practical, entertaining tips on solid-state circuitry teach you how to troubleshoot quickly. Industrial maintenance session covers higher-power solid-state devices and applications. Wayne Lemons instructs.

DAY 3 - DIGITAL ELECTRONICS
for Home or Industry

Clear up mysteries of digital electronics: gates, flip-flops, R-S stages, truth tables, and more. Practical help in troubleshooting digital circuits. Instruments that make servicing clear and direct. An information-packed day that puts you on top of digital technology, whether for consumer or industrial electronics. James R. Manery and Forest Belt instruct.

VTR Servomechanisms - OPTIONAL (Separate Fee of $150)

Take the uncertainty and frustration out of VTR servicing. Forest Belt guides you step-by-step through the electronic heart of motor control in Beta and VHS video recorders. Truly understand the unusual three-phase, electronically commutated, direct-drive DC motor that spins the helical-recording heads drum. On the day industrial technicians attend, U-Matic will be treated too.

FEES:

Consumer/Dealer Tech Session November 7, 8, 9, 1979	$ 750 *
Industrial Tech Session November 14, 15, 16, 1979	$ 850 *
VTR Servomechanisms Session November 10 or 17, 1979	$ 150 †

FEES INCLUDE:

- † * Timely training
- † * Best teachers
- † * Carry-home manual
- * Hands-on experience
- † * Certificate of training
- * All workshop materials and functions
- * Hotel room (double-occupancy)
- * Meals † Lunch only

Here's my enrollment.

NAME ________ AGE ________
COMPANY ________ TITLE ________
ADDRESS ________
CITY ________ STATE ________ ZIP ________
PHONE ( ) ________

Mail to: **Liaison**
P. O. Box 40821
Indianapolis IN 46240

I want to attend:

☐ Consumer/Dealer Technician Session
November 7, 8, and 9, 1979 — $ 750

☐ Industrial Maintenance Technician Session
November 14, 15, and 16, 1979 — $ 850

☐ VTR Servomechanisms Session - Consumer
November 10, 1979 — $ 150

☐ VTR Servomechanisms Session - Commercial
November 17, 1979 — $150

TOTAL Enclosed $ ________

Check number ________ Money Order ________

Service Association conventions

By Carl Babcoke

August was crowded with conventions of various electronic associations whose members are technicians, shop owners or managers. This brief report covers ETA-I, NESDA/ISCET and NATESA.

Electronic Technicians Associated, Inc. selected Dick Glass of Indianapolis, IN as president. Glass was one of the founders.

Ron Crow of Ames, IA, has been appointed as ETA-I director of certification.

ETA-I

Bingeman Park Convention Center in Kitchener, Ontario (Canada) was the location August 3, 4 and 5 for the annual convention of the Electronic Technician Association International (ETA-I). The following were chosen as officers or executives: chairman—Jesse B. Leach of Maryland; vice chairman—D. C. Larson of Texas; secretary—George Savage of Nebraska; and treasurer—John McPherson of Virginia. Dick Glass of Indiana and Ron Crow of Iowa were reappointed as president and director of certification respectively. Chairmen of the three ETA-I divisions are Bill Patullo for the Canadian division (ETA-C), Leon F. Howland for the certified-technician division, and Alan Hartley for the electronics-educators division.

Under development is a job-placement program for technician members of ETA-I. Any techs who want better or different positions are to fill out "Career Opportunity Application" forms. ETA-I then sends copies of these completed forms to prospective employers who request them. Any employer needing a technician should contact ETA-I for this information.

Plans are being formulated for 2-day seminars about computer programming and other technical subjects. One of the present training programs includes a 4-page question-and-answer article about op-amps. Other training methods are under consideration.

ETA-I will analyze (for a fee) the business operations of ETA-I dealers or shop owners. The dealer

Houston ETA-I members admired the Norris Brown "Man of the Year" award plaque held by ETA chairman Leach. From the left are Leach, John Othahal-Mechura, Chuck Domingo, Bill Bragg and D. C. Larson. George Savage of Nebraska received the first "Man of the Year" award.

Frank Moch, executive director, addressed NATESA members and delegates.

Doc Blakely provided a hilarious after-dinner speech at the NATESA convention, courtesy of RCA.

completes a form that lists key factors of the business, then ETA-I will analyze those facts, compare them to industry norms and make specific suggestions for improvements.

Write to Electronic Technicians Association-International at 7046 Doris Drive, Indianapolis, IN 46224. The phone number is (317) 241-7783.

NATESA

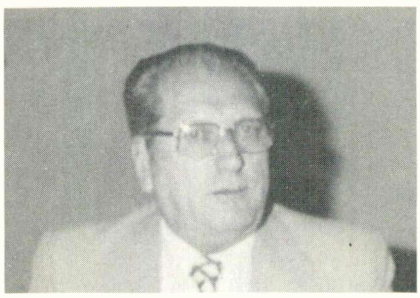
Attendance at the 29th annual convention of the National Association of Television and Electronic Servicers of America (NATESA) exceeded the expected registration by about 15%. The convention was held in Carson's Nordic Hills summer resort (near Chicago) August 23 through 26. Meals and other functions were sponsored by General Electric, GTE-Sylvania, Howard W. Sams, Magnavox, PTS Electronics, RCA, Sony and Zenith. Attendance awards were supplied by Quasar and Magnavox. Several association-business and election meetings were held.

The Business Practices Panel with moderator Richard Lay discussed direct-mail advertising, parts pricing, repair pricing with the NATESA form, and a report on the CESC. Panel members were Frank Daniels, Paul Dontje, George Weiss and David McKalip. During the Technology Overview program

NATESA officials were sworn in at the awards banquet. From the left, Frank Moch (executive director), Lelia Aunspaw (secretary), Paul Kelley (president), George Weiss (immediate past president), Richard Ebare (treasurer), and Leo Cloutier (vice president).

Association conventions

From the left, Dorothy Cicchetti (vice president of region 2), Everett Pershing (past president), J. W. Williams (executive director), and Bob Villont (president) are pictured during a NESDA business session.



New officers of NESDA are (from top left): Robert Villont—president; Bill Lawler—vice president; Warren Baker—secretary: Bill Abernathy—treasurer; J. W. Williams—executive director.

(moderated by Carl Babcoke, **Electronic Servicing** editor), Bob Giger gave specific procedures for servicing several of the newest RCA TV chassis, and Chet Dunn made a detailed presentation of features

The NESDA trade show had a western theme. At the Electronic Servicing booth, Virginia Babcoke helped husband Carl (ES editor) distribute magazines and talk to those attending the trade show.

and circuits in the Magnavision video-disc player. Howard Larson (Dan Flanders) told of crime against a dealer and the punishment of the guilty person.

Sperry Tech (increment-pricing products) received the NATESA Friend of Service award. Recipient of the 1979 Shumavon Award was A. Edward Stevens of Florida. Many other award plaques were presented to those who helped make the convention successful.

Following the Zenith-sponsored dinner, an old black-and-white film was shown. It illustrated Zenith radio manufacturing and sales slogans from the late 1920's. Although the film originally had a serious purpose when it was made, nostalgia about the old equipment changed the present reaction to pleasure and merriment.

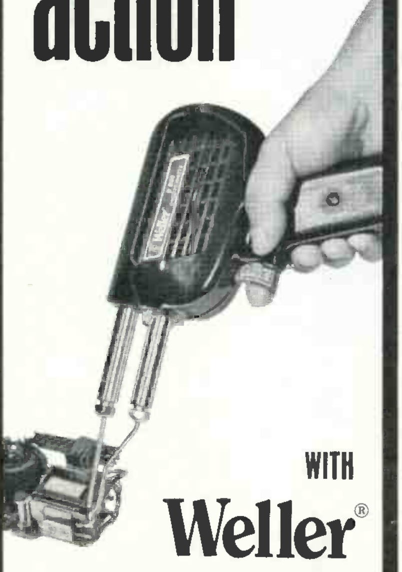
Another nonserious highlight was the rapid-fire monologue of jokes and funny stories by Dr. James Blakely who was brought to the convention by RCA.

All previous NATESA officers were elected again. They are: president—Paul F. Kelley of Rhode Island; vice president—Leo E. Cloutier of California; secretary—Lelia Aunspaw of Ohio; and treasurer—Richard Ebare of Vermont. Frank Moch again was appointed executive director. These officers were sworn in by Ed Stevens at the traditional Saturday night NATESA banquet which included a floor show.

NATESA is located at 5908 South Troy, Chicago, IL 60629, and the phone number is (312) 476-6363.

NESDA/ISCET

More than 500 delegates, family members, officers and manufacturer's representatives attended the 1979 National Electronics Service Convention August 13 through 18 at the Marriott Hotel in Tucson, AZ. National Electronic Service Dealers Association (NESDA) business seminars were based on the theme, "Meeting the Challenge of Change," while the International Society of Certified Electronic Technicians (ISCET) sponsored technical



Association conventions

ISCET new officers are (from the left): Frank Grabiec, Larry Steckler, Jack Kelly, and Robert Ocasio (not present).

presentations called "Coping with the New Technology." Various manufacturers cooperated with these seminars.

Highlight of the NESDA association-business sessions was a joint address by president Bob Villont and the new executive director, J. W. Williams. Although problems of the past two years were discussed frankly, membership reaction was generally one of optimism and cooperation.

Robert A. (Bob) Villont of Tacoma, WA was elected unanimously as president for a second term. Other elected national officers include: vice president—Bill Lawler of California; secretary—Warren Baker of New York; and treasurer—Bill Abernathy of Texas.

At the awards presentation, General David Sarnoff (RCA founder) was inducted into the Electronics Hall of Fame. NESDA president Villont was named as "Man of the Year," Bill Lawler was honored as NESDA's "Officer of the Year," and Bill Abernathy was selected as "Outstanding Committee Chairperson."

This year, the electronic trade show had a western theme, as shown in some pictures.

New officers of ISCET are: chairman—Larry Steckler of New York; vice chairman—Frank Grabiec of Arizona; secretary—Robert Ocasio of New York; and treasurer—Jack Kelly of Arizona. Of course, all ISCET members are CETs. Bud Izen of California was appointed national training director of ISCET. The ISCET membership also unanimously endorsed the appointment of J. W. Williams to handle the administrative affairs.

August 17 through 24 in 1980 at the Galt House in Louisville, KY was chosen for the next annual convention of NESDA/ISCET.

Many meals were sponsored by companies who furnished the speakers. RCA treated everyone to an evening and western-type banquet at Old Tucson, a simulated pioneer town that is used for many movies.

NESDA is at 2708 West Berry Street, Fort Worth, TX 76109, and the phone number is (817) 921-9061. □

Reports from the test lab

Each report about an item of electronic test equipment is based on examination and operation of the device in the **ELECTRONIC SERVICING** laboratory. Personal observations about the performance, and details of new and useful features are spotlighted along with tips about using the equipment for best results.

By Carl Babcoke

Model 1479 oscilloscope from B&K-Precision has many advanced features including dual-trace operation, 30MHz vertical bandwidth, signal-delay line, triggered sweep with manual or automatic control and bright sharp traces. High sensitivity and a wide choice of sweep speeds along with flexible locking methods make the scope suitable for audio, TV, digital, 2-way radio and general circuit testing.

CRT features

Bright blue P31 phosphor with post-deflection of 4kV produces sharp traces of high brightness on

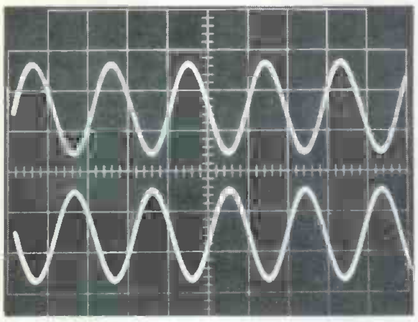


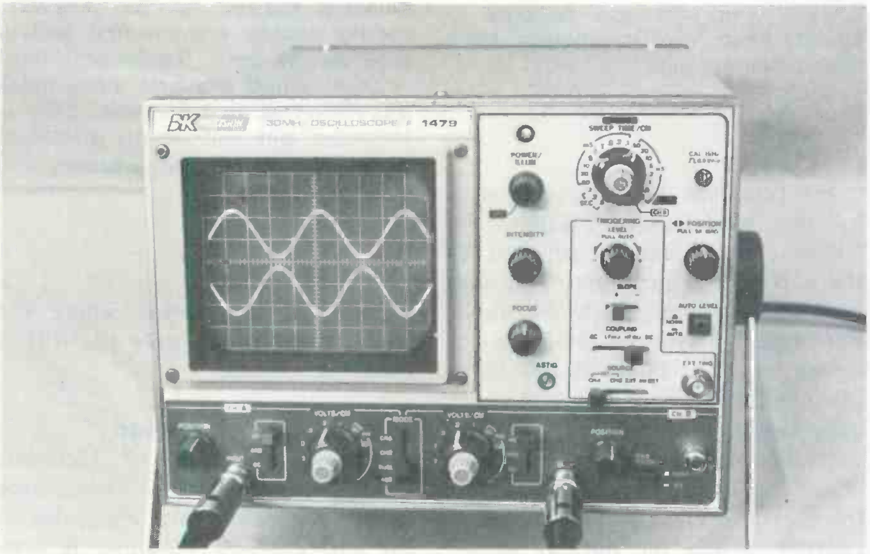
Figure 1 The graticule has full-size 8cmX10cm calibrations. Here is a typical waveform and graticule when the illumination is adjusted for maximum.

the 5.1-inch CRT. The external graticule has standard 8 x 10 centimeter squares plus smaller calibrations on the two center lines (Figure 1). A control on the on/off switch adjusts brightness of the graticule lines. The usual intensity and focus controls are provided along with a screwdriver-slotted astigmatic control that improves the focus at the edges.

Vertical

Response is rated from dc to 30MHz (at -3dB) with a rise time of 11.7nS for both vertical channels. Ten ranges (Figure 2) cover 5mV/cm to 5V/cm plus a variable uncalibrated control. With an X10 probe, the deflection is 50mV/cm to 50V/cm (or 400V for full height).

Each channel has a lever-type switch located between the volts/cm switch and the positioning control



B&K-Precision model 1479 is a new wide-band oscilloscope with many features making it an indispensable instrument for all types of service work.

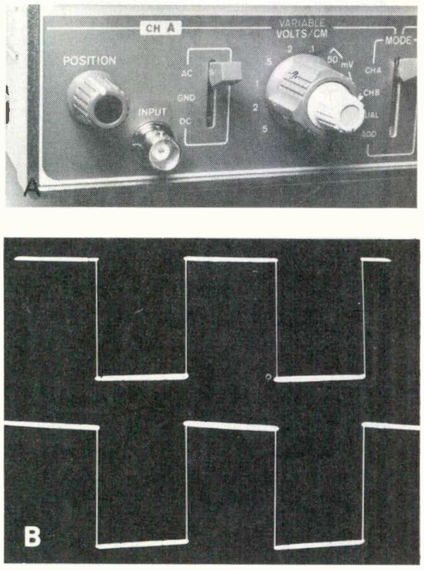


Figure 2 (A) Each channel has a lever-type ac/dc coupling switch that is convenient to operate. (B) Square waves of 20Hz had no tilt during dc-coupling operation. With the low-capacitance probe and ac coupling, the tilt at 20Hz is barely noticeable (bottom trace, indicating good low frequency response.

to provide a choice of ac or dc coupling to the input signal. The center "gnd" position disconnects the input signal and grounds the input to the vertical amplifier, thus preventing feedthrough from stray capacitance. These lever switches are more convenient to use than slide switches.

A signal-delay line is included in each vertical channel. Without these delay lines, the beginning edge of fast-rising pulses or square waves would be missing. Only high-performance lab scopes have this feature.

A 1000Hz square wave is provided at the calibrate jack for probe adjustments. (Two probes are furnished.) Remember, *only 10:1 low-capacitance functions need adjustments.* Do *not* adjust when the direct probe input is used. The trimmer capacitor is located at the scope end of the cable, as shown in Figure 3. Connect each probe in turn to the calibrate jack and adjust the trimmer for flat tops and bottoms on the square waves. The probe has an insulated hook for safe, convenient and dependable connections to the circuits under test.

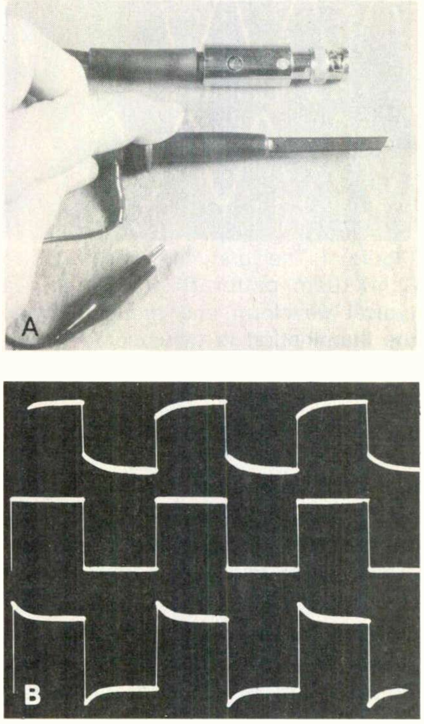


Figure 3 Two good-quality probes are supplied with the 1479 scope. A change from X1 to X10 attenuation is accomplished by removing part of the probe, rotating it 180° and reinstalling. The amount of attenuation is shown in a window. Better frequency response and easier adjustments were obtained by placing the trimmer at the scope connector. The trimmer screw is adjusted through a hole in a metal sleeve of the BNC connector (picture A). At each probe, the connecting hook is exposed when spring-loaded insulation is pulled back. (B) These waveforms illustrate right and wrong probe adjustments. Top trace shows insufficient compensation that reduces high frequencies; the center trace is correct, with tops and bottoms in straight lines; while the bottom trace shows overpeaking.

Six functions are made possible by the *mode* switch (Figure 4). Either channel can be selected by the *chB* or *chA* positions. The *dual* position connects both channels. For sweep times of 1mS/cm or slower, chopped mode at 200kHz is provided. Higher sweeps automatically switch the operation to alternate. The *add* position adds signals of both channels together into one trace. However, channel B has a polarity switch for normal or inverted phase, and when the inverted mode is selected, the *add* function

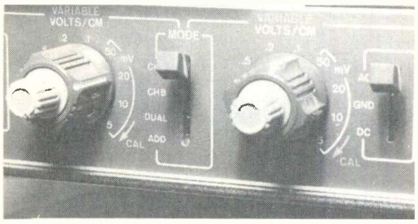
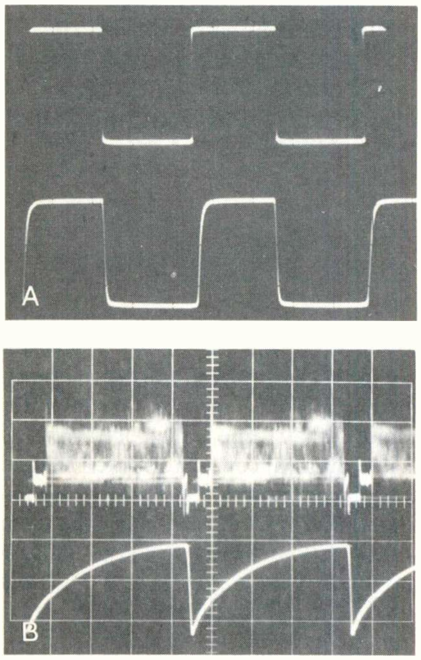


Figure 4 Six types of dual-trace operation can be selected by this mode switch and other control settings.



(A) Top trace shows 20kHz square waves, with 200kHz square waves below. The 20kHz waveform was very good, and it included the leading edge. However, the CRT mask obscured part of the first positive peak. The 200kHz square waves show some rounding (caused by the generator, not the scope), and the first leading edge can be seen. Signal-delay lines in both vertical channels allow those leading edges to be visible. This is important with pulses. (B) Dual-trace waveforms were sharp, bright and stable.

becomes a subtraction where the single trace shows only the difference.

X-Y operation

For vector phase of Lissajous figure operation, the sweep/time switch is rotated fully clockwise to the *chB* position. Channel A continues to operate as before, but the horizontal sweep is driven by the signal coming through channel B.

This type of X-Y operation is far superior to the old method of feeding an external signal direct to the horizontal-sweep amplifiers. The volts/cm switch, variable gain and positioning operate as before with correct calibration (except for the channel B positioning control which now moves the trace horizontally.) There is one minor limitation: Since the same horizontal-amplifier stages handle the new channel B deflection, the frequency response extends only to 2MHz at -3dB. But that response is much better than the 200kHz of earlier circuits.

Horizontal sweep times

A wide-band scope should have an equally wide selection of sweep times, and the model 1479 B&K-Precision does. It provides from 0.5S/cm (taking 5 seconds for one trace) to 0.2μS/cm (see Figure 5). When the 5X magnifier switch is pulled out, the waveform becomes five-times wider, and this provides the equivalent of 0.04μS (or 40nS/cm) fast sweep.

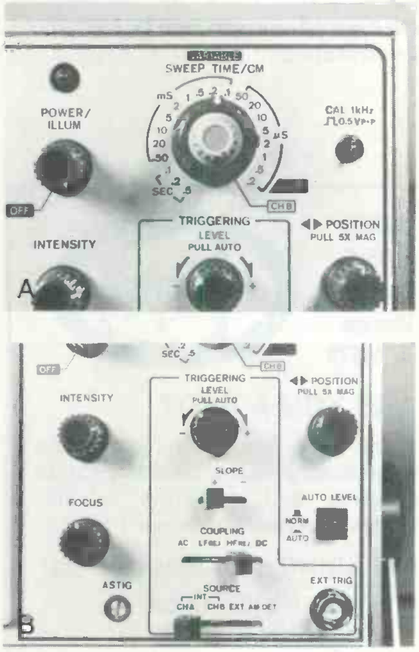


Figure 5 (A) The sweep-time switch selected horizontal trace times from 0.5S/cm to 0.2μS/cm. A concentric control permits the sweep times to be reduced gradually. For correct calibration, this variable knob must be turned completely clockwise. Pulling out the horizontal-position knob widens the sweep five times, thus giving the effect of one-fifth sweep time. (B) All triggering controls are inside this area which has a line around it. One unusual feature is the AM detector (AM DET) position of the source switch. This permits a stable display of any modulated RF carrier by locking to the audio that's recovered from this same signal.

Triggering (locking)

As explained previously in other scope articles, the locking of a triggered scope actually is produced by triggering at the *same* point of a waveform. When the vertical waveform reaches the level selected by the triggering controls, the horizontal deflection begins. It sweeps from left to right across the screen and shows whatever waveform is there during that time. The beam retraces to the left, but the deflection then is stopped until triggered again by the same voltage level in the vertical waveform.

Basic triggered scopes show a horizontal trace when properly triggered, but no waveform or horizontal line when *not* triggered correctly. Many of the newer scopes provide a way for the horizontal trace to be seen even when it is not locked. Model 1479 has two such options.

The triggering level control can be rotated to start the trace at the desired point on either the positive or negative peak of the vertical signal. No trace is seen unless a vertical signal is present and the sweep is triggered correctly. When the knob is pulled out, however, the sweep operates even without a signal or locking.

In addition, an *auto level* button with normal and automatic positions is provided. At the normal position, triggering is determined by the triggering-level control, described before. When the button is pushed in to the auto position, triggering occurs at the average-voltage point of the vertical waveform (see Figure 5B).

Sync controls

Other controls are needed to select the source of triggering sync, to provide the best polarity, and to give any desired sync filtering.

Polarity is selected by the *slope* switch. Some waveforms lock better with one polarity than the other. With some waveforms, the horizontal position moves slightly according to the polarity selected.

A *source* switch is located near the bottom of the triggering section. It selects triggering sync from these sources: either vertical channel; a signal from the external-triggering jack; or from the AM detector that is provided internally for locking to the *modulation* of an RF carrier.

Few scopes have an AM detector for the sync, but it is a valuable feature for observing the modulation of a 27MHz CB radio carrier without the bother of connecting to the radio's audio circuit.

The *coupling* lever switch gives a choice of ac sync coupling, ac with low frequencies attenuated, ac with high frequencies attenuated, or dc coupling. These options produce better locking with some problem signals.

Incidentally, the 1479 is said to trigger on signals up to 50MHz.

Comments

Two physical features of the 1479 should be mentioned with approval. Four slotted plastic pieces are fastened to corners of the back panel. These are grooved so the power cable can be coiled there securely when the scope is not in use. Also, they serve as feet when the instrument is placed with the scope screen facing up, for storage or carrying.

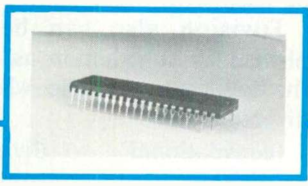
The carrying handle has finger grooves, and it functions also as a tilt stand. Both knobs are pressed toward the scope cabinet to release the tilt stand, which then can be moved to the desired position. After the knobs are released, the tilt stand locks in that position.

Addition or subtraction of the two vertical waveforms into one trace is a feature that can be very valuable for certain tests. The addition mode allows the summing of two signals without any necessity of floating the scope between two ungrounded points. One example is the showing of true base/emitter waveforms by combining base-to-ground with emitter-to-ground waveforms. Subtraction of two signals can reveal any waveform change (such as distortion) between signal source and the output of an amplifier.

Stability of the model 1479 was outstanding. No drifting of vertical gain, horizontal time or brightness was noticed. Even the horizontal base lines had minimal drifting.

All important power supplies are regulated. This allows full brightness to be achieved without any blooming (any change of trace size upsets calibration accuracy).

In summary, the B&K-Precision model 1479 is a new-generation wide-band scope with excellent performance. ☐



Microprocessor mathematics

By Jack Webster

Subtraction, multiplication and division are performed by *addition* in the microprocessor arithmetic-logic unit (ALU).

In previous articles, microprocessor terminology was discussed along with descriptions of each basic section and function. Although this article is the last of the series, additional information will be presented at irregular intervals.

Binary addition

A previous discussion of binary arithmetic is continued here. As stated last month, there are only four possible additions for binary numbers (highs and lows, or ones and zeros). These are the four forms:

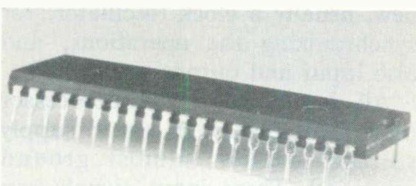
0	0	1	1
+0	+1	+0	+1
0	1	1	10

Larger numbers are added by combining these four forms.

In the case of 1+1, a zero is marked on the paper and the 1 is carried to the next step, as shown in these examples:

Decimal addition

(+1)	3+9 = 12
13	1 is carried
+ 9	2 is marked down
22	



Shown approximately life-size is an 8080 N-channel 40-pin 8-bit microprocessor. The chip inside is even smaller.

Binary addition

(+1)	
1 1 0 1	1+1 = 10
+1 0 0 1	1 is carried
1 0 1 1 0	← 0 is marked down

binary	decimal
1 1 1	7
+1 1 1	+7
1 1 1 0	14

The second binary addition has 1+1 = 10 in the right-hand column. The zero is marked down and the one is carried for addition to the two ones already in the next column. They are added as 1+1 = 10 and 10+1 = 11, so the one is marked down and the other one is carried. Again, the same addition happens in the left-hand column. This can be illustrated by the following:

binary	decimal
1 1 0 1	13
1 0 1 1	+11
1 1 0 0 0	24

1 + 1 = 10; mark 0 and carry 1
1 + 0 + 1 = 10; mark 0 and carry 1
1 + 1 + 0 = 10; mark 0 and carry 1
1 + 1 + 1 = 11 (as shown before)

Binary 11000 equals decimal 16 + 8 + 0 + 0 + 0 = 24.

Binary subtraction

One way to accomplish binary subtraction is to start with the same four examples of addition but modified as shown:

0	1	1	0	(minuend)
-0	-0	-1	-1	(subtrahend)
0	1	0	0*	

*Note: borrow a 1 from the next column to the left.

When the subtrahend is larger than the minuend, it is necessary to borrow a 1 from the previous column. This is similar to the traditional method of subtracting decimal numbers, as shown in the next example.

26	(minuend)
-19	(subtrahend)
7	

The 9 in the right-hand column is larger than the 6 in the minuend, so it cannot be subtracted in the usual way. Instead, a 1 is borrowed from the next column, and the problem has the following intermediate form:

(-1)	borrowed 1
2	16
-1	- 9
0	7

The same procedure can be used for binary numbers also, as shown by a simple example.

binary	decimal
10	2
-01	-1
01	1

Microprocessors

After borrowing 1 from the second column, the subtraction problem appears this way:

	binary	
(-1) ←		
1	borrowed	10
-0		-1
0		1

The answer can be checked by adding the difference to the subtrahend which produces the original minuend. For example in this problem, the difference (1) plus the subtrahend (1) equals the 10 minuend. Or, 1 + 1 = 10 in binary.

Complements

In the September microprocessor article were examples of subtracting decimal numbers by adding certain numbers and their mathematical complements.

Similar computations can be done with digital numbers, but first a definition of digital complements must be presented. The one's complement of a binary number is obtained by changing all zeros to ones and also changing all ones to zeros, as shown in this example:

binary number	0 1 1 0 1 0 1 1
one's complement	1 0 0 1 0 1 0 0

Incidentally, the one's complement at one time was used to represent negative numbers. The left-hand digit in an 8-bit word was used to represent the positive or negative sign of that number.

For example, the number +7 was represented by **0** 0000111. The one's complement (**1** 1111000) of that number represents -7. The left-hand digit is called the **m**ost **s**ignificant **b**it (MSB), and the number is positive when the bit is 0 and it is negative when this bit is 1.

The two's complement of a number is found by taking the one's complement and adding a binary 1. In the previous example, the 8-bit word for number 7 is 0 0000111. This is the sequence for obtaining the one's and two's complements:

7 decimal is	0 0000111
one's complement is	1 1111000
add binary 1	+1
two's complement	1 1111001

Subtraction with two's complement

Microprocessors do not have any circuitry for subtracting numbers directly. Instead, the subtracting is performed by *adding* the two's complement of the subtrahend.

For example, 11 is subtracted from 19 first in the usual binary fashion, followed by subtraction by two's complement, as shown here:

conventional binary	decimal
00010011	19
-00001011	-11
00001000	8

adding two's complement

00010011	(decimal 19)
+11110101	(two's complement of 11)
100001000	(decimal 8)

Note: discard last carry

Microprocessor circuitry can be simplified greatly by performing subtraction with binary addition as illustrated. Actually, the two's complement of a number is the microprocessor's method of writing negative numbers. In other words, 00001011 is the 8-digit word for decimal +11, and the 11110101 two's complement is the 8-digit word for -11. Adding a -11 is the same as subtracting a +11.

Multiplication and division

Division and multiplication also can be performed by addition. For example, both conventional and multiplication-by-addition are illustrated next for the problem of multiplying 17 by 7.

conventional multiplication	multiplication by addition
17	17
X 7	+ 17
	+ 17
	+ 17
	+ 17
	+ 17
	+ 17
119	119

Essentially the same procedure can be used with binary numbers.

Division also can be accomplished by subtraction as shown in the following example where 64 is divided by 16.

conventional division	division by subtraction	
16) 64 = 4	64	(1)
	- 16	
	48	(2)
	- 16	
	32	(3)
	- 16	
	16	(4)
	- 16	
	00	

After 16 is subtracted from 64 four times, the remainder is 0; therefore, 64 divided by 16 equals 4.

Microprocessors do not subtract numbers. Instead, they add the two's complements. If this problem had been solved with binary rather than decimal numbers, the two's complement of 16 could be added for 4 times to obtain a 00000000 reading.

Performing subtraction, division and multiplication by addition would be very inefficient if done by a human. But digital circuits calculate so rapidly that the extra time required by using addition for everything is of little consequence. This concession allows the design of ALUs to be less complicated.

Summary

Various articles in this series have explained that a typical microprocessor IC has an arithmetic-logic unit (ALU) for computations, a section of read-only memory (ROM) for permanently stored date, some random-access memory (RAM) that can receive and store data which later can be used or replaced with new, usually a clock (oscillator) for synchronizing the operations, and also input and output ports.

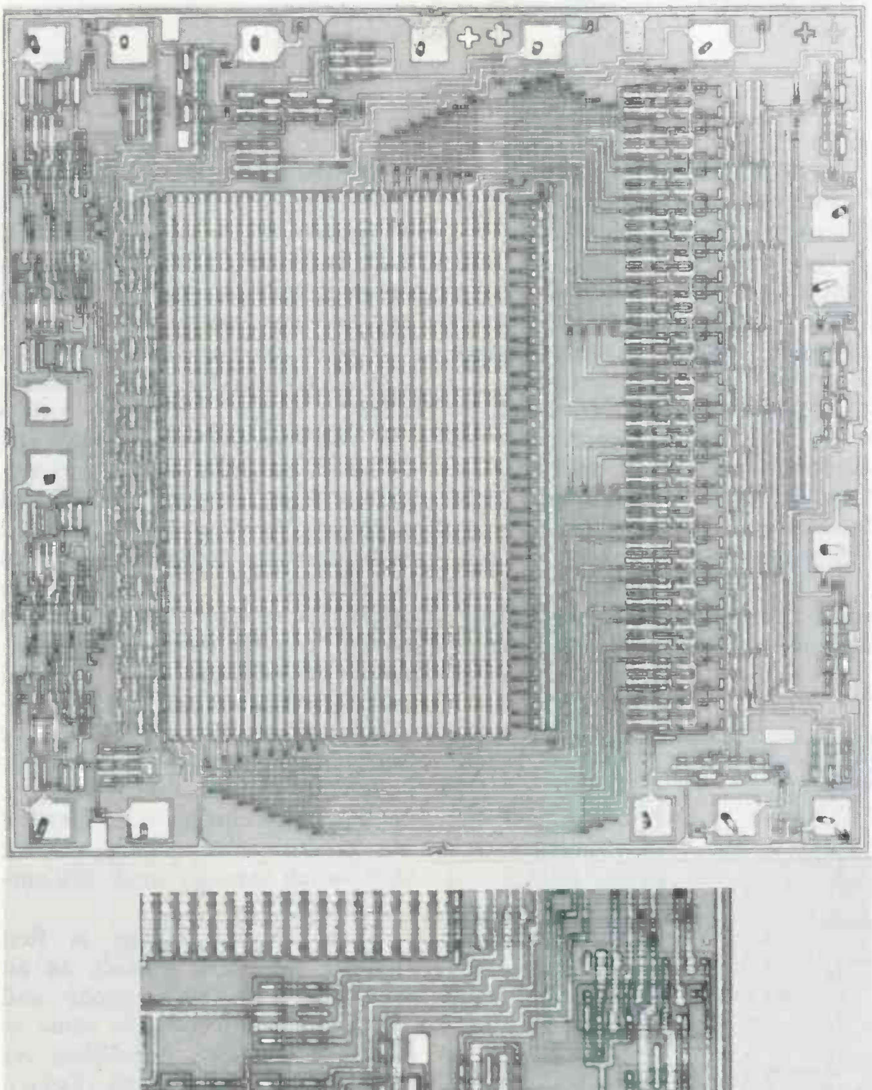
All inputs to a microprocessor must be either high (near supply voltage) or low (almost ground potential). These input signals can be dc digital pulses or dc steady voltages made high or low by external switches. No varying or intermediate-voltage signals should ever be applied.

Likewise, all outputs from each microprocessor are highs or lows that can be either patterns of dc digital pulses or steady high and low dc voltages. These outputs can activate external circuitry that operates LEDs, relays or other peripheral equipment.

If a microprocessor is called on to accept an input from an analog (varying-amplitude) signal, an analog-to-digital converter must be used as an interface. Similarly, a digital-to-analog converter can be employed at some output ports to recover the analog equivalent of a digital signal from the microprocessor.

A microprocessor system that might include additional memory and support ICs on a module or circuit board plus any related input and output equipment is called "hardware." Manuals and programming sequences for microprocessor or computer operation are known as "software."

The cost of developing the software and debugging it is far more expensive, in many cases, than the price of the microprocessor equipment alone. This unique unbalance of costs occurs because *microprocessors are general-purpose devices.* They are extremely versatile, but do not accomplish anything without outside help.



For the Motorola model MCM1452 1024-bit Read-Only Memory (ROM), one picture shows the entire IC chip, which is about a quarter-inch square. The other is a 27-times enlargement of one corner of the same chip. (*Courtesy of Motorola*)

Therefore, many of the tasks assigned to microprocessors utilize only a small percentage of their total resources. This probably is true of the microprocessors used in TVs and other home-entertainment equipment; and it is fortunate, otherwise the servicing would be nearly impossible.

Look at one example. Suppose a certain microprocessor had a 1056-bit ROM that needed testing. Imagine manually switching 8-bit signals as inputs and monitoring the correct outputs for 1056 separate tests! Of course, testing the ALU and RAM sections would require similar excessive times. IC manufacturers have special test equipment that makes all checks automatically. Such equipment is too expensive for troubleshooting in the field.

Microprocessors in TVs

Practical in-circuit tests of microprocessors used in the tuner-control sections of newer color TVs are not as difficult as previously stated. Probably most functions will operate normally, thus allowing more time for the few items remaining.

Generally, the techniques will be similar to those used now with other ICs. Make certain the supply voltage (or voltages) is correct and without excessive hash. Check for the proper input digital signals. And finally, verify the absence of the normal output highs and lows. If no wrong conditions are found (except the lack of output), then replace the IC.

After more of these microprocessor-controlled color receivers are in the field, **Electronic Servicing** will supply its readers with troubleshooting procedures for specific models. □

Quick tests of thyristor controls

By Wayne Lemons

Thyristors have become popular as controls for both consumer and industrial electronic gear. A thyristor is the solid-state equivalent of a gas-filled thyratron tube. It even works the same. A small gating voltage turns on the thyristor, and it continues to conduct until anode current drops below a certain value.

Best known among thyristor devices in control circuits are the silicon-controlled rectifier (SCR) and the TRIAC. The latter acts as (and is diagrammed as) two SCRs connected in parallel but facing in opposite directions.

Inside an SCR circuit

Internally, an SCR contains four alternating layers of silicon; two N-type and two P-type. An SCR acts much like a regular silicon diode, except it will not conduct at all until a small activating voltage is applied to its gate element.

A positive trigger (gate) voltage allows the diode to conduct in its forward direction. It continues to conduct even when the gate voltage is removed. This action can be compared to a door with a latch; the latch, once released, has no more control over the door's opening and closing until the door is relatched. To cut off an SCR, forward current through it must be reduced to a low value or zero. At that time the SCR diode again becomes an open circuit and only the gate has control.

SCR action may be compared in some ways to the current-locking relay of Figure 1. Closing switch PB1 energizes the relay through coil L1. With the relay contacts closed, current flows through both the load *and* coil L2. Magnetism from L2 holds the relay energized, regardless of whether PB1 stays closed or open. To release the relay, load current can be reduced to a low value, or PB2 can be depressed momentarily to short out L2.

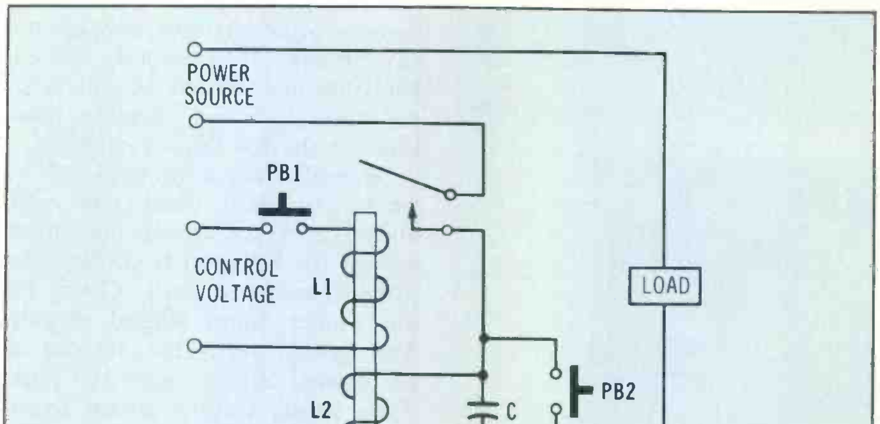


Figure 1 An SCR may be compared to a current-locking relay that stays on after being activated, then unlatches when the hold-in coil is shorted out.

Figure 2 shows an SCR in a dc circuit. In this application its function is similar to what Figure 1 depicts. Gate current is so small it can control even a high-current SCR switch through small low-current wiring.

When the dc voltage is first applied, the SCR appears as an open circuit between anode and cathode. The effect is the same as an open switch. Assuming its forward breakover voltage (V_{BOO}) and peak reverse voltage (PRV) ratings are high enough, the SCR remains an open circuit.

However, a small current applied to the gate terminal (by a closed PB1) turns on the SCR. Resistance between anode and cathode becomes very low. In other words, the SCR reacts almost identically to a regular silicon diode. Since the cathode-anode junction is forward-biased by the dc power source, current flows through the SCR to the load. Once this occurs, the load current "holds" the SCR in conduction. Any change in *gate* voltage or current now has no effect.

To stop the flow, current through the SCR must somehow be reduced to a point where there is not enough anode current to hold the SCR on. A temporary short from anode to cathode, such as with a pushbutton, will unlatch the SCR. It resumes being an open switch.

Transistor regenerative switch

The latching feature of an SCR results from internal structuring of N and P silicon layers. In some industrial controls, transistors are connected as latches or regenerative switches. Internal workings of such circuits resemble those in SCR switches.

Figure 3 illustrates one simple regenerative switch. Q1 is an NPN transistor; Q2, a PNP. This stage can control considerable power if a suitable high-current transistor is chosen for Q2. Q1 needs only to be large enough to dissipate current drawn by R3 and R4.

First consider the gate open. No current flows, despite a positive voltage applied to Vcc. This is because bias for Q1 comes from the collector of Q2 through R2. Conversely, bias for Q2 develops in the collector circuit of Q1. With neither transistor conducting, neither one has bias.

However, a positive voltage applied to the gate terminal, even momentarily, initiates current flow in Q1. Emitter-collector current in Q1 flows through the emitter-base junction of Q2. This bias starts current flowing in Q2. With Q2 biased on, current starts flowing through the load. Positive voltage at the collector of Q2 feeds through R2 to the base of Q1. Q1 conducts even more. Almost instantly, therefore, both Q1 and Q2 saturate, and full Vcc voltage reaches the load. The gate no longer has control, because positive bias through R2 holds both transistors in saturation. The stage is *latched.*

To unlatch the stage, as with an SCR, current through the bias circuits must be reduced to a point where voltage across the load (at the collector of Q2) is insufficient to keep Q1 biased on (through R2). Once Q1 stops conducting, bias for Q2 disappears and halts conduction there too. The stage unlatches. The unlatching action can be accomplished by removing or drastically reducing Vcc, or by forcing either transistor to zero bias—for example with a momentary pushbutton between base and emitter.

Unlike an SCR, this regenerative switch may also be turned off by a negative gate pulse sufficient to cut off Q1 momentarily. This negative pulse, however, must be of considerably larger amplitude than the positive pulse on the gate required for latching.

Another interesting facet of this switch is that it may be gated on by a momentary short *across* either Q1 or Q2 (collector-to-emitter). Also, because of its gain, the stage triggers easily, even by a mere touch at the gate terminal. To prevent erratic triggering, gate impedance must be kept as low as possible. Some designers shunt a resistor (R5) between gate and common; and, if only dc control is expected, a designer may add a capacitor to common from the base of Q1.

How an SCR handles ac

Dc voltage drop across a conduct-

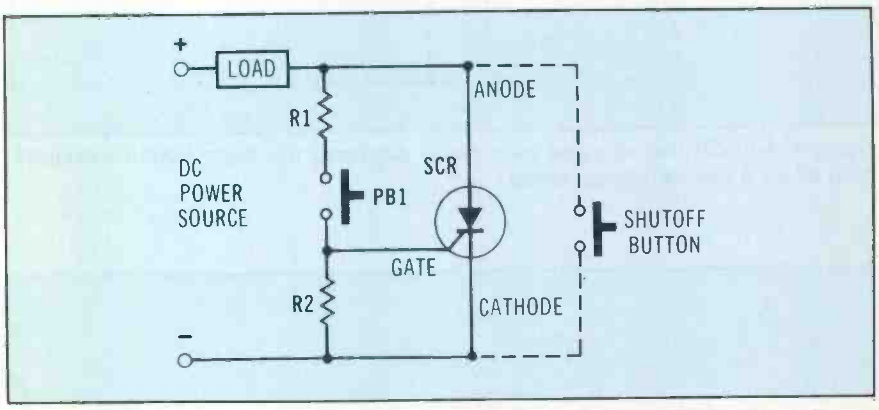


Figure 2 SCR in a dc circuit does not conduct until gate voltage turns it on, despite forward cathode-anode bias.

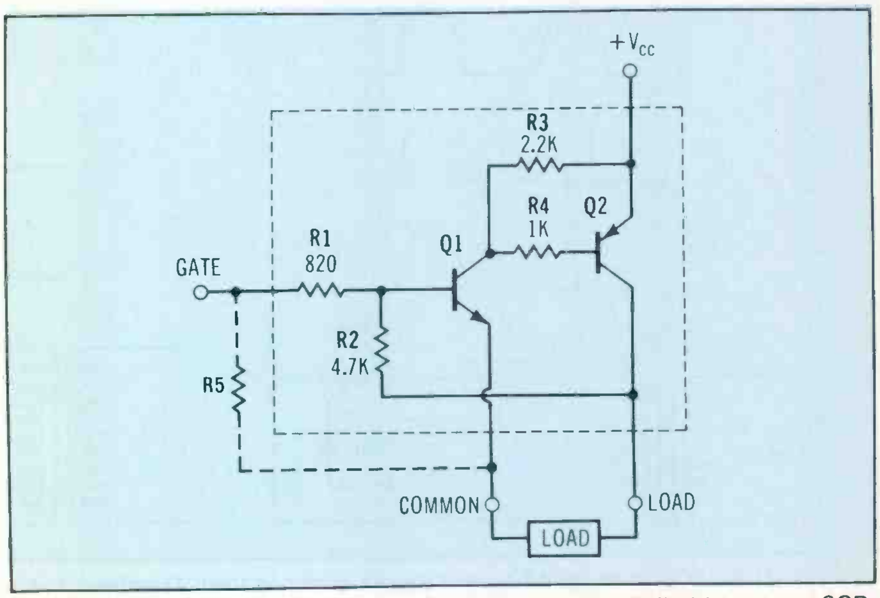


Figure 3 A transistor regenerative switch bears many similarities to an SCR. Resistors' values are typical for Vcc of 6V to 12V.

ing SCR typically measures less than 1V. But an SCR behaves as a diode with ac, even when fully turned on. It conducts only on forward half cycles, the same as a regular silicon diode (Figure 4). If the device or load to be controlled operates satisfactorily from pulsed dc, variable control (motor speed, lamp brightness) can be accomplished as well as on-off action.

Consider speed control of a dc motor, for example. When ac is applied to the SCR, it automatically unlatches 60 times per second because of the reversing polarity. If the gate pulse is also derived from the ac line, the SCR can be triggered on only during a portion of each power cycle. This reduces the effective power supplied to the load. In the case of a motor, limiting the average power reduces the speed. If a lamp is the load, lowering power dims the lamp.

Figure 5A shows a simple method of securing gate control from the ac power line. With small values of R, the gate turns the SCR fully on and the SCR operates as a simple rectifier (waveform 1). As R is increased, the gate receives less current, so the SCR does not turn on at the beginning of the cycle, but later. Hence the SCR only conducts current during a portion of the half-cycle (waveform 2). Less than half of the applied ac power reaches the load.

As R is increased further, a point occurs where the gate turns on only

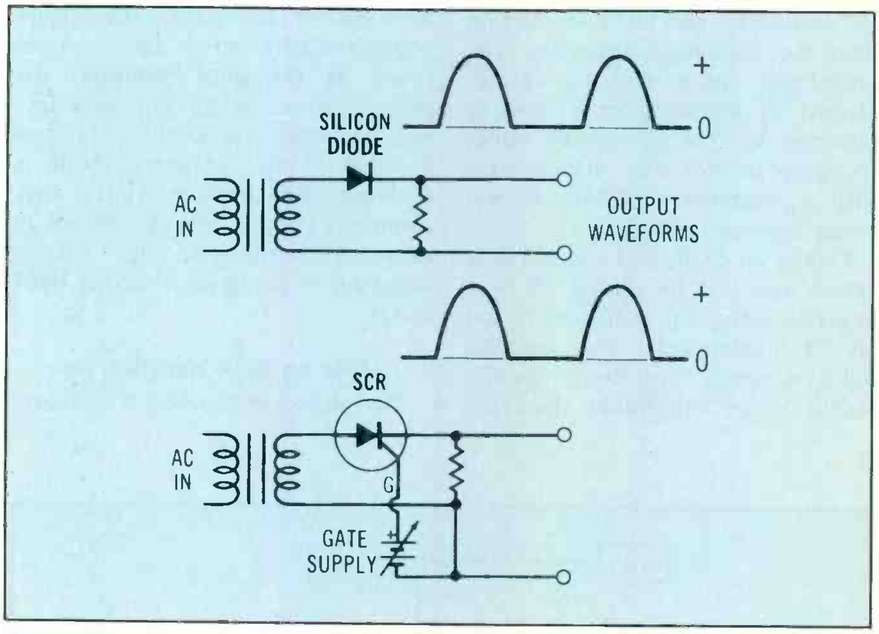


Figure 4 An SCR that is gated on steadily produces the same output waveform from ac as a regular silicon diode.

Figure 5 (A) An SCR that's gated by ac controls power to load. Waveform 1 is half-cycle, 2 is less than half-cycle, 3 is quarter-cycle of applied current. This circuit is limited to a control range between ½ and ¼ (90°) of cycle. In B, adding a capacitor allows control over the entire half-cycle (180°).

at the very peak (90° point) of each ac cycle, and only the remaining quarter-cycle reaches the load (waveform 3). Increasing the resistance beyond this point leaves the SCR turned off. Unless the gate receives sufficient current to turn on at the peak, it simply stays off during the downward slope of the sine wave. So no current at all goes to the load.

In some circuits 90° of control may be useful or even desirable. But for most operations, 180° of control works better. Fortunately, reasonably good 180° control can be obtained with rather simple circuitry.

Figure 5B shows a single capacitor added. Essentially, the capacitor takes a certain time to charge through R. Gate current is delayed by the time constant of R and C. Triggering takes place later in the half-cycle, since at a particular setting of R the gate capacitor will not have charged sufficiently to trigger the gate until sometime after the downward slope of the sine wave has reached the anode of the SCR (waveform 4). Thus the SCR may be triggered on during only a tiny portion of the cycle. This delivers smooth control from an entire half-cycle all the way to virtually zero. Hence the term *180° control.*

The diode in the gating circuit prevents negative pulses from reaching the gate. A high enough negative pulse could cause breakover in the gate-cathode structure, bringing damage or erratic operation. In some SCR controls, a DIAC (discussed later) is used instead.

Sometimes a load is placed at the cathode of an SCR rather than at the anode, as in Figure 6. This provides some feedback control of motor speed. Since a rotating motor develops a certain counter-emf, the speed of the motor creates at the SCR cathode a proportionate bias that must be overcome by the gate trigger voltage. This alters the point on the ac cycle at which the SCR fires. If the motor slows down the counter-emf is less and the SCR fires sooner. The converse occurs if the motor speeds up. The motor-produced bias thus tends to hold the speed stable under varying mechanical loads on the motor shaft.

Resistor R1 and capacitor C2 may be found in SCR or TRIAC circuits controlling an inductive load. Their purpose is to integrate any kickback voltage from the inductance and prevent erratic firing of the SCR. An SCR might also be triggered randomly by transients, especially if the gate impedance is high or if interference spikes are allowed to reach the gate. DIACs or neon lamps often are placed in gate circuits to prevent signals of lower voltage than that of the trigger pulse from reaching the gate.

Many high-power SCRs incorporate an internal ohmic path between the gate and cathode, a construction sometimes called *shorted emitter*. The low impedance thus achieved minimizes any tendency to self-triggering in the high-power circuit.

SCR testing

An ohmmeter can help you find most defective SCRs either in or out of the circuit. Common troubles are anode-to-cathode shorts, opens, and—less frequently—failure to trigger or failure to hold once triggered. When testing an SCR, use the Rx1 range of your VOM.

You should be aware of your ohmmeter-lead biasing. Does the red lead of the ohmmeter connect to positive voltage inside the instrument, or to negative? Figure 7 demonstrates how to check your meter. If the main or red probe causes conduction when connected to the anode, the ohmmeter is said to be of forward polarity. If the black or common lead on the diode anode causes conduction, as in Figure 7B, the ohmmeter is reverse polarity.

You also need to know whether your ohmmeter is one of the

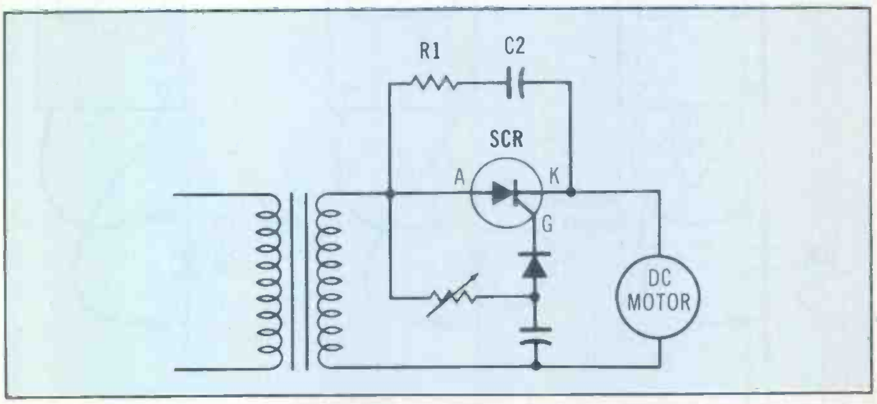


Figure 6 In some speed controls, the motor might be connected in the cathode circuit of the SCR. R1 and C1 prevent self-triggering of the SCR due to inductive-load kickbacks.

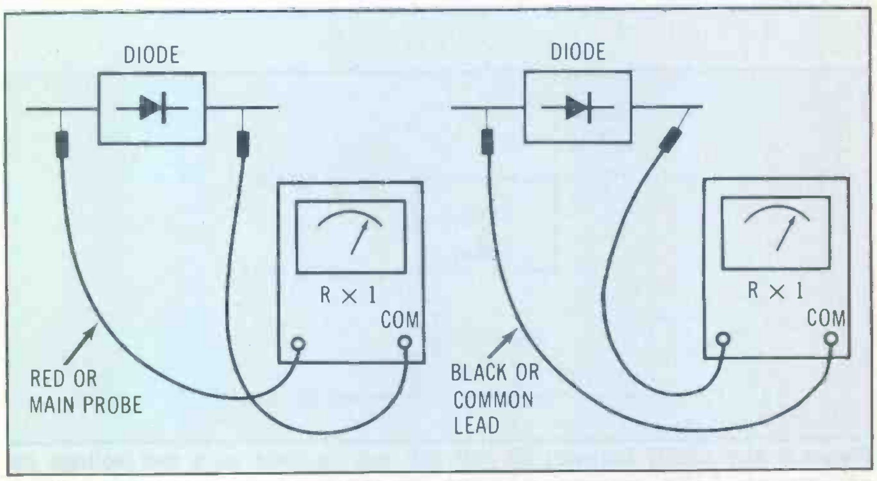


Figure 7 Use a diode to reveal polarity of voltage coming from the leads of your ohmmeter.

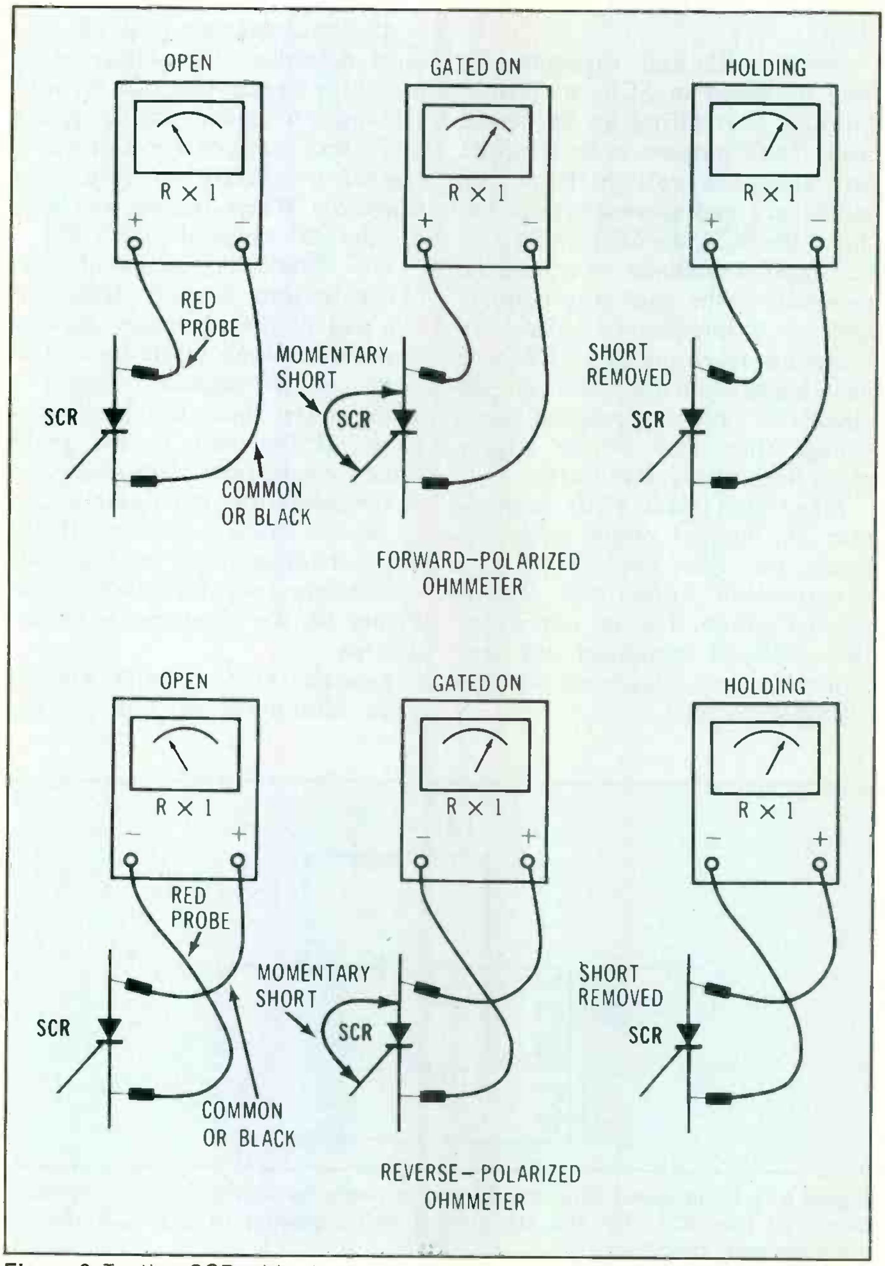


Figure 8 Testing SCR with ohmmeter of either polarity. Clue: Always gate SCR from anode voltage.

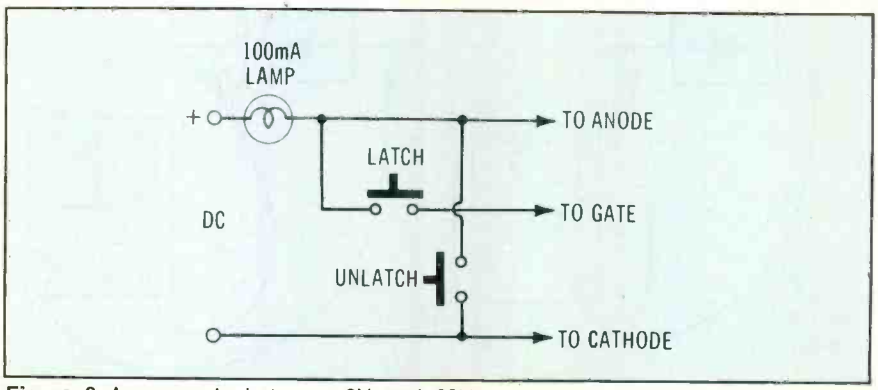


Figure 9 Any supply between 6V and 28V can be used as a test voltage for higher-power SCRs, provided the lamp has the same rating and draws about 100mA.

extremely sensitive ones that uses only 1.5V for the Rx1 ohmmeter scale. That's not enough ohmmeter "power" to check some SCRs.

A small, low wattage SCR generally exhibits diode characteristics between the gate and cathode. That is, an ohmmeter measures high resistance in one direction and low when the ohmmeter leads are reversed. However, this is not true of many larger SCRs. Nearly all of them show between gate and cathode an internal resistance low enough to swamp out any ohmmeter other than the resistance itself—typically less than 15 Ω.

No normal SCR should cause any *anode-to-cathode* reading less than infinity on the Rx1 scale. Ohmmeter polarity should make no difference in the anode-cathode reading. That is, *the* SCR *should read open* **unless** *it is gated.*

Here's how to check an SCR for gating (triggering) and its ability to hold. Connect the positive ohmmeter lead to the anode terminal of the SCR, and the negative lead to cathode, as in Figure 8. Momentarily clip a jumper between the anode and gate of the SCR. The ohmmeter (Rx1) should then indicate forward conduction. Once begun, forward conduction should continue, even after the gate jumper is disconnected. To stop conduction, remove one ohmmeter lead from the SCR terminal. Repeat the test.

Figure 8 shows the procedure for both forward- and reverse-polarized ohmmeters. If the SCR triggers on but will not hold when gate is opened, don't conclude immediately that the SCR is faulty. Meter current may not be enough to hold the SCR in conduction. Some larger SCRs may require more than 50mA of holding current, although most will hold with 25mA or less. Small SCRs need only 1mA of current—or even less.

The simple circuit in Figure 9 illustrates go/no-go testing of larger SCRs that require more hold current than a standard ohmmeter supplies. Any convenient dc above 6V is suitable if you have a matching lamp. The lamp should light to full brightness at 100mA or so. No resistor is needed in the gate circuit since anode voltage drops to less than 1V when the SCR fires. A good SCR should fire upon brief contact at the latch switch. The unlatch button momentarily shorts across the SCR, dropping hold current to zero, which turns off the SCR. The test sequence should be repeated a couple of times.

Infrequently, an SCR tests normal on low-voltage dc but performs erratically at regular circuit voltage. It might even cause fuses or circuit breakers to blow.

This may be due to the forward breakover voltage (V_{BOO}) being exceeded, either because the SCR is defective or because an incorrect replacement has been chosen. At some critical forward voltage, any SCR will self-trigger, even with gate voltage at zero. Any pulse or transient that momentarily exceeds this voltage can fire the SCR.

An SCR can be checked for forward breakover voltage using the method in Figure 10 (or a similar one). For test voltages up to 400V or so, a 10k (5W) series resistor limits the current enough for short-cycle testing. Advance the dc power supply voltage slowly while watching the voltmeter. When the actual V_{BOO} is reached, the SCR should fire and voltmeter reading should drop to near zero.

Also, you can determine the peak reverse voltage (PRV) of the SCR by reversing the SCR leads and repeating the previous sequence.

If power is removed and the dc path opened between anode and cathode (perhaps by removing a fuse or disconnecting one end of the load), ohmmeter and low-voltage lamp tests become valid in many SCR circuits. For greater safety, however, disconnect any two leads of the SCR before tests are made—or after in-circuit testing proves inconclusive. *Breakover tests should preferably be made with all three leads of the SCR disconnected* (in other words, out-of-circuit).

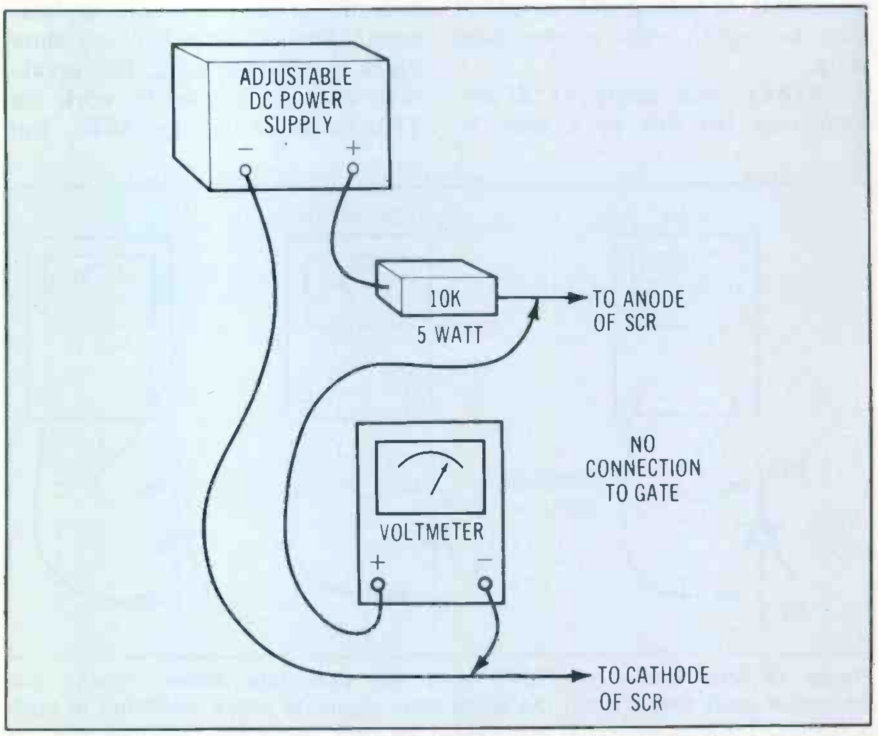


Figure 10 Testing SCR breakover voltage. For testing reverse breakover, connect positive lead of supply to SCR cathode and the negative lead to anode.

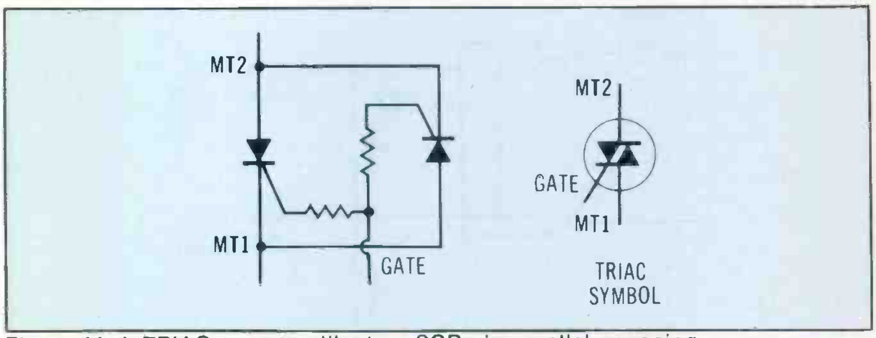


Figure 11 A TRIAC operates like two SCRs in parallel-opposing.

The TRIAC

Basically, a TRIAC comprises two SCRs in parallel but hooked in opposite polarity. Figure 11 shows the circuit equivalent and the TRIAC symbol. In fact, if the gate circuits were properly isolated with resistors or diodes, two SCRs could be connected to switch ac power the same as a TRIAC does.

A TRIAC has three terminals, the same as an SCR. But, unlike an SCR, a TRIAC carries no cathode lead to the outside. Instead a TRIAC exposes two anode terminals and a gate terminal. The anodes are labeled Anode 1 and 2 or Main Terminal (MT) 1 or 2.

With an ohmmeter, a TRIAC may at first seem to test the same as an SCR. You find low resistance (but no diode action) between anode 1 and the gate. You should measure high resistance between anode 2 and the gate, and high resistance between the two anodes.

But there's a significant operational difference. A TRIAC, because it's designed for full-wave switching of ac, can be triggered (gated) by *either* a positive or negative pulse. An SCR can be triggered only by a positive voltage.

Figure 12 shows how to test a TRIAC with your ohmmeter. Note that, regardless of meter-lead polarity, trigger for the gate must be taken from anode 2 or main terminal 2. This proves that a TRIAC gate can be triggered with either polarity of voltage.

As with SCRs, larger TRIACs might not "hold" when tested with an ohmmeter. The circuit in Figure 9 can be modified to test these TRIACs. Just add a reversing switch, as in Figure 13. Again, any reasonable dc voltage (6V or more) may be used, with a matching lamp.

TRIACs, the same as SCRs, sometimes fail due to a shift in breakover voltage characteristic (or because of an incorrect replacement). Such failures will not show up in low-voltage tests. The breakover tests of Figure 10 work for TRIACs as well as for SCRs. But with TRIACs, the tests should be made both ways; exchange polarities between MT1 and MT2, just to be sure the device triggers in both directions.

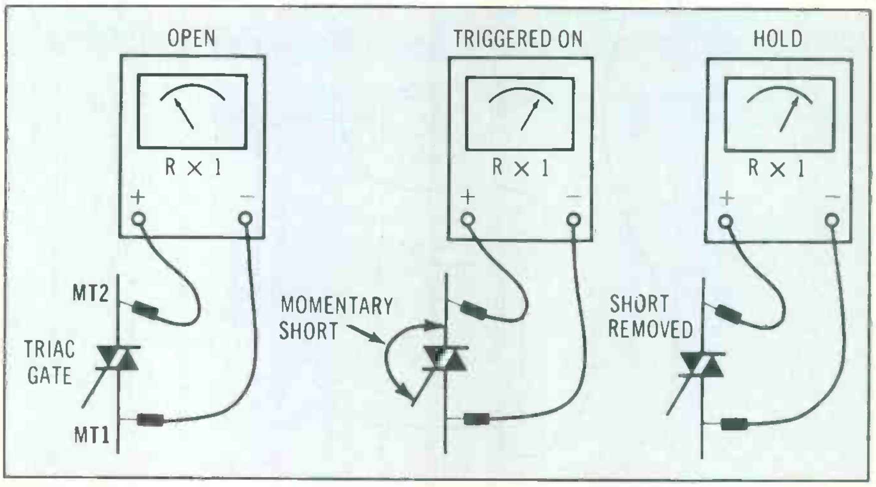


Figure 12 After testing a TRIAC with the procedure above, reverse the ohmmeter leads and perform the same tests again, to check operation in both polarities. The ohmmeter Rx1 scale must be used, to provide sufficient holding current.

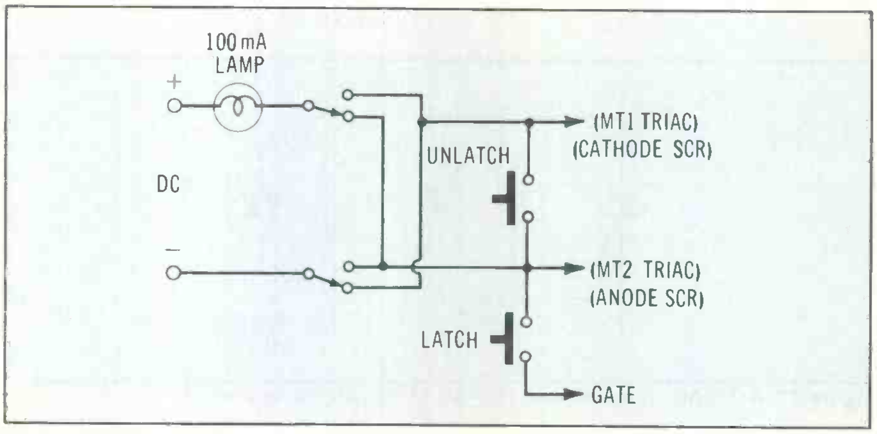


Figure 13 For checking both TRIACs and SCRs, add a DPDT switch. Test all TRIACs in both positions.

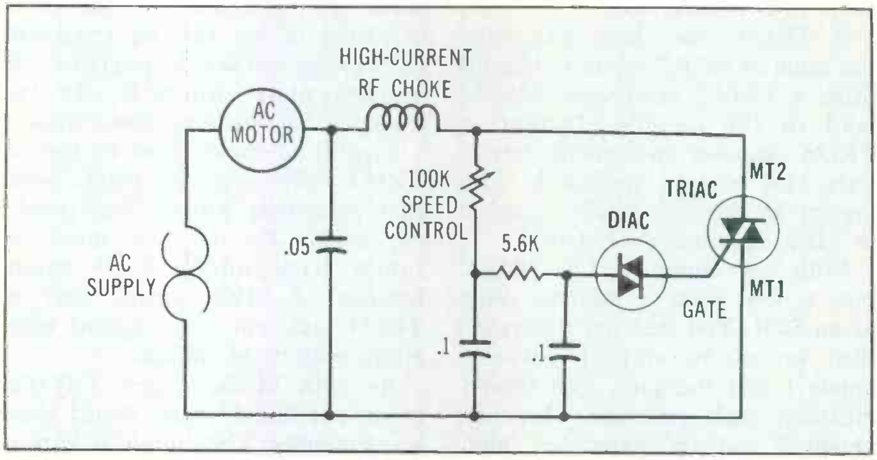


Figure 14 A practical TRIAC-type motor speed control should have a choke and capacitors to suppress RFI.

TRIACs appear in numerous control circuits for heaters, lights, motors, and even high-horsepower 3-phase motors. They are suitable for any other load requiring on/off or variable power control from a remote point. Figure 14 illustrates a simple motor-control circuit using a TRIAC. Varying the speed-control pot makes the TRIAC switch turn on for all or some portion of a cycle, in the same manner as described for SCRs. But where the SCR controlled only a half-cycle, the TRIAC controls both half-cycles, providing 360° control from zero to full power.

The DIAC in the gate circuit of Figure 14 is a type of thyristor that has no gate of its own. It is designed to break down and conduct upon application of either positive or negative voltage of a certain specified amplitude. Commercial DIACs are available with breakover ratings from about 7V to 30V. Once breakover occurs, the voltage must drop a small amount before current stops flowing.

This compares to a neon lamp, which ordinarily fires at 60V but then remains on until applied voltage drops to around 50V. Sometimes neon lamps rather than DIACs are put in the gate circuits of TRIACs. In either case, uniformity of triggering is improved.

A DIAC can be checked with a dc voltage and limiting resistor, as in Figure 10. Then reverse the voltage to see that breakover occurs at about the same voltage for both polarities. Or, an ac voltage can be applied and the breakover point monitored on an oscilloscope, as Figure 15 portrays. Whether tested by dc or ac, the breakover point in both positive and negative directions should be within 5% of one another.

A shorted DIAC can be spotted with an ohmmeter. But for a suspected open DIAC, a higher dc or ac test is necessary. On rare occasions, premature breakover of a DIAC occurs in either the positive or negative direction. At times this may have little or no effect on

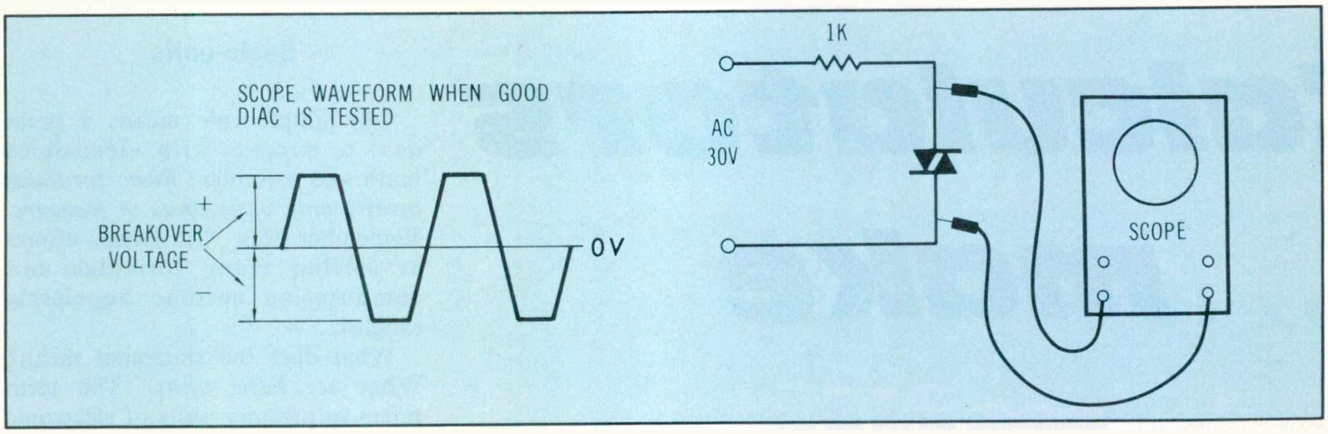


Figure 15 DIAC testing with ac and oscilloscope may not reveal imbalances, unless dc scope coupling is used.

circuit operation. In other circuits it may cause a borderline trouble that is difficult to diagnose. A DIAC comes under suspicion when applied power varies erratically at low power settings, or if dial calibration of a controller has changed, or when there are any evidences of nonlinear control operation.

QUADRAC

In a few controller designs, you might find a device called a QUADRAC. This is a TRIAC with the DIAC gate built in. Testing of a QUADRAC requires sufficient gate voltage to overcome the internal DIAC barrier of from 7V to 28V or so. Otherwise testing is comparable to TRIAC testing.

Quick tips for testing

By and large, intermittent leakage or breakover cause only a small percentage of faults in SCRs, DIACs or TRIACs. This is fortunate, because it makes simple trouble-shooting procedures efficient and usually reliable.

If these direct-control devices check normally, then the trouble is likely in transistor or IC stages that drive the gating circuit. A fault might also exist in the load, or in a power-supply circuit. Sometimes the defect is no more complicated than a dirty potentiometer or rheostat that introduces discontinuities, creates transients, and causes erratic triggering; a new pot is the cure.

Altered resistor values could reduce the trigger point or the pulse itself to some marginal value. Ordinarily, trigger pulse amplitudes to the gates of SCRs or TRIACs are more than ample. This assures reliable triggering and reduces the switching-time lag. When marginal or erratic operation occurs, a check of gate-pulse amplitude is one of the first tests to make.

RF interference

One side effect of solid-state switching is creation of radio-frequency radiation. An RF choke, often toroidally wound, and a bypass capacitor help minimize this interference. Generally, they are connected as in Figure 14. Shielding and case-grounding also help. □

Electronics Math Simplified

The article "Calculators Make Milli • Micro • Decimals Easy" is from a service training *Monograph* titled *Easi-Way Solutions for Electronics Math and Formulas*.

Many technicians avoid electronics math and formulas. Often, that's because they learned high-school algebra so long ago. Hundreds of otherwise excellent technicians miss FCC and other exams only because of this weakness in mathematics.

Forest Belt, author of *Monograph*, set out to devise some shortcut that any technician could use for electronics math. The natural tool was, of course, a calculator. But only a certain type would suffice: The so-called *scientific calculator*. Next came the matter of adapting and simplifying methods of use to suit the particular needs of technicians. The technique had to be useful and quick for problems encountered everyday in maintenance, servicing and installation. And, it should never become outdated.

The first result was a brief math and formulas seminar which fit into an early version of Belt's Training Workshops in Communications Servicing. It soon became obvious that there is a need for a self-study version. And the *Easi-Way Solutions Monograph* resulted.

This booklet, the largest in the *Monograph* series, contains the equivalent of several hours' instruction and clarifies enough different kinds of math and formulas to enable you to handle almost any electronics problems. Dozens of try-it-yourself exercises, similar to the three in the article, prove that you can use what you learn. Exercise answers appear on the inside back cover of the *Monograph*.

Certain arithmetic and math problems are inescapable when you work in electronics everyday, whether maintaining and servicing or designing. This unique mathematics shortcut forms a basis for whatever math crops up. And you do not need to know algebra! The *Monograph* shows you how to let your calculator make the algebraic mainpulations. You simply *arrange* the formulas and feed the numbers into the calculator.

You can order this *Monograph* from **Service Training Group, P.O. Box 47, West Newton, IN 46183.** The order number is 28A-E1079. Price is $12.50 postpaid ($15 outside the US) Send check or money order, not cash. Sorry, no COD orders accepted by STG.

Answers for Calculators Exercises (page 34)

Exercise 1 0.3575
Exercise 2 4.7 -09 and 4700
Exercise 3 4.7 -03 and 0.0047

Calculators make milli micro decimals easy

By Forest Belt

Any service or maintenance technician who does his arithmetic with pencil and paper is hopelessly behind the times. He wastes time and effort.

Today, technicians can use calculators efficiently, even when they don't know higher math. You can buy an elaborate *scientific calculator* for well under $50, sometimes half that if you shop around. You will save that much the first week you use it.

Calculators mean that anyone who knows basic arithmetic can manage complex algebraic computations without really knowing algebra at all. The calculator does the manipulations. An instruction booklet comes with each calculator, and describes every operation that model performs.

Nevertheless, field experience proves that many technicians find it difficult to sort out decimals. For example, multiplying millihenries times microfarads in a resonance formula introduces as many as fifteen decimal *places*. Yet these calculations are surprisingly easy, thanks to a mathematical trick called *scientific notation*. And nothing speeds and simplifies this kind of arithmetic more than a calculator does.

* *A Forest Belt service and trade mark*

Basic units

One simple rule means a great deal to success with electronics math and formulas: *Basic formulas involve only basic units of measure.* Remember this. Otherwise, efforts at solving many formulas and computation become hopelessly tangled.

What does the statement mean? What are *basic units?* The term refers to primary units of electronic measurement. Volts, for example, and amperes, ohms, farads, henries, seconds, watts and hertz (cycles-per-second), all are basic units. And the formulas that are most valuable to you in servicing and maintenance are all expressed in these basic or primary units.

Simple Ohm's Law, for example: When you work with $E = IR$, the value of current I must be given in ampere (amps) and resistance R in ohms; the answer, E, comes out in volts.

You cannot indiscriminately mix milliamps, megohms, and kilovolts. You must stick to the primary units of measure, because solving the formula accurately depends on it.

Consider volts. A measured value may be only a fraction of a volt. Prefixes let you express the value as a whole number, which generally is easier to deal with than a decimal fraction. Suppose you measure 0.032V at some circuit point. That's 32/1000 or 32 thousandths of a volt. In practice, it is more practical to call it 32 millivolts (mV), because *milli* means "thousandth." But you should not use millivolts in the basic formula, because millivolt is *not* a *basic* unit. The basic unit is volt.

It would be similar if you measured 1500V somewhere. Since kilo means thousand, you would likely call the voltage 1.5 kilovolts. You would nevertheless have to convert that back to volts for use as a value in a basic formula.

These so-called "metric" prefixes permeate the field of electronics. You run into milli, micro, nano, pico, and others whenever you talk or read about electronics. Some involve so many decimal places that you can quickly lose track, even in an ordinary calculation.

Display shows results here in henries. You can convert to milli or micro.

Press x and enter 1. Then press EE or EXP and enter 03 to convert to millihenries.

For microhenries, starting with henries (top), press x, then enter 1, press EE, and enter 06.

However, you will not lose track in your calculator if you remember the initial fact: Basic formulas involve only basic units. In other words, every value entry you make into your calculator must end up in whole-unit terms. You'll see how.

Of course, you immediately face a difficulty. How can you punch in a value that uses more digits or zeroes than your calculator displays? Directly, you cannot. Using scientific notation, you can.

And that's what you do. In fact, scientific notation, as you will learn to use it here, opens the door to simplification you never dreamed possible. No more trying to figure out decimal places. You simply do not have to worry about them. The clue is in how you enter values into your calculator. You do it according to the decimal prefixes.

Easy decimal notation

Begin with a common situation, one you may encounter every day servicing solid-state equipment.

Milli stands for thousandth. Thus 0.005 ampere (5 thousandths of an ampere) is called 5 milliamps and abbreviated 5mA. But entering milliamps directly into your calculator would throw off the calculations, because basic formulas are set up around full units.

You have two alternatives for entering this kind of value into your calculator. Finding a measurement of 5mA, you could mentally convert it to amps, and enter the digits 0.005 on the calculator. That's okay, but only as long as the value remains within the digit capacity of your calculator display.

You may as well learn a more dependable method right at the outset. This method works for every kind of measurement that involves a decimal prefix. The secret: Use scientific notation. Here's how the system works.

Consider 5mA as your first example. This is 5 milliamps or 0.005 *amps.* So 5mA is the same scientific notation, as 5 x 10^{-3} amps. That's because you move the decimal point three places leftward to rewrite the 5 *milli*amps back into 0.005 *amps.* So 5 mA is the same as 5 x 10^{-3} amps. (However, if this sounds mathematically unfamiliar, don't worry about it. Just do what the next sentences tell you to do. You will soon understand.)

You can enter milliamps into the calculator directly, using the exponent feature of a scientific calculator.

First enter 5. Then, to account for the milli in milliamps, you also tell the calculator that you really mean "x 10^{-3}." You enter the "x 10" instruction by pressing the EE or EXP key. Then enter the exponent itself by punching the 3 button. Since the exponent in this case is negative, you must also press the +/- key after you punch the 3.

Try the steps just described on your calculator. The display should look like this:

5. -03

The ease of this entry method becomes apparent when you enter a mixed decimal value.

Example: Punch in the value for 3.05mV. Enter 3.05 on the keyboard. Press EE. Enter -3 as the exponent. The display reads

3.05 -03

As you proceed, the calculator treats the entry exactly as if you had entered 0.00305 *volts.* The calculator has itself taken care of placing the decimal point according to the milli prefix. You had nothing to figure out about decimal places.

Micro means *millionth. Micro* can also be expressed as X 10^{-6}. So, here is how you handle 3.75 microamps. (Try it.) Enter 3.75; press EE; enter 6; press +/-. With the .00000375 ampere thus entered so easily in correct scientific notation, you can proceed with your calculation.

Nano is X 10^{-9}. You don't run into this prefix much in everyday servicing, but you might. A value of 23 nanoseconds (ns) is 23 x 10^{-9} seconds. Enter 23; press EE; enter 9; press +/-. Then proceed.

Pico is the same as micro-micro, and in scientific notation is equivalent to X 10^{-12}. This expression is common among capacitors. You enter *pico-* expressions the same as other decimals, except that you use a -12 exponent.

Below is a table that lists the most common decimal prefixes for electronics. With this table near at hand, you can enter any electronics value into your calculator directly, and the calculator chip takes care of complicated decimal-point placements.

Decimal prefixes table

pico	(10^{-12})	millionth-millionth
nano	(10^{-9})	thousandth-millionth
micro	(10^{-6})	millionth
milli	(10^{-3})	thousandth
centi	(10^{-2})	hundredth
kilo	(10^{3})	thousand
mega	(10^{6})	million
giga	(10^{9})	thousand-million

Of course, when the exponent is not negative, you leave the +/- key untouched, and the exponent you enter remains positive.

When you enter values by scientific notation, your *answer* shows up displayed the same way. You might then want to convert back to *standard notation*. If you have trouble visualizing multiple zeroes and decimal places, write down the scientific notation answer as shown on the display, but without the exponent. To return this to standard notation, move the decimal point. If the exponent displayed is negative, move the decimal point leftward as many places as the exponent says. Insert zeroes if you need to. If the exponent has no minus sign, move the decimal point in the answer rightward as many places as the exponent indicated, adding whatever zeroes you need.

It is vital that you grow accustomed to this scientific-notation mode of entry, and to reading any answer that appears in this form. Without it, you become hopelessly lost in a morass of zeroes and decimal-point shifts.

To summarize: Virtually all formulas are in primary terms. When substituting values for letters, you use whole-unit values: ohms for resistors, henries for coils, farads for capacitors, cycles-per-second (Hertz) for frequency, and so on. When values are smaller or larger than units, you use decimal prefixes to name them: megohms, millihenries, microfarads, kilohertz, and the like. This keeps the numerals manageable.

Consequently, upon entering values into your calculator to solve a formula, you punch the numbers exactly as given, but account for each prefix by using a scientific-notation exponent—either positive or negative, depending on the prefix. Doing this places each value into the working register in terms of basic units of measure.

Making the answer read directly

The answer, then, also is displayed in basic units. There may be exponents in the display, representing scientific notation. So you need a quick, easy way to convert the displayed answer into values and terms that are again easily understandable—that is, into micro-, or milli-, or kilo-, etc., terms.

Actually, you don't even have to write down the display figures. You can convert back to decimal units right on the calculator. It's easy, and takes only a few steps.

Look again at the decimal prefixes table. Note the exponent indicated for whatever prefix you want to change a whole-unit display into, and then *change the exponent sign*.

Here's the way to proceed when you have a whole-unit answer displayed in scientific-notation:

1. Press the x key.
2. Enter 1.
3. Press the EXP or EE key.
4. Enter the exponent for whichever prefix you want, but make the sign *opposite* to what's in the decimal prefixes table.
5. Press the = key. The display shows the answer, stated in terms of the prefix you chose.

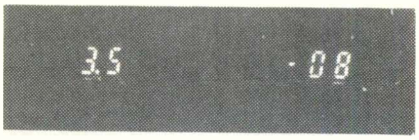
Try this example on your calculator: Add 37.2 and 43.8 microvolts (μV). Enter 37.2, press EE, enter -06. Press +. Enter 43.8, press EE, and enter -06 again. Press =. The display should read 8.1 -05. That answer is in volts, since *volt* is the basic unit; remember, you corrected both of your original microvolt entries by entering them, in scientific notation, as volts.

Now, to convert this display back to microvolts, consult the prefix table. The exponent for microvolt is -06, so you will use 06. Start the conversion by pressing the x key. Enter 1. Press EE. Enter 06. Press =. Now you see the answer expressed in microvolts. The display should read 81.0, and the answer is 81 microvolts.

Start again. Add 37.2 μV and 43.8 μV as before. Now, just for practice, convert 8.1 -05 volts to *millivolts.* Press x, enter 1, press EE, enter 03 (see the table and don't forget to change the sign), and press =. The answer is 0.081 millivolts.

Here's some more practice for you, with answers on page 31.

Exercise 1. Enter 3.575, press EE or EXP, and enter -07. Display should now read 3.575 -07. Imagine that's an answer, in farads. Now convert the reading to microfarads, using the procedure just outlined. The display now reads __________ microfarads.



Calculator has produced answer in seconds. Convert it to make reading it easier.

For microseconds, press x, enter 1, press EE, and then enter 06 exponent.

For milliseconds, press x, enter 1, press EE, and enter 03 exponent.

For nanoseconds, exponent to enter is 09. Keep sign positive for all of these.

Exercise 2. Enter 2.16, press EE, enter -09. Press +. Enter 2.54, press EE, enter -09. Press =. The display reads__________. Assume that's total capacitance in farads. Convert this now to picofarads using the procedure you have just learned. The display now reads __________.

Exercise 3. Clear the register. Repeat the addition in Exercise 2, but convert the answer to microfarads instead of picofarads. The display reads__________, which means the sum of the two capacitances is__________μF.

When the exponent in the display is the same as for one of the prefixes listed, you can get the habit of reading the display directly in terms of that prefix. Hence, for 6.557 -03 volts on the display, you would read 6.557 millivolts. If the display shows 7.25 03 volts, it can be read directly as 7.25 kilovolts.

For exponents in between those in the table, use the next prefix, NOT the next smaller exponent, to express the value. Work the problem on the calculator exactly as described for exponents in the Table. □

Repairing OLD TVs

By Gill Grieshaber, CET

Older color TVs develop different common defects, and thus require modified troubleshooting techniques, from those needed for the same receivers when they were new. These tips should help technicians repair older TVs quicker.

Stresses from heat and voltage cycles that occur over a period of years tend to ruin different types of components than those that usually failed when the color TV was new. Also, some materials (such as circuit boards, coil forms and tube caps) weaken or disintegrate from heat, humidity and material fatigue.

Older TVs often have multiple defects, compared to the single major failure that's common with new receivers. Also, many minor troubles might have accumulated over the years. These older machines generally require more labor time for adjustments and resoldering, in proportion to the number of new parts installed.

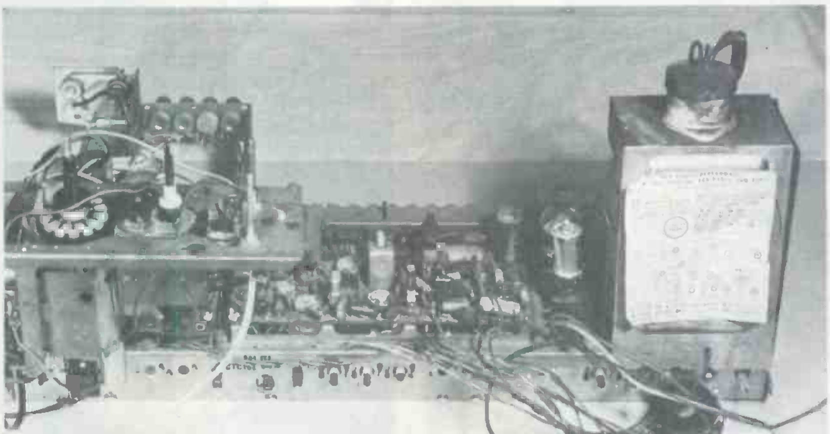
To prevent the total billing from exceeding the TV receiver's value, and to forestall expensive callbacks, it is necessary that a technician work efficiently by knowing fast ways of eliminating all secondary or intermittent problems.

This article provides examples of typical defects and many remedies that are unique to older TV receivers.

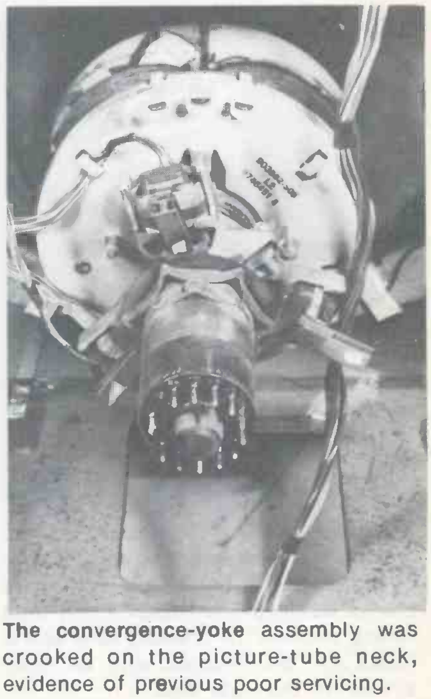
Technician damage or neglect

A 6-year-old tube-type color TV is likely to have had five to seven repairs or service calls. After that many servicing incidents, several tube shields probably are missing, a couple of coil cores are cracked or frozen, solder splatters are on the chassis, and the convergence coils are in the wrong position.

The first step, therefore, when checking an old timer is to give it a thorough visual examination. Look



An old RCA CTC16 chassis was selected as an example. Notice that the tuner assembly is mounted correctly on the chassis for servicing or transportation. Two chassis screws and matching slots in the tuner bracket hold the assembly. (If the tuner is placed on top of chassis wiring severe damage can occur to unshielded coils and other fragile components.)



The convergence-yoke assembly was crooked on the picture-tube neck, evidence of previous poor servicing.

for burned resistors and cracked circuit boards, of course, but be alert also for missing parts and other technician-caused problems.

All such deficiencies should be written down for later reference, but they should not necessarily be brought to the owner's attention. Blaming another technician often gives **all** technicians a bad name.

Next, all sweep tubes should be tested, since they usually have higher list prices, and the emission and tracking of all three picture-tube guns should be checked.

A decision should be made at this time about whether or not to proceed with the repairs. For trade-in sets, the repair cost should not exceed a certain percentage of the proposed selling price. An estimate should be given for all customer merchandise. These are important business decisions, for some old receivers *should* be junked.

Remove the chassis

The chassis should be removed from the cabinet for the next examinations. It is false economy to attempt these repairs in-cabinet. Expect to find **several** bad solder joints. Most of these joints originally were soldered correctly. But the heat of tubes and resistors or heavy heater currents have ruined the solder gradually. Several examples are shown in pictures.

Sometimes a suspected joint shows a crack around the wire lead or rivet when moderate finger pressure is applied to board or component. Resistors that dissipate large amounts of heat often deteriorate the solder at their connecting joints. This is very common when a large resistor is mounted on a circuit board.

Another excellent method is to check all suspected joints by using a reading glass or a low-power microscope. Shine a bright light on the area and move circuit board, resistors and other large components while their soldered joints are observed through the magnifier.

Perhaps many technician readers will reply that looking at each joint is a waste of time, for it's easier to give them **all** a fast resoldering. Unfortunately, a joint that has become pitted by arcs and has rough grainy solder often *will not tin properly*. In such cases, the intermittent problem is not solved by casual resoldering, especially when done by an iron with insufficient heat. The only certain method is to tin both parts of the joint separately, solder them with a hot iron and then check the joint with a reading glass.

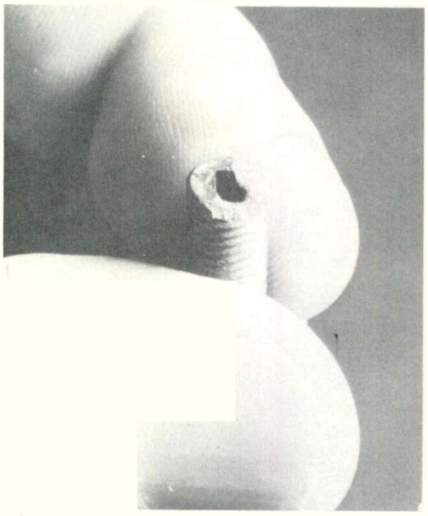
Circuit boards in older RCA-type chassis often were mounted by soldering board rivets to metal lances of the chassis. As they age, these joints are very likely to become intermittently open. One such open occurs between the metal lance and the rivet. It often can be located by attempting to move the board up and down. But use care, for the lance might be loose **inside** the solder.

A tiny circular crack is difficult to find when it forms between a rivet and the ground wiring on the board. Flexing the board slightly sometimes widens the crack enough for the open space to be seen. It is imperative for a magnifier to be used here also.

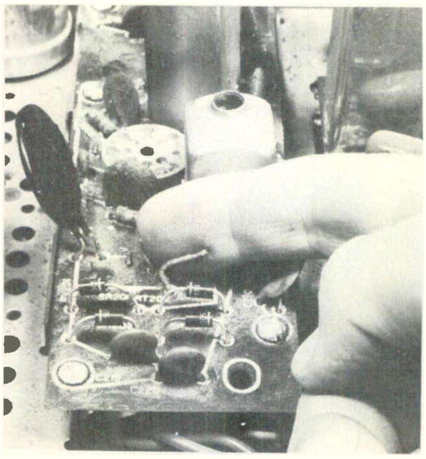
Many symptoms from bad grounds

Any intermittent open circuit can cause much trouble before it's located, but bad grounds are the worst of all since the symptom and the physical location do not always correspond.

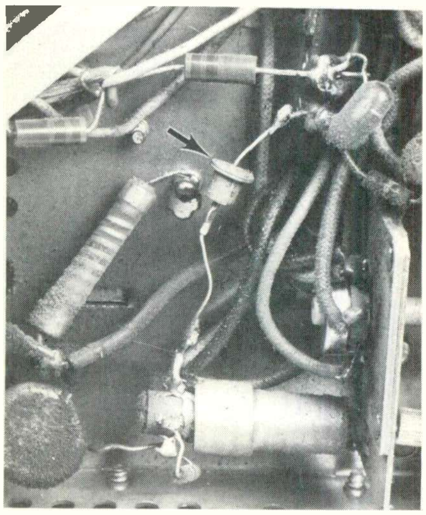
IF circuit boards usually have six or seven separate grounds around the edges. Several might be connected to different ends of the *same* common ground wiring. Sometimes, a chassis ground is connected to one circuit ground only. An open in such a single-circuit ground is likely to produce a major symptom, such



This core from a convergence-board coil was cracked at one end. It still operated alright, but longer lengthwise cracks would prevent such a coil from tuning properly. A cracked core sometimes can be removed with an Allen wrench of the right size.



The degaussing thermistor was missing. Such an open circuit stops all operation except the tube heaters. For a temporary test, short across the thermistor leads. The thermistor also functions as a surge resistor, so it's advisable to replace any bad ones rather than jumpering them permanently.



Another servicing mistake was the conventional *top-hat* diode used as a boosted-boost diode. This one was not shorted, but it should have been, for these are called on to supply about 300V of extra dc voltage—far above the ratings of the wrong replacement.

as oscillation or loss of all IF gain.

On the other hand, an intermittent open at one of the multiple common grounds does not stop all IF operation. Instead, the IF alignment curve shifts, thus causing the color level to change. This can be misinterpreted as a color-IF problem, thereby wasting much valuable time.

Erratic picture quality or color

To find the source of erratic color intensity or varying B&W quality, operate the receiver from a crosshatch/color-bar generator. Both color and B&W problems can originate in the picture IFs. If the color is affected, tune in color bars. While watching the color bars on the TV screen, bend the IF circuit board, particularly around the grounds. Check the grounds with a magnifier and resolder all that need it. There is a good probability that repairing the bad grounds will also correct the erratic color level.

Should the erratic continue, gently rock the tubes and IF coils. Corroded tube sockets are another common source of unstable operation. Spray some good-quality tuner cleaner into all pins of any sockets that are suspected. A little cleaner sprayed on the pins of the tube while it's out of the socket also is a good idea. After the tube is replaced, watch the screen and rock it again.

Many alignment jobs can be made unnecessary by this cleaning and ground-soldering method.

Bad grounds or corroded sockets that produce ringing or oscillation in the luminance signal can be identified and corrected in the same way.

Loss of raster by blooming

One common problem appears as a rapid increase of brightness that soon produces blooming and loss of HV and raster. In the older RCA designs, an intermittent ground at the right rear corner of the chroma board opens the cold side of the -Y amplifier's heater circuit. Of course, the tubes eventually stop conducting, which raises their plate voltages. Because these plate voltages supply the picture tube grids, the brightness is increased severely. This ground location is shown in one of the picture illustrations.

Darker picture

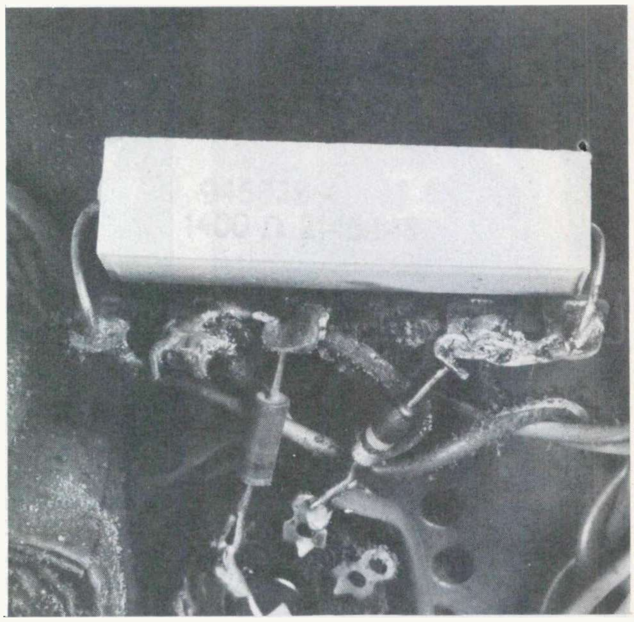
Horizontal-blanker stages in older color receivers were (and are) a constant source of misleading symptoms. In the CTC16 schematic of Figure 1, a large negative voltage is generated by blanker grid current. Part of this negative voltage is used for the killer control, the brightness control, and the 6JE6 horizontal output tube grid. Defects at this grid circuit could affect the picture brightness, the color-killer action, or the lifespan of the 6JE6 tube. Also, the pulse amplitude from the blanker plate plays a large part in determining the picture brightness, since it indirectly establishes the -Y tube plate voltages. Excessive blanker-tube current might burn open the cathode resistor that's shared with the color bandpass tube, thus eliminating all color. This is a busy circuit that can cause many different trouble symptoms.

An intermittent ground at grid resistor R742 increases the negative voltage there and darkens the picture by way of the brightness control.

Flashing horizontal bars

Erratic white and black horizontal bars can appear on any or all high-band (channels 7 through 13)

More than eight bad solder joints were found. This closeup picture has arrows added to mark four joints ruined by resistor heat. These resistor leads were loose in the solder.



Heat from the large 20W 1400 Ω wire-wound resistor deteriorated all soldering joints on the terminal strip and carbonized the insulation. None of the joints were open, but would have gotten worse with time.

channels if the neutralization of the RF amplifier tube is wrong. The adjustment is stable if it's left alone, but excess tuner spray that gets inside the trimmer capacitor can give the effect of a wrong adjustment.

Adjusting efficiency and HV

If the high voltage is adjusted too low by excessive 6BK4 current, the 6BK4 will fail often. If the HV and efficiency adjustments are wrong, the 6JE6 horizontal-output tube will fail excessively.

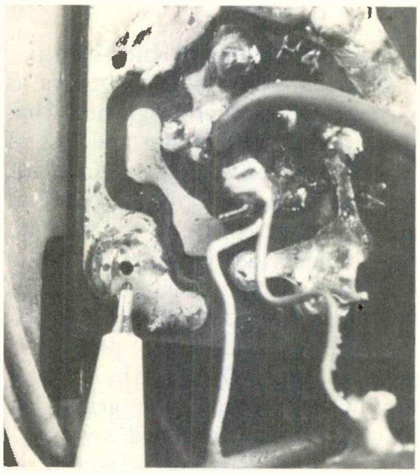
Clearly, dependable operation requires that both adjustments be made correctly. However, *these two adjustments affect each other*, and they should be performed at about the same time.

An additional complication is the small change of 6JE6 plate current that occurs during adjustment of the efficiency coil. Older B&W receivers called this coil "horizontal linearity," and its adjustment made a large change in linearity. Efficiency coils do not change the linearity very much. Instead they are peaked for minimum 6JE6 plate current.

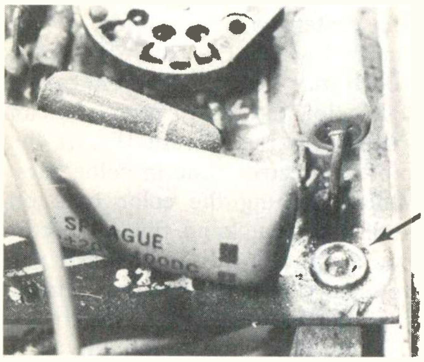
Adapter sockets are available for attaching an external meter to read the 6JE6 cathode current. That method works moderately well. However, the screen-grid current and the plate current respond in reverse to efficiency-coil adjustments, thus the cathode current changes a smaller amount.

A better method involves monitoring screen-grid voltage during the adjustment (Figure 2A). A decrease of 6JE6 plate current from efficiency-coil adjustment increases the screen-grid current and *reduces the screen voltage.* (HV current changes affect plate and screen-grid currents alike.) This is a convenient way of monitoring since many RCAs allow measuring of the screen voltage through the space below an elevated 6JE6 socket (see photograph).

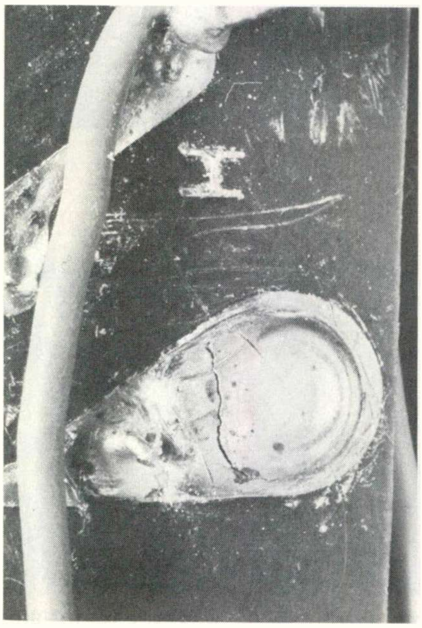
Unfortunately, efficiency adjustments vary the amount of 6BK4



A pen points to the hole in a ground joint of the IF board where a ground lance had pulled loose. Erratic color level often results from opens at auxiliary grounds.



Many RCA chassis develop intermittently open connections at one of the chroma board grounds (see arrow). An open produces extreme brightness and loss of HV. This pictured joint was not bad yet, but both lead wires of the metal-film resistor in front of it were loose in the solder.



This crack at a ground in the oscillator circuit extended around the rivet completely. It caused intermittent operation of the horizontal oscillator. Flexing of the board made the crack more visible.

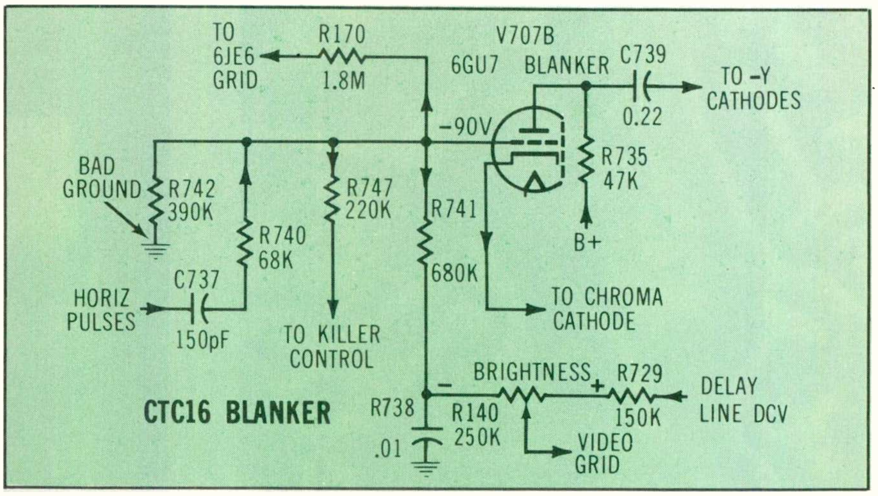


Figure 1 The CTC16 horizontal-blanker circuit can affect the chroma level, the horizontal-output grid voltage and the picture brightness. Horizontal pulses at the grid are clipped (by grid rectification) and amplified, then the plate pulses are applied to the common cathodes of the -Y amplifiers to produce horizontal blanking. Also, switch-selected variations of the plate pulse amplitude are used to determine the CRT grid dc voltages. Other pulses from the cathode are transferred to the bandpass color amplifier where the burst is gated out. Dc voltage developed by grid/cathode shunt rectification of the grid pulses is fed to other circuits, such as the color killer, one end of the brightness control and the horizontal-output grid. Wrong voltages and pulse levels can cause many different symptoms.

HV regulator current, and the amount of regulator current affects the optimum efficiency setting.

To minimize the number of alternate regulator and efficiency adjustments, the following procedure was developed:

- Connect a dc voltmeter across the 1000 Ω 6BK4 cathode resistor (remembering that both ends are about 400V above ground).
- With a black raster, adjust the HV control for the maximum regulator current recommended for that model (see Figure 2B). Remember, 1V on the meter represents 1mA of regulator current. Old CTC12 to CTC15 chassis should be limited to about 1mA, while newer models (such as CTC31 or CTC38) can stand 1.6mA. Models without adjustable controls can be tested but not adjusted.
- While the meter is still connected, advance the brightness control slowly until the regulator current *barely* reaches zero (use color bars for a stable reading).
- Now, adjust the efficiency-coil core for minimum dc volts at the screen grid.

That's all. However, it is advisable to repeat the procedure one more time.

The amount of screen voltage can give definite hints about where a sweep defect is located. For the CTC16, a screen voltage of about +80V indicates the 6JE6 has no dc plate voltage. At the other extreme, if the tube does not have red plate but the sweep is narrow and the HV is low, a screen voltage of +200V or more indicates a weak 6JE6 tube. Other screen voltages point to different bad parts or adjustments.

Judging brightness

Picture tubes in older model color TVs never (even when new) had as much brightness as new models do now. Therefore, it is difficult to know when maximum brightness has been reached.

With TVs that have a 6BK4-type of HV regulator and a 1000 Ω cathode resistor, an easy test will prove when the brightness is maximum. Monitor the voltage drop across the resistor and increase the brightness until the voltage barely reaches zero (or slightly above, just to be certain). That is the point of maximum brightness because any increase will cause blooming and reduced HV.

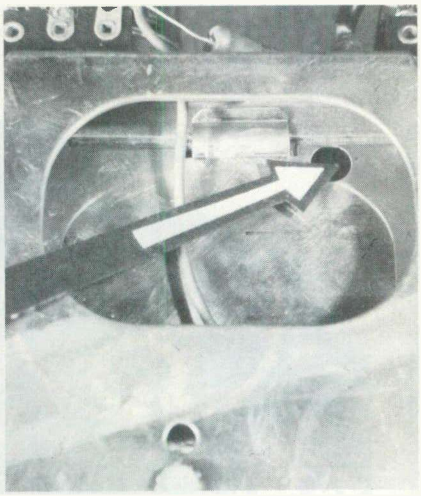
If the voltage drop stops at a higher point even when the control can be rotated further, the picture tube is definitely weak. If the voltage reading does not drop to zero (although the brightness control has reached the end of travel), then the raster gray scale needs to be retracked at higher screen-control settings.

Corroded switches

The picture-tube bias and service/normal switches are the cause of many elusive problems. Because they are so seldomly used, corrosion builds up rapidly.

In CTC16 versions, the picture-tube bias switch selects one of three possible values of plate resistance for the blanker tube. With pulses, a lower-value plate resistor increases the pulse amplitude which in this case causes increased grid/cathode clamping at the -Y amplifier tubes. Increased clamping in turn raises the negative grid bias, thus increasing the plate voltage of each -Y amplifier. The higher plate voltages raise the picture-tube grid voltages and in turn produce higher picture brightness.

Therefore, any intermittent continuity inside the bias switch produces erratic brightness. And a



Many of the older tuners with Nuvistor RF amplifiers by now have had tuner cleaners sprayed accidentally into the neutralization trimmers. This gives the effect of wrong neutralization and produces oscillation on some high-band channels. The trimmers must be thoroughly cleaned out with a solvent and allowed to dry before they are adjusted.

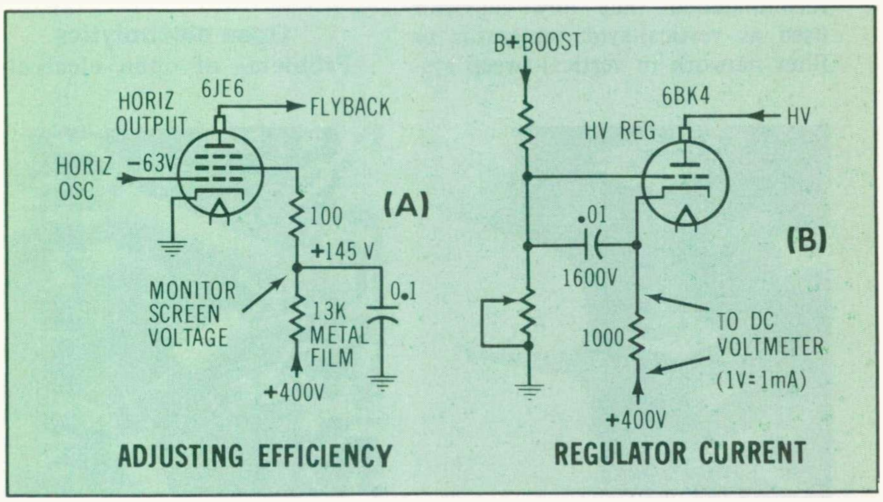


Figure 2 Efficiency-coil and HV-regulator adjustments are easy and accurate when made by this method. First, find the point of maximum brightness (preferably on color bars) by monitoring the voltage drop across the 1000 Ω 6BK4 cathode resistor (schematic B) and increasing the brightness until the resistor voltage barely reaches zero. Then go through the procedure listed in the text. Adjust the efficiency coil for minimum 6JE6 screen voltage (schematic A). Finally, turn down the brightness to a black raster and adjust the HV control for the proper maximum voltage across the 6BK4 cathode resistor. That's all. This method works well with similar circuits as long as the output screen has a large dropping resistor.

steady open usually darkens the picture.

Even worse are the symptoms of a defective service/normal switch. This switch seldom is suspected of any problem, but corroded contacts that open a circuit can kill the raster and prevent the video from reaching the picture-tube cathodes. Video and vertical-sweep signals both connect to the switch; therefore, internal leakage can reduce the height or add vertical to the video thus causing a shaded raster.

If any doubt exists about the service/normal switch, remove the wire that connects to the vertical-output grid and then connect together the three ungrounded switch lugs. Any improvement of performance indicates a bad switch.

Temporary cures sometimes can be obtained by spraying a lot of tuner spray inside the bad switch and then sliding it back and forth several times. This trick also works at times with erratic volume or hold controls.

Beware of printed components

The failure rate of capristors (combined capacitors and resistors) seems to be much higher than that of discrete components. In fact, it's recommended that any capristor used as vertical-sync integrator or filter network in vertical-sweep systems should be replaced by the equivalent individual components. Many schematics show the values.

Raspy sound

Distorted or raspy audio tone quality can originate either in the speaker, the FM discriminator or the audio amplifier. Bad speakers are common in old TVs. Most speaker defects can be identified easily. For example, a flapping or buzzing sound that occurs only at loud volume might be caused by an unglued rim, a child's toy lodged against the cone, or a nearby loose object that vibrates in sympathy with cone movement.

On the other hand, if the sound quality is fair when the volume is loud but becomes progressively worse as the volume is reduced, it's a good bet the voice coil is rubbing against the magnet's pole piece. Gentle pressing of a finger against one point after another around the *rear* of the cone sometimes will minimize the raspy sound. This identifies the problem, which is not that easy to correct perfectly. A cheap "cure" is to stuff a wadded paper handkerchief between the frame and cone. However, the only permanent solution is to replace either the cone or the speaker.

Open electrolytics

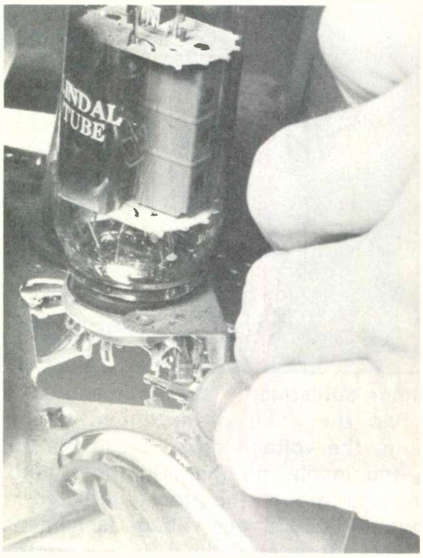
Problems of open electrolytic capacitors should be easily solved now by one of the new generation of capacitor testers. Digital-readout highly-accurate capacitance meters are available from B&K-Precision (model 820), Data Precision (model 938) and Sencore (model CA-55 and model LC-53). Also, the ESR meter from Creative Electronics does not measure capacitance directly but instead checks the equivalent-series resistance. This is sufficient for electrolytics, and the ESR meter can test almost all electrolytics in-circuit without the necessity of disconnecting any leads.

In the absence of one of these meters, there's the clue of white powder around the terminals or else a shunting test.

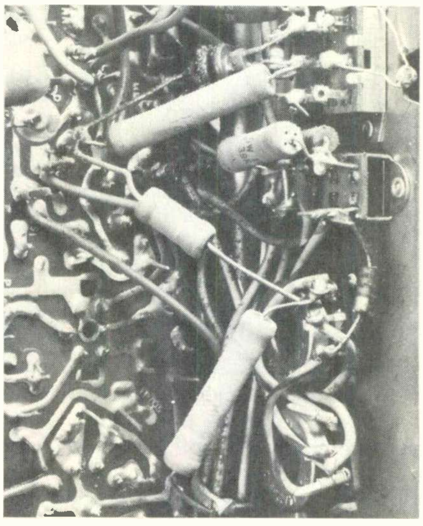
Comments

Hundreds of "fixes" are known for the older color TV receivers, so seldom should any one repair require an excessive amount of technician time. In fact, servicing the older models should be profitable even when several problems are encountered.

Readers are invited to write to the editor if they would like more tips of this kind or if a certain circuit puzzles them. Write to:
Carl Babcoke, Editor
Electronic Servicing
P.O. Box 12901
Overland Park, Kansas 66212 □



The 6JE6 or 6LQ6 screen grid often can be reached for voltage tests through the ventilation space below the tube-socket shelf.



The sliding-type service/normal and picture-tube-bias switches often produce baffling symptoms, such as a shaded picture, erratic brightness or insufficient height.

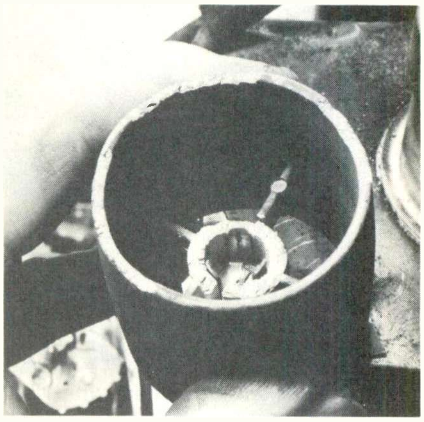


Plate caps on regulator and horizontal-output tubes can be sources of mysterious noise patterns in the TV picture. One common defect is a broken weld where the lead wire is fastened to the metal cap. Such a cap should be replaced since the high heat would melt solder. This 6BK4 cap was crumbling but the weld was alright.

productreport

Power supply

PTS Electronics has designed the MSP-501 fully regulated 5Vdc power supply with an output current capability of up to 5A for microprocessors and other similar electronic devices. Features include a new hybrid regulator and output circuitry for high reliability, noise and ripple of less than 10mv, short-circuit current limiting, and a front panel 4.5 to 6.0Vdc calibration adjustment. The MSP-501 has a $99.95 user net and a 1-year limited warranty.

Circle (50) on Reply Card

Hand-held DMM

Hand-held 3½-digit Model 8022A from **John Fluke** has 10 ranges of ac and dc volts, eight ranges of ac and dc current and six ranges of

ohms. Pushbutton switches are designed for better reliability. A set of Fluke-designed test leads are included.

The unit sells for $129.

Circle (51) on Reply Card

Power vacuum desoldering system

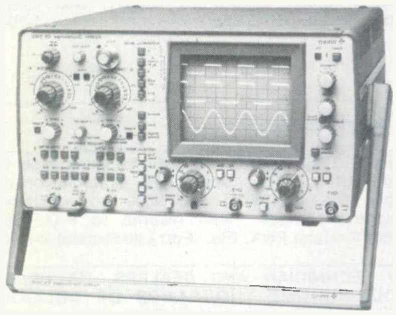
Model SS100 from **Sylvania** is a self-contained desoldering system

for removal of solid-state devices from circuit boards. An internal pump provides vacuum controlled by a switch on the handle of the soldering iron. A switch selects either 40- or 20-W iron power. Two iron tips are included and six others are available.

Circle (52) on Reply Card

60-MHz scope

A 60-MHz oscilloscope from **Gould** is a dual-trace unit with a bandwidth from dc to 60 MHz, maximum vertical sensitivity of 2 mV/cm, and triggering to 100

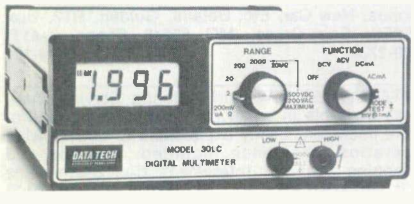


MHz. The OS3500 display modes are flexible and include CH1 or CH2 alone, CH1 and CH2 alternate or chopped, CH1 and CH2 added algebraically and X-Y.

Circle (53) on Reply Card

Digital multimeter

A 3½-digit 6-function digital multimeter has been introduced by Data Tech. The model 30LC has a basic dc accuracy of .1%. A large .5-inch LCD is used for low power drain from four off-the-shelf, disposable, size D flashlight batteries. Either alkaline or zinc-carbon batteries may be used. The unit uses a single DVM LSI chip as its analog to digital conversion. Automatic zero and polarity are included. Functions include ac and dc voltage



and current, resistance to .1 Ω resolution and a diode test feature. The list price for the basic instrument including one set of batteries is $159.

Circle (54) on Reply Card

Temperature probe

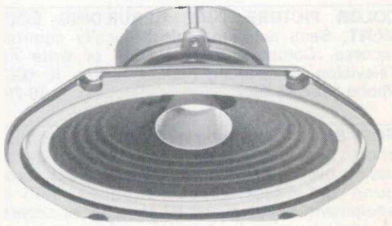
Simpson has announced a temperature probe for testing, troubleshooting, and service of electronic, electrical or heating and air-conditioning equipment. The probe connects to almost any analog or digital volt-ohm milliammeter. A

9V transistor battery provides up to 750 hours of operation, and a battery test feature prevents unexpected loss of power or faulty readings. Priced at $97, the Simpson 00758 probe will be available from Simpson distributors nationwide.

Circle (55) on Reply Card

Rear-deck speakers

An automotive air suspension speaker, designed for rear deck mounting in 1978 and 1979 Ford autos is being offered by **Quam Nichols.** The Model 68C20FEX features a heavy-duty 20-ounce ceramic magnet, an orange foam surround, and whizzer cone. The speaker's suggested retail price is $13.62.



Circle (56) on Reply Card

the marketplace

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VIDEO TAPE—4 hr. VHS, $15.99; 2 hr. Sony, $12.25; 3 hr. Sony, $16.95. Video recorders, cameras. Entertainment Electronics, 8-B Centre Ave., East Rockaway, N.Y. 11518, (516) 887-2550. 10-79-2t

TV SALES & SERVICE business in lower Bucks County, Pennsylvania. RCA franchise, 25 years at present location. Including large shop, store, 3 bedroom house, garage. Owner retiring. Write to Electronic Servicing, Dept. 522, P.O. Box 12901, Overland Park, KS 66219. 10-79-1t

SATELLITE TELEVISION—Movies, sports, etc. Build or buy your own earth station. Send $3.00 for information. Satellite TV, RD 3, Box 140, Oxford, N.Y. 13830. 10.79-3t

T.V., STEREO SERVICE BUSINESS, on eastern Long Island, N.Y. Low overhead, large inventory, owner moving. (516) 654-2639. 10-79-1t

Advertising Services

TERRIFIC SWAP OFFERS NATIONWIDE! 7 issues $3.50. "Electronics Trader," Box 73-ES, Folly Beach, SC 29439. 1-79-tf

Wanted

TUNER TECHNICIAN. 18 months experience or more. Unique opportunity. 40% Commission on labor, 5% on parts, and 40% on additional shipping charges. Send resume to P.O. Box 6456, Oakland Park, Fla. (Fort Lauderdale). 9-79-2t

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Help Wanted

CLOSED CIRCUIT TELEVISION TECHNICIAN: University of Illinois seeking maintenance technician for small format television equipment. Starting $13,270, raises to $17,035 over two years, plus annual increases. Two years electronics study, two years electronic maintenance required. Contact: Don Swift, Personnel Services, University of Ill., Champaign, IL 61820, (217) 333-3109. Affirmative Action, Equal Opportunity Employer. 8-79-3t

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MEN/WOMEN FOR FUN! Shaklee Independent Wholesale Distributors earn $200-$5,000 monthly, Bonus, New Car, Etc. Details, Golden, RT2, Box 392ES, Fair Grove, MO 65648 Phone (1-417) 759-2738. 3-79-12t

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Phone: (312) 299-2601

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Helen Hull, P.O. Box 12901
Overland Park, KS 66212
Phone: (913) 888-4664

NEW YORK, NEW YORK
Joe Concert, 4 W. 58th St.
New York, NY 10019
Phone: (212) 888-1977

FT. LAUDERDALE, FLORIDA
Brinker and Brinker
2240 N.E. 53 Street
Ft. Lauderdale, FL 33308
Phone: (305) 771-0064

SAN FRANCISCO, CALIFORNIA
John MacKay, 703 Market St., Room 1109
San Francisco, CA 94103
Phone: (415) 546-1040

LONDON, ENGLAND
John Ashcraft & Co., 12 Bear St.
Leicester Square, London, WC2H 7AS
England, Phone: 930-0525

LOS ANGELES, CALIFORNIA
Maureen Eagleton,
3055 Wilshire Blvd.,
Los Angeles, CA 90010

AMSTERDAM, HOLLAND
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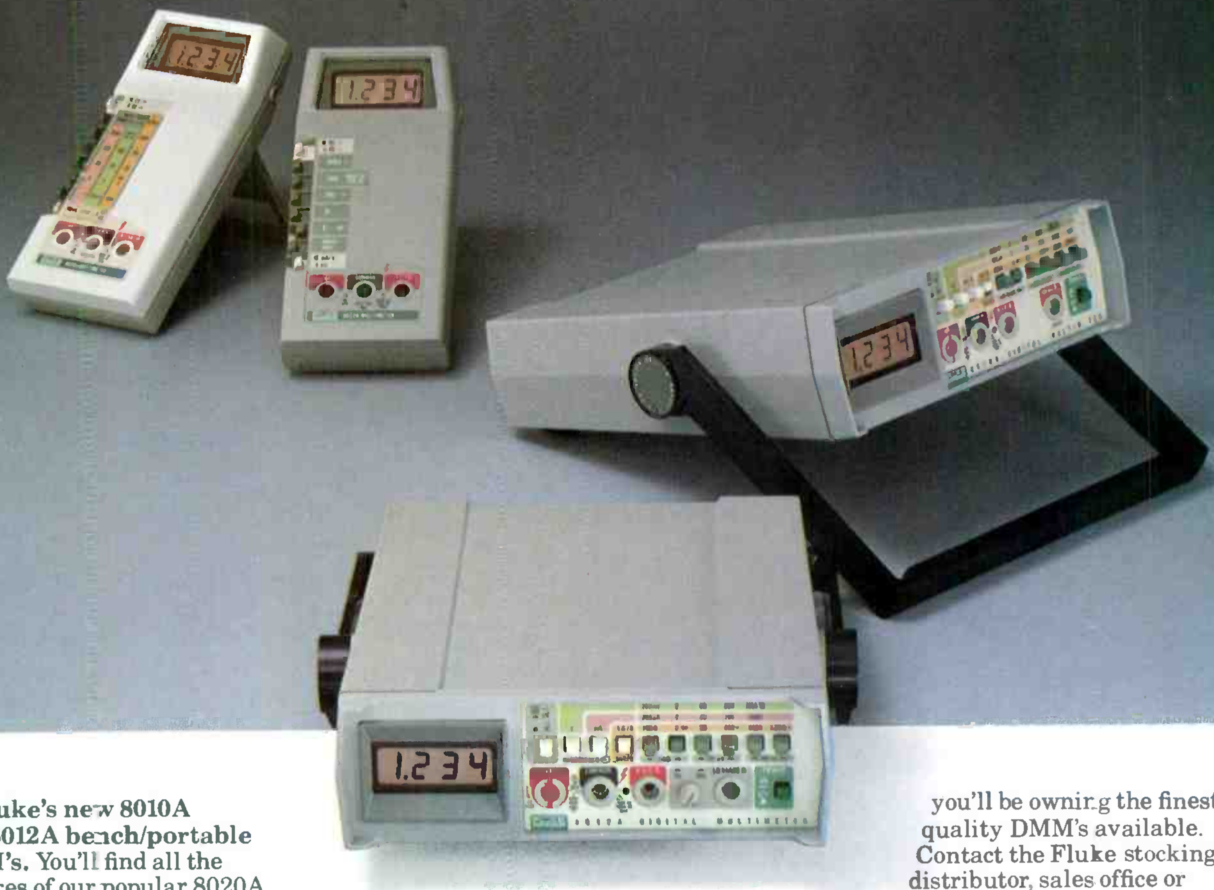
Take the step up from handheld DMM's



To Fluke's new 8010A and 8012A bench/portable DMM's. You'll find all the features of our popular 8020A handheld DMM plus many more capabilities (some not found in any other DMM) in these two instruments. At prices only a few dollars more than most handhelds.

A sensible package with sensible features. The 8010A and 8012A's bench/portable design is ideal for those who want the best of both worlds. They fit smartly on your bench and use ac power or get right up and go to the job with you. Optional rechargeable batteries are available. Both incorporate the same design goals that made our handheld 8020A DMM so rugged and reliable.

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☐ Please send 8010A/8012A specifications.
☐ Please have a salesman call.
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