November, 1979 □ $2.25

Electronic Servicing®

Special test equipment issue

RCA CTC99 features

Servicing horiz. sweep

Electronic Servicing

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November, 1979 □
Volume 29, No. 11

Electronic Servicing®

Maintenance

Servicing

Departments

About the cover

Graphic design by Linda Franzblau

electronic scanner

news of the industry

DiscoVision Associates has been established by MCA and International Business Machines (IBM) to manufacture and market videodisc players and videodiscs. IBM has several patents for computer disc storage while MCA owns and produces many films and TV shows. MCA's present distribution of videodiscs for Magnavox Magnavision players is not affected by the agreement with IBM.

Color TV sales to dealers during August were down 11.7% from those of August, 1978; while for the first 34 weeks of 1979, color sales were 0.4% lower than for the same period in 1978. Monochrome TV sales increased by 13.6% and 4.2% respectively for the same periods. Sales of home videocassette recorders increased in August by 61.1% over sales in August of 1978. For the first 34 weeks of 1979, videocassette sales were 29.6% higher than those of 1978.

Magnavox is expected in early 1980 to begin selling a new videocassette recorder built by N. V. Philips, the parent company of Magnavox. The 4-hour machine has potential for 8-hour operation plus 16-day programming of TV stations, fast motion, slow motion and stop action. Recently, 42 technicians attended extensive Magnavox videodisc training sessions at Fort Wayne, IN. This training was in anticipation of the 1980 national marketing of Magnavision videodisc players.

RCA reported an increase of 12% in color TV sales to dealers for the 1979 third quarter.

Sampo Corporation plans to manufacture television receivers in the United States, beginning in 1980. A subsidiary of the Taiwan company is to produce console color sets first. About 10% of Sampo's output now is through private-label merchandise.

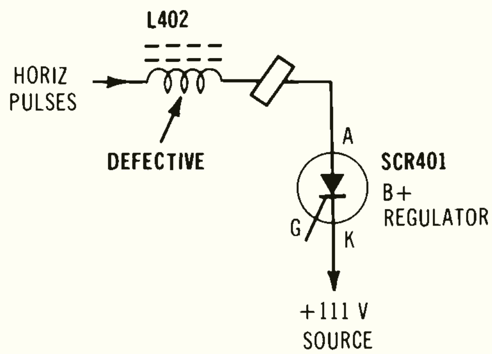
Trends in audio equipment displayed at the Japan Audio Fair included cassette decks for the new metal tape, more pulse-code-modulation (PCM) adapters that permit super-hi-fi audio recording on videocassette machines, more digital displays on tuners and amplifiers, a mini-cassette deck using metal-particle tape, and remote controls of tuners, amplifiers and tables. Several prototypes were displayed. Sanyo Electric demonstrated a home cassette audio deck with PCM giving a signal-to-noise ratio of 85dB in a modified Elcaset cassette; and Pioneer Electronic showed a PCM tape deck using Beta format without the video function.

Electronic controls and digital readouts are used extensively in new 1980 autos. Optional equipment for Ford Thunderbird and Cougar includes a cluster of electronic instruments with warning lights, a bar-chart fuel gauge and digital-readout speedometer. Engines of the Continental Mark VI have third-generation electronic engine controls, called EEC III, that regulate fuel-air ratio, secondary air to the exhaust-emission system, purging of the evaporative cannister, ignition timing, and EGR flow. Electronic keyless-entry systems are offered as options on some Ford models. A row of five pushbuttons must be pressed in a certain sequence to unlock one door, all doors or the deck lid.

symcure

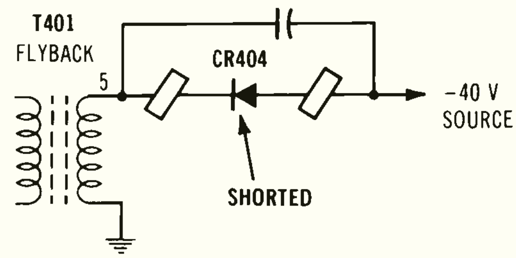
Symptoms and cures compiled from field reports of recurring troubles

Chassis—RCA CTC90
PHOTOFACT— 1710-2



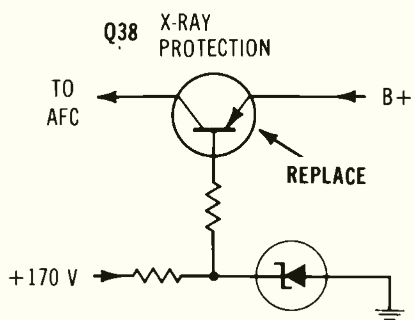
Symptom—Shutdown occurs erratically when brightness is increased
Cure—Substitute L402 as a test

Chassis—RCA CTC90
PHOTOFACT—1710-2



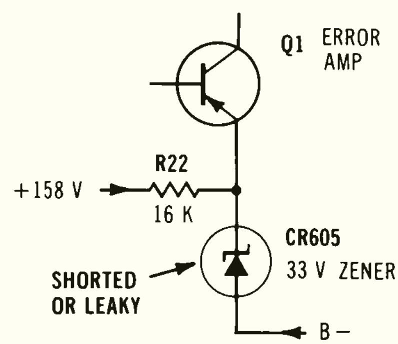
Symptom—No height, and only right edge of line has brightness
Cure—Check CR404, and replace it if shorted

Chassis—RCA CTC87
PHOTOFACT—1778-2



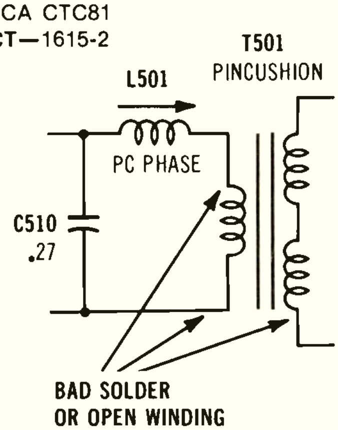
Symptom—No sound, raster or horiz sweep
Cure—Substitute Q38 as a test

Chassis—RCA CTC87
PHOTOFACT—1778-2



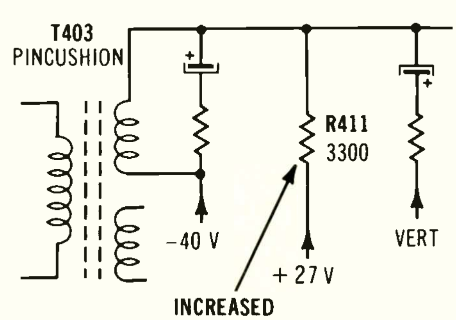
Symptom—Narrow picture, regulated B+ is low
Cure—Check CR605 (33V zener), and replace with regulator trim kit 145113 if it is leaky or shorted

Chassis—RCA CTC81
PHOTOFACT—1615-2



Symptom—Insufficient height with bowed scanning lines at top
Cure—Check for bad soldering or open windings around T501

Chassis—RCA CTC86
PHOTOFACT—1703-1



Symptom—Narrow width
Cure—Check resistor R411, and replace it if increased in value

people in the news

A. J. "Jerry" Leeper has been appointed manager, new market development of B&K-Precision. Previously, Leeper was president of AJL-Distribution. Leeper has also held marketing management positions with G.D. Searle & Company, Rohm and Haas and was a field engineer with Beckman Instruments.

George U. Messner, southern region sales manager for Honeywell's Micro Switch division, is the recipient of the Meritorious Achievement Award presented annually by the Textile Industry Committee of the Institute of Electrical and Electronics Engineers. Messner has been active in IEEE since 1952, and is currently a member of the committee's executive council.

Four vice presidents have been named to the reorganized and renamed Memorex consumer products group. The vice presidents and their departments are: **Howard F. Earhart,** operations; **Harry G. Hensman,** engineering; **John R. Humphreys,** consumer sales; and **Barry K. Berghorn,** consumer and business media products.

Switchcraft has named **William Gautreau** director of manufacturing. Gautreau was director of materials control.

The Electronic Representatives Association, New York chapter, has announced the formation of a communications, audio/visual, professional electronics products (CAP) division and named **Joel H. Schwartz,** of L-C-A Sales, as chapter vice president, CAP division.

Gerald M. Mills has been named vice president of sales and marketing at Littlefuse. Previously, Mills was director of sales for Switchcraft.

RCA has named **Dr. James Vollmer** a group vice president. He is responsible for the Government Systems and Commercial Communications divisions. Vollmer is a former physics professor who has been with RCA for 20 years. □

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: Schematic, dial parts and tubes 80, 47, 24, 2 ea. 35, 27 for RCA Victor Superette radio model R-4. Quote price, delivered. *Len Powell, 1800 Crestview Rd., Baltimore MD 21239.*

Needed: KRK168 and KRK167 tuners. *Michael Hardecker, 805 Stiles Ave., Maple Shade, NJ 08052.*

For Sale: B&K-Precision model 1077B, excellent cond., $425; Sencore SM-158 speed aligner, new, $225; Heath KT 3120 FET/transistor tester, $60; Heath IG-5218 sine/square audio generator, never used, $90; Conar solid-state scope with RCA dual-tracer and probes, like new, $225. *A. Dolgins, 1905 Woodley St., Arlington, VA 22207.*

Needed: Schematics and/or manual for Edison radio receiver model R5 and Edison power unit type 8P, receiver type 7R. These are all one unit. Will buy, or copy and return. *Jerome Galiley, 1303 Justin, Cardiff, CA 92007.*

For Sale: Leader LCG-388 color-bar generator, $75; Heathkit IT-28 capacitor checker, $29; Tektronix 531 scope with type 53/54B plug-in and cart, $175. You pay shipping. *P. J. Serafinas, 120 Embleton Rd., Owings Mills, MD 21117.*

For Sale: B&K-Precision model 283 digital multimeter with battery pack, $140 post paid; Leader LCR-740 transistorized LCR bridge, like new, $220 postpaid. *H. Geller, 12622 N.E. 3rd St., Bellevue, WA 98005.*

For Sale: Precision test master series 10-20 of tube and set tester complete with panel but no case, $55. *E. R. Bushman, 207 N. Broadway, Grand Marais, MN 55604.*

For Sale: Photofact folders 1-100 in ten original loose leaf binders plus 44 additional sets, $50 or best offer; Sams record changer manual (1947), $5; Sams communications manual, $5. *Sidney Smith, 629 Avey, Brooklyn, NY 11235.*

For Sale: Riders Troubleshooter's Manual Volumes 1 through 19, with index, and about 500 tubes for old radios. *Art's Radio R.R. 1 Box 15, Mascoutah, IL 62258.*

Needed: Parts supply source for a Shetland (now out of business) electric blender. *M. B. Danish, Mike's Repair Service, P.O. Box 217, Aberdeen Proving Ground, MD 21005.*

For Sale: Sencore CR-31, with manual and all sockets, $295; Sencore SM-152, with cables, manual and record, $250; Heath GR900 modular color TV, with remote and six books, $175; other equipment available. All prices plus shipping. *Mario Rosignuolo, 368 S. Hill Blvd., Daly City, CA 94014.*

Needed: Part number 94D351-1 Admiral horizontal oscillator coil for TK-10-2A chassis. *R. B. Stuart, 18 Dangle Ave., Akron, OH 44312.*

Needed: Service manual and schematic for Tektronix 465 scope. Will buy, or copy and return. *Alex Minelli, 718 Michigan St., Hibbing, MN 55746.*

For Sale: CB shop equipment including Sencore CB-42 analyzer, Sencore PS-43 Porta-Pack power supply, Conar model 255 scope, Conar signal tracer, substitution box, meters, probes and NRI course, Almost new with probes, $1500 or best offer. *John Groome, Route 7, Box 340B, Danville, VA 24541.*

For Sale: More than 90 car radio vibrators, covers 1930s to 1950s new, most in original boxes. $200 plus shipping. *Damascus Electronics, 12240 S.E. Wildwood Dr., Gresham, OR 97030.*

For Sale: Solar model CE capacitor Exam ETER with manual, used very little, $17.50; Conar signal generator model 280 (170kHz to 60 MHz), Practically new, $30; NRI TV and radio servicing course, complete with all kits (kits for 19-inch solid-state TV including cabinet, never assembled), $250. *David Bloom, 21 Dodge Rd., Hyde Park, MA 02136.*

Needed: Power transformer part number 54-26 for a model 0-10 or 0-12 Heathkit scope. *Everett Poff, 4010 Emerson Rd, Sterling, IL 11414.*

Needed: Cushman CE-3 (or better) monitor. *Martha Lake Electronics, 16521 13th West, Lynwood, WA 98036.*

For Sale: RCA new dynamic transistor FET tester type WT-524A, $80; Heathkit model HM-102, HF-RF power & VSWR meter, $30; RCA constant voltage dc-power supply type WP-704A, $60. *W. D. Shevtchuk, 1 Lois Avenue, Clifton, NJ 07014.*

Needed: One number 886 antique ballast radio tube, or information about a substitute. Herby's Electronics, *P.O. Box 176, Grainfield, KS 67737.*

For Sale: Mini Products amateur mini quad antenna, model HQ-1 covering 6-10-15 and 20 meter bands, $80. Very good for DX. Prefered local buyers. *W. D. Shevtchuk, 1 Lois Avenue, Clifton, NJ 17014.*

For Sale: Rider's radio manuals with complete index, volumes 1 through 22, number 3 missing, sold as a complete set only, $200. Purchaser pays shipping costs. *Hanson's Radio & TV, P.O. Box 28, Almelund, MN 55002.*

Needed: Used correspondence courses on TV and radio repair. Quote price. *Kenneth G. Wood, Jr., 7614 Riverdale, New Carrollton, MD 20784.*

Reader's exchange

Needed: Old radio magazines, service manuals, old radio tubes and stock, 1 or 1000. Please include price in first letter. *Dallas Swindal, 1112 San Jose Lane, Hanahan, SC 29406.*

For Sale: Sencore CG-135 color-bar generator, $40; Natco 3030-1 16mm sound projector, $130; two Victor Animatophone 60-10 16mm sound projectors, both $125. 42 new and used color and B&W TV yokes plus a few flybacks, all $100; Electrovox model KZ 711 intercom with 3 stations, all new, best offer. *Danny Brou, 212 Wainwright Road, Pineville, LA 71360.*

Needed: Two new 6-V 4-prong vibrators for Ford car radio. Gus Green, *12692 Green St., Boron, CA 93516.*

For Sale: TEAC model 33405 four channel, four track tape recorder. One year old, less than 40 hours of use, $900. Shipping prepaid. *Lenton Miller, Rt. 1, Walling, TN 38587.*

Needed: Service manual for JFD Roto King antenna rotator. Motor unit is RT100 and control is RT100A; service manual for a Textronix type B plug in; one 17B-B14 horizontal-output tube (or replacement) for Onkyo B&W model 12PCU; service manual for model 403B audio generator by Bryston; and a service manual for a model 257 Simpson VOM. *Rejean Mathieu, C/O Hydro Quebec Telecome, Chantier E.O.L., Bare James, Quebec JOY-2YO.*

For Sale: CB-42 analyzer, $750; CB-41, $115; DVM-35, $75; RC-167, $75; B&K-Precision model 283 DMK, $125. All instruments are new or like new. *Lionel Murmur, 15 Knox Terrace 2C, Wayne, NJ 07470.*

For Sale: RCA WT501A transistor checker, in or out of circuit, $35. *Ray Paulson, 5657 Mesa Verda, Margate, FL 33063.*

Needed: Two secondary control panels for Philco color TV. Model C4861BWA, Chassis 3CS45. This panel has a Philcomatic switch, tint, color, brightness and contrast controls. Please advise price, or information as to where I could obtain them. *Mike Costello, 40 Whiteway St., St. John's Nfld, Canada A1B 1K2.*

Needed: Surplus model ME-48CU (mfg 91820) VOM. State condition and price. *American TV, 10702 N.E. Fourth Plain Blvd., Vancouver, WA 98662.*

For Sale: Heathkit IM-28 VTVM, $50; Heathkit IG-28 color bar/dot generator, $90; Heathkit 30KV HV probe, $20; EICO 635 tubetester, $47; B&K-Precision 520 transistor tester, $140; TSC tuner subber, $18. All items plus shipping. *Gunter Seuring, Rt. 2, Box 338 Hidden Lakes, Mukwonago, WI 53149.*

For Sale: Conar single-trace, 6MHz triggered scope with full probe kit in pouch, $150. Also switches, circuit breakers, diodes, etc. Send for list. Payment by certified check, cash or money order only. Leonard *Elgart, 3510 Avenue H, Brooklyn, NY 11210.*

Needed: One B&K-Precision tube tester, in working condition for reasonable price. *John Williams TV Service, 579 Milwaukee St., Denver, CO 80206.*

For Sale: EICO 232 VTVM, EICO 147 and 150 signal tracers, Conar tube checker and transistor tester, other items. *J. C. Clark, 1702 Converse Ave., Cheyenne, WY 82001.*

Needed: Sylvania or RCA adapters for model CK3000 Sylvania Chek-a-Color test jig. *P.A. TV Service, 5087 Ridge Rd. West, Spencerport, NY 14559.*

Needed: Used or dud CRT for Conrac 17-inch monitor. Part number is 520035-004 or 17269P4. Please quote price. *S.O. Sellers, Rt. 11, Box 160, Bessemer, AL 35020.*

Needed: Name and address of distributor or manufacturer of photoflash tubes of all types and sizes. Especially need 120V to 450V transformer and 2-coil 200 watt/second flash tube. *Elmer Mosley, 720-R Poplar St., Kenova, WV 25530.*

For Sale: B&K-Precision model 415 sweep/marker with all cables, probes and manual, new, never used, $375; B&K model 282 digital multimeter, excellent condition, $70; Heathkit model IT-28 capacitor checker, never used, $40. You pay shipping charges. *John Hull, 13218 Carolyn St., Cerritos, CA 90701.*

Needed: Power transformer and efficiency coil for Zenith chassis 16Z8C19. *Elmer Mosley, 720 Poplar St., Kenova, WV 25530.*

Needed: Horizontal output transformer, part number VZ12016 for a model 6911C Broadmoor color TV. *James Higley, 1460 Cypress Ave., Hanover Park, IL 60103.*

Needed: B&K-Precision series 747 tube tester, reasonable. *Ken Miller, 10027 Calvin, Pittsburgh, PA 15235.*

For Sale: B&K Precision model 1471 dual-trace 10MHz scope with 2 PR-35 probes. With manual, $400; B&K Precision 1077B television Analyst, with manual, $400 or best offer; B&K Precision 1248 digital IC color generator, with manual; General Electric variable transformer, $35 or best offer; Tube caddy with about 300 tubes, $400 or best offer. All equipment used very little. *P. Krasowski, 116A Coles Mill Rd., Williamstown, NJ 08094.*

For Sale: Sylvania model 500 TV sweep generator, brand new in original carton, $50; Measurement Lab model 78B signal generator (20-32MC & 190-230MC), Philco 9-inch VTVM for panel mount with ac and RF probes and service manuals, $25; Admiral tuners, brand new in original cartons, 94D52-1 & 94C18-2, $5; brand new 2x2 tubes, $2 each; 104 tubes, $1 each. *Certified Radio/TV Labs, 1455 55th St., Brooklyn, NY 11219.*

Needed: Old dealer signs and advertising materials for Crosley, DeForest, RCA, Grebe and Cunningham of the 20s and 30s for museum. *Don Patterson, 636 Cambridge Road, Augusta, GA 30909.*

Needed: UHF fine tuning shaft for Zenith 175-87UAB tuner, or used tuner at a reasonable price. *Keith's TV, 2853 Gallows Rd., Falls Church, VA 22042.* ☐

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91	92	93	94	95	96	97	98	99	100

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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

Sencore model LC-53 is a complete analyzer of inductors and capacitors. It tests inductances in henries, and has a ringing test for "Q" (shorted turns). Capacitors are checked for both capacitance and leakage. Autoranging eliminates all range switches.

Sencore model LC-53 "Z Meter" is a unique inductor-capacitor tester with many automatic features. The inductance of a coil or transformer can be checked by one pushbutton. Another button gives a direct reading of capacitance. Both functions have automatic ranging and digital readout for accurate and easy testing of components.

Capacitor leakage is measured at 12 dc voltages between 3V and 600V with the leakage current displayed on the digital readout. The relative "Q" of unknown inductors is tested by the Sencore ringing method, and the number of rings is shown on the readout.

Power comes from the 120V line, so there are no batteries to run down at inconvenient times. Although the unit usually is considered to be for bench use, transportation or storage in a vertical position is made easy by the combination handle and tilt stand, a place to store the power cable, and plastic feet at the unit's back panel.

Testing inductors

Inductances in henrys are tested in the LC-53 by measuring the ac voltage that results from varying the coil current by a specific amount. Six automatically selected ranges cover inductances between 1 microhenry (1μH) and 9,990 millihenries (9,990mH or 9.99H). Decimal position also changes automatically, and LEDs at the right of the digital display (Figure 1) indicate whether the reading is in μH or mH. In-circuit tests are possible if the circuit resistances are fairly high. The Sencore manual gives the limits.

These tests resemble ohmmeter readings in their simplicity (Figure 2). Connect the hook-type test probes to the inductor terminals and then press the *inductor-value* button. That's all. One LED lights to show whether the reading is in μH or mH, and the digital display gives the reading with correct decimal placement.

For small inductances where the test-lead inductance becomes a source of error, the probes should be placed approximately where the

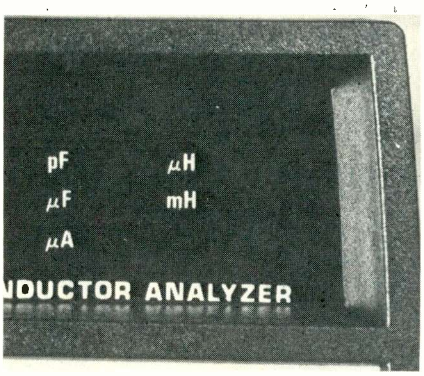


Figure 1 LEDs light up behind these markings to show whether the readout is in pF, μF, μA, μH or mH.

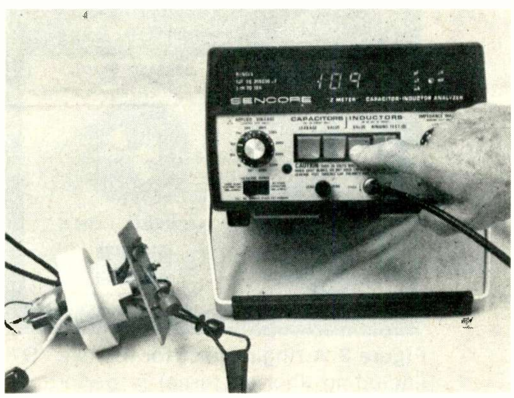


Figure 2 The true inductance in μH or mH is indicated when the inductor value button is pressed. This flyback checked 10.9mH.

measurement will be made. The hook probes are shorted together, the *value* button is pressed, and the *lead-zero* knob is rotated slowly until the readout is 00.0 with the minus sign showing occasionally. (Slow rotation is required because about two seconds are required for each reading when the probes are shorted.) After the zeroing, tests of small inductances can be made accurately.

When the inductance value is above 10H or if no inductor is connected to the test leads, the display will show 8880 with the three eights blinking. This is the overrange indication.

Ringing tests—For coils of unknown inductance ratings or for shorted-turns tests of vertical- and horizontal-sweep components, a ringing test that shows relative "Q" is included. This test is about the same as supplied by the Sencore YF-33 Ringer.

The probes are connected to the inductor, the *ringing-test* button is pressed, and the *impedance-match* knob is rotated through all six positions (Figure 3). The readout shows the number of rings before the amplitude drops to the standard value. Use the knob position that gives the highest number of rings, for accuracy. For most sweep coils, a reading of more than 10 indicates a normal coil.

Test results—Many inductors in an old color-TV chassis were checked for value and ringing. One peaking coil measured 380μH and 24 rings. Another gave readings of 4.2μH with five rings. The delay line measured 1.66mH and no rings.

An out-of-circuit audio transformer's 4Ω winding read 8.10mH and two rings, while the primary measured 8910mH and five rings.

These tests were interesting but did not prove whether or not the inductors were defective, since the ratings were not known. New coils with factory ratings were tested next.

A stock peaking coil was marked 250μH. It measured 244μH and 17 rings. A 12μH coil checked 12.1μH. These are very accurate readings. However, at first a 1.35μH peaking coil tested 0.9μH. A careful reading of the manual found the Sencore method of obtaining accuracy with reactances under 2μH. The lead-zero control is offset to give a 2μH reading with test leads shorted together. Then the reading is made and the 2μH subtracted. With this corrected method, the reading was 1.5μH, which is very good for such a low value.

Many technicians probably wonder if the inductance value test can find shorted turns as well as the ringing test does. One old flyback was checked with these comparative results: the primary measured 10.6mH and gave 95 rings, with a 5-turn short, the readings were 9.7mH with 30 rings; when the 2-turn rectifier-filament winding was shorted, the readings changed to 10.5mH and 25 rings. The inductance test can show serious cases of shorted turns, but the ringing test is more sensitive to just a few shorted turns.

Comments—Notice that the inductance-value tests require direct current. Therefore, coils in series with a blocking capacitor cannot be tested; they read as if open.

Tests of inductor's values in henries are repeated continuously as long as the value button is depressed. So, if the coil under test changes in inductance, the reading changes at the next sampling. However, the ringing test is different. It rings the inductor only *once* for each press of the ringing button or rotation of the impedance-matching knob to the next position. *Then the readout retains the number of rings, even if the inductance is disconnected.* Releasing the ringing button (or any rotation of the impedance knob) initiates a new reading, which without an inductor becomes zero. This is normal operation and it has no drawbacks. It is mentioned only for information to prevent questions later on, and because this is different from operation of the YF-33 Ringer and the built-in ringing function of the VA-48. Their ringing is continuous.

Testing capacitors

Capacitances are measured in the LC-53 by charging the capacitor under test through a specified resistance and counting the time required for the capacitor charge to rise to +5V (one time-constant).

The instrument autoranges through 10 available ranges to provide capacitance readings between 1 picofarad (1pF) and 199,900 microfarads (199,900μF). All readouts are direct-reading with LEDs at the right indicating whether the reading is in pF or μF. The decimal moves as needed, and one or two zeros are added at the end to fill out any required number. Accuracy is rated at ±1% of reading plus the resolution error, or ±5% plus resolution error for values over 1000μF.

To test most capacitances, connect the test clips to the out-of-circuit capacitor, press the *capacitor value* button, notice from the LEDs whether the value is expressed in pF or μF, and then read the value on the digital display.

For accuracy of capacitances

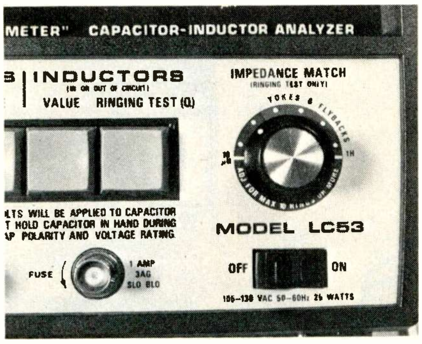
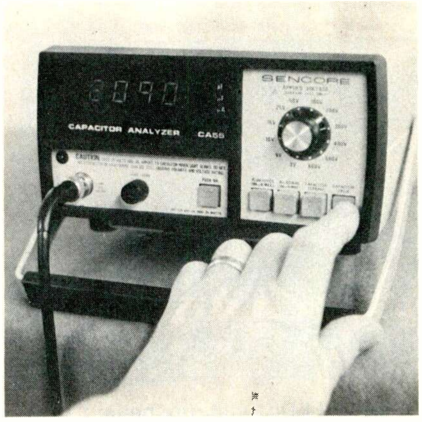


Figure 3 A ringing test for relative "Q" (including shorted turns) is performed by pressing the inductor ringing test button and rotating the impedance match knob for the highest readout of rings.



Model CA-55 has the same capacitor tests as the LC-53, but it does not check inductors.

lower than 1000pF, the test lead should be placed where it will not be moved very much when it is connected. Without anything connected to the test clips, press the value button and slowly adjust the lead-zero control for 00.0 with the negative sign flashing occasionally. Then make the capacitance measurement.

Capacitances of less than 2pF sometimes read 00.0 because of the auto-ranging window. Therefore, for these small values, offset the zeroing adjustment to provide a 2pF reading without a capacitor, make the capacitance reading, and subtract the 2pF from it. The remainder is the true capacitance.

Readings of most capacitance values are seen on the digital display immediately after the value button is pressed. However, very large values require longer. For example, a 50,000μF capacitor has a delay of about five seconds before the reading appears. Any capacitor that does not give a reading within 30 seconds probably is excessively leaky and should be replaced.

Polarity of the test leads is not important except for electrolytic types. For those, the red clip should go to the positive capacitor lead and the black clip to the negative. A 39G144 test lead adapter is furnished for connecting to large terminals.

Leakage tests—Model LC-53 has an excellent leakage test for capacitors. The *applied-voltage* switch selects

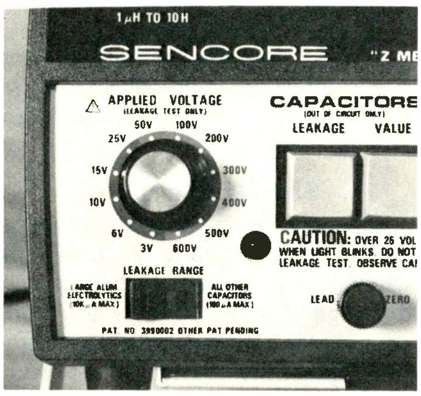


Figure 4 Two ranges of leakage current and 12 levels of dc voltage are available for testing capacitor leakage. The digital readout shows the leakage current in μA.

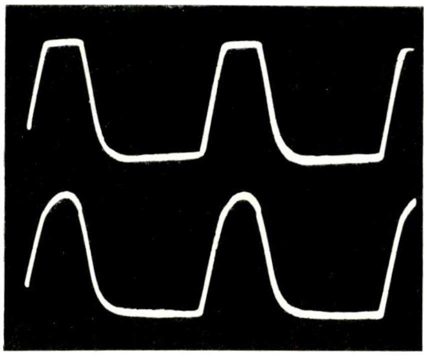


Figure 5 Without a capacitor across the test leads, the dc leakage voltage consists only of positive-going pulses. A test capacitor of 0.3μF or so brings the average voltage up to the marked values. Top trace is the 15V waveform while the 500V waveform is shown below.

dc voltages of 3V, 6V, 10V, 15V, 25V, 50V, 100V, 200V, 300V, 400V, 500V and 600V, as shown in Figure 4. Two amounts of leakage current are selected by the *leakage-range* switch. The 9,990μA range is for large electrolytics or others that have high leakage. Other types should be measured on the 99.9μA setting of the leakage-range switch.

Ceramic, polyester, polycarbonate or mica dielectric capacitors should not show any leakage current on the display. Any that have leakage are defective and should be replaced.

Electrolytics usually show some leakage. A chart that lists permissible electrolytic leakage according to capacitance is mounted underneath the LC-53 cabinet where it can be pulled out for reference.

There is a small precaution when testing small capacitances for leakages. Without a capacitor connected to the test leads, the leakage voltage consists of positive-going 60Hz pulses (Figure 5). If a resistor is connected across the test leads instead of a capacitor, the measured voltage (and current) will be only ⅓ to ½ of the rated value. For the *full* rated voltage, the capacitor under test needs to be .03μF or larger. Of course, if a very small capacitance value (say 12pF) must be tested at the full 600V, a larger capacitances having low leakage can be paralleled with it during the leakage test.

The leakage test can be used to reform many old electrolytic capacitors. These reforming methods must apply the dc voltage for an hour or so. To keep the leakage button depressed, a 39G145 rod is included with the analyzer. It is placed between the button and the carrying handle, which is moved near the test buttons.

When none of the buttons are pressed, the test leads are shorted together, thus discharging the external capacitors. No leakage voltage is applied to the test leads until the leakage button is pushed.

Comments

For protection of the analyzer from charged capacitors and other external overloads, a 1A slow-blow fuse is located behind the BNC test lead connector. The fuse can be removed and replaced by unscrewing the BNC connector.

A 48-page operation and maintenance manual is supplied with the analyzer. It has much detailed information about the instrument and how to use it for many unusual tests. One section explains how the LC-53 can be used to test SCRs, TRIACs, HV diodes and coaxial cable.

Inductor and capacitor readings were very accurate when measuring components of known values. Busy technicians should appreciate the convenience of merely pressing a button or two for the majority of tests. The LC-53 is recommended for all electronic-service shops.

Model CA-55

Sencore model CA-55 capacitor analyzer has capacitor-testing functions that are identical to those described for the LC-53. The switches are arranged differently because the inductor tests are not there.

Model CA-55 capacitor analyzer sells for $495, and model LC-53 inductor/capacitor analyzer is priced at $695. □

Digitization of low-frequency signals

By E. Stanley Busby, Jr. ,Engineer, Ampex Corporation

Industrial controls and TV broadcasting equipment often contain circuits that convert analog signals to digital signals, or digital to analog. Such interfaces have made noise-free digital audiotape recorders possible. In the future, improved versions might be the answer for digital video. An experienced design engineer describes the general operation of some circuits that digitize low-frequency signals.

Many digital meters indirectly measure dc voltage by counting the time required for an R/C circuit to reach a certain level as it charges or discharges. This counting and displaying operation is repeated over and over, usually several times per second.

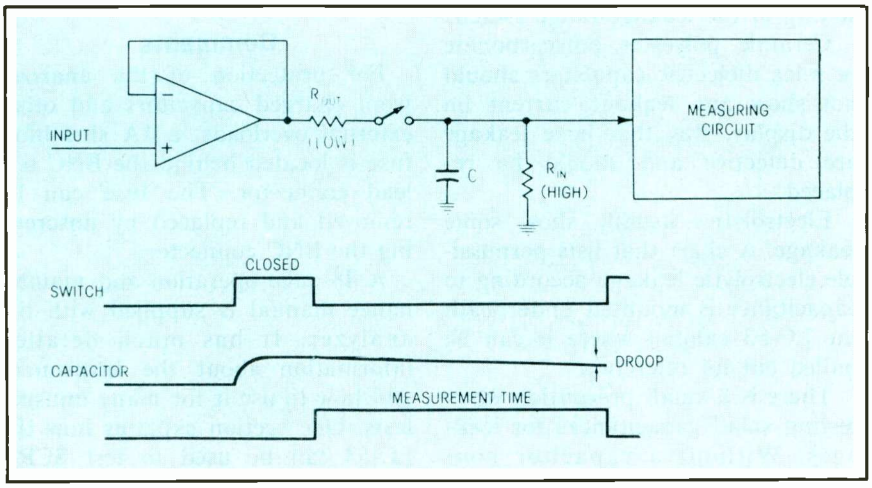


Figure 1 A dc voltage can be measured or digitized by a sample-and-hold action. The instantaneous value of an ac signal also can be determined by a similar method; however, the sampling time and the holding time must be selected carefully.

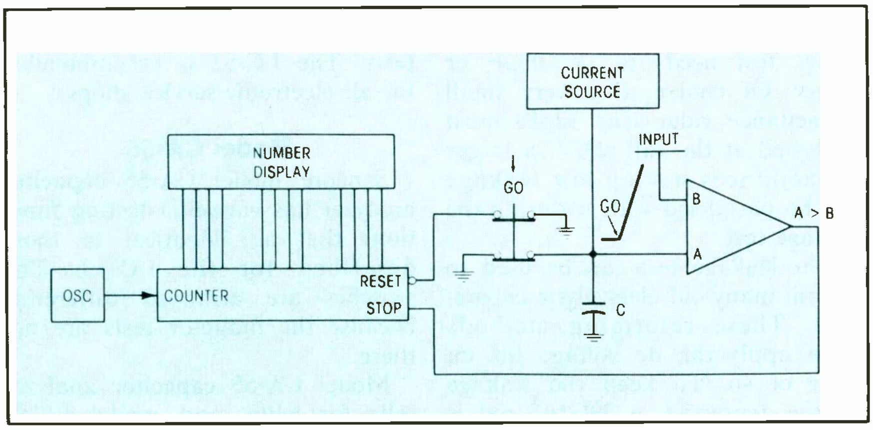


Figure 2 Some digital multimeters measure an unknown dc voltage by counting the time required to charge a capacitor until its voltage equals the unknown.

The important word in the previous paragraph is "*counting.*" A nonvarying dc voltage is easily measured by the counting method. A dependable and accurate reading usually can be obtained by the first or second timing count. Each counting period requires perhaps a quarter to a half second. Measuring the average amplitude of ac voltages is not much more difficult. The ac is changed to dc, a correction factor is added, and the resulting dc is measured.

However, conversion of an ac signal *waveform* to digital for processing or storage, followed by conversion back to the *original* analog waveform, is more difficult. One of the problem areas concerns the length of each individual measurement.

Low-repetition-rate signals (such as industrial-control signals or audio) require careful matching of the duration of each measurement versus the repetition of the signal. When the time between measurements (or sampling) is too long for the conditions, some part of the waveform will be missing. For example, a sine wave might have segments missing between each measurement.

Also, a measurement time that's too long can allow several repetitions of the waveform to occur, thus changing several sine waves into a straight line.

These two timing relationships must be optimized for best results. For example, if a sine wave is converted from analog to digital, processed or stored, and then is finally converted from digital to analog, the output waveform should be the same as the original input. These same precautions apply to digitized video signals.

Several preliminary concepts and a few alternate methods of digitizing ac and varying-dc signals are examined next.

Sample and hold

Figure 1 shows how an electrical signal can be made to hold still while being measured. The procedure goes: close the switch long enough for the capacitor to charge up, open the switch to prevent further change, then measure the voltage across the capacitor.

How fast to repeat the measurement? If a sampling frequency of less than double the highest signal frequency is used, the sampling lower sideband is inside the signal bandwidth. The resulting distortion is heard as a *birdie*, is seen on TV as *moire*, and is called an *aliasing component* by digital engineers.

Theoretically, a *brick wall* filter having an infinitely steep cut-off (that eliminates all modulating frequencies above half the sampling rate) could permit sampling at exactly twice the signal bandwidth. However, a brick-wall filter is not possible, and so the sampling rate always is chosen to be faster than twice the signal bandwidth. In systems with analog input, digital in the middle, and analog output, bandwidth-restricting filters are used before and after digitization.

Single ramp A/D

Probably the most simple method of converting a voltage to a number (analog-to-digital or A/D) is the indirect method used in most digital voltmeters. Figure 2 shows one elementary approach. To measure, a short circuit is removed from the capacitor, and at the same time, a counter (usually a BCD counter in bench instruments) is started from zero. The capacitor charges linearly until its voltage exceeds the voltage to be measured. The counter is then stopped and its contents displayed.

This requires that the current source, capacitor, and counting frequency have good long-term stability. There are a number of schemes used to reduce these stringent demands, some of them ramping the capacitor up and down as many as four times. By doing this, the accuracy requirements are concentrated in the reference current source and the instrument can be caused to "zero" itself before each measurement. For digitizing audio or video signals to any usable resolution, this method is too slow.

Start at the output

A/D conversion is often accomplished with the same circuit used to convert a number to a voltage (digital-to-analog or D/A). Figure 3 shows the simplest D/A circuit. R_1, when connected, furnishes a current into the amplifier which is responsible for ½ full-scale output; R_2 is responsible for ¼ full-scale; R_3 for ⅛ and so on.

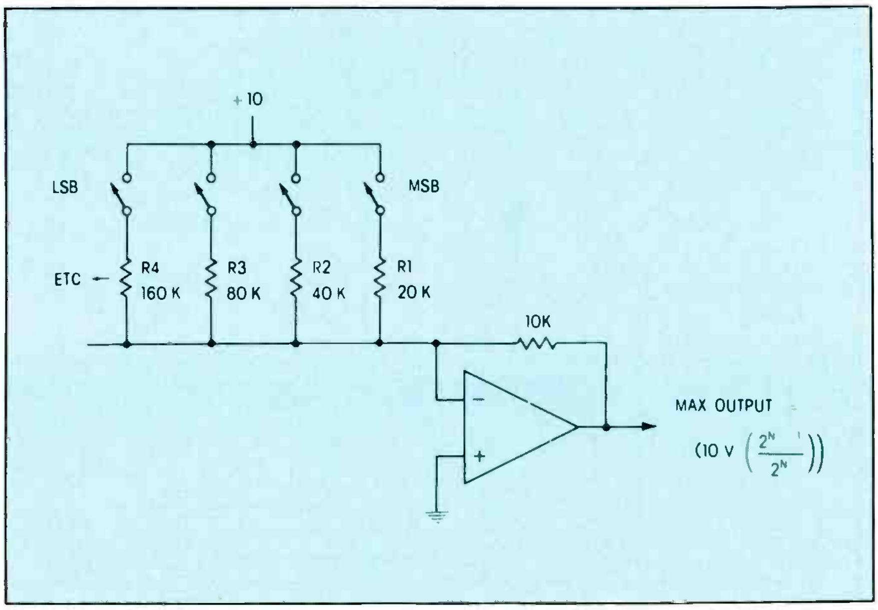


Figure 3 One binary-weighted resistor and switch for each digit can function as a simple digital-to-analog (D/A) circuit. LSB is the least-significant-bit and MSB stands for most-significant-bit. Each bit adds its own voltage to the output.

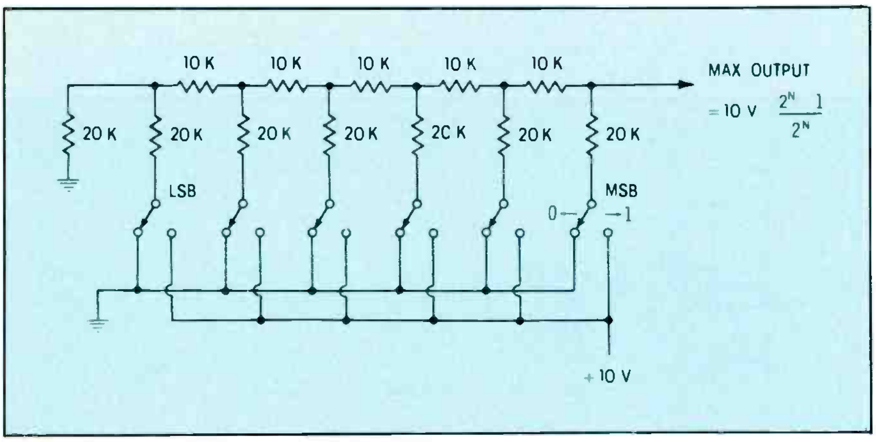


Figure 4 A ladder attentuator can perform the same D/A function as the binary-weighted circuit of Figure 4, but the smaller spread of resistances allows better temperature stability.

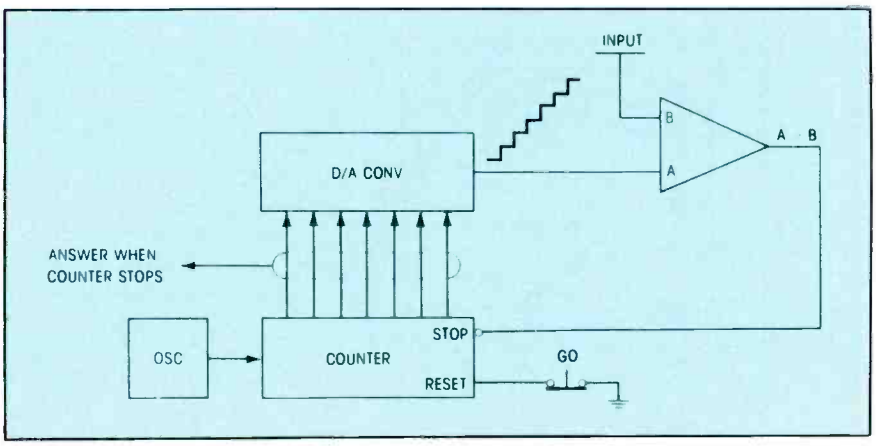


Figure 5 A/D conversion can be performed by reversing the previous circuits. A counter starts at zero, and the staircase output is compared to the unknown voltage. The counting continues until the staircase voltage equals or exceeds the unknown. When the counter stops, the readout shows the digital value of the unknown voltage.

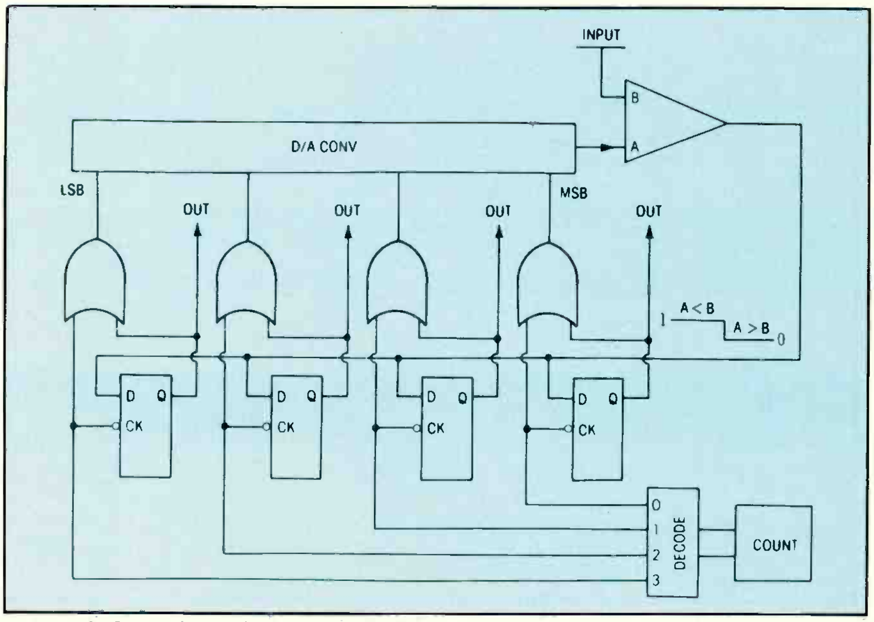


Figure 6 Operation of the successive-approximation A/D is faster than the counting type because fewer tests are required. First, the MSB (which gives half scale) is compared with the unknown voltage. The circuit then latches or doesn't latch that MSB and tries the next bit, and so on until a match is obtained and the readout shows the digital value.

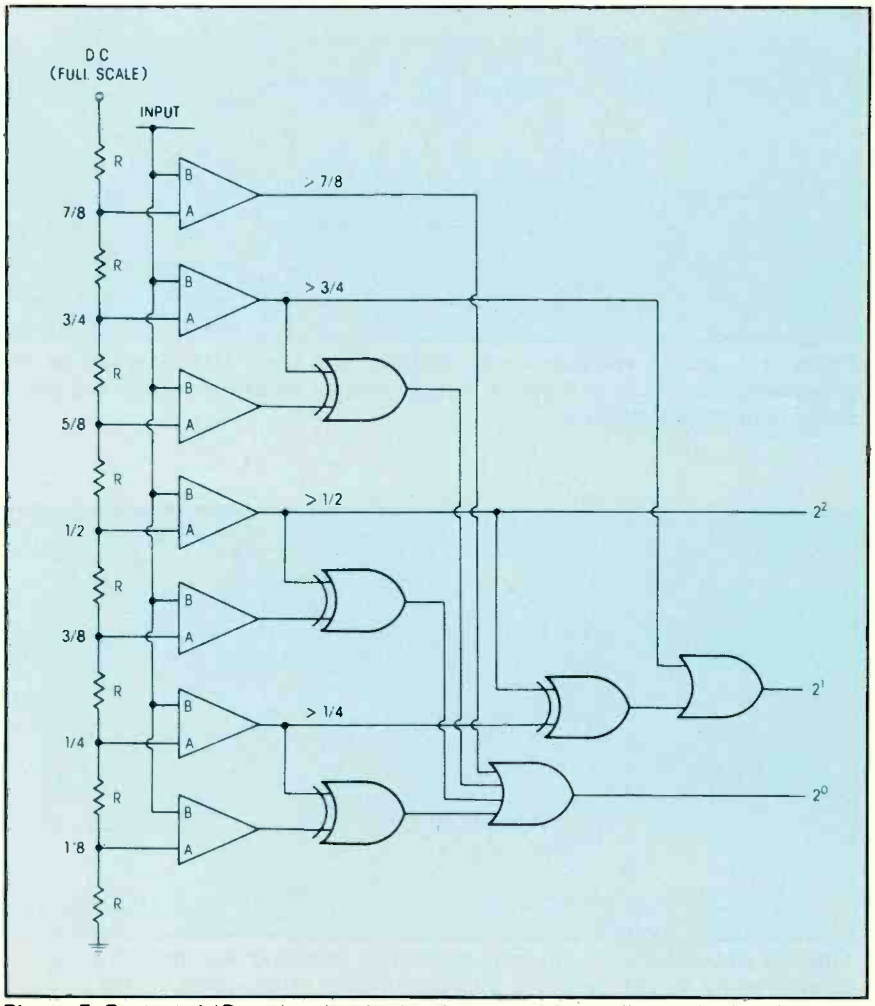


Figure 7 Fastest A/D action is obtained by a "one look" circuit that has one comparator for each analog level. Therefore, 255 comparators are required for an 8-bit digitizer.

Digitization

Adding one more resistor doubles the resolution. It has a problem: even with moderate resolution, the resistor values cover an enormous range.

This makes it very difficult to maintain their two-to-one ratio over a range of temperatures, even when they are encapsulated into the same package.

Figure 4 shows how a ladder attentuator can be used. Arranging the resistors into a ladder attentuator (Figure 5) allows D/A operation without temperature drift.

Try it on for size

Figure 5 shows how a D/A can be used as an A/D. A counter which starts at zero drives a D/A whose output is compared to the input being measured. The D/A output increases one step at a time. When it exceeds the input, the counter is stopped and the number read from it. In the worst case (full scale) it is slow, because it must step through each intermediate value in turn.

A very popular method is illustrated in Figure 6. The most significant bit (responsible for ½ full-scale) is turned on and the D/A output compared with the input. If the D/A output is too much, this bit is turned off and if not is latched on. The next bit (¼ full-scale) is turned on and tested to see if it should be kept or not. In this way it is only necessary to make N tests for an N bit A/D instead of 2^N tests for the counter type. It is adequately fast for digitizing audio frequencies, but not for video.

Do it all at once

Figure 7 shows the fastest approach of all. To conserve paper, the illustration is for a 3-bit A/D. One look at the input sample yields an answer. Its problem is that it requires 2^N-1 comparators for N bits. An eight-bit digitizer would require 255 comparators. It has been done for digitizing video where time is very short. There are better ways.

When time is short...

Television video is normally sampled at three or four times the subcarrier frequency.

The method used in many digital time-base correctors is shown in Figure 8. Fifteen comparators in a *one-look* configuration examine the input sample and split out the four most significant bits of the end product. These four bits are applied to a D/A whose output is subtracted from the input sample. The remainder is amplified 16 times and applied to an identical 4-bit one-look A/D to yield the four least significant bits.

Stepping over the bad

D/A circuits take time to settle down after the input number is changed. As their output moves from one value to another, they are likely to produce nasty transients. The fast component of the transients will be smoothed by the output low-pass filter, but the average of all these ragged edges does not necessarily equal zero and this can produce undesirable effects in the output analog *signal.* A solution is to *re-sample* the D/A output as shown in Figure 9, capturing it only after it has become stable. It's like opening the curtains only when the sun is out.

There is a loss of amplitude at high frequencies of the same form as that produced by a playback head gap or an optical scanning slit on a film projector. In practical systems, it is usually less than three dB and easily equalized.

Different Kinds of noise

You may hear the term *"quantizing noise."* It is not a noise in the sense that it sizzles in the background when no one is talking. Rather it comes from the deliberate limiting of accuracy when converting a signal to a number.

The final output is then only an approximation to the input. A large, spectrally pure input sine wave will emerge as a large sine wave accompanied by some low-level trash spread throughout the spectrum. The magnitude of this trash is halved for each added binary bit of resolution. It occurs *only* in the presence of a signal. It is similar to the *asperity noise* or *modulation noise* of an audiotape recording.

Idling noise is more like real noise. If an amplifier somewhere has a little dc offset, its output (with zero input) can present to the A/D converter a voltage midway between step N and step N+1. Add to this the inevitable thermal noise in all amplifiers, and the A/D sometimes says N and sometimes says N+1. The output varies accordingly.

The peak amplitude of this garbage is one step. It can be minimized by adding to the input signal a square wave at half of the sampling frequency and having an amplitude of ½ step. This tends to concentrate the noise at a frequency which later will be removed by the output low-pass filter. This added signal is called *dither.*

It would seem that adding more bits of resolution is the answer to all ills. It is, if you can afford it. For N bits, memory cost is at least proportional to N and the cost of A/D's and D/A's tends to vary as 2^N. More accuracy also takes more time.

Analog systems tend to distort large signals, while digital systems mangle weak signals. But there are tricks that allow digital performance to exceed that of analog.

Comments

In industrial situations, digital circuits minimize drift problems and permit elimination of noise from analog control signals. Also, certain kinds of machine controls are practical only in digital form.

The number of digital circuits in industrial equipment will expand greatly.

Digital TV transmitters, tape recorders, and color receivers are coming some year soon. Look for them. □

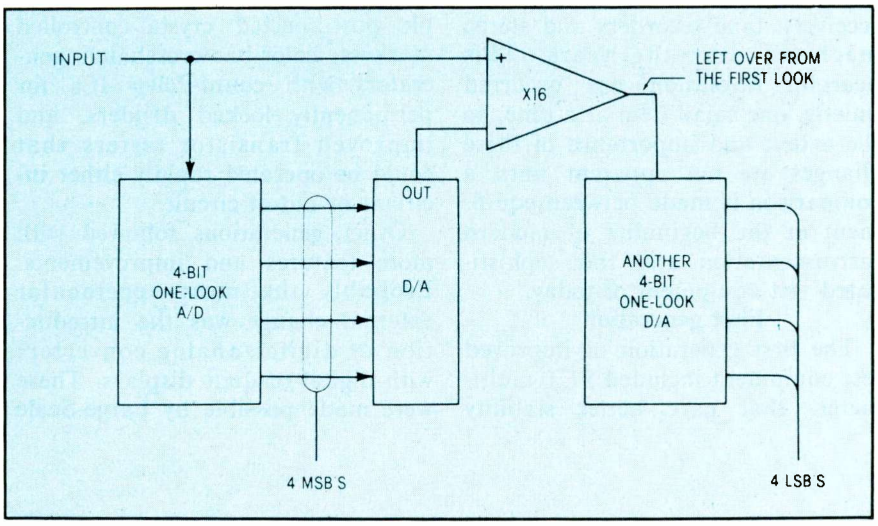


Figure 8 In some TV time-base correctors, the number of comparators is reduced by digitizing in two steps. First, 15 comparators in a 4-bit one-look system digitizes the larger amplitudes. Then the second 4-bit D/A system produces the 4 LSBs.

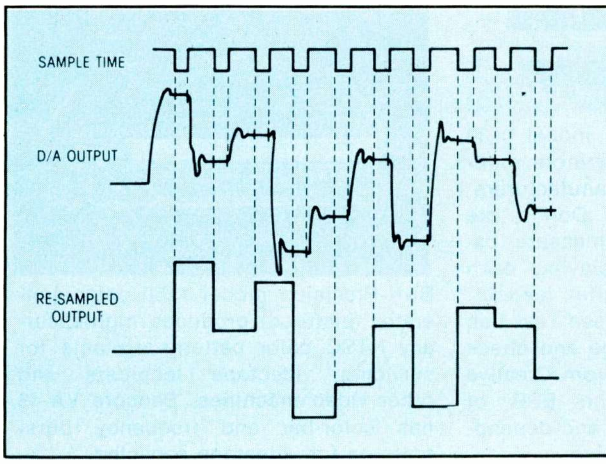


Figure 9 Overshoots or transients in the output of a D/A system can be removed by resampling, as shown.

Test Equipment roundup

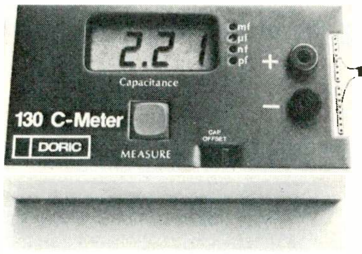
Electronic test equipment has advanced in step with the significant improvements of radios, television receivers, tape recorders and stereo machines over the years. This peaceful revolution has occurred quietly, one small item at a time, so the extent and importance of these changes are not apparent until a comparison is made between equipment at the beginning of modern instrumentation and the sophisticated test equipment of today.

First generation

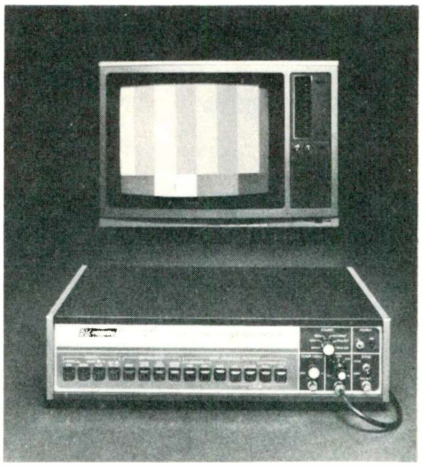
The first generation of improved test equipment included FET multimeters that gave better stability with decreased drain (thus making battery operation practical), sweep-alignment generators with multiple post-injected crystal-controlled markers, color-bar/crosshatch generators with count-down ICs for permanently locked dividers, and improved transistor testers that could be operated rapidly either in-circuit or out-of-circuit.

Other generations followed with more features and improvements. Probably the most spectacular external change was the introduction of digital/analog converters with digital-readout displays. These were made possible by Large-Scale Integration (LSI) ICs which crowd thousands of transistors into a small package. The result was unprecedented accuracy at reasonable cost.

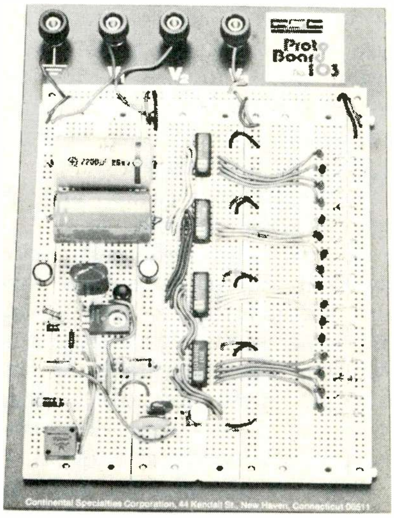
For example, older volt-ohm-meters (VOMs) typically had accuracy ratings between ±3% and ±5%. However, with a drifted zeroing adjustment and parallax error, the true accuracy often was no better than ±10%. Contrast those figures to digital multimeters with ratings between ±0.1% and ±0.5%. Even more important than accuracy, in many cases, are those digital displays that are direct



Pictured is the Doric model 130 capacitance tester. Ten or more models are offered by other manufacturers. A few (such as the Doric) are autoranging, and most measure capacitance alone by displaying each accurate result on a digital readout. Sencore has two models (see Test Lab this month) that autorange and check leakage. The ESR Meter from Creative Electronics measures the ESR of capacitors to give a rapid and dependable test of bad electrolytics.



B&K-Precision model 1250 color generator (pictured) produces high-accuracy NTSC color patterns suitable for servicing videotape recorders and other video machines. Sencore VA-48 has color-bar and frequency burst patterns for videotape servicing.



Digital experiments or home-built gadgets are produced easier and more accurately by a modern breadboard, such as this Continental Specialties model 103.

Roundup	GENERATORS						METERS							
	RF with audio mod	Audio, pulse, function, sine/sq	CB channels	Dot/crosshatch/ color bars	NTSC color	Sweep alignment	Capacitance and/or inductance	Frequency counter	Analog multitester	Digital multimeters	RF power/ VSWR	Transistor tester	Power supplies	Digital probes
Ballantine								25		25				
Beckman										26				
Berkeley	27					27					27	27		
Bird											28			
Boonton	29						29		29	29				
Cincinnati Electrosystems		30											30	
Continental Specialties		31					31	31					31	31
Creative							32							
Data Precision							33	33	33					
Data Tech							34			34				
Datel-Intersil										35			35	
Doric							36			36				
Dumont										37				
B&K-Precision	38	38	38	38	38	38	38	38	38	38		38	38	38
Fluke		39						39		39				
GenRad		40				40								40
GC									41					
Hewlett-Packard	42	42					42	42	42	42	42		42	42
Hickok	43	43	43	43				43	43	43	43	43		
IET Labs							44							
Leader	45	45	45	45	45	45		45	45	45	45	45		
Lectrotech	46		46	46		46		46				46		
LFE									47	47				
Marconi		48												
Narda	49										49			
Newport								50						
Polarad	51	51												
PTS										52		52	52	
Sencore	53	53	53	53		53	53	53		53	53	53		
Systron-Donner	54	54						54		54			54	
Tektronix		55		55			55	55	55	55		55	55	55
Triplett									56	56				
VIZ	57	57		57				57	57	57	57	57	57	57
Wavetek	58	58				58								
Workman									59		59			

Circle numbers listed above on Reply card for more information.

reading, with correct decimal placement and automatic positive or negative signs. And digital multimeters sometimes sell for about the same price as analog types.

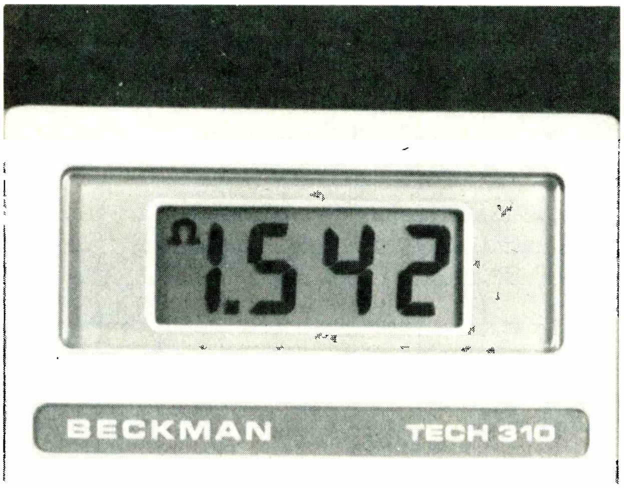
Digital circuitry is very common in modern test equipment. However, digital readouts are not very effective when presented with a varying input signal. Don't judge the worth of any instrument solely on whether or not it has digital circuitry. There are other important considerations.

Digital ohmmeters, for example, are usually not efficient at identifying rapid and small variations of resistance. Some manufacturers furnish an extra test. One multimeter emits an audio tone when continuity is established; another rapidly lights an ohm symbol. A few digital multimeters have auxiliary analog meters (perhaps without calibrations) which show those varying readings. If varying or erratic readings degrade your tests, examine these extra features of digital instruments or use analog types.

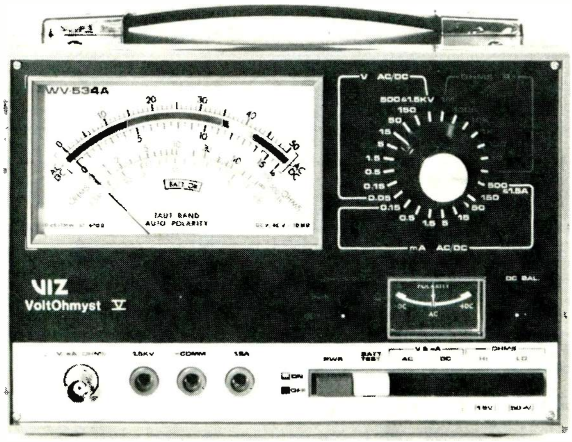
True-RMS and peak-to-peak ac measurements are features previously unheard of in digital multimeters, but they are beginning to become available in selected models. Check the specifications, if these measurements are important to your troubleshooting.

It is unlikely that digital circuitry ever will replace scopes (however, scopes will include more digital features in the future). Although the emphasis this month is not on scopes, it is true they have reached new heights of performance. This is fortunate, for scopes will be increasingly important for servicing in the future.

The table on page 19 lists generic types of test equipment and their manufacturers along with Reader's Service numbers for catalogs and data sheets. Also, a few unique instruments will be described and pictured. □



Several digital multimeters provide a rapid audible or visual indication of continuity to help in the location of intermittents. The Beckman TECH-310 (pictured) shows an ohm symbol in the upper left corner of the display. Data Precision model 936 has an overvoltage alarm and a continuity beep, while an audible signal from Weston model 6100 meter sounds for dc voltages or continuity below certain ranges.



For technicians who prefer a VTVM-type of analog multimeter, VIZ offers the super-deluxe WV-534A VoltOhmyst V. Some of the features include: automatic polarity with plus and minus indication, ac and dc voltages between 0.05V and 1500V full scale, high- and low-power ohms ranges, and both dc and ac current.

Metered power supplies are becoming a necessity for voltage substitution during troubleshooting or for testing modules and other components out of the machine. PTS Electronics model DG-5 features four adjustable-voltage supplies which can provide either positive or negative voltage. The built-in digital voltmeter can monitor any of the four supplies or be switched to jacks for external tests.

A few digital multimeters now measure decibels, true RMS and peak or peak-to-peak ac voltages. The Fluke digital multimeter models 8010A and 8012A measure true RMS ac values. The 8920 series (pictured) does not measure dc but reads true RMS voltages up to 20MHz, or dBs at many impedances. Ballantine 3030A accurately reads average, peak, true RMS or decibels. The microprocessor controlled Sencore DVM-56 (to be available in January) measures peak-to-peak, average, true RMS or decibels. Models 248, 258 and 248OR from Data Precision are 4½-digit multimeters that measure true RMS.

Quick tip

Buzz test that failed

By Wayne Lemons, CET

Audio-amplifier gain can be estimated by an electronic technician who touches his finger to the input connection and listens for hum or buzz from the speaker. This shortcut technique has been used for more than 50 years and continues to be a valid test in many cases where only a good/bad indication is sufficient. *Audible buzz proves the following stages have sufficient gain; but a lack of buzz indicates a defect has eliminated the gain.*

Infallible test?

One technician had used the buzz test for years without making diagnostic mistakes and he believed it was an infallible method. However, all tests have limitations, as the technician soon learned when a transistorized public-address system was brought to the shop for repair. After the bottom shield was removed, the tech touched his finger to the mic jack's *hot* lug. A loud buzz came from the test speaker indicating normal gain. But when he plugged in the microphone and spoke into it, no sound came from the test speaker even at maximum gain setting.

Bad mic, plug or cable

The technician now assumed that the mic, cable or plug was defective. But no sound came from a test mic when it was substituted. Reasoning that the jack might be shorting to ground only when the mic plug was inserted, he searched for shorts and opens by using the ohmmeter range of a VOM. There were no opens or shorts (either with a mic plugged in or without it), and the wiring was correct.

The technician reviewed the procedure and repeated the tests. But the conclusion was the same—the amplifier worked normally except with a microphone.

Better tests

Up to this point, the technician had diagnosed efficiently by performing simple, but appropriate, tests. The buzz test indicated a dead microphone, but replacement of it disproved that possibility. If the tech then either had given up or had shotgunned the input stages, he would have wasted much time and learned nothing.

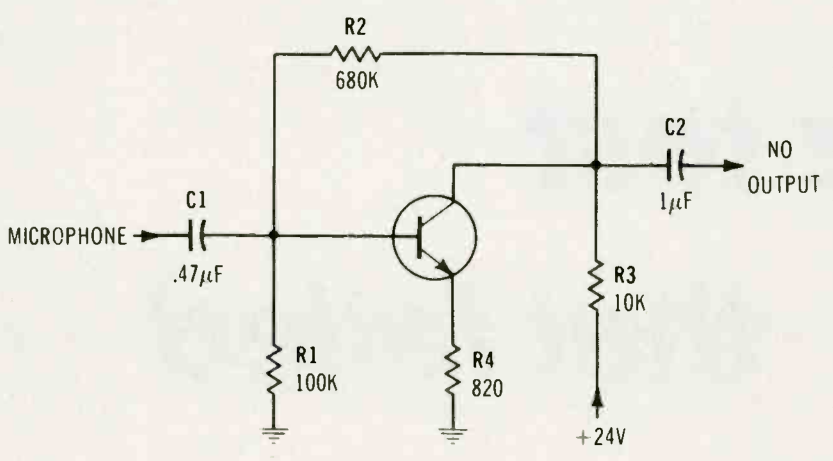
Fortunately, this technician guessed correctly that a limitation of the buzz test was responsible for the ambiguous conclusions, and he went on to the next level of more-precise tests.

His troubleshooting ESP guided him to the first transistorized stage, the microphone preamplifier. Dc-voltage measurements were the first to be performed, and they revealed abnormal conditions. Voltage at the collector (see schematic) was equal to the supply voltage and the base voltage was almost zero. These dc voltages proved the transistor was non-conducting because of insufficient forward bias. This stage *should* have had zero gain. How did the buzz pass through?

Curiosity caused the technician to measure the dc voltages during a repeat of the buzz test. With his finger touching the input lug and a buzz coming from the speaker, the base voltage measured about -1Vdc, and the collector reading was about half of the supply voltage. During the buzz test, the transistor *was* conducting and amplifying. Those voltages hinted that the buzz signal was acting as bias for the transistor, thus permitting amplification. But unexplained was the question of why the microphone signal was ignored rather than being used as bias, also.

Use theory either before or afterwards

When the total picture is con-



WHICH COMPONENT IS BAD?

fused, a good rule for troubleshooting is to follow all *known* discrepancies or symptoms. Often this will lead to finding the bad component, and then the theory can be reviewed later.

Therefore, the technician investigated the source of the insufficient base bias. He disconnected the base ends of R1 and R2 and measured their resistances. R2 was within tolerance, but R1 had increased to more than 7MΩ. A new resistor restored proper microphone volume.

Explanation

Current between collector and emitter in a silicon transistor is zero for all reversed-bias voltages, and it also is zero for forward-bias voltages of less than 0.5V (dc or peak). Only forward bias of more than 0.5V produces significant amounts of C/E current and gain.

A 60Hz signal of several volts can be transferred to a high-impedance amplifier input by ungrounded fingers. During positive peaks this signal acts as strong forward bias, thus saturating the transistor with maximum collector current. The negative peaks are reversed bias which eliminates all collector current. Therefore, the buzz-test (collector) output signal is a series of strong pulses.

The signal level of most public-address microphones is about 1mV. Suppose the forward bias of the malfunctioning transistor is 0.15V. Adding the 1mV signal increases the bias to only 0.16V on positive peaks. This is far below the conduction threshold. The transistor remains cut off, no signal is at the collector, and no microphone sounds reach the speaker.

All of the confusion and wrong symptoms would have been prevented if the technician had applied a .01V signal from an audio generator to the microphone input. **Moral:** The buzz test for gain can cause gross errors when applied to amplifier inputs that normally are supplied with less than about 0.1V of signal. □

Details of buzz tests

Tests by hum or buzz are possible because an ungrounded human body picks up a significant amount of 60Hz power signal by capacitance action from surrounding electrical wiring. Amplitudes of more than 200VPP have been measured with an ungrounded scope when the low-capacitance probe was grasped firmly between thumb and finger. Less-firm connections reduced the variable amplitude. When a 1MΩ resistor was used as a load, the signal dropped to about 75VPP. The low-resistance load of a transistor would lower the signal even more, although the reduced amplitude is sufficient for a buzz test.

Results were very different when the scope was grounded by the third prong of the ac plug. Only about 1VPP could be obtained by finger connections. About 5VPP was obtained from a 15-ft wire. With an ungrounded scope the measurement had been 100VPP.

Tubes vs. transistors

Accuracy of the buzz test varies according to the total amplifier gain and the impedance of the input. Loudest buzz volume is obtained from high gain amplifiers having high-impedance inputs. Therefore, a larger percentage of tube amplifiers fulfill these qualifications than the solid-state versions do.

For example, an input for ceramic phonograph record cartridge has an input resistance of 500,000Ω or higher and the amplifier gain is sufficient for full output with about 0.5V RMS at the input. These amplifiers provide a loud buzz regardless of whether they have tubes or transistors.

Tube circuits of two or more stages produce a satisfactory buzz during tests. However, a single power-output transistor might not produce a buzz because of the low input impedance. Many audio stages in TVs have sufficient gain for a dependable buzz test.

Another variable is that the buzz volume depends on the amplifier grounding. Different results are obtained when one side of the ac line is bypassed to ground with a capacitor than when both sides are bypassed or if a single capacitor is connected between the ac inputs.

However, for most tests there is more than enough amplitude of 60Hz signal to drive the amplifier into distortion. This distortion is the reason why the test signal sounds as a raw buzz rather than a smooth hum (as it would with a pure sine wave of that frequency).

Waveform examples

Figure 1 shows actual waveforms obtained by grasping the base lead of the transistor in the previous circuit. The amplitude was not stable, making detailed analysis and sharp traces very difficult to obtain. Therefore, a second set of waveforms was simulated (Figure 2). The Figure 2A waveform shows base-signal clipping that begins at +0.6V above the zero-voltage line. Current from the forward bias between base and emitter produces the line of clipping marks where transistor amplification begins. This analysis is proved by the collector waveform of Figure 2B.

Comments

In most applications, the buzz test of amplifier gain is practical and dependable. However, question the results if they do not agree with other allied tests. Go on to instrument analysis if there is doubt about the accuracy of any buzz test. □

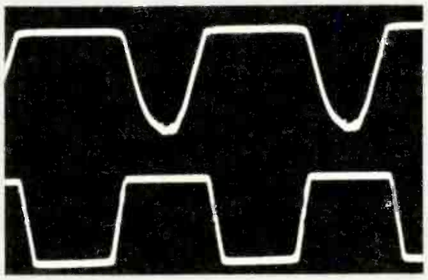


Figure 1 Top scope trace is the base waveform with part of the positive peak clipped by transistor base current during an actual buzz test in the previous circuit. Collector waveform (lower trace) is a near-square wave because the finger hum at the base was strong.

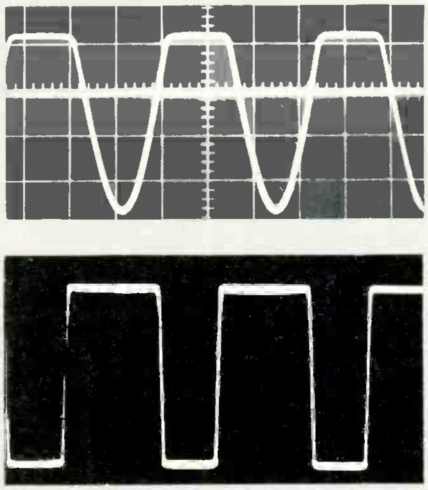


Figure 2 (A) To obtain a stable waveform, a sine-wave generator was used during a simulated buzz test. Scope gain was 0.5V/division, so the zero-voltage line shows no base conduction until +0.6V. Base current then clipped the sine wave. This base current in turn produced collector/emitter current. (B) The collector waveform was almost a square wave, with the positive peaks reaching the +8V-supply level during negative base peaks (cut-off bias) and the negative peaks reaching saturation at about +0.1V during positive base signal.

Tips for servicing horizontal sweep

Although no tube-type color TVs have been manufactured for several years, about half of the bench repairs now involve these older models, according to many shop owners. Therefore, these service techniques are for tube-equipped TV models.

By Homer L. Davidson

More component failures occur in the horizontal-sweep section than in all other color-TV circuits combined. Most of the power of a TV is used there, which increases the number and seriousness of the parts' defects. Problems are compounded by the high-voltage circuit, which is included with the horizontal deflection.

A good sequence of tests is absolutely necessary if a technician is to locate the source of trouble in the shortest time. Such logical methods should include waveform analysis, ac and dc voltage measurements, and other instrument tests *after* the preliminary steps and *before* replacement of any parts that are suspected without proof.

Which testing sequence?

Horizontal-sweep and high-voltage problems can occur in so many different ways and exhibit such a variety of symptoms that an all-inclusive list of tests should not be followed completely in all cases. For example, tests for frequency drift usually would not require many of the visual steps. However, those preliminary steps are vitally important in cases of missing raster.

Also, fewer instrument tests are required when important clues can be seen on the raster. And more instrument tests should be performed when there is no raster and picture.

Therefore, you would not be expected to do all steps in the suggested sequence that follows. Instead, begin at a point that's appropriate for the symptoms.

Visual and preliminary steps

For cases of intermittent noise lines, missing raster and picture, excessive replacement of horizontal-output tubes, raster blooming, or a narrow picture, perform this list of preliminary tests:

- Look for missing tubes and tubes with cracked glass or loose plate caps and connectors.
- With power turned on, look for any tube showing internal arcs. those showing a gassy ionized glow. Blue glow on the inside of the glass envelope is merely fluorescence. It is harmless and should be ignored. A blue glow between plate and cathode indicates gas, and the tube should be replaced.
- Gently tap the horizontal tubes with a plastic rod or the handle of an insulated screwdriver. Replace any tuve showing internal arcs.
- After the power has been applied for two to three minutes, carefully examine the damper and horizontal-output tubes for any red areas on the metal plate. A tube with a red plate either is bad or there is an overload in the circuit at input or output. Try a new tube as a test, but don't let it show a red plate for more than a few seconds, because it might be ruined.
- If none of the previous tests aroused suspicion, test all horizontal-sweep tubes including oscillator, output, damper, HV and focus rectifiers, and regulator (if used). Replace any bad ones.
- Assuming that no raster has been obtained to this point, the high voltage should be checked at the picture tube. Normal HV but no raster indicates the horizontal deflection is alright but the picture tube is bad or a chassis defect is preventing it from conducting the HV and showing a raster.
- If the HV is normal but there is no raster. the dc voltages at the picture tube socket should be checked against the schematic. Low G2 screen voltages, low control grid voltages, or high cathode voltages can eliminate the raster. Wrong grid voltages point to a problem in the chroma circuit, and high cathode voltages indicate a video

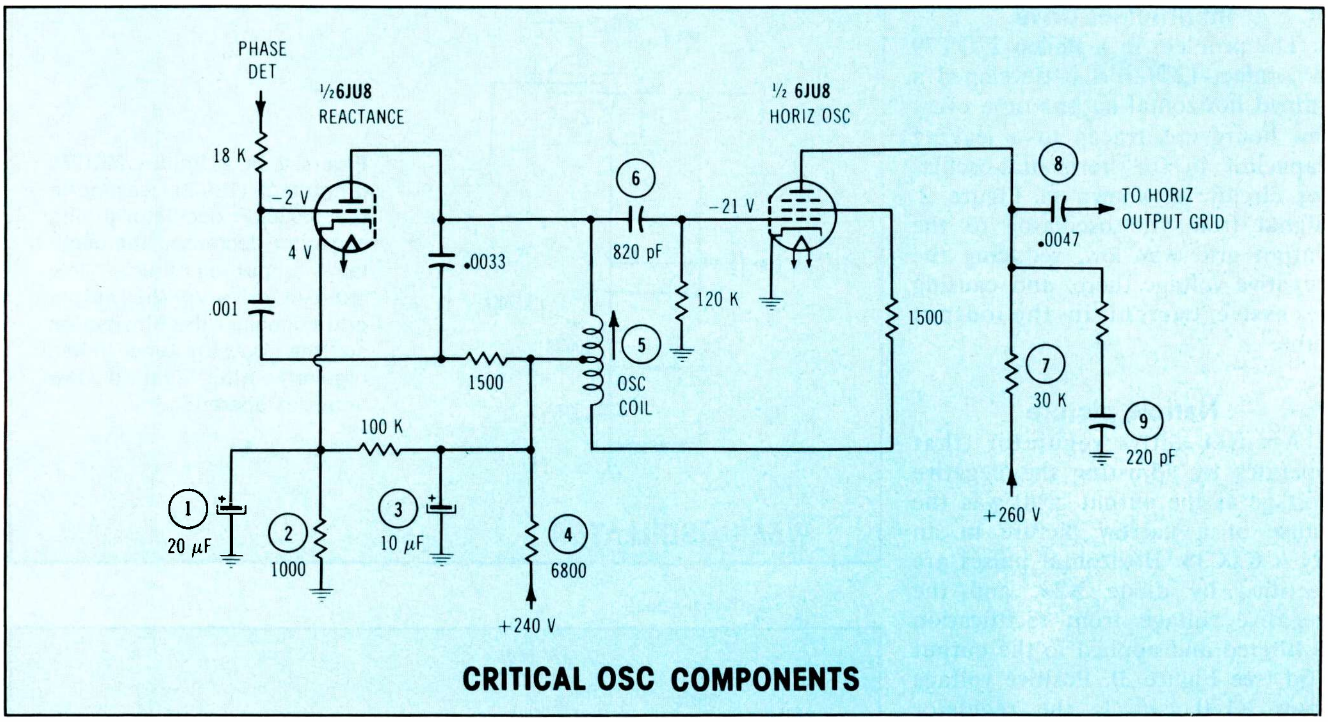


Figure 1 These are the reactance and horizontal-oscillator components that should be tested first in the Admiral 6H10 (Photofact 1113-1). An open #1 capacitor causes soft locking, resistor #2 burns when the tube shorts, an open #3 capacitor weakens the output-grid drive, #5 oscillator coil can become intermittent from bad soldering, leakage in #6 coupling capacitor changes the frequency, reduced values of #7 resistor can shorten the output tube life, a leaky #8 coupling capacitor also ruins output tubes, and the resistance and capacitor values of #9 waveshaping can affect frequency or the lifespan of the output tube.

defect. Loss of focus voltage or heater voltage also kills the raster.

- But when there is no high voltage, measure the grid and screen voltages of the horizontal-output tube. Judge them by schematic voltages.
- A common shortcut is to measure the negative dc voltage at the output control grid and then assume the oscillator signal is proper if this reading is within tolerance. However, an oscillator signal about double in frequency kills the HV while providing the correct negative voltage. Also, dc voltages can reach the grid from outside sources, thus giving wrong dc voltages when the oscillator signal is normal. A distorted waveform from the oscillator can provide the correct dc voltage but give wrong operation. It is best to measure with a scope the waveshape, amplitude and frequency of the grid waveform. This removes the guesswork.
- When the output or damper tube (or both) have a red area on the plate, a limited analysis of the source of trouble is possible. A red spot on a damper plate before the output turns red is caused either by loss of oscillator drive or by damper-circuit leakage. Such damper leakage does not allow the *output* plate to run red, but a loss of oscillator drive does. A red plate of the output tube (but none in the damper) indicates an excessive ac load at the plate of the output tube. This can be a shorted or gassy HV rectifier, shorted turns in a pincushion transformer or excessive current in a regulator tube. Excessive picture tube current will do the same, but the overload can be removed by unplugging the CRT socket.
- A narrow picture and reduced high voltage can be caused by low oscillator-signal voltage at the output grid by a weak output tube, a weak damper tube or low screen-grid voltage.
- A defective HV regulator can kill the raster, cause blooming or produce a dim narrow picture. Most regulators can be defeated easily to prove whether or not they are at fault. No damage occurs if the TV is not operated very long without the regulation. Removing the plate cap (watch out for arcs) works fine for 6BK4s, while pulse regulator tubes can be taken out of the socket (if the heaters are not in series). Varistor grid regulators can be defeated usually by disconnecting the horizontal pulses at the varistor. Check a schematic for the best method.
- Total loss of oscillator signal at the output grid overloads the output tube, causes a bright red plate and destroys the output tube within a few seconds. This probably is the principal cause of excessive output-tube failures.
- Soft horizontal locking and horizontal-frequency drift usually originate in the horizontal phase-detector or the horizontal-oscillator stages.

Critical oscillator components

Figure 1 schematic shows the components of reactance stage and horizontal oscillator that should be checked first during any oscillator malfunction.

Insufficient drive

The problem in a Philco 22QT79 (Photofact 1239-3) that developed a ruined horizontal-output tube every few hours was traced to a leaking capacitor in the horizontal-oscillator circuit, as shown in Figure 2. Signal from the oscillator to the output grid was low, reducing the negative voltage there, and causing excessive current in the output tube.

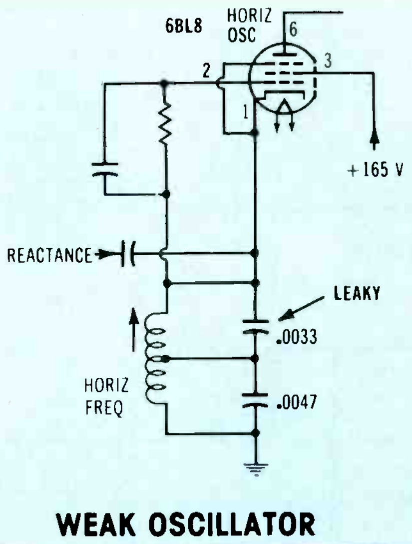


Figure 2 In a Philco 22QT79 (Photofact 1239-3), leakage in the .0033μF oscillator-tuning capacitor decreased the oscillator output amplitude. This reduced drive at the output grid increased the dissipation so the output tube failed regularly after just a few hours of operation.

Narrow picture

An over-active regulator (that operates by adjusting the negative voltage at the output grid) was the cause of a narrow picture in an RCA CTC38. Horizontal pulses are rectified by diode X23, and the negative voltage from rectification is filtered and applied to the output grid (see Figure 3). Positive voltage from R170 cancels the regulator negative voltage at high brightness. But at low brightness, the diode pulse amplitude and rectified negative voltage increase. This increase of negative grid voltage reduces the maximum 6LQ6 plate current and decreases the high voltage.

In this case the grid bias was about -75V.

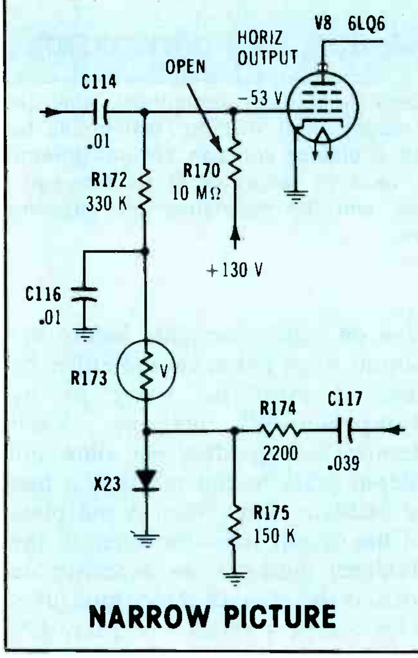


Figure 3 A narrow picture on the screen of a CTC38 RCA was produced by *too much HV regulation*. R170 is included to add some positive voltage to the output grid where it cancels excess negative voltage from varistor rectification. When R170 opened, the output grid was excessively negative, thus giving the effect of a weak tube.

Boost problem

A dim picture and a slightly narrowed picture were the symptoms of a Penncrest TV. Although drive at the output grid was low, the most significant clue was the insufficient boost voltage.

Changing capacitor C115 (Figure 4) cured the problems.

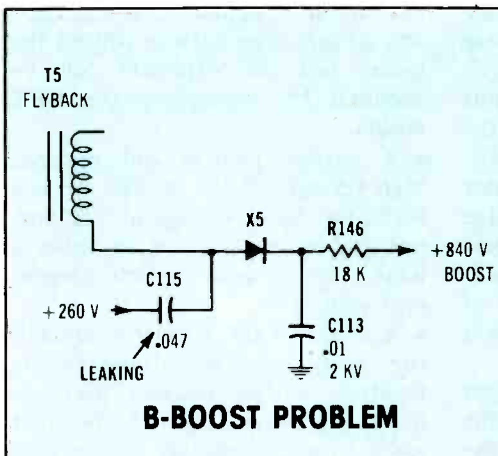


Figure 4 The Penncrest's dim narrow picture directed attention to the low boost voltage. Subsequent testing around the flyback and damper finally located severe leakage in C115, the .047μF boost capacitor.

Damper capacitors

Shorted damper capacitors eliminate all high voltage, and leaky damper capacitors often narrow the picture and distort the linearity (see Figure 5).

One lead of each capacitor should be removed for an accurate leakage test. Use only good quality capacitors for replacement of any bad ones.

A quick test for a shorted damper capacitor is to operate the TV *without* a damper tube. If careful adjustment of brightness brings a dim picture with foldover, it is certain a short somewhere is in

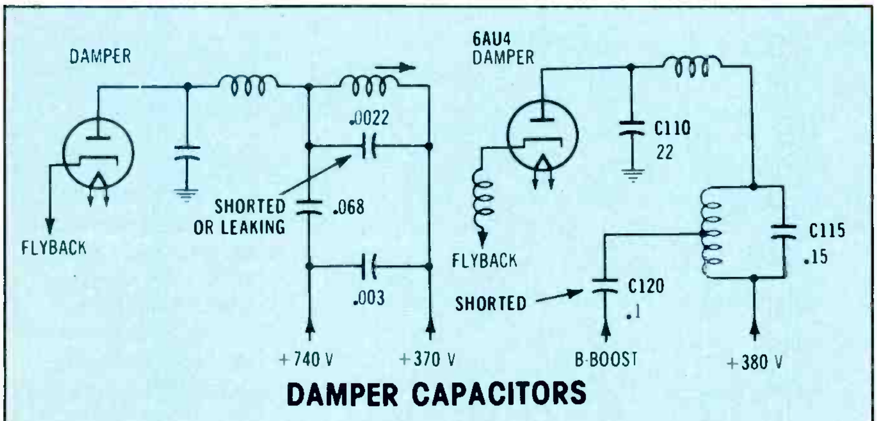


Figure 5 Bad capacitors in the damper circuit can kill the high voltage, narrow the picture or distort the linearity. The A circuit had poor linearity and excessive output plate current because the .0022μF capacitor was nearly shorted. No HV was present in the B circuit when C120 shorted.

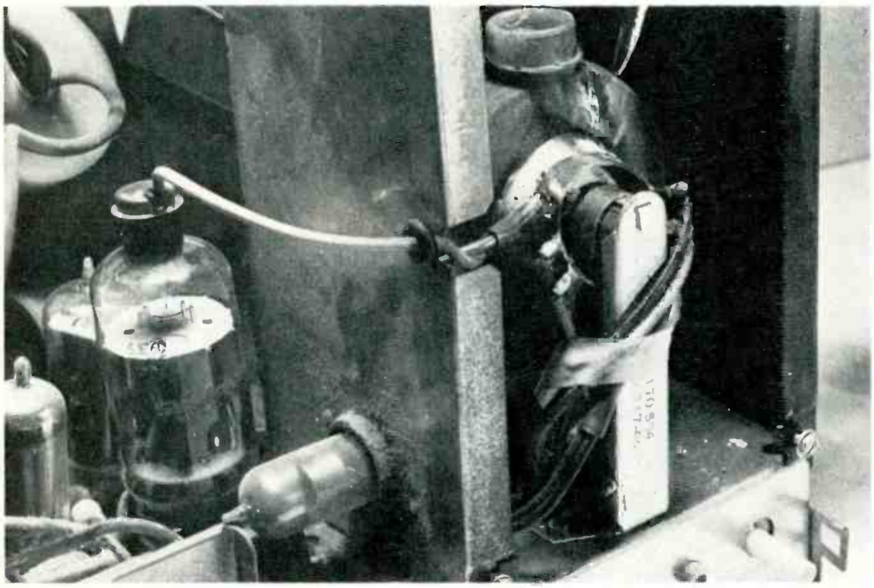
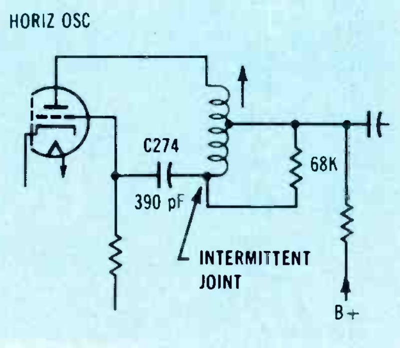


Figure 6 An arc burned a path down the HV coil of the flyback. This overloaded the output tube, causing a red plate. Dampers don't have red plates, but output tubes do, when serious overloads occur in the flyback area of the output stage.

Figure 7 After the horizontal oscillator stops working, the horizontal-output tube will be ruined within a few seconds. An intermittent C274 often is the cause. However, in this case, a connection was intermittently open at the end of the oscillator coil. Use a silver-mica type to replace C274. The temperature coefficient of most other types produces excessive drifting and erratic locking.



RUINS OUTPUT TUBES

parallel with the damper tube. These damper capacitors are usually the cause of the short.

Shorted damper tubes and capacitors often overheat the horizontal output tube and cause red areas on the plate. However, other bad plate loads, such as the carbonized path of the flyback in Figure 6, also kill the high voltage and cause a red plate.

Intermittent oscillator

Any moderate overload of the horizontal-output tube will ruin it. Such overload conditions usually cause these failures at *regular* intervals. Drive and cathode current of the output tube are the important tests for those symptoms.

However, failure of the output tube at very *irregular* intervals *after careful tests have shown no steady overload* are caused most often by an intermittent horizontal oscillator. No other defect ruins an output tube quicker.

There are two general causes of an intermittent oscillator. One is weak oscillation that sometimes does not start when the TV is turned on. Suspect that cause if the receiver fails to light up, but works dependably otherwise.

The other basic defect is an intermittent in the oscillator circuit, such as a hairline crack in the circuit board or an intermittent component. Alternate applications of heat and coolant spray help locate erratic components.

Other unsuspected sources are loose contacts in the tube socket or a bad ground at the oscillator tube's heater pin.

Figure 7 shows the troublemaker in one RCA CTC39. A bad soldered joint at the C274 end of the oscillator coil would open sometimes. Of course, this stopped the oscillation completely.

To reduce the number of ruined output tubes while you search for the cause of intermittent oscillation, monitor the output grid with scope or dc meter. Turn off the TV power within seconds after the monitor shows lack of drive to the output grid.

Excessive high voltage

A previous example showed how

too much regulation could reduce both the width and high voltage. The opposite is true also. A lack of regulation can increase high voltage during times of dark scenes (the extra width is not noticeable).

For normal picture brightness, the Figure 8 circuit should balance the negative voltage (from pulse rectification by the two varistors) against a positive voltage coming from the high-voltage control (R113). At those times, the regulator circuit essentially does nothing; the negative and positive voltages are equal.

When the screen goes dark, the HV and width increase, if there is no regulation. But the regulation varistors receive higher pulse amplitude and they produce a higher negative voltage which exceeds the positive voltage from the HV control. This increases the negative output grid voltage and the width and HV are reduced.

Therefore, any defect that eliminates the variable negative voltage causes excessive high voltage. In fact, the HV is higher than it would be without regulation (that is, with the bottom end of R108 grounded). An open in C106, R109, varistors V110 or V111 can produce excessive HV without regulation.

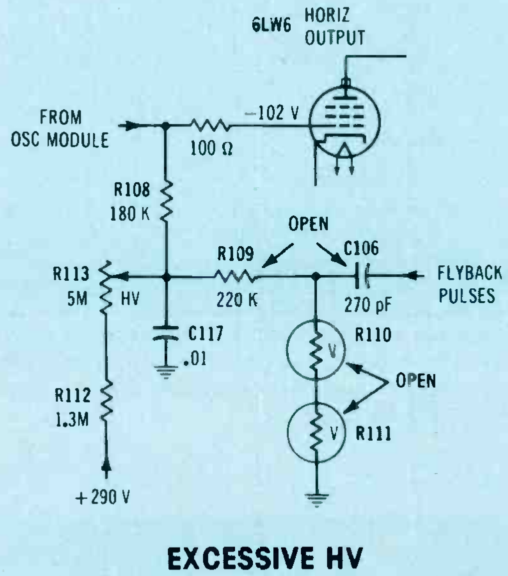


Figure 8 Excessive width and high voltage in the Zenith can be produced by any open circuit that removes the negative voltage that's produced by varistor rectification of horizontal pulses. The most common opens have been in R109, C106 and one or both of the varistors, R110 and R111.

Arcing

All metal connections or soldered joints around high voltage should have rounded corners to prevent HV arcs. As shown in Figure 9, apply a silicone-rubber seal over each flyback or HV-rectifier-socket connection.

Many of the older Zeniths had a 1500Ω resistor at the HV tube socket. It was wired in series with the HV to the picture tube. These resistors often become erratic and cause noise lines in the picture.

Watch out for loose or corroded plate caps on output or HV tubes. They too can radiate noise.

Comments

These methods and hints should help technicians troubleshoot horizontal-sweep problems in less time. Remember, use visual and short-cut methods first, but follow them with instrument readings to identify the difficult repairs. □

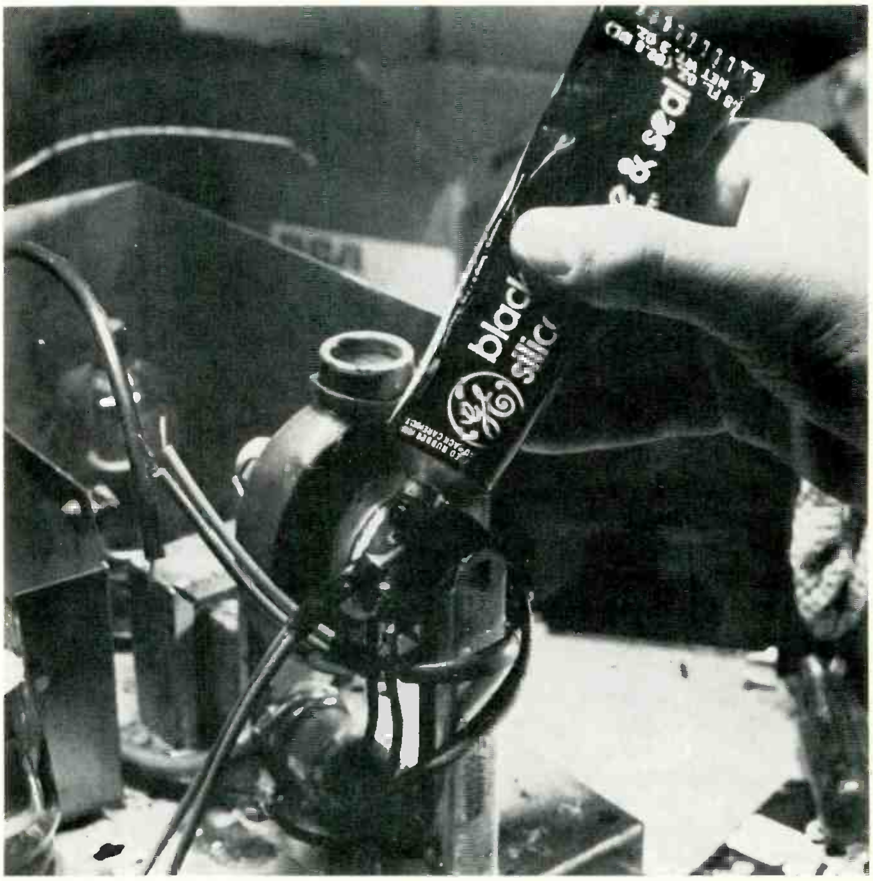


Figure 9 When sweep and HV components are replaced, make sure the soldered joints have smooth rounded tips. Then cover each joint with silicone-rubber sealant.

RCA CTC99 features and "hot" power supply

By Gill Grieshaber, CET

Programming active and skipped TV channels on frequency-synthesis tuner systems requires prior knowledge of the correct method. This information is given for RCA CTC99 and CTC101 chassis, along with explanations of other new features, plus details of hot and cold power supplies and the start-up circuit.

New to the RCA 1980 color-TV line are receivers with CTC99 and CTC101 chassis. These are almost identical, although the CTC101 has a comb filter that decreases color disturbances on certain scenes and also increases sharpness of the luminance (B&W) part of the picture. Several versions of the *ChanneLock* frequency-synthesis tuner systems are offered. One type has a 10-button keyboard for direct channel selection and an LED readout. Another has remote control with up/down volume, up/down channel selection and channel readout on the TV screen. The type that will be analyzed has a conventional volume control plus up/down channel scanning (nonprogrammed channels are skipped over) with LED readout of the channels.

The sample TV used for this series is an RCA model FD485W (Figure 1) which has a CTC99 chassis. However, details of the CTC101 comb filter will be provided later.

CTC99 features

New features include the use of more ICs than any previous RCA TV, two special ICs in the IFs, a countdown IC that replaces both vertical and horizontal oscillators, simulated stereo (called *Dual Dimension Sound*) in some versions, an electronic pincushion circuit, single-circuit-board construction with grounded rails around the board, and elimination of convergence. Most other circuits are similar to those of previous *XtendedLife ColorTrak* models. These include hot and cold grounds (which eliminate a power transformer), and SCR regulation of the main B+.

These CTC99 and CTC101 chassis have major sections located in the same general areas as those of the previous CTC93 chassis. So, some technicians probably will find the general layout familiar (Figure 2).

Channel programming

All 82 TV channels are available with no adjustment necessary. A push on the up button changes the tuner to the next higher channel, and a push on the down button tunes-in the adjacent lower channel. Or, either button can be held steadily and the tuner scans the channels at about 2/s.

Even with this convenience, it would be too much work for a viewer to scan through 82 available channels for six local stations. The solution is a method of bypassing all undesired channels. (Of course, any channel can be restored when needed.) This method is simple and quick.

Picture A of Figure 3 shows the channel-selector appearance when the control door is closed. To the left of the on/off/volume knob are the large red LED digital channel readouts. Two channel-selector pushbuttons are below. Those are the only controls needed after the programming is completed.

A viewer can set the system to tune-in or bypass any channel by opening the door and operating the switch and buttons. The channel flip-type switch has *select* and *lock* positions (Figure 3B). Below it are the *erase* and *add* pushbuttons. When the channel select/lock switch is in the select position, the tuner stops at each of the 82 channels, regardless of the programming. However, any that have been erased previously have a black picture without sound. To erase a channel, operate the up or down pushbuttons until the proper channel number is seen on the LEDs, then press the *erase* button, noticing that the picture (or snow) and sound disappear after a short time.

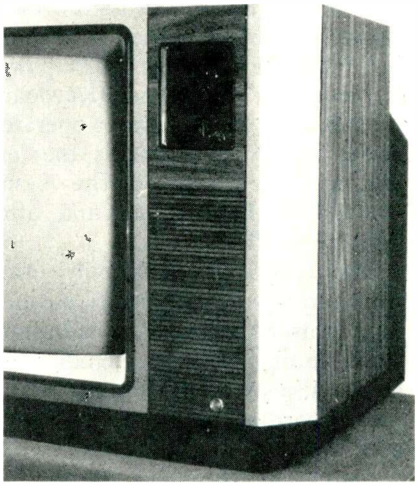


Figure 1 RCA model FD485W is a 19-inch color TV with a CTC99 chassis. Its circuits and servicing will be analyzed for the next few months.

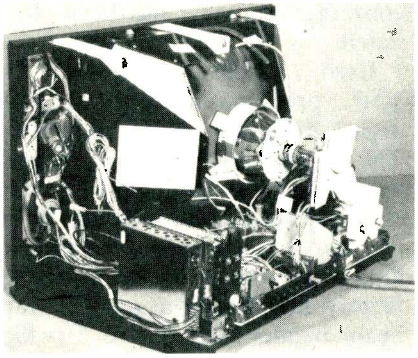


Figure 2 Many components are accessible for servicing when the cabinet back is removed. The connecting wires allow the chassis to be operated farther to the rear, after removal of two screws.

To restore any previously erased channels, press the *add* button and notice that the picture (or snow) and the sound appear. This channel erasing or adding should be done for all channel positions. Finally, after the selection is complete, the channel-select/lock switch is flipped to lock (Figure 3C).

In the lock position, only those channels that were added or not erased will be selected by the up and down pushbuttons.

This channel-scanning system has one peculiarity. After the set has been turned off (or the power has been lost), the lowest programmed channel will be tuned-in when the receiver is turned on the next time. For example, assume that a certain locality has only channels 3, 10 and 27 selected by the up/down scanning. If the receiver was tuned to channel 27 when turned off, channel 3 will be tuned-in when power is turned on next time. (Keyboard models have a transformer-operated power supply that retains the last channel memory, so the same channel is there before and after every turn-off.)

Figure 4 shows the only other front-mounted component: a small light sensor (probably a cadmium-sulphide or cadmium-selenide type) which adjusts contrast and brightness according to the level of incident light striking the cell.

No convergence—almost

A casual look at the CTC99 chassis and picture tube (Figure 5) shows no convergence assembly on the picture tube neck or any convergence board. That's because convergence almost has been eliminated.

Used for the first time is the 100° precision-in-line-guns (PIL) ***Super Accufilter 100*** picture tube. The in-line guns and a uniquely wound yoke reduce edge convergence adjustments to a minor tilting of the yoke. Center convergence and purity-magnet functions are factory-adjusted by a magnetic-tape beam bender (see Figure 5) which resembles black plastic tape wound around the neck and secured by a plastic tie.

If the yoke ever moves (or anything disturbs the center convergence), a conventional multi-

Figure 3 These pictures show how stations are tuned by up/down scanning. (A) Only the digital channel readout, an on/off/volume control and the up/down channel-scanning buttons are visible when the door is closed. (B) Customer controls are under the door. To add or erase channels, the channel select/lock switch is flipped to *select*. The system stops at each channel (whether active or erased) in the select mode. (C) After the channels are programmed, the channel select/lock switch is changed to the *lock* mode. Operation of the channel up/down scanning buttons then allows stopping *only* at the added (or active) channels.

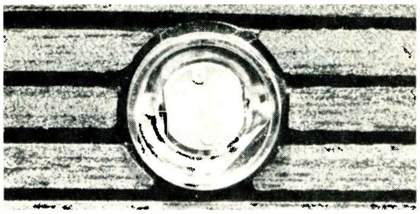


Figure 4 A front panel mounted light-sensitive cell adjusts the levels of brightness, contrast and color according to the intensity of light falling on it.

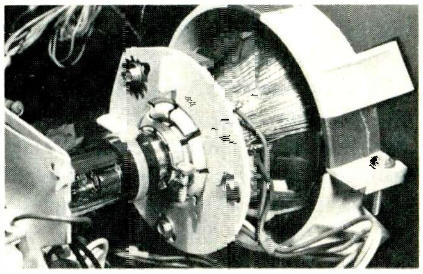


Figure 5 No convergence board or adjustable beam-benders are necessary.

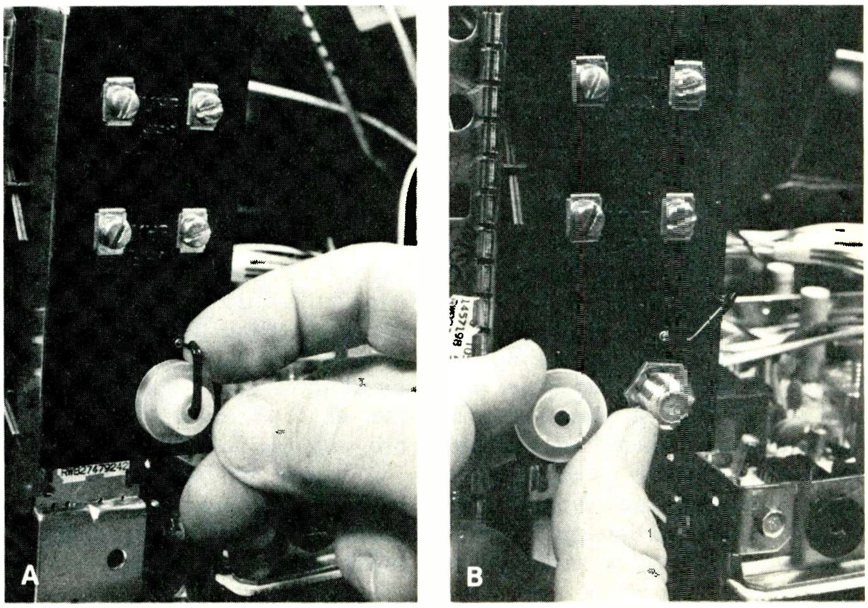


Figure 6 (A) To change from 300Ω VHF antenna operation to 75Ω cable, pull out on the captive wire, remove the plastic cover and attach the CATV or MATV cable to the connector (shown in B).

section beam bender must be installed to replace the magnetic tape, since it cannot be adjusted or reused.

Cable input

As the CTC99 chassis comes from the factory, there are separate UHF and VHF 300 Ω inputs. Both have the usual twin screw-type terminals (Figure 6A). This cap covers the 75 Ω input that goes direct to the VHF tuner section. When 75 Ω operation is desired, the wire should be pulled out, the cap removed, and the external cable attached to the coax connector (Figure 6B).

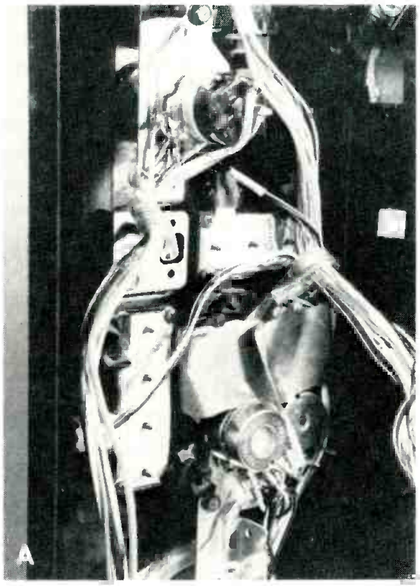
Tuner-control system

No tuners are mounted in the area behind the cabinet's front panel where two bulky mechanically operated tuners traditionally were placed. Instead, only switches, controls, and the LED readout are there (Figure 7A). The tuners are located beside the main chassis, as shown in Figure 7B.

Specifically, the shielded box nearest the chassis contains both the UHF and VHF tuners, while the other shielded box encloses the control circuitry. Details of this sophisticated tuning system will be given later in the series.

Cold chassis—hot ground

One previous distinction between types of TV receivers was whether the chassis was hot or cold. Cold-chassis sets had a power transformer that provided various ac voltages, and it also allowed isolation between the 120V line and the TV chassis. Hot-chassis TVs did not have power transformers. The 120V line power was rectified to produce dc voltages. However, one side of the ac line (or a leg of the bridge rectifier) was grounded to the chassis. The safety of TV users



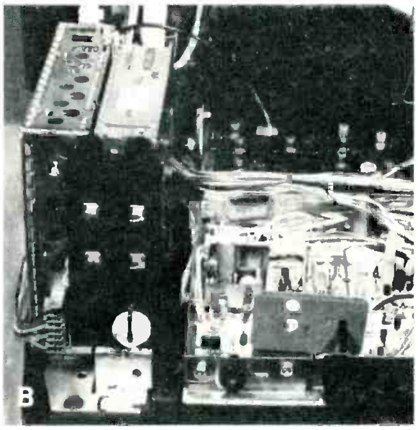


Figure 7 No tuners, but only controls and readout, are behind the front panel (picture A). The tuner-control system and the combined tuners are located beside the chassis (picture B).

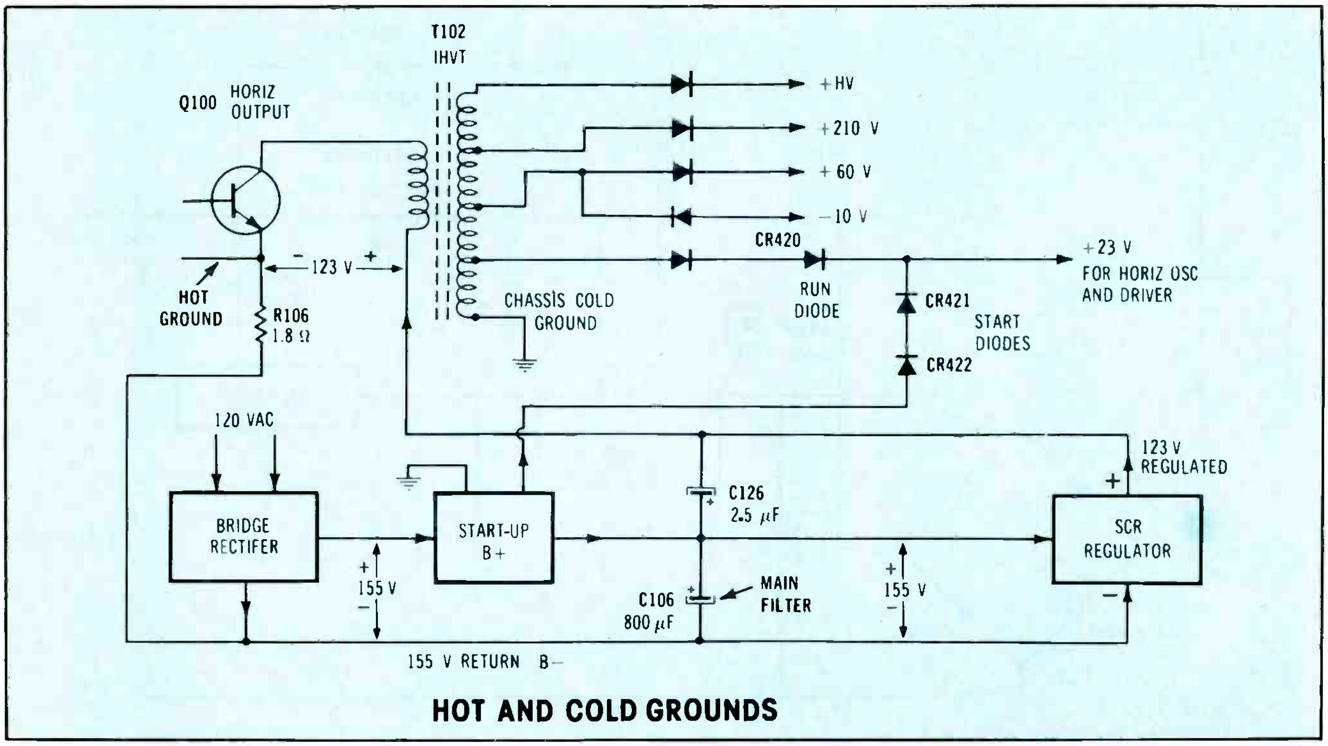


Figure 8 Rectified line-voltage power (hot-ground system) is isolated from chassis grounds. It supplies only the regulator and the horizontal-output transistor. Isolation for the cold-ground wiring is provided by a transformer in the start-up circuit and the flyback transformer. Shields and chassis rails are safe to touch; however, an isolation transformer should be used during servicing because some techniques connect the hot and cold grounds together temporarily.

required elaborate precautions to insulate the hot chassis from cabinet, knobs, shafts, antenna connections and all other metal parts that might be touched from the outside.

In the XtendedLife series, RCA has combined most advantages of both hot and cold types, without many drawbacks of either. This is accomplished by using a bridge to rectify the ac line. Only one +155V source is produced—a hot supply that must be (and is) isolated from the TV chassis.

As shown in Figure 8, the 155V supply first activates the start-up (temporary) B+ source, then the 155V is regulated by the SCR system to 123V, which powers the horizontal-output transistor. Notice that the 155V and 123V power supplies are connected only to the SCR (and its circuitry) and to the Q100 horizontal-output transistor along with its heat sink and associated components. Therefore, very few areas of the circuit require any special insulation. Only the circuits just mentioned are hot. All other shields, rails and circuit grounds are cold. Unless the insulation precautions are circumvented, this receiver should be just as safe as a transformer-operated TV.

Figure 9 shows the horizontal-output transformer's heat sink, which is the most accessible hot ground (flyback is behind it). At the extreme right is C106, the only filter in the hot supply.

In the CTC99 and CTC101 chassis, the flyback transformer supplies isolation and the multiple ac-voltage taps needed for separate dc-voltage sources. In other words, the flyback assumes most duties of the power transformer used in older cold-chassis TVs. Of course, lower dc voltages can be obtained from higher-voltage supplies by dropping resistors or voltage dividers, but many watts of power would have to be dissipated uselessly in resistors.

Another significant reduction of power-line wattage and interior cabinet heat has been achieved by use of an SCR (instead of a power transistor) to control the 123V supply. As described next month, the SCR either is fully conducting or else is totally open. Therefore, little heat is dissipated in the SCR.

Hot power supply

Figure 10 is a schematic of the 155V hot (ungrounded) power supply, including the start-up wiring. The permanently attached power

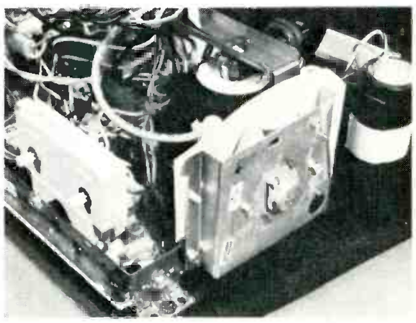


Figure 9 Both focus and CRT screen voltages are obtained from a HV bleeder (at left). The horizontal-output transistor is on a small heat-sink chassis (center) that is connected to hot ground. Near the front corner is C106, the only hot-supply filter capacitor.

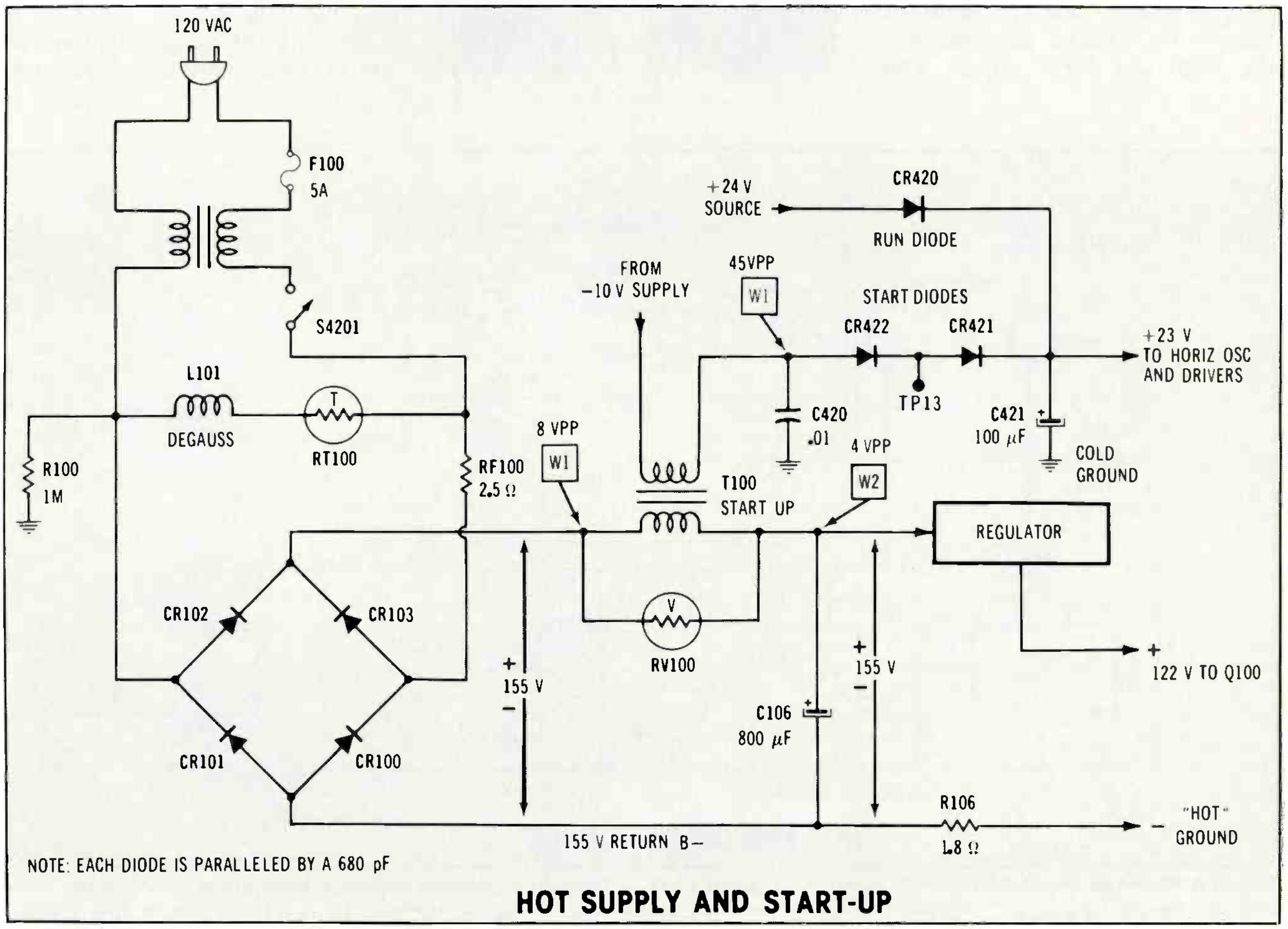


Figure 10 This is a complete schematic of the bridge hot supply and the start-up circuit which is described in the text.

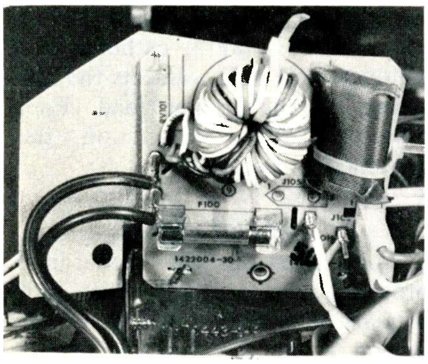


Figure 11 Fuse, radiation choke and the line bypass capacitor are mounted on a small circuit board. The line cable is attached permanently to the circuit board.

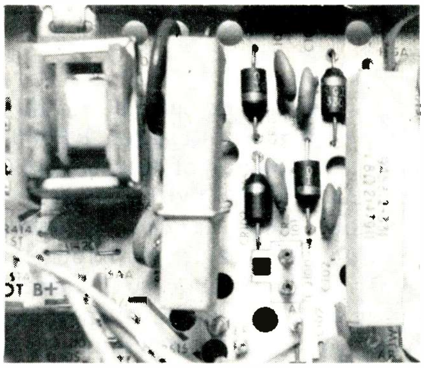


Figure 12 The four diodes of the bridge are flanked by large resistors RF100 on the left and R106 on the right. At the upper left is the T100 start-up transformer.

cable enters at a small vertically-mounted circuit board near the rear/center of the main chassis, as shown in Figure 11. However, the four diodes of the bridge-rectifier circuit are near the main circuit board's front edge (Figure 12) next to the T100 start-up transformer, while the C106 filter capacitor is mounted outside the corner in front of the horizontal-output transistor (see Figure 9).

Incidentally, varistor RV100 is a type of thyrector usually connected across the 120V line to eliminate line spikes. And it is used for the same purpose here. RT100 of the degaussing circuit increases resistance when heated. This degaussing action is identical to that of previous models.

The cold side of the 150V supply is called ***150V return*** until it passes through R106 (1.8 Ω) and reaches the Q100 horizontal-output emitter where it is called the ***hot ground.*** This terminology will be used throughout to eliminate any confusion.

Start-up operation

B+ power for the Q100 horizontal-output transistor comes from the hot (isolated) 150V supply. But the oscillator/countdown and driver stages are powered from the cold +23V supply that comes from rectification of flyback pulses.

Therefore, if there is no start-up action when the receiver is turned on, nothing operates. The output transistor has collector voltage but can't conduct without base drive; and the driver stages can't function without the +23V supply that comes from the output transistor and the flyback.

This stalemate must be broken by a temporary source of about +23V that substitutes for the regular 23V supply. This extra voltage source exists long enough to start the oscillator and driver stages and thus activate the output transistor and the low-voltage supplies coming from flyback pulses. After the other stages begin operation, the temporary start-up voltage must be disconnected. Those specifications seem to call for elaborate circuitry. However, the actual circuit is very simple.

When receiver ac power is off, filter capacitor C106 is in a discharged state (Figure 10). Application of power then produces a large

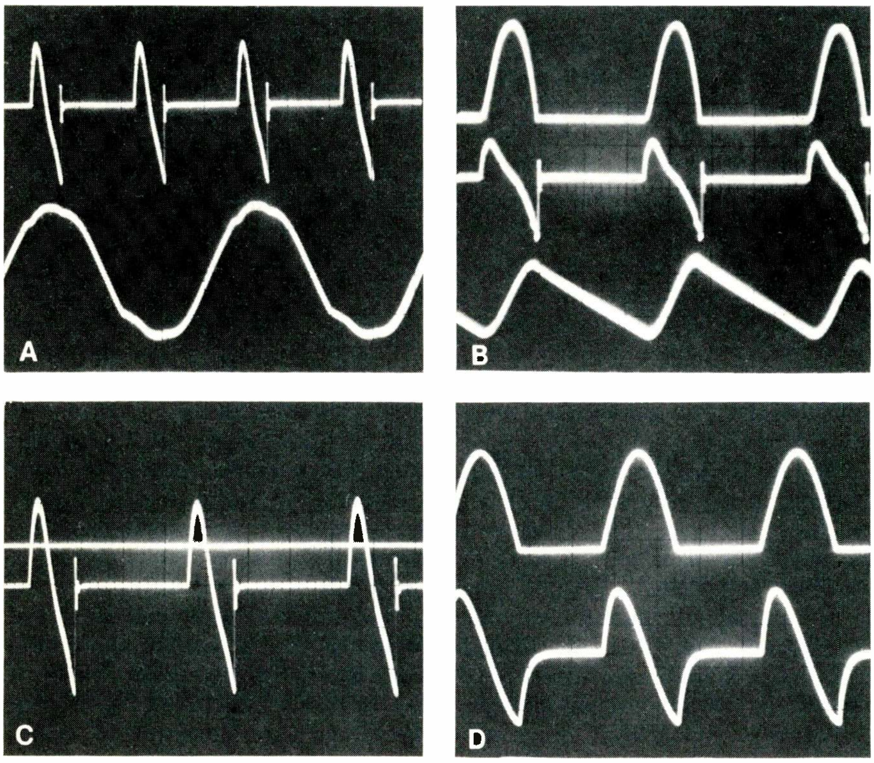


Figure 13 Waveforms of the start-up circuit help explain its action. (A) Bottom trace shows 60-Hz line voltage. Twice as many cycles in the top waveform prove the repetition rate of the start-up signal at the anode of CR422 is 120Hz from full-wave rectification. (B) Top trace shows pulses of C106-charging current that power the start-up action. Center trace is the waveform across the T100 primary that results from the charging current (top trace). Bottom trace is the conventional sawtooth ripple across C106 filter. (C) This dc waveform shows why -10V is brought to the T100 secondary. Without the -10V, the positive tips would extend more than 24V above the zero line on bright scenes, and the start-up diodes might conduct thus throwing the whole +23V-supply load on the start-up circuit, which is not designed for so much load. With the -10V, only about 12VPP extends above the zero line, and this is not enough to cause CR422 and CR421 to conduct. During turn-on time, the amplitude is increased greatly for a split second, so CR422 and CR421 conduct and start the horizontal oscillator and driver stages. (D) These waveforms explain the peculiar waveshape at T100. Top trace shows half-wave rectification, and the bottom trace reveals the waveshape after it goes through a high-pass filter. In other words, differentiation of half-wave pulses produces the bottom waveform, which is almost identical to the T100 waveforms.

RCA power

rush of rectified dc current into the C106 capacitor. Resistor RF100 limits the amount of turn-on current. But between the bridge rectifier and C106 is the primary winding of start-up transformer T100. This initial current surge through T100 consists of positive pulses at a 120Hz repetition rate (see waveforms in Figure 13).

Those pulses of direct current produce a waveform across the T100 primary winding. By transformer action, the same waveform of greater amplitude appears at the secondary where the amplitude is high enough to cancel the -10V of reversed bias and force the start diodes CR422 and CR421 to conduct positive peaks to the +23V supply. This positive voltage (filtered by C421) allows the horizontal oscillator and driver stages to operate, thus activating the horizontal-output transistor and the flyback which furnishes pulses for the low-voltage supplies.

After the oscillator and driver stages begin operation and the dc voltages of the various flyback-powered low-voltage supplies reach proper levels, the TV functions. But, the start-up circuit now must be disconnected.

After turn-on, the surge current through T100's primary diminishes rapidly to normal, thus causing a corresponding decrease of acV to the turn-on diodes. Finally, the decreasing signal cannot overcome the -10V of bias; thus the CR422 and CR421 start diodes are reverse biased and become open circuits. The turn-on (or starting) action now is over, and the start circuit is disconnected.

To recap, during start-up time the anode of run diode CR420 has zero voltage, but the cathode has positive voltage from the start diodes. Therefore, CR420 is an open circuit that disconnects other loads from the +23V line. This lighter load increases the starting voltage so the oscillator and drive can function. Later when the +23V source becomes fully active and the start-up voltage has decreased, the CR422 and CR421 start diodes are reverse biased. They become open circuits; this disconnects the starting circuit from the +23V supply. At this time, the anode of CR420 is more positive than its cathode, so it conducts and thus connects the 23V source to the proper load. Each time the TV is turned on, this sequence is repeated.

Waveforms

The start-circuit waveforms produced one surprise: the T100 primary waveform was radically different from the one expected. Because the winding current flowed in positive pulses, it seemed logical that the winding's ac-voltage waveform should be similar. (This would be true if the winding had only resistance.) For the waveform to make sense, remember that inductances often differentiate a waveform, thus changing it as though the signal had gone through a high-pass filter. At the output of a sine-wave generator, a few components were added to clip (rectify) the sines into positive peaks and then differentiate them. As shown in Figure 13, the start-up waveform and the filtered test waveform were almost identical. Other background material is contained also in Figure 13.

Next month

Power supplies years ago were simple and required no great troubleshooting skills. That is not true of late model solid-state circuits. For example, one low-voltage supply (to be examined next month) seems to have all components in the wrong places, including a grounded diode.

In addition, the entire 123V-regulator circuit will be analyzed. Four transistors determine where in the horizontal cycle the SCR conducts. Longer conduction times produce higher regulated voltage, after the pulses of current are integrated. In previous years, RCA recommended that the regulator module be replaced when problems existed there. In the CTC99 and CTC101 chassis, the regulator components are not on a separate board, but are scattered around the single large circuit board. Therefore, total replacement is not possible, and these circuits must be repaired at the component level when problems occur. Specific repair information is a necessity.

Troubleshooting methods will be supplied at the end of the power-supply coverage. □

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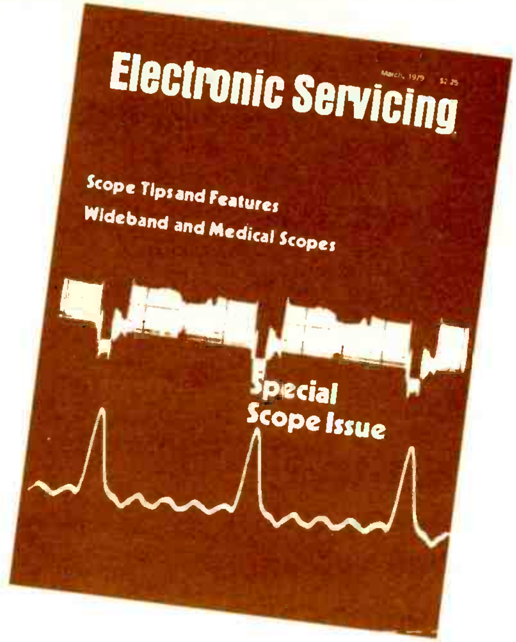

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test equipment report

10MHz triggered scopes

Two 10MHz, 5-inch scopes, the dual-trace model 1476 and single-trace 1466, are available from **B&K-Precision**. The scopes feature 18 sweep range selections, triggered and automatic sync with 10mV/cm sensitivity, and a fully regulated

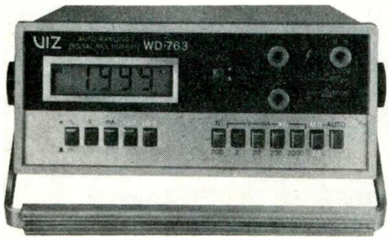
power supply. Calibration is unaffected by ±10% line voltage changes.

The 1476 is priced at $700. The 1466 is $560. Prices include probes.

Circle (60) on Reply Card

Digital multimeters

A new line of digital multimeters from **VIZ** features a choice of LED or LCD display, accuracy of 0.1% (dc volts) and function indication (voltage, current or resistance).



Overload protection is provided for all functions in all models. All models are designed for battery or ac operation. A 6V ac adaptor is supplied, or it may be operated on 4 C cells.

Circle (61) on Reply Card

Capacitance meter

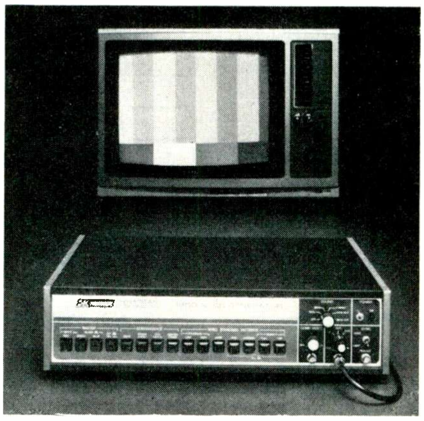
A 3½-digit benchtop ac-powered capacitance meter has been introduced by **Continental Specialties.** The Model 3001 measures capacitances from 1pF to .1999F in nine ranges. Accuracy is within ±1 count on all ranges within 0.1% of indicated reading.

Suggested price is $190.

Circle (62) on Reply Card

NTSC color generator

B&K-Precision has made available a new NTSC color-pattern generator, Model 1250. The unit can be used for aligning and trouble-shooting videotape recorders. The 1250 features the NTSC bar pattern and a 5-step staircase pattern with



selected chroma levels. Available patterns include dot, cross-hatch, dot-hatch, center cross and color raster. In addition to the video patterns, the 1250 generates a 4.5MHz sound carrier with 1kHz or 3kHz modulation.

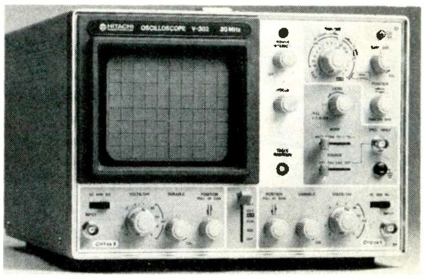
The price is $795.

Circle (63) on Reply Card

30-MHz scope

Hitachi has introduced the V-302 dual-trace 30-MHz oscilloscope. The unit features sensitivity up to 1mV (with X5 vertical magnifier), triggered time base sweep speeds from .02μs to 0.2s/div in 19 calibrated steps, a TV sync-separator circuit, X10 sweep magnifier, trace rotation and a signal-delay line.

The V-302 is available for $945, including probes. The single-trace V-301 is $745.



Circle (64) on Reply Card

Digital frequency counters

The 500HH series of hand-held digital frequency counters from **DSI Instruments** have frequency ranges of 50Hz to 500MHz, and 50Hz to 100MHz. The 8-digit LED display, with characters that measure .4-inch high, features automatic decimal point shifting and zero blanking. Total case dimensions (excluding antenna) are 3.5"x1.25"x 5.75".

Circle (65) on Reply Card

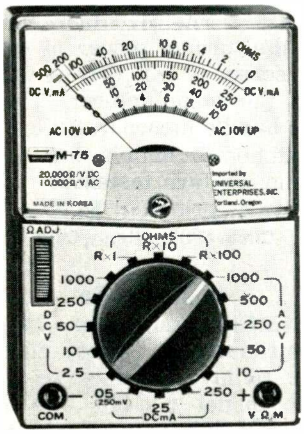
Multifunction frequency counter

The FC-841 from **Soar Corporation** is a 7-digit multifunction frequency counter that covers the 10Hz to 50 MHz range. The counter can be plugged into an ac outlet or a car's cigarette lighter. The FC-841 is supplied complete with batteries, antenna, and test lead and is priced at $90.

Circle (66) on Reply Card

Multitester

Universal Enterprises M75 has 17 ranges chosen to place most measurements near midscale. Features include a fuse-protected ohm circuit, three-color-coded scale and front panel, diode protected movement and one year warranty.



Circle (67) on Reply Card

Portable DMM

B&K-Precision has designed the model 2815 3-½ digit portable 0.1% DMM. The unit offers LCD readout and rf interference shielding. A 9-V alkaline battery powers the unit. The 2815 features an automatic low-battery warning indicator, auto zero and auto polarity. The 2815 is available at local distributors for $150.

Circle (68) on Reply Card

Analog multimeter

The S-20 analog multimeter from **Soar** features a d'Arsonval meter movement. Five function modes, as well as 20 measurement ranges make this instrument versatile. A mirrored scale minimizes parallax reading errors. The battery-operated S-20 can measure ac and dc voltage from 0 to 1000V, dc current from 0 to 250 mA, resistance from 0 to 1MΩ and dB from - 20 to +36. Typical accuracies are ±3%dc and ±4% ac. Price is $35. □

Circle (69) on Reply Card

Circle (11) on Reply Card

Circle (12) on Reply Card

productreport

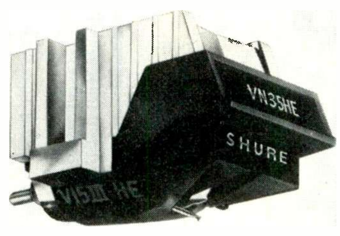
Cordless telephone

The DuoFone ET-300 cordless pushbutton telephone is now available from **Radio Shack.** The ET-300 has an operating range of up to 300 feet from the base unit, and a universal dial system. The phone features an auto-redial for one-button redialing of the last number called. Priced at $219.95, the ET-300 is available from participating Radio Shack stores and dealers nationwide.

Circle (71) on Reply Card

Phono cartridge

Shure Brothers has announced the addition of the V15 Type III-HE to its series of V15 Type III phono cartridges. The new model features a hyperelliptical nude diamond tip. User price of the V15 Type III-HE cartridge is $115. The VN35HE stylus may be purchased alone for $38.



Circle (72) on Reply Card

Temperature sensors

Two film temperature-sensing resistors have been introduced by **TRW/TRC Resistors.** A metal glaze-on-ceramic element offers near-linear change in resistance, thermistor-like impedance, fast response time and small physical size, according to the manufacturer.

Circle (73) on Reply Card

Tool kit

A 15-piece inch-size Super Driver Tool Kit from **Metrifast** features twice the turning power of conventional screw or nut drivers according to the manufacturer. The ball torque handle incorporates an internal ratchet to enable the user to continuously turn fasteners.

The kit is priced at $8.95.

Circle (74) on Reply Card

Mobile radio

Cobra Communications, Dynascan has introduced a remote hideaway mobile radio to replace its earlier remote model 63GTL. The Cobra 66GTL is a full-featured AM mobile CB with all the controls located in the microphone. These include LED channel readout and the "up-down" channel selector, on/off/volume, squelch, RF gain, ANI, and the off/ch9 switch. Size of the 66GTL chassis is 7-3/16"x5½"x1-5/8."

Circle (75) on Reply Card

Quick disconnect system

Antenna has introduced a quick disconnect system for the Persuader CB antenna enabling the owner to remove the 60-inch whip to protect it from theft or damage. The system can be used on all Antenna coil-in-cup antennas, but it is specifically designed for the Persuader trunk lip model, according to the manufacturer. List price is $10.28.

Circle (76) on Reply Card

Desoldering tool

Hunter Associates offers model GSS combination soldering iron and solder removal unit. A vacuum is created by the Venturi principle from air pressure supplied either by a compressed-air line or a foot pump. A solder catcher is provided to prevent extracted solder from falling back onto the circuit board.

The tool sells for $39.95.

Circle (77) on Reply Card

Digital clock-radio

RCA has designed an AM/FM/FM stereo car radio with digital station/readout and clock. The radio is equipped with a special nosepiece for universal application, permitting in-dash installation in most late model domestic cars. To simplify installation, the unit incorporates universal type *bullet* connectors for two or four-speaker hook-up, automatic power antenna activator lead, antenna trimmer and adjustable shafts. The suggested list price is $227.50.

Circle (78) on Reply Card

catalogs literature

RCA has a catalog of replacement remote control transmitters for RCA color TV sets. The 4-page brochure illustrates all current RCA products and provides a convenient cross-reference chart, to help identify the correct units.

Circle (79) on Reply Card

The Antenna Specialists offer a 6-page brochure discussing 800MHz base and mobile antenna systems. The brochure contains information and specifications on A/S's complete line of 800MHz antennas including ¼-wave, 3dB-gain and low silhouette mobile antennas.

Circle (80) on Reply Card

RCA has issued a 16-page directory of knobs for all control functions of RCA monochrome and color TV sets. The directory covers model years 1977 through 1979. It lists part numbers for channel selectors, fine tuning, on-off volume, brightness and contrast, horizontal sync., Accumatic and automatic fine tuning and auxiliary knobs.

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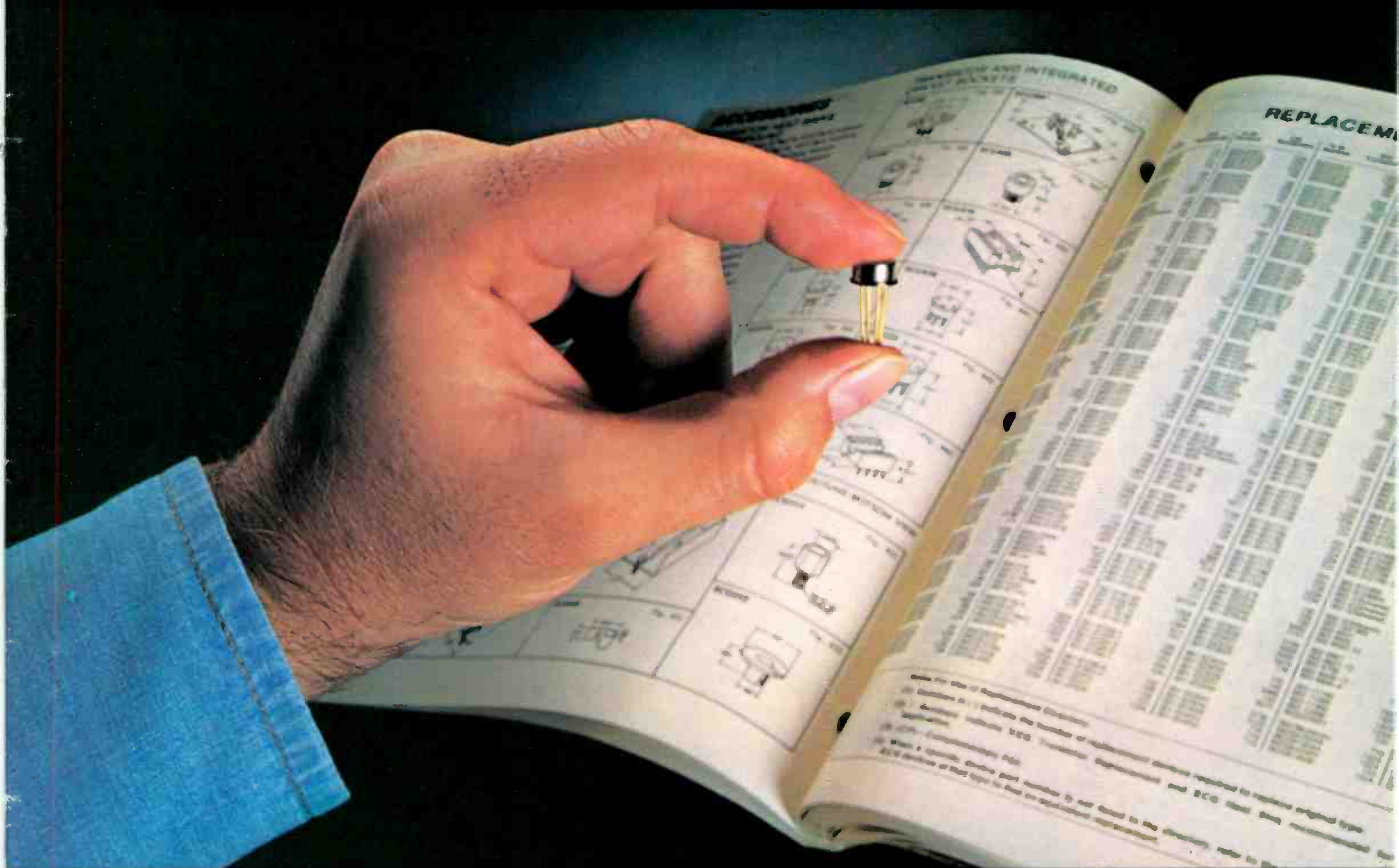

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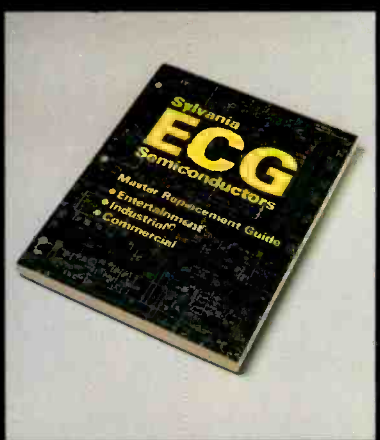

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