June, 1979 □ $2.25

Electronic Servicing®

Special resistor issue

Programming a memory

Second look at waveforms

Electronic Distribution Show

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Electronic Servicing

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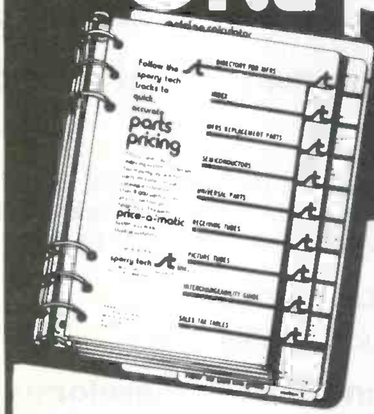

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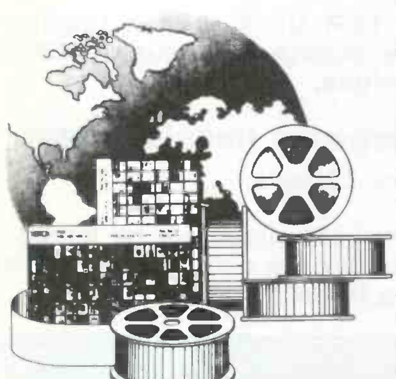

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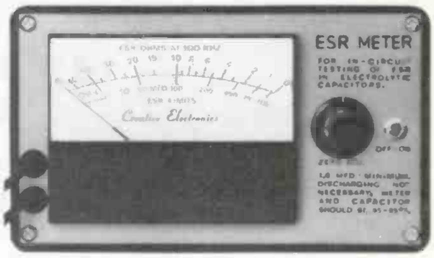

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Circle (5) on Reply Card

June, 1979 ☐
Volume 29, No. 6

Electronic Servicing®

17 **Selecting replacement resistors**
Carl Babcoke

Resistors have been changed and improved over the years. This information advises in selection of replacement resistors having equal or better characteristics.

24 **Resistor roundup**
Electronic Servicing Staff

25 **A second look at waveforms, part 1**
Gill Grieshaber

Location of the two peaks and a dc-voltage measurement of any waveform can be determined by the zero and average lines provided by any good scope. Practical examples will be given next month.

34 **Memorizing a phone number**
Jack Webster

A method is described for storing and reading-out a 7-digit phone number.

39 **1979 Electronic Distribution Show**
Carl Babcoke

42 **Reports from the test lab**
Carl Babcoke

The "ESR METER" from Creative Electronics locates those important but elusive ESR defects in electrolytic capacitors.

45 **Emergency transistor test**
Wayne Lemons

A small transistor can be forced to amplify (and thus to identify the collector and emitter) by use of a VOM and a finger.

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About the cover

The picture of resistors illustrates *Selecting Replacement Resistors* which begins on page 17. *Electronic Distribution Show* coverage starts on page 39. Graphic design is by Linda Franzblau, with photography by Carl Babcoke.

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WHAT'S NEW IN TV? ASK GE.

Because we designed and built the world's very first home television set.

And since that time, General Electric has played a critical role, by introducing some of the most significant features to the television industry.

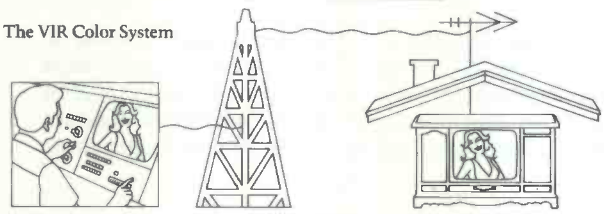
They're why we call our line, Performance Television.

Now, the company renowned for over half a century of innovations takes great pride in presenting to you, our new television products and features that make this General Electric Performance Television. 1980.

INTRODUCING:

1. VIR II. A combination of our VIR Broadcast Controlled Color system that won an Emmy in 1977 for the first use of VIR in a home receiver and our color-averaging system Color Monitor. Now, if VIR isn't on a program, Color Monitor automatically keeps the colors consistent.

The VIR Color System



1. The broadcaster transmits a VIR signal with the color picture through the communication system.

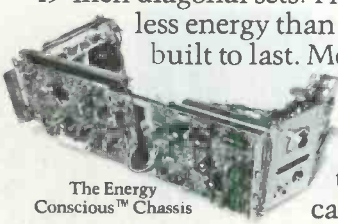
2. The VIR signal lets the broadcaster monitor and maintain realistic color while transmitting the picture.

3. GE VIR sets use this signal to automatically adjust the color picture in your home.

2. Precision Quartz Electronic Tuning. It requires no set-up. No fine tuning ever. All channels are tuned precisely by proven phase-lock-loop circuitry linked to an accurate Quartz crystal.

The tuning system comes in three different channel selection options. All channel, one-knob. Random-access keyboard. And the brand-new GE remote control.

3. The Energy Conscious™ Chassis. It's 100% solid-state. Modular. And it's now standard in all our 19-inch diagonal sets. The new chassis uses up to 22% less energy than our previous units. And it's built to last. Modules are mounted vertically, so heat can dissipate faster. Plus our new chassis features special count-down circuitry that eliminates both the vertical and horizontal controls.



The Energy Conscious™ Chassis

4. "Dual-Mode" Remote Control. It has a memory bank that lets customers program their favorite channels from their easy chair. And then scan from one station to the next. Instantly. With just one touch of the scan button.

GE "Dual-Mode" Remote Control

5. The VHS "Command Performance" Video Cassette Recorder. It's completely programmable. Capable of recording up to five different shows, at different times, on different channels. Up to four whole hours. And the programming controls make recording as easy as taking a week's vacation.

The VHS "Command Performance" Video Cassette Recorder

That's General Electric Performance Television. 1980. Put our new systems and features together with all the other great features found in our televisions and your customers get some of the finest, most automatic and advanced TV's we've ever made.

Learn more. Contact your General Electric sales representative.

All you'll have to ask is, "What's New?"

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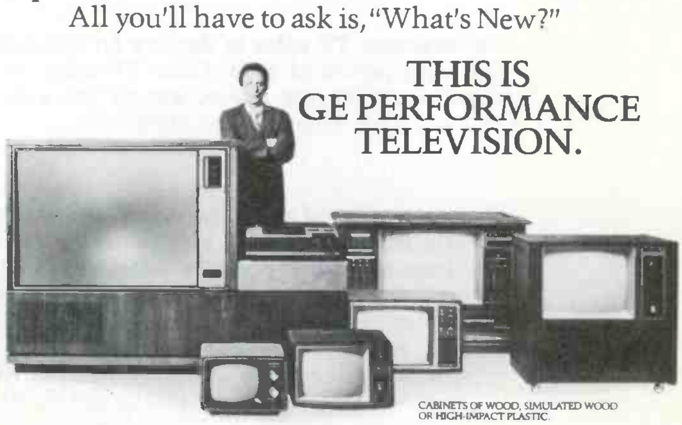


CABINETS OF WOOD, SIMULATED WOOD OR HIGH-IMPACT PLASTIC.

GENERAL ELECTRIC

electronicscanner

news of the industry

Hitachi, Limited, has established Hitachi Consumer Products of America. Following US government opposition to a joint manufacturing facility with General Electric, Hitachi formed this production company in addition to the companion Hitachi Sales Corporation. Both corporations are to be based in Compton, CA. Full operations are planned for January, 1980.

NARDA makes available to its members a series of videocassette tapes about good selling techniques. Although there is no charge to NARDA members, a deposit and prompt return of each tape are necessary. NARDA is the National Association of Retail Dealers of America at 2 North Riverside Plaza, Chicago, IL 60606.

The 70 millionth Sylvania picture tube was manufactured in March. The first Sylvania experimental picture tube was developed in Salem, MA, during 1931. Mass production of B&W tubes began in 1946, and the first Sylvania color picture tube was produced in 1955, with mass production by 1962.

A new dealer incentive program called 'RCAs Redi-Check Awards '79" continues until October of 1979. More than 700 merchandise awards are available to TV service dealers who purchase RCA tubes and SK devices in certain quantities. One Redi-Chec certificate is given for each 10 RCA receiving tubes. And one certificate is given for every $40 purchase of SK solid-state devices (distributor resale prices). Certificates are redeemable for merchandise that is shown in the prize book.

Seven new video games have been added to the Odyssey-2 by Magnavox. Presently the total is 24 games.

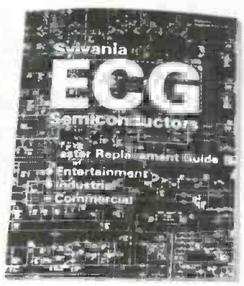
The Commercial Microwave-Oven Department of Sharp Electronics is continuing a series of one-day seminars for its service organizations. During the first two months of 1979, 17 seminars were held. All Sharp technicians should be trained by the end of 1979.

Monochrome TV sales to dealers for the first 17 weeks of 1979 were increased 6.8% compared to the same period of 1978. Color TV sales were reduced by 0.2% for the same period. Most radio sales were sharply lower, except for auto radios which increased by 8.1%. Home VTRs sold 45.1% higher compared to 1978.

Flame spraying of zinc coatings on the inside of plastic housings might significantly reduce problems of radio-frequency interference (RFI). Metco has developed the sophisticated spraying equipment required for zinc coatings. Such metallic coatings applied to the inside of a TV cabinet would act as a shield to external RF.

WE'VE GOT THEIR NUMBERS

The new Sylvania ECG® Master Replacement Guide puts it all on the line for you. With a parts listing for more than 2,200 devices. Including microwave ovens, VTR's,



mobile communications, and optoelectronic products. So pick up a copy at your local distributor. And hold some of the world's largest companies in the palm of your hand.

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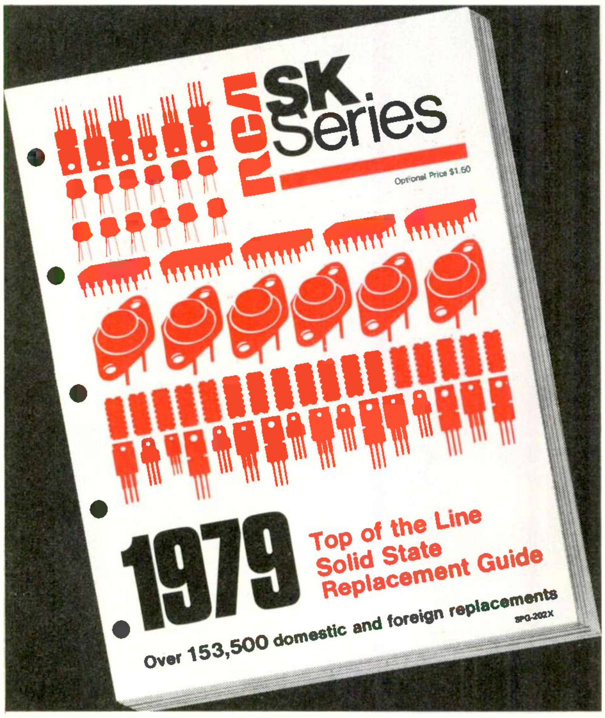


New RCA SK Solid State Replacement Guide

- **Largest RCA SK Replacement Guide to date.**
- **Over 950 SK types replace over 153,000 domestic and foreign types.**
- **Everything you need under one cover for quick, easy, profitable servicing.**
- **The industry's only Guide to include SK numbers and the other leading numbering system.**

The new 1979 RCA SK Solid State Replacement Guide has easy-to-find, easy-to-read information on RCA's full line of replacement transistors, rectifiers, thyristors, integrated circuits and high voltage triplers. Thousands of hours of engineering went into the preparation of this guide which covers consumer, commercial and industrial applications.

RCA SK Replacement Solid State

people in the news

Carlen DeJong

Helmut Beierke has been named administrator of product research and design for PTS Electronics. He will investigate new products and services and be responsible for research and development of new products. Carlen DeJong, formerly PTS regional manager and supervisor of the PTS-Denver Servicenter, has been promoted to regional vice-president. DeJong joined PTS in 1971.

Zenith's board of directors has elected officers for three new positions. Karl H. Horn becomes executive vice-president/general manager of picture tube and components operations; Joseph P. Fiore now is senior vice-president/general manager of B&W TV, audio and video devices; and Robert B. Hansen (formerly vice-president of TV engineering) becomes senior vice-president/general manager of all color TV operations.

The new director of technology for Micro Switch is Dr. Charles L. Hudson, who has held several staff positions in aerospace electronics projects for Honeywell, the parent company.

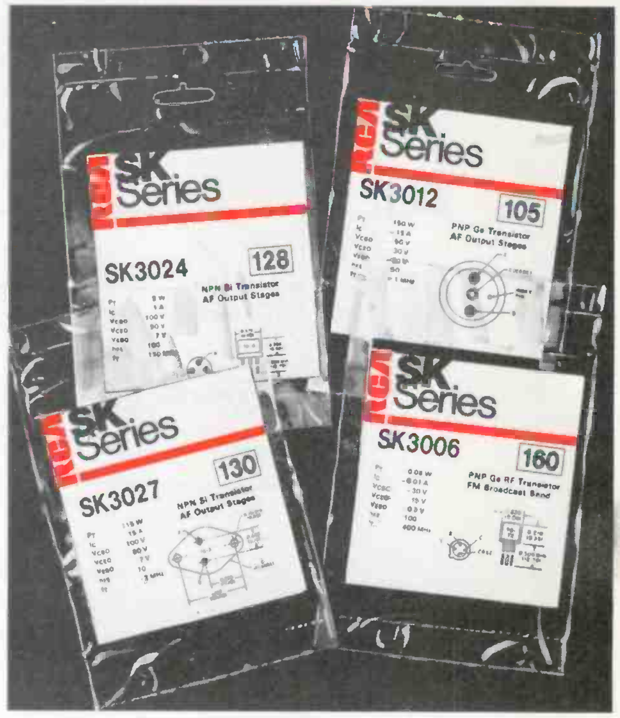
.... RCA SKs make it easy for you to offer reliable service at a profit.

New Numbering System

All SKs now feature, where applicable, the product numbers of the other leading system used by ECG,* REN and TM. For example, whenever an SK device replaces an ECG device, the ECG number is now part of the SK number. (SK 3444, a direct replacement for ECG 123A, is now listed as SK 3444/123A.) The new 1979 RCA SK Solid State Replacement Guide is the only guide you need. You can buy and install RCA SK devices with confidence that the replacement is right and the quality is right too.

Best of all, RCA Top of the Line quality means fewer costly call-backs and more profitable customer servicing for you. See your RCA SK distributor for all your solid state replacement needs and ask for your copy of the new authoritative RCA SK Replacement Guide, SPG 202X; or send your request with check or money order for $1.50 to RCA Distributor and Special Products, P.O. Box 597, Woodbury, N.J. 08096.

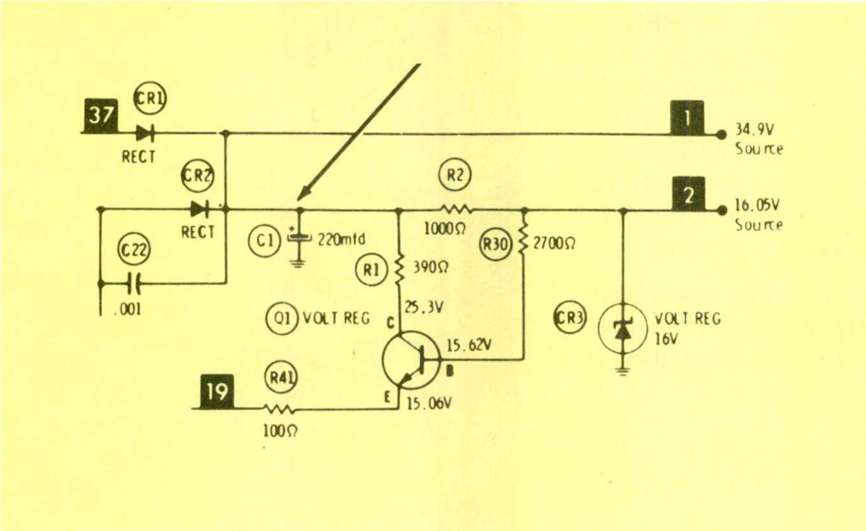
*ECG is a trademark of GTE Sylvania



Alfred C. "Pete" Griffin has been named to the new position of director of engineering for Radio Shack. He will be responsible for consumer-product engineering and evaluation.

RCA Distributor and Special-Products Division recently honored its top district sales managers of 1978. Award recipients (from the left) are Ray Schmit, George Gahalla, Oscar Goedecke III, Charlie Kilian, Bud Mowrey, and Bud Scott.

troubleshooting tips



Remote would not apply power
RCA CTC48A
(Photofact 1300-2)

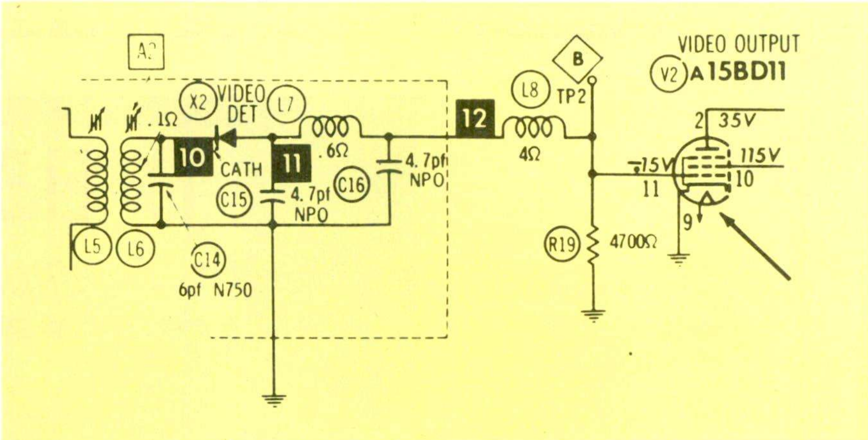
No power was applied to the main TV receiver when the remote transmitter was used in the usual manner. Power was applied if the spring-loaded on/off switch was held in solidly.

Although I never had worked on this model before, it seemed reasonable to start by checking the on/off driver circuit and associated components. Those parts tested okay, and temporary substitution gave no improvement.

My scope showed square waves at many points in the remote receiver. But, I assumed (wrongly!) that the waveform was normal. After I examined the schematic more, I could see the square waves were wrong. By shunting each electrolytic with a new one, I found C1 (220 μF) was open. A new capacitor solved the puzzle and taught me to not accept strange waveforms as normal. The best piece of test equipment still is a human brain.

Steven Devine
Jackson, MI

No picture or sound
GE V-2 B&W
(Photofact 1114-2)



First test for the no-sound, no-picture complaint was to measure dc and signal ac voltages at video testpoint 3. Both ac and dc readings were about zero voltage.

Resistance tests with both polarities of the ohmmeter showed about 50 Ω; there was no diode action. I suspected a shorted X2 video-detector diode. Evidently, the diode had been replaced before, because the shield showed signs of a Caesarean entry through the side (such practices are not professional, but they do save time).

After I replaced the diode, the TV operated okay for about an hour. Then the new diode shorted. This made me suspect an intermittent short in the 15DB11 between screen grid and control grid.

However, I didn't have a replacement tube. Therefore, I changed the circuit by adding a 0.05 μF coupling capacitor and 1 MΩ grid resistor. The TV operated fine for the week required to receive a new 15DB11 tube. At that time, I restored the original wiring and installed the new tube.

Such diode failures can occur in many models that direct couple the video detector and the video amplifier.

John Bailey
Short Hill, NJ

Editor's Note: To protect against similar tube shorts in the future, connect a 470-Ω small-wattage resistor between the tube grid and the detector circuit. This limits the current through the diode without affecting the sharpness of the picture.

Want more information? Circle the numbers of those items of interest to you

GET MORE FACTS

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61	62	63	64	65	66	67	68	69	70
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G. ☐ Other (Specify ....

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61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

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Check One:

A.☐ Independent Electronic Service Organization
B.☐ Retailer with Electronic Service Department
C.☐ Independent or Self-Employed Service Technician
D.☐ Electronics, Radio, TV Manufacturer
E.☐ Industrial Electronic Service
F.☐ Wholesaler, Jobber, Distributor
G.☐ Other (Specify ....

Position
Check One:

H.☐ Owner, Manager
I.☐ Ser. Manager
J.☐ Technician
K.☐ Other

Be sure you have checked ONE box in each column above!

Please print plainly:

NAME ____________________ FIRM ____________________

FIRM ADDRESS ____________________

CITY ____________________ STATE ________ ZIP CODE ________

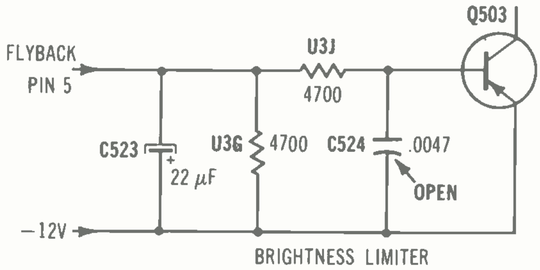
TELEPHONE: Include area code ____________________

Want more information? Circle the numbers of those items of interest to you

symcure

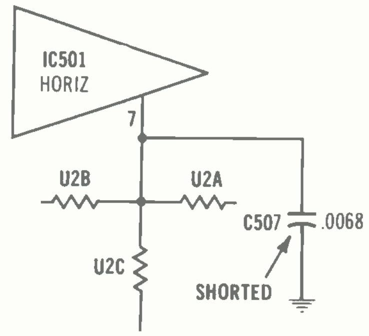
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 9JB1 (B&W)
PHOTOFACT—1712-2



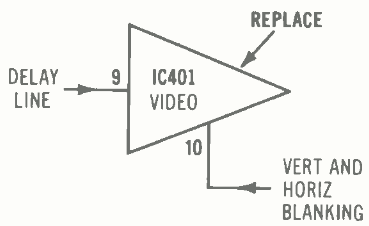
Symptom—Vertical bars (jail bars)
Cure—Check C524, and replace it if open

Chassis—Zenith 9JB1
PHOTOFACT—1712-2



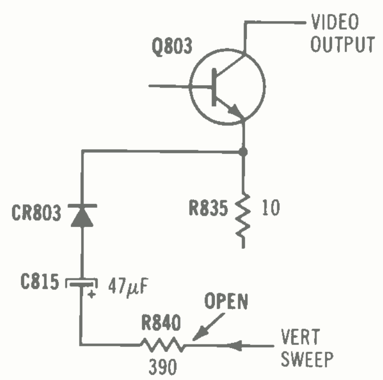
Symptom—No high voltage
Cure—Check C507, and replace it if shorted

Chassis—Zenith 9JB1
PHOTOFACT—1712-2



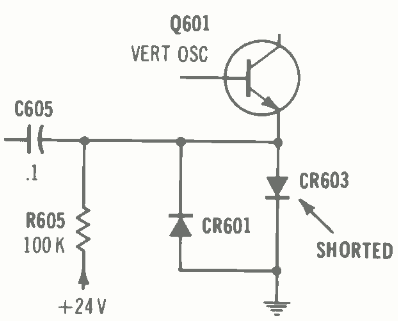
Symptom—Dark shading at top of picture
Cure—Replace video IC IC401 as a test

Chassis—Zenith 19GB1
PHOTOFACT—1692-2



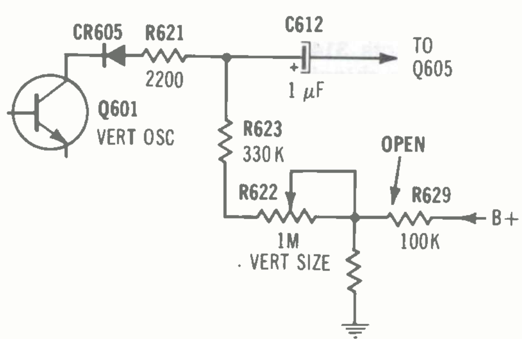
Symptom—Retrace lines
Cure—Check resistor R840, and replace it if open

Chassis—Zenith 19GB1Z
PHOTOFACT—1692-2



Symptom—No vertical locking
Cure—Check diode CR603, and replace it if open

Chassis—Zenith 22GB1
PHOTOFACT—1581-2



Symptom—Insufficient height
Cure—Check resistor R629, and replace it if open or increased

reader's exchange

There is no charge for a listing in *Reader's Exchange*, but we reserve the right to edit all copy. If you can help with a request, write directly to the reader, not to **Electronic Servicing.**

For Sale: Conar model 255 5-MHz 5-inch triggered scope, like new with probes and manual, $175; RCA WO-33B 5-MHz 3-inch scope, with probes and manual, $150. *Albert Labanouskas, 426 Larch, Scranton, PA 18509.*

For Sale: Sylvania CK3000 test jig with manual and 57 adapters; Sencore Ringer YF33 (new); Heath IT5230 CRT tester; Heath IG57A sweep/marker; Heath IG28 color-bar/dot generator; Heath I0102 scope with 3 probes; Heath IG37 stereo generator; Heath IG102 RF generator; Polaris HV probe; EMC model 213 tube tester; and Telematic tuner-sub, battery operated. *Mike Murphy, 40512 Regency Drive, Sterling Heights, MI 48078.*

Needed: Tekfax 113. Will buy or trade a Tekfax 114. *Gene Moats, #10 Route 6, Parkersburg, WV 26101.*

For Sale: Model 304H Dumont scope with service and calibration manual, $225 with shipping. *Stan Richards, P.O. Box 3981, San Angelo, TX 76901.*

For Sale: Early Photofacts, 3 to 800. One set is $3 plus $1 postage and handling, one folder from set is $1 plus 50 cents handling and postage. Money returned if order can't be filled. *Ronald Stuttard, Sr., 13 Tindall Drive, Clinton, NY 13323.*

Needed: Low-distortion audio generator (Leader model LAS-5500 or equivalent), harmonic distortion analyzer, dual-trace scope (Heathkit 4235 or equivalent) with delayed sweep plus other high-end servicing equipment. *C. E. Havens, Ruff's Trailer Park, Route 8, Box 24, Harrison, AR 72601.*

For Sale: Model 545 Tektronix scope with 1A1 dual-trace plug-in, in like-new condition, $500. *Don Marx, 32 Farm Road, Saint James, NY 11780.*

For Sale: Photofacts 314 through 800 (not complete), $1 per folder plus shipping; new 8XP4 and 10YP4 test tubes, $15 each. *William Shevtchuk, One Lois Avenue, Clifton, NJ 07014.*

Needed: Schematic and technical data for Penetrator model 12 PT30 made by Fyr Fyter Company. *Joe Duvall, 11345 Waterville Street, Whitehouse, OH 43571.*

Needed: Specifications for building a 450 V, 400 W/s photoflash with a 4000 μF capacitor. Need ratings of power transformer and rectifiers. *Elmer Mosley, 720 Poplar, Kenova, WV 25530.*

Needed: Second-IF transformer part S32-3510 for model 41-221 code 121 1941 Philco radio. *Ray Dustin, 5907 Shimer, Indianapolis, IN 46219.*

Needed: These tubes at reasonable prices: 2A3, 2A5, 6U5, 6E5, 7N7, 53, 45, 26, 864, X99, 71A, 47 and 3KP4. Dud transmitting tubes of the 20s and 30s needed for display. *Don Patterson, 636 Cambridge Road, August, GA 30909.*

Needed: Main IF board (714C449-9/A8735-6) and tuner (94C381-8) for a model 5L5181 chassis 12K2086-2 run 14 Admiral TV. Must be in working condition, quote price. *Myers TV, 10 Country Life Drive, O'Fallon, MO 63366.*

Needed: HV/flyback transformer (24P65171A49) for model CP469EW chassis D14TS-924C01 Motorola TV. Send price asked. *Hawkes TV, US Route 302, Westbrook, ME 04092.*

For Sale: Heath IG-57, $125; EICO 369 marker, $115; Sencore MU-150 tube tester, 2.5 years old, $215 ($350 list); Sencore FE-20 multimeter with HV probe, $65; Sencore transistor checker, $65. *Tony Bodo, 4380 Hayes, Gary, IN 46408.*

Needed: Used 470DLB22 Sony picture tube in fair condition. Quote price. *C. V. Todd, 1320 N.W. 116th, Miami, FL 33167.*

For Sale: Model IO-18 Heathkit lab scope, $145; model IG-57A Heathkit marker/sweep generator, $125; model IM-18 Heathkit VTVM, $25; model 466 CRT tester/rejuvenator, $110; and some older Photofacts, $1.25 folder. *H. Volk, P.O. Box 521, Pinellas Park, FL 33565.*

Needed: Instruction and service manual for a model C-20 PACO resistance/capacitance bridge. Will buy, or copy and return. *Harlan H. Reager, Sr., 1729 North 7th, Lebanon, PA 17042.*

Needed: AM FM RF generator. Also, FM stereo-multiplex generator. *Rick Cole, Route 4 Box 51R, Marshfield, MO 65706.*

For Sale: Complete files of **PF Reporter/Electronic Servicing,** *Radio Electronics* and *Radio & TV News/Electronics World* from 1953 through 1978. Will sell any or all complete sets, but will not break them. *Frank Cowart, 611 Myrtle, Green Cove Springs, FL 32043.*

Needed: Motor for Miranda Nocturn stereo (Allied Impex). Please quote price. *Conrad Eaton, 2710 Belleview Avenue, Cheverly, MD 20785.*

For Sale: Test equipment manuals are available for B&K-Precision, RCA, Sencore, Simpson, Triplett, Tektronix, H-P, Hickok and Amphenol. Send your needs and a stamped self-addressed envelope. *Ron Jordan, 5277 Larchwood Drive, San Jose, CA 95118.*

Needed: A good power transformer (54-26) for an 0-10 or 0-12 Heathkit scope. *Frank Cowart, 611 Myrtle, Green Cove Springs, FL 32043.*

Needed: FM generator, FM deviation meter, audio generator, bridge, frequency meter (up to VHF), 30-W VHF wattmeter, and a 50-Ω dummy load. A fire destroyed everything, so reasonable prices are needed. *Frank Sikonski, 16 Oakwood Avenue, Lincoln, RI 02865.*

For Sale or Trade: Assorted new tubes, dealer's cost $540, sell for $450 or trade for triggered scope of equal value. *Johnnie Jones, RR2, Shelbyville, MO 63469.*

For Sale: B&K-Precision 415 sweep generator, $300; B&K 466 CRT tester/rejuvenator, $100; B&K 282 digital multimeter, $100; B&K 520 transistor tester, $100; B&K 607 tube tester, $100; B&K 700 tube tester, $70, Sprague TO-6 capacitance tester, $100; Sencore 75 parts substituter, $60; Sencore TC-142 tube tester, $85; Lèctrotech CRT-100 CRT tester, $70; Heath IG-57A sweep, $75; Heath IG-28 dot/bar generator, $70; Amphenol dot/bar generator, $50; Heath 2½ digit multimeter, $50; Heath 5-MHz scope, $70. Heath VTVM, $15; and out-of-print Photofacts, $2.75 each. *Action TV, 1180 Los Altos Avenue, Los Altos, CA 94022.*

Needed: Schematic and service data for model SX1000TA Pioneer radio. Will buy, or copy and return. *Ora Troyer, RR #1, Box 244, Mertztown, PA 19539.*

For Sale: Sencore model MU-150 tube tester, like new, $250; B&K-Precision model 466 picture-tube tester/rejuvenator, mint condition, $100; Heathkit IT-11 capacitor tester, $30; EICO model 145 signal tracer, $25; new Telematic color-tube tester with adapters,

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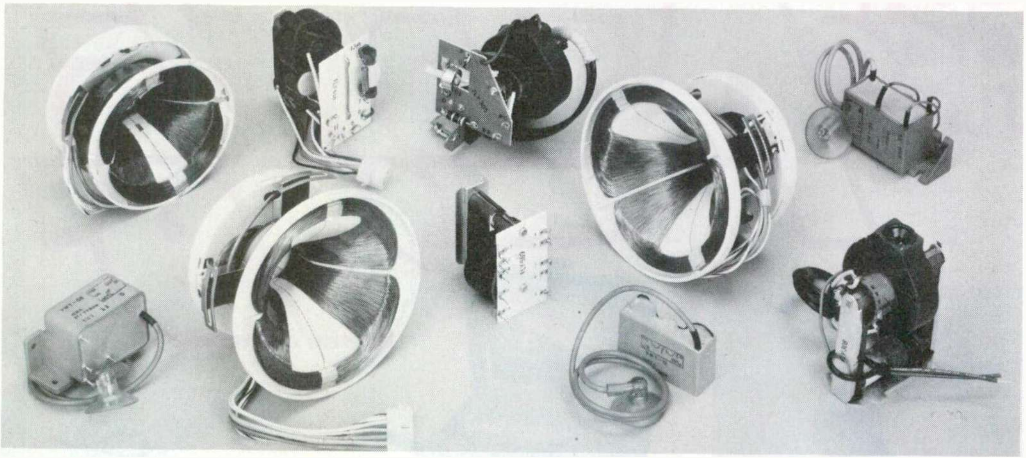

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$40 or trade for scope. *K. Miller, 10027 Calvin, Pittsburgh, PA 15235.*

Needed: Service data for the model 1869 Korvette color TV (an XAM made by Sanyo). *Julian Kupchynski, 34-23 Jordan Street, Flushing, NY 11358.*

Needed: Service data for a model K-50 York cassette tape recorder. Will buy, or copy and return. *Mike's Repair Service, P.O. Box 217, Aberdeen Proving Grounds, MD 21005.*

For Sale: Sencore PS-29 scope, used only a few hours. Will send (shipping prepaid) on receipt of $425 money order. *Melvin Gable, 206 South Matteson, Bronson, MI 49028.*

Needed: One type 224 (screen-grid type with grid on top) tube, at reasonable price. *Jag's Radio & TV Service, 14 Rudolph Road, Forestville, CT 06010.*

For Sale: Stelma distortion analyzer (TTY), $25; Lambda regulated supply model LMCC24Y, $90; LM251Y adjustable supply, $75; LM848Y 48-V supply, $85; new Superior Powerstat, 1000 W; NEC line tester and oscillator, $15; Tektronix P6032C probe with 20x attenuator, $35; Tektronix P80 probe with 5 attenuators, $70; Tektronix type N with GR to UHF adapter, $40; Fluke 801B voltmeter, $35; Heath SB620 Hamscan, $100; GEL model 11S2 telemetry receiver, $75; and Teltype model 28 KSR, $190. *Vincent J. Shroad, Jr., 26 Wildrose Lane, Levittown, PA 19054.*

Needed: Used Sencore PS-29 scope, state price and condition. *Bill Walters, P.O. Box 78, Nevada, MO 64772.*

For Sale: B&K-Precision TV Analyst model 1066; Hickok model 610A FM-alignment generator; Hickok model 209 VOM; Precision model 915 counter-type tube checker; Superior roll-chart tube checker, 5TP4 scope CRT; Rider's 6 to 19 radio manuals and 1 to 23 TV manuals. Make offers. *Troch's, 290 Main Street, Spotswood, NJ 08884.*

Needed: Schematic and service information for model 6250 Wurlitzer church-type organ. *Walter Latinski, Box 215, Shoreham, NY 11786.*

For Sale: Old radio schematics for 1926, 1938, 1939 and 1942. Send self-addressed stamped large envelope and $2 for each make and model number. Unfilled orders will be refunded. *Joseph Cochrane, P.O. Box 573, Bricktown, NJ 08723.*

For Sale: Flucke 8000A DMM, $100; Data Precision model 175 DMM, $50. *Michel Vignali, 137 14th Avenue, San Mateo, CA 94402.*

For Sale: B&K-Precision 1077 TV Analyst, $485; RCA Mark II test jig with CRT, $110; Sencore PS-163 dual-trace scope, $665; Sencore SG-165 stereo analyzer, $500; RCA Senior VoltOhmyst, $65; Sencore YF-33 yoke and flyback tester, $155; Sencore SM-158 sweep/marker, $288; Sencore RC-167 substituter, $100; Heathkit model IT-18 transistor tester, $35. All like new with manuals and probes. Or, $2200 lot price including shipping. *Thomas Kardos, 433 South Yorbita Road, La Puente, CA 91744.*

For Sale: Precision model 230 multi-bias supply, $30; complete set of Precision probes, $25; Sylvania scope calibrator model 300, $30; also, yokes, flybacks and tubes for B&W TVs. Send for list. *Al Crispo, 159-30 90 Street, Howard Beach, NY 11414.*

Needed: Schematic, parts list and instruction book for a model 107C Professional AEC #SGM-49C geiger counter made by Precision Radiation Instruments. Will buy, or copy and return. *R. C. Jurgaitis, 3418 West 65th, Chicago, IL 60629.*

For Sale: Model 415 B&K-Precision sweep/marker with cables and manual, excellent condition, $200. *Ken Post, Route 2, Zumbrota, MN 55992.*

Needed: One 6B7 radio tube. *Ken Post, Route 2, Zumbrota, MN 55992.*

For Sale: Model WO-505A 5-inch RCA scope, excellent condition, originally $300, sell for $175. *Doug's TV, 710 Port Washington Boulevard, Port Washington, NY 11050.*

For Sale: Sencore model SM158 Speed Aligner, like new, $145; EICO model 944 flyback/yoke tester, never used, $29; Heathkit model V-7A VTVM, excellent condition, $25; B&K-Precision model E-2000 signal generator, like new, $129. All have manuals and leads, shipped postpaid. *Tom Seller, 60 Greeley, Hudson, NH 03051.*

Needed: Information about rates for servicing TV, radio, tape and other electronic products. *V. Robertson, 8449 Sunny Brae Avenue, Canoga Park, CA 91306.*

For Sale: Obsolete and hard-to-find TV flyback and vertical-blocking transformers (RCA, Ram, Stancor, etc.), 10 to 25 years old, ideal for dealers of used TVs, more than 200 for $250 plus shipping. *Jack Stollman, 132-02 Jamaica Avenue, Richmond Hill, NY 11418.*

Needed: Spindle assembly for takeup reel (part 01288210) and a number 13286540 detent spring for a model 5150 Wollensak type recorder. Also, need a PW700 color board (number 130726) for a CTC22A RCA color TV. Please quote price for these. *Harvey Rousseau, 6 Longview Drive, Milford, MA 01757.* □

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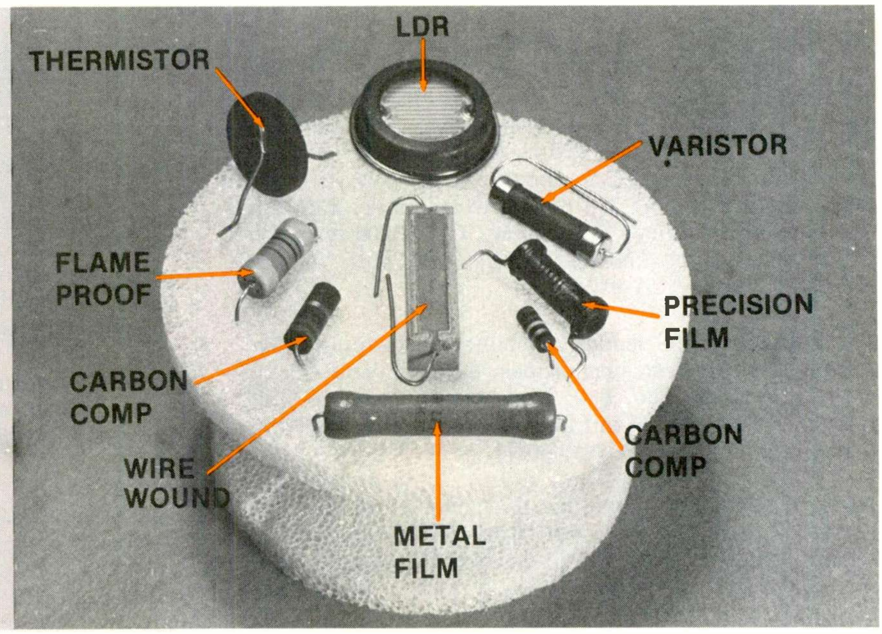


Several basic types of resistors are identified by arrows and captions.

Selecting replacement resistors

Resistors are available now in many different types and ratings. They vary considerably in performance and stability. This information is compiled to help technicians select replacement resistors that will equal or exceed the original performances.

By Carl Babcoke, CET

In previous decades when electronic products were less complicated, the choice of a small resistor for replacement was very simple. First, the value in ohms was obtained from a schematic. Next, any new resistor of equal wattage (or larger, if it could be squeezed into the space) was installed. There were no other considerations.

When applied to late-model color TVs, unfortunately, this simple method might produce inferior pictures, or it could cause a delayed failure which extensively damages several other components. Yes, modern equipment *demands* that more attention be given to the selection of a proper replacement resistor from the many excellent types now available.

Although the rules for obtaining an appropriate type of resistor are few and not difficult, they are easier to remember after the reasons behind the rules are explained. Therefore, some background information will be supplied first.

What is a resistor?

The word "resistor" implies a component that resists something. In this case it resists the flow of current. And in a secondary sense, it resists the effect of voltage.

With the few resistor types of 30 years ago, it would have been sufficient to define a resistor as a component having a voltage/current relationship that is both constant and linear. Although that definition excluded capacitors, diodes and inductors, it soon became obsolete with the introduction of unique resistors that changed resistance according to the amount of voltage, the exact temperature or the intensity of light falling on the resistor element. These interesting types of resistors will be explained later, and a better definition of resistors is proposed at the end.

Carbon-composition resistors

Carbon is the material used in the majority of resistors. Figure 1 shows construction details of the hot-molded carbon-composition type of resistor. Carbon is mixed with non-conductive binders and fillers to form the resistive center, which is combined with the end wires and the external insulation during one trip through an automated machine.

Hot-molded carbon resistors are available typically in wattages from 1/8 W to 2 W. Smaller numbers of 3-W and 4-W sizes are manufactured also.

Variations of the carbon-versus-filler ratio and the physical size of the resistive element produce values between 10 Ω and 22M Ω. These values can be held to a manufacturing tolerance of about ±10%. Then ±5% and ±2% tolerance values are obtained by testing a whole run and removing those resistors that are within the tighter tolerances.

It's not practical to manufacture or select carbon resistors of better tolerances because the normal resistance variations from aging and heat cycles often exceed those limits. If tighter tolerances are needed, a more stable type of resistor should be selected.

Temperature coefficients of these carbon resistors are between +1000 parts-per-million (PPM) per degree Centigrade and -1000 PPM. However, many of the molded resistors have a small negative coefficient. That is, the resistance decreases slightly from an increase of temperature.

Hot-molded carbon resistors are being superceded slowly in new equipment by carbon-film types.

Carbon-film resistors

A thin film of carbon is deposited from a carbon-bearing high-temperature gas onto a cylindrical rod of ceramic or glass substrate. That's why this type of resistor sometimes is called a deposited-film type. Finally, metal end caps with lead wires are crimped firmly over the ends, and insulating material is applied by molding or by dipping (see Figure 2).

For lower resistance values, the film is continuous from end to end. Higher values require the carbon film to be placed (or cut) in spirals around the core. Extremely high values have one long continuous spiral which gives a long narrow path of carbon.

Carbon-film resistors usually are

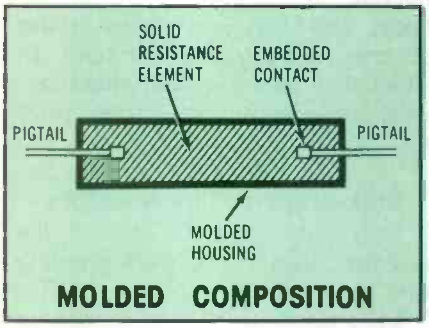
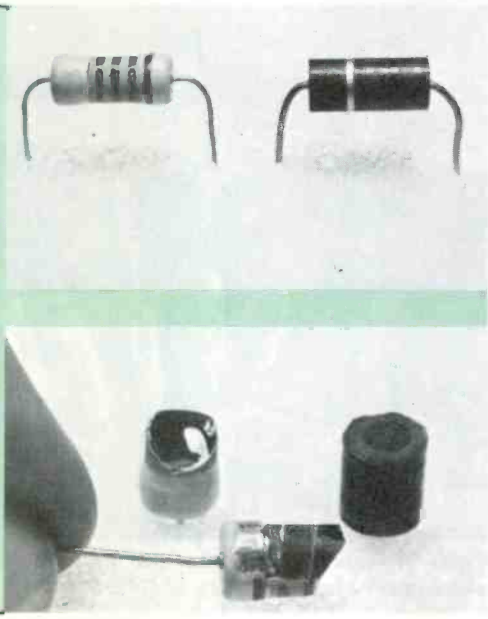


Figure 1 Hot-molded carbon-composition resistors are manufactured in automated machines. Resistance values are indicated by the colors of stripes around the body.

Two resistors were broken to illustrate the construction. At the left in both pictures is the RCA flameproof type. The other is a good-quality carbon-composition type. After they were broken, the flameproof resistor was found to have a core of glass or some ceramic that was smooth and reflective. The half held by thumb and finger has had the insulation scraped to show the metal cap and the spirals of resistive material. At the right, a center of carbon-and-filler and the insulation (which is thick to provide strength) are the only visible parts of the carbon-comp type.



Resistor Quiz

1. **True/False** Two 1-watt resistors always can dissipate 2 watts.
2. **True/False** Wire-wound resistors produce the least amount of noise.
3. **True/False** Varistors follow Ohm's Law.
4. **True/False** Film resistors have the least reactance of all types.
5. **True/False** Many carbon resistors change resistance after repeated hot and cold cycles.
6. **True/False** Don't replace any resistor with one of higher wattage.
7. **True/False** Hot-molded resistors have minimum skin effect.
8. **True/False** Carbon is the least stable of all resistive materials commonly used in resistors.
9. **True/False** All metal-film resistors are non-inductive.
10. **True/False** Resistor self-heating because of the power dissipated sometimes is an advantage.

Answers to the Resistor Quiz

1. **False** Only under specific conditions can two resistors safely dissipate twice the wattage of one. Each resistor must have its own free air space (don't bind two together) and be attached to cool terminals. Also, they should be of the same type and have identical resistances and wattage ratings. (Of course, if the resistors are operated at a small fraction of the wattage rating, such extreme care is not necessary.) For operation with unequal wattage ratings, the resistance values must be chosen carefully so each resistor is allocated its rated wattage.
2. **True** Bulk-metal (not seen often in consumer products) and wire-wound resistors have the lowest noise amplitude.
3. **True** Yes, varistors follow Ohm's Law, but some variations of the formula can't be used because the voltage/resistance ratio is not linear. The amount of voltage used to test a varistor can vary the resistance. Therefore, use the formula: resistance equals voltage divided by current.
4. **False** Hot-molded carbon-composition resistors have the least reactance.
5. **True** Carbon resistors are the most susceptible to resistance changes from aging and heat cycles.
6. **False** For carbon resistors, higher wattages provide better heat dissipation, and the cooler operation promotes improved stability. Higher wattages of metal or wire-wound resistors usually offer no improvements. In the safety areas of new products, use only approved replacements.
7. **False** Film-type resistors have thin resistance elements and thus have the least amount of skin effect.
8. **True** Yes, carbon is the least stable, but it is cheap and easy to fabricate. The stability is satisfactory for non-critical applications.
9. **False** Only when the film is solid without spirals are these resistors non-inductive. Hot-molded carbon types have the least inductance.
10. **True** In degaussing and current-limiting circuits, the self-heating of thermistors is necessary for the desired change of resistance.

manufactured in values between 1 Ω and 200M Ω. This type is gaining in popularity, and the number used per year probably will continue to increase unless the metal-film types overpower it by better stability.

Metal-film resistors

Construction of metal-film resistors is similar to that of the carbon-film types previously described. Thin-film types have a one-millionth-inch coating of chromium, nickel or aluminum. Metal-oxide, bulk-property metal or glazed-metal are used for the thicker coatings.

When the coating is continuous, the basic resistance is only a few thousand ohms. Spiral grooves are cut in the metal film to increase the resistance value of each resistor, which can be trimmed this way to good tolerance. Flat designs can be laser-trimmed for very-high accuracy.

Metal-film resistors fall into two categories. One group includes high-accuracy, high-stability precision resistors that nearly equal the excellent performance of the best precision wire-wound types. The other group is made up of lesser-accuracy resistors for uses where higher wattages and minimum drift of resistances are important. These latter types often are included in new equipment as an alternate to larger wire-wound resistors, or where the stability of carbon-com position is not satisfactory.

These metal-film resistors are manufactured by depositing Nichrome or other metal alloy on a glass or ceramic rod while the components are in a vacuum. The end caps with leads and the insulation are added later.

Cermet-film resistors

A mixture of precious metal and ceramic binders is screened onto a ceramic rod or tubing before it is "fired" at a high temperature to produce glazed metal and cermet-film resistors. Cermet is a combination of *cer*amic and *met*al.

Generally, cermet resistors are smaller than the other types, they can be made in larger resistances up to 500 M Ω, some types can operate up to 8000 V/in of the body, and they are stable under adverse environmental extremes. In short, they have excellent characteristics that justify the higher price for many applications.

Bulk-property film resistors

Only pure metal is used as the resistive element in bulk-property film resistors.

They are limited to the middle of the resistance range (about 30 Ω to 100K Ω) and a maximum of 0.75 W, but they have excellent advantages such as these:

- the best high-frequency response of any type of resistor;
- availability in precision tolerances;
- a stable temperature coefficient; and
- very small noise contribution.

Except for a few limitations and the price, bulk-property resistors approach the ideal.

Flame-proof resistors

Flame-proof resistors are not basically different from others. Although little specific information could be obtained about the internal construction, many of them appear to be metal-film types. In any event, the flame-proofing consists of a ceramic or glass rod at the center in addition to an overall ceramic coating which will not burn or out-gas when the resistor is overloaded.

Flame-proof resistors can be used to replace many other types, but *they especially are recommended for the safety areas* marked on schematics.

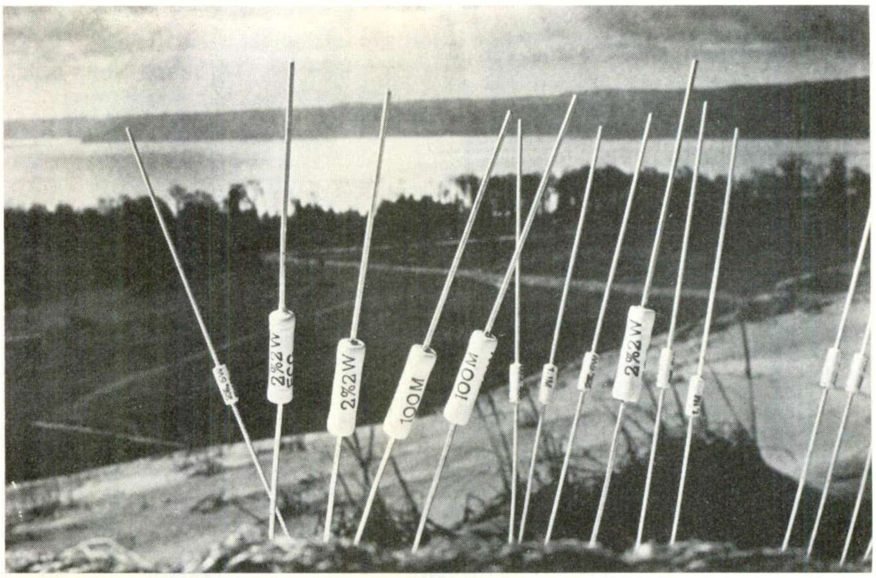
Resistor stability

It seems logical that a resistor should not change resistance at all after it is manufactured. That is not the case; all resistors change in value, but some types change more than others do.

Temperature—One major cause of resistance variation is temperature. Ambient temperature surrounding each resistor and the internal rise of temperature from the power dissipated inside the resistor both contribute to resistance variations.

Changes from cycling—A resistor often undergoes a "retrace" change of resistance when operated alternately between room temperature and rated wattage. In other words, cold resistance following hot operation is different from the original cold resistance. Some resistors show a permanent *significant* change after only a few heat cycles.

This resistance change from heat cycles was reported in the June 1970 issue of **Electronic Servicing.** Of all the wire-wound, metal-film and carbon-composition resistors that were tested, only the carbon ones suffered any permanent change. One 0.5-W resistor was



These flameproof resistors are part of the Sylvania ECG semiconductor replacement line. (*Courtesy of GTE-Sylvania*) about 12% higher after only three cycles. A 1-W carbon had a permanent 17% increase after three heat cycles. *The worst example was a 0.5-W 3.3-MΩ carbon type that increased a big 47%.* None of these resistors showed any external change or signs of overload.

A similar test made this April confirmed the trend, although the resistors showed only moderate permanent increases after four or five heat cycles at rated wattage. Probably these better results are explained by modern improved manufacturing techniques.

Overload tests—Both series of tests included operation of resistors in steps of increasing wattages above the ratings. The tests were stopped each time when the resistor showed visible signs of overload. When an overload of 10 times rating was applied to one half-watt resistor, the resistance decreased to about a third of the original value and the color-bands were scorched.

Other similar carbon resistors (not the ones heat cycled) showed a slight decrease of resistance when the ambient temperature was raised. They also measured slightly high when sprayed with canned coolant. According to these imprecise tests, they evidently had a small negative temperature coefficient.

Conclusions—Moderate permanent increases of resistance were measured following tests that operated these carbon-composition resistors between zero watts and rated watts for several cycles. However, any massive overload *decreased* the resistance by a huge amount.

This characteristic of carbon to reduce its resistance from strong overloads (rather than burn open) is one reason why carbon-type resistors are seldom recommended in the safety areas of electronic circuits. Such near-shorts could allow extra damage to other components. *Safety resistors should either open or maintain the original resistance.*

Color code

A resistor that's physically too small to have the capacitance and wattage printed on it usually has

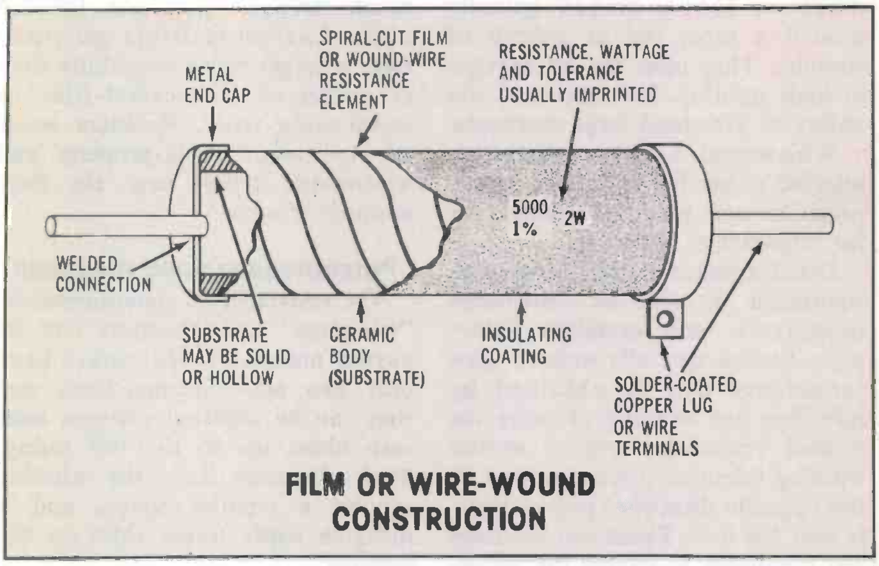


Figure 2 Carbon-film and metal-film resistors usually have each resistance element arranged in a few spirals to lengthen the path and thus increase the resistance. Lead wires serve as connections. Colored bands around the body indicate the resistance and tolerance. By contrast, wire-wound resistors have a tight spiral of many turns of resistance wire. They might have lugs or lead wires (or a combination of both), and the specs are printed on the bodies which usually are round but covered with vitreous enamel or a square ceramic covering.

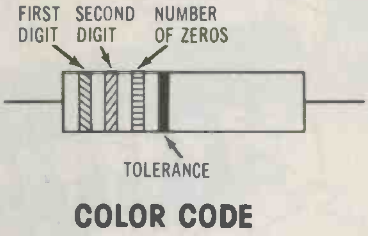


Figure 3 This is the standard color code for all small resistors.

COLOR	FIRST DIGIT	SECOND DIGIT	ZEROS	TOLERANCE
BLACK	0	0	—	
BROWN	1	1	0	
RED	2	2	00	
ORANGE	3	3	000	
YELLOW	4	4	0,000	
GREEN	5	5	00,000	
BLUE	6	6	000,000	
VIOLET	7	7	0,000,000	
GRAY	8	—	—	
WHITE	9	—	—	
GOLD				±5%
SILVER				±10%
NO COLOR				±20%

this information indicated by four stripes of color around the body, as shown in Figure 3.

Wire-wound resistors

Wire-wound resistors and variable controls are the least standardized of all resistor types. They are available in many different shapes and forms, and usually are the most expensive type of resistor.

Most wire-wound resistors are constructed by winding a length of resistance-alloy wire (chromium-nickel or copper-nickel) spirally around a tube, rod or bobbin of ceramic. They offer the advantages of high stability, low noise and the ability to withstand large overloads.

Wire-wound resistors usually are selected either for low noise, ultra-precision and excellent stability or for large-power handling.

Disadvantages include large size, significant amount of distributed capacitance, and excessive inductance (unless specially wound). Low inductance can be obtained by installing one winding of twice the desired resistance, with a second winding (identical except wound in the opposite direction) placed tightly over the first. These two windings are paralleled to cancel the inductances and provide the correct resistance.

Adjustable voltage dividers and variable controls also are manufactured with wire-wound elements.

Noise in resistors

All resistors produce noise internally, but the amplitude varies greatly according to the materials used in the resistive element. There are two main sources of resistor noise.

Thermal noise—Thermal noise also is called "white noise" and "Johnson noise." It has equal noise power at all frequencies, and the noise exists without any voltage or current being applied to the resistor. The noise amplitude increases with higher resistances and higher temperatures.

Current noise—Passage of current through a resistor produces current noise which has an amplitude that varies inversely with frequency (that is, higher frequencies of current cause less current noise). The noise amplitude is proportional to the square of the current. Tripling the current, for example, produces noise that's nine times louder. One conclusion from these facts is that a large amount of dc current produces the strongest noise amplitude.

The intensity of current noise can be controlled somewhat by the choice of materials and the type of construction.

When current is present in a resistor, the current noise usually is much stronger than the Johnson noise. Carbon resistors generally have a larger noise amplitude than is produced by cermet-film or metal-oxide types. *Resistors made of pure metal* (bulk-property and wire-wound types) *have the least amount of noise.*

Potentiometers and rheostats

The resistance of potentiometers, "trimmers" and rheostats can be varied manually. Rheostats have only two active connections, and they can be adjusted between near zero ohms up to the full rating. Most rheostats have the winding around a circular shape, and a movable wiper finger rides on the element.

Potentiometers are similar, but they have connections at each end of the resistive element, plus the center wiper connection. These controls usually are connected as voltage dividers. Some potentiometers have a straight (linear) resistance element, and the wiper is moved in a straight line. But most have the element in the conventional circular shape.

Trimmers are pots or rheostats that are designed for only occasional adjustments (such as instrument calibration). The shaft is short or has just a slot for a screwdriver. Other trimmers are capable of high resolution because the shaft must be turned several revolutions for end-to-end adjustment.

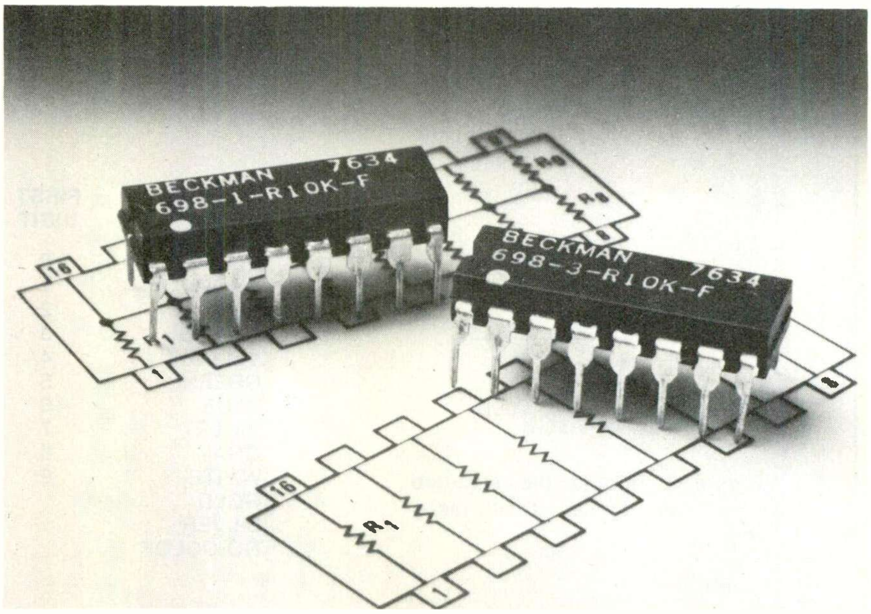
Pots and rheostats have resistive elements made of carbon, cermet or resistance wire. The taper of all variable controls must be specified.

Ac versus dc

All practical real-world fixed resistors have some inductance and an appreciable amount of capacitance, as shown in Figure 4.

Film resistors are best for high-frequency signals where "skin effect" becomes a problem. At those frequencies, a molded-carbon resistor might appear to be 10 times higher in resistance, because the current flows only through the outer part of the carbon.

However, film resistors that have a large number of spirals can be



Special resistors in DIP style are used on many computer or other digital logic modules. (*Courtesy of Beckman Instruments*)

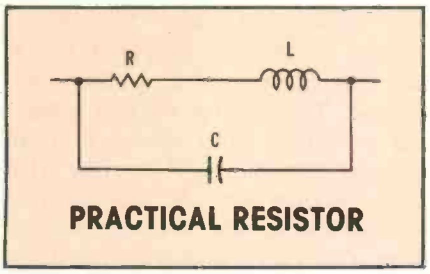


Figure 4 A real-world resistor has some capacitance in parallel and some inductance in series with it because of the construction.

too inductive for signals above about 10 MHz.

Molded-carbon types usually have a low inductance because the resistive element is a straight rod of carbon. But the end-to-end capacitance might be excessive for some applications. For example, one 22-MΩ sample tested 4.7 pf on the B&K-Precision digital capacitance meter. This is uncomfortably close to the capacitance of a good scope probe.

Maximum voltage rating

A common half-truth is that the *maximum voltage* for any specific resistor can be found by Ohm's Law according to the resistance and the power rating. It is true for low-to-medium values of resistance, but the statement does not apply to high values where the calculated voltage (according to Ohm's Law) exceeds the true maximum voltage of the resistance material. (Each kind of resistance material has a definite voltage-per-inch rating. Voltages higher than this figure cause some kind of material failure or malfunction.)

According to Ohm's Law, a 1-MΩ resistor must have 1000 V dc applied in order for it to dissipate 1 W. However, 1000 V is about twice the rated maximum voltage.

When the maximum voltage is not known, *never apply more than 700 Vdc* (about 500 V RMS for sine waves) *for every inch of resistor body length.*

Linear resistors

All resistors previously described were *linear* types. The current increased or decreased in perfect step with the voltage. And the wattage was the same whether a resistor was supplied with positive, negative or ac voltage.

Other resistors operate in one or more non-linear ways.

Thermistors

Any temperature variation of its resistive element changes the resistance of a thermistor. This includes any heat variations from the power that's applied to the thermistor, and it is the basis for the use of thermistors in TV degaussing circuits and as surge resistors in power supplies. In fact, the self-heating provides a regenerative action that speeds the operation and forces it to completion.

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But when a thermistor is employed as a sensor to measure temperature, the circuit must apply a negligible wattage to the thermistor to prevent self-heating which would upset the accuracy.

Thermistors are manufactured in both positive-temperature and negative-temperature coefficients (PTC and NTC).

Varistors

Voltage-dependent resistors (VDRs) are metal-oxide varistors which change resistance according to the amount of voltage at their terminals. A higher voltage decreases the resistance in a gradual curve, so varistors can be used to some degree as voltage regulators.

A varistor gives equal resistances from equal positive or negative voltages. The voltage/resistance chart has the same curve at both top and bottom. Without a high front-to-back resistance ratio, varistors should *not* be able to produce dc voltage by rectification. Next month in a waveform article by Gill Grieshaber, look for the conditions that allow a varistor in a TV receiver to generate a negative dc voltage.

A specialized kind of varistor has sharp knees at both the top and bottom of its curve. These varistors are used to clip transient voltages from ac power lines, for example, and they will be described in detail in a later issue.

Most varistors are constructed from carbide granules that are mixed with a ceramic binder before they are fired at a high temperature and the leads are installed.

Light-operated resistors

Resistors whose resistances are controlled by light levels are called light-dependent resistors (LDRs), and they are made of cadmium-sulfide or cadmium-selenide. LDRs are capable of huge resistance changes. One type might measure 2 MΩ in total darkness and then change rapidly to about 100 Ω when a bright light reaches the element.

These LDRs are employed to sense the level of light in a room and then adjust the TV brightness and contrast to appropriate settings.

After the resistance of an LDR has been controlled by the amount of light, that resistance is linear to any applied voltages. Therefore, LDRs can be used as variable resistors to attenuate audio signals.

Definition of a resistor

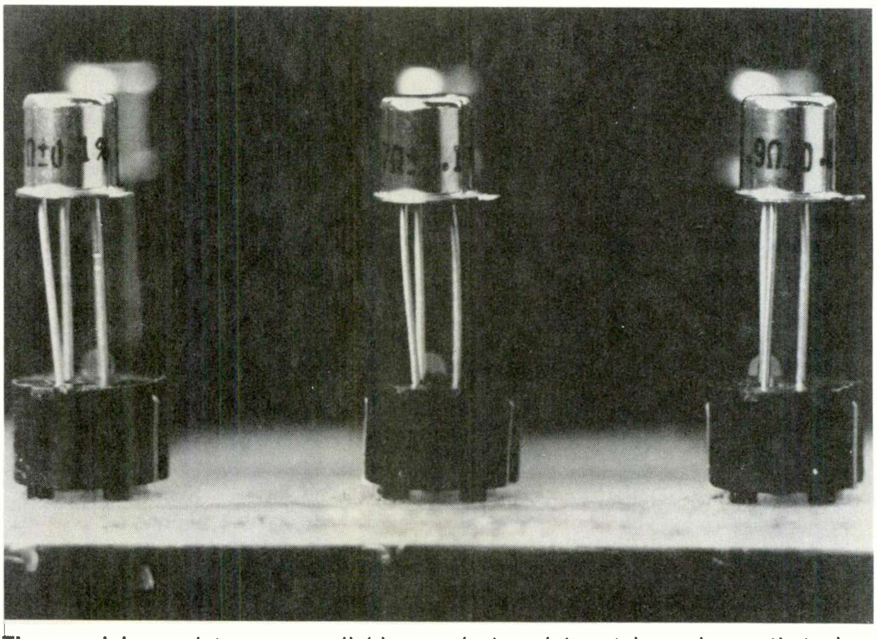
One book compares resistance in electrical systems to *friction* in mechanical systems. That's not very exact and doesn't cover all of the applications. Another source says a resistor offers a known degree of opposition to the flow of an electrical current. But an inductance does that also. A third idea is that a resistor produces heat in itself while opposing current flow.

Perhaps this multi-part definition is necessary to describe resistors adequately. A resistor must fulfill *all* of these requirements:

- A resistor is specifically designed to produce a known value of resistance; it is a component whose largest property is resistance. Inductors and capacitors also have resistance, but it is secondary there.
- A resistor or resistance offers the *same* opposition to the flow of either unvarying (dc) current or varying (ac) current. Therefore, the waveform of the current is identical to the voltage waveform. These statements are not true of capacitors and inductors.
- A resistor in series between a voltage source and the load limits the current by reducing the load voltage. The resistor current develops a voltage drop across its own internal resistance. Therefore the load voltage equals the source voltage minus the resistor voltage drop. On the other hand, if a short then reduces the load voltage to zero, the resistor is in parallel with the voltage source, and the current is limited by the resistance value. These are minor and major current limitations.
- Current through a resistor or resistance generates heat. This is not true of pure capacitances and inductances. (Of course, voltage is required for current flow.)
- Resistance or a resistor does not change the phase of a varying (ac) current (inductors and capacitors cause phase shifts).
- The same amount of current flows through a resistor or resistance when either a certain positive voltage or an identical negative voltage is applied to it. This is not true of diodes, transistors and other solid-state devices.

Replacement resistor tips

Using a 1 W to replace a ½ W (or a 2 W to replace a 1 W) carbon-composition resistor is a good technique, but only in certain



Tiny precision resistors are available now in transistor-style packages that plug into transistor sockets. (*Courtesy of Vishay Resistive Systems*) circuits. Generally, this kind of higher-wattage substitution is safe in audio, IF, video and the low-level stages of vertical and horizontal sweep.

Substitution of a larger size eases the tolerance requirements since the larger resistors run cooler (better conduction and radiation cooling) and they appear to be less prone to resistance variations not caused by overloads.

Of course, replacement of a carbon resistor with a metal type is usually an improvement without any drawbacks. However, keep in mind the possibility of higher inductive properties in the metal types.

The resistor selection becomes more critical in the horizontal-sweep circuits because of the strong pulse amplitudes and higher dc voltages, such as boost, focus and high voltage.

Here is an extreme example. Many older color-TV receivers had a small 66-MΩ resistor that acted as a bleeder for the 5000-V focus supply. This calculates as a dissipation of only 0.38 W (less than half a watt). A technician decided to replace it with a 2-W carbon-composition resistor. However, these were available in values only up to 22-MΩ, so three were used in series. Within a few weeks, the TV developed poor focus. The three resistors had a burned look, and each measured just a fraction of the rated resistance.

What could have gone wrong? A total of six watts was used (a 10 times safety factor). The technician had neglected the handy rule of not applying more than 700 Vdc/in. of the resistor body.

Each 2-W resistor was about ¾-inch long, so it was rated (in the absence of specific data) at 525 Vdc. But each 22-MΩ resistor was called on to withstand about 1700 V, which is more than a three times overvoltage.

Also, don't forget the change of resistance when carbon-composition resistors are subjected to heat cycles. A resistor with horizontal signal across it has 15,734 heat cycles/s. Practical experience has shown a higher-than-normal failure rate of resistors used in the plate circuit of horizontal-oscillator tubes. That's one area to examine if the picture lacks width on the right edge and the HV is a bit low.

For replacements up to 2-W sizes and where the original specifications are not known, it is best to stock only metal-film flame-proof resistors.

Of course, the gray overlays on schematics take precedent over all of these general suggestions. The components in those areas are important for improving safety and preventing fires. Therefore, use only manufacturer-recommended replacements, or duplicate the original specifications for all safety-area components. □

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Resistor roundup

For more information on resistors mentioned in this chart, circle the appropriate number on the reader service card located elsewhere in this issue.

Company	Fixed wire-wound	Fixed carbon comp	Fixed carbon film	Fixed metal film	Fixed cermet film	Trim-mers & pots	Varis-tors	Ther-mis-tors	Net-works & chips
BECKMAN					20	21			22
CARBORUNDUM		23			24		25	26	
COMPONENT GENERAL									27
DALE ELECTRONICS	28		29	30		31			
DAVEN	32								33
DUNCAN ELECTRONICS	34					35			
HYCOMP					36				37
HYBRID SYSTEMS									38
JULIE RESEARCH LAB	39					40			
OHMITE	41	42	43	44		45			
RCA				51					
SPRAGUE	46		47					48	49
VISHAY									50
ZENITH				52					

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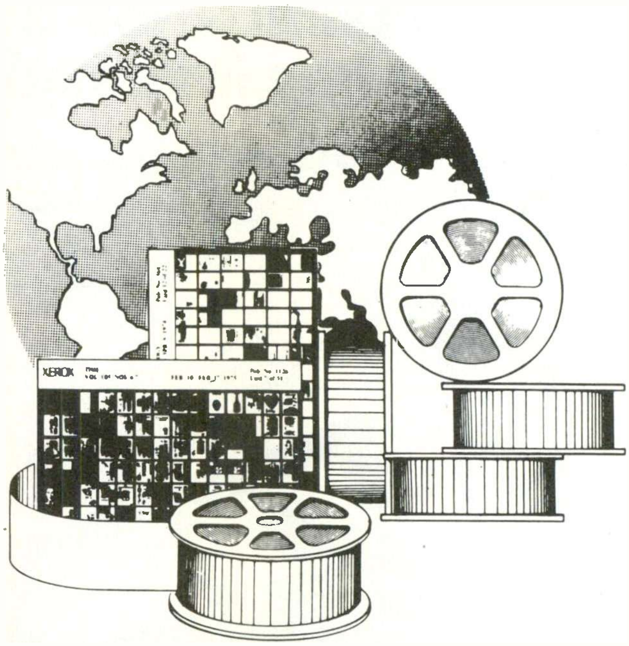

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A second look at waveforms, part 1

Scope waveforms are valuable for much more than merely revealing the waveshapes of signals. The March and April scope tips articles pointed out measurements of dc voltages and frequencies as two scope capabilities that should be employed more often. Most of the information this month is about identifying and locating zero and average lines in any waveshape. Some of the July coverage will include analyzing familiar waveforms in a new way.

By Gill Grieshaber, CET

Clamping & clipping sine waves

A sine wave by definition is a signal having only one frequency; a fundamental without harmonics. Many RF signals have a sine waveshape. The power-line waveform *should* be made up of sines. Most explanations of waveshapes begin with sine waves.

Unfortunately, some important facts about these waveforms are not emphasized enough. One such fact is the location of the *average-voltage* line. Others are the functions and values of this line.

Another important parameter is the location of the *zero-voltage* line. Sometimes the average-voltage and the zero-voltage lines are located at the same point, but not always! It depends on another factor, which will be explained later.

Fortunately, any scope that has both ac and dc coupling in the vertical amplifier can reveal the location of both these lines. And a scope with only ac coupling can show the average-voltage line *automatically!*

A tale of two lines

Coupling capacitors and signal-coupling transformers pass the ac signal but remove any steady dc level. Therefore, the output signal from either T1 or C1 in Figure 1A will be a sine wave when the input is supplied with a sine wave, and neither can pass any permanent dc voltage. That's why a scope cannot respond to dc voltage when it is operated in the ac mode. However, some important information can be obtained by using those ac and dc scope modes alternately.

Both of the Figure 1B sine waves have an imaginary average-voltage line running horizontally through the exact center of the waveshape. How can that be proved with an ac-coupled scope? Just remove the scope signal and the horizontal line that results will be located precisely where the center of the sine wave had been before. And because the line is caused by a lack of any voltage, it is called the *zero*-voltage line.

This action can be proved by several methods. Alternately connecting the sine wave signal and then removing it will show both waveforms in rapid succession (if the scope locks fast enough). A permanent record is obtained by photographing the line and the sine with two exposures (many of the ES waveforms are made in this way). The best way is to use a dual-trace scope. With no signal applied to either channel, move both horizontal lines to the center line of the scope so the two become just one

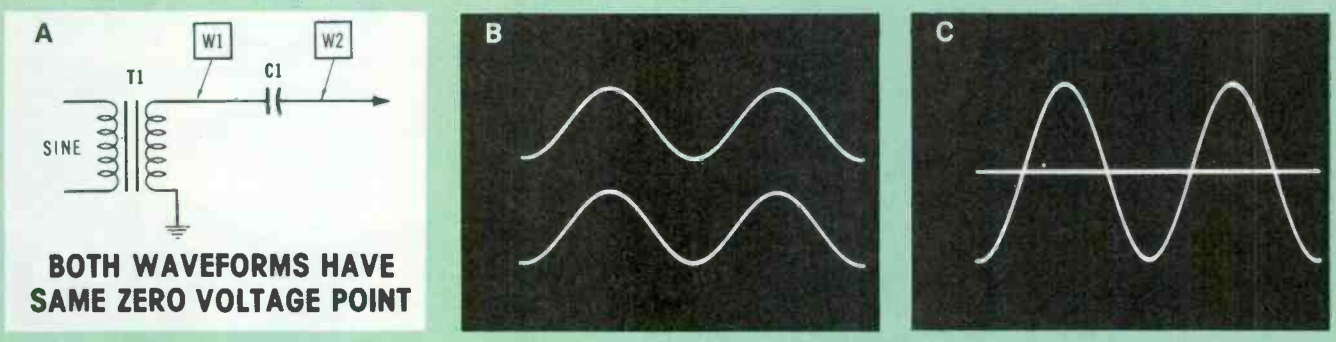

Figure 1 (A) The isolated secondary of a coupling transformer and a coupling capacitor both pass a replica of the input waveform but each removes any steady dc voltage. (B) A dual-trace scope proves the sine signals at the W1 and W2 testpoints have the same waveshape and amplitude. (C) When the scope is set for ac coupling, removing the sine signal produces just a horizontal line. This is the *zero-voltage line* since it is generated by zero voltage. A sine wave is symmetrical; therefore, a line across the exact center represents the *average* voltage. In this case, both zero and average-voltage lines have the same location. Remember this rule: *When no dc voltage is present, the zero-voltage and average-voltage lines are the same.*

Waveforms

line. Then apply the sine wave to *one* channel. The resulting combined waveforms are shown in Figure 1C.

But, wait a minute. The original intent was to find an average-voltage point or line, and the previous method found only the zero-voltage line. No doubt there is a mathematical method of proving both are the same, but it's easier to use a bit of common-sense logic. Sine waves are symmetrical. Therefore, it follows that the top and bottom halves are precisely equal, so the average line *must* be across the exact center.

The zero-voltage line and the average-voltage line *both* extend across the exact center of a sine wave. This permits the first important tip: *When no dc is present, the zero and average-voltage lines are the same.*

Sine waves with dc voltage

Addition of a diode can clamp the ac signal to a desired dc voltage. Figure 2A shows clamping

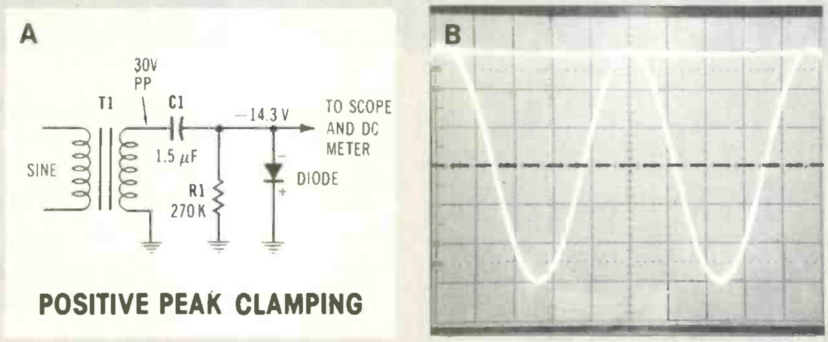

Figure 2 (A) When connected after a coupling capacitor, a diode can clamp the tip of either the positive or negative peak to any selected dc voltage. The positive peak is shown clamped to zero voltage (ground). (B) The dc scope waveform locates the zero line just barely below the positive tips. (When the dc mode is selected, center the scope waveform and then remove the input signal. The resulting line is zero voltage.) However, the average-voltage line remains at the waveform center, marked here by a dotted line. Since the top line represents zero, the average line must be in a negative area. And the number of graticule divisions shows the voltage. Each scope division is 5 V; therefore, this waveform should measure slightly less than -15 V on a dc meter (it measured -14.3 V). The zero line is 0.6 V below the extreme tip, and this subtracts from what should have been a -15 V reading (if the diode had no voltage drop). This experiment verifies the following rule: *The scope reading between the zero line and the average-voltage line equals the dc voltage measured by a meter.*

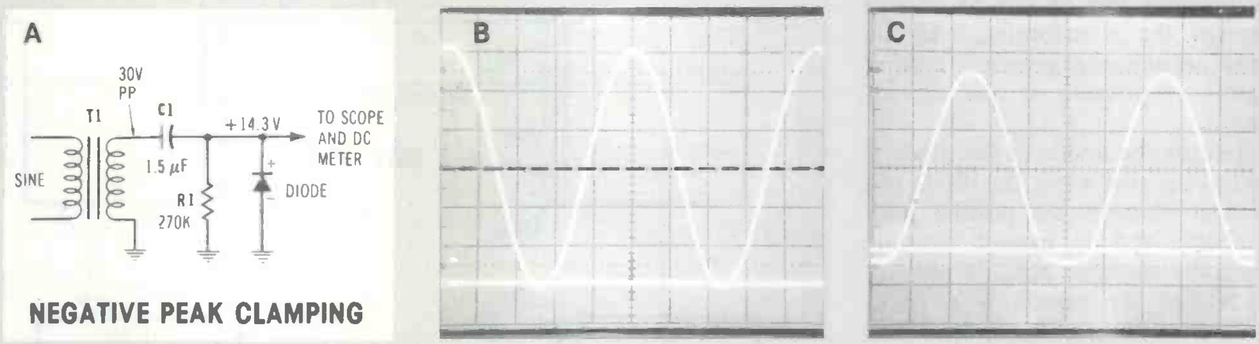

Figure 3 (A) This schematic is identical to Figure 2A except for the diode polarity which clamps the negative peak to produce positive dc voltage. (B) Dc scope operation verifies the location of the zero-voltage line at about 0.6 V above the negative tips, and ac operation shows the average line is at the center (marked by dotted lines). Slightly less than 3 scope divisions are between the two lines. This is a bit less than +15 V at 5 V/div, and the reading agrees with the Figure 2 rule. (C) When the sine-wave source has poor regulation, the diode current flattens the tip as shown. This flattening causes errors, so a better signal source should be used for all experiments.

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to zero voltage. Transformer T1 provides a low impedance for the circuit that follows. The C1 capacitor prevents loss of any dc voltage through the transformer, and the large capacitance prevents loss of signal amplitude at the circuit output.

Because the anode of the diode is toward the sine wave, the diode will conduct whenever the positive peak is there, and it cannot conduct when the negative peak is present. In reality, the circuit is a peak-reading shunt rectifier (which will not be explained here). C1 stores a charge that prevents conduction of the diode except at the *extreme* tip of each positive peak.

The diode cathode is grounded. Therefore, ***each sine wave positive tip is grounded during conduction of the diode.*** Logic says this point of conduction *must* be zero voltage. The dc waveform of Figure 2B proves the truth of that assumption.

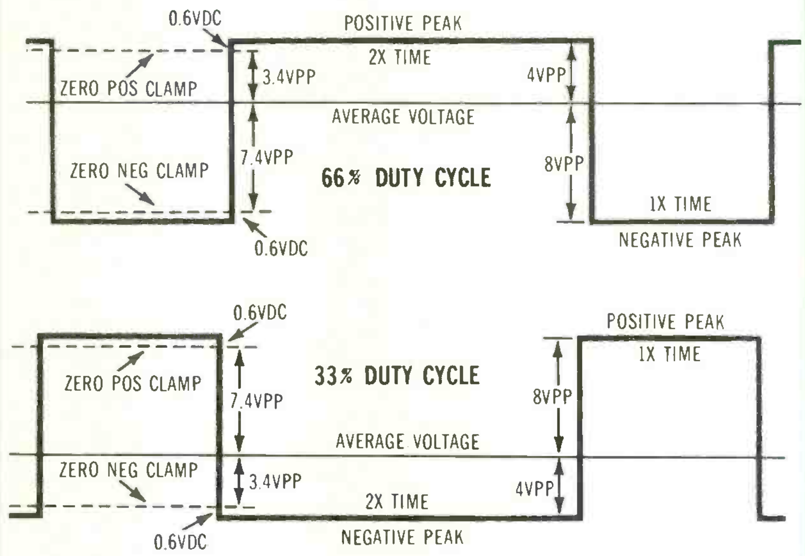
However, the previous analysis revealed that both the average and zero lines extended across the same exact center when no dc was present. But now the zero line is not at the center. Does this hint that dc has been produced? If so, how much dc? And where is the average-voltage line?

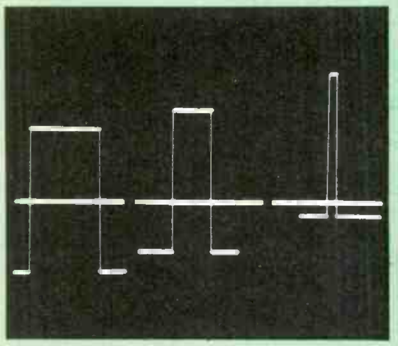
Voltage measurements can be used to answer those questions. When 30 VPP reached the diode through C1, a dc meter measured exactly -14.3 V dc. When the 0.7-V drop across the diode is added, the total is -15 V, which is exactly half of the sine wave peak-to-peak reading.

The average-voltage line remains at the center of the sine wave, so it and the zero line are separated by 15 V peak-to-peak. Again, this is half of the sine-wave amplitude.

The dc-voltage reading and the peak voltage between the zero line and the average-voltage line are both equal to half of the total sine-wave amplitude.

Therefore, under the stated conditions, this second important rule also must be true: *The peak voltage between the zero line and the average line equals the measured dc voltage.* In the previous example when no diode was present, the peak voltage between the lines was zero and the dc voltage measured





Three separate exposures were made by covering two-thirds of the scope screen each time. The centering was not changed. Vertical lines have been touched up to make them visible. This picture shows how pulse waveforms position themselves on the average-voltage line according to the duty cycle. The drawings show that the clamping zero line is spaced from the peak tip by the 0.6 V diode voltage. Therefore, all dc voltages are decreased by 0.6 V. (Also, the drawings illustrate Figure 5C.)

zero. The new rule proved to be correct for both examples. Is it valid for other wave shapes? The question will be answered later.

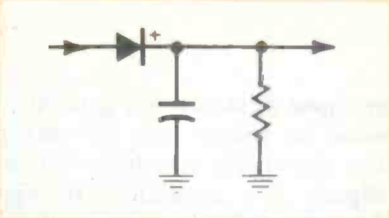
Several additional facts are proved. When the positive peak is clamped to zero volts, all of the waveform (except the 0.7 V for the diode) is negative. Therefore, clamping the positive peak produces negative dc voltage (which is equal to half of the waveform amplitude for sine waves).

Figure 3A schematic and the Figure 3B waveforms prove that clamping the negative peak also produces the same results, except the dc voltage is +14.3 V.

An unsuccessful measurement is illustrated by the Figure 3C waveform where the signal source was a sine/square generator having an output impedance so high that the diode load flattened the negative tip. The flattened tip introduced one error and the low-level output (12 VPP) caused the diode voltage drop to be more significant by comparison. The total effect of both errors reduced the accuracy of the experiment too much for it to have any value. In Figure 3B, the same generator was used, but a powerful amplifier was added between it and the peak-clamping circuit.

Clipped sine waves

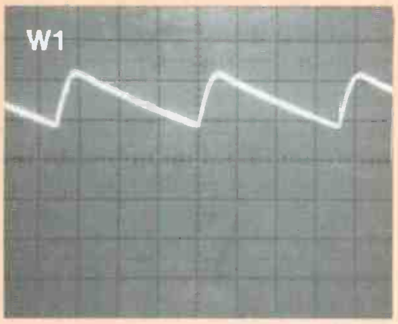
The resistor/diode arrangements of Figure 4A will clip (remove) the negative peak (leaving positive dc voltage and the positive peak)—or will clip the positive peak, which produces negative dc voltage and leaves the negative peak untouched.



Positive and negative peaks

All ac waveforms have two peaks for every cycle. The positive peak by definition is the positive portion of one cycle, and the negative part of the same cycle is the negative peak. Unfortunately, conventional scope waveforms give no hint about where one peak ends and the other begins. With pulses, jagged waveshapes and other non-sinusoidal waveforms these peak locations are not obvious. And yet a point of zero voltage *must* exist between adjacent positive and negative voltages. How can this zero point be found on scope waveforms?

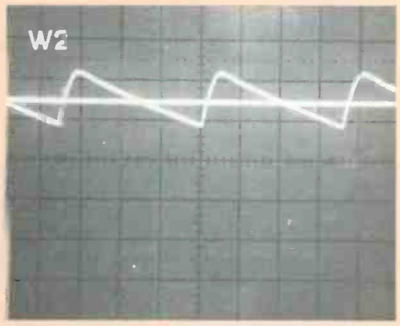
A diode has no difficulty when locating the zero-voltage point in a signal. During rectification of an ac voltage, a diode operates *only* on the voltage between the zero point between the peaks and whichever peak represents forward bias to it. In other words, a diode rectifies the voltage of one peak while ignoring (as though it is not present) the reverse-polarity voltage on the other side of the mysterious zero point. Many other devices and circuits operate from the same zero point, and do it automatically. A scope is one of these.



Scope produces only one line

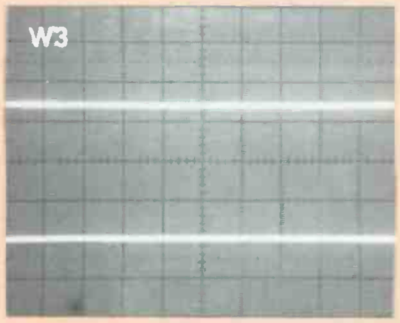
The DC/GND/AC switch on the scope panel shorts across the input coupling capacitor when at the dc position, thus allowing any dc of the signal to pass through the direct-coupled vertical amplifiers. The ground position disconnects the incoming signal and grounds the input of the vertical amplifiers.

Operation of this coupling switch can produce a line either at the zero-voltage point (for dc operation) or at the average-voltage point (for ac). The difference is made possible by the input coupling capacitor. Inside the scope beyond the capacitor, the circuit can furnish a line *only* at the zero-voltage point.



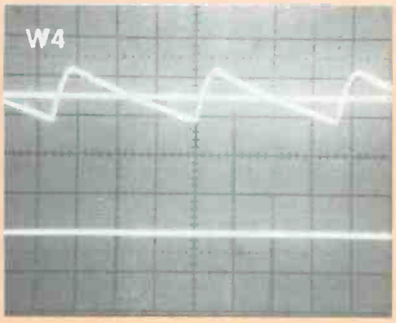
Measuring a power supply

The basic principle should be made clear by the following method. It can be performed with a single-trace scope, but it is easier to understand in dual-trace. Objectives of these measurements are to determine the amount of dc voltage (using zero and average lines) and the ripple amplitude of the power supply shown in the schematic. (The supply output was +17 Vdc and 7 VPP of ripple. Less ripple or higher dc decreases the visibility, but does not change the accuracy.)



With both probes connected to the supply output, one channel is set for dc coupling and the other for ac. While using the same channel sensitivities (5 V/div here), merge the two waveforms in the upper section of the screen, and make certain the amplitudes are identical so only one waveform (W1) is displayed. This merged waveform is the ripple sawtooth, which can be measured in the usual way.

For the channel with ac coupling, move the switch to the center (ground) position. One sawtooth waveform changes to a line through the approximate center of the sawtooth waveform from the other channel (W2). This line represents the *average* voltage of the sawtooth waveform (ac).



Next, move the other-channel coupling switch (formerly at dc) to the ground position, which changes the last sawtooth waveform into a line near the bottom of the screen. It represents the location of *zero* voltage for dc operation.

The two lines of W3 now are the only waveforms on the screen. Measure the peak-to-peak (or peak) voltage between them. That value is equal to the dc voltage from the power supply.

This is another example of the rule proposed in the article, which states: *The peak-to-peak reading between the average-voltage line and the zero-voltage line equals the dc voltage as measured by a dc meter.*

Finally, W4 shows the ripple and the two lines as they would appear on a three-channel scope.

Remember that the part of a sine wave above the average-voltage center line is called the positive peak, and similarly the part of a sine wave below the average-voltage center line is called the negative peak. The transformer removes any permanent dc voltage or current, and there is no capacitor to allow peak-reading rectification. Therefore, in the top schematic, the negative peak is forward bias for the diode, which conducts thus causing a short (except for the 0.6 V drop across the diode) during the time of the negative peak. This is shown by the top waveform of Figure 4B (along with the true zero-voltage line). With 30 V peak-to-peak from the transformer, the output voltage as measured by a dc meter was +4.3 V. After the 0.6 V drop of the diode is added, the theoretical output voltage is +4.9 V.

In the top waveform of Figure 4B, the clipped peak of the sine wave measured 15 V peak-to-peak. The average-voltage line (about a third of the way from the bottom of the waveform) was placed by using ac scope coupling, while the zero line at the bottom was produced by the dc scope function. Between the two lines is about 5 V peak.

Average voltage for full-wave clipped sines is 63.7% of the peak voltage; for half wave, it is 31.8% of the peak voltage. And +15 V multiplied by 31.8% equals +4.8 V dc.

Three methods produced a figure for the dc voltage. According to calculations for half-wave rectification, the voltage was +4.8 V. The measured output voltage plus voltage drop of the diode totaled +4.9 V. And the dc voltage according to the peak voltage between the zero-voltage line and the average-voltage line was about +5 V dc.

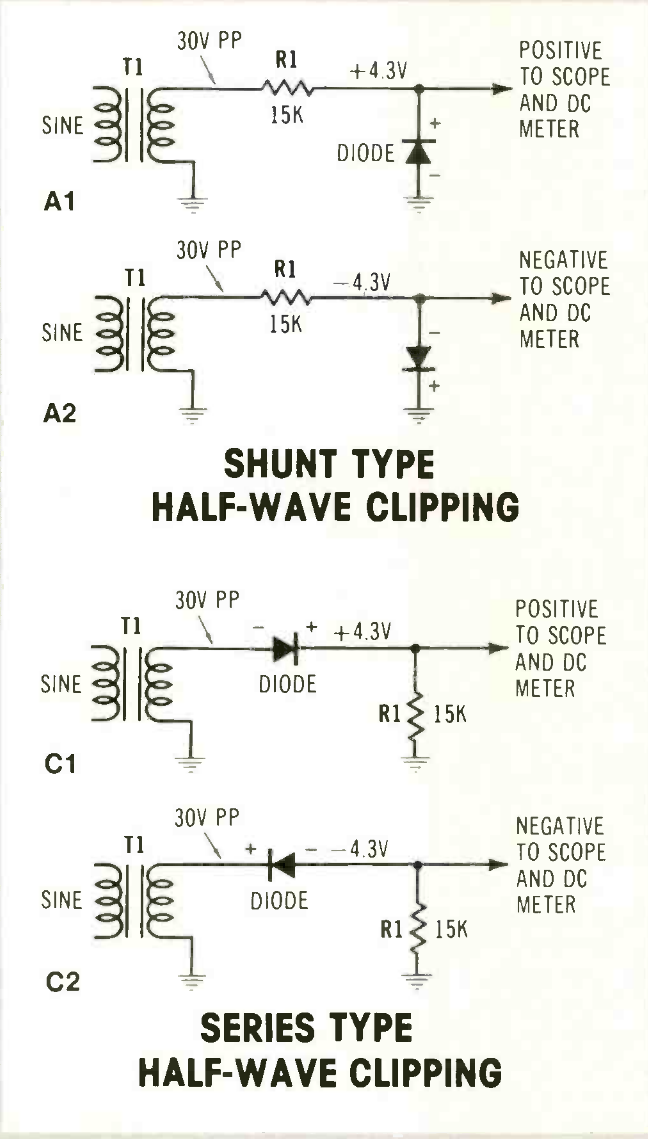
This similarity of results proves *the scope method of placing the average-voltage line is valid,* with the only inaccuracies coming from the usual problems of reading scope waveforms.

The bottom schematic corresponds to the bottom waveform trace in Figure 4B where the positive peak is clipped (shorted out) by the diode and leaving 15 V peak-to-peak and a measured -4.3 V dc.

If the resistor and diode are swapped as shown in Figure 4C, the same dc voltage will be obtained, but the visible waveform will have slightly less amplitude. In Figure 4A, the 0.6 V (that's necessary before the diode begins to conduct) protrudes beyond the zero line, while the Figure 4C version does not permit any output waveform to be visible on the scope screen until after the diode 0.6 V has been overcome and conduction begins.

So, the conclusion is that both the zero-voltage line and the average-voltage lines can be placed accurately by the dc and ac scope functions.

The next important question is this: Are the previous two rules-of-thumb accurate when applied to



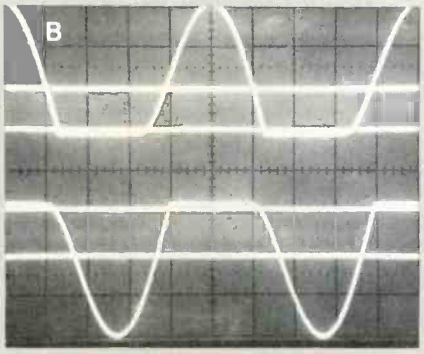


Figure 4 A diode and a resistor can remove one sine-wave peak by clipping. (A1) The negative peak is removed by diode conduction, leaving only positive half cycles that measure as positive dc voltage. (A2) When the diode polarity is reversed, the positive peak is clipped, leaving only negative peaks that measure as negative dc voltage. (B) The top waveform was obtained from the A1 circuit, while the bottom waveform came from the A2 circuit. In the top waveform, notice that a small bit of the negative peak (below the zero line) is not removed. That's because a silicon diode must have forward bias in excess of 0.6 V before full conduction can occur. This small amount of undesired peak subtracts from the dc voltage, which otherwise would measure +15 V. (C) These series clipping circuits also remove one peak because the diode does not conduct until it is supplied with more than 0.6 V of forward bias. Therefore, 0.6 V is removed from the waveform near the zero-voltage point. This can be proved by careful scope measurements. The waveforms of B verify the rule given in Figure 2, and also that the average-voltage line is correctly located at 31.8% of the half-wave amplitude.

pulses of various duty cycles and to square waves?

Measuring & clamping pulses

Pulses represent the worst obstruction to a complete acceptance for the two rules proposed so far. If they accurately describe the dc levels obtained by clipping or clamping pulses, then those rules are worthy of being generally accepted. Pulses can assume almost an infinity of shapes. Some pulses have squared tips, others have sloping sides and rounded tips. And the duty cycle (ratio of on time to off time) can be nearly any value. In fact, square waves can be considered as pulses with a 50% duty cycle.

To reduce these many variables to a manageable number, just a few examples are illustrated by square-tipped pulses from a VIZ model WR-549A pulse generator.

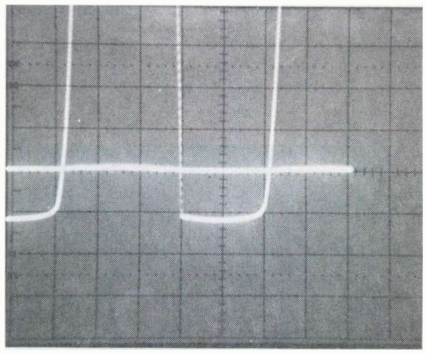
Note: All measurements of pulses and square waves are made with the circuits of Figure 5A. However, the dc voltages listed there apply only to the 1-to-10 ratio pulses.

Measuring square waves—If the clamping diode of Figure 5A is disconnected and a square wave is applied to the input, the dc and ac functions of a scope will show both the zero-voltage and average-voltage lines extended across the exact center of the square wave (Figure 5B).

According to the rules proposed earlier, this indicates an absence of any dc voltage. A test with a dc meter verified the lack of dc.

When the negative peak was clamped by connecting the diode cathode to the ac signal, the average-voltage line remained at the center (the waveshape was not distorted), but the zero-voltage line then was located at the tip of the negative peak, as shown by Figure 5B.

A scope measured a peak reading of 6 V between the two lines. Therefore, the dc voltage should have been +6 V. A dc meter checked +5.5 V. After addition of the +0.6 V of diode drop, the total



When the Figure 4B top waveform is made taller by changing to 0.5 V/div, the part of the negative peak that extends below the zero line is very plain. It measures 0.6 V, which is the amount of silicon-diode forward bias that is ignored by the diode.

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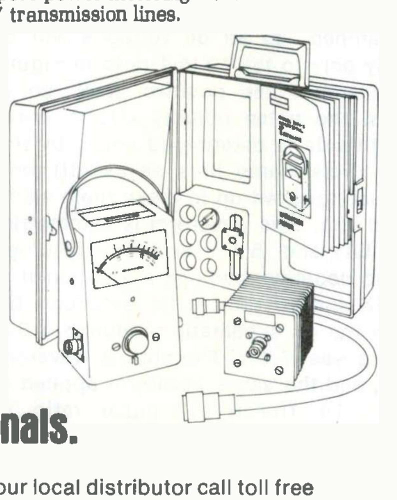

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2SA 485	1.90	2.10	2.40
2SA 489	1.10	1.25	1.40
2SA 495	.25	.35	.40
2SA 497	1.00	1.20	1.30
2SA 509	.30	.35	.40
2SA 537A	1.50	1.70	1.90
2SA 561	.30	.35	.40
2SA 562	.30	.35	.40
2SA 634	.40	.45	.50
2SA 643	.30	.40	.45
2SA 673	.30	.40	.45
2SA 683	.40	.53	.59
2SA 684	.40	.53	.59
2SA 695	.40	.53	.59
2SA 699A	.50	.64	.70
2SA 706	.85	1.00	1.10
2SA 719	.25	.35	.40
2SA 720	.25	.35	.40
2SA 733	.20	.27	.30
2SA 744	4.20	4.40	4.90
2SA 745R	3.60	4.00	4.40
2SA 747	4.20	4.40	4.90
2SA 847	.40	.53	.59
2SB 54	.30	.40	.45
2SB 55	.40	.53	.59
2SB 75	.30	.40	.45
2SB 77	.30	.40	.45
2SB 186	.20	.27	.30
2SB 187	.20	.27	.30
2SB 324	.25	.35	.40
2SB 367	1.10	1.25	1.40
2SB 405	.25	.35	.40
2SB 407	.70	.90	1.00
2SB 434	.80	.90	1.00
2SB 473	.70	.90	1.00
2SB 474	.70	.80	.90
2SB 507	.70	.90	1.00
2SB 511	.70	.80	.90
2SB 536	1.00	1.20	1.30
2SB 557	2.10	2.50	2.80
2SB 595	1.10	1.40	1.50
2SB 596	1.10	1.40	1.50
2SB 600	5.00	6.00	6.60
2SC 183	.40	.53	.59
2SC 184	.40	.53	.59
2SC 281	.25	.35	.40
2SC 372	.20	.27	.30
2SC 373	.20	.27	.30
2SC 380	.20	.27	.30
2SC 381	.30	.40	.45
2SC 382	.30	.40	.45
2SC 387A	.30	.40	.45
2SC 394	.30	.40	.45
2SC 458	.20	.27	.30
2SC 481	1.30	1.40	1.50
2SC 482	1.10	1.25	1.40
2SC 485	1.30	1.40	1.50
2SC 495	.45	.55	.60
2SC 497	1.10	1.25	1.40
2SC 509	.30	.40	.45
2SC 517	3.00	3.20	3.40
2SC 535	.30	.40	.45
2SC 627	1.30	1.45	1.60
2SC 696	1.00	1.20	1.30
2SC 710	.20	.27	.30
2SC 711	.20	.27	.30
2SC 712	.20	.27	.30
2SC 717	.35	.40	.45
2SC 730	3.00	3.20	3.40
2SC 732	.20	.27	.30
2SC 733	.20	.27	.30
2SC 734	.20	.27	.30
2SC 735	.20	.27	.30

TYPE	25UP	10-24	1-9
2SC 756	1.50	1.80	2.00
2SC 756A	1.50	1.80	2.00
2SC 775	1.40	1.60	1.80
2SC 776	2.00	2.20	2.50
2SC 777	3.00	3.25	3.50
2SC 778	2.90	3.20	3.40
2SC 781	2.00	2.20	2.50
2SC 784	.35	.40	.45
2SC 789	.80	.90	1.00
2SC 793	2.00	2.20	2.50
2SC 799	2.00	2.20	2.50
2SC 828	.20	.27	.30
2SC 829	.20	.27	.30
2SC 838	.35	.40	.45
2SC 839	.30	.40	.45
2SC 867	3.20	3.40	3.70
2SC 897	2.00	2.20	2.50
2SC 900	.20	.27	.30
2SC 930	.20	.27	.30
2SC 945	.20	.27	.30
2SC 959	1.00	1.20	1.30
2SC 1000	.35	.40	.45
2SC 1013	.50	.64	.70
2SC 1014	.50	.64	.70
2SC 1018	.70	.80	.90
2SC 1030C	1.80	2.10	2.40
2SC 1060	.70	.80	.90
2SC 1061	.70	.80	.90
2SC 1079	3.40	3.55	3.90
2SC 1080	3.40	3.55	3.90
2SC 1096	.45	.55	.60
2SC 1098	.50	.64	.70
2SC 1111	2.10	2.50	2.80
2SC 1114	4.20	4.40	4.90
2SC 1115	2.50	2.70	3.00
2SC 1116	3.20	3.40	3.70
2SC 1116A	3.40	3.55	3.90
2SC 1124	.80	.90	1.00
2SC 1127	.80	.90	1.00
2SC 1162	.70	.80	.90
2SC 1166	.30	.40	.45
2SC 1172B	3.20	3.60	3.95
2SC 1173	.50	.64	.70
2SC 1177	11.00	12.60	14.00
2SC 1209	.25	.35	.40
2SC 1226	.50	.64	.70
2SC 1226A	.50	.64	.70
2SC 1237	1.80	2.00	2.25
2SC 1239	2.20	2.70	2.90
2SC 1306	1.30	1.70	1.90
2SC 1307	2.20	2.70	2.90
2SC 1318	.30	.40	.45
2SC 1364	.30	.40	.45
2SC 1383	.30	.40	.45
2SC 1384	.30	.40	.45
2SC 1400	.30	.40	.45
2SC 1403	3.20	3.40	3.70
2SC 1419	.60	.70	.80
2SC 1475	.70	.90	1.00
2SC 1567A	.60	.70	.80
2SC 1667	3.00	3.20	3.40
2SC 1675	.25	.35	.40
2SC 1678	1.30	1.45	1.60
2SC 1687	.40	.45	.50
2SC 1728	1.05	1.20	1.30
2SC 1730	.45	.53	.59
2SC 1760	.90	1.10	1.20
2SC 1775	.30	.40	.45
2SC 1816	1.50	1.75	1.95
2SC 1908	.25	.35	.40
2SC 1909	2.20	2.70	2.90
2SC 1945	4.50	5.00	5.80
2SC 1957	.60	.70	.80
2SC 1969	3.60	4.00	4.40
2SC 1973	.70	.80	.90
2SC 1974	1.30	1.70	1.90

TYPE	25UP	10-24	1-9
2SC 1975	1.30	1.70	1.90
2SC 2028	.50	.64	.70
2SC 2029	1.50	1.80	2.00
2SC 2076	.50	.64	.70
2SC 2091	.90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2098	3.20	3.40	3.70
2SD 72	.50	.64	.70
2SD 90	1.30	1.45	1.60
2SD 91	1.30	1.45	1.60
2SD 92	1.45	1.60	1.80
2SD 93	1.60	1.80	2.00
2SD 180	1.60	1.80	2.00
2SD 187	.30	.40	.45
2SD 188	1.80	2.10	2.40
2SD 201	2.30	2.40	2.65
2SD 202	3.40	3.55	3.90
2SD 226A	1.30	1.45	1.60
2SD 234	.60	.70	.80
2SD 235	.60	.70	.80
2SD 236	1.30	1.45	1.60
2SD 261	.30	.40	.45
2SD 287	2.50	2.70	2.90
2SD 291	2.10	2.50	2.80
2SD 313	.60	.70	.80
2SD 315	.60	.70	.80
2SD 325	.60	.70	.80
2SD 356D	.70	.80	.90
2SD 357D	.70	.80	.90
2SD 358	.70	.80	.90
2SD 359	.80	.90	1.00
2SD 381	.85	1.00	1.10
2SD 427	1.80	2.00	2.25
2SD 525	.90	1.10	1.20
2SD 526	.60	.70	.80
2SK 19BL	.45	.55	.60
2SK 23	.85	1.00	1.10
2SK 30	.40	.45	.50
2SK 33	.60	.70	.80
2SK 34	.50	.64	.70
2SK 40	.50	.64	.70
2SK 41	.50	.64	.70
2SK 49	.40	.45	.50
2SK 55	.60	.70	.80
2SK 61	1.10	1.25	1.40
2SK 68	.40	.45	.50
2SK 68	.40	.45	.50
3SK 22Y	1.40	1.60	1.80
3SK 35	1.30	1.45	1.60
3SK 37	1.80	2.10	2.40
3SK 39	.90	1.10	1.20
3SK 40	1.30	1.45	1.60
3SK 41	1.30	1.45	1.60
3SK 45	1.30	1.45	1.60
3SK 48	3.40	3.55	3.90
3SK 49	1.30	1.45	1.60
AN 214Q	1.30	1.70	1.90
AN 239	4.20	4.40	4.90
AN 247	2.50	2.70	3.00
AN 274	1.50	1.75	1.95
AN 315	1.80	2.00	2.25
BA 511A	1.80	2.00	2.25
BA 521	1.90	2.10	2.40
HA 1151	1.50	1.75	1.95
HA 1156	1.60	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1322	2.50	2.70	3.00
HA 1339	2.50	2.70	3.00
HA 1339A	2.50	2.70	3.00
HA 1342A	2.50	2.70	3.00
LA 4031P	1.80	2.00	2.25
LA 4032P	1.80	2.00	2.25
LA 4400	1.90	2.10	2.40
M 51513L	2.00	2.20	2.50
STK 011	3.60	4.00	4.40
STK 015	4.20	4.40	4.90

TYPE	25UP	10-24	1-9
STK 435	4.50	5.00	5.60
TA 7045M	2.00	2.20	2.50
TA 7055P	2.00	2.20	2.50
TA 7060P	.90	1.10	1.20
TA 7061P	.90	1.10	1.20
TA 7062P	1.10	1.25	1.40
TA 7089	2.00	2.20	2.50
TA 7129P	1.30	1.70	1.90
TA 7203P	2.50	2.70	2.90
TA 7204P	2.00	2.20	2.50
TA 7205P	1.60	1.80	2.00
TA 7310P	1.30	1.45	1.60
TBA 810SH	1.90	2.10	2.40
TC 5080P	5.00	5.20	5.80
TC 5081P	3.00	3.20	3.40
TC 5082P	3.40	3.55	3.90
UHIC 002	5.00	5.20	5.80
UHIC 004	5.00	5.20	5.80
UHIC 005	5.00	5.20	5.80
UPC 20C	2.10	2.50	2.80
UPC 563	1.90	2.10	2.40
UPC 575C	1.30	1.45	1.60
UPC 576	1.90	2.10	2.40
UPC 592H2	.80	.90	1.00
UPC 1001H	1.90	2.10	2.40
UPC 1008C	5.00	5.30	5.90
UPC 1020H	1.90	2.10	2.40
UPC 1025	1.90	2.10	2.40
UPC 1156	1.90	2.10	2.40
UPD 857C	8.00	8.40	9.50
PLL 01A	3.00	4.20	4.60
PLL 02A	5.00	5.30	5.90
PLL 03A	7.60	8.00	8.80
IS 84	.45	.55	.60
IS 188	.16	.18	.20
IS 332	.35	.40	.45
IS 953	.16	.18	.20
IS 1007	.35	.40	.45
IS 1209	.35	.40	.45
IS 1211	.35	.40	.45
IS 1555	.20	.22	.25
IS 1588	.20	.22	.25
IS 1885	.16	.18	.20
IS 2076	.20	.22	.25
IS 2093	.35	.40	.45
IS 2473	.16	.18	.20
IN 34	.12	.13	.15
IN 60	.12	.13	.15
10D1	.25	.35	.40
10D10	.45	.55	.60
VO 6B	.25	.35	.40
VO 6C	.25	.35	.40
WZ 050	.20	.22	.25
WZ 052	.20	.22	.25
WZ 061	.20	.22	.25
WZ 071	.20	.22	.25
WZ 075	.20	.22	.25
WZ 081	.20	.22	.25
WZ 090	.20	.22	.25
WZ 120	.20	.22	.25
WZ 192	.20	.22	.25
WZ 260	.20	.22	.25
WZ 280	.20	.22	.25
SG 613	5.20	5.40	5.95
MPS U31	1.30	1.70	1.90
78L05	.90	1.00	1.10

TYPE	VOLT		
UZP-6.2B	6.2	1 W	.35
UZP-6.8B	6.8	1 W	.35
UZP-7.5B	7.5	1 W	.35
UZP-8.2B	8.2	1 W	.35
UZP-9.1B	9.1	1 W	.35
UZP-10B	10.0	1 W	.35
UZP-11B	11.0	1 W	.35
UZP-12B	12.0	1 W	.35
UZP-13B	13.0	1 W	.35
UZP-15B	15.0	1 W	.35

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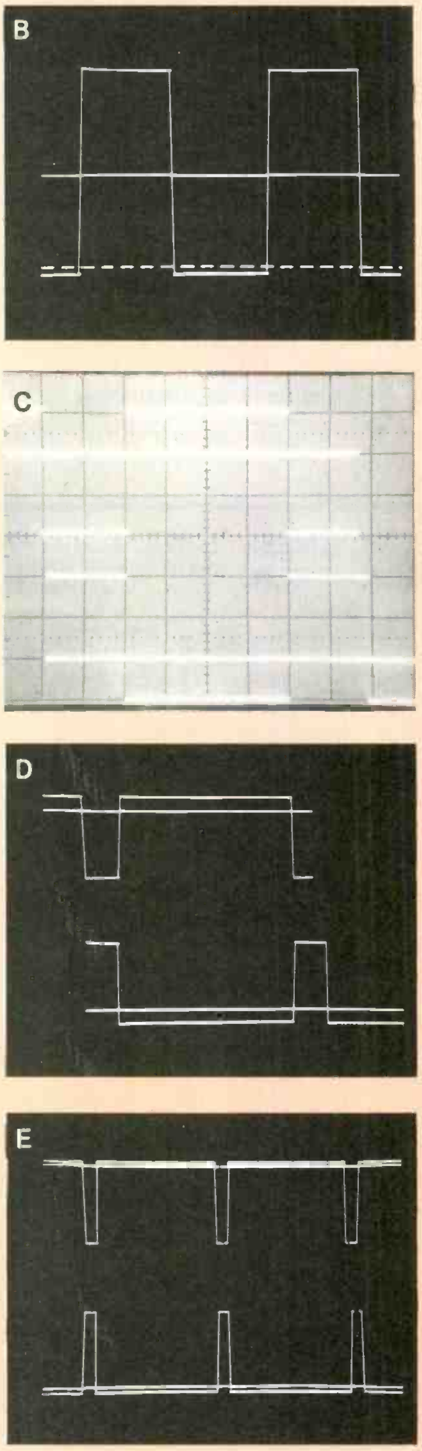
was +6.1 V. The scope reading of +6 V compares very favorably.

Both sine and square waves are symmetrical, and both responded to the proposed rules about the zero and average lines. This hints that all symmetrical waveforms will respond in the same way. Other experiments have verified this assumption.

Why must allowances be made for the diode voltage drop? All



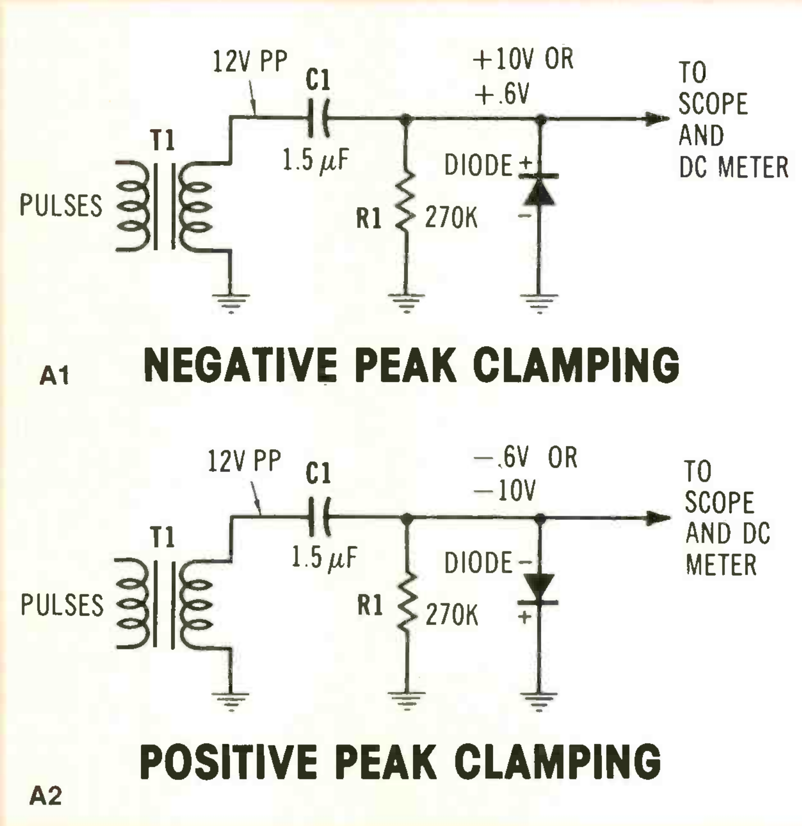


Figure 5 Pulses can be clamped by the same method used before with sine waves. However, the pulse polarity affects the dc voltages. (A1) The negative peak is clamped, so all dc voltages will be positive. The dc voltages shown apply only to the 10-to-1-ratio in Figure 5E. (A2) Reversing the diode polarity clamped the positive peak, so all dc voltages are negative. Notice that the pulse polarity affects only the *amount* of dc voltage; *polarity* of this dc is determined solely by the diode polarity. (B) Pulses of 50% duty cycle (same time on as off) are square waves. The vertical lines have been touched up to make them visible and a zero line is indicated by a dotted line. This waveform is symmetrical, so +5.4 V were measured in Figure 5A1 and -5.4 V were the reading in Figure 5A2. (C) Different positive and negative readings are obtained when the duty cycle is 66% (*on* time is 2X and *off* time is 1X) as shown by the top waveform. The top waveform in the A1 schematic produced +3.4 V, while in the A2 schematic the reading was -7.4 V. The bottom waveform produced +7.4 V in the A1 schematic, and the same waveform applied to the A2 schematic produced -3.4 Vdc. (D) The 5-to-1 pulse ratio causes even larger differences between dc readings of the two polarities. The top waveform in circuit A1 produced +1.5 V, and -9.3 V in circuit A2. Circuit A1 and the bottom waveform measured +9.3 V, with circuit A2 producing -1.5 V. After all readings were increased by 0.6 V for the diode, they were 2.1 and 9.9 V for a total of 12. This matches the 12 VPP at the circuit. A slight error of pulse width accounts for the small discrepancy. (E) Proper polarity differences with a 10-to-1 ratio should produce basic readings of 1.1 and 10.9 voltages after the diode voltage is considered. That was true in this case also.

CAN CAPACITORS ABSORB PULSES?

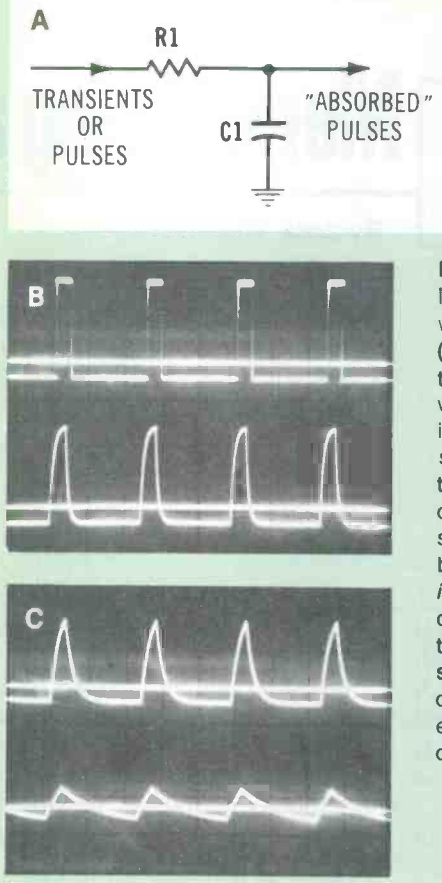


Figure 6 A low-pass RC circuit (A) is formed by the resistances of wires, switches and transformers. (Inductive effects of the pole transformers add LC sections which produces much more filtering.) This sequence of waveforms shows changes that occurred to the sharp pulses as the C1 capacitor value was increased in steps. Instead of being *absorbed* by the capacitor, the pulses were *integrated* so the amplitude was decreased without any change of total power. The third waveform shows unmistakable voltage-charging curves on the leading edges and voltage-discharging curves on the trailing edges.

diodes reduce power supply voltages, for example, but the reduction often is overlooked because a drop of less than a volt out of several hundred is not significant. But it is important in teaching situations such as these where purity of waveform is more important than a high signal amplitude.

Measuring 33% duty-cycle pulses—Figure 5C pictures 66% duty-cycle pulses at the top and 33% duty-cycle pulses at the bottom. Graticule markings are shown, along with the average-voltage lines.

Rectification of these two inverted waveforms in the circuits of two polarities in Figure 5A should produce four different dc voltages, if the rules previously given are correct.

Those examples of average-voltage lines presented before involved symmetrical waveforms where it was obvious that the same voltages were present in each peak and the line *must* be at the center. But with pulses, this relationship no longer is valid. Figure 5C has another obvious relationship: *A certain voltage for one length of time equals half as much voltage that is there for twice the amount of time.*

This logical assumption indicates that a scope can position the average-voltage line (even if it has pulses or irregular areas) both correctly and automatically, thus making it unnecessary to calculate the line position. From here on, therefore, the accuracy of average-voltage lines will be accepted, and no attempt will be made to explain or justify the use of a line produced by the scope.

Figure 5D gives the waveforms and measured voltages for 83% and 17% duty cycles (5:1), and Figure 5E does the same for 90.9% and 9.1% duty cycles (10:1). Notice that the theoretical and measured voltages (after correction for diode drop) are almost identical.

Absorbing (?) pulses

Statements about transient protection sometimes include a sentence that says capacitors absorb part of the pulses. Figure 6A is the schematic of a circuit used to test the truth of that statement, while the waveforms in Figures 6B and 6C showed the changes when various values of capacitors were used for C1.

The average-voltage line is shown for each waveform. And because this is an ac application, the zero line is identical to the average line. At the beginning of the sequence, the positive-going pulses had far more amplitude than the negative peaks showed. After strong filtering (last waveform), the amplitude was reduced and the waveshape approached a rounded sawtooth.

However, *the pulses were not absorbed but instead were merely integrated by the RC time constant.* Remember the time-constant curves presented several months ago? Well, the second and third waveforms are made up of voltage charging and discharging curves for different amounts of time. Basic theory can explain almost any electronic phenomena if it is completely and correctly applied.

Comments

All ac voltages were stated in peak or peak-to-peak values. This was done deliberately because it is the only way correct answers can be obtained regardless of the wave shapes. Technicians should begin to measure all ac voltages in peak and peak-to-peak, and then use scopes to show average and zero lines when it's necessary to predict the amounts of dc voltage that should be produced by those particular waveforms.

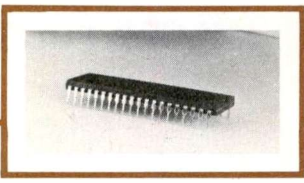
A summary of the helpful rules about zero and average lines follows:

- When no dc is present, the zero-voltage and average-voltage lines are the same. Conversely, when the lines are separated, dc voltage must be there.
- Peak voltage between the zero line and the average-voltage line equals the measured dc voltage plus any diode voltage drop. (Of course, where defects exist, that is what the dc voltage *should* measure.)

Next month

Different rectifier performances between fast-recovery diodes and conventional 60-Hz diodes are to be shown in special waveforms.

The principles of the zero and average lines will be applied to the grid signal of horizontal-output tubes and the waveforms in tube-type vertical sweep circuits. □



Memorizing a phone number

By Jack Webster

Additional information is presented about digital memories of the type used in microprocessors. Also described are the connections and manual switching necessary for storing and reading-out a 7-digit phone number.

The cell array of the Figure 1 memory consists of 32 horizontal rows and 32 vertical columns, with a memory cell located at each intersection of a row and a column (see Figure 2). Actually, each cell is a flip flop which can memorize a digital high (1) or low (0).

Therefore, every cell has an *address* (location) that is identified by the intersection of a specified row and a specified column. In Figure 2, for example, memory cells are pointed out at A3, B4 and other addresses.

Because there are 32 rows and 32 columns, a total of 1024 cells is obtained by multiplying 32 times 32. Consequently, as many as 1024 bits (binary digits) can be stored in the memory that's traditionally called a 1K memory.

If 64 rows and 64 columns are provided, the total is 4096 cells for a 4K memory.

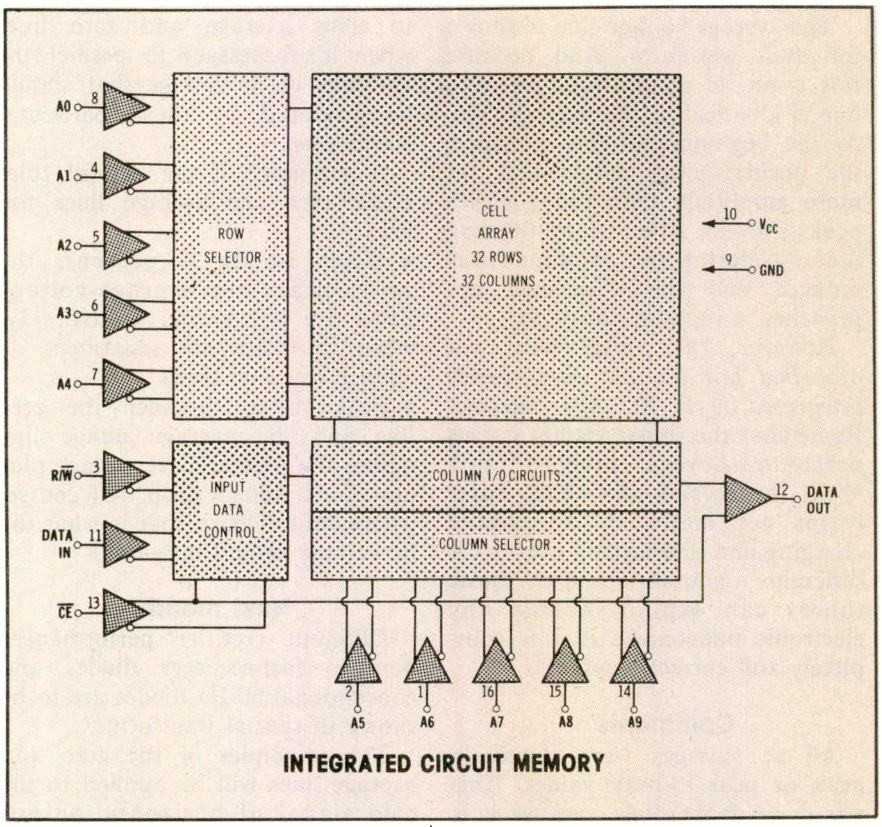


Figure 1 This 1K digital memory is similar to the type used in microprocessors. It has 32 vertical columns and 32 horizontal rows for a total of 1024 memory cells.

Addressing each cell

Each individual cell must be accessible during addressing so it's possible to *write* data into the cell. Similarly, it's necessary to address each cell to *read* the digital high or low data that is stored in the cell.

If individual wires were used for each cell in Figure 1, a total of 1024 wires would be required for writing and reading all of the cells. Obviously, such a large number of addressing wires is not practical, especially since most memories have many more cells than 1024.

However, Figure 1 shows only five row-selector inputs and five inputs to the column selector. This large reduction of the number of addressing wires is made possible by devices called *decoders* which convert the five inputs to 32 individual address lines.

Operation of a simple 2-input decoder is illustrated in Figure 3, where two inputs produce four individual addressing lines. The same general principle is used in larger decoders having five inputs and 32 output lines.

Read/write memory

Figure 4 shows an example of a read/write memory chip. Incidentally, the term random-access memory (RAM) usually is used instead of read/write. The IC is a TTL-type 7489 which can be wired to store and retrieve any telephone number.

The following truth table shows how the 7489 memory IC is programmed to store a number (write enable) or to read back the number (memory enable).

TRUTH TABLE

MEMORY ENABLE	WRITE ENABLE	FUNCTION
0	0	WRITE
0	1	READ
1	1	DO NOTHING

A few examples will show how a phone number (perhaps your office or home number) can be memorized and retrieved. The phone number for the example is 482-9046.

Storing digit 4

To store the first digit (decimal 4) in the first row, the *select inputs* are switched to 0000, which selects the first row for the storage mode. Next, the actual number 4 is changed to binary 0100, which is entered into the **data inputs** terminals. (Of course, only binary digits can control electronic memories or be stored and retrieved.)

The phone number fourth digit is a decimal 9. To store a 9 in the fourth row, the select inputs are set for 0100 (decimal 4) to reach the fourth row while the data inputs are set at 1001 (decimal 9) to store a decimal 9 there. At the same time, both the ME and WE inputs are set at logic level 0. This writes the digit 9 into the fourth row of the memory.

Retrieval

To retrieve a number from any row, the row-select input is set with the binary code for that row. For example, the third row stores the decimal 2 (0010 binary) of the phone number.

These settings will retrieve the phone number third digit:

SELECT INPUTS	0011	(for third row)
ME	0	
WE	1	

Inversion

One additional factor must be understood about the 7489 memory before it is used. In simpler memories, the stored data is the complement of the number entered at the data-inputs terminals. For example, if 0110 is entered, the number is stored as 1001. And the number retrieved also is a complement. Obviously, this is not desirable nor practical.

To eliminate the problem and allow storage of the correct number,

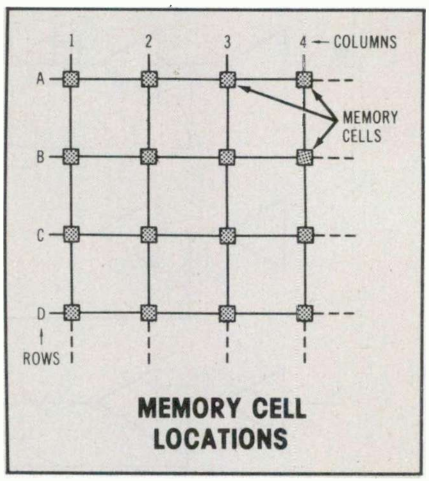


Figure 2 A flip flop that acts as a memory cell is located at each intersection of a row and a column. Arrows point to cells at A3, A4 and B4. The intersections and cells are described by the technique used with auto road maps.

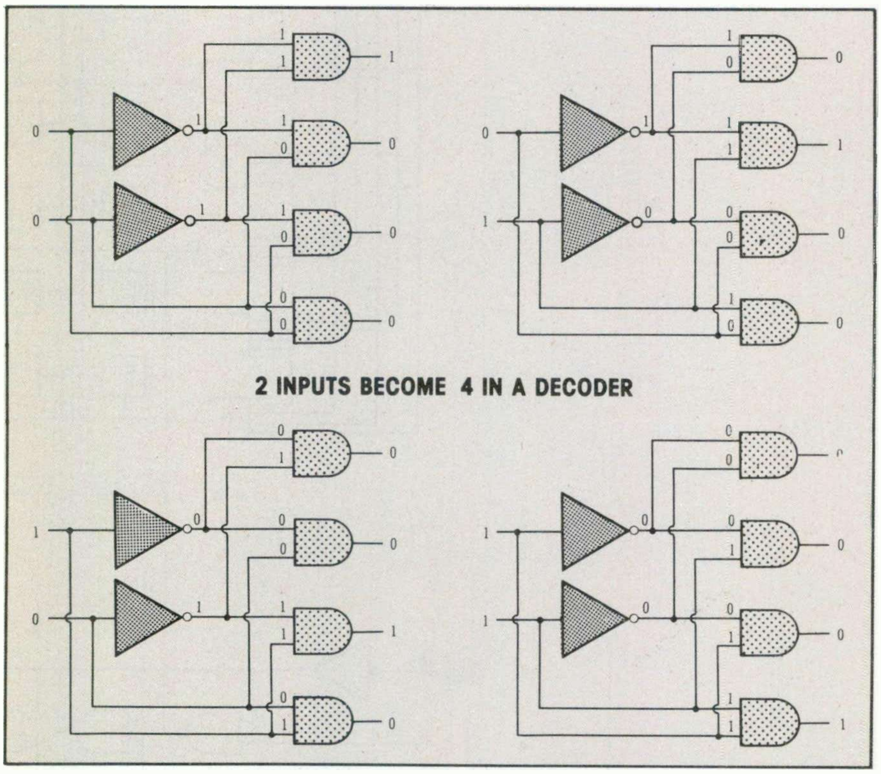


Figure 3 Two inputs to a decoder become four individual addressing lines. (Five inputs provide 32 addressing lines in Figure 1.) The four possible inputs and outputs are illustrated.

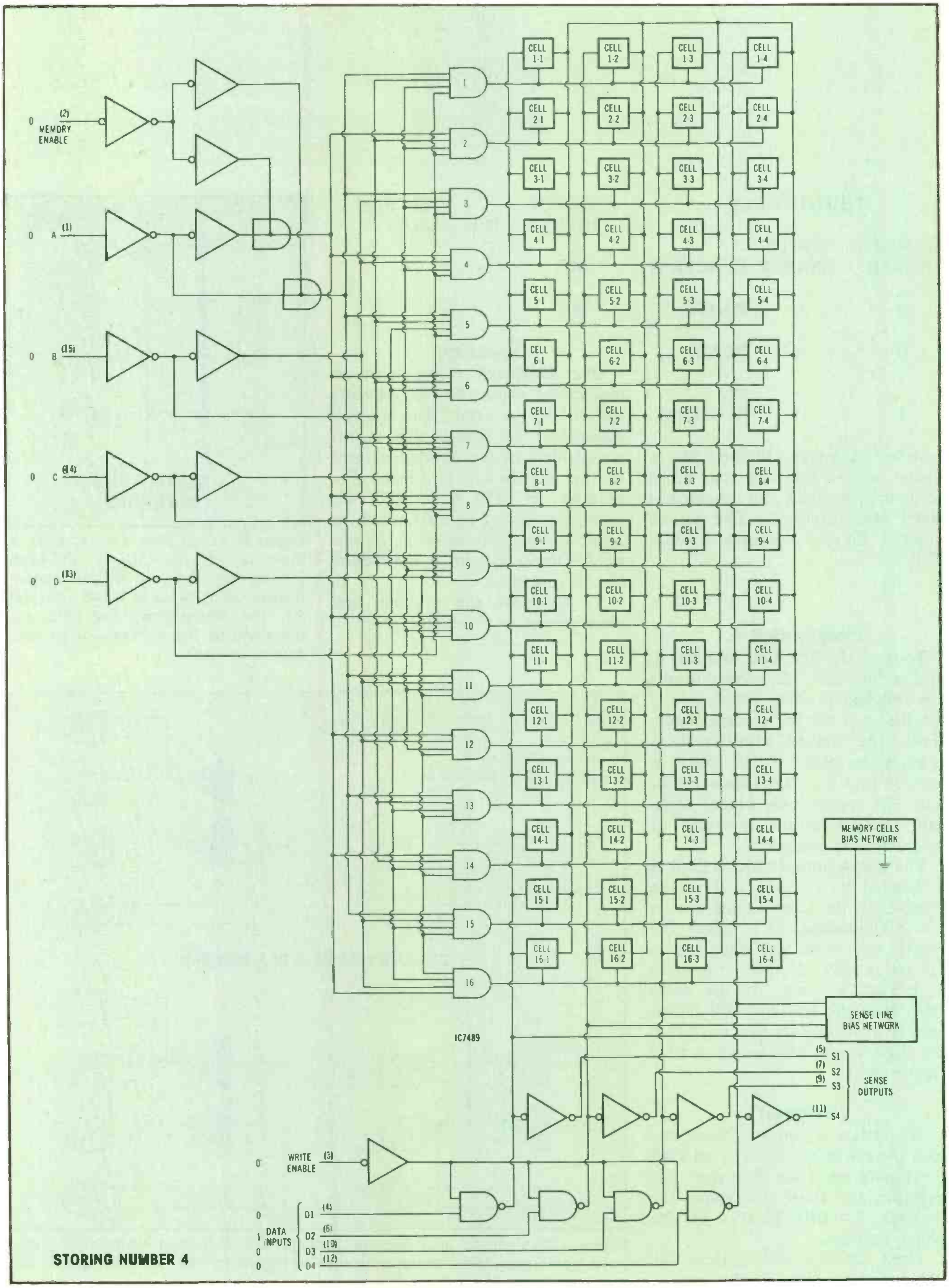


Figure 4 A 7489 RAM memory IC is shown as it stores a number 4 in row 1.

inverters (NOT gates) are supplied at all of the data-input lines (D1 through D4) of the 7489. This inversion corrects the complementary numbers and allows the desired number to be stored and retrieved.

Storing the phone number

Special keyboards and decoders normally are used with computers and microprocessors to store data in a memory. However, the basic principles are made more clear by manual coding, as done with the switches of Figure 5.

Each of the seven numbers is stored into the 7489 in sequence. Remember that the 7489 is a volatile memory, and a removal of the supply voltage erases all stored numbers. If the phone number is to be kept for days or weeks, the supply voltage to the 7489 must be maintained for the entire time.

Displaying the stored number

A circuit for displaying in sequence each of the seven phone digits is shown by the block diagram of Figure 6. A binary counter is programmed to count from decimal 0 to 7 (binary 0000 to 0111), and it steps the memory through the first seven rows of cells where the phone numbers are stored. After the seventh count, the counter resets to decimal 0 and counts again up to 7, and so on. The decoder converts the sense outputs to the code required for displaying decimal digits on the readout.

Microprocessor memory

A microprocessor can retrieve numbers from a memory that is located either inside the microprocessor IC or inside another IC. This memory can be a read-only memory (ROM) or a read/write type of random-access memory (RAM). RAMs are not pre-programmed, but they can accept and store microprocessor information in addition to allowing the stored data to be read at any time.

These digital numbers are moved by the microprocessor along conductors called *buses*. Figure 7 shows the buses between a microprocessor and its external memory IC. One bus is used for the address, and this corresponds to the path

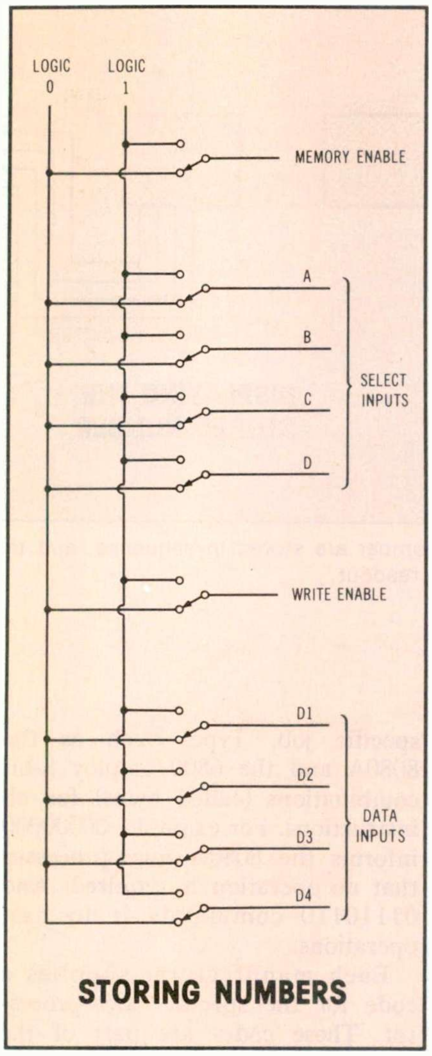


Figure 5 Ten toggle switches can be used to program a phone number into the 7489 memory IC after they are wired as shown.

traveled by the select inputs. Numbers (such as the telephone number of the experiment) are delivered to and retrieved from the memory by way of the memory-data bus.

An *input* device is essential for placing a number into a memory. Usually, it converts the decimal value into its binary equivalent, and then delivers the information along an input bus. Figure 8 shows the memory bus between a microprocessor and the outside world.

When a number is retrieved from memory, it is delivered to the outside world along an output bus.

The microprocessor must send a signal to the input-output (I/0) devices to turn them on at the proper time. This prevents any receiving or delivering of data

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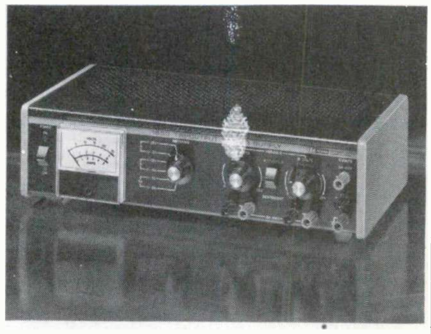
the auto-tracking B&K-PRECISION 1650



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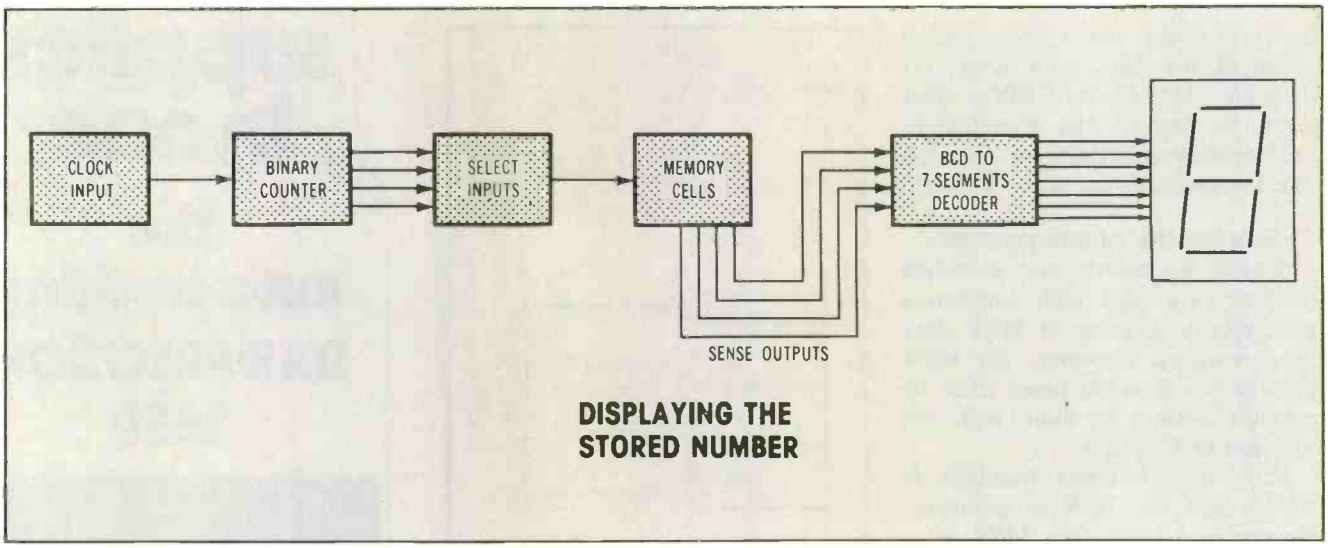


Figure 6 The 7 numbers of the phone number are stored in sequence, and this arrangement of ICs will display those numbers in proper sequence on the LED readout.

before the microprocessor is ready for it. The I/0 bus is used for this purpose also.

It is common practice to reduce the number of buses by making each one serve more than a single purpose.

Bits & bytes

As explained before, a bit is a binary digit, a digital high or low. Many of these bits must be used to instruct a microprocessor for each specific job. Types such as the 8080A and the 6800 employ 8-bit combinations (called bytes) for all instructions. For example, 00000000 informs the 8080A microprocessor that no operation is required. And 01110110 commands it to halt operations.

Each manufacturer supplies a code for the specific microprocessor. These codes are part of the software (instructions and programs) and they will be discussed in greater detail later.

These 8-bit (or one byte) codes are very unwieldly to work manually. The earliest models of computers forced the operators to feed the numbers into the processor by setting various switches. This was somewhat similar to the method shown in Figure 5.

It now is common practice to use special codes that are easier for the operators. The next article will show how to write these codes. □

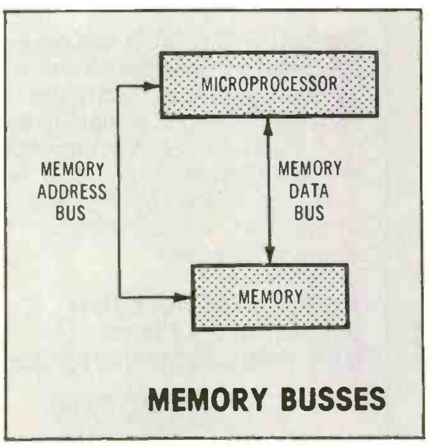


Figure 7 Busses are conductors that carry digital signals between various sections inside an IC or between the ICs of a microprocessor system. These busses connect a microprocessor IC with an external memory IC.

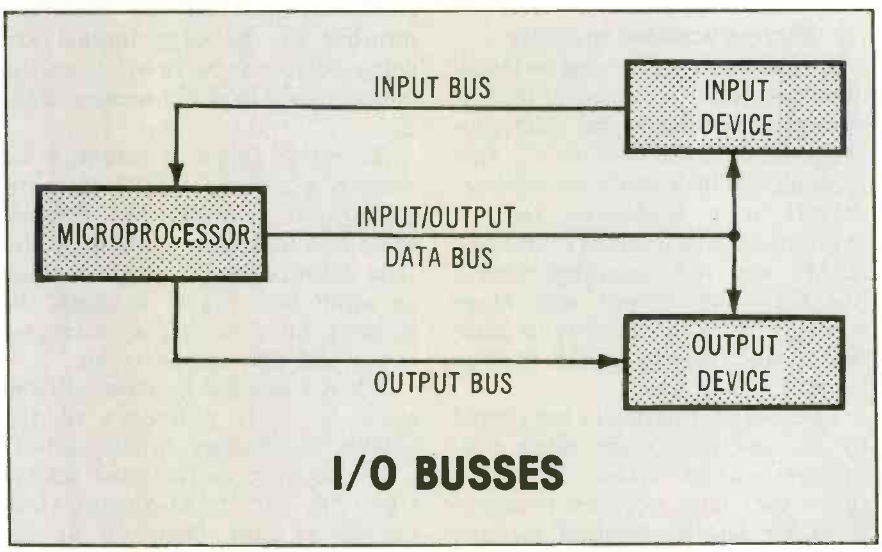


Figure 8 Other busses are those for the input and output devices that connect a microprocessor with the outside world.

1979 Electronic Distribution Show

"The Olympics of Electronic Distribution" was the theme for the Electronic Distribution Show in Las Vegas May 1 through 4. Athletes from past and future Olympic competition were present to emphasize the importance of the show.

Each ED show is an international trade fair where many manufacturers have booths or conference suites for the display of their latest products to representatives of electronic wholesale distributors.

Therefore, the show is important to all electronic service organizations because many of the products and test equipment they will need during the year are selected there by local wholesale distributors. The following pictures show a few of the booths and new products at the show.

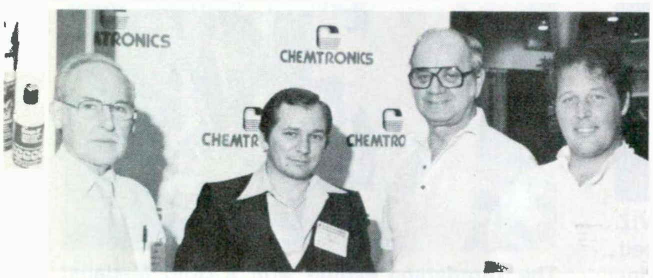
Jessie Owens (left) and Bob Mathias carried in the Olympic symbolic torch at the formal opening of the Electronic Distribution Show. Owens was the track star of the 1936 Berlin Olympics, and Mathias twice was winner of the Olympic Decathlon.

The huge hall of the Las Vegas Convention Center was crowded with booth displays, manufacturer's officials and distributor representatives.

On hand to operate the B&K-Precision booth were Thomas Clements (left) and Stephen Brow. The new instruments included a wide-band scope, a pulser digital probe and a versatile function generator.

Antennas, test jigs, solid-state replacements and other allied products were displayed in the RCA Distributor and Special Products Division exhibit.

Jim Reilly (left, national sales manager for **Electronic Servicing**) listened as Sencore technical representative Bruce Townsend demonstrated the new Sencore digital multimeter that includes a microprocessor.



Chemtronics president Al Friedman (left) discussed new products with Robert Langmesser, Frank Zinner and Steven Lees. Video recorder-care accessories were featured.

Distribution show

The PTS chicken gave away hard-boiled eggs as a reminder that all brands of module "eggs" should be placed in one PTS basket.

Features of a new NTSC-type Leader color generator were explained to George Laughead (left, **Electronic Servicing** publisher) by Bill Brydia, Leader Instrument vice-president.

At the Littelfuse booth, advertising manager Elaine Thompson answered questions and presented catalogs.

Randy Winegard (left, Winegard Company president) described advantages of the new model 20/20 indoor rotary antenna to Carl Babcoke (center, **Electronic Servicing** editor) and Joseph Ridge, Winegard sales manager.

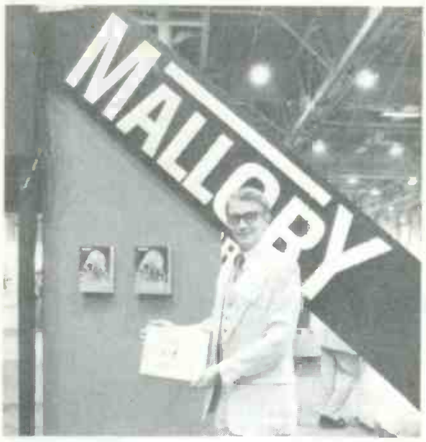
Entertainer for the evening Winegard 25th anniversary party was Red Buttons, popular TV and night-club comedian.

Drawings in the Olympic theme decorated the outside walls of the Sprague booth.

Randolph Zelov (right, VIZ vice-president) discussed many new instruments, including VIZ model WR-515B Signalyst and a pulse generator.

The Thordarson exhibit won a Gold Medalist award. A few of the featured Thordarson products were flybacks, yokes and universal-replacement semiconductors.

In the General Electric booth, the emphasis was on tubes, universal-replacement semiconductors and Ni-Cad batteries.



Several seminars were conducted during the Electronic Distributors Show. Bernard Schnoll, Alfred Cowles and Hartley Bond (at the microphone) comprised the panel for the MRO seminar.

Jim Shaw, Mallory advertising manager, was proud of the Gold Medalist award presented for the attractive Mallory booth that included small flags of all nations.

In charge of the Workman booth was Frank Pounds, Workman field sales manager (right).

Douglas Brown (left) and H. Philip Heisig discussed the small portable 30-MHz dual-trace scope in the Non-Linear booth.

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2SA 509	.35	2SC 712	.25	2SC 1567A	.70	2SK 23	1.00	TA 7061P	1.10
2SA 562	.30	2SC 717	.40	2SC 1675	.30	2SK 30	.45	TA 7062P	1.30
2SA 564A	.34	2SC 730	3.30	2SC 1678	1.50	2SK 33	.70	TA 7063P	1.45
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2SA 673	.40	2SC 734	.25	2SC 1760	1.05	2SK 55	.70	TA 7120P	1.80
2SA 678	.50	2SC 735	.25	2SC 1775	.35	3SK 22Y	1.75	TA 7203P	2.80
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2SA 706	1.00	2SC 784	.35	2SC 1957	.75	3SK 45	1.50	TC 5080P	5.55
2SA 720	.35	2SC 789	.90						
2SA 733	.25	2SC 793	2.40						
2SA 747	4.80	2SC 799	2.40						
2SB 22	.50	2SC 828	.25						
2SB 54	.35	2SC 829	.25						
2SB 77	.40	2SC 839	.35						
2SB 175	.40	2SC B67A	4.45						
2SB 186	.25	2SC 900	.25						
2SB 187	.25	2SC 930	.25	2SC 1969	4.25	3SK 48	3.65	TC 5081P	3.25
2SB 324	.35	2SC 945	.25	2SC 1973	.65	3SK 49	1.50	TC 5082P	3.75
2SB 367	1.30	2SC 1000BL	.40	2SC 1974	1.80	AN 2140	1.80	UHIC 001	5.55
2SB 405	.30	2SC 1013	.60	2SC 1975	1.80	AN 239	4.75	UHIC 002	5.55
2SB 407	.90	2SC 1014	.60	2SC 2028	.60	AN 247P	2.85	UHIC 003	5.55
2SB 463	1.10	2SC 1018	.80	2SC 2029	1.90	AN 274	1.45	UHIC 004	5.55
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2SB 507	.85	2SC 1060	.80	2SC 2091	1.10	AN 315	2.15	UPC 20C	2.65
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2SC 380	.25	2SC 1162	.80	2SD 187	.40	HA 1339	2.90	UPC 1008C	5.70
2SC 382	.40	2SC 1166	.35	2SD 218	3.40	HA 1339A	2.90	UPC 1020H	2.30
2SC 387A	.40	2SC 1172B	3.80	2SD 234	.75	LA 4031P	2.15	UPC 1025H	2.30
2SC 394	.30	2SC 1173	.65	2SD 235	.75	LA 4032P	2.15	UPC 1156H	2.30
2SC 458	.25	2SC 1209	.35	2SD 261	.35	LA 4400	2.30	UPD 857C	9.35
2SC 460	.50	2SC 1226	.65	2SD 287	2.80	M 51513L	2.40	UPD 858C	7.15
2SC 481	1.40	2SC 1226A	.65	2SD 291	2.70	PLL 01A	4.50	UPD 861C	9.05
2SC 482	1.40	2SC 1237	2.10	2SD 313	.65	PLL 02A	5.75	C-3001	1.60
2SC 485	1.40	2SC 1239	2.80	2SD 315	.75	PLL 03A	8.65	2SC F8	2.90
2SC 495	.55	2SC 1306	1.80	2SD 325	.70	SG 613	5.80	4004	2.40
2SC 509	.40	2SC 1307	2.80	2SD 330	.84	STK 011	4.30	4005	2.50
2SC 517	3.20	2SC 1318	.40	2SD 356	.75	STK 013	8.75	78L05	1.10
2SC 535	.35	2SC 1364	.40	2SD 358	.85	STK 015	4.75	MPS U31	1.90
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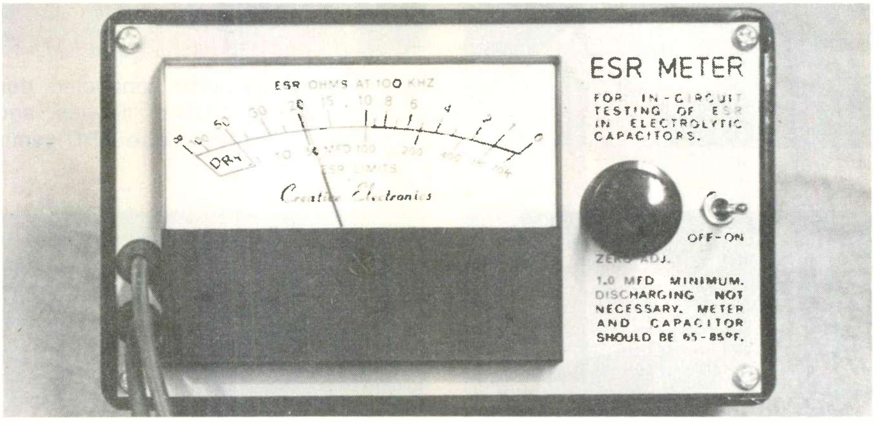
Reports from the test lab

By Carl Babcoke

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.



ESR Meter from Creative Electronics tests the in-circuit ESR of capacitors 1 μF or larger. Two "C" cells power the unit for about 200 hours.

Electrolytic tester

Creative Electronics has introduced ESR Meter, a unique tester of electrolytic-capacitor ESR. According to instructions, the most serious and common problem with electrolytics is excessive equivalent series resistance (ESR) rather than a loss of capacitance. One definition of ESR is that it includes all capacitor losses that degrade the performance as though a fixed resistor of the ESR value is added in series with a perfect capacitor. Excessive ESR in electrolytic capacitors limits the flow of charging and discharging current. This current limiting reduces the effectiveness of the capacitor and also produces heat which can speed eventual total failure. Perhaps the heat damage explains why so few partially-open capacitors are found and how a high ESR can predict an early failure.

Checking electrolytics

Operation of the ESR Meter is similar to measuring resistance with a VOM. Use the following sequence:

- Flip on the power switch;
- Short together the two permanently attached test leads and rotate the zero-adjust control until the pointer reaches zero ohms at the right edge of the scale;
- Connect the test leads to the suspected capacitor (either polarity is satisfactory since the test is made with ac); and
- Interpret the reading obtained.

Hair-splitting decisions are seldom necessary. Most capacitors seem to test very good or completely bad. Two calibrations are supplied on the meter. A direct-reading ohms scale is on top of the arc. Underneath is another scale in microfarads. At one point near the center are the double calibrations of 10 Ω and 100 μF. This indicates that an ESR of 10 Ω is the maximum permissible for a 100 μF capacitor.

For example, a 10-μF 10 Ω capacitor should be rejected. A 100 μF capacitor is borderline at 10 Ω and defective at any higher resistance. Also, any electrolytic rated at 1 μF or larger should be rejected if the reading is 50 Ω or higher.

How it operates

A 100 kHz square wave of approximately 60 mV is fed internally through a small coupling capacitor to the external capacitor under test. (That is why the capacitors do not require discharging before they are checked.) At such a high frequency, the pure capacitive reactance of the tested capacitors is a virtual dead short. Therefore, the only resistance remaining to limit the current is the capacitor ESR. In other words, this instrument uses ac current to measure dc resistances.

In-circuit

Capacitors usually can be tested accurately either in-circuit or out-of-circuit because most circuit resistances are much higher than the ESR.

Test results

Many capacitors were tested during examination of the ESR Meter. Of course, the instrument correctly identified both open and normal electrolytics. None of the results were borderline or questionable. Most good electrolytics showed far less than the permissible ESR. The good/bad point for a 200 μF capacitor, for example, is 5 Ω but several checked about 0.4 Ω.

A TV filter had been replaced several months ago on suspicion alone since the capacitance tested okay. The TV intermittent was cured by a new capacitor. An erratic ESR reading of the *old* capacitor pinpointed the source of the problem. Picture-pulling and instability can be produced in TV receivers by high or erratic ESR in filter or AGC capacitors, and ESR tests are highly recommended for those conditions.

Incidentally, the tester can be used to measure non-inductive small resistances, such as wires of all kinds or carbon resistors.

In summary, the $88 ESR Meter performed all of the functions claimed for it, and should make a profitable addition to most service shops. □

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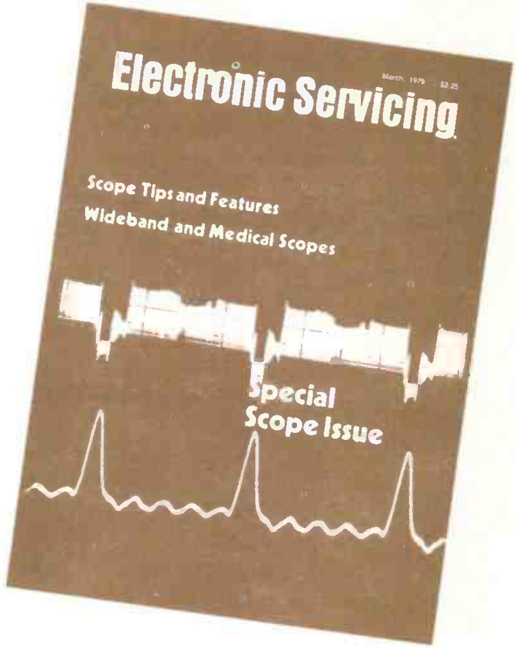

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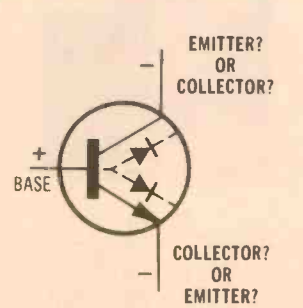
Emergency transistor test

By Wayne Lemons, CET

Most technicians know how to use an ohmmeter for quick tests of transistors by measuring the forward and reversed resistances of base/collector, base/emitter and emitter/collector as if they were diodes. Of course the ohmmeter must have sufficient voltage to turn-on silicon transistors, and the polarity of the meter leads must be known. (Many portable VOMs have positive voltage at the black lead and negative at the red during resistance tests.)

Although such tests can locate obvious or severe defects, they have serious limitations. If all junction resistances are normal, the base lead has been identified (see Figure 1). However, both emitter and collector measure nearly the same relative to the base. Some other test must be used to determine the collector.



B/E AND B/C JUNCTIONS TEST SAME RESISTANCE

Amplification

A simple series of additional steps can identify the collector lead by forcing the transistor to amplify. With the ohmmeter set for the X1000 range, go through these steps:

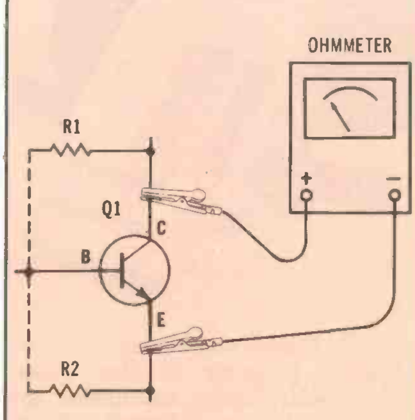
- Connect the ohmmeter between collector and emitter leads (Figure 2).
- Dampen a finger.
- Touch the wet finger between base and one of the other leads. Notice the resistance reading.
- Touch the wet finger between base and the other transistor lead. Compare this reading with the former one.

The finger resistance that produced the lowest reading is between base and collector. If both readings are about the same, perhaps the meter polarity was not right for the transistor polarity. Reverse the test leads at the transistor and repeat the four steps.

If no significant difference is obtained with either polarity, the transistor probably cannot amplify, and it should be replaced.

Behind the test is the principle that a suitable resistance between base and collector will supply forward bias when a voltage of correct polarity is applied to the collector. Of course, many transistors will have a small amount of collector/emitter current when the polarity is reversed. But of the four possible connections of bias resistor and C/E polarity, only *one will produce maximum C/E conduction.*

Better consistency of results can be obtained if a 24K resistor is used instead of the wet finger. However, the benefit of emergency measurements is lost. For more accuracy it's always advisable to use a good type of transistor tester. □

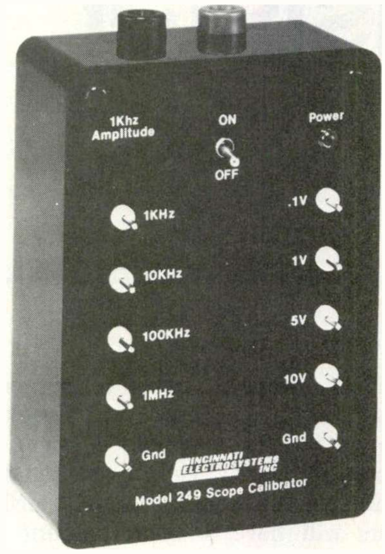


R1 TURNS ON Q1
R2 TURNS OFF Q1

test equipment report

Portable calibrator

A compact calibration source of precision dc voltages and accurate ac frequencies is model 249 Scope Calibrator from **Cincinnati Electrosystems.** Frequencies of 1 kHz, 10 kHz, 100 kHz and 1 MHz have an



accuracy of ±0.005%. The 10 Vdc source has an accuracy of ±0.05%, while the other dc voltages are rated at 0.1% accuracy. These standards are useful for calibrating scopes, DMMs and counters.

Model 249 sells for $59.95.

Circle (55) on Reply Card

Digital multimeter

Special features of the model 8020A **Fluke** digital multimeter include pushbutton selection of 26 ranges and 7 functions while the meter is held by a left hand, 3½-digit LCD display and a conductance function that allows *leakage measurements up to 10,000 MΩ.*

Accuracy of the dc volts and ohms ranges has been increased to 0.1%. A carrying case and special probes (that prevent accidental shocks to the operator) are included. Polarity and zeroing are automatic. Three way overload protection is built in, with transient protection to 6 kV.

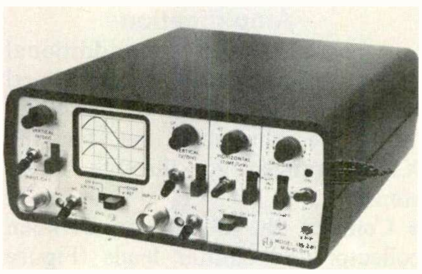
Price of model 8020A is $169, and many accessories are available for extra charge.

Circle (56) on Reply Card

Dual-trace scope

Miniscope model MS-230 from **Non-Linear Systems** provides dual-trace 30 MHz operation in a portable scope weighing only 3.5 lbs.

Vertical sensitivity is from 0.01 V to 50 V per division with 12 positions plus a variable. Triggered-



sweep times range between 0.05 μs and 0.2s per division. Each screen division is 0.25 inch arranged in 5 across and 4 high.

Model MS-230 sells for $559 with input cables and a battery charger that permits battery or ac-line operation. Accessories include a 10X low-capacitance probe and a leather carrying case with shoulder strap and belt loop.

Circle (57) on Reply Card

Microprocessor-controlled counter

Philips model PM-6667 counter provides high-resolution measurements of low frequencies and nearly automatic operation.

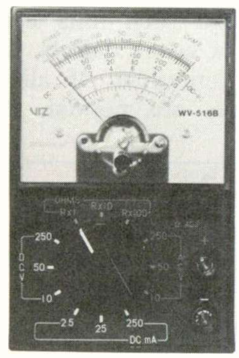
Seven-digit resolution of low frequencies is obtained by multiple period measurements followed by microprocessor computation of the reciprocal frequency value during each 1 s measurement time. The counting ranges cover from 10 Hz to 120 MHz.

A 6-position attenuator allows input levels from 15 mV to 5 V RMS.

Automatic triggering eliminates false counts from noise without control adjustments. The microprocessor selects the range which gives best resolution without overflow while positioning the decimal and lighting the proper Hz, kHz or MHz indicator.

An optional battery pack and carrying case allow the counter to be used for 6 hours per charge away from power lines.

Circle (58) on Reply Card



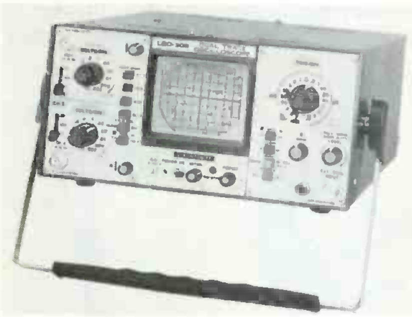
VOM

A hand-sized VOM is offered for $19.95 by VIZ. Model WV-516B has 12 ranges plus dB calibrations, sensitivity of 2000 Ω/V and measures ac and dc voltages up to 250 V, dc current to 250 mA, resistances up to 500,000 Ω and decibels between -20 dB and +22 dB. Model WV-516B comes with resistance battery, test leads and a 1-year warranty on parts and labor.

Circle (59) on Reply Card

20-MHz scope

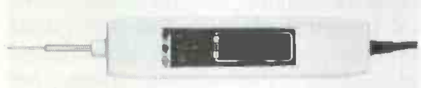
Leader Instruments model LBO-308 is a portable, dual-trace 3-inch scope with a bandwidth of 20 MHz. Operation is from line ac, dc or an optional battery pack. Maximum sensitivity is 2 mV per division, and



it is adjustable in 12 ranges plus a variable control. The X5 sweep magnification provides a minimum sweep time of 0.1 μS/div.

Model LBO-308 is priced at $950 with two direct/low-capacitance probes.

Circle (60) on Reply Card

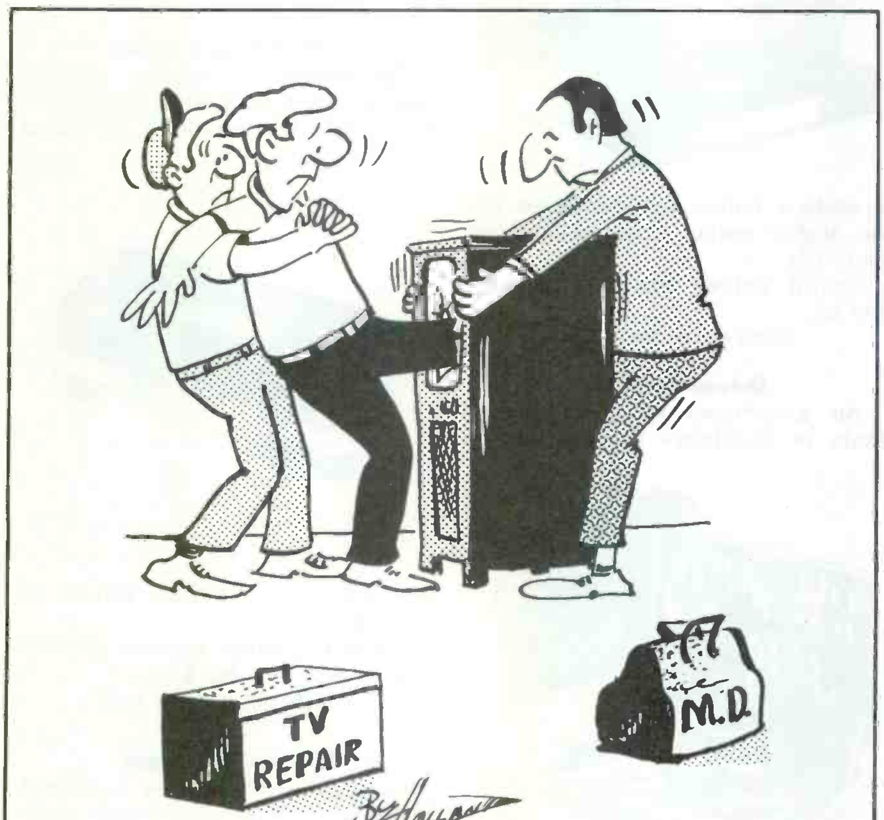


Logic-probe kit

Solder, wire, hardware, circuit board, case and all components are furnished by **Continental Specialties** for the model LPK logic-probe kit that sells for $19.95.

After it is assembled, model LPK probe is powered through attached clip leads from the circuit being tested. Three LEDs indicate a digital high, pulses or a digital low. An internal pulse stretcher detects pulses as narrow as 300 nS and causes the pulse LED to flash at 10 times per second. The internal circuitry is protected against reversal of supply polarity and against overvoltage.

Circle (61) on Reply Card



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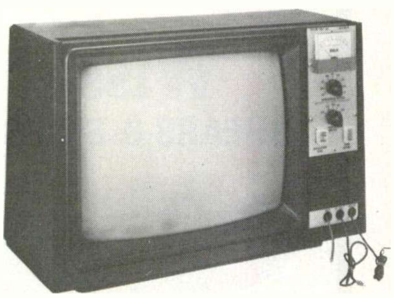
Circle (14) on Reply Card

productreport

Color-TV test jig

Model 10J106B color-TV test jig offered by the **RCA Distributor Division** includes a TV-type cabinet containing a 33 kV rated 19-inch picture tube, front-mounted test speaker, plus a 35-kV HV meter, 9-poisition horizontal yoke selector, 5-position vertical impedance selector, deflection yoke and CRT base



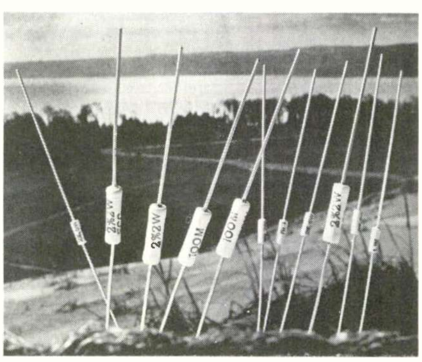
sockets, and wires for HV, ground and audio on the front panel. A broad line of adapters is available. An index of setups is included with the jig.

A 10J107 test jig adapter is available that includes a low-impedance yoke and cables. The separate adapter unit has 9-position horizontal and 5-position vertical switches and a yoke socket.

Circle (62) on Reply Card

Sylvania resistors

GTE Consumer Electronics has added 259 new Sylvania ECG flameproof resistors. The Sylvania line now includes quarter-W values from 1Ω to 1 MΩ, half-W values from 1 Ω to 22 MΩ, and 1- and 2-W values



from 0.10Ω to 100 MΩ.

According to the manufacturer, these ECG resistors are flameproof because the metallic resistance element is between a ceramic core and an outer ceramic coating.

Circle (63) on Reply Card

Transistor manual

The ninth edition of **Howard W. Sams** *Transistor Specifications Manual* provides electrical and physical data for more than 19,000 bipolar transistors. Parameters given for each transistor are polarity, maximum voltage, power dissipation, collector current, operating frequency, cutoff current, and dc current gain.

Book number 21516 sells for $8.95.

Circle (64) on Reply Card

Premium videocassettes

Memorex now offers a line of videocassette tapes in the VHS format. The cassettes offer a choice of 1-2 hours (T-60) or 2-4 hours (T-120). The new tape is said to

provide a better signal-to-noise ratio, higher output level, and longer head life.

Retail prices are $19.99 and $27.99.

Circle (65) on Reply Card

Deluxe tool kits

An assortment of name brand tools is available in the model

705WT and 710WT *Troubleshooter Tool Kits* from **Platte Luggage.**

Circle (66) on Reply Card

Illuminated magnifier

The Magnilite, manufactured by **O. C. White Company**, has a magnifying 3-diopter lens inside a 22-W circular fluorescent lamp

that can be positioned by spring-tensioned arms that extend to 45-in.

The Magnilite is available in a choice of nine colors and is priced at $69.52.

Circle (67) on Reply Card

Cassette tape eraser

The **Robins** non-electric cassette tape eraser uses built-in magnets to erase recorded material in about

two seconds. No line power is required.

Robins catalog number 24-004 tape eraser lists for $20.

Circle (68) on Reply Card

Cordless telephone

Telephone calls can be answered by the Muraphone from mobile locations as far as 700 ft. from the base station. This **Mura Corporation** system has an ac-powered base station

(which is connected to the telephone) and a mobile unit that operates from internal rechargeable batteries.

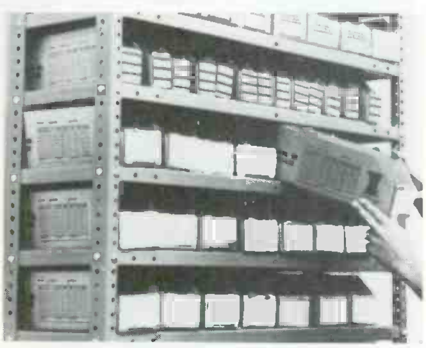
An incoming call causes the mobile unit to emit a beep signal. To answer, the person called extends the antenna and presses the talk button.

Retail price of the Muraphone is $89.95.

Circle (69) on Reply Card

Parts bins

Econo-Bins in nine sizes are offered by **Economy Carton Company**. An inventory-control form is



printed on the side of each fiberboard bin, and space is provided on the front for labeling or indexing.

Circle (70) on Reply Card

Semiconductor guide

The 1979 ECG *Semiconductor Master Replacement Guide and Catalog* is available from **GTE Consumer Electronics** distributors for $2.95. The guide lists 2200 solid-state devices that can be used as substitutes for original devices in both foreign and domestic brands of equipment.

The 161-page technical section includes fast-reference specifications of the new types plus selector charts to help choose a substitute for a device of unknown specifications. It also includes technical data for transistors, diodes, rectifiers, thyristors and integrated circuits.

Circle (71) on Reply Card

CB Antennas

"Power Wing" CB antennas from **Channel Master** are capacitively top loaded, and are just 16-inches

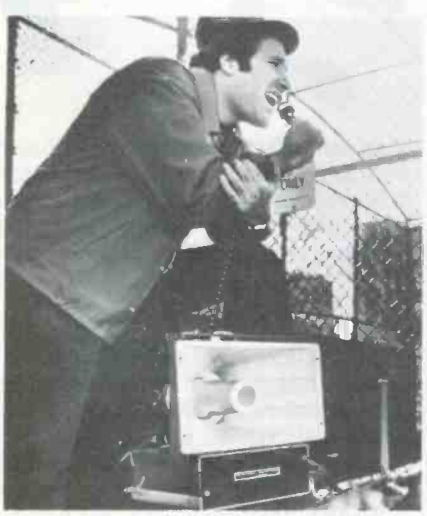
high from base to wing. The units incorporate an aerodynamic design, with rigid construction.

Circle (72) on Reply Card

Loudspeaker system

The Half-Mile Hailer manufactured by **Perma Power Electronics** is designed for athletic events, picnics, rallies and crowd control without the mechanical feed-back problems associated with megaphones. The operator holds a microphone instead of a bulky horn so neither vision nor sound is obstructed.

The solid-state, weather-proof Half-Mile Hailer comes complete with microphone, amplifier and horn speaker. A shoulder strap or gripper handle is included also for



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Product report

portability. The unit operates on flashlight batteries and the manufacturer's suggested list price is less than $200.

Circle (73) on Reply Card

Wallplates

Winegard Company has introduced five RV wallplates.

Model RP-1211 is designed to be used with Winegard's RVH-2K amplified RV antenna. It features a 75-ohm antenna input, 300-ohm output to the TV set, on-off switch and indicator light.

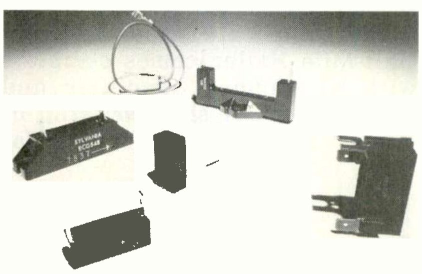
Models RP-6001 and RP-6011 are designed to be used with Winegard's RVH-3 and RVH-6 RV antennas. They feature 75-ohm antenna inputs, two 75-ohm outputs, on-off switches, indicator lights and 12 VDC cigar-type receptacles for TV sets.

Models TG-7701 and TG-7711 are 82-channel TV outlets with 75-ohm inputs and outputs and 12-volt receptacles. They accept standard F-type connectors for coaxial cable. List price is $15.50.

Circle (74) on Reply Card

Microwave-oven rectifiers

Nine HV rectifiers (ECG540 through ECG548) are available from **Sylvania** for replacement use in microwave ovens. These rectifiers can replace 77 types used by 16



oven manufacturers, and are listed alphanumerically in the Sylvania ECG semiconductor master guide and 1979 catalog, along with the industry numbers they replace.

Circle (75) on Reply Card

Flameproof resistors

RCA has added 120 flameproof film resistors to their line. These additional types are in the low range from 0.1 to 9.1 Ω in half, 1 and 2 W ratings.

These resistors are in blister packs with two resistors per package.

Circle (76) on Reply Card

Bulk-tape eraser

A longer on-time duty cycle and stronger magnetic strength are features of the **Fidelipac** Blank-IT tape

eraser. Magnetic tape of all audio formats and both VHS and Beta videocassettes can be erased rapidly, according to the manufacturer.

Circle (77) on Reply Card

Nut driver kit

Vaco number K7 nut-driver kit contains seven hollow-shaft hex nut

drivers in a plastic pocketed apron. All popular sizes from 3/16 in. to 1/2 in. are included.

Circle (78) on Reply Card

Technical manual

GTE Consumer Electronics offers the 16th edition of the *Sylvania Technical Manual*. This 590-page updated manual contains technical information about 3000 foreign and domestic receiving tubes and TV picture tubes.

The manual sells for $2.75.

Circle (79) on Reply Card

catalogs literature

Simpson's 60-page 4-color catalog (number 4900) lists the Simpson line of analog and digital panel meters, meter relays, controllers, and test instruments. One new item is model 463 digital multimeter with LCD display.

Circle (80) on Reply Card

Gould's Form 449-7 is a 4-page illustrated bulletin that describes general-purpose scopes, including some dual-trace and dual-beam models.

Circle (81) on Reply Card

Thor Electronics' wholesale pricing guide is a 40-page catalog listing 10,000 types of tubes, semi-conductors, ICs and computer equipment.

Circle (82) on Reply Card

Texas Instruments calculators, electronic games, security devices, office products and radios are described in a 36-page catalog by **Markline.**

Circle (83) on Reply Card

Tool kits by **Electronic Tool** ranging from complex to simple are described in a catalog, along with listings of test equipment.

Circle (84) on Reply Card

TEI's Electronics' 52-page 1979 catalog is offered. Included are speakers, microphones, intercoms, PA systems, test equipment and electronic hardware.

Circle (85) on Reply Card

General Electric has added 25 new transistors and voltage regulators to the Pro line of replacement semiconductors. Crossreference material is available in the ETRM-4311P *GE Semiconductor Guide.*

Circle (86) on Reply Card

Fordham Radio Supply offers a new 164-page discount mail-order catalog for 1979. Name-brand test equipment is featured along with tools, tubes and repair kits.

Circle (87) on Reply Card

Standard Handling Devices has released its winter 1979 catalog of 168 pages featuring equipment for lifting, transporting or conveying merchandise around parts and service areas.

Circle (88) on Reply Card

Workman offers X78-2 1979 *Semiconductor Catalog and Crossreference* which now contains more than 145,000 cross listings of semiconductors.

Circle (89) on Reply Card

ETCO has 64 pages of parts, gadgets and bargain-priced factory surplus. All parts are said to be in stock and ready for shipment.

Circle (90) on Reply Card

B&K-Precision offers a full-color 6-page brochure describing the complete line of B&K-Precision digital multimeters. Also included are details of the TP-28 temperature probe.

Circle (91) on Reply Card

Mouser Electronics has a newly released 104-page catalog with prices of test equipment, hardware and tools. More than 10,000 items are listed.

Circle (92) on Reply Card

Jenson Tools has published a catalog of more than 2000 types of hard-to-find tools, including micro-tools, tool kits and cases, test equipment and soldering devices.

Circle (93) on Reply Card

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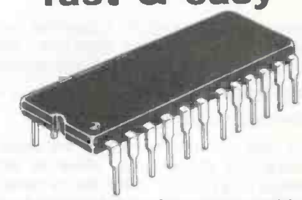

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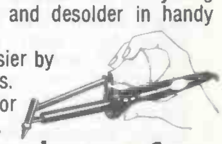

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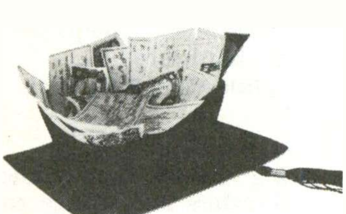

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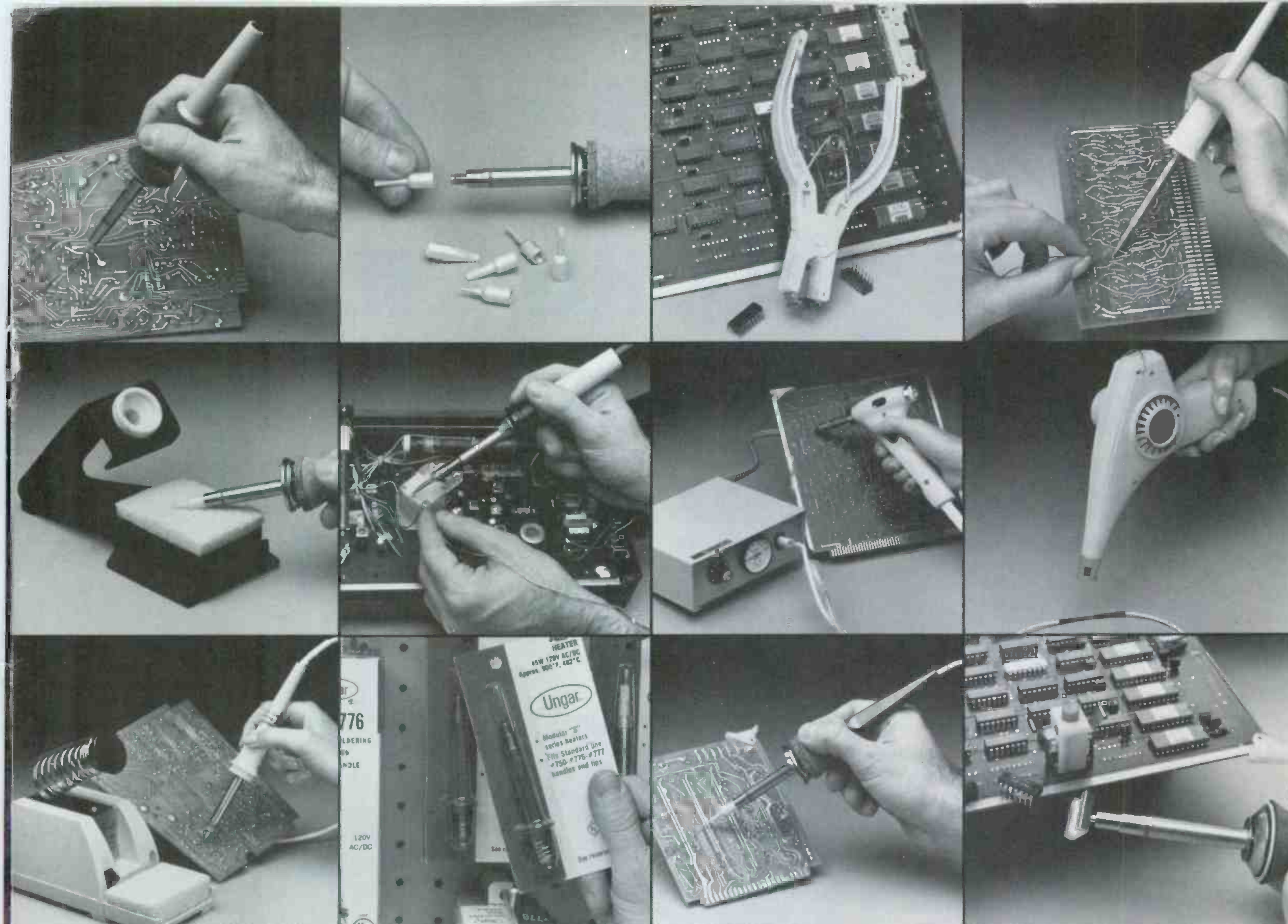

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