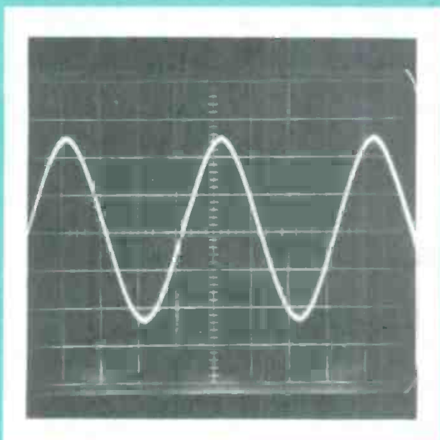
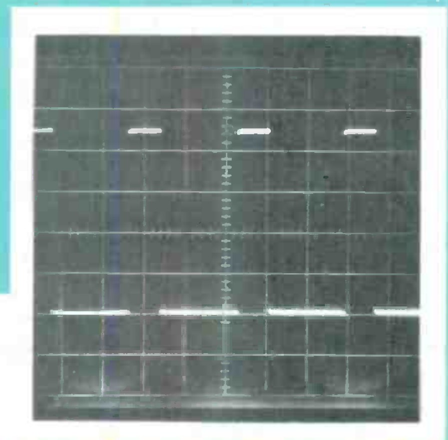
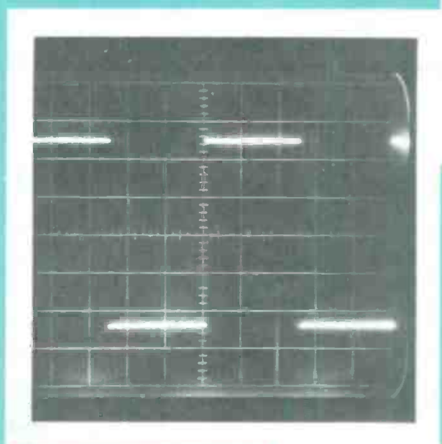
January, 1980 ❑ $2.25

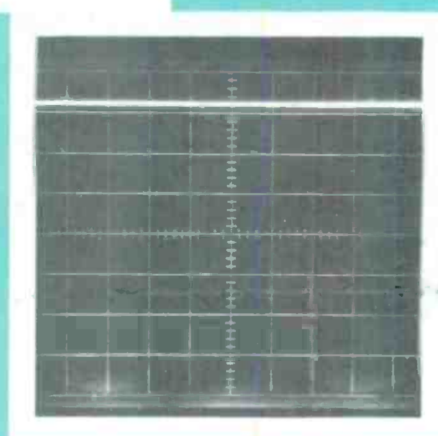
Electronic Servicing®

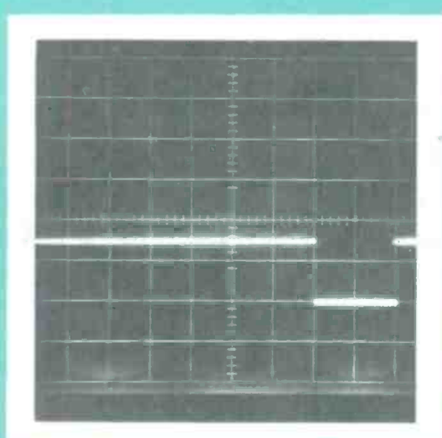
Understanding digital signals











Profitable labor rates

Servicing older Zeniths

EMIL J DE NAGEL
BOX 92A
IRON RIVER MI 54847
2376
03

Channel Master gives you 3 ways to insure CRT sales...

Safety

Implosion protection techniques used by Channel Master to produce **All** of their certified replacement tubes are recognized under the Component Program of Underwriters Laboratories Inc.

Channel Master has been meeting or exceeding industry implosion protection standards for over eighteen years by continually developing sophisticated new equipment and techniques. Local "rebuilders" just don't have these same resources and often try to cut costs by skimping on implosion protection. Tubes from these outfits are not only dangerous but can also cost you dissatisfied customers and lost sales.

Industry surveys indicate that there are some 30 million color receivers that are at least 7 years old, still in use in American homes today. Since the average life span of a color picture tube is 6 to 8 years, 30 million 7 year old sets represent an enormous continuing growth potential for CRT sales.

Superior Quality

During production, Channel Master examines every CRT by putting it through twenty separate and distinct tests. The tubes are even taken for a bumpy 65 mile ride and then tested again for focus convergance, emission and gas ratio, high voltage leakage, inter-electrode leakage and peak cathode emission—just to make sure each tube delivered lives up to its guarantee.

Warranty

Whether it's a two year Monarch, three year Color Lux or a lifetime Opti-Chrome "LT," the warranty that comes with every Channel Master CRT is your assurance that you're giving your customers the best CRT available. They will appreciate the value you've given them, and you will appreciate their return sales!

Channel Master...We work harder to make you look better.

Channel Master

Division of Avnet, Inc.,
ES180, Ellenville, New York 12428

Circle (1) on Reply Card

Electronic Servicing

Editorial, advertising and circulation correspondence should be addressed to P.O. Box 12901, Overland Park, KS 66212 (a suburb of Kansas City, MO); (913) 888-4664.

EDITORIAL
Bill Rhodes, *Editorial Director*
Carl Babcoke, *Editor*
Mary Thornbrugh, *Associate Editor*

ART
Dudley Rose, *Art Director*
Linda S. Franzblau, *Graphic Designer*

CIRCULATION
John C. Arnst, *Director*
Evelyn Rogers, *Manager*

ADMINISTRATION
George H. Seferovich, *President*
George Laughead, *Publisher*

ADVERTISING
Greg Garrison, *National Sales Manager*
Pam Morris, *Production*

Regional advertising sales offices listed near Advertiser's Index.

ABP Member, American Business Press

Member, Audit Bureau of Circulation

ELECTRONIC SERVICING (USPS 462-050) (with which is combined PF Reporter) is published monthly by Intertec Publishing Corp., 9221 Quivira Road, Overland Park, KS 66212. Controlled Circulation Postage paid at Shawnee Mission, KS 66201. Send Form 3579 to P.O. Box 12901, Overland Park, KS 66212.

ELECTRONIC SERVICING is edited for technicians who repair home-entertainment electronic equipment (such as TV, radio, tape, stereo and record players) and for industrial technicians who repair defective production-line merchandise, test equipment, or industrial controls in factories.

Subscription prices to qualified subscribers: 1 year—$12, 2 years—$19, 3 years—$24, in the USA and its possessions. All other foreign countries: 1 year—$15, 2 years—$25. Subscription prices to all others: 1 year—$25, 2 years—$50, in the USA and its possessions. All other foreign countries: 1 year—$34, 2 years—$68. Single copy price $2.25; back copies $3.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks delivery for change of address. Allow 6 to 8 weeks for new subscriptions.

INTERTEC PUBLISHING CORP.

VA-VA-VA-VOMS!

MONEY-SAVING TEST EQUIPMENT

The excitement in VOMs and testers today is coming only from MURA. With a full line of test equipment that provides high performance and solid construction at surprisingly low prices.

There's a Techlite® meter, for example, with a sensitivity of 50,000 ohms/volt DC and 12,500 ohms/volt AC. Another in which the lowest DC range is .125 volt full scale. And another that measures DC current on any one of ten ranges and resistance on any one of five ranges.

Then there's a Clamprober® that can accurately measure AC current and voltage without even breaking into the line. And a battery tester with non-polar leads that you can safely connect to either battery terminal for quick and easy measurements.

So the next time you need troubleshooting equipment, don't shoot your budget. Get in on the excitement from MURA.

MORE FOR YOUR MONEY
MURA
CORPORATION
177 Cantiague Rock Road
Westbury, N.Y. 11590

Circle (3) on Reply Card

Coming in February

Electronic Servicing.

RCA horizontal sweep; more Zenith tips; and CB case histories.

January, 1980 ☐
Volume 30, No. 1

Electronic Servicing®

Maintenance

Servicing

Departments

About the cover

Graphic design by Linda Franzblau

©Copyright, 1980, by Intertec Publishing Corporation. All rights reserved. Material may not be reproduced or photocopied in any form without written permission of publisher.

electronicscanner

news of the industry

Whirlpool has demonstrated a microprocessor-controlled dishwasher, said to be the first national brand with solid-state controls. The dishwasher is not scheduled for distribution until late in 1980.

Leader Instruments recently celebrated the opening of its new headquarters in Hauppauge, NY. Leader's growth called for more space in the near future, and the increase became mandatory when the previous facility in Plainview was destroyed by a tornado during the summer of 1978.

The ISCET Technical Library now is open for business at 5631 Irving Park Road, Chicago, IL, 60634, under the direction of George Sopocko, CET. Sopocko offered to continue the work of Henry Golden, CET, who was incapacitated by serious illness last year. The library has schematics for many older radios, TV receivers, amateur radios and test equipment. The fee for search and copy of two pages costs $2 plus 50 cents for each additional page.

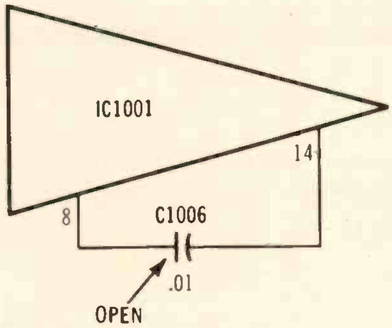
Electronic machines that talk in words, and others that repond to spoken words are attracting much attention now. A prototype microwave oven that talks will be displayed by Quasar at the January CES show. At the same show, Toshiba is scheduled to demonstrate a hi-fi system that responds only to the voice of the registered owner. A total of 19 commands using 15 words can be executed. Voice-activated TV remote controls and video games were displayed by several manufacturers at the recent Japan Electronics show. All machines were prototypes and no commercial versions are planned for at least two more years. However, a Sharp talking calculator now is on sale in Japan for about $250. During key entries, the calculator vocalizes the digits; while the answer or a playback of a previous entry can be voiced as individual or overall numbers. A 6-kilobyte ROM stores the 60 words as a pulse-code signal that is compressed by a factor of five. A 4-bit microcomputer performs part of the speech synthesis control and all calculator functions. One RAM stores and replays the 100-step vocal memory. This model CS-6500 calculator has a 16-digit fluorescent display.

A new type of microwave oven by Sharp controls both heat and cooking time by sampling the vapor, smoke and odors from the food. The sensor has a 4-bit microcomputer which remembers 7 modes of reheating or cooking times for various foods, and no manual adjustments are required. Model R-500W oven is available only in Japan.

symcure

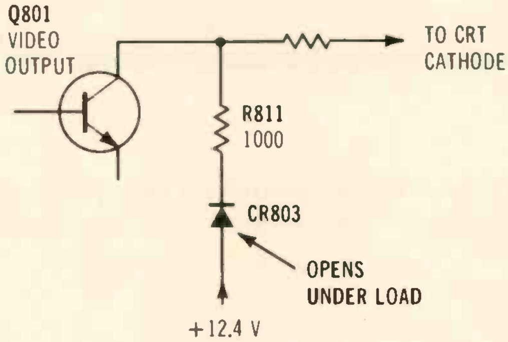
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 12JB2X (and others) B&W
PHOTOFACT—1413-3



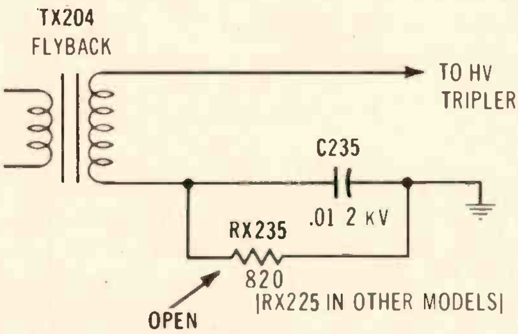
Symptom—Weak or intermittent audio volume
Cure—Check capacitor C1006, and replace it if open

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



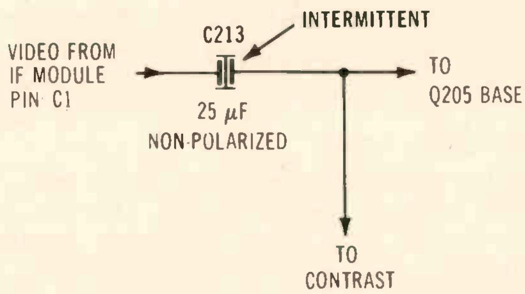
Symptom—Excessive brightness with retrace lines
Cure—Replace diode CR803 as a test for intermittent operation

Chassis—Zenith 19HC50
PHOTOFACT—1681-2



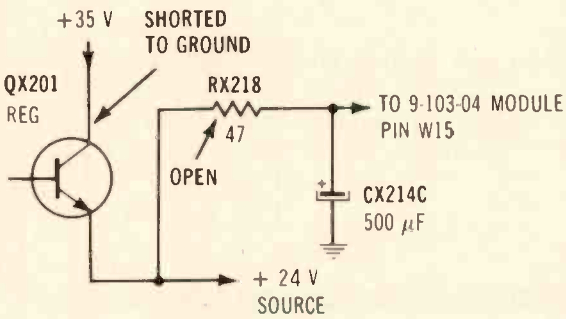
Symptom—No raster or rapid flashing in picture
Cure—Check RX225 or RX235, and replace or short across it if open

Chassis—Zenith 19EC13
PHOTOFACT—1413-3



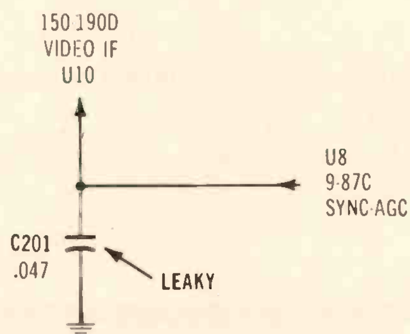
Symptom—Low-frequency streaking through picture
Cure—Check non-polarized capacitor C213, or replace as a test

Chassis—Zenith 19HC45
PHOTOFACT—1676-2



Symptom—No picture or sound
Cure—Repair short at QX201 collector and replace open RX218

Chassis—Zenith 19HC45
PHOTOFACT—1676-2



Symptom—Excessive snow on all channels
Cure—Check AGC capacitor C201, and replace if leaky or shorted

reader's exchange

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

Needed: Used or new, one workable power transformer for a York solid-state, lamp radio clock, desk console model DCR-93. Other numbers on unit are 7034-914-576/100. O.B.T.V., *Box 166, Southborough, MA 01772.*

Needed: Information on a Victor talking machine type Z-12920. Would like to have picture or drawing of governor and spring, also, cradle that holds horn. *Bentley's TV Service, Gray, GA 31032.*

For Sale: Antique radio tubes dating back to the early 1920s. *Ray Potter, 902 W. 15th St., Williston, ND 58801.*

For Sale: 110 back issues of **Electronic Servicing**, in like new condition, best offer; Heathkit IG-57A post-marker sweep generator with all cables and manual, $100; and Radio Shack dual power supply (0 to 18 volt at 1 amp), $50. *Paul Smith, #1 Clearview, Cottondale, AL 35453.*

Needed: Operating instructions and schematic for Knight sweep/marker generator, model KG-687. *Richard Taylor, 5333 Julington Creek Rd., Jacksonville, FL 32223.*

For Sale: Sencore CG-169 color/bar generator, excellent condition, $100. *Wilbur Tomlin, Box 102, Cary, NC 27511.*

Needed: RCA WG-295C video multimarker. *Wilbur Tomlin, Box 102, Cary, NC 27511.*

Needed: Two 12A6 tubes and one UF86 tube. *Belvedere Electronics, 6219 Belvedere Blvd., Omaha, NE 68111.*

Needed: Service information for an Alpine AM/FM 40-channel CB radio; model BR610. *Tom's TV Service, Box 36, Kennedale, TX 76060.*

For Sale: Johnson Viking II with model 122 VFO; Gonset Communicator IV for two meters. *George Robinson, 7155 Walden Rd., Newburgh, IN 47630.*

Needed: Part VR-5-6-7-8 number 220-191-4 combination vertical hold and linearity, horizontal hold and range controls for a Magnavox T925 chassis. *C. V. Todd, 1320 N.W. 116th, Miami, FL 33167.*

For Sale: B&K-Precision 415 sweep/marker generator, $250; EICO 368 sweep/marker generator, $40; Castle VHF Tuner Subber $20; Heathkit 5-inch 5MHz model IO-20 scope with probes $60; Lectrotech V7 vectorscope/color generator, $70; All items first class condition with manual, schematic and cables. *Long's TV and Radio Service, 720 Goshen, Salt Lake City, UT 84104.*

For Sale: About 200 new TV/radio tubes; No reasonable offer refused. *Western Auto Store, Thayer, MO 65791.*

Needed: Meter for a model 658-1 Jackson dynamic tube tester. *Richard Napper, 811 Osage, Manhattan, KS 66502.*

Needed: A meter (only) for a Precision Instrument vacuum-tube multimeter, series EV-10. *Alex Ralston, Box 366, Unity, Sask., Canada SOK 4LO.*

Needed: Schematic for an antique RCA radio, model 29K; Also, a Sprague capacitor analyzer. *Mitchell Electronics, 4 Golf Ave., Maywood, NJ 07607.*

Needed: Service and instruction manual for Sylvania TV sweep generator, type 500; B&K-Precision model 1000 ac bridge analyzer, model BR-44; Superior transistor radio tester, model 88. Will buy original or copy, or will copy and return. *Arjay Radio Service, 1329 S. Spring St., Springfield, IL 62704.*

For Sale: Radio and television equipment, tubes, most anything needed for TV repair shop. *Horace L. Graham, 1006 h. Buffalo, Cleburne, TX 76631.*

Needed: Schematic for a Fisher model 203 80W stereo receiver. *Charles Harris, 7614 Vicar St., New Carrollton, MD 20784.*

Needed: Service manual or schematic for Trio M/N 9R-59 shortwave receiver. Will buy, or copy and return. *Bob Burley, 9007-129B Ave., Edmonton Alta, T5E-OP4.*

For Sale: Riders radio manuals, Riders TV manuals. State your needs. *Trouch's TV, 290 Main St., Spotswood, NJ 08884.*

For Sale: Photofacts to 800, mostly complete; new B&K-Precision 415 sweep/marker shipped pre-paid, $350; other equipment. Send SASE for complete list. *Richard Hardy, Rt. 2 Box 350B, Grove, OK 74344.*

Needed: Paco in-circuit capacitor checker model C-25; Mercury cap checker model 1400. Both schematics needed. *ABE, 615 S. Louise St., Glendale, CA 91205.*

For Sale: Older out-of-print Photofacts. Send SASE with numbers desired. *Gene Elfstrom, 76 Waterworks Rd., Freehold, NJ 07728.*

For Sale: Last call, Sams 1-500 Photofacts individual schematics, 75 cents. Includes postage and handling. Will destroy after January 1, 1980. Money returned if not available. *Abbott TV Service, Box 99, Gifford, PA 16732.*

Reader's exchange

For Sale: Sencore CR-161 CRT tester; tube caddies, and solid-state supplies. *Padraig O'Cuinn, 144 Castilian Way, San Mateo, CA 94402.*

Needed: A rotary switch for a model CR176 Magnavox radio. Switch has 3 sections with 5 poles per section and 12 positions. *James Gregorich, 117 2nd Street North, Virginia, MN 55792.*

For Sale: US Army surplus radio transmitter Signal Corps model BC-375-E with antenna-tuning unit, dynamotor unit, automatic pilot component, and 7 slide-in transmitter-tuning units. *Bill Hennen, 324 Forest Avenue, Aurora, IL 60505.*

Needed: B&K-Precision TV Analyst model 1077B in good working condition, with manuals, cables, transparencies and accessories. State price. *Victor Villalta, 165 Guttenberg, San Francisco, CA 94112.*

For Sale: Complete set of Rider TV manuals volumes 1-27 inclusive; complete set of Rider radio manuals volumes 1-22 inclusive with index. Best offer for both complete sets. *American TV, Star Route, Santa Barbara, CA 93105.*

For Sale: B&K-Precision model 415 sweep/marker, $275; B&K-Precision model 501A curve tracer, $100; Heathkit FM/stereo generator, $70. Hardly used, with manuals and probes. All prices plus freight. *Bill Stough, 10 West Main, Union, MO 63084.*

Needed: Setup booklet and manual for a Mercury model 1100 tube tester. An updated book would be best. *James Moragne, 14½ Pine Grove Avenue, Asheville, NC 28801.*

For Sale: Sencore model 158 sweep/marker including all cables in original carton, perfect condition, used little, $175. *Oneco TV Service, RFD 1, Box 472, Porter Pond Road, Moosup, CT 06354.*

For Sale: TV, stereo and CB test equipment, also parts and many other items. Closed my shop and will sell cheap. Send self-addressed stamped envelope for price list. *Ben Gaddis, 306 North Jackson, Elk City, OK 73644.*

Needed: One channel-2 tuner strip (2Q24) for Ward's Airline color TV model GEN-12440A. Other tuner marks are: Standard Kollsman, Sharp 129905. *William Hennen, 324 Forest Avenue, Aurora, IL 60505.*

For Sale: Obsolete hard-to-find TV flybacks and yokes for old B&W sets, about 30 items in original boxes with drawings, $15; Clarostat kit of wire-wound controls, $8; 2 AM car radios, $8 each; Panasonic FM stereo cartridge, $10; small speakers, $1 and up. All prices plus postage. *Al Crispo, 159-30 90 Street, Howard Beach, NY 11414.*

For Sale: B&K-Precision model 510 in- or out-of-circuit transistor tester, $45; Sencore DVM-36 digital multimeter with ac adapter and NiCad batteries, $75. *John DeLuco, 435 Ocean Boulevard, Cliffwood Beach, NJ 07735.*

For Sale: B&K transistor checker, $105; Sprague tel-ohmike T06A, $160; Sencore speed aligner SM-158, $90; Sencore FE-149 multimeter, $35; Sams #501-800, $150. All items are in perfect condition. *Al Television Technicians, 1127 S.W. 112th Ave., Miami, FL 33176.*

Needed: B&K 520-B transistor tester and good picture tube tester and rejuvenator. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

For Sale: B&K-Precision Analyst transistor model 970, $225; RCA (VIZ) WR-50C RF generator, $100; Non-Linear Systems LM-3 digital multimeter, $125; Triad 20A power supply, $75. All in excellent condition with boxes and manuals. *Gary Castellini, 3567 Lincoln Avenue, Vineland, NJ 08360.*

Needed: Schematic and/or manual for Edison radio receiver model R5; it has Edison power unit type 8P and receiver type 7R. *Jerome Galiley, 1303 Justin Road, Cardiff By Sea, CA 92007.*

For Sale: Instruction manuals for Tektronix 535A and 545A scopes; USM-24C manual; Approved A200C signal generator; ATR 6V-variable battery eliminator. *Irving Goodman, 516 South Kenmore Avenue, Los Angeles, CA 90020.*

For Sale: My collection of Rider's radio and TV manuals, old Photofacts, Supreme service manuals, and other antique radio service material. Buy what you need; no reasonable offer refused. *Morris Beitman, 1760 Balsam Road, Highland Park, IL 60035.*

For Sale: Parts for old car radios such as Packard, Kaiser-Frazer, Delco, Bendix, Motorola and Ford. Also, 6V and 12V vibrators and new custom Motorola AM car radios back to 1955. *Gorski TV-Radio, Rd #7, Box 655, Flamington, NJ 08822.*

Needed: Books about servicing transistor radios, TVs, modules and tuners, at reasonable cost. *P. Valer, 428 West Roosevelt Boulevard, Philadelphia, PA 19120.*

For Sale: B&K-Precision 1077B Analyst, $485; RCA Mark II test jig with CRT, $110; Sencore Speed Aligner SM158 (sweep/marker), $210; Sencore Substituter RC-167, $100. All like new with manuals and probes. Included for a lot sale is a Heathkit IT-18 transistor tester ($35 if separate). Thomas Kardos, *433 South Yorbita Road, La Puente, CA 91744.*

For Sale: Sony model 5-303W micro TV for parts; Harman Kardon stereo multiplex converter model MX-500, with schematic; best offer. *Mike's Repair Service, P.O. Box 217, Aberdeen Proving Ground, MD 21005.*

Needed: Schematic for model 350 B&K-Precision picture-tube rejuvenator/tester. Especially need specs of power transformer. Will buy schematic, or copy and return. *Greg Richey, 212 South David, Springfield, IL 62705.*

For Sale: In mint condition, one Quasar yoke 24D70165A06, one Thordarson flyback FLY-312, one solid-state HV rectifier EP62X84. Will ship anywhere via United Parcel COD. *Arthur Kramer, Honest TV, Box 68, East Norwich, NY 11732.*

Needed: Schematic and service literature for Belair model CRH-401 8-track/FM-stereo. Will buy, or copy and return. *Tom Houlihan, 2 Willow Road, Saugerties, NY 12477.*

For Sale: Thirteen items of radio and TV test equipment, some in warranty. Send for list. *Daniel Seidler, 5827 South Campbell Avenue, Chicago, IL 60629.*

Needed: Photofact folder 909. *Loren Olson, 206 Front, Newark, NJ 60541.*

For Sale: Rider's manuals volumes 1 through 16, unabridged and indexed, $200 including postage. *Louis Pavan, 15 Carston, Selden, Long Island, NY 11784.*

Needed: Schematic of model 2746E29 (WTG number 61234) Bradford clock radio. *Anth-Roup Electronics 182 Kimberly Avenue, East Haven, CT 06512.*

Needed: Pre-1950 portable and table model television receivers for restoration. State price and condition. *Paul Simmons, 5003 Aurora Drive, Kensington, MD 20795.*

For Sale: Complete NRI course, mobile communicattions with FCC license, asking $75. Includes all answer sheets, texts, reference texts, study guides, FCC progress exams and their answer sheets. *Kenneth W. Harden, Arizona State Prison, Box B-30260, Florence, AZ 85232.*

For Sale: REM CRT tester and cathode-recovery unit, $190; Leader color-bar generator, $175; B&K-Precision model 280 digital multimeter with direct/100K probe, $70; Sencore Hybrider transistor tester, $200. *Ray Duffy, 1821 N.E. 65 Street, Fort Lauderdale, FL 33308.*

Needed: Part number 102213 output transformer for 40W Knight kit amplifier model 83YU774. *Raymond Chalmers, 18 White Clay Drive, Newark, DE 19711.*

For Sale: 175 electronic magazines (Radio Electronics, PF Reporter, Radio Television and **Electronic Servicing**) plus many old servicing books, all for $50 or trade. **Needed:** B&K-Precision model 1070 Analyst. *Kenneth Miller, 10027 Calvin Street, Pittsburg, PA 15235.*

For Sale: Miscellaneous antique radios including Philco cathedral. Send stamped self-addressed envelope for list. Also, PS-163 Sencore and Heathkit IO-4550 scopes, both dual-trace and triggered, excellent condition. *Richard Sanderford, 6400 Andy Drive, Raleigh, NC 27610.*

Needed: RCA WC-412 sub box. State condition and price. Phil Schrock, 84343 Hilltop Drive, *Pleasant Hill, OR 97401.*

For Sale: Bell & Howell 11-volume color-TV course complete, books only, best offer. *Colin Michaud, 1110 N.E. 164th Avenue, Vancouver, WA 98664.*

For Sale: B&K-Precision 415 sweep/marker generator, never used, $200; B&K-Precision 1077B TV Analyst, used once, $200 plus shipping. *R-H Electric, 5069 Ridge Road East, East Williamson, NY 14449.*

Needed: Volume control with switch for model HE-8060A (489763-215 and 40X062-003) Singer color TV. *Willies TV, P.O. Box 252, Planada, CA 95365.*

For Sale: B&K-Precision TV Analyst model 1077B with manual and cables, just recalibrated by factory, $425 plus shipping: Bell & Howell 5MHz scope (Heath IO-4540) with L/C probe, jack for ringing tests and manual, $125 plus shipping. *Jim's TV, 43 Kory Drive, Kendall Park, NJ 08824.*

Needed: Multiplex adapter model MPX-100 for Fisher Radios, new or used in good working order. *Dexter Seymour, DC Technical Laboratory, 1012 Colonial Road, Franklin Lakes, NJ 07417.*

Needed: Schematic for model TV-23M Miratel TV monitor. *L. Wenrich, 1014 South Mansion Drive, Silver Spring, MD 20910.*

For Sale: Photofacts from 1 to about 800, for best reasonable offer. Also, my business is closed so tubes, resistors, capacitors and other components are for sale. *James Bunyan, 28430 Lakeview, Nuevo, CA 92367.*

Needed: Parts list and schematic for a model CTR-9650S Crowncorder. Also, need address for a stateside parts source. *John Koneski, Rt. 2, Box 327, Russellville, AR 72801.*

Needed: Service manual or schematic for a model TR-201 Martel (small reel) tape recorder. Will buy, or copy and return. *Mike Morales, 1470 Jefferson Avenue, Brooklyn, NY 11227.*

Needed: Used test equipment of these models (or equivalents): Heathkit IM-58 audio distortion analyzer; Heathkit IG-18 audio generator; Heathkit IM-104 FET VOM; B&K-Precision 501A or Heathkit IT-3121 transistor curve tracer; and Heathkit IG-5230 CRT tester/rejuvenator. Manuals are needed. *M. Rejean Mathieu, c/o Hydro-Quebec Telecommunications, Chantier E.O.L. Baie James, Quebec, Canada JOY 2YO.*

For Sale: Measurement Lab model 78B signal generator, $20; Sylvania model 500 TV sweep generator, new in original carton, $50; Admiral tuners (94D52-1 and 94C18-2) new in sealed cartons, $5 each; Rider's TV manuals volumes 5 through 26, $80, and Riders radio manuals volumes 16 and 17, $8.50 each. *M. Seligsohn, 1455 55th Street, Brooklyn, NY 11219.*

Needed: Used test equipment of these models (or equivalents): Heathkit IG-5240 color-bar generator; Heathkit IM-4180 or Lampkin FM deviation meter; Tektronix type CA dual-trace plug-in; Sprague capacity tester; Heathkit impedance bridge; and Heathkit GD-1150 ultrasonic cleaner. *M. Rejean Mathieu, c/o Hydro-Quebec Telecommunications, Chantier E.O.L., Baie James, Quebec, Canada JOY 2YO.*

For Sale: New tubes, OZ4, $2; 2X2, $2, 1U4, $1; Freed power transformers, 750V at 0.175A plus four filament windings, new, $10; Pilot model AA-905 monaural amplifier with push-pull 6L6 outputs, $30; also assorted resistors and capacitors. Shipping charges extra. Send for list. *M. Seligsohn, 1455 55th Street, Brooklyn, NY 11219.*

For Sale: Many Photofact folders between 1 and 800, and other schematics, $2 each or make offer for all. Write for list. *Bill's TV, 6 Harvest Circle, Madison, WI 53713.* □

Creative Electronics
ESR METER checks electrolytics IN-CIRCUIT and is TV shop FIELD-TESTED:
Used It 3 months; it only missed once—Marinette, Wis. (Typical) It's fantastic—St. Joseph, Mo. The most fantastic instrument I've ever bought—Billings, Mt. Please ship another; very satisfied—Glen Rock, Pa. Squeal & no sync: 3 bad caps in B+ & AGC; Many Thanks—Taos, N.M. Please rush; heard good reports—Hicksville, N.Y. One tremendous meter—Alexandria, Minn. Send your Super meter; heard about it—N. Olmsted, Ohio. Love that ESR Meter—Acton, Mass. Used it intensively for 30 days; it's been 100% effective—Pittsburgh, Pa. I understand that if I'm not completely flabbergasted, you will refund my money—Sanford, Fla. (Refund not requested)
60-day Satisfaction Guarantee.
Send check or M.O. or call (313) 435-8916 for COD
Or write for free brochure to:
Creative Electronics
ESR Brochure ES 11-79
1417 N. Selfridge
Clawson, Mich. 48017
$88.00 postpaid in USA
Circle (4) on Reply Card

APPLIANCE REPAIR BOOKS

Thirteen Handbooks written in easy-to-understand language by experts in the service field with illustrations and diagrams! Acclaimed by instructors and professionals alike! How to diagnose and repair air conditioners, refrigerators, washers, dryers, ranges, microwave ovens, dishwashers, vacuum cleaners, electrostatic air cleaners, RV gas appliances, hair dryers, motors, water heaters, coffeemakers, can openers, floor polishers, steam irons, food mixers, lawn care appliances, electric knives, electric and digital clocks and many others. Also fundamentals of solid state, setting up a shop, using test instruments and more. Only **$2.65 to $4.90 ea.**
SEND FOR FREE PRICE LIST
Gamit, Dept. ES
110 W. St. Charles Road,
Lombard, Illinois 60148
Circle (5) on Reply Card

people in the news


Murl Reeves (right) presents the PTS "Distributor of the Month" award to Richard Speroni.

PTS "Distributor of the Month" is Richard Speroni. Speroni, owner and manager of Lectronic Supply Company, Woodsocket, RI, has operated his business for 15 years from a wheelchair. He has stocked the PTS line of products and services for seven years.

Harold E. Patterson has been named senior vice president and general manager, Sylvania systems group. Patterson was previously vice president and general manager, eastern division, Sylvania systems group. He succeeds **Donald O. Kiser**, who has become senior vice president, human resources, for GTE.

Also at GTE, **Richard R. Fidler** has been elected vice president, engineering, for the Sylvania systems group.

Galileo Electro-Optics has appointed **Paul R. Henkel** director of its Channeltron product line. **Po-Ping Lin** has assumed the post of director of the company's microchannel plate product line.

Robert P. Poirier has been appointed director of industrial and plant engineering. **Phillip W. Skinner** has been appointed sales engineer for Galite, a subsidiary of Galileo.

Peter Schindo has been appointed national sales manager, consumer video, of the Panasonic television division. His responsibilities include marketing all Omnivision VHS consumer videotape recorders, cameras and accessories. Previously, he was video manager for Harvey Sound.

The Varian Electron Device Group has named **Alexia Vanides** advertising manager. She was formerly marketing communications specialist for Hughes Helicopters.

Nolan Hoffman has been promoted to North American sales manager for Weston Instruments. His position will concentrate on the development of business for Weston's line of analog, aerospace and digital products. Hoffman had served as western regional manager.

Shure Brothers has announced the retirement of **Victor F. Machin**, executive vice president of marketing, manufacturing and personnel. A portion of Machin's duties will be assumed by **Raymond E. Ward** in his new position of executive vice president of marketing. Manufacturing and personnel functions will be assumed by **J. H. Kogen** in the new position of executive vice president-operations manager.

John J. Nugent has been named vice president and controller-Electronic Components by General Telephone and Electronics. Nugent is responsible for financial control operations of the Sylvania Electronic Tube Division, the Sylvania Circuit Products Division and the Sylvania Distributor & Special Markets Division.

Charles M. Liddic has been promoted to manager, semi-conductor and special products for the department headquartered in Owensboro, KY. **Roy T. Hutchison** and **Robert M. Sagebiel** have been named to product planner, semi-conductors; and specialist, special products, respectively.

Jeffrey A. Hamilton has been appointed Midwest regional sales manager for PTS Electronics Hamilton will assist in marketing policy, advertising, product promotion and will be responsible for the PTS distributor sales for a 6-state area including Indiana, Illinois, Wisconsin, Iowa, Kentucky and Ohio. □

Reports from the test lab

By Carl Babcoke

In past years, a pulse generator was not needed for servicing electronic equipment. Sine or square waves were adequate for all audio applications. Even research laboratories did not always consider a pulse generator essential. But the requirements of test equipment have changed, and an adjustable pulse generator can be very helpful for checking both digital and analog circuits. Such a generator is the moderately priced VIZ model WR-549A.

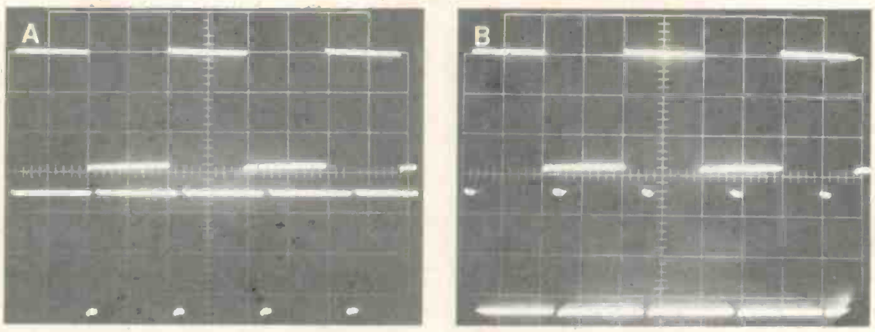


Figure 2 These waveforms show the effects of T1 and T2 adjustments. (A) The top trace shows square waves of about 50Hz rep rate, produced by 10mS of T1, and 10mS of T2. (Scope sweep was 5mS/div, so duration of each cycle was slightly under 20mS or .02S. Rep rate is reciprocal of the time in seconds.) Both the positive pulses and the zero voltage spaces between have the same 20mS time duration. When the T2 switch has changed to 1mS and T1 was not moved, the bottom-trace waveform shows the same duration for the positive pulses. However, the zero spaces between have only 1/10 of the previous duration. Sometimes these are called negative-going pulses, but that really applies only to ac waveforms. These are long-duration pulses. (Rep rate now is about 95Hz.) (B) Again the top trace shows 10mS/10mS square waves. When the T1 duration was decreased to 1mS and T2 was not changed, the bottom trace shows narrow positive pulses of 1mS duration, while the zero spaces have the original 10mS duration. Total duration of one cycle is 11mS which is about 91Hz repetition. These are short duration dc pulses. In all these waveforms, zero dc volts is along the bottom. Without a load at the output, all pulses measured 12VPP.

Pulse-generator features

Two six-position switches and two variable controls determine the duty cycle and repetition rate of output signals from the VIZ WR-549A. Also on the front panel are an on/off/level control and twin binding posts for the output signal. The instrument is powered from the ac line and draws only 5W.

Square waves between approximately 2.5Hz and 5MHz can be obtained by adjustment of the four controls. Pulses have a more restricted range, for the limits depend on the duty cycle. The repetition range should be more than adequate for any servicing application. However, the repetition rate often is of lesser importance than is the on time or the duty cycle. All can be measured by a scope.

In digital language, the rise and fall times are 20nS ($0.02\mu S$) or faster, and the minimum output level should be 5VPP with a load of 10 transistor-transistor logic gates (10 TTL fanouts).

This good performance and simple operation requires one trade-off: It is essential for the operator to have knowledge of how the WR-549A generates pulses and how to measure them with a triggered scope.

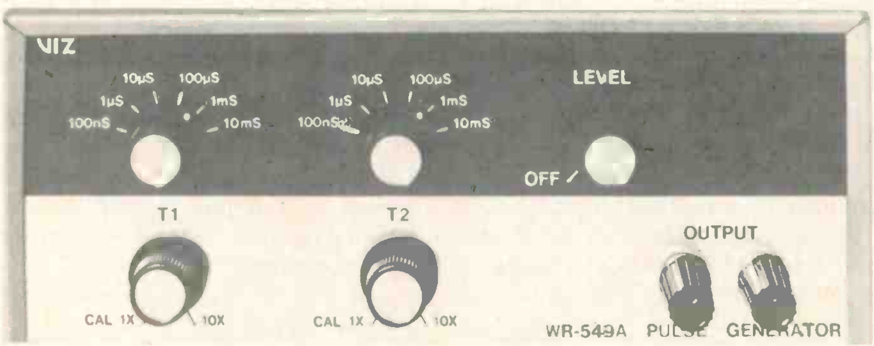


Figure 1 Model WR-549 is a versatile pulse generator from VIZ. Each one-shot pulse source has six possible duration times between 100nS and 10mS, selected by switches T1 and T2 (at top). The calibrations are correct only when both variable controls (below) are turned to the X1 calibrate positions (CCW). Turning the controls clockwise lengthens the duration up to a maximum of almost X10. T1 determines the duration of each positive pulse, while T2 sets the duration of each zero-voltage space between positive pulses.

Two one-shots in sequence

Instead of a single tunable oscillator and variation of the pulse width, the WG-549A has two separate one-shots that operate in sequence. Each can be adjusted for duration. The trailing edge of the first one-shot pulse triggers the second one-shot. Then the pulse's trailing edge from the second triggers the first again, and so on in a continuous series of pulses.

Settings of the six-position T1 switch and the X1/X10 variable control (see Figure 1) determine the time duration of the first one-shot. The switch provides fixed times and the control allows continuous (but uncalibrated) increases of those times. T2 switch and its associated control do the same for the second one-shot.

The first one-shot provides the positive segment of the generator output signal, while the second one-shot produces a time of zero voltage. In other words, the generator has no coupling capacitors; the output either is maximum dc

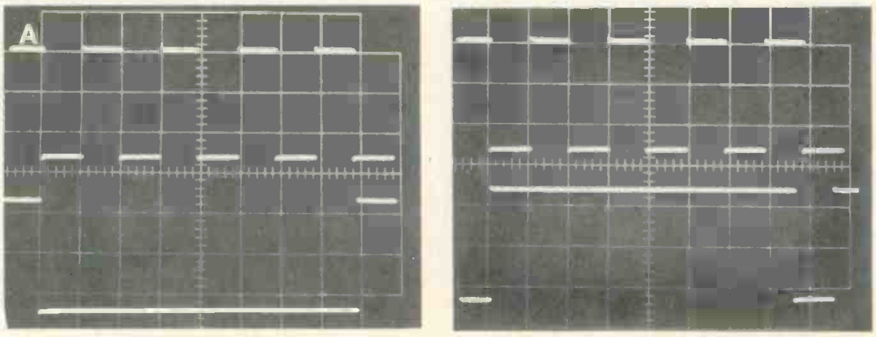


Figure 3 CW rotation of T1 or T2 controls *increases* duration of that pulse. (A) The top trace (20mS/div) showed T1 9.95mS and T2 10mS durations for a rep rate of about 50Hz. For the lower trace, T1 setting remained the same and T2 was turned fully CW. This increased T2 to about 80ms for a new rep rate of about 12Hz. (B) These conditions started the same with 9.95mS and 10mS but T1 control was turned fully CW, thus lengthening the T1 duration by almost eight times the original.

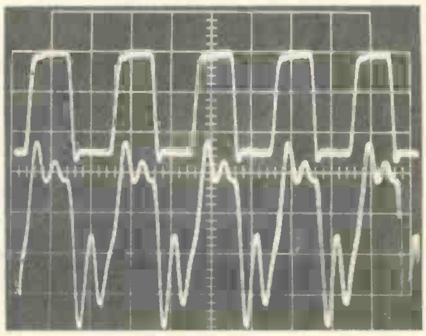


Figure 4 These waveforms show the critical importance of output cables that match the circuit impedances, and of proper grounding for all fast rise-time waveforms. Top trace shows 4.7MHz square waves viewed on a good-quality 35MHz scope, while the bottom trace with the ringing and incorrect increase of amplitude was made without any change of scope settings but with an external ground between scope and generator instead of grounding through the scope probe clip. The generator has no noticeable ringing, but poor interconnecting wiring can add them. In the lower trace, notice the slight FM (sideways movement) effect at the right when the ground was bad.

voltage or zero voltage. (An external coupling capacitor can be connected if needed for a specific application.)

Therefore, the generator signal has true digital positive pulses for high states and zero voltage for digital lows. The timed duration of both highs and lows are independently adjustable.

Waveforms show operation

Figure 2 shows how long-duty-cycle (negative-going) pulses and short-duty-cycle (positive-going) pulses are created by reversing the settings of T1 and T2 switches.

Remember that the variable time controls must be turned to the X1 (CCW) position if the precise (within ±5%) time selected by T1 or T2 is needed. Other positions of these controls are uncalibrated.

During tests of the sample generator, the marked times of T1 and T2 were increased by a factor of about nine when the controls were rotated to maximum (clockwise), as shown in Figure 3. Any duty cycle between the two traces of each picture can be obtained by intermediate settings of the appropriate variable control.

Average dc output voltage

Output of the WR-549A generator is direct from an emitter follower without a coupling capacitor. Therefore, the measured dc voltage at the output varies with the level-control setting and the waveform's duty cycle. With the level control at maximum, square waves produced +6.36 and 13VPP, 1:10 ratio pulses gave +1.24V, 1:100 ratio gave +0.168V, while 10:1 ratio produced +11.74V, and 100:1 ratio gave +12.86V. These readings were recorded while a digital meter was the only output load. Lower-resistance loads decreased the waveform amplitude and the dc-voltage reading. No changes of waveshape were noted when the load was varied.

Undesired waveform changes

Square waves and pulses with fast rise times are susceptible to ringing and other distortions from improper termination impedances or tortuous ground returns. Figure 4 top trace shows the normal square waveform at 4.7MHz (highest rep rate for this sample instrument) when the scope probe was connected properly with the *probe* ground used at the generator. In contrast, the lower trace shows the increased amplitude and excessive ringing that resulted from using a *separate* ground between scope and generator. Of course, ringing is resonance that requires capacitance and inductance. Both are supplied by ground and probe wires during mismatched operation.

The generator is free of these resonances, but care must be used when it is used to drive other equipment. Digital-logic circuits (including frequency counters) give false results when fed by distorted waveforms such as the lower trace of Figure 4.

Applications

The following are some applications of the VIZ WR-549A pulse generator:

- a substitute for a digital clock;
- signal source for testing CMOS, RTL or TTL logic circuits;
- source of signal for pulse modulation of LEDs or lasers;
- test signal for pulsed servo systems and transponders or switching regulators;
- adds pulses to dc power supplies to test the transient response;
- shock excitation of mechanical devices to determine resonant point;
- signal source for testing ultrasonic transducers;
- can be a signal source for generating sawteeth and other waveforms.

This model WR-549A VIZ pulse generator should be very useful for these and other applications. It performed excellently during the lab tests. □

Circle (7) on Reply Card

Part 1

A close look at digital signals

By Forest Belt

Whether in a factory maintenance shop or at a consumer electronics bench, you must understand these basic characteristics of digital signals before you can troubleshoot effectively.

Not everyone knows that some digital *signals* are simple dc voltages. The following explanations should be helpful as a review, or they could improve your expertise by bringing complete understanding of scoping digital signals.

Signals for TTL and CMOS devices are made up of only two digital *states*. They go by various terms. Sometimes they're called *high* and *low*, *on* and *off*, or *up* and *down*. In books, magazine articles and truth tables, you find the shorthand symbols: 1 and 0.

The terms logic-high and logic-low appear often. Digital circuitry follows the principles of binary logic set forth by George Boole. His two-number math system (called *Boolean algebra*) belongs mainly to the theoretical or design side of digital electronics. You can service digital equipment expertly without mastering binary arithmetic, so don't let the mathematics turn you off.

TTL and CMOS

By way of background, you should know that most digital electronics use two different kinds of devices. One category involves silicon diodes, bipolar transistors and regular resistors. These are in a family labeled TTL, for *transistor-transistor-logic*.

The other group incorporates *metal-oxide semiconductor* (MOS) materials. These are often placed in a *complementary* configuration, giving the term CMOS for this family of digital-electronic devices.

Signals handled by the two families of logic devices are similar, but their logic levels or voltages differ considerably. For TTL logic, a *high* condition exists when signal voltage exceeds 3V or so, with 4V considered optimum for dependable operation of TTL gates and latches. CMOS logic devices need 13V or so for a distinct *high* condition. Logic-low in both families is below 1V.

Between the low and high logic levels is a limbo area producing indeterminate operation. A gate cannot be depended on to funciton predictably when voltages do not rise to the full level for logic highs or drop close to zero for logic lows. In practical circuitry, logic-high levels may vary as much as a volt or two from the 4V and 13V amplitudes.

Steady-state digital signals

Some technicians find it vaguely difficult to think of steady dc voltages as *signals*. Yet in digital usage, dc frequently constitutes a signal.

This phenomenon has several viewpoints. On the one hand, you might think of a logic-circuit device as being signaled to turn on or off by input of a particular logic level—either high or low.

Consider just one example. Switching logic often uses an OR gate. A logic-high dc voltage applied to either input turns on an OR gate, forcing its output logic-high. The dc input voltage acts as a *signal*. It signals the gate to turn on, and to place logic-high at its output terminal.

Truth tables, such as those in Figure 1, tabulate the output responses of digital-logic devices to various steady-state dc input signals. The first table shows OR-gate functions. Either or both inputs with logic-high states will signal the OR gate to output a logic-high. Two logic-lows call for a logic-low output.

A NOR gate acts as an OR gate that has its output inverted. A logic-high at either or both inputs turns on a NOR gate. However, an *operating* NOR gate has a *logic-low* output because of inversion. (Only a logic-low at both inputs gives a logic-high output). A low output is equivalent to a ground signal for

Super Guide for Semiconductors

Nearly 180,000 listings! 1,120 pages! Coverage includes bipolar transistors, field effect transistors, diodes, rectifers, and integrated circuits.

Use whatever information is available to select the replacement you need. U.S., European, and Far Eastern type numbers and manufacturers part numbers—any number you find stamped on the part or listed in a parts list—all are included. Cross reference is made to General Electric, Mallory, Motorola, Raytheon, RCA, Sprague, Sylvania, Thordarson, Workman, and Zenith replacement parts.

Save time and trouble. Get accurate information. Order your copy of Sams Semiconductor General-Purpose Replacement Guide today!

Howard W. Sams & Co., Inc.
4300 West 62nd Street
Indianapolis, IN 46268
(317) 298-5564

Clip Out-Mail Today

YES-Please send me Sams Semiconductor General-Purpose Replacement Guide. If I'm not completely satisfied, I may return it within 15 days of receipt for full credit or refund. Add sales tax where applicable.

☐ Sams Semiconductor General-Purpose Replacement Guide. No. 21576
Price: $14.95

Name ____________

Address ____________

City ____________

State ________ Zip ______ Total $ ______

☐ Check ☐ Money Order ☐ Master Charge

☐ Visa/BankAmericard

Exp. Date ____________

Account No. ____________

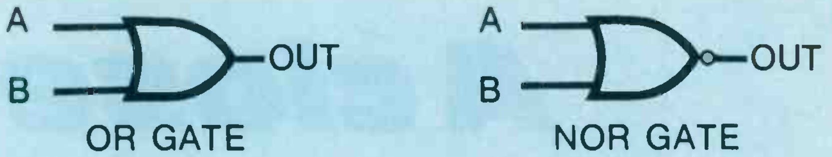
Interbank No. ________ (Master Charge Only)

Mail to:

Howard W. Sams & Co., Inc.
4300 West 62nd Street
Indianapolis, IN 46268

TC53C

Digital signals



OR GATE

A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

NOR GATE

A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

Figure 1 Truth tables show, in tabular form, the functions of logic symbols and devices, and are clues to what you can expect from digital signals of the steady-state variety.

any stage or device that is connected to it.

Perhaps you are familiar already with the actions and truth tables of all digital-logic gates. The vital point is that the steady dc *states* described here are actually digital signals. With some practice, you should find it easy to think this way about steady-state dc input and output voltages: *they are real signals.* Although a certain reorientation of thinking is required, it is crucial to understanding the next step.

Effects of timing

One element has been omitted from the foregoing discussion. Voltage and amplitude (logic level) are mentioned, but not the element of time. And *time* is a vital factor that must be considered in connection with any signal. As it turns out, timing is actually more important to digital-electronic signals than is voltage amplitude.

A steady-state signal almost seems to have no time element. By its very name, this kind of dc signal either appears to be there or not. A given circuit point or terminal is either *on* (logic-high) or it is *off* (logic-low). The circuit either has voltage present, or it is grounded.

But remember that the point or terminal has to be forced to one signal condition or the other. And, since there are only two conditions, the circuit always goes from logic-low to logic-high or from logic-high to logic-low.

The matter of *timing* enters the picture when you become concerned with *how long* a circuit point or terminal remains in one logic condition or the other.

What has been described as steady-state logic levels are really digital signals with *long* time durations. Suppose the OR gate in Figure 1 were to have a logic-high applied to input A. Output immediately goes logic-high, and stays there until the input high is removed. This could be anytime from a fraction of a second later, to an hour or years.

Now consider the effects of input timing. Suppose the high at input A lasts for 10 minutes. Output will stay logic-high at least that long.

Nine minutes after input A goes high, imagine that input B also receives a logic-high signal. Nothing changes right then, since the gate output already is logic-high.

But what happens if the B-input signal has a duration of six minutes? The OR-gate output stays high for a total of 15 minutes. That's nine minutes from A input alone, one minute while both inputs are high, and another five minutes until input B goes back to logic-low.

When digital signals are applied to actual logic devices, their effects (even those from steady-state signals of long durations) might overlap. Indeed, they are intended to overlap. Timing is vitally important in digital electronics.

Steady-state signals are dc voltages (or grounds) applied for certain purposes. Then, when different conditions are desired, the steady-state signals are altered to arrange the new circuit conditions. The signals may be shifted manuaally by some operator, other circuits or timing devices. But the combinations and timing of dc logic signals often are crucial to operation of any number of stages, circuits, and sections in an electronic system, whether simple or complex.

Cycles and timing

To display digital signals properly on a triggered scope, a technician needs a genuine understanding of signal timing. Again, this discussion may seem basic. But continue with the review, anyway. It will help orient thinking for the best analysis of waveforms in digital-electronic circuits. In fact, you'll gain a lot of familiarity if you duplicate these displays and exercises on your own scope.

Start with a signal that is not digital, but is very common: a sine wave. It can come from any audio generator.

Figure 2A shows how the sine wave should appear on your scope. The signal voltage rises gradually and steadily from zero (at the centerline) to a positive peak, whatever that value may be. Then the voltage trace rolls over the peak and falls smoothly back to zero. Continuing on, the sine-wave voltage builds to a peak in the negative direction, and then rises just as smoothly again to zero. This constitutes one cycle.

But that's only part of the description. A time element is involved too. To view the sine-wave signal on a scope, a certain time base must be selected. Suppose the sine-wave frequency is the common 60Hz. Set a time base of 2ms/div on the scope, and measure time along the X-axis of the scope graticule.

The rise of voltage from zero to a positive peak occupies a bit more than two X-axis divisions, or 4ms. The gradual fall from peak back to zero voltage takes another 4ms. The negative peak is reached more than 4 ms later, and the cycle ends at zero some 16-plus milliseconds after it started. Actual measurable *duration* of one entire sine-wave cycle is 16.667ms.

Another example brings you closer to the principle of digital-electronic signals. Feed a 1000Hz square-wave signal into a triggered scope. Set the scope sweep for a time base of 0.2 ms/div. To make analysis easy, make *trigger polarity* or *slope* positive (+) and set *trigger level* anywhere on the first upslope of the signal waveform. The display should resemble Figure 2B.

Here's how to approach analysis of this waveform. First, ascertain its amplitude. What setting has been used for the scope's input attenuator? (Be sure the input *variable* knob is at the calibrated end of its rotation.) Count the vertical (Y-axis) divisions occupied by the signal. In Figure 2B, the waveform is roughly five divisions high, and the input knob was set at 0.1 volt/div Multiply five divisions by 0.1V for each one, and you get 0.5V peak-to-peak amplitude. As it happens, a 10:1 probe was in use. So the actual amplitude of signal at the probe tip is 5V peak-to-peak.

Next, measure signal timing. One cycle of this square wave begins as the trace is swept upward from zero-base at the graticule centerline. The trace rises 2½ divisions, remains there for 2½ horizontal (X-axis) divisions, falls back to zero-center, and then continues another 2½ vertical (Y-axis) divisions to its negative-direction maximum. There the trace amplitude holds while the sweep covers another 2½ divisions along the time base. Then, rising back to zero-center, the trace ends one cycle.

Considered in this fashion, one cycle of this 1000Hz square wave appears to take up five divisions along the X-axis of the graticule. With each division representing a time base of 0.2ms, this means each whole cycle takes 1ms to occur.

Digital signal timing

Actually, the description just given is an *outmoded* way of "seeing" signals of this kind. They are more easily understood in digital terms. Take a look at the waveform in Figure 3. It appears very similar to the square wave of Figure 2B.

In one sense, they are much the same. Amplitude is close, and in timing they look exactly alike. But the signal in Figure 3 does not come from an audio or square-wave generator. It is created by a pulse generator. It is, in reality, a digital signal. It should be analyzed in a digital way.

Digital signals, remember, have only two states: *on* or high, and *off* or low. In Figure 3, those are the only two conditions visible. Zero, instead of being at the graticule centerline, is based two divisions lower. That's where the trace rests when no digital voltage deflects it upward, when the digital signal from the generator is off or at logic-low.

When the digital-pulse signal turns on, the scope beam moves suddenly upward. As the generator holds the signal high for a certain period, the scope sweep moves the

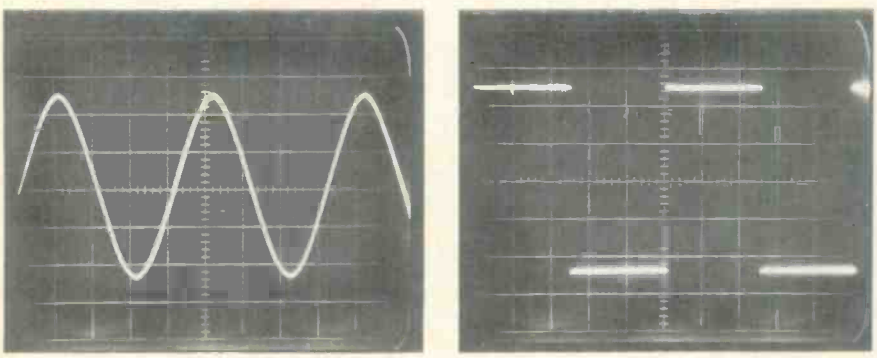


Figure 2 Sine and square waves are the more ordinary signals most technicians have studied on their scopes. Principles of timing and cycle duration have some bearing on digital signals, too, but must be considered in a different manner.

trace sideways. After a finite period of time, the generator turns off. The sweep beam moves almost instantly back downward to the *zero* base line, two divisions below center. With those mechanics in mind, you can analyze the digital waveform in Figure 3.

First, *amplitude*. The scope's input attenuator still is at 0.2volt/div. The signal covers two divisions on the Y-axis. With the 10:1 probe in place, therefore, signal amplitude is 4V.

Notice the term peak-to-peak was omitted this time. That's because digital signals are either off (zero volts) or on (peak voltage). The digital signal displayed in Figure 3 is for TTL or related families of logic circuits. Its logic-low condition is at or near zero volts, which serves as the base line for the scope trace. The logic-high condition occurs at 4V, the *on* amplitude. Hence, this digital signal is said to have an amplitude of 4V.

Now analyze the *timing* of the digital signal in Figure 3. For digital signals, you are interested in two conditions: *on* and *off*. The signal is *on* when amplitude is 4V, *off* when amplitude drops to zero or near zero.

To study a digital signal, you set a time base on the scope that allows a measurement of both *on* and *off* times of the signal. In Figure 3, a time base of 20μs/div makes the display seen.

The logic-high time duration, sometimes called *pulse width*, covers 2½ divisions on the X-axis. At 20μs/div, that figures out to 50 μs of logic-high.

Then the generator turns the signal off, and the trace drops to zero, along the base reference line. The scope trace keeps moving sideways, swept by the scope time-base generator. So the lower trace represents *off* or zero-amplitude time. Duration of this logic-low time also covers 2½ divisions. So off-time, too, is 50μs.

So, Figure 4 is a 4V digital signal with on-time of 50μs and off-time of 50μs. The digital signal stays *on* just half of the time, and is said therefore to have a *duty cycle* of 0.5 or 50%.

On duty or off?

This matter of logic-high time versus logic-low time in a digital signal proves critical in many electronic systems. It needs deeper examination.

To cause the scope display pictured in Figure 4A, a digital signal has risen to logic-high; keeps the beam deflected at logic-high for the length of time it takes the sweep to cross two graticule divisions; then falls to logic-low; and stays logic-low for a duration of one division. Then the two-division logic-high pulse recurs, followed by another one-division period of logic-low; and so on. Each complete *cycle* or logic-high/logic-low covers three graticule divisions. This pulse series is considered *repetitive*, as it keeps repeating its pattern.

The relationship between logic-high time and logic-low time grows quite significant in certain applications. Your interest should be directed to how much to total time the signal stays logic-high. The timing in one complete high/low cycle can disclose this information.

In Figure 4A, the digital waveform is *up* for two divisions out of every three. That means logic is high two-thirds of the total time. Its *duty cycle*, therefore, could be expressed as the fraction ⅔.

Duty cycle also can express logic-high time as a percentage of total time in one high/low cycle. For Figure 4A, divide the two divisions of high by the three total high/low divisions, and multiply the result by 100. The answer is 66.67% usually rounded to 67%.

Figure 4B portrays a digital signal with a different duty cycle. Logic-high time covers two divisions; logic-low time takes up three.

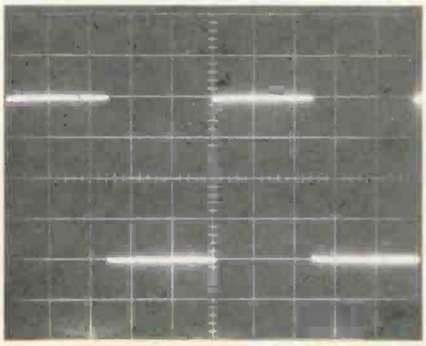


Figure 3 Looks like a square wave, but it's not. This signal is digital, with a duty cycle that leaves it on half the time and off the other half.

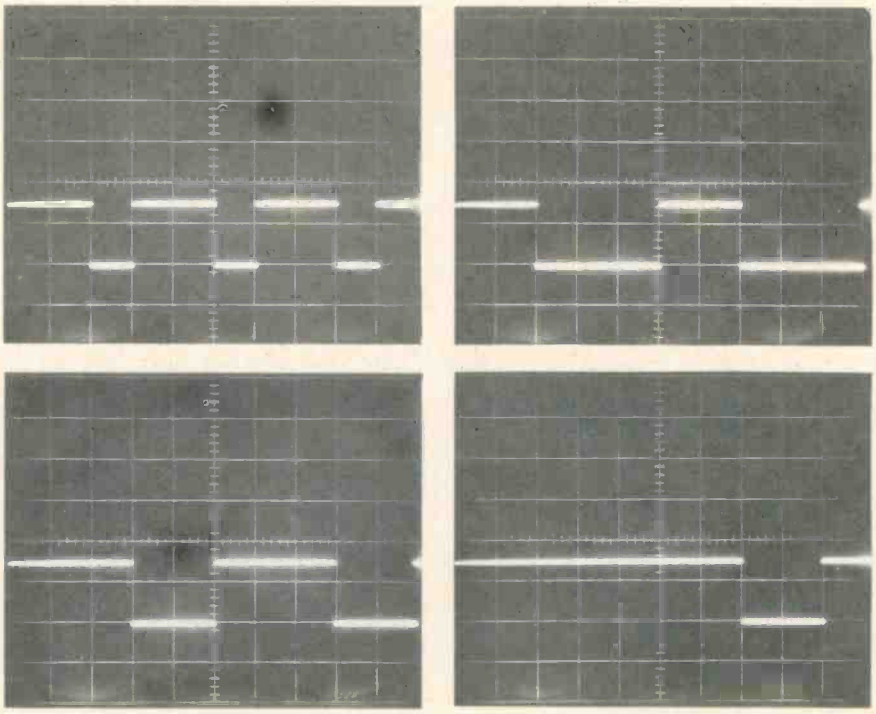


Figure 4 Examples of various duty cycles; you can recognize these rather easily just by inspection. Text explains calculations involved in more critical duty-cycle measurements.

Total time for one high/low cycle is five divisions. Hence, the digital signal is logic-high for two out of five time units, whatever they might be. The scope's time base must be known to evaluate how much time each division represents. This is not necessary for computing duty cycle.) Duty cycle in Figure 4B amounts to two divided by five, giving a decimal of 0.4 and a duty cycle of 40%.

The digital signal in Figure 4C is logic-high for more time than it is logic-low. Logic-high uses up three of five time-units (graticule divisions). Divide three by five, and you establish that the cycle is 0.6 or 60%.

You should be able to calculate duty cycle in Figure 4D without assistance. Logic-high time is seven divisions; logic-low exists for a mere two divisions. What is the duty cycle?

Your reasoning and calculations should run something like this: Total time for one high/low cycle in this digital signal is nine divisions of the graticule. Of those nine time-segments, the logic-high condition prevails for seven. Hence, seven divided by nine equals 0.7778, which rounds off to a duty cycle of 0.78 or 78%.

DC reference for digital

Now, think back to the steady-state digital signals mentioned in the first paragraphs of this article. Remember, they are merely DC voltages applied (for *on* or logic-high) or not applied (*off* or logic-low). Or, you can think of them as dc voltages (logic-high) or circuit grounds (logic-low). You can detect these steady-state digital signals three ways.

Simplest, if you have the instrument handy, is with a *logic probe.* A light-emitting diode (LED) in the probe lights when logic is high at a point being tested, and stays dark when the point is at logic-low.

Some technicians prefer using a voltmeter. If the logic incorporates TTL-family devices (or DTL, RTL, or other TL configurations), the 10V scale of a voltmeter shows quickly whether a circuit point or terminal is logic-high (3V to 5V) or logic-low (near zero). For CMOS-type logic, use the 20V or 30V scale to detect logic-high (around 14V) or logic-low (near zero).

For the sake of utility, technicians should master the third method, using a scope. While that might seem a bit elaborate, it really is not. Even with steady-state logic systems, troubles occur that cannot be revealed by logic probe or voltmeter.

Few technicians use their scopes for dc measurements. In situations where voltages may reach 100V or 200V dc, that's understandable; signal levels, by comparison, would be lost. But in digital-electronic systems, you can save considerable troubleshooting time if you accustom yourself to measuring dc voltages with your scope. Coincidentally, you can do a better job of signal analysis, even with steady-state digital signals.

These methods are relatively simple. A few exercises will familiarize you with techniques used by experienced digital technicians.

Turn on your scope, and set it for *automatic triggering*. This delivers a trace, even without an input signal. If the scope is dual-trace, set it first to use one input channel only.

Set the scope's input mode for dc coupling. Continue to use the 10:1 probe. This is always a good idea during troubleshooting, unless the greater sensitivity of a direct probe is needed.

Clip the probe ground lead to its tip. This assures a definite zero volts or logic-low. Adjust the trace line on the scope screen to sweep along the centerline (Figure 5A). This will constitute a *zero-voltage reference* or logic-low base line.

A flashlight battery offers a handy source of dc voltage for this introductory exercises. Hold the ground lead of the probe against the negative end of the battery, and touch the probe tip to the positive post. The whole trace moves upward.

Setting of the scope's input attenuator determines how far the trace deflects upward. Turn that switch to 0.05V/div (50mV/div on some scopes. For a direct probe, the 0.5V/div position is the same.)

Figure 5B shows the result of measuring a fresh D-cell. Voltage applied to the probe has raised the trace three divisions plus one subdivision. Each Y-axis division represents 0.5V, and each subdivision equals 0.1V. Consequently, dc voltage measured by the scope in Figure 5B is 1.6V.

Think of this in digital terms. A 1.6V steady-state high has been sensed by the dc input of the scope. This deflects the trace—the whole trace—an amount proportional to its amplitude and to the sensitivity

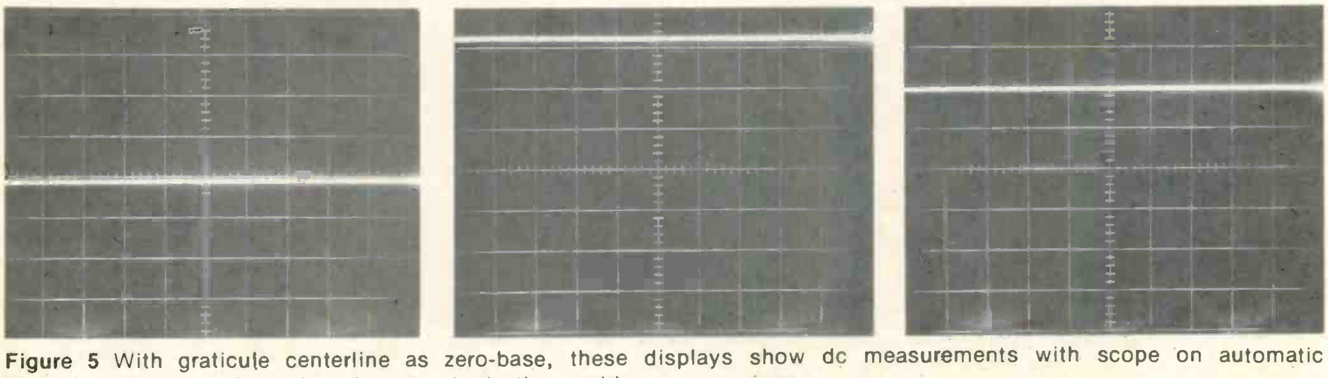


Figure 5 With graticule centerline as zero-base, these displays show dc measurements with scope on automatic triggering. Text exercises show how to obtain these with your own scope.

setting (input attenuator) of the scope.

Why the whole trace? Because time duration of the applied logic-high *exceeds* the time base of the scope's sweep. The scope beam keeps tracing the same 1.6V path again and again. The dc high holds the trace at that level until you decide to take the voltage away by removing the probe tip from the D-cell post. Then the voltage drops back to the zero-reference base line established earlier. And it stays there as long as the probe senses a ground (no voltage).

Connect the scope next to a 9V transistor-radio battery, probe to positive and ground clip to negative. The trace deflects far off-screen. This means input sensitivity must be reduced. Flip the volts/div switch to higher and higher values until one is reached that provides on-screen deflection of the trace. Figure 5C reveals a deflection of two full divisions. The input attenuator has been set at 0.5 volt/div, which represents 5 volts/div with a 10:1 probe in use. The battery used for Figure 5C must have been a fresh one; the dc value was almost 10V.

Possibly the most important fact to realize from these exercises is that *the trace returns to the same zero-reference position every time the voltage is removed or the probe tip is grounded.* Using the dc input mode of the scope, zero or logic-low always remains at the same reference line on the screen—which is established with the vertical-position knob. This holds true even when digital circuitry is switching high and low at very rapid rates, and for all sorts of pulse durations.

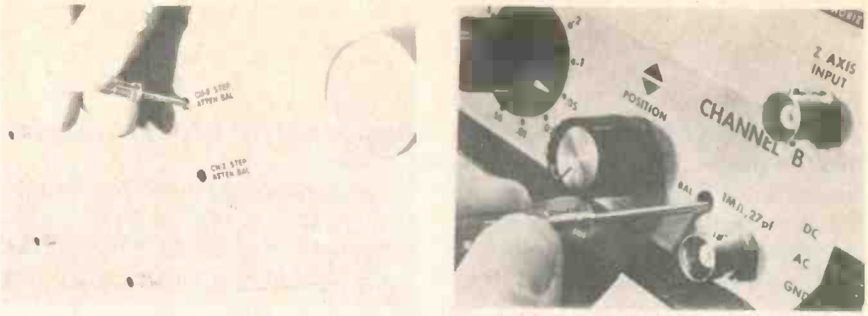


Figure 7 Dc balance adjustments may be on front or on side of your scope. Short probe tip to ground, and adjust balance until trace stays at zero position at all input settings.

In Figure 6A, a TTL pulse signal has its zero-base along the second line below center on the graticule. Signal highs happen to be at 4.5V. They therefore fall between the second and third lines above center on the graticule.

Question: What setting has been chosen for the volts/div switch to make the display in Figure 6A?

If you answered 0.1V/div, you're catching on—and you remembered to consider the 10:1 probe.

Using the same reasoning, figure out the proper input setting for the CMOS digital signal in Figure 6B, and state the exact level (amplitude) of its logic-high condition. You are right if you found logic-high to be 14V, and the attenuator set at 0.5V/div.

One final *caution* about scopes and the dc input mode. In some scope models, dc balance drifts quite a bit during warmup. Imbalance can alter the zero base as you switch attenuator ranges.

To combat balance errors, and for other good reasons, keep your scope on and warmed up all the time. If balance drift poses a problem after a 1-hour warmup, you might have to recalibrate dc balance in your scope every day or two—in both channels.

Short the probe tip to its ground lead. Find the dc-balance control for the active channel (see Figures 7A and 7B). While switching between 0.5, 0.2, and 0.1 on the volts/div dial, adjust dc balance (sometimes called attenuator balance) until the trace remains at the same place on the screen for all settings of the attenuator knob. Check other positions too, and refine the dc balance adjustment as necessary. Repeat with the other channel.

Time base and triggering

In the Electronics Upgrading Seminars we conduct for LIAISON, one day is devoted to hands-on familiarization with triggered scopes. In those sessions, the following question comes up regularly: What scope time base should be selected to make dc measurements?

The answer will appear in the next article of this two-part series. It will also include a step-by-step procedure for analyzing *any* digital signal very quickly. □

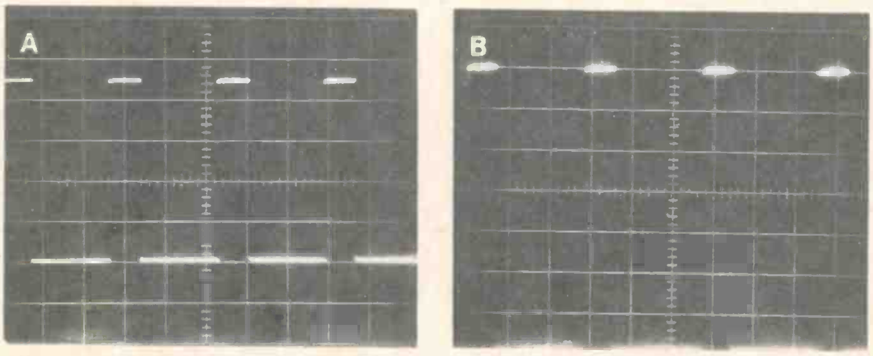


Figure 6 These are digital signals with pulses shorter in time than logic-low times. (A) TTL signal with value of 4.5V. (B) CMOS uses higher voltage, 14V in signal shown here.

Note: This two-article series has been adapted from a forthcoming Forest Belt's Service Training Monograph titled: "Triggered Oscilloscopes—Waveforms and How to Analyze Them."

Filled with waveform photographs and explanations, this new Monograph will function as both training guide and reference manual for analog and digital signals your triggered scope should find in a wide variety of modern electronic equipment. You will see waveforms—good and bad—from television, industrial controls, communications gear, microprocessors, and the like.

Release of this third Monograph in the Forest Belt "Triggered Oscilloscopes" series is scheduled for later this year. If you want to be advised when this new publication is ready for shipment, mail your name and address and the notation "68A-El/280" to: Service Training Group, P.O. Box 47, West Newton, IN 46183 (no obligation). STG will send you an order form when the "Waveforms" Monograph has been printed.

GRAB THIS OPPORTUNITY

Attend

Key Electronics Upgrading Seminars

DAY 1 - TRIGGERED SCOPES
Hands-On Workshop

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

DAY 2 - SOLID-STATE UPGRADING
and Updating

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

DAY 3 - DIGITAL ELECTRONICS
for Home or Industry

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

BE THERE, ENROLL NOW!

LEARN FROM EXPERTS WHO SPEAK YOUR LANGUAGE

☆ ***Forest Belt***
TRIGGERED SCOPES
Hands-On Workshop
VTR Servomechanisms - OPTIONAL

☆ ***Wayne Lemons***
SOLID-STATE UPGRADING
and Updating

☆ ***Bob Manery***
DIGITAL ELECTRONICS
for Home or Industry

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

BE THE BEST SERVICE TECH IN TOWN

Two Locations For Upgrading Quickly and Effectively

Pittsburgh
March 12 – 14
VTR SERVOMECHANISMS
March 15
Pbgh. Enrollment Deadline February 8

Los Angeles
April 13 – 15
VTR SERVOMECHANISMS
April 16
L.A. Enrollment Deadline March 7

Package Fees Include:

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

Seminar-Only Fees Include:

- Timely training
- Best teachers
- Carry-home manual
- Hands-on experience
- Certificate of training

master charge
THE INTERBANK CARD

☐ *Pittsburgh*
☐ *Los Angeles*

☐ *Put me on LIAISON'S mailing list.*

FEES: ☐ 3-day Package $950 ☐ 4-day Package $1100 ☐ 3-day Seminar Only $735 ☐ VTR Workshop Only $200

Total Enclosed $_____ ☐ Check #__________ ☐ MO ☐ $200 Deposit, Balance Due Feb. 20, 1980

☐ Charge my Master Charge #______________ Expires__________ Signature______________

NAME______________________ AGE________ PHONE (   )______________

ADDRESS______________________ COMPANY______________ TITLE______________

CITY______________________ STATE______________ ZIP______________

Liaison *Electronics Seminars* (317) 253-7774

P. O. Box 40821 Indianapolis IN 46240

Typical repairs of *older* Zenith TVs

These case studies cover typical repairs of Zenith E, F, G, and H older solid-state chassis.

By Robert L. Goodman, CET

Technicians often think of these early all-solid-state Zenith color TVs in terms of the first letter in the chassis number. For example, chassis 19EC45 is a 19-inch table model in the series that's usually called the E chassis. Similar models of the next year are referred to as the F series, with the G and H series following in succeeding years.

Most circuit details of a 19FC45 are identical to those of a 25FC45, although one is for 19-inch tubes and the second is in 25-inch models. Also, several different models use the same module numbers.

Therefore, *a tip for one chassis number might apply equally to several others.*

19EC45 intermittents

Usually when power was applied, the TV operated correctly. But at other times, switching on the ac power gave sound without high voltage or picture. After several hours of operation, the picture and high voltage occasionally would disappear. No damage appeared to occur during these blackouts, and the performance was normal when a picture could be seen.

The most likely cause of these symptoms is an intermittent open (or a large increase of resistance) in R222, which supplies collector voltage to driver transistor Q803 (see Figure 1).

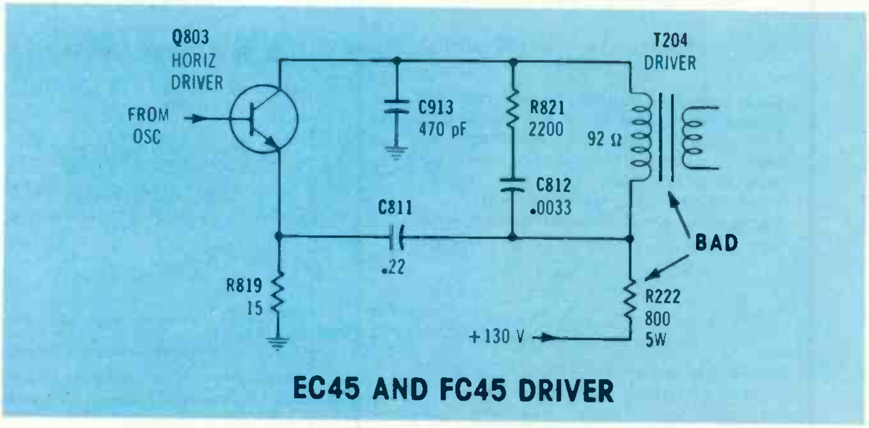


Figure 1 T204 driver transformer and B+ resistor R222 are two horizontal components that occasionally fail in the 19EC45 and 19FC45 Zenith chassis.

Christmas tree

Some 19EC45 Zeniths have exhibited a Christmas-tree effect, as shown in Figure 2, when switched on. Others have shown center foldover. During both symptoms, the driver and output transistors became abnormally warm.

Driver transformer T204 (Figure 1) was defective in those cases. The defect probably was shorted turns.

Vertical line

Another 19EC45 showed a verti-

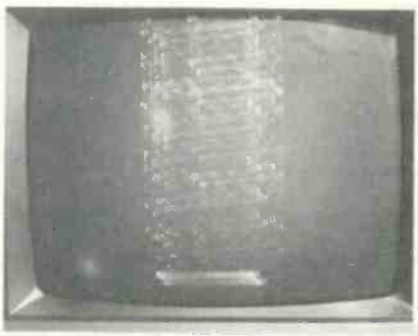


Figure 2 An unstable Christmas-tree effect was caused by a defective T204 horizontal-driver transformer.

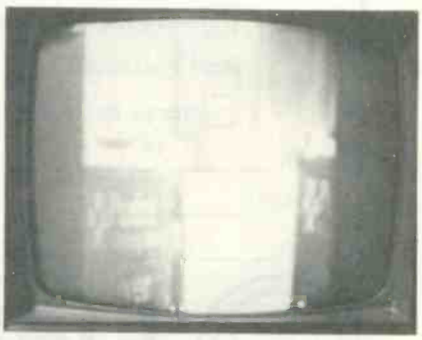


Figure 3 A bad solder joint at the base return of the horizontal-output transistor narrowed the picture as shown.

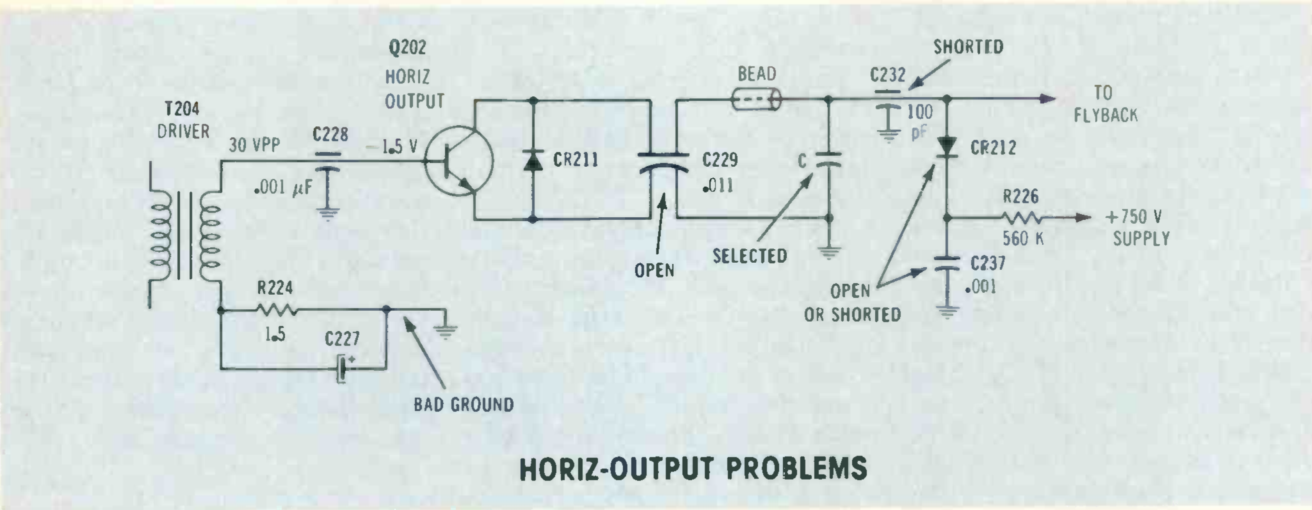


Figure 4 Several components with high rates of failure are pointed out by arrows. The values are for a 25FC45 chassis.

cal line at the left of center. Intensity of the line could be varied with the fine tuning, and it was stronger on several UHF channels. Otherwise, the picture was normal.

This probably was a type of snivet, which sometimes is produced by a tiny RF arc or other ionization. Ionization makes ozone, and sometimes it can be smelled. No defects could be found. Finally, the T204 driver transformer was replaced and the line disappeared.

Intermittently narrow picture

As shown in Figure 3, the 19EC45 picture erratically narrowed on both sides. Neither heat nor line voltage seemed to be a factor. Jarring of the chassis sometimes would trigger the problem or restore the width after the defect narrowed it.

Delicate probing with a plastic rod indicated the sensitive area was around or underneath the heat sink of the horizontal-output transistor. The defect was located visually as a cracked solder connection where R224 and C227 are grounded (schematic of Figure 4). Incidentally, many similar bad joints have been found in the 25DC56 chassis.

Dead short

If the circuit breaker continues to trip each time it is reset and an ohmmeter test shows a near short on the +130V supply, check for shorts or extreme leakage in feedthrough capacitor C232 (Figure 4). This feedthrough is located underneath the heat sink, and when the power is applied it might smoke, glow in the dark, or have normal appearance (although shorted internally).

Narrow at left

At unpredictable times, the picture narrowed at the left edge, giving the appearance of a horizontal-linearity problem. Temperature of the horizontal-output transistor increased. Unless the power was turned off quickly, the output transistor would be destroyed by the overload.

Scope checks revealed a distorted waveform at the base of Q202 output transistor. The dc voltage also was wrong. Usually, the base measures about -1.5V, but this one tested -2.5V.

Further waveform tests upstream showed correct waveform at the driver base, thus narrowing the suspected area. Resistance of the T204 primary winding was about 150 Ω and normal resistance is 92 Ω.

Replacement of drive transformer T204 corrected all wrong symptoms.

Output transistor drive

Several points need to be made about conditions at the base of Q202, the horizontal-output transistor. No external dc voltage is fed to the base as forward bias (Figure 4). Instead, the drive signal furnishes forward bias only during times when the signal positive peak exceeds about +0.5V. (R224 and C227 add a bit of reverse bias that varies with signal amplitude. So, small variations of drive amplitude do not affect the operation.)

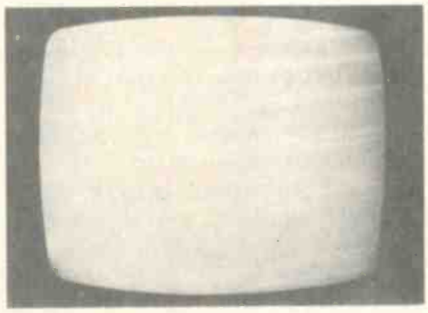


Figure 5 Low contrast and retrace lines resulted from an open boost diode.

Therefore, if *all* base-drive signal is eliminated, Q202 has no forward bias and no collector current. It is not damaged because it does nothing. The transistor can be ruined quickly, however, by wrong base amplitude, incorrect drive frequency, or a distorted waveform at the base. (Of course, the transistor can be damaged also by excessive load in the collector circuit.)

A very helpful test is to measure the amplitude, waveshape and frequency of the Q202 drive signal. Remember, *if the transistor is removed or the base-emitter junction is open, the waveform will resemble sawteeth with spaces between them.*

Low contrast and retrace lines

Reduced brightness along with

retrace lines in a picture of low contrast were noticed in this Zenith (Figure 5).

When the service switch was pushed to the setup position, no horizontal line could be seen, even after all three screen controls were rotated fully clockwise. A snap diagnosis might conclude that the problem was in the video because of the low contrast. However, two other basic sections also affect the setup line. Demodulated chroma signals (at the bases of red, blue and green outputs) supply non-adjustable voltages to the video-output transistors. And picture-tube brightness is greatly affected by the screen voltages.

Dc-voltage measurements showed reduced cathode and screen levels at the picture tube. Also, adjustment of a screen control produced little change of voltage at the corresponding screen grid. Both ends of the screen controls had about +200V when tested.

These symptoms proved that something in the +750V supply was defective. But more than one component could be at fault. Usually diode CR212 is shorted or open, C237 might be leaky or shorted, and R226 could be open or have excessive resistance.

If C237 opens, the ripple amplitude across R226 multiplies, causing R226 to overheat and fail.

This +750V is fed to one end of each screen control, and any reduction of voltage also decreases the brightness and changes the cutoff characteristics of the picture tube.

Space Command remote control

The partial schematic of Figure 6 illustrates several trouble areas in 3-button and 4-button remote systems of the Zenith E and F series. No modules were used in those systems, so technicians must make all repairs rather than replacing modules. These were the first Zenith remotes that employed triacs as on-off switches for the TV ac power. In turn, the triacs were triggered by a photo-optical isolator that was controlled by the remote circuit. This A201 isolator requires less power than a relay and, in conjunction with the triac, provides dependable switching plus isolation of the hot ac power from the cold chassis.

Erratic turning on or off of the TV power without any command from the remote hand-held transmitter can be caused by these problems:

- Leakage can develop in the off/on pushbutton switch that's located on the TV front panel. With +24V at one switch contact, only slight leakage across the switch is enough to forward bias Q203 and trigger the astable multivibrator which controls the switching (Figure 6). If the intermittent action stops when both switch leads are disconnected, the switch is bad and should be replaced with a Zenith number 85-1397-01.
- Intermittent Q206 or Q207 bistable flip flop transistors can cause unwanted turn on or turn off. Check transistors, capacitors C231 and C214 and all resistor values.
- Erratic conditions in CR226 triac or A201 photo-isolator often cause problems. In normal operation, the flip flop lights the incandescent bulb inside A201. Light falling on the internal light-dependent resistor (LDR) reduces its resistance (which is connected between anode and gate of the triac) and triggers CR226 triac into conduction to feed ac power to the TV chassis. Any dc voltage of approximately 24V measured across the bulb wires of A201 indicate an open bulb. If A201 is open, the triac can be triggered for testing by connecting a 180 Ω resistor from triac main-terminal 2 to the gate. However, removal of the remote chassis for servicing is time-consuming. Therefore, for intermittent problems where the defect is not identified definitely, it is recommended that *both* A201 and CR226 should be replaced at the same time. Also, breaker tripping at turn-on can be caused by a triac of borderline characteristics. If the TV cannot be turned off, the triac might be shorted. This can happen from nearby lightning strikes, although R251 should minimize the possibility.
- Picture fluttering, a pulsating raster or erratic turn-off sometimes occurs after the TV has operated for long periods of time. The fluttering is especially noticeable at the edges of the picture, and the 130V supply varies excessively from brightness changes. These symptoms have been produced by faulty A201 photo-isolator assemblies. Plug the TV into a variable-voltage transformer and operate it for about 30 minutes at 125Vac. Then slowly turn down the voltage. A normal TV should show no problems until the line voltage drops below 75V. If the picture begins to flutter or disappear at times with voltages around 110V, then the photo-isolator is defective. To be safe, install a new triac, also.

Miscellaneous remote problems

If all remote operations are intermittent or inoperative, check for a blown fuse (see Figure 6). A bad fuse might indicate a shorted CR225 rectifier. If the 24V supply is low by several volts, check for an open C216 filter capacitor or a leaky CR225.

For failure of the audio volume to step up or down properly, suspect a faulty IC201 (dual flip flop). This IC also can cause erratic mute or volume-level operations. When the defect is not in the remote, check for loose connections around the audio and speaker wiring, and replace the sound module.

Continuous channel changing (that stops only when the TV is turned off) calls for test or replacement of motor-control transistors Q208 and Q209. One might be shorted. Also, shorted carry-over switch contacts force the channel motor to run continuously. Some early models used SCRs to switch the motor power. A short in any SCR causes continuous motor operation.

Flashes in picture

Early production H-chassis sets sometimes showed flashes across the picture, severe arcing, or perhaps no raster or HV. This can be caused by an open resistor RX225 (Figure 7) located at the cold end of the flyback's high-voltage winding. This resistor is included to provide a reading (by Ohm's Law) of the picture-tube current during brightness-limiter adjustments. Therefore, the resistor can be paralleled by a piece

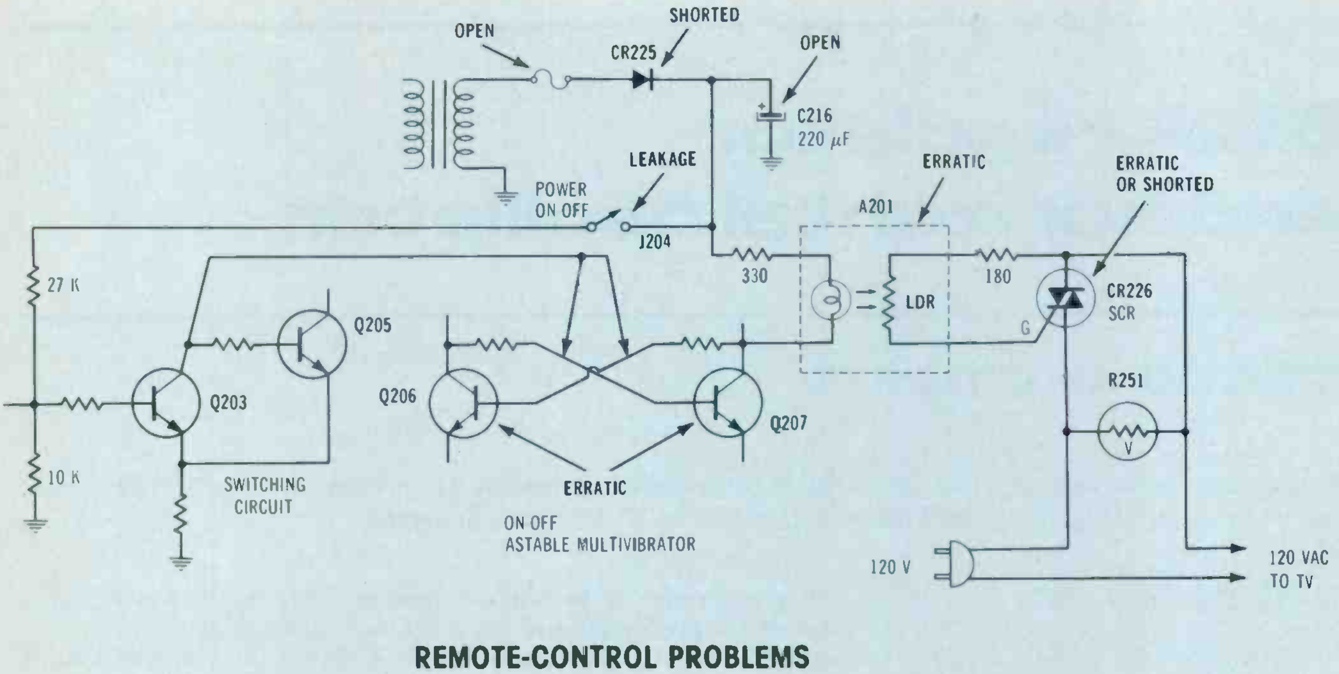


Figure 6 This partial remote-receiver schematic shows components to be suspected for causing remote malfunctions.

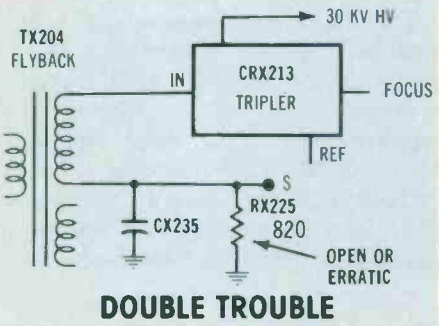


Figure 7 RX225 (820 Ω, 3W) is used only during adjustments of automatic-brightness limiter action. Therefore, if it is open, it either can be shorted out or replaced. Capacitor CX225 might ruin a video IC if arcs occurred when RX225 was open.

of wire (as is done on later production runs) except when needed for the adjustment. Several other models also included the same resistors, but without the CX235 capacitor. If the resistor opens or increases greatly in resistance, CX225 charges to a higher voltage. And any HV arc or other sudden discharge causes the CX225 charge to feed back through the ABL circuit and damage the IC on the 9-90-01 module. Always check resistor RX225 whenever this module or its IC is defective.

Electronic tuner drift

In rare cases, a faulty UHF tuner produces frequency drift in the VHF tuner. These electronic tuners operate by application of a specific dc tuning voltage to the internal varactor diodes. And the same tuning voltage is supplied to both tuners. Therefore, a varying leakage in a UHF varactor diode or bypass capacitor can cause a corresponding shift of tuning voltage (and frequency) in the VHF tuner as well.

Verify such a possibility by pulling out the UHF-tuner plug on the control panel. Elimination of the drift proves the UHF tuner is responsible. Of course, if the drift has gotten worse gradually and someone has tried to offset the drift by channel readjustments, unplugging the UHF tuner might eliminate some or all of the VHF stations. After drift correction, the channels should be reset.

It's possible also for a VHF tuner to cause UHF drifting.

Other defects that can produce frequency drifting include unstable control voltages coming from the center panel, a defective 33V zener that stabilizes the tuning-voltage supply, a bad connection or noisy tuning potentiometer in the channel selector, or leakage in the AFC diodes that are located on the 150-190 IF module.

Set-up switch problems

Many different symptoms can result from bad contacts in set-up switches, especially with E and F chassis. These problems occur often, but usually they are the last to be suspected.

The following are common symptoms of corroded contacts in set-up switches:

- Streaks or lines flash across the screen.
- The picture might go dark and bright intermittently.
- Only a raster without video can be seen.
- The screen is dark and shows no picture.
- An overpeaked picture resembling a negative is on the screen.

Temporary repairs sometimes can be made by spraying the internal contacts with tuner cleaner and sliding the switch back and forth a few times. Internal leakage between contacts might not be removed by cleaning. Replacement of the switch is often the only permanent solution. □

SCR regulator and horizontal oscillator

CTC99 & CTC101

Remaining coverage of the RCA SCR-regulator operation is presented first. Then the master/horizontal oscillator and other stages inside IC U400 are analyzed.

By Gill Grieshaber, CET

Regulation of the +123V supply is enhanced by two separate actions. A dc voltage of +155V and negative-going pulses are present at the SCR anode. *Variable power* to maintain a constant +123V regardless of load or line-voltage changes comes from automatic changes of the SCR conduction time (produced by four transistors in the regulator circuit). The pulses are included to unlatch the SCR during each retrace. However, the first half of each pulse is rectified by the SCR (silicon controlled diode), and this extra boost of power adds a *non-varying* contribution to the +123V—supply voltage.

Detailed regulation operation

Complete understanding of the 123V regulator requires an extensive analysis of dc waveforms at each point of the circuit. These waveforms also should show the zero-voltage line and the +33V supply line. Especially important are the dc waveforms from base to emitter. Such an analysis was made, but only a few of those waveforms will be presented in a condensed discussion.

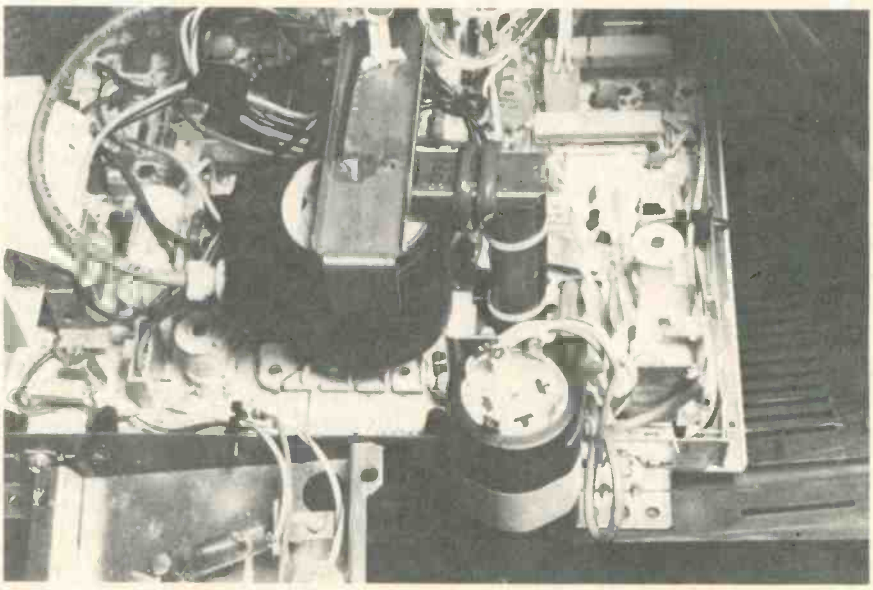
Oscillator frequency control—The emitter of Q102 is connected to the +33V supply and the base receives a sample of the regulated (123V supply) voltage through the R116/R117 voltage divider. Several resistors (pictured in the upper left corner of Figure 1 were clipped out during calibration at the factory to make up the precise value of the voltage divider top leg. There is no adjustable control, as shown in the complete schematic of Figure 2.

Because the emitter has a fixed voltage, the forward bias of PNP Q102 is in proportion to the regulated voltage. It is possible to analyze according to bias and its corresponding affect on collector voltage. For example, a higher regulated voltage provides lower forward bias to PNP Q102, which in turn decreases the C/E current. For a PNP transistor, the positive supply enters at the emitter. Therefore, the plate voltage becomes less positive. Such a method is accurate, but slow and complicated.

It's easier (and sufficient) to consider that the collector change always is opposite to the base change. A positive-going base produces a negative-going collector, and a negative-going base produces a positive-going collector.

Therefore, an increase of the regulated voltage causes this sequence: a positive-going Q102 base; a negative-going Q102 collector; a negative-going Q103 base; and a positive-going Q103 collector.

Q103 collector current charges C132, so a higher regulated voltage places a higher positive voltage at



All 123V regulator components are located in front of the flyback; at the right in this picture taken from the high-voltage side.

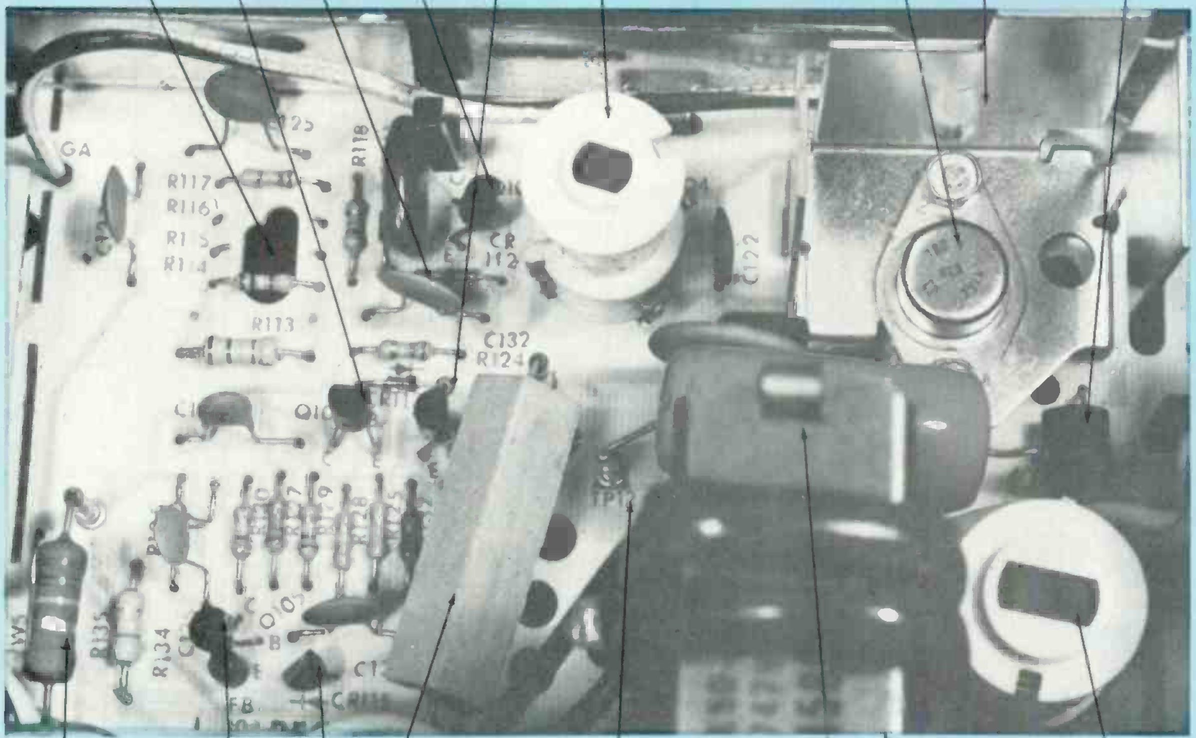


Figure 1 Arrows point to major components of the regulated +123 supply.

the active end of C132 (the other end connects to the +33V supply). This charges C132 at a *slower* rate, thus delaying the start of SCR conduction, and the regulated voltage decreases to the desired value.

It seems wrong that a *higher* positive voltage applied to the variable-voltage end of C132 represents a *lower* charge. That's because one end of the time-constant capacitor usually is grounded, but this circuit applies +33V to the non-varying end. Remember, *a charged capacitor has full supply voltage across it* (maximum voltage) while *an uncharged capacitor has the same voltage at both ends.* Therefore, if the varying end has +33V and the fixed end has +33V, the capacitor is discharged completely. (In conventional circuits, both ends would have zero volts when discharged.)

Notice, however, that Q104 is triggered when its emitter voltage (which is clamped by CR113 to the C132 voltage) decreases to a critical point about 0.6V below the instantaneous base voltage (see the Figure 2 waveforms). But, none of this is possible unless Q105 previously was conductive during the horizontal-retrace time. Triggering of Q104 will be explained more thoroughly after the Q105 operation is clarified.

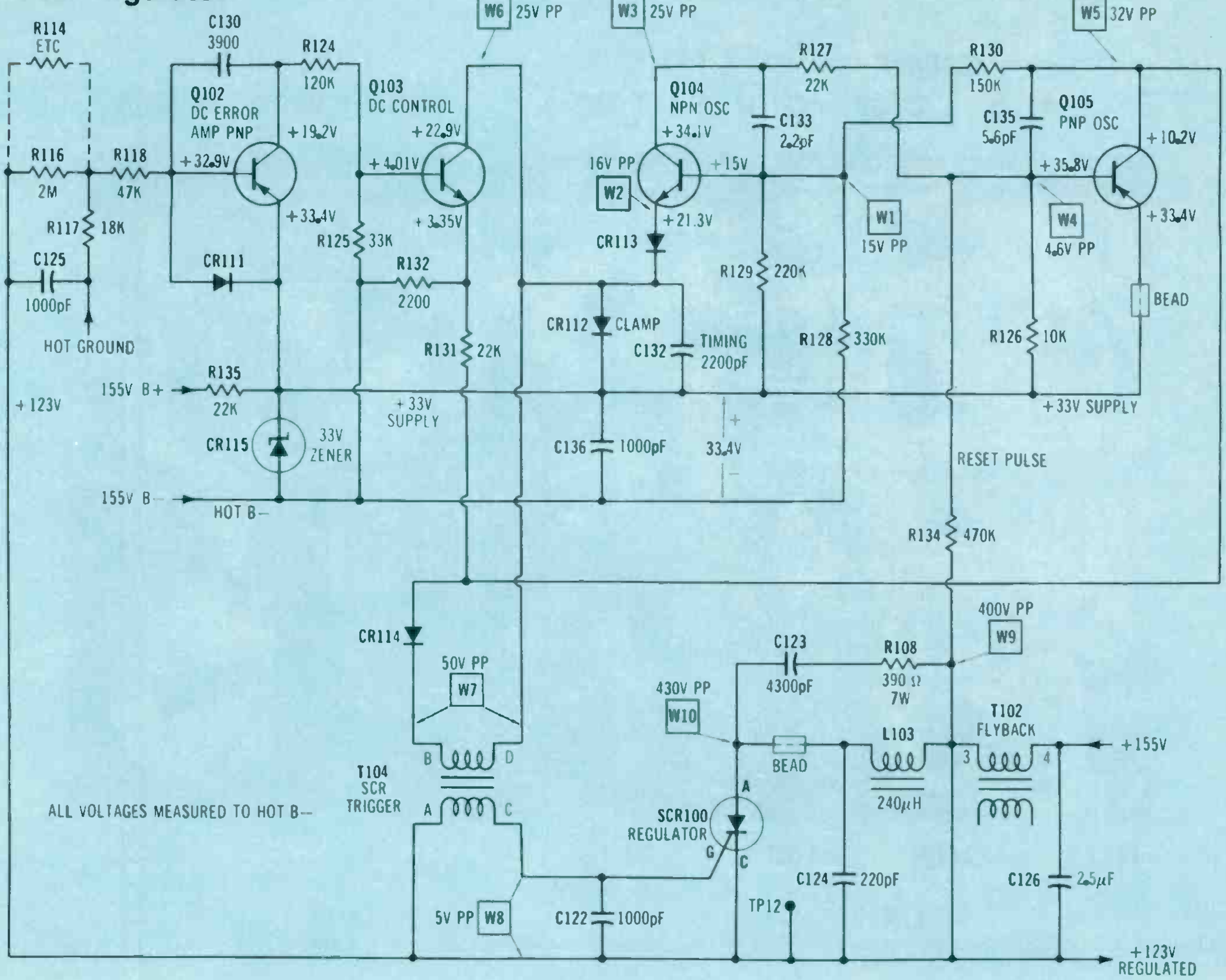
Q105 conducts twice—Regulator action is synchronized to the horizontal sweep by applying a negative-going flyback pulse to the Q105 base during retrace. The resulting Q105 conduction discharges C132 which starts the regulator timing operation. (Q104 and the oscillator function is not used here, although Q104 conducts slightly.) A small triggering pulse reaches the SCR gate, but the SCR is being unlatched by the negative-going anode pulse, so it is ignored.

The sole purpose of this Q105 conduction is to bleed C132 completely so it can be charged according to the Q103 collector current. Notice that Q103 has no resistive dc path to B+. Instead, that end of C132 has +33V following the discharge by Q105, and the Q103 collector current is the charging current of C132.

Unless a flyback pulse or an oscillation pulse from Q104 reaches the Q105 base, Q105 has insufficient bias for any collector current. Therefore, the Q105 base and emitter waveforms are pulses (see W4 and W5 in Figure 2).

Emitter triggered Q104—The situation is completely different for Q104. R129 and R128 supply a fixed amount of positive voltage to the Q104 base (in waveform W1 of Figure 2, this appears as a base line). But for most of each cycle, the Q104 emitter is more positive than the base (which is reversed bias) and Q104 cannot conduct. First conduction occurs when the

SCR regulator



CTC99 123V REGULATOR

emitter voltage (W2 in Figure 2) drops slightly below the base voltage, thus producing forward bias.

When Q104 receives a small forward bias, it conducts to apply a small negative-going signal to the Q105 base. In turn, Q105 conducts and applies a positive-going signal to the Q104 base. Both signals are forward bias for the respective NPN and PNP transistors. The effect is regenerative, going to saturation in a short period of time. Finally, C132 is drained and Q105 current stops. This starts a degenerative action which quickly forces the Q104 emitter more positive than its base. Thus, Q104 current stops also.

Now C132 begins to charge *again* from the Q103 collector current, and a partial charge is built up before a negative-going flyback pulse reaches the Q105 base and discharges it. This is slightly more

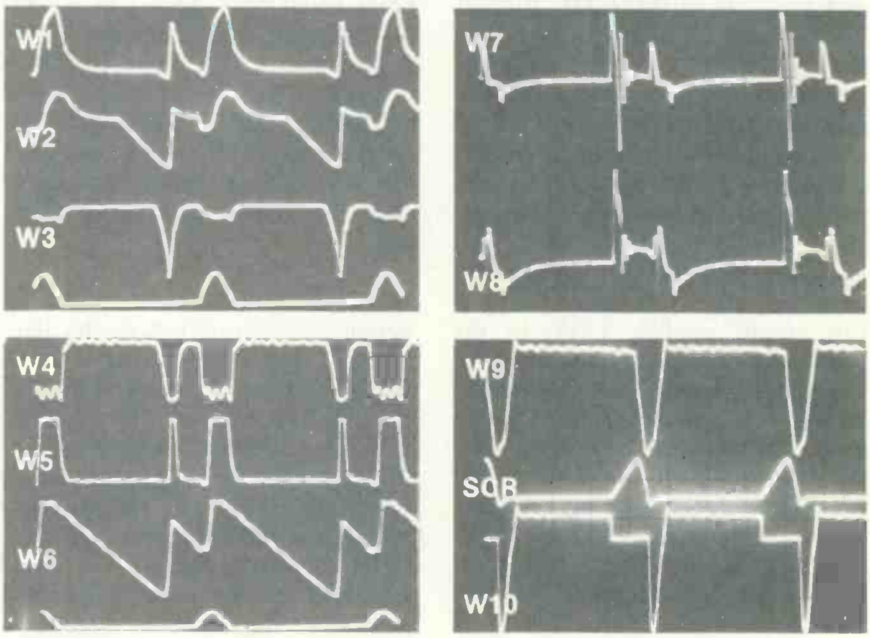


Figure 2 This is a complete schematic of the +123V regulated supply. The brightness was turned down to stabilize the circuit action. Therefore, the voltages and waveforms will be slightly different when tested with a normal picture.

than one horizontal scanning line.

Of course, the Q105 current pulse triggered the SCR into conduction to replenish the +123V supply at the proper time according to the operation of Q102 and Q103 that slowly charge C132.

All Figure 2 waveforms show slightly more than two horizontal lines, and several pictures have horizontal flyback pulses which establish the beginning of each scanning line.

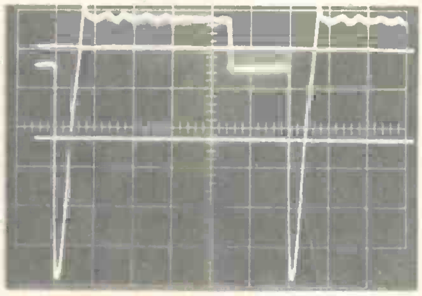


Figure 3 Two dc-voltage lines on the SCR-anode waveform help clarify operation of the regulator SCR. The upper horizontal line marks the average voltage of the waveform. However, +155V is fed to the circuit, thus the line represents the +155V supply. The single stair-step below the line is the +123V supply voltage. It appears at the SCR anode because the anode and cathode are shorted together during SCR conduction. (This stair-step moves to the left when a higher regulated voltage is needed.) Because of the +155V supply, the true zero-voltage line is moved down to the approximate center of the pulses (lower line).

Operation of L103

If the flyback pulses and hot-supply dc voltage were connected to the SCR100 anode without going through inductance L103, those pulses would be applied directly to filter capacitor C126 when the SCR conducted. Clearly, this would represent an ac short across the flyback, and it would kill the high voltage.

Therefore, L103 is included to serve as a low-loss decoupling between the flyback pulses and the filter capacitor. Also, it slows down both the increase and decrease of SCR current (see W10 in Figure 2).

Rectifying negative pulses

W9 waveform in Figure 2 shows 400VPP negative-going pulses that are fed from the flyback to L103 and then to the anode of SCR100. At first, it seems impossible for the SCR to rectify *negative* pulses. But these are not dc pulses; therefore, the positive peak can be rectified. Also, the inserted +155V supply moves the zero line down to increase the positive-peak amplitude and the rectified voltage.

The peculiar SCR anode waveform in W11 is not easy to understand until the various dc levels are identified as shown in Figure 3. The horizontal line at the top is the average voltage of the waveform; however, +155V is added to it, so the line represents +155V. Just below it is a stairstep of +123V which is present at both anode and cathode of SCR100 during conduction. Then, the horizontal line near the vertical center of the waveform is the true zero line. The left half of the large pulse is decoupled from the flyback by L103, and during conduction, no pulse is there because filter C126 has removed it. Therefore, the SCR current continues after the start of the flyback pulse (although at a decreasing rate) until the input pulse drops to the zero line. There the SCR unlatches, and all conduction current (both +155V and pulse) ceases. This explains the rectification of pulses that *appear* to be too negative to allow rectification.

Notice that the +123V step is taller (higher voltage) at the end of conduction following the pulse rectification. Also, the SCR on time is about 25%. Therefore, without the dc from pulse rectification, the regulated voltage would be about +40V and not +123V. This extra supply voltage provides excellent regulation at low line voltages.

Regulation versus line voltage

The multiple scope traces of Figure 4 compare the waveforms at line voltages of 120Vac (picture A) and 60Vac (picture B). Lower line voltage reduced both flyback and SCR pulses by about 25%, and the step between supply and regulated voltages almost disappeared. The 120V SCR on-time of about 25% lengthened to about 50% at 60Vac. These waveforms were made when the raster was black. With a normal picture, the regulator step moves sideways (in response to the varying CRT current) and blurs the waveform.

Attempts were made by varying both brightness levels and line voltage to move the step (that shows start of SCR conduction) farther to the left (thus increasing conduction time), but without success. Evidently this approximate 50% duty cycle is the maximum permitted by the design.

As a test of the regulation, the line voltage was varied and the following figures obtained:

LINE	+155V	+123V
125	163.4	123.6
120	156.1	123.4
115	147.7	123.3
110	141.3	123.1
105	134.2	123.0
100	126.7	122.9
95	119.6	122.7
90	112.0	122.1
85	104.7	121.2
80	99.0	118.5
75	91.6	112.9
70	85.4	105.5
65	80.1	99.2

Notice that the regulated voltage was higher than the source (155V supply) voltage for all line voltages of less than 100Vac. This is better than perfect regulation (in one sense), and it is possible only because of pulse rectification.

No visible narrowing of picture occurred until the line voltage dropped to below 85Vac. Some slight narrowing was noticed at about 80V, and below 70V hum bars and retrace lines could be seen.

One limitation was discovered about operation at low line voltages. If the TV was operated first at normal voltages and then the line voltage was reduced, it would operate (with some hum bars and a loss of width) at less than 60 line volts. But if the TV was turned off

What the 1980 Census can do for your business

Help you increase profits.
"The Census is an essential tool in modern marketing research." That's what Arthur C. Nielsen, Jr., Chairman of the Board of one of the country's largest marketing research firms, said about data gathered by the Census, which is available for your business use.

How you can use the Census

- Forecast sales trends, market potential, population growth
- Study buying habits and changes in purchasing power
- Select new areas for testing
- Determine best locations for new stores, plants, shopping centers, warehouses
- Allocate salesmen, advertising and outlets
- Determine sales forces, routing schedules, territories and quotas

We're counting on you. Answer the Census.

CENSUS '80
A Public Service of This Magazine & The Advertising Council

SCR regulator

for a time and then turned on at the low line voltage, the start-up circuit did not work. Therefore, the TV would not operate until the voltage was increased above about 90V.

One of the troubleshooting techniques that will be described later makes good use of this ability to show a picture with low supply voltages. The source voltage is supplied through a resistor that limits damage from overloads, and a positive voltage is applied to TP13 (between CR421 and CR422) to start the oscillator, which drives the output transistor and produces some HV and width.

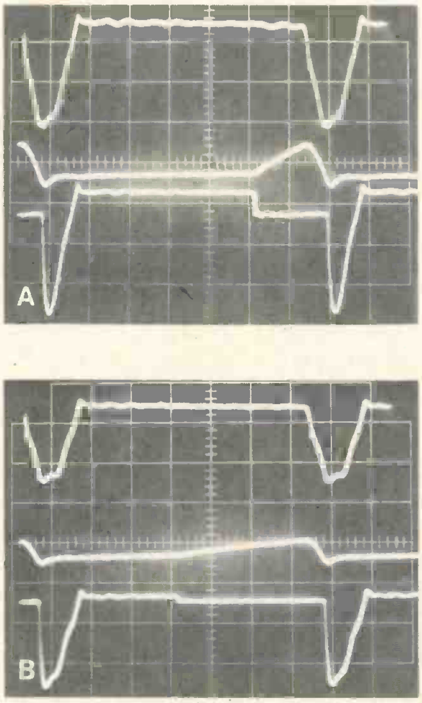
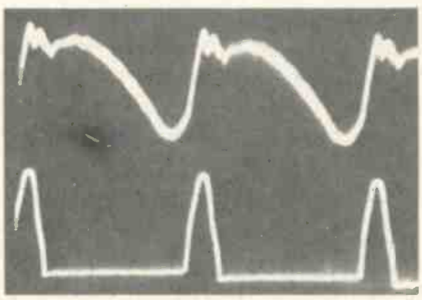


Figure 4 (A) These are the normal flyback pulses (top trace), SCR anode current (center), and SCR-anode waveform (botton trace) when the raster was black and the line voltage was 120Vac. The scope controls were not adjusted, but line-voltage reduction to 60Vac produced the changed waveforms of (B).



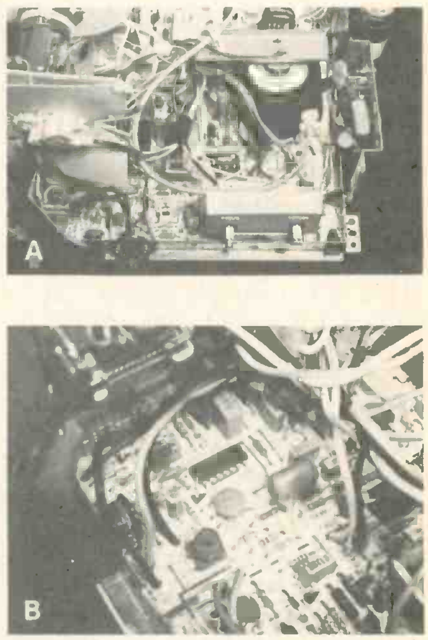
Top trace shows the +123V regulated supply's 6VPP ripple, while the horizontal-sweep waveform is included below to show timing of the ripple.

Horizontal frequency

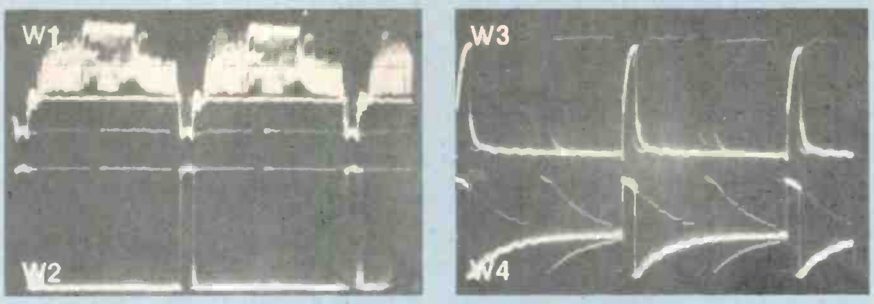
The CTC99 and CTC101 chassis employ a single IC (U400) to produce both horizontal and vertical sweep frequencies from a single master oscillator and a series of dividers.

Frequency of this master oscillator is not 15.734Hz, but must be twice that frequency. For interlaced scanning, each vertical color field must have 262.5 horizontal lines. But dividers cannot produce a half line, so the master oscillator is operated at 31.468kHz which provides the required 59.94Hz vertical-field rate when divided by 525 lines.

From the 31.468kHz master oscillator frequency, it is necessary only to divide by two to obtain the correct 15.734kHz horizontal line rate.



(A) Because of the CRT socket and a maze of wires, the U400 horizontal-oscillator (and vertical-countdown) IC is not visible. (B) After wires and components are moved, U400 can be seen. It is a 14-pin DIP IC on the circuit board under the right side of the picture-tube socket/board.



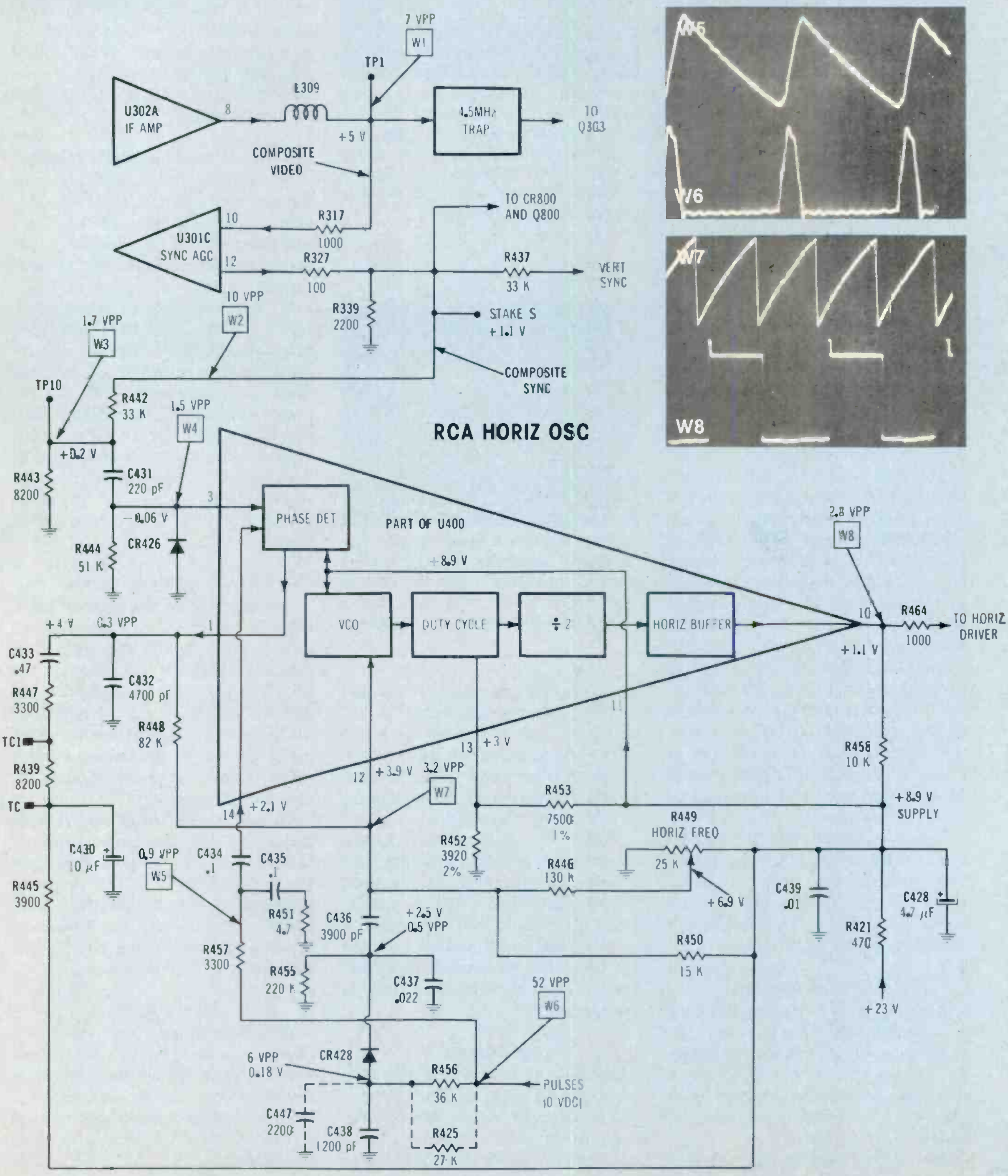


Figure 5 Waveforms and voltages are included with this complete schematic of the CTC99 horizontal phase-detector and oscillator. The master oscillator frequency is twice that needed for the horizontal sweep.

SCR regulator

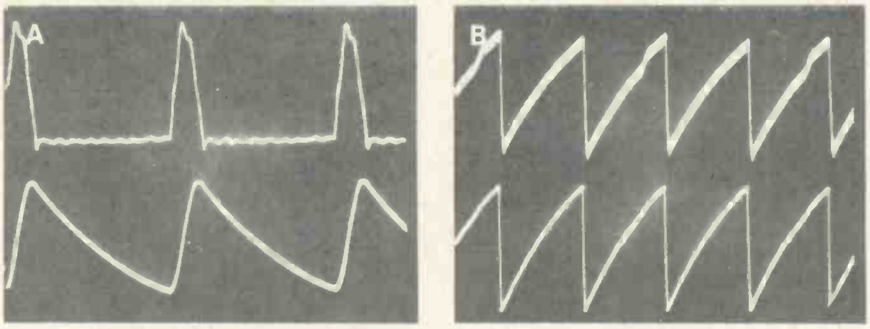


Figure 6 This is a sequence showing the anti-bend waveforms. (A) Top trace shows the horizontal pulses brought to R456 in Figure 5 (waveform W6). The bottom trace shows sawteeth at CR428 anode (formed by R456 and C438 from the pulses). (B) Most of the top trace is 31,468Hz sawteeth from the master oscillator, but dents in alternate cycles are ripple from CR428 cathode. Bottom trace shows the master oscillator sawteeth (W7 in Figure 5) at pin 12 of U400. Tiny dents in alternate sawteeth show effects of the anti-bend action.

Figure 5 shows the complete schematic of the progression from composite video to sync, to the locked 31.468kHz master oscillator, the divide-by-two and the internal buffer stage. The vertical countdown stages are in the same IC, but they are described later.

The phase detector requires differentiated horizontal-sync pulses at pin 3 (W4 waveform) and a sawtooth horizontal signal (W5) at pin 14. This is the conventional type of phase detection. However, notice that *both sync and feedback signals operated at the 15.734kHz horizontal rate,* but the error-correction control voltage at pin 1 is brought to pin 12 where it controls the frequency of the *31.468kHz master oscillator.* In other words, the operation is like that of a phase-locked loop (PLL) with phase detector and oscillator operating at different frequencies.

Another similarity to the PLL is that the oscillator is voltage tuned, and without any sort of tuned circuit. Only pulses and square waves are needed, so a tuned circuit would be superfluous.

Oscillator locking

Locking of the master oscillator is accomplished by combining the phase-detector correction variable-dc voltage (from pin 1) with a manually adjusted dc voltage from the horizontal-frequency control (R449).

For locking adjustments, the sync is removed by grounding TP10, and the free-running frequency is adjusted for zero-beat with a station picture by rotation of R449. Then the short is removed from the sync. That's all; there are no stabilizing or additional adjustments.

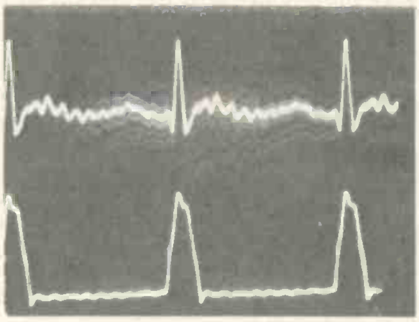


Figure 7 Narrow 0.25VPP pulses (top trace) are found at the U400 pin-1 correction voltage that locks the master oscillator. Lower trace shows normal flyback pulses for comparison.

When the picture was locked correctly to a station picture, the sweep frequency measured 15,734.3Hz. With TP10 grounded, it was 15,775Hz, and when the TV was changed to an unused channel, the frequency measured 15,738Hz. Those figures show excellent oscillator operation.

Anti-bend

Bending at top of the raster is prevented by applying filtered horizontal pulses to the oscillator. First, the pulses are integrated into sawteeth by R456 and C438, then peak rectified by CR428, and finally the ripple from rectification is applied thorugh C436 to the oscillator voltage at pin 12. Figure 6 shows the waveform sequence.

When diode CR428 was shorted as a test, a crosshatch showed several narrow horizontal bands of displacement that moved up slowly through the raster. These bands were not very noticeable on station pictures, but the stability was affected slightly.

VCRs vs. weak-signal stability

As these TVs come from the factory, the component values provide fast correction of oscillator frequency. This is necessary for stable operation with videocassette tape recorders.

If excessive snow or strong local noise sources produce unstable pictures, the time constant can be changed by removal of resistor R425 and capacitor C447 (at the bottom of Figure 5 schematic), and shorting stake TC to stake TC1. Figure 7 shows the small-amplitude waveform that appears at the error voltage (U400 pin 1). The amplitude is reduced by the time-constant change.

Duty cycle and divider

Downstream of the master oscillator inside U400 is a stage called *duty cycle,* which provides the desired waveform for driving the divide-by-two stage that follows. The dc voltage at pin 13 is critical for generation of the correct duty cycle. Therefore, the voltage divider resistors R453 and R452 have 1% and 2% tolerances.

Output signal from the divider drives the internal buffer, and its square-wave output goes from pin 10 through R464 to the base of transistor Q406 buffer. In turn, Q406 output feeds the horizontal driver and it drives the base of the horizontal-output transistor.

Next month

Details, voltages and waveforms of the horizontal buffer, driver, and output stages will be presented next month. Power supply and horizontal troubleshooting methods will be combined after the circuit analysis is completed. □

Index of 1979 articles

TITLES OF ARTICLES

ANTENNAS

COLOR TV

DIGITAL

HORIZONTAL & HV

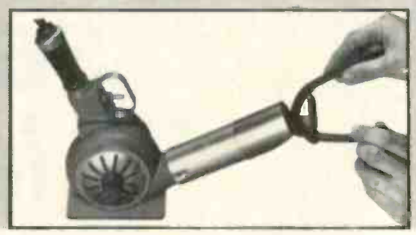
INDUSTRIAL ELECTRONICS

SYMCURE

TROUBLESHOOTING TIPS

MASTER heat gun

Wherever fast, portable heat is the need.



Heating shrink tubing is just one of many jobs the Master Flameless Heat Gun performs in electronic assembly. It's the perfect source of fast, portable heat for *drying components, heat-checking circuitry, softening plastics and adhesives, melting solder, etc.* Industrial quality for production line duty. Eight models: 200°F to 1000°F. 120V or 230V. UL listed — CSA certified. Base plate rotates 90° for convenient benchtop use. Special application attachments available.

SEE US AT NEPCON BOOTH #466

For FREE product bulletin from the originators of heavy duty heat guns, contact your distributor, or call or write:

In Canada, contact Martin Industrial Sales, Ltd. 4445 Harvester Road, Burlington, Ontario L7L 2X1

MASTER appliance corporation
2420 - 18th Street
RACINE, WI 53403 U.S.A.
Tel. (414) 633-7791
Telex 269-505

Circle (6) on Reply Card

Sams has VCR's covered

New Photofact® Specialized Series brings you complete Service Data for . . . Videocassette Recorders. Service just like famous Photofact coverage of . . . TV, Home Radio, Auto Radio, and CB.

Everything you have come to expect from Photofact® is now yours for videocassette recorders. Helpful, reliable Photofact information. Full photo coverage for easy I.D. of all components and wiring. CurcuiTrace® testpoints and junctions. Standard notation schematics. Parts lists showing exact replacements. All mechanical and electrical adjustments. And more. Time saving information for servicing VCR's — today's growth product in electronics.

VCR-1 covers Sony videocassette recorders SL-7200 & SL-7200A. This 128 page volume is the first in the Photofact VCR Specialized Series. RCA, Zenith, JVC, Magnavox, Panasonic, and others will follow.

Videocassette recorders are moving. Your customers have them. And Photofact has them covered. Sign up with your Sams Photofact distributor for your VCR series today!

Howard W. Sams & Co., Inc.
a subsidiary of ITT
4300 West 62nd Street/Indianapolis, Indiana 46206

Calculating service labor rates

By Dick Glass, CET

Most shops seem to feel that it is nearly impossible to closely estimate the hourly rate they need to make a reasonable profit and to pay wages and overhead. They say that there seems to be too many variables: the amount of service work seems to vary; the tough dogs require so much extra time; and the flat-rating of service calls, over-the-counter jobs, and benchwork makes an hourly rate of little value.

These things all seem to be true. However, the flat-rate charges have to be based on actual average time spent. For instance, the charge for a TV bench repair should be about three times the charge for a service call because it takes about three times as long to do the average bench repair.

Tough dogs are a permanent part of your business

As long as you are in the servicing business, you will have tough dogs. Every one of the 190,000 American service technicians regularly runs into tough dogs, so it follows that tough dogs are not your fault and you should not feel that you must pay a personal penalty in time and dollars for them. You should estimate your tough dog expense and consider it the same as any other legitimate expense, as a cost to be included in your hourly rate.

The fact that there are so many variables in the servicing business is only one more reason why you should know your exact cost of doing business and know exactly what your hourly rate must be. If your rates are only based on how fast you think you can repair a set and you do not consider your lost time (billing time, parts procurement time, management time, and so on), you are like a landlord who rents out a house only six months out of the year, yet who bases the rent charge on its being occupied all 12 months of the year. The house eventually will fall into disrepair because the landlord cannot afford to repair it, and since he is losing money, he has no incentive to repair it.

Some more reasons for knowing your hourly cost of doing business are:

1. Once you know your rate per hour, you can better estimate special jobs for which you have no established flat rate.
2. Many shops find that their service-call price matches their hourly rate. (Time studies show that an average service call involves about one hour of time.)
3. Pricing systems, such as the Sperry Tech *TV & Radio Tech's Guide to Pricing* or *Tech Spray Pricing System*, are workable only if you know your hourly rate.
4. Warranty work can be

This is a reprint of Chapter 13 from the ***Service Shop Management Handbook***, book number 21602 from Howard W. Sams & Co., Inc. The book sells for $9.95.

Circle (8) on Reply Card

analyzed better if you know your cost.

5. Knowing your cost—not guessing—can give you the facts you need to counter customers' complaints regarding your prices. (You need the conviction that your prices are fair.)
6. Should you ever be the target of a "TV fraud *expose*" by consumer agencies or communications media people, you can easily defend yourself if you know your cost (especially if you are also acquainted with industry averages).

Two methods of establishing rates are discussed in this book. They are the Nesvik System and the Sterling System.

The Nesvik System for calculating rates

Using the Nesvik System, we will analyze the costs that a typical one-technician TV service shop might have and the profit and return on investment that it needs. By adding all of the costs shown in table 13-1, we can establish an hourly rate.

Based on an hourly rate of $15.80 and a 40-hour work week, the technician owner must have $632 per week (see Table 13-1). Since the technician cannot charge for all the 40 hours that he works each week, the $632 needed each week must be dividied by the number of hours actually worked. Let us assume that 25 hours per week is the actual time spent on service work. To determine the hourly rate, simply divide $632 b y 25 hours and you get $25.28 per hour.

If the technician owner were able to charge for an average of only 20 hours per week, or 50% of the 40 hours, then his rate would have to be $31.60 per hour (see Table 13-1).

If this typical dealer calculated the rates as we have in Table 13-1, he would need $25.28 per hour and would have to be productive 62½% of the time. If service is being performed on warranty or contract repairs, where no parts profits are realized, the $25.28-per-hour rate is a must. On repair work where parts are sold, parts profits can be used to decrease rates. For instances, if labor income was $25,000 and parts sales were $15,000 (at 100% markup), this would give a gross profit of $32,500. He could then charge $6 less per hour and still make $632 per week. The hourly rate then would be $19.28.

Calculating rates in multiple-technician shops

You can easily see how the hourly rate is arrived at for a one-technician shop (Table 13-1). It may become confusing when you try to use the same (NESVIK) system to calculate rates in multiple-technician shops. So let us attempt to calculate the rates as if we were operating a three-technician shop.

Wages—We can reach an average per-hour wage for the three technicians. Using the actual wages paid in the three-technician shop we will arrive at an average wage of $6 per hour.

Technician 1 earns	$ 7 per hour
Technician 2 earns	$ 7 per hour
Technician 3 earns	$ 4 per hour
Total	$18 per hour

Divide $18 by 3 technicians = $6 per hour.

Table 13-1. Using the Nesvik system for a one-technician television service shop

	Per Hour	Per Week
Technician Wage	$7.00	
Overhead Costs ($8000 ÷ 2000 hours)	$4.00	
Profit of 30% on Overhead and Wages ($11.00)	$3.30	
15% Return on Investment ($20,000)	$1.50	

Total	$15.80	
40 Hours Per Week		$632.00

Since the three technicians plan to each work 40 hours per week (taking two weeks vacation) we can use 2000 hours per year as their total annual work time, each, or 6000 hours combined work time for the three.

Technician 1 works	2000 hours
Technician 2 works	2000 hours
Technician 3 works	2000 hours
Total	6000 hours to obtain 1 year's labor income.

Then, in the example of the three-technician shop we must have $12 income each hour of the 120 technician-work-hours. To determine the hourly rate to be charged for service work, we need to know the probable productivity of the three technicians. This we would find out from calculating previous months or the past year. If productivity turned out to be averaging 50%, then the $12 per-hour income needed would require a $24 per hour charge rate for service work.

Overhead—Note that the overhead figure used in Table 13-2 is larger than that shown for the one-technician shop. A three-technician shop should have a larger overhead. Unfortunately, there is no "standard" overhead for any size of service shop due to the lack of conformity in this business. Some one-technician shops have overhead expenses as high as 40% or 50% of total sales. Others, working out of low rent locations (homes, garages, etc.), may incur overhead expenses as low as 20%. Some shops do a major amount of their work in the home, thus incurring heavy truck expenses while others do very little outside work, thus incurring small vehicle expenses. Overhead expenses are not predictable for service shops as any industry. They are, however, predictable enough for the individual shop to compare with previous monthly or annual results. To compare overhead expense percentages with other similar shops you must first analyze both shops to make sure both overhead figures include similar items. For instance, one shop may include owner's salary in overhead expenses and this may be a sizable amount, perhaps 10% or more. The shop to be compared may neglect to account for any owner salary in either overhead or direct labor expenses. This discrepancy would make comparison invalid unless these items were accounted for.

In the Table 13-2 example we have shown an increased overhead total of $16,000 ($8000 higher than the one-technician shop in the Table 13-1 example). The overhead, once it is known, should not be divided by the 2000 hours the shop is open for business, but should be divided by the 6000 hours in which the labor is produced (3 X 2000 hours).

Profit—In our example we are using 30% of overhead and wage costs as the goal for a business profit. You may not like using this method to arrive at a planned profit figure. Instead you may want to set a profit goal based on total sales. By doing so you can come up with the same profit goal ($15,600). For instance, if you anticipated a $100,000 annual total sales amount and you set a goal of 15%-of-sales as the profit goal, you would have reached the same approximate total and per-hour amount even though you used a different formula to arrive at that amount. In this example we use a profit percentage of the two cost items—wages and overhead expenses. By using this method you can estimate the profit a beginning business needs. That is not to say this means of establishing a profit goal amount is better than the total-sales method or any other method. In fact, once you get used to ratios, you may want to establish your profit goal using a percent of assets, or a percent of total investment, rather than the method we use in the Nesvik system, or the total sales percent method.

Return On Investment—The 15% return on investment used in the previous example may be too low. Remember that the return on investment should be thought of as an amount of profit or income, in addition to the business profit, or the wages you may personally receive. Some business people expect to receive their total investment back within five years. If that were the case, a 20% return on investment would be required $1 per work-hour instead of the 75 cents we used in Table 13-2). Note that the return on investment amount is also divided by the 6000 hours worked, not the 2000 hours the business is open.

Productivity—Once you have made the calculation and arrived at a per-hour income figure that is necessary to produce the dollars your business must have, the very real effect of lost time must be considered. As in the Table 13-1 example you can see that the $15.80 per-hour income figure must be divided by the productivity percentage of the shop to arrive at the amount the shop must charge in order to average $15.80.

If all service repair jobs were the same and each job took the same amount of time; there was a constant supply of repair jobs; there were no recalls; there was no time lost searching for parts and schematics or talking to customers about estimates and so forth, the above shop could have a "charge rate" per-hour of $15.80. This would bring in the necessary amount of income. But there is a lot of lost time in the repair business. In fact, small shops rarely manage to achieve even 40% productivity. Something continually wastes the available time. Rather than hoping that in the future productivity will increase, you should face the truth as it is now. If your productivity is 30%, decide either to improve it, or use that 30% figure in establishing your per-hour rate. Otherwise you are fooling yourself.

If the shop in Table 13-1 had a percentage for productivity of 30%, what would the hourly charge rate be to maintain the $15.80 hourly income requirement? It would be $52.67! To charge less than $52.67 (with actual productivity of 30% in that shop) means something has to be reduced. Since overhead, expenses cannot be reduced, one of the other three items will have to be eliminated. In practice, the shop owner would hope for improved productivity. That will not occur, so the business profit will be eliminated as well as the return on investment. With those two items out of the way, the overhead and wages are only $11 per hour, which translates into a $36 hourly charge rate. Only a few shops have the courage to charge that amount right now though, so unless the shop has some product sales or parts profits to fall back on, the owner will probably reluctantly accept wages of less than the $7 per hour goal for his time. If he is willing to accept only $4 per hour for his time, he can get away with charging only $27 per hour or even less if he subsidizes the labor with parts profits (as many do for some reason).

You may find in your shop that your own productivity is pretty low and that your charge rate, therefore, must be high as in the previous example—$52.67 per hour. You then may say, "Gosh! There is *no way* to charge $52.67 per hour, in this business."

That may be true. The secret is, however, to see what you should be charging and then worry about whether you can get it. If you never know what you should charge you cannot possibly improve on your present position. Your only solution to low profits is to *work harder* and *faster* and to hope. You will hope that recalls will disappear, that time-wasting customers and sales people will leave you alone, that

Table 13-2. Nesvik system used for a three-technician shop

	Per Hour	Per Week
Average Technician Wage Per Hour	$6.00	
Overhead Costs ($16,000 ÷ 6000 hrs.)	2.65	
Profit of 30% on Overhead + Wages of $8.66	2.60	
15% Return on Investment ($30,000 ÷ 6000)	.75	
Total	$12.00	
120 Work Hours Per Week (40 × 3 technicians)		$1440

difficult repairs will diminish, and that your employees will become more efficient. That will not happen. The real result will always be a low income for you.

Nesvik calculation on a weekly basis

To figure your rates on a weekly basis is more difficult, because your overhead expenses may be hard to average out, since they vary so much from week to week, and even from month to month. However, for purposes of showing you how to figure your rates, simplified examples of a three-technician shop are as follows:

Wages—The average hourly wage for a three-technician shop can be found by adding their wages together and dividing the total by three.

Overhead—It is best to take the overhead figure for last year (from your tax form or your annual profit and loss statement) and divide it by 52 (weeks) to find the average weekly overhead, then $16,000 ÷ 52 = $308 per week.

Profit—If you set your annual profit goal at $15,000 (in addition to your wages), then $15,000 ÷ 52 = $288 per week.

Return on Investment—If your investment total is $30,000 (as an example) and you expect a 15% return on that amount of money, then $30,000 x 0.15 = $4500 per year, and $4500 ÷ 52 = $86 per week.

Performing the calculations (Table 13-3) on a weekly basis produces a $11.68 per-hour "income" amount rather than the $12 amount reached in Table 13-2. The reason for the small difference is that we have not considered the two weeks (each) vacation time as we did in Table 13-2. (Without considering vacations the 40 hour weeks would allow 2080 hours of work annually, instead of 2000.)

The horror of facing the truth

If your present rates are $15 per hour (or thereabouts) it may be difficult to accept the fact that you may need twice that amount to be profitable. The important thing is to face the truth and to at least understand what your charges must be. If you feel that competition, or past precedent, or your future customer relations will suffer if you start charging realistic rates, you can continue to maintain your rates at their present levels. If you, as a manager, do know what they *should* be, and you know the amounts were arrived at scientifically, you may eventually want to do something about narrowing the gap between present rates and those you must have to be profitable. If you can solve the problem by improving productivity, that is fine. For instance, in the above example, the $11.68 per-hour rate needed is only a $12.98 per hour *charge rate* at 90% productivity for all three technicians. Unfortunately, 90% productivity is unattainable in most shops and 20% to 40% is the rule. Since most shops do not know that, and have never figured productivity in their shop on a weekly or annual basis, they assume it should be 80% or 90% and go about setting their rates accordingly. It's like putting your money in a pocket with a hole in it that you are unaware of, never realizing why you cannot fill your pocket up.

Another important feature of the Nesvik system is that it allows you to take each of the five factors—wages, overhead expenses, ROI, profit, productivity—into account. By understanding the effect of each factor, and the (fair) amount of each, it is easy for you to justify your charges whether it be to the customer, licensing board, manufacturer, or government agency who may not think that your prices are fair. With the absolute knowledge that they are proper you will always have the upper hand in any pricing dispute.

Table 13-3. Nesvik system showing the hourly income requirement and weekly amount needed

	Per Hour	Per Week
Technician Wages	$6.00	$720
Overhead Costs	2.56	308
Profit for the Business	2.40	288
Return on Investment	.72	86
Totals	$11.68	$1402

Quiz

Answer the following questions either T (true or F (false).

____1. The Nesvik system of figuring service rates produces an hourly income requirement that can be used to set the hourly rate at which repair work should be charged.

____2. The Nesvik system can be used to establish or adjust "flat-rate" prices also.

____3. Assuming that maximum merchandise and parts profits are already being realized, the alternatives to low income in a service shop are increase prices or increase productivity.

____4. A shop owner discovers that the shop needs $20.00 per hour, each of the 40 hours per week it is open for business. The owner calculated the technicians' average productivity and found it to be 35%. The per-hour "charge rate" must be set at approximately $57.00.

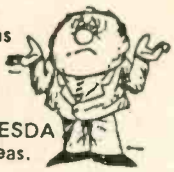
____5. A manufacturer with whom you might enter into a servicing contract agreement, or a government regulatory agency would probably disallow any consideration of investment return or business profit, should you use these two items in explaining why your proper service rates are justified.

____6. Productivity of 30% probably shows a lack of management ability and should not be tolerated or used as an excuse for higher service charges. □

Answers on page 41

NATIONAL ELECTRONICS SERVICE DEALERS

Are you standing idly by while ideas that can be money in your pocket fly away?



Membership in NESDA is one of those ideas.

WHAT DO YOU GET FROM NESDA?

1. Insurance
2. Special Bancard Rates
3. ServiceShop Magazine
4. Electronic Service Industry Yearbook
5. Service Industry Information
6. Legislative Programs with State and National Government
7. Advocate for Better Warranty Practices
8. Business Information

Don't let your bucks get lost in the shuffle.

Send in your check today.

On the bottom line it will mean extra $$$ in your pocket.

JOIN NESDA

And Your State Association

Send for more information:
NESDA, 2708 W. Berry St.
Fort Worth, TX 76109

NATESA
5908 S.
Troy
Chicago
IL 60629

ARE YOU A PRO?

...the not for profit association championing independents' right to compete, and delivering valuable benefits continuously since 1950.

- LEADING SPOKESMAN
- TRADE INFORMATION DISPENSER
- WATCHDOG
- LOBBYIST
- YARDSTICK OF STANDARDS
- CONSUMER RELATIONS
- COUNSELOR
- PROBLEM SOLVER

We are not freeloaders. So our check for $60.00 dues is attached. As our special premium, please ship the indicated $15.00 Manual.

☐ Practical Business Manual
- OR -
☐ Service Contract Manual

productreport

Telephone dialer

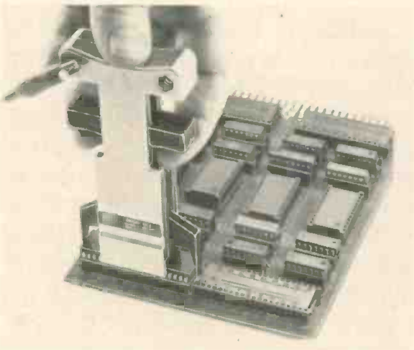
The Phone Controller, from **Dictograph**, is a telephone accessory designed for use with pushbutton or dial telephone circuits. The unit stores up to 30 different numbers. It features a programmable memory, built-in speaker, automatic redial of the last number, and programmable redial of up to 14 tries until the party called answers. Numbers entered or being dialed are displayed on an LED readout, which displays a quartz crystal-controlled digital clock when the unit is not in use for dialing.

The unit sells for $99.95.

Circle (9) on Reply Card

28-40 Pin IC extractor

The model EX-2 from **OK Machine and Tool** extracts all 28-40 pin DIP ICs having standard .600" body widths, including MOS and CMOS devices. The EX-2 is self-adjusting and lifts IC using uniform pressure



applied simultaneously at both ends of the IC. Designed one-hand operation, the EX-2 features chrome plating for static dissipation, and a terminal lug for attaching a ground strip (strap not included).

The EX-2 is priced at $7.95.

Circle (10) on Reply Card

Remote answerer

The Tele-Tender 37 Remote, the newest addition to **TT Systems** line of phone answerers, can be queried for messages from any phone with a pushbutton dial, eliminating the need to carry a remote key tone box. The unit features twin cassettes: one for recording incoming messages; the other is a repeating cassette that contains the outgoing message. Features include unlimited incoming message length, a ring-adjust selector, and a LED indicator light that indicates when messages have been received. The Tele-Tender 37 Remote answerer is ac-operated and sells for $299.

Circle (11) on Reply Card

Video head cleaners

Fuji's video head cleaning cassettes are available for both VHS (VCL-30) and Beta (BCL-20) videocassette recorders. The non-abrasive cassettes are available in 30 ft and 20 ft lengths respectively. According to instructions, a 10-second run will clean the heads, eliminating oxides and binder residues.

The price of a VCL-30 is $25 and the BCL-20 is $18.50.

Circle (12) on Reply Card

Soldering station

Weller has developed the EC2000 electronically controlled soldering station, capable of maintaining a constant preset tip temperature. Settings and instant readings are shown on an LED digital display.

The EC2000 features variable temperature settings from 350° to 850°F, a platinum sensor inside the iron's tip and an interference-free design. Nine tip styles are available.

Circle (13) on Reply Card

Tool set

Vaco has introduced the 70110 10-piece Torque Commander tool set. The set features five sizes of nut drivers, two Phillips and three regular straight slotted screwdrivers. All drivers are interchangeable and slip in and out of the Torque Commander handle. The set is packaged in a clear plastic case. ☐

Circle (14) on Reply Card

catalogs literature

The **B&K-Precision** test instruments shown in the BK-80 big catalog are featured in a 52-page, compact catalog, suitable for insertion in a 6¾ size envelope. The BK-80 catalog is illustrated and describes specifications, features and applications of B&K-Precision equipment.

Circle (15) on Reply Card

A 14-page replacement guide and catalog is available from **Sylvania**. The 4-color catalog cross references 1000 industry part numbers to 117 Sylvania ECG replacement devices.

Circle (16) on Reply Card

A 104-page catalog by **Tucker Electronics** lists approximately 2100 pieces of reconditioned electronic test equipment and microwave components. Instrument categories include: amplifiers, analyzers, bridges, frequency measuring equipment, signal generators, lab standards, meters, scopes, power supplies, recorders, RFI/EMI equipment and more. Each unit is described and priced. All units are reconditioned and calibrated to manufacturer's specifications.

Circle (17) on Reply Card

A 20-page catalog of wire wrapping tools and other electronic assembly tools and parts is available free from **OK Machine and Tool**. The catalog includes specifications and price listings.

Circle (18) on Reply Card

Howard W. Sams has released a computer book catalog featuring a complete selection of computer and computer related titles. The books, written by professionals, feature photos and illustrations and are listed in five categories.

Circle (19) on Reply Card

The 1980 **Cornell-Dublier** General Line/MRO Components Catalog is now available. The 60-page catalog is illustrated, offers a cross-reference section, and includes electrolytic capacitors, ac capacitors, EMI filters, relays and decade-boxes. □

Circle (20) on Reply Card

Corrections

On page 21 of the October, 1979 issue of **Electronic Servicing**, the 0100 answer in the first example under *Binary subtraction* should be changed to 0011.

In the second column of page 23 in the November article *Buzz test that failed*, both 1mV references to the output signal from microphones should be changed to 10mV. Also, in the accompanying schematic on page 22, the R1 and R2 callouts should be reversed, so that an increase of R1 resistance (between collector and base) reduces the forward bias of that NPN transistor.

Quiz answers

From page 39

1. *True.* The system separates the four real, distinct costs that make up the hourly minimum income that service businesses must have to succeed. By separating each of the four ingredients of the hourly rate, a realistic judgment can be made as to the proper amount of income that will be required to satisfy each one. Added together, the total hourly income requirement can easily be understood or explained.
2. *True.* Flat-rate prices (which most shops still use) are always established by dealers in varying amounts, based on the anticipated (or experienced) times each type of repair appears to take. Figuring out the needed hourly income rate is useful even in "flat-rate" pricing shops as, once the hourly income rate is determined, the flat rates can be adjusted to produce the required amount.
3. *True.* Most unsuccessful shop owners hope something else will come along to substitute for inadequate service charges. Many expect the repair jobs to eventually get easier. Some hope the future will hand them a new and unique sales product that can provide profits with which to subsidize unprofitable service rates. Since there is no reason to expect such improvements, the logical answer then is to establish realistic and profitable charges, in addition to attempting to increase productivity.
4. *True.* It could be less if the shop could figure out a way to improve on the 35% productivity average of the technicians. It is extremely difficult for a small shop to overcome it, however. If the shop owner is looking the facts squarely in the eye he can see he must charge for repair work at near $57.00 per hour. If he has healthy parts profits the $57.00 rate could be reduced somewhat; however, parts profits are not the major portion of service income as they once were, which may make the reduction that could be made rather small.
5. *False.* Practically all of these "big business, big government" people are totally ignorant of costs of doing service business. If you know your costs and can explain or justify them as the Nesvik system allows you to do, you will, in the majority of cases, convince others that you know what you are doing and that your prices are fair.
6. *False.* The extreme difficulty involved in electronic repairs, the difficulty in obtaining literature and parts, the unserviceable products, and dozens of other problems with repair work make 30% productivity more the rule than the exception. To average 30% while setting service rates expecting 60% is to blind oneself to the truth.

test equipment report

Delayed sweep scope

B&K-Precision has introduced the model 1530 30MHz scope with delayed sweep. It offers five ranges of time base delay from 1μs to 100ms. Vertical input sensitivity is 2mV per division. The 1530 features variable hold-off, front panel X-Y

operation, differential measurement capability, and algebraic addition and subtraction of two vertical input signals. The unit operates on 115 or 230 Vac.

The 1530 includes probes and manual for $1340.

Circle (21) on Reply Card

RF wattmeter

A new series of RF wattmeters has been announced by **Bird** with the 4381 Power Analyst, a 9-mode digital directional RF wattmeter for power levels from 1/10W to 10,000W, and from ½ to 2300MHz.

CW or FM power, both forward or reflected, is displayed in watts or dBm. VSWR is calculated continuously and indicated, as is dB return loss.

The unit is priced at $590.

Circle (22) on Reply Card

Hand-held multimeter

The **Heath** IM-2215 hand-held portable digital multimeter features alternating high-to-low resistance test voltage, built-in references for in-the-field calibration, and a 3½-digit LCD display. Five ranges allow ac voltage measurement to 750V rms and dc voltage to 1000V. Ac and dc current flow is measurable to 2000mA. The unit is battery-operated and battery condition is monitored continuously.

The IM-2215 is priced at $94.95.

Circle (23) on Reply Card

Temperature probe

The **Hickok** TP-20 probe measures temperatures from -55° to 150°C or -67° to 302°F. The probe operates up to 500 hours on one 9V battery, and features a battery test position.

The TP-20 probe and the LX-303 DVOM are available at a total price of $115.

Circle (24) on Reply Card

Dual-trace scope

The **Gould** OS253 is a compact portable 12MHz dual trace scope that weighs 15 lbs. Case size is 5¼"x12"x16½"; the display area is 8cm x 10cm CRT.

Circle (25) on Reply Card

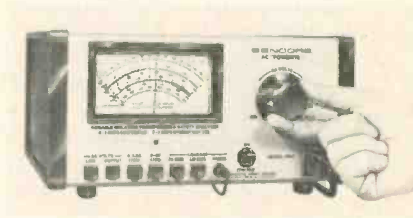
Capacitance sub box

Cincinnati Electrosystems' model 315 capacitance box is an accurate and inexpensive instrument for troubleshooting and maintenance use. This compact unit substitutes any of 21 capacitance values ranging from 100pF to 10μF. It measures 4" x 2 7/8" x 1 9/16", and is priced at $20.95.

Circle (26) on Reply Card

Isolation transformer

Sencore has designed the PR57 ac Powerite 400W isolation transformer. The unit features an automatic safety check, probe and one-button



leakage check. Ac voltage is variable from 0 to 140V. A 2% recessed 6-inch meter is used to monitor ac volts, current and watts.

The unit sells for $375.

Circle (27) on Reply Card

Production test oscilloscope

Leader Instruments LBO-5800 production oscilloscope system will allow the operator to select up to 32 preset configurations of oscilloscope controls to view waveforms at up to eight test points in a unit under test. In operation the operator attaches up to eight probes to the unit under test and uses a single button to cycle through up to 32 tests. All vertical, horizontal and trigger controls are automatically set to pre-programmed positions during each test.

The system consists of four components: the LBO-5810 programmable oscilloscope, the LPC-5811 memory/control unit, the LPC-5813 input selector and the LPC-5812 programmer. A single test station including programming capabilities is $5995. ☐

Circle (28) on Reply Card

letters to the editor

To the Editor:

Your article *Calculators make milli—micro—decimals easy* in the October issue will confuse readers unless they use the same calculator that Forest Belt did.

I have two Texas Instruments calculators and both operate differently from each other and from the one in the article. Problems arise when converting from scientific notation to basic units. For Forest's calculator, the progression is: press X; then 1; and finally EE followed by the desired exponent. The TI-30 series is this: press X; press 1; press INV; press EE and enter the exponent. Only two steps are necessary for the TI-55: press INV; press EE and enter the exponent.

Other calculators probably operate differently than these. I enjoy reading your magazine and have gained a lot of good information.

J. C. Cook
San Leandro, CA.

Dear Mr. Cook:

Thank you for these comments. Of course, the instruction book for any new item of equipment should be studied carefully.

Carl Babcoke, Editor

To the Editor:

I enjoyed the October article about servicing older TVs and would like to read an article about adjusting width on TVs that have no width control.

An RCA CTC31A chassis shows only 7 of the 10 color bars, but the focus is good and there is no blooming. Could a width control be added to this set?

Sherman Mead
Gouldsboro, PA

Dear Mr. Mead:

Most normal CTC31 TVs show about nine color bars, so a control to reduce width should not be necessary. Either the high voltage is too low (even if it is regulated) or the circuit has been modified. First try the regulator and efficiency coil adjustments as given on page 39 of October **Electronic Servicing**. Also, check the 6JE6 screen-grid voltage and measure the value of the 15K (7-W film type) screen resistor. A lower resistance will cause excessive width and a short life for the 6JE6. If all else fails, carefully check the side pincushion and top/bottom pincushion circuits.

Carl Babcoke, Editor

To the Editor:

I really enjoyed the article about repairing old TVs that appeared in the October issue. Articles like this make the subscription price worth every penny.

A T958 Magnavox that I'm working on has one remaining problem. Some channels have strong color while others have weak color. Can you give some tips?

James Knutson
Waterville, Quebec, Canada

Dear Mr. Knutson:

Look at the problem this way: The video stages, chroma circuits, and picture-IF circuits are the same for *all* channels. Therefore, you must search for some circuit or operation that is *different* for each channel. The following list covers most of the areas or conditions: the type of antenna or some mismatch that produces standing waves in the lead wire; misalignment of RF and antenna stages in the tuner; inability of the fine tuning to adjust to the proper point for maximum color on some channels; or a defect in the automatic-chroma gain control (ACC) circuit.

Carl Babcoke, Editor

To the Editor:

The article about older TVs in the October issue was very interesting. I am working on an RCA CTC31 that is dark at the top of the picture and changes gradually to light at the bottom. I would appreciate your help with this tough dog.

Russ Reeves
Westernport, MD

Dear Mr. Reeves:

Probably a defect in the vertical blanking is responsible for the shading. It's likely that capacitor C30 or blanking diode X11 (using Photofact 928-3 numbers) is shorted. Shading also can be caused by vertical-sweep waveforms reaching the video circuits through bad filters, but this is very rare.

Carl Babcoke, Editor

To the Editor:

In reference to your offer at the end of the *Repairing old TVs* article, I would like any information you can send me about these televisions. Thanking you in advance for any assistance you can give in this matter.

Vincent Traks
Staten Island, NY

Dear Mr. Traks:

Several readers misunderstood the comments on page 40. One paragraph stated: "Hundreds of 'fixes' are known for the older color TV receivers..." This meant the authors knew of these tips—not that the tips were printed and ready for mailing. The last paragraph said, "Readers are invited to write to the editor if they would like more tips of this kind..." The editor received dozens of letters from readers asking either for specific information by mail or for more articles on similar subjects in **ES**. Therefore, beginning with this January, 1980 issue, articles about typical defects and repairs of older TVs will appear regularly. Write to the editor about other subjects you would like to see discussed in **Electronic Servicing**.

Carl Babcoke, Editor

IT'S NO PUZZLE
TO ORDER
OELRICH SERVICE FORMS
FOR TV-RADIO & 2 WAY RADIO SERVICE LEGAL FORMS FOR CALIF. FLA. UTAH NOW AT YOUR PARTS JOBBER OR WRITE FOR CATALOG B64
OELRICH PUBLICATIONS
4040 N. NASHVILLE AVE. CHICAGO, ILLINOIS 60634

Circle (29) on Reply Card

FREE CATALOG
HARD-TO-FIND PRECISION TOOLS
Lists more than 2000 items: pliers, tweezers, wire strippers, vacuum systems, relay tools, optical equipment, tool kits and cases. Send for your free copy today!
JENSEN TOOLS INC.
1230 SOUTH PRIEST DRIVE · TEMPE, ARIZONA 85281

Circle (30) on Reply Card

themarketplace

Advertising rates in the Classified Section are 35 cents per word, each insertion, and must be accompanied by cash to insure publication.

Each initial or abbreviation counts a full word.

Minimum classified charge $3.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $3.00 per insertion to cover department number, processing of replies, and mailing costs.

Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or a distributor.

Advertising Services

PROJECTION TV: Fact sheet prepared by an optical expert. Directions, sources for lens, screen, and kit hardware for quality installations. Send $1 to Bernard Lee, Box 211, Little Silver, N.J. 07739 11-79-3t

Business Opportunity

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

BUSINESS OPPORTUNITY: Established 30 yr. TV & HiFi Sales & Service in Ventura, CA. Owner retiring-$37,500 + flooring of new sets. A real buy. Bill Cote & Associates, 2000 Main St. East Ventura, CA 93003 (805) 648-7741 1-80-1t

SO CALIFORNIA—TV Sales & Service, attractive store, long established lucrative business. RCA service center. Owner retiring. Will train. Beautiful, growing area. Phone (714) 837-2105. 1-80-1t

For Sale

REPLACEMENT COLOR YOKES—DEALER ONLY. Zenith 95-2501-2532-2638-2667-S-89633 etc. $19.94, Magnavox 361380-1 $21.95, Sylvania, GE etc. $17.95 to $22.95. Request for price list on your letterhead. David Sims Enterprises, Inc., 665 Jericho Turnpike, Huntington Station, N.Y. 11746, (516) 549-3925. 5-79-tf

AUTOMOBILE RADIO and tape replacement parts: Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469, (212) 881-9600, out of New York State, (800) 223-8314. 5-79-tf

TV & RADIO TUBES, 36 cents EA!! Free color catalog. Cornell, 4221 University, San Diego, California 92104. 8-76-tf

SAMS PHOTOFACTS—700 thru 1850 with file cabinets, $1000, many AR, MHF, & TR manuals, and misc test equipment. Leisure World TV, 13928 Seal Beach Blvd., Seal Beach, CA 90740. Phone 213-598-5600 1-80-1t

FOR SALE: 19" B&W Admiral TV, model 19B890K. Purchased 1978; unboxed; never been used. $115 each. 47 sets available. Hurry while supply lasts. Sun Country Rental, 1473 Lee Trevino, El Paso, TX 915/0760. 1-80-1t

PRINTED CIRCUIT boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. DANOCINTHS INC. Dept. ES, Box 261, Westland, MI, 48185. U.S.A. 1-80-2t

TV & ELECTRONICS SERVICE BUSINESS. Established since 1958. Also excellent location for sales. R. Myers, 900 S. Solano, Las Cruces, N.M. 88001. 1-80-1t

WHO'S FIRST? Make tests, contests, quiz bowls sparkle. Tell who pushes button first...any number buttons. Ingenious, low-cost, two-wire circuit. No relays, ICs, PCs or special parts. Build public relations loan rental, sales, to teachers, ministers, coaches, club leaders, party givers, sales motivators, etc. Illustrated plans $5.00 postpaid. Wayne Lemons, Electronics Building R2, Buffalo, MO 65622. 1-80-3t

COLOR PICTURE TUBE REBUILDING EQUIPMENT. SEMIAUTOMATIC ELECTRONICALLY CONTROLLED PROCESS. COMPLETE TRAINING. Call or write Atoll Television, 6425 W. Irving Park, Chicago, IL 60634. Phone 312-545-6667. 12-79-2t

ELECTRONIC SURPLUS: CLOSEOUTS, LIQUIDATIONS! Parts, equipment stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-011, Box 762, Plattsburgh, N.Y. 12901. 6-78-tf

RADIO & TV. SERVICE FOR SALE: Established 5 years, new equipment & parts, low overhead, inventory included, Jake Sharet, 16 N. Water, Greenwich, Conn. 06830 12-79-2t

HELP WANTED

WE NEED BOTH TUNER AND MODULE TECHNICIANS for our expanding operation. Top pay for first class technicians. Call toll free 1-800-433 7124 or 1-800-772-7411. 1-80-1t

HELP WANTED: TV Technician-experienced, paid vacations, fringe benefits, excellent opportunity with secure future, start March 1980, Delman TV, 651 E. Park Ave., Long Beach, N.Y. 11561, 516/432-7373 12-79-2t

Perform a death-defying act.

Have your blood pressure checked.

Give Heart Fund
American Heart Association

Electronic Servicing

Advertising Sales Offices

NATIONAL SALES MANAGER
Greg Garrison, P.O. Box 12901,
Overland Park, KS 66212;
Phone: (913) 888-4664

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

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

LOS ANGELES, CALIFORNIA
Herb Schiff,
3055 Wilshire Blvd.,
Los Angeles, CA 90010
Phone: (213) 387-0639

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

AMSTERDAM, HOLLAND
John Ashcraft & Co., John J. Lucassen,
Akerdijk 150A, 1171 PV-Badhoevedorp
Holland;
Phone: 2968-6226

TOKYO, JAPAN
International Media Representatives, Ltd.,
2-29, Toranomon 1-chome, Minato-ku,
Tokyo 105, Japan;
Phone: 502-0656

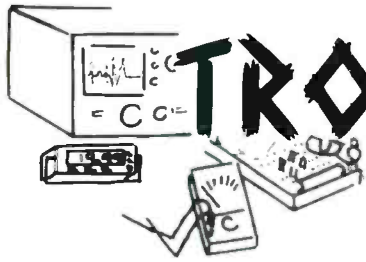
advertisers' index

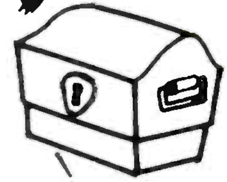
WE'RE FIGHTING FOR YOUR LIFE

Have Your Blood Pressure Checked

The American Heart Association

UNLOCK TROUBLESHOOTING SECRETS





Through this Treasure of servicing Know-How!

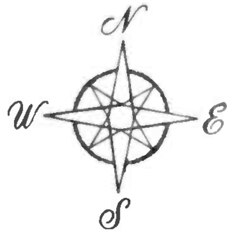


Chart your path with this introductory collection of REPRINTS
from among the best servicing articles ever published.

Employ today's TOP Authors as your Guides:
FOREST BELT, JACK DARR, WAYNE LEMONS, CARL BABCOKE
...and other popular writers.

Valuable bargains in specific, timely, easy-to-remember, profitable training ...at less than $2 a page.

Service Training REPRINTS

Each	$ 5.50	postpaid
15 - 24	5.25	each
25 or more	5.00	each

(Add 20% outside U.S.)

____AD-0001 Digital Principles for Communications - 1
____AD-0002 " " " " - 2
____AD-0003 " " " " - 3
____AD-0004 " " " " - 4
____AD-0005 Digital Electronics in Video Cassette Recorders
____AD-0006 Replacement Transistors—Do They Work?

____AV-0001 Troubleshoot Video IFs with Sweep - 1
____AV-0002 " " " " " - 2
____AV-0003 Find Chroma Troubles with Sweep Generator
____AV-0004 Really Understand Television Alignment
____AV-0005 Television Alignment Techniques - 1
____AV-0006 " " " - 2
____AV-0007 Television Chroma Alignment
____AV-0008 Servicing Pulse-Derived B-Plus Supplies

____AA-0001 Troubleshoot Direct-Coupled Audio Stages
____AA-0002 Cassette Recorder Workshop - 1
____AA-0003 " " " - 2
____AA-0004 " " " - 3
____AA-0005 " " " - 4
____AA-0006 How Eight-Track Car Stereos Work

____AC-0001 Understand CB Transmitters the Easi-Way
____AC-0002 Understand CB Circuits the Easi-Way
____AC-0003 Understand Oscillators the Easi-Way
____AC-0004 Troubleshoot Citizens Band Receivers
____AC-0005 Modulation Limiting in CB
____AC-0006 Mobile Installations in Custom Vans
____AC-0007 How To Fix Small Transceivers - 1
____AC-0008 " " " " " - 2
____AC-0009 " " " " " - 3
____AC-0010 Switching From CB to FM Two-Way

____AO-0001 Hints for Better Troubleshooting
____AO-0002 Installing Security Systems
____AO-0003 Testing Transistor Automobile Ignition
____AO-0004 Creative Electronic Servicing

____AT-0001 Which Scope—Recurrent or Triggered?
____AT-0002 Triggered Scopes Simplified
____AT-0003 Triggered Oscilloscopes for Color
____AT-0004 How To Use Triggered Scopes (programmed)
____AT-0005 Why Vectorscopes are Popular
____AT-0006 Introduction to Vectorscopes - 1 and 2

ES

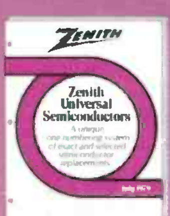
X HERE!
I have selected ______ Service Training REPRINTS, for which I enclose $__________ check or money order.

Name ______________________ Age ________
Address ______________________ Phone ________
City ______________ State ________ Zip Code ________

FREE... Binder and Index Guides with order of $200 or more

MAIL TO: **Service Training GROUP**, Post Office Box 47, West Newton, IN 46183

150,000 REASONS WHY YOU SHOULD SWITCH NOW TO THE BIGGEST, BROADEST-EVER LINE OF ZENITH UNIVERSAL SEMICONDUCTORS covering Zenith exact replacements plus the most popular types in the industry—all in a new catalog!



It's all under one numbering system that saves you time and adds value to any Zenith semiconductor you may already have in stock!

Switch now to Zenith Universal Semiconductor replacements and see how well your shop shapes up...your bottom line, too.

Check with your Zenith distributor for your copy of Zenith's Universal Semiconductor cross-reference guide...and ask how you can enjoy the convenience of our special Tube Caddy/Benchtop Organizer.

ECG is a registered trademark of GTE SYLVANIA

Shown here are just a few of the more than 150,000 cross-references in the July, 1979 edition of the Zenith Universal Semiconductor cross-reference guide.

ZENITH®

The quality goes in before the name goes on®

Zenith Radio Corporation / Service, Parts & Accessories Division / 11000 Seymour Avenue / Franklin Park, Illinois 60131

Circle (2) on Reply Card