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Electronic Servicing

A HOWARD W. SAMS PUBLICATION

UNDERSTANDING VIDEO GAMES

More transistor tests

Industrial sensors

Magnavox horizontal

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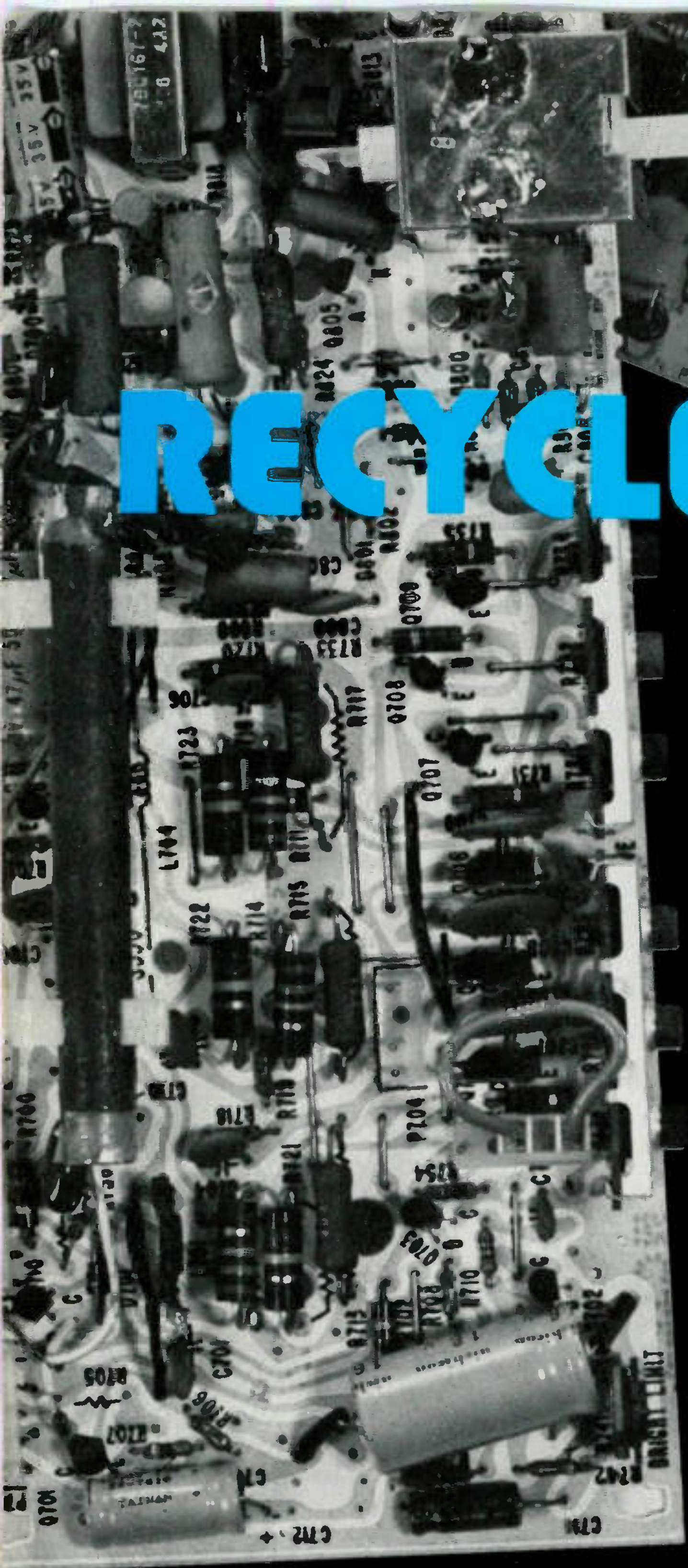

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PRECISION TUNER SERVICE

THE COMPLETE LIST OF ALL PTS SERVICENTERS APPEARS ON THE NEXT PAGE

For More Details Circle (1) on Reply Card

August, 1977 ☐ Volume 27, No. 8

Electronic Servicing®

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About The Cover

Very popular now are the video games that use TV screens as playing fields for simulated sports events. The photo is by courtesy of the Magnavox Company.

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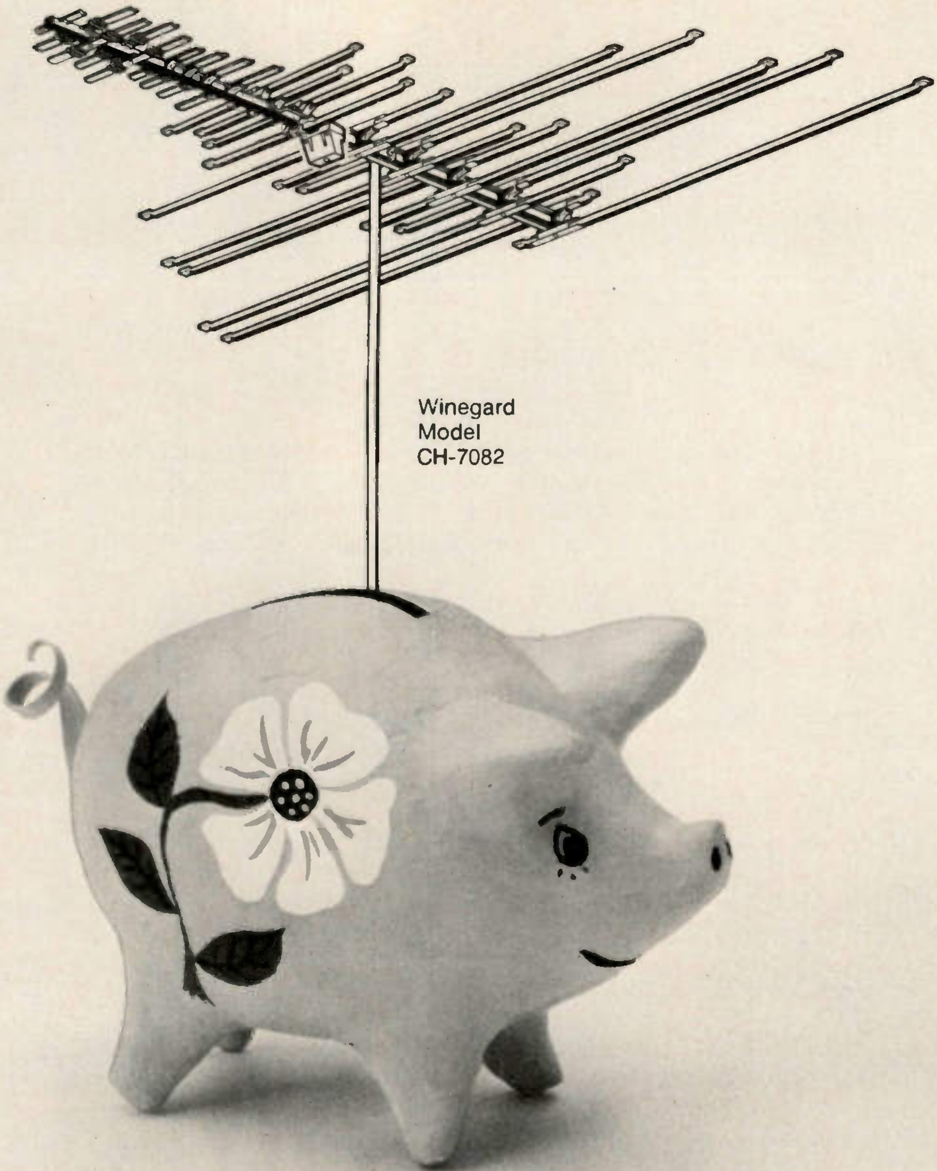

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electronicscanner

news of the industry

The first six-state regional convention of the Television-Radio Association of New England (TRANE) will be held September 23 through 25 at the Hartford Connecticut Hilton. A trade show is featured, along with a full-day NESDA PSM school by Dick Glass on Friday. Contact George Dukas at (203) 758-1033.

A Profitable Service Management (PSM) school, with Dick Glass as instructor, is scheduled for September 26 at the Holiday Inn, Route 82 and 171, Strongsville, Ohio. Contact Bob Masa at (216) 888-4200.

The Electronic Industries Association (EIA) has formed a special committee to examine the standardization of CB selective-calling signals. The move was announced by John Sodolski, EIA staff vice president, and Stuart Meyer, committee chairman. Meyer said the committee's objective is to arrive at one standard signalling plan which could be adopted voluntarily by all CB manufacturers, thus heading off the possiblity of incompatibility among products of different manufacturers. Simple calling systems were used in the early days of CB radio, but recent advances in solid-state and microprocessor technology, combined with the present day crowding of CB channels, have brought about renewed interest in the systems.

The Federal Communications Commission is running behind schedule in its efforts to test new video games, *Retailing Home Furnishings* reports. According to an FCC spokesman, the Commission has reduced the submission-to-approval time to about four weeks, but there still isn't enough manpower to deal with the increasing number of video games being introduced onto the market. Of those video games tested by the FCC this year, nearly 50% have failed, primarily due to high radiation levels (above 15 microvolts at 1 meter).

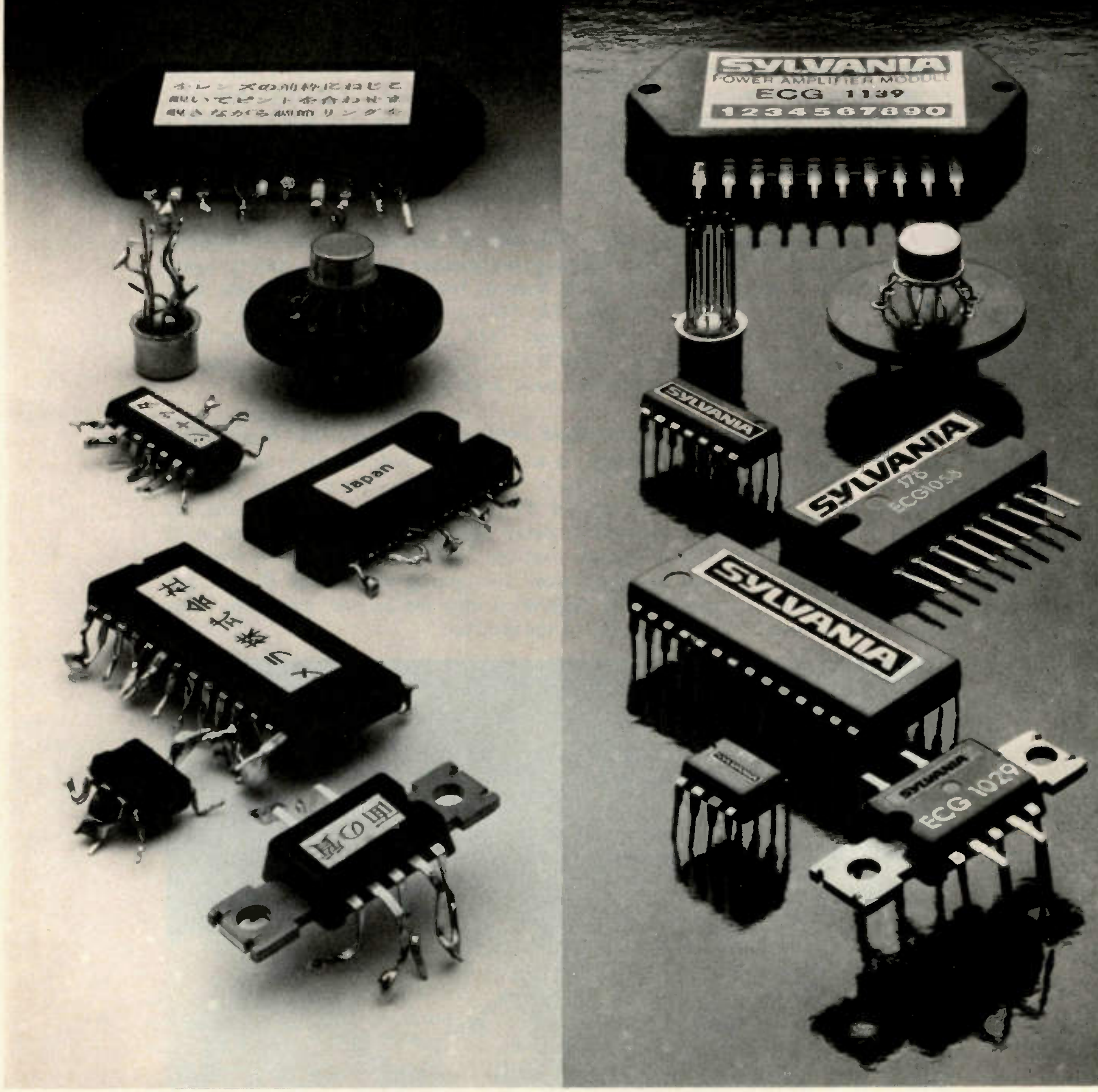
Applications for CB licenses increased more than 10% for the first half of 1977, compared with the same time period for 1976, according to the FCC. Approximately 11 million CB licenses have been issued by the FCC since 1958, and over half of them were granted in the last 18 months.

Litton Microwave Cooking Products has filed suit in U.S. District Court against the Whirlpool Corporation for patent infringement and unfair competition. The Litton Industries division said that Whirlpool's model 7000 series microwave ovens have infringed upon and continue to infringe upon Litton's patents for the door assembly and overall exterior design of its model 400 series ovens.

The Justice Department has begun an investigation of Japanese color TV manufacturers to determine whether they have violated U.S. antitrust laws. *Retailing Home Furnishings* reports that the investigation will examine alleged collusive and market allocation agreements entered into from 1963 to 1973 by 18 Japanese firms.

continued on page 6

In replacement parts nothing is foreign to us.



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Pick up a copy of the replacement guide at your distributor today, so you'll be able to pick up all the parts you need in just one stop tomorrow.

GTE SYLVANIA

continued from page 4

Philco Consumer Electronics has announced the recall of 3,132 Philco 15-inch and 19-inch color receivers (models C2925JWA, C2912JWA, and C2525JWA) that were manufactured between April and July of 1977. A grounded user might receive a shock as he depresses completely the AFT spring-loaded button when the TV wall outlet is not properly polarized. The possible hazard was found by factory quality-control people, and there are no reports of any shocks to set users.

RCA is recalling three 19-inch b&w 1977 models. *Retailing Home Furnishings* reports that rough handling during shipping might cause the picture tube to come loose, creating a potential 60-volt shock hazard. Model numbers and first four digits of the serial numbers are: AB191S, 7182 through 7223; AB192W, 7154 through 7223; and AB195FX, 7166 through 7223. About 18,000 sets have been shipped to distributors and dealers since mid-April. RCA said, however, that no reports of electrical shocks to consumers have been reported.

Sencore has announced specially-prepared seminars nationwide for combination CB/AM/FM radios. The seminars, conducted by Sencore test equipment specialists, are technically-oriented "how to" learning sessions covering effective troubleshooting of CB and stereo circuits. Two one-hour videotapes, prepared by Sencore's field engineering department, detail the operation and application of Sencore SG165 AM/FM Stereo Analyzer and the CB42 Automatic CB Analyzer in troubleshooting combination in-dash units. Two young technicians (below) are shown learning to test stereo channel separation with the Sencore analyzers, from instructions provided by the videotape at the seminar.

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	SAN MATEO, CALIF. 94402	600 S. Amphlett Blvd.	Tel. 415-348-3292
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LOUISIANA	SHREVEPORT, LOUISIANA 71104	2423 Southern Avenue	Tel. 318-221-3027
MASSACHUSETTS	SPRINGFIELD, MASS. 01108	405 Dickinson St.	Tel. 413-788-8206
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NEVADA	LAS VEGAS, NEVADA 89102	1114 South Casino Center Blvd.	Tel. 702-384-4235
NEW JERSEY	TRENTON, NEW JERSEY 08638	1139 Pennsylvania Ave.	Tel. 609-393-0999
	JERSEY CITY, NEW JERSEY 07307	454 Central Ave.	Tel. 201-792-3730
NEW YORK	ROCHESTER, NEW YORK 14615	37 Pullman Ave.	Tel. 716-647-9180
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OREGON	PORTLAND, OREGON 97210	1732 N.W. 25th Ave., P.O. Box 10141	Tel. 503-222-9059
PENNSYLVANIA	PITTSBURGH, PA. 15209	515 Grant Avenue	Tel. 412-821-4004
TENNESSEE	MEMPHIS, TENNESSEE 38111	3158 Barron Avenue	Tel. 901-458-2355
TEXAS	DALLAS, TEXAS 75218	11540 Garland Road	Tel. 214-327-8413
CANADA	ST. LAURENT, QUEBEC H4N-2L7	305 Decarie Boulevard	Tel. 514-748-8803
	CALGARY, ALBERTA T2H-1Y3	P.O. Box 5823, Stn. "A"	Tel. 403-243-0971

WATCH US GROW

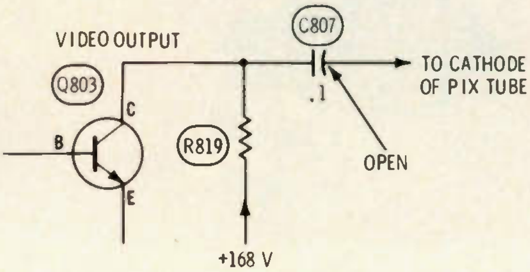
If you want to branch out into the TV Tuner Repair Business write to the Bloomington Headquarters about a franchise.

For More Details Circle (7) on Reply Card

symcure

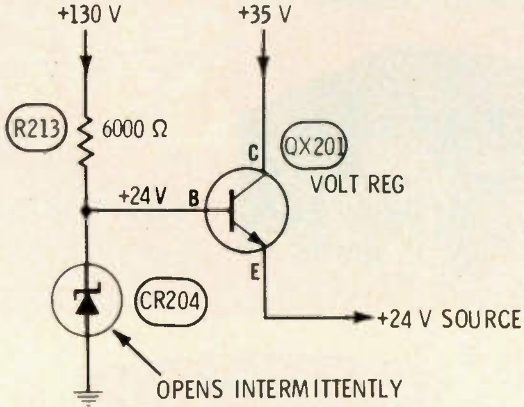
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 12GB1 B&W
PHOTOFACT—1603-2



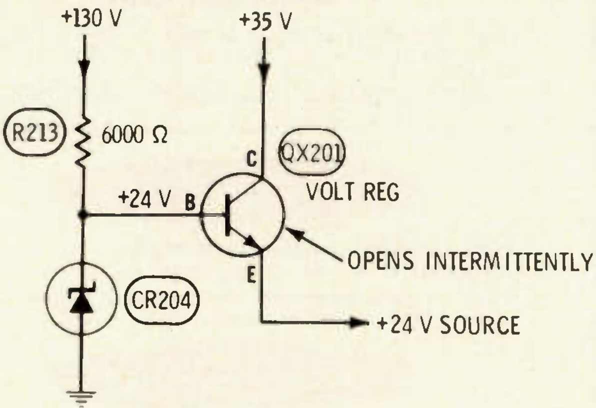
Symptom—Low contrast with retrace lines
Cure—Check C807, and replace it if open

Chassis—Zenith 23GC45
PHOTOFACT—1558-2



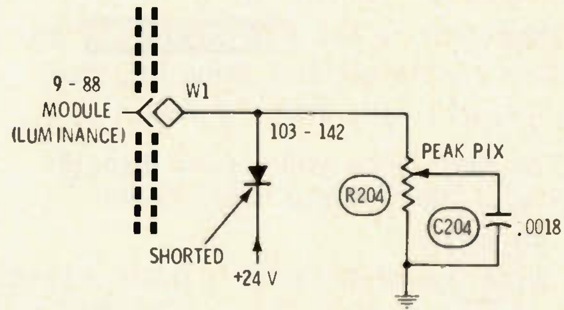
Symptom—Picture intermittently goes dark
Cure—Check or replace zener diode CR204

Chassis—Zenith 23GC45
PHOTOFACT—1558-2



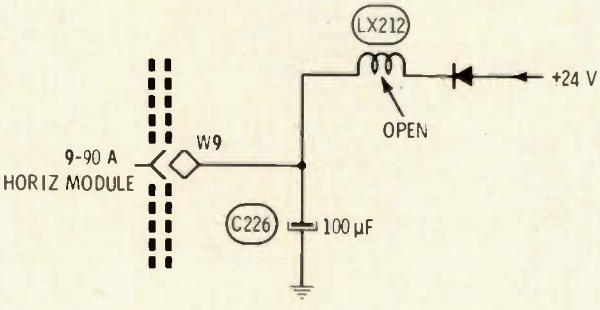
Symptom—Intermittent raster
Cure—If 24-V supply is intermittent, replace QX201

Chassis—Zenith 23GC45
PHOTOFACT—1558-2



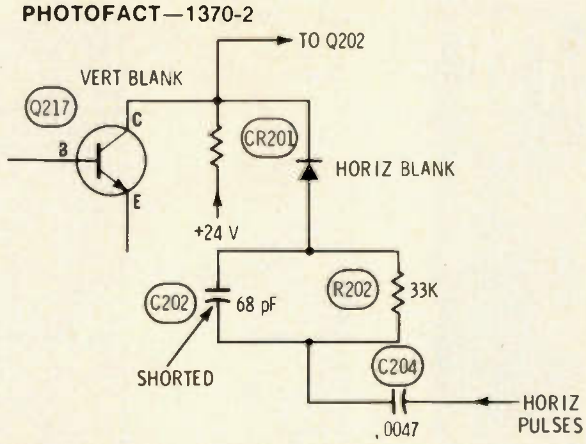
Symptom—Little or no brightness
Cure—Check diode (not on all schematics), and replace it if shorted

Chassis—Zenith 23GC45
PHOTOFACT—1558-2



Symptom—No HV, no raster
Cure—Check peaking coil L212, and replace it if open

Chassis—Zenith 25EC58
PHOTOFACT—1370-2



Symptom—One side of raster is darker and has retrace lines
Cure—Check C202, and replace it if shorted

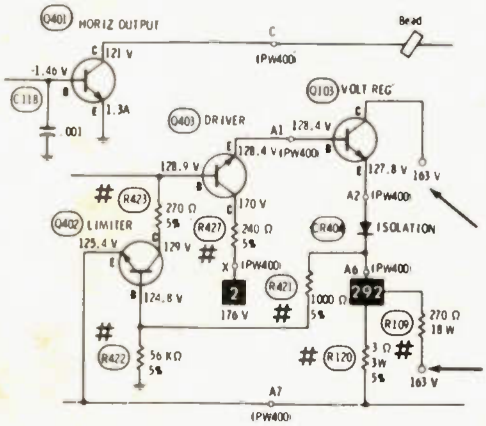
troubleshooting tips

Send in your helpful tips—we pay!

Narrow, blurred picture
RCA CTC70AD (Photofact 1468-2)

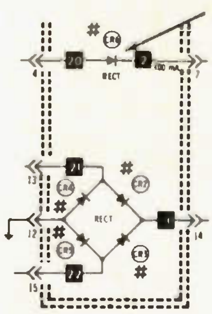
The picture was narrow by about 3 inches at each edge, and the focus was poor at normal brightness. When the brightness setting was reduced, the width increased somewhat.

Instead of a MAH004B module, as shown on the schematic, this set had a MAH009A horizontal module, which had more components.



I checked all of the diodes and transistors of the horizontal-output circuit on PW400 board, but didn't find any bad ones. Then, because I had no MAH009A module, I checked all of the transistors on the module. All were okay.

While taking DC voltage readings on and around the module, I found that the +88 volts at pin 10 of the module measured only about +40 volts, and the bias voltage of the horizontal-output transistor at pin 12 also was low. The voltage for pin 10 comes through external resistors R109 and R120 from the +163-volt supply. Therefore, I pulled the MAB002A supply module and checked CR6, finding it very leaky.



I replaced CR6 and the picture came on with full width, good brightness, and normal focus. Later, the CR6 checked nearly a dead short.

From this case, I concluded that a good place to start checking for a narrow picture is the +163-volt supply. Both the regulator and output stages operate from it.

William Pokorny
Rice Lake, Wisconsin

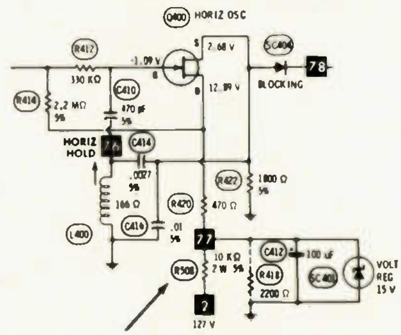
continued on page 12

troubleshooting tips

continued from page 11

No raster, no audio
Sylvania A19-2 (Photofact 1473-2)

I have found several of these color sets with the same defect, so the repair now is easy.



First, I check R508 (10K ohms at 2 watts), and replace it if the value has increased or it is open. The audio channel receives B+ power from scan rectification of the horizontal-sweep signal. That's why the sound also is dead.

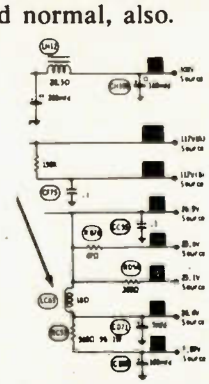
R. Dean Gilmore
Alexandria, Louisiana

No color
Admiral T15K10-1A (Photofact 1392-1)

I tried fine tuning, color control, and color killer, but had no color.

Even though the color section is transistorized, I always check the 3.58-MHz oscillator first, just as I learned to do with tube sets.

In this case, the DC voltages of Q18 were well within tolerance, and the collector signal measured 6V PP. The stage was okay. All of the Q19 buffer voltages were wrong. I suspected a bad transistor, but it checked good. The demodulator (Q20) had low voltages at base, emitter, and collector. This transistor checked normal, also.



I began to wonder about the source voltages, and measured zero volts at sources 5 and 6. Switching to an ohmmeter, **I found an open LC63 choke.**

However, replacing the choke coil did not bring back the color. Finally, I remembered trying the killer adjustment, and a slight readjustment of the killer control gave excellent color.

Robert E. Snow, Jr.
Clearwater, Florida

reader's exchange

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

For Sale: Sencore color-bar generator, Model CG126, dots, crosshatch, vertical bars, horizontal bars, and color bars, $30. *B&A Radio-TV, 30 Oak Street, Hogansville, Georgia 30230.*

For Sale: Hickok Model 220 semiconductor analyzer, with probes, excellent condition, $200. *Richard D. Ray, 208 Daris Avenue, Lancaster, Kentucky 40444.*

Needed: Setup book for Superior Instruments' Model 82A "Rapid Tube Tester". Will buy, or copy and return. *Smith TV Service, 1912 Ebenezer Road, Newberry, South Carolina 29108.*

For Sale or Trade: B&K Model 970 radio analyst, like new; Eico Model 380 color generator; other test equipment. *Norman Round, 33 Franklin Street, Lawrence, Massachusetts 01840.*

Needed: Schematic for Emerson portable radio Model MB-310, with instructions for stringing the dial cord. Will buy, or copy and return. *Hector Medina, 1845 West Roscoe, Chicago, Illinois 60657.*

Needed: New or used power transformer T686-115 for Fisher stereo Model 440, chassis 610-ST. *D. M. Bernatonis, 211 Sunbury Street, Minersville, Pennsylvania 17954.*

Needed: Schematic and alignment information for Demco "The Star" AM CB base station transceiver manufactured by Command Electronics of Schoolcraft, Michigan. Will buy, or copy and return. *V. P. Marion, Jr., Service Manager, Citizen Electronics, 500 Main Street, Archbald, Pennsylvania 18403.*

For Sale: Seven RCA Institute and two National Radio Institute home-study courses, $7 plus transportation each; or $50 for all nine, plus transportation. Write for complete list and description. *William Shevtchuk, One Lois Avenue, Clifton, New Jersey 07014.*

For Sale: Hickok Model 550X tube tester (Navy Model 0Z-1), plus tube socket adapter MX-1123/U. Test tubes from 1945 up to 12-pin compactrons; an elaborate tester, $40. *A. C. Weiss, 11658 Harvard Drive, Norwalk, California 90650.*

For Sale: Heathkit scope Model 10-14, and Heathkit color-bar and dot-generator Model 1G-28, with manuals; both factory calibrated. Less than 10 hours on each. *Joe Sargis, 1385 Bayshore Drive, Englewood, Florida 33533.*

continued on page 16

Services the latest solid state chassis!
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All-new Zenith Universal Color TV 800-880 Test Rig

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Features a 19TT 30KV 19" Chromacolor® picture tube with a limited one-year warranty.

A quick and easy-to-use plug positively locks-in to allow you to match the 800-880 Test Rig to the TV chassis being tested.

Magnetic shield helps eliminate the effects of stray magnetic fields.

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And the proper adapters are included with the 800-880 to allow servicing of virtually all Zenith TV chassis, while optional Zenith adapters are available to permit servicing 110° Zenith sets as well as other brands.

Additional adapters available from Zenith increases its versatility to over 10,000 sets from 52 manufacturers. Zenith adapters currently on your shelf can also be used.

Also included is a complete up-to-date Instruction and Cross-Reference Guide with each and every unit.

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25¾" wide; 20" deep; 18¾" high.

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Monitors the voltage of the chassis under test. It's ideal for performance verification after work is completed, plus the monitor is a great aid in servicing.

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All the current Zenith adapters necessary to service most Zenith chassis are supplied with the rig. A complete up-to-date Cross-Reference Guide is included to cover most all other TV brands. A special optional adapter is available to cover the 13-inch sets.

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reader's exchange

continued from page 13

Needed: Service and instruction manual for B&K-Precision Model 1075 analyst; B&K-Precision A107 Dynasweep analyzer; and Solar Model C-F Exameter. Will buy, or copy and return. *Bruce's Radio & TV, Delta, Iowa 52550.*

Needed: Service data for a Bradford 17" B&W 1971-vintage TV (with chassis ID HG 1; model number removed). Will buy, or copy and return. *Phil & Bill Electronic Servicing, Route 2 Box 1-WH, Colonial Beach, Virginia 22443.*

For Sale: Bases for new Garrard record changers: B1/B2, $6.50 each postpaid; B1P/B2P, $8.50 each postpaid; BM/WB-600, $8.50 each postpaid; and UH/MB-10, $8.50 each postpaid. *Davis Electronics, 2655 West Park Drive, Baltimore, Maryland 21207.*

Needed: Record/play unit, motor, and record/play head for Concord F-128 8-track tape machine. Will consider old complete unit if it has good parts. *M. R. Davis, 2655 West Park Drive, Baltimore, Maryland 21207.*

Needed: Accurate RF generator for CB work. Also, TV test equipment for color and B&W. *Tom Vander Tuuk, 340 Oakwood Drive, Griffith, Indiana 46319.*

Needed: Manual and/or schematic for B&K-Precision TV analyst, Model 1075. *Harry Matosian, 14035 Hartsook Street, Sherman Oaks, California 91423.*

For Sale: Eico factory-wired sine/square-wave generator, 20-200,000 Hz, like new, $49.50. Heath in-out circuit transistor tester, hardly used, $22.50. *Milton Kaufman, Box 3504, New Hyde Park, New York 11040.*

For Sale: B&K Model 415 sweep marker generator, still in box. Also, Bell & Howell home-study course in electronics, specializing in television repair. Best offer. *Clarence Gillow, 608 Black Drive, Prescott, Arizona 86301.*

For Sale; RCA WR538A color-bar generator; Eico 324 signal generator; Conar 250 scope with all probes; Conar 311 resistor and capacitor tester; Conar 280 signal generator; Conar 224 tube tester with CRT tester; and Conar isolation transformer. Each item has a manual and is in perfect condition. Make offer. *Mark Womelduff, 706 West 7th, R.R. 2, Garnett, Kansas 66032.*

Needed: Schematic and alignment data for a Heathkit AR-3, and a Bendix MRT-6FB (an FM tube-type transceiver that has been converted for two-meter operation). Will photocopy and return. *Robert D. Houlihan, 497 East Fremont Street, Galesburg, Illinois 61401.*

For Sale: Tektronix 511A scope, $50; Marooni TF-1247 20-300 MHz oscillator, $20; HP 5240 frequency counter, $40; and Heath IO-102 scope, $85. *J. Lel, P.O. Box 5312, Fargo, North Dakota 58102.*

Needed: Riders radio manuals, volumes 17, 20, 21, 23, and indexes. Several extra volumes for trade. Old 4-pin radio tubes needed for early Radiola collection. *Ben Westfall, 323½ Newport Avenue, Long Beach, California 90803.*

Needed: Service and operating manuals for a Precision Apparatus tube tester, Model 620. Will buy, or copy and return. *Rudy Forsberg III, 224 Lewis Place NE, Massillon, Ohio 44646.*

Needed: Manual and diagram for B&K Model 1403A scope. Will buy, or copy and return. *Ed Tonrath, 3035 La Salle Avenue, Rockford, Illinois 61111.*

For Sale: PF Index from #24, and *Electronic Servicing* to March 1977. Best offer. *John Bossone, 24 Benjamin Drive, North Providence, Rhode Island 02904.*

Needed: B&K sweep/marker generator, with probes and manual. *William C. Corning, 7700 Boeing Avenue, Los Angeles, California 90045.*

Needed: Manual for S-32A Telequipment scope. Will buy manual, or a good copy. *C. K. Fitzsimmons, 321 W. North Avenue #60, Lompoc, California 93436.*

Needed: Schematic and service data with parts list for an Akai Model M9 tape recorder. Will buy, or copy and return. *H. Vogt, 4431 Troost Avenue, Kansas City, Missouri 64110.*

Needed: A probe for Model CT-1 Century VTVM. *George H. Vogedes, 973 Madison Street, Brooklyn, New York 11221.*

For Sale or Trade: Heath "Q" meter and Heath impedance bridge. Need Heath IO-101 vectorscope and IC breadboard with self-contained power supply. *Ed Tanrath, Electronic Services, 3035 LaSalle Avenue, Rockford, Illinois 61111.*

For Sale: Hewlett Packard L08A signal generator, $275. Professionally serviced recently. *Stuart A. Jay, 1600 West Avenue, Beach Haven, New Jersey 08008.*

For Sale: Rider's radio manuals volumes 1, 1-through-5 abridged, 2, 3, 4, 5, and 6; $40 each. Volumes 7 to 17; $20 each. 00A, 01A, 199, 299, 20, 15, 25B8, 12FR8, and FM1000; $15 each. *Goodwin Radio Shop, Rankin, Illinois 60960.*

For Sale: Large quantity back numbers of Electronics World, Radio Electronics, Popular Electronics, Service, Radio-TV Maintenance, Radio-TV Service Dealer, Audio, Electronics, etc. Send self-addressed stamped envelope for list. *Roy Berthold, 66 Reid Ave., Port Washington, New York 11050.*

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reader's exchange

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Needed: Sencore SG-165 stereo analyzer, UPS-164 power supply, CB-42 CB Tester in good condition and reasonable. *Bill Walters, P.O. Box 78, Nevada, Missouri 64772.*

For Sale: Eico 235 VTVM; Heathkit V-7A VTVM; Eico 955 in-circuit capacitor tester; Eico 369 TV-FM sweep & post injection marker generator; Heathkit AG9A audio generator; Eico 1020 power supply; Eico 685 transistor analyzer; Eico 379 sine/square wave generator; and Eico 950 resistance-capacitance comparator. All come with manuals. Make offer for one or all. *Donn's TV Repair, 5484 Mildred Street, Simi Valley, California 93063.*

Needed: Instruction manual for RCA WO-91B scope. Will buy, or copy and return. *Anton Sommer, 2801 Herron Road, Herron, Michigan 49744.*

Wanted: Good used 19HTP22, 490GB22, 22QP22 CRTs. *M. B. Danish, Mike's Repair Service, P.O. Box 217, Aberdeen Proving Ground, Maryland 21005.*

For Sale: RCA Model WR50A RF signal generator, frequency range 200 Hz to 40 MHz in 6 bands, probes included; in good working condition, $30. *Al's TV Service, 1158 Burton SW, Grand Rapids, Michigan 49509.*

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For Sale: Precision sweep generator, Model E400; and Precision scope, Model ES500, with test lead and manuals, $125; Transvision picture-tube tester/reactivator with HV sparker, $35. *A. L. Crispo, 159-30 90th Street, Howard Beach, New York 11414.*

For Sale: Hewlett-Packard signal generator Model 608A, $225; Bird wattmeter Model 43, $85; Heath frequency counter Model 1B-1103, $195. All in excellent condition. *Stuart Gray, 1600 West Ave., Beach Haven, New Jersey 08008.*

For Sale: Sencore Model CB42 CB tester. Never been used; still under warranty. Asking $815. *L. D. Dickson, 384 Harrison Street, Coalinga, California 93210.*

Needed: Schematic for Lafayette AM/FM 99-3515L radio receiver. Would like to receive correspondence from technicians. *Manuel Pacheco P., Apdo. Postal 31, Sucursal D, Merida, Yucatan, Mexico.* □

The Operation Of

Popular devices of our modern life include the games that simulate a sports event on the screen of any TV receiver. The lines and rectangles of each game are produced by digital pulses. Although the explanations and circuit theory are based on "Odyssey" models by Magnavox, many of the basic principles apply to other brands.

LSI Video Games

These new electronic games that are played on the screens of TV receivers are called "video games" because the digital pulses that simulate the playing-field lines, the players, and the game ball are used instead of the analog video of conventional TV signals. This digital video is added to the vertical sync, the horizontal sync, and the blanking to make up the composite video which modulates an oscillator for either channel 3 or channel 4. The modulated carrier goes through a game/TV selector switch before it reaches the TV antenna terminals.

Video Games

by G. Andrew Schuhler
The Magnavox Company

Therefore, any TV can serve as readout of the game; and no modifications are necessary.

In the TV receiver, the modulated carrier is treated exactly the same as if it were from a TV station. The sweep circuits lock to the sync, and the video is displayed on the screen.

LSI (Large-Scale Integration) ICs which contain hundreds of diodes and transistors simplify the wiring of these games.

For example, only four LSI-type ICs are required for each Magnavox "Odyssey 100" (Figure 1) and other models add two more to allow additional players and automatic scoring.

Before describing the details, I'll give some general information that should help you understand the circuit philosophy of video games.

Four Types Of Video

For years, crosshatch generators have given us stable patterns of lines and dots that are viewed on the TV screens. These patterns are similar to those produced by video games.

However, there are two important and unique differences: some of the video patterns of the games are not continuous across the TV screen, and the simulated "ball" and "players" can be moved around the screen during the game playing.

These four kinds of video waveforms are added to the game composite video signal:

- video that simulates walls or nets (they do not move during play);
- video pulses from two or more players (these move according to the players' manipulation of the controls);
- one video waveform that represents the playing ball (this waveform moves under the control of the players; also, it appears to ricochet from walls or the invisible rebound lines); and
- video information for scoring

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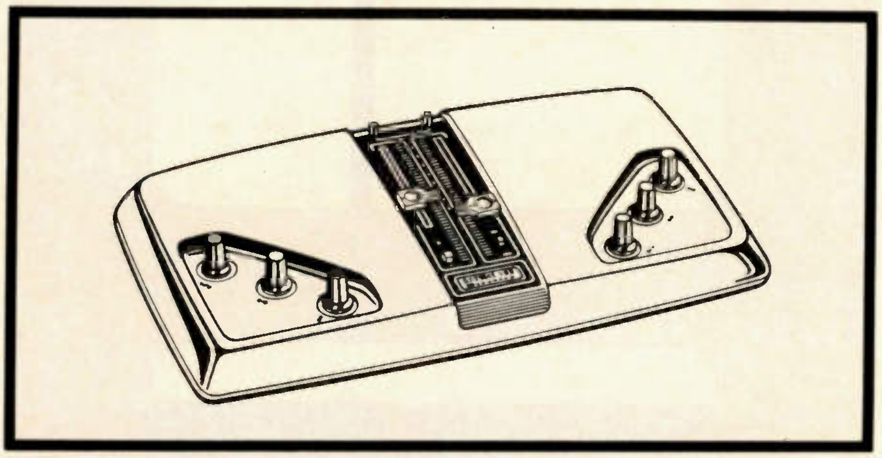

Figure 1 The Magnavox "Odyssey 100" permits "tennis" and "smash" games to be played. Four ICs are used in this model. Other models add two more ICs for "hockey," two more players, and digital on-screen scoring. (*Courtesy of Magnavox*)

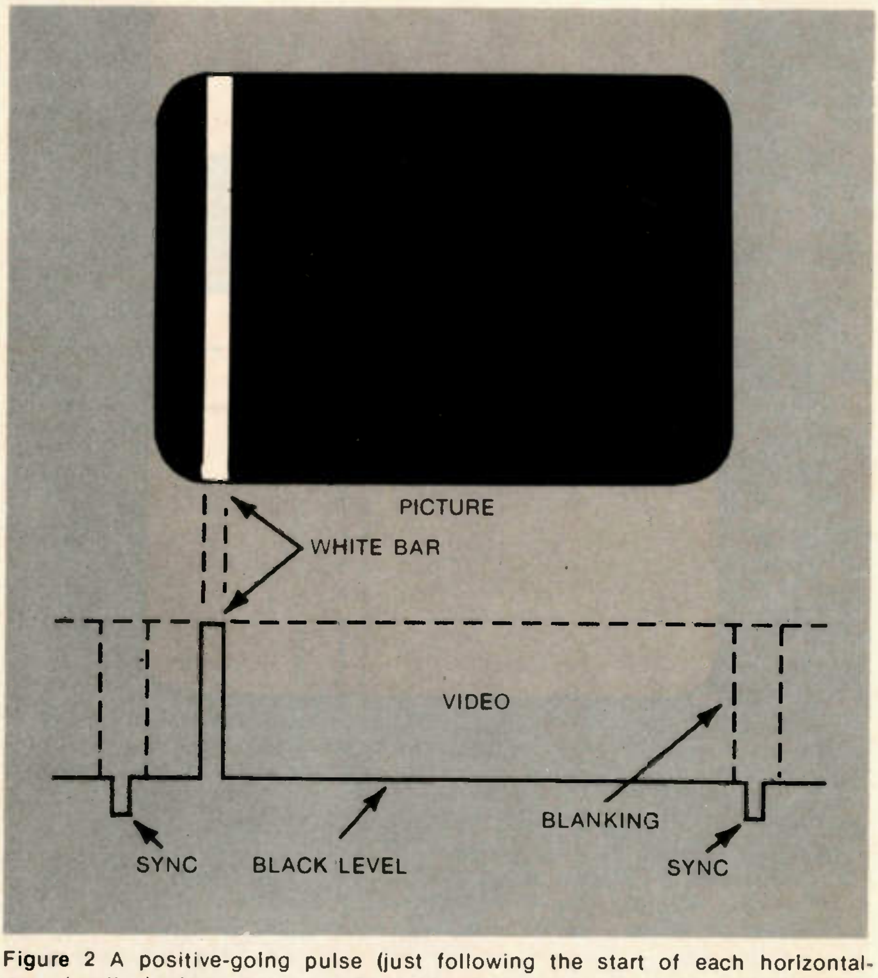

Figure 2 A positive-going pulse (just following the start of each horizontal-scanning line) added to the negative-going sync pulses produces a single white vertical bar on the TV screen. The picture-tube screen is above, and the video waveform is shown below.

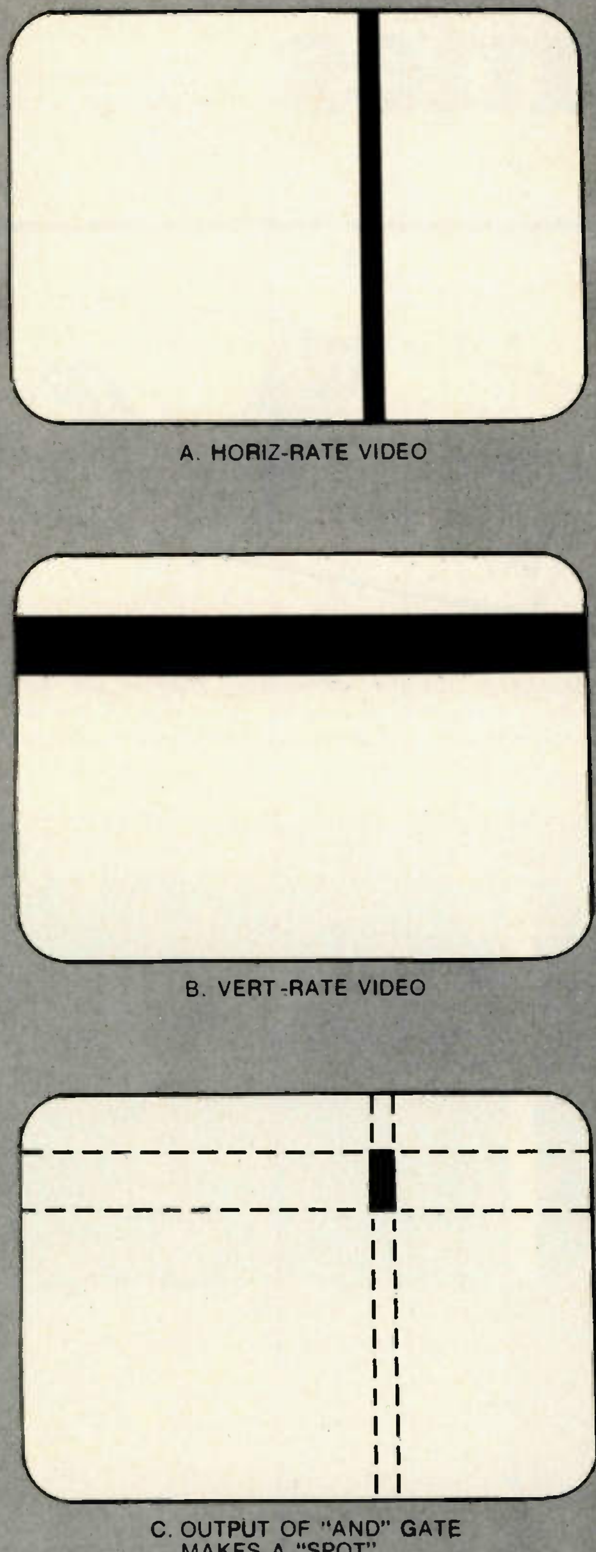

Figure 3 To make a short vertical bar, both horizontal-rate and vertical-rate pulses must be combined. (A) A horizontal-rate pulse alone produces a solid vertical line across the full TV screen (B) A wider vertical-rate pulse by itself provides a single horizontal line across the screen. (C) When both pulses trigger an AND gate the output signal is there only during the times both pulses coincide. This shows on the screen as part of a vertical line.

Video Games

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(these elements must change). Some models show two single lines to indicate which player is ahead; others have an on-screen *digital* readout of the exact score.

The Principles Of Generating Game Lines

Walls

The easiest game line to produce is the "wall" on the left side of a handball court (Magnavox calls the game "Smash"). As shown in Figure 2, it's necessary only to generate a positive-going pulse (at the picture tube) that occurs slightly after the start of each horizontal scanning line.

When all of the raster lines on the screen of the TV receiver have this positive pulse, a white vertical line is formed. The drawing of Figure 2 has dotted lines to indicate the location of blanking pulses in normal TV composite video. Of course, the repetition rate of the pulses making the vertical line must be the same as the horizontal-sync pulses; only the time of arrival (phase) is different.

Walls that are not continuous from top to bottom must have video from both horizontal-rate and vertical-rate signals. This principle is given next for the player signal. The game "Hockey" has two walls, with a hole representing the goal net in each.

Player video

Another video waveform composed of both horizontal and vertical signals is the narrow rectangle that simulates a game player.

A positive-going pulse of the desired width (duration) and horizontal position between sync pulses is generated (see Figure 3). At the same time, a vertical-rate wider pulse is produced between the vertical sync pulses. When these two signals trigger the inputs of an AND gate, the output will appear on the TV screen as a short vertical bar.

Remember that the output of an AND gate can be high (positive) *only* when *both* input signals are high. Therefore, the AND gate produces an output only during the time both the horizontal and vertical signals are there.

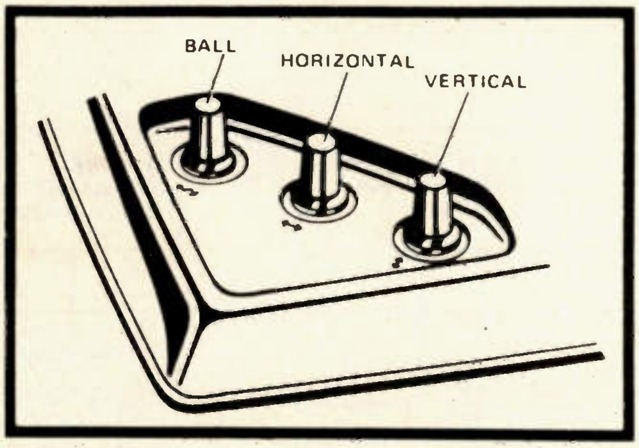

Figure 4 Each player has three controls. The horizontal and vertical controls determine the direction the player spot moves. The ball control adds vertical movement (controlled by the player) to the normal horizontal ball travel. It is used to outmaneuver the other player. (*Courtesy of Magnavox*)

Moving the player

If the pulse of Figure 3A is moved to the left (nearer the preceding sync pulse and farther from the following sync pulse), the player rectangle moves the same amount to the left. Or, when the vertical pulse making the horizontal line in Figure 3B is moved lower (farther from the preceding vertical sync pulse and nearer the following vertical sync pulse), the player rectangle moves downward the same relative amount.

If both actions are equal and occur simultaneously, the player rectangle will move diagonally down to the left at a 45° angle.

This is the method of moving the player symbols and the ball symbol. Many of the details of the circuit operation inside the ICs will be given. However, some facts are industrial secrets (called proprietary information) and are not known completely.

DC voltages are applied to the proper pins of the ICs to change the phase of the pulses, which in turn move the visible symbols on the screen of the TV receiver. Incidentally, all of these small squares and rectangles are called "spots," and we will refer to them that way from now on.

These DC voltages come from two sources. One set of voltages are varied by the player controls. The Odyssey game has three controls for each major player (Figure 4). Movements of the players by the horizontal and vertical controls are obvious by the names. The "ball" control diagonally moves the spot

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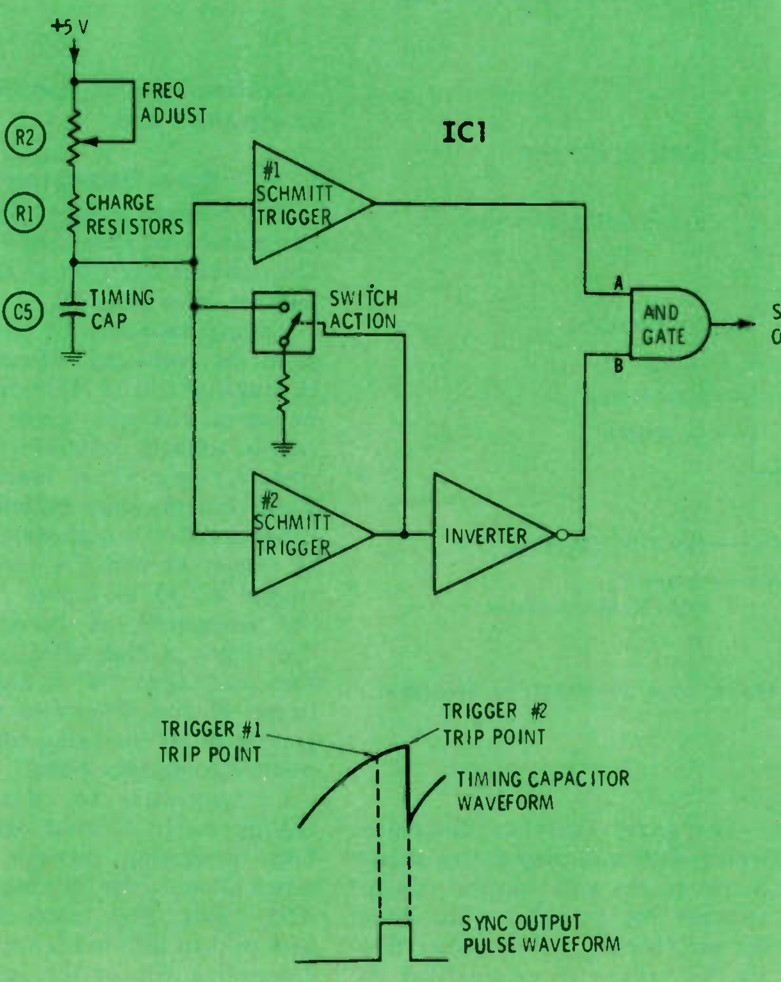

Figure 5 This is the simplified circuit of the sync generator; there are two (vertical and horizontal) that differ only in the values of R1, R2, and C5.

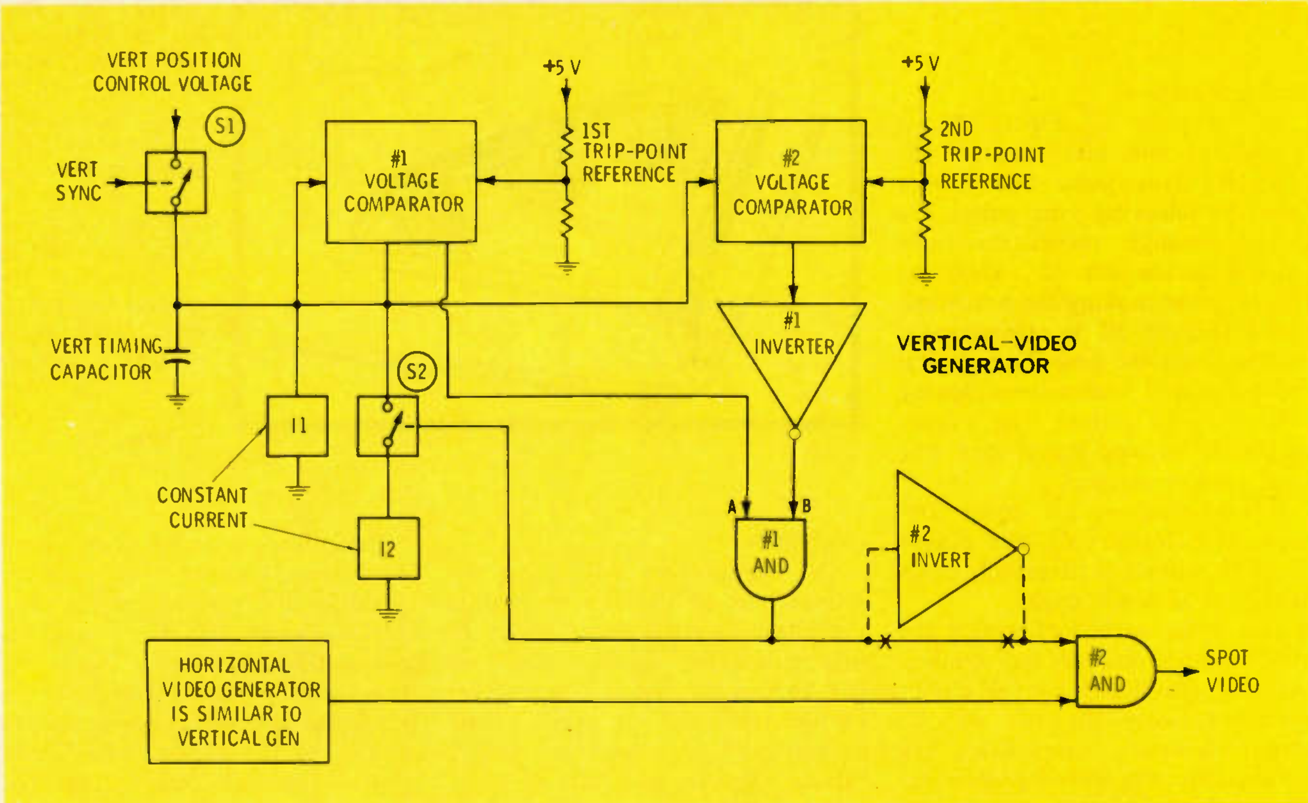

Figure 6 Vertical-rate pulses are produced in a spot generator. One voltage comparator starts the pulse, and the other comparator stops it. The vertical-position control voltage determines when the pulse is generated (phase relative to the sync). A similar circuit, except for smaller values of a few components, furnishes the variable-phase horizontal-rate pulses. Both together through the AND gate make one spot.

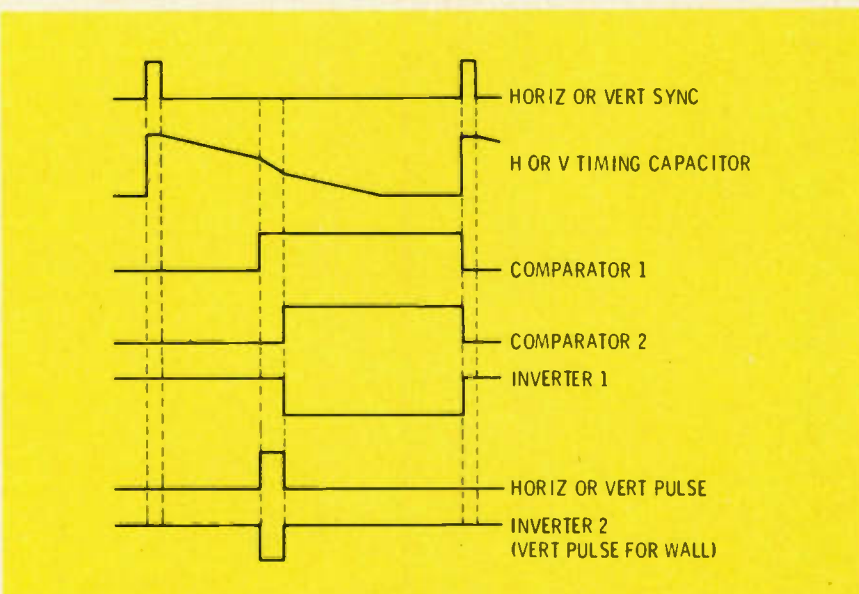

Figure 7 These are the waveforms of a typical spot generator, as described in Figure 6.

Individual circuit operations will be explained next.

Sync Generators

Two Schmitt triggers form each horizontal sync pulse (see Figure 5). One initiates the start of the pulse, and the other stops it.

Timing capacitor C5 is charged from the regulated +5-volt supply through R1 and R2. Before it becomes charged with the full supply voltage, Schmitt trigger #1 fires. Trigger #2 is inactive (low state), but the invertor following it changes this to a high state. Output of trigger #1 and the invertor for trigger #2 go to inputs "A" and "B" respectively of the AND gate. "A" input is high after trigger #1 fires, and input "B" is high before trigger #2 fires. Therefore, the AND gate produces the rising edge of the positive-going sync pulse.

C5 continues to charge, and slightly later, Schmitt trigger #2 fires, producing through the invertor a low at the "B" input of the AND gate. This forces the AND gate to turn off, and it supplies the descending side of the sync pulse. The sync pulse has been produced;

Video Games

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representing the ball, and is used by the player who has control of the "English" in an effort to outmaneuver the other.

The game switches determine which walls and players are shown. Score-reset and power on/off switches are provided also. Power for the Odyssey games comes from six "C" cells or an external 9-V AC adapter.

however, the R1+R2/C5 charge circuit has not been reset.

When trigger #2 turns on, a switch action inside IC1 bleeds the voltage from C5. After the voltage decreases sufficiently to turn off both triggers, the switch action opens, allowing capacitor C5 to begin charging again. Conditions now are right for manufacture of the next sync pulse.

The generator for the vertical sync is identical, except for the larger values for R1, R2, and C5. Therefore, we will not describe the vertical generator.

All of the components of the two sync generators (except for the timing resistors and capacitors) are inside IC1.

Video pulses

Each item of information that shows on the TV screen is produced by a video generator, and the name indicates the kind of video. Examples are "right-wall generator," "ball generator," etc.

Spot Generator

One basic video generator, with minor variations, is used to produce the various kinds of video. For simplicity, this generator is referred to as a "spot generator."

Figure 6 shows a typical generator for the vertical part of the spot signal. A constant-duration (width) pulse is required, whose position must be adjustable between the preceding and following sync pulses. This adjustment varies the vertical position of the spot (player or ball) on the TV screen.

Each pulse is generated by two voltage comparators. One starts the pulse by giving a high, and the other terminates the pulse with a low.

Here's how it works. During vertical sync time, S1 (which is in the IC) closes, passing the vertical-position control voltage (selected by one of the player controls) to charge completely the vertical-timing capacitor. After the duration of the sync pulse, S1 opens, and the vertical-timing capacitor begins to discharge through the constant-current circuit (I1).

When the capacitor voltage reaches the trip point (determined by the trip-point reference voltage) of #1 voltage comparator, the

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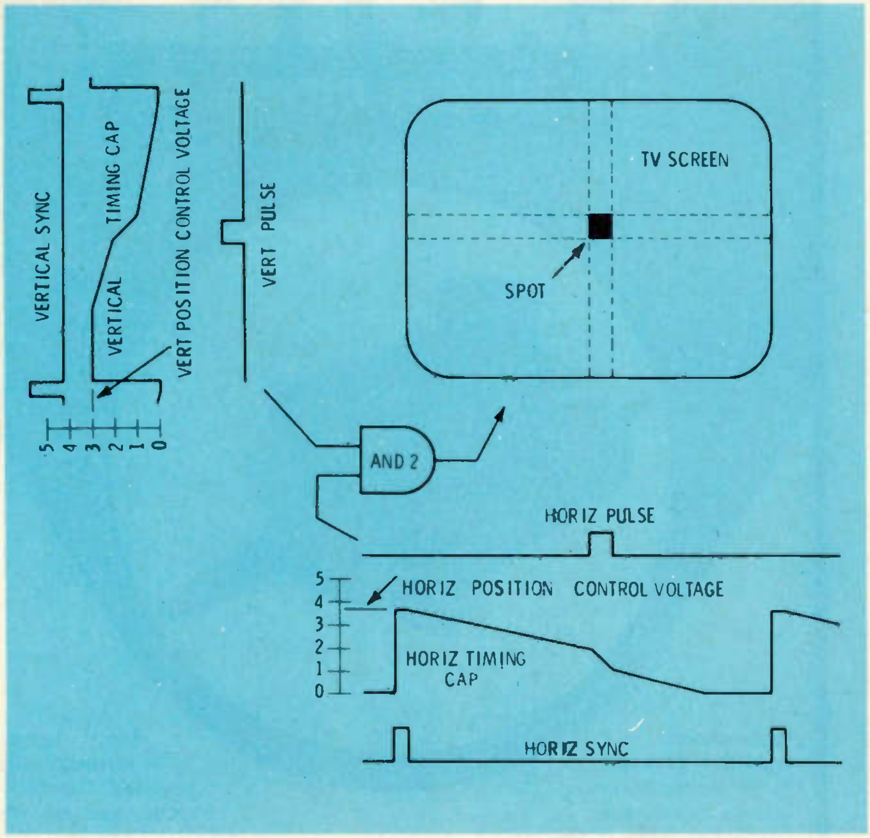


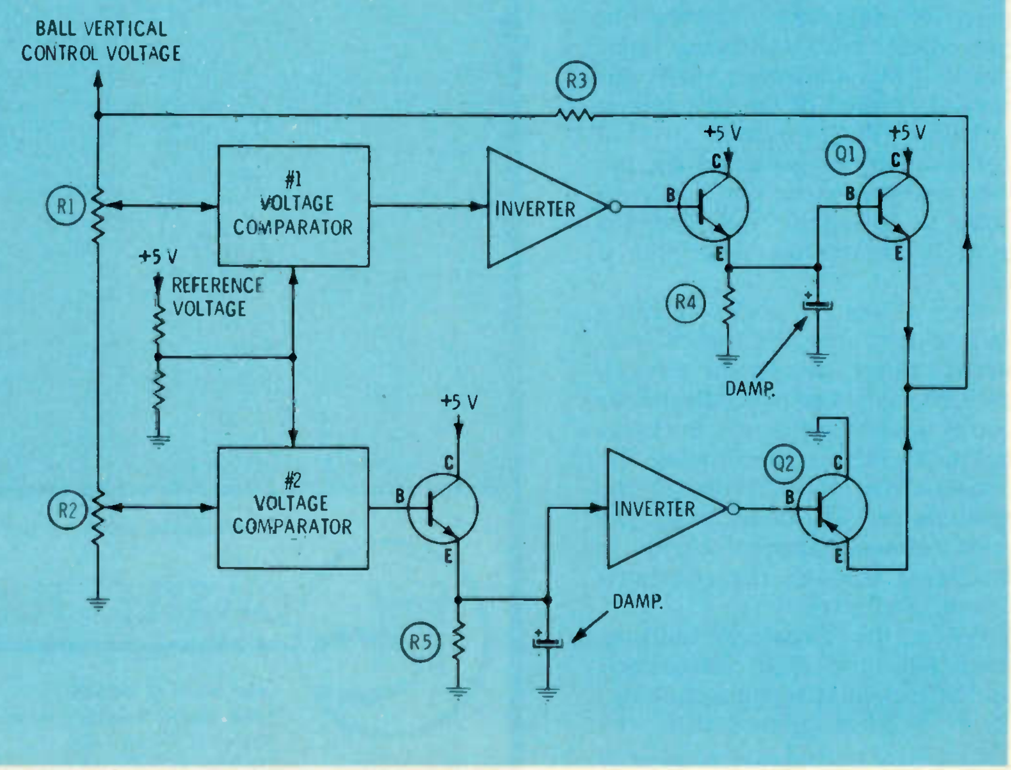
Figure 8 These drawings illustrate the waveforms in a spot generator, and how they combine in the AND gate to form a square or rectangle on the TV screen.

output of the voltage comparator switches to "high," and it is applied to the input "A" of #1 AND gate.

At this time the #2 voltage comparator is not tripped, so the output is "low," but it is inverted to a "high" by the #1 inverter. This "high" goes to the "B" input of the #1 AND gate, thus forcing the output of the AND gate to go "high," **which is the start of the spot pulse,** and also activates S2 to switch in another constant-current load (I2) that now discharges the vertical-timing capacitor at a faster rate.

When the voltage of the vertical-timing capacitor drops to the trip point of the #2 voltage comparator (determined by the 2nd trip-point reference voltage), the output of the #2 comparator goes "high." Of course, the high is inverted to a "low" by the #1 inverter, and it is applied to the "B" input of the #1 AND gate, thus changing the output of the gate to a "low." The **"low" terminates the spot pulse,** and opens S2 so the discharge of the vertical-timing capacitor reverts to the original rate.

Figure 9 Two voltage comparators produce temporary "highs" to simulate the rebound of the ball spot from a side wall. This works in connection with the ball-control voltage which moves the ball spot up or down.



The pulse for the spot has been generated at a phase determined by the vertical-position control voltage (which is adjusted by a player). Of course, this signal alone would create a horizontal line completely across the TV screen. A similar circuit operating from the horizontal-position control voltage must supply the horizontal-rate pulse.

Typical waveforms of the timing capacitor, comparators and inverter are shown in Figure 7.

The drawings of Figure 8 show the spot on the TV screen that's produced when both the vertical and horizontal pulses activate an AND gate, thus confining the spot to a small area of the TV screen. A square spot was formed by the conditions given, and this is suitable for a ball symbol. However, the player simulations have a wider vertical-rate pulse than that of the horizontal-rate pulse, giving a taller rectangle.

Similar spot generators produce other pulses that simulate the various walls, ball, and players. If the video is to be used as a goal (a wall with a hole in it), the output signal from the vertical-spot generator is inverted by inverter #2, as shown in Figure 6.

During the design of the game, the width of the spot (from the horizontal-spot generator) and the height of the spot (from the vertical-spot generator) are determined by the value of the timing capacitor versus the load of the constant-current supply, I2. The exact position of the spot is determined by the value of the timing capacitor, the constant-current load I1, and the position-control voltage.

But, after the game is built, the shape of the spot is not adjustable, and the position of the spot is determined by the position-control voltage.

Rebounding

Two voltage comparators having a common reference voltage (see Figure 9) are used to detect whether a "high" or a "low" voltage condition exists on the ball vertical-control line. This voltage is adjustable by the players-ball (English)

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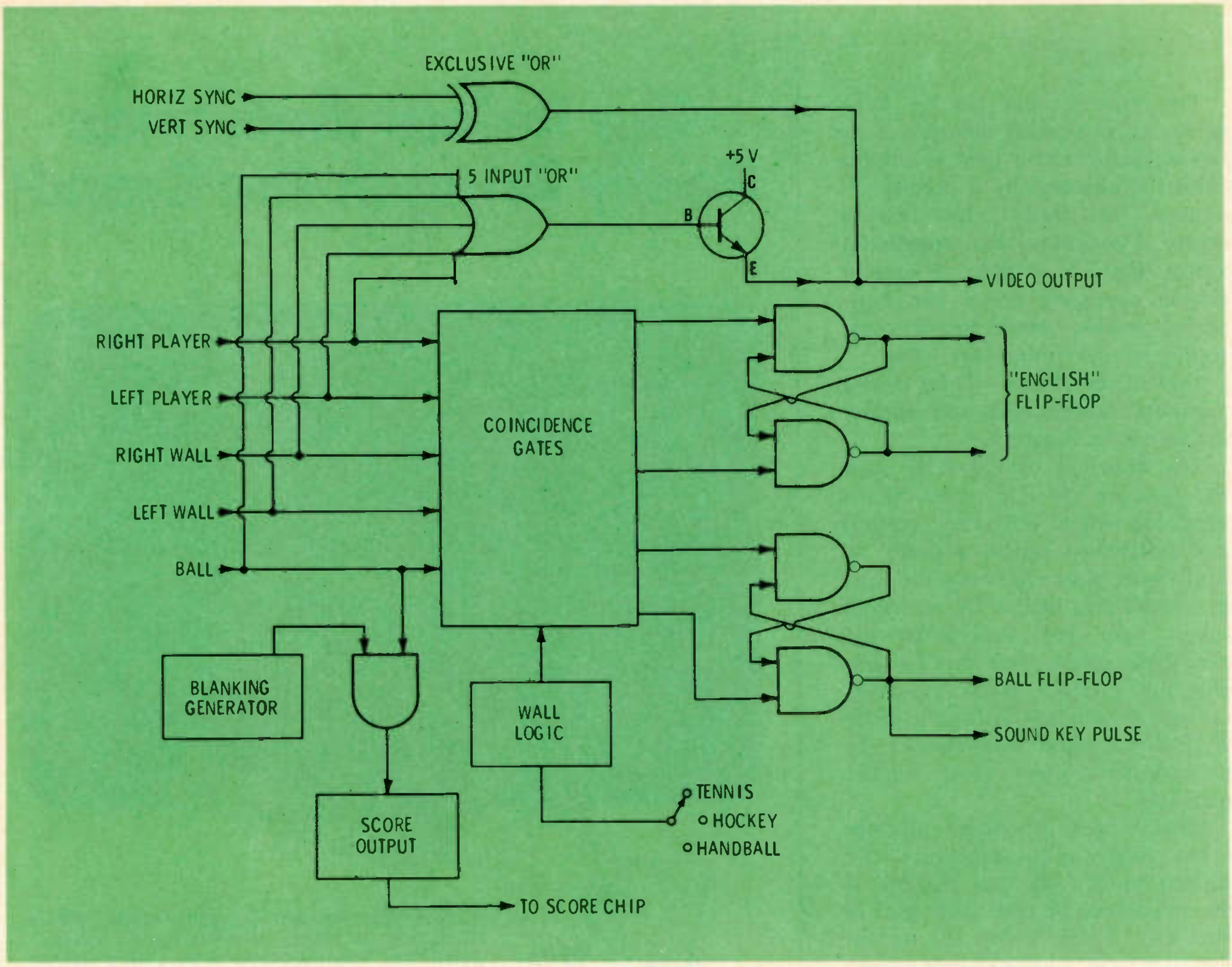

Figure 10 Both sync signals and five sources of video pulses are combined in the OR gates before they modulate the channel oscillator. The logic portions detect coincidence of the proper pulses (same phase of each), determine which player has control of the ball English, provide a pulse to simulate the sound of an impact between spots, select wall configuration, and check the coincidence of blanking and ball for scorekeeping purposes.

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control, which also determines the vertical position of the ball on the TV screen.

As the ball reaches a preset point near the top (or bottom) of the screen, the appropriate comparator transfers a voltage "high" through a switching transistor to the damping capacitor at its output line.

Trip points for the upper and lower rebound are preset by R1 and R2. The damping capacitor retains the "high" long enough to turn on Q1 (or Q2). When the transistor turns on, a voltage "high" is applied to the ball vertical-control line through R3. This voltage cancels the voltage that's already there, causing the ball to reverse its vertical direction (that is, bounce away from the rebound wall).

As the ball continues away from the rebound wall, the comparator that supplied the "high" to the damping capacitor switches off. However, the damping capacitor discharges slowly through the 100K ohms R4 (or R5 in the other circuit) until Q1 (or Q2) turns off. (Q1 and Q2 normally are not conducting when the ball is at or near the center of the TV screen.) When Q1 (or Q2) is not conducting, the ball-control voltage line no longer is affected by the rebound action, and it assumes the voltage that's supplied by the English control.

Note: If a player having ball (English) control at this time is forcing the ball into an extreme upward or downward direction, the ball returns to the rebound wall for a repeat of the rebound operation. However, when a player leaves his English control in this extreme position too long, the bounce will weaken until eventually the ball remains at the rebound line.

Video Summer And Logic

Before the composite video modulates the channel oscillator, the sync pulses and the various pulses for players, walls, and ball must be combined. All of these video sources are mixed in an exclusive OR gate, and a 5-input OR gate (Figure 10).

Coincidence gates

Coincidence of the ball pulses versus the pulses of the players (or the walls, depending on which game is selected) is detected by the coincidence gates. Although the

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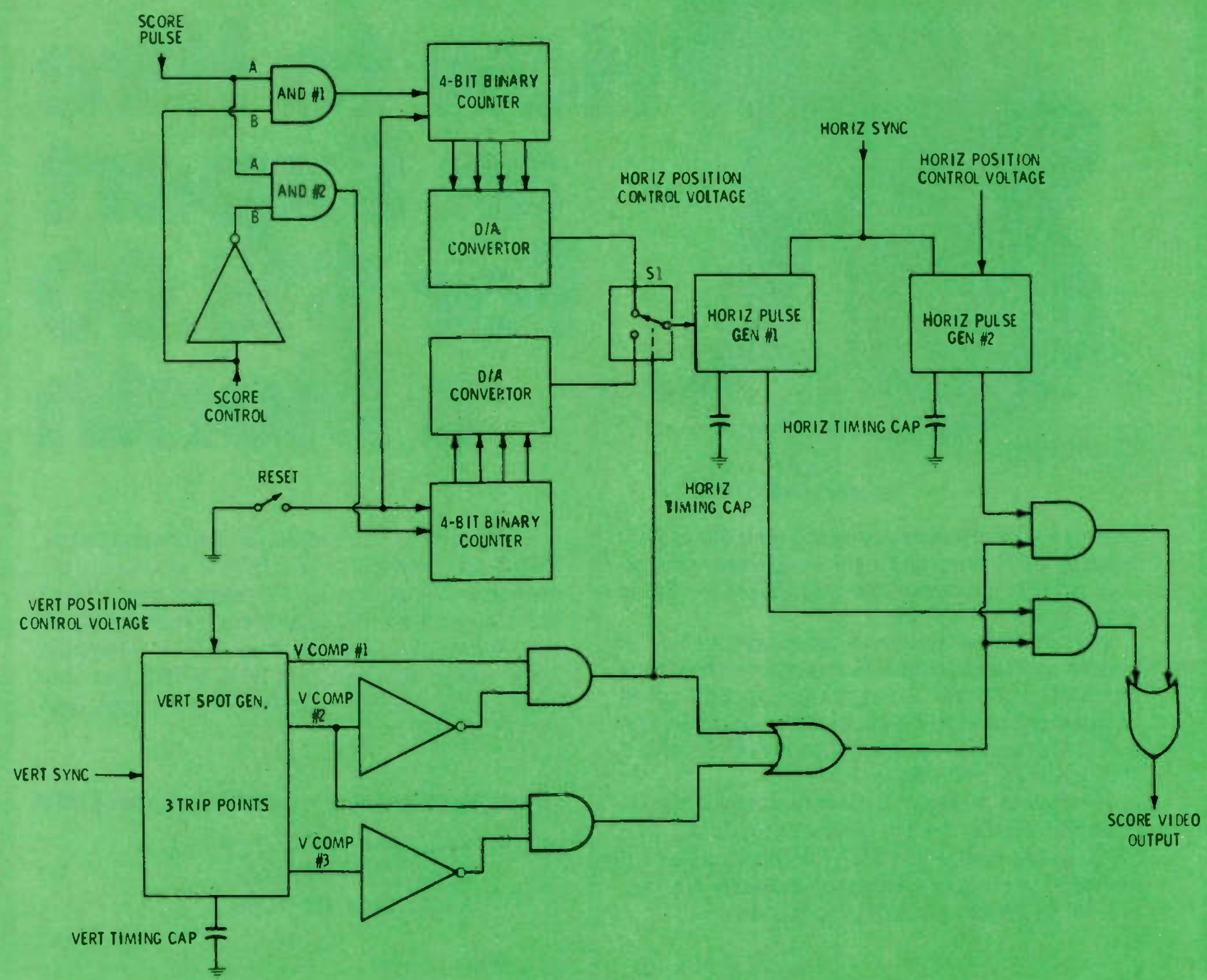
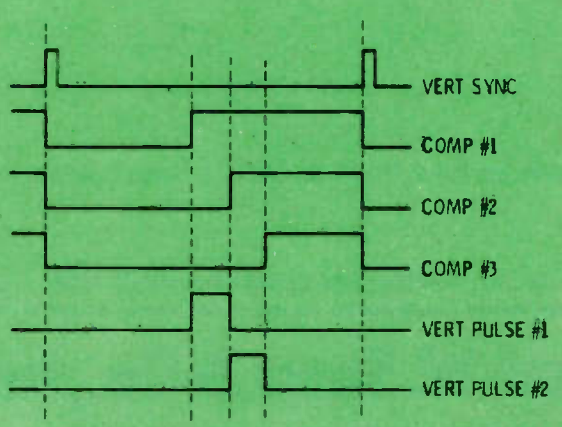


Figure 11 Odyssey 200 has two on-screen vertical bars that move to show which player is ahead in the scoring. Each player has a 4-bit binary counter that counts to 15 before requiring resetting. Three vertical voltage comparators produce two consecutive vertical pulses, so the scoring bars are seen one above the other.

Figure 12 These waveforms are typical of the three comparators that produce the consecutive vertical pulses in Figure 11.



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visual collision of the simulated ball and players on the TV screen *appears* to trigger the rebound of the ball and the sound of the impact, that's just an illusion. Actually, the same phase (coincidence) of the pulses involved is the event that begins those actions.

The proper coincidence also activates the "English" and ball flip-flops (NAND gates). The "English" flip-flop changes the polarity of the voltage applied to the player "English" control, and determines, therefore, which player has control of the vertical direction of the ball.

The ball flip-flop output is applied to the ball video generator as an increasing or decreasing horizontal control voltage, which reverses the horizontal direction of the ball. When the horizontal control voltage increases, the ball moves from right to left. But, if it's decreasing, the ball moves from left to right.

With those games that include a sound circuit, each change of ball direction produces a keying pulse to activate the sound.

The "wall-logic" control determines whether the ball should pass through a wall (as in tennis), or rebound (as in hockey or handball). Also, it enables the coincidence gates to detect ball coincidence with the back side of a player (as necessary in handball).

Finally, a blanking generator is included in this IC to provide a method of determining when a goal has been made. In that case, the ball video and the blanking pulse are in coincidence; when they trigger an AND circuit, a score-keeping device is activated. This blanking pulse is slightly wider than the horizontal sync, and is centered about the sync pulse.

Bar Scorekeeping

The Magnavox games without digital scoring keep a relative score with two vertical bars, one for each player, which can be moved to the right sixteen times as scores are made. The bar scorekeeping can only show which player is ahead, since his bar is to the right of the other bar.

When a score is made (Figure 11), a "high" is placed at the "A" inputs of AND gates #1 and #2. A score-control voltage is applied to the "B" inputs of the same gates. The polarity of this control voltage is determined by the direction of the ball at the time the score was made. If the ball disappeared at the right edge of the screen, the polarity is "high." When it goes off the screen at the left edge, the polarity is "low."

Gates #1 and #2, therefore, determines which players 4-bit counter will be advanced. Each counter drives a digital-to-analog (D/A) converter, which provides the horizontal position voltage for pulse

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Video Games

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generator #1. This generator provides the horizontal portions of the score bars. The analog voltages from the D/A converters are selected by S1, which is controlled by vertical pulse #1.

The vertical portion of the score bar is produced by a spot generator that's similar to those previously described, except that *three* voltage comparators are used. The three comparator outputs are gated together to produce two consecutive vertical pulses. Figure 12 gives the waveforms.

Horizontal pulse generator #2 detects coincidence with either score bar when the corresponding counter is in the binary state 1111 (15). When that occurs, the winning player's bar is blanked to indicate a win.

Digital scorekeeping

Circuitry for digital scorekeeping is similar to that just described, except a 7-segment number is produced by a BCD-to-7/segment decoder. The horizontal position of the score digits is determined by a horizontal-position counter which is driven by an internal 1 MHz oscillator. The vertical position of the score is determined by a vertical-position counter and decoding circuitry. The counter is reset by vertical sync, and is clocked by horizontal sync.

Each player's digital score appears on the screen only after a score has been made. Then it disappears when the next ball video begins.

Regulation And Modulation

Little has been written about these two subjects. The 5-volt regulator is conventional, feedback-controlled, and protected against short circuits.

The composite video is applied to a diode modulator, which varies the carrier level of a channel-4 transistorized oscillator. Another transistor switches in an additional tuning capacitor when channel 3 is desired.

Complete Block Diagram

Figure 13 shows a block diagram of the Magnavox "Odyssey 200" video game. In addition to the variable controls shown, many set-up-type controls are supplied inside the game. These controls adjust the vertical and horizontal sync pulse frequencies, and vary the position of the walls so the game can be played on receivers that have excessive width or an off-center picture.

Many of the components shown in previous schematics are inside the various ICs.

Servicing?

These explanations of the circuit operations should help you repair video games. If you would like detailed troubleshooting methods, write to the editor:
Carl Babcoke
Electronic Servicing
P. O. Box 12901
Overland Park, Kansas 66212 □

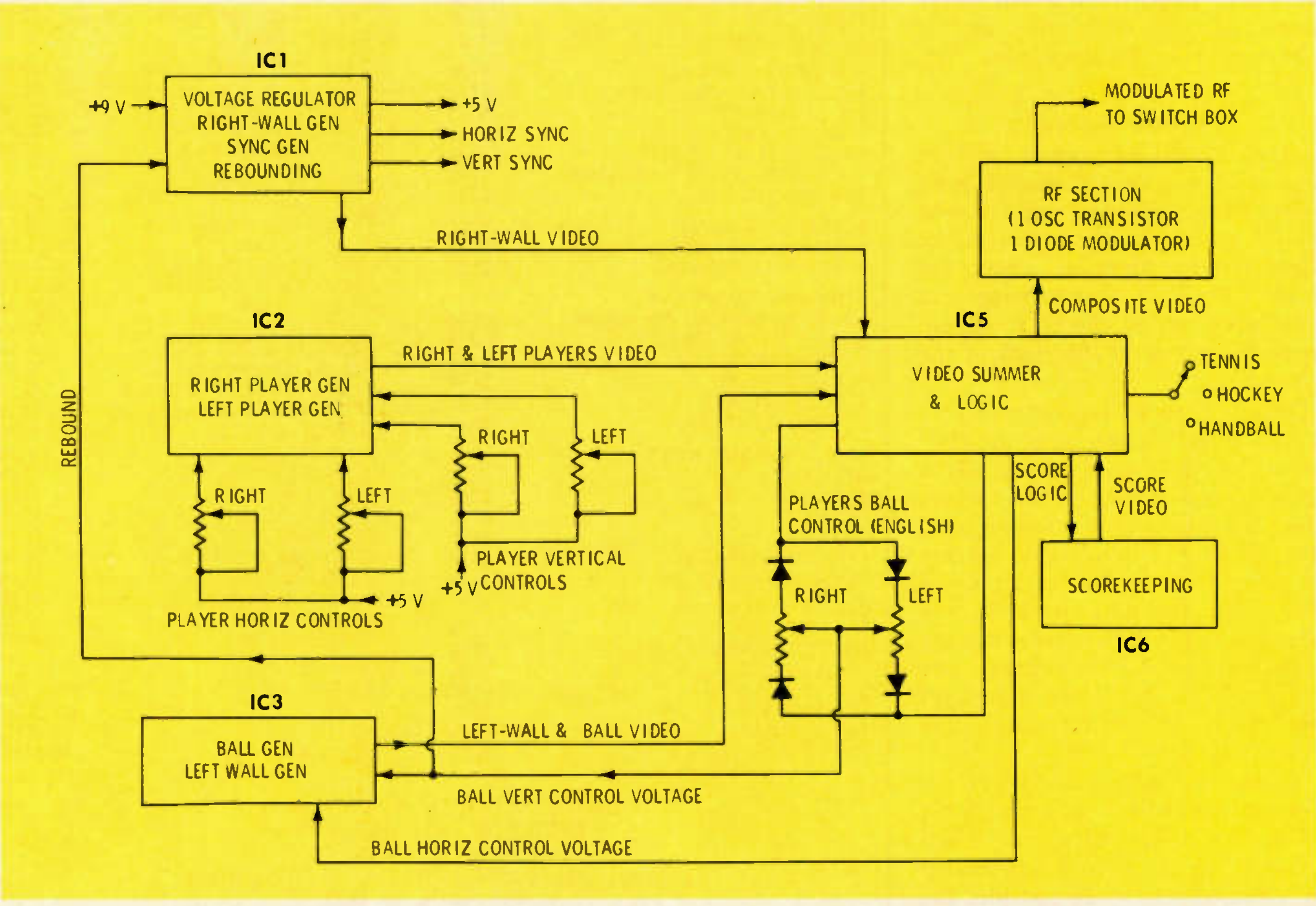
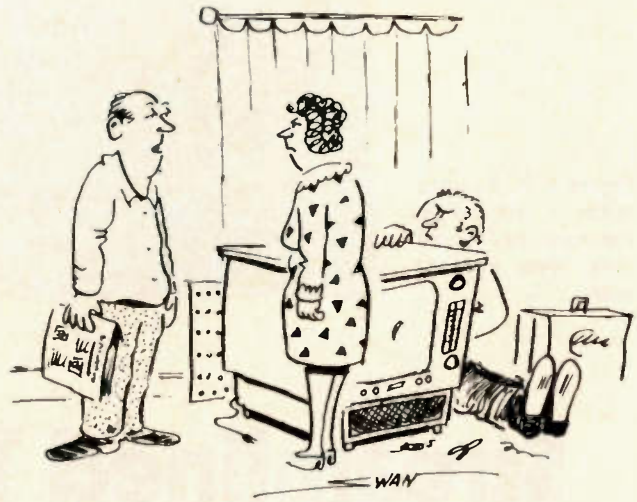


Figure 13 This is the block diagram of a Magnavox "Odyssey 200" video game. Except for the DC control voltages and the RF section, all circuits and waveforms are digital. IC4 generates the backcourt player spots.

CARTOON CORNER

"The service man wants
to know if it's a color set.
Would you call walnut
a color?"



"Why not be a good sport and let him fix
what *he* thinks is wrong with it?"

"He's just another typical man—I tried
to tell him what's wrong, but he'd rather
play with those electronic gadgets!"

"I've kicked it until my toes are sore,
but it still won't work."

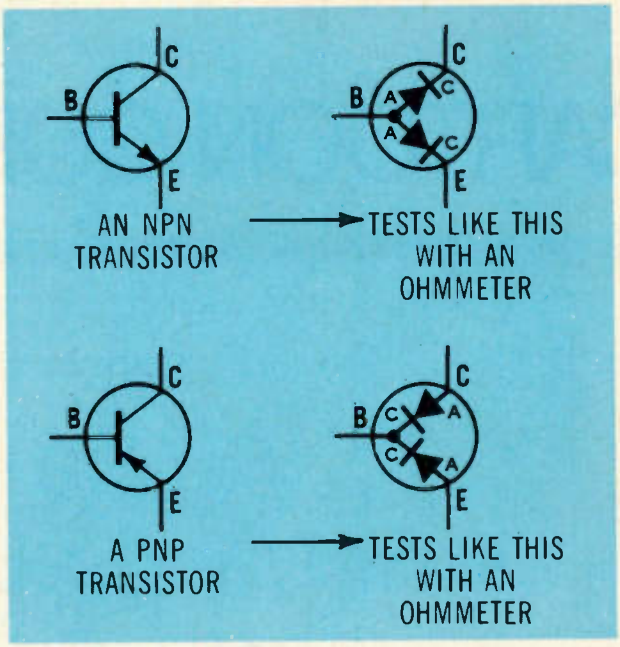


Figure 1 To an ohmmeter, transistors measure as though they were two diodes.

Streamlined Tests For Transistors

By Wayne Lemons

This time-tested sequence of transistor tests will identify most bad transistors in-circuit, and save valuable time. Keep your expensive equipment in reserve for the cases requiring extreme accuracy of measurement.

How many tests should you make before trying a replacement transistor? Or, maybe the question should be: How many tests can you *afford* to make before trying a replacement transistor?

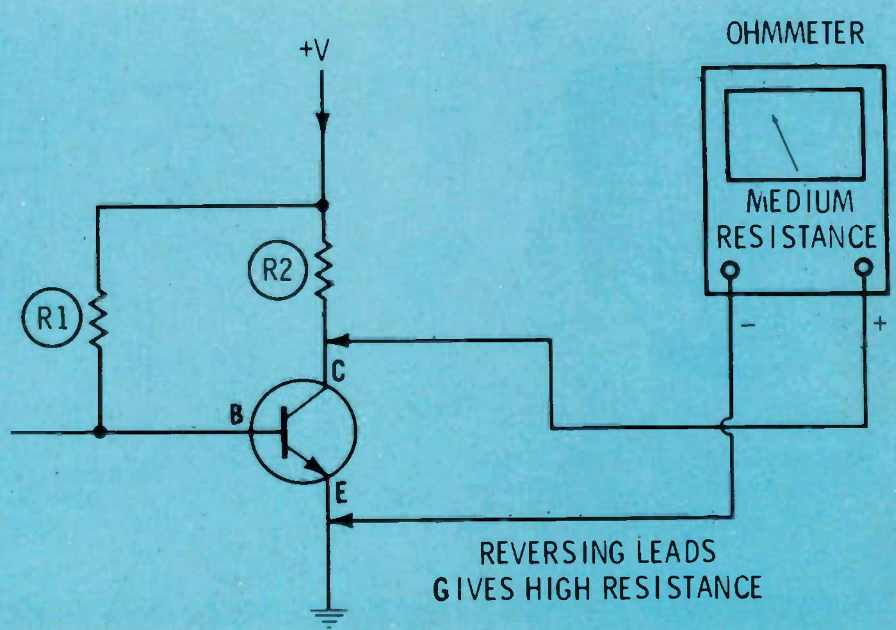
A few years ago when replacement transistors were expensive and not readily available, it was very important to be sure that the transistor was defective before making a trial replacement. But today, you can afford to make a few systematic tests, and if they prove inconclusive, replace the transistor as a practical test. This kind of procedure will save money for both you and the customer.

However, this does not mean you should "shotgun" every job, replacing transistors right and left and hoping the set will start working again. "Shotgunning" (replacing parts randomly, rather than making tests) makes sense only if you have narrowed the trouble to a particular target area, and in-circuit tests for defects have proved unconvincing.

The following tests make up an excellent systematic approach to in-circuit diagnosis of *silicon* transistors. These are quick, nearly-foolproof tests that 80% to 90% of the time indicate whether you should or should not try a replacement transistor.

Use as many of these steps as necessary to prove the transistor is bad. If the results are inconclusive, try replacing the transistor.

Figure 2 Although silicon transistors usually measure open between collector and emitter when out-of-circuit, some diode action often can be obtained in-circuit. Reason: The ohmmeter voltage feeds through the B+ to the base.



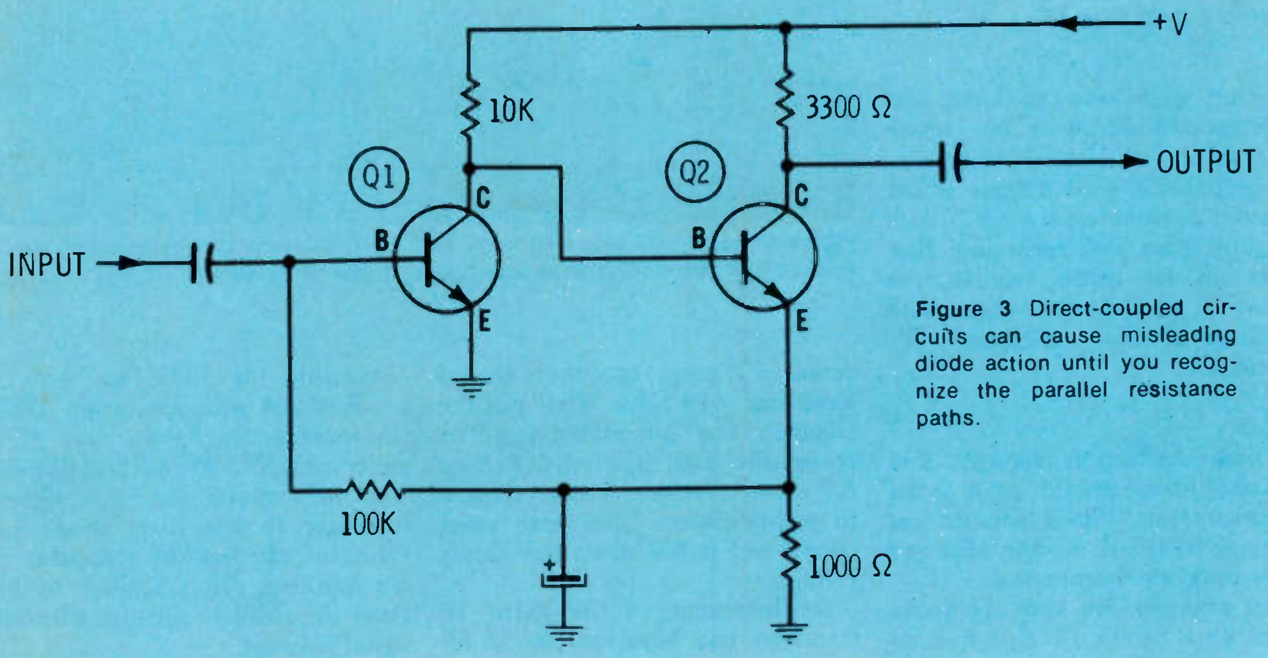


Figure 3 Direct-coupled circuits can cause misleading diode action until you recognize the parallel resistance paths.

Step 1

Using an ohmmeter, check the transistor in-circuit. At this point, do not use a "low-power" range, but instead a VOM or VTVM with higher voltage. The ohmmeter DC voltage must be sufficient to cause transistor conduction, when it's in the forward-bias direction.

Figure 1 shows that an ohmmeter tests a transistor as two diodes. If you measure from base to emitter, you get a low reading with one polarity of the ohmmeter test leads and a high reading when the test leads are reversed. This is called "diode action" or "DA." The reading from base to collector has the same DA. If there is no DA across either or both junctions, the transistor is defective. Replace it.

When out of the circuit, silicon transistors—unlike germanium types—will have a very high resistance from collector to emitter regardless of which way the ohmmeter leads are connected. However, here we are concerned about in-circuit tests.

Figure 2 shows why DA from collector to emitter sometimes is possible when checked in-circuit. With the positive lead of the ohmmeter connected to the collector of the NPN transistor, the positive voltage also has a path to the base circuit through R2 and R1. (Note: When a VOM is used as an ohmmeter, the test lead having the positive voltage often is the black lead, because of the ohmmeter-battery circuitry. That's the lead connecting to negative during voltage tests.)

If the voltage at the base exceeds about 0.55 volt, the transistor will "turn on" and the ohmmeter will read the lowered collector-to-emitter resistance (this is true transistor action). Reversing the ohmmeter leads reverses the transistor voltage and the transistor does not conduct. (If you do get DA from collector to emitter, in-circuit, it's a good indication that the transistor *is* working as it should.)

Incidentally, there is one precaution. Direct-coupled stages (Figure 3) have multiple conduction paths that can be very confusing. For those few stages, perhaps you should remove the transistors for tests out-of-circuit.

In summary, you should look for diode action between base and

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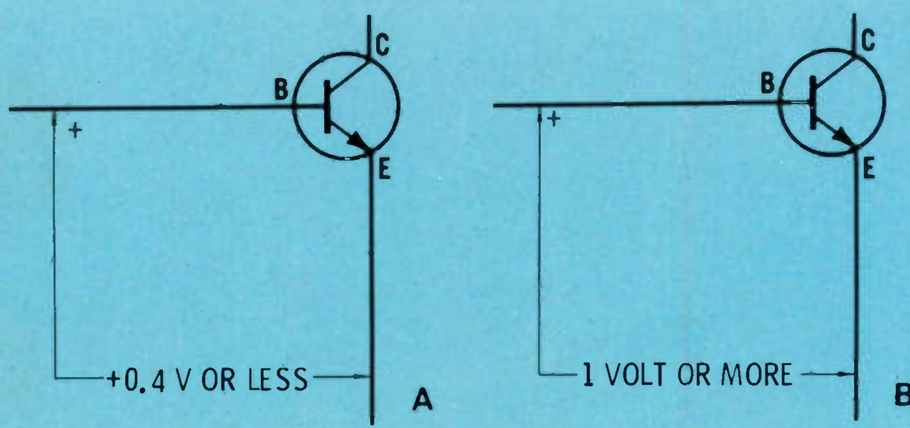

Figure 4 The transistor in schematic A is not conducting because of a defective bias circuit or a bad transistor. In schematic B, the high bias voltage indicates an open B/E junction; replace the transistor.

Transistor Servicing

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emitter, and between base and collector. In addition, be certain there is no C/E short. The transistor probably is good if there is DA from collector to emitter, or if both readings show high resistance. **But, you can be quite certain the transistor is defective when both readings are low resistance** (it's shorted).

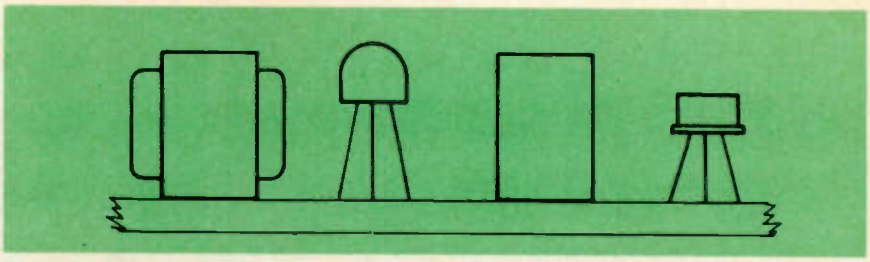


Figure 5 Transistors mounted fairly high by their leads can be checked easily in-circuit by cutting the base lead. Later, it can be soldered.

Step 2

Check the supply voltage. You probably have done this prior to the ohmmeter test, but if not, do *not* overlook it. If you do, the next two steps could be meaningless.

For example, not long ago I was checking a Zenith TV that had no snow and a picture only with a strong local signal. I checked the bias on the third IF transistor and found it was about 0.5 volt, but there was no voltage across the emitter resistor. I *assumed* the transistor was bad and replaced it, but the set had the same symptom.

Finally, I checked the collector and source voltages (I should have done this much sooner). Both measured +7 volts, but they should have been +24 volts. What was the trouble? The pincushion-amplifier transistor had shorted, burning the emitter resistor, which changed to a low value. This near short circuit had pulled down the supply voltage.

Replacement of the third IF transistor had been useless. So remember to measure the source (supply) voltage.

Step 3

Measure the transistor bias from base to emitter. For NPN transistors the base should be positive; negative for PNP transistors. (There are exceptions for signal-biased class B and class C transistors, which will be discussed later.)

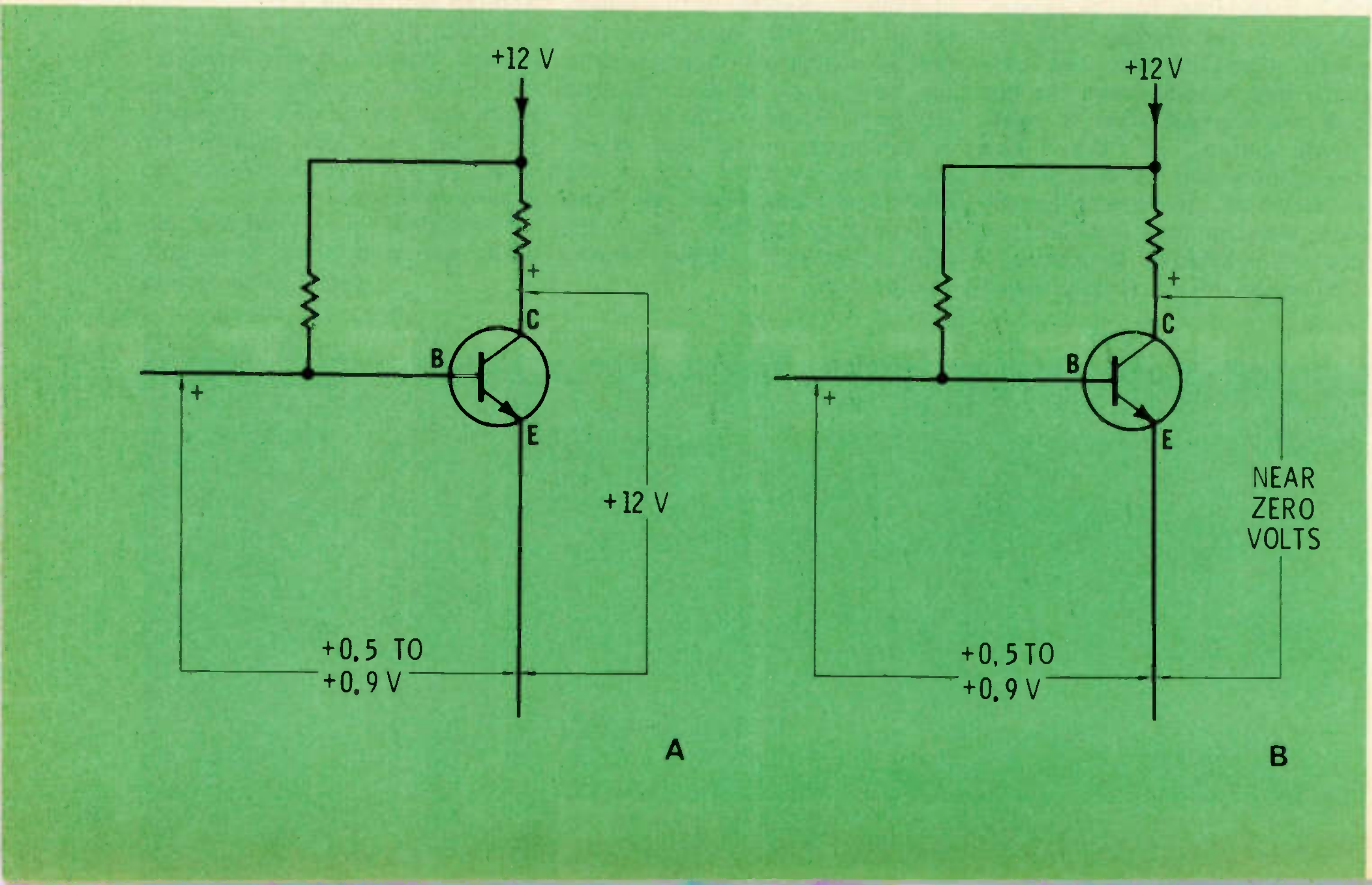
Measure the B/E bias with a sensitive and accurate meter. Digital meters are ideal, but FET meters and VTVMs are satisfactory.

If the forward bias of a silicon transistor is less than about 0.5 volt, you can bet the transistor is not working. That applies to all class A circuits (those without signal biasing).

If the forward bias of a silicon transistor is more than about 0.9 volt, the transistor has an open base-emitter junction (or a replacement has been installed incorrectly). Replace it (see Figure 4).

A transistor defect often causes low bias, but the real question is: How do you determine if the transistor is the cause of low bias? The solution is to disconnect the

Figure 6 Both transistors have forward bias of the proper range, but the C/E DC voltage proves they are not working correctly because A is open and B is shorted.



base and notice any change of bias.

When the transistor is mounted similar to those of Figure 5, determine which is the base lead and clip it about half-way between the transistor and board (this will allow you to butt-solder it back together easily, if the transistor is not at fault). With the lead clipped, measure the bias voltage from the base lead on the board to the transistor emitter lead. If the voltage has risen to about 0.6 volt or more, you can be almost certain that the transistor is bad. Replace it.

If the transistor is not mounted so the base lead can be clipped, you might be able to cut the printed board with a single-edged razor blade or a sharp knife, thus isolating the base lead from the remainder of the base circuit. Again, if the voltage rises at the board to about 0.6 volt or more, replace the transistor.

When the base lead cannot be clipped easily, or the in-circuit bias resistor checks are inconclusive, the best bet generally is to replace the transistor as a test. My experience with hundreds of transistor circuits is that a bad transistor is by far the most common cause of low bias.

Step 4

Use step 4 only after all possible information is obtained by the previous tests and you still are not sure whether or not to try a replacement transistor.

If the bias of step 3 is between about 0.55 volt and 0.9 volt, this is within the general bias limits of silicon transistors. **For step 4, measure the voltage between collector and emitter** (see Figure 6).

If the voltage drop across the transistor equals the source, and there is significant resistance in either the collector or emitter circuits, replace the transistor.

If the voltage drop across the transistor is nearly zero, short between the base and emitter while keeping the voltmeter leads in place (C/E). This removes all transistor bias. The transistor, if good, should be cut off, and the collector-emitter voltage should rise significantly. If it doesn't, replace the transistor.

If the voltage does rise, this indicates trouble in the bias circuit. Figure 7 is an example of an actual trouble in a CB transceiver. Note that the C/E voltage is nearly zero, while the bias voltage measured 0.72 volt, which is too high for that particular transistor. Since the base resistor measured 100K, the extra voltage must be coming from somewhere else. I shorted the base to the emitter and read 12 volts from collector to emitter. **C1 was leaky.**

What About Signal-Biased Circuits?

The previous discussion is applicable to most class A circuits, such as AF, RF, and IF amplifiers. But with some modifications, the same techniques are useful for testing signal-biased transistors, such as sync separators, keyed AGC, and oscillators.

Step 1 is applicable to any circuit, except for those with very low base-emitter resistances. In such cases, the most common transistor trouble is a C/E short, which usually can be found with an ohmmeter. The exception is a

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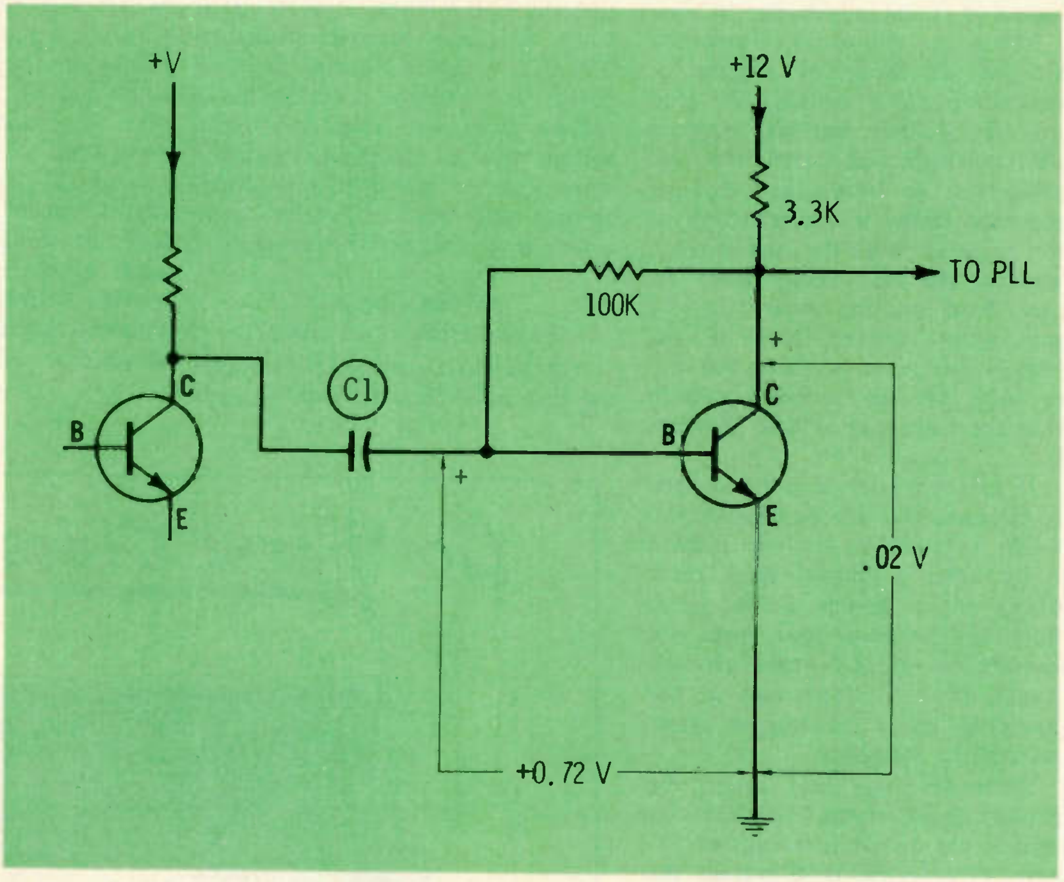
Figure 7 This schematic shows an actual trouble found in a CB transceiver radio. The B/E forward bias was too high for that kind of transistor. C1 was leaking voltage to the base from the previous stage.



Transistor Servicing

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transistor that breaks down only when a higher DC or pulse voltage is applied.

These simple ohmmeter tests of suspected transistors might not seem very sophisticated to a technician who has a bench full of expensive test equipment. But the ohmmeter method saves time, while finding the defect in the majority of cases.

For example, two good technicians, who together had more than 50 years of experience, worked more than an hour in a CB transceiver that had zero output and a peculiar whistle when the mic button was pushed. Their mistake was searching for a bad electrolytic or an open ground, as they worked on the whistle, instead of the no-output symptom.

"Simple" ohmmeter tests proved that both the RF driver and the RF output transistors had open B/E junctions. After the two transistors were replaced, the RF output was normal, and the whistle was gone.

Step 2, about the measuring of supply voltages, always applies, regardless of the kind of circuit.

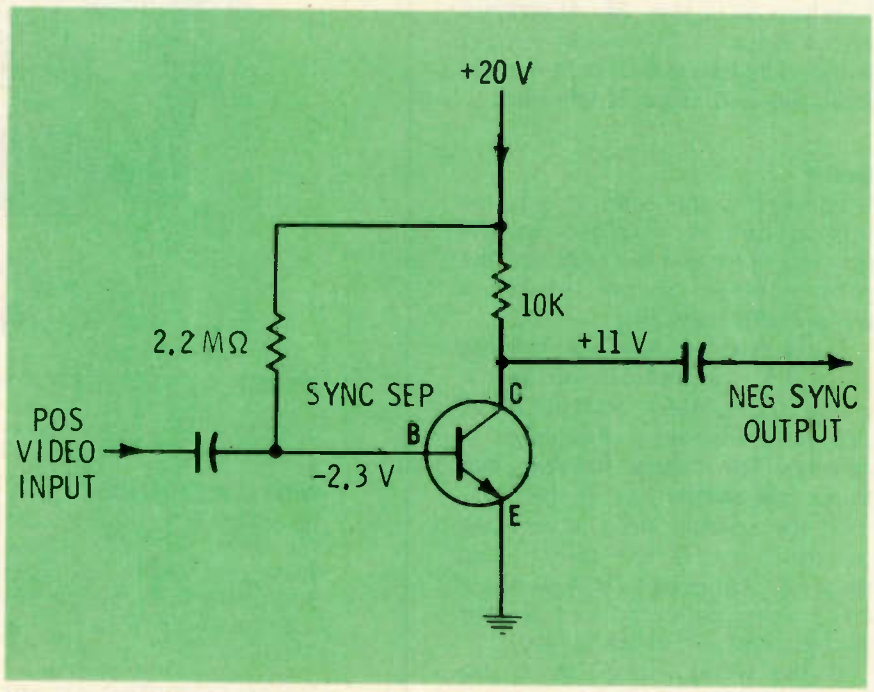


Figure 8 The *average* bias of this NPN transistor is negative, because the B/E junction acts as a diode to rectify the video signal. Thus, only the sync tips are amplified, and appear at the collector.

Step 3 (bias measurement) also is effective. However, with signal bias the measured forward bias either is very low or has reversed polarity.

Figure 8 shows the circuit of a transistorized sync separator. The bias at the base (as measured by a meter) of this NPN transistor is negative because it's produced by rectification of the signal. The signal input level is higher than 1 VPP, so the B/E junction acts as a diode, rectifying the signal and developing a base voltage that's negative, on the average. This negative voltage cuts off the transistor conduction except during the most positive peaks of the video signal. Therefore, the base has forward bias (and amplifies) only when the sync part of the signal reaches the base. That's why the output has sync pulses only.

When you find the bias polarity is reversed, it's certain the B/E junction is okay. On the other hand, a positive base voltage for NPNs indicates that no input signal is reaching the base, or that the transistor is open.

In all cases, the "high" bias check is valid. Forward bias readings exceeding 0.9 volt prove the B/E junction is open, and the transistor should be replaced.

Step 4 also is valid for signal-biased circuits. Measure the C/E voltage. If this voltage equals the source voltage, the transistor is not conducting. Replace it. When the C/E voltage is nearly zero, short between base and emitter, or remove the signal input. If the C/E voltage remains at zero, the transistor is defective. (Rarely, the collector load might be open.)

Of course, step 4, as previously noted, probably will be meaningless, if you have *not* proven by step 3 that bias problems are not the trouble.

Summary

When simple tests will find the defective transistor in a short time, don't use complicated equipment or procedures. This does not imply that precision equipment and sophisticated techniques should be avoided, but you should try the easy things first.

The purpose of this article is not to tell you how to localize the stage that has the bad transistor, but rather to advise you how to proceed with these effective preliminary checks after a stage is suspected.

My advice is to use conventional methods (such as signal tracing) to localize the faulty stage, and then follow the four steps given here. If the steps don't prove conclusively whether the transistor is bad or good, replace it with a new one, as the ultimate test.

In condensed form, here are the four steps for **in-circuit** tests:

Step 1 Use a "high"-power ohmmeter to check for diode action between B/E and B/C. Finally, test for C/E shorts.

Step 2 With power applied, measure the source voltage of the suspected stage. Don't question the transistor until you know the source voltage is okay.

Step 3 Measure the B/E bias DC voltage. If the forward bias is 0.9 volt or more, replace the transistor (it's open). When bias is less than 0.5 volt, disconnect the base lead. If the bias rises to 0.6 volt or higher, replace the transistor (it's leaky); but if it does not rise that high, check the bias circuit.

Step 4 Measure the C/E voltage. If it's at (or near) the source voltage reading, replace the transistor. Otherwise, short the base to emitter, which should greatly increase the collector voltage. If it does not, replace the transistor.

Although these tests are simple and easy to do, they can identify most bad transistors. This saves your expensive test equipment for the more difficult diagnosis. □

Reports from the test lab

By Carl Babcoke

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

Danameter II

Model 2100A digital multimeter (Figure 1) from Dana Laboratories is the first Liquid-Crystal Display (LCD) digital meter examined in our Test Lab. LED displays are highly visible when the room lighting is moderate to dark, but are difficult to see in bright lights or under sunshine. In fact, it is a problem to photograph a meter so the genuine display (not a touch-up) shows properly. Often, low light is necessary.

With LCDs, the situation is reversed. Bright lighting or sunshine produces a brilliant display (Figure 2). In total darkness, the LCDs can't be seen at all. Of course, the light level is not critical for satisfactory readings. The black figures against a pale gray background are visible with almost any reasonable amount of light.

One interesting discovery about the LCD display is that the digits apparently appear on a clear plastic overlay portion of the assembly, and not on the translucent backing. Therefore, sharp light rays (from a spotlight, for example) cast shadows of the digits on the back of the display. Also, the black numerals disappear gradually, when the power is turned off. Some of these visual effects are illustrated in the photos.

Of course, the best feature of LCDs compared to LEDs is the sharply-reduced current drain. These Danameters, each operating from a single, common 9-volt radio battery, are said to operate for about 3,000 hours per battery. **This is about 8 hours use per day for a year.** So, it is not necessary to turn off the meter between measurements.

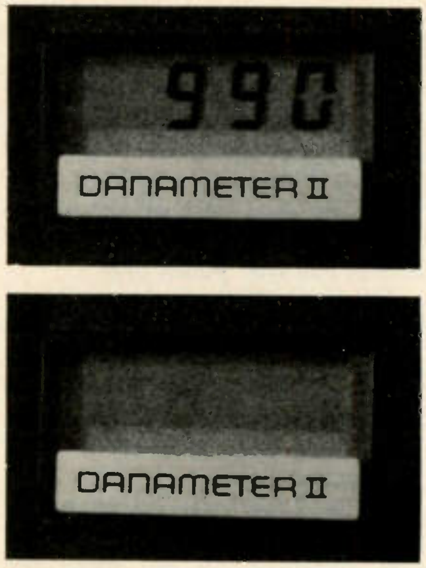


Figure 2 The black digits of the Danameter appear to be formed on clear plastic at a short distance from the backing. Brighter room lights increase the brilliance of the diffused reflector which is behind the black digits. One picture shows the battery-test display; the other is the display, but with the meter turned off.

Switching

A single 18-position switch turns on the instrument and selects any of the 17 ranges and functions. Conventional ranges of DC volts, AC volts, resistances, and DC current are provided. AC current can be measured by the addition of an optional set of shunts.

The switch has a simple, but effective, method of showing which range is in operation (see Figure 3). First, the knob has a large white bar. Also, each position (except off) has a hole through the panel, and a large red dot is rotated behind the panel by the knob. Therefore, one hole appears to be a small red dot, indicating the range in use.

The panel around the knob has two areas marked in pale gold that divides the positions into four quarters (this does not show distinctly in the photos) for the four basic functions.

All functions have overload protection, but there is one precaution. If you have 120 VAC across the test leads (for example), don't rotate the switch through the DC current ranges. Consult the operating manual for details.

A separate switch position tests the battery voltage.

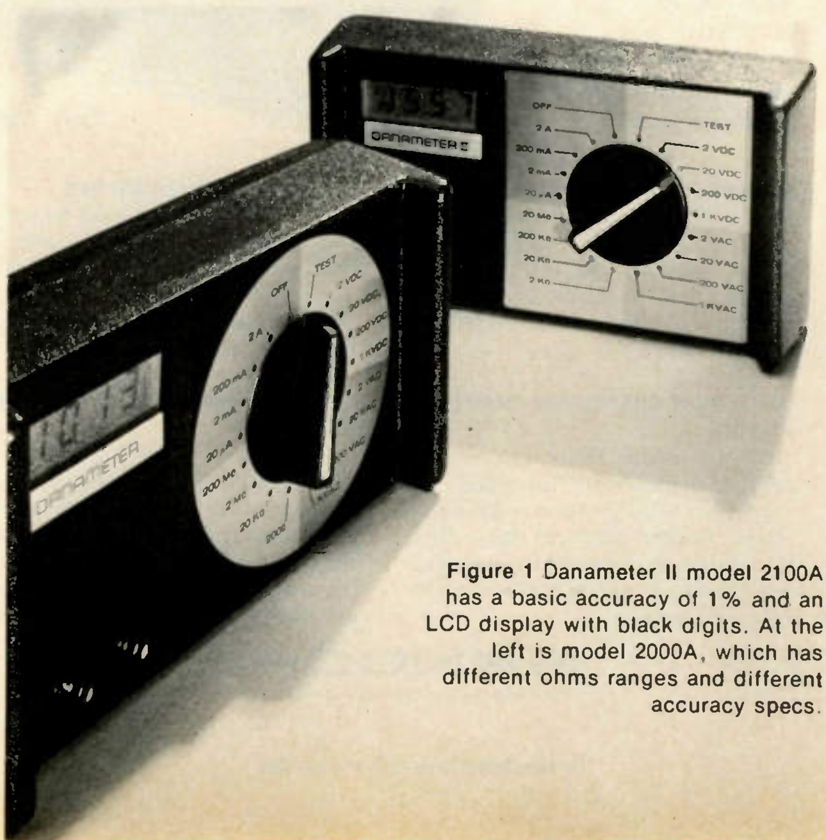


Figure 1 Danameter II model 2100A has a basic accuracy of 1% and an LCD display with black digits. At the left is model 2000A, which has different ohms ranges and different accuracy specs.

Other features

These Danameters have 3½-digits of LCD-type display, with the basic reading going up to 1.999 (for the 2-volt range) before overranging. Any overrange changes the display to the letters "OL."

Large-Scale-Integration (LSI) ICs are provided, to simplify the circuit. The digital CMOS IC is said to have 2000 transistors, and the analog IC has 150 transistors.

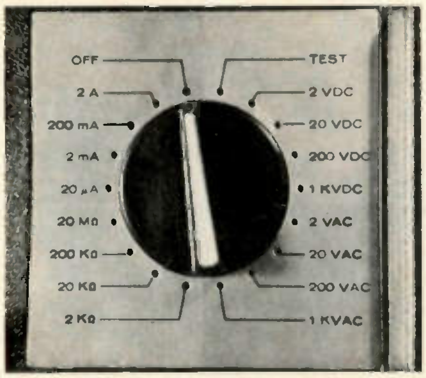


Figure 3 A single rotary switch turns the meter on and off, has a test position for the internal 9-volt battery, and selects any of the 17 functions and ranges.

Auto zeroing is provided for all functions and ranges, with automatic polarity indication for DC volts and current readings.

A full range of accessories is available for these models, including: a carrying case; shielded test lead; two HV probes (up to 50 KV); RF probe for 25V RMS signals to 200 MHz; deluxe test leads; and a set of AC-current shunts.

The Cycolac-T case is said to survive a six-foot drop to concrete.

DC Volts

The basic accuracy is ±0.1% of reading plus 1 digit for the 2V, 20V, 200V, and 1000V DC ranges. Incidentally, the 1000V range actually is a 2000V range, but it should not be used above 1000 VDC (or 700V RMS) to protect the meter. The same precaution applies to AC volts, also.

Positioning of the decimal is automatic with the rotation of the switch. Input resistance is 10 megohms for all ranges of DC volts.

AC Volts

Accuracy of the AC volts ranges is specified as ±0.2% of reading plus 1 digit, within the frequencies of 60 Hz and 1 KHz. The response falls at the higher frequencies; therefore, you should check the flatness of your individual meter and prepare a correction chart for any audio applications requiring extreme accuracy.

The AC readings are of the average type, with the calibration adjusted for RMS with sine waves. Input impedance is 2 megohms in parallel with 50 pF for all ranges.

Ohms

All resistance readings of the 2K, 20K, 200K and 20M ranges are in thousands of ohms. The accuracy varies with the range, but typical accuracy of all but the top range is ±0.2% of reading plus 1 or 2 digits.

Open-circuit voltage is slightly above 3.5 volts, so there is no danger to any semiconductors.

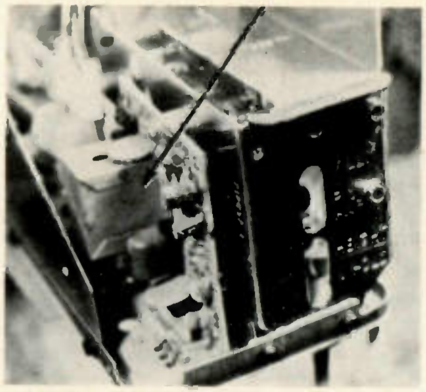
DC Current

Typical accuracy of the four DC current ranges is ±0.3% of reading plus 2 digits. Full-range currents are: 20 microamperes; 2 milliamperes; 200 milliamperes, and 2 amperes.

Comments

The Danameter II model 2100A proved to be accurate and very convenient in operation, and I enjoyed testing it. □

Servicing Magnavox Modular Color TV, Part 3



When the Magnavox chassis is in the service position and you face it from the rear, the M106 horizontal module is located on the right arm of the chassis. Also, M109 module is just in front of M106.

By Gill Grieshaber, CET

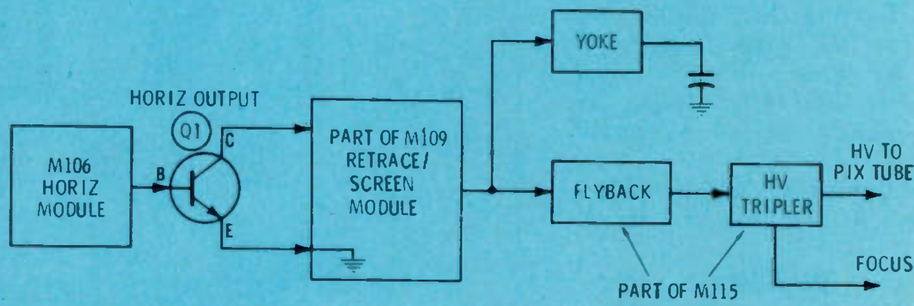


Figure 1 This block diagram shows the distribution of the horizontal-sweep components on three modules, the chassis, and the yoke.

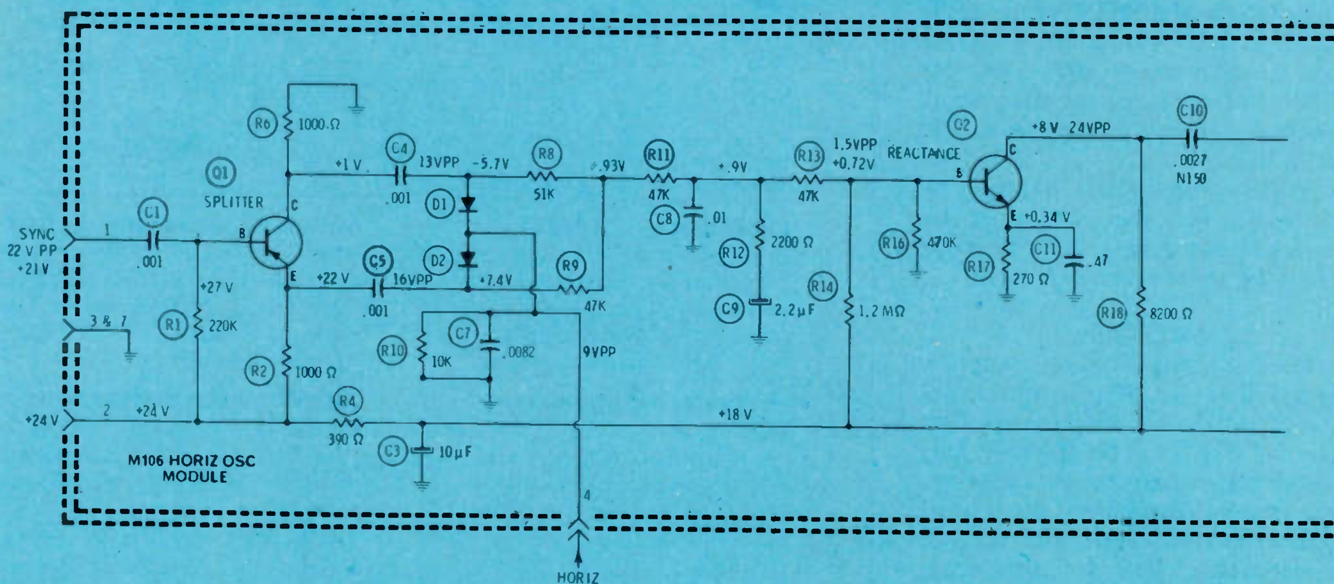


Figure 3 Here is the complete schematic of the Magnavox M106 horizontal module. Q1 clips the sync again, amplifies it, and supplies both polarities of sync to the balanced phase detector. A sawtooth sample of the horizontal sweep is brought to the common connection of D1 and D2. Most of the DC voltage at D1 or D2 is from rectification of the sawtooth signal, with the instantaneous amount of voltage determined by the phase between sync and sweep sample. When the oscillator frequency drifts, the D1/D2 phase-detector output (at the junction of R8 and R9) becomes an

Continuing with the Magnavox T995 circuits and servicing, the horizontal oscillator, driver, output, and high-voltage circuits are analyzed. Also, many waveforms and typical DC voltages are listed.

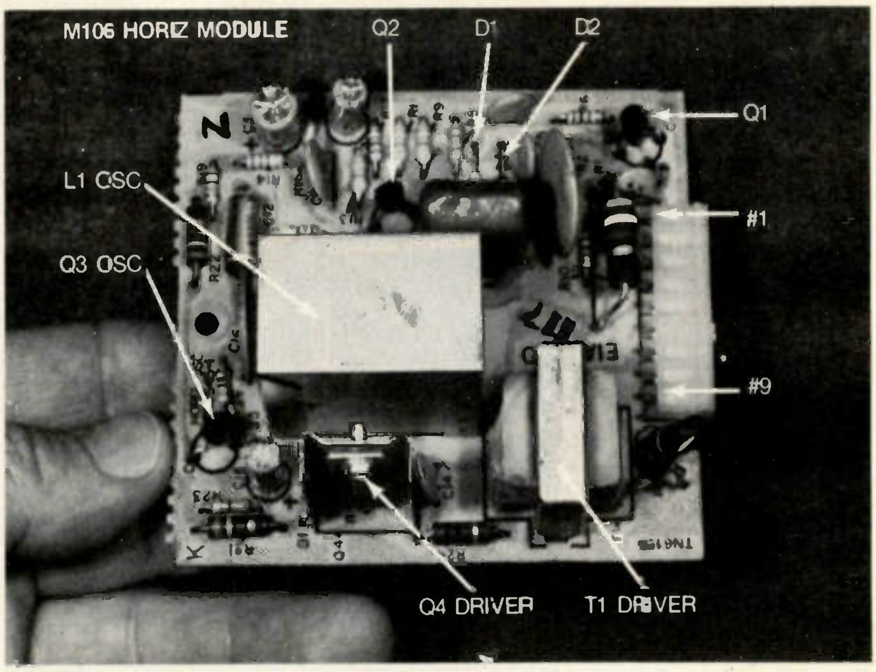


Figure 2 Arrows point to the major components of the M106 horizontal module. A hole in the shield of the oscillator coil provides access to the core for adjustment with an alignment hex tool. (This is the only frequency adjustment; there is no hold control for the user.)

Magnavox Horizontal Sweep

Horizontal circuits of the Magnavox T995 chassis are engineered for efficient operation and easy servicing. Various components are located on the chassis, the yoke, and three modules, as diagrammed in Figure 1. In fact, I was surprised to find one assembly classified as a module. It is composed of flyback, HV tripler, focus control, and a few other parts mounted on a metal plate, and connected to external wiring by two plugs, a focus connector, and the HV lead. Therefore, the T995 has one more module than was reported in Part 1.

Horizontal Oscillator And Driver

The horizontal phase-detector, reactance-control, horizontal-oscillator, and horizontal-driver stages comprise the M106 horizontal-oscillator module. Major components are identified in Figure 2.

No user-adjustable horizontal-hold control is furnished; therefore, a stable oscillator with tight locking is needed. These requirements are satisfied by a balanced phase detector, and the reactance control of a sinewave oscillator. Figure 3 gives the complete schematic.

Horizontal sync and phase detector

Sync pulses enter the module at pin 1, and go through C1 to the base of Q1, which acts as a phase inverter to supply sync pulses of opposite polarities. Several of the waveforms are shown in Figure 4.

Q1 has no forward bias except the incoming sync pulses. It is a

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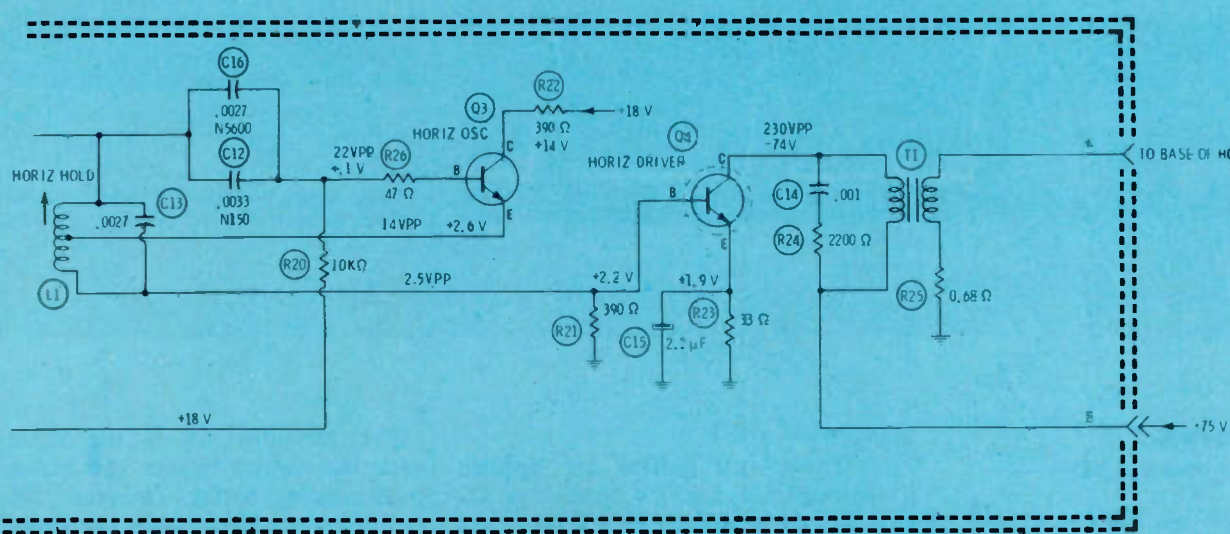
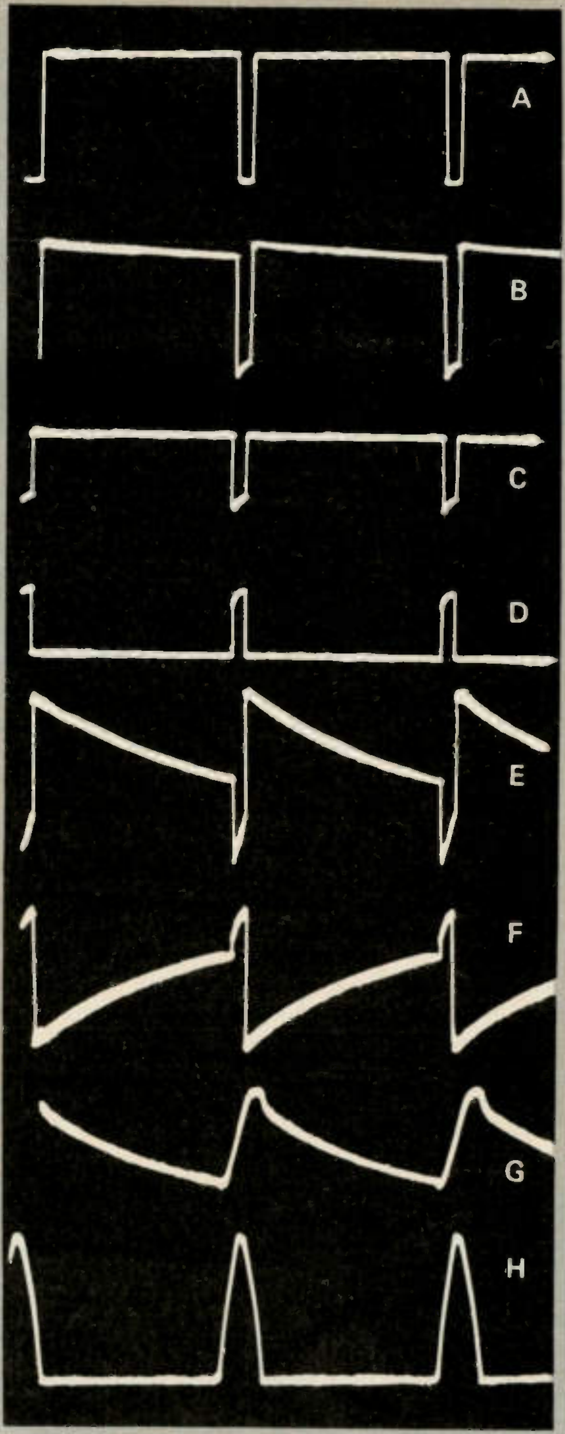


error-correcting voltage that, through Q2 reactance stage, restores the correct frequency and phase of the horizontal oscillator. The Q3 horizontal oscillator is an emitter-coupled type, with C13 and L1 comprising the tuned circuit that principally determines the frequency. Emitter current of Q3 flows through R21, and the resulting signal is applied to the base of Q4, which (through T1) drives the base of the horizontal-output transistor.

Figure 4 These waveforms are typical for the sync-inverter and phase-detector stages of the Magnavox T995. (A) The incoming sync at module pin 1 measures 25 VPP, with a DC voltage of +21. (B) At the base, the amplitude is the same, although the waveform is tilted slightly. (C) The emitter waveform is identical to that of the base, but the amplitude is only 14 VPP. According to the DC base and emitter voltages, Q1 has reverse bias. However, the negative-going base pulses furnish the forward bias. (D) The 14 VPP pulses at the collector have opposite phase relative to base and emitter. (E) At the cathode of D2 appear the negative pulses from the emitter of Q1, plus sawteeth that are the ripple from the rectification of the positive peaks of the horizontal signal at the anode. (F) The waveform at the anode of D1 is made up of positive pulses from the collector of Q1, plus sawtooth-shaped ripple from the rectification of the negative peak of the sweep waveform at the D1 cathode. (G) A 9-VPP approximate-sawtooth signal from the sweep circuit is brought to the cathode of D1 and the anode of D2. The DC voltage is nearly zero, so the peaks can be rectified equally. (H) Flyback pulses from the collector of the horizontal-output transistor show the phase of these waveforms. (Scope was set for horizontal-rate sweep.)



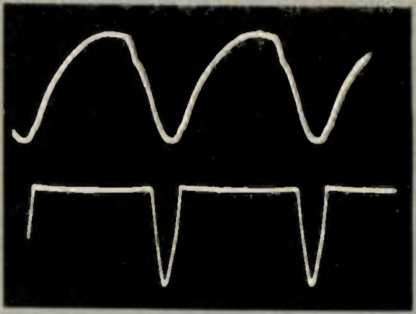


Figure 5 Waveform across oscillator coil (L1) is almost a sine wave (top trace). Inverted sweep pulses of the bottom trace show the relative phase between oscillator and sweep.

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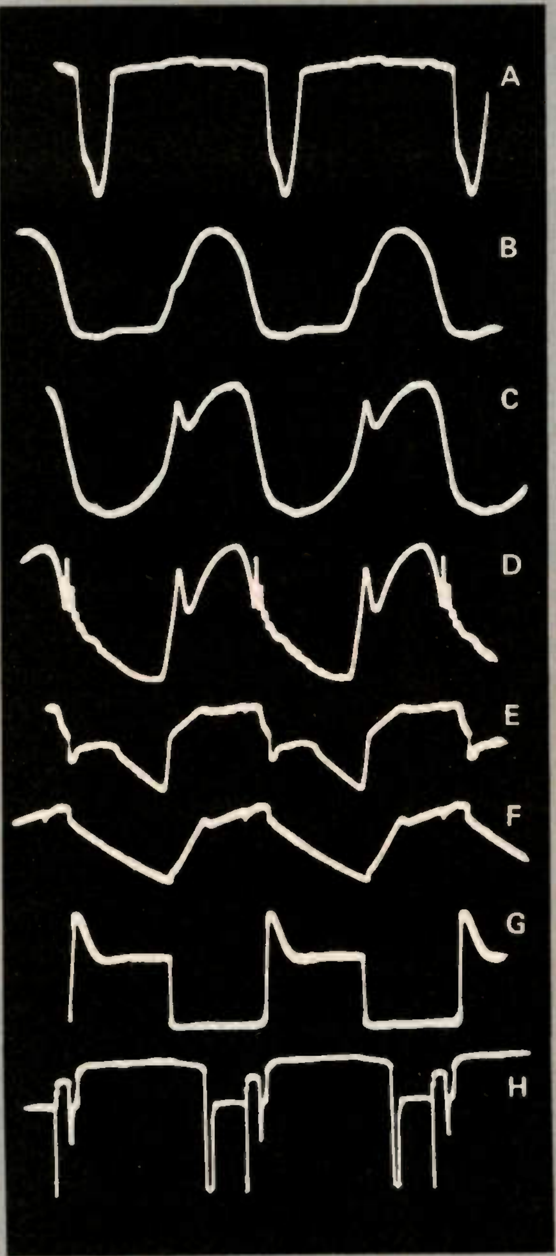
PNP type of transistor, and *apparently* has reversed bias. That's because the B/E junction rectifies the negative-going pulses, producing a positive DC voltage at the base. Output from the emitter has the same phase as that of the base, while the collector signal has the opposite phase.

These sync pulses are applied through C5 and C4 to diodes D2 and D1 respectively. Where the cathode of D1 and the anode of D2 are tied together, a sawtooth waveform (filtered from a sample of horizontal sweep) is applied. **These diodes function as shunt rectifiers to the sync pulses, and as series rectifiers to the sawtooth signal.**

For example, C4 is the input capacitor (which makes the action peak-reading) to D1. Therefore, the positive-going sync pulses are **shunt** rectified at the anode of D1, with the AC ripple and the negative DC voltage together going to the output at R8. At the same time, the sawtooth signal (having no DC component) at the cathode is **series** rectified by D1. The negative peak

Figure 6 Here are waveforms of the Q2, Q3, and Q4 stages. (A) Ripple of 1.5 VPP is at the base of Q2. (B) At the collector of Q2, the waveform of 24 VPP comes from the oscillator. (C) The base signal of Q3 (oscillator) is 22 VPP. (D) A similar waveform of 14 VPP appears at the emitter of Q3. (E) Emitter current of Q3 develops this waveform across R21, and it goes to the base of Q4. (F) The emitter of Q4 is bypassed by C15, but the time constant is small; therefore, the 2.5-VPP emitter waveform is similar to that of the base. (G) Strong square waves (230 VPP) with overshoot at the rising sides are produced at the collector of Q4. (H) Although the secondary waveform of T1 (which feeds the base of the horizontal-output transistor) *should* be the same as that of the primary, it is completely different. Evidently, the coupling of the transformer is not very tight, thus permitting the collector waveform to feed back to the base of the output transistor. This peculiar waveform is typical for similar circuits.



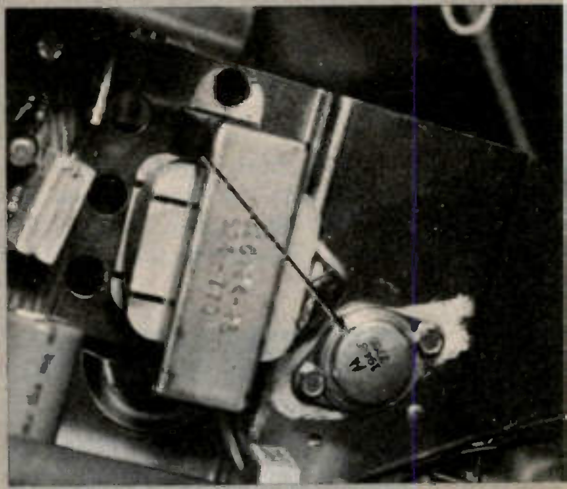


Figure 7 The horizontal-output transistor (Q1) is just in front of the vertical choke, when the chassis is in the service position.

of the sawtooth causes conduction of D1, and C4 acts as the peak-reading filter capacitor for the negative DC output voltage. That's why the ripple from this rectification has a sawtooth shape (see Figure 4). Of course, D2 operates in the same way, except that all of the polarities are opposite.

If only the sync pulses are present, the DC output at C8 (where the DC and ripple of both rectifiers are combined) is nearly zero, because the positive and negative voltages cancel. On the other hand, if the sync pulses are missing but the sawtooth is there, the output also is nearly zero. Only when *both* the sync pulses and sweep sawteeth are present can an error-correcting DC voltage be created.

When both pulses and sawteeth are there, **the output DC voltage at R11/C8 depends on the relative phase between those two types of signal.** For example, suppose the horizontal oscillator begins to drift out of phase with the sync. The peak signal from anode to cathode of one diode increases (thus increasing that output DC voltage),

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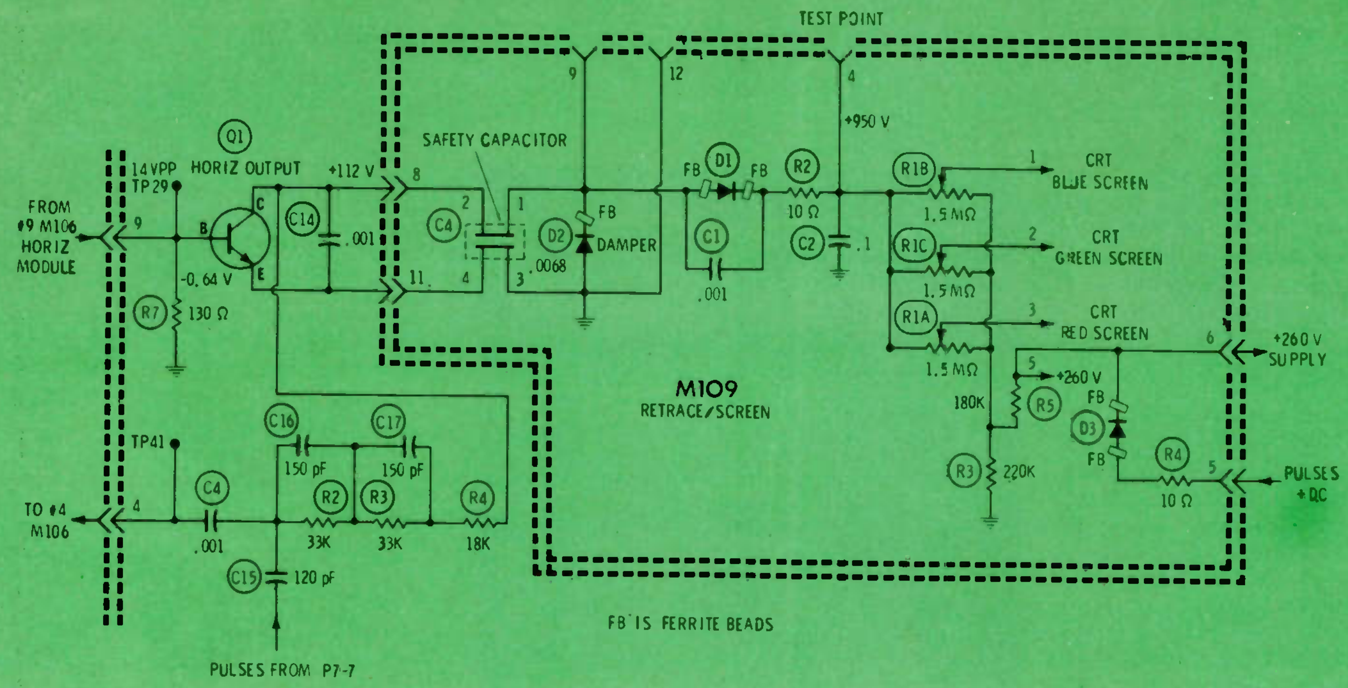

Figure 8 Q1 output transistor and several components are mounted on the metal chassis, as shown in this schematic. The safety capacitor, damper diode, three screen-grid controls, two scan rectifier circuits, and other parts are located on the M109 retrace/screen module.

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while the peak signal across the other diode decreases (thus decreasing the other output DC voltage). Therefore, the combined output voltage at C8 is positive or negative. It is filtered by R11/C8 and R11/R12-C9 before reaching the base of Q2, the reactance transistor, where it changes the C/E resistance of Q2. The C/E path of Q2 is in series with C10, and the two in turn are paralleled across the L1 oscillator coil. So, the change of C/E resistance varies the oscillator tuning, thus swinging the frequency back toward the correct sync/sawtooth phase. R14 brings a minimum forward bias to Q2, and

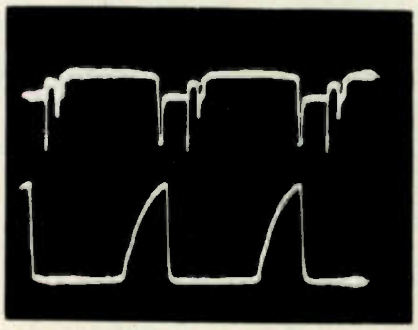

Figure 9 This change of waveshape at the base of Q1 horizontal output proves the B/E junction is open, or the transistor has been removed. Normal complex waveform at Q1 base is shown by the top trace. When the transistor is removed, the base-to-ground waveform (lower trace) appears as narrow sawteeth.

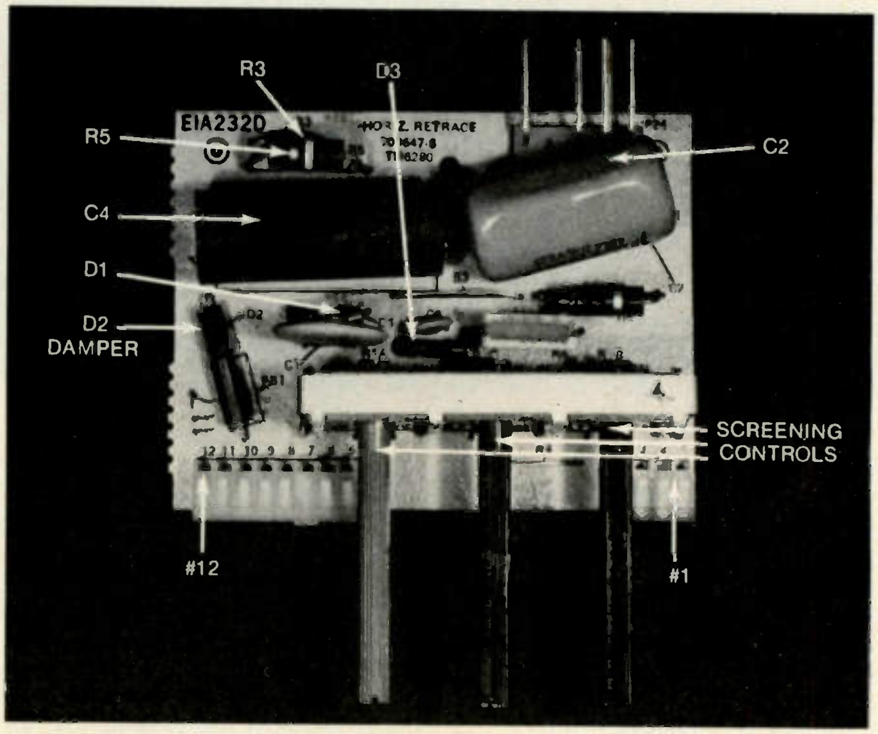

Figure 10 Major components of the M109 retrace/screen module are identified by the arrows.

the bias is responsible for the slight DC unbalance at D1 and D2.

The oscillator stability and locking are excellent; therefore no user-operated horizontal-hold control is provided.

Horizontal Oscillator

Q3 is an emitter-coupled type of horizontal oscillator. The signal across the oscillator coil (with C13, it is a tuned circuit) has a waveform that's approximately a sinewave (Figure 5). Oscillators of this type are very stable; therefore, a bias change is not sufficient to vary the frequency for locking. Instead, a reactance-control stage (Q2) is supplied.

Notice that the base input signal for Q4 (Figure 6E), taken across R21 at the "cold" end of L1 oscillator coil, does NOT have a sine waveform. R21 is not part of the tuned circuit; therefore, the waveform is that of the Q3 emitter *current*, and all Class "C" oscillators draw current in pulses.

The base of Q4, horizontal-driver transistor, is direct connected to the emitter of the oscillator, Q3. And the bias of Q4, therefore, depends almost entirely on the emitter current of Q3. (Of course, the voltage developed across R23 is *subtracted* from the base/ground

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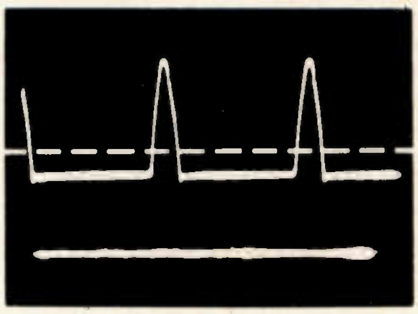
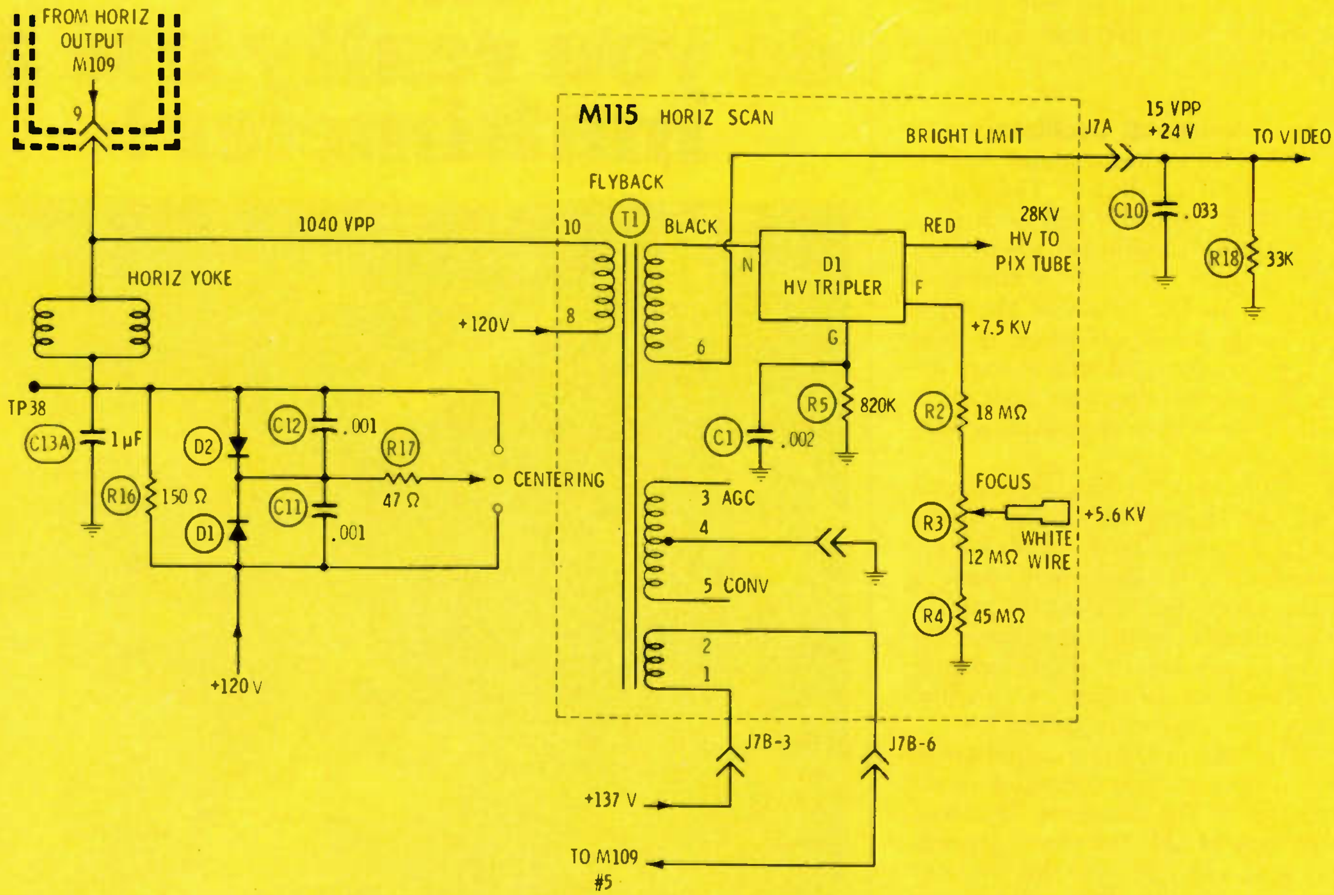


Figure 11 Dual-trace DC scope waveforms help clarify the input AC and DC signals to scan rectifier, D3. The lower trace is the zero-voltage line. Later, the dotted line was added to the photograph. It shows the average voltage of the 170-VPP pulse waveform. The +137 DC volts is between the dotted line and the zero-voltage line, while the part of the waveform that is rectified is between the dotted line and the top of the pulses. Therefore, about 140 volts peak of the waveform and +137 volts from the DC supply add to an input of 277 volts to D3, giving a rectified DC output of +260 volts.



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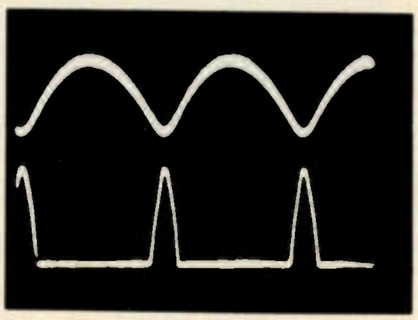

Figure 12 Horizontal yoke and centering, plus the M115 horizontal-scan module circuits are shown in this schematic. The normal parabolic waveform that's across C13A (shown at B with sweep pulses for a phase comparison) is rectified either by D1 or D2, and the resulting current goes through the yoke coils to move the picture to right or left.

voltage to give the true forward bias.) Excessive Q3 current might cause Q4 to fail. Or, insufficient Q3 current could prevent Q4 from driving the horizontal-output transistor hard enough; thus, causing center foldover and possibly a slow failure of the output transistor. Q4 is an intermediate-power type with a small heat sink, and does run warm.

Figure 6 shows all of the waveforms from the base of Q2 to the collector of Q4. At the collector of Q4, the waveform (Figure 6G) is a square wave with one extra tip. T1 couples this square wave to the base of Q1, the horizontal-output transistor, which is mounted just in "front" of the vertical output choke (see Figure 7), when the chassis is tilted down in the service position.

But, traveling through driver transformer T1 radically changes the base waveform (Figure 6H) of Q1, the horizontal output of the schematic in Figure 8. Perhaps the internal C/B capacitance feeds harmonics of the 15734-Hz sweep frequency back to the base, or the huge C/E current passing physically through the base might be responsible. At any rate, all similar circuits exhibit the same amazing change of waveform. Do NOT try to figure out the Q1 collector current from the base waveform. Only the C/E *current* waveform tells the truth.

Incidentally, this weird waveform gives us a foolproof way of telling when the base of Q1 is open. The complex waveform (Figure 9) changes to rounded sawteeth with lines in between. Whenever you see this base waveform on your scope, you can bet Q1 base circuit is open.

Retrace/Screen Module

Continuing with Figure 8, we notice that both the collector and emitter wiring of Q1 go to module M109 (pictured in Figure 10). First, the paths of the collector and emitter currents pass through safety capacitor C4. This is the same general type of capacitor that gave so much trouble in many Zeniths. However, we have no reports of any unusual failures in the Magnavox receivers.

A smaller capacitance between collector and emitter (which eventually is grounded) produces *much* higher HV. If the safety capacitor should open at any of the four leads, either the emitter or collector circuit would be broken, thus killing all HV and horizontal sweep. This is preferable to operation with excessive high voltage, which might ruin the flyback and picture tube. (Incidentally, the defect of the Zenith capacitors was a change of the dielectric, not open leads.)

Three diodes, including the damper diode, are on the M109 module. D1 rectifies the Q1 collector pulses, producing about +940 volts for the picture-tube screens, while D3 is a "scan" rectifier that is fed horizontal pulses and some DC voltage to develop +260 volts that's used for the color-output transistors. Figure 11 shows the DC and AC waveforms of the input to D3.

Yoke And Centering

From pin 9 of the M109 output module, the collector signal of Q1 splits and goes to the horizontal yoke windings and to terminal 10 of the flyback, T1. Both yoke windings are in parallel (thus eliminating any need for capacitors or other networks), and they are bypassed to ground through C13A. (The yoke and C13A also form a series-tuned circuit which forces a rapid retrace. But that's another story.)

The sawtooth yoke current produces a 45-VPP parabolic waveform across C13A (Figure 12); and for horizontal centering, this signal is rectified to produce a DC current through the yoke windings.

Three pins and one movable insulated connector comprise the centering selector. When the connector is at the D2/C12 pin, R17 partially shorts out D2. This leaves D1 to rectify the parabolic waveform, sending positive voltage and current (the current actually does the work) back through the yoke

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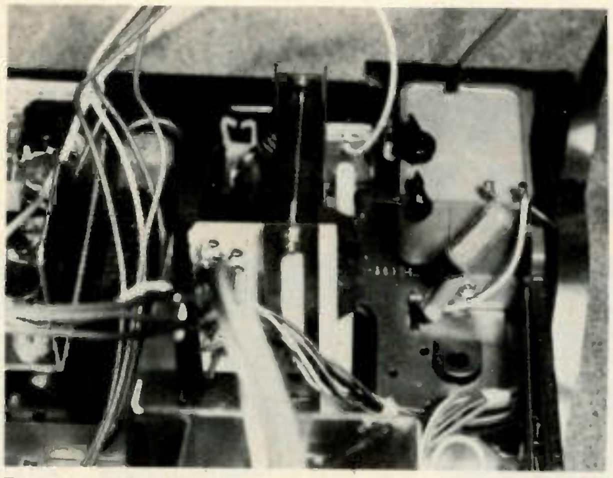

Figure 13 Components of the M115 horizontal-scan module appear to be mounted to the main chassis. But the module can be taken out without any resoldering.

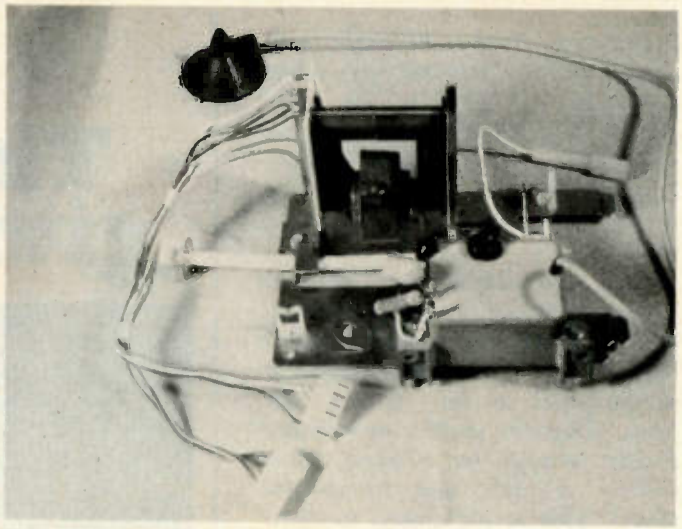

Figure 14 After four screws are removed and four connectors are unplugged, the M115 horizontal-scan module can be lifted out as a unit.

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windings, and moving the picture to one side by an inch or so. When the connector is at the center vacant pin, both diodes rectify the same amount, and the voltages and currents cancel, preventing any change of centering.

Or, when the connector is at the D1/C11 pin, D1 is shorted out, leaving D2 to create a negative voltage and current for the yoke, and moving the picture sideways in the other direction.

Q1 and the yoke circuit would operate normally without a flyback, if another way was provided to bring in B+ to the collector of Q1. A test method could be worked out for bringing in the B+ through a choke, and reducing the B+ to about 60 volts to prevent Q1 from being destroyed by the higher pulses that would be generated because of the lighter load. For now, just remember that the flyback is not necessary to produce normal yoke current.

Flyback And Tripler Module

If you would glance casually in the direction of the flyback (see Figure 13), you might be fooled (as I was) into thinking the flyback, tripler, and other components were mounted on the main chassis. Not so. If you remove four screws, remove the HV connector from the anode of the picture tube, unplug the focus wire, and unplug two connectors, the M115 horizontal-scan module could be lifted out. Those components are mounted conventionally on a metal plate (Figure 14).

Wiring of the horizontal-scan module is shown in Figure 12. The flyback has a primary winding, a HV doughnut for the tripler, and two windings (one centertapped) to produce pulses for the circuits noted. The circuit is simple, and it works very well.

An internal tap of the tripler (D1) provides about 7.5 KV of CRT focus voltage, which is reduced and adjusted by R2, R3, and R4.

Figure 15 shows the clean pulses at terminals 3 and 5 of the flyback. The waveform from terminal 2 was shown earlier with the DC component added.

Bright-Limit Circuit

The "cold" end of the HV

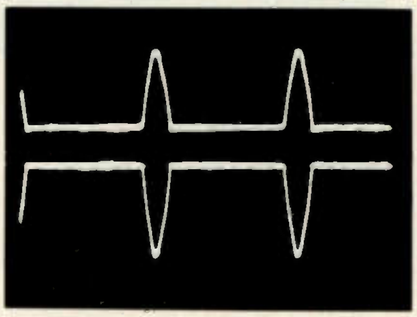


Figure 15 Top trace shows the 106-VPP sweep waveform at terminal 3 of T1 flyback. It goes to the AGC and other circuits. The 270-VPP waveform of the lower trace supplies the convergence and other circuits that connect to flyback terminal 5.

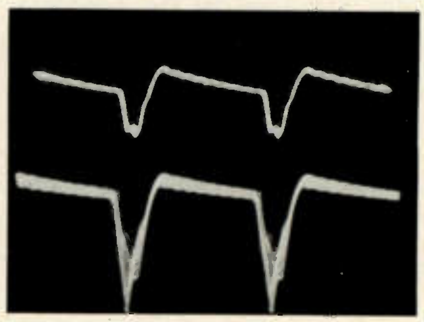


Figure 16 Both the DC and AC voltages at terminal 6 of the flyback change according to the amount of picture-tube current. Because this is the back side of the tripler diodes, increased current develops a larger *negative* voltage. However, a positive voltage comes from the video and the brightness-limit circuits; therefore, the DC voltage is less positive when the picture brightness is increased. Top trace shows the 10-VPP waveform (with +26.3 VDC) produced by a dim picture. A very bright picture gave +22.2 volts DC and the 18 VPP waveform of the lower trace.

winding does not go to ground directly, but HV current develops AC and DC voltages across R18 and C10, which are external to the scan module.

Remember the rule-of-thumb about rectifier polarities (borrowed from Editor Babcoke): when a DC voltage is produced by diode rectification, the voltage will be positive if it comes from the cathode of the diode. Or, it will be negative, when it is taken from the anode. In this case, terminal 6 of the flyback connects inside the HV tripler to the anode of the first diode. Therefore, HV current through the picture tube and tripler produces a *negative* voltage at terminal 6. However, the video circuit that receives this negative voltage has a larger positive voltage. So, the negative voltage merely reduces the positive one.

With the brightness turned down for a black raster, terminal 6 measured +26.3 VDC and 10 VPP (see Figure 16 for the waveform). Then, when the brightness was advanced to a bright picture, the readings were +22.2 VDC and 18 VPP, respectively.

Comments

When a Sencore Ringer (yoke and flyback tester) was connected to flyback terminals 8 and 10 out-of-circuit, button 5 gave a reading of 13.5. When in-circuit, the reading was about 32, with the same reading obtained between Q1 collector and ground. Shorts placed across the flyback windings reduced the Ringer readings to about 1, proving it can be used effectively to check this flyback.

The high voltage measured +31 KV with a black raster and +28 KV with normal brightness. No HV regulation is provided except for regulation of the +120-volt supply that feeds the horizontal-output transistor.

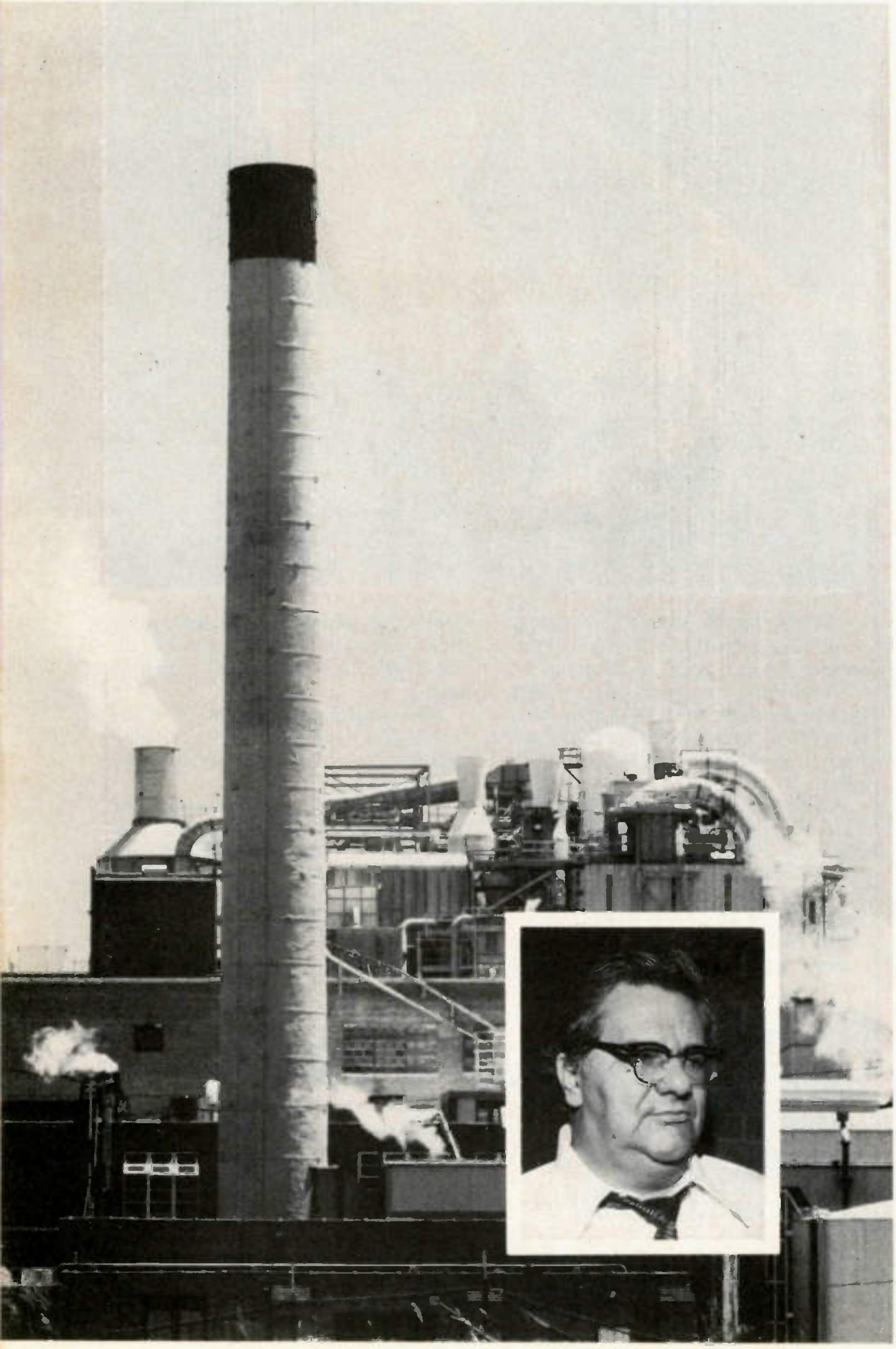
Most of the transistor leads are accessible, after the chassis is inclined in the service position. Many test points are available, and they are plainly marked. Troubleshooting the horizontal-sweep circuit should present no unusual problems.

Later in the series, we will give more servicing procedures, and list some of the changes to the modules. □

The Basics Of Industrial Electronics, Part 2

By J. A. "Sam" Wilson, CET

The resistivity of some materials vary widely according to the heat. Examples are given of passive transducers that use **thermistors** *to sense temperatures in industrial applications.*



In Part 1, we defined active transducers as sensors that generate a voltage. By comparison, passive transducers undergo a change of resistance, capacitance, or inductance while they are sensing some form of energy.

Resistors used as passive transducers to sense temperatures will be discussed this month.

Laws And Effects Of Resistor Transducers

Physical laws and effects needed for proper understanding of resistor transducers are shown in Figure 1.

Current flowing through a resistor always produces these two effects:

- a voltage drop occurs across the resistor; and
- heat is produced in the resistor.

The resistance of any material can be calculated from the basic equation: Resistance equals the length (in centimeters) divided by the area (in square centimeters) times the specific resistance (rated in microohms per cubic centimeter).

Also, the resistance of most materials changes with temperature. Therefore, it is necessary to consider the temperature along with the value of resistivity.

When the resistance increases with rising temperature, the material is said to have a **positive temperature coefficient.** Or, if the resistance decreases from a rising temperature, the material has a **negative temperature coefficient.**

Metals usually have a positive temperature coefficient (PTC), while semiconductors often have a negative temperature coefficient (NTC).

Bolometers

Bolometers are passive temperature-sensitive transducers. They are made of materials that have a large change of resistance when their temperature is varied. There are two general types of bolometers.

A **barretter** (called a resistance thermometer) is made with a very thin thread of metallic wire that's suspended between two contacts. This wire often is made of platinum.

A **thermistor** is made of semiconductor material, and usually has an NTC. However, Texas Instruments (and other manufacturers) makes a thermistor of heavily-doped semiconductor material that has a PTC. It's called a **sensistor.**

Thermistors are most often found in industrial equipment. Figure 2 shows three types of thermistors.

Bead-type thermistors have glass envelopes filled with an inert gas or evacuated to a vacuum.

Problems Of Measuring Temperature With Thermistors

A simple thermometer circuit with a thermistor sensor is shown in Figure 3. As the temperature that's being measured increases, the thermistor resistance decreases, thus increasing the current through the meter. The scale of the meter is calibrated in degrees, either Fahrenheit or Centigrade.

If the voltage source is not regulated, changes of supply voltage will produce nearly equal changes of meter current and reading. One solution to the voltage-regulation problem is to connect the thermistor in a bridge circuit (described later), because the supply voltage does not change the accuracy of bridges.

Another problem is that the current flowing through the thermistor increases the temperature of the thermistor. Therefore, any increased current from higher temperatures in turn increases the thermistor temperature a second time, causing a reading error.

Now, this self-heating temperature rise *could* be compensated for by a change of meter calibration. Unfortunately, the effect is not constant.

For example, the amount of self-heating depends on the heat conduction of the medium that surrounds the thermistor. The effect is increased by mounting the thermistor in a vacuum. And the temperature will be significantly lower in water than when the thermistor is surrounded by motionless air.

In addition, the calibration resistor of Figure 3 also has a temperature coefficient, and changes of the ambient heat varies its resistance and current.

There is even a small amount of coil resistance change inside the meter, because the wire too has a temperature coefficient.

Of course, the self-heating effect of thermistors can be minimized by using the smallest current possible. This also reduces the drifting of meter and calibration resistor.

A Benefit From Self-Heating

The self-heating effect of Figure 3 can be used to an advantage in one kind of circuit that indicates a low level of liquid (see Figure 4).

When the level of the liquid is

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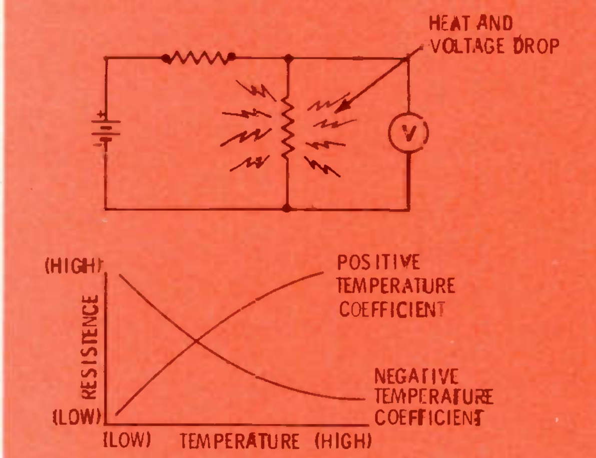

Figure 1 Current flowing through a resistance produces a voltage drop and heat, illustrated by A. The graph at B gives typical resistance versus temperature curves for PTC and NTC materials.

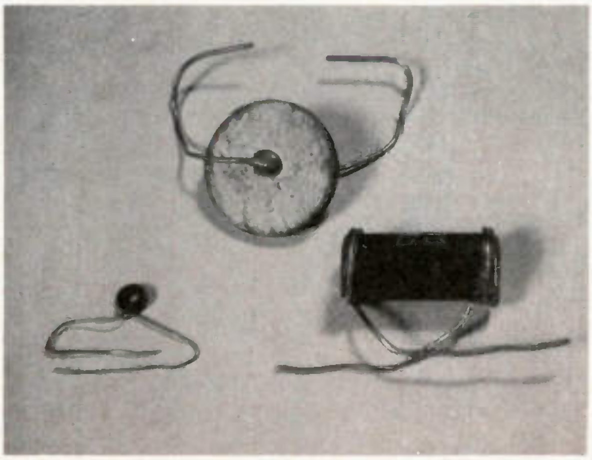

Figure 2 The tiny thermistor at lower left can have either PTC or NTC, depending on the material used, and often is encased in a glass bead. A "washer" type of thermistor is shown at center top. This one has NTC, and it is intended for use in automatic degaussing. A "Globar" type that resembles a conventional carbon resistor is pictured at the lower right.

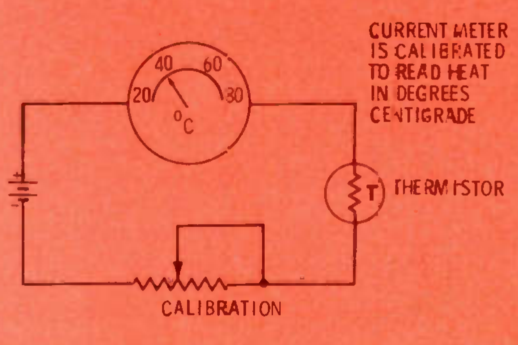

Figure 3 A thermistor and a current meter can be used to measure the approximate temperature. The calibration control adjusts for minor variations of individual thermistors (this one has NTC). Any variation of the supply voltage changes the reading, so the stability is not very good.

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high, the thermistor is immersed in the liquid. The temperature from self-heating is small because the liquid carries the heat away more quickly than if the thermistor were in air.

However, when the liquid level is low, exposing the thermistor to air, the thermistor temperature increases because of the self-heating, thus decreasing the resistance and increasing the relay current enough to close the contacts and light the "Empty" warning sign. Table 1 summarizes the various actions.

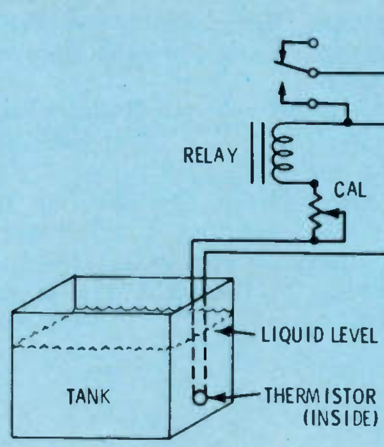


Figure 4 Although the self-heating of thermistors from the current in the circuit ordinarily is considered a shortcoming that limits the accuracy and stability, the self-heating effect can be used to indicate whether the thermistor is in liquid or air. When immersed in a liquid, the NTC thermistor runs cooler (higher resistance) than after the tank runs dry and the thermistor is surrounded by air. In air it operates hotter, has a lower resistance for increased current, and the stronger current trips a relay which lights a warning sign.

Table 1

CONDITIONS OF FIGURE 4

LIQUID LEVEL	THERMISTOR SELF-HEATING	THERMISTOR RESISTANCE	COIL CURRENT
high	low temp	high ohms	low
empty	high temp	low ohms	high

Thermistor Bridge Circuits

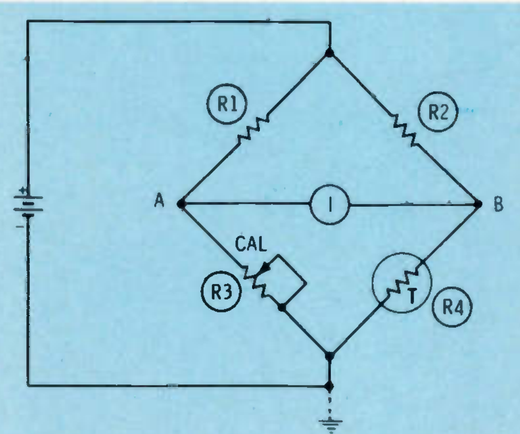
Figure 5 shows how a thermistor thermometer can be changed to a balanced-bridge circuit that is not sensitive to variations of supply voltage. When the bridge is balanced, the resistances conform to this equation: R1/R3=R2/R4, and the meter has no current.

If the temperature changes, the thermistor changes resistance, thus unbalancing the bridge and sending through the meter a current of an amount and polarity that depends on the temperature.

The formulas for the voltages at points A and B are given in Figure 5, and they show that those voltages are directly proportional to the supply voltage. In other words, if the supply voltage is increased or decreased, the voltages at points A and B both will be increased or decreased by the same amount. Therefore, calibration and accuracy of the circuit are not affected by any variation of the supply voltage.

In actual thermistor bridges, one of the other resistors in an adjustable type, so it can be varied to obtain correct calibration.

If greater sensitivity of the circuit is needed, the voltage *between* points A and B can be amplified.



$$\text{Voltage at A} = \text{Voltage source times } \frac{R3}{R1 + R3}$$

$$\text{Voltage at B} = \text{Voltage source times } \frac{R4}{R1 + R4}$$

Figure 5 The temperature meter of Figure 3 can be made immune to the effects of a changing supply voltage by rewiring it as a bridge. As is usual with all true bridges, the null (or zero-current point) first must be found by watching the zero-center meter and varying the calibration control. After the null is found, the temperature is read from the dial markings of the calibration control. (Another version gives automatic meter readout from a meter scale similar to that in Figure 3, but the accuracy at extreme readings is affected slightly by any supply-voltage changes. The schematic is the same as this one; the difference is whether the meter or the calibration control provides the reading in degrees.)

Time Delay By Thermistor

An appreciable amount of time is required for the self-heating of a thermistor to reach a stable point. This effect can be used as a time delay. A graph of thermistor current versus elapsed time is shown in Figure 6, along with the circuit.

In practical instruments, the thermistor current trips a relay after it stabilizes at a high level (see

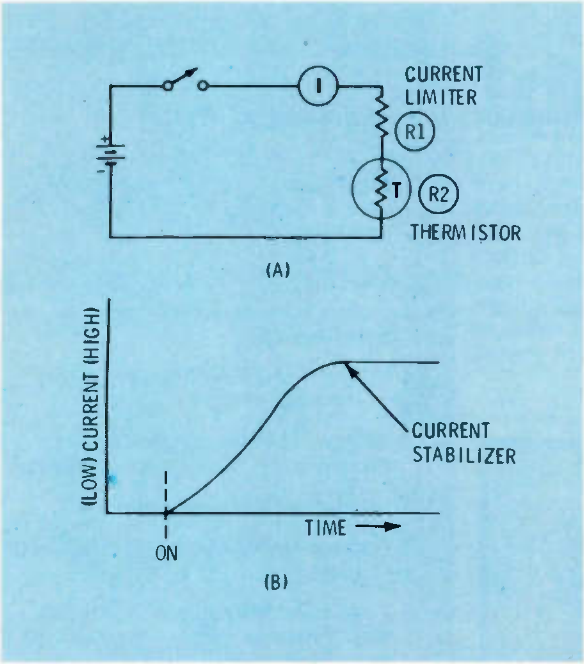


Figure 6 When the self-heating effect and the current both are large, a significant amount of time must elapse before the thermistor current stabilizes. The circuit is at A, and the current-versus-time graph is at B. This can be used as a time-delay circuit.

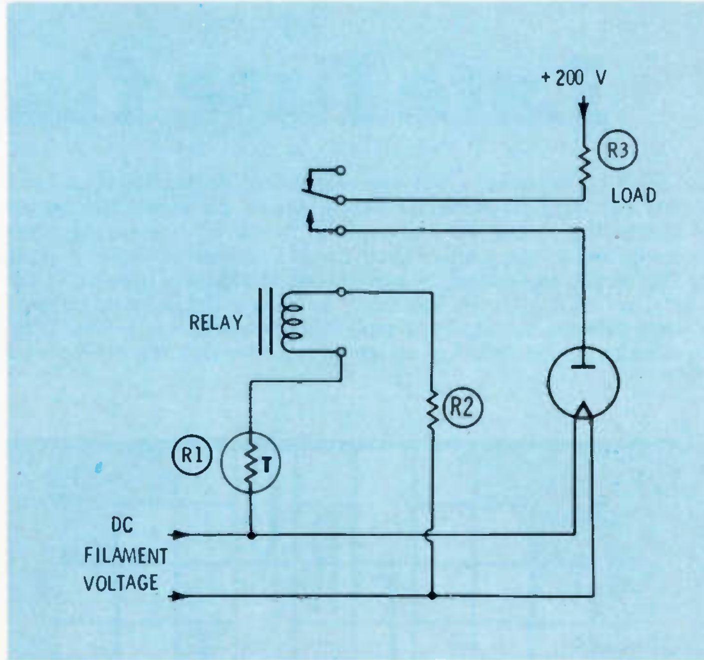


Figure 7 Here is a practical application of the time-delay principle in Figure 6. The tube should not have plate voltage until the filament has operated for a certain time. The thermistor current builds up gradually, and the values are chosen so the relay trips just before the current stabilizes.

Figure 7). The plate voltage is not applied until the self-heating increases the current by a sufficient amount. Such circuits can be used with tubes requiring a filament preheating before the plate voltage and current are applied.

Closed-Loop Temperature Control

A thermistor and a transistor can be the special components of a closed-loop temperature control (Figure 8). Bias of the transistor is determined by the voltage divider made up of R1, R2, and R3. R2 prevents the forward bias from becoming so high that the transistor would be destroyed, and R1 is adjusted for the desired temperature in the small oven.

Heat for the oven comes from R4, the collector load resistor, which is inside the insulated box. The oven heat determines the resistance of the thermistor, R3, that's also inside the oven.

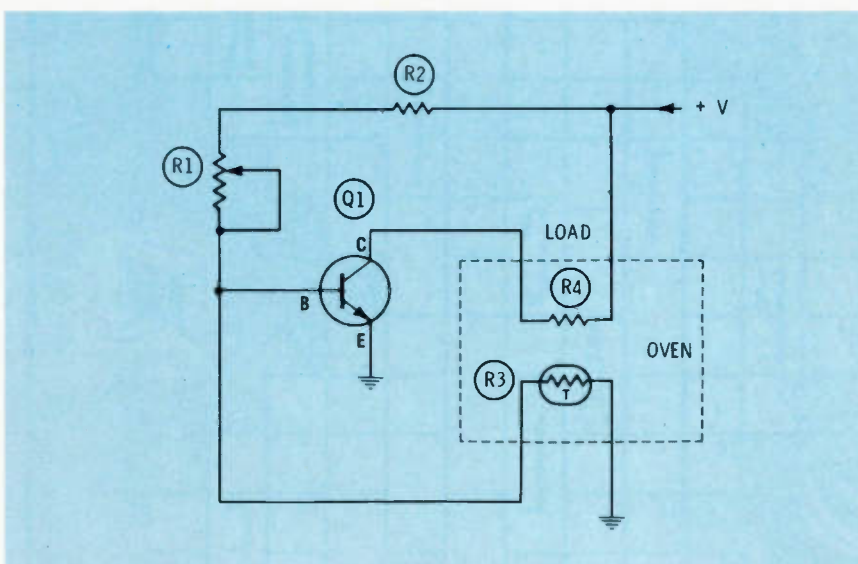


Figure 8 Temperature control in a small box, such as an oven for critical components, can be done by enclosing the heat-producing collector resistor and the NTC thermistor in the oven. Higher temperatures reduce the transistor bias and decrease the heat from R4.

Assuming that the oven temperature has reached the desired value, any increase of temperature decreases the resistance of R3 thermistor. The decreased resistance reduces the forward bias of Q1, thus reducing in turn the collector current and the heat emitted by R4. Sufficient heat cuts off the conduction of Q1.

If the oven temperature falls below the desired heat, the R3 resistance rises, applying more forward bias to Q1, and causing increased collector current, which produces more heat inside the oven.

These two heating and cooling actions operate gradually, without steps.

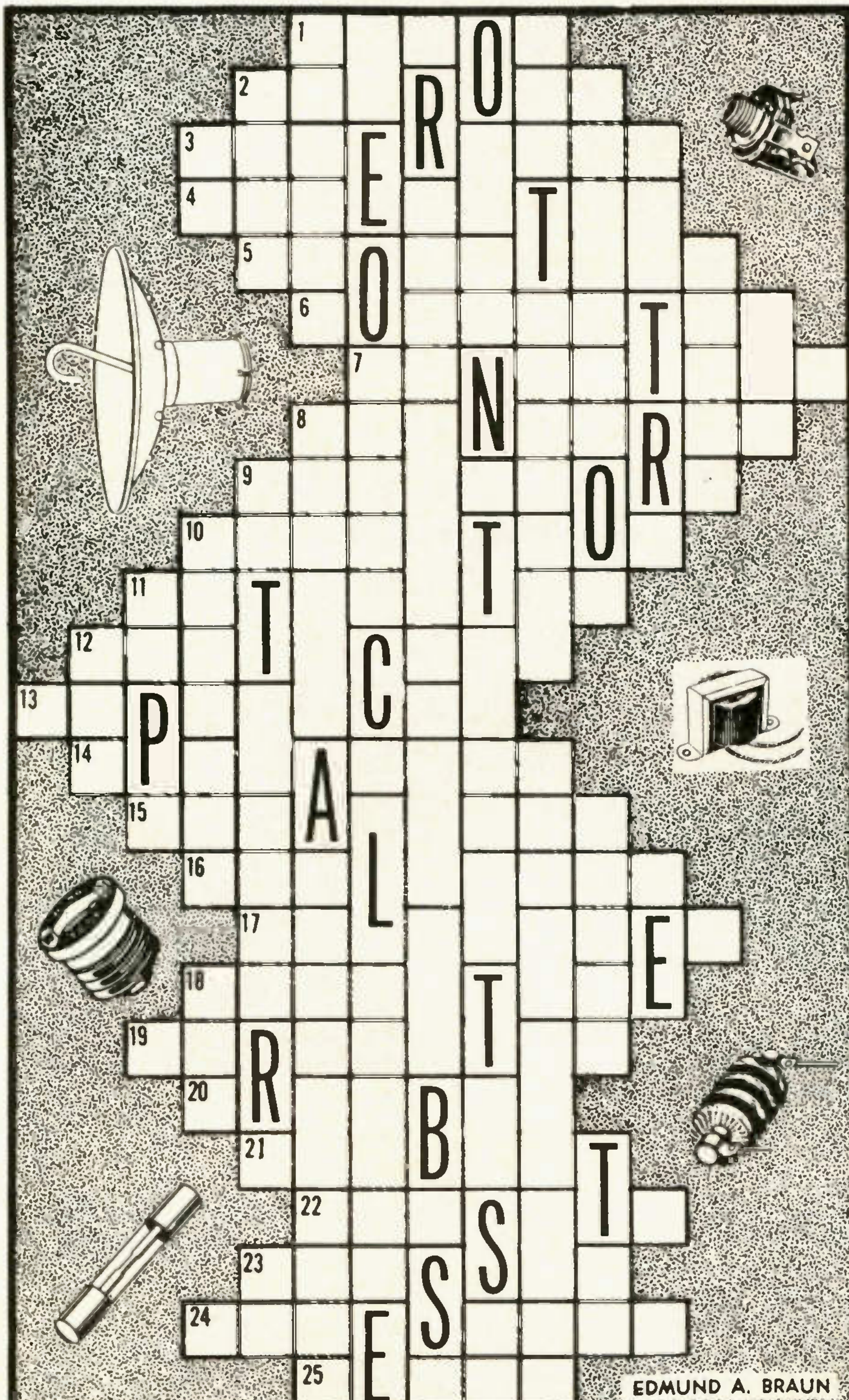
Next Month

Capacitive and inductive transducers will be explained next month. □

Late fuse flash!

by Edmund A. Braun

Time out for a coffee break—but who can afford coffee these days! Instead, have fun solving this Just-across-word Puzzle based on electronic terminology. Each word is connected to the word above and below by one or more letters but only one is usually shown as a clue. Each correct answer is worth 4 points; a perfect score is 100. If you're a novice in electronics and miss a few, don't fret, you'll have added to your vocabulary in the field. It should prove fairly easy to get a high score except perhaps for someone who thinks "kinetic" is a New England state, or that "steel wool" is the result of sheep eating iron-rich food! Ready? Pencil sharp? Then, GO!



1 Metallic cover over insulation of wire or cable to protect it from damage.

2 Pertaining to iron.

3 Permissible deviation from a specified value.

4 Diagram showing circuits, parts, assemblies, etc.

5 Science concerning production, transmission, and effect of sound.

6 Instrument for measuring EMF.

7 Representation on a much reduced scale.

8 Term used primarily in industrial electronics to mean a hot-cathode gas diode.

9 An electronic musical instrument.

10 Mechanical oscillation or motion about a reference point of equilibrium.

11 Fixed or calculated approximately.

12 Calibrated screen placed in front of a CRT for measuring purposes.

13 Based on actual measurement, observation, or experience as opposed to theoretical determination.

14 Performance of a task, work, or function.

15 Radio facility which provides signals for guiding aircraft onto center line of a runway.

16 One-thousandth of a unit of EMF.

17 Transmitted transient images of fixed or moving objects.

18 To give a ferrous metal the power to attract other ferrous metal.

19 Instrument capable of measuring very high temperatures such as molten metal.

20 Failure of a circuit or element to perform in a standard manner.

21 Type of antenna.

22 A measure of light reflecting or transmitting of an area.

23 The frame or base of a set.

24 Point at which an effect is first produced, observed, or otherwise indicated.

25 Holder designed to receive and position the edges of a lens, meter, etc.

Gazing into our crystal ball, we see the solution is on page 66.

Troubleshooting 4-Channel Auto Tape Players part1

By Homer L. Davidson

Suggestions are given for finding bad heads or defective amplifier stages, along with examples of typical troubles. Head adjustments are described, also.

Common Tape-Player Problems

Most electronic tape-player troubles originate in just two general areas: the tape head and input stage; or, the power-output stage that drives the speaker. Tape heads wear out, and they might shift from the optimum alignment position. Input amplifier stages are no more prone to hum and noise than other stages are, but any excessive hum or noise is more noticeable because of the high amplification that follows. Transistors, ICs, and resistors can produce undesired crackling or hissing noises.

Most complaints of distortion or no volume are caused by defective power-output transistors.

Although troubleshooting techniques for all stages will be given, these two problem areas receive the most attention. You can save servicing time by knowing about these common sources of typical tape-player problems.

Four-Channel Sound

The mixing of music channels during studio recording is done very differently according to whether the tape will have two channels or four. But, in tape players, there are no basic differences, except the two-channel machines have two identical amplifiers, and the four-channel versions have four identical amplifiers (Figure 1).

Also, the tape cartridges are the

continued on page 58

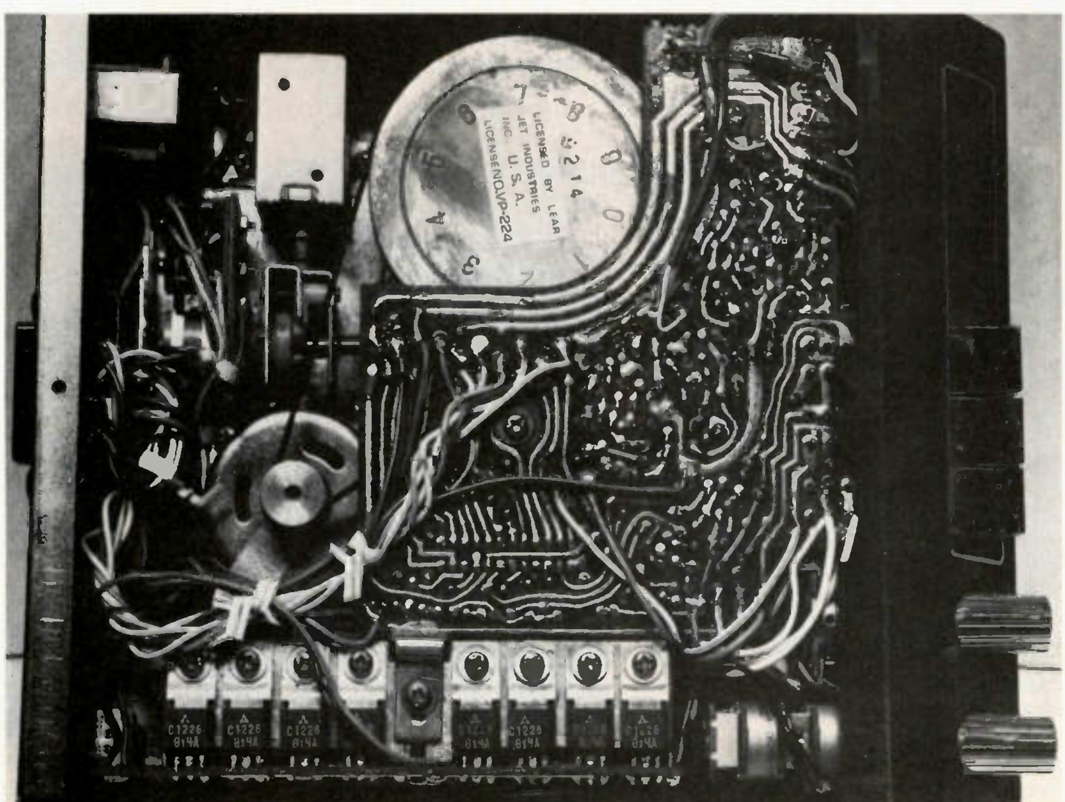


Figure 1 Eight power transistors in this auto stereo tape player prove it has four channels.

4-Channel

continued from page 57

same, with just one difference. Four-channel tapes have a special groove in the case to activate the automatic track-switching function of those machines that have it.

Each tape has eight recorded tracks. For two-channel stereo, this provides four programs, with each program using two stereo tracks. The head must be moved vertically to these four positions in turn.

Since four-channel stereo requires four tracks, only two programs can be placed on each tape. The head is required to assume either of only two positions.

Except for the extra components of the two additional channels, which might cause crowded conditions on the boards, servicing four-channel tape machines is no more difficult than repairing two-channel models.

Tape Heads

Four-channel tape heads have the same approximate size and appearance as the heads for other formats. However, there must be four separate core/winding/gap assemblies inside, and these can be identified by the visible gaps on the face of the head. Machines that record must have four more gaps (see Figure 2) for erasing old tracks.

Be very careful not to scratch the face of a head. Any kind of head groove tends to scrape off the tape coating, and the groove fills up with oxide. When the oxide builds up a thick covering it forces the tape away from the head, sometimes causing weak volume or attenuated high frequencies. **One common symptom is playback of fair quality, but with no volume during recording.**

Therefore, after the first evaluation of the performance is made, you should clean all oxide from the face of the head and demagnetize it. Clean off the iron oxide with head-cleaning liquid from a swab on a long wooden stick, and demagnetize the head with a plug-in cartridge, as shown in Figure 3.

DC resistance of each head winding might be between 190 and 850 ohms, depending on make and model. All four windings should measure about the same. Demagnetize the head after you use an ohmmeter to check the windings.

The windings, or the leads and terminals, can become intermittent. Usually the defect is an open, which eliminates all sound from the one channel. Move the external cables around and listen for an intermittent symptom.

Many things can magnetize a head. Models that record often magnetize the head from the clicks and pops during switching. Some music has non-symmetrical waveforms, and this can magnetize a head.

Magnetized heads cause the normal tape hiss to be much louder, and also they act as a magnet to erase some of the high frequencies of the music. Demagnetizing the head stops future erasure of the highs, but nothing can restore the highs after they're gone. So, **demagnetize oftener than you think necessary.**

Crosstalk

Crosstalk is any music of another program that's heard when you play the tracks you want. Seldom is the head defective. Usually a wrong vertical position locates the gaps *between* the tracks of different programs, rather than "over" the correct set of tracks.

Worn parts or loose adjustments of the track-change mechanism are the most common cause of crosstalk. Crosstalk between amplifier channels only reduces the stereo separation. Incorrect head elevation is the only defect that can cause the faint sound of another musical selection to be heard.

Listen to several tapes before you

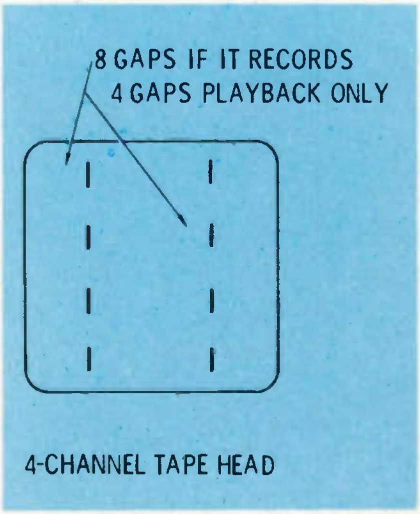


Figure 2 Four gaps (each with internal core and windings) are required for a head to give four-channel stereo sound. Four additional gaps are necessary for erasing, if the machine also records tapes.

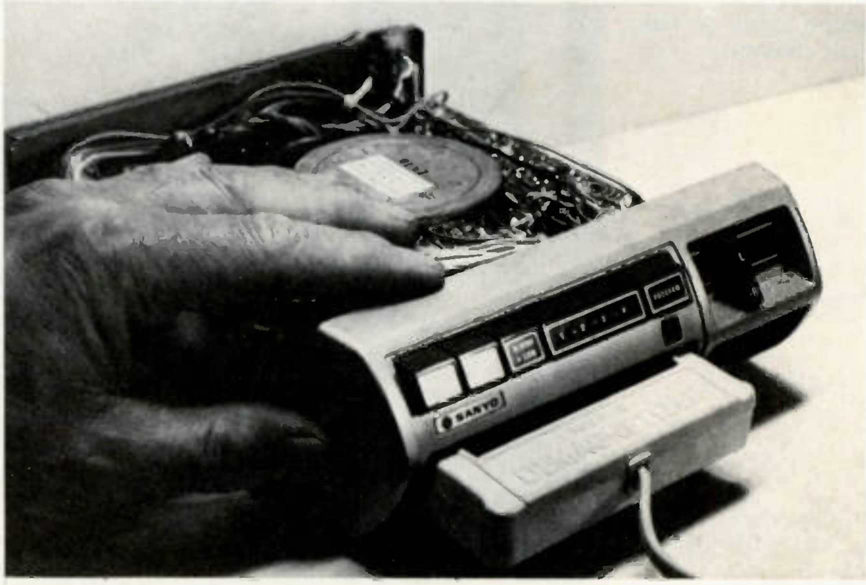


Figure 3 Tape heads should be demagnetized often. Use a long degausser, or insert a special demagnetizer Stereo-8 cartridge. With conventional demagnetizers, take care to not scratch the face of the head.

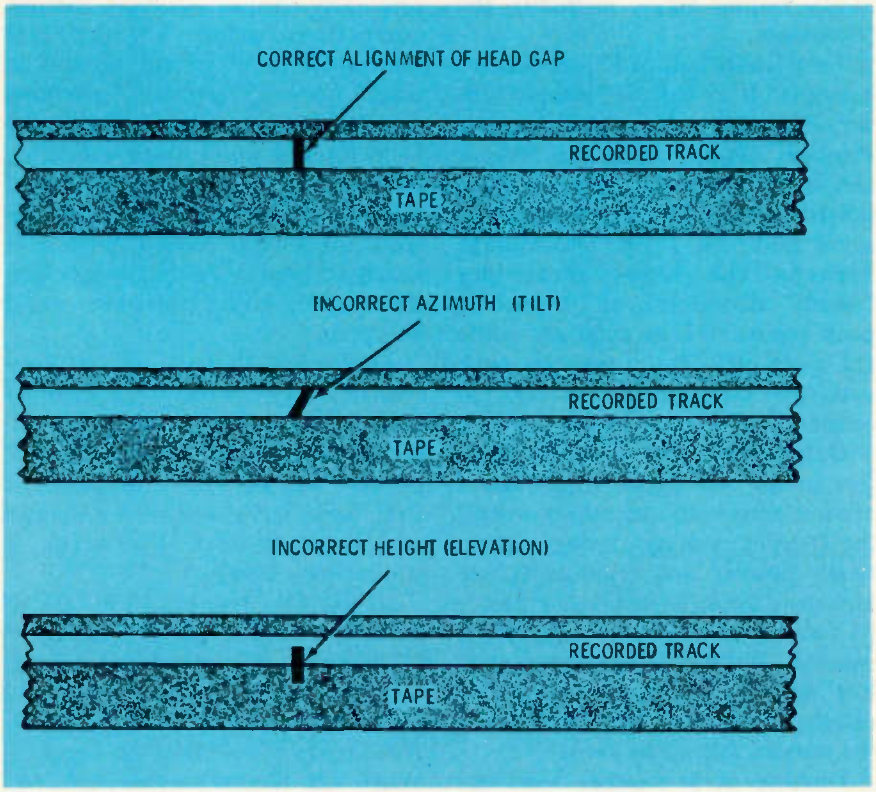


Figure 4 An incorrect azimuth (tilt) adjustment reduces the high-frequency response. Wrong height (elevation) does not affect either distortion or the frequency response, but it can lower the volume. An extreme elevation error might position the gap over parts of two tracks, thus causing "crosstalk," which is music of the wrong program.

Figure 5 A test cartridge is strongly recommended for tilt and elevation adjustments, along with a scope as the indicator. A meter or a listening test can be used, but tape hiss and noise reduce the accuracy.

start to correct any crosstalk. Tapes vary in the exact placement of the tracks, particularly some "bootleg" tapes. Even with good tapes, you must adjust for an average, and not for perfection with only one tape.

Head alignment

There are only two kinds of head alignment (Figure 4). Vertical position (relative to the length of the tape) affects both the volume and the crosstalk, if the height error is severe. Azimuth or tilt of the head gap determines the high-frequency response. Neither adjustment changes distortion.

Although the adjustments are simple, some interaction occurs between them. Therefore, it's best to repeat the sequence several times to obtain the best accuracy. The adjustments can be done with a normal cartridge, but you will save time and do a better job with a test tape.

I recommend the RCA 327 cartridge for head adjustments, and a scope for the indicator. (A meter can be used, but tape hiss can confuse the results.)

Insert the 327 test cartridge, as shown in Figure 5, and connect the scope probe across the *right-hand* speaker terminals. Listen for the tone and watch the scope screen at the same time. Adjust the scope gain for a pattern 1-inch high. Start with channel 2, and adjust the azimuth screw (usually at one side of the head) for maximum height of the high-frequency waveform. Change to channels 1 and 3 and listen for the tone. There should be none, because nothing is recorded on them.

For head-height adjustment, change to channels 2 and 4, and adjust for *maximum* tone level. Check channels 1 and 3. If an appreciable tone is there, repeat the azimuth and height adjustments again.

Testing The Audio Stages

Having four identical audio amplifiers can be very helpful when you're troubleshooting. DC voltages and signal levels of the bad channel can be compared with the other three.

continued on page 62

4-Channel

continued from page 61

If all four channels are dead, but the tape is moving past the head, you can assume that lack of DC power is the problem. Check first for a blown fuse or a loose wire in the supply voltage. If these easy tests don't locate the origin of the problem, use a DC voltmeter to trace the open.

When a newly-installed fuse blows instantly as the cartridge is inserted, the motor might be shorted, or one of the output stages could have a short.

Excessive current or a short in an output stage often burns up the emitter or collector resistors. Check visually for the telltale signs; they can save you a lot of time.

Testing output stages

Most audio power amplifiers use some variations of the two-transistor output stages shown in Figure 6. The transistors are operated in Class "B" mode, with each drawing current alternately. For lowest distortion, the two transistors should be matched in gain and current.

If the output transistors are matched for current, then they should have equal voltage drops across each one. This is the basis for a quick and fairly-accurate test of the output stage, including the transistors.

Take the circuit of Figure 6A, for example. It is called "complementary—symmetry" output, using identical output transistors, except one is NPN and the other is PNP polarity. Bases are driven from the same point (a slight DC voltage between the bases minimizes "notch" distortion), so a positive peak causes Q1 to conduct, while Q2 is cut off. Also, a negative peak cuts off Q1 and causes Q2 to conduct.

Output from the common emitters in an AC signal that centers around zero volts. In others words, the output voltage swings alternately positive and negative as one and then the other transistor passes its polarity of supply voltage to the common-emitter point. These positive negative volatages should be equal; therefore, **a DC meter reads the output voltage as zero.**

Looking at it another way, the DC output voltage is the **average** of the two supply voltages. If the positive supply is +20 volts and the negative supply is -20 volts, the average is zero. Perhaps it would help if you thought of the transistors as two equal (but variable) resistors.

The previous statements about zero DC output voltage assume correct operation. So, this last sentence can be turned around to read: **Correct operation produces zero DC output voltage.** That is the basis for one quick troubleshooting test. If the DC output voltage of Figure 6A is zero, the output circuit (and any direct-coupled drivers) is nearly certain to be operating okay. (Of course, both transistors could be open!)

Any defect that affects the current of either transistor (or changes one supply voltage) causes a DC output voltage that measures either positive or negative. Imagine the C/E path as a resistor, and this idea becomes clear. The circuit is similar to a bridge.

If the DC resistance of Q1 is normal, but the DC resistance of Q2 is open, the DC output voltage will be highly positive. Or, if Q2 resistance is okay, but Q1 is open, the output will be highly negative. When Q1 is shorted between collector and emitter, the output is the same as the positive supply voltage. When Q2 is shorted between collector and emitter, the output equals the negative supply voltage.

Single power supply

The circuit of Figure 6B is the same as 6A, but it is adapted for operation with a *single* positive power supply. Therefore, the common emitter DC voltage is the *average* between zero and the supply voltage. In other words, the common emitters should measure approximately *half* of the supply voltage. A +40-volt supply should provide about +20 volts at the common emitters.

Figure 6C is a "quasi-complementary" type. That means it appears to be a complementary type, but it is not. Both transistors have NPN polarity, requiring a phase inverter to drive the base of Q2. The DC analysis is the same as for 6B, except the output is taken from the emitter of Q1 and the collector of Q2.

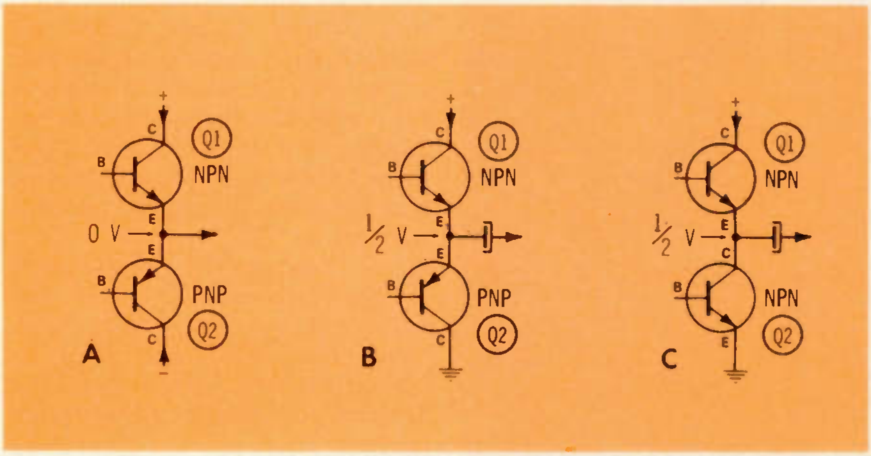


Figure 6 These are the three basic transistor output circuits that most often are used in stereo amplifiers. (A) The complementary-symmetry type has two power supplies of equal DC voltage and opposite polarity. No coupling capacitor is required between the emitters and the speaker, because the DC voltage there should be about zero. (B) This is the same circuit, but modified for a single positive DC power supply. A large coupling capacitor is necessary. (C) Although there are similarities to circuit B, transistor Q2 has NPN polarity and is reversed. Also, Q2 requires a phase inverter before the base. **The DC voltage at the output of both B and C should be about half of the supply voltage,** for normal operation.

Next Month

Conditions needed to achieve maximum voltage gain will be discussed in Part 2 next month. ☐

productreport

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Tuner Cleaner

A new aerosol cleaner and lubricant has been developed by **Chemtronics**. The product, "Tuner Renu," improves the operation of television tuners by cleaning tuner contacts and depositing a light lubricating film that protects the contacts and permits smooth detent action.

Tuner Renu, formulated especially for color TV tuners, is non-flammable, causes no drift, and is safe for all plastics. It can be sprayed directly onto tuner contacts by removing the tuner shield. Or, in some TV sets, it can be sprayed into the tuner through the front of the TV set by removing the tuning knob.

For More Details Circle (39) on Reply Card

Counter Merchandiser

A new point-of-purchase merchandiser featuring a dealer stock of CB microphone connectors is available from **Workman Electronic** under its "Eltratec" label.

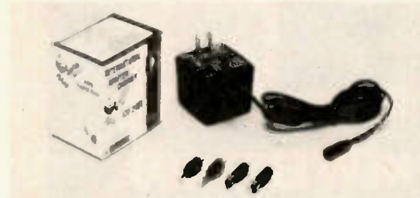
The model WD491 wire counter display offers 14 different types of connectors covering 95% of the CB transceivers on the market today.

A cross-reference permits counter sales personnel to select the proper connector by CB model number.

For More Details Circle (40) on Reply Card

AC Adapter

Dynamic Instrument's new International Model universal AC adapters power all popular calculators, radios, tape cassettes, walkie-talkies, and other low-powered, battery-operated products from either a 120-volt or a 240-volt AC power source.



Four interchangeable plug tips accommodate the various sockets and polarities found at the input receptacles of different products. □

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test equipment report

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Digital Multimeters

Sencore has added a .1% (DC accuracy) portable, 3½-digit multimeter to its line. The new DVM37 is designed for the technicians who require more accuracy.

Features include one-third less circuit loading for greater accuracy (15 megohms input impedance rather than the conventional 10 megohms); high/low power ohms on all resistance ranges through 20 megohms; battery-saving feature with a push-to-test switch on the test probe; auto polarity; auto zero; auto over-range; and an unbreakable case with fully protected circuits.

The DVM37 operates from standard "C" cells or from the AC line with a separate power adapter (model PA202). Suggested price of the multimeter is $248.

For More Details Circle (42) on Reply Card

Isolation and Autotransformer

B&K-Precision has introduced a combination isolation and autotrans-

former for bench use. The new TR-100 is designed for use in industry, shops or schools.

Three isolated and three direct outlets are featured, providing high, medium and low (130 VAC, 115 VAC, 105 VAC) line voltages. The isolated outlets are rated at 400 VA continuous, while the direct outlets are rated at 500 VA.

The TR-100 allows safe testing of transformerless equipment, minimizing a potential shock hazard. In addition, it can be used to vary the input line voltage applied to an electrical device or instrument under test.

For More Details Circle (43) on Reply Card

Resistance Sub Box

Phipps & Bird have a pocket-size slide-switch resistance substitution unit which can deliver more than 11 million resistance steps.

Measuring just 4"x6"x1-3/16", the unit is housed in aluminum and features three binding posts, one to ground the case. It uses one-half-watt resistors with one percent tolerance and gives an accurate range from 1 ohm to 11,111,110 ohms in one-ohm steps.

For More Details Circle (44) on Reply Card

Frequency Counter

A low-cost frequency counter, Model 6202B with a range from 20 Hz to 10 MHz, has been introduced by **Syston-Donner.**

Model 6202B features a 3-position (X1, X10, X100) input attenuator switch, and an offset control, making possible high-accuracy measurements of complex, non-sinusoidal waveforms. The variable offset control also has a fixed preset-trigger position. Four selectable gate times allow measurement readouts to appear at convenient resolutions from 0.1 Hz to 100 Hz.

Price of Model 6202B is $295. □

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antenna systems report

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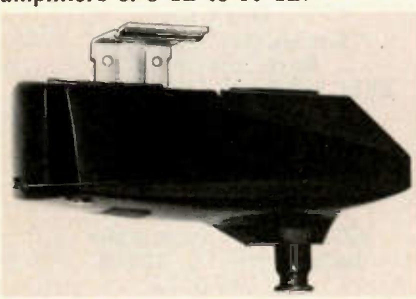
Antenna Preamps

Winegard has added five high-gain, low-noise preamplifiers to its Gold-Star line: GA-3800 (VHF only); GA-4800 (UHF only); GA-8800 (VHF/UHF); and GA-6300 and GA-6700 (both VHF/FM only).

UHF/VHF noise figures run between 3.5 dB and 4.2 dB, compared to typical noise figures for other preamplifiers of 8 dB to 10 dB.



The Gold-Star preamps also feature a lightning-protection circuit that minimizes transistor burn-out. Antenna and downlead connections are internal. A fixed FM trap in the VHF circuitry prevents overload from strong FM stations.

The preamps can be mounted on the antenna mast or boom; weatherproof housing protects circuitry. They include a power supply in metal housing with mounting bracket, and F-59 connectors.

For More Details Circle (46) on Reply Card

Disguised CB Antenna

Antenna Incorporated has introduced a cowl-mount CB disguised antenna that is similar in appearance to most standard automobile AM/FM receiving antennas, and is pretuned at the factory for a SWR of 1.5:1 or less across all 40 channels. The Model 11004 also has a conventional cable and plug for an AM/FM car radio. Includes an in-line coaxial-cable connector and 18 feet of low-loss RG-58/U coaxial cable.

For More Details Circle (47) on Reply Card

CB Dual-Antenna System

New from **Avanti** is the AV-535 co-phased dual-antenna system. Designed for use on cars, pickups, campers, and other recreational vehicles, the system consists of two 48" stainless steel, top-loaded Avanti "Fazer" antennas with chrome-plated steel gutter-clip mounts and 24' co-phasing harness. The system is removable for easy transfer from one vehicle to another.

For More Details Circle (48) on Reply Card

U/V Converters

Jerrold Electronics has developed a new UVC series of solid-state UHF to VHF TV-channel converters for use in Master Antenna TV (MATV) systems.

These new converters can be used to distribute UHF channels on unused VHF channel frequencies. For example, UHF Channel 48 can be converted to VHF Channel 10 and distributed on that frequency throughout the MATV system.

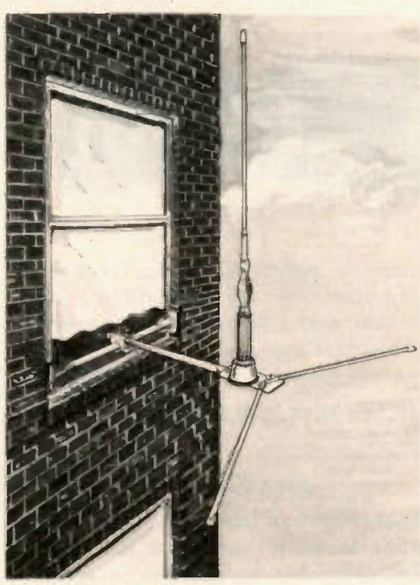
The typical noise figure is 10.5 dB, and output capability is +40 dB mV. Conversion gain varies from 6 dB to 14 dB, depending on the frequencies involved. Frequency stability is ±.05% between +14°F and +140°F.

Model UVC is available from current production at a list price of $175.85.

For More Details Circle (49) on Reply Card

CB Window Antenna Mount

A new CB window antenna mount by **RMS Electronics** accommodates any mobile CB antenna. The self-grounding window mount, Model CBWM-50, features ground plane elements similar to larger base station CB antennas. The mount has all-



aluminum weather-proof elements, a steel mounting bracket, and hardware.

CBWM-50 has a $12.95 list price in a regular shipping carton, or a $13.95 list if skin-packed in a peg-hang card. It does not include a CB antenna. □

For More Details Circle (50) on Reply Card

audio systems report

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Automatic Microphone Mixer

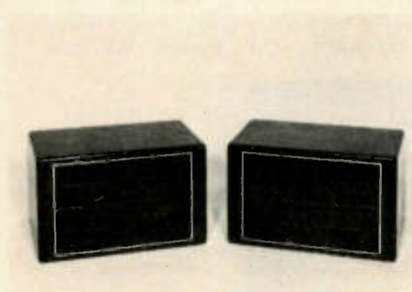
The **Altec** Model 1628A is an 8-channel, solid-state microphone mixer, with provision for plug-in input accessory modules. One unique feature is the patented circuit which adjusts automatically the individual mike gains and the mix gain according to changes of the channel signal versus the system signal. It is said that this makes possible maximum gain without feedback for each single mike or combination of mikes.

Other features include LED indicators of active channels, RF shielding on input and power leads, and short-circuit protections of the power supply and the output stages.

For More Details Circle (51) on Reply Card

Mobile Speakers

Components Specialties presents their "Stereo Van System," a high-fidelity speaker system designed for mobile use. These speakers do not



require an additional power booster or amplifier and are compatible with most AM and FM radios, or 8-track and cassette tape decks.

The suggested list price is $149.95.

For More Details Circle (52) on Reply Card

Amplifiers

Monogram has introduced the 3000 Slimline series of amplifiers featuring digital computer techniques to monitor both current and voltage.

The Model 3000 has a basic preamplifier, two tape monitors, and tone controls. Models 3100, 3200, and 3300 high-power switching amplifiers are rated at 8 ohms with 100, 150, and 200 watts RMS, respectively. □

For More Details Circle (53) on Reply Card

Solution to:

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2 ferrous	15 localizer
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7 miniature	20 trouble
8 phanotron	21 doublet
9 novachord	22 density
10 vibration	23 chassis
11 estimated	24 threshold
12 graticule	25 bezel
13 empirical	

Start with 100 points and deduct 4 points for any part you may not have answered correctly

Your rating:

60 - 64	Good try.
68 - 72	Very good.
76 - 84	Excellent.
88 - 96	Terrific.
100	PERFECT. Our congratulations!

catalogs literature

Circle appropriate number on Reader Service Card.

66. Cornell-Dubilier—has prepared a four-color, four-page brochure on its Ham II, CD-44, and "Big Talk" rotor communication systems. The brochure covers interior rotor construction and has tables for all three units. Included are such factors as hardware, mounting, maximum antenna size, and typical loads.

67. Thordarson Meissner—has included all of its new electronic replacement products in two revised cross-reference guides, entitled "TV Replacement-Parts Guide" (Form TVPG 9) and "CB Replacement-Parts Guide" (Form CBRG 2).

68. Tucker Electronics'—new 20-page catalog lists approximately 500 individual pieces of reconditioned electronic test equipment. Instrument categories include: amplifiers, analyzers, bridges, frequency measuring equipment, signal generators, lab standards, meters, scopes, recorders, RFI/EMI equipment, and more. Each unit is described and priced.

70. Waldom Electronics'—new 32-page catalog features the newest types of Hollingsworth and Waldom solderless, quick-disconnect terminals, connectors, and crimp tools for electrical and electronic wire applications. The "WH-1" catalog cross references all Waldom terminals and connectors with those made by Hollingsworth. It also provides mechanical dimensions, terminals insulations, and wire size ranges available.

71. Multicore Solders—has published a six-page brochure which provides complete information on soldering aluminum, including complete information on soldering aluminum, including complete application, technical data, joint design recommendations, and soldering techniques. The brochure provides performance information with a table on the solderability of various wrought and cast aluminum alloys, different aluminum finishes, as well as other metals and alloys using Alu-Sol 45D.

73. Westinghouse—has released a cross-reference guide covering all rectifiers, SCRs, transistors, and assemblies currently available from the Westinghouse semiconductor division. The guide includes more than 10,000 JEDEC, Westinghouse, and competitive parts numbers. It also includes package outline diagrams and a description of causes of power semiconductor failures.

75. Shape Magnetronics—offers a new product brochure which describes the company's LT-1 series and LT-2 series of constant-voltage transformers. The brochure includes complete electrical and mechanical specifications of the CVTs.

76. PTS Electronics—has released an updated list of modules which can be rebuilt by PTS. Under the PTS module program, dud modules are purchased, then rebuilt and offered with a one-year warranty. Modules which are broken, have missing parts, or types that cannot be rebuilt are not included in the program.

77. RCA—presents a children's coloring book to promote its new line of 40-channel CB radios. The 24-page "RCA Co-Pilot Ten-Code CB Coloring Book" contains humorous drawings as well as a glossary of CB "slanguage".

80. Sperry Instruments—has issued a new product bulletin, SP-73 (Issue B), featuring the complete Sperry line of multi-testers. The bulletin offers detailed specifications, product descriptions, a list of features, packaging information, and prices of each multi-tester. There also is a price list of accessories. □

The MARKETPLACE

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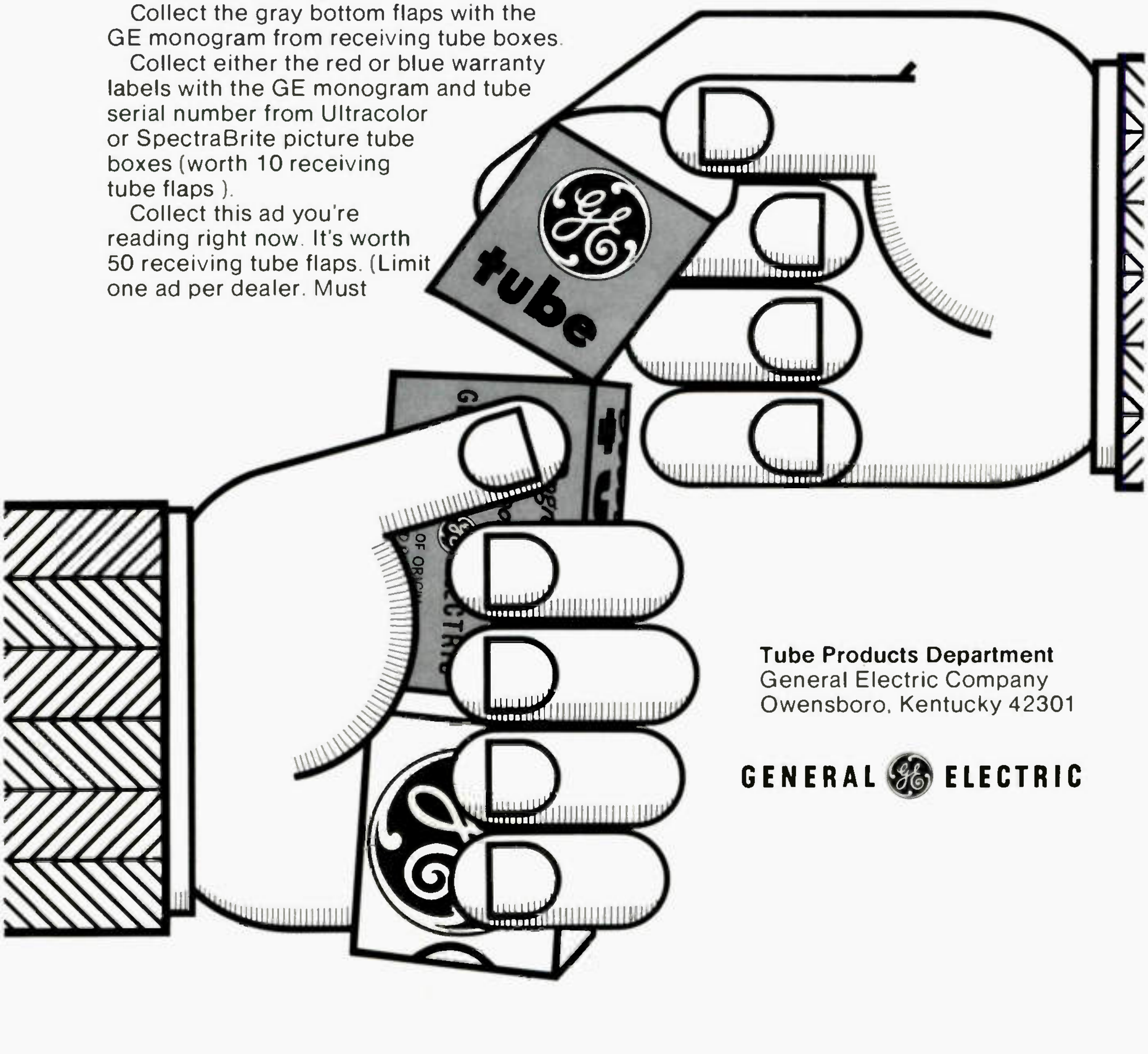

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