JULY 1975 • 75 CENTS
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ELECTRONIC TECHNICIAN/DEALER

WORLD'S LARGEST TV-RADIO SERVICE & SALES CIRCULATION

Capacitors—Types, Characteristics & Applications

Powers, Logs & dBs

"Exotic" Semiconductors

Power Supply Regulators

ELECTRONIC
TECHNICIAN/DEALER

July 1975 • VOLUME 97 NUMBER 7

THE COVER: The variety of modern capacitors on this month's cover—which include polarized and nonpolarized electrolytics, ceramics, micas, and polyester-and-polystyrene-film types—is evidence of the fact that advances in electronic technology inevitably lead to specialization, proliferation and complexity of even a "standard" component such as the capacitor. Although most advances in technology ultimately produce better performing, more reliable products, they also increase the knowledge and skill requirements of servicers.

FEATURES

DEPARTMENTS

J.W. PHIPPS
Editor
1 East First Street
Duluth, Minn. 55802
(218) 727-8511

ALFRED A. MENEGUS
Publisher
757 Third Avenue
New York, N.Y. 10017
(212) 754-4382

TOM GRENEY
Publishing Director

JOSEPH ZAUHAR
Managing Editor

MARILYN MACDONALD
Production Manager

JOHN PASZAK
Graphic Design

LILLIE PEARSON
Circulation Fulfillment

GENE BAILEY
Manager, Reader Services

LOIS SANDERS
Promotion Director

ROZ MARKHOUSE
Classified Advertising Manager

CONTRIBUTING EDITORS

JOSEPH J. CARR
BERNARD B. DAIEN

MANAGERS

DAVE HAGELIN
43 East Ohio Street
Chicago, Ill. 60611
(312) 467-0670

CHUCK CUMMINGS
Ad Space South/West
613 North O'Connor
Irving, Texas 75060
(214) 253-8678

KEN JORDAN
DONALD D. HOUSTON
1901 West 8th Street
Los Angeles, Calif. 90057
(213) 483-8530

CHARLES S. HARRISON
CY JOBSON
57 Post Street
San Francisco, Calif. 94104
(415) 392-6794

ROBERT UPTON
Tokyo, Japan
C.P.O., Box 1717

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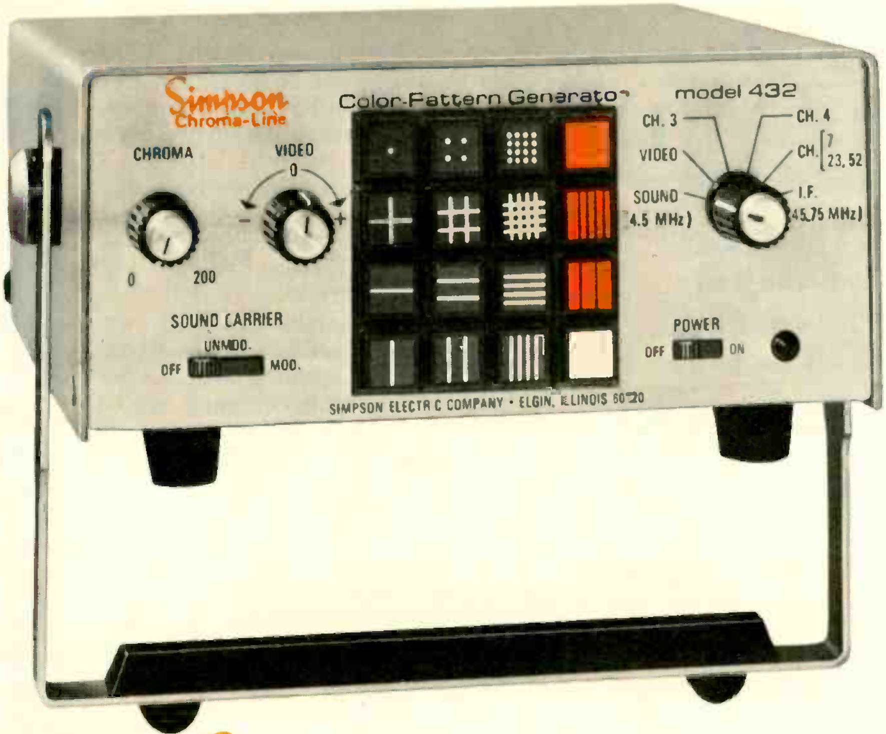
POSTMASTER: Send Form 3579 to ELECTRONIC TECHNICIAN/DEALER, P.O. Box 6016, Duluth, Minnesota 55806.

A NEW DIMENSION

has been added to professional color TV servicing



The new

Simpson® Chroma-Line Model 432

COLOR-PATTERN GENERATOR

For Faster, Easier Color TV Servicing

This new Simpson model is an all solid-state instrument incorporating the latest digital LSI and SSI technology for maximized color-pattern stability and reliability. Today's professional TV technicians will appreciate its many extra features and performance characteristics.

- 16 "touch command" patterns instantly available in a 4 x 4 pushbutton matrix
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- 2 UHF channels: 23 and 52
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- 75 Coax and 300 Ω Balun Outputs
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FOR COMPLETE SPECIFICATIONS, WRITE FOR BULLETIN T829

MODEL 432 Complete with two cable assemblies, for Coax and 300Ω inputs, and Operator's Manual . . . . **$179.**

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LETTERS

Sources of Information About TV Receivers Sold In Canada

In the Letters department of the March 1975 issue of ET/D, Mr. Ruh described the difficulty he had in obtaining service information and parts for an AGS TV receiver.

Service data for AGS and most other TV receivers sold here in Canada can be obtained from the following source:

RCC Publications
461 King St., W.
Toronto, Canada M5V 1K8

Other ET/D readers might be interested in also learning about the following Canadian company which markets a line of replacement parts (tradename ELCOM) for TV receivers manufactured in Canada:

Lake Engineering Co., Ltd.
123 Manville Rd.
Scarborough, Ontario

I also want to point out that some receivers manufactured in Canada by subsidiaries of U.S. companies are not identical to the same models manufactured in the U.S.

Charles Calvert
Radio College Of Canada
Toronto, Canada

Mr. P.M. Leyden of St. Catharines, Ontario also sent us the same information about sources of data for Canadian-built TV receivers. A warm "thanks" to both of these helpful neighbors up North.–The Editor

Another Formula For Computing Required Service Labor Income

With reference to Table 2 in the article titled *Profitable and Competitive Pricing of Service Labor* (page 12, December 1974 ET/D), I would like to suggest the following simple formula for calculating the gross service labor income:

$$\text{Selling Price} = \frac{\text{Total Costs}}{100\% - \text{Desired \% of Profit}}$$

(expressed as a decimal)

This formula is widely used in business and has the advantage that it can be used to calculate any desired percentage of profit. For example, using this formula and figures in Table 2:

Gross Service Labor Income =

$$\frac{\$93{,}784}{100\% - 20\%} = \frac{\$93{,}784}{0.8} = \$117{,}230$$

For a 10-percent profit the divisor would be 0.9, and for a 25-percent profit it would be 0.78, etc.

James M. Willis
Texarkana, Texas ■

TECHNICAL LITERATURE

Thyristor/Rectifier Directory

A 68 - page, pocket - size directory describing over 500 RCA thyristors and rectifiers is now available. The Thyristor/Rectifier Pocket Directory, TRP - 440A, tabulates the thyristors (SCR's, ITR's, and triacs), diacs, and rectifiers available from RCA, and classifies these devices according to voltage and current ratings, gate charateristics and package styles. Also included are type - number cross - reference information for RCA's new device numbering system, applications information charts and a list of RCA sales offices and distributors. *RCA Solid - State Division*, Box 3200, Somerville, NJ. 08876.

Signal Source Test Instruments

A new, 6 - page, fold - out, short - form catalog is available describing 31 different models of signal source instruments which include: function generators, phase generator, frequency synthesizers, and complex - waveform synthesizers. This catalog also contains a model capability cross - reference chart and prices. *Exact Electronics, Inc.*, Box 160, Hillsboro, OR. 97123.

Test Equipment

A 16 - page catalog covers a variety of test equipment, including two new VOM's — the Model 310, Type 3 and the Model 615. The catalog, No. 60 - T, covers Triplett's full range of products from general, multi - purpose VOM's through laboratory and special features testers temperature testers and accessories. It contains a handy selection guide chart, designed to help select a tester for specific requirements, and lists both sales representatives and service modifications centers. Dept. PR, *Triplett Corp.*, Bluffton, Ohio 45817.

Chemical Products

A new 12 - page catalog of chemical products made exclusively for the electronics industry is now available. The catalog features application information, photos, descriptions, and specifications on chemicals used to speed electronic servicing and facilitate maintenance of electronic equipment. Included are tuner sprays, contact cleaners and lubricants, circuit coolers, insulating sprays, lubricants, moisture removers and heat sink compounds. *Chemtronics Inc.*, 1260 Ralph Ave., Brooklyn, NY.

Electrical Maintenance Hints

A new hardbound edition of the Westinghouse Electrical Maintenance Hints handbook is now available. The 1,450 - page manual is designed to provide plant maintenance personnel with a convenient reference source on maintenance practices for the most commonly used types of electrical apparatus. It contains 46 chapters, each organized to help the user quickly locate any particular subject. Each chapter is indexed by topic and sub - topics, which eliminates the need to completely read or review the entire chapter to obtain information on a specific subject. It also contains photographs, diagrams, charts, tables and test procedures. Price is $15. *Westinghouse Electric Corp.*, Printing Division, P.O. Box 398, Trafford, PA. 15085.

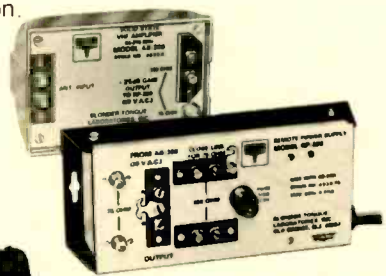
Electronic Parts Catalog

A 32 - page 100 Anniversary Catalog featuring a beat inflation sales of electronic parts is available. For your free catalog, write to *B&F Enterprises*, 119 Foster Street, Peabody, MA. 01960.■

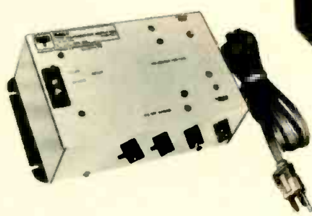
9 new ways to improve tv reception and your profit-picture.

Whether it's a 1000-set installation at the International Hotel in Las Vegas...or a basic 4-set home TV system, there's a Blonder-Tongue MATV product that will deliver better TV reception.

Here are 9 new products backed by 25 years of experience in improving TV reception.



1. AB-300, 25dB gain Ch 2-13, FM. Dual voltage power for short or long 25dB loss runs of 75 ohm or 3000 ohm downlead.



2. DA8-T—famous DA8B fully transistorized. 13dB gain. Lower noise. 1 input/8 outputs. VHF/FM. Universal 300 ohm/75 ohm.

3. DA-21—21dB gain, 75 ohm. VHF/FM and all CATV channels to 300 MHz.

4. Homer 375 Amplified Splitter—VHF/FM and all CATV channels to 300 MHz. 3 sets 300 ohms and one set at 75 ohms from a CATV cable input.

5. Vamp T-75 Mast-Mounted Preamp—17dB gain. Patented ICEF overload protection circuit. 6dB noise figure 75 ohm downlead 2-13.

6. CR-4—Deluxe compound, parallel-jaw crimping plier.

7. Model 4994—75 ohm 2-way antenna switch. Video, VHF, FM and all CATV channels to 300 MHz.

8. 4946 U/V/FM—An economical band separator for TV sets and an FM takeoff connection.

9. SA-1000 Semi-automatic Rotor. Computer-age LED tuning indicator. 360° rotation. Economical two-wire installation.

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These new BLONDER-TONGUE products are now at your distributor.
Blonder-Tongue Laboratories, Inc., One Jake Brown Road, Old Bridge, New Jersey 08857

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NEWS OF THE INDUSTRY

GTE Sylvania Implements New Color TV Picture Tube Labeling System

A new, clearer method of identifying color TV picture tube types has been developed and implemented by the Electronic Components Group of GTE Sylvania.

Under the new system, the grade of the tube is printed clearly on the carton—either "ALL NEW," "NEW SCREEN & GUN" or "NEW GUN." A back-up color code is also used on each carton, with red indicating "all new," blue indicating "new screen and gun," and green indicating "new gun." In addition, two type number prefixes, "AA" for "all new" and "A" for "new screen and gun," are included on the cartons of these types of tubes, to conform to California and Florida picture tube grading regulations.

Winegard MATV Field Training Schedule

The Commercial Products Division of the Winegard Company has announced the following schedule of one- and three-day workshop seminars on MATV.

July 15	Knoxville, Tenn.	Mr. Jim Williams (404) 469-3450
July 17	Dayton, Ohio	Mr. Roger Good (614) 846-8449
July 28-29-30	Burlington, Ia.	Mrs. Sandie Powell (319) 753-0121
Aug. 26	Alexandria, Va.	Mr. Dennis Williams (302) 834-8469
Aug. 28	Orlando, Fla.	Mr. Leo Riddle (813) 293-5070
Sept. 8	Torrance, Calif.	Mr. Ben Hedges (213) 772-1451
Sept. 10	Anaheim, Calif.	Mr. Ben Hedges (213) 772-1451
Sept. 11	Tucson, Ariz.	Mr. Ben Hedges (213) 772-1451
Sept.*	Boston-Portland, Mass.	Mr. Dave Johnson (603) 888-0323
Sept.*	Gape Girardeau, Mo.	Mr. Jon Peterson (815) 459-8294
Oct.*	Fargo, N.D.	Mr. John Jordahl (507) 332-8052
Oct.*	Minneapolis, Minn.	Mr. John Jordahl (507) 332-8052
Oct. 21-22-23	Raleigh, N.C.	Mr. Jim Williams (404) 469-3450
Nov. 11-12-13	Fla.	Mr. Leo Riddle (813) 293-5070

*Specific date not yet determined but will be at least 45 days in advance.

Advance registration for any of the preceding seminars can be made by contacting the indicated District Manager or by calling James C. Banard, National Sales Manager, Commercial Products Division, Winegard Company, (319) 753-0121, or write him at 3000 Kirkwood St., Burlington, Iowa 52601.

RCA, Zenith Presidents Report Increased Color TV Sales Late In 1st Half, Predict That Upward Trend Will Continue

RCA President Anthony L. Conrad and Zenith President John J. Nevin both have reported increases in color TV sales during the 2nd quarter, and both believe that the trend will continue.

RCA's Conrad, speaking before the 56th Annual meeting of RCA shareholders in early May, said that the depressed sales in the color TV industry—a principal cause of RCA's first quarter earnings decline—had been improving in recent weeks, and then added, "The trend from here on should be upward."

Zenith's Nevin at about the same time said, "The worst of the sales decline is well behind us. There's no question that there's been a significant upturn of sales to dealers."

121 Million TV Sets In Use

As of 1974, there were 64 million monochrome and 57 million color TV receivers in use in the U.S., or a total of 121 million TV receivers in use.

These and other statistics and facts about the electronic industry and the products which are produced, marketed and serviced by it are reported in the 120-page *1975 Electronic Market Data Book,* recently released by the Electronic Industries Association (EIA). Copies of the book can be obtained by nonmembers for $20. Write: 1975 Elect. Mdt. Data Book, EIA, 2001 Eye St., N.W., Washington, D.C. 20006.

Pay TV To Spread By Satellite If FCC Approves

Home Box Office, Inc., a subsidiary of Time Inc., which since 1972 has been providing the Northeastern States with a single channel of pay-TV programming, reportedly has made arrangements with RCA Global Communications for use of its satellite facilities to initially distribute pay-TV programming to two community antenna TV (CATV) systems in Florida, and eventually to other states in the West and Southwest.

If approved by the Federal Communications Commision (FCC), Home Box Office's plan to distribute pay-TV via satellite could become operational as early as this October.

Initially, the pay-TV program will be sent from Home Box Office's central studio and transmission control center in Manhattan to a satellite transmission system. The satellite pay-TV signal will be received by two separate receiving (earth) stations built in Florida by two large CATV companies: American Television and Communications, and UA-Columbia Cablevision. The signals will then be distributed via microwave to cable systems in Florida owned by these two companies, and to Florida cable systems owned by other companies.

Later (possibly as early as 1976), UA-Columbia Cablevision also will build earth stations for distribution of satellite pay-TV signals to its CATV systems in Arkansas, Texas, Arizona, California and Washington State.

Wisconsin Service Association Surveys The Incidence of TV Module Replacement

The Wisconsin Electronic Service Association (WESA) recently asked its members to list the TV modules they replace most.

Following is a list of the modules (or panels) which WESA members say they replaced most often, with the most frequently replaced under each brand listed first and the rest listed in descending order according to frequency of replacement:

- Admiral: M-20 Ch, A8911-1; 3M20 Ch, A8912-2; M24 Ch, A8912-2, A8926-2; M-25 Ch, A8919-1, A8920-1, A8921-1, A8923-4, A8924-1, A8926-4; M30 Ch, A8927-3, A8931-1, A8929-1
- Motorola: CA, BA, JA, AZ, F(A), GA
- Philco: 69-1025, 69-1005, 69-1014
- RCA: 132-581, 132-582, 132-579,134-007, 138-697, 135-871, 133-455, 139-685, 133-563, 132-583, 132-580
- Sylvania: 02-375000-1,2,3 & 02-37503-1,2 and 3
- Zenith: 9-27, 9-37, 9-86, 9-87, 9-90, 9-92, 9-97. (Zenith ICs: 150-162, 150-186, 150-190, 221-43).

NATESA Convention August 7-10

The National Alliance of Television and Electronic Service Associations (NATESA) will hold its annual convention August 7-10 at Pheasant Run Resort in St. Charles, Ilinois.

Limousine service from Chicago's O'Hare Airport and the Chicago Loop to Pheasant Run is available seven times per day.

The registration fee for the convention is $25.00 per person, and includes sponsored meals, refreshments, hospitality suites, banquet and floor show.

For more information about the NATESA Convention, write Frank Moch, NATESA, 5908 S. Troy St., Chicago, Ill. 60629.

Washington and Oregon Associations Schedule Joint Convention July 25-27

The Washington State Electronics Council (WESC) and the Oregon Television Service Association (OTSA) are holding a joint convention July 25-27 at the Jantzen Beach Thunderbird Motel in Portland, Oregon.

A two-day business management school will be presented by the Portland Community College during the convention.

The registration fee for the convention, including the business management school, is $60.00 for servicers and $30.00 for their wives.

More information about the joint convention can be obtained by calling James Rolison (503-282-7751) or Robert A. Villont (208-475-8300).

NESDA Convention August 12-17

The National Electronic Service Dealers Association (NESDA) will hold its annual convention August 12-17 at the Hyatt House Hotel in Winston-Salem, North Carolina. Registration information can be obtained by writing: NESDA, 1715 Expo Lane, Indianapolis, Ind. 46224, or phone (317) 241-8160.

PTS Opens New Tuner Service Centers In Ohio and Maryland

PTS Electronics, Inc., Indiana-based TV tuner repair company, recently announced the opening of two new service centers, one at 4005A E. Livingston, Columbus, Ohio 43227, and 52 Holland St., Davis Square, Sommerville, Maryland 02144.

Senate Passes Consumer Agency Bill

The United States Senate on May 15 passed bill S.200, which, if subsequently passed by the House of Representatives, will create the Agency For Consumer Protection.■

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INTRODUCING AT JUST $39.95

U.S.A. ONLY

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ONE YEAR GUARANTEE

STILL ONLY $9.95

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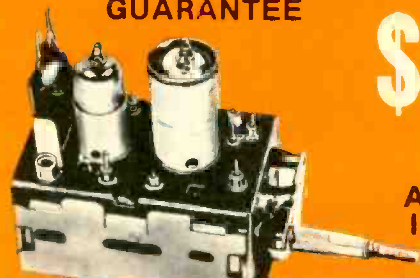

FEATURES

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- **AC Powered**
- **90-Day Warranty**

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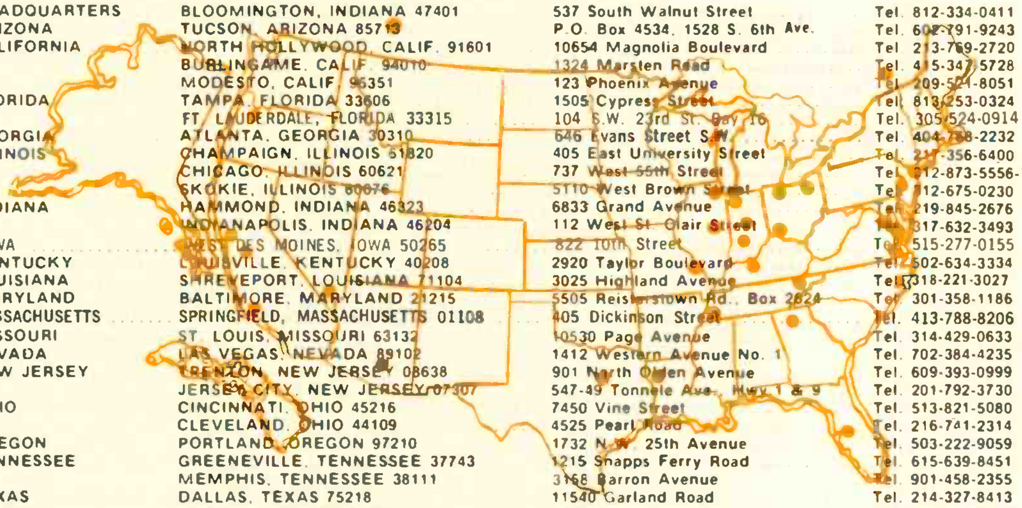
- This price buys you a complete new tuner built specifically by Sarkes Tarzian Inc. for this purpose.
- All shafts have a maximum length of 10½" which can be cut to 1½".
- Specify heater type parallel and series 450 mA or 600 mA.

CUSTOMIZE

- Customized tuners are available at a cost of only $15.95. With trade-in $13.95. (U.S.A. only)
- Send in your original tuner for comparison purposes to any of the centers listed below.

TSC

WATCH US GROW



HEADQUARTERS	BLOOMINGTON, INDIANA 47401	537 South Walnut Street	Tel. 812-334-0411
ARIZONA	TUCSON, ARIZONA 85713	P.O. Box 4534, 1528 S. 6th Ave.	Tel. 602-791-9243
CALIFORNIA	NORTH HOLLYWOOD, CALIF. 91601	10654 Magnolia Boulevard	Tel. 213-769-2720
	BURLINGAME, CALIF. 94010	1324 Marsten Road	Tel. 415-347-5728
	MODESTO, CALIF. 95351	123 Phoenix Avenue	Tel. 209-521-8051
FLORIDA	TAMPA, FLORIDA 33606	1505 Cypress Street	Tel. 813-253-0324
	FT. LAUDERDALE, FLORIDA 33315	104 S.W. 23rd St. Bay 16	Tel. 305-524-0914
GEORGIA	ATLANTA, GEORGIA 30310	646 Evans Street S.W.	Tel. 404-758-2232
ILLINOIS	CHAMPAIGN, ILLINOIS 61820	405 East University Street	Tel. 217-356-6400
	CHICAGO, ILLINOIS 60621	737 West 55th Street	Tel. 312-873-5556-7
	SKOKIE, ILLINOIS 60076	5110 West Brown Street	Tel. 312-675-0230
INDIANA	HAMMOND, INDIANA 46323	6833 Grand Avenue	Tel. 219-845-2676
	INDIANAPOLIS, INDIANA 46204	112 West St. Clair Street	Tel. 317-632-3493
IOWA	WEST DES MOINES, IOWA 50265	822 10th Street	Tel. 515-277-0155
KENTUCKY	LOUISVILLE, KENTUCKY 40208	2920 Taylor Boulevard	Tel. 502-634-3334
LOUISIANA	SHREVEPORT, LOUISIANA 71104	3025 Highland Avenue	Tel. 318-221-3027
MARYLAND	BALTIMORE, MARYLAND 21215	5505 Reisterstown Rd., Box 2624	Tel. 301-358-1186
MASSACHUSETTS	SPRINGFIELD, MASSACHUSETTS 01108	405 Dickinson Street	Tel. 413-788-8206
MISSOURI	ST. LOUIS, MISSOURI 63132	10530 Page Avenue	Tel. 314-429-0633
NEVADA	LAS VEGAS, NEVADA 89102	1412 Western Avenue No. 1	Tel. 702-384-4235
NEW JERSEY	TRENTON, NEW JERSEY 08638	901 North Olden Avenue	Tel. 609-393-0999
	JERSEY CITY, NEW JERSEY 07307	547-49 Tonnele Ave., Hwy 1 & 9	Tel. 201-792-3730
OHIO	CINCINNATI, OHIO 45216	7450 Vine Street	Tel. 513-821-5080
	CLEVELAND, OHIO 44109	4525 Pearl Road	Tel. 216-741-2314
OREGON	PORTLAND, OREGON 97210	1732 N.W. 25th Avenue	Tel. 503-222-9059
TENNESSEE	GREENEVILLE, TENNESSEE 37743	1215 Snapps Ferry Road	Tel. 615-639-8451
	MEMPHIS, TENNESSEE 38111	3158 Barron Avenue	Tel. 901-458-2355
TEXAS	DALLAS, TEXAS 75218	11540 Garland Road	Tel. 214-327-8413
VIRGINIA	NORFOLK, VIRGINIA 23513	3295 Santos Street	Tel. 804-855-2518
WISCONSIN	MILWAUKEE, WISCONSIN 53216	4722 W. Fond Du Lac Ave.	Tel. 414-871-7655
CANADA	ST. LAURENT, QUEBEC H4N-2L7	305 Decarie Boulevard	Tel. 514-748-8803
	CALGARY, ALBERTA T2H-OL1	448 42nd Avenue S.E. P.O. Box 5823, Stn. "A"	Tel. 403-243-0971

IF YOU WANT TO BRANCH OUT INTO THE TV TUNER REPAIR BUSINESS, WRITE TO THE BLOOMINGTON HEADQUARTERS ABOUT A FRANCHISE.

...for more details circle 128 on Reader Service Card

Capacitors—Types, Characteristics and Applications

Electrostatic and electrolytic capacitors differ not only in their design and construction, but also in their circuit applications. You should not attempt to replace electrostatic types with electrolytics and vice versa

By Joseph Zauhar

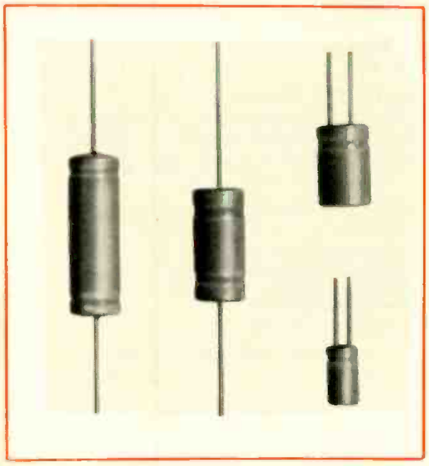


Fig. 1—Two of the most commonly used types of electrolytic capacitors are the single-end printed-circuit type shown on the left in the photo and the tubular axial lead type shown to the right.

■ Servicing of the vast number of consumer home entertainment electronic products, both domestic and foreign, can create a problem of parts availability for the electronic technician. Capacitors are a good example, and if the exact replacement part is not always available, we must use the correct capacitor type for the many critical circuits. A better understanding of the various capacitor types can eliminate future difficulties and improve your effectiveness and profit.

There are many different types of capacitors, which vary in shape, size and capacitance value. We must remember they all have been constructed for a specific application employing materials which make them superior to other capacitors for the particular circuit in which they are employed.

Capacitors can be placed into two categories and can be identified as either an electrolytic or electrostatic type. We must recognize what the basic differences are between the two capacitor types in both construction and applications.

ELECTROLYTIC CAPACITORS

Electrolytic capacitors will store more electrical energy for their physical size than any other capacitor. Instead of the usual plates separated by a dielectric as compared to the electrostatic type, a very thin film of aluminum oxide is formed on the surface of an aluminum anode functioning as a dielectric and a liquid electrolyte forms the cathode. A second metallic conductor acts as the connection to the liquid cathode providing an external connection.

The aluminum and the tantalum capacitors are two of the most common types found in home entertainment products. They are basically constructed in the same manner, covering the aluminum or tantalum anode with an oxide film. The liquid or solid electrolyte is the cathode.

The aluminum-oxide provide a very high resistance to current flow in one direction and a low resistance in the opposite direction. First, the film functions as a dielectric and then the plate in the second instance.

The two most commonly used types of electrolytic capacitors are the tubular axial lead and the single-end printed circuit-type shown in Fig. 1 and most common twist prong "can" (Fig. 2), with one or more sections with a common cathode.

Electrolytic Capacitor Tolerances

Because of the electro-chemical processes employed during the manufacturing of electrolytic capacitors—along with the variation in the etching process—it is difficult to produce an electrolytic capacitor close to its intended capacitance. This is generally not a problem when replacing a capacitor, because most circuits will tolerate at least a fifty percent excess capacitance and in many cases several hundred percent.

A typical electrolytic having a tolerance of −10 percent to +50 percent means that a 100 mfd capacitor will have an actual capacitance value of between 90

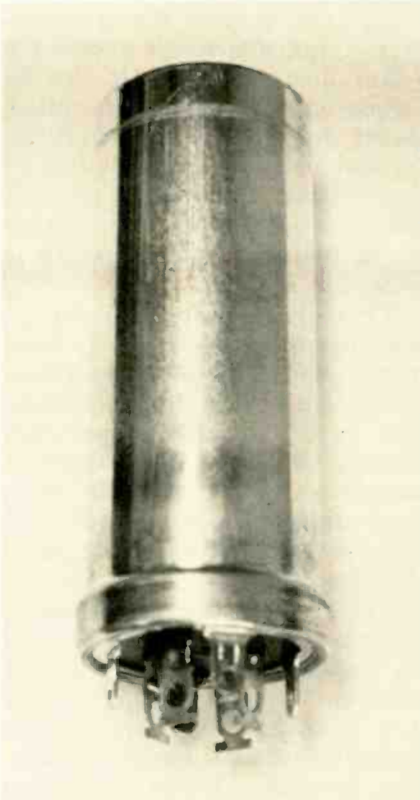


Fig. 2—The most common aluminum-cased electrolytic twist prong "can" capacitor with one or more sections containing a common cathode.

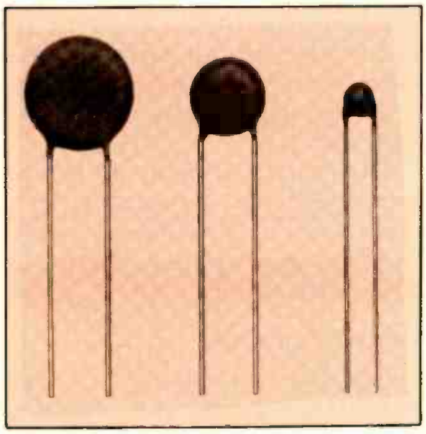


Fig. 3—The popular disc-type ceramic capacitor.

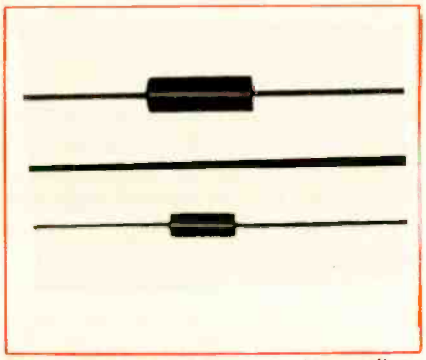


Fig. 4—Tubular axial lead ceramic capacitors.

and 150 mfd. To find its exact capacitance it would have to be measured.

Suppose a circuit is designed for 60 mfd capacitor, we could replace it with a 100 mfd to 120 mfd without any problems. The thing to remember is that it makes very little difference in a filter circuit to use a larger value, but never substitute a capacitor having a lower rated capacitance than the original value.

The maximum practical voltage limit for electrolytics is 450 volts. By employing special processing methods and careful selection of material, capacitors have been produced with a maximum voltage rating of 525 volts. The maximum operating temperature must be reduced from 85 degrees C (185 degrees F) to 65 degrees C (149 degrees F) for capacitors rated at higher voltages. A capacitor rated above 450 volts at 150 degrees F can be operated at 185 degrees F when used at 450 volts or less.

As the voltage rating of an electrolytic increases, the capacitance tolerance becomes less. If a capacitor is rated at 1 to 50 volts DCW at a tolerance of −10 percent to +250 percent, above 350 volts DCW, the tolerances would be reduced to −10 percent to +50 percent.

When replacing an electrolytic capacitor, always remember to use one with a capacitance rating of at least as high as the original one replaced, and a voltage rating at least as high.

Electrolytic Capacitor Substitution

Electrolytic capacitors store large amounts of energy for their size and to replace them with a paper-type capacitor of equal value would be difficult with the available space. Also, they may have some electrical characteristics which may cause circuit malfunctions if replaced with the paper-type.

Paper types cannot be substituted with an electrolytic even if they are of equal value. The paper types were chosen because of their better voltage characteristics, or polarity-reversal characteristics. The polarity of an electrolytic capacitor is extremely important and electrolytics do not provide the close tolerance needed in some circuits.

Increasing The Capacitance and Voltage of A Capacitor

Often we find a circuit requiring a specific amount of capacitance, but only smaller value capacitors are available. Suppose you need a 60 mfd, 300 volt DCW capacitor, then simply place two 30 mfd, 300 volt DCW capacitors in parallel. In some rare cases, we may change the RC time constant enough to cause problems or the two paralleled capacitors are too large for the available space in the chassis, then the exact replacement is required. When connecting two capacitors in parallel, we increase the capacitance, but the voltage rating remains the same. Unlike capacitance, voltages in parallel are not additive.

If we find a circuit requiring a higher working voltage, we can place two capacitors in series. Two 80 mfd, 150 volts DCW connected in series will be equal to a single 40 mfd, 300 volt DCW. The RC time constant may change enough in some rare cases, because the resistance is lower in the parallel circuit and higher in the series circuit than in an equivalent single capacitor.

Substituting Non-Polarized Capacitors

In the event that a non-polarized twist-prong capacitor is required, place both positive leads of two tubular electrolytic capacitors through the respective solder lugs and connect the negative leads together, but do not ground them. You should employ capacitors with higher voltage ratings and twice the capacity of the original. If two 100 mfd, 450 volt DC capacitors are connected back-to-back, we will now have a 50 mfd, 300 volt AC non-polarized capacitor. This same arrangement can be useα to replace tubular non-polarized capacitors.

Electrolytic Capacitor Myths Dispelled

Listed are some of the common myths expressed by many electronic technicians concerning the substitution of electrolyte capacitors in different electronic circuits:

• *Using a higher value capacitor in the input filter circuit of the power supply will increase the output voltage.* Actually, the purpose of the filter is to smooth the AC ripple. Increasing the input filter capacity will not increase the voltage higher than the peak AC voltage.

If the original filter has loss capacity, a new filter capacitor will increase the voltage, but only to the proper specified voltage.

• *Substitution of an electrolytic with more capacitance will increase leakage.* An old capacitor will normally have more leakage than a new capacitor with a higher capacity rating. With the exception of some coupling circuits, this is a minor factor.

• *Substitution of electrolytic capacitors of higher capacitance in some coupling circuits will cause them to malfunction.* This could be true if the inductance of the capacitor has increased because of the larger size and more layers of electrolyte. The latest manufacturing process, employing hard aluminum foils, now makes it possible to reduce its size for the same value to such a fraction of the original one that this is no longer an important factor.

• *Electrolytic capacitors will deform at lower voltages or when stored on the shelf for a period of time.* The capacitors produced about 10 or 15 years ago were manufactured with those characteristics, but the new capacitors are stable and will function at lower working voltages without deforming and changing capacity.

The self-life of the new aluminum-cased capacitors are extremely long, as compared to the ones manufactured many years ago. The stabilities of the electrolyte and the purity of the aluminum used prevent them deforming to lower voltage ratings when either idle or operating at lower voltages than the ones specified on the original capacitor.

ELECTROSTATIC CAPACITORS

Electrostatic capacitors are very different when we compare them to electrolytic capacitors—not only in the way they are manufactured, but in their circuit applications. They are produced with close tolerances generally around +10 percent, unless noted or specified.

The most common dielectric employed in the manufacturing of electrostatic capacitors include: impregnated paper, ceramic, mica, film and air.

Ceramic Capacitors

Ceramic is probably the most versatile dielectric offering unique characteristics. The material can be used proportionately in different methods to provide the various types of ceramic capacitors.

Their physical styles are almost as varied as their electrical characteristics, which include the popular disc, Fig. 3, tubular axial lead, Fig. 4, and extend into the more sophisticated, Fig. 5, trimmer (variable and feedthrough types). The disc and tubular styles are the most common in their simplist forms. They consist of a circular disc or a hollow tube of ceramic dielectric with metal electrodes applied to their opposing faces. Wire terminals are connected to the electrodes and the body of the capacitor is covered with insulating material. Because they employ ceramic as a dielectric and their comparative simplicity, they are generally very low in cost, but they are very reliable.

There are four types of ceramic capacitors, general-purpose, temperature-compensating, temperature-stable, and frequency stable.

General-Purpose: The construction of this capacitor is common to other disc ceramics. It can be employed as substitutes for mica, paper, or polyester types in filter, bypass, or coupling capacitors in non-critical circuits. A general purpose miniature monolithic capacitor with epoxy coating is shown in Fig. 6.

Temperature-Compensating: These capacitors have a wide range of available temperature-co-efficients. The P types capacitors have a positive temperature change while the N type have a negative change. The NPO type has practically no capacitance change from −25 degrees C to 85 degrees C.

The prefix letter P on a capacitor means that above +25 degrees C, the capacitance will increase with the temperature (or a positive co-efficient); N means the capacitance will decrease (negative co-efficient); and the letters NPO designates no change except with the NPO type which does not have a number.

If we find a designation of P100,

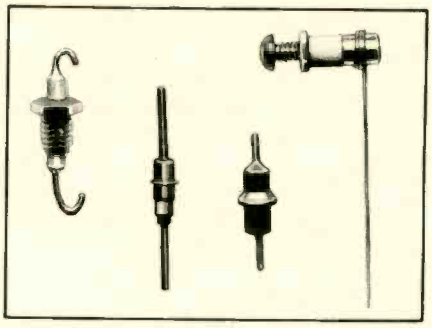


Fig. 5—The trimmer (variable) and the feedthrough ceramic capacitors are the more sophisticated types.

	AIR	CERAMIC	MICA	PAPER	PLASTIC FILM	ALUM. ELECT	TANT ELECT
FILTERING		✓	✓	✓	✓	✓	✓
COUPLING	✓	✓	✓	✓	✓	✓	
BYPASS		✓	✓	✓	✓	✓	✓
ENERGY STORAGE				✓	✓	✓	✓
TUNING	✓	✓	✓				
TEMP. COMP.		✓					

PRIMARY APPLICATIONS OF CAPACITORS IN HOME ENTERTAINMENT PRODUCTS it signifies that for every degree centigrade of temperature increase (between +25 degrees C and +85 degrees C), the capacitance will increase 100 parts per million. A capacitor with an N750 rating provides a decrease of 750 parts per million per degree increase, and an N1400 will provide almost twice the amount.

Temperature-Stable: The temperature stable capacitor is quite similar to the NPO type with some refinements. Its temperature range has been increased so that from −60 degrees C to +100 degrees C, the capacitance changes only +7.5 percent from the stated value at +25 degrees C.

Frequencly-Stable: The capacitors are constructed so that they will maintain a relatively constant resonant frequency over their operating temperature range.

The tolerance of ceramic capacitors will be rated in guaranteed minimum value (GMV) or in percent. The GMV rating is the manufacturer's guarantee that the capacitor will not have less capacitance than stated at 25 degrees C.

Mica Capacitors

A few dipped-mica capacitors are used in consumer electronic products and are very reliable. They are identified by ink stamping, manufacturer's name or symbol, minimum capacitance in picofarads, tolerance in percent and the DCW. They can be obtained with one percent tolerance or better.

The mica capacitor has a high degree of stability over a large range of operating temperatures and quite often employed where radio frequencies are encountered.

Many ceramic capacitors can be directly replaced with dipped-mica types providing better performance and dependability. This replacement does not apply to temperature compensating applications.

Plastic-Film Capacitors

Polyester-Film: Those capacitors (Fig. 7), are used quite extensively in home entertainment products and solid-state transistorized circuitry has expanded their use.

The advantages of these capacitors are: they are very dense; they can be produced into very thin sheets which are fairly stable as far as their physical size; and they have a high dielectric strength along with good insulation resistance.

The construction of the polyester-film capacitor is similar to that of a paper type. The impregnating oils are not used because the dielectric qualities are dependent on the film itself.

The most popular types are the dipped, molded, and wrap-and-fill styles which are all extended-foil construction with less inductance.

Polystyrene-Film Capacitors: These capacitors, shown in Fig. 8, offer good stability in a small package. Its insulation resistance is very high in comparison to all of the other commonly used capacitors. Aging has practically no effect on its capacitance value and they have a slightly negative temperature-coefficient.

The disadvantage of this capacitor is that its upper temperature range is only approximately +85 degrees C.

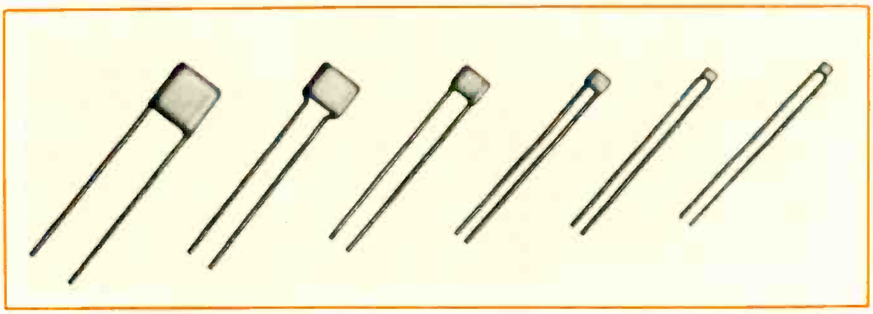


Fig. 6—General purpose ceramic capacitors with an epoxy coating for environment protection.

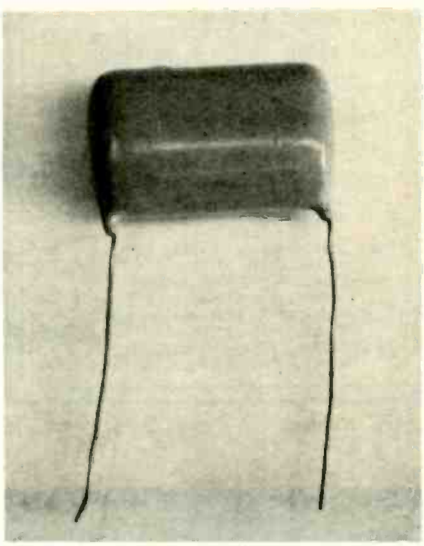


Fig. 7—Plastic-Film capacitor.

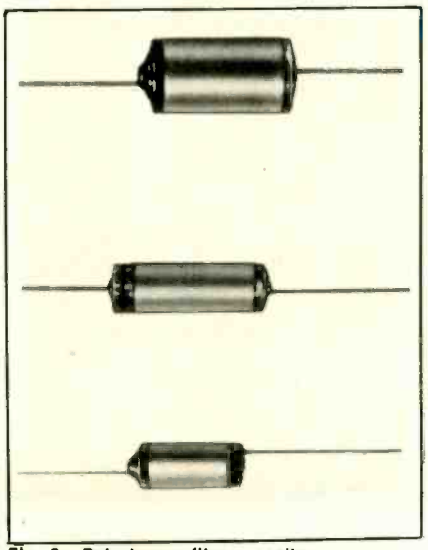


Fig. 8—Polystyrene film capacitor.

Rules For Replacing Electrostatic Capacitors

- Dipped paper Mylar capacitors can generally be used to replace film, paper and combination paper-film capacitors.
- Dipped epoxy capacitors will replace wrapped, molded or potted construction types.
- Mica capacitors can be substituted for ceramic capacitors where temperature compensation is not critical.
- Capacitors with higher voltage ratings can be used, except in frequency sensitive circuits.
- DC rated capacitors should be decreased when used for AC applications.
- The capacitor value is decreased if its operating temperature is exceeded.
- Power capacitors are usually rated at AC voltage and in most cases can not be replaced with DC capacitors. ■

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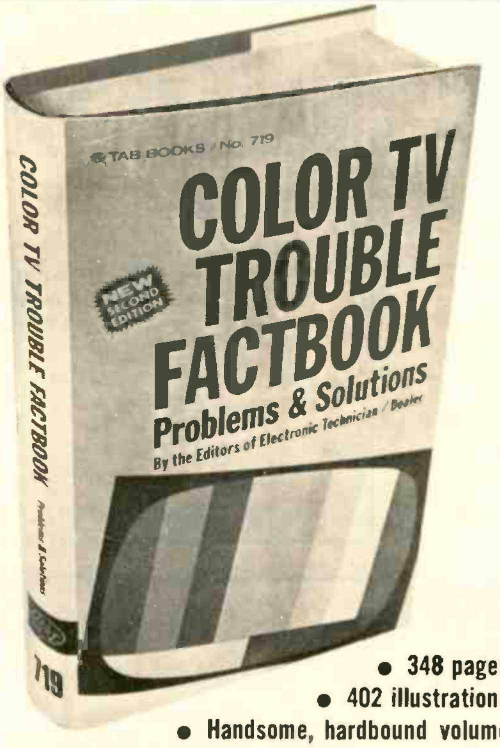

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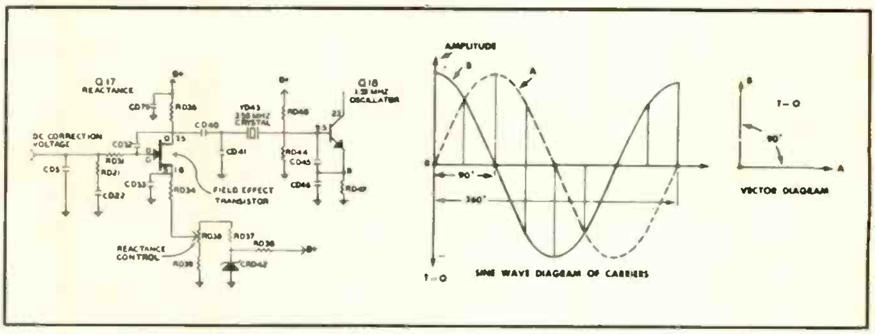

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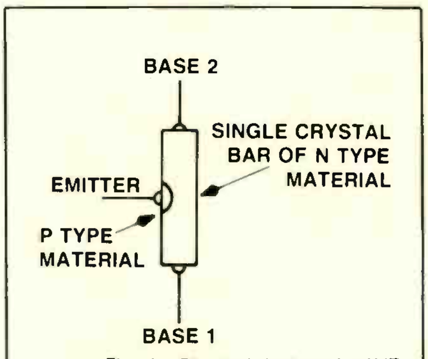

Fig. 1—Physical design of a UJT.

"Exotic" Semiconductors-Theory & Testing

By Bernard B. Daien, ET/D Contributing Editor

How UJTs, PUTs, Diacs and Triacs function and how to test them and SCRs

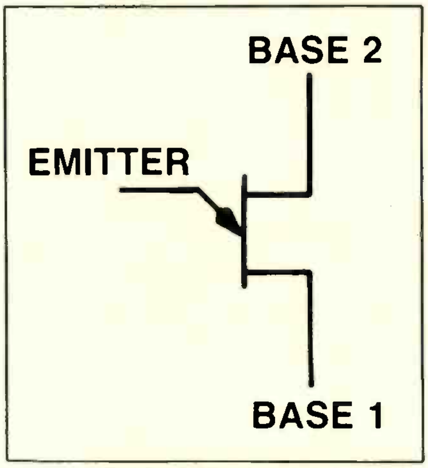

Fig. 2—Schematic symbol of a UJT.

■ The unijunction transistor (UJT) is an interesting device which can be used in silicon-controlled rectifier (SCR) firing circuits, timers, waveform generators, and a number of other applications. It has been around for a long time, but, until lately, it costs a bit more than most entertainment equipment manufacturers cared to spend. As a result, its use generally was confined to industrial controls and military applications.

Recently, however, the PUT (programable uninjunction transistor) was developed. It offers the same level of performance as a conventional unijunction transistor, but at a much lower cost. The PUT is almost identical in application and function, but is quite different in construction.

Fig. 1 illustrates the basic internal construction of a UJT. A single crystal bar of N type material has an electrical connection made to each end. Somewhere between the ends a "tap" is made in the form of an electrical connection to some P type material. This forms a PN junction, the same as a diode. Because the UJT only has a single junction, it is called a *uni-junction* transistor. The bottom of the bar is labeled *Base 1,* the top *Base 2,* and the tap is the *Emitter*.

Fig. 2 shows the schematic symbol for a UJT with the terminals identified.

Fig. 3 illustrates how the UJT functions. When a source of voltage is impressed across the bar, current flows through the bar as it would through any resistance. Because the emitter is tapped into the bar in a manner similar to the tap point on a tapped resistor, we can show this schematically by means of imagined resistors R_2 and R_1. And because the emitter is tapped into the bar via some P type material which forms a PN junction, the resultant junction is represented in Fig. 3 by diode D1.

If we assume that the tap was made at the center of the bar, then +5 volts would appear at the tap, as shown. If we now apply less than +5 volts to the emitter connection, diode D1 will be reverse biased, and no current will flow into the emitter. If more than +5 volts is applied to the emitter, diode D1 becomes forward biased, and emitter current flows from Base 1 through D1 to the emitter connection. Once current flows from base to emitter, the emitter input resistance decreases and, consequently, the voltage across the emitter-base junction decreases because of the lowered input resistance. Despite this decrease in voltage, the emitter current remains heavy because the junction is forward biased. The injection of emitter current releases still more current as a result of semiconductor action.

The combination of a decreasing voltage and an increasing current is indicative of what is called a *negative resistance,* which is the principal operating characteristic of the UJT. The emitter of the UJT exhibits negative resistance, which can be used for many applications, as explained later.

Fig. 4 shows the negative resistance of the UJT in graphic form. When the emitter is below the "peak point," very little emitter

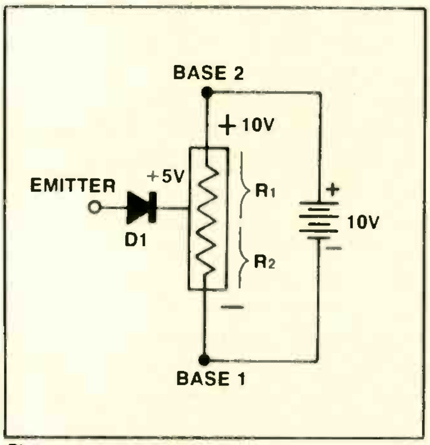

Fig. 3—Functional diagram which illustrates the operating theory of a UJT.

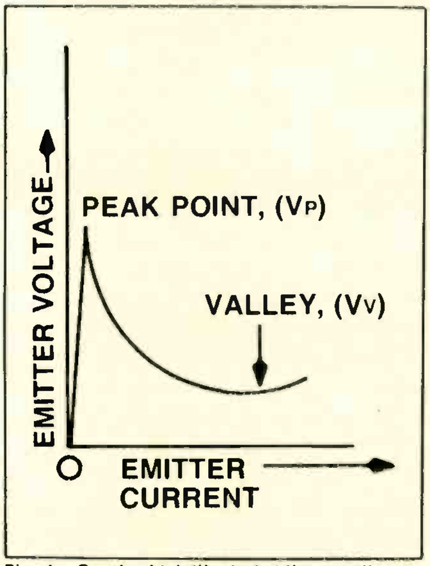

Fig. 4—Graph which illustrates the negative resistance characteristic of the emitter of a UJT.

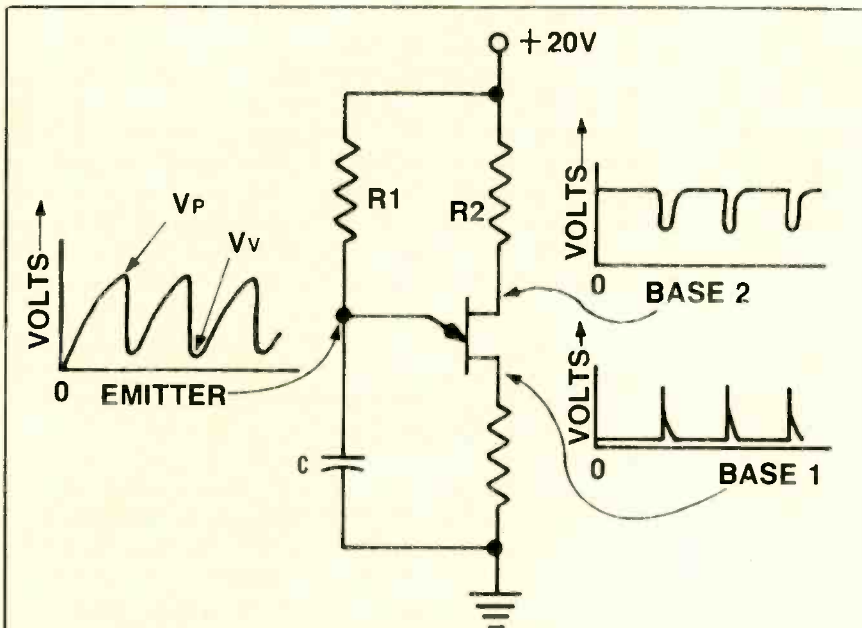

Fig. 5—UJT-equipped relaxation oscillator.

current flows because the emitter is reverse biased. When the "peak point" is passed, the emitter becomes forward biased, and simultaneously the emitter current increases while the emitter voltage falls to the "valley" level.

Now, let's look at an illustrative UJT circuit and its typical waveforms. The circuit in Fig. 5 is a UJT relaxation oscillator. When voltage is first applied to the circuit, capacitor C charges towards the emitter *peak point* (V_P). When V_P is reached the emitter becomes forward biased, discharging the capacitor to the *valley* voltage (V_V) level. As the cycle repeats itself, a sawtooth waveform is created at the emitter (providing that charging resistor R1 is reasonably large). If the value of R1 should decrease to under 10,000 or so ohms, the emitter might stay latched on. This is an important point to remember, because the frequency of oscillation is determined by the values of R1 and C and a constant determined by the type of UJT. An attempt to increase the frequency of oscillation by reducing R1 to a very small value will stop oscillations.

The waveform at Base 1 in Fig. 5 is a positive-going, sharply peaked pulse. The waveform at Base 2 is a negative-going pulse. From this it can be seen that the UJT can provide several different types of waveforms with few external components. Typically, it is operated as a pulse and nonlinear waveform generator, and not as a linear amplifier like a bipolar transistor.

The emitter pulse waveform in Fig. 5 is frequently used (via capacitor or transformer coupling) for SCR firing purposes because it has the fast rise time and sufficient energy (capacitor discharge) required to insure efficient SCR triggering.

TESTING UJTS

The circuit in Fig. 5 can be used as a simple UJT good/bad tester. Use a .05-mfd capacitor, a 33,000-ohm resistor (for R1), and 47-ohm resistors for the base resistors. A 9-volt transistor battery will suffice for a power source. A small 16-ohm speaker placed across the Base 1 resistor will audibly indicate oscillation if the UJT is operating normally.

In-circuit testing of UJTs can be difficult, because the narrow pulses used in many circuits are not readily visible on most service type scopes, and DC tests performed with multimeters do not indicate the presence of such pulses at all. Further, since the UJT only has one junction, as previously discussed, attempts to evaluate its condition by the methods used to check a bipolar transistor (forward and reverse resistances of both junctions) are not applicable. It is recommended that the out-of-circuit oscillation test be used.

THE NEED FOR PUTS

Before we can go futher, a new term, *Intrinsic Standoff Ratio,* must be defined. Despite the formidable name, it is quite simple. If you look again at Fig. 3, it is obvious that if the emitter "tap point" is placed higher or lower on the bar, the peak firing point will be changed accordingly. The higher the tap on the bar, the more voltage it takes before the peak point is reached.

Since we are dealing with a voltage divider, the peak point is always a fraction of the total applied voltage, and the fraction is determined by tap location. The symbol for this fraction is "η" the Greek letter similar to a lower case letter "n." This is the *Intrinsic Standoff Ratio,* and is used as follows: Assume we have applied 20 volts to a UJT with a standoff ratio of 0.5. The emitter peak point will fire at 0.5 times the applied voltage, or 0.5 times 20 volts = 10 volts V_P. So you see that the standoff ratio merely describes where the tap is on the bar, and in this case it was at the 50-percent point. The standoff ratios of most UJTs run between 0.5 and 0.9, principally because of factors related to the design and fabrication of the device.

As you can see, the standoff ratio is fixed. The actual standoff ratio usually is slightly different than the published value because of the forward junction voltage drop. (The emitter is a junction similar to a diode.) If you should need a UJT with a different standoff ratio, you have to buy one, and as with all components, there are tolerances. If you need a "tight" tolerance, you are in for a job of selecting one out of many by testing each one. To overcome this problem, a new device has been developed. It is called a *Programmable Unijunction Transistor* (PUT).

PUTS AND SIMILAR DEVICES

To better understand the PUT, we will first examine its basic structure, which also is common to SCRs, Triacs, Diacs, and many other "snap action" devices. Fig. 6 illustrates the derivation and basic structure of such devices.

Fig. 6A shows a PNP and an NPN transistor connected to form a "latching" circuit. When voltage is applied to the anode and cathode terminals, no current flows because both transistors are in the "off" state. If, however, one of the transistors can be made to turn on, it will, in turn, forward bias the other transistor. (The collector of each transistor is tied to the base of the other transistor.)

Once turned on, the circuit in Fig. 6A will stay latched on because each transistor continues to supply base drive to the other. The circuit can be turned on intentionally three ways, and inadvertently one other way. If the terminal labeled "anode gate" is supplied with even a momentary pulse that is negative with regard to the anode, the PNP transistor will turn on, initiating latchup. If the "cathode gate" is made even momentarily positive with respect to the cathode, the NPN transistor will turn on, with the same result. And, if the voltage between anode and cathode is increased beyond the voltage rating of the devices, "break over" occurs, causing turn on and latchup.

It is possible to cause undesired turn-on of the circuit in Fig. 6A by applying voltage at such a rapid rate that the steep wavefront reaches the gate via the junction capacitances. This also can happen due to transients. (Remember, it takes only a short duration pulse to cause turn-on.) To prevent this unwanted turn-on, small external capacitors, resistors or inductances often are used as low-pass filter elements.

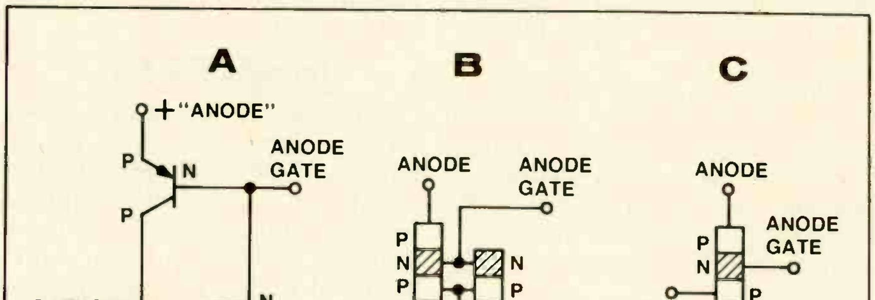

Fig. 6—Illustration which reveals the basic structure (A) of a four-layer semiconductor device and the "evolution" of the basic structure into a device with two separated but interconnected transistors (B) and, finally, into a practical four-layer device (C) which, with minor variations in construction, is useful as an SCR, a PUT and a Diac.

Fig. 6B shows the PNP and NPN internal transistor structures, along with the wiring interconnections and terminals. Notice that the N segments are tied together, as are the P segments.

In Fig. 6C the two separate structures have been consolidated into one, eliminating the interconnections. This is the basic *four layer* semiconductor device which can be used in many ways. Slight differences in fabrication are used to optimize performance for particular uses. For example:

- An *SCR* (silicon controlled rectifier) omits the anode gate lead, and thus is fired only by a pulse that is *positive with respect to the cathode.*
- The *PUT* omits the cathode gate lead, and is fired by a voltage that is negative *with respect to the anode.*
- The DAC omits both gate leads, and is fired by break-over caused by excessive applied voltage. (This device also is called a *bilateral switch,* and in some versions is made of only 3 layers.)
- The *Triac* is a somewhat more complex device. It can be considered to be two SCRs in parallel but with *reverse* connections (each anode connected to the other cathode). This "composite SCR" can be turned on by voltage of either polarity, whereas an SCR can be turned on only when the anode is positive. The one gate of the Traic turns on the device when it is driven by a voltage of the same polarity as the anode terminal. For example, when the anode voltage is positive, the Traic turns on if a positive voltage also is applied to the gate. When the anode is negative, application of a negative voltage to the gate will turn on the device.

TESTING SCRS AND TRIACS

All variations of four-layer diodes are non linear devices, which means that they generate pulses or other waveforms whose

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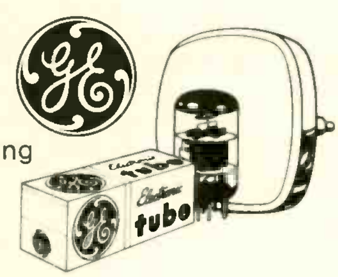

BOTTOMS UP

shapes are unrelated to the input voltage waveform. Generally, SCRs and Triacs are used as power-switching devices at frequencies up to 100 KHz, while UJTs, Diacs and four-layer diodes are used in the same frequency range to drive power switches and perform other functions (except linear amplification).

Because four-layer devices do not amplify in a conventional linear manner, they are difficult to test with the usual methods used for linear devices. In most cases, such tests are meaningless. There are, however, some simple in-circuit tests that can be performed on SCRs and Traics (power-switching devices) with common TV test equipment. The key to such testing lies in the fact that four-layer devices "latch up" (conduct) when certain conditions exist, and stay latched until the current through them drops to zero for a period of time sufficient to enable the device to turn off. The current can be made to drop to zero by placing a reverse bias on the device, by interrupting (opening) the circuit with another device or component. What we are looking for is one of the following conditions: A) A *shorted* device, B) an *open* device, C) a device that does not respond to the normal "turn on" signal, or D) a device that does not turn off with a normal "turn off" condition.

Testing The SCR

Like an ordinary rectifier, the SCR never conducts when it is reverse biased. Unlike a rectifier, the SCR conducts in its forward direction only if its gate is driven *positive* with respect to its cathode for a certain minimum *period of time* (turn-on time interval).

The following checklist should make SCR troubleshooting easier for you:

1) Does the SCR stay on all the time?

a) If yes, does the voltage across the SCR go to zero (or reverse bias) for several microseconds for a "fast switching" type SCR, or for ten times that long for a standard-speed SCR?

b) If yes, you should also determine if the gate drive is ever absent.

c) If gate drive is absent, and voltage across the SCR goes to zero for the appropriate time, the device must turn off if it is good.

2) Does the SCR stay off all the time?

a) If yes, is proper gate drive supplied during the interval the anode is forward biased? (Gate must be positive with respect to cathode for the appropriate interval of time, to insure turn-on).

b) If the anode is positive and the gate is driven with a proper signal, the SCR must turn on if good.

The preceding checklist assumes that you have made the usual check of anode supply voltage before testing the device. The gate drive can be checked only by disconnecting the lead to the gate and examining the waveform amplitude and duration on a scope. The gate drive waveform *cannot* be analyzed with the gate in the circuit, since the gate/cathode forms a diode, which clamps the waveform at the amplitude level of the diode forward drop. Once the SCR goes into heavy conduction, the internal voltage drop "masks" the applied drive.

The preceding list also tells you what circuit defects to look for and what voltages will be present or absent for each. Note, however, that you must use a little common sense too. For example, the SCR should remain *on* only if the gate drive is present during the interval the anode is forward biased, (Gate drive during anode reverse bias is ineffective, as SCRs only conduct when forward bias is applied to the anode.) An SCR which conducts on the *reverse biased* half of an AC cycle is shorted.

Testing The Triac

Triacs can be triggered on when the anode is negative or positive, although the gate sensitivity varies from state to state. This tends to make testing a little confusing. Things become a little clearer if you consider the Triac as a solid-state relay, replacing a magnetic single-pole, single-throw relay. It works on AC or DC of either polarity, just the way the magnetic (or reed) relay works, with one exception: Magnetic relays stay activated as long as the coil is energized, and open only when the coil is deenergized, but the Triac *stays* latched up even after the gate drive is removed. Just as with an SCR, the voltage across the Triac must go to zero long enough for the Triac to unlatch. Unlike an SCR, reverse bias won't turn off a Triac under many circumstances, because the Triac works with voltages of *either* polarity.

As with SCRs, when troubleshooting Triacs you will be looking for a shorted or open device, or one which does not respond to the gate signals. If the Triac *stays on* all the time, disconnect the gate lead. If the Triac still stays on, it is defective. If not, the gate drive source is at fault.

If the Triac *stays off* all the time, disconnect the gate lead and check for the gate drive, which should be several volts for more than 25 microseconds. If there is gate drive, the Triac is probably defective. If there is no gate drive, the problem is in the gate drive or eariler sensing circuits.

Again, remember to check the anode supply voltage. Semiconductors, like vacuum tubes, do not function properly without the correct voltage applied.

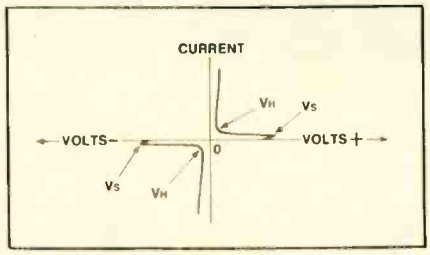

Fig. 7—Voltage-vs-current graph for a typical Diac.

THE DIAC

Up to this time we have merely mentioned that these diodes are used frequently to fire SCRs and Traics, but there was no discussion as to why they are so popular in this application. Fig. 7 helps to illustrate why. It is a volts-versus-current curve for a typical Diac.

Note that as the voltage across the Diac is made more positive,

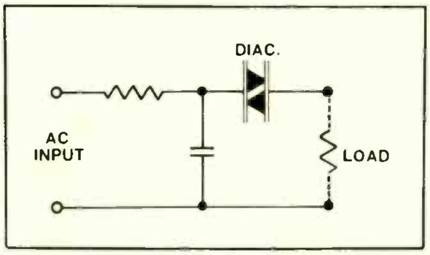

Fig. 8—A representative Diac-equipped circuit for triggering an SCR or Triac.

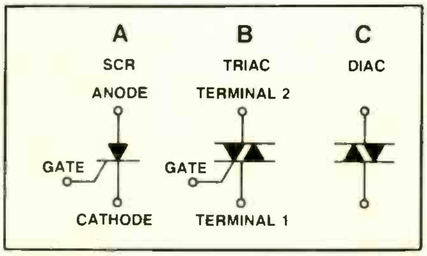

Fig. 9—Schematic Symbols for an SCR (A), a Triac (B), and a Diac (C).

very little current flows until the *switching voltage level,* Vs, is reached. Then the device "snaps," the current increases very rapidly (in microseconds), and the voltage across the device falls to a low value, termed the *holding value,* VH.

If the Diac is used in a circuit like that in Fig. 8 (which also shows the symbol for a Diac), the output will consist of one pulse for each half cycle of AC input. The pulse is negative for a negative half cycle, and positive on the positive half cycle. Operation is as follows: The capacitor charges. When the voltage across the capacitor reaches the Diac's switching voltage, the Diac suddenly conducts, and the voltage drop across it decreases. The capacitor then discharges into the load through the low forward resistance of the Diac. Since the capacitor's discharge current is limited primarily by the load resistance, a relatively large current can flow through the Diac. This is very desirable for SCR and Triac firing because their gates should be driven by a pulse with fast rise time and relatively high current and high voltage, thus insuring fast turn-on. A slowly rising pulse would result in slow turn-on, causing high SCR dissipation and other undesirable effects.

As illustrated in Fig. 7, the Diac works equally well with positive or negative voltage applied; consequently, it works in the same manner on both the positive and negative half cycles, which is necessary when driving Triacs. (Remember, Triacs operate on both halves of the AC input cycle.)

SCR, TRIAC AND DIAC SYMBOLS

Fig. 9 shows the schematic symbols for this family of devices, along with element labels.

Fig. 9A is the SCR symbol with the anode, cathode and gate clearly labeled.

Fig. 9B is a Triac, the gate of which is easily identifiable, but the other two terminals are merely titled "Terminal 1" and "Terminal 2," since either can be considered to be an anode, or a cathode, depending upon the direction of conduction.

Fig. 9C, a Diac, normally has no terminal labels at all, since it is a symmetrical device which functions equally well in either direction.

GATE AND OUTPUT MEASUREMENTS

When troubleshooting semiconductor switching devices, remember that the triggering and/or output waveforms of such devices might be a half or a quarter cycle of a sine wave or might be a narrow pulse, depending upon the particular device and its application, and that conventional service-type meters cannot be relied upon to give meaningful indications of such pulse-type waveforms. A narrow pulse might not produce any type of meter indication at all, and low-duty-cycle waveforms of, say, 100 volts amplitude might produce low readings. Only peak-reading meters and oscilloscopes are accurate devices for these nonlinear waveforms. The peak meters at least indicate what the peak value of the wave is. A scope, the best choice of all, shows the waveshape, duration *and* amplitude, providing it is a wide-band scope with a stable triggering system capable of "catching" fast, narrow pulses. The newer service scopes with a useful 10MHz bandwidth that is flat to 5 MHz are adequate. But if your scope is "3dB down at 4.5 MHz," it actually reads 7 volts on a 10-volt peak signal at 4.5 MHz if you calibrate it at a low frequency. A 30 percent error is three times greater than acceptable, even for the "roughest" sort of service work. If your scope is rated "plus or minus 1 db" at 4.5 MHz, it is satisfactory for all but the most critical type of measurements you will encounter in the servicing of semiconductor switching devices.

SELECTING REPLACEMENTS

All devices with a 1N—, or 2N—number are registered and supposed to conform to a uniform standard, so they should be interchangeable. Several manufacturers are now providing approval for substitutes provided by semiconductor firms, (among these are Zenith), and that's a big help. "House number" parts often can be replaced by parts recommended in service literature for the equipment prepared by independent major publishers. A good rule is: "When in doubt, get an original replacement part." SCRs, Diacs, etc., are sorted out on a voltage/current/turn-on and turn-off time basis. The average service shop simply does not have the required time and test equipment to grade out devices for substition purposes.

During 1974-75, there has been a noticeable increase in the attention semiconductor manufacturers have given to the replacement parts market. This is probably because their OEM business has declined. In any event, the replacement and substitution manuals now offer more items, are better organized, and are more accurate than in the past, and, consequently, they are more useful. In general, the parts offered as "substitutes" are capable of withstanding more voltage and current than the original parts, and in the case of older types of devices, the newer versions offered are superior in most other respects too. Despite this, if the part has a standard 1N—, 2N— or 3N— number, or some other commonly encountered number, you usually can save real money by buying it under that number instead of the "replacement part number" offered in crossreference literature. ■

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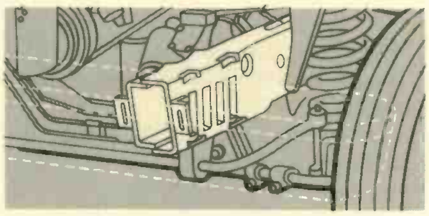
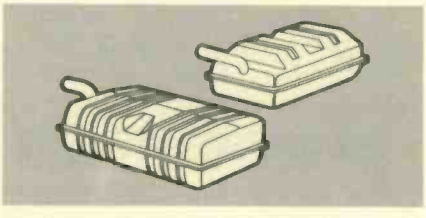
Separate body with frame, the only American van with this construction, provides a strong foundation for the entire vehicle. Frame rails are designed to help cushion impact from the front. To resist corrosion, key components are galvanized and the entire cab is primed by deep-dip Electrocoat. These vans are built to keep their value. Cruise-O-Matic, power front disc brakes, 300 Six are standard.



Energy-absorbing frame rails help cushion front impact. Frame is the first in any American van.



Standard and auxiliary fuel tanks are located between the frame rails, total up to 42.6 gallons.

Powers, Logs & dBs—A Brief Review

By Jack Hobbs and J.W. Phipps

■ If you are like most of us, you probably were "exposed" to powers of ten, logarithms and decibel computations a few years ago during the "math portion" of a formal electronics course. And, unless you are one of the rare electronic technicians who uses these areas of math on a daily or even weekly basis, you, like most of us, probably have gotten a little rusty. If so, the following brief review of the fundamentals of powers of ten, logarithms and decibels should help brush away some of the mathematical cobwebs, so that you'll feel a little more comfortable when the occasional need for mathematical computation arises in your "practical" workaday world of servicing electronics.

POWERS OF TEN

The principal reason for using *powers of ten* is to simplify the *multiplication* and *division* of the large whole numbers and/or large decimal fractions which electronic mathematical computations inevitably involve.

TABLE 1
POWERS OF TEN AND EQUIVALENTS

Power	Equivalent Value	Term	Abbreviation
10^{12}	1,000,000,000,000	Tera-	T
10^{11}	100,000,000,000	—	—
10^{10}	10,000,000,000	—	—
10^{9}	1,000,000,000	Giga-	G
10^{8}	100,000,000	—	—
10^{7}	10,000,000	—	—
10^{6}	1,000,000	Mega-	M
10^{5}	100,000	—	—
10^{4}	10,000	—	—
10^{3}	1,000	Kilo-	K
10^{2}	100	—	—
10^{1}	10	—	—
10^{0}	1	—	—
10^{-1}	0.1	deci-	d
10^{-2}	0.01	centi-	c
10^{-3}	0.001	milli-	m
10^{-4}	0.0001	—	—
10^{-5}	0.00001	—	—
10^{-6}	0.000001	micro-	μ
10^{-7}	0.0000001	—	—
10^{-8}	0.00000001	—	—
10^{-9}	0.000000001	nano-	n
10^{-10}	0.0000000001	—	—
10^{-11}	0.00000000001	—	—
10^{-12}	0.000000000001	pico-	p

Expression of a number in powers of ten is merely a way of stating how many times a smaller number (and subsequent products derived from it) have to be multiplied by *ten* to equal it. For example, to equal 100, the number 1 has to be multiplied *twice* by 10, or $1 \times 10 = 10 \times 10 = 100$. This same mathematical expression can be *abbreviated* to read: $100 = 1 \times 10^2$.

Similarly, to equal 1000, the number 1 must be multiplied by 10 *three* times, or $1 \times 10 = 10 \times 10 = 100 \times 10 = 1000$. And, likewise, this mathematical expression can be *abbreviated* to read: $1000 = 1 \times 10^3$.

To express *any* whole number as a smaller whole number and/or decimal fraction, move the decimal point to the *left* as many places (digits) as you deem necessary for convenient computation and then use the *number of places* as the power of ten *exponent*. (In the expression $1000 = 1 \times 10^3$, the small *3* is the *exponent*, or power.) For example, to express the number 1361.5 as a smaller *whole* number, the decimal point is moved *three* places to the *left* and the "new" number is expressed as 1.3615×10^3.

Decimal fractions, such as .4632, can be expressed as whole numbers in the same manner except that the decimal point is moved to the *right* and a *negative sign* is placed before the exponent. For example, .4632 can be expressed as 4632×10^{-4}.

Listed in Table 1 are the whole numbers in multiples of ten from 1 to 1 trillion and their equivalent values expressed as powers of ten. Also included are decimal fractions in multiples of ten from .1 to 1 pico and their equivalent values expressed in powers of ten.

As stated previously, the principal reason for using powers of ten is to make large whole numbers and/or large decimal fractions easier to multiply and divide. Examples of these applications of powers of ten are shown in the computations in Table 2.

COMMON LOGARITHMS

The logarithm, like the power of ten, is a method of "re-phrasing" numerical quantities so that they can be more easily multiplied and divided. As with powers of ten, *multiplication* of logarithms is accomplished by algebraic *addition*, and *division* is accomplished by algebraic *subtraction*.

In the *common* system of logarithms, the logarithm (abbreviated "log") of a number is the *power*, or *exponent*, to which the number *10* must be raised to equal that number.

As you will recall from the previous discussion of powers of ten, 10 can be expressed as 10^1, 100 can be expressed as 10^2, 1000 can be expressed as 10^3, etc. Numbers between even multiples of ten (for example, those between 1 and 10, 10 and 100, and 100 and 1000, etc.) are expressed as the same, or "original," group of digits (minus the zeros which precede or follow it) plus a power of ten exponent (such as 10^2) which tells how many times that number must be multiplied by 10 to equal the "original" number. For example, 5600 can be expressed in powers of ten as 56×10^2.

On the other hand, common logarithms convert an "original" numerical quantity into a completely different, two-part numerical expression *which tells how many times 10 must be multiplied by itself to equal "the original" numerical quantity*. In other words, the log of a number tells you to what power *ten* must be raised to equal that number.

The first segment of a log is a *whole number* called the *characteristic*. The characteristic of a numerical quantity *equal to 1 or greater* is computed by counting the *number of digits to the left* of the decimal point and then *subtracting one*. For example, the characteristic of 1560.8 is *3*.

The characteristic of a numerical quantity *less than 1* is computed by counting the *number of digits to the right* of the decimal point and then adding a *negative sign*. For example, the characteristic of .0456 is *−4*.

The other segment of a

logarithm is a 4-digit decimal fraction called the *mantissa*. The mantissa is obtained from a *table of common logarithms*, a portion of which is shown in Table 3. To find the mantissa of a particular numerical quantity, locate in the *"N" column* of the log table the *first two-digits* of the number. Then proceed horizontally along this line of numbers until you reach the vertical column whose heading number corresponds to the third digit of the number you are converting to a log. The four-digit number in this column is the mantissa. For example, the *mantissa* of 1560.8 is found by searching down the "N" column until you come to 15, then proceed horizontally to the vertical column with a heading of 6. The mantissa of 1560.8 is .1931. By combining the characteristic (3) and the mantissa (.1931) you arrive at the log of 1560.8, which is 3.1931.

If the number you are converting to a log has only one or two digits, or if the third digit is a zero, always use the first, or "zero," vertical column. For example, to find the mantissa of 2, 200 or 2000, proceed down the "N" column to 20 and use the mantissa under the "N" vertical column, which is 3010. The complete log of 2 is .3010, the complete log of 20 is 1.3010, and the complete log of 200 is 2.3010.

If the number you are converting to a log has more than three digits, you can find the fourth digit by referring to the *"proportional parts"* segment of the log table in Table 3. (Four-place logs are the highest accuracy you will need for most electronic-related computations, and three-place logs are usually adequate.) For example, to find the mantissa of 1543.6, find 15 in the "N" column and then move horizontally to the "4" column, which gives a "three-place" mantissa of .1875. Then proceed on the same horizontal line to the "3" column of the proportional parts segment, which gives a fourth-digit readout of .0008. Adding the .1875 and the .0008 produces a mantissa of .1883, which is accurate to four places. The complete log of 1543.6 is 3.1883.

The antilog of a log is merely the *"original"* number which was converted to a log. An antilog is found by first finding the log's mantissa in the log table and then combining the "N" column two-digit number and the single digit in the heading of the vertical column in which the mantissa appeared. The decimal point is then placed to the *right* a number of spaces equal to the characteristic plus 1. (For logs with negative characteristics, the decimal point is positioned to the *left* a number of spaces equal to the characteristic.) For example, the antilog of log 3.3118 is 20 ("N" column digits) and 5 (mantissa column heading), producing 2050.

Examples of the applications of common logarithms in electronics are given in the following discussion of decibels.

DECIBELS

A ratio of 20 called the *bel* has been used for years as the basis for computing and expressing many electronic measurements that otherwise would be more difficult and less accurate. However, because the *bel*, like the farad, for example, is a large unit, the *decibel* (0.1 bel, abbreviated dB) is used for most practical applications.

The dB is the *logarithm of the ratio* of two powers, two voltages or two currents. Or, we can say that *the dB is a unit of measurement of the ratio of two quantities.*

The dB is used in measuring, computing and expressing *power* gain or loss, *voltage* gain or loss and *current* gain or loss. Specific applications include checking frequency response variations in audio amplifiers; measuring ambient noise and other sound levels; and computing antenna gain over that of a half-wave dipole or an isotropic.

One good reason for employing dB formulas, and therefore logarithms, is to avoid multiplying and dividing complicated figure groups. By using dBs, the process is frequently reduced to simple algebraic addition and/or subtraction. Logarithms minimize figuring and reduce multiplication and division to simple addition and subtraction, respectively.

Why The Logarithmic Decibel

The human ear responds to different levels of sound in a *nonlinear* manner. A given volume of sound must be changed about *26 percent* before the ear perceives a change. But the ear won't notice a subsequent series of volume increases unless each increase includes an *additional 26 percent* added to each previous increase. In other words, the process must proceed in an *exponential* manner.

For example, assume that an "average" human ear can detect a *reference* sound level of 1mW, which we can arbitrarily call zero dB. This level would have to be increased to 1.26mW (or about 1dB) before the ear could detect a *change*. Then the volume would have to be increased to about 1.6mW (or to 2dB) before another change is noticed. At the 17th in-

TABLE 2

MULTIPLICATION & DIVISION USING POWERS OF TEN

MULTIPLICATION:

Rule—Add the exponents algebraically

Example—50 microamps x 10K ohms,

$$\begin{array}{r} 50 \times 10^{-6} \\ \underline{\times\ 10 \times 10^{3}} \\ 500 \times 10^{-3} = .5 \text{ volts} \end{array}$$

DIVISION:

Rule—Algebraically subtract the exponent of the denominator from the exponent of the numerator

Example—1000 volts divided by 25 K ohms,

$$\frac{1 \times 10^3}{25 \times 10^3} = 1/25 = .04 \text{ amps}$$

SQUARING:

Rule—Multiply the number by itself and double the exponent

Example—2000 volts squared divided by 100 ohms,

$$\frac{(2 \times 10^3)^2}{1 \times 10^2} = \frac{4 \times 10^6}{1 \times 10^2} = \frac{4 \times 10^4}{1} = 40 \text{ K watts}$$

SQUARE ROOTS:

Rule—Extract the square root of the number and divide the exponent by 2

Example—The square root of (20 K ohms times 50 microfarads).

$$\sqrt{20 \text{ K ohms} \times 50 \text{ microfarad}} =$$

$$\sqrt{2 \times 10^4 \times 50^{-6}} = \sqrt{2 \times 50 \times 10^{-2}} =$$

$$\sqrt{100 \times 10^{-2}} = 10 \times 10^{-1} = 1$$

TABLE 3

COMMON LOGARITHMS

N	0	1	2	3	4	5	6	7	8	9	Proportional Parts 1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11

crease of the original level we would be at the 17dB or 50mW output level. At the 30th increase (or 30dB level) the power output would have soared 1,000 times—to the 1W level. Hence, the nature of the human ear, which responds logarithmically, has established a practical system for measuring power gains and losses.

Practical dB Formulas

Perhaps the most useful dB formula employed in our work, especially in audio, is that used with power and known as *the dBm formula*. In most electronic work, dBm is an arbitrary "reference system" in which zero dBm is 1mW (1 milliwatt) of power developed by 0.7746 volts across a resistance of 600 ohms. The standard power dB formula is written: dB = 10 log $\frac{P2}{P1}$. This means simply that dB equals 10 times the logarithm of P2 divided by P1.

The best way to understand the dBm process is first to apply its basis to Ohm's power formula: $P = \frac{E^2}{R} = \frac{0.7746^2}{600} = \frac{0.6 \times 10^3}{600} \rightarrow \frac{600}{600} = 1mW$. Next, assume that we have a preamp or amplifier that requires a 1mW input to produce 2W output. We want to know the *dBm* gain of the amplifer. So, dBm = 10 log $\frac{2}{1 \times 10^{-3}}$ = 10 log $\frac{2 \times 10^3}{1}$ = 10 log $\frac{2000}{1}$ = 10x3.3010 = +33dBm. If P2 is greater than P1, a gain results and is expressed as +dBm. If P2 is smaller than P1, a loss results and is expressed as −dBm. Let's double the power output to 4W: 10 log $\frac{4W}{1mW}$ = log 4000 = 3.6021 x 10 = 36 dBm. Note that by doubling the power we increased the dBms by 3. This 3dB increase is one basic characteristic that should be remembered about *doubling power*.

If power is increased 10 times, the dBm equivalent increases by +10. This is another basic characteristic that should be remembered.

When figuring amplifier gain by the dBm formula you frequently might be confronted with an input specified in millivolts instead of milliwatts. For example, a manufacturer says that with an input of 4mV to a certain preamp stage, his amplifier produces a 10-watt output. We want to know the overall amplifier gain in dBm. Assuming that the function generator sine-wave output is measured across 600 ohms at 4mV on an RMS-reading TVOM, it is practical to assume 4mV as zero dB and convert it to power with $P = \frac{E^2}{R}$. Once the voltage reading is converted to power, you can proceed with the regular formula for finding dBm gain.

One practical advantage of the dBm formula, in which 1mW is always P1 or the input, is the ease of determining the dBm gain or loss. Since log 1 (one) is zero, you need only determine the log of P2 and multiply by ten (move the decimal one place to the right) to obtain +dBm.

Simplifying Procedure

Because 10 times the *log of the ratio* of the input and output powers is either plus or minus dBm, by *subtracting* the log of P1 from P2 you can eliminate the operation of *dividing* P2 by P1.

For example, an amplifier has an input (P1) of 1mW and an output (P2) of 10 watts. Thus $\frac{10W}{1mW} = \frac{10}{.001} = \frac{10}{1 \times 10^{-3}} = \frac{10 \times 10^3}{1} = \frac{10{,}000}{1}$ *The ratio* is 10,000 to 1. The log of 10,000 is 4.0000, and 10 × 4.000 is

+40dBm. Let's increase the *input*, P1, 10 times. The log of P2 (10,000) remains the same, but P1 has been increased from 1 in the ratio to 10 and the log of 10 is 1.0000. So, 4.000-1.0000 = 3.0000 × 10 = +30dBm.

Zero And Negative dBm

The preceding has brought us to that much used by misused and misunderstood twilight-zone known as *OdB, or reference level.* For example, $\frac{10\text{ watt}}{10\text{ watt}}$ = log 10 - log 10 = 1.000 - 1.000 = 0.

If the input (P1) is increased by a factor of 10, the ratio becomes: $\frac{10\text{ watt}}{100\text{ watt}}$ Log 10, as before, is 1.0000 and log 100 is 2.0000. We have now arrived at that area of "less than nothing," or −dBm. At first glance, it might appear that 1.0000-2.0000 would give us −9.0000 × 10 = −90dBm. But this can not be true because the input has been increased according to powers of 10 and should have a ratio accordingly, or 0.1:1.

At this point, if you do not already know, you must learn to manipulate logarithms in the *negative* area, which involves merely observing simple *algebraic* principles and certain rules of logarithms. In the preceding problem, the log *characteristic* of 0.1 is −1. In common logarithms the *mantissa* (the decimal fraction to the *right* of the decimal, as provided in common log tables) must remain *positive*. The *characteristic* (the number to the *left* of the decimal) can be *either* positive *or* negative. Additionally, for convenience in figuring you can add 10 or higher multiples to *negative* characteristics if you subtract the same amount at the end. For example: $\frac{10w}{100w}$ = (log 10) − (log 100) = (1.0000 + 10) − 2.0000 = 11.0000 − 2.0000 = 9.0000 − 10 = −1.0000 × 10 = −10dBm.

If we turn this last problem upside down so that we have a 10 watt input (P1) and a 100 watt output (P2) we will come up with +10dB, or the opposite "image" of −10dB.

Finding Power With dBm Given

We have the dBm zero reference given (P1 = 1mW) and the output (P2) given is +40dBm. We want to know the *output power* (P2). P2 = antilog $\frac{dBm}{10}$ = anti log $\frac{40dBm}{10}$=4. Antilog 4 = 10,000mW = 10 watts.

And on the minus (loss) side: P2 = antilog $\frac{-40dBm}{10}$ = −4. Antilog −4 = 0.0001mW = 0.1μW = 100nW. To check the preceding computation: −dBm = 10 log $\frac{100nW}{10^6nW}$ = log 100 = 2.0000 + 10 = 12.0000 − 6.0000 (log 10^6 nW) = 6.0000 − 10 = log −4.0000 × 10 = −40dBm.

The above formula for converting −dBm to power when the specified −dBm (the numerator) is not evenly divisible by 10 must be revised somewhat to provide accurate results. Likewise, when a different zero reference, say 6mW, is used, the formula is revised to: P2 = 0.006 x antilog $\frac{dB}{10}$.

Voltage/Current dB Formulas

A manufacturer's specs say an amplifier has a 0.5V, or 500mV, input which provides an output of 25V. Disregarding impedances, what's the dB voltage gain? dBV = 20 log $\frac{E^2}{E^1}$ = 20 log $\frac{25{,}000mV}{500mV}$ = log 25,000 − log 500 = 4.3980 − 2.6990 = 1.6990 × 20 = 34dBV.

The dBmV (or dBμV) system is particularly useful for dealing with antennas, especially MATV systems. This method employs a zero reference of 1,000 microvolts, or 1mV. With it, computations are limited principally to algebraically adding the gains and losses of the various active and passive elements in the system, whether large or small. By employing this method, a "finger-tip" check can be maintained throughout the system planning and installation procedure so that each TV and FM outlet will be provided with sufficient signal, which for TV sets is normally considered to be 1mV (or 1,000 microvolts) for adequate color TV reception. ■

TABLE 4
DECIBELS

	Current or Voltage Ratio		Power Ratio	
dB	Gain	Loss	Gain	Loss
0	1.000	1.000	1.000	1.0000
1.0	1.122	.8913	1.259	.7943
2.0	1.259	.7943	1.585	.6310
3.0	1.413	.7079	1.995	.5012
4.0	1.585	.6310	2.512	.3981
5.0	1.778	.5623	3.162	.3162
6.0	1.995	.5012	3.981	.2512
7.0	2.239	.4467	5.012	.1995
8.0	2.512	.3981	6.310	.1585
9.0	2.818	.3548	7.943	.1259
10.0	3.162	.3162	10.000	.1000
20.0	10.000	.1000	100.00	.0100
30.0	31.620	.0316	1000.00	.0010
40.0	100.000	.0100	10,000	.0001
50.0	316.200	.0031	100,000	.00010

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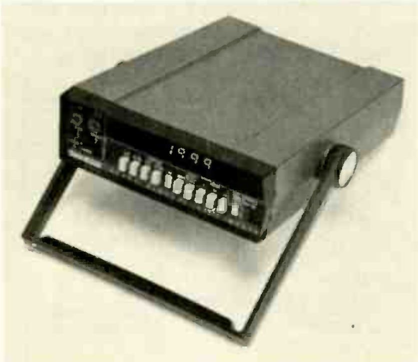

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Now you need an instrument to look at the voltages at each pin of an IC with sufficient accuracy and resolution to determine proper IC operation.

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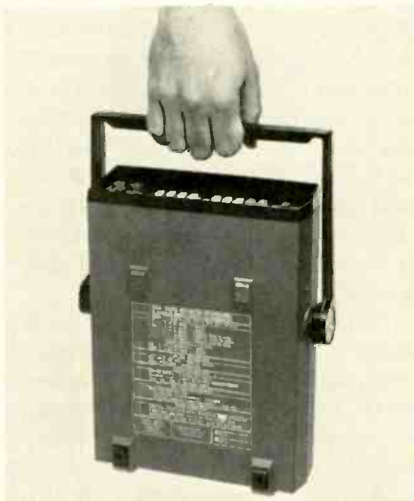

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Power Supply Regulator Circuits

How they function and how to service them

By Joseph J. Carr, ET/D Contributing Editor

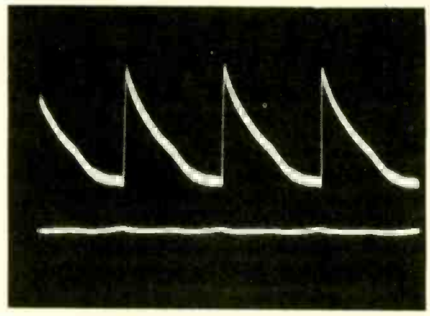


Fig. 1—Top waveform reveals 240mV of ripple present at a point immediately preceding the voltage regulating circuit of a power supply. Bottom trace, taken at the output of the regulator circuit, reveals the significant reduction of ripple which a regulator is capable of achieving. Both traces were taken with a dual-trace scope with both vertical amplifiers set for equal gain.

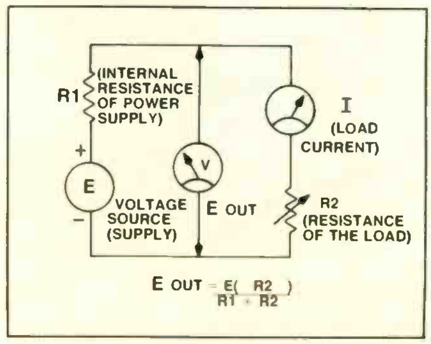


Fig.2—Equivalent circuit of a power supply and its load. R1 represents the internal resistance of the power supply itself and R2 represents the varying resistance of the circuits to which the power supply furnishes operating voltages. Also shown is the formula for computing the voltage output of a supply.

■ There are a number of reasons why equipment manufacturers go to the expense of incorporating regulated DC power supplies into their equipment. In FM receivers, for example, the local oscillator will drift all over the band if an unregulated power supply is used. This is why most FM receivers use a regulated supply at least in the tuner stages.

On the other end of the spectrum are certain audio amplifier designs which are able to operate with lower distortion when regulated voltage sources are used to supply the driver and pre-driver.

Another aspect of regulated supply application is the inherent reduction of power supply ripple component in high-gain audio equipment. The source of such ripple is rectification of AC sine waves. Fig. 1 graphically demonstrates the superior ripple reduction of a solid-state regulated power supply. Both traces were taken using the same "volts/div." factor for the vertical amplifiers. The upper trace is the waveform which appears across the output of the diode rectifier. From this point to ground there was a 250-mfd electrolytic capacitor. The lower trace was taken using the same oscilloscope deflection factor, but from the output of the regulator. Note that although the input voltage to the regulator exhibits about 240 millivolts of ripple, there is practically none at the output. It would take a very large capacitor to reduce ripple this much in a conventional power supply circuit. In fact, one manufacturer of auto radio bench power supplies, Delco, used to advertise that their "electronically regulated" power supply has the *equivalent* of 1.0 farad of filtering. What they meant was that electronic regulation reduced ripple to a level that would have required a 1-*farad* filter capacitor for comparable ripple reduction in a conventionally designed power supply.

Regardless of the type of equipment being serviced, I have found that odd and/or multiple trouble symptoms occur when incorrect voltages and/or excessive ripple are applied to circuits. This happens so often that I have made it a standard procedure to use both a voltmeter (amplitude) *and* a scope (ripple) to check power supplies whenever odd, unusual or multi-symptom situations are encountered.

THE NEED FOR REGULATION

There are two basic reasons why the output voltage of a power supply will vary: 1) changing input voltage, and 2) changing output load conditions. The former is especially a problem in automotive electronics and in those areas where the power mains are overloaded.

The latter problem, changing load conditions, can be better understood by referring to Fig. 2. All practical power supplies can be represented by an "ideal" voltage source, which has zero internal series resistance, and a series resistor (R1) which represents the true series resistance of an actual supply.

The total variable resistance of the various individual circuits which the power supply feeds in parallel is represented in Fig. 2 by a single variable resistance, R2, which is in *series* with the internal resistance (R1) of the supply. Because the conduction of the stages represented by R2 varies, so do their individual resistances and the resultant current drain (load) on the power supply. When the value of R2 decreases (increased

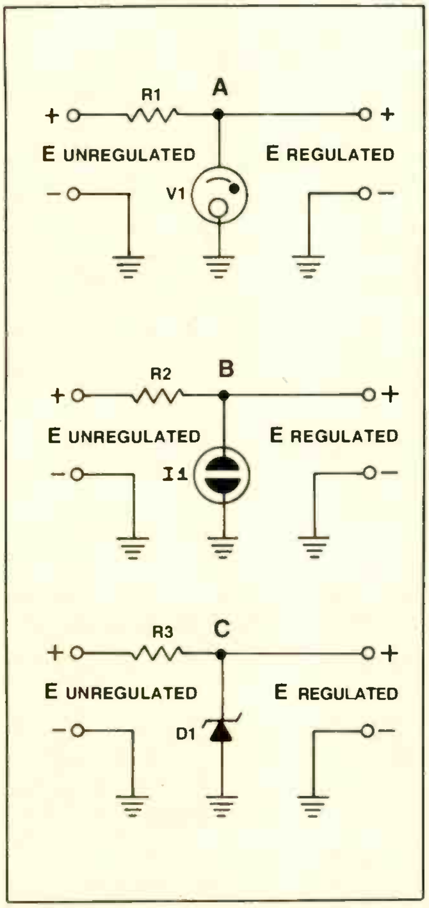


Fig.3—Three basic types of shunt regulator devices: A) gas regulator (0A2, 0B2, etc.), B) Neon glow lamp (NE-2, NE-51, etc.), C) Zener diode.

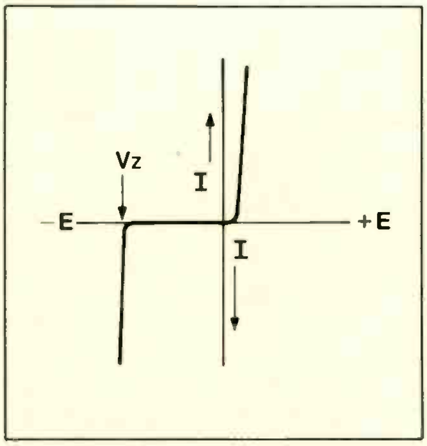


Fig. 4—Current-vs-voltage characteristics of a typical Zener diode.

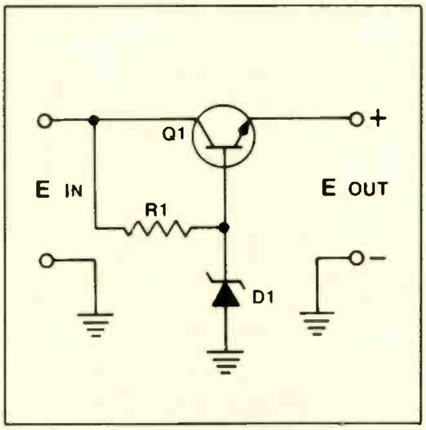


Fig. 5—Series-pass regulator circuit.

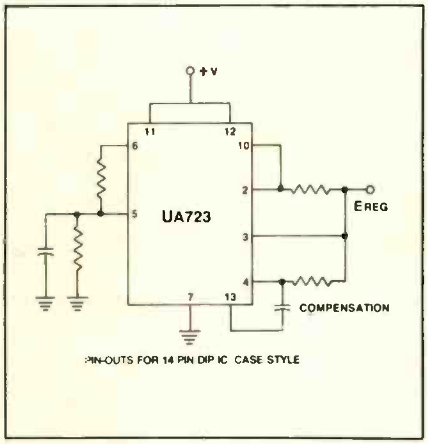


Fig. 6— Typical IC-equipped power supply regulator circuit.

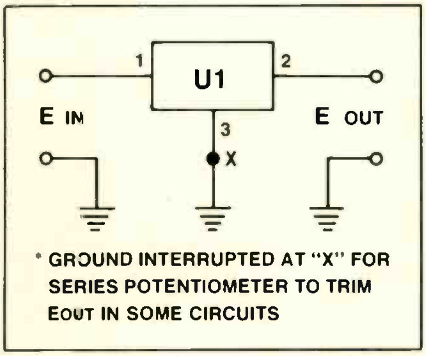


Fig. 7—Three-terminal voltage regulator device. Because some are packaged in TO-type transistor cases, they often are mistaken for transistors.

current drain, or load), the output voltage of the supply also decreases, as will be verified if you mentally plug various values into the voltage output formula in Fig.2.

To prevent the output voltage of the supply from decreasing as the current drain (load) increases, it is necessary to maintain a constant ratio between the internal resistance of the power supply (R1) and the load resistance (R2). For example, if R2 decreases (increased load, or current drain), the value of R1 should be made to effectively decrease a proportionate amount, so that the output voltage of the power supply will remain relatively constant. This is *voltage regulation*.

Such regulation can be accomplished by two basic methods:

1) A variable resistance whose value automatically adjusts to changes in the load of the power supply can be placed in *parallel to R2* so that as R2 decreases (load increase) the parallel variable resistance increases a proportionate amount, to keep the effective value of R2 relatively constant.

2) A variable resistance whose value automatically changes inversely to changes in the power supply load can be placed in *series with R1* so that as the value of R2 decreases (increased load) the effective total value of R1 and the additional series resistance also decreases a proportionate amount, to maintain a constant ratio between the values of R1 and R2.

BASIC SHUNT-TYPE REGULATING DEVICES

Fig. 3 shows several shunt-type devices used to regulate power supply outputs. Fig. 3A is a cold-cathode gas tube, which was used for many years in vacuum tube equipment. Fig. 3B is another gas-type regulator, a neon glow lamp.

Both of these types of gas-filled devices provide regulation because the voltage drop across an ionized gas cell tends to remain constant even though the current through it changes.

In other words, the internal resistance of a gas regulator changes inversely when the voltage applied changes.

Fig. 3C is another type of shunt regulator device, the Zener diode. These devices have a peculiar voltage-current characteristic curve, which is shown in Fig. 4. Note that when the PN junction of the diode is forward biased, the current flow is identical to that of any solid-state diode. However, when the Zener diode is reverse biased it operates somewhat different than a conventional solid-state diode. When a normal PN junction is reverse biased, no current flow occurs. In a Zener diode, this is true only up to the point where the reverse-bias voltage reaches a critical value known as the *Zener voltage*. When this voltage is applied to the junction, it "breaks down" and begins conducting current.

Between zero volts and Vz, the

Zener diode exhibits the large resistance associated with any reverse-biased semiconductor diode. At voltages from the Zener point on up, though, the Zener diode has a very low resistance. This characteristic allows the Zener to be used as a shunt-type regulator, provided that the series current can be limited to a safe value by R3. Although it tends to change slightly with changes in temperature, Vz is stable enough to provide relatively good regulation.

SERIES-PASS REGULATING CIRCUITS

When either critical stability or more flexibility is needed, other regulation techniques and circuits are used. Some are discrete transistor circuits (Fig. 5), while others use either special ICs (Fig. 6) or three-terminal devices (Fig. 7).

One popular IC regulator, the UA723, comes in several package styles and is flexible enough to be found in a wide variety of equipment.

Three-terminal regulators are relatively new but already are being used in consumer electronic equipment. Because they come in TO-3, TO-66 and plastic transistor cases, they can easily be mistaken for transistors. If service information is not available, circuit location and the lack of other components (such as a Zener diode and resistor at the "pseudo-base" terminal) are the best means of identifying a three-terminal regulator. This can be an especially aggravating problem if the set manufacturer uses "house numbers" to identify semiconductors and yet offers inadequate service data.

Fig. 5 is a *series-pass* transistor regulator. Note that regulator action in the series-pass design is accomplished by effectively raising and lowering the resistance of the series-pass element of the regulator circuit.

This circuit increases the current range of the regulator and "amplifies" the regulating effects of the Zener diode which is used to stabilize the transistor base. Because collector-emitter resistance is dependent on base-emitter bias,

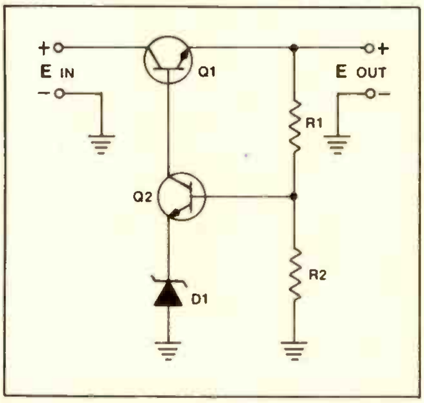


Fig. 8—This series-pass type of regulator circuit is similar to that in Fig. 5 except that a second transistor, Q2, is used to control the base of series-pass transistor Q1 instead of it being controlled directly by Zener diode D1. This circuit arrangement provides closer regulation than that in Fig. 5.

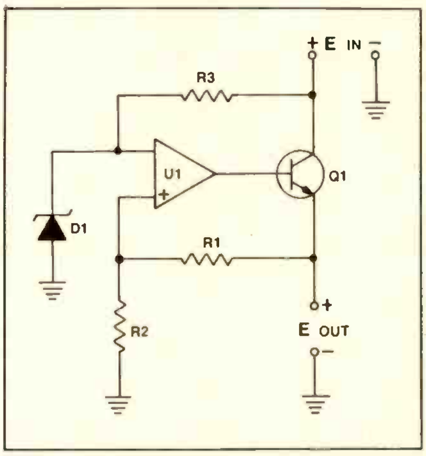


Fig. 9—A series-pass regulator circuit which is controlled by a differential operational amplifier.

the base of Q1 is held at a fixed voltage by Zener diode D1. When the demand for output load current decreases, the emitter voltage increases, causing the base-emitter bias to decrease slightly. This, in turn, causes the transistor to pass less current, thereby effectively increasing the collector-emitter resistance in series with the load.

When the demand for load current increases, the emitter voltage drops and, because this increases the forward bias of the base-emitter junction, the transistor conducts even harder. This, in turn, lowers the collector-emitter resistance, causing the output voltage to increase back to the steady state value.

For a regulator equipped with an NPN transistor, the steady state output will be close to (Vz + Vbe) or (Vz + 0.7). For a regulator equipped with a PNP transistor, the steady state output voltage will be about 0.7 volts lower than the Zener voltage (Vz). This is a good guide for selecting replacement Zeners in the absence of cross-reference data.

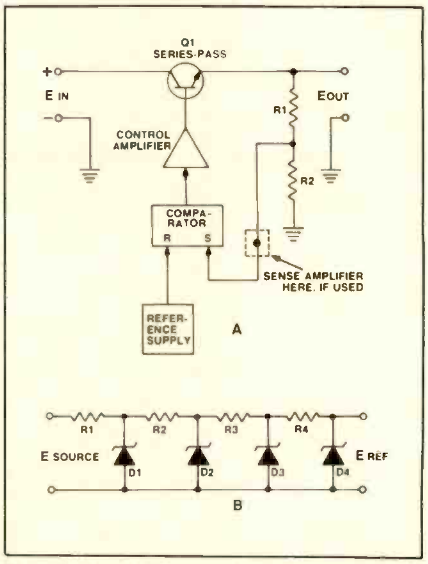


Fig. 10—Block diagram of a more complicated series-pass regulator (A), in which a reference (B) is compared with the output voltage.

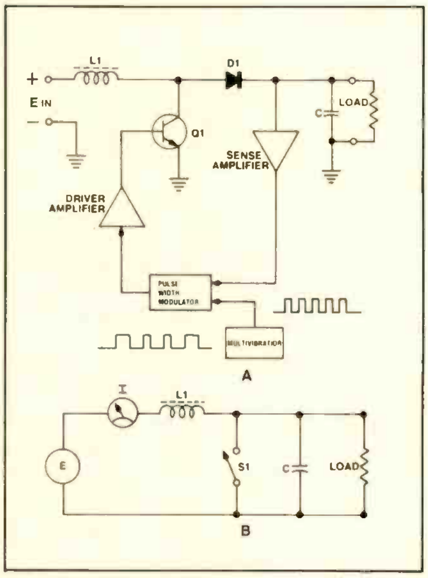


Fig. 11—A switching, or flyback, type of regulator (A), which uses a variable duty cycle switching system to control the output voltage. A simplified illustrative schematic of this system is shown in (B).

Figs. 8 and 9 show similar but more complex designs of series-pass regulator circuits. A second transistor, Q2, with a Zener stabilizing its emitter voltage, is used in Fig. 8 to control the base of the series-pass transistor Q1. A

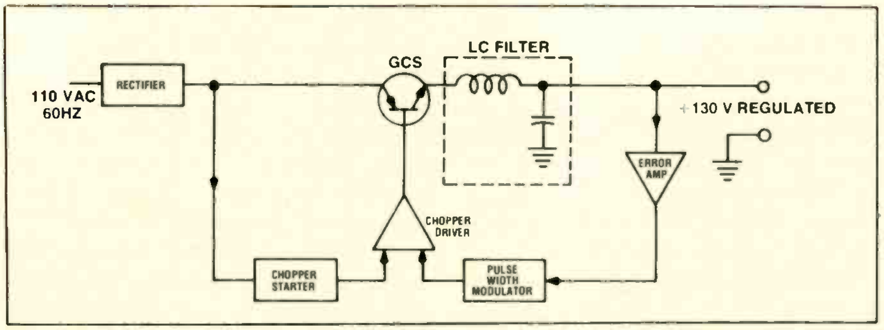


Fig. 12—Block diagram of the switching type of power supply and regulator used in Sony's KV-1722 Trinitron color TV receiver.

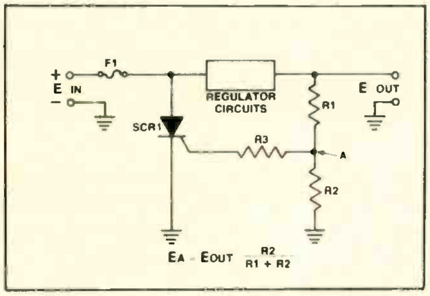


Fig. 13—SCR "crowbar" protection circuit shown here blows fuse if either the series-pass transistor or Zener fail in a way that causes an excessive output voltage.

REGULATED POWER SUPPLY FAILURES

(Based on 37 Individual Incidences)

COMPONENT WHICH FAILED	TOTAL NUMBER	PERCENTAGE OF TOTAL
Zener Diode	17	46 %
Series-Pass Transistor	14	38
All Others *	6	16

*Four of these were the "other" transistor in circuits such as Fig. 8.

sample of the output voltage, in turn, drives the base of Q2 via voltage divider R1 and R2.

The circuit of Fig. 9 uses a Zener (D1) to stabilize one input of a differential IC operational amplifier (U1), while a sample of the output voltage is applied to the other differential input via voltage divider R1 and R2. The output voltage, which controls the base of the series-pass element, is proportional to the *differential* input voltage.

COMBINATION REGULATORS

Regulated power supplies come in several varieties, and you can expect to see more than one type in some equipment. For example, a recent color TV chassis and several FM receivers use a simple Zener to regulate some voltages, but for regulation of more critical voltages, they use a series-pass transistor or op-amp design.

More complex equipment, of course, requires more complex regulators. An example of such a regulator is block diagrammed in Fig. 10A. Q1 is the same type of series-pass transistor used in less sophisticated circuits. Its base, however, is controlled by an amplifier (either discrete transistor or IC) driven by a voltage comparator circuit. Output current generated by the control amplifier is steady as long as the reference voltage (Fig. 10B) and the output of voltage divider R1/R2 (or sense amplifier) are equal. Changing load conditions, however, make the output of voltage divider R1/R2 vary, which causes the comparator to either increase or decrease the output of the control amplifier.

SWITCHING REGULATORS

Fig. 11 shows the block diagram of a modern, very efficient power supply called the *switching regulator* or *flyback regulator*. Fig. 11B is a simplified version.

Consider the electrical situation across the load in Fig. 11B when switch S1 is closed. Output voltage is zero and the current is limited only by any series resistance in the power source or inductor L1. During this period, energy is stored in the magnetic field around L1. When S1 is opened, this field collapses and dumps a countervoltage into the circuit, producing an output voltage equal to the source voltage plus the countervoltage. This voltage will decay to the value of the source voltage if the switch is left open long enough for the field to discharge completely.

In actual circuits, switch S1 will be a shunt transistor such as Q1 in Fig. 11A. A multivibrator or oscillator supplies a pulse train which drives a pulse width modulator (PWM) to electronically "toggle" Q1. Use of a PWM causes the on/off state (duty cycle) of Q1 to vary in response to changes in the output voltage.

Sony uses a switching power supply in their KV1722 and other Trinitron chassis which is similar but not identical to the circuit of Fig. 11. A partial functional diagram of the KV-1722 switching power supply is shown in Fig. 12. The electronic switch is a Silicone Controlled Switch (SCS) which Sony calls a *Gate Controlled Switch*, or *GCS*. This device is a PNPN switch which behaves similarly to a flip-flop-connected PNP/NPN pair (hence the two-arrow symbol). Each "transistor" in the pair regeneratively drives the other, causing an increased, more nearly perfect, switching time. A low-pass filter at the output of the supply reduces the probability of hash from high-frequency switching transients, which would interfere with other circuits.

TROUBLESHOOTING PROCEDURES

Troubleshooting the more complex regulators can be tricky because they are negative-feedback control circuits. Once you are certain that the reference voltage source is operating normally, check the series-pass element. After that, test the rest of the semiconductors.

Analysis of one month's service records kept by one service shop with which I am familiar reveals that in 37 repairs of regulated power supplies the component failures by percentage of type were as shown in the accompanying table. From this table it can be seen that the fastest approach to troubleshooting is to check the high-failure-rate items after first determining that the reference voltage source (if used) is functioning normally.

Then check the negative feedback aspect of the circuit.

One word of caution regarding equipment equipped with supplies which come in with a blown fuse: don't replace the fuse and turn on the set until the series-pass element and the Zener have been examined. The reason for this precaution is that some regulators are equipped with a protection circuit, like that in Fig. 13, which blows a fuse whenever excessive voltage appears at the output. This circuit remains inert as long as the sample of the output voltage at point "A" is too low to supply a sufficient current through R3 to trip the gate of the SCR. If the regulator should fail in a manner which places excessive voltage across the output, a larger current will flow in R3, and the SCR will be gated on. This causes the anode-cathode resistance to drop to a fraction of an ohm, drawing enough current to pop fuse F1.

Some technicians merely check the output line with an ohmmeter and, if no short is found, they replace the fuse and try a "smoke test." The only trouble is that, after blowing the fuse, the SCR and all other circuits return to their normal "off" conditions (except for the fuse and the failed component.) Once the fuse is replaced without finding the cause, the whole cycle repeats itself.

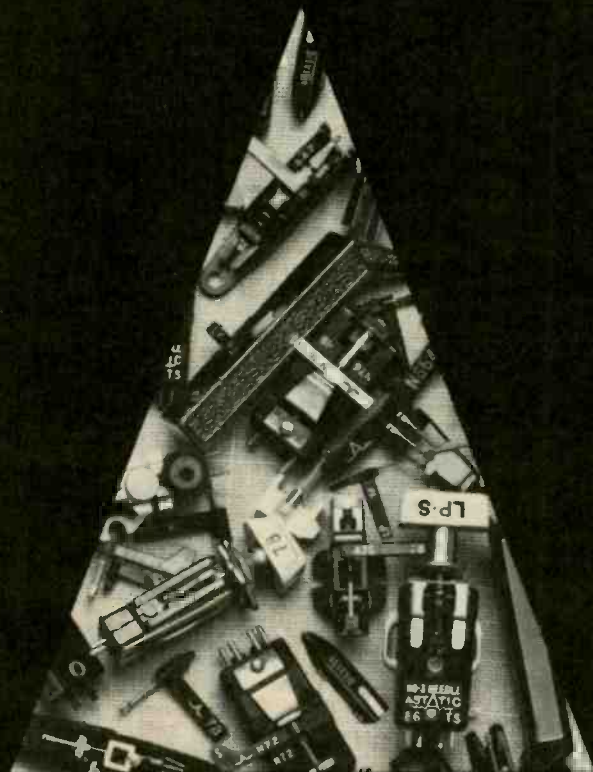
One of my early employers, Nelson Moodie, of Colonial Radio in Arlington, Va., used to have a saying (among many): "Fuses don't cause trouble, they indicate trouble!" Moodie's admonition goes double for SCR "crow-bar" protected supplies such as that in Fig. 13.

Another difficulty encountered in the servicing of regulated supplies is the possibility that a short in the equipment, not in the power supply itself, caused the failure of the supply circuits. To eliminate this possibility, use a bench supply, or combination of supplies, if needed, to substitute for the set's supply long enough to test the rest of the circuitry. These supplies, which are available from a number of sources, including RCA, Heath and Kepco, include current-limiting protection. Disconnect the set's power supply (even if this means a razor cut on the PC foil) and connect in the "outboard" power supplies.

Once you are satisfied that the set is working, replace the defective components and reconnect the set's internal power supply.

CAUTION: Should you try using two or more electronically regulated bench supplies in parallel to increase their current capability, you might run into a problem whereby the two supplies keep fouling up each other's voltage sensing circuits. In one type of symptom, the breaker of one supply will trip and the other will be forced to supply all current requirements.

Another symptom occurs with supplies equipped with auto-reset breaker. Supply A will shut down Supply B, which shuts down A, which shuts down B, etc. ■



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...for more details circle 132 on Reader Service Card

A diode and three fuses protect the Triplett Model 60 from overload damage. For more information about this instrument circle 100 on the Reader Service Card.

Triplett's Model 60 VOM is shock-resistant to accidental drops up to five feet.

TRIPLETT MODEL 60 VOM

The most important interesting feature of Triplett's Model 60 VOM is its ability to withstand misuses and hard everyday servicing needs.

The instrument has built-in protection against accidental high energy overload, is shock resistant to accidental drops up to a five foot height, modular constructed so that it can be quickly serviced in the field, and is designed to meet rigid safety standards to prevent electrical shock.

After throwing the instrument on the floor a few times and applying an AC input voltage, with the instrument set to the ohms range, no detectable harm was noted to the instrument or its accuracy. We were quite convinced it could take a lot of abuse.

Safety Features

To help eliminate destruction from accidental drops, the instrument features a case of molded black, high impact thermoplastic material, in combination with a suspension meter module which literally floats inside the outer case. The case finish has a non-slip "finger-tread" surface finish for handling ease.

The meter movement is protected by a diode module and to prevent harm from normal overload conditions it is protected by a 2 amp, 1000 volt (20 KW on DC; 30 KVA on AC) fuse and two zeners are used to protect the instrument against high energy fault currents and provide protection of the tester circuits up to 1000 volts.

A separately sealed battery compartment permits external access to the batteries and fuses without removing other parts of the instrument. Also found in this compartment are a spare ⅛ amp and 1 amp fuses. There are no exposed parts, this design insulates the user from the instrument itself. It also provides an internal electrical system which prevents explosive arcs in high energy circuits up to 2 amps, 1000 volts fuse capacity. The test lead jacks on the front panel are recessed safety connectors and a large imprinted label spelling out the safety precautions to observe when using the instrument are additional safety features.

Construction Features

The instrument employs a 45 μa suspension movement with a 4½ inch scale. It is contained in a separate protective housing of modular design which can be removed and replaced in a short time in the field if necessary. Only two connecting wires require resoldering to put the tester back into operation. The removal of eight screws completely disassembles the instrument.

The single range selector switch helps to prevent incorrect settings and enables you to select any one of the 28 ranges. The scale includes markings for direct readings when employing the optional Clamp-on AC Ammeter.

Also featured is a special "Confidence-Test" feature which is built into the unit for periodic reassurance checks of its meter.

Measurement Ranges

DC Volts. Ranges: 0-1, 3, 10, 30, 100, 300, 1000 Volts at 20,000 Ohms/Volt. ± 2 percent of full scale all ranges. *AC Volts*. Ranges 0-3, 10, 30, 100, 300, 1000 Volts at 5000 Ohms/Volt. Accuracy is ± 3 percent of full scale all ranges. *DC Current Ranges:* 0-0.1, 10, 100, 1000 Milliamperes at 320 Millivolts. Accuracy is ± 2 percent of full scale all ranges. Resistance Ranges: 0-1K, 10K, 100K, 1M, 10M, (12, 120, 1.2K, 12K, 120K ohms center scale). Accuracy is ± 2 percent of arc length. *Decibels*. Range: −20 dB to +52 dB Accuracy is ± 2 per cent of full scale all ranges. *Output volts* (AC) Ranges: 0-3, 10, 30, 100, 300 volts at approximately 5000 ohms/volt. Accuracy is ± 3 pecent of full scale all ranges.

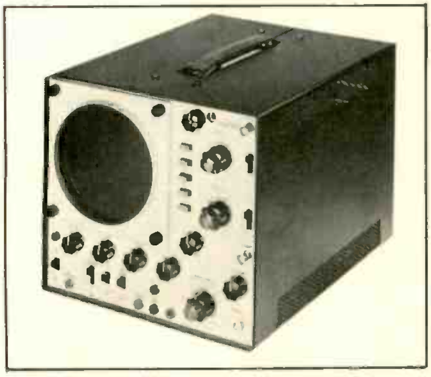
The instrument measures approximately 3¼ inches by 5¼ inches by 7¼ inches and weighs 2½ pounds with batteries (1-9 volt, and 1-½ volt "D" cell).

The instrument comes complete with safety test leads, insulated alligator clips, batteries, spare ⅛ amp and 1 amp fuses and instruction manual. Price is $90.

LECTROTECH MODEL TO-60 OSCILLOSCOPE

There are growing needs for a dual-trace oscilloscope in the home entertainment equipment servicing. The dual trace scope, used in industry and labs for many years, is appearing on service benches with increasing numbers.

Lectrotech's Model TP-60 solid



Lectrotech Model TO-60 Automatic Dual-Trace Oscilloscope. For more information about this instrument circle 102 on the Reader Service Card.

state, 15 MHz, dual trace triggered sweep, oscilloscope permits dual display of waveforms in five modes, allowing you to compare the waveforms for shape, amplitude and time duration.

Features

Automatic Triggering Sweep triggers solidly on all signals within the rated band width. Automatic *Astigmatism* Spot definition is always clean and sharp over entire CRT screen. Automatic *Horizontal Sweep* Special circuit provides free-running horizontal sweep in absence of triggering signal in the ground/free-run position. The time base remains at high brightness for all sweep speeds. Automatic *Horizontal/Vertical Triggering.* When viewing video signals, the horizontal and vertical triggering is selected automatically by the time base switch.

TV trigger selector automatically converts the trigger amplifier to an amplitude selectable Sync Separator. This feature provides stable triggering on composite TV video signals. *Unique trigger circuit* provides automatic triggering to frequencies in excess of 15 MHz with as little as 1 division of displayed signal. It is an ideal instrument for the display of sweep alignment response curves. The DC coupler amplifiers provide maximum stability for these curves and minimize the need for both oscilloscope and sweeper adjustments and it is compatible with all existing sweep generators. Channel A or Channel B can trigger independently of each

other in single channel modes. In dual channel modes the triggering is provided by channel A.

Other features include: vectorscope input for color TV servicing, external horizontal amplifier, external horizontal input, calibrated horizontal time base, TV sync selector, and calibrated vertical attenuator.

Specifications

Vertical Amplifier Bandwidth: DC to 15 MHz min. *Risetime:* 23 nano seconds. *Sensitivity:* .01 volts/div. to 20 volts/div. in 1-2-5 step sequence plus continuously variable control. *Input Impedance* 1 Megohm ± 1 percent shunted by 30 picofarads *Horizontal Sweep* Type: Miller Integrator *Sweep Speeds* .2 second/per division to .5 micro second/per division in 1-2-5 step sequence plus continuously variable control. With 5X magnifier sweep speed increases to 11 micro second/per division. *Triggering Source,* Internal external and line *Type:* Automatic or amplitude selection with preset stability *External Horizontal Amplifier* Bandwith: DC to .5 MHz Sensitivity: .5 volt/per division Input Impedance: 100 K shunted by 30 picofarads *Cathod Ray Tube Display Area:* 8 by 10 Cm *Blanking:* DC coupled.

Size and Weight

The instrument measures 9 inches high by 10 inches wide by 13¼ inches deep and weighs 25 pounds. The price is $489.50.

SYSTRON DONNER MODEL 7004A DIGITAL MULTIMETER

The Systron Donner Model 7004A Digital Multimeter is a full four-digit instrument. It offers the five selectable functions of DC voltage, DC current, AC voltage, AC current and resistance.

Some of the outstanding features of the unit include high input impedance on the three most sensitive ranges, extended AC frequency response, new ease of calibration, and improved serviceability.

All function and range selections are made from the front-panel pushbutton controls. The readout features a nonblinking

Systron Donner Model 7004A Digital Multimeter. For more information about this instrument circle 103 on the Reader Service Card.

display of four full digits plus overrange, auto-positioned decimal point, and an indicator for off-scale readings. Polarity indication for DC voltage and current is automatic with a minus indicator display.

Resolution and Accuracy

All measurements are made with 0.01 percent resolution on a full four-digit display. A fifth readout digit allows 30 percent overrange capability. Accuracy on the top four DC voltage ranges is + 0.01 percent of reading + 0.01 percent of full scale from + 20 degrees to + 30 degrees C for 30 days minimum. To maintain accuracy, it features 1000 megohm imput impedance on the three most sensitive ranges to help eliminate loading errors.

Measuring Ranges

The instrument provides 25 measuring ranges. Five DC voltage ranges and five AC voltage ranges permit measurements from 10 microvolts to 1000 volts (500 volts rms maximum on AC). Current measurements (both DC and AC) can be made without the need for external shunts. Five resistance ranges provide readings from 100 milliohms to 13 megohms.

Noise Rejection

A fully floating and guarded input circuit provides better than 100 dB of common mode noise rejection at all noise frequencies from DC to 1000 Hz. To maintain accuracy in presence of unwanted ripple, or normal mode noise, it combines the built-in noise rejection characteristics of Dual-Slope integration with a full-time noise filter to achieve better than 60 dB of rejection at power line frequencies.

Portability Design

The unit weighs eight pounds and measures 3½ inches high. Its half-rack width allows the multimeter to be mounted in any standard instrument rack—single or two-across. It also is equipped with a carrying handle and tilt stand for portability. An optional battery pack can be purchased which allows approximately six hours of continuous operation. The batteries are recharged by its built-in charger when operated by AC power. The battery pack mounts inside of the multimeter package and includes a convenient self-test feature for monitoring the battery condition.

The digital logic and readout board swings up to permit access to components and solder connections. Inter-connections are made through plug-in PC connectors.

For use outside of the shop the multimeter may be supplied with accessories such as snap-off front and rear covers and a carrying case with storage compartment for probes and cables. The price is $675.

TUNER SERVICE CORPORATION SUBSTITUNER

Tuner Service Corporation has recently added the SUBSTITUNER to their growing field of specialized equipment.

The instrument has a brushed aluminum base with a flash anodized finish. The power supply is transformer-powered with a full wave rectifier circuit. The output voltage is regulated by a zener diode to provide good performance when operated with varying line voltages.

Tuner Service Corporation's SUBSTITUNER. For more information about this instrument circle 104 on the Reader Service Card.

The unit employs both a detent VHF tuner along with a detent UHF tuner. The VHF tuner has a push to fine tune feature, with memory allowing the operator to go from channel to channel without readjusting the fine tuning. The UHF tuner allows selection of UHF channels in the same manner.

A manual gain control (MGC) located on the front panel of the unit controls its gain. An added feature is a LED indicator located in the upper right hand corner of its cabinet, whose intensity varies depending on the adjustment of the MGC. As you increase or decrease the gain, the intensity of the indicator varies proportionately.

Separate VHF and UHF inputs facilitate the checking of home antenna systems. Separate VHF OUT, Channel 1 IN, and IF OUT connections facilitate the checking of the TV set's tuner for a good/bad condition. A noted safety feature is a cover which encloses these connections at the rear of the unit, which must be removed to gain access to the phono-jacks. This prevents exposure to the high voltage present on the phono plugs when Substituner is connected to hot chassis TV set.

The Substituner comes complete with a three foot cable terminated within the extension in-line jack, which allows the use of a short phono-jack cable or a phono to clip lead cable for versatility.

The IF output frequency is centered around 44 MHz, the standard IF frequency. This allows the unit to be used for signal injection tests in the majority of TV sets.

Removal of the back protective cover, which is held in place by two screws, is necessary to gain access to the UHF OUT and CHANNEL 1 jacks.

The Substituner can be used to check the VHF tuner, UHF tuner, Channel 1 to VHF tuner and the AGC system.

In many cases the reception may be as good as, if not better than, the original tuner except where the bandpass is adversely affected by the coupling in the IF section of the receiver. The price is $39.95.■

TECHNICAL DIGEST

The material used in this section is selected from information supplied through the cooperation of the respective manufacturers or their agencies.

ADMIRAL

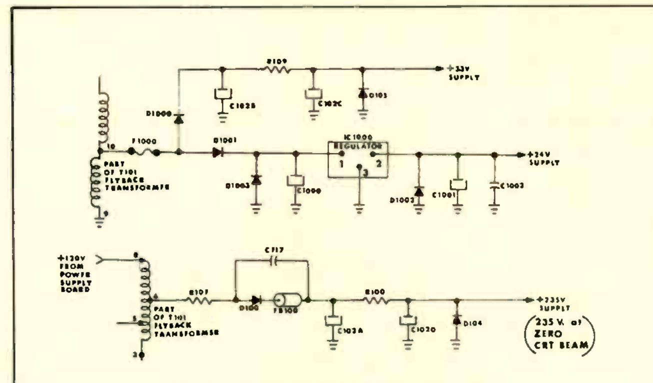
Color TV Chassis M10 — Scan Derived Power Supplies

This chassis employs three scan derived DC power supplies: 33 volt, 24 volt and 235 volt. The 33 volt and 24 volt supplies are protected by F1000, a 1.5 amp fuse.

Positive horizontal pulses from terminal 10 of the flyback transformer are coupled through F1000 to the anodes of D1000 and D1001. The pulse is rectified by D1000, filtered by C102B, C102C and R109, to become the B+ 33 volt supply. Diode D105 is used for protection which decouples any negative transient energy to ground. This provides protection to the solid state components connected to the 33 volt supply.

The same pulse is rectified by D1001 and filtered by C1000, producing a 35 volt supply which is dropped by IC1000 to become the B+ 24 volt supply. Diodes D1002 and D1003 act as protector diodes for transient protection in the same manner as D105. Further filtering of the B+ 24 volt line is provided by C1001 and C1002. Integrated circuit IC1000, the B+ 24 volt regulator circuit, maintains this supply at 24 volts during normal load variations.

The third scan derived supply is provided by the D100 circuit. A positive horizontal pulse from terminal six of the flyback is coupled to D100 by R101. This supply is unique in that the horizontal pulse is "stacked" on the B+ 120 volt supply from the power supply board and therefore, only requires a half - wave rectifier to achieve 235 volts of B+. The pulse at the D100 anode is rectified by the diode where the derived voltage is added to the B+ 120v reference supply and becomes the B+ 235 volt source. Diode D104 provides transient protection in the same manner as D105, D1002 and D1003. Filtering is provided by C102A, C102D and R100.



SCAN DERIVED POWER SUPPLIES

All of the scan derived B+ supplies are dependent on correct operation of the power supply board. This is the case because the pulse amplitude in the flyback transformer (from which all three derive) is a function of the B+ 120 volt regulated supply as well as proper horizontal circuit operation.

GENERAL ELECTRIC

Color TV Chassis MC—No Raster, But Sound Normal

If you encounter a no raster problem, but the sound is normal, and resistor R1103 on the Buffer Module is overheated or open, inspect the assembly and make the following changes: 1) Remove the high voltage assembly mounting screw and turn the assembly to view the back side. Check for a broken wire to capacitor C1702B (can type electrolytic). In early production the wire was stretched tight and may have been broken in shipment. 2) Replace or redress the wire to provide slack, and resolder to C1702B. 3) Replace Resistor R1103 (EP14X63) if overheated or open. 4) If raster is not restored, check Q1702. If set was left on, it may have failed.

MAGNAVOX

Color TV Chassis T985/986 — Vertical Jitter

Vertical jitter may occur on some of these portable color TV chassis. When the amount of jitter varies as the brightness is changed, the problem is probably caused by a low high voltage setting or high line voltage. Ensure that the high voltage is set to 22 kv for the T985 and 24 kv for the T986 (zero beam current). The condition can be further improved by changing the value of R7 on the 120v regulator module. The resistor should be changed from 220 ohms to 470 ohms.

A second condition of vertical jitter which is not associated with brightness change may be corrected by adding a .1 mfd capacitor across R12 on the Vertical Oscillator module.

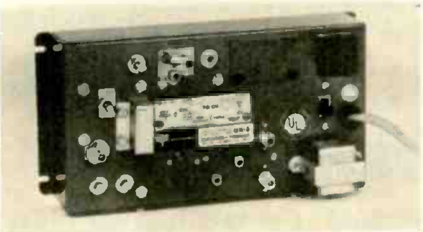
21 Detent Tuners — Replaceable UHF Pot Strips

The 21 detent tuner is a combination of VHF tuning strips and UHF potentiometer strips. The UHF strips apply voltage to a separate varactor UHF tuner. The PN for the UHF strips is 171356-1. If a UHF pot strip becomes defective, it should be replaced in lieu of replacing the complete tuner. ■

NEW PRODUCTS

UHF-TO-VHF CONVERTER 135

The *Blonder - Tongue* Model UX - 3 single - channel UHF - to - VHF crystal - controlled converter will now be available with a 0.002 percent



crystal in place of the standard 0.005 percent crystal. The new crystal, available at an extra charge of $45, improves stability and maintains FCC CATV rules tolerance specifications of 25 KHz carrier frequency drift. The converter is a solid - state, low - noise UHF to VHF converter in CATV and MATV systems. Each converter is designed for a specific conversion from one UHF channel to one VHF channel. The circuitry eliminates the possibility of deteriorating the UHF noise figure with the indiscriminate use of high - noise external amplifiers. In weak - signal areas, a mast - mounted preamplifier would be used to preserve the best signal - to - noise ratio. In areas where signals are medium to strong, the converter input comes directly from the antenna. The unit has a 75 - ohm input and two 75 - ohm "Loop - Thru" mixing outputs. This output feature permits low - loss mixing of non - adjacent VHF channels into head - end amplifiers.

OSCILLOSCOPE 136

A 10 MHz dual channel, general purpose portable oscilloscope Model 1010A is introduced by *Ballantine Laboratories, Inc*. This all solid - state

instrument provides 5 mV/cm sensitibity in two identical input channels over the full bandwidth of DC to 10 MHz. In the dual channel display mode switching from alternate to chopped sweeps is automatically accomplished by the sweep range switch operation. The amplitude and sweep ranges are fully calibrated. The trigger system is flexibile, and provides a bright baseline display in the absence of an input signal. The 3.6 kv accelerating voltage on the 8 x 10 cm CRT provides bright easy to read traces, even at the sweep rate of 100 ms/cm. The trigger selection provides modes optimizing video frame and line sync. Lissajous patterns are quickly set up by switching into the X - Y mode of operation. The instrument weighs 15 lbs and is priced at $495.

DIGITAL MULTIMETER 137

A portable Digital Multimeter Model IM-2202 is the lowest - priced digital multimeter *Heath* has ever offered. Included in the unit are four rechargeable nickel - cadmium batteries and a built - in charging circuit. Up to eight hours of continuous operation can be obtained from each charge or it can operated from 110 to 220 VAC

when necessary. Its 26 ranges include full scale ranges of 100 mV to 1000 volts DC, 100 mV to 750 volts AC, 100 µA, to 1000 mA and 100 ohms to 1000 kilohms. The 100 percent overrange capability allows measurements up to 1.999 on all ranges except 1000 VDC and 750 VAC, giving full 2 amp or 2 megohm capability. Overrange condition is automatically indicated by a flashing "1" display. If a lab standard is used for calibration, DC accuracy is + 0.2 percent. For AC, accuracy with a lab standard 0.2 percent. For AC, accuracy with a lab standard is + 0.5 percent to 10 KHz. Internal standards supplied with the kit allow easy field calibration to + 0.5 percent for DC and + 1 percent for AC. The large 3½ - digit display features automatic polarity indication and decimal point placement. A continuous - rotation *range* switch and four pushbutton *function* switches select any of the measurement ranges. Price is $179.95.

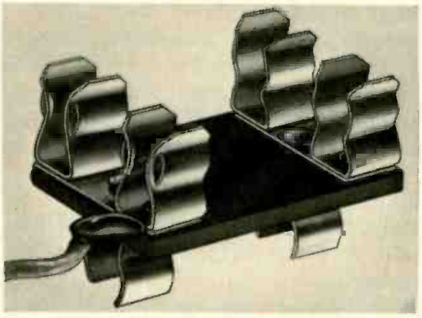
FM SIGNAL GENERATOR 138

The Model 1012 FM Signal Generator, introduced by *Gaw Co., Inc.*, is designed specifically to meet the requirements of the mobile communications industry. It features digital frequency read - out, eight frequency ranges, low frequency output for IF alignment, internal/external modulation — DC coupled, double -

trace sweep modulation, automatic output leveling, external counter to beyond 20 MHz, electronic fine tuning, double shielding, spectral purity, and less than 100 Hz residual FM. The design of the instrument offers the user a frequency source and a standard of RF voltage and deviation. The spectral purity of the unit, in combination with the frequency counter, give the unit wide application.

FUSED POWER-TAP 139

A new product that greatly simplifies power connection for the installation of auto radios, stereos, and other electrical appliances is introduced by *3 B&D Products, Inc.* Called "Add - a



fuse," the device has prongs on one side of an insulating board that snap into an existing fuse clamp. On the opposite side of the board there are two fuse clamps. One receives the fuse for the circuit in which Add - a - fuse is plugged, and the other picks up and fuses the hot side for power to the new installation. A piece of hookup wire is attached for connection to the appliance. The arrangement makes both circuits independently fused.

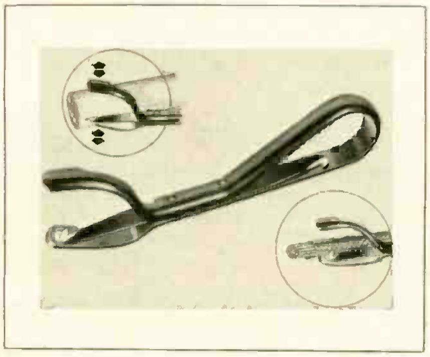
SWEEP/FUNCTION GENERATOR 140

Dana Exact Electronics, Inc., announces a low cost Sweep/Function Generator with 50 ohm output. The Model 196A offers sine, triangle, square, pulse, and sweep waveforms over a frequency range of 0.1 Hz to 1 MHz. Signal amplitudes of 20 volts p - p open circuit or 10 volts p - p into a 50 ohm load are available. The instrument has an internal sweep generator to sweep the frequency of the main generator with a variable sweep width up to three decades (1000:1). The sweep rate is adjustable from 1 msec to 10 secs. Other features include DC offset, variable ramp or pulse

waveform with inverting capability, square/pulse risetimes of less than 100 nsec, and a separate TTL compatible output with less than 25 nsec risetime. Price $350.

CABLE SHEATH SLITTER 141

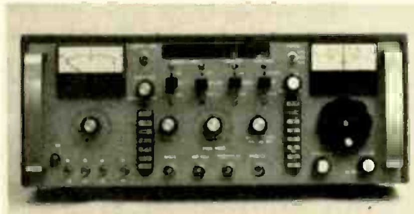
P.K. Neuses, Inc., introduced a cable slitter tool for slitting most any type of large or small cable jackets. The No. N-62267 slitter has a very sharp, tough hook blade which digs in between the sheathing and wires and with the side supports, guarantees the user an accurate jacket stripping. The



razor sharp hook allows the user to cut into cable at any point without any previous notching, thus avoiding hazard to the inside wires as well as hands. Two screws hold the blade in cutting position and also secure an extra blade with the cutting end protected until used. The forked ends of the slitter are ductile aluminum, and may be carefully bent to fit endless cable sizes. The tool is 6 inches by 1½ inches and weighs only two ounces.

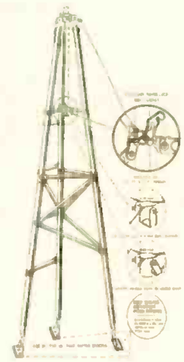
CB SERVICE MONITOR 142

The *Lampkin* Model 109 CB Service Monitor measures and generates RF and audio frequencies, monitors single sideband, measures AM and FM modulation, generates CW and AM signals and serves as a digital frequency counter with a range of 50 Hz to 30 MHz. The Model 109 is designed to easily accommodate future growth of CB. For example, if Band E is activated, a 220-230 MHz band and FM deviation feature can be quickly added at a nominal cost. As the service shop grows, up to six other 10-MHz bands in addition to CB can be added to allow servicing of marine, aviation, and business frequencies through 512 MHz. Other options allow the addition of a frequency error meter, sweep and 12 volt DC operation. Other features



include: The ability to measure frequencies to accuracies of better than 1 part per million; an eight-digit LED frequency display; capability of eight 10-MHz bands and measurement of AM modulation (0-100 percent) and FM modulation (2 KHz and 6 KHz scales). The unit weighs 17 pounds and measures 6¾ inches high by 17 inches wide by 11 inches deep. Basic price is $1,550.

TRIPOD ROOF TOWER 143

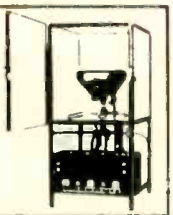


A new 10 foot Tripod Roof Tower has been developed by *South River*. Carton packed, this heavy duty 10 foot, galvanized, rust-resistant, tower is shipped partically disassembled. It can be assembled in a short time with no previous assembly experience. The tower, Model HDT-100KD was designed for TV/FM/CB antennas that required un-guyed, roof-top installation. It incorporates a climable ladder in its design for ease in mounting the mast and antenna. This unit includes pitch patches for watertight leakproof roof mounted installation. Diagonal, torque-buttressing structural members contribute to the high strength, low weight, special design of this unit. Weighing under 28 lbs., this unit has been designed to come within the 108 inch dimension limitation imposed by UPS on shipments. A 15 foot Model HDT-150 tower is also available for UPS shipment within the same dimensioned carton.

CLASSIFIED

RATES: 35¢ per word: 45¢ per word Bold Face Type. Add $3.00 if you wish Box Number. Minimum $10.00 charge. Classified Display Rate billed $40.00 per inch, 1 inch minimum. Remittance must accompany order. Mail ad copy to: Roz Markhouse, ET/D, 757 3rd Ave., N.Y., N.Y. 10017.

Business Opportunities



Improve sagging sales with high profit-quick turnover CB equipment. Write for dealer application. Wheeler-Dealer Electronics, Dept. ET/D, Bascom, Florida 32423.

For Sale

RADIO & T.V. TUBES - 36 cents each. Send for free Catalog. Cornell, 4215-17 University, San Diego, Calif. 92105.

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HARD-TO-FIND TV & RADIO PARTS NEW AND USED. ASK ANYWAY CMC 4329-4 WOODMAN, SHERMAN OAKS, CA. 91423

FOR SALE

Established Radio & TV Sales and service in Sunny Arizona. Retiring. P.O. Box 236, Mesa, Arizona 85201

REBUILD PICTURE TUBES. We sell new & used equipment with complete instructions in our plant. We buy used equipment. Factory Outlet, 951 E. Hudson St., Columbus, OH 43211 614-263-0645.

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TUBES receiving, factory boxed, low prices, free price list. Transleteronic, Inc. 1365 39th St., Brooklyn, N.Y. 11218A, Telephone; 212-633-2800.

FOR SALE-RIDERS MANUALS 23 Radio, 21 TV, Vol 1 Sams Best offer lot over $7.50 @ LYSTEMS, 106 Eddy, Dix Hills, NY 11746

For Sale: Howard W. Sams Photofacts, complete set-folder #140-#1402. In four filing cabinets, complete price $1400.00. Valley TV & Appliance, 29465 Chualar Cyn. Rd., Chualar, Calif. 93925.

TV & RADIO TUBES .36¢ EA!! Send for free color parts catalog Your order free if not shipped in 24 hours. Cornell Electronics 4215-17 University San Diego California 92105

UNUSUAL SURPLUS, CLOSEOUTS AND PARTS CATALOG. RUSH $1 ETCO-4 ELECTRONICS. Box 741, MONTREAL H3C2V2.

BURGLAR alarm police dialing unit automatically calls police or any number. $29.95. Easy to program and easy to install. Free literature. S&S Systems, Box 12375 E, North Kansas City, Mo. 64116

For Sale: Used picture tube rebuilding equipment, complete-and equipment for laminating and delaminating face plates, and supplies. Escom Pack Sr., Paver Barnes Road, Marysville, Ohio 43040 (513) 642-7161

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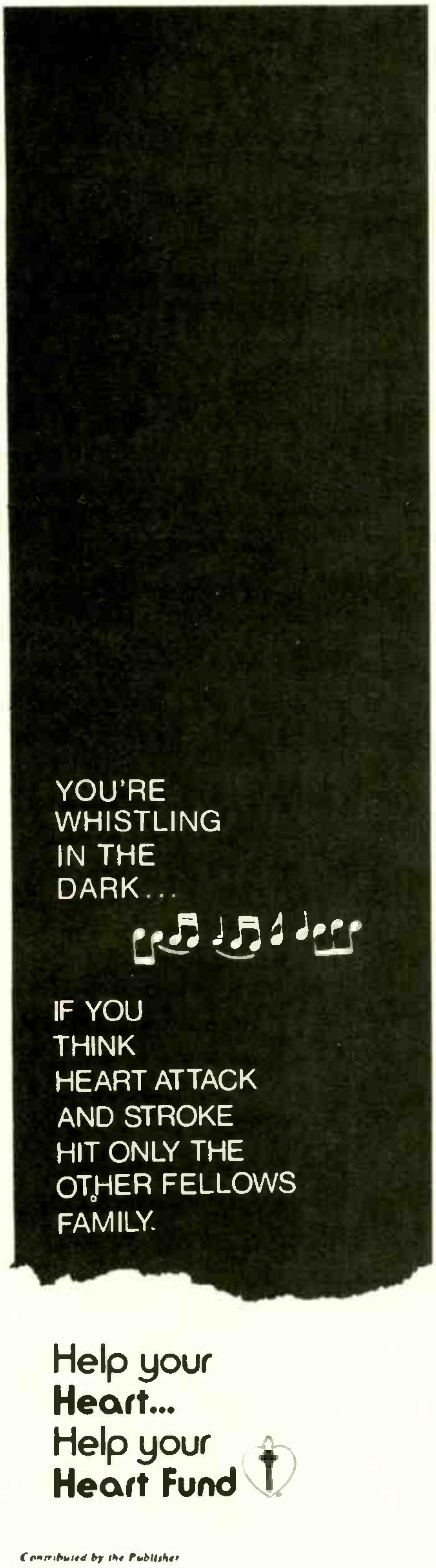
ELECTRONIC TECHNICIAN/DEALER CLASSIFIED

Construction Plans

DIGITAL CIRCUIT plans are available for; Automatic 125 Meg. freq. counter with many features, Delux Logic Probe with pulse indicator, Digital Clock 6 digit readout, 60 Hz. time base for all digital clocks; Digital tachometer. Plans $2.50 each, Boards available for all plans, drilled, etched and plated, Com-Tronics, 144 Cloverside Ct., Buffalo, N.Y. 14224. 7/75



Construction Plans

Complete Construction Plans — TELEPHONE: Answering Device, Automatic Dialer, "Black Boxes," Call Diverter, Call Limiter, Conference Bridge, Central Dial Exchange, Melodic Ringing, Recorder-Actuator, Remote Control, Schematics, Speakerphone, Telelink Burglar Alarm, Voice Schrambler, $3.00 each. ELECTRONIC: Biofeedback Conditioner, Horticulture Stimulator, Multifrequency Encoder Network (Speeds telephone calling 100%!). $5.00 each. ONE YEAR SUBSCRIPTION to Telephone Electronics Line (TEL) $6.00. "The Legal Aspects of Interconnection" book, $29.95. All of the construction plans above plus a one year subscription to TEL $29.95. TELETRONICS COMPANY OF AMERICA, 22035 Burbank Blvd., Suite 122, Woodland Hills, Calif. 91364.

WHY BUY A CRT RESTORER? If you have a B&K 465 or 466 rejuvenator, convert it to a CRT Restorer. For information James R. Chancellor, 1708 Edgerly Avenue, Albany, GA 31707

Educational Courses

REPAIR TV TUNERS-High Earnings; Complete Course Details, 12 Repair Tricks, Many Plans, Two Lessons, all for $2. Refundable. Frank Bocek, Box 3236, Ent., Redding, CA 96001.

Repair your own TV. Valuable Information $2.00. TIP$ Bruce, Miss. 38915.

EDUCATION
UNDERSTAND digital electronics—calculators, microprocessors, clocks. New programmed learning courses. Design of Digital Systems, 6 volumes, only $14.90. Digital Computer Logic, 4 volumes, $9.90. Both $19.90. Unconditional refund if dissatisfied. CAMBRIDGE LEARNING ENTERPRISES, Box 428, FDR Station, New York, NY 10022

BUILD THAT ELECTRONIC ORGAN YOU ALWAYS WANTED AT A PRICE YOU CAN AFFORD. Third edition of "Organ Builder's Guide" pictured product kit line, circuits, block diagrams, design rationale using IC divider and independent generators with diode keying. $3.00 postpaid. Also, free brochure on keyboards. DEVTRONIX ORGAN PRODUCTS, Dept. A., 5872 Amapola Dr., San Jose, CA. 95129

How to save money on tuner repairs. Information $2.00 TIP$ Bruce, Miss. 38915

Manuals and Periodicals

HEAR POLICE/FIRE Dispatchers! Catalog shows exclusive official directories of "Confidential" channels, Send self-addressed stamped envelope. Dealers wanted. Communications, Box 56-ET, Commack, NY 11725

NEW CANADIAN MAGAZINE. "ELECTRONICS WORKSHOP". $5.00 YEARLY. SAMPLE $1.00. ETCO-C, Box 741 MONTREAL H3C2V2.

Wanted

WANTED: PICTURE TUBE REBUILDING EQUIPMENT used or new. Call or write Atoll TV, 6425 W. Irving Park, Chicago, Illinois 60634. (312) 545-6667. Evenings until 11 PM call (312) 235-0420

Want Schematic for Korvettes TV set XAM Model 1269 and need part number for yoke and horiz. trans. Arthur R. Vickery, The Music Shop, 548 Main St., Torrington, Conn. 06790.

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ADVERTISER'S INDEX

ELECTRONIC TECHNICIAN/DEALER TEKFAX

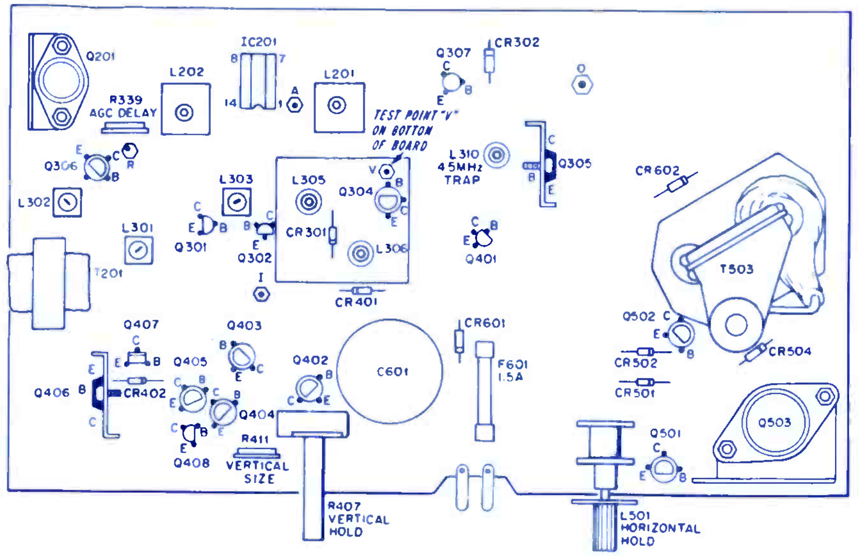
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

GROUP 275

1593

ADMIRAL
TV Chassis TL6

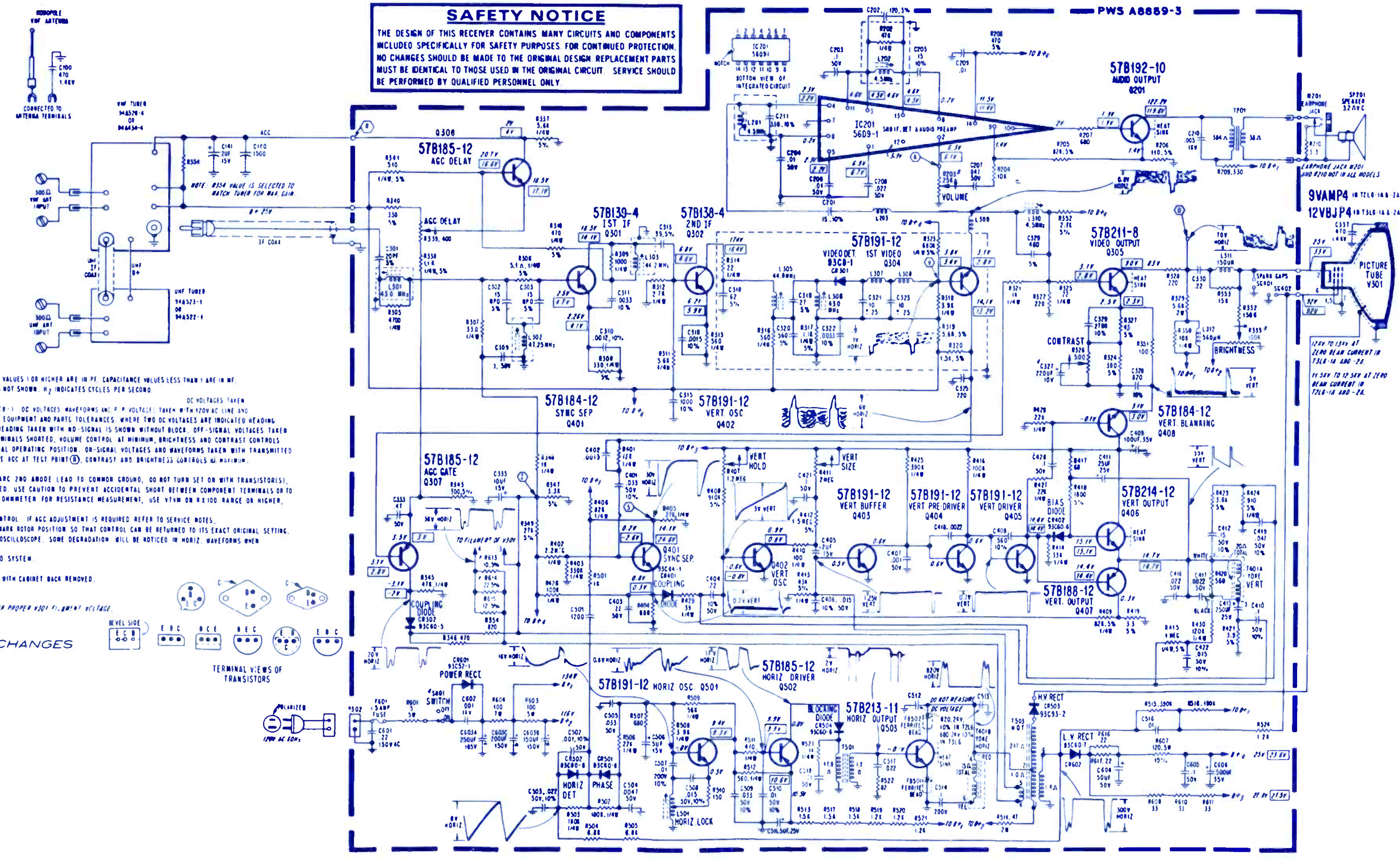
JULY • 1975



SYMBOL	DESCRIPTION	ADMIRAL PART NO.
R333	100K, briteness control	75A1-212
R339	400 ohm AGC delay	75A101-35
L201	coil, 4.5MHz	72A317-1
L301	coil, 47.25MHz trap	72A415-8
L306	coil, det.	72A316-8
L310	coil, 4.5MHz, trap	72A317-9
L501	coil, horiz. lock	94A480-1
T201	xformer, audio output	79A172-1
T401	yoke deflect T2L6	94A372-3
T401	yoke deflect T3L6	93A372-4
T501	xformer, horiz. drive	72A417-1
T503	xformer, horiz. output	79A166-4
R203	25K, vol control w/Sw	75A1-225
R326	500 ohm, contrast control	75A1-211
R333	100K, briteness control	75A1-212
R339	400Ω, AGC delay	75A101-35
R411	2 M, vert size	75A101-61
R407	1.2 M, vert hold	75A191-3
F601	fuse, 1.5a	84A7-15

SAFETY NOTICE

THE DESIGN OF THIS RECEIVER CONTAINS MANY CIRCUITS AND COMPONENTS INCLUDED SPECIFICALLY FOR SAFETY PURPOSES. FOR CONTINUED PROTECTION, NO CHANGES SHOULD BE MADE TO THE ORIGINAL DESIGN. REPLACEMENT PARTS MUST BE IDENTICAL TO THOSE USED IN THE ORIGINAL CIRCUIT. SERVICE SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.



SCHEMATIC NOTES

RESISTOR VALUES 1/2 WATT, 10%. CAPACITANCE VALUES 1 OR HIGHER ARE IN PF. CAPACITANCE VALUES LESS THAN 1 ARE IN MF. RESISTANCE VALUES OF COILS LESS THAN 1Ω IS NOT SHOWN. Hz INDICATES CYCLES PER SECOND.

VOLTAGE AND WAVEFORM NOTES. DC VOLTAGES TAKEN WITH VTVM WITH RESPECT TO COMMON GROUND (B-). DC VOLTAGES WAVEFORMS AND P-P VOLTAGES TAKEN WITH 120V AC LINE AND MAY VARY DEPENDING ON CALIBRATION OF TEST EQUIPMENT AND PARTS TOLERANCES. WHERE TWO DC VOLTAGES ARE INDICATED READING TAKEN WITH TV SIGNAL IS SHOWN IN BLOCK, READING TAKEN WITH NO-SIGNAL IS SHOWN WITHOUT BLOCK. OFF-SIGNAL VOLTAGES TAKEN ON UNUSED VHF CHANNEL WITH ANTENNA TERMINALS SHORTED, VOLUME CONTROL AT MINIMUM, BRIGHTNESS AND CONTRAST CONTROLS AT MAXIMUM. ALL OTHER CONTROLS IN NORMAL OPERATING POSITION. ON-SIGNAL VOLTAGES AND WAVEFORMS TAKEN WITH TRANSMITTED NOISE FREE SIGNAL PRODUCING 4 TO 5 VOLTS AGC AT TEST POINT (B). CONTRAST AND BRIGHTNESS CONTROLS AT MAXIMUM.

TRANSISTOR CAUTION.

TO AVOID DAMAGE TO TRANSISTORS, DO NOT ARC 2ND ANODE LEAD TO COMMON GROUND. DO NOT TURN SET ON WITH TRANSISTOR(S), TUBE(S) OR LEADS REMOVED OR UNSOLDERED. USE CAUTION TO PREVENT ACCIDENTAL SHORT BETWEEN COMPONENT TERMINALS OR TO COMMON GROUND. DO NOT USE AN ORDINARY OHMMETER FOR RESISTANCE MEASUREMENT, USE VTVM ON R X 100 RANGE OR HIGHER.

AGC CAUTION.

DO NOT DISTURB FACTORY SETTING OF AGC CONTROL. IF AGC ADJUSTMENT IS REQUIRED REFER TO SERVICE NOTES. IF NECESSARY TO DISTURB AGC ADJUSTMENT, MARK ROTOR POSITION SO THAT CONTROL CAN BE RETURNED TO ITS EXACT ORIGINAL SETTING.

◆ ALL WAVEFORMS TAKEN WITH A WIDE-BAND OSCILLOSCOPE. SOME DEGRADATION WILL BE NOTICED IN HORIZ. WAVEFORMS WHEN USING NARROW BANDPASS EQUIPMENT.

*COMPONENT NOT MOUNTED ON PRECISION WIRED SYSTEM.

WARNING:

USE ISOLATION TRANSFORMER WHEN SERVICING WITH CABINET BACK REMOVED.

⏚ COMMON GROUND (B-).

§ REPLACE WITH SAME PART NO. AS ORIGINAL.

†RESISTORS MAY BE REMOVED AT FACTORY FOR PROPER V301 FILAMENT VOLTAGE.

RUN CHANGES

(10) Start of production

TERMINAL VIEWS OF TRANSISTORS

1594

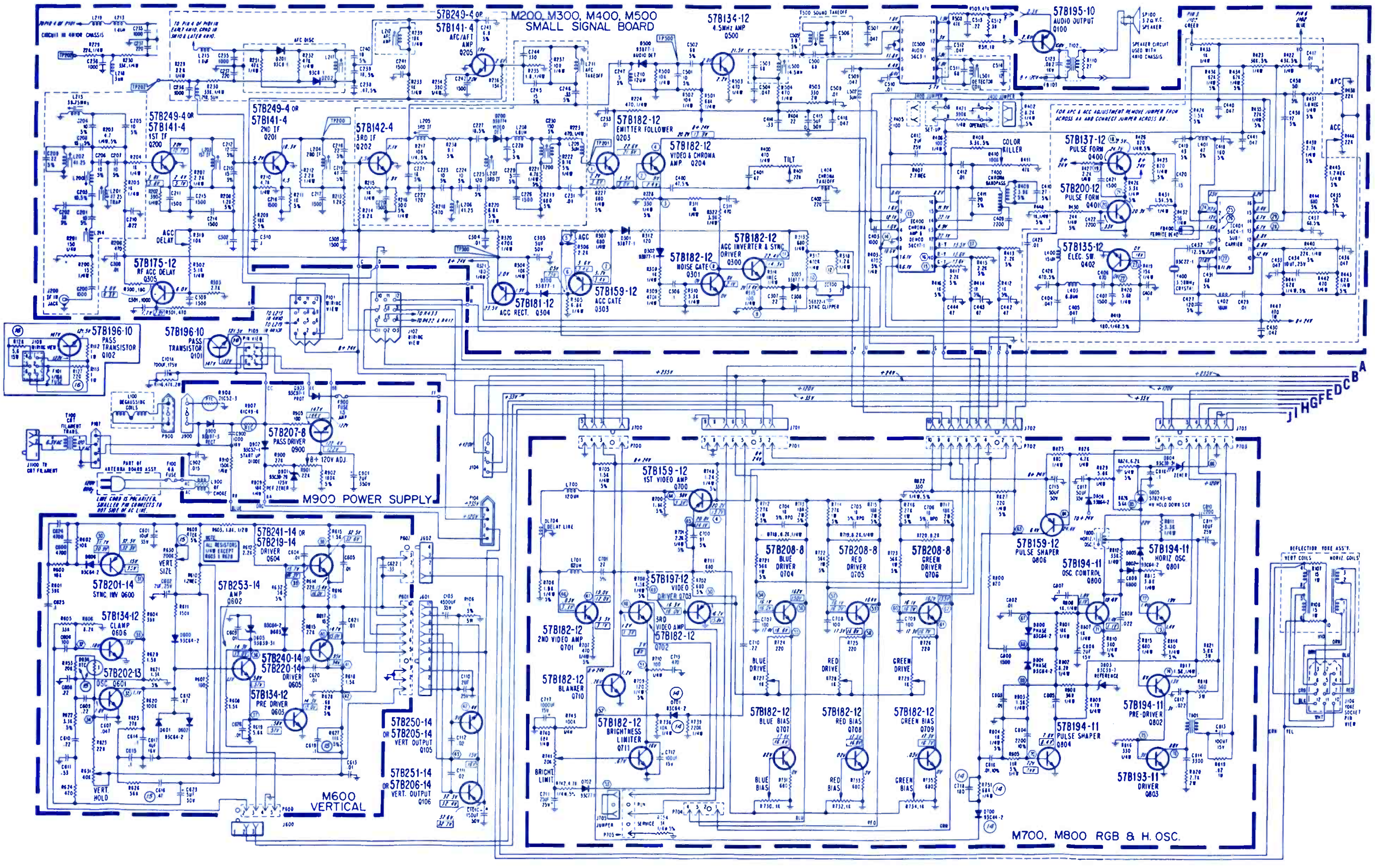
ADMIRAL
Color TV Chassis
4M10

JULY • 1975

ELECTRONIC TECHNICIAN/DEALER TEKFAX

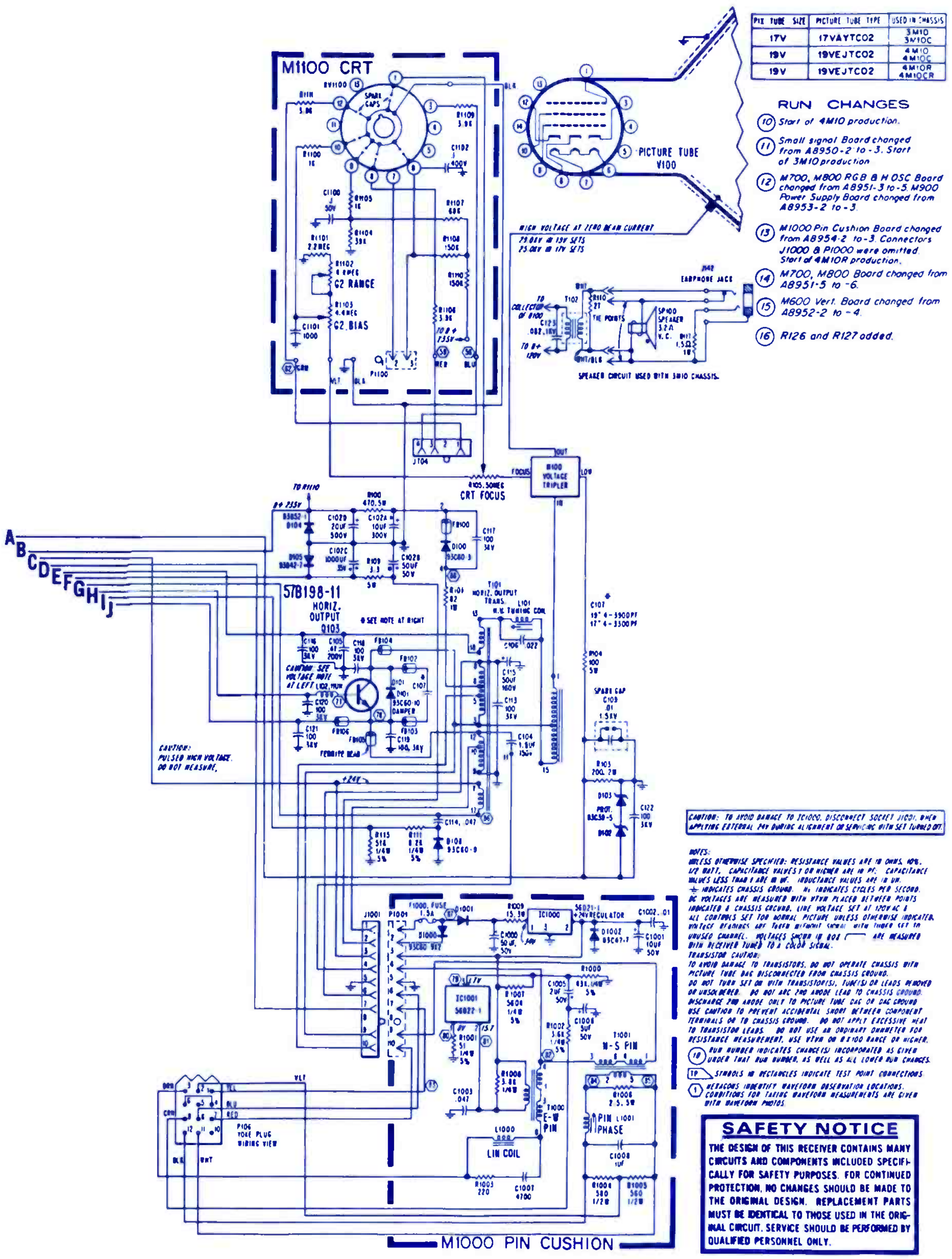
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

MODEL	FINISH	CRT	TUNER CLUSTER	VHF	UHF	CHASSIS
19C618	Walnut	19VEJTC02	NC2800-1	94A492-2	94A462-1	4M10
			NC2808-1	94A493-2	or	
			NC2809-1	94A507-2	94A466-1	



SYMBOL	DESCRIPTION	ADMIRAL PART NO.
F900	fuse, 1.5 amp	84A4-7
	fuse clip 2 used	84A33-1
F1000	fuse 1.5 amp	84A4-7
L900	line choke	73A31-23
R153A,B	250K, dual tint control	75A195-21
R154A,B	5K, dual color control	75A195-20
R155A,B	10K, dual brite control	75A195-17
R156A,B	5K, dual contrast control	75A195-20
R630	200K, vert size	75A101-28
R631	60K, vert hold	75A191-2
R634	thermistor	61A41-9
R741	20K, brite limit	75A101-47
R901	22K, B+ 120V, adj	75A199-3
T800	coil osc adj	94A351-3

ADMIRAL
Color TV Chassis 4M10



PIX TUBE SIZE	PICTURE TUBE TYPE	USED IN CHASSIS
17V	17VAYTC02	3M10 3M10C
19V	19VEJTC02	4M10 4M10C
19V	19VEJTC02	4M10R 4M10CR

RUN CHANGES

(10) Start of 4M10 production.

(11) Small signal Board changed from A8950-2 to -3. Start of 3M10 production

(12) M700, M800 RGB & H OSC Board changed from A8951-3 to -5. M900 Power Supply Board changed from A8953-2 to -3.

(13) M1000 Pin Cushion Board changed from A8954-2 to -3. Connectors J1000 & P1000 were omitted. Start of 4M10R production.

(14) M700, M800 Board changed from A8951-5 to -6.

(15) M600 Vert. Board changed from A8952-2 to -4.

(16) R126 and R127 added.

CAUTION: TO AVOID DAMAGE TO IC1000, DISCONNECT SOCKET J1001 WHEN APPLYING EXTERNAL 24V DURING ALIGNMENT OR SERVICING WITH SET TURNED OFF.

NOTES:
UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS, 10%, 1/2 WATT. CAPACITANCE VALUES 1 OR HIGHER ARE IN PF. CAPACITANCE VALUES LESS THAN 1 ARE IN UF. INDUCTANCE VALUES ARE IN UH.
⏚ INDICATES CHASSIS GROUND. Hz INDICATES CYCLES PER SECOND.
DC VOLTAGES ARE MEASURED WITH VTVM PLACED BETWEEN POINTS INDICATED & CHASSIS GROUND. LINE VOLTAGE SET AT 120V AC & ALL CONTROLS SET FOR NORMAL PICTURE UNLESS OTHERWISE INDICATED. VOLTAGE READINGS ARE TAKEN WITHOUT SIGNAL WITH TUNER SET TO UNUSED CHANNEL. VOLTAGES SHOWN IN BOX ▭ ARE MEASURED WITH RECEIVER TUNED TO A COLOR SIGNAL.
TRANSISTOR CAUTION:
TO AVOID DAMAGE TO TRANSISTORS, DO NOT OPERATE CHASSIS WITH PICTURE TUBE DAG DISCONNECTED FROM CHASSIS GROUND.
DO NOT TURN SET ON WITH TRANSISTOR(S), TUBE(S) OR LEADS REMOVED OR UNSOLDERED. DO NOT ARC 2ND ANODE LEAD TO CHASSIS GROUND. DISCHARGE 2ND ANODE ONLY TO PICTURE TUBE DAG OR DAG GROUND. USE CAUTION TO PREVENT ACCIDENTAL SHORT BETWEEN COMPONENT TERMINALS OR TO CHASSIS GROUND. DO NOT APPLY EXCESSIVE HEAT TO TRANSISTOR LEADS. DO NOT USE AN ORDINARY OHMMETER FOR RESISTANCE MEASUREMENT. USE VTVM ON R X 100 RANGE OR HIGHER.
(10) RUN NUMBER INDICATES CHANGE(S) INCORPORATED AS GIVEN UNDER THAT RUN NUMBER, AS WELL AS ALL LOWER RUN CHANGES.
TP SYMBOLS IN RECTANGLES INDICATE TEST POINT CONNECTIONS.
(1) HEXAGONS IDENTIFY WAVEFORM OBSERVATION LOCATIONS. CONDITIONS FOR TAKING WAVEFORM MEASUREMENTS ARE GIVEN WITH WAVEFORM PHOTOS.

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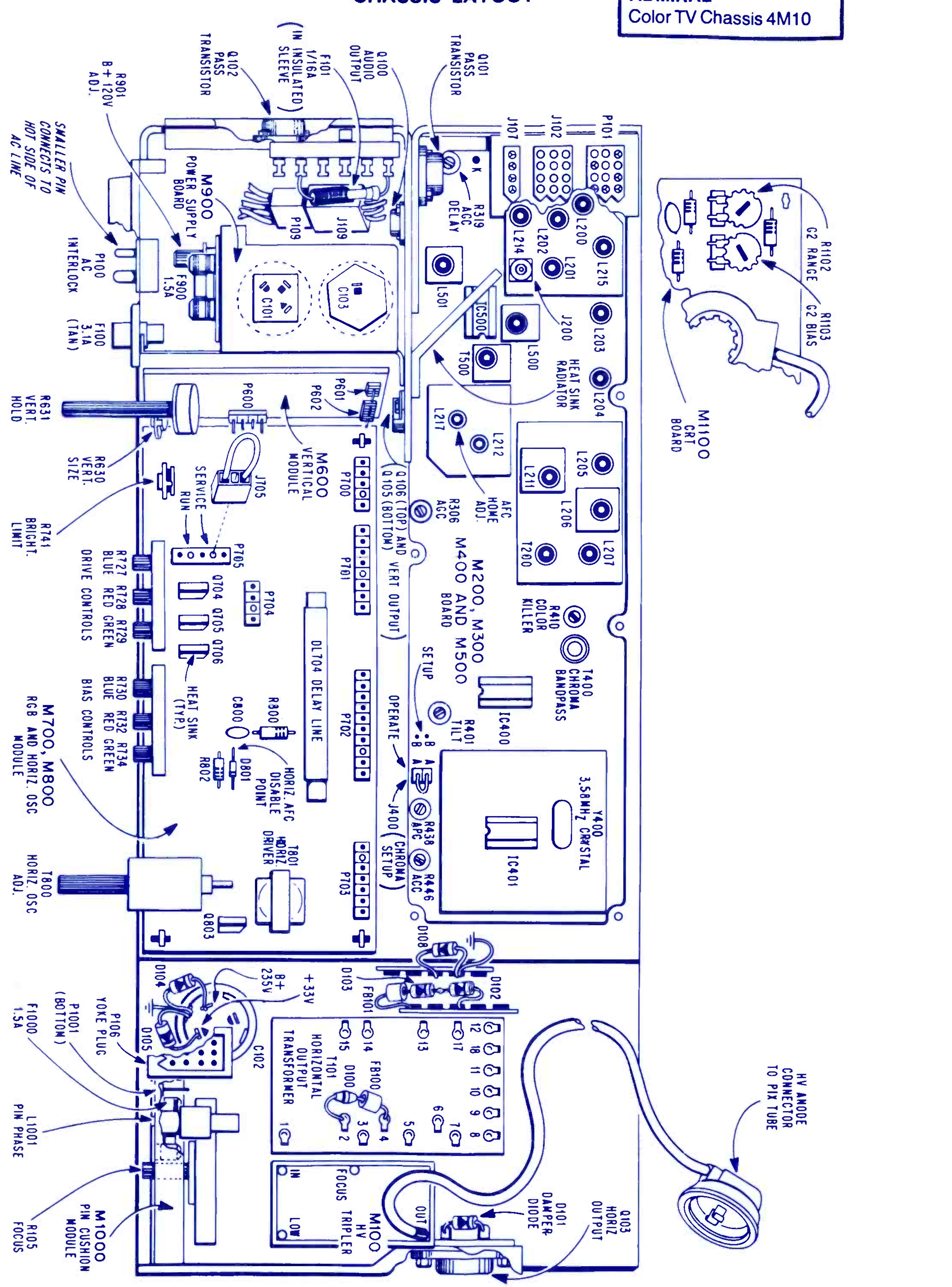
CHASSIS LAYOUT



1595

MAGNAVOX
Color TV
Chassis T995

JULY • 1975

ELECTRONIC TECHNICIAN/DEALER TEKFAX

COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

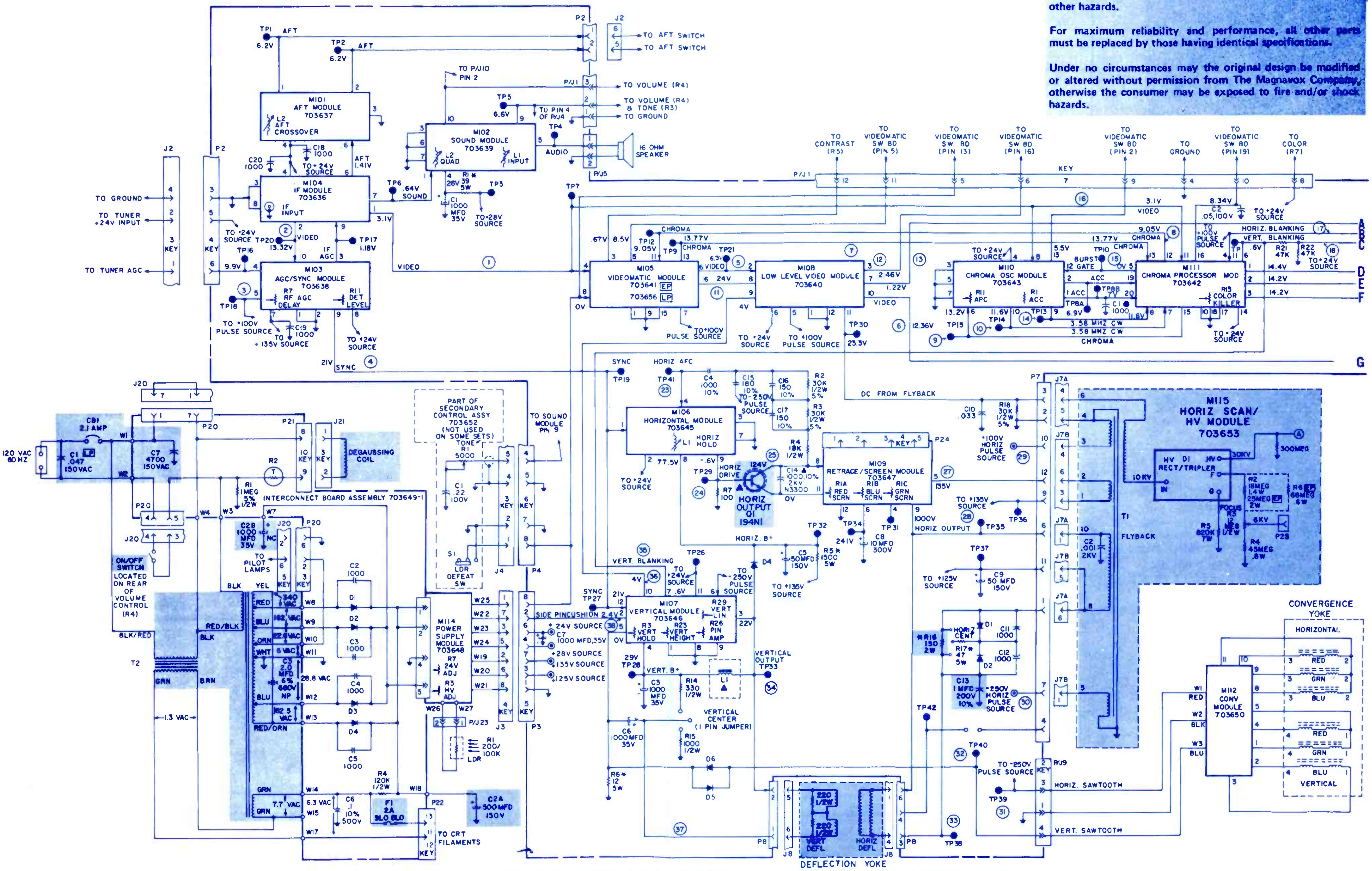
WARNING

Magnavox Consumer Electronics Company is committed to marketing safe products which meet or exceed applicable safety standards of industry, government agencies and independent laboratories. It therefore uses parts in its products designed for maximum safety, reliability and performance.

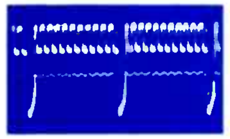
For continued safety of this product, parts shown in the shaded areas of this schematic must be replaced with only those identified in the Parts List of this manual. Use of substitute replacement parts which do not have the same safety characteristics as specified, may create shock, fire or other hazards.

For maximum reliability and performance, all other parts must be replaced by those having identical specifications.

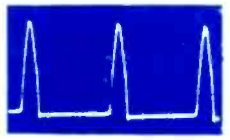
Under no circumstances may the original design be modified or altered without permission from The Magnavox Company, otherwise the consumer may be exposed to fire and/or shock hazards.

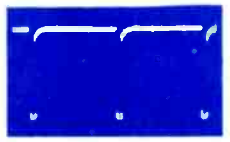


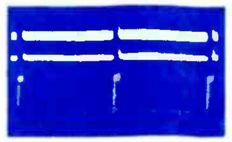
MAGNAVOX
Color TV
Chassis T995


1 1.6V P/P H

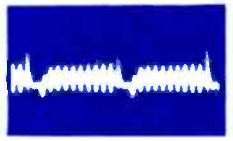

2 4.5V P/P V

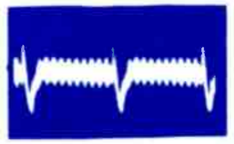

3 100V P/P H

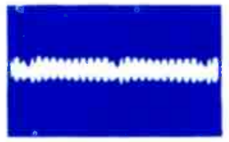

4 23V P/P H

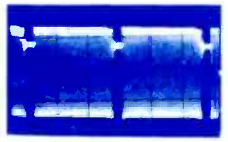

5 3V P/P V

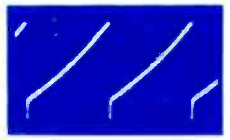

6 7V P/P V

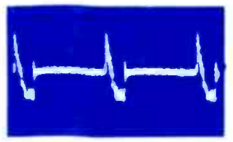

7 .4V P/P H

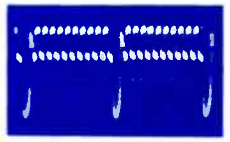

8 .2V P/P H

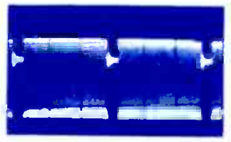

9 1.3V P/P H

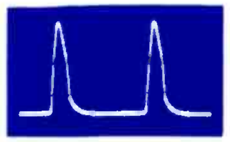

10 1.5V P/P H

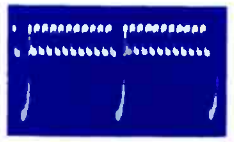

11 5V P/P V


12 .2V P/P H


13 1.2V P/P H


14 2V P/P H


15 5.5V P/P H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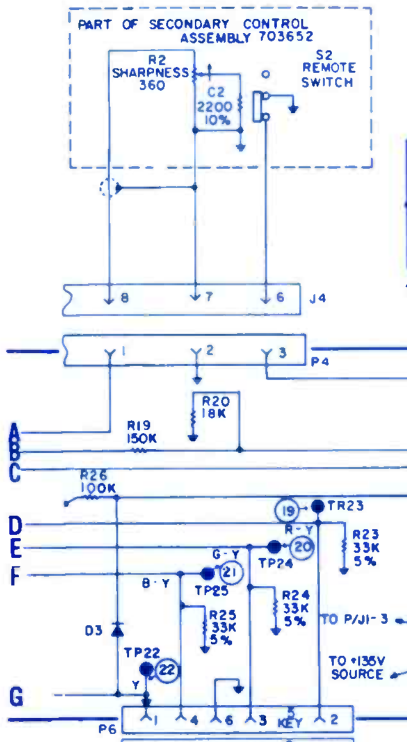
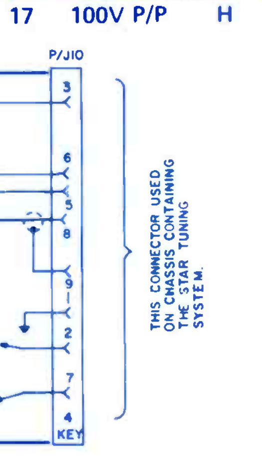
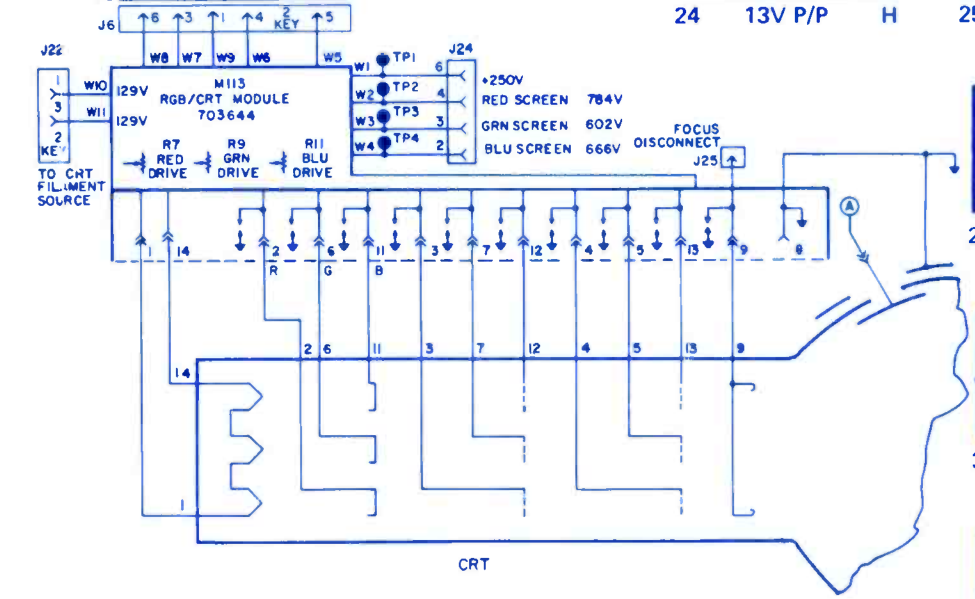
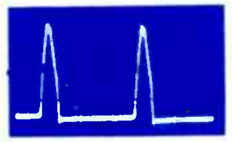
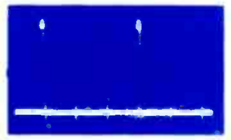
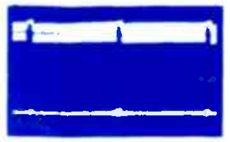
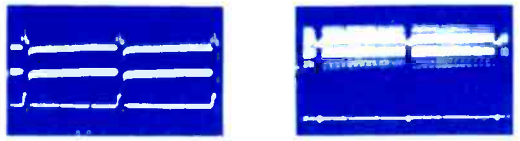




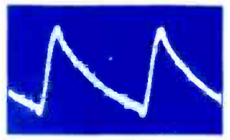

17 100V P/P H

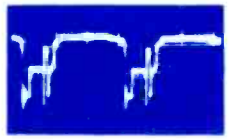

18 20V P/P V

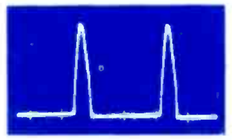

19 10V P/P V

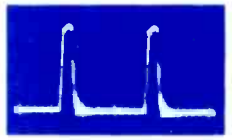

20 7V P/P V

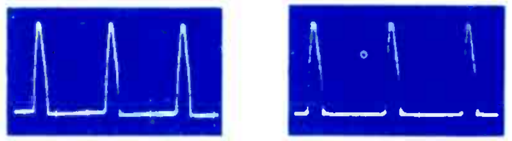

22 7V P/P V
21 10V P/P V

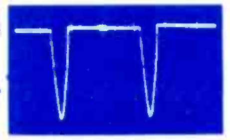

23 12V P/P H

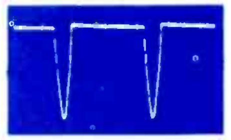

24 13V P/P H

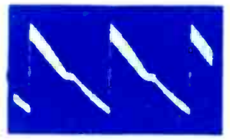

25 875V P/P H

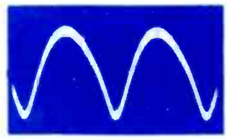

27 130V P/P H

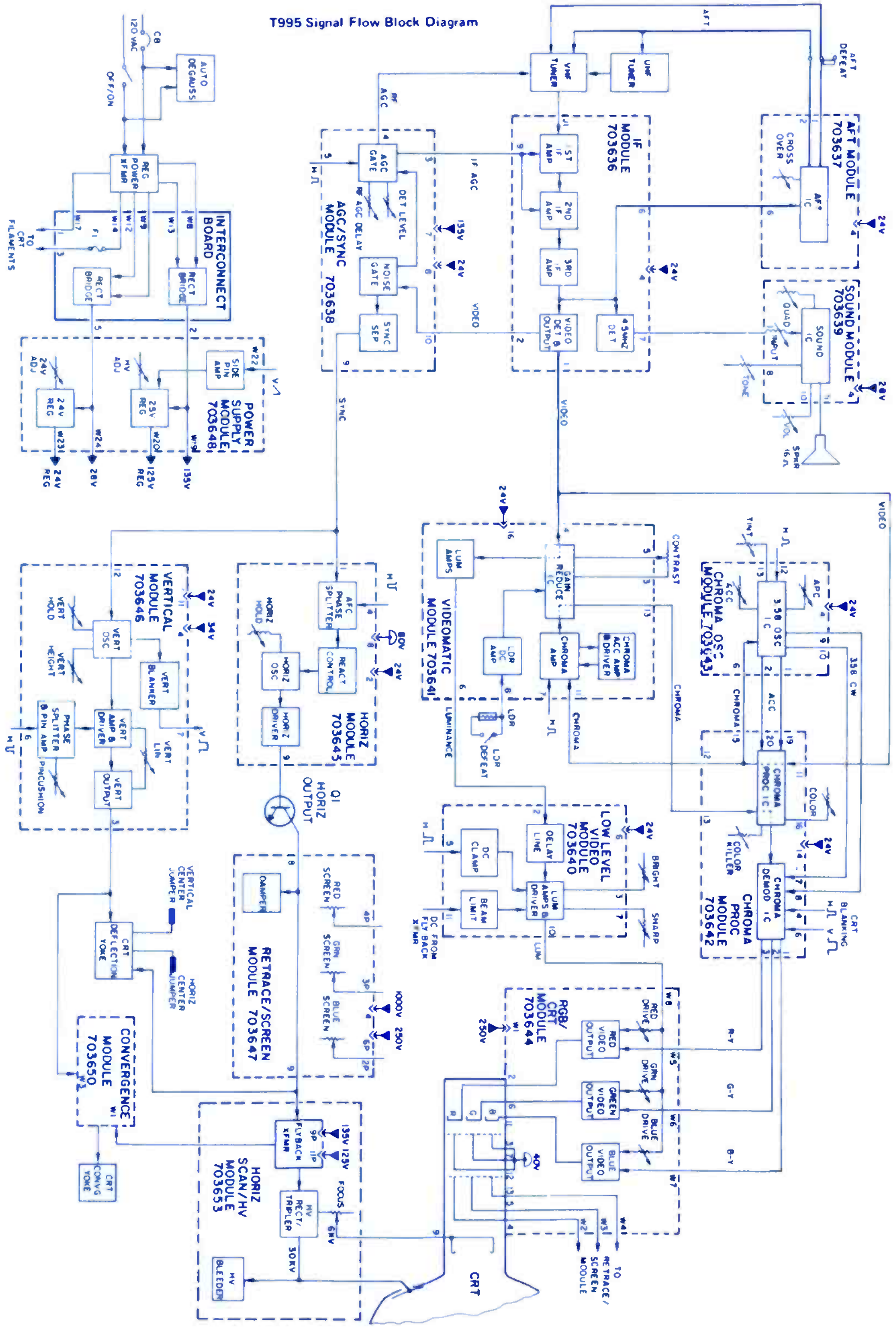

28 875V P/P H
29 100V P/P H


30 240V P/P H

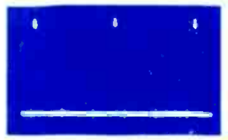

31 240V P/P H

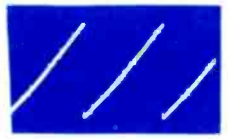

32 7V P/P V

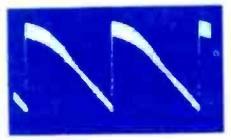

33 45V P/P H

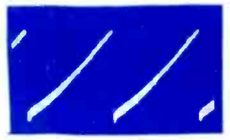



34 80V P/P V


35 21V P/P V


36 5V P/P V


37 9V P/P V


38 4V P/P V

1596

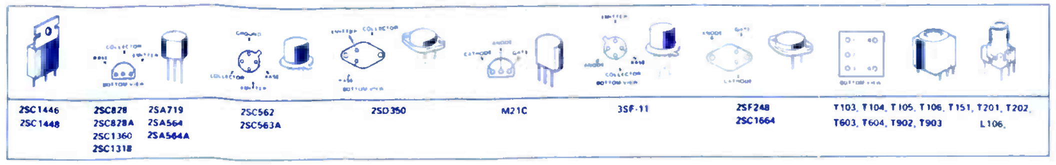
PANASONIC

Color TV Model
CT-324

JULY • 1975

ELECTRONIC TECHNICIAN/DEALER TEKFAX

COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

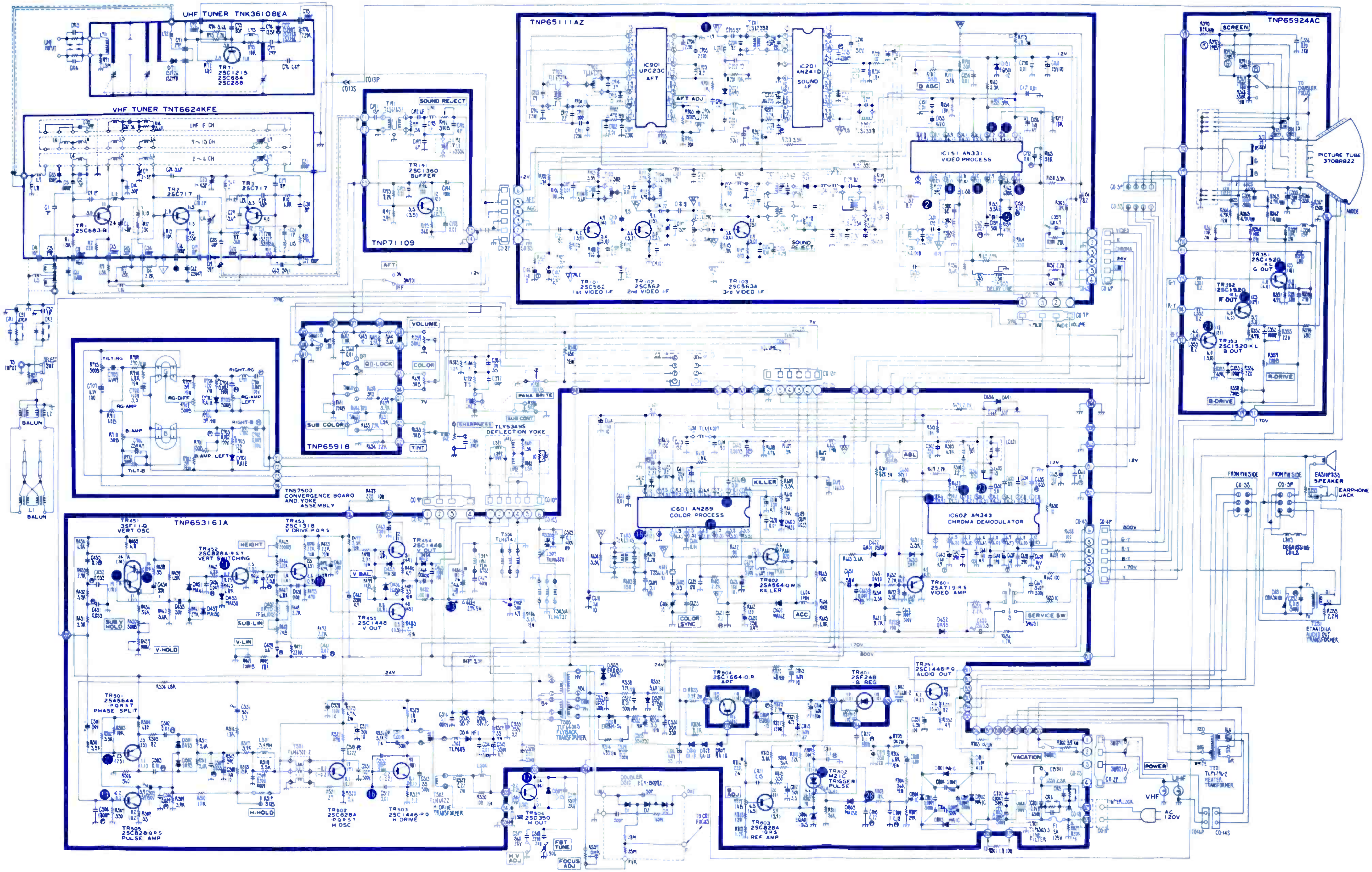


NOTICE

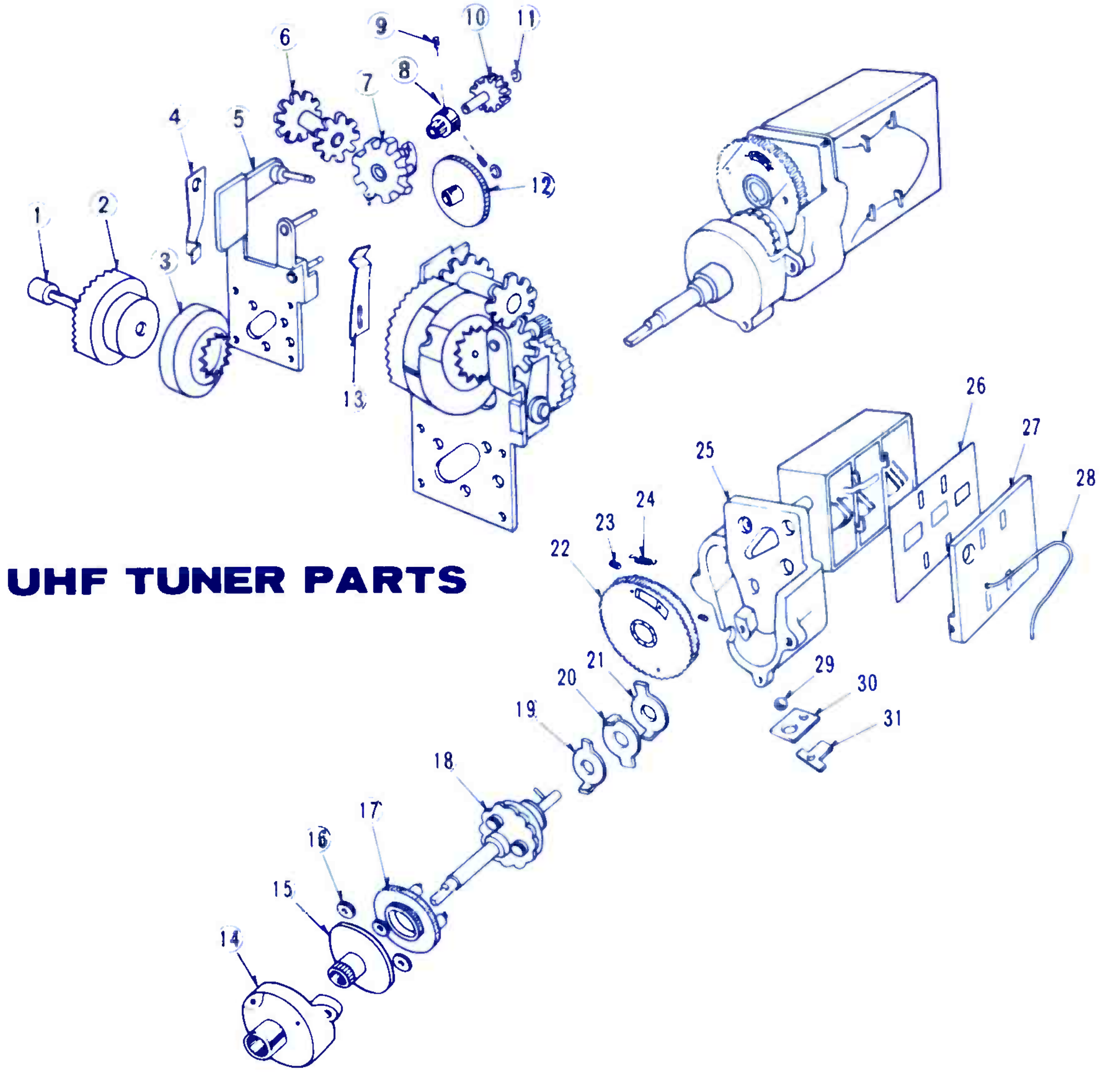
1. RESISTOR
All resistors are carbon 1/4W resistor, unless otherwise noted the following marks.
Unit of resistance is OHM (Ω) (K = 1,000, M = 1,000,000)
△ Solid resistor
● Metal oxide resistor
□ Wire wound resistor
Thermistor
Fuse resistor
2. CAPACITOR
All capacitors are ceramic 50V capacitor, unless otherwise noted the following marks. Unit of capacitance is μF, unless otherwise noted.
M Polyester capacitor
S Polystyrene capacitor
Electrolytic capacitor
3. COIL
Unit of inductance is μH
4. TEST POINT
Test point position (TPA2)
5. VOLTAGE MEASUREMENT
Voltage is measured by a volt ohm meter with DC 20K OHM/V

receiving color bar signal, when all controls are set to the maximum position.

6. Number in red circle indicates waveform number. (See main manual.)
7. When arrow mark (↗) is found, connection is easily found along with the direction of an arrow.
8. When schematic diagram of a board is described in more than two places, they are encircled with dotted line.
9. This schematic diagram is the latest at the time of printing and subject to change without notice.



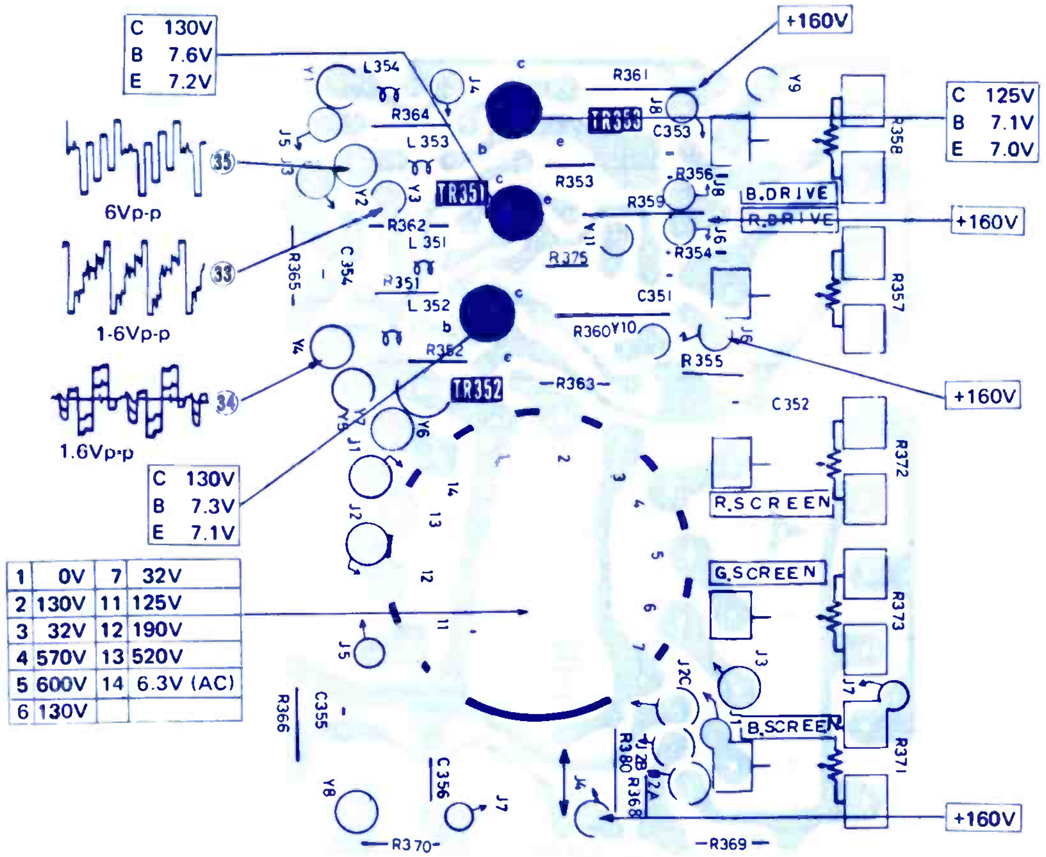
UHF TUNER PARTS



PANASONIC
Color TV Model
CT-324

SYMBOL	DESCRIPTION	PANASONIC PART NO.
R118	sound reject 500 ohm B	EVLR6BA00B52
R182	delayed AGC 5K B	EVTVOUOOMB53
R903	AFT adj. 50K B	EVLR6BA00B54
R820	fuse resist 68 ohm ± 5%	ERQ12HJ680
R450	sub Vertical-hold 50K B	EVTS3BA00B54
R465	height 200K B	EVTJOUS15B25
R468	sub Vertical-lin 2K B	EVTS3BA00B23
R469	Vertical - lin, 200K B	EVTJOUS15B25
R479	Vertical-balance 1K B	EVTS3BA00B13
R614	ACC 10K B	EVTS3BA00B14
R817	B+ adj. 1K B	EVTS3BA00B13
R610	kill 10 K B	EVTJOUS15B14
L502	choke coil	TLP408
T505	flyback xformer	TLF6404S
FI	fuse	TSF35503
R220	sound control 50K L	
R259	sound control 50K L	EVA85A06A54L
R380	bana-brite 100K B	EVX59AF25550
R381	2ohm C	
R386	sub contrast control 5K C	EVV58AF25C53
R387	sharpness control 5K C	EVV85AF25C53

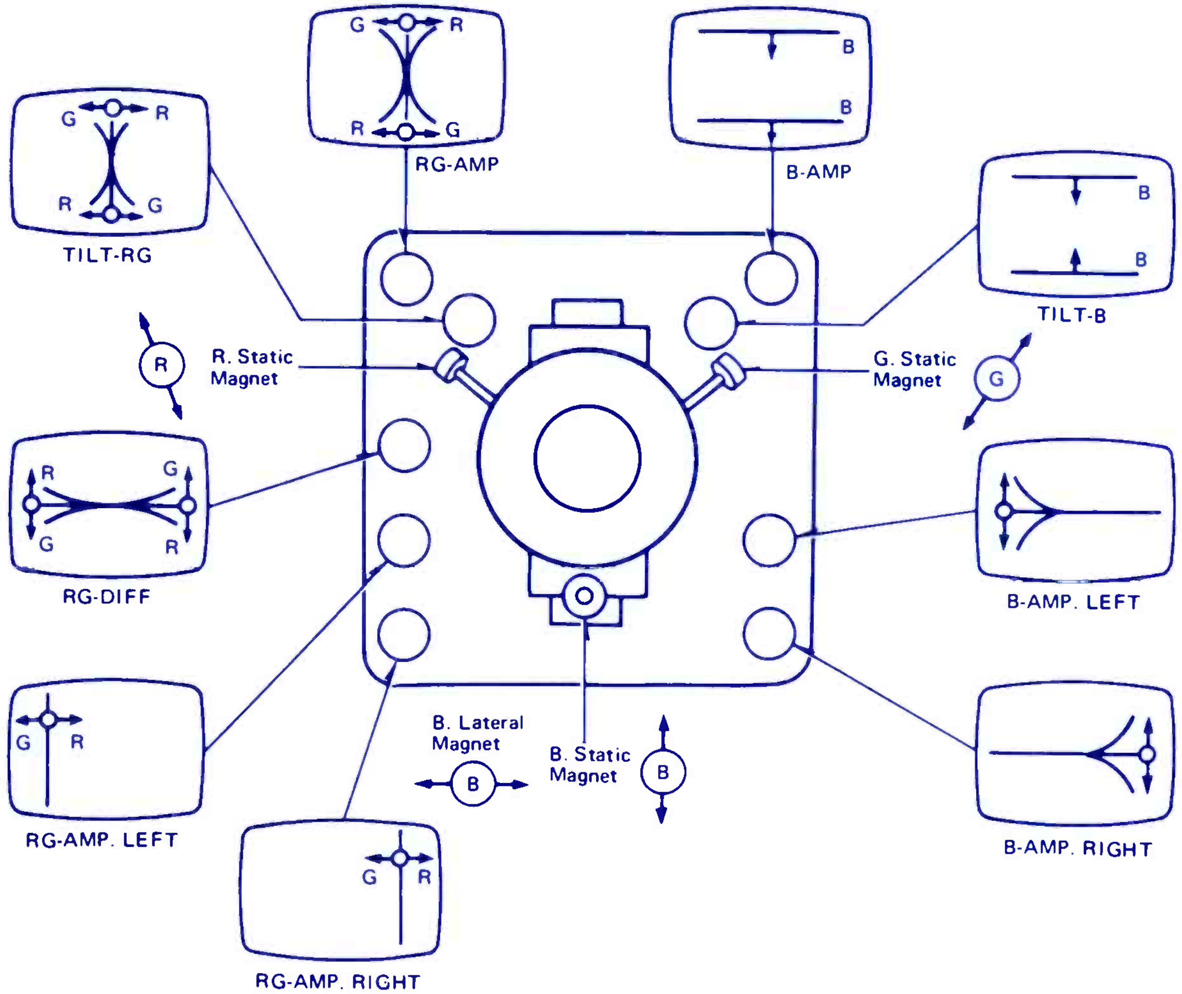
Ref. No.	Part No.	Description	Ref. No.	Part No.	Description
		UHF TUNER (TNK36108EA) PARTS	⑮	DM01-0007-00	Indicator Shaft DM-01A
A		Indicator Ass'y DM-01B	⑯	DM01-0015-00	Pinion Gear DM-01B
①	DM01-0051-00	Supporter DM-01A	⑰	DM01-0006-00	Indicator Gear DM-01A
②	DM01-0074-00	Indicator Drum DM-01D	⑱	DM05-0002-00	Shaft Assembly DM-01B
③	DM01-0073-00	Indicator Drum DM-01C	⑲	N8-827-07	Stopper 07
④	DM01-0044-00	Indicator Spring DM-01A	⑳	DM01-0017-00	Stopper DM-01B
⑤	DM05-0005-00	Indicator Bracket Assembly CM-01B	㉑	DM01-0018-00	Stopper DM-01C
⑥	DM01-0046-00	Geneva Stop DM-01A	㉒	DM05-0013-00	Double Gear Assembly
⑦	DM01-0070-00	Idle Gear DM-01C	㉓	N15-812-11	Screws
⑧	DM01-0071-00	Hub Gear DM-01C	㉔	N9-814-02	Double Gear Spring 02
⑨	N15-812-11	Screw	㉕	DM01-0002-00	Housing DM-01B
⑩	DM01-0071-00	Hub Gear DM-02C	㉖	UY01-0047-00	Inner Cover UY-01A
⑪	N17-818-04	E-Ring	㉗	UY01-0026-00	Cover UY-01A
⑫	DM01-0069-00	Idle Gear DM-02B	㉘	UY01-0027-00	Cover Spring UY-01A
⑬	DM01-0045-00	Indicator Spring DM-01B	㉙	N7-811-03	Ball 03
B		Complete Tunern	㉚	DM01-0062-00	Detent Spring DM-03A
⑭	DM01-0001-00	Housing DM-01A	㉛	DM01-0063-00	Spring Retainer DM-01A



1	0V	7	32V
2	130V	11	125V
3	32V	12	190V
4	570V	13	520V
5	600V	14	6.3V (AC)
6	130V		

CONVERGENCE ALIGNMENT

Convergence board of CT-324 is different from that of CT-914. Proceed with the steps as shown



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TRAV-LER

TV Chassis
TR2-1A/2A

ELECTRONIC TECHNICIAN/DEALER TEKFAX

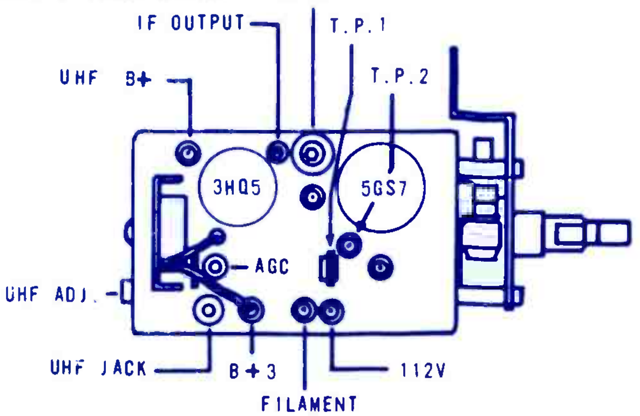
JULY • 1975

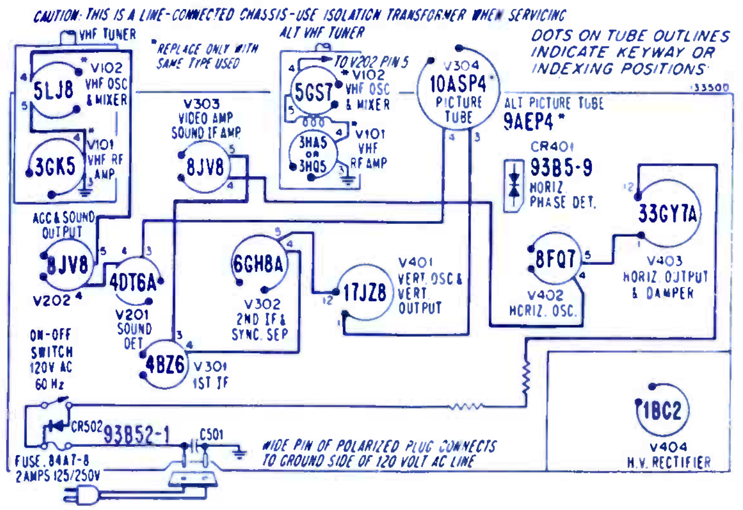
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

MODEL CHART

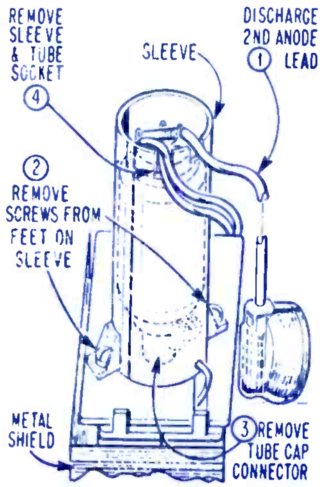
MODEL	COLOR	TUNER	CHASSIS
T9P800 T9P802 T9P803 T9P805 T9P827	Black White/Red White/Gold White/Avocado Black/Walnut	94A363-6 VHF 94A361-3 UHF	TR2-1A
T9P800M T9P802M T9P803M T9P805M T9P827M	Black White/Red White/Gold White/Avocado Black/Walnut	94A281-15 VHF 94A296-4 UHF	TR2-2A

TOP VIEW OF TUNER





TUBE LOCATION CHART



HV ENCLOSURE