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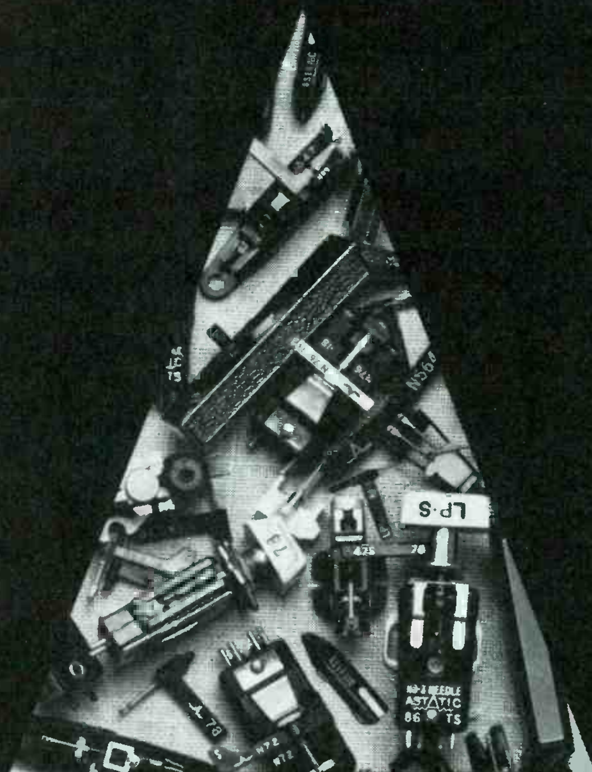

ELECTRONIC
TECHNICIAN/DEALER

May 1975 • VOLUME 97 NUMBER 5

THE COVER: Because some characteristics of field - effect transistors (FETs) make traditional ohmmeter testing inconclusive, in - circuit dynamic testing, symbolized on this issue's cover, is usually the best approach to FET testing, particularly MOSFETS.

FEATURES

DEPARTMENTS

A HARCOURT BRACE JOVANOVICH PUBLICATION

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TECHNICAL LITERATURE

TEST ACCESSORIES

A new 68 - page catalog listing test accessories designated for manufacturers and laboratories engaged in testing or designing the electronic equipment is available at this time. Included are a table of contents and an alphabetical - numerical index as well as a separate section highlighting 14 major new additions to the Pomona line. Special products covered in the new catalog include IC test clips, attenuators, bulkhead receptacles, miniature and standard binding posts with wire - wrap terminal, molded banana plugs and accessories, BNC, TCN, Type N and UHF adapters; coaxial test accessories and adapters, panel receptables — jacks, plugs and patch cords, test clips and shielded black boxes. The catalog has photographs, specifications and a quantity price discount schedule. *ITT Pomona Electronics,* 1500 East Ninth St. Pomona, Ca. 91766.

MAGNETRON TUBES

A new guide to microwave ovens, both commercial and consumer types, is now available. It lists brand name, manufacturer and model number of most microwave ovens sold in the United States within the last ten years. With each model number is the type number of the Amperex magnetron which is a direct, interchangeable equivalent. The guide also includes a condensed catalog of Amperex magnetrons currently offered as replacements to the service industry through authorized Amperex tube distributors. *Amperex Electronic Corp.,* 230 Duffy Avenue, Hicksville, NY 11802.

SPECIAL-PURPOSE CRT'S

A catalog providing information on Flying Spot Scanner Cathode Ray Tubes (CRT's) for video signal generators and Photorecording CRT's for photographic applications is now available. This brochure, STC - 905, describes the use of these special - purpose cathode - ray tubes, classifies the various tubes by size and tabulates many of the parameters for preliminary selection. For a copy, contact your *RCA* Sales Representative or write Building 100, *RCA,* New Holland Ave., Lancaster. PA. 17604.

ELECTRONIC PARTS AND EQUIPMENT

A wholesale catalog that contains one of the most complete listing of audio, electronic parts, test equipment and accessories is now available. It also lists surplus equipment and parts, such as transistors, resistors, filters, yokes, etc. *Qualitone Industries, Inc.,* 17 Columbus Ave., Tuckahoe, NY. 10707.

TEST INSTRUMENTS

A new catalog describing a complete line of Heath/Schlumberger assembled high performance instruments is now available. Featured in this latest catalog is a new precision single - trace oscilloscope Model SO-4530. Other instruments featured in the catalog are oscilloscopes, VOMs and VTMs, power supplies, generators and strip chart recorders. *Heath Company,* Benton Harbor, MI. 49022.

SOLDERING EQUIPMENT

A new 24 - page general catalog which describes their complete line of soldering equipment is now available. The catalog includes the following: Soldering Irons, Soldering Iron Hold-

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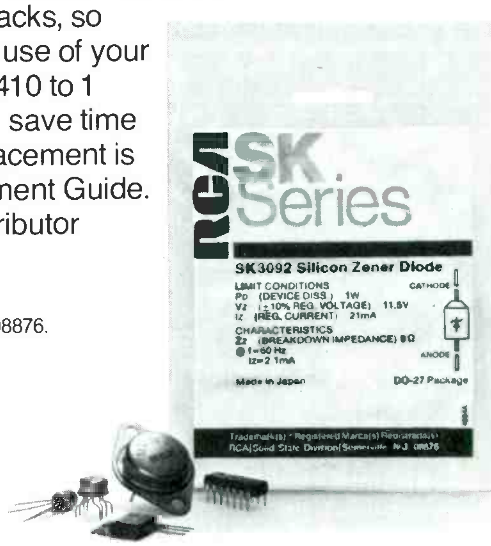
RCA Solid State, Box 3200, Somerville, N.J. 08876.



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ers, Soldering Tool and Accessory Kits, Soldering Iron Tips, Soldering Aids, Solder Pots. It describes each product in detail. *Precision Electric Co.*, Inc., 49 Sullivan Street, Westwood, NJ. 07675.

MOBILE COMMUNICATIONS

A 16 - page, full - line brochure entitled "Vehicular Communications" listing everything in mobile communications equipment is now available. The brochure covers the latest Motorola offerings in mobile communications featuring fuel and cost - saving mobile radios, car telephones and data communications equipment. *Motorola Communications and Electronics, Inc.*, 1301 E. Algonquin Road, Room 4420. Schaumburg, IL. 60172.

COLOR - TV SERVICE HANDBOOK

The fifth volume of RCA's popular Color - TV Service Handbook is now available. This compact 276 - page handbook provides the specific service data needed for routing service adjustments and preliminary troubleshooting on 1973 and 1974 models of the following 16 set manufacturers: Admiral, Motorola, Airline, Dumont, Emerson, General Electric, Hitachi, Magnavox, Olympic, Panasonic, Packard Bell, Philco, RCA, Sony, Sylvania and Zenith. The easy - to - use handbook contains a Chassis Index to guide the user to the proper sections of the handbook. Included information on chassis layouts, leakage current hot and cold checks, RCA receiving and picture tube replacements, SK series semiconductor replacements and the following adjustment procedures: purity, convergence, AGC, horizontal hold, color killer, pin cushion, black and white set - up, color AFPC (field), high voltage and a variety of miscellaneous adjustments. Price $3.75 each. *RCA Electronic Components*, 415 South Fifth Street, Harrison, NJ. 07029.

TEST INSTRUMENTS

A new 6 - page condensed catalog listing a complete line of electronic test and measuring instruments for industry, laboratories, schools and radio - TV servicing is now available. Among the equipment listed are oscilloscopes, VTVM's, VOM's, generators, tube/transistor testers, power supplies and probes, available in wired or kit form. *Eico Electronic Instrument Co.*, Inc., 283 Malta Street, Brooklyn, NY. 11207.

RECEIVING TUBES

A 12 - page Export Price List containing more than 2,000 receiving tube types is now available. The list is said to contain the most complete range of American, European and Japanese consumer and industrial receiving tubes available anywhere. Many classic and antique are also listed. *International Components Corp.*, 105 Maxess Road, Melville, NY. 11746.

EXACT REPLACEMENT TV PARTS

A nation wide comprehensive program to make the purchase and use of Thordarson Meissner exact replacement TV parts more profitable and practical is now available. The program will entail a mailing of their new comprehensive pocket TV replacement guide which lists more than 30,000 original equipment part numbers along with the T-M replacement number. Comments concerning their products and replacement information along with suggestions on new replacement items that are needed in the industry are welcomed. *Thordarson Meissner Inc.*, Electronic Center, Mt. Carmell, IL. 62863.

TECHNICAL BOOKS

A fully illustrated, 44 - page catalog featuring full color covers, describing the firm's unique Electronic Book/Kits is now available. *Tab Books*, Blue Ridge Summit, PA. 17214.■

NEWS OF THE INDUSTRY

Service Technician New Chief Of California Bureau of Repair Services

William J. Hayes, electronic service technician and former owner of three TV/appliance sales and service firms in the Sacramento area, recently was sworn in as the new chief of California's Bureau of Repair Services, the state agency which registers and regulates TV service businesses in California.

Hayes, who has been assistant chief of the Bureau since 1966, was first employed by the Bureau in 1965 as a field investigator.

Majority Of Color TV Sold In 1974 Were All - Solid - State Portable or Table Models

Portables and table models represented 67.7 percent of the color TV receivers sold last year, and, for the first time, the majority of sets sold were in the 21 - inch - or - smaller category, according to the *1975 Consumer Electronics Annual Review,* a book compiled and published each year by the Consumer Electronics Group of the Electronic Industries Association (EIA). These and a variety of other statistics about the consumer electronic market are included in the 44 - page book, which is available for 50 cents from the EIA, 2001 Eye St., N.W., Washington, D.C. 20006.

Over 70 Percent of TV Households Have Color

About 48.5 million homes, or 70.8 percent of all TV households, had color TV as of January 1 of this year, according to estimates by NBC Research.

There were 57 million color and 64 million monochrome TV receivers in use on January 1, says NBC.

RCA Service Company Maintains Over One Million TV And Appliance Service Contracts

The RCA Service Company in 1974 was able to maintain a total of over one million service contracts for home TV and appliances, according to RCA's 1974 Annual Report.

The report states that revenue received by RCA's Consumer Services operations, of which RCA Service Company is a part, increased for the 20th consecutive year, although earnings declined. TV servicing, says the report, was the biggest source of revenue for the Consumer Services Divison of RCA.

Zenith Reveals Advanced Technology In Annual Report

A new thin - panel TV display device, a surface wave integrated filter for color TV IF sections, and microcircuit programmed TV electronic channel selector display devices are three color TV related areas of electronic technology in which Zenith made significant progress during 1974, according to Zenith Radio Corporation's Annual Report for 1974.

The miniature surface wave integrated filter, the complete package of which is as small as a dime, combines "solid - state and acoustic wave principles" in a unique microcircuit that replaces 12 separate parts in the IF section of a color TV and eliminates the need for IF alignment during the life of the receiver.

Microcircuits for use in TV electronic tuning systems, including programmed channel selectors and displays, are under development or in pilot production at Zenith's Microcircuit Facility. The report states that Zenith intends to extend all - electronic tuning to its entire TV line.

During 1974, says the report, Zenith researchers made significant progress in the development of a practical, gas discharge, thin - panel TV display device which may eventually replace today's form of TV picture tube. According to the report, since the demonstration of an early version of the device at a technical conference not long ago, substantial advances have been made in brightness, efficiency and color. Says the report, "the concept of thin - panel, mural television has, therefore, moved a step closer to commercial reality."

CB Radio Continues To Boom

Applications received by the Federal Communications Commission (FCC) for Class D Citizens Band (CB) Radio Licenses during January reached an all - time monthly high of 72,658, up 124 percent over the 32,459 applications received in January 1974. This is the largest annual percentage increase since the Citizens Band Radio Service was instituted by the FCC, although annual increases since 1972 have been significant, with applications in 1974 exceeding those in 1973 by 95 percent, and those in 1973 exceeding applications in 1972 by 34 percent.

As a result of continuous, substantial increases in CB license applications during the past four years, the total number of licenses in effect as of January 1975 exceeded 1 million.

It is anticipated that the number of CB radio license applications received during this past March will exceed the record set in January because in March the license fee was reduced from $20 to $4.

Projections by the Citizens Radio Section, Communications Divison, Electronic Industries Association (EIA), indicate that 1 out of 28 of all American families and 1 out of 15 farm families now use Citizens Band two - way radio. More than 6,250,000 of these sets are in use, with installations in 1 out of 33 vehicles on the road. This includes:

1 out of 39 passenger cars
1 out of 5 long - haul trucks
1 out of 7 recreational vehicles
3 out of 7 four - wheel drive vehicles

CB Two - Way Radio is also used on 1 out of 7 pleasure boats.

Over $1.5 billion has been invested in Citizens Band radio equipment currently in use by the American public, according to the EIA.

PTS Opens New Tuner Repair Facilities In Arizona and Wisconsin

PTS Electronics, Inc., Indiana - based TV tuner repair firm, has opened a new service center in Phoenix, Arizona (2412 W. Indiana School Road, 85015) and in Milwaukee, Wisconsin (3509 W. National, 53215).

All 1976 GE Color TV To Have 90 - Day Labor Warranty

General Electric's entire 1976 TV line — both black - and - white and color — will have 90 - day labor warranties.

This announcement was made by Fred R. Wellner, general manager of GE's TV receiver Products Department, during the recent introduction of the first GE 1975 all - solid - state color TV to carry a 90 - day labor warranty.

Monochrome TV receivers in GE's 1976 line, to be introduced in June, will have a 90 - day parts and labor warranty and a one - year picture tube warranty. Color TV receivers in GE's 1976 line will have one - year parts, 90 - day labor and two - year picture tube warranties.

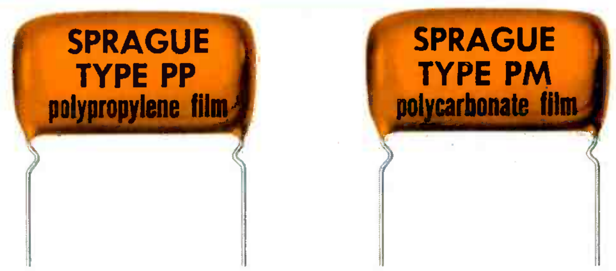
The return to color TV 90 - day labor warranty was started by RCA early this year and since then has been picked up by six other major color TV manufacturers — Admiral, GE, Magnavox, Quasar, Sylvania and Zenith — all of whom have 90 - day labor warranties on at least one current - model - year color TV receiver. ■

Avoid serious problems when replacing film capacitors

Use genuine Sprague Type PP and PM Capacitors in critical deflection circuits.

The next time you replace a dipped tubular in one of the newer color TV sets, don't automatically assume you're replacing an ordinary every-day film or paper capacitor. If it happens to be a deflection capacitor used for commutation or S-shaping, you need a polypropylene or polycarbonate film replacement with (1) high a-c current-carrying capability; (2) close capacitance tolerance; (3) good capacitance stability. The standard replacement capacitors used in the industry, even our superior Type PS dipped tubulars, just won't do the job . . . they could cause the set to become inoperative again.

Play it safe . . . dipped tubulars may look alike on the surface, but there can be a *big* difference in the film dielectric. Keep a supply of Sprague Type PP and PM capacitors on hand for those critical situations where ordinary replacements could cause serious problems.



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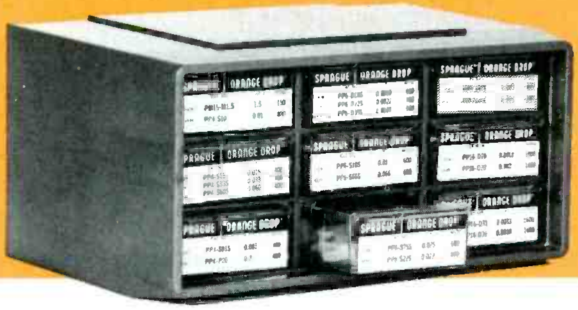

the KF-28 ASSORTMENT

. . . a total list price value of $65.00 . . . with a regular dealer net of $35.95 . . .

for a low, low $25.20 dealer net

Be ready for those critical application replacements in today's color TV sets with the KF-28 Assortment. It contains 41 Type PP and PM polypropylene and polycarbonate capacitors in 20 popular ratings, stocked in a handy cabinet that puts the film capacitors you need at your fingertips, neatly organized and easy to find. Measuring 9¾" wide x 5" high x 6½" deep, this attractive blue 9-drawer cabinet has clear plastic drawers with adjustable dividers. Prelabeled drawer fronts identify the capacitors inside. A raised area on top of the cabinet and a depression in the bottom facilitate stacking of two or more cabinets.

Get a KF-28 Assortment from your Sprague distributor today!

ASSORTMENT KF-28 CONTENTS

Quan.	µF @ WVDC	Cat. No.	Quan.	µF @ WVDC	Cat. No.
2	1.5 @ 150	PM15-M1.5	2	.01 @ 600	PP6-S10S
2	.01 @ 400	PP4-S10	2	.066 @ 600	PP6-S66S
2	.015 @ 400	PP4-S15	2	.075 @ 600	PP6-S75S
2	.033 @ 400	PP4-S33S	2	.022 @ 800	PP8-S22S
2	.06 @ 400	PP4-S60S	2	.047 @ 800	PP8-S47S
2	.081 @ 400	PP4-S81S	2	.051 @ 800	PP8-S51S
2	.2 @ 400	PP4-P20	2	.0018 @ 1600	PP16-D18
2	.0018 @ 600	PP6-D18S	2	.002 @ 1600	PP16-D20
2	.0022 @ 600	PP6-D22S	2	.0033 @ 1600	PP16-D33
3	.0039 @ 600	PP6-D39S	2	.0039 @ 1600	PP16-D39

For cross-reference information on close-tolerance polypropylene and polycarbonate film capacitors, showing original part numbers with correct Sprague replacements, ask your Sprague distributor for Cross-Reference Guide C-873, or write to: Sprague Products Company, 65 Marshall Street, North Adams, Mass. 01247.

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ELECTRONIC ASSOCIATION DIGEST

Information about the activities of national, state and local associations of electronic servicers, dealers and manufacturers. Material for publication in this department should be addressed to: Service Association Digest, ET/D, 1 East First St., Duluth, Minn. 55802.

NESDA/ISCET Annual Convention August 13-17

The annual joint convention of the National Electronic Service Dealers Association (NESDA) and the International Society of Certified Electronics Technicians (ISCET), the technician affiliate of NESDA, is being held August 13-17 at the Winston-Salem Hyatt House and Convention Center, Winston-Salem, North Carolina.

The NESDA/ISCET convention will be hosted by the Electronic Technicians Association of North Carolina (ETANC), which will be holding its annual convention in conjunction with that of NESDA and ISCET.

The convention will open with a golf tournament at 9:00 AM on Wednesday, August 13. (Registration for the golf tournament is $10.00.)

Activities scheduled for Thursday, August 14, are: a ladies tour of attractions in the Winston-Salem area (10:00 AM; the NESDA Profitable Service Management School (9:00 AM-5:00 PM), the registration fee for which is $20.00 per person; and the NESDA executive committee meeting (8:00 PM).

Scheduled for Friday, August 15, are: Keynote Breakfast (8:00 AM); the Electronic Circus, an electronic servicer-oriented trade show with technical seminars (9:00 AM-6:00 PM); and the annual meeting of ETANC (8:00 PM).

Activities scheduled for Saturday, August 16, are: the NESDA annual officers election meeting (9:00 AM); the ETANC annual officers election meeting (9:00 AM); and the Awards Banquet and Dance (7:00 PM).

On the final day of the convention, Sunday, August 17, a prayer breakfast will be held at 9:00 AM, and ISCET delegates and all other interested electronic technicians will meet at 1:00 PM.

The registration fee for the convention is $40.00 per person and includes those meals which are sponsored by NESDA supporters, a cocktail party, entry to the Electronics Circus and related technical seminars and the banquet and dance.

Room rates at the Hyatt House reportedly range from $21.00 for singles to $27.00 for doubles.

Additional information about the NEDA/ISCET convention can be obtained by writing to: NESDA, 1715 Expo Lane, Indianapolis, Indiana 46224; or phone NESDA at (317) 241-8160.

Wisconsin Annual Convention May 30-June 1

The Wisconsin Electronic Service Association (WESA) is holding its annual convention May 30-June 1 at the Marriott Inn just off of Interstate 94 at 375 South Moorland Road in the Brookfield area near Milwaukee.

The convention will open with a NESDA business management school from 9:00 AM to 5:30 PM on Friday, May 30. The school is sponsored by Taylor Electric, a Milwaukee RCA distributor.

Information about registration can be obtained by phoning WESA president John Stanczak, (414) 476-6514.

Florida ESA Annual Convention June 20-22

The annual convention of the Florida Electronic Service Association (FESA) will be held at the Don Ce Sar Resort Hotel, St. Petersburg Beach, Florida, June 20-22. The Television Service Dealers Association of Pinellas County is sponsoring the convention.■

Facts About Testing FETs

By Bernard B. Daien

Because these semiconductors behave like vacuum tubes, they should be tested in a manner similar to that used for tubes

FETS VS BIPOLARS

■ Bipolar transistors require a forward bias to turn them on. The input signal then "rides" on top of the bias, to vary the collector current. Typically, the forward bias on a silicon signal transistor is about 0.65 volts at room temperature. An input voltage of 0.6 volts will, for practical purposes, turn off the device, and 0.7 volts will drive it into saturation. Thus, the combined bias and signal applied to the emitter - base junction of a bipolar transistor cannot vary more than 100 millivolts peak to peak. This corresponds to 50 millivolts peak, or 35 millivolts RMS, for a sine wave input signal. Worse yet, long before cutoff and saturation are reached, the output signal starts to compress, or "round off." When cutoff or saturation is reached, the compression causes the sine wave to take on the appearance of a square wave, and is commonly referred to as a "clipped" signal because of its appearance. Such distortion is also termed *harmonic distortion,* because the distorted wave can be analyzed as the original sine wave plus generated harmonics. These harmonic products are undesirable in receiving equipment.

Field - effect transistors (FETs), on the other hand, are able to handle much larger input signals without generating significant harmonic products.

When a device is "nonlinear," it also tends to "mix" the different signals applied to the input, so that they cannot be separated by the tuned circuits which follow the device. This results in *cross modulation,* a type of modulation whereby one carrier is transferred to another. TV sets in particular suffer from this form of distortion because a very small amount of cross modulation is readily visible on the screen and because there are usually several different input signals present at the tuner (sound carrier, chroma carrier, picture carrier and, often, adjacent channel carriers).

Because FETs are more linear in the presence of a strong input signal than are bipolar transistors, they reduce cross modulation effects.

Another advantage of FETs compared to bipolar transistors is that FETs can be AGC'ed as effectively as vacuum tubes. Bipolar transistors cannot be effectively AGC'ed for several reasons: First, varying the bias of a bipolar, even slightly, tends to make the device nonlinear because either the positive or negative peaks of the amplified signal will be flattened as the amplitude of the input signal approaches saturation or cutoff. Secondly, internal capacitances of the bipolar transistor change, detuning the center frequencies of tuned circuits. Thirdly, input and output impedances change, varying the loading on tuned circuits, which, in turn, changes their bandwidths (Q).

Modern FETs, especially metal oxide silicon field - effect transistors (MOSFETs), exhibit significantly less change in capacitances and impedances than do bipolar devices.

TYPES, SYMBOLS & TERMINOLOGY

All FETs, regardless of type, operate on the principle of controlling current flow by means of an *electrostatic field* in the same manner that a vacuum tube grid controls cathode - to - plate current. This is quite different from the operation of a bipolar transistor, in which a small *current* injected into the base is multiplied by the beta (gain) of the device. Simply stated, a bipolar transistor is a current amplifier, but a FET is a voltage - to - current converter/amplifier.

The current multiplication factor, or *current* gain, of a bipolar transistor is called *beta.* Unfortunately, no such simple term can be used to describe the amplifying ability of a FET, principally because with the FET we are talking about how *voltage* input affects *current* output. Fortunately, this "apples and oranges" problem was solved years ago with vacuum tubes by the use of a characteristic called *transconductance,* which is the ratio of the change in output current caused by a change in input voltage (I/E.)

A 1 - volt input change which produces a 1 - ampere output change is I/E = 1/1 = 1 mho of transconductance. The term *mho,* which is *ohm* spelled backwards, is used to designate transconductance because conductance (I/E) is the opposite of resistance (E/I). Because the current through a tube or FET is usually in milliamperes, it is easier to state that the ratio of volts to *milli*amperes is *milli*mhos. One step further takes us to volts and *micro*amperes, which is *micro*mhos. Thus, a 1 - volt change in input which causes a 1 - milliampere change in output indicates that the FET (or tube) has a transconductance of 1000 micromhos (1 milliampere equals 1000 microamperes).

The term *transadmittance* is sometimes used in place of transconductance. The symbol for transconductance is GM and for transadmittance the symbol is YFS.

The JFET

Fig. 1 is the schematic symbol for a junction field - effect transistor (JFET). Notice that the input is a junction called the *gate.* The output is called the *drain,* and the common terminal is called the *source.* These correspond to the base, collector, and emitter, respectively, of a bipolar transistor, but with one major difference: The input junction of a JFET is always *reverse biased,* while the input junction of a bipolar device is forward biased.

The reverse biased input of the

JFET cannot inject a current as can a bipolar input junction; its influence on source - to - drain current is achieved through the electrostatic field of its capacitance. (A reverse biased junction is a capacitor, a phenomenon which is also utilized in varactors, or tuning diodes).

The MOSFET

Fig. 2 is the schematic symbol for a MOSFET. The principal difference between the JFET and the MOSFET is that the input of the MOSFET is actually a small capacitor instead of a semiconductor junction. The capacitor is formed by laying down an insulating dielectric. This offers an advantage because *both* polarities of input voltage can be used to control source - to - drain current. (A capacitor has no "forward" or "reverse" voltage.) The method by which the MOSFET is fabricated creates another element called the *substrate* (also called *bulk*). This additional element can be employed as a second gate.

The MOSFET, like the JFET, influences the flow of current between the source and the drain by means of the electrostatic (capacitive) field created by the application of a voltage to the small capacitance input gate. Because the gate capacitance of the MOSFET utilizes an insulating dielectric, it also is referred to in some literature as an IGFET (insulated - gate, field - effect transistor).

Just as bipolar transistors are made with NPN and PNP materials, FETs come in two types: *N Channel,* and *P Channel.* The FETs in Figs. 1 and 2 are N Channel, as indicated by the arrow pointing *in*ward. P Channel devices have the arrow pointing *out*ward. The type of channel material determines the polarities of voltage which should be applied to the terminals.

You also need to know if the MOSFET is an *enhancement* or *depletion* type. Remember, the gate of all JFETs must be reverse biased. If the reverse bias is increased, the drain current is reduced, and this is called *depletion.*

MOSFETs, on the other hand, because of their capacitor input, can be designed to operate with any polarity of input. If the MOSFET is designed to have very little current flow at *zero input bias* and the bias is required to turn on the MOSFET to some useful working current, then you are working with an *enhancement* MOSFET. The term *enhancement* implies an *increase* in drain current with bias.

If the MOSFET runs at high drain current with zero bias and must be biased to reduce the drain current to some useful value, then you have a *depletion* MOSFET. The symbols for enhancement and depletion P - Channel MOSFETS are shown in Figs. 3 and 4.

Those who are familiar with vacuum tubes will have no difficulty in understanding the similarity between MOSFETS and certain types of vacuum tubes. Some tubes used in class B amplifier service are *zero - bias* types and do not require the usual reverse bias applied to the grid. Other tube types require the application of considerable negative grid voltage to reduce the plate current to the proper no - signal current level.

The new symbols and terms are not difficult to master. The JFET gate input is an arrow, which symbolizes a *junction.* The MOSFET gate input is a capacitor symbol, with a bar for one plate of the capacitor and a space for the dielectric. The *enhancement* MOSFET symbol has *broken* lines, indicating a normally open circuit which must be closed. The *depletion* MOSFET is made up of a *solid* line which indicates a closed circuit which must be opened by biasing.

Some FETs have two gate inputs, permitting the use of the second gate for AGC, or for mixing (converter). The symbol for a dual - gate MOSFET (N Channel, depletion mode) is shown in Fig. 5.

Because the input of a FET is either a reverse biased junction or a capacitor, the input impedance is very high (megohms). Consequently, it is easy for an excessively high voltage to build up on the input gate (via static charge, etc.), rupturing the input gate and thereby ruining the device. Many modern FETs use zener diodes to protect the input gate, as shown in Fig. 5. Two zeners are used to guard against overvoltage of either polarity, along with two series diodes to provide "steering"

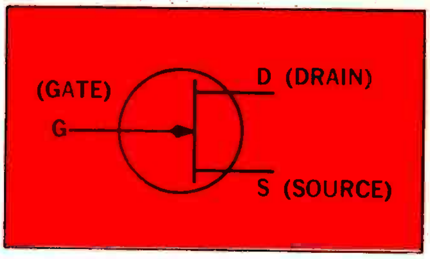

Fig. 1 —Schematic symbol for an N - channel JFET.

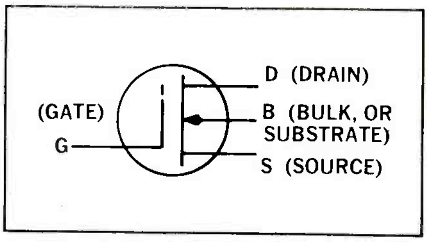

Fig. 2 — Schematic symbol for an N - channel MOSFET.

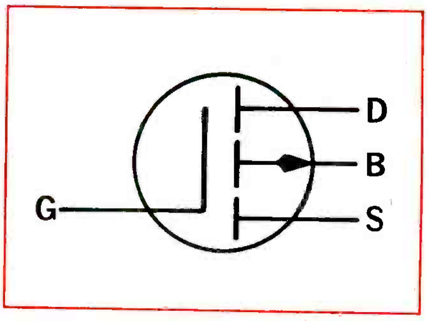

Fig. 3 — Schematic symbol for a P - channel, enhancement type MOSFET.

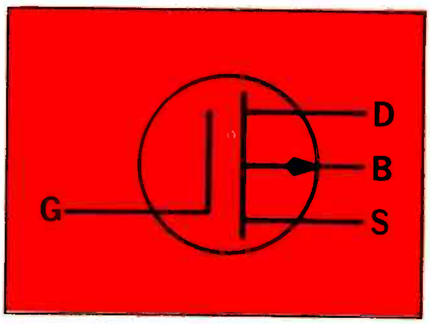

Fig. 4 — Schematic symbol for a P - channel, depletion type MOSFET.

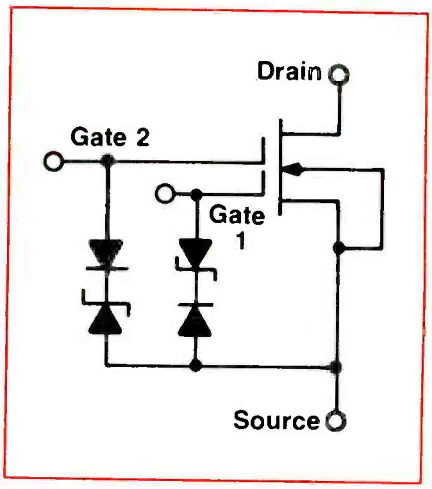

Fig. 5 — Dual gate, diode - protected MOSFET.

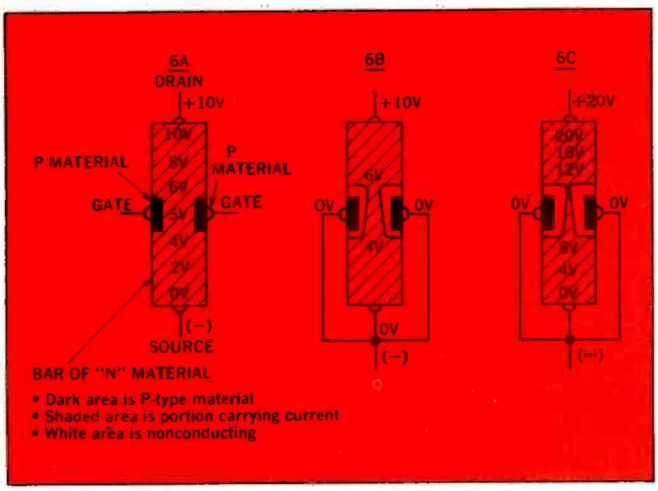

Fig. 6 — Cross sectional views of a JFET which illustrate JFET operation and biasing.

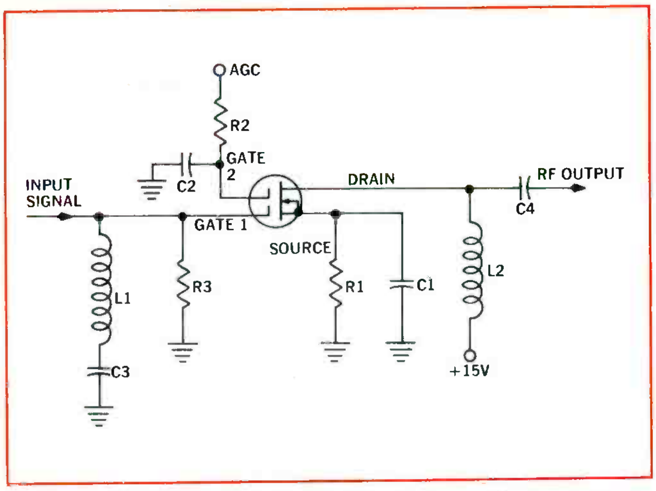

Fig. 7 — RF amplifier stage equpped with an N - channel, depletion type MOSFET.

for the zeners. Most FET's can withstand at least 20 volts of gate input. The zener/diode type of gate protection limits the gate voltage to 8 volts, thus eliminating what used to be a very serious problem in the handling and application of FETs.

When replacing a FET that does not incorporate diode protection, do not remove it from the special protective package in which it comes until you are ready to use it. To insure that no static charge exists between you and the set into which the FET is to be inserted, ground everything together (including your body). Also, be sure that the soldering iron is grounded.

FET BIASING

The service technician needs to know how a FET is biased, because part of the bias is actually generated internally, and also because the primary differences between FETs and bipolar transistors, so far as the service aspect is concerned, are in the input/bias circuit. You *cannot* test the ratio of gate - to - source resistance of a MOSFET with an ohmmeter the way you check out a bipolar transistor. In a MOSFET there is no "forward" resistance, only "reverse" resistance.

If you are using an ohmmeter which uses a 1.5 - volt or lower battery (such as a multimeter on the RX10 range, or a multimeter or VTVM with a "low - power" ohms range), you should read an *open* circuit (infinite resistance) between the gate and either the drain or the source.

Fig. 6 is a simplified cross section of a JFET which illustrates the operation of the device. Fig. 6A shows a bar of N - type material. The lower end (source) is connected to a negative voltage, while the top end (drain) is 10 volts positive. The two gate terminals, made of P - type material, are left floating. Because the N material is a conductor, current flows through the entire bar (shaded area).

If you were able to measure the voltage at different points on the bar, you would find the voltage distributed equally across its length, just as in any resistor. Therefore, if the gate terminals are halfway up the bar, they would be located at the 5 - volt points with higher voltage just above, and lower voltage just below, as shown in Fig. 6A.

In Fig. 6B, the gates have been tied to the source, putting the P - type gate material at zero volts potential with respect to the source. Since the tops of the gates are at the +6 - volt point on the bar, a reverse potential of 6 volts exist across the junctions formed by the P material gates and the N material bar at that point. Because of the high reverse bias, no current flows in the vicinity of the reverse junction, as denoted by the white areas at the junction interfaces.

At the bottoms of the gates, the reverse bias is only 4 volts; therefore, because of the weaker electrostatic field, the reverse field does not extend quite so far into the bar. The result is a wedge - shaped nonconducting area which constricts the source - to - drain current flow.

In Fig. 6 C, the drain voltage is increased to 20 volts, twice the voltage used in Fig. 6B. Because the voltage along the bar also is increased by a factor of two, the tops of the gates are now opposite the 12 - volt points on the bar, and the bottoms of the gates are at the 8 - volt points. The increased reverse bias enables the reverse electrostatic fields, generated by the reverse - biased gate junctions, to touch each other. This "pinches off" the current flow through the device, reducing the source - to - drain current to about zero. Different JFETs have different *pinch off* voltages, and you must consider this difference when trying to substitute one FET for another, even though they are similar in most other respects.

From the preceding you can see that the JFET can "bias itself," even with the gates returned to ground. The degree of self - biasing depends upon the voltage applied between drain and source. The JFET will conduct with a low voltage between source and drain, but will reach pinch off as the voltage increases. In a receiver, if the drain supply should increase (as, for example, when a series of regulator shorts), the FET will pinch off, making it appear as if the FET were open or the bias were incorrect. This can be a fooler; so before you check anything else, always check the *supply* voltage that feeds the FET. JFETs are very voltage sensitive in this regard.

A JFET also can be pinched off by application of a negative voltage to the gates. This method is seldom used because the inherent ability of the FET to cut off itself with zero or some small positive voltage is more convenient, and, because it avoids the need for a negative bias supply, it is more economical.

Although the two opposite gates of the JFET provide the pinch off action, it is *not* necessary to tie the two gates together. Instead, one gate can be used as a signal input with a fixed bias, while an AGC voltage is applied to the other gate, to adjust the gain of the FET.

MOSFETS operate in a manner similar to the JFET except that they can be designed so that the device is "off" until some bias is applied to turn it on (enhancement type) or they can be designed to be fully "on" until an inhibiting bias reduces the drain current to the desired value (depletion type).

Because we now know that the current in a FET depends upon the value of drain voltage applied to it as well as the amount of bias, it is easy to see that the application of correct values of voltages are essential to the operation of a FET. In contrast, the collector current of a bipolar transistor is less dependent on the collector voltage because the collector current is determined principally by the beta times the base input current.

TEST PROCEDURES

When examining the drain - to - source characteristics of FETs during servicing, you might be surprised to note that ohmeter tests of a JFET will indicate good conduction in both directions. This is because, as shown in Fig. 6, the drain - to - source path is a conducting bar in which the same amount of current will flow in *either* direction, as in a resistor. There is no PN junction in series with the drain - to - source path. For this reason, you cannot test the source - to - drain path of a FET properly with an ohmmeter.

However, the input of a JFET does have a "forward" and "reverse" junction between the gate and the bar material. (The drain and the source are in reality connected to each other at each end of the bar.) Thus, if you cannot obtain a reverse - biased junction indication with the gate as one terminal, the gate is shorted (a common defect). If you cannot obtain a reverse - biased junction *and* a forward junction indication using the gate as one terminal, the gate is open.

A MOSFET has no "forward" gate junction, so you cannot use an ohmmeter to check it, except to test for a *shorted* gate. Open gates are not detectable with an ohmmeter. In certain diode - protected MOSFETs, the ohmmeter voltage might be sufficient to indicate what appears to be a "leaky" gate, but this is deceptive because the input protecting diodes are doing the conducting, not the gate itself.

At this point, it should be apparent that the methods used for testing bipolar devices are not useful for testing FETs. The clue to proper testing of FETs lies in their very name: "*field* - effect transistors." They control (amplify) current by increasing or decreasing an *electrostatic field* between the source and drain. The strength of the field is dependent upon the application of the proper voltages to *all* terminals.

This need for correct voltages indicates a need for *dynamic* testing, which can be accomplished right in the circuit. The simplified schematic in Fig. 7 illustrates how this can be done.

The device in Fig. 7 is a MOSFET (N Channel, depletion mode). You might be asking yourself, "How would I know the type if I didn't have the schematic before me?" To do so, you'd have to do some "detective" work. One way that works in some instances is to use one of the new semiconductor testers which "self - programs" to test any transistor or FET, regardless of type. The in - circuit testing functions of these testers are generally reliable when they indicate a "good" device, but most do not reliably indicate a defective device. Incorrect supply voltages, shorted components, etc., can "fool" such testers into indicating a "bad" device.

This points up the need for schematics when working on the new solid - state sets, many of which are equipped with other hard - to - identify devices such as silicon controlled rectifiers (SCRs), darlingtons, etc. To attempt to service such equipment without adequate service data is false economy.

The circuit shown in Fig. 7 is an RF amplifier, similar to those used in the tuners of TV and FM receivers. The first step in testing this FET is to determine if the FET is conducting at some reasonable level of current. A quick check of the voltage drop across the drain resistor will reveal this. The supply voltage also should be checked at this time. If the supply voltage at the "bottom" of the drain resistor is normal and the FET is drawing no current, than a quick check should be made to determine if the supply voltage is actually being applied to the drain. An output coil (L2) might be open. With power off, the bypass capacitor (C1) across the series source resistor (R1) should be checked; if it is shorted, there will be no voltage across the source resistor.

These are all simple tests *like those that you would perform on a vacuum tube amplifier if you had no tube checker*. If you can think of the FET in terms of a vacuum tube instead of as a semiconductor, you can successfully test FETs. As a matter of fact, the FET is often referred to as a "solid - state tube," and justifiably so.

If correct voltage is being applied to the drain and the source bypass capacitor is not shorted, next check Gate 1, which is grounded via resistor R3. There should be zero DC volts on it. If Gate 1 is shorted, there will be DC voltage on it. The potential on Gate 2 is checked next to see if the proper voltage exists on it. There might be a defect in the AGC chain.

Because FETs do not "wear out," or lose emission, as do tubes, look only for shorts or opens. As in a tube circuit, if all element potentials are correct and the FET is drawing reasonable current, the defect probably is in another related stage. Once again, the key words are, "as in a tube circuit." If you will think back, the only time a tube is defective, with applied voltages all correct, is when the emission of the tube has decreased. (Gas and internal grid emission also are not problems with FETs, and therefore, are also omitted from consideration.) Incorrect biasing affects drain current and, in turn, shows up as a voltage error (for example, across the source resistor).■

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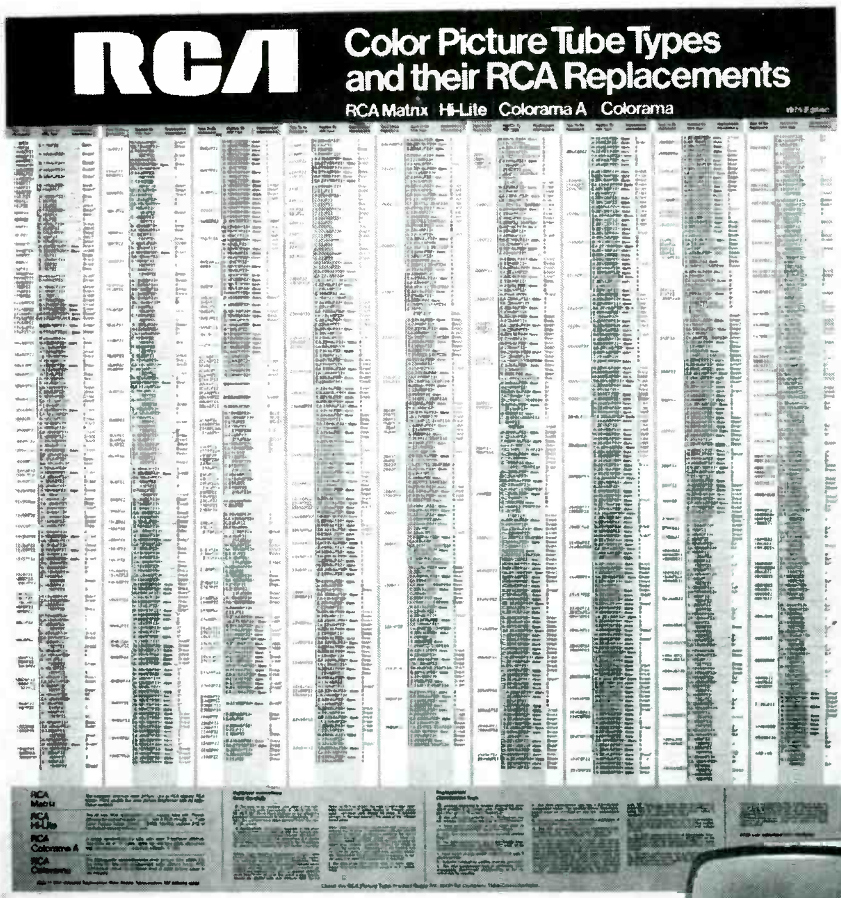

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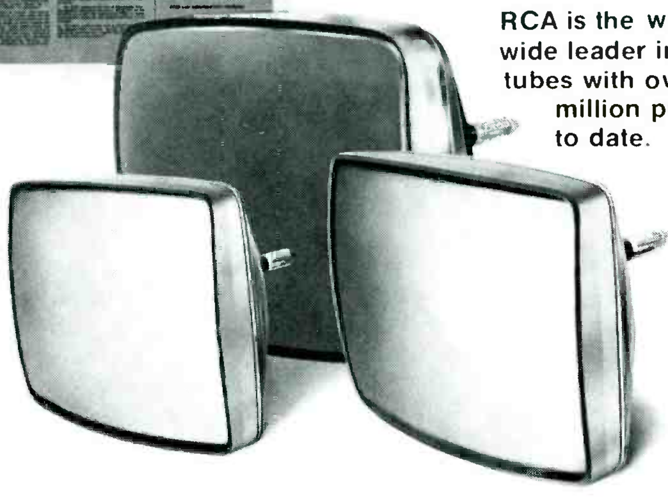

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Medical Electronics— A Healthy New Field For Servicers

By Joseph J. Carr, ET/D Contributing Editor

■ Although most electronic service firms and technicians are aware of the dramatically increasing use of electronic technology in a variety of medical - related applications, few have seriously investigated the opportunities available in medical electronics servicing, principally because they believe that the skill and knowledge required to service such equipment exceeds their present capabilities. This belief is based on the assumption that any equipment which often plays a vital role in life and death situations, and which is as expensive as most medical electronic equipment is, must be extremely complex.

The fact is, although a few types of medical electronics equipment, such as that used in radiology/nuclear medicine and in some lab applications, do contain more complex technology than that in consumer electronic products, most medical electronic equipment which can be serviced locally is no more complex than a color TV receiver.

Most medical electronic equipment *is* more expensive than comparable consumer electronic products, principally because fewer of a particular medical electronic product are needed and therefore fewer are produced, and because most medical electronic products must be more accurate and more reliable than consumer electronic products, which means better materials, closer tolerances and more stringent quality controls, all of which increase the cost.

The higher initial cost plus the fact that some medical electronic equipment must be serviced on an immediate, around - the - clock basis means that servicing it can be very profitable for the service firms or technician who is willing and able to provide the proficient, quick - response service required by medical care facilities. For example, one eastern medical center reports that during the period 1971 - 73 it paid several electronic service firms an average of $25 an hour for "time and travel" (travel time and service labor), with "time and travel" charges for each service call during the period averaging $88.

Pay for medical electronic service technicians ranges from about the level paid TV benchmen to significantly higher levels, depending on such factors as geographical location, competition, overtime, etc. One firm with which I am familiar has six "field" technicians, all of whom average between 10 and 30 hours of *overtime* each week.

In the following paragraphs, the electronic technology in representative medical electronic equipment is examined so that you can decide for yourself whether or not it is more complex than that in consumer electronic products and, consequently, whether or not your present electronic knowledge and diagnostic skill will permit you to enter this relatively lucrative, new service field.

BLOOD PRESSURE METERS

In operating rooms (OR) and Intensive Care Units (ICU) it is sometimes necessary to continuously monitor blood pressures in particular patients. Because this would be difficult to accomplish manually, electronic equipment is used.

While *veinous* (de - oxygenated, returning to heart) blood tends to flow evenly at low pressure, arterial (oxygenated) blood is pulsitile and at substantially higher pressures. Pressure peaks occur when the heart is in contraction, thereby forcing blood into the main arteries. This period of heart contraction is called *systole*. Pressure will fall to a minimum, but not all the way to zero, when the heart relaxes *(diastole)*, allowing the lower heart chambers to refill with blood. The maximum and minimum pressures created over this cycle are the source of the two numbers quoted whenever somebody takes your blood pressure (BP). Fig. 1 shows a pressure - vs. - time graph for blood pressure of 120/80.

Almost everybody is familiar with the manual means for obtaining a person's blood pressure. That technique uses an inflated cuff to shut off (occlude) the flow of blood in an artery of your arm. Once this is done, pressure in the cuff is slowly released while the operator simultaneously listens to the artery with a stethescope and watches a pressure gauge. When the cuff pressure drops to a point equal to systolic blood pressure, blood will spurt through the occlusion, creating distinctive sounds called *Korotkoff sounds*. These sounds disappear when the cuff pressure equals diastolic pressure. Pressure valves are read from the guage at the points indicated by the sudden appearance (systolic) then disappearance (diastolic) of Korotkoff sounds.

There also are at least three electronic methods used for measurement of blood pressure. One type of blood pressure meter uses an automatically inflated cuff and a microphone placed over the artery just below the occlusion. Active filters inside the equipment separate the low - frequency Korotkoff sounds, providing start/stop criteria for circuits

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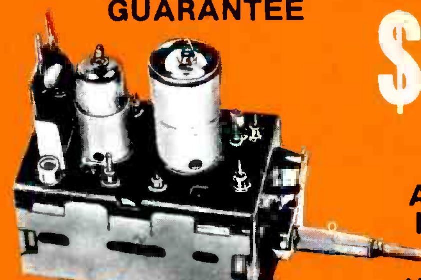

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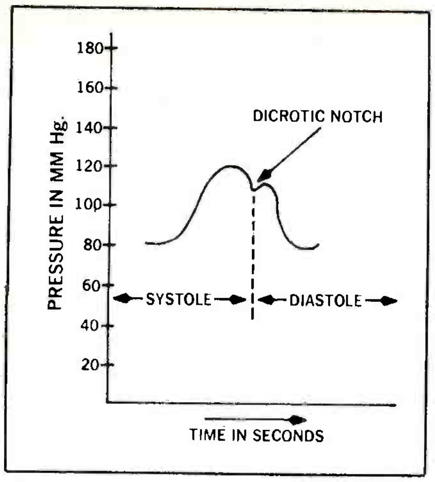


Fig. 1—Waveform generated when blood pressure is plotted against time. For arterial pressure, the minimum, or diastolic, pressure never falls to zero but does decrease to a minimum. This waveform shows a pressure of 120/80.

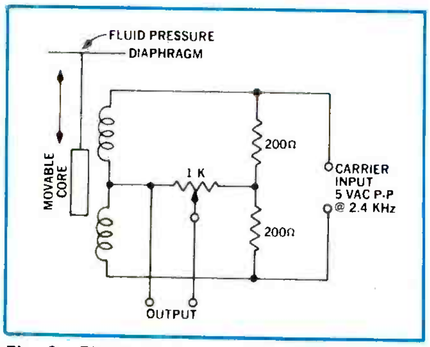


Fig. 2—Blood pressure can be measured electronically with a saline column placed in the patient's arterial system. Pressure in the column flexes the diaphragm in the transducer. This couples to either the movable core of a differential transformer inductance or to one arm of a resistance Wheatstone Bridge. Typical medical transducers fit nicely into the palm of the hand.

measuring cuff pressure. Other types of BP equipment, notably the well - known Roche *Arteriosonde,* uses an ultrasonic flow detector (Doppler) to control the measurement. These two techniques have the advantage of being *noninvasive*; that is, nothing is placed inside the patient's body.

Invasive measurements are those in which a probe, electrode, transducer or other object must be placed inside some portion of the patient's body. Such techniques are, by far, most often encountered in the measurement of blood pressure. In most, a fluid column (a thin, saline - filled catheter) is surgically placed inside an artery of the arm or wrist. This simple procedure is performed by a doctor. Pressure variations in the blood are coupled through the saline solution to a transducer port where they flex a diaphragm (see Fig. 2) which drives either a

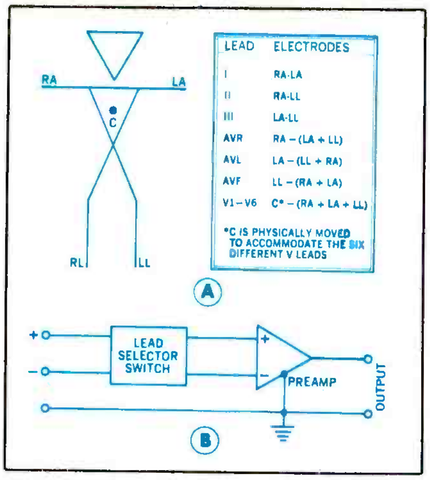


Fig. 3—Sources and means of obtaining input to electrocardiograph (ECG) strip recorder. A) Standard locations and configurations (composition) of ECG "leads." Leads I, II and III are simple voltage drops. "A" (augmented) and "V" leads are composite voltage drops developed when one input to the ECG differential preamplifier (B) receives a signal from a single electrode and the other input receives signals simultaneously from two or three other electrodes.

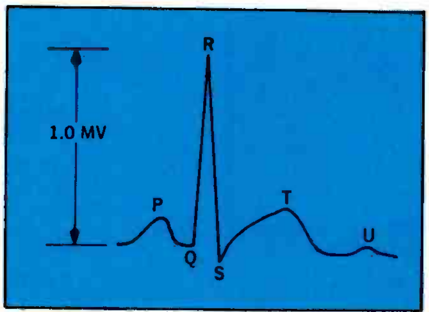


Fig. 4—Stylized version of the normal Lead I human ECG waveform. Letters P, Q, R, S, T and U designate certain major features. Actual amplitudes and shapes tend to vary from one patient to another, but one can expect the maximum amplitude of the R-wave to be around 1.0 millivolt.

variable resistance or the core of a special inductor. Excitation to the transducer can be either DC or AC. In resistance Wheatstone bridge transducers, either DC or AC can be used. However, only AC can be used in inductive types. Hewlett - Packard carrier amplifiers used for monitoring of blood pressure generally provide a 2.4 - KHz, 5 - volt p-p signal.

Most blood pressure meters are equipped with either a waveform output jack or an internal oscilloscope so that the actual pressure *waveshape* can be viewed. Once the waveform is calibrated with a known zero point and another known point (usually 200 mm, Hg), it is a simple matter to read diastolic and systolic pressure values from the minimum and maximum points on the waveform. In a few models there also is a logic circuit designed to display the diastolic and systolic pressures on either an analog or digital meter calibrated in millimeters of mercury pressure. These are mostly clocked - capacitor, peak - holding circuits.

ECG RECORDERS

The electrocardiogram (ECG) is a voltage - vs. - time graph of an electrical signal generated by the human heart. Electric current generated by the cells of the heart is propogated to all parts of the body by the electrical conductivity of tissues. A signal waveform of the voltage drop between two points on the surface of the skin can be picked up by simple disc electrodes pasted or strapped in place on the skin. The signal is processed in a differential amplifier.

Several different common voltage drops used by medical people are detailed in Fig. 3A. These voltage drops are called "leads." (This word choice might be confusing to electronic technicians, who associate the word "lead" with a length of wire.) Fig. 4 is a stylized representation of the waveform obtained when the Lead I voltage drop is plotted by a strip - chart (paper) recorder. The letters P, Q, R, S and T in Fig. 4 help identify standard major features of the waveform. Keep in mind that a waveform from one particular patient might be quite different than that from another. This fact might cause a few problems for the servicer who is not used to testing equipment of this sort.

ECG strip chart recorders, probably the most widely used type of medical electronic equipment, are found in a number of configurations: suitcase - mounted, for portable use; in roll - around carts, for general hospital use; and in permanent bedside installations, for use in ICU/CCU. These machines provide a written record of the ECG waveform as viewed on an oscilloscope. Actual writing is done by an analog pen onto a strip of 50 mm wide special paper. Paper is transported past the pen at a rate of either 25 or 50 mm per second, thus establishing the horizontal time base. The pen of the recorder is driven push - pull by a galvanometer; vertical deflection varies as the voltage varies. Although some ink - type pens are used, the majority of ECG strip recorders use a hot - tip pen which thermally etches the tracing onto special paraffin - treated paper. The tips of such pens are equipped with an electric heating element which operates at low voltage. The heated pen tip rubs against the paper. When the paper is heated by the pen, it turns black, leaving the trace.

When the analog pen is in the center of the paper, the input voltage to the amplifier input is zero. If the voltage goes positive, the pen will deflect upwards. If the voltage goes negative, the pen will deflect downward.

Most ECG machines develop only a relatively limited number of problems. Most can be field serviced with a parts supply easily carried in a briefcase, a tool box or a tube caddy. For openers, operate the equipment or have someone operate it for you. A surprising number of problems occur simply because the user is unfamiliar with the equipment. This is especially true where there is a large part - time medical staff. Look for insufficient sensitivity, incorrectly loaded paper, etc. Also, ex-ect to replace a lot of styli. The input of an ECG amplifier is differential, to suppress common - mode, 60-Hz power line interference. Should one leg of the cable connected to the patient become open, either by accidental disconnection or by breakage, the 60-Hz interference will become a differential signal and will appear on the ECG tracing. If it is of sufficiently high amplitude, it can drive the stylus against the high - or low - end stops, breaking or bending the pen. In other cases, age or excessive heat will cause the heating element to open. In either event, replacement is the cure. Also, expect to replace lamps and power switches. One very common switch failure is the SPST pushbutton *standardize* switch. When pressed in, this switch applies a 1.0 - mv pulse on the trace, for amplitude calibration. In older units, you will replace a few 12AX7 tubes. New equipment is, of course, solid state.

Fig. 5—Self - contained medical monitor system for use in operating rooms, intensive and coronary care facilities and emergency rooms. *(Courtesy: Hewlett - Packard.)*

Fig. 5 shows another type of ECG monitor: Hewlett - Packard's Model 7830A, which is often found in emergency rooms (ER), OR, ICU and CCU monitoring systems. It is designed for applications that require an immediate view of the ECG without the need of a written record, although that also is available as an outboard accessory. It includes an internal oscilloscope with optional dual - trace capability, and ECG preamplifier, a heart - rate meter (cardiotachometer) and an alarm system, all integrated into a single cabinet. The cable shown in the illustration is connected to the surface electrodes pasted on the patient's skin. Heart rate is indicated on the screen of the CRT by a horizontal line (in the lower left quadrant) whose length is proportional to the heart rate in beats per minute. Figs. 6 and 7 show similar equipment in different configurations.

BEDSIDE MONITORING EQUIPMENT

One of the primary goals of any field servicer, regardless of what he is repairing, is to return the equipment to normal operation in the shortest time possible and with minimum interruption to his customer's routine. Nowhere is this more important than in medical electronic servicing. Recognizing this essential need, most manufacturers of medical electronics equipment use plug - in printed - circuit boards similar to those in modern TV receivers. An example of such a design is shown in Fig. 8, which is a photo of the interior of American Optical's bedside monitor. The defective circuit "card" is replaced so that the patient is back on a monitor as soon as possible. Remember, the patient might have just been through dangerous surgery or a heart attack. Your customer will be less than happy if you take too long to repair such a vital means of acquiring information on the patient's condition. Defective cards can be repaired back at the shop or returned to the manufacturer.

The relative simplicity of most bedside monitors is revealed in the block diagram in Fig. 9. Although there is probably no specific make

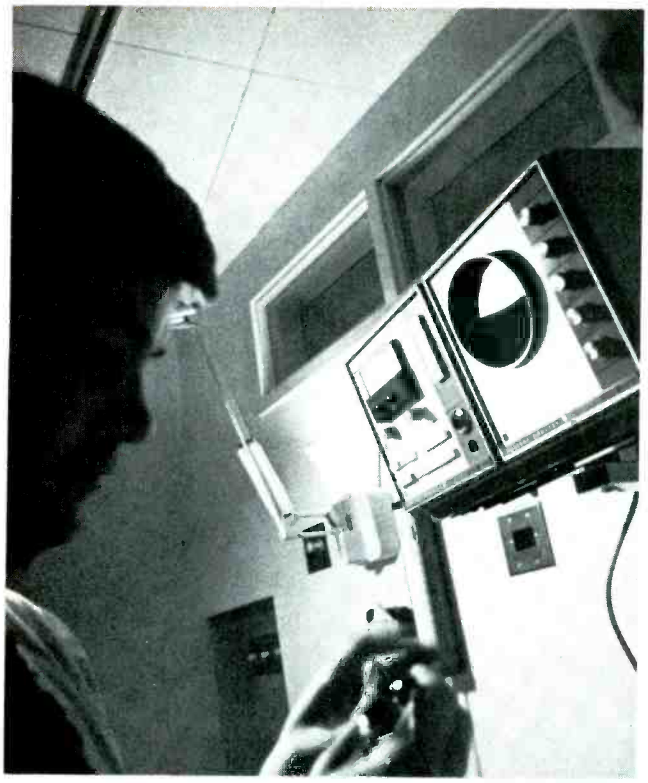


Fig. 6—Wall - mounted cardiac monitor system.

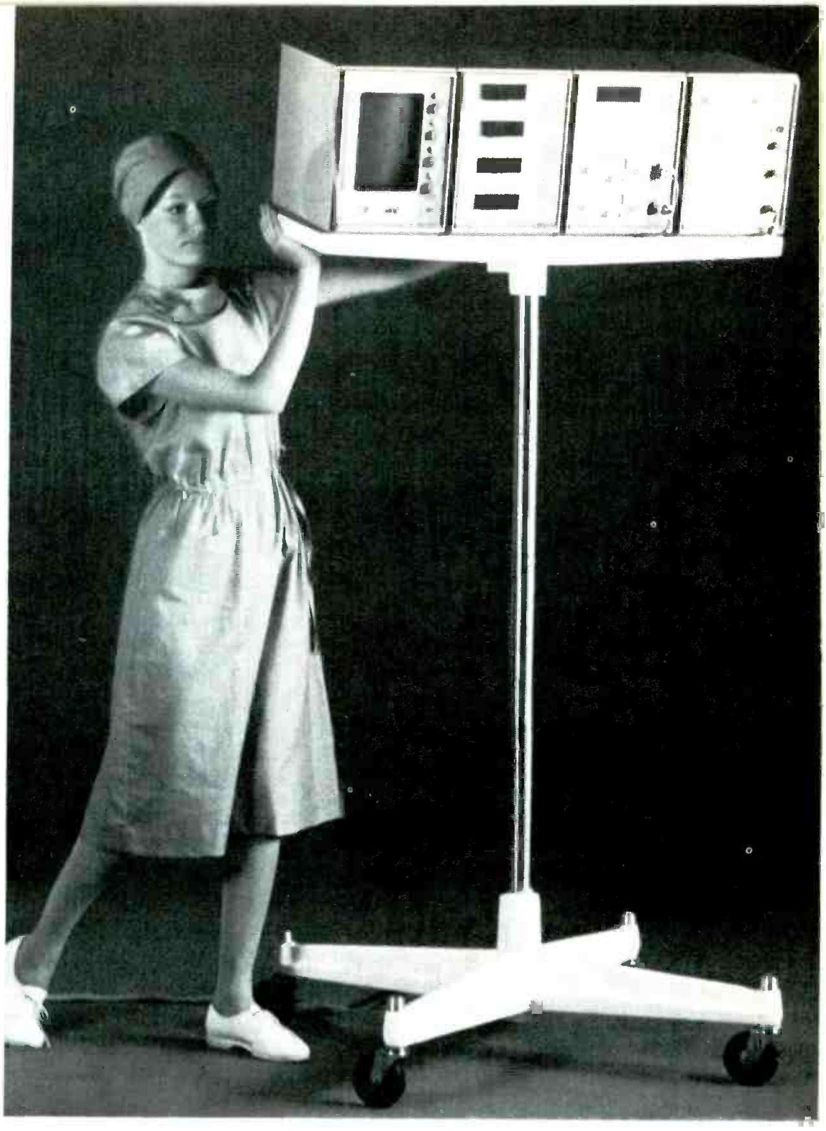


Fig. 7—Portable cardiac monitor system. *(Courtesy of General Electric.)*

and model of equipment which has all of the features shown in Fig. 9, the basic design in this illustration is typical of the entire class of cardiac monitor instruments.

Packaging is one characteristic which varies widely from one manufacturer to another. Many, such as older models of American Optical monitors, use completely integrated, nonmodular packaging, with little servicing flexibility. Newer models, however, are modularized, with individual sections which can be pulled intact from the mainframe for service. In such cases, the scope, ECG amplifier, etc., are separate modules in a common cabinet. Both this "semimodular" design and a completely modular design are used by Hewlett - Packard. Some of their units are completely free standing. For example, the 7800 - series of monitoring equipment includes a two - channel oscilloscope, Model 7803B, which is packaged in a half - rack cabinet such as that of the 7830 in Fig. 5. A heart rate meter, Model 7807C, produces the ECG signal, a DC meter output for heart rate and an alarm function. Models 7809 and 7819 are arterial pressure and venous pressure/patient temperature modules, respectively.

As mentioned previously, preamplifiers for ECG use are differential input types because of the existence of large common - mode interference signals from 60-Hz power lines and other electronic devices in close proximity to the patient. Because most of the information present on the ECG waveform is contained within the band from 0.5 Hz to 100 Hz, most ECG preamplifiers are designed to pass only signals within this range. For long - term monitoring, this range is reduced even more, to eliminate noise from 60-Hz and "biological" signals generated by the patient's skeletal muscles. The high - frequency response of such instruments rolls off somewhere between 30 and 45 Hz.

A few models have selectable bandwidth, for both monitoring and diagnostic purposes. ECG preamplifier output waveforms are fed to several points in the monitor or to equipment external to the module. Some of these are an output jack for remote monitoring, and internal scope or chart recorder, and a cardiotachometer (heart rate meter). In many cases there also will be a low - level output on the front panel, for use in driving external recorders and for synchronizing defibrillators and cardioverters. The usual source for this signal is the regular output signal which is fed through a 60-dB resistive voltage divider.

Monitor oscilloscopes use the same 25 and 50 mm-per-sec and sweep as the recorders. Otherwise, the trace would look different on paper than it does on the screen of the scope and would lead to a lot of confusion. Because a typical medical scope will have a CRT width of 10 cm, a .25 - Hz sawtooth sweep oscillator is usually used. This gives the required 25 mm - per - second sweep, which crosses the CRT screen in 4 seconds.

Most electronic technicians are surprised to learn that most medical oscilloscopes are relatively simple compared with a modern TV service oscilloscope. TV bench scopes must use electrostatic deflection because of the relatively high vertical amplifier bandwidth required for color TV servicing. Electromagnet (yoke) deflection is

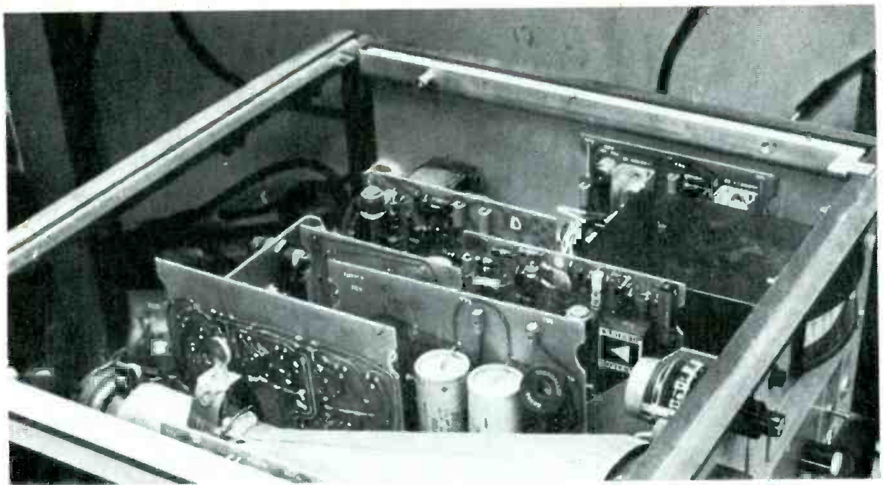


Fig. 8—Modular construction and plug - in printed - circuit cards are required to insure rapid bedside service. Printed - circuit cards can be either repaired back at shop or returned to factory for exchange or repair.

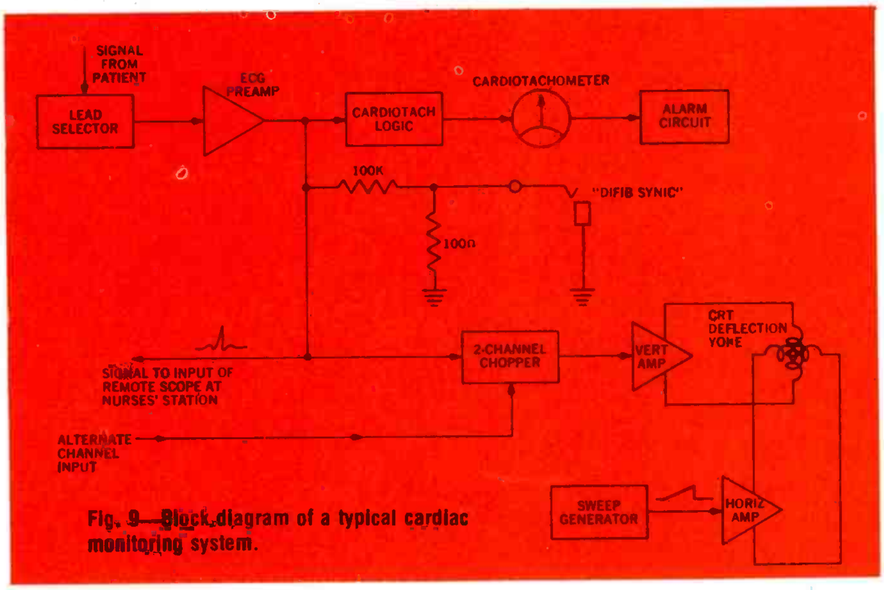


Fig. 9—Block diagram of a typical cardiac monitoring system.

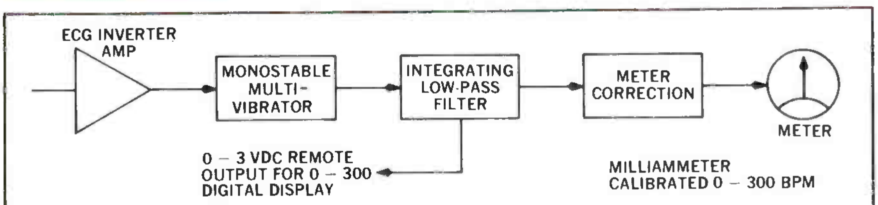


Fig. 10—Block diagram of a typical cardiotachometer circuit. Positive - going R-wave triggers a monostable (one - shot) multivibrator which produces pulses of constant amplitude and duration. Integrator section (a low - pass filter) converts these pulses into a DC level proportional to heart rate. In the Hewlett - Packard system, 0 - 300 beats per minutes (BPM) is represented by a DC range of 0 - 3 volts.

limited to applications involving frequencies no lower than the high audio or low ultrasonic range. In medical applications, however, 1000 Hz is the maximum vertical amplifier frequency, and 100 Hz is more commonly used. Because of the low bandpass requirements, both electrostatic and electromagnetic deflection systems are used. For example, American Optical uses electrostatic, while Hewlett - Packard uses a yoke. In yoke systems, the similarity between the sweep sections of the scope and that of b-w TV receivers is most interesting. Sanborn's (H-P's predecessor) wall - mounted monitor scopes use circuitry straight out of TV textbooks. In fact, the flyback transformer replacement supplied by Hewlett - Packard for these scopes is a universal replacement type (Triad) made for Wells - Garner TV receivers. In light of this, it is a safe bet that the TV technician would not be on unfamiliar ground when troubleshooting such monitor scopes.

Regardless of the deflection system used, all medical scopes are equipped with a long - persistance CRT phosphor so that all of the salient features of each waveform complex can be viewed at the same time. Even this, though, isn't as good as the storage function built into modern medical oscilloscopes. Some newer scopes use one of two types of storage mechanism. A few use the same "special CRT" method used in many laboratory - type scopes. Others use digital storage techniques in which the analog signal is first digitized then stored in either a recirculating shift register or in one of the modern solid - state computor - memory ICs. The current ECG signal is displayed by such scopes in "real time" in the upper left hand corner of the screen. Immediate past ECG complexes are shifted in position across the screen and, therefore, trail off to the right. This type of scope is popular with medical users because it allows them to compare both the current ECG and the past few immediate complexes for up to several seconds.

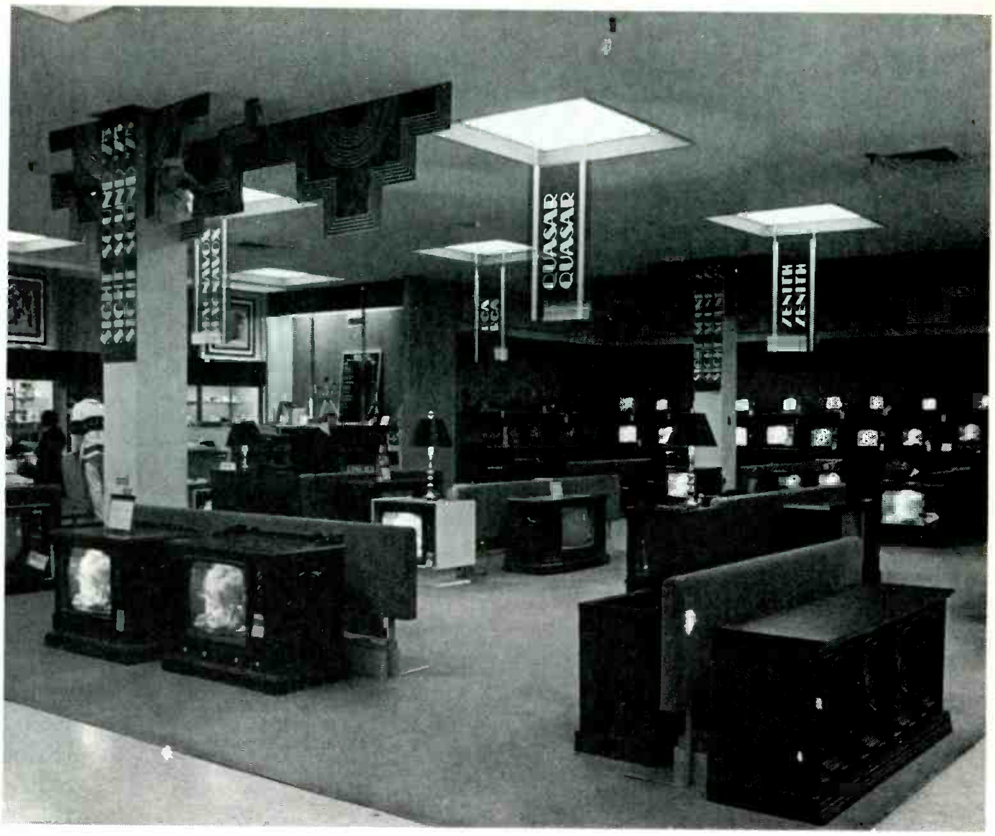
Cardiotachometers are circuits which measure heart rate in beats per minute. Fig. 10 is a block diagram of a popular cardiotachometer used by Hewlett - Packard in the 7807 heart rate meters. ECG analog signals may have either polarity despite the general shape shown in Fig. 4. The first stage, then, is an absolute - value type of amplifier in that it has only positive - going output signals. These are fed to the monostable multivibrator as trigger pulses. —This circuit is designed to produce one and only one output pulse on receipt of a trigger pulse. These output pulses will all have the same amplitude and duration; only the number per minute will change as the heart rate changes. These pulses are integrated in the low - pass filter, producing a DC output voltage which is proportional to heart rate. A meter correction circuit keeps the 0 - 100 BPM section so that the most used portion of the scale has the highest resolution. Interestingly enough, Hewlett - Packard chose to use 0 - 3 VDC as the range for the DC

continued on page 44

Showroom MATV

By J. W. Phipps

A super sales aid and source of profit for retailers and servicers



A TALE OF A LOST SALE

■ Mr. and Mrs. American Consumer had been thinking about buying a new color TV for about two weeks. Then Mr. Consumer saw in his morning paper an ad announcing a special color TV sale at Ace's TV Sales & Service. He showed the ad to Mrs. Consumer and suggested that they visit Ace's after supper that evening. Mrs. Consumer agreed, and that evening they visited Ace's showroom.

Mrs. Consumer told Mr. Ace that they wer interested in a large screen console with Mediteranean style ca inet. Mr. Ace confidenti guided the Consumei across the showroom to demonstrator consol model which seemed t be exactly what the Con sumers were looking for Mrs. Co umer seemed very pl ed with the appear of the cabinet Mr. Ace pointed t a number of cosmetic features. Mr. Consumer asked about the price, and when Mr. Ace told him, Mr. Ace could tell by Mr. Consumer's reaction (or lack of reaction) that the price at least was no more than Mr. Consumer expected to pay, and possibly less.

Mr. Ace then turned on the receiver, switched it to an active channel and began explaining the "automatic" operating controls. However, Mr. Consumer quickly interrupted him and asked why there were shadow - like images and little peckles" in the picture. r. Ace attempted to plain in layman's ms that the shadows d little "speckles" ise) were not caused the set, and just as Mr. ce got around to stating ie the reception would e much better in the onsumer's home, Mr. onsumer remarked hat their old set at home produced the same kind of picture. He then took Mrs. Consumer by the arm, said that perhaps they should look at a couple of other brands before making a decision, and, before Mr. Ace could react, the Consumers were out the showroom door.

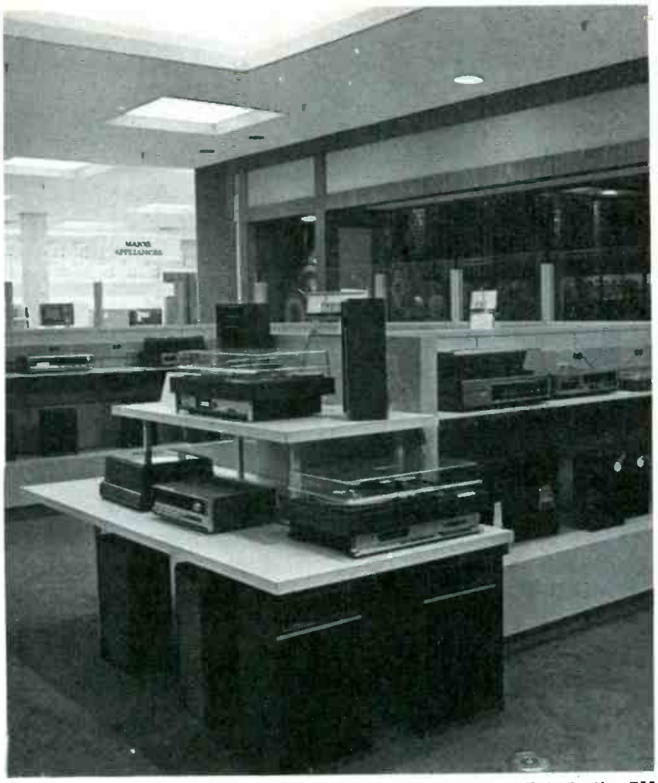
Mr. Ace stood there, watching the showroom door swing shut behind Mr. and Mrs. Consumer wondering what went wrong. Half way through the presentation it seemed to him that he was well on the way to a sale (of which he had not seen too many lately); then, right after he turned on the set, the Consumer's enthusiasm had suddenly waned and they had abruptly left before he had even reached the "closing" phase of his sales presentation.

WHY BETTER SHOWROOM MATV SYSTEMS ARE NEEDED

The preceding scenario is a fictional dramatization which points up just how important a role live demonstration plays in the sale of color TV, FM radio and home antenna systems. Unfortunately, real - life versions of this scenario are occurring too frequently in the showrooms of home entertainment electronics retailers throughout the country. Sales are being lost because consumers are *not* being shown the crisp, distortion - free reception which most color TV and FM radio receivers are capable of producing when they are connected to a well designed, properly functioning antenna system.

During the late 1950's and throughout most of the 1960's, the majority of color TV buyers were buying their first color TV receivers and consequently did not really know what quality of picture they should reasonably expect. Color TV was still somewhat of a novelty and many viewers were satisfied so long as there was merely *some color* on the screen.

The MATV system for a home entertainment electronic showroom should provide sufficient numbers and proper placement of outlets to permit connection of all TV and msot FM radio in the showroom. If the portable TVs on the shelves along the walls were the only sets connected to the MATV system, it would make it difficult for salesmen to interest customers in the more expensive (and usually more profitable) table and console models on the floor. *(Courtesy of Blonder - Tongue.)*



A showroom MATV system should include appropriate outlets in the FM radio display area. *(Courtesy of Blonder - Tongue.)*

Today, with approximately 65 percent of the households in the U.S. equipped with color TV, it is no longer a novelty and consumers are more knowledgeable about what quality of color TV picture they should reasonably expect. Those who have to date experienced poor reception are (or will be) looking for *improved* reception from their next color TV. Those who have experienced good or excellent reception are (or will be) expecting *nothing less* than this when it comes time to replace their present color TV or buy a second set for the den or bedroom.

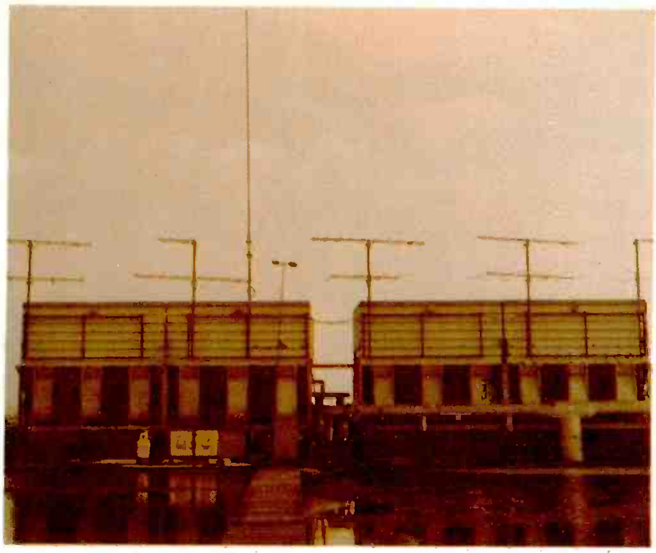
Most of the 35 percent of U.S. households who have not yet purchased a color TV receiver have nevertheless had sufficient color TV viewing experience at friends' and relatives' homes to realize that color TV reception *can* be clear and distortion - free, and most therefore will be significantly more demanding than first - time color TV buyers were in the past.

The fact that consumers today are more discriminating about color TV picture quality is not the only reason that home entertainment electronics retailers must be prepared to demonstrate high quality color TV reception in their showrooms. The combination of an inflated, depressed economy plus increased saturation of the color TV market have made color TV a hard sell (at least for the present, if not long term). Consumer spendable earnings are down and color TV prices effectively have increased. Consequently, consumer awareness of price has increased at about the same rate and at about the same time as consumer awareness of picture quality. Although price, ease of operation, warranty, and the aesthetics of cabinet style and cosmetic features are still prime considerations in a consumer's decision to buy or not to buy a particular color TV receiver from a particular dealer, most consumers will compromise, or trade off, any or all of these factors to some degree if they are adequately impressed by the quality of the picture produced by the receiver. Thus, the high quality of the picture produced by a well designed and properly operating showroom MATV system can put the consumer in a more *flexible* buying mood.

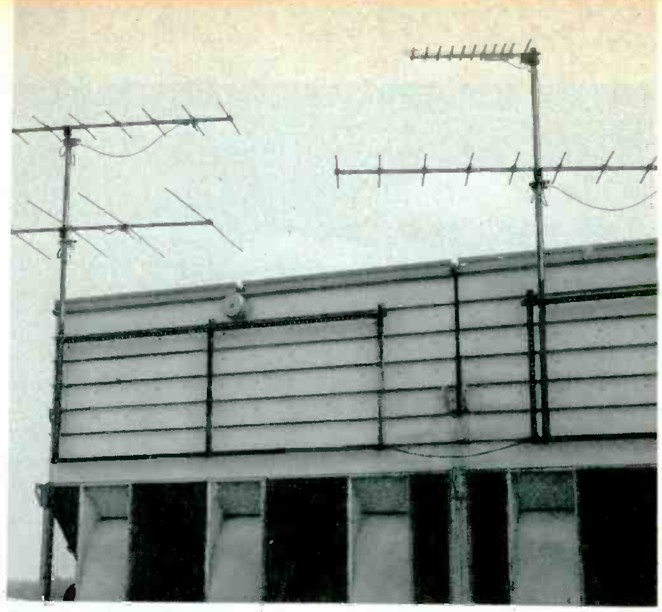
In addition to helping the dealer sell more and higher - profit color TV and FM radio receivers, a properly operating showroom MATV system also can help a dealer sell home MATV systems, either separately or as part of a "total color TV reception package" consisting of a color TV receiver and a complete home MATV system. Seeing *is* believing, and once a customer actually sees the clear, crisp, distortion - free color TV picture produced by a properly operating combination of color TV receiver and MATV system, it doesn't take much sales effort to sell the customer on the concept of a "total color TV reception package."

SERVICERS CAN PROFIT TOO

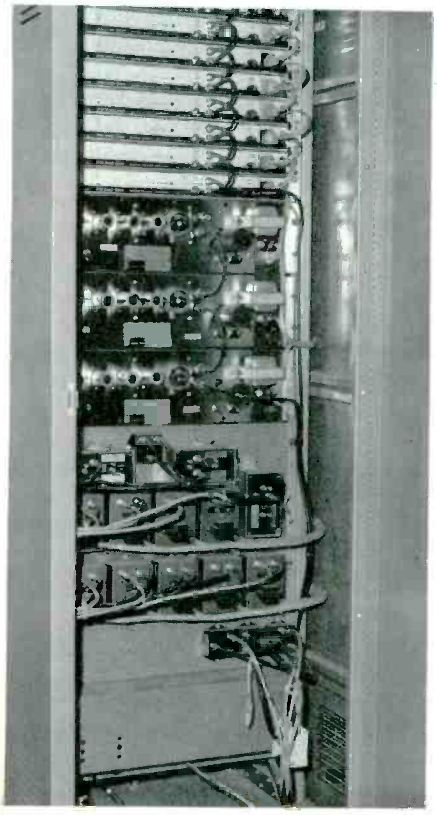
The urgent need of retailers for well - designed, properly functioning showroom MATV systems offers electronic servicers the opportunity to break into the MATV installation business by selling to and installing a showroom MATV system for home entertainment electronics retailers who do not have a service department or who for some other reason are not in a position to install their own showroom system. Either before or after a servicer installs an MATV system in such



Yagi antenna farm of a typical showroom MATV system. One single - channel antenna is provided for each active TV channel. Mounted on the mast below each antenna is a preamp. *(Courtesy of Blonder - Tongue.)*

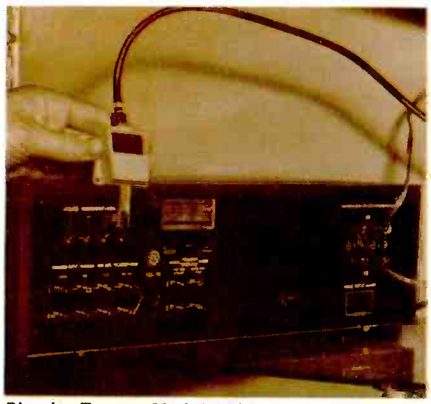


Close - up view of four of the antennas of a typical showroom MATV system. Each of the three large antennas are designed for reception of a single TV VHF channel, and the smallar antenna is for TV UHF reception. *(Courtesy of Blonder - Tongue.)*



Shown here is the head end equipment for a typical showroom MATV system. An MCA single-channel amplifier is used for each TV VHF channel, and an MCS-U UHF amplifier is used for each TV UHF channel. *(Courtesy of Blonder - Tongue.)*

TV signal tapoff shown here supply signals for two demonstrator TV receivers. Note that it is located in a relatively "hidden" area and is positioned adjacent to a dual - receptacle power outlet. *(Courtesy of Blonder - Tongue.)*



Blonder Tongue Model 3416 matching transformer matches impedance of RG-59 coaxial cable to input impedance of FM/stereo FM receiver.

Both VHF and UHF signals are fed to each receiver via a single coaxial cable and then separated by a VHF/UHF band separator immediately before application to the respective VHF and UHF antenna input terminals of the TV receiver. "Alligator" type clips make connection and disconnection simple and quick. *(Courtesy of Blonder - Tongue.)*

a dealer's showroom, he can negotiate with the dealer for installation of all home MATV systems sold by the dealer.

Some servicers install the nonservicing retailer's showroom MATV system *at cost* if the retailer agrees to subcontract all home MATV installation to them on an exclusive basis.

Other servicers and MATV installers carry the "subcontracting" arrangement one step farther and offer retailers a "home MATV package" which includes both parts and labor for a mutually agreeable price. In this way the servicer or installer purchases and/or stocks all MATV system components and hardware, relieving the retailer of all aspects except the actual effort of selling the system to the customer.

Home entertainment electronics retailers and servicers who need assistance in designing and pricing out a showroom MATV system can obtain such assistance free from most major antenna manufacturers, including Blonder - Tongue, Channel Master, Finco, Jerrold and Winegard.■

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DC Amperes	*0-5* (250 MV Drop)
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New In Color TV For 1975 — Part 9

By Joseph Zauhar

Conclusion of a series which analyzes the new and significantly changed circuits in 1975 color TV. This month we review Panasonic's all - solid - state chassis equipped with the latest version of their Quintrix picture tube.

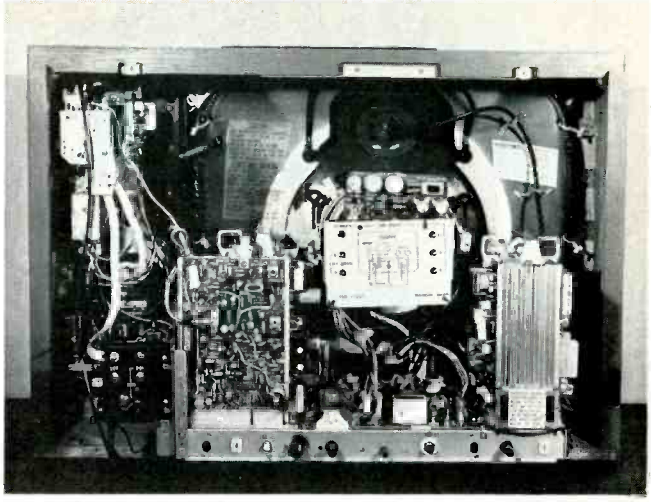

Fig. 1—Panasonic's solid state, modular "Quatrecolor" color TV chassis. *Courtesy of Panasonic.*

■ Two basic chassis are employed in Panasonic's 1975 Color TV line. The chassis are completely solid state and are used in TV models with 13- to 25 - inch (diagonal) size screens.

The 19 - and 25 - inch TV sets are available with the "Quatrecolor" modular chassis (ETA-81, 82, and 10).

Most of the circuits used in the Quatrecolor (Fig. 1) chassis closely resemble those of the original Quatrecolor chassis introduced in 1972. The basic operation of the chassis was covered in ELECTRONIC TECHNICIAN/DEALER, July 1973. The chassis employs five modules, and many will interchange between different Quatrecolor chassis, for example, the "A" Board TNP-71107, which is used for the Video IF, AFT and sound detection function, is applicable to all of the TV sets. The "B" Board TNP-71408 is used nearly on all Quatrecolor chassis. The boards are designed to snap in and out of the chassis, making component replacements simpler and faster for the service technician.

The brightness, contrast and color saturation are simultaneously controlled by a "Pana - Brite" control knob located on the front control panel.

A "Q - Lock" circuit is used to lock the function of the color, tint, brightness and contrast controls by pressing a button on the control panel for a pleasing picture; or if you prefer, they can be adjusted manually.

COLOR TV CHASSIS ETA81, 82

The ETA-81 chassis is currently used in 19 - inch (measured diagonally) TV Models CT-924 and CT-934. This chassis provides a second anode voltage of 28.5 kv.

The ETA-82 chassis is used with the 25 - inch (measured diagonally) TV Models CT-2514, CT-2524, and CT-2534, and provides a picture tube second anode voltage of 30 kv.

COLOR TV CHASSIS ETA-10

The ETA-10 chassis is used in the Model CT-954, which has some circuit changes to accommodate the 19 - inch (measured diagonally), 110 degree in - line picture tube.

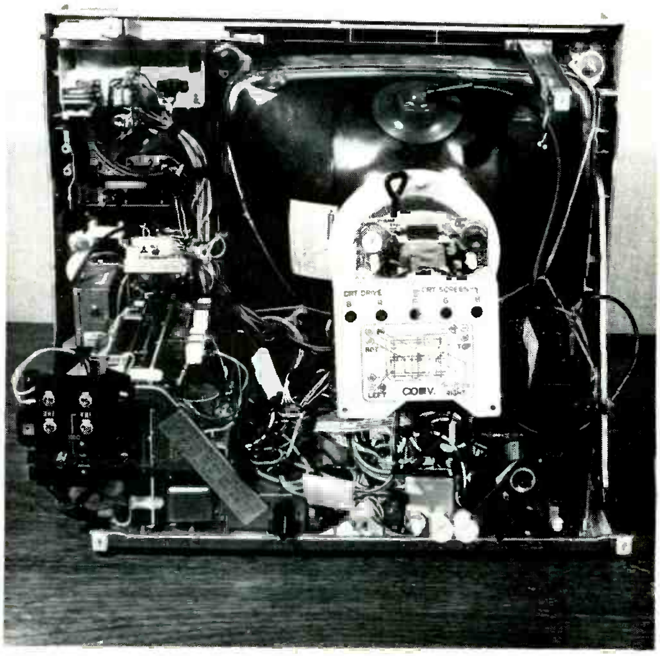

Fig. 2—Panasonic's non - modular color TV chassis ETA-12. *Courtesy Of Panasonic.*

NON-MODULAR COLOR TV CHASSIS ETA-12

The ETA-12 family of chassis are employed with 13 - inch Models CT-314 and CT-324; 17 - inch Model CT-714 and 19 - inch Models CT-914 and CT-974 which is equipped with remote control. The 13 - inch models provide a high voltage of 24.5 kv and the 17 - and 19 - inch models 28.5 kv.

This non - modular chassis (Fig. 2) is basically quite similar to the modular chassis except for some circuit simplifications which we will now discuss.

Low Voltage Power Supply

The low voltage power supply employed in the ETA-12 offers exceptional chassis protection.

A 1.5 amp fuse is placed in series with one side of the AC line and a circuit breaker in series with the other side of the AC line.

To protect the chassis from transient spikes caused by lighting and other sources, a spark gap is mounted on the AC interlock socket.

The chassis is

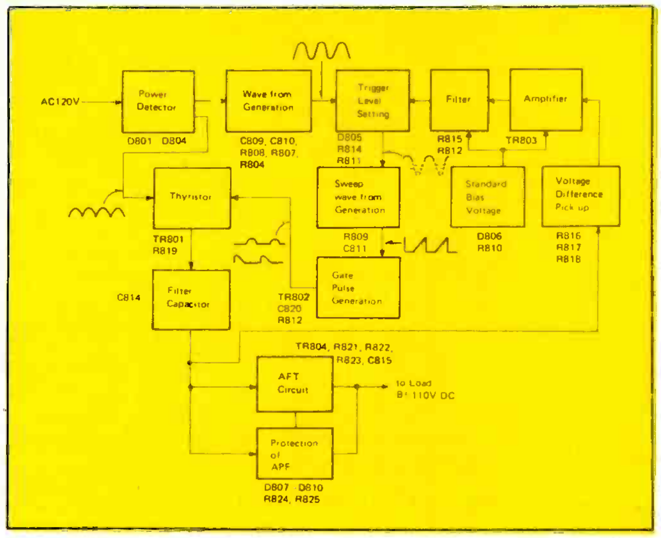

Fig. 3—Simplified block diagram of the voltage regulating circuit employed in the ETA-12 color TV chassis. *Courtesy Of Panasonic.*

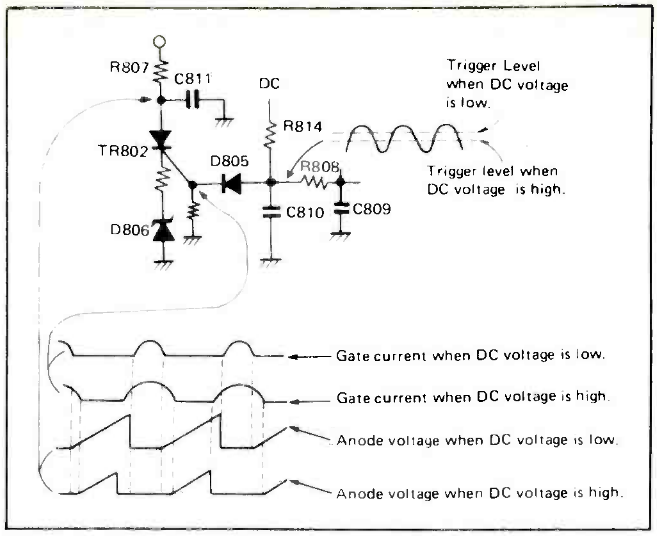

Fig. 4— The saw - tooth waveforms vary in form according to the level of the DC current supplied through resistor R814. *Courtesy Of Panasonic.*

grounded through a 1.8 ohm resistor which is inserted in series with the AC power source and chassis ground. This resistor reduces surge current from being applied to the rectifiers.

Voltage Regulating Circuit

The function and equivalent circuit elements of the voltage regulating circuit is shown in the simplified block diagram Fig. 3. Capacitor C808 is used to block DC current flow. The pulsating current which is divided by resistors R904 and R807 now becomes a sine - wave pulsating current formed by a high time constant integration circuit consisting of C809, R808 and C10. DC voltage is superimposed by resistors R813 and R814 with the pulsating current to obtain an AC waveform of 4 volts p-p without a triggering pulse from D805.

Diode D805 is used to determine the gate pulse trigger level to turn on thyristor TR802. The cathode side of the thyristor is previously set at a reference voltage of six volts by zener diode D806. When the gate input voltage exceeds this reference voltage, TR802 turns on. If the DC level which has been superimposed with the pulsating current of about 4 volts p-p increases gradually, as shown in Fig. 4, the triggering time is short when the DC level is low, and becomes long when the DC level is high. To detect voltage fluctuations and amplify them, the voltage is divided by resistors R816, R817, and R818. Resistor R817 supplies the triggering voltage for TR803, this voltage is then compared with the six - volt reference voltage. When the base voltage of TR803 increases, the collector voltage drops, and vice versa.

When the trigger pulse is applied to the gate, it causes current flow from the anode to the cathode and thyristor TR802 is abruptly discharged to approximately the six - volt reference voltage. When TR802 is turned off, charging takes place through C811, from the 30 - volt power source side. As a result, a saw - tooth waveform shown in Fig. 4 appears varying in form according to the level of the DC current supplied through R814. An inverted - sign wave appears at resistor R812 on the cathode side of TR802. If the voltage across C814 drops the base current of TR803 drops, and the collector voltage increases. As a result, the DC voltage on the anode of D805 increases, the gate period of TR802 widens, the conducting period becomes longer, and the cathode voltage of TR801 increases. Filter capacitor C814 smoothes the output pulse of TR801.

When the B+ voltage increases, the same circuit actions occur, and the B+ voltage is decreased by narrowing the gate period of TR802 and decreasing the conducting period of TR801. Variable resistor R817 stays fixed and the voltage is determined in the standard condition. Capacitor C821, C812 and resistor R815 are used to keep TR802 cutoff. The 30 - volt supply used for the power source of the stable circuit is regulated by resistors, R805, R806 and capacitor C817.

Video System

The video circuits employed in the ETA-12 chassis (Fig. 5) are simplified by using an integrated circuit, IC602, Type AN343, for the chroma demodulator, color difference and the second video amplifier circuits.

This integrated circuit receives chroma band signals from the Color Processing IC601, Type AN289 and delayed luminance video signal from the Video Processing IC151 Type AN331. The color processing amplifier also supplies a reference color subcarrier signal to the color demodulator in IC602.

The color difference signals received from IC602, drive the bases of the R, G, B output transistors TR351, TR352 and TR353. The luminance signal received from IC602 is fed through the video output emitter follower transistor, TR601, to the emitters of transistors TR351, TR352 and TR353.

This system produces a maximum of 120 volts peak RGB drive to the picture tube for 1 volt peak at the picture detector input to IC151.

As compared to the Quatrecolor chassis, the non - modular chassis design eliminates one IC and two transistors without a noticeable loss of performance. Although a ringing type of 3.58 MHz crystal oscillator is used for the non -

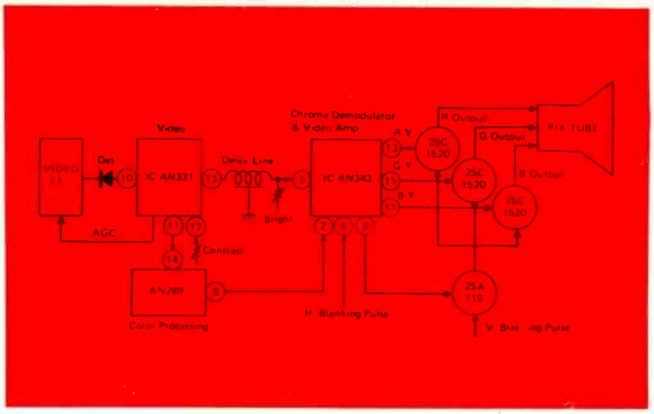

Fig. 5—Simplified block diagram showing the signal path of the video system. *Courtesy Of Panasonic.*

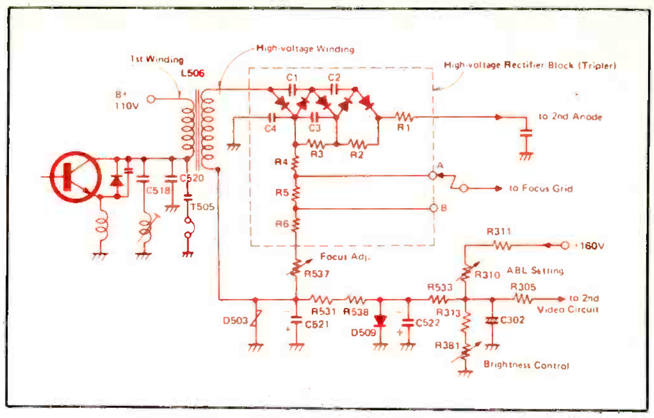

Fig. 6—Schematic diagram showing the ABL and high voltage output circuit used in the ETA-12 color TV chassis. *Courtesy Of Panasonic.*

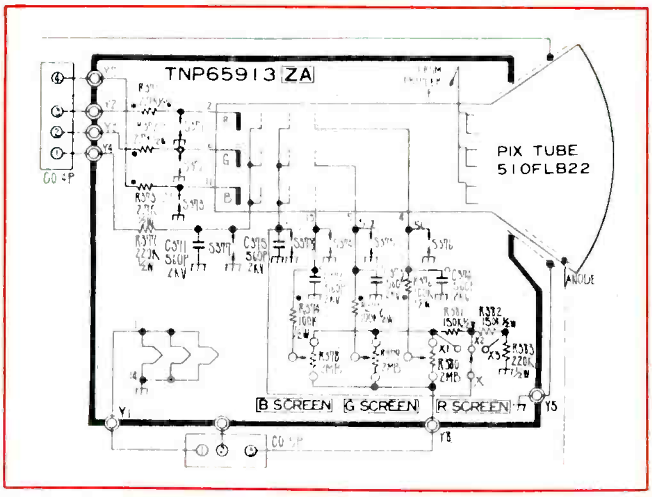

Fig. 7—Circuitry employed in color TV chassis using the new Quintrix pentode picture tube. *Courtesy Of Panasonic.*

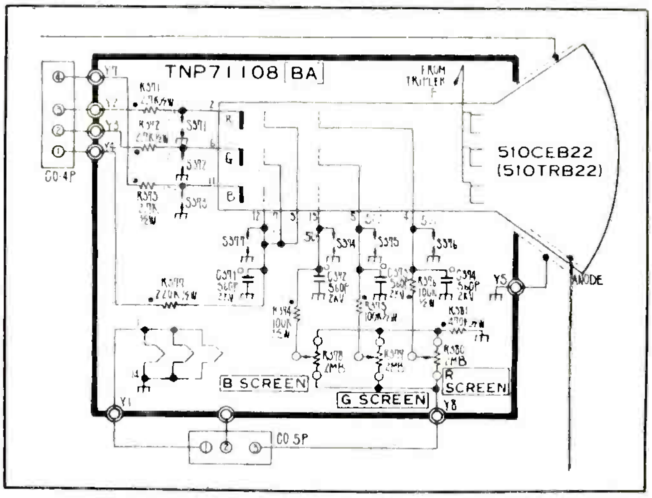

Fig. 8—Circuitry employed in color TV chassis using the regular tetrode picture tube. *Courtesy Of Panasonic.*

modular chassis, equivalent performance has been achieved.

The overall luminance video response is shaped for approximately 6 dB of peaking at 1.5 MHz, falling to about −3 dB at 2.8 MHz. The horizontal resolution is better than 250 lines and the apparent sharpness is enhanced by application of the appropriate overshoot or pre - shoot in the delay line or video amplifier.

Horizontal blanking is achieved by applying a shaped horizontal output transformer pulse to the second video amplifier in IC602 and a vertical output pulse blanks the video output emitter follower transistor TR601 during vertical retrace.

High Voltage Output Circuit

The picture tube second anode accelerating voltage is obtained through the tripler (Fig. 6) which rectifies the horizontal output pulse received from the high voltage winding of the flyback transformer. This transformer is tuned to the fifth higher harmonic wave by C518 and variable coil L506, stabilizing the high voltage pulse. The focus divider consists of resistors R4, R5, R6, and Focus Adjustment control R537. The variable range of R537 can be altered by connecting the focus grid wire to Point A or B. Resistors R2 and R3 are used to minimize the high voltage regulation to the low beam current and R1 is used to correct partial distortion of picture caused by incomplete DC high voltage filtering when a sudden change in beam current occurs.

Depending on the picture tube current, not only the horizontal output sustain electrical loss, but the picture tube itself deteriorates in purity which is caused by heating of the shadow mask. For these reasons and for sufficiency in X - ray radiation, it is necessary to restrict the current applied to the picture tube.

As the anode current increases, high - frequency current flows through the high voltage winding of the horizontal output transformer. Proportional current flows through R531, R538, R533, R310, R311 which are connected to the flyback at terminal 6, as if to compensate for the loss of energy.

The positive going pulse has a low impedance path becuase of D509, whereas, for the negative pulse, it increases in impedance.

When there is maximum beam current, the bias current of the second video amplifier input base is put into the negative going direction through R533, to reduce beam current. Resistor R310 is the ABL Setting control which adjusts the positive current from the 160 volt line to set the amount of beam current. Diode D502 is a device which protects the adjacent circuit elements from damage if the high voltage anode comes in contact with chassis ground.

Quintrix Picture Tube

The "Quintrix" color picture tube is employed on all 13 - inch 17 - and

continued on page 42

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Understanding Scope Specs — Part 2

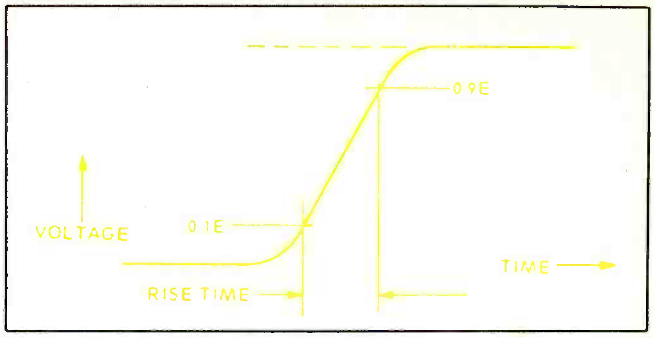


Fig. 9—"Rise time" is the time it takes the leading edge of a square wave to rise from 10 percent to 90 percent of its maximum amplitide.

■ In Part 1, AC and DC coupling and vertical amplifier bandwidth were discussed, followed by an introduction to vertical amplifier rise time. Part 2 begins with a review of the meaning of rise time and continues with an explanation of the effects of rise time and how it is measured, followed by analyses of horizontal amplifier characteristics and vertical amplifier sensitivity, accuracy and input impedance.

RISE TIME (TRANSIENT RESPONSE)

For an amplifier to faithfully reproduce pulses with steep leading edges, the amplifier must permit a very rapid rise in voltage. In a vertical amplifier, this allows the CRT beam to deflect very rapidly and to follow the nearly vertical edge of a steep pulse. This characteristic of the vertical amplifier is known variously as *rise time, transient response,* and *time response.* It is expressed by a number that is actually an interval of time. Before the rise time, or transient response, of a vertical amplifier can be well understood, it is necessary to understand the steep - sided pulses whose observation depends on this characteristic.

For precision in describing the steepness of the leading edge of a pulse such as a square wave, it is desirable to be able to express the steepness in numbers. This need leads us to the concept of the rise time of a wave, defined as the time required for the leading edge to rise from 10 percent of the peak value to 90 percent of the peak value. This is illustrated in Fig. 9.

Although the above definition is the generally accepted one, rise time is occasionally taken as the time required for the leading edge to rise from 5 percent of the peak value to 95 percent of the peak value. However, if this or any other definition other than the one given in the preceding paragraph is intended, the intended definition is given along with the rise time.

The rise time of a device that transmits waveforms or displays them is taken as the rise time of the displayed waveform resulting from a theoretically perfect square - wave input. A perfect square wave is impossible to obtain in practice, of course. In practice, the rise time of an amplifier or other device is determined using a square wave whose rise time is even *less* than the rise time of the amplifier or other device being tested.

(From Chapter 7, UNDERSTANDING & USING THE OSCILLOSCOPE, By Clayton Hallmark, TAB BOOKS, Copyright 1973. A review of the complete book follows this article.)

One thing of interest for our purposes here is the effect upon rise time when a theoretically perfect square wave is passed through two or more devices in cascade, or series. Suppose that device a has a rise time T_{ra}, and device b has a rise time, T_{rb}. If a theoretically perfect square wave were fed into the two devices in cascade, the rise time T_{ra} of the output wave should be

$$T_r = \sqrt{T_{ra}^2 + T_{rb}^2}$$

T_r is thus the rise time of the cascade combination of devices a and b.

For example, if a perfect square wave were fed into an amplifier having a rise time of 3 microsec, and if the output of this amplifier were fed into another amplifier having a rise time of 4 microsec, the rise time of the output T_r would be about 5 microsec.

Now, suppose we want to amplify or display a certain waveform, and suppose further that we want the rise time of the output or displayed waveform to be the same as that of the input waveform, within some specific tolerance. Using the chart in Fig. 10, which was constructed according to the formula given for T_r, we can find how good an amplifier or scope must be to achieve this result. For example, Fig. 10 shows that if we wanted to observe the rise time of a waveform whose rise time is 0.04 microsec, we would need a scope whose rise time is not more than 0.01 microsec if the error in the rise - time observation is to be kept to less than 3 percent.

Ideally, a scope should have a vertical system capable of rising in about one - fifth the time that the fastest (steepest) signal rises. In such a case, Fig. 10 shows that the rise time of the signal (as displayed on the scope) will only be in error by about 2 percent. Vertical systems having a rise time no better than *equal* to the rise time of the fastest signal to be observed are often considered adequate. Whether they are or not depends on the accuracy required. In any case, when the rise time of the scope is known, the rise time of the signal can be calculated from the rise time measured on the screen using the formula

$$T_s \sqrt{T_i^2 - T_o^2}$$

in which T_s is the actual signal rise time, T_i is the indicated rise time, and T_o is the scope rise time. The accuracy with which the rise time can be calculated decreases sharply for signals that rise faster than the verti-

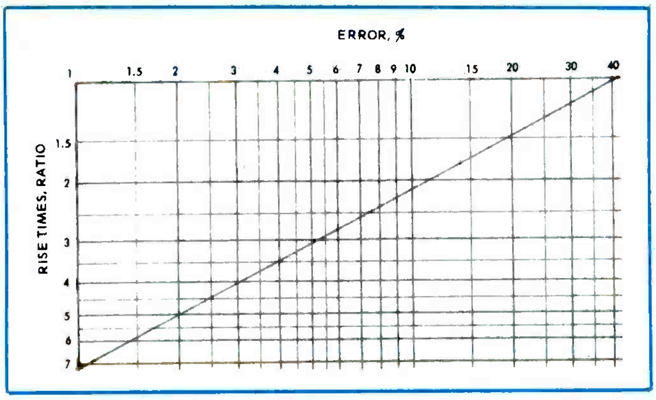


Fig. 10— The percent by which the output or displayed rise time exceeds the input signal rise time depends on the ratio of the amplifier or scope rise time to the input signal rise time.

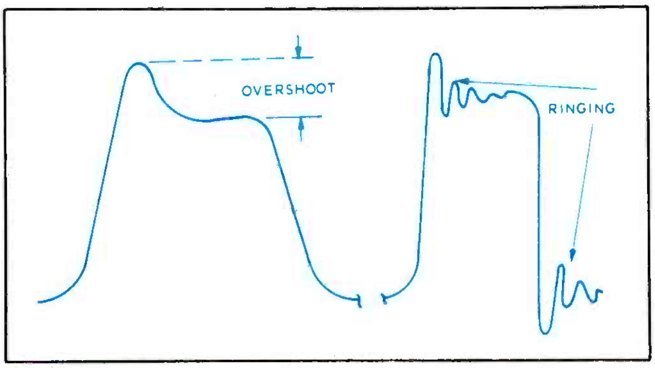


Fig. 11—To avoid overshoot and ringing, the product of rise time and the upper 3 dB frequency should be between .33 and .35.

cal system, because of the increased importance of measurement errors. To illustrate, the following sweep - timing or display reading errors will cause the calculated rise time to be in error by as much as 100 percent.

When T_o/T_s = 2/1;11 percent will cause a 100 percent calculation error.

When T_o/T_s = 3/1;5 percent will cause a 100 percent calculation error.

When T_o/T_s = 4/1;3 percent will cause a 100 percent calculation error.

When T_o/T_s = 5/1;2 percent will cause a 100 percent calculation error.

Thus, if the scope rise time is 5 times the signal rise time, an error of only 2 percent in sweep timing or display reading will result in a 100 percent error in the calculated rise time.

When the fastest sweep is relatively slow compared to the vertical system rise time, the leading edge of the displayed waveform will be steep, and the measurement will be confined to a small portion of the screen. Under these circumstances, the accuracy with which the display can be measured is reduced, and the accuracy with which the rise time of the signal can be calculated is greatly reduced.

Fortunately, very accurate rise time measurements are not required as often as rise time comparisons. For *comparing* the rise time of two signals, a scope rise time no better than the rise time of the signals is usually adequate.

The rise time and high - frequency response of scopes are two of the most important scope characteristics, and they are closely related. Rise time is the more important characteristic for "faster" scopes, and bandwidth is the more important one for "slower" scopes. The product of rise time and frequency should produce a number whose value lies between 0.33 and 0.35, if the scope is to display fast - rising signals without overshoot or ringing. Overshoot, as illustrated in Fig. 11, is an excessive initial response to a pulse signal. It is seen in a scope display as a peaking of the leading edge of a pulse. Ringing is a damped oscillation occurring in a signal as a result of an abrupt changing the signal. This defect in a pulse is also illustrated in Fig.11.

To illustrate the computation of the product of rise time and frequency response, the product of 0.023 microsec rise time and 15 MHz frequency is $0.023 \times 10^{-6} \times 15 \times 10^{-6} = 0.023 \times 15 = 0.345$. Since for optimum transient response the product should be between 0.33 and 0.35, a scope with the exemplary characteristics will have optium transient response; that is, it will reproduce steep signal waveforms without significant overshoot or ringing. A factor larger than 0.35 would indicate overshoot greater than 2 percent, and a factor larger than 0.4 would indicate overshoot greater than 5 percent.

You can calculate the rise time of your scope if you know the upper 3 - dB - down frequency of the scope, using the equation

$$T_r = \frac{K}{B}$$

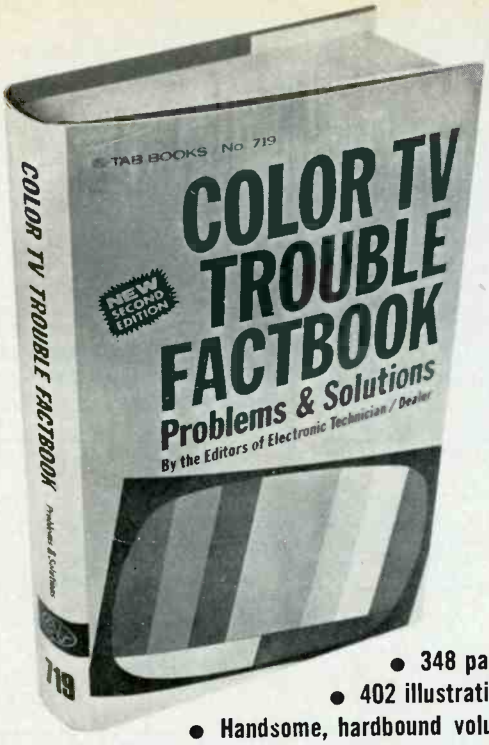
where K is 0.35, for an overshoot of less than 3 percent, and B is the upper frequency limit. For example, if the scope response is 10 MHz at the minus 3 dB point, the rise time is 0.035 microsec or 35 nsec (35×10^{9}sec). Such a scope can display a waveform with a rise time of 5 x 35 nsec, or 175 nsec, with a rise - time accuracy of 2 percent. Or, it can display a waveform with a rise time of 3x 35 nsec, or 105 nsec, with a rise - time accuracy of 5 percent. (See Fig. 10).

HORIZONTAL AMPLIFIER CHARACTERISTICS

Horizontal amplifiers are generally similar to vertical amplifiers, and in some cases are nearly identical. However, the performance requirements for horizontal amplifiers are not as stringent as those for vertical amplifiers.

The waveforms generated by the time - base (horizontal sweep) generator make less demand on the horizontal amplifier than signals that may be applied to the vertical amplifier make on it. As a result, the bandwidth of the horizontal amplifier may be about a third the bandwidth of the vertical amplifier.

Besides vertical amplifier response, another factor that limits the maximum presentable frequency of a scope is *sweep speed*. Since 1 MHz has a period of 1 microsec and 10 MHz has a period of 0.1 microsec, in order to display a single 10 MHz waveform on the screen, the sweep must take 0.1 microsec to span the trace. If it takes longer, more than one waveform will be displayed. A 10 MHz scope having a 1 microsec sweep means that you will see 10 waveforms on the sweep. The sweep speeds of most triggered - sweep scopes are set by a calibrated control at so many seconds or microseconds per division. The smaller the number, the faster the sweep and the higher the frequency that can be displayed as a single waveform. Many scopes are provided with



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some form of expansion for even faster sweep speed, making more detailed examination of fast signals possible.

In order to examine one particular part of a waveform, there are two different methods. One is to increase the horizontal gain so that the pattern goes off the screen at both sides, and the trace is thus expanded. Another method, to be discussed further in a later chapter, is to delay the sweep trigger and to use a very fast sweep. This method, *calibrated sweep delay,* has a number of advantages, but it increases the cost of the scope.

The overall speed of response of a scope depends on both sweep speed and on rise time. A figure of merit rating that can be used to express the overall response speed of a scope is the ratio of the vertical system rise time to the time - per - division of the fastest sweep.

Sweep speed is usually continuously adjustable over the total range of the sweep speeds. Usually, continuous coverage between the lowest and highest speeds is provided by a step - type range control, which clicks in at definite speeds, and by a vernier control, which permits continuous coverage between the speeds selectable by the range switch.

The vernier sweep - time - per - division may or may not be calibrated. This control allows us to spread or compress a waveform so that it occupies a certain desired number of graticule divisions, as might be desired for making phase measurements. The control is even more useful if it is calibrated, since calibrated sweep allows fractional time measurements to be made without using subdivisions of the graticule scale.

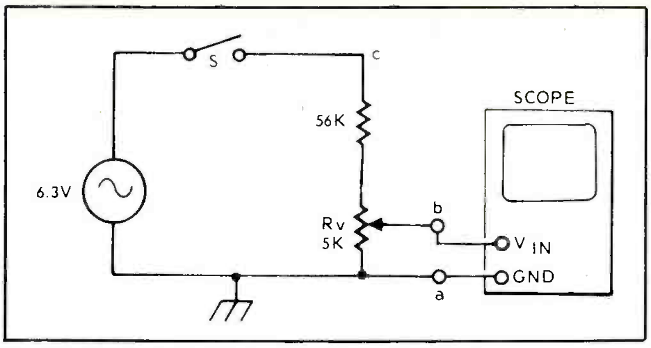


Fig. 12—Test setup for determining scope sensitivity.

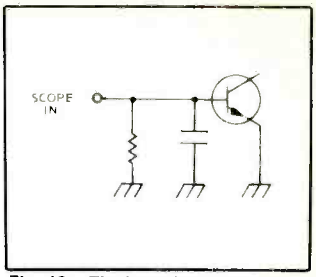


Fig. 13—The input inpedance of the vertical amplifier of a scope consists of paralleled resistance and capacitance.

VERTICAL SENSITIVITY

This characteristic is related to the deflection sensitivity of the CRT and to the gain of the vertical amplifier. The deflection sensitivity is the amount of deflection caused by 1v applied to the deflection plates. This is an inherent characteristic of the CRT, and for most tubes is about 0.1 cm per volt. In other words, 1 v on the deflection plates produces 0.1 cm of CRT beam deflection. The deflection sensitivity of the CRT limits the minimum and maximum signals that can be measured. Also, the deflection sensitivity limits practical direct measurements to 1v minimal signal, since smaller signals would cause a display amplitude even less than 0.1 cm. Deflection sensitivity and screen size also fix the maximum measurable level. If the voltage at the deflection plates times the deflection sensitivity is greater than the screen size permits, the beam will be deflected off screen.

Inserting a probe and an amplifier between the signal source and the vertical deflection plates increases deflection sensitivity and isolates the signal source and the CRT. This vertical deflection system, by including an amplifier, implies voltage gain. Vertical amplifiers increase *deflection sensitivity.* They increase the deflection that a signal voltage can cause. Also, the amplifiers contain calibrated step control of gain and attenuation, thereby extending input deflection sensitivity from, perhaps, 0.04 div /v to 100 div/v in several steps.

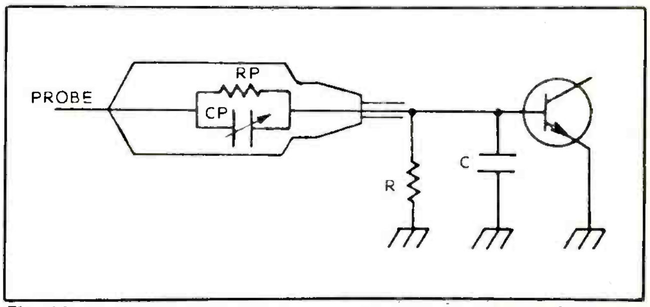


Fig. 14—A passive probe can improve the input impedance of a scope.

Since division - per - volt terminology usually requires calculation for practical observations, vertical deflection sensitivity is usually expressed in terms of *deflection factor*. Deflection factor is the *inverse* of deflection sensitivity, and is expressed in volts per division. Here's an example: If a CRT has a deflection sensitivity of 0.1 cm per volt, it has a deflection factor of 10 volts per cm. If the amplifier has a gain of 1000, the vertical deflection sensitivity will be increased to 100 cm per volt, and the deflection factor, the sensitivity of the scope itself, will be 0.01 volt per cm, or 10 m v per cm.

If the specs for a scope give the vertical sensitivity as 10 m v per cm, this means that an applied signal of 10 m v at the vertical input terminals will produce a 1 cm vertical deflection with the vertical gain turned all the way up.

If you do not know the vertical sensitivity of your scope, you can determine it by use of the following procedure.

1) Connect the circuit of Fig. 12, connecting the output of the voltage divider to the vertical input of the scope to be checked.

2) Set the vertical attenuator and vertical gain controls for maximum vertical gain. Adjust voltage divider level control R for a signal giving 1 cm of vertical deflection on the CRT.

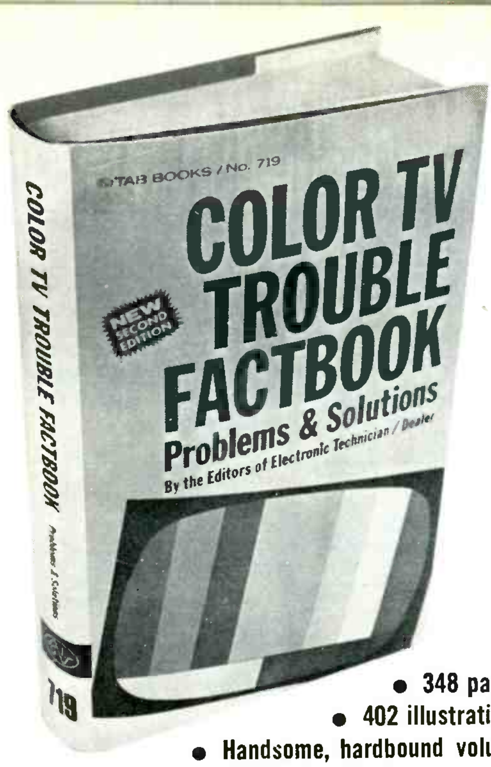
3) Open switch S and measure the resistances Rab and Rbc. Substitute the measured resistances in the formula:

mv per cm, sensitivity =

$$\frac{R_{ab}}{R_{bc}} \times 6.3 \times 2.828 \times 103$$

VERTICAL ACCURACY

Vertical accuracy is a measure of the distortion produced in the vertical deflection system, and is stated as a percentage. If a scope has a vertical accuracy of 3 percent — a very good accuracy, by the way — then once the scope is calibrated, it should be possible to measure voltages with an accuracy of 3 percent or better. If, for example, a scope with a vertical accuracy of 3 percent is calibrated for 20v per div, a deflection of 5 div will indicate an amplitude no less than 97v and no greater than 103v. The accuracy of good modern scopes var-



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Truetone—Chassis 2DC4815.

Westinghouse—Chassis V2655; V2656; V-8001

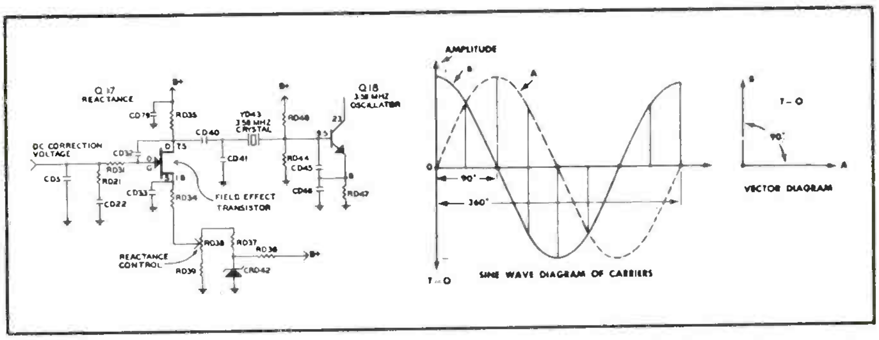
Zenith—Chassis 12A13C52; 14A9C51; 19-DC12; 19DC22; 19DC28; 25DC57; 20X138.

Twice the size of the bestselling original, this newly updated edition is a fully indexed all-in-one reference guide to color-set troubles and recommended solutions, manufacturers' service notes, and production change data—all alpha-numerically arranged by manufacturer and model. This low-cost handbook contains service tips, troubleshooting data, and special problem-solving aids for all the more popular U.S. and Canadian color TV makes and models, from A (Admiral) to Z (Zenith).

But that's not all! Included also are details concerning repetitive troubles, field-factory changes, new and unusual circuits and descriptions of how they work, special adjustment procedures and other such pertinent service information. Of particular importance are the manufacturer's production changes —this book includes a detailed accounting of such changes where they might logically affect set performance and where the technician might replace a "factory" component with an unsuitable substitute.

This book should be considered a "must" for every practicing professional TV service specialist . . . the information it contains may easily save you hours of time repairing a "tough-dog" color TV. Partial schematics, location diagrams, chassis layouts, and sketches are included as necessary to make every entry easy to understand and simple to implement in the field. To our knowledge, no other single volume contains so much easy-to-find information about so many individual models and brands of color receivers. A complete cross-reference index is provided to enable you to quickly find the specific material you need. In all, over 600 specific items are included.

The material provides instant solutions to many color TV circuit troubles, enabling you to diagnose and repair hundreds of otherwise difficult-to-solve problems. If you service color TVs, this organized file of data will pay for itself time and again. 348 pps., hundreds of schematics and diagrams. Hardbound. Publisher's list price $8.95.



Literally hundreds of complete and partial schematics and illustrations make each of the over 600 entries in "Color TV Trouble Factbook" easy to understand.

AN EXTRAORDINARY OFFER...

...for more details circle 104 on Reader Service Card

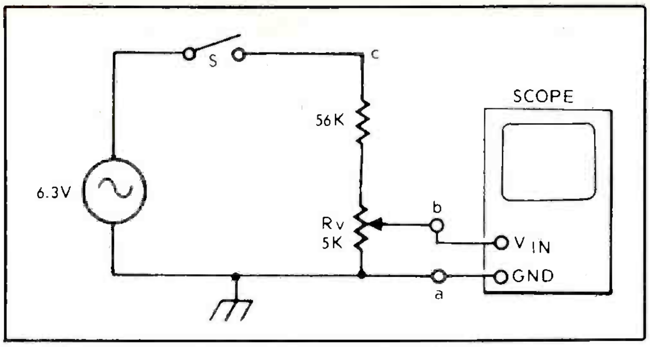


Fig. 12—Test setup for determining scope sensitivity.

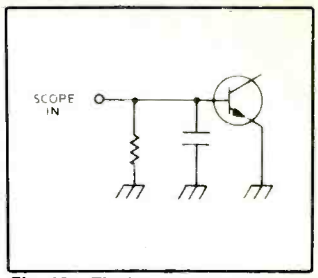


Fig. 13—The input inpedance of the vertical amplifier of a scope consists of paralled resistance and capacitance.

some form of expansion for even faster sweep speed, making more detailed examination of fast signals possible.

In order to examine one particular part of a waveform, there are two different methods. One is to increase the horizontal gain so that the pattern goes off the screen at both sides, and the trace is thus expanded. Another method, to be discussed further in a later chapter, is to delay the sweep trigger and to use a very fast sweep. This method, *calibrated sweep delay,* has a number of advantages, but it increases the cost of the scope.

The overall speed of response of a scope depends on both sweep speed and on rise time. A figure of merit rating that can be used to express the overall response speed of a scope is the ratio of the vertical system rise time to the time - per - division of the fastest sweep.

Sweep speed is usually continuously adjustable over the total range of the sweep speeds. Usually, continuous coverage between the lowest and highest speeds is provided by a step - type range control, which clicks in at definite speeds, and by a vernier control, which permits continuous coverage between the speeds selectable by the range switch.

The vernier sweep - time - per - division may or may not be calibrated. This control allows us to spread or compress a waveform so that it occupies a certain desired number of graticule divisions, as might be desired for making phase measurements. The control is even more useful if it is calibrated, since calibrated sweep allows fractional time measurements to be made without using subdivisions of the graticule scale.

VERTICAL SENSITIVITY

This characteristic is related to the deflection sensitivity of the CRT and to the gain of the vertical amplifier. The deflection sensitivity is the amount of deflection caused by 1v applied to the deflection plates. This is an inherent characteristic of the CRT, and for most tubes is about 0.1 cm per volt. In other words, 1 v on the deflection plates produces 0.1 cm of CRT beam deflection. The deflection sensitivity of the CRT limits the minimum and maximum signals that can be measured. Also, the deflection sensitivity limits practical direct measurements to 1v minimal signal, since smaller signals would cause a display amplitude even less than 0.1 cm. Deflection sensitivity and screen size also fix the maximum measurable level. If the voltage at the deflection plates times the deflection sensitivity is greater than the screen size permits, the beam will be deflected off screen.

Inserting a probe and an amplifier between the signal source and the vertical deflection plates increases deflection sensitivity and isolates the signal source and the CRT. This vertical deflection system, by including an amplifier, implies voltage gain. Vertical amplifiers increase *deflection sensitivity.* They increase the deflection that a signal voltage can cause. Also, the amplifiers contain calibrated step control of gain and attenuation, thereby extending input deflection sensitivity from, perhaps, 0.04 div /v to 100 div/v in several steps.

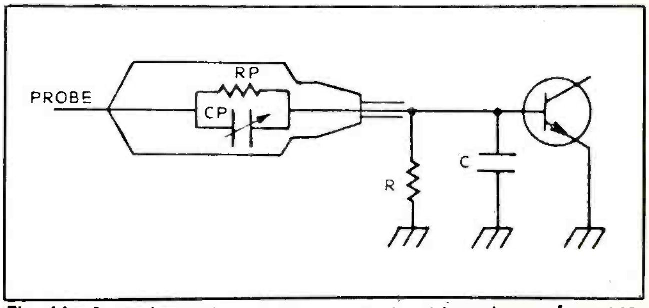


Fig. 14—A passive probe can improve the input impedance of a scope.

Since division - per - volt terminology usually requires calculation for practical observations, vertical deflection sensitivity is usually expressed in terms of *deflection factor.* Deflection factor is the *inverse* of deflection sensitivity, and is expressed in volts per division. Here's an example: If a CRT has a deflection sensitivity of 0.1 cm per volt, it has a deflection factor of 10 volts per cm. If the amplifier has a gain of 1000, the vertical deflection sensitivity will be increased to 100 cm per volt, and the deflection factor, the sensitivity of the scope itself, will be 0.01 volt per cm, or 10 m v per cm.

If the specs for a scope give the vertical sensitivity as 10 m v per cm, this means that an applied signal of 10 m v at the vertical input terminals will produce a 1 cm vertical deflection with the vertical gain turned all the way up.

If you do not know the vertical sensitivity of your scope, you can determine it by use of the following procedure.

1) Connect the circuit of Fig. 12, connecting the output of the voltage divider to the vertical input of the scope to be checked.

2) Set the vertical attenuator and vertical gain controls for maximum vertical gain. Adjust voltage divider level control R for a signal giving 1 cm of vertical deflection on the CRT.

3) Open switch S and measure the resistances Rab and Rbc. Substitute the measured resistances in the formula:

mv per cm, sensitivity =

$$\frac{R_{ab}}{R_{bc}} \text{ x } 6.3 \text{ x } 2.828 \text{ x } 103$$

VERTICAL ACCURACY

Vertical accuracy is a measure of the distortion produced in the vertical deflection system, and is stated as a percentage. If a scope has a vertical accuracy of 3 percent — a very good accuracy, by the way — then once the scope is calibrated, it should be possible to measure voltages with an accuracy of 3 percent or better. If, for example, a scope with a vertical accuracy of 3 percent is calibrated for 20v per div, a deflection of 5 div will indicate an amplitude no less than 97v and no greater than 103v. The accuracy of good modern scopes varies between about 2 and 5 percent. In general, the more expensive the scope, the greater the accuracy.

HORIZONTAL ACCURACY

In addition to the accuracy of the vertical deflection system, we are also concerned with the accuracy of the time base. This is specified in terms of the maximum error in the timing of the sweep over the full width of the sweep, for any calibrated sweep. A calibrated sweep is one selected with a sweep frequency control that gives a direct reading in *time* units. Depending on scope type and manufacturer, calibrated ranges are available between a range minimum of 1 ns per cm, and a range maximum of 1 microsec per cm to 5 sec per cm. If the time - base accuracy is specified as 3 percent, for example, the time required to make a full horizontal sweep should not be less than 97 percent nor more than 103 percent of the time indicated by the sweep - speed setting. If, then, the sweep speed is set at 1 microsec per cm, and if the full - scale sweep is 10 cm, a 3 percent time - base accuracy means that the sweep may cover the full - scale distance in as little as 9.7 microsec, or as much as 10.3 microsec. Time - base accuracy is important when accurate time measurements are to be made.

It is also important to make a distinction between time - base accuracy and *sweep linearity,* to which time - base accuracy is related. Time - base accuracy is highly dependent on sweep linearity. However, basing the accuracy on the full - scale sweep has the effect of averaging the various rates of horizontal sweep that may occur during one complete sweep. There are various kinds of sweep nonlinearity, and several of them may be present in the same scope. The most common involves slowness at the beginning and end of the sweep, with the fastest sweep rate occurring near the center of the sweep. Since there is no generally accepted way of specifying linearity, it is not included in the specifications of a scope.

VERTICAL INPUT IMPEDANCE

The input impedance to the vertical amplifier can be simulated by a high resistance shunted by a small capacitance, as in Fig. 13. Since capacitive reactance varies with frequency, in order for the impedance spec to hold for all frequencies, it is expressed in terms of resistance and capacitance, rather than in terms of resistance and capacitive reactance. It may be referred to by such names as input RC, and input time constant. The resistive part of the spec is typically 1 megohm, and the capacitive part is typically 15 to 50 pF.

In some applications, even this high resistance and small capacitance may produce undesirable loading of the circuit whose waveforms are being observed. In other words, the loading can cause different waveforms to be displayed than would exist with the scope disconnected, and thus can give a misleading presentation. To minimize this loading, a passive probe, that is, one containing no amplifying device, may be used with the scope. Such a passive probe may consist of a parallel resistor and capacitor, as in Fig. 14. The result of using the probe is that there is connected to the circuit being investigated a new effective loading capacitance smaller than the original capacitance and a new effective loading resistance larger than the original resistance. Thus the loading effect of the vertical input circuit is reduced through the use of a probe, and the input resistance might be increased to 10 megohms, say, and the capacitance might be decreased to perhaps 10 pF. ■

TECH BOOK REVIEW

Understanding & Using The Oscilloscope

(TAB BOOK NO. 644)
Author: Clayton Hallmark
Price: $7.95 Hardbound
$4.95 Paperback
Published: July, 1973
Size: 272 pages

An authoritative, comprehensive source of technician - oriented information about the circuit theory, features, specifications, operating procedures and applications of simple and advanced oscilloscopes.

Chaper 1 describes the composition of sine and complex waveforms typically encountered by service technicians. Chapter 2 describes the physical and electrical design of the CRT and the fundamentals of scope deflection and time - base circuits.

Chapter 3 provides a thorough but concise explanation of the operation and functions of recurring and triggered sync and sweep circuits.

The operations of the various functional systems in a typical triggered - sweep scope are described in Chapter 4. Included are the input attenuator, vertical amplifiers, sweep generator, horizontal amplifier, power supply and the various types of probes commonly used by service technicians.

Chapters 5 and 6 outline the setup, calibration and specific applications of a triggered - sweep scope which is representative of those available to and typically used by service technicians.

Chapter 7 thoroughly explains the specifications which a technician must consider when selecting a scope to fit his particular needs.

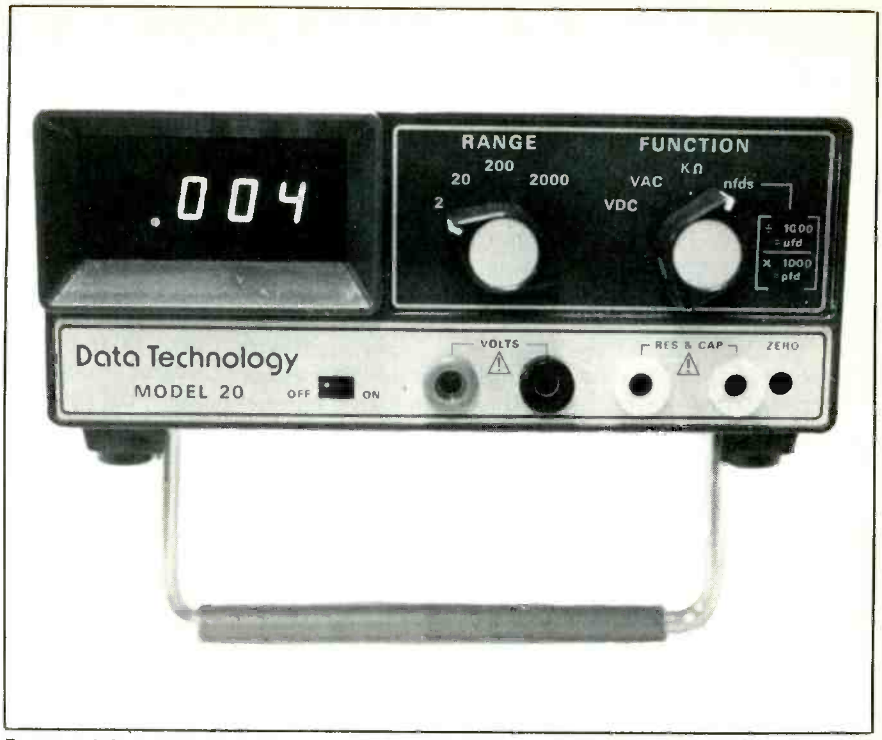
The special features and applications of dual - trace, dual - beam, storage, sampling and other "advanced" types of scopes are described in Chapter 8. CRT - equipped special - purpose test instruments such as spectrum analyzers, engine analyzers, vectorscopes and semiconductor curve tracers are examined in Chapter 9.

The final chapter discusses relatively uncommon yet simple applications of scopes. These include strain gage measurements, production testing, time - domain reflectometry and CRT screen photography.

Well written and profusely illustrated, this text is must reading for any service technician who now uses or plans to use any type of oscilloscope.

CONTENTS: Functional Basics — The Cathode-Ray Tube — Sweep Circuits — Oscilloscope Circuitry — Setup, Calibration And Use — Scope Versatility in Testing — Understanding Scope Specs — Advanced Scopes — Special Purpose Instruments — Sophisticated Techniques. ■

TEST INSTRUMENT REPORT



For more information about this instrument, circle 100 on the Reader Service Card.

DATA TECHNOLOGY MODEL 20 DMM

■ Servicing of electronic equipment often requires replacing capacitors. Many of us use substitution or other methods of troubleshooting for a defective capacitor because we don't have the additional equipment required to make capacitor measurements. If we employ conventional methods, it becomes a time consuming test setup.

Data Technology has introduced the Model 20 DMM that not only provides DC volts, AC volts and ohms measurements but capacitance measurements as well in one instrument package.

The instrument is small, measuring only 2.5 inches by 6.25 inches by 9 inches, and it weighs just 3 lbs. It features a high - impact case and a single printed - circuit board, with components mounted flat for maximum strength. The unit can be field stripped in seconds by pulling out on two fasteners on the rear of the cabinet. The top and bottom of the cabinet can then be removed for servicing or calibration, if required. The five - step calibration instructions are clearly printed on the inside of the top cover.

The operation of the instrument is simplified by employing one knob for the setting and the other for the function selection. A flashing display indicates an input greater than the selected range. A 2 - inch stand makes viewing of the readings easier and acts as a carrying handle.

The IC circuitry used yields a low component count and low power drain, eliminating heat build - up, crowded circuitry and keeps the production costs down.

When taking capacitance readings, a shielded wire should be used because the long leads can introduce noise into the component readings. Effective lead shielding methods are given on the bottom of the case. Clip - on terminals are provided, eliminating the use of the long test leads for out - of - circuit readings of resistance or capacitance.

Capacitance is measured by employing an integration technique, whereby dV/dt (the rate of change of voltage with respect to time) is a function of the unknown capacitance.

Capacitors with severe leakage affect the readout in the following two ways: 1) a higher capacitance readings and/or 2) the readings are not duplicated on another range. For example,

When: R_{LEAK} C_{FS}= Error= 1%
Where: R_{LEAK}= Leakage Resistance (Megohm)
C_{FS}= Full Scale Capacitance (μF)

Example: A capacitor with 1 megohm of leakage produces a 1 percent readout error when measured on the 0-2000 nf range.

This instrument is capable of measuring DC voltages (range +2 volts to + 1000 volts; resolution 1mv to 1000mv), AC voltages (range 2 v rms to 800 v rms; resolution 1 mv to 1 volt) and resistances (ranges 2 K to 2 megohm; resolution 1 to 1000 ohms) plus capacitance (range 2nf 0.002, μf to 2000 nf 2, μf; resolution 1 pf to 0.001 μf). The input impedance in the DC measuring mode is 10 megohms, and 10 megohms shunted by 40 pf in the AC measuring mode. The conversion time is 40 ns. The display employs ⅓ - inch Sperry glow - tubes and flashes for counts greater than 199 (over range indication.)

The options include: Rack Mount (single), Rack Mount (side - by - side), Test Lead Kit, Carrying Case, High - Voltage Probe (30 kv), 115 v rms Power, 230 v rms Power, 100 v rms Power and IC Sockets. Price is $199.

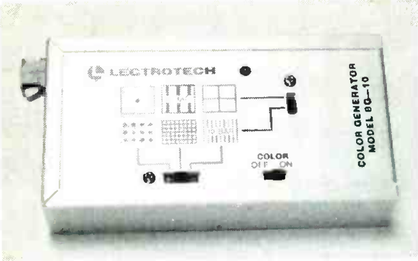
LECTROTECH MODEL BG-10 COLOR GENERATOR

A portable color generator, compact and light enough to be carried in your pocket or tube caddy, provides all test signals and patterns required for color TV setup and convergence.

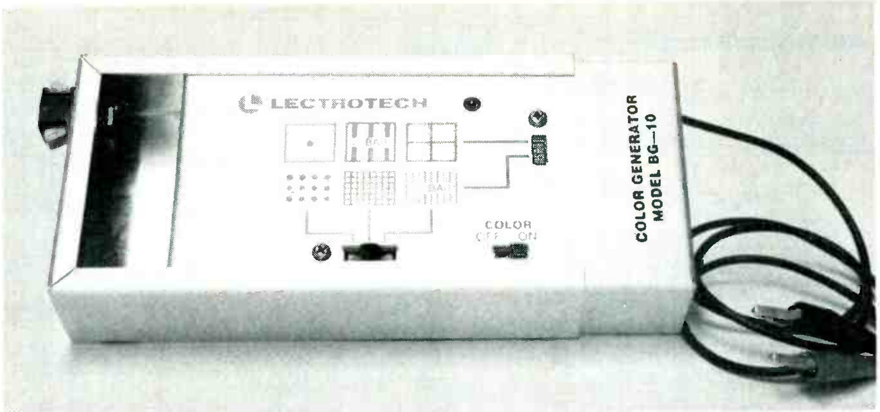
This instrument is contained in a metal case with a self - contained cable compartment for the RF output cable. It measures 3 inches wide by 5½ inches long by 1¼ inches deep. A protective carrying pouch is available as an optional accessory.

The basic stability of a bar generator is determined by the frequency divider circuitry, sometimes referred to as the counters. This pattern generator employs digital logic to perform all counting functions to achieve a high degree of stability. As a result, there are no internal adjustments and its accuracy is not affected by temperature changes.

The RF output signal available from this unit can be adjusted for channels 3, 4 or 5. The RF oscillator coil is factory tuned to chan-



For more information about this test instrument, circle 101 on the Reader Service Card.



Lectrotech Model BG 10 Color Generator shown in the open position which automatically switches on the power.

nel 4. This channel output can be changed by adjusting a coil which is accessible through a small opening in the side of the unit when it is in the *ON* (open) position. When the unit is in the *OFF* (closed) position, this coil is not accessible. Turning the slug clockwise will increase the frequency to that of channel 5. Turning the slug counterclockwise will decrease the frequency to that of channel 3. A standard .078 - inch hex - head alignment tool is required to make this adjustment.

The *on/off* switch function is automatic to prevent accidentally leaving the instrument on after use and draining the batteries. When the unit is opened to expose the RF output cable, an internal switch automatically turns *on* the power. When the unit is closed again, the internal switch turns *off* the power. The LED *on/off* indicator, which is located on the upper center of the front panel, is also turned on and off by the internal on/off switch.

The various patterns are selected by the use of two slide switches. They are the three - position main *Pattern Selector* and the two - position *Row Selector* switch. The main *pattern selector* selects those patterns displayed in the vertical column, while the *row selector* selects the top or bottom horizontal row. For example: if the *DOT* pattern were to be selected, turn the pattern *selector* switch to the *dots* position. If you wished to display the *three - bar* color pattern, the pattern selector switch would be placed in its center position and the *row selector* switch would be placed in its upper position.

When the three - bar color pattern or the ten - bar gated rainbow patterns are to be selected, the *color on/off* switch must be placed in the *on* position. This switch is located to the right of the main *pattern selector* switch. If this switch is not turned on only black - and - white bars will be displayed. Noted: when b - w patterns are being used, this switch must be in the *off* position; otherwise, because of the presence of the color signal, the display will not be clear and stable.

The six patterns that are produced by this instrument are:

Single Dot — The dot pattern is used mainly for static convergence.

Crosshatch — The full crosshatch pattern is used for observing both vertical and horizontal linearity and for all dynamic convergence procedures

Single Cross — The single - cross pattern is used to determine the exact center of picture. It is also used to evaluate convergence in the center of the picture tube in both the vertical and horizontal plane

Three Color Bars — The three - bar pattern is most useful when used in conjunction with a vectorscope. With only three bars on display, the vector patterns can be more easily interpreted

Ten Color Bars — The color bar pattern is used to test the performance of the chroma circuits. It is most useful in troubleshooting the chroma circuits when a standard known signal must be used.

When using the color generator to service a color TV receiver, the fine tuning should be correctly adjusted; thereafter it will not be necessary to retune the receiver as the generator is switched from pattern to pattern.

The proper method of tuning the TV receiver is to use the cross hatch pattern. Turn the fine tuning knob of the TV receiver in the direction that would produce sound beats on a live TV signal. As the fine tuning is rotated in this direction, the vertical lines will become dim and then disappear. Turn the fine tuning in the opposite direction until the vertical lines become sharp and clear.

If the receiver employs a *picture peaking* control, set this control to the position that produces the sharpest picture. In the *soft* position, the vertical line brightness will be severely reduced. Always operate the TV receiver at the lowest brightness and contrast levels consistent with adequate viewing for the sharpest clearest lines. Excessive receiver contrast and brightness will cause the TV receiver to defocus on the bright white lines.

The instrument is powered by two 9 - volt batteries and is priced at $89.50.■

TECHNICAL DIGEST

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

MAGNAVOX

Radio Chassis R243/4/5/7—Output Failures

Bias diodes D401 and D402, will often be damaged when a multiple - component output failure occurs on these chassis. These diodes are difficult to test in the chassis, and they may be overlooked when replacing the other damaged components. Consequently, repeat failure will occur. Every time a multiple - component output failure occurs on these chassis D401 and D402 should be replaced, to guard against a repeat failure. After repairs are completed, be sure to perform the bias adjustment on the amplifiers.

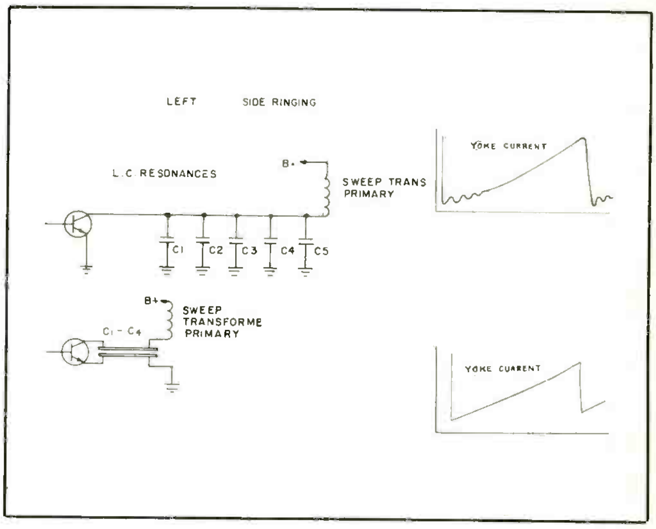
ZENITH

Color TV Chassis 17/19EC45—Ringing on The Left Side Of Raster

The following information is devoted to changes that have been made in color TV chassis to improve their performance and reliability. These changes have been incorporated since the "E" line was introduced. Included are the reasons why the changes were made and the components concerned.

Critical Safety Componet — New four lead capacitor in the horizontal output circuit.

Shown in the illustration are several redundant retrace capacitors. These capacitors are required to guard against excessive high voltage in the event of a single unit failure mode. Guide lines laid down by HEW rules forbid the use of a single "lumped value" capacitor with a single common ground return. Several redundant value capacitors were spread out at widely spearate locations within the horizontal output circuit in order to conform with HEW regulations. The wiring required with the use of redundant capacitors could, in some instances, produce an undesirable ring effect. A new and unique 4 - lead capacitor has been designed and developed. It is installed on the horizontal output transistor heat sink as shown in the illustration. One feature of this new capacitor is that if there is an open



mode failure, the DC current path is removed from the horizontal output transistor and renders it inoperable. This feature completely eliminates any possibility of "excessive" high voltage being developed which could result from the open mode failure of any one of the redundant capacitors now in the chassis. The compactness and short - lead connections of this new capacitor also prevents the development of multiple resonance.

Do not install this capacitor on a receiver which is not equipped with one at the date of manufacture.

A second possible cause of ringing on the left side of the raster was found in the B+ supply to the Video IF module. Under certain conditions ringing in the horizontal circuit could be introduced into the +24 volt supply, and then into the video IF stages, and finally into the video stages where it might show up as ringing on the left side of the picture. In order to minimize this possibility, the +24 volt supply for the IF strip was changed from terminal U4 on the sound module to a filtered + 24 volt supply source at terminal W13 on the AGC - Sync module.■

NEW IN COLOR...

continued from page 30

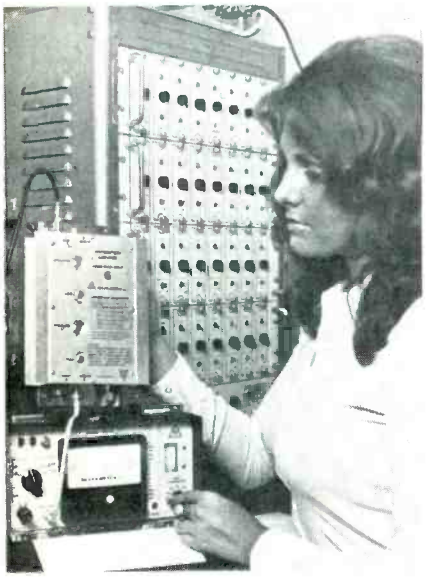
19 - inch (diagonal) model color TV sets. This picture tube is a negative guardband black matrix picture tube which employs the Quintrix electron gun having an additional prefocus grid. It is the pentode type rather than the conventional tetrode type. The tube has the delta configuration in 90 - degree versions whereas the 110 - degree 19 - inch version employs in-line guns and slotted type mask.

The circuit arrangements for the Quintrix picture tubes are shown in Fig. 7 and the regular tetrode picture tube circuits in Fig. 8. The potential of G_2 has an influence on the cut - off point, therefore, a three - position tap is provided to optimize the voltage on the additional electrode.■

NEW PRODUCTS

MATV DISTRIBUTION AMPLIFIER 135

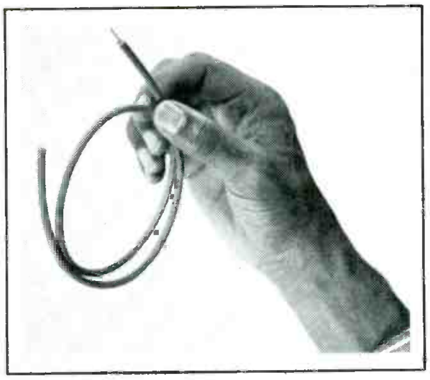
Delta - Benco - Cascade has introduced a CATV apartment house amplifier for the MATV market. The DA-60 is a push - pull, high - output level, broadband (40 - 300 MHz) amplifier which is ideal for large apartment complexes. This amplifier on a 12 - channel system can be driven to — 60 dBmV without noticeably affecting the picture quality. With a wide range



of gain and tilt controls, it has a flat operating gain of 45 dB which can be reduced to 10 dB with two switchable attenuators and continuous gain control. The 15 dB switchable attenuators can be preadjusted to the required values, knowing the approximate input level, and the design output level. All settings are shown on the cover plate. Price is $175.

HIGH VOLTAGE TV WIRE 136

The Wire and Cable Business Dept. of *General Electric Co.* has developed a thin - wall, flexible wire for high - voltage television applications. The wire is rated at 15 and 20 VDC, complements the departments 30 and 40 kv DC TV wire. The flexible wire surpasses all applicable UL requirements, including the mechanical cut - through test. The insulation cut - through strength was increased by adding a 5 mil nylon extrusion over



the Vulkene insulation of the 15 and 20 kv DC wires. Heavier wall insulation on the 30 and 40 kv DC sizes provides ample protection, eliminating the need for the nylon to meet the requirements.

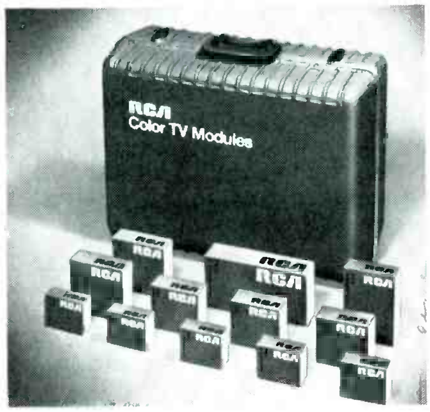
SUBSTITUTE TUNER 137

Added to the *Telematic* Kaddy Mate line is the AC powered, Model KTE - 725 Tuner - Mate. The unit operates on all VHF channels with the capability

of checking an existing UHF tuner by mixing it through its own UHF tuner channel strip. The tuner is of the latest solid - state design with low current drain. It can be used as a substitute unit while the original tuner is being repaired, allowing continued use of the TV set.

COLOR TV MODULE CADDY 138

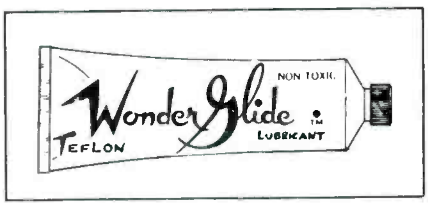
RCA Parts and Accessories has introduced a bigger and better color TV module caddy. The caddy allows service technicians to carry a larger selection of the modules needed to service RCA modular TV chassis. It comes with one each of the 12 most frequently used RCA modules, and has twice the capacity of the former RCA caddy. There is ample storage



space, both in the bottom and in the lid, to hold extras of all the modules currently available. Other items such as the RCA Home Service Handbook, the XL - 100 Components Kit, or certain tools can be placed in the caddy. The slim design also makes it easy to handle and measures only 8 inches deep. The price is $118, with a full complement of modules.

TEFLON LUBRICANT 139

Wonderglide Lube Products Corp. has introduced a lubricant called Wonder - Glide™, which has many uses in electronics. It can be used to lubricate TV tuners, switches and



other moving parts, including telescoping antennas. Since it prevents rust, an application of the lubricant on antenna elements will lengthen their lives. In addition, it can be used to

MEDICAL ELECTRONICS...

Continued from page 23

representation for O-300 BPM, allowing the use of a simple voltmeter as the readout device. (This also simplifies servicing.)

PATIENT SAFETY FACTORS

Many of us have seen published accounts of how little current it takes to kill. Most of these accounts state that 300 milliamperes is the "lethal level of current." This is true only through *intact* skin. In certain hospital situations in which the body is "invaded," a much lower level of current is lethal. Although there is much debate over just how low the lethal level is, most authorities accept 10 *micro*amperes as the maximum safe level of uncontrolled current which should be allowed to flow in a patient's body. This becomes a concern for the servicer because of leakage currents existing on the chassis and cabinets of equipment being serviced. Capacitive coupling between the AC power wiring and the chassis causes a minute current to flow on the chassis. A ground wire, the so-called "third-wire," in the power cable drains the leakage current harmlessly off to ground. Consequently, not only is it essential that the servicer check for ground continuity, he should also check for proper tension of the ground lug on the power plug. If that stud is bent or flattened or if the spring in the wall socket is weak, insufficient contact force will cause a weak ground. Typical leakage current values for a poor but present ground are three or four times the maximum limit of 10 microamperes.

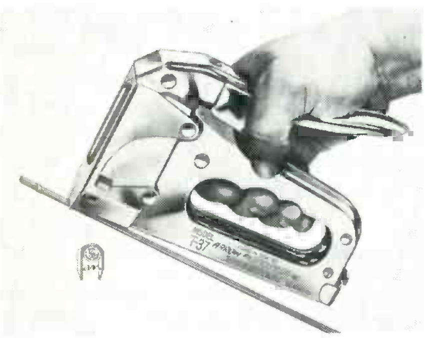
IN PART 2

Next month, we will continue to discuss medical instruments, including the *defibrillator* (which is over-used by TV show "doctors" to resuscitate a failed heart) plus test equipment needed for medical servicing and a few RF devices used in the operating room. For those of us whose gray hair can no longer be gracefully denied, some of these latter devices will appear surprisingly similar to the "spark gap" transmitters used before the universal availability of RF power generating vacuum tubes.■

lubricate motors, gears, sliding windows and doors, door hinges, pulleys, locks, appliances, drawers, etc. The lubricant is not affected by salt water and is good in operating temperatures ranging from — 25°F to + 400°F. It is available in tubes, jars and aerosol spray cans.

STAPLE GUN TACKER 140

The Model T-37 Staple Gun Tacker is introduced by *Arrow Fastener Co., Inc*. It is designed for safe, fast and efficient fastening of wiring objects up to 5/16 in diameter. The tapered striking edge gets into close corners and the grooved guide positions the wires for proper staple envelopment. A grooved driving blade stops the staple at the right height to prevent wire damage. The round crown staple snug - fits the wire for neat installation. The all - steel constructed stapler is widely used in telephone, electrical, electronics, CATV and communications industries. Takes ⅜ inch, ½ inch and 9/16 inch staples.

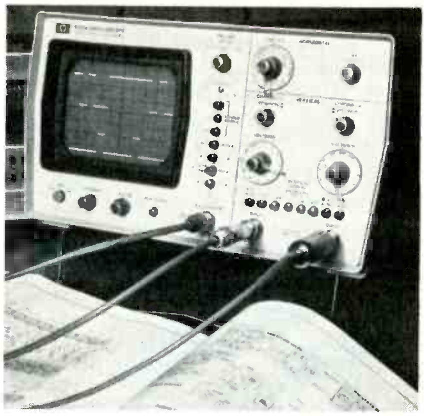


CONTACT BURNISHER 141

The CB - 5 pocket burnisher comes with a handy clip and magazine of extra blades. The blades fit into a chuck at the end of the barrel allowing the user practically any degree of blade rigidity by simply varying the depth of the blade in the chuck. The insulated black plastic barrel and cap permits working on live contacts. The burnisher comes with six .007 - inch thick blades. It can also be used with .0035 - inch thick blades, new satin finish blades, or 1¼ inch by .025 diameter ball ended (ball diameter .020) abrasive rods for cleaning concave points. *P. K. Neuses, Inc.*, offers the most complete line of contact cleaning tools designed for any type of contact — silver, platinum, gold, palladium, tungsten, molybdenum. These tools, being non - residual, leave no filings, grit, dust or film to start a new carbonaceous build - up. All burnishers are insulated, flexible and economical with just enough stiffness to apply the right amount of pressure to the contact face offering minimum wear on costly contacts.

OSCILLOSCOPE 142

A new 15-MHz dual - channel oscilloscope, Model 1222A from *Hewlett - Packard* has a built - in delay line to make visible the leading edge of traces, a feature of special value in digital applications. It provides the user the option of viewing Channel A with Channel B either added or subtracted (A ± B modes). Identical dual channels provide calibrated X - Y displays. The oscilloscope has 3% vertical accuracy, calibrated 8 x 10 cm display, internal graticule to eliminate parallax, dc coupling, triggered sweep and pushbutton beam - finder. Deflection factor is adjustable from a sensitive 2 mV/cm to 10 V/cm, so the instrument is useful not only for the general run of



logic, control, audio and video measurements but also for such low - level uses as receiver tests. Built - in TV sync separation assures stable, automatic triggering on frame or line for convenient TV trouble - shooting. Calibrated sweep, accurate within four percent, makes it easy to diagnose timing problems. The instrument weighs 16¼ lbs. Price is $895.

ALL PURPOSE/TEST TABLE 143

The *General Electric* Tube Products Dept. is making available to electronic servicers two sturdy, roll - around tables for a wide variety of in - shop applications. The All - Purpose Table (right) has a 24-inch-square plywood top and is capable of handling loads up to 250 lbs. The Test Table has a 17-inch by 19-inch angled top at a 34-inch working height and rubber casters for finger-tip mobility. The plywood top is insulated against "shorts" and "grounds", non-marring, and heat-resistant. A lower shelf is included with both tables; the Test Table's sec-

ond shelf offering the same protection as its angled top. Both tables come partially - assembled in sturdy, reshippable cartons. They offer users five minute nut - and - bolt assembly.

MATV PASSIVE DEVICES 144

Many new miniaturized MATV passive devices are introduced by *RMS Electronics, Inc.* They are hybrid split-

TAB ALL-IN-ONE SCHEMATIC/SERVICING MANUALS FOR COLOR and B & W TV, RADIOS and HI-FI

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EMERSON See **Admiral Vol. 2.**

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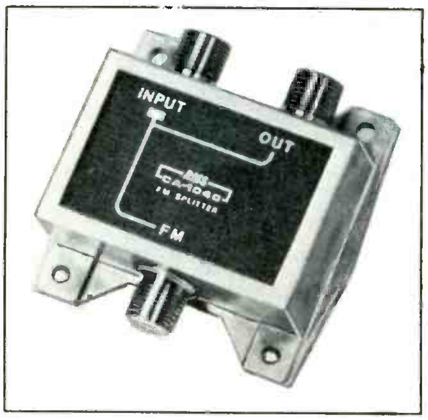

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RECTIFIER 146

A newly - designed *International Rectifier* R210, 2 - amp "universal" rectifier with an improved surge rating is introduced. The 2 - amp, 1000 - volt rectifier is housed in a smaller case style and has a 60 - amp surge rating compared to the 50 amps available previously. this provides much greater protection against surge currents caused by line voltage transients. The universal device replaces all rectifiers in commercial and entertainment equipment. ■

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MICROPHONE 148

A directional microphone to allow live insertions in the presentation of a cassette/slide presentation has been introduced by *3M Co.* The microphone permits remote control of three popular Wollensak AV visual - sync re-

corders for public address use. The noise - cancelling characteristics of the new microphone make it especially suitable for PA work. Directional characteristics keep acoustic feedback at a minimum and it may be either hand - held or mounted on a stand. In addition to the normal on/off switch, it has a pushbutton pause control which stops the tape recorder (and the slide sequence). As long as the button is held, the recorder is stopped; tape motion resumes as soon as the button is released. The microphone is supplied with a 20 - foot cord, and comes with a padded vinyl storage/carrying case. It is priced at $99.95.

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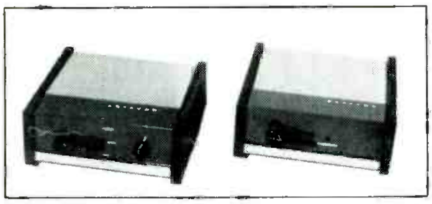

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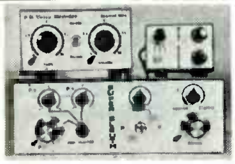

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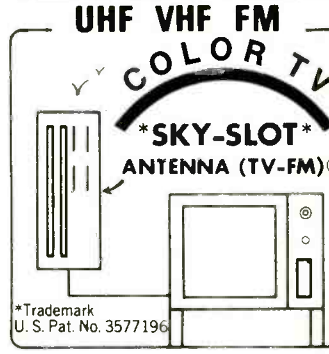

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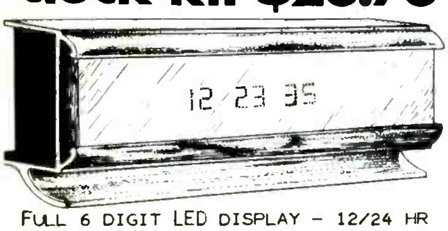

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ELECTRONIC TECHNICIAN/DEALER

TEKFAX

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

GROUP **273**

	SCHEMATIC NO.		SCHEMATIC NO.
ADMIRAL TV Chassis T5R3	1583	ZENITH TV Chassis 19FB14	1587
AIRLINE Color TV Model GAI-12915A	1584	ZENITH Color TV Chassis 19FC45Z	1586
TRAV-LER Color TV Chassis T41K10-4A/B	1585		

1583

ADMIRAL

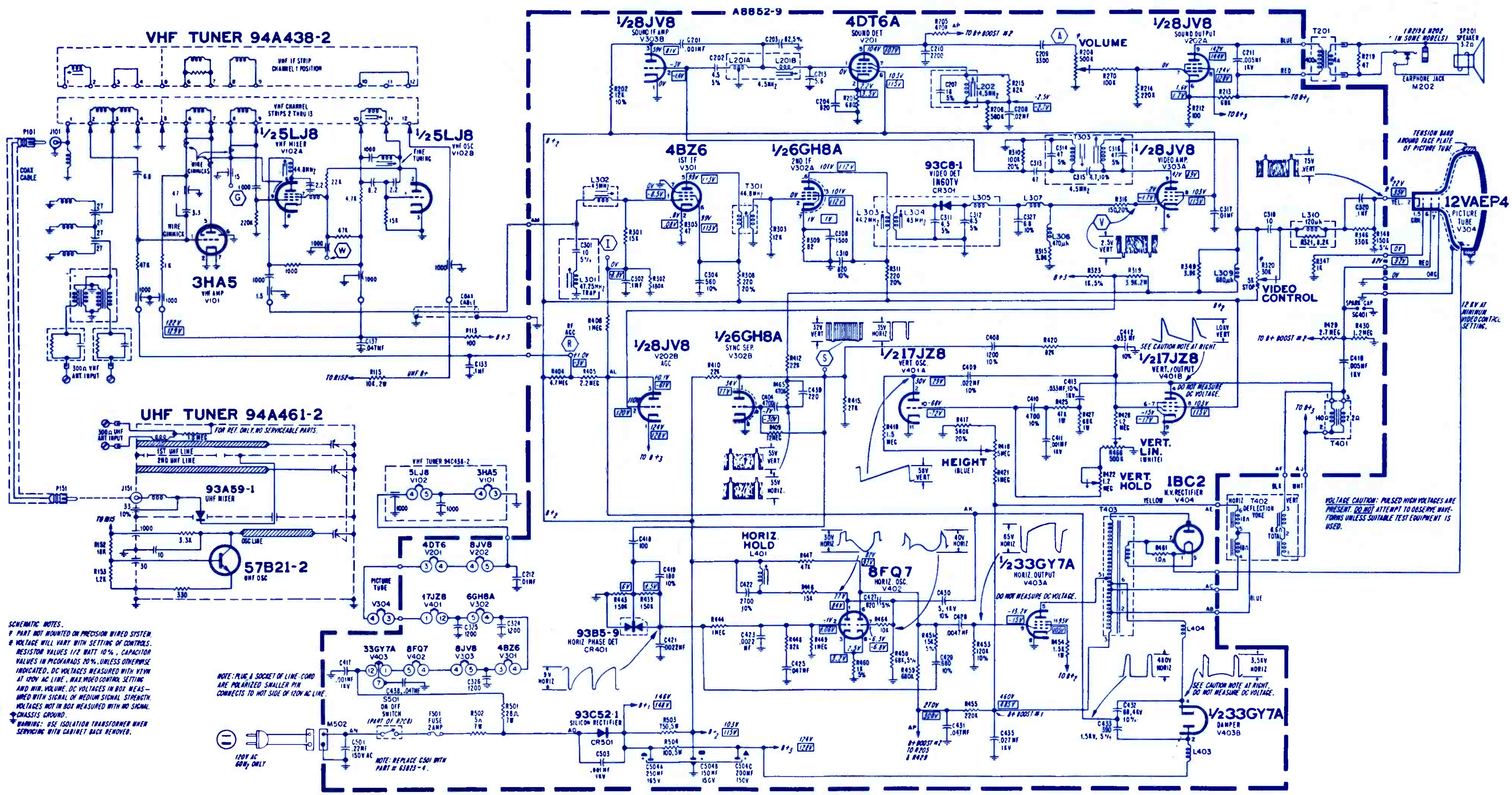
TV Chassis
T5R3

MAY • 1975

SYMBOL	DESCRIPTION	ADMIRAL PART NO.
R208	500K vol, on/off switch	75A1-185
R320	30K, video contrast	75A112-13
R418	height control	75A101-16
R422	1.2M vert hold control	75A100-8
R466	vert lin control	75A101-17
R502	5.5 ohm, fuse type	61A48-1
C504A	150mf, 156v	67A30-11
C504B	150mf, 150v	67A30-11
C504C	200mf, 150v	67A30-11
L202	quad coil	72A132-77
L401	horiz lock coil	94A17-19
T201	audio output xformer	79A124-5
T303	sound takeoff xformer	72A185-5
T401	vert output xformer	79A139-4
T402	deflect yoke assmy	94A372-2
T403	horiz output xformer	79A138-30
CR301	video detect	93A8-1
CR401	horiz phase detect	93A5-10
CR501	silicon rectifier	93A52-1
	VHF tuner	94A438-2

MODEL CHART

MODEL	FINISH	CRT	VHF	UHF	CHASSIS
12P647	Walnut	12VAEP4	94A363-2	94A465-2	T5R3-1A
12P647M	Walnut	12VAEP4	94A438-2	94A461-2	T5R3-2A



1584

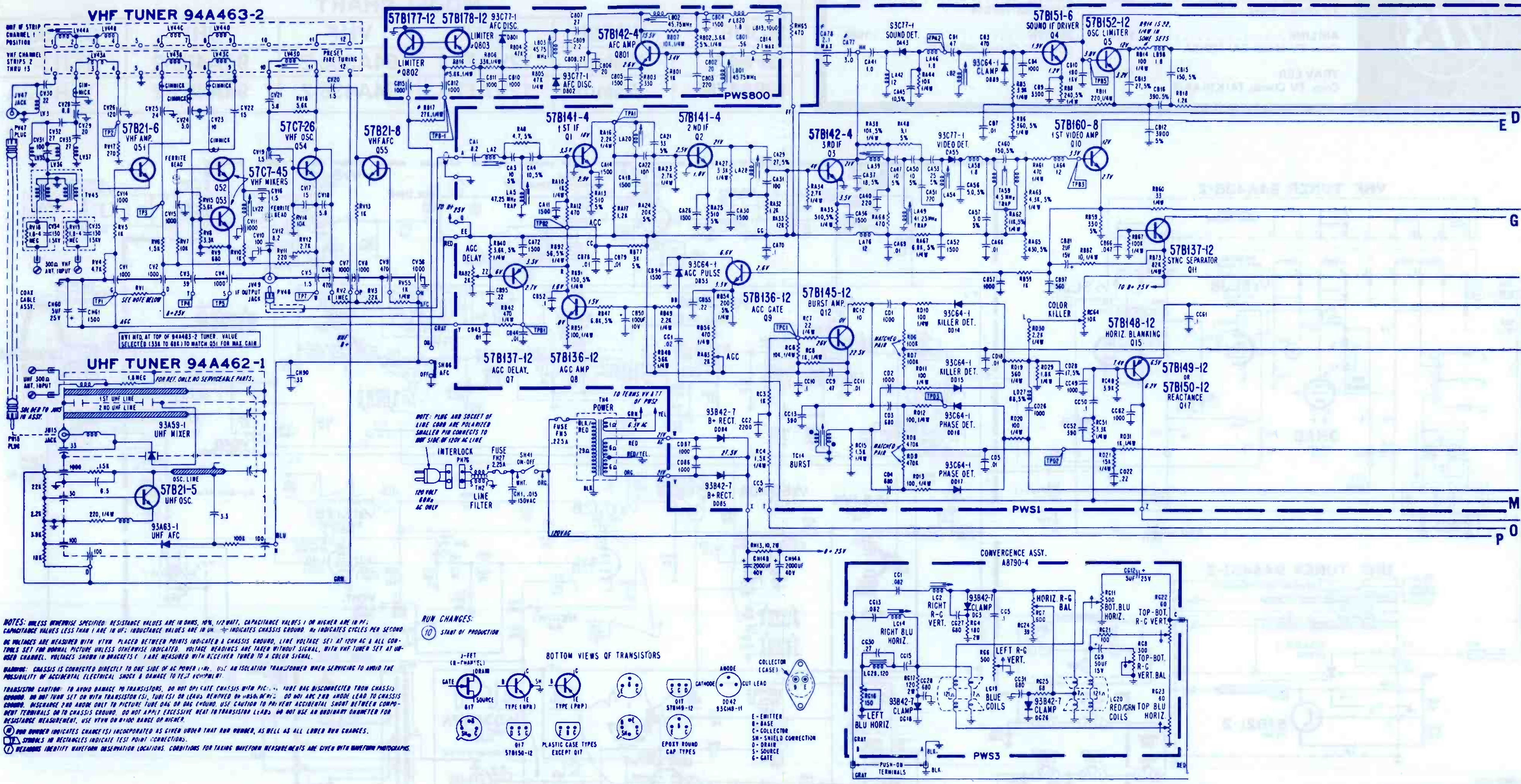
AIRLINE
Color TV Model
GAI-12915A

ELECTRONIC TECHNICIAN/DEALER TEKFAX
MAY • 1975

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

1. TPB3. Base 1st Video Amp (Q10) 2.5V P-P Vert. (PWS1)
2. TPA2. Sound Detector, 0.25V P-P Vert. (PWS1)
3. Collector, 1st Video Amp (Q10) 8V P-P Vert. (PWS1)
4. Grid (Pin 5) Horiz. Output V6) 240V P-P Horiz. "AB" (PWS2)
5. Plate (Pin 10) 2nd Video Amp (V2A) 50% Contrast. 100V P-P Video. 150V P-P Blanking. Vert. "GG" (PWS2)
6. Base, Sync Separator (Q11). 7V P-P Vert. (PWS1)
7. Collector, Sync Separator (Q11), 6V P-P Vert. (PWS1)
8. Plate (Pin 4) Sync Amp (V2A), 60V P-P Vert. (PWS2)

20. Collector, R-Y Demodulator (Q21), 1.5V P-P Horiz. (PWS1)
21. Junction RF34 and RF46, 2.2V P-P Horiz. (PWS2)
22. TPF2, R-Y Amp Output (V4A), No Color, 90V P-P Horiz. (PWS2)
3. TPF2, R-Y Amp Output (V4A) with Color, 250V P-P Horiz. (PWS2)
24. TPF4, B-Y Amp Output (V4C) with Color, 280V P-P Horiz. (PWS2)
25. TPF3 G-Y Amp Output (V4B) with Color, 150V P-P Horiz. (PWS2)
26. Collector, Horiz. Blanket (Q15), 3.3V P-P Horiz. "Z" (PWS1)
27. Base, Horiz. Blanker (Q15), 5.8V P-P Horiz. (PWS1)
28. TPC1, Base, Burst Amp (Q12), 6V P-P Horiz. (PWS1)
29. Collector, Burst Amp (Q12), 45V P-P Horiz. (PWS1)
30. Collector, 3.58MHz Buffer (Q19), 22V P-P Horiz. Base, 3.58MHz Buffer (Q19), 2.3V P-P Horiz. Emitter, 3.58MHz Buffer (Q13), 2.2V P-P Horiz. Base, Q20 and Q21 6V P-P, Horiz. (PWS1)
31. Collector, 3.58MHz Osc. (Q18), 11V P-P Horiz. (PWS1)
32. Cathode, Burst Gate Diode (DC19), 12.5V P-P Horiz. (PWS1)



SYMBOL	DESCRIPTION	AIRLINE PART NO.
CH10A, B		
C, D	300mf/350v, 300mf/350v, 80mf/200v, 10mf/350v electro	67A15-415
CH14A, B	2000mf/40v, 2000mf/40v electro	67A15-413
RH150A, B	bleeder focus module	61A71-1
RA82	2K AGC delay	75A101-31
RA83	2K AGC	75A101-31
RC64	10K color kill	75A101-18
RE54	3.4M vert size	75A95-18
RE55	100K vert hold	75A95-18
RE56	300K vert lin	75A95-18
RH28	2K brite	75A198-4
RH29	350 ohm contrast	75A198-3
RH34	500 ohm tint	75A198-2
RH39	500 ohm color	75A198-2
RH42	50K volume w/SH41	75A140-31
RH125	5M high voltage adj	75A135-57
RH149	30M focus adj	75A108-8
LA5	coil 47.25MHz trap	72A316-12
LC16	coil chroma take off	72A329-1
LC34	coil 47 UH 2nd bandpass	73A55-28
LD52	coil 1 UH 3.58MHz output	73A55-37
LD63	coil 10 UH demod	73A55-8
LF24	coil horiz adj	94A351-1
MH57	deflect yoke inc. PH49	94A571-2
TA59	xformer 4.5MHz trap	72A216-7
TB20	xformer ratio detect	72A318-1
TC14	xformer burst	72A325-3
TC29	xformer bandpass	72A327-1
TH2	xformer line choke	73A31-16
TH4	xformer power	80A108-14
TH18	xformer horiz output	79A169-3
TH44	xformer audio output	79A141-4
TH73	xformer vert output	79A165-1
FH5	fuse .225a chemical	84A28-12
FH27	fuse 2.25a chemical	84A28-16
	tuner UHF	94A462-1
	tuner VHF	94A463-2

AIRLINE
Color TV Model
GAI-12915A

9. B+ 300V Input Ripple, 18V P-P Vert. "NN" (PWS2)

10. B+ 300V Ripple, 1.6V P-P Vert. "EE" (PWS2)

11. B+ 110V Ripple, 0.1V P-P Vert CH10C

12. Collector, B-Y Demodulator (Q20), 8.2V P-P Horiz. "M" (PWS1)

13. Emitter, AGC Gate (Q9), .5V P-P Horiz. (PWS1)

14. Collector, 1st Bandpass Amp (Q13), 8V P-P Burst, 4V P-P Chroma, Horiz. (PWS1)

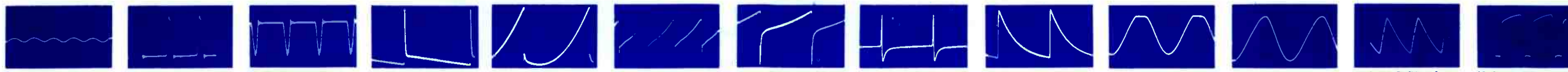
15. Cathode, Burst Blanker Diode (DC44), 8V P-P Horiz. (PWS1)

16. Base, 2nd Bandpass Amp (Q14), Chroma 0.13V P-P Horiz. (PWS1)

17. Collector, 2nd Bandpass Amp (Q14), 0.22V P-P Horiz. (PWS1)

18. Emitter, 2nd Bandpass Amp (Q14), Chroma 0.18V P-P Horiz. (PWS1)

19. Emitter, B-Y Demodulator (Q20), 0.7V P-P Horiz. (PWS1) Emitter, R-Y Demodulator (Q21), 0.9V P-P Horiz. (PWS1)



33. B+ 25V Ripple, 0.025V P-P Vert., CH14A

34. AGC Pulse, 28V P-P Horiz., "P" (PWS1)

35. Burst Keying Pulse, 11V P-P Horiz., "T" (PWS2)

36. Plate (Pin 4) Vert. Output (V1B), 1150V P-P Vert. (PWS2)

37. Cathode (Pin 9) Vert. Output (V1B), 22V P-P Vert. (PWS2)

38. Grid (Pin 6) Vert. Output (V1B), 10V P-P Vert. (PWS2)

39. Plate (Pin 2) Vert. Osc. (V1A), 80V P-P Vert. (PWS2)

40. Grid (Pin 10) Vert. Osc. (V1A), 95V P-P Vert. (PWS2)

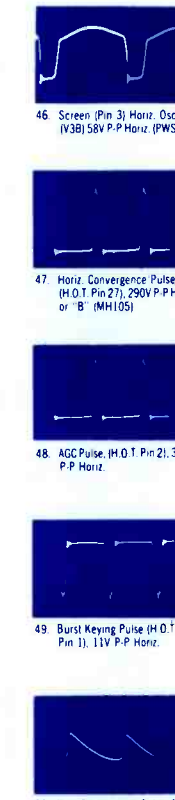
41. Cathode (Pin 11) Vert. Osc. (V1A), 60V P-P Vert. (PWS2)

42. Grid (Pin 2) Horiz. Osc. (V3B), 38V P-P Horiz. (PWS2)

43. Plate (Pin 1) Horiz. Osc. Control (V3A), 57V P-P Horiz. (PWS2)

44. Cathode (Pin 8) Horiz. Osc. Control (V3A), 1V P-P Horiz. (PWS2)

45. Plate (Pin 6) Horiz. Osc. (V3B), 240V P-P Horiz. (PWS2)



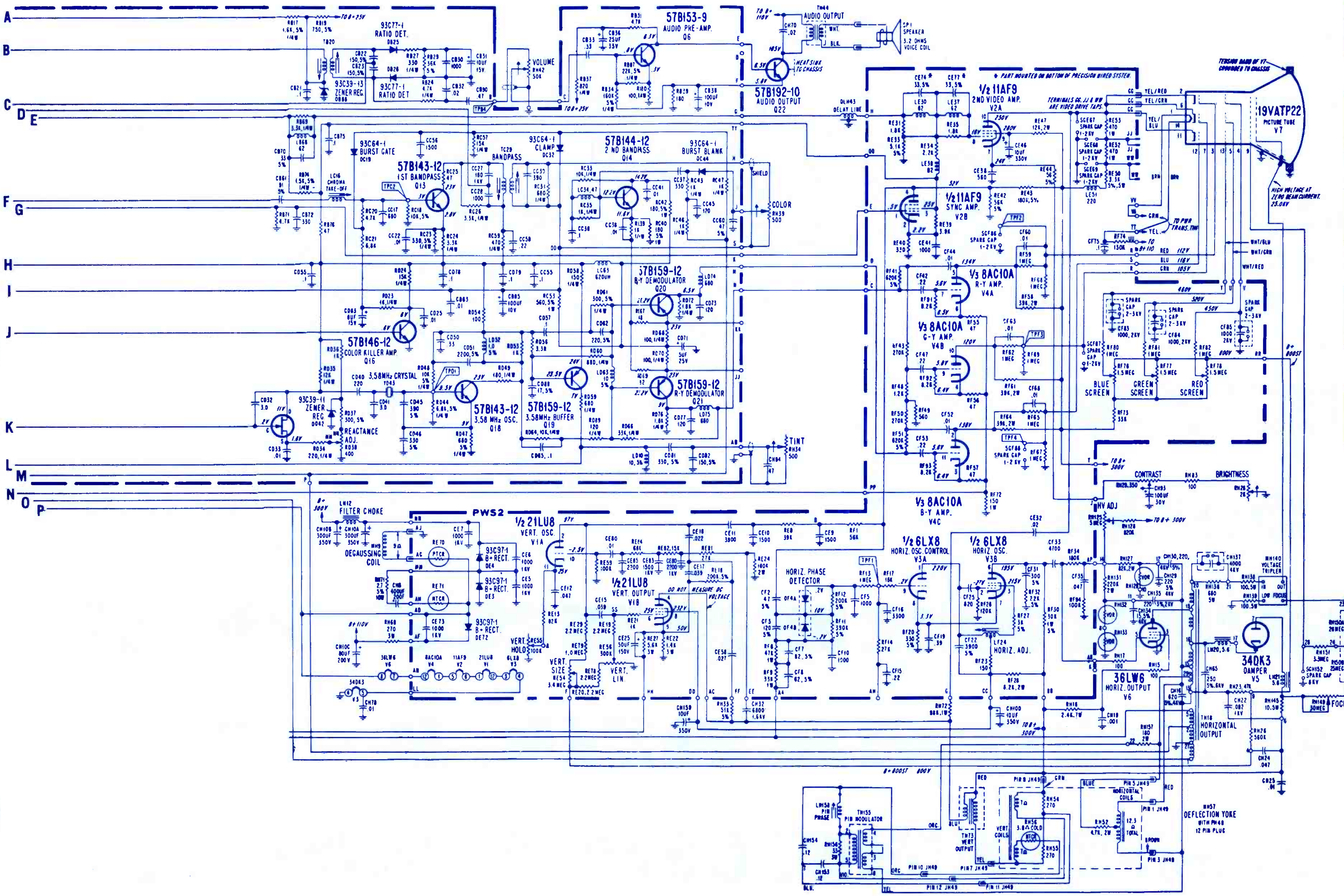
46. Screen (Pin 3) Horiz. Osc. (V3B) 58V P-P Horiz. (PWS2)

47. Horiz. Convergence Pulse (H.O.T. Pin 27), 290V P-P Horiz. or "B" (MH105)

48. AGC Pulse, (H.O.T. Pin 2), 32V P-P Horiz.

49. Burst Keying Pulse (H.O.T. Pin 1), 11V P-P Horiz.

50. Vert Convergence Pulse, 6V P-P Vert. "C" (MH105)



1585

TRAV-LER

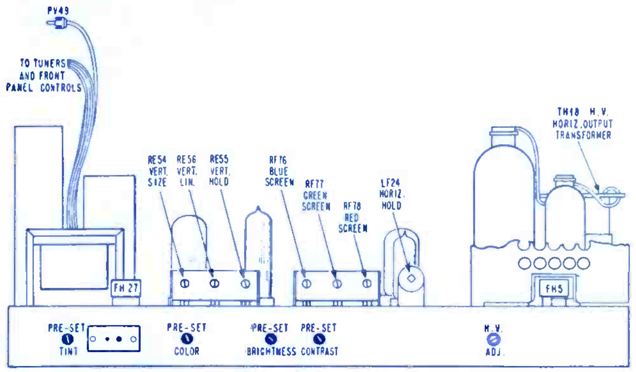
Color TV Chassis
T41K10-4A/B

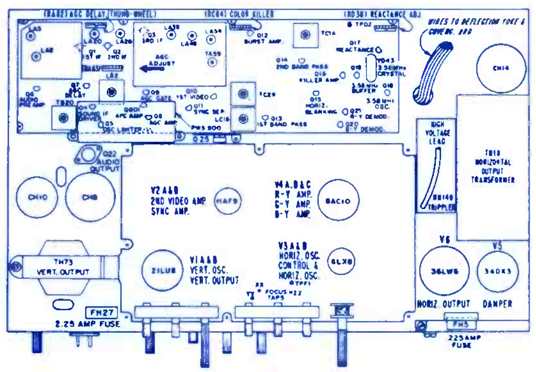
ELECTRONIC TECHNICIAN/DEALER TEKFAX

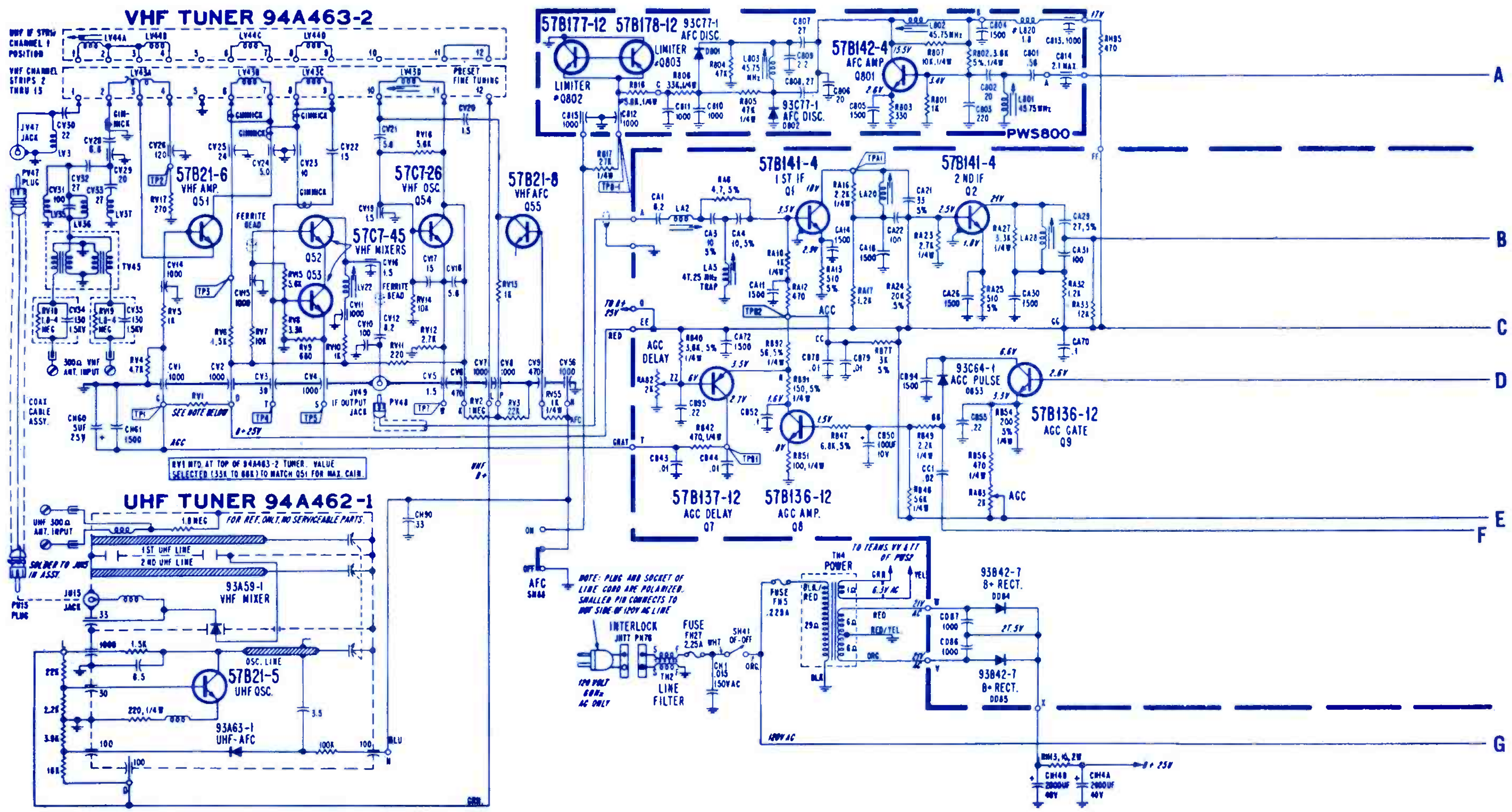
MAY • 1975

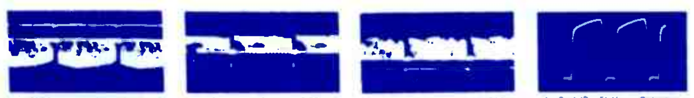
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

SYMBOL	DESCRIPTION	TRAV-LER PART NO.
RA82	2K AGC delay	75A101-31
RA83	2K AGC	75A101-31
RC64	10K color kill	75A101-18
RD38	400 ohm react adj	75A101-35
RE54	3.4M vert size	75A95-18
RE55	100K vert hold	75A95-18
RE56	300K vert lin	75A95-18
RH28	2K brite	75A140-25
RH29	350 ohm contrast	75A140-26
RH34	500 ohm tint	75A140-17
RH39	1K color	75A140-18
RH42	50K vol/SH41 on/off switch	75A140-19
RH103	1K preset color	75A135-52
RH104	500 ohm preset tint	75A135-51
RH117	350 ohm preset contrast	75A135-54
RH118	2K preset brite	75A135-53
RH125	5M high voltage adj	75A135-57
LB2	coil 4.5MHz	72A317-1
LC16	coil chroma takeoff	72A329-1
LF24	coil horiz adj	94A351-1
MH57	deflect yoke T13P857	94A379-8
	deflect yoke T17P877	94A379-9
TB20	xformer ratio detect	72A318-1
TC14	xformer burst	72A325-3
TC29	xformer bandpass	72A327-1
TH2	xformer line choke	73A31-16
TH4	xformer power	80A108-13
TH18	xformer horiz output	79A169-1
TH44	xformer audio output	79A141-1
TH73	xformer vert output	79A165-1
FH5	fuse .225a chemical	84A28-12
FH27	fuse 2.25a chemical	84A28-16
	tuner UHF	94A462-1
	tuner VHF	94A463-2









1 TPB3, Base 1st Video Amp (Q10) 2.5V P-P Vert (PWS1)

2 TPA2 Sound Detector 0.75V P-P Vert (PWS1)

3 Collector 1st Video Amp (Q10) 8V P-P Vert (PWS1)

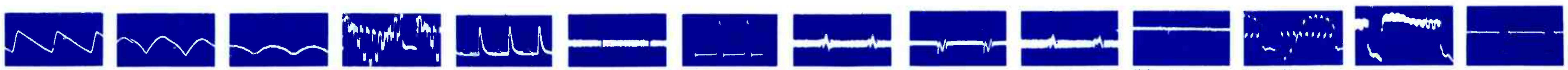
4 Grid (Pin 5) Horiz Output V6) 240V P-P Horiz "AB" (PWS2)

5 Plate (Pin 10) 2nd Video Amp (V2A) 50 Contrast 100V P-P Video 150V P-P Blanking Vert "GG" (PWS2)

6 Base Sync Separator (Q11) 7V P-P Vert (PWS1)

7 Collector Sync Separator (Q11), 6V P-P Vert (PWS1)

8 Plate (Pin 4) Sync Amp (V2A), 60V P-P Vert (PWS2)



9 B+ 300V Input Ripple 18V P-P Vert "NN" (PWS2)

10 B+ 300V Ripple 1.6V P-P Vert "EE" (PWS2)

11 B+ 110V Ripple 0.1V P-P Vert CH10C

12 Collector, B-Y Demodulator (Q20), 8.2V P-P Horiz "M" (PWS1)

13 Emitter, AGC Gate (Q9), 5V P-P Horiz (PWS1)

14 Collector, 1st Bandpass Amp (Q13), 8V P-P Burst, 4V P-P Chroma, Horiz (PWS1)

15 Cathode, Burst Blanker Diode (DC44), 8V P-P Horiz (PWS1)

16 Base, 2nd Bandpass Amp (Q14), Chroma 0.13V P-P Horiz (PWS1)

17 Collector, 2nd Bandpass Amp (Q14), 0.22V P-P Horiz (PWS1)

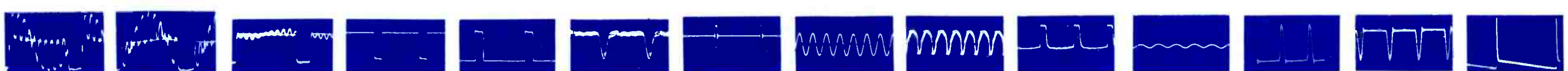
18 Emitter, 2nd Bandpass Amp (Q14), Chroma 0.18V P-P Horiz (PWS1)

19 Emitter, B-Y Demodulator (Q20), 0.7V P-P Horiz (PWS1) Emitter, R-Y Demodulator (Q21), 0.9V P-P Horiz (PWS1)

20 Collector, R-Y Demodulator (Q21), 1.5V P-P Horiz (PWS1)

21 Junction RF34 and RF46, 2.2V P-P Horiz (PWS2)

22 TPF2, R-Y Amp Output (V4A), No Color, 90V P-P Horiz (PWS2)



3 TPF2, R-Y Amp Output (V4A) with Color, 250V P-P Horiz (PWS2)

24 TPF4, B-Y Amp Output (V4C) with Color, 280V P-P Horiz (PWS2)

25 TPF3 G-Y Amp Output (V4B) with Color, 150V P-P Horiz (PWS2)

26 Collector, Horiz Blanker (Q15), 3.3V P-P Horiz "Z" (PWS1)

27 Base, Horiz Blanker (Q15), 5.8V P-P Horiz (PWS1)

28 TPC1, Base, Burst Amp (Q12), 6V P-P Horiz (PWS1)

29 Collector, Burst Amp (Q12), 45V P-P Horiz (PWS1)

30 Collector, 3.58MHz Buffer (Q19), 22V P-P Horiz Base 3.58MHz Buffer (Q19) 2.3V P-P Horiz Emitter 3.58MHz Buffer (Q19) 2.2V P-P Horiz Base Q20 and Q21 6V P-P Horiz (PWS1)

31 Collector, 3.58MHz Osc (Q18), 11V P-P Horiz (PWS1)

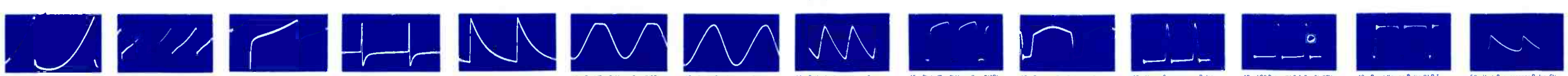
32 Cathode, Burst Gate Diode (DC19) 12.5V P-P Horiz (PWS1)

33 B+ 25V Ripple, 0.025V P-P Vert, CH14A

34 AGC Pulse, 28V P-P Horiz "P" (PWS1)

35 Burst Keying Pulse, 11V P-P Horiz "T" (PWS2)

36 Plate (Pin 4) Vert Output (V1B) 1150V P-P Vert (PWS2)



37 Cathode (Pin 9) Vert Output (V1B), 22V P-P Vert (PWS2)

38 Grid (Pin 6) Vert Output (V1B), 10V P-P Vert (PWS2)

39 Plate (Pin 2) Vert Osc (V1A), 80V P-P Vert (PWS2)

40 Grid (Pin 10) Vert Osc (V1A), 95V P-P Vert (PWS2)

41 Cathode (Pin 11) Vert Osc (V1A), 60V P-P Vert (PWS2)

42 Grid (Pin 2) Horiz Osc (V3B) 38V P-P Horiz (PWS2)

43 Plate (Pin 1) Horiz Osc Control (V3A) 57V P-P Horiz (PWS2)

44 Cathode (Pin 8) Horiz Osc Control (V3A) 1V P-P Horiz (PWS2)

45 Plate (Pin 6) Horiz Osc (V3B) 240V P-P Horiz (PWS2)

46 Screen (Pin 3) Horiz Osc (V3B) 58V P-P Horiz (PWS2)

47 Horiz Convergence Pulse (H.O.T. Pin 27), 290V P-P Horiz or "B" (MH105)

48 AGC Pulse (H.O.T. Pin 2), 32V P-P Horiz

49 Burst Keying Pulse (H.O.T. Pin 1), 11V P-P Horiz

50 Vert Convergence Pulse 6V P-P Vert "C" (MH105)

TRAV-LER Color TV Chassis T41K10-4A/B

MODEL CHART

MODEL	COLOR	VHF	UHF	CHASSIS
T13P857	Walnut	94A463-2 or 94A392-1	94A462-1 or 94A466-1	T41K10-4B
T17P877	Walnut	94A463-2 or 94A392-1	94A462-1 or 94A466-1	T41K10-4A

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.

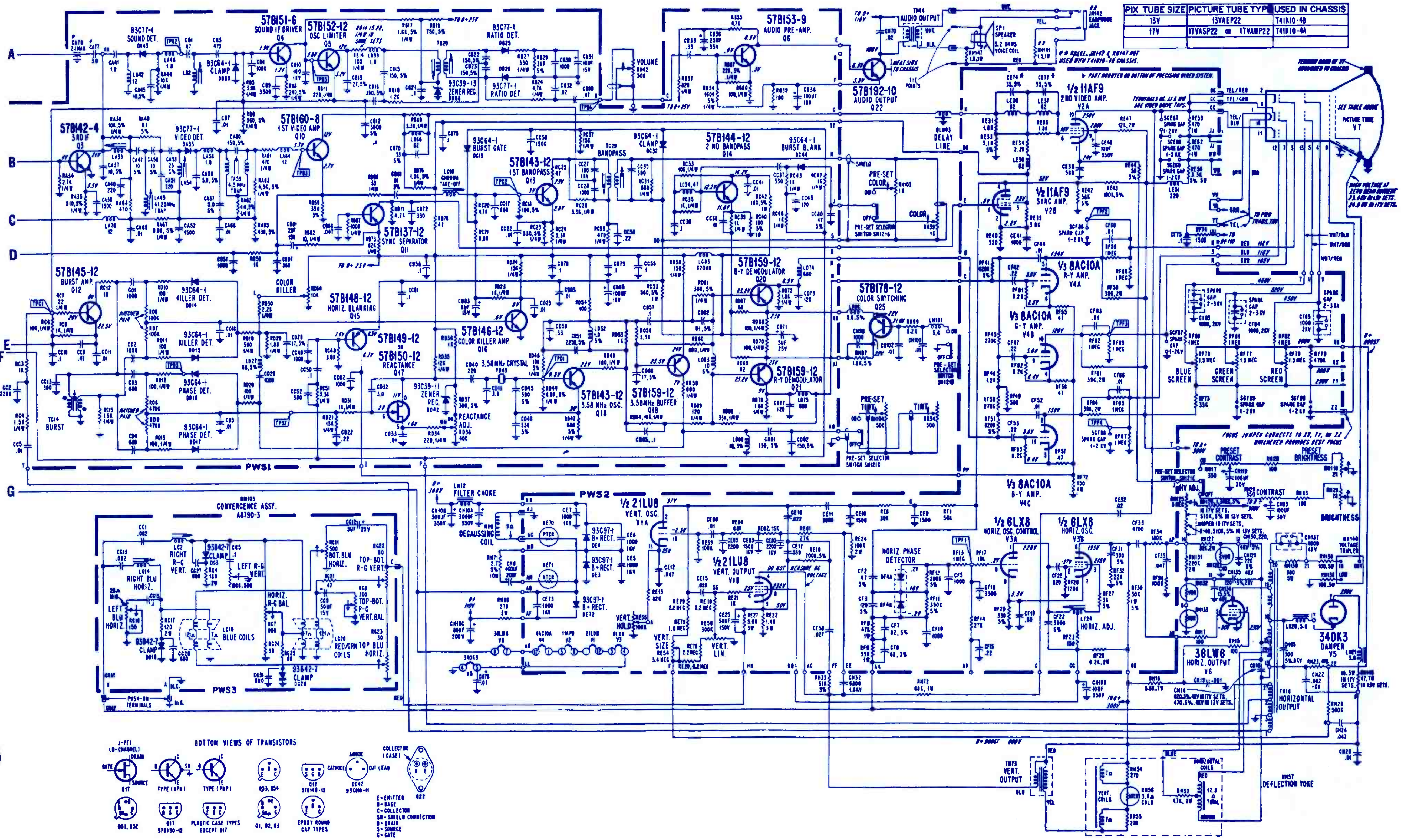
DC VOLTAGES ARE MEASURED WITH VTVM PLACED BETWEEN POINTS INDICATED & CHASSIS GROUND, LINE VOLTAGE SET AT 120V AC & ALL CONTROLS SET FOR NORMAL PICTURE UNLESS OTHERWISE INDICATED. VOLTAGE READINGS ARE TAKEN WITHOUT SIGNAL, WITH VHF TUNER SET AT UNUSED CHANNEL. VOLTAGES SHOWN IN BRACKETS ( ) ARE MEASURED WITH RECEIVER TUNED TO A COLOR SIGNAL.

WARNING: CHASSIS IS CONNECTED DIRECTLY TO ONE SIDE OF AC POWER LINE. USE AN ISOLATION TRANSFORMER WHEN SERVICING TO AVOID THE POSSIBILITY OF ACCIDENTAL ELECTRICAL SHOCK & DAMAGE TO TEST EQUIPMENT.

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×100 RANGE OR HIGHER.

RUN NUMBER INDICATES CHANGE (S) INCORPORATED AS GIVEN UNDER THAT RUN NUMBER, AS WELL AS ALL LOWER RUN CHANGES.
SYMBOLS IN RECTANGLES INDICATE TEST POINT CONNECTIONS.
HEXAGONS IDENTIFY WAVEFORM OBSERVATION LOCATIONS. CONDITIONS FOR TAKING WAVEFORM MEASUREMENTS ARE GIVEN WITH WAVEFORM PHOTOGRAPHS.

PIX TUBE SIZE	PICTURE TUBE TYPE	USED IN CHASSIS
13V	13VAEP22	T41K10-4B
17V	17VASP22 or 17VAWP22	T41K10-4A



1586

ZENITH

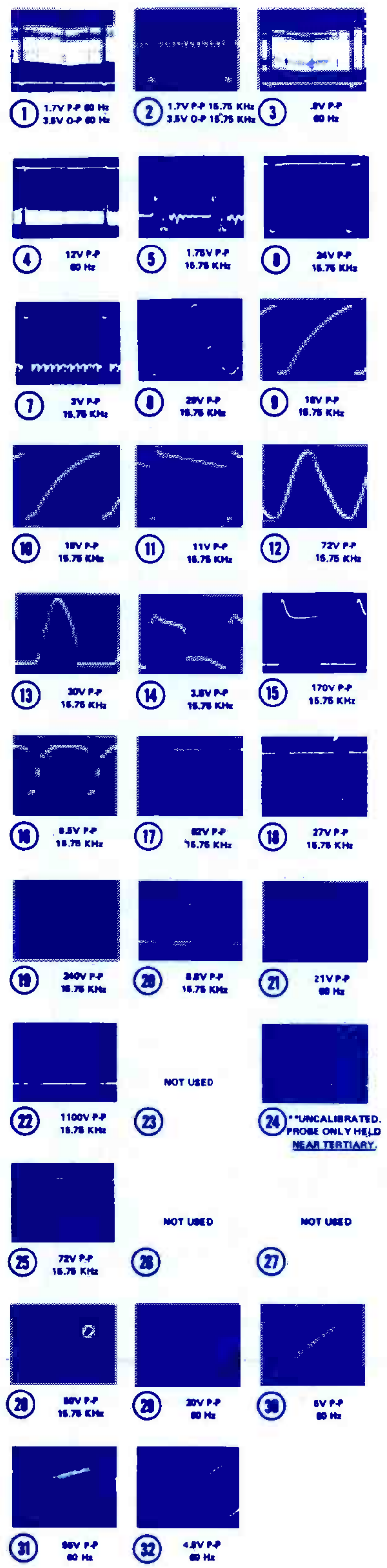
Color TV Chassis
19FC45Z

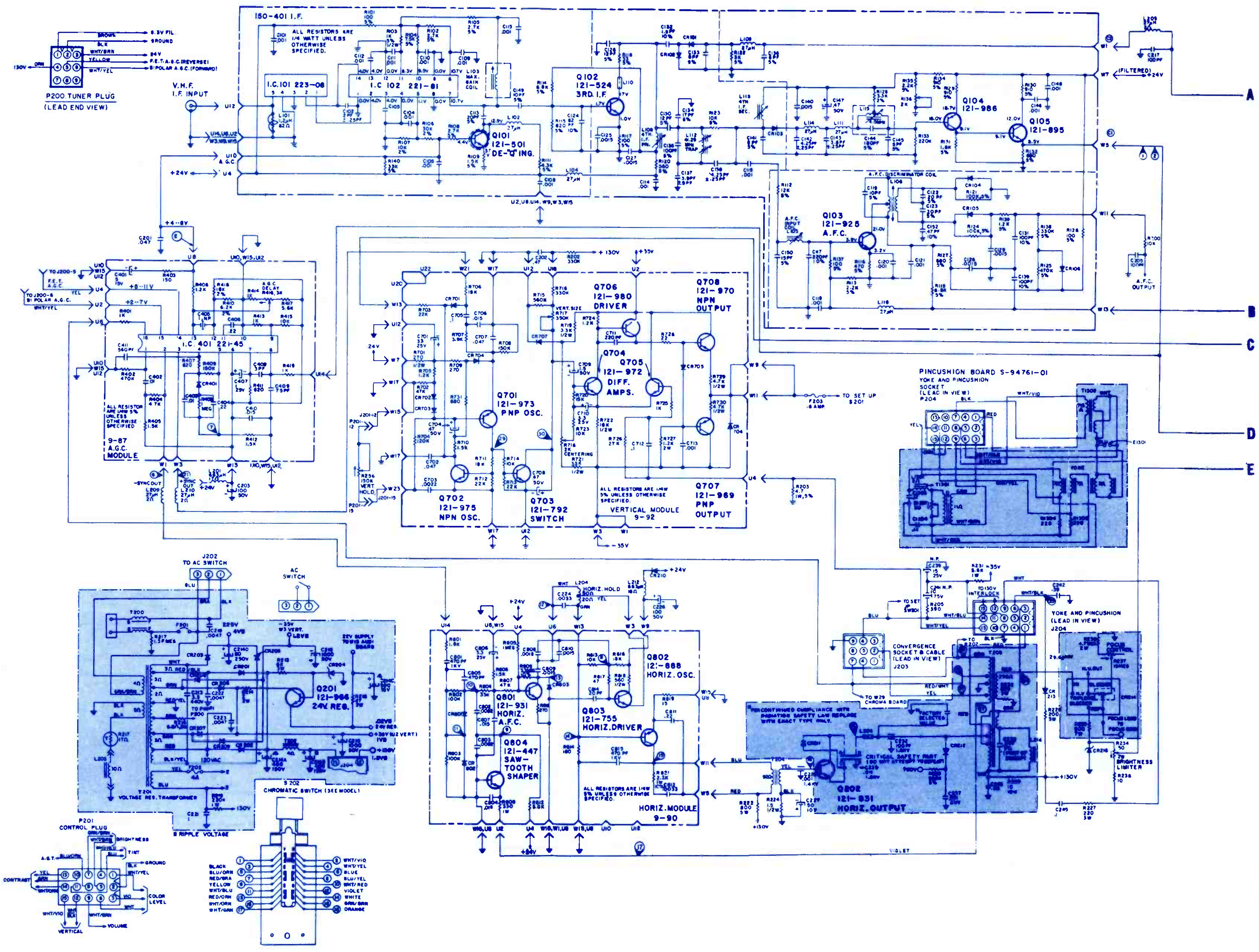
MAY • 1975

ELECTRONIC TECHNICIAN/DEALER TEKFAX

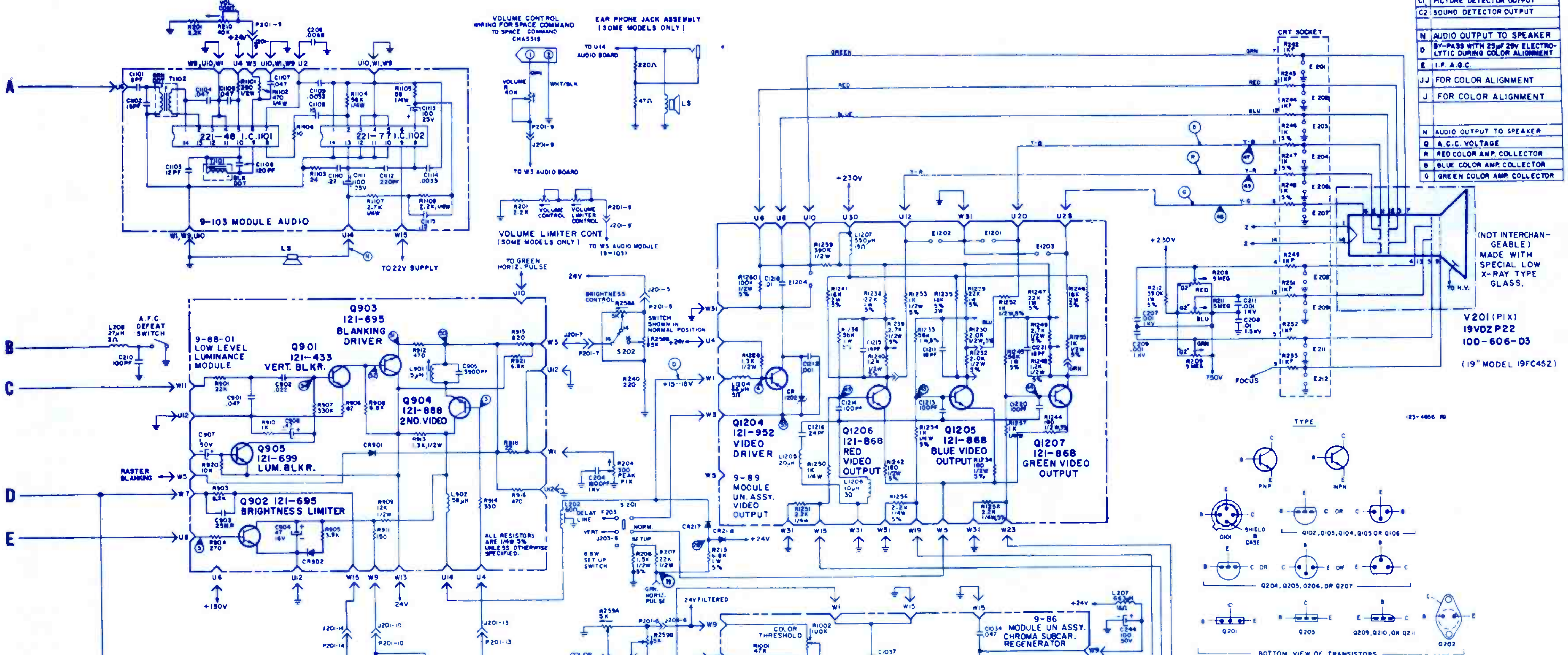
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

SYMBOL	DESCRIPTION	ZENITH PART NO.
R234	50 ohm brite limiter control	63-10141
P237	15M focus control	63-10276
R416	3K AGC delay	63-9697-01
R717	350K vert size	63-9697-05
R718	2K vert center	63-9697-06
R1002	100K color threshold	63-9228
R1015	20K auto color control	63-9697
R1018	20K auto phase control	63-9697
L204	horiz hold coil	S-56875
L1002	chroma take off coil	95-3080
T202	power choke	95-2925-02
T206	horiz output xformer 19FC45	S-96473-02
T1101	quad xformer	95-2789
F201	circuit breaker	85-976-02
F202	fuse	136-29
F203	fuse	136-87

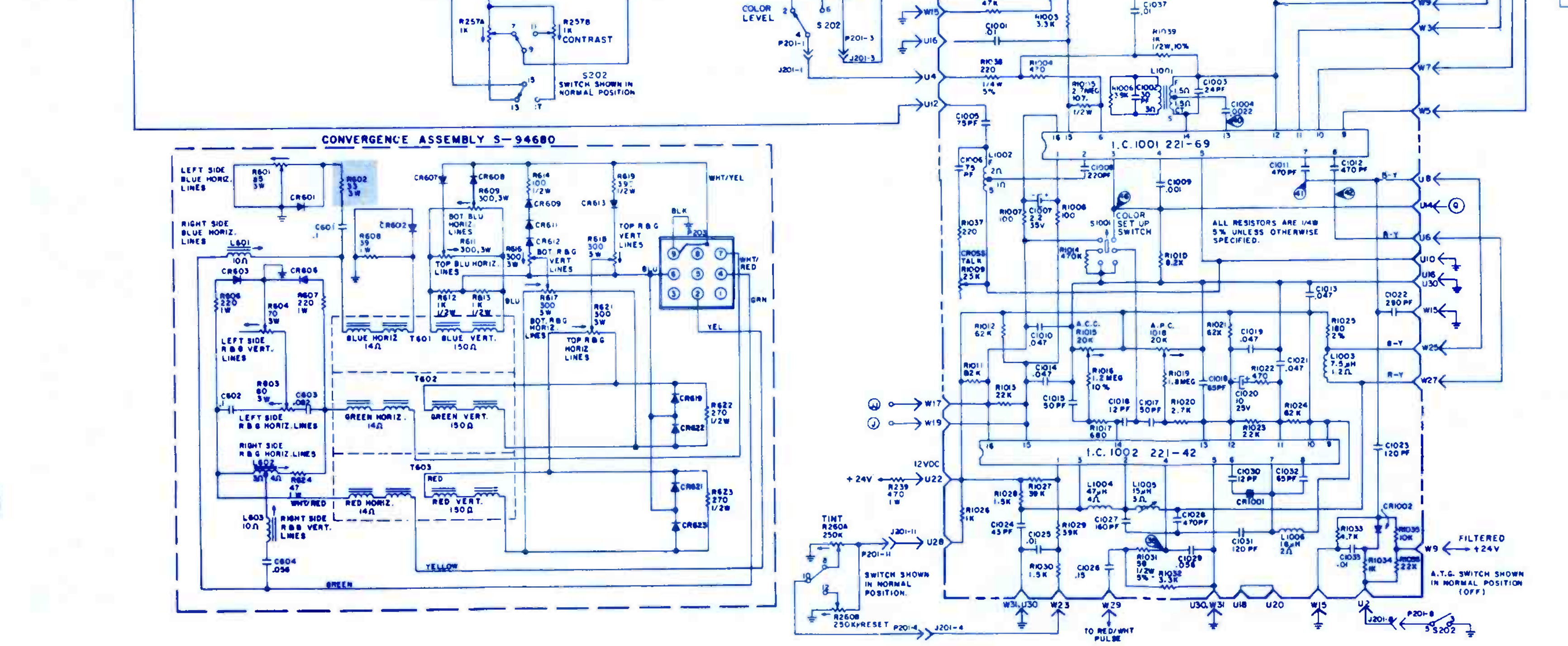




ZENITH
Color TV Chassis
19FC45Z



TEST POINTS	
C1	PICTURE DETECTOR OUTPUT
C2	SOUND DETECTOR OUTPUT
N	AUDIO OUTPUT TO SPEAKER
D	BY-PASS WITH 25µF 25V ELECTROLYTIC DURING COLOR ALIGNMENT
E	I.F. A.G.C.
JJ	FOR COLOR ALIGNMENT
J	FOR COLOR ALIGNMENT
N	AUDIO OUTPUT TO SPEAKER
Q	A.C.C. VOLTAGE
R	RED COLOR AMP. COLLECTOR
B	BLUE COLOR AMP. COLLECTOR
G	GREEN COLOR AMP. COLLECTOR



NOTES.

TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS.

PHOTOGRAPHS TAKEN ON A STANDARD GATED RAINBOW COLOR BAR SIGNAL THE HUE SETTING ADJUSTED FOR PROPER COLOR. THE WAVE SHAPES AT THE RED, GREEN AND BLUE CATHODE GRIDS OF THE PICTURE TUBE DEPEND ON THE HUE, COLOR LEVEL, CONTRAST AND PICTURE PEAKING CONTROLS.

FOR WAVEFORMS 43 THRU 49, TEST POINT "D" MUST BE BY-PASSED WITH A 0.1 MF CAPACITOR.

ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED

ALL VOLTAGES ARE D.C UNLESS OTHERWISE SPECIFIED.

ALL D.C. VOLTAGES TO BE MEASURED WITH A VACUUM TUBE VOLTMETER HAVING 11 MEGOHM INPUT RESISTANCE.

ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT AND NORMAL SETTING OF CONTROLS AND CHANNEL SELECTOR SET TO CHANNEL 2 UNLESS OTHERWISE SPECIFIED

COIL RESISTANCE MEASUREMENTS TAKEN WITH COILS DISCONNECTED FROM CIRCUIT.

ALL RESISTORS ARE ±10% TOLERANCE CARBON, 1/2 WATT UNLESS OTHERWISE SPECIFIED.

COIL RESISTANCE NOT GIVEN UNDER ONE OHM.

ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

FOR CAPACITOR TOLERANCE, SEE LEGEND.

CATHODE RAY TUBE 2 ND. ANODE VOLTAGE TO BE MEASURED WITH ELECTROSTATIC OR 20K OHMS PER VOLT MIN. HIGH VOLTAGE METER.

ARROWS ON POTENTIOMETER INDICATE CLOCKWISE ROTATION.

INDICATES ALIGNMENT AND TEST POINT.

PF = PICOFARAD MHz = MEGAHERTZ µH = MICROHENRY

INDICATES ±20% MAY BE USED. INDICATES VOLTAGE SOURCE.

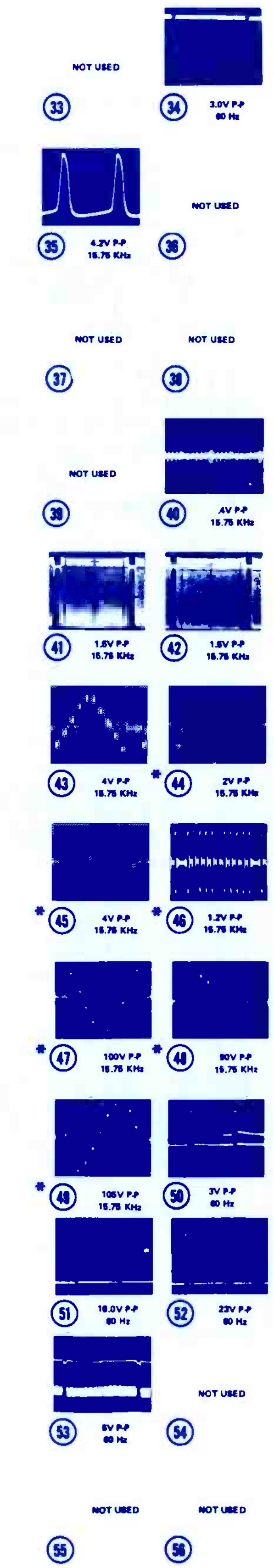
INDICATES WAVEFORMS CHECK POINTS. (SEE CHART WAVEFORM MEASURED FROM POINT INDICATED TO CHASSIS GROUND.)

INDICATES WAVEFORM (SEE CHART) WAVEFORM MEASURED ACROSS POINTS INDICATED (NOT TO CHASSIS GROUND) OSCILLOSCOPE SHOULD NOT BE GROUNDED TO CHASSIS. REVERSING LEADS REVERSES WAVEFORM

INDICATES CHASSIS GROUND.

INDICATES CHROMATIC SWITCH WIRING POSITION

INDICATES PIN NUMBER ON MODULE BOARD

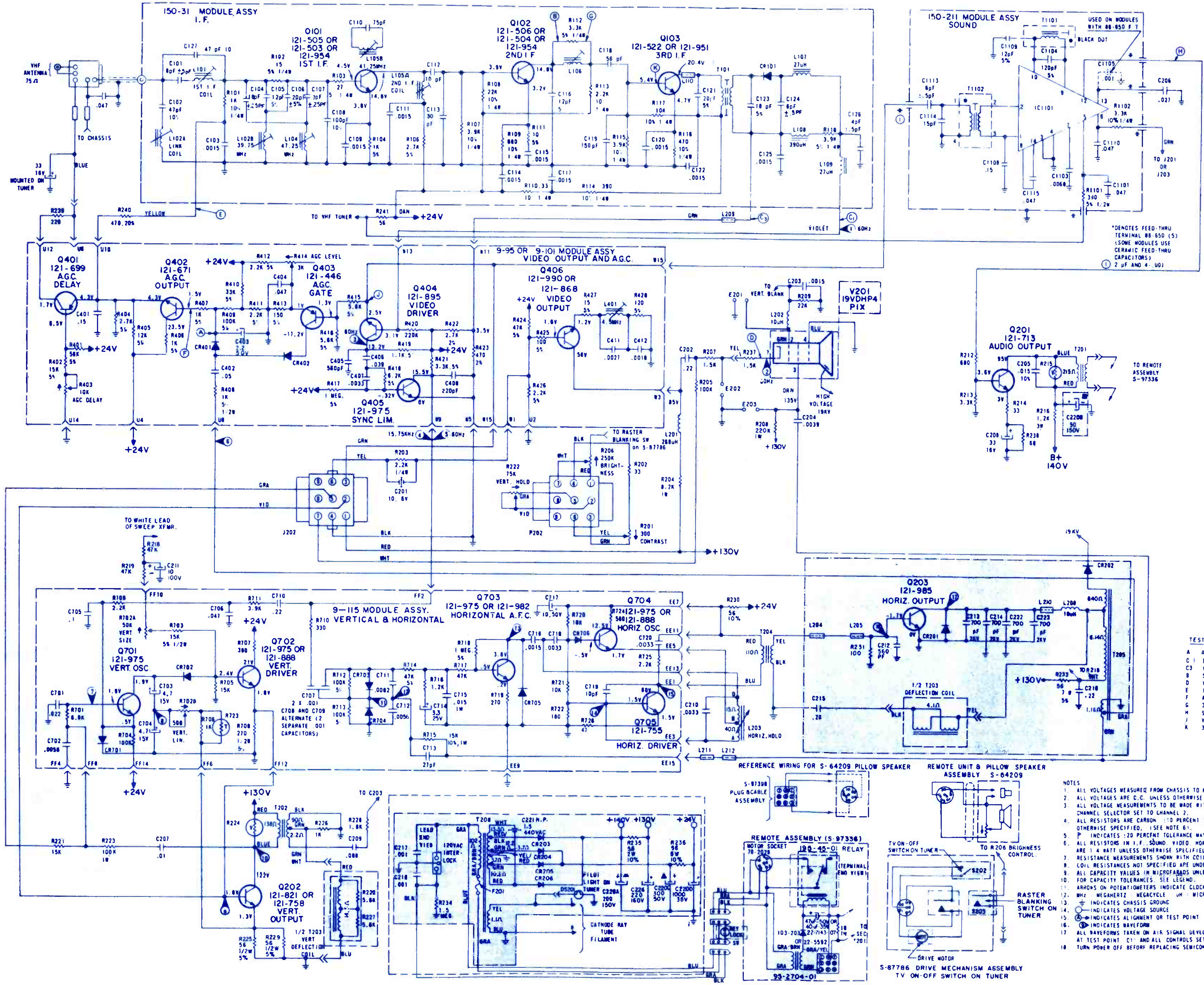


* FOR WAVEFORMS 43 THROUGH 49, BYPASS TEST POINT "D" WITH 1.0 MF CAPACITOR.

1587
ZENITH
TV Chassis
19FB14

ELECTRONIC TECHNICIAN/DEALER TEKFAX
MAY • 1975
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

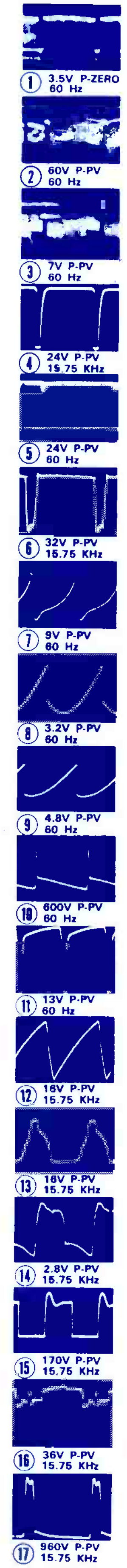
SYMBOL	DESCRIPTION	ZENITH PART NO.
C220A	200mfd electro capacitor 150v	
C220B	50mfd electro capacitor 150v	22-7314
C220C	300mfd electro capacitor 50v	
C220D	1000mfd electro capacitor 35v	
R215	varistor	63-5440
R224	varistor	63-10281
R414	3K AGC level control	63-10148
R702A	50K rotary dual rotary control	63-10225-01
R702B	500 ohm rotary	63-10225-01
R723	thermistor	63-10290
T201	audio output xformer	95-3120
T204	horiz driver xformer	95-2895-03
T205	sweep xformer	S-97079
T208	power xformer	95-3141-01
T1102	quad xformer	95-2620
F201	fuse .6a bel fuse	136-100



TEST POINTS

A	A.G.C. OUTPUT
C1	DETECTOR OUTPUT
C3	VIDEO BIAS
B	SECOND IF COLLECTOR
D	VIDEO OUTPUT
E	IF-A.G.C.
F	A.G.C. OUTPUT
G	3RD IF ALIGNMENT
H	SOUND DISCR. OUTPUT
J	VIDEO DRIVER OUTPUT
K	3RD IF BASE

NOTES
1. ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.
2. ALL VOLTAGES ARE D.C. UNLESS OTHERWISE SPECIFIED.
3. ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT WITH CHANNEL SELECTOR SET TO CHANNEL 2.
4. ALL RESISTORS ARE CARBON ±10 PERCENT TOLERANCE, 1/2 WATT UNLESS OTHERWISE SPECIFIED. (SEE NOTE 6).
5. INDICATES ±20 PERCENT TOLERANCE MAY BE USED.
6. ALL RESISTORS IN I.F., SOUND, VIDEO, HORIZONTAL AND VERTICAL MODULES ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
7. RESISTANCE MEASUREMENTS SHOWN WITH COILS DISCONNECTED FROM CIRCUIT.
8. COIL RESISTANCES NOT SPECIFIED ARE UNDER ONE OHM.
9. ALL CAPACITY VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
10. FOR CAPACITY TOLERANCES, SEE LEGEND.
11. ARROWS ON POTENTIOMETERS INDICATE CLOCKWISE ROTATION.
12. MHz = MEGAHERTZ = MEGACYCLE uH = MICROHENRY
13. INDICATES CHASSIS GROUND
14. INDICATES VOLTAGE SOURCE
15. INDICATES ALIGNMENT OR TEST POINT
16. INDICATES WAVEFORM
17. ALL WAVEFORMS TAKEN ON AIR SIGNAL DEVELOPING 2.5 VOLTS PEAK TO ZERO AT TEST POINT C1 AND ALL CONTROLS SET FOR NORMAL VIEWING.
18. TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS



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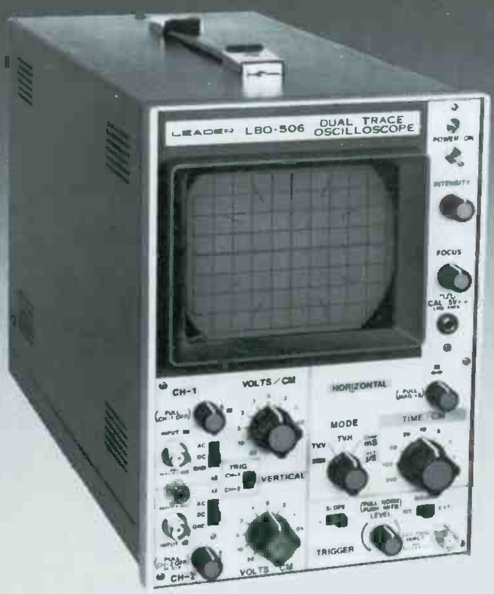

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