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A HARCOURT BRACE JOVANOVICH PUBLICATION

ELECTRONIC TECHNICIAN/DEALER

WORLD'S LARGEST TV-RADIO SERVICE & SALES CIRCULATION

EDITOR'S MEMO

An Early Reminder: Take A NATESA And/Or NESDA Tax-Deductible Vacation This Summer

The annual conventions of the National Alliance Of Television & Electronic Service Associations (NATESA) and the National Electronic Service Dealers Association (NESDA) are scheduled for August.

Why plug a couple of events three months in advance—even worthwhile events such as the NATESA and NESDA annual conventions?

Well, last year I reminded ET/D readers of the scheduled dates of these two important electronic service industry events about one month in advance—which, according to the many letters I received, was too late for many of you to alter your vacation travel plans to include one or both of the conventions.

So, to prove that I learn from my mistakes—usually—this year I'm reminding you *three* months in advance:

NATESA ANNUAL CONVENTION

Dates: Aug. 25-28

Place: Carson's Nordic Hills Resort, Itasca, Illinois (Between Chicago's O'Hare International Airport and downtown Chicago)

For Registration Info: Write Frank Moch, NATESA, 5908 S. Troy St., Chicago, IL 60629, or call Mr. Moch at 312-476-6363

NESDA ANNUAL CONVENTION

Dates: Aug. 16-20

Place: Sheraton Twin Towers, Orlando, Florida

For Registration Info: Write Dick Glass, NESDA, 1715 Expo Lane, Indianapolis, IN 46222 or phone Mr. Glass at 317-241-8160

And remember, you don't have to be a NATESA or NESDA member to attend either convention, and your transportation costs to and from the conventions and most of your other convention expenses probably will qualify as tax-deductible business expenditures.

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THE COVER: We "borrowed" a few items from the parts inventory of one of our neighbors in Duluth—Master Radio & TV—to produce our cover photo. It is symbolic of our two-part "TV OEM Replacement Parts Source Directory", which begins on page 33.

DEPARTMENTS

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NEWS OF THE INDUSTRY

Summer Consumer Electronics Show To Be Biggest Ever

Predictions are now that the Summer Consumer Electronics Show (CES) to be held at McCormick Place in Chicago, June 5-8, will surpass all previous shows by the number of exhibitors and space used. Jack Wayman, senior vice president, Consumer Electronics Group, Electronic Industries Association, the sponsor, says that 90% of exhibit space is sold, for a total of 400,000 square feet, making it one of the five largest trade shows in the country.

Show manager, Bill Glasgow, says the Summer CES is "the largest trade show in the world devoted exclusively to consumer electronic products."

For the first time, said Wayman, "the summer CES will use the entire facilities of McCormick Place, which includes the Mall, lobby, and concourse levels. In addition, 150 public rooms and suites in adjacent McCormick Inn will be used by audio component exhibits.

The 1977 Summer CES will follow its custom of generally arranging exhibits by category, namely, audio compacts, audio components, television, video games, calculators and watches, and CB radios.

New Home Entertainment Industry Organization Planned For California

Efforts are being generated to launch a new organization in California to represent the interests of the consumer appliance and home entertainment industries. The idea is to provide a voice for the industry in their dealings in the areas of government active in the regulation of business.

Electronic Industry Sales in 1977 Expected To Rise Ten Per Cent

According to the 1977 Industrial Outlook, a report prepared by the U.S. Department of Commerce, sales of electronic products should reach $58.39 billion—a 10 percent increase over shipments in 1976 of $52.98 billion. New markets and an expected business upturn are the reasons for the expected increase.

The report forecasts a 27% increase in 1977 in the sales of CB radios for a total of $1.4 billion, of which 75% will be imports, mostly from Japan.

The sales of electronic components will increase this year 8 per cent over 1976, with a total expected of $12.17 billion.

RCA Launches Third New TV Chassis In Three Years

Another new color TV chassis has been introduced by RCA—the third in as many years. The new chassis weighs 8½ pounds less than the old chassis and with 8 modules draws only 86 watts. It is designed for the low-end 19-inch and 25-inch color models, but so far is available only in 19-inch sets. RCA officials say that the new chassis operates 24% cooler with higher performance and will be easier to service than any previous RCA models.

Television Imports Increased By Almost 71% In 1976

According to the import/export figures for consumer electronic products compiled by the Electronic Industries Association (EIA), a total of 7,160,760 television units, or 70.9% more than 1975, were imported in 1976. Color TV imports increased 133.3% in 1976 over 1975, while B & W TV imports increased by 45.5%.

Total radio imports of 41,364,156 units were 29.5% over the 31,941,044 units imported in 1975. Phonograph imports increased by 89% over 1975, and other consumer electronic imports showed similar gains.

Dollar value, at customs level, also increased in all consumer electronic categories.

Meanwhile, exports of consumer electronic products also increased in all categories, except with home radios and audio tape equipment.

Some CB Manufacturers Decide To Diversify

Two of the most active CB radio manufacturers, Hy-Gain and Pathcom (Pace), have decided to put their producing and marketing eggs in more than one basket. Both firms have announced diversification into other lines but CB.

Hy-Gain Electronics plans to purchase Darco, Inc, a firm in Omaha, Nebraska, that produces automatic meter-reading equipment that works in conjunction with communications products. In addition, Hy-Gain says they will also produce a broader line of marine radios and automotive audio products.

Pathcom, meanwhile has reorganized its operation into two groups—one for consumer products and the other for land mobile and marine products. They also will introduce a

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It's a CB Profit Center All in One Handsome Instrument

The CB service market is growing and more "on the ball" technicians are getting into the act every day. Competition for the CB business is getting tougher and you'll want to be sure you can compete. Knowledge alone won't be enough. You'll want to get ahead by simplifying your work to get the most jobs out with the least effort. You'll want to concentrate on your troubleshooting and not fiddle with 15 cable connections and 28 knobs on different instruments. So you will want to get an instrument that takes you from antenna input to speaker, and from mike to antenna load in one neat package.

To top that off, the complete CB42 is hundreds of dollars below the nearest competition, and thousands below most. We've got our competition beat, and you'll beat your competition, too, by saving these six ways with this CB42 Profit Center.

$AVE ON REPAIR TIME:

One simplified tester in a single case saves time on every test on any CB that comes in your door, including Single Sideband sets; you won't even need a scope.

$AVE ON READOUT TIME:

One direct-reading digital readout saves interpretation time and reading errors. You'll know the CB's frequency, generator frequency, Percent Off-Channel, positive/negative modulation and distortion, RF output, and audio output with a simple flick of a switch. Only the CB42 is this simple and complete.

$AVE ON CHANNEL CHECKING:

Simply rotate the CB42 and CB selectors through all 40 channels and read "percent off center frequency" on the direct-reading digital meter (.005% FCC maximum deviation) in less than two minutes for all 40 channels.

$AVE ON TIME CONSUMING CONNECTIONS:

Three cables, provided with your CB42, do the entire job; audio cable, transmitter cable, and receiver cable.

$AVE ON ANNOYING HOWL:

Why get a screwdriver in the back from the guy next to you, when you can substitute for that annoying speaker howl? Just plug the built-in, non-grounded speaker sub cable into the transceiver and quietly monitor the audio output on the meter.

$AVE ON BENCH SPACE:

The CB42 takes less than one-third the bench space of other equipment. You can even take it to the field with you, for on-the-spot mobile checks, since it is also 12 Volt battery powered.

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line of pagers for common carriers and industrial/institutional users.

Both Hy-Gain and Pathcom will remain strong in CB but price, supply and the transition problems from 23-channels to 40-channels and the resulting losses in revenue reportedly caused them to diversify as insurance against the instability of the CB market.

Three-year Warranty On TV Parts & Labor Offered Now By Canadian Firm

Canada's only independent color TV manufacturer—Electrohome—is now offering through retailers a three-year warranty on parts & labor for their products. John Pollock, Electrohome president, according to *TV Digest,* feels that extended warranties "seem to be the coming thing in Canada's sluggish market."

Electrohome's 3-year TV service labor warranty is the longest in North America.

Matsushita To Supply RCA With Their VHS Video Cassette Recorder/Players

It's been announced that the Matsushita Electric Co. will supply the RCA Corporation with the VHS (Video Home System) video cassette recorder/players built to RCA's specifications.

The Matsushita system was chosen after a thorough analysis of the alternatives, according to Roy H. Pollack, vice president & general manager, RCA Consumer Electronics.

"The VHS format offers the best balance of all the essential needs of the consumer—value, playtime, performance, quality and reliability," according to Pollack.

The Matsushita system, said Pollack, can record and play up to four full hours of material on a single cassette, which is double the playtime capacity of other systems. Pollack emphasized that Matsushita's four-hour playtime does not require any mechanical changer mechanism. The new product will appear in the U.S. in late summer of this year.

In a later announcement, the Panasonic Company, which is a division of Matsushita, revealed that it will also introduce and market the VHS type video recorder/player later this year.

Infrared Remote Tuning To Be 1978 Feature of GE Color TV

Digital remote varactor tuning using infrared light instead of ultrasonics will be introduced in some General Electric color TV sets for 1978. This is an addition to the VIR feature—or "broadcast-controlled" color—introduced by GE last year. To be included on 6 consoles and two 19-inch models, the new remote tuning system will add around $140 to price of sets.

GE also will introduce a non-VIR type of automatic color control to most of its other non-VIR models in 1978—a move which is thought to be competitive with other manufacturer's color control systems, such as "Color Track" and "Color Sentry."

PTS Electronics Adds Two New Service Centers

The total number of company-owned tuner/module rebuilding service centers for PTS Electronics has now expanded to 46 with the purchase of two existing tuner companies.

The firm has purchased and consolidated the Tune-Rite TV Tuner Co. of Wauwatosa, Wisconsin, with the PTS operation in Milwaukee, and after purchase of the Tuner Service Co. of Baltimore, has opened a PTS operation at 5505 Reisterstown Road in Baltimore.

1977 Consumer Electronics Annual Review Now Available

The 1977 Consumer Electronics Annual Review containing the 1976 statistics, current status and history of all consumer electronic products is now available free of charge from the Electronic Industries Association's Consumer Electronics Group.

The 34-page booklet provides a unique overview of a multi-billion dollar industry that is one of the largest and most important in the world. The book contains statistical charts that compare the annual sales growth of the industry's products, and a report on the current status and analysis of consumer electronics at all marketing levels and distribution. For a free copy, write to EIA, Consumer Electronics Group, 2001 Eye Street, N.W., Washington, D.C. 20006.

Introduction of New TV Lines To Occur Later Than Before

According to a survey conducted by *TV Digest*, the first trade exposure of the new TV lines will occur later than in 1976 for 10 brands, 3 earlier and 3 about the same date. The favorite site for the unveilings will be Las Vegas, site of 4 meetings, followed by Chicago with 3. The earliest was JVC, introduced in April, and the latest will be Magnavox, set for July 25. ■

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TECHNICAL LITERATURE

A Semiconductor Cross Reference Guide & Catalog of all of Motorola's HEP products is now available. The new 184-page book lists and describes replacements for over 60,000 different discrete devices and ICs. Included are discrete silicon and germanium power transistors, thyristors, small-signal FETs and bipolar transistors, C.B. RF power transistors, zeners, rectifiers and opto-electronic devices. One hundred and ninety-eight new products have been added to the catalog; 104 are newly offered TTL functions. Industry-popular TO-220 packaged components are also included. And a single chip, 3½ digit DVM IC, that utilizes CMOS technology to provide both linear and digital circuit functions, is also described. The new catalog is available for $2.00 from HEP distributors, or write to Technical Information Center, *Motorola Semiconductor Products, Inc.*, P.O. Box 20294, Phoenix, Arizona, 85036.

A Manual On CB Transceiver Servicing, the manual for B&K-Precision's Model 1040 CB Servicemaster, is now available as a reference guide. The manual contains individual chapters on CB performance testing, CB receiver adjustments and troubleshooting CB transceivers. In the CB Performance Testing chapter, 22 different test procedures are detailed with explanations of each specification. Troubleshooting information describes how to locate a CB transceiver fault in the shortest time possible and even synthesizer troubleshooting data is included. Both AM and SSB transceiver types are covered. The manual is available for $5 (postpaid) from *B&K-Precision,* Sales Department, 6460 W. Cortland Avenue, Chicago, IL 60635.

A New Loudspeaker Catalog, "Quam '77, The Sound Decision," is now available from Quam-Nichols Company. The 12-page catalog lists 127 different loudspeakers available off-the-shelf to cover virtually any loudspeaker application. As a new feature, the catalog includes listings for a recently introduced group of mobile 2-way radio replacement speakers. In addition, the catalog includes updated listings of general purpose, automotive, high fidelity, music instrument and sound system loudspeakers and matching line transformers. Also included are updated listings of general purpose, automotive, high fidelity, music instrument and sound system loudspeakers and matching line transformers. To aid in speaker selection, the catalog provides drawings of loudspeaker shapes and mounting configurations and complete descriptions of the properties and usages of the various magnetic materials used in the speakers. Available free from *Quam-Nichols Company*, 234 East Marquette Road, Chicago, IL 60637.

Two Test Instrument Catalogs are now available from Leader Instruments. The first is their full-line catalog of oscilloscopes, vectorscopes, multimeters, color bar and pattern generators, DVM's, millivolt meters, signal generators, wattmeters, sweep/marker generators and accessories. Photographs, specifications and prices are included. The second catalog is a descriptive, illustrated listing of the test instruments included in the Leader Communication Instruments Performance Test Center. Included are antenna couplers, an SWR wattmeter, and RF power meter, dip meter, antenna impedance meter, a CB harmonic meter and 3 inch oscilloscope. Both catalogs are available free to the industry from *Leaders Instruments Corp.*, 151 Dupont Street, Plainview, N.Y. 11803.

Electronic Test Instruments are displayed and described in full color in the latest catalog from Sencore. Included are descriptions of the Sencore 'family' of Cricket transistor tester/analyzers, the Big Henry multimeters, the Mighty Mite tube tester, the Big Mack and Super Mack CRT testers and restorers, and the Little Huey digital color bar generator, plus the full line of other test equipment, including the CB Analyzer. Prices are included. Available free from *Sencore Instruments*, 3200 Sencore Drive, Sioux Falls, S.D. 57107.

Color Video Products, Systems and Accessories are fully described in the latest illustrated catalog from JVC Industries. The catalog provides information about videocassette equipment such as color players and player-recorders, electronic editing VCRS and a new remote control unit. Portable color systems incorporating the firm's lightweight two-tube color camera, VCRs and VTRs. Available free from *JVC Industries, Inc.*, 58-75 Queens Midtown Expressway, Maspeth, N.Y. 11378.

Electrical And Electronic Tools and Safety Equipment are described fully in the new catalog, No. 120, from Klein Tools. For anyone working outdoors on antennas, electrical and electronic equipment, this is the complete catalog of tools and equipment needed for the job. Everything from pliers to safety harnesses. Fully illustrated in 76 pages. Available free from *Klein Tools*, 7200 McCormick Road, Chicago, Illinois 60645.

CB Antennas and Accessories are described and illustrated in the first catalog issued by the newly formed Winegard Industries, Inc. The new literature, Catalog 770, is designed to acquaint the CB dealer and consumer with the company's 40-channel mobile antennas. Technical information and illustrations are provided for each of the firm's base load, center load and top load models. Included is a listing of antenna replacement parts and accessories, such as coaxial cables, mounts, whips, connectors and coils with springs. Available free to both distributors and dealers from John Von Harz, *Winegard Industries, Inc.*, 3002A Winegard Drive, Burlington, Iowa 52601.

Antenna Tuning Systems For CB are described and illustrated in the latest brochure from Norcom Electronics. Titled "The Ultimate in Antenna Systems," the brochure describes Isolated Circuit Tuners, which are tuning instruments for mobiles, co-phased systems, and single or multiple antenna base station operations. Included are descriptions of the firm's line of Iso-Tune, Ultra-tune, and Back Talk antenna tuners, which are claimed to increase talk power for CB radios. Available free from *Norcom Electronics, Inc.*, Box 332, Northfield, Ohio 44067.

TV Test Rigs, Brighteners, and Substitute Tuners are some of the items included in the latest catalog from TeleMatic. The new literature lists a universal TV test rig, yoke & convergence adaptors, extension tools, brighteners cross-referenced to tubes, crystal checkers, CRT testers, high voltage probes, curve tracers and power supplies. Also included are TV high voltage repair parts and kits. Available free from *TeleMatic*, 2245 Pitkin Avenue, Brooklyn, N.Y. 11207.

Exact Replacement Products for CB and TV Equipment are cross-referenced in a new replacement guide from Thordarson Meissner, Inc. The guide lists 44 flame-retardant flybacks and 14 yokes for the TV replacement market, of which 7 yokes and 19 flybacks are designed for imported TV sets. Also included is information on CB replacement parts, including 19 chokes, 16 driver transformers and 34 output/modulation transformers. The cross reference guides—for TV, TVPG 9, and for CB, CBRG 2—are available free at *Thordarson* distributors. ■

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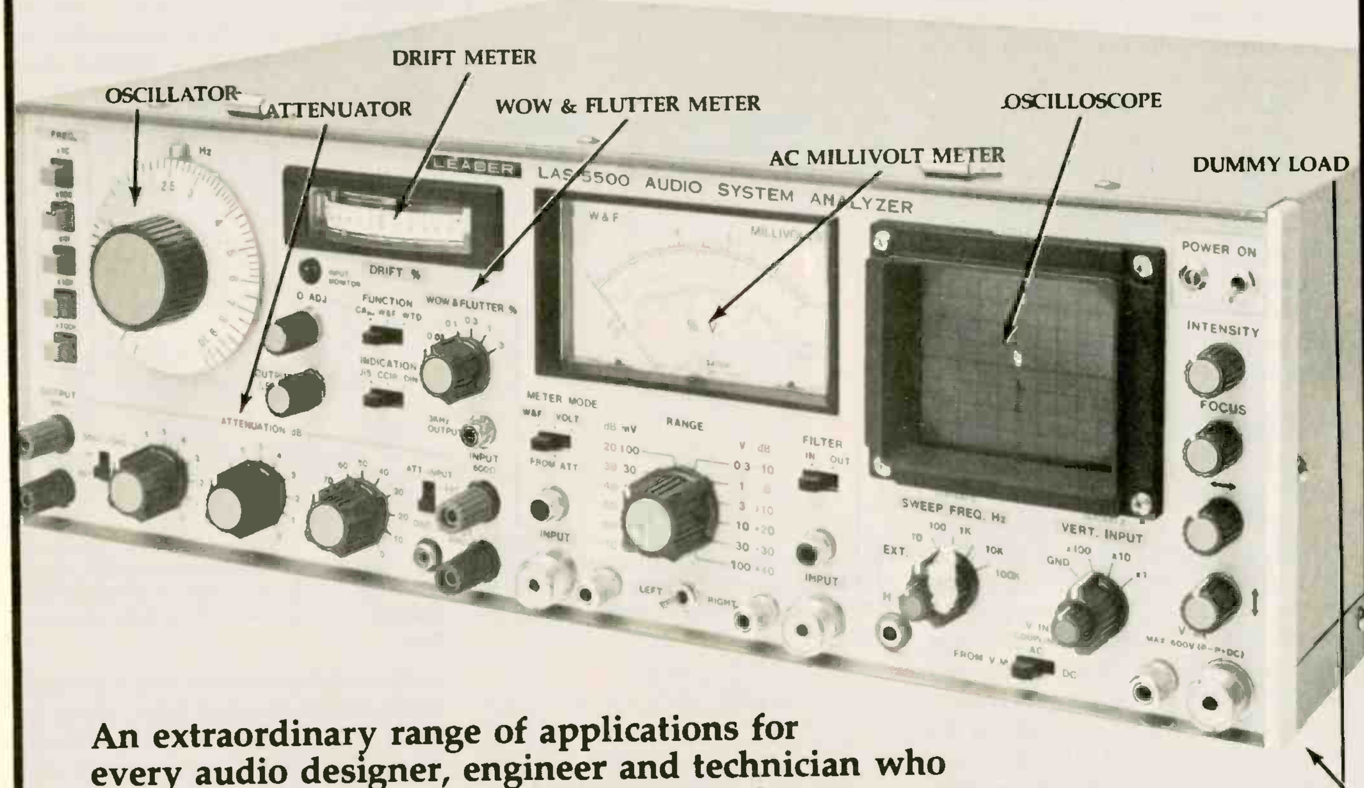

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...for more details circle 120 on Reader Service Card

Beta Overview

By J.W. Phipps

What this transistor characteristic means from a servicers point of view and how it is measured

■ A bipolar transistor's ability to provide current—and therefore voltage and/or power—amplification is dependent on how much current it can produce in its output circuit for given levels of current in its input circuit when its junctions are properly biased (emitter-base junction forward biased and base-collector junction reverse biased).

This characteristic of current 'transfer' from input to output is aptly titled *forward current transfer ratio* and is referred to as *alpha* if measured with the transistor connected in a common-base configuration (Fig. 1) and *beta* if measured with the transistor connected in a common-emitter configuration (Fig. 2).

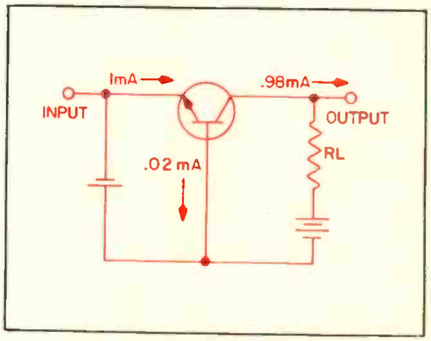


Fig. 1—Common-base circuit configuration. Base is common to both the input (emitter-base) and the output (collector-base) circuit.

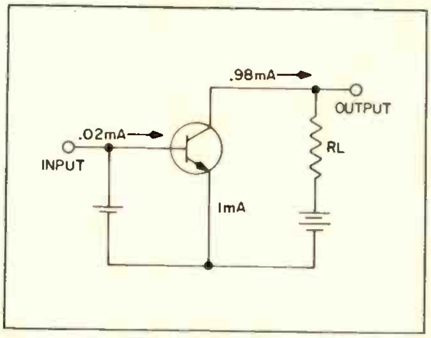


Fig. 2—Common-emitter circuit configuration. Emitter is common to both the input (base-emitter) and the output (collector-emitter) circuit.

THE RELATIONSHIP OF ALPHA & BETA

Alpha and beta are mathematically related. If the alpha of a transistor is known, the corresponding current gain in terms of beta can be computed, and vice versa. The principal difference between the two terms is the input element used in computing the ratio of input to output current.

As shown in Fig. 1, alpha is determined with the transistor connected in the common-base configuration. The *input* element in this configuration is the *emitter* and the output element is the collector. The formula for computing DC alpha is Ic/Ie. The DC alpha for the transistor in Fig. 1 therefore is .98mA divided by 1mA, or .98. (In the common-base circuit, current gain is always less than unity, or less than 1.)

The same transistor is shown connected in the common-emitter configuration in Fig. 2, for beta measurement. In this circuit configuration, the *input* element is the *base* and the output element, again, is the collector. The formula for computing DC beta is Ic/Ib. The beta of the transistor is therefore .98mA divided by .02mA, or 49.

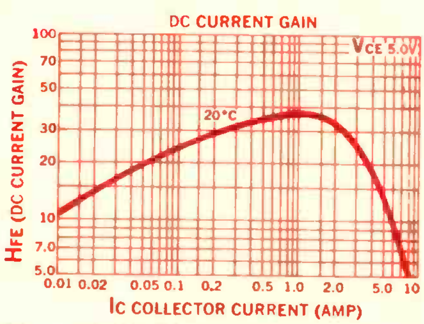


Fig. 4—Chart which illustrates how the DC beta of a bipolar power transistor depends on the collector current at which it is measured.

CLASS	APPLICATION	CURRENT CAPABILITY
SIGNAL	AUDIO, RF, IF	1 mA – 10 mA
INTERMEDIATE POWER	AUDIO, SWITCHING	10 mA – 100 mA
POWER	AUDIO, REGULATOR, OUTPUT	100 mA – 1 A

Fig. 5—Three general classes of bipolar transistors and the corresponding collector current range typically associated with each.

The following formula is used to convert alpha to beta: beta = alpha/1−alpha. Consequently, the beta of the transistor in Fig. 1 is: .98/1−.98 = 49 (or the same as that in Fig. 2).

The formula for converting beta to alpha is: alpha = beta/1 + beta. Thus, the alpha of the transistor in Fig. 2 is: 49/1+49 = .98 (or the same as that in Fig. 1).

A look at the inherent division of currents in a bipolar transistor provides a more revealing explanation of the relationship between alpha and beta and why alpha is always less than 1 while beta is always greater than 1. In any circuit equipped with a bipolar transistor, the current flowing in the emitter circuit always divides between the base circuit (.5 to 5%) and the collector circuit (95 to 99.5%). Consequently, collector current is always equal to emitter current minus base current, or Ic = Ie−Ib.

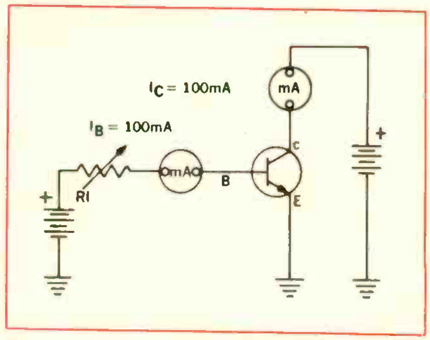
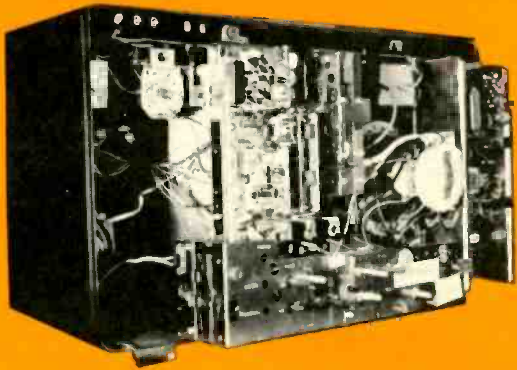


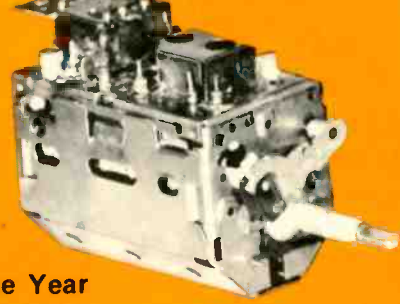
Fig. 3—Common-emitter circuit which, along with chart in Fig. 4, is used to illustrate how collector current level affects beta measurement.

Therefore, alpha, which is the ratio of collector current (Ic) to emitter current (Ie), also can be expressed as (Ie−Ib) divided by Ie. Applying this expression to the conditions in the common-base circuit of Fig. 1 we find that alpha equals (1.00A−.02A) divided by 1.00A, or .98.

And, beta, which is the ratio of collector current (Ic) to base current (Ib), can be expressed as

Tuner Service Corporation





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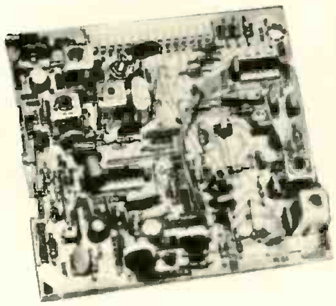

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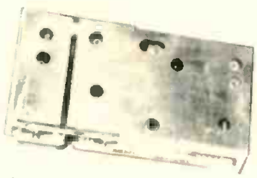

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(Ie−Ib) divided by Ib. Applying this expression to the conditions in the common-emitter circuit in Fig. 2 we find that (1.00A − .02A) divided by .02A, or 49.

WHY BETA IS PREFERRED OVER ALPHA

Beta is the transistor gain characteristic measured by most service-type transistor testers principally because changes in transistor characteristics (such as junction leakages) which affect the DC operating point of a transistor-equipped circuit, and therefore its gain, produce larger (and therefore more easily measured) variances of beta than they do alpha, even though such changes produce the same effect on the current gain of the circuit.

TWO TYPES OF BETA

Actually, there are two 'types' of beta. The type we have discussed up to this point is called the *DC*, or *large-signal*, beta and is commonly labeled HFE.

The other type is called *AC*, or *small-signal*, beta and is commonly labeled Hfe. Small-signal beta is measured by superimposing a small AC signal on the DC beta of Fig. 2 and measuring the resultant change in the collector current. In other words, AC beta is the ratio of a small change in collector current produced by a small change in base current.

Service-type transistor testers typically measure only DC beta.

CURRENT RANGE	CALIBRATION SETTING	COLLECTOR CURRENT	BETA MULTIPLICATION FACTOR	BETA MULTIPLICATION FACTOR AFTER SWITCHING TO NEXT LOWER CURRENT RANGE
100 μA	Not Used			
1 mA	CAL X1 CAL X5 CAL X10	.1 mA .5 mA 1 mA	X1 X5 X10	NOT AVAILABLE NOT AVAILABLE NOT AVAILABLE
10 mA	CAL X1 CAL X5 CAL X10	1 mA 5 mA 10 mA	X1 X5 X10	X10 X50 X100
100 mA	CAL X1 CAL X5 CAL X10	10 mA 50 mA 100 mA	X1 X5 X10	X10 X50 X100
1 A	CAL X1 CAL X5 CAL X10	.1 A .5 A 1 A	X1 X5 X10	X10 X50 X100

Fig. 7—Chart of collector current ranges of the Model IT-121. Current range is selected with RANGE pushbuttons. BETA CAL is then adjusted to position meter needle over meter CAL setting which corresponds to desired collector current level. When BETA button of FUNCTION selector is pushed in, beta is value indicated by beta scale of meter, multiplied by corresponding multiplication factor in chart. If needle deflects off-scale, next lower current range is selected and corresponding higher multiplication factor in chart is used.

HOW BETA IS AFFECTED BY COLLECTOR CURRENT

An accurate evaluation of the current gain characteristics of a transistor in relation to its type and application require that the beta test *should* be made with the transistor collector current as near as possible to the level it is in the application in which the transistor is used.

Assume that R1 in Fig. 3 is decreased until a current of 1 ampere (1000 MA) is produced in the collector circuit. If the current in the base circuit is 100 MA at this setting of R1, the beta of the transistor is 1000MA divided by 100 MA, or 10.

The value of beta just computed applies only when 1000 MA of current is produced in the collector circuit. Other levels of collector current will produce different values of beta. This is illustrated by

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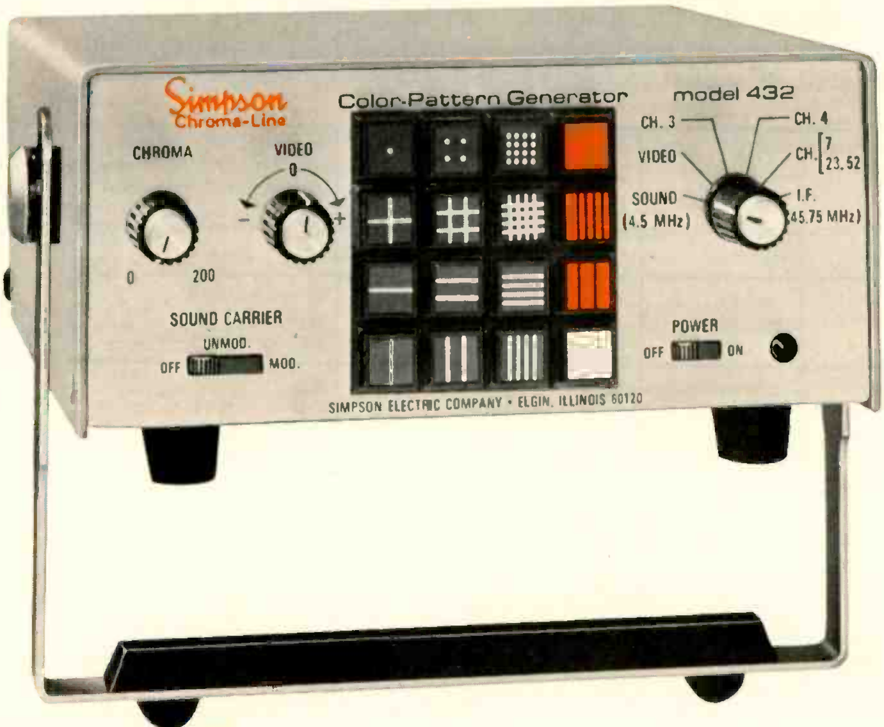

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Fig. 4, which is the gain-vs.-collector current curve of a typical power transistor. Note that beta decreases as collector current approaches zero and also as the collector current approaches the maximum current level which the transistor can safely handle.

Fig. 5 shows the three general classes of bipolar transistors and the ranges of collector current at which they typically are operated.

MEASUREMENT OF BETA WITH A SERVICE-TYPE TRANSISTOR TESTER

As an example of how DC beta is measured with a direct-reading service-type transistor tester, let's use Heath's Model IT-121, shown in Fig. 6.

The collector current levels provided by the Model IT-121, shown in the chart in Fig. 7, cover the range from .1mA to 1A. The appropriate current range is selected by pushing in one of five RANGE pushbuttons.

For in-circuit testing, the transistor elements are connected via test leads to corresponding jacks on the top center of the front panel. For out-of-circuit testing, the transistor is plugged into a socket on the top right of the front panel.

To set up the Model IT-121 for beta measurement, the TRANS pushbutton of the MODE selector and the BETA = INFINITY pushbutton of the Function selector are pushed in and the NPN/PNP pushbutton of the MODE selector is either pushed in (for PNP) or released (for NPN). This establishes the circuit in Fig. 8, which actually is a bridge configuration, as shown in Fig. 8B. Rt in Fig. 8B represents load resistor RS and any in-circuit shunt resistances (indicated by Rx in Fig. 8A). The principal purpose of this circuit is to balance out shunt resistances and leakage currents when the transistor is tested in-circuit, and to balance out leakage currents during out-of-circuit testing. This is accomplished by adjusting R11, the SET BETA INFINITY control, so that the meter needle is placed over the BETA INFINITY mark on the Beta scale (Fig. 9). With the meter needle at this point, the opposing currents in the two legs of the bridge are equal and cancel out each other. Consequently, no current flows

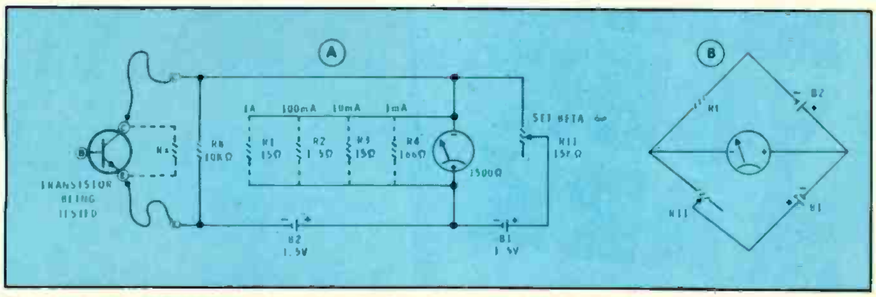

Fig. 8—BETA=INFINITY circuit of IT-121. A) Actual circuit. B) Equivalent circuit.

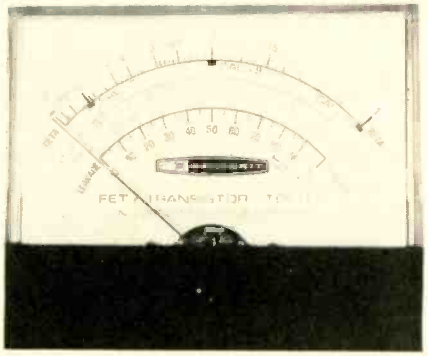

Fig. 9—Meter of IT-121. Top scale is direct-reading scale, with corresponding collector current/beta multiplication indicators below it.

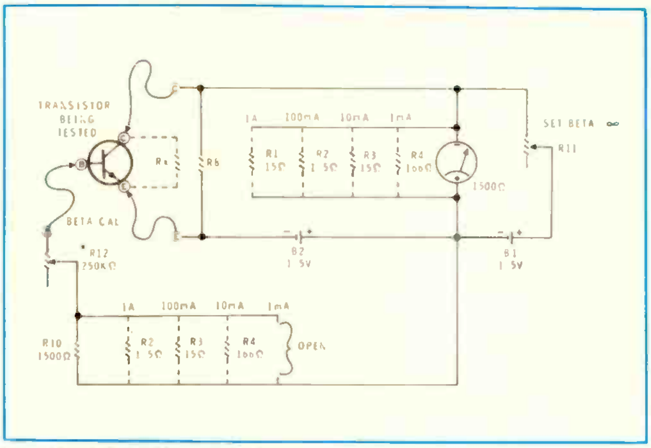

Fig. 10—BETA CAL circuit of IT-121.

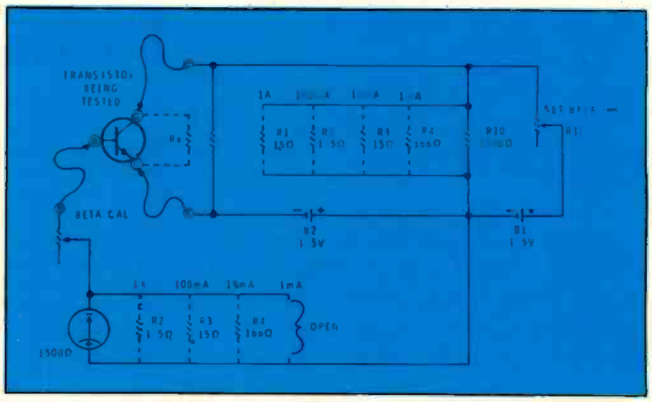

Fig. 11—BETA READOUT circuit of IT-121. (Same circuit as in Fig. 10 except that meter and R10 are interchanged so that meter is in base circuit of transistor.

through the meter. Any subsequent unbalancing of the bridge, as indicated by movement of the meter needle, will be related only to actual collector current. If during this setup procedure the meter needle cannot be placed over the BETA INFINITY meter mark, either the transistor is defective, the NPN/PNP pushbutton is in the wrong position or, if the transistor is being tested in-circuit, a circuit defect exists.

Resistors R1 through R4 in Fig. 8A are meter-shunt resistors which change the sensitivity of the meter to correspond to the collector current range selected.

After the bridge has been balanced to cancel out the effects of in-circuit resistances and any leakage inherent in the transistor, the BETA CAL pushbutton of the FUNCTION SELECTOR is pressed in, connecting the base of the transistor into the test circuit, as shown in Fig. 10. Variable resistor R12, the BETA CAL control on the front panel, adjusts the emitter-base current of the transistor and, consequently, the transistor collector current. R12 is adjusted to produce sufficient current flow through the meter to place the meter needle over the X10, X5 or X5 meter calibration mark, depending on which collector current range and level have been selected. (Refer again to the chart in Fig. 7.) For example, if a collector current level of 10mA is desired, the 10mA pushbutton of the RANGE selector will have been pushed in and the BETA CAL control will be adjusted to place the meter needle on the CAL X10 mark. The level of current flowing in the collector at this meter indication is 10mA.

Next, the BETA pushbutton of the Function selector is pushed in, establishing the circuit shown in Fig. 11. It is identical to that in Fig. 10 except that R10 and the meter are interchanged. This does *not* affect the transistor operating conditions established previously, because the resistances of the meter and R10 are identical (1500 ohms). However, note that the shunt resistance across the meter when it is in the base circuit is *ten* times *larger* than the shunt for the corresponding current range when the meter was in the collector circuit. This *increases* the meter sensitivity by a factor of 10, so that the current required for full-scale deflection of the meter in the base circuit is only 1/10th of what it was in the collector circuit. One reason for this consistent difference of meter sensitivity between collector and base is that the base current of a transistor is inherently much smaller than the collector current and therefore requires a more sensitive meter for readable indications. And, if the meter is to be calibrated to read beta directly, as is the meter of the IT-121, the factor by which the meter sensitivity differs between base and collector readings must be consistent for each current range and must relate to the multiplication factor of the current ranges, which for the IT-121 is 10. (Note that the current ranges of the IT-121 shown in Fig. 7 differ by a factor of 10).

As an example of how the IT-121 meter scale reads out beta directly, suppose that the beta of a small-signal audio transistor is being measured at a collector current level of 1mA. The 1mA pushbutton of the RANGE selector is pushed in and the BETA CAL control is adjusted to place the meter needle over the CAL X10 mark (Fig. 9). The current now flowing in the collector circuit is 1mA. The meter is then switched to the base circuit by pressing in the BETA button of the

Function selector. Suppose the meter needle swings to the 1 (full-scale) position on the beta scale (Fig. 9). Because the meter sensitivity is now 10 times greater than it was in the collector circuit, the indication represents .1mA of current flowing in the base circuit. Since beta equals Ic/Ib, the beta of the transistor is 1mA/.1mA, or 10. The beta scale reading verifies this (meter reading of 1 multiplied by the calibration factor of 10 = 10).

EVALUATING THE RESULTS

The principal purpose of measuring the beta of a transistor during troubleshooting is to determine whether or not the transistor is capable of producing the current gain (and therefore power and/or voltage gain) required for the application in which it is used.

The beta of a number of properly operating transistors of the same type can vary over a relatively wide range. During the design of a circuit, the "design center" beta of the type of transistor to be used is selected as the beta around which the circuit will be designed. The 'normal' spread of beta values above and below the design center are compensated for by building in additional components which stabilize the operating point of the circuit throughout the wide range of beta values of transistor of the type that will be installed in the circuit during manufacturing.

From the preceding it can be seen that the "normal" beta of properly operating transistors of the same type is usually a relatively wide range instead of a specific value and that, consequently, beta usually should be evaluated in terms of the *minimum* value specified for that type in transistor manuals. (One exception to this rule is when transistors of the same type must be matched for use in complementary symmetry circuits, etc.) If the beta of a transistor at least meets the "minimum beta" specification for its type, it usually can be considered to be capable of performing its intended circuit function, if its other characteristics, such as junction leakages, are within normal specified limits.

If the transistor does not produce at least the minimum specified beta, or if the tester being used to measure its beta cannot be calibrated while it is connected to the tester, the transistor probably is defective. However, if the transistor has been tested only in-circuit, remove it and test it out-of-circuit before discarding it. A defect in the circuit might be causing the abnormal indication.

BETA APPLIED TO REPLACEMENT SELECTION

When selecting replacement transistors you probably will encounter (if you haven't already) the fact that so-called 'first-grade' lines of transistors offered by most major transistor manufacturers typically have betas which range over a three-to-one spread for a given type. For example, a particular type might be specified 'B 50 Min., 150 Max' and, often, with 'Typical B75' tossed in to help 'narrow' things down. The reason for such a seemingly large range of beta for a given type is that the manufacturer simply can not sort quantities of the type any closer without increasing the unit price. For reasons explained earlier, this 'wide-range' approach to beta specifying usually does not present a problem in most replacement applications.

However, to keep tolerance-sensitive circuits within required parameters without resorting to more complex, and usually more expensive, circuit designs, some consumer electronic manufacturers order and use transistors with betas sorted closer than previously described. These 'original equipment replacement' transistors frequently are assigned nonstandard 'house numbers' by the equipment manufacturer. Such close-tolerance transistors usually should be replaced only with OEM-approved types.

Generally, the beta of capacitor- and transformer-coupled audio stages are not particularly critical. However, the beta of most DC-coupled, IF, RF and matched-pair stages *are* critical.

Transistors with 2N--- numbers are supposed to be directly interchangeable, and typically are. Transistors with 'Foreign' and 'House' numbers frequently are not interchangeable with so-called 'replacement' types. ■

Electronics Self-Test: Capacitor Replacement Selection

Sixteen carefully chosen multiple-choice questions which test a technician's knowledge of the various factors involved in the selection of a replacement capacitor. (Answers are on page 20.)

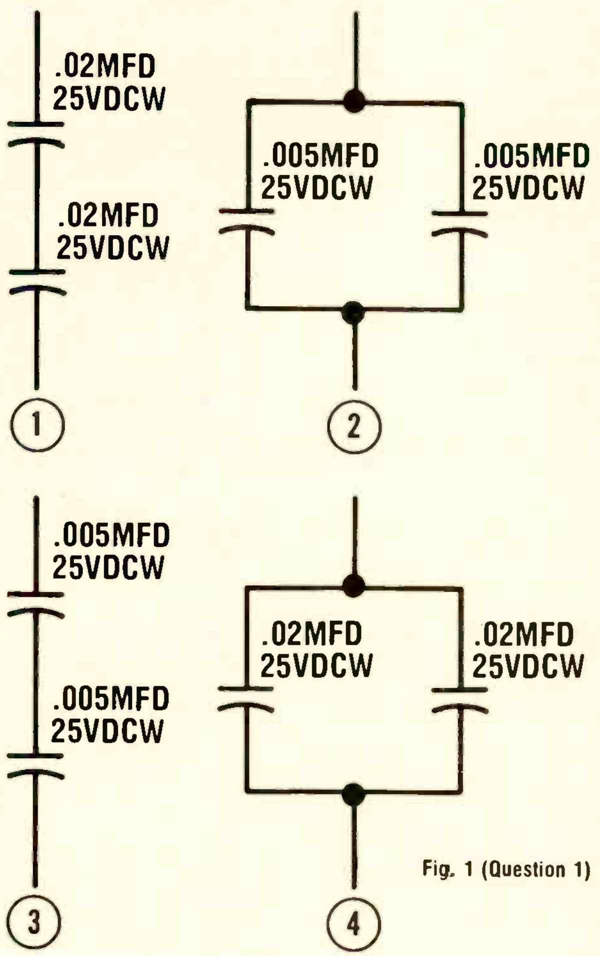

Fig. 1 (Question 1)

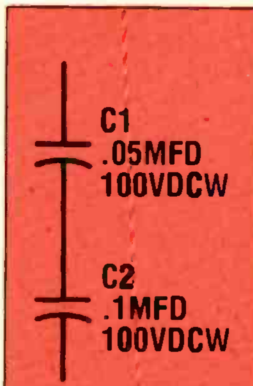

Fig. 2 (Questions 2 & 3)

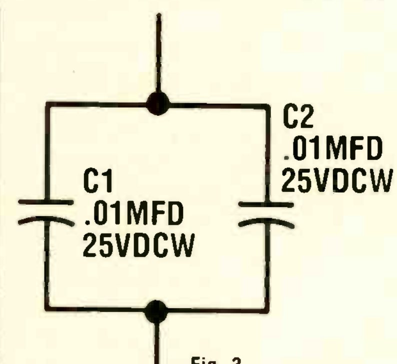

Fig. 3 (Questions 4 & 5)

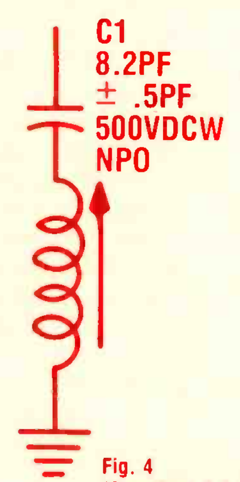

Fig. 4 (Questions 6 & 7)

1) Which one of the combinations of capacitors in Fig. 1 is the most suitable replacement for a single capacitor with a rating of .01mfd, 50VDCW?

a) 1 ____
b) 2 ____
c) 3 ____
d) 4 ____

2) What is the maximum DC voltage which can be applied across the two capacitors in Fig. 2 without exceeding the DC voltage rating of either capacitor?

a) 100VDC ____
b) 200VDC ____
c) 50VDC ____
d) 150VDC ____

3) What is the total capacitance of the two series-connected capacitors in Fig. 2?

a) .15mfd ____
b) .033mfd ____
c) .05mfd ____
d) .0015mfd ____

4) What is the maximum DC voltage which can be applied across the two parallel-connected capacitors in Fig. 3?

a) 50VDC ____
b) 25VDC ____
c) 12.5VDC ____
d) 100VDC ____

5) What is the total capacitance of the two parallel-connected capacitors in Fig. 3?

a) .005mfd ____
b) .02mfd ____
c) .01mfd ____
d) .025mfd ____

6) Fig. 4 is a simplified representation of a series-resonant 41.25MHz (sound) trap in the input of the video IF section of a color TV receiver. What does the designation 'NPO' mean?

a) The value of the capacitor will either decrease or increase as the ambient temperature changes ____
b) The capacitor can be replaced with either a positive- or a negative-temperature coefficient type ____
c) The value of the capacitor will remain within the specified design value throughout a relatively wide range of ambient temperatures ____
d) None of the above ____

7) Which of the following is the most suitable replacement for the ca-

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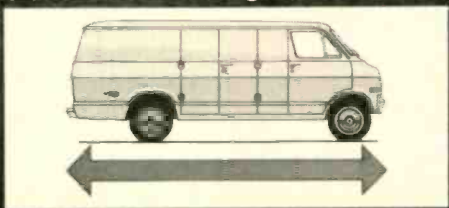

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pacitor in Fig. 4?
a) An 8.2pf, GmV, ceramic
b) An 8.2pF, polystyrene
c) An 8.2 pf, NPO, ceramic
d) An 8.2pf, oil-impregnated paper

8) Coupling capacitor C1 in Fig. 5 is described in the service literature as a '.01mfd, GMV, 500V, disc.' What does 'GMV' mean?.
a) General applications, medium voltage capacitor
b) Guaranteed minimum voltage at which capacitor is rated
c) Guaranteed minimum value of capacitance at room temperature (+25° C)
d) Value of capacitor will not exceed that specified by manufacturer

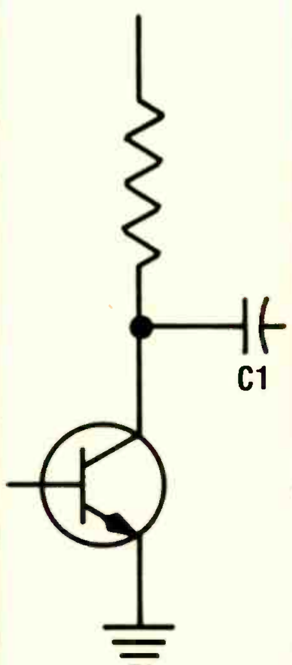


Fig. 5 (Question 8)

9) Which of the following is the most accurate description of the value of the capacitor in Fig. 6 at the time of manufacture?
a) Its value will never deviate from .1mfd by more than ±10% regardless of the ambient temperature
b) Its value should be within ±10% of .1mfd at +25°C (+77°F)
c) Its value at +25°C will always be .1mfd so long as the DC voltage across it is within ±10% of 200 volts
d) Its value will not decrease more than 10% below .1mfd so long as the voltage across it does not exceed 200VDC

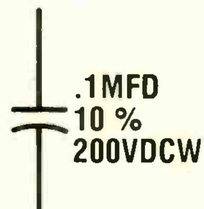


Fig. 6 (Question 9)

10) The capacitor in the tuned-tank circuit of Fig. 7 is described in the service literature as a '47pf, 5%, 500V, N750 disc.' What does 'N750' mean?
a) Capacitance will decrease 750 parts per million for each 1°C the temperature increases below +25°C

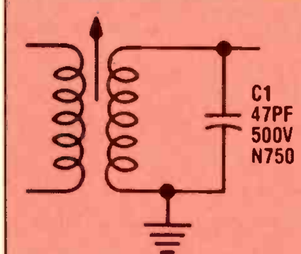


Fig. 7 (Question 10)

b) Capacitance decreases above voltage levels of 750 volts
d) Capacitance remains unchanged at temperatures no lower than 750 parts per million of +25°C

11) Which one of the following types of capacitors is most often suitable for replacing comparable values of the other listed types?
a) Paper
b) Mica
c) Ceramic
d) Polyester

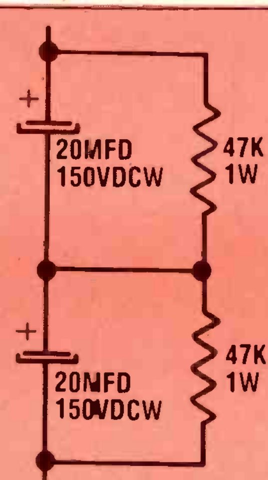


Fig. 8 (Questions 12, 13, & 14)

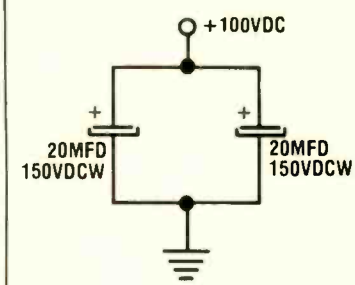
12) What is the total capacitance of the two series connected electrolytic capacitors in Fig. 8?
a) 40mfd
b) 20mfd
c) 10mfd
d) 15mfd

13) What is the maximum DC voltage which can be applied across the two capacitors in Fig. 8 without exceeding the voltage rating of either capacitor?
a) 300VDC
b) 150 VDC
c) 75VDC
d) 175VDC

14) Which of the following best describes the *principal* purpose of the two resistors in Fig. 8?
a) Equalization of the internal resistance of the two capacitors
b) Equalization of the capacitance
c) Equalization of the voltage drop across the two capacitors
d) Bleed off the charge when the equipment is turned off

15) Which of the following statements about modern electrolytic capacitors is *not* true?
a) Electrolytics inherently have a higher characteristic leakage current than electrostatic capacitors
b) Operation of an electrolytic capacitor at DC voltage levels below its VDCW rating will not destroy it
c) Tantalum-foil electrolytic capacitors have a relatively short shelf-life because of oxide deformation
d) An electrolytic rated at 100mfd, 250VDCW typically might actually have a capacitance of between 90 and 150mfd

Fig. 9 (Question 16)



16) Which of the following statements is *not* true about the two parallel-connected electrolytic capacitors in Fig. 9?
a) Their total combined capacitance is greater than 20mfd
b) The DC voltage applied across them does not exceed their individual voltage ratings
c) Because their total combined internal resistance is less than that of either capacitor used separately, their total combined leakage current is also greater
d) If one of the capacitors opens, the total capacitance will increase

ANSWERS: 1) a— 2) d— 3) b— 4) b— 5) b— 6) c— 7) c— 8) c— 9) b— 10) a— 11) c— 12) c— 13) a— 14) c— 15) c— 16) a

WINEGARD WORKS... For Us!

In its little more than two years existence, the Davis Antenna Company of Waldorf, Maryland has shown phenomenal growth. Brothers Buddy and Raymond Davis expect to put up more than 2,500 Winegard antenna installations in 1977, over half of them with Winegard's new low noise preamps. Having tested many different manufacturer's products in the tough reception areas surrounding Washington, D. C. the Davis brothers now use Winegard products exclusively.

"It seems we get a lot of the reception problems other people can't solve," Buddy said, "and we know from experience that if it is at all possible to get a decent picture, Winegard equipment will do it. We use a wide variety of Winegard models in both the Chromstar and Gold Star antenna and preamplifier lines."

The Davis Antenna Company also has branched out into MATV installations and here again, use Winegard electronic products exclusively. "We have attended several Winegard MATV seminars and they have really helped us in a professional way," president Buddy Davis said. "We give a one-year guarantee of satisfaction to both our MATV and antenna customers because Winegard products have proven very reliable. In addition, we don't cut corners on our installations."

You, too, can enjoy greater success in the television reception business by going first-class with Winegard.

Winegard works... for professional installers all over the country. Let us work for you. Just call your Winegard distributor or write to us.

Buddy Davis (l.), Raymond Davis (r.), Davis Antenna Co. Waldorf, Md.

WINEGARD

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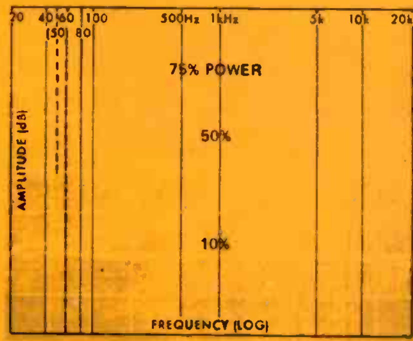


Fig. 1—This is the kind of frequency response a spectrum analyzer will display at 75%, 50% and 10% of maximum power for an amplifier set for "level."

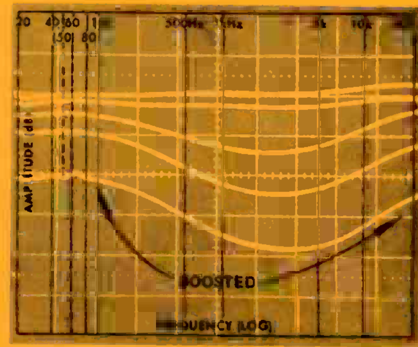


Fig. 3—Display of the effect of loudness control setting changes on frequency response.

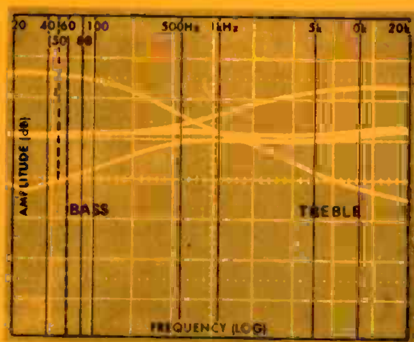


Fig. 2—Frequency responses displayed at different tone-control settings, to show maximum range of control.

Fig. 4—Display of responses that show the frequency corrective action of a Dolby "B" encoder, when operating at different levels.

Professional Audio Tests & Measurements Using An LF Spectrum Analyzer—Part Two

The conclusion of our two-part series which describes how an LF spectrum analyzer can provide a quick, direct measurement of stereo amplifier performance (Part 1 appeared in the January 1977 issue of ET/D)

■ One of the more fascinating and informative features of the spectrum analyzer is its ability to display frequency response. Of special importance is the visual demonstration it provides of the function of the loudness and tone controls.

A spectrum analyzer is well worth its cost for any servicer dealing with owners of quality stereo equipment. In addition to providing visual demonstration of the performance of the customer's equipment, the presence of an analyzer in your shop lets the customer know that you are properly equipped for quality service.

Frequency Response Measurements

Modern stereo equipment involves more than just one frequency response. The loudness control, for example, changes frequency response as its setting is varied. The tone controls also change the response in a wide variety of ways, according to the settings of the bass and treble knobs, each of which can be set independently, between maximum roll-off and maximum boost.

With the spectrum analyzer, you can run response tests for all of these variations in a matter of seconds. The result is *visual*, and you can make a permanent record, if you wish, with an inexpensive camera attachment. Of you can view the change comparatively, by using a storage oscilloscope.

After establishing output loading and input matching the level, as described in Part 1 (Jan., 1977, A message from RCA Consumer Electronics

No. 2 in a series

"About thirteen years ago I called in a management consultant . . . that was a turning point for my business."

"With solid state technology cutting into the frequency of TV service, you must explore every avenue of diversification."

"Good employee relations is just as important as good customer relations. Ignore either, and you're guaranteed to fail!"

"Emphasis on service is more than just technology. It's procedure and organization as well."

C. J. Rucker, Rucker TV, Fort Worth, Texas 76107.

"I believe in the exchange of management and technical ideas. Some of the concepts that I've picked up at association meetings and seminars have led Mike and me to take a hard look at my business."

New Operating Procedures Increased Profits

Mike Webber is Rucker's General Manager. Together Mike and C. J. have implemented new operating procedures with re-emphasis on service and specialization. Through these organizational changes, net profit has more than doubled with less volume. Mike points out that about 75% of their profit stems from service and the remainder from sales.

"Open Door" Policy in Management/ Employee Relations

One major reason for Rucker's success is the maintenance of good management/ employee relations. Weekly meetings keep six technicians informed about the company's business condition and what is expected of them, and company management, to maintain profit momentum. A targeted profit level may make profit sharing possible in the near future. Mike keeps an open door policy so technicians can check their performance status or discuss any problem that may come up.

Tod McAllister and Russel Lack, Rucker's top "outside men", especially appreciate air conditioned trucks. "In our area of the country, it's a must," C. J. states. "We heartily recommend it for consideration by other dealers."

Diversification and Training

Technicians are encouraged to take full advantage of all training provided by the six manufacturers for which Rucker's carries parts. However, there's one exception among the six technicians. Due to Rucker's diversification, Gary Brignac mans one of the four radio-equipped trucks providing maintenance for nine Xerox mammography machines at hospitals and clinics. These machines aid in the early detection of breast cancer. Rucker's service contract with Xerox resulted from the acquisition of Gary from a local college. He had been Xerox-trained and now serves full time on his assignment.

Another area of diversification involves the servicing and sales of video playback units and microwave ovens.

Customer Goodwill Program

The other major factor in Rucker's success is the dedication of the entire organization to creating good relationships with both existing customers and potential clientele. New residents to Fort Worth receive a postcard depicting Rucker's, offering a $5.00 discount on their first service call, and welcoming them to the community. A similar card is sent to each customer after a service call, written in longhand for the personal touch, thanking them for doing business with Rucker. Purchasers of new products receive a thank you note emphasizing service after the sale.

When making in-home service calls Rucker technicians leave brightly colored pot holders imprinted with a sales message.

Service contracts are available with the purchase of a new set, as well as a credit payment plan. All bookkeeping is handled by a full time clerk, and only about 2% of the credit business has been "bad." Also, on any major repair, like a new picture tube, the customer is given a full rebate on a new set purchase within a 90-day period if he decides that the "new set" route would have been better.

The entire service area is paneled and tiled, a showplace of functional, attractive working conditions. In the customer service area attractive displays and appearance are all important. Each customer is greeted with "Welcome to Rucker's . . ."

Two-Way Radio System Aids Efficiency

The two-way radio system is a productivity tool. Each technician radios in when one service call is completed and Rucker's customer service people telephone the next customer on the list to make sure someone is home before the truck heads out. This ensures a steady sequence of service call completions. Each field tech maintains "work performed" reports showing time in the home, parts changed, service contract parts involved, "demand" labor, in-warranty labor, new set delivery data and additional information on mileage and call completion.

The shop itself contains a dozen work bench "islands," with readily-available scopes and tools, manned by senior technicians Paul Ashour and Jack Hilton. Small parts in plastic bags are easy to reach and store in a specially designed sliding peg-board cabinet. A perpetual inventory system reduces parts ordering problems.

Service Manager Jerry Daniel selects small parts from specially-designed storage unit with eight sliding peg-board panels. Parts are in small plastic bags.

Good Service Spells Success

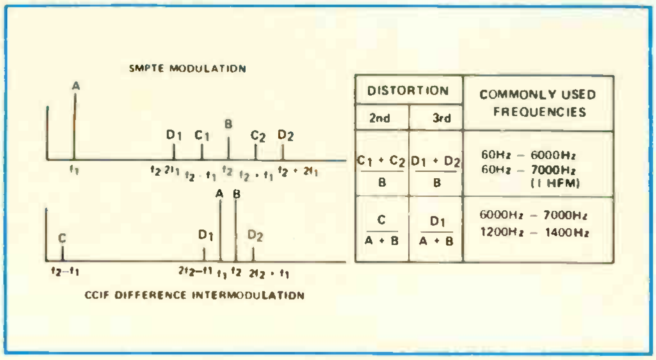
"Giving the best service possible is why we're here. It's what keeps people coming back." That's why C. J. Rucker has been successful. "It's all a matter of being able to place yourself on the other side of the counter . . . how would **you** want to be treated?"

RCA

Consumer Electronics Division
600 N. Sherman Drive
Indianapolis, IN 46201

Better Service Through Better Communications.

...for more details circle 127 on Reader Service Card



DISTORTION 2nd	DISTORTION 3rd	COMMONLY USED FREQUENCIES
(C1 + C2) / B	(D1 + D2) / B	60Hz – 6000Hz 60Hz – 7000Hz (I HFM)
C / (A + B)	D1 / (A + B)	6000Hz – 7000Hz 1200Hz – 1400Hz

Fig. 5—A comparison of the two standard forms for Intermodulation Distortion (IM) measurement: top line is SMPTE basis for tests, and bottom line is CCIF test basis.

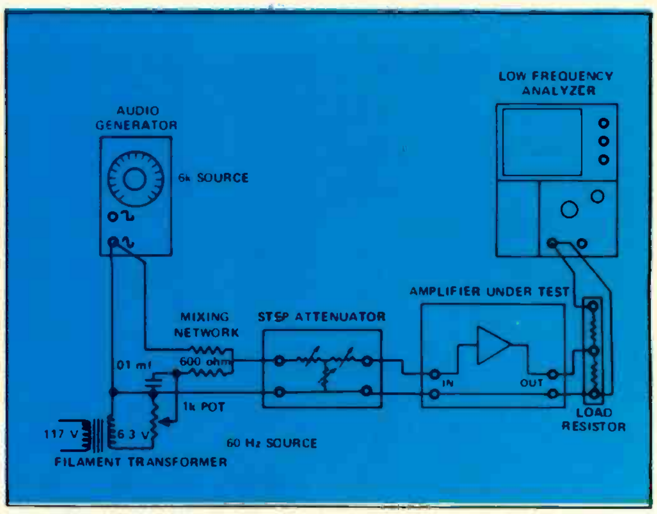


Fig. 6—A simple equipment setup for obtaining SMPTE-type data using a spectrum analyzer. A simple substitution can change this setup for the CCIF-type test.

ET/D), follow the procedure below for measuring frequency response:

- Set the spectrum analyzer and audio generator for the sweep mode, so they will cover 20 Hz to 20 KHz.
- Adjust the input level by means of the calibrated attenuator, to suit the rated input used for the test (see Sensitivity Measurements, later in article).
- If you are checking the loudness control to show the different contours it produces, you will use several different output levels, keeping the input level constant, changing output level by means of the loudness control setting.
- Observe, and record on film if you wish, the responses at different settings on the controls you are testing.

In Fig. 1 you see straight frequency responses recorded at different power levels. EIA standards recommend that frequency response be measured not higher than 10 dB below the rated power output, which is approximately one-third the output voltage for maximum power. EIA standards also recommend that response be measured not lower than 20 dB above the noise level, to be covered later in this article.

In Fig. 2, we see frequency responses recorded at different tone control settings, illustrating the range of control that can be achieved. Remember that when checking the treble and bass controls, the opposite control (treble or bass) should be set to "flat". In fact, it may be advisable to check for interaction of these controls by trying both of them at maximum roll-off and at maximum boost. (This is not shown in Fig. 2).

The effect of various settings of the loudness control is shown in Fig. 3. Remember, the initial set-up for loudness control measurement, the input level is kept constant. Thus, when you put the control through various settings the analyzer will display the different output level responses. Note that near the top of the control settings, the response is flat. Lower down, the response shows progressively more bass and treble boost.

In Fig. 4, you see the response action of a Dolby "B" encoder. Because the Dolby encoder is a dynamic device, full measurement of its capabilities requires much more sophisticated equipment, including real time analyzers. The different responses shown demonstrate the frequency compensation built in for a change of level.

Intermodulation Distortion (IMD)

All of the different "standard" methods for measuring intermodulation distortion (IMD) require the use of more than just one audio signal generator. With an LF spectrum analyzer, however, you not only eliminate the need for extra equipment but the analyzer also provides more information than any of the other instruments can individually or collectively provide.

There are two standardized IMD tests that can be performed with a spectrum analyzer. The SMPTE method, using two tones, was de-

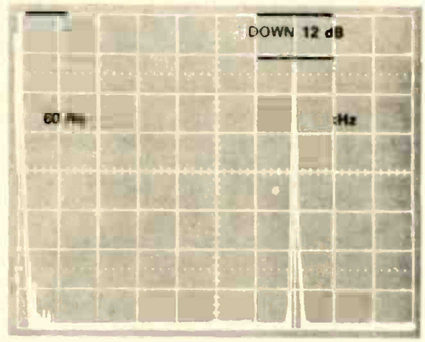


Fig. 7—A spectrum analyzer frequency display, showing relative amplitudes of signal set up for the SMPTE test.

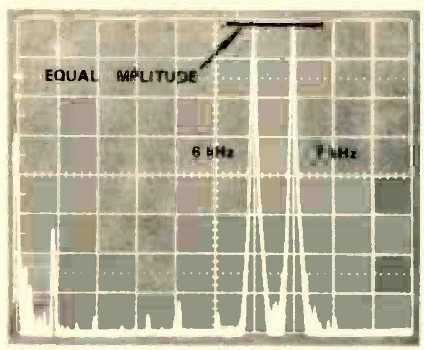


Fig. 8—A spectrum analyzer display showing correct signal settings and some responses, using the CCIF method of test.

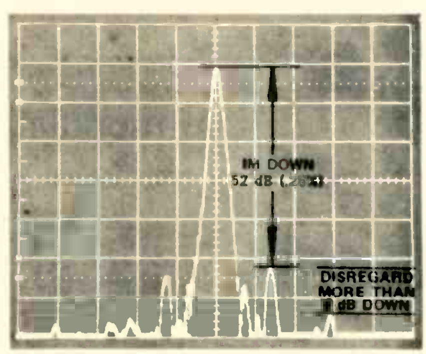


Fig. 9—A spectrum analyzer display that shows indication of SMPTE-type distortion, and its interpretation.

veloped by the Society of Motion Picture and Television Engineers, and the CCIF difference method was created by the International Telephone Consultative Committee. The setup for both tests is as follows:

• First, you need a mixing network. Fig. 6 shows how this can be rigged for the SMPTE test, using a line filament transformer to get the 60 Hz signal. For the CCIF test, the output of a second audio generator will have to be substituted for the 60 Hz input.

• For the SMPTE test, a 60 Hz signal and a 6 KHz signal are used in a voltage ratio of 4:1. This means that the 6 kHz tone will be down 12 dB from the 60 Hz tone, as in Fig. 7. The CCIF Difference method requires a setup that uses two equal amplitude input signals, as shown in Fig. 9.

• Now by tuning the 6 kHz signal to center screen with the FREQUENCY control—in other words, by expanding the frequency base—you can measure the levels of distortion produced by the equipment under test. This distortion appears as sidebands around the base of the 6 kHz tone in Fig. 9. These sidebands are modulation components of 60 and 120 Hz, generated by the 60 Hz tone. The distortion components revealed by the CCIF difference method are shown in Fig. 8.

Note that the highest distortion component shown in Fig. 9 is 52 dB below the higher frequency test signal. Any distortion component more than 6 db below that will not contribute significantly to the overall *measured* distortion.

A distinct advantage of the LF spectrum analyzer method is that, with both methods, the analyzer shows distortions that regular "meters" miss. In the case of the SMPTE measurement, some of the components seen on the spectrum display may be due to phase-shift modulation, rather than simple amplitude modulation, which was prevalent in the early motion picture days when the SMPTE measurement method was devised. The spectrum analyzer is capable of measuring both phase-shift and amplitude modulation, while standard audio equipment will miss phase-shift modulation completely.

In the case of the CCIF Differ-

Test Frequencies (all in Hz)	2nd Harmonic Group			3rd Harmonic Group			4th Harmonic Group			5th Harmonic Group		
	Difference	Harmonic	Sum	Difference	Harmonic	Sum	Difference	Harmonic	Sum	Difference	Harmonic	Sum
2000	100	4000	4100	1900	6000	6100	200	8000	8100	1800	10000	10100
2100		4200		2200	6300	6200	3900	8400	8200	2300	10500	10200
							4300		8300	5900		10300
										6400		10400

Fig. 10—Table of distortion products due to different forms of distortion curvature, when input frequencies are 2,000 and 2,100 Hz. (All figures shown are Hz. (Courtesy TAB Books)

Test Frequencies (all in Hz)	2nd Harmonic Group			3rd Harmonic Group			4th Harmonic Group			5th Harmonic Group		
	Difference	Harmonic	Sum	Difference	Harmonic	Sum	Difference	Harmonic	Sum	Difference	Harmonic	Sum
2000	1900	4000	5900	100	6000	7900	2100	8000	9900	1800	10000	11900
3900		7800		5800	11700	9800	3800	15600	11800	4100	19500	13800
							9700		13700	7700		15700
										13600		17600
2000	50	4000	4050	1950	6000	6050	100	8000	8050	1900	10000	10050
2050		4100		2100	8850	6100	3950	8200	8100	2150	10250	10100
							4150		8150	5950		12850
									6200			10200
2000	950	4000	4950	1050	6000	6950	1900	8000	8950	100	10000	10950
2950		5900		3900	8850	7900	3050	11800	9900	4850	14750	11900
							6850		10850	5050		12850
										9800		13800

Fig. 11—A table of distortion products, with test frequencies adjusted so that a specific distortion product will appear at 100 Hz. All figures shown are Hz. (Courtesy, TAB Books)

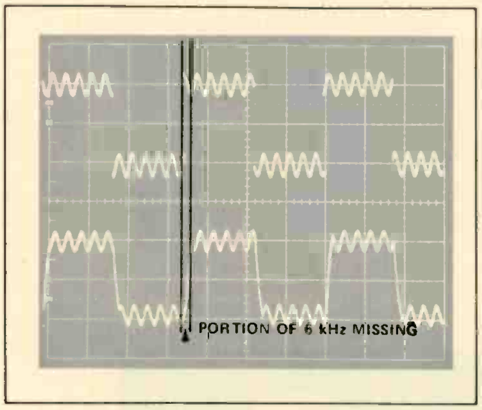


Fig. 12—A Transient Intermodulation Distortion (TIM) display on a spectrum analyzer using dual trace with a regular time base, adjusted for steady waveform.

ence method, standard measuring equipment will find only the distortion product identified by the line "C" in Fig. 5. The spectrum analyzer, on the other hand, will find other distortion products such as D_1 and D_2. Any of these additional distortion products can produce what the listener would describe as "dirty highs".

Any two test frequencies can be used to identify distortion products, as long as the sum and difference of the frequencies and their harmonics remain within the audio frequency range of 20 Hz to 20,000 Hz.

The distortion products that could be produced by different forms of distortion curvature at input frequencies of 2,000 and 2,100 Hz are shown on the chart in Fig. 10. A table of distortion products produced when test frequencies are adjusted so that a specific distortion product will appear at 100 Hz is shown in Fig. 11.

Transient Intermodulation Distortion (TIM)

The test for Transient Intermodulation Distortion (TIM) is a search for kinds of distortion, not revealed in previous tests, that occur in music. It is a limited test involving terms not yet standardized.

The TIM test uses a low frequency square wave at 500 Hz, for example, with a higher frequency sine wave at 6000 Hz, for example. Fig. 12 shows the test waveform

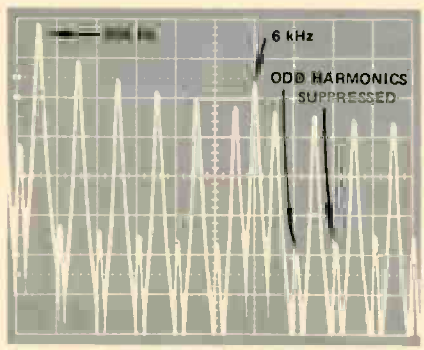


Fig. 13—A spectrum analyzer display of the waveform seen at the top of the TIM display shown in Fig. 12.

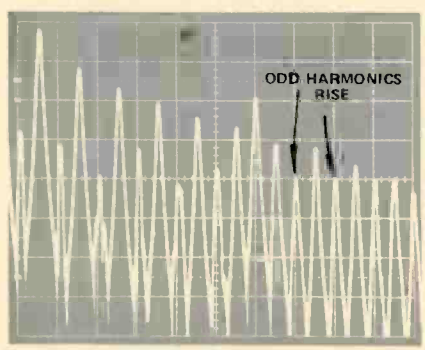


Fig. 14—A spectrum analyzer display of the distorted waveform seen at the bottom of the TIM display shown in Fig. 12.

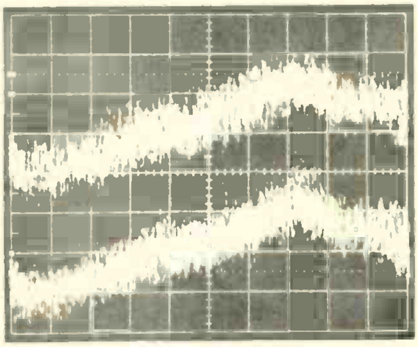


Fig. 15—A dual trace displayed when noise is used as an input to the spectrum display, with the sync selector switch at the 'line' position.

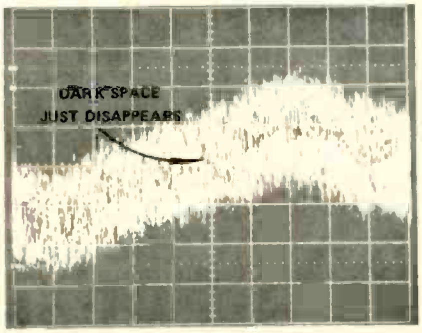


Fig. 16—In the Signal To Noise Ratio measurement, the voltage offset of the spectrum analyzer is adjusted until the dark area between the two traces shown in Fig. 15 just disappears.

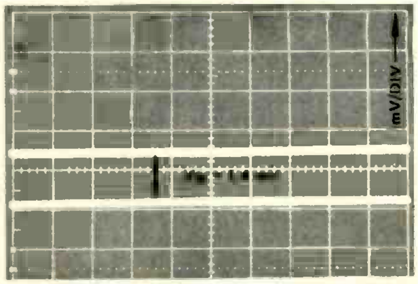


Fig. 17—In the last step of the Signal To Noise Ratio measurement, using the spectrum analyzer, the noise inputs are disconnected, two separated lines appear, and the separation between the lines is measured in volts. This measurement is the V_N.

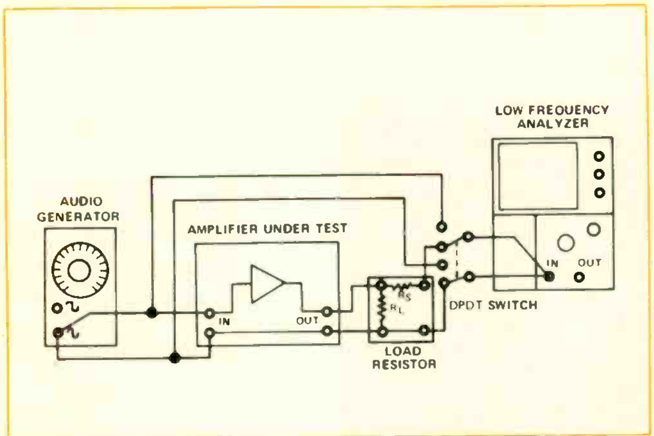


Fig. 18—This is the spectrum analyzer setup for measuring amplifier sensitivity.

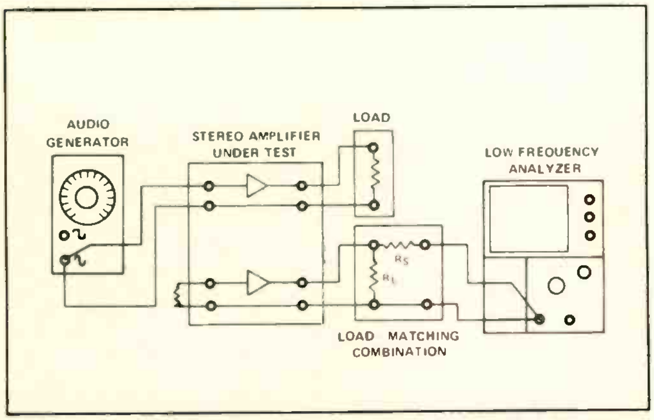


Fig. 20—A spectrum analyzer setup for measuring crosstalk in a stereo system. For quadrophonic systems, all channels, except for the one being measured, should be driven at rated power output.

	SENSITIVITY FOR 10W OUTPUT		
	LEFT	RIGHT	(TYPICAL) OVERLOAD
PHONO HI	1.15mV	1.13mV	57mV
PHONO LO	.38mV	.38mV	21mV
AUX 1	63mV	61mV	3.4V
AUX 2	62mV	60mV	3.4V
TAPE MONITOR	105mV	103mV	8.1V
TUNER	63mV	61mV	3.4V
TAPE HEAD	.41mV	.41mV	20.5mV

Fig. 19—A chart showing a typical tabulation of input sensitivity results.

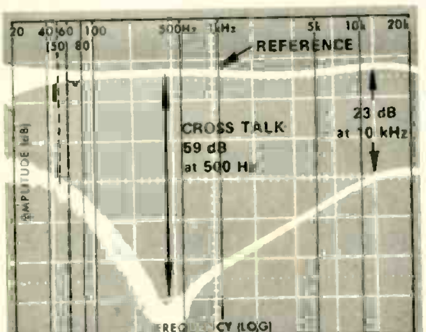


Fig. 21—A spectrum analyzer display of crosstalk measurement.

(upper trace), as well as a distorted output (lower trace), produced during this type of test.

The frequencies of the two signal generators should be set so that the trace in the time domain (as in Fig. 12) is steady. This way, the upper frequency will be an exact multiple of the lower frequency. Once this is set, you can switch to the spectrum analyzer mode, and check the effect for distortion.

Fig. 13 shows the frequency spectrum for the test input. Fig. 14 shows the change produced in the spectral display by TIM distortion in the amplifier.

Signal To Noise Ratio

The measurement of the ratio of the rated output of an amplifier to noise is called the Signal to Noise Ratio (S/N). The main difficulty with the procedure is getting a precise measurement of the *noise* level, or voltage. When displayed in the time domain, noise looks like "dancing grass" on the oscilloscope screen.

To be able to accurately measure this "dancing grass", a dual trace time base is needed, and the amplifier noise must be applied to both inputs of the scope, on the same range setting. Remember that the amplifier input must also be correctly terminated and shielded for this measurement. By setting the sync selector switch at the 'line' position, the jumping, which is caused by hum, will stop—and the traces will exhibit a jiggling action, as in Fig. 15.

Now, by using the position controls for the separate traces, you'll be able to bring the traces together, until the dark space between them just disappears (Fig. 16). Now switch each input to ground, leaving a pair of lines spaced apart, as in Fig. 17. The calibration of the scope, on the ranges to which the inputs are set, will indicate the noise voltage, or level.

With the noise level established, the signal to noise ratio can be calculated by combining this infor-

continued on page 52

Understanding and Servicing IC-Equpped AGC systems

By Paul Shih

The function hasn't changed—but components and troubleshooting techniques for the new IC-equipped AGC systems are different. Here are descriptions of several IC AGCs and how they can be serviced.

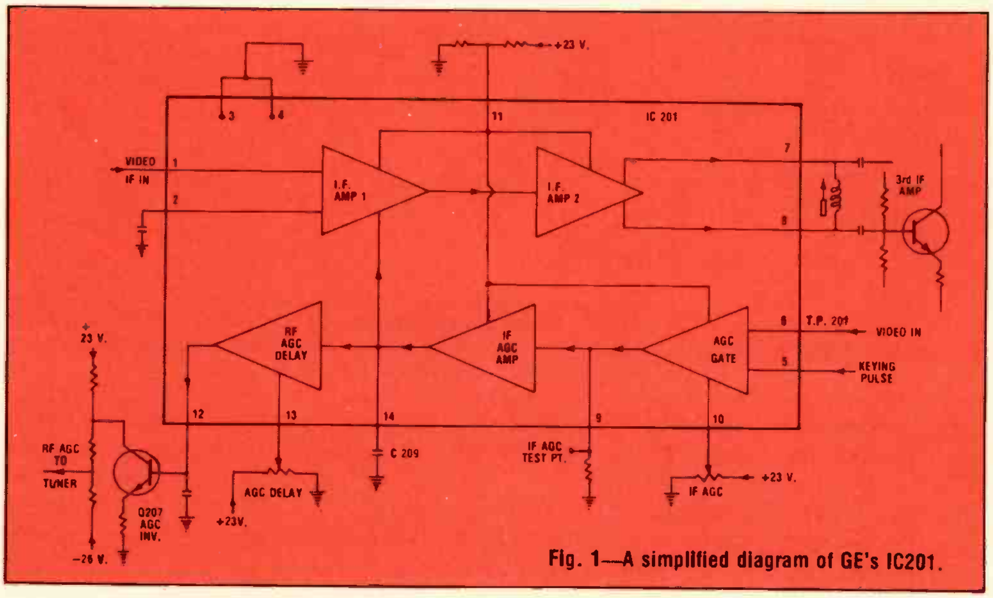


Fig. 1—A simplified diagram of GE's IC201.

■ Because of changes in atmospheric conditions affecting radio wave propagation, television signal strength tends to vary at the receiving antenna. In fact, signal strength may also vary from channel to channel. To compensate for these variations in signal strengths, television engineers developed the Automatic Gain Control circuit (AGC).

Though revolutionary changes have occurred in television circuitry in recent years, the basic function of the AGC circuit remains the same. That function is to automatically increase the receiver gain when the signal strength decreases, and to decrease the receiver gain when the signal strength increases. And, although AGC *function* hasn't changed, the components that perform the function have changed—from the days of tubes to solid-state discrete AGC systems to today's IC AGC.

A previous issue of ET/D, in December, 1976, covered the fundamental principals of operation of keyed and non-keyed discrete AGC systems. The article was titled "Discrete AGC In Solid-State Color TV". This month's article is devoted to the newer IC AGC system.

IC-Equipped AGC Systems

Since 1972, major manufacturers have been using integrated circuits (ICs) in many sections of the TV receiver, including the AGC section. Both keyed and non-keyed IC AGC systems are in use presently. For examples, the RCA CA3068, GE IC201, and Zenith IC401 are keyed types, and Quasar IC301 (AN331) and Sony CX-100B are non-keyed types.

The GE IC 201

General Electric, in the video-IF panel on the MC-2 chassis, uses one discrete transistor AGC DC amplifier and part of one IC (IC201) to perform the AGC function.

As a keyed AGC system, GE IC201 (Fig. 1) requires a horizontal keying pulse on its pin 5 in addition to a sample of video signal supplied to pin 6. The variable DC voltage developed by the AGC gate is amplified by the IF AGC amplifier inside the IC and then filtered by an external capacitor C209. The derived IF AGC voltage is coupled to the first IF amplifier inside the IC to control the IF gain. This IF AGC voltage is also coupled to the RF AGC relay stage, and a positive RF relayed AGC voltage is developed at pin 12. After voltage inversion by an NPN discrete AGC inverter, a negative RF relayed AGC voltage is available for controlling the RF gain in the tuner.

The RCA CA 3068

Without any noise immunity system, noise in the video circuit can develop a false AGC voltage which would produce "wash-out", "blank raster" and/or a momentary "loss of sync". RCA CA3068, an IC for the video-AGC-sound sub-system, is designed with a noise-immunity circuit which mainly consists of noise peak detector Q26 and noise clamp Q15 (Fig. 2, colored portion). Video output from the emitter of Q25 (pin 19) is coupled internally to the keyed AGC amplifier Q13 and the noise detector Q26. The voltage developed across C4 is proportional to the strength of noise pulses. During the period

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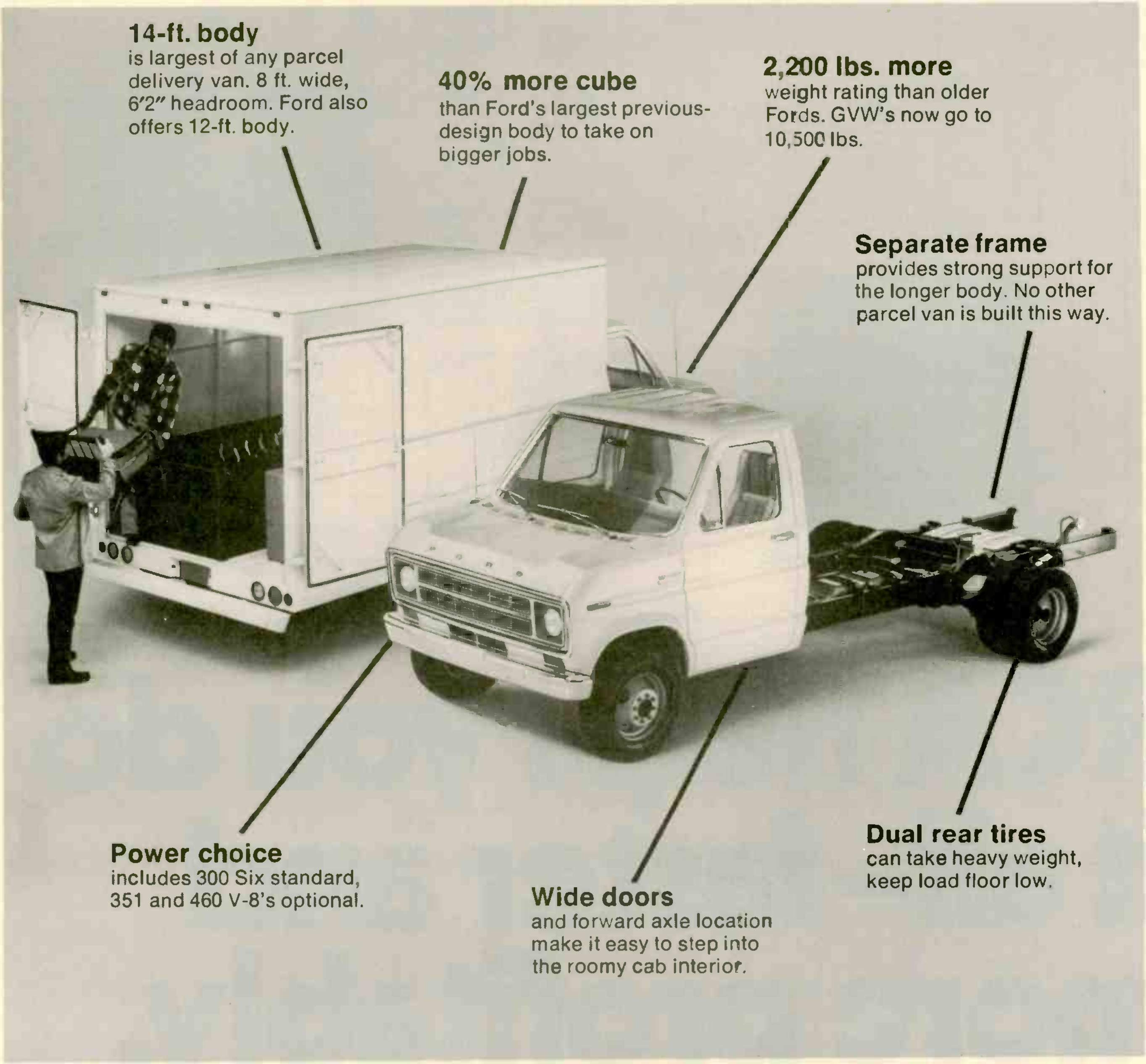

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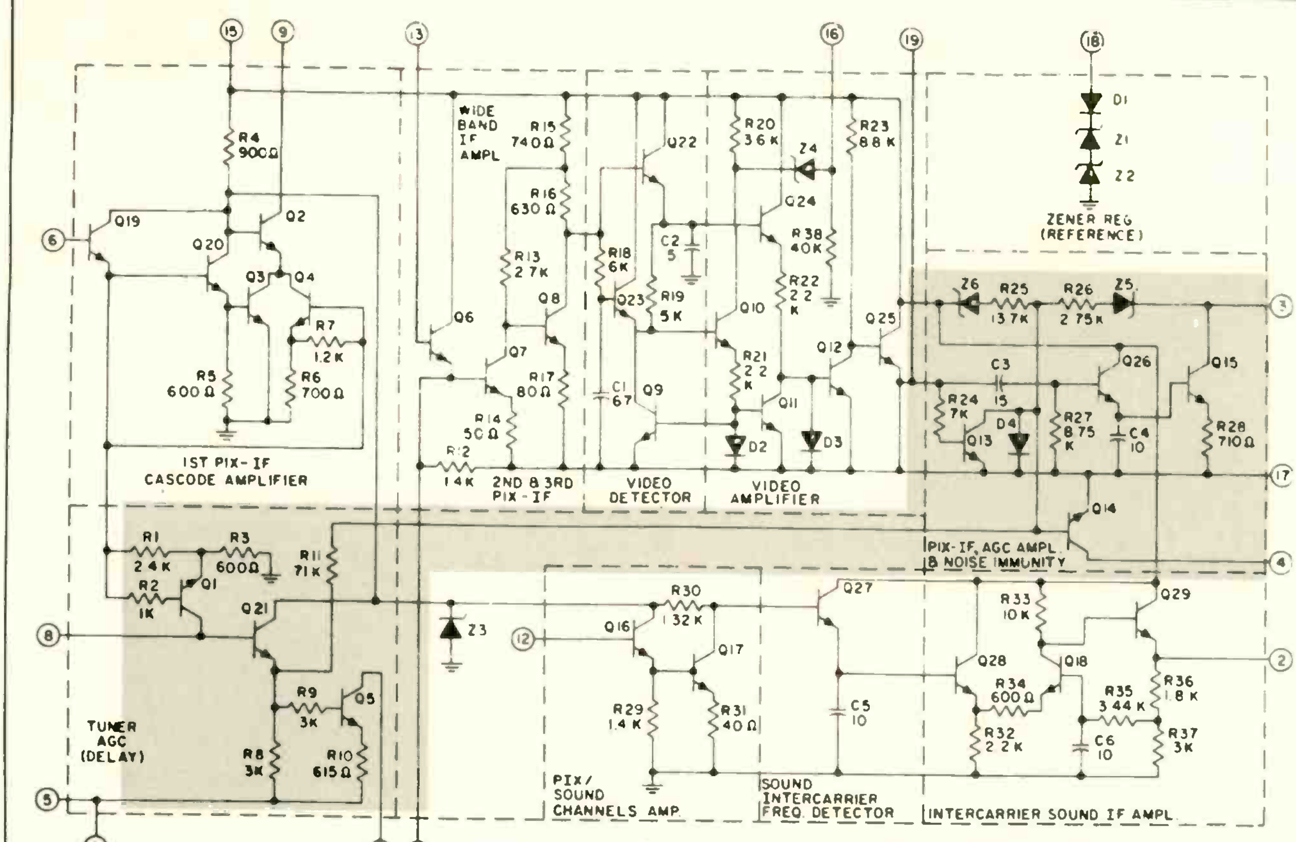


Fig. 2—A schematic of the RCA CA3068 video-AGC-sound subsystem. (Courtesy RCA Semiconductor)

of high noise input, the voltage across C4 is high enough to turn on Q15, which then clamps the keying pulse from the flyback to ground. Thus, the noise pulse can not turn on the AGC amplifiers Q13 and Q14, and there will be no false AGC voltage build-up.

Without a noise pulse in the video signal, the flyback keying pulse is allowed to arrive at the collector of Q13. At the same time, the horizontal sync pulse of the composite signal also arrives at the base of Q13. Under this condition, Q13 conducts, which then turns on the AGC output transistor Q14. The conduction of Q14 discharges an external 10 mfd capacitor, and the integrating action of the capacitor produces the IF AGC voltage.

The IF AGC voltage available at pin 4 is routed externally through the secondary of the IF take-off transformer to the IF input at pin 6 for controlling the IF gain.

The output from the keyed AGC amplifier Q13 is also coupled to an RF delay stage (Q21 and Q5) inside the IC. The conduction of Q5 pro-

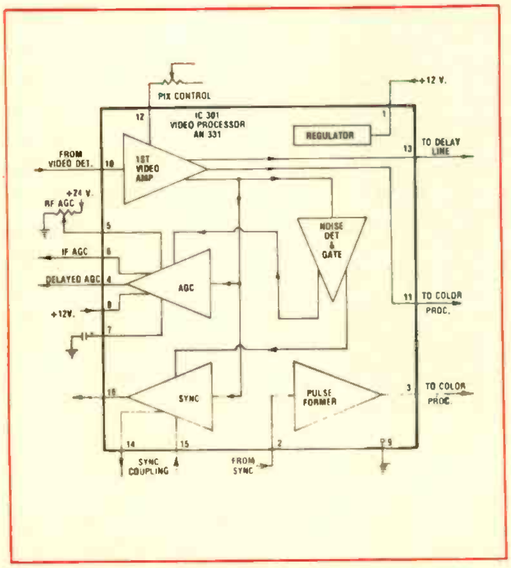


Fig. 3—A simplified diagram of Quasar's IC 301.

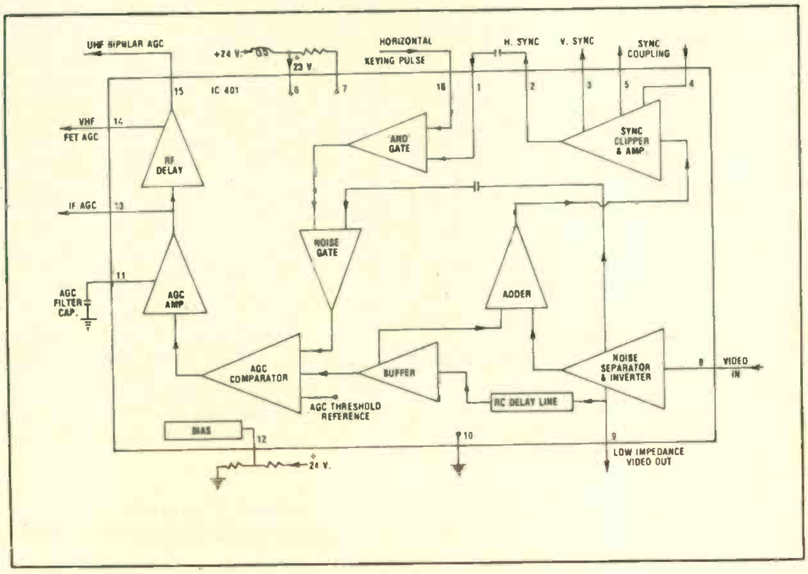
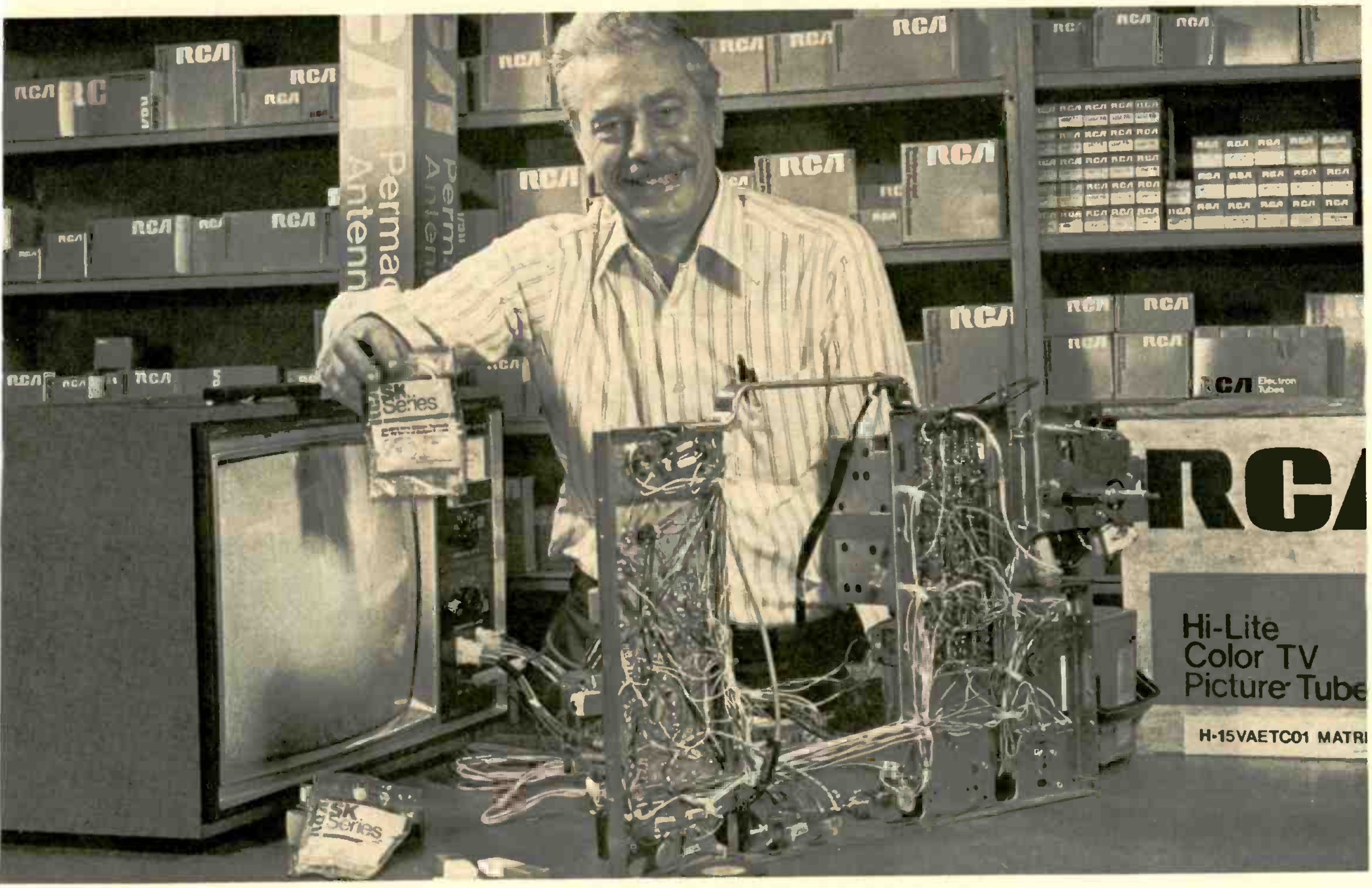


Fig. 4—A simplified diagram of Zenith's IC 401.



duces a negative-going RF delay AGC voltage at pin 7.

Quasar's IC301

Figure 3 illustrates IC301 which performs as a video-sync-noise immunity-non-keyed AGC sub-system in Quasar's TS-951 chassis. The AGC stage receives the video signal from the first video amplifier inside the IC. By sensing sync amplitude which represents a given signal level, the AGC peak detector develops an AGC voltage. After amplification in the AGC stage, the IF AGC voltage appearing at pin 6 is filtered and coupled to the first and second IF amplifier stages. This same voltage at pin 6 is applied to a delay stage within the IC, and the resulting delay RF AGC voltage at pin 4 is then coupled to the tuner.

IC 301 has a built-in cancellation stage. Any noise present with the video signal that exceeds sync level turns on the noise gate, and the inverted noise pulse output from the gate is coupled to the AGC and sync stages to cancel out the noise pulse. The net effect of this noise cancellation system is that the noise pulse can not build up any false AGC voltage in AGC system and, thus, produce momentary "wash-out" or "blank raster."

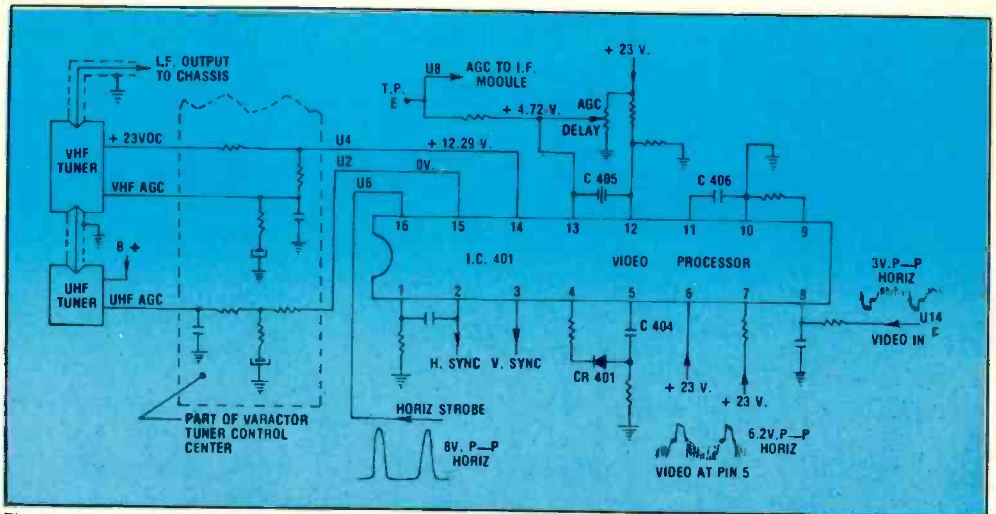


Fig.5—A schematic diagram of the keyed AGC system used in Zenith's chassis 25GC50.

Zenith's IC401

Many Zenith color receivers use IC401, as shown in Fig. 4. It is a rather unique and sophisticated sync/AGC system which incorporates some 60 transistors and two zener diodes to provide forward IF AGC, both forward and reverse RF delay AGC, and ver-

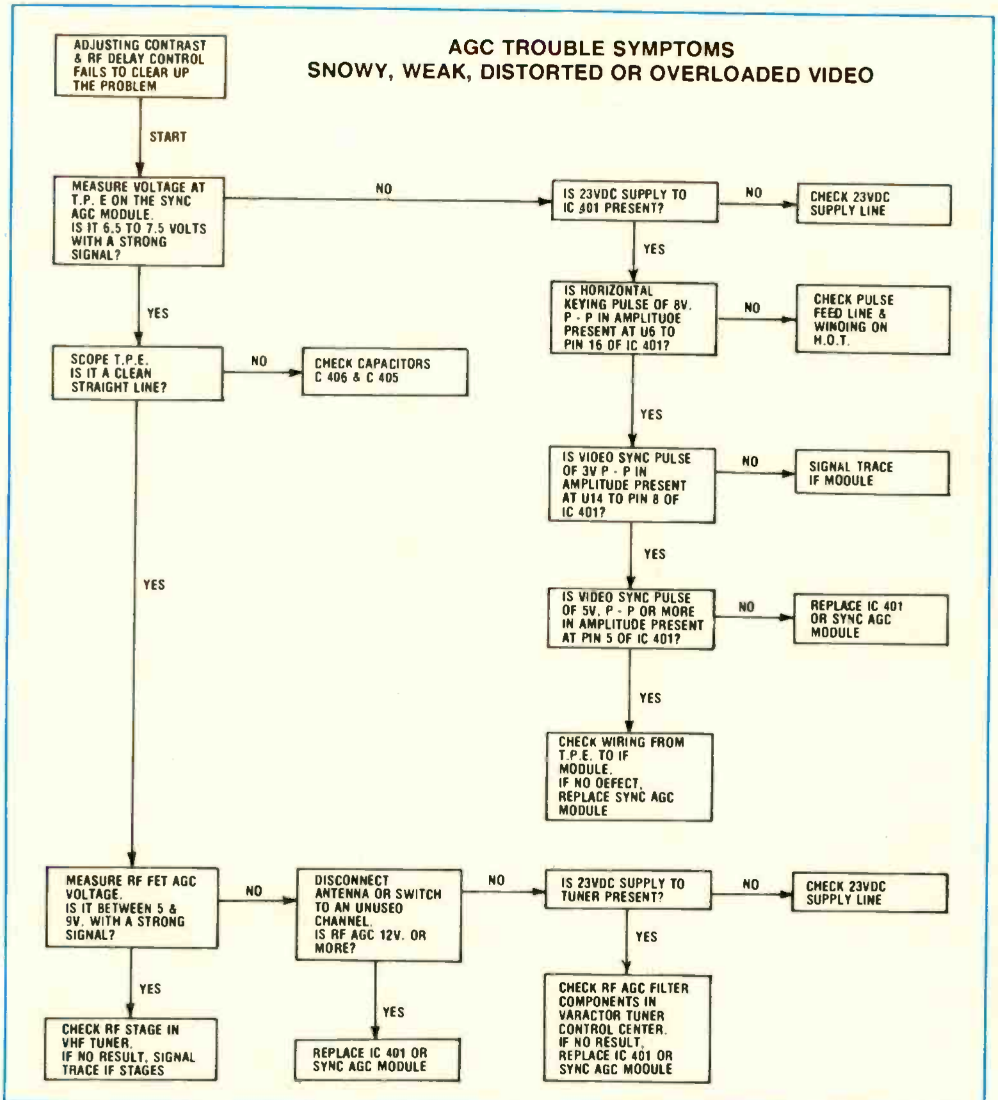


Fig. 8—Troubleshooting chart for the keyed AGC circuit shown in Fig. 5.

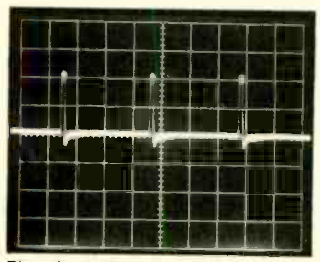


Fig. 6—The waveform produced when an open AGC filter capacitor causes pulses at the horizontal rate to appear on the AGC bus line.

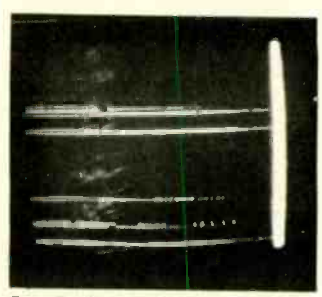


Fig. 7—Line flashing and picture shading effect on TV picture tube caused by spurious pulses on the AGC bus line.

tical and horizontal sync outputs.

The heart of this sync/AGC system is an AGC comparator which produces the initial AGC voltage by comparing the input sync tip level with a reference voltage generated internally by a pair of Zener diodes and associated circuitry. As a result of this internal reference system, the need for an external IF AGC level control is eliminated.

Two other unique features of the system are an "AND" gate and a noise gate, which eliminate or reduce noise-and horizontal sync-related AGC problems. When a noise pulse is present, the noise gate disables the comparator, holding the AGC voltage at the level produced by the amplitude of the last sync tip level. When the horizontal sync pulse does not coincide with the flyback pulse, the "AND" gate is opened, stopping the normal function of the comparator. The AGC voltage under this condition is held at the level established just before the horizontal flyback pulse dropped out of sync. This arrangement prevents AGC "lockout" or "hand-up" problems, to which conventional AGC systems are not immune.

The AGC voltage generated by the comparator is then amplified, delayed, or inverted before becoming available at the pin terminals. A simplified schematic of Zenith's AGC system in which IC401 is used, is shown in Fig. 5.

Troubleshooting IC-Equipped AGC Systems

Troubles developed in the IC-equipped AGC system exhibit the same symptoms as troubles developed in a discrete AGC system. The most common symptoms are: picture bending or overloading caused by no or low AGC voltage; faded or no picture caused by excessive AGC voltage; and picture flashing or shading caused by spurious AC signals appearing on the AGC bus line (see Figs. 6 and 7).

Operation Check

The preliminary step in troubleshooting an expected AGC defect is to perform the operation check. Look for the change in the quality of the picture as the IF or RF AGC control is rotated. The picture should be snowy or washed-out at one end of the control rotation and bended or overloaded at the other end of the rotation. In addition, the DC voltages at the tuner AGC input and the IF AGC test points should vary when any of the controls is turned or when the antenna is connected to or removed from the receiver. The rotation of the noise gate control, if one is provided, should also produce DC voltage variations in the AGC system. The change in the AGC voltage can also be observed by switching to another channel or to between channels.

Localizing and Isolating the Trouble

If little or no change in picture quality or DC voltages is noticed during the operation check, or if the change is erratic or abrupt, a defective AGC system is indicated.

The procedures used in troubleshooting IC AGC systems are similar to those used for discrete AGC circuitry. However, certain unique characteristics of the IC from the servicing viewpoint must be recognized. First, inaccessibility for

continued on page 51

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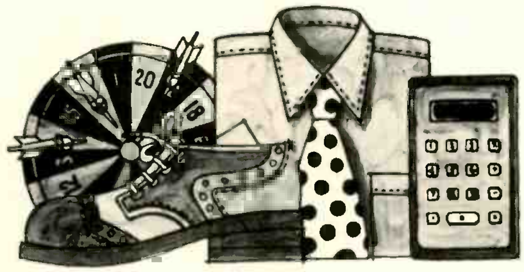

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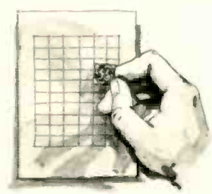

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Syosset, N.Y.
(516) 681-7270

Yonkers Electronic Supply Co.
129 Lake Avenue
Yonkers, N.Y.
(914) 969-6044

Southeastern Radio Supply Co.
414 Hillsborough St.
Raleigh, North Carolina
(919) 828-3211

S/S Electronics, Inc.
503 No. 7th St.
Fargo, N.D.
(701) 237-5003

Fox Radio
4314 Lee Road
Cleveland, Ohio
(216) 991-7777

Larrick Tube Testing Co.
23 Mackoil Street
Dayton, Ohio
(513) 258-1211

Central Distributors
1035 Conger
Eugene, Oregon
(503) 342-1101

Central Distributors
955 N.E. Union
Portland, Oregon
(502) 234-0711

Central Distributors
605 N. Fir St.
Medford, Oregon
(503) 773-6677

Steinberg Electronics, Inc.
2520 No. Broad St.
Philadelphia, Pennsylvania
(215) 223-9400

Almo Electronics Corp.
2119 West Main Street
Jeffersonville, Pennsylvania
(215) 529-7580

Triangle Electronics
6580 Frankstown Ave.
Pittsburgh, Pennsylvania
(412) 441-9659

Jabbour Electronics
1744 Cranston St.
Cranston, Rhode Island
(401) 944-2570

Wholesale Radio Supply Co.
515 E. Bay Street
Charleston, So. Carolina
(803) 722-2634

Bluff City Distributor
234 East Street
Memphis, Tenn.
(901) 523-9500

Currey's, Inc.
923 8th Ave. So.
Nashville, Tenn.
(615) 242-4223

Wholesale Electronic Supply
Ross Avenue at Central
Dallas, Texas
(214) 824-3001

Angie Electronics
2300 Chenevert
Houston, Texas
(713) 222-6386

R & R Electronic Supply Co.
1607 Avenue G
Lubbock, Texas
(806) 765-5737

McAllen Radio
413 So. Broadway
McAllen, Texas
(512) 682-2412

Ballard Supply Corp.
2430 South 900 West
Salt Lake City, Utah
(801) 972-2430

Avec Electronics
2002 Staples Mill Road
Richmond, Virginia
(804) 359-6071

Pearl Electronics
1300 First Avenue
Seattle, Washington
(206) 622-6200

Superior Radio Parts Company
1433 East Main Street
Madison, Wisconsin
(608) 257-1477

Manufacturer
PHILCO TV—
Division of GTE Sylvania
National Parts Manager
GTE Sylvania
700 Ellicott Street
Batavia, New York 14020
(716) 343-3470

Regional Parts Depots

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GTE Sylvania, Inc.
608 Dubuque Avenue
South San Francisco, California 94080
(415) 583-0787

South

GTE Sylvania
2508 Hickory Avenue
Metairie, Louisiana 70003
(504) 737-1770

East

GTE Sylvania
815 Second Avenue
New Hyde Park, N.Y. 11040
(516) 437-0100

Central

GTE Sylvania
3306 West Bloomingdale Ave.
Melrose Park, Illinois 60160
(312) 344-5200

Philco Franchised Distributors (alphabetically by states)

South Alabama Distributors, Inc.
4552 Baldwin Avenue
P.O. Box 2766
Montgomery, Alabama 36105
(205) 288-5100

Bill Edwards Distributing Company, Inc.
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Tucson, Arizona 85719
(602) 624-2596

Carlton-Bates Company
Scott Hamilton Drive at 69th Street
Little Rock, Arkansas 72209
(501) 562-9100

Ransom Distributing Company
4570 Ironton
Denver, Colorado 80239
(303) 371-5350

Pensacola Appliance Company, Inc.
1810 Barrancas Avenue
P.O. Box 266
Pensacola, Florida 32592
(904) 438-4688

Hopkins Equipment Company
801 Great Southwest Parkway
Atlanta, Georgia 30326
(404) 349-1674

Hardware Products Company
201 Locust Street
Sterling, Illinois 61081
(815) 625-1331

Gray-Breese Company, Inc.
3750 West 16th Street
Indianapolis, Indiana 46222
(317) 637-5341

The Ridge Company, Inc.
1535 South Main Street
South Bend, Indiana 46613
(219) 234-3143

Woodlawn Distributing Company
242 East Woodlawn Avenue
Louisville, Kentucky 40214

(502) 361-1211

United Distributing of
Shreveport, Inc.
6318 Union Street
P.O. Box 3607
Shreveport, La. 71103
(318) 869-2341

R.P. McDavid Co., Inc.
5904 Jefferson Highway
P.O. Box 23686
New Orleans, La. 70183
(504) 733-6322

The Emery Waterhouse Co.
P.O. Box 659
Rand Road
Portland, Maine 04104
(207) 775-2371

Washington Appliance
Wholesalers, Inc.
P.O. Box 135
10501 Ewing Road
Beltsville, Maryland 20705
(301) 937-4500

Saginaw Distributors, Inc.
1761 East Genesee Avenue
Saginaw, Michigan 48601
(517) 754-0441

Cabell Electric Company
422-428 South Farish Street
P.O. Box 1199
Jackson, Mississippi 39205
(601) 948-5741

Wilson Distributing Company
2000 Grand Avenue
Kansas City, Missouri 64108
(816) 471-4240

Brightman Distributing Company
10411 Baur Boulevard
St. Louis, Missouri 63132
(314) 993-6666

Radio Equipment Company
625 North 18th Street
Omaha, Nebraska 68103
(402) 341-7700

Gorman Appliance Company of
New Mexico
1326 Twelfth Street Northwest
P.O. Box 743
Albuquerque, New Mexico 87103
(505) 243-2274

Greylock Electronics
Division of Entronic Industries, Inc.
763 Ulster Avenue Mall
Kingston, New York 12401
(518) 459-5221

Great Central Distributing Company,
Inc.
831 Fayette Street
P.O. Box 1032

Syracuse, New York 13201
(315) 475-1681

Brown-Rogers-Dixson Co.
675 North Main Street
P.O. Box 2111
Winston-Salem, North Carolina 27102
(919) 722-1112

C and L Supply, Inc.
335 South Wilson
Vinita, Oklahoma 74301
(918) 256-6411

Luckenbach and Johnson, Inc.
1828 Tilghman Street
Allentown, Pennsylvania 18105
(215) 434-6235

Good Industries, Inc.
P.O. Box 471
Altoona, Pennsylvania 16603
(814) 944-7178

Young Brothers Electronics, Inc.
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Erie, Pennsylvania 16512
(814) 454-5297

General Distributors, Inc.
456 Steubenville Pike
Pittsburgh, Pennsylvania 15205
(412) 922-1300

Max Pasley, Inc.
506 South Cliff Avenue
Sioux Falls, South Dakota 57103
(605) 336-3760

Southern Furniture Sales Company
2213 Polymer Drive
Chattanooga, Tennessee 37421
(615) 899-2510

Shobe, Inc.
2449 Scaper Street
Memphis, Tennessee 38114
(901) 743-9821

Gorman Engineering Company, Inc.
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El Paso, Texas 79901
(915) 532-5483

Kimball Electronics
350 Pierpont Avenue
Salt Lake City, Utah 84101
(801) 328-2075

Bluefield Hardware Company, Inc.
302 Campbell Avenue Southeast
Roanoke, Virginia 24013
(703) 343-7521

Bluefield Hardware Company, Inc.
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400 Bluefield Avenue
Bluefield, West Virginia 24701
(304) 327-5131

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232 Bluefield Avenue
Bluefield, West Virginia 24701
(304) 327-7191

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Bluefield, West Virginia 24701
(304) 325-8106

J.H. Fagan Company
2450 South 170th Street
New Berlin, Wisconsin 53151
(414) 786-9610

Manufacturer

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Director of Service & Parts
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9401 West Grand Avenue
Franklin Park, IL 60131
(312) 451-1200

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Birmingham, Al. 35233
(205) 252-4195

The Carroll Co., Inc.
615 Telegraph Rd.
Mobile, Al. 36603
(205) 433-1621

Frank Lyon Co.
65th & Scott Hamilton
Little Rock, Ar. 72204
(500) 562-7600

555 Inc.
1601 E. Washington
No. Little Rock, Ar. 72114
(501) 376-3471

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733 W. 22nd St.
Tempe, Az. 85282
(602) 968-8645

Quasar
104 Fulton St.
Fresno, Ca. 93708
(209) 486-5700

Quasar
2041 Saybrook Av.
Los Angeles, Ca. 90040
(213) 726-2900

Quasar
501 Forbes Avenue
South San Francisco, Ca. 94080
(415) 871-4120

L & H Dist., Inc.
4330 E. 48th Ave.
Denver, Co. 80216
(303) 321-7333

Quasar
111 Prestige Rd.
Prestige Pk.
East Hartford, Ct. 06108
(203) 528-4468

Quasar
2170 Emerson St.
Jacksonville, Fl. 32207
(904) 396-2888

Quasar
13148 W. Dixie H'way.
North Miami, Fl. 33160
(305) 891-6442

Quasar
4115 W. Kennedy Blvd.
Tampa, Fl. 33609
(813) 872-2686

Brown Dist. Co.
1003 Donnelly Av. S.W.
Atlanta, Ga. 30310
(404) 753-6136

Electrical Dist., Ltd.
1440 Kapiolani Blvd.
Honolulu, Ha. 96805
(808) 946-4811

The Timmermann Co.
108 E. Fourth St.
Des Moines, Ia. 50309
(515) 243-0133

Jones Dist. Co.
2650 Bridgeport
Sioux City, Ia. 51111
(712) 277-8600

R. Cooper Jr., Inc.
25 E. Howard St.
Des Plaines, Il 60018
(312) 297-5100

Lofgren Dist. Co.
1202 Fourth Av.
Moline, Il 61265
(309) 764-7436

Yeomans Dist. Co.
1503 W. Altorfer Dr.
Peoria, Il 61614
(309) 691-3282

Gerlinger-Schuler, Inc.
2131 Fairfield Av.
Fort Wayne, In. 46804
(219) 745-0562

Quasar
1341 Sadlier Circle W. Dr.
Indianapolis, In 46239
(317) 359-8214

Vanderheyden Dist.
1743 N. Commerce Dr.
South Bend, In 46624
(219) 232-8291

Barton Dist., Inc.
635 Hydraulic St.
Wichita, Ka. 67214
(316) 262-3707

Falls City Supply Co., Inc.
1021-23 Floyd St.
Louisville, Ky. 40203
(502) 587-7444

Major Dist. Co.
449 S. 16th St.
Paducah, Ky. 42001
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4129 Euphrosine St.
New Orleans, La. 70185
(504) 822-1190

Frank Lyon Co., Inc.
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Shreveport, La. 71108
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RSL Dist., Inc.
14 Perry Rd.
Bangor, Me. 04401
(207) 947-7396

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Portland, Me. 04102
(207) 773-0297

Washington Appliance Whsle., Inc
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Beltsville, Md. 20705
(301) 937-4500

Quasar
25 Dartmouth
Westwood, Ma 02090
(616) 534-8601

Potter Dist., Inc.
4037 Roger Chaffee Dr. SE
Grand Rapids, Mi. 49508
(616) 534-8601

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Troy Trade Center
1307 Allen Dr.
Suite A
Troy, Mi. 48084
(313) 588-3683 (3680)

The Forster Co.
1000 Turners Cross Rd.
Minneapolis, Mn. 55416
(612) 542-2411 or 2422

Appliance Dist of Miss.
1019 Wholesale Row
Jackson, Miss. 39207
(601) 352-7787

Superior Dist. Co.
1601 Baltimore St.
Kansas City, Mo. 64108
(816) 842-0151

Disco Dist. Co.
11649 Adie Rd.
Maryland Heights, Mo. 63043
(314) 567-5820

Ozark Motor & Supply Co.
440 E. Tampa St.
Springfield, Mo. 65805
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Taylor Dist., Co. Inc.
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Billings, Mt. 59102
(406) 245-3055

American Dist. Inc.
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Omaha, NB 68102
(402) 341-6433

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670 Chestnut St.
Manchester, NH 03105
(603) 625-5444

M & W Appliance Dist.
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Albuquerque, NM 87107
(505) 247-0249

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Linden, NJ 07035
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Buffalo, NY 14203
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Ozone Pk., NY 11420
(212) 835-8984

GTP Leisure Prod.
420 Marcellus St.
Syracuse, NY 13204
(315) 471-8416

Thermo Industries, Inc.
4300 Golf Acres Dr.
Charlotte, NC 28208
(704) 394-7311

Thermo Industries, Inc.
1424 S. Bloodworth St.
Raleigh, NC 27611
(919) 834-3651

Bristol Dist. Co.
4501 W. Main St.
Fargo, ND 58102
(701) 282-5330

Modern Dist., Inc.
200 E. Hill St.
Oklahoma City, Ok.
73105
(405) 528-4537

Quasar
494 Highland Rd.
Cincinnati, Oh 45240
(513) 851-4180

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1425 Rockwell Ave.
Cleveland, Oh. 44114
(216) 696-0400

Gerlinger Equipment Co.
1001 Adams St.
Toledo, Oh. 43697
(419) 248-4681

The Moore Co.
800 12th N.W.
Portland, Or. 97209
(503) 221-1600

Charles L. Bell Co., Inc.
834 N. 12th St.
Allentown, Pa. 18105
(215) 820-6450

Penn Appliance
Distributors, Inc.
1650 Bobali Dr.
Harrisburg, Pa. 17105
(717) 939-0451

Philadelphia Dist., Inc.
630 Clark Ave.
King of Prussia, Pa.
19406
(215) 265-4700

Three Rivers, Inc.
10 Sheridan Rd.
Pittsburgh, Pa. 15209
(412) 821-4880

Frank Lyon of Puerto
Rico, Inc.
Carlyn Industrial Park
Carr. Sabana Abajo
Caroline, PR 00630

Shepard-Jenkin Inc.
335 Harborside Blvd.
Providence, RI 02905
(401) 467-9494

The Climatic Corp.
715 Bluff Rd.
Columbia, SC 29202
(803) 799-8510

Braid Electric Company
727 E. 11th St.
Chattanooga, Tn. 37403
(615) 266-4707

E.B. Copeland & Co.
503 W. Jackson Av.
Knoxville, Tn. 37917
(615) 525-6296

Mills-Morris Co.
677 Phelan St.
Memphia, Tn. 38101
(901) 774-9810

Braid Electric Co.
1100 Demonbreun Viaduct
Nashville, Tn. 37203
(615) 242-6511

Consolidated Dist. Co., Inc.
1010-20 NE 3rd Av.
Amarillo, Tx. 79105
(806) 372-1246

Porter Burgess Co.
1233 Levee St.
Dallas, Tx. 75207
(214) 741-5161

M & W Appliance Dist.
1830 Mills St.
El Paso, Tx. 79901
(915) 533-4464

Mischer Southwestern
2801 N. Loop W.
Houston, Tx. 77008
(713) 869-6966

Central Dist. Co.
1201 E. Houston St.
San Antonio, Tx. 78201
(512) 225-1541

Western Supply Co., Inc.
1901 S. 300 West
Salt Lake City, Ut. 84115
(801) 487-9941

RSL Dist., Inc.
16 Commerce St.
Williston, Vt. 05495
(802) 862-5771

E.A. Holsten, Inc.
1400 Overbrook Rd.
Richmond, Va. 23261
(804) 359-3511

E.A. Holsten, Inc.
122 Pennsylvania Av.
Virginia Beach, Va. 23230

Taylor Dist. Co., Inc.
East 124 Sinto
Spokane, Wa. 99202
(509) 328-8110

Quasar
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Tukwila, Wa. 98188
(206) 575-0382 or 4183

Midwest Corp.
307 Sandy Blvd.
Clarksburg, WV 26303
(304) 623-3781

Midwest Corp.
1403 Washington Av.
Huntington, WV 25711
(304) 529-6214

Midwest Corp.
300 First Av. S.
Nitro, WV 25143
(304) 722-2921

Dykro, Inc.
N90 W14401 Commerce Dr.
Menomonee Falls, Wi. 53051
(414) 255-1900

IN PART 2...
The remainder of our OEM TV Replacement Parts Source Directory, including distributor listings for RCA, Sharp, Sony and GTE Sylvania, will appear in the June issue of ET/D.

...for more details circle 134 on Reader Service Card

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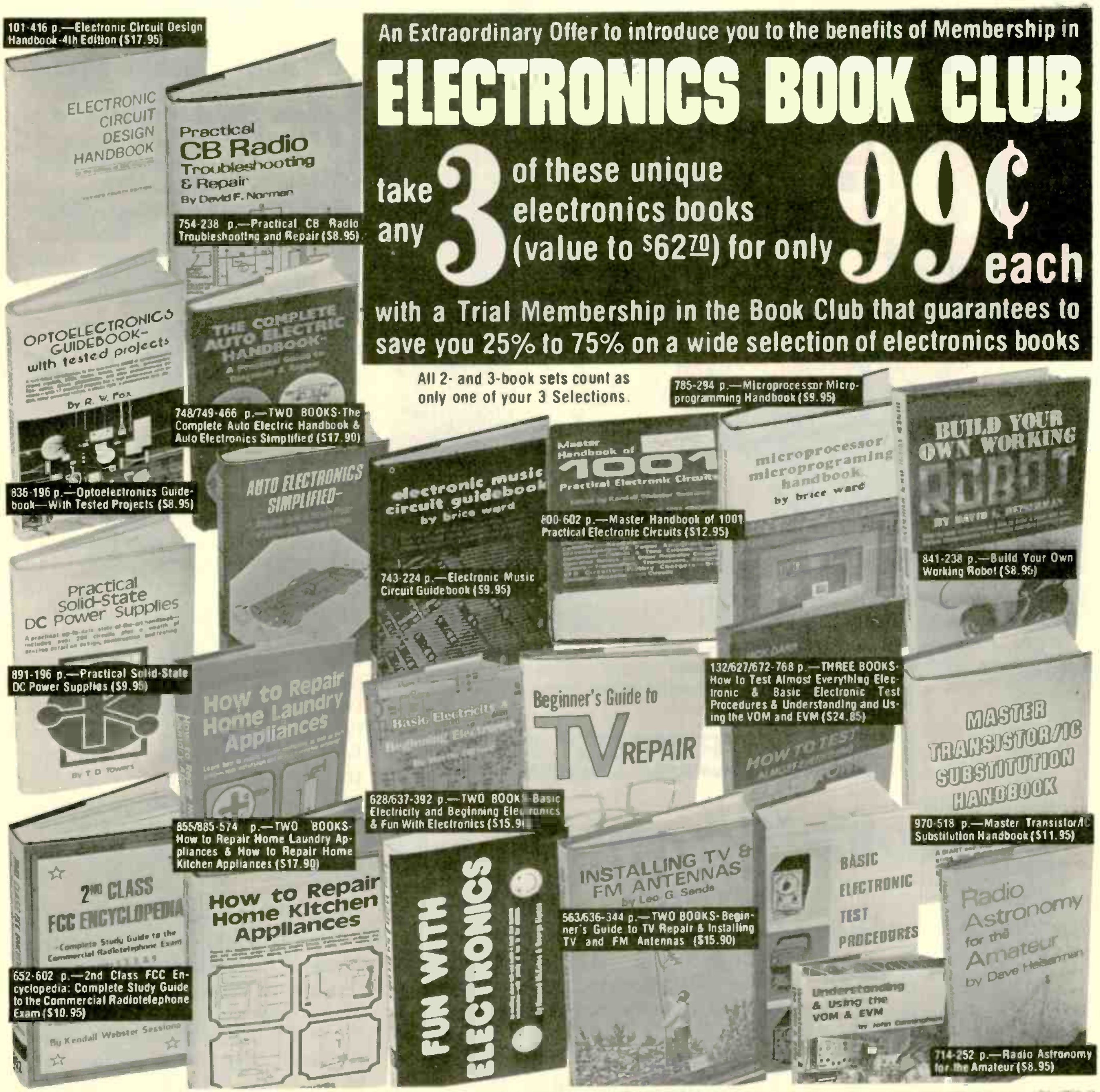

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Fig. 1—The complete Hickok CommLine CB Service System, plus an additional system-expanding 500-MHz (frequency counter). For more information about this test instrument system circle Number 144 on the Reader Service Card in this issue.

TEST INSTRUMENT REPORT

Hickok's 'CommLine' CB Service System

■ Hickok recently introduced a series of seven compatible test instruments especially designed to function together as a complete rack-mounted CB Service System, as shown in Fig. 1, or, alternatively, each of the seven instruments may be purchased and used independently.

THE 'BASIC' SYSTEM

The 'Basic' version of the Hickok CB Service System consists of the following instruments and related accessories:

- *The Model 388 CB In-Line Tester (Fig. 2),* which measures and provides a .3-inch-high LED display of the following four transmitter performance parameters: SWR from 1.00:1 to greater than 10:1 via a four-digit readout; RF power from .1 watt to 100 watts in two ranges (.1-10 watts and 1-100 watts) via a three-digit readout; **percentage of modulation** from 1% to 110% via a three-digit readout; and **frequency** from 10Hz to 55MHz (10ppm accuracy) via a seven-digit readout.
- *The Model 245 RF Generator (Fig. 3),* which provides modulated or unmodulated RF signals throughout two frequency spectrums: from 100KHz to 16MHz (all CB IF frequencies) and from 26.9MHz to 27.6MHz (all 40 CB channels).
- *The Model 244 Mobil/Comm Power Supply (Fig. 4),* which provides adjustable, regulated DC operating voltages throughout the range from 10.5 to 14.5 VDC.
- *The CL-2 CommLine Accessory Kit,* which includes: 1) a 5-watt RF dummy load; 2) a two-position coaxial switch, for switching the receiver under test to either the CB In-Line Tester or to the RF Generator; 3) an acoustic coupler, for through-the-mike modulation of the transceiver under test; 4) a Model VP-8 RF probe; and 5) the four cables and two leads required for interconnection of the three 'basic' CommLine test instruments and the transceiver under test.

The total price of the previously described 'basic' version of the CommLine CB Test System is $752.

THE COMPLETE SYSTEM

The 'complete' version of the Hickok CommLine CB Service System consists of the Model 244 Mobil/Comm Power Supply, the Model 256 RF Generator, the CL-2 Accessory Kit and an "X" version of the Model 388 CB In-Line Tester (which is equipped with a temperature compensated crystal oscillator that provides lppm accuracy and an aging rate of + lppm/year) plus the following three additional test instruments:

- *The Model 334 Digital Multimeter,* which provides measurement and 3½ digit readout of DC voltages from .1mV to 1200 volts, AC voltages from .1mV to 1000 volts (RMS), DC and AC (RMS) current from .1μA to 2000MA, and resistances from .1Ω to 20 megohms, with automatic polarity indication and decimal positioning.
- *The Model 217 Semiconductor Analyzers,* which provides in- and out-of-circuit testing of bipolar,

Fig. 2—Hickok's Model 388 CB In-Line Tester.

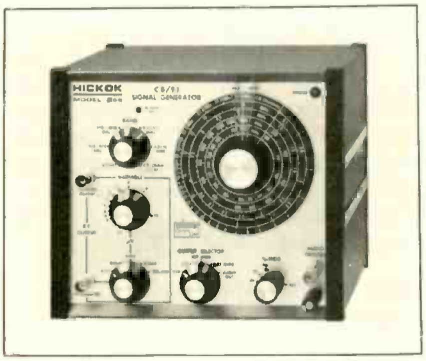


Fig. 3—Hickok's Model 256 CB RF Generator.

Fig. 4—Hickok's Model 244 Mobil/Comm Power Supply.

unijunction, and junction field-effect transistors, conventional and zener diodes, SCRs and triacs.

- *The Model 270 Function Generator,* which provides sine, square and triangle waveforms at frequencies from 1Hz to 1MHz in six pushbutton-selected decade ranges.

The total price of this complement of six compatible test instruments, the CL-2 Accessory Kit, and the rack-mounting hardware required to mount the system as shown in Fig. 1 is $1559.80. (An additional Hickok test instrument, the Model 385X 500-MHz Autoranging Frequency Counter, is shown in the system setup in Fig. 1. This instrument is not required for CB service, but is available to expand the capability of the CommLine system to include two-way communications equipment operating at frequencies up to 500MHz.) ■

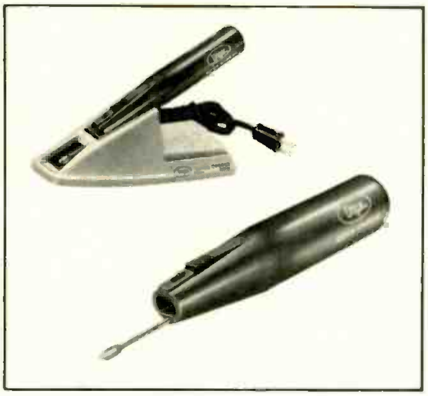
NEW PRODUCTS

Descriptions and specifications of the products included in this department are provided by the manufacturers. For additional information, circle the corresponding numbers on the Reader Service Card in this issue.

CORDLESS SOLDERING STATION 145

Ungar Division of Eldon Industries recently introduced a new cordless soldering station, Model 200, which consists of a holder/battery charger unit and a battery powered soldering iron.

Designed for bench or field use, the iron of the Model 200 is powered by a Ni-Cad battery pack which can be



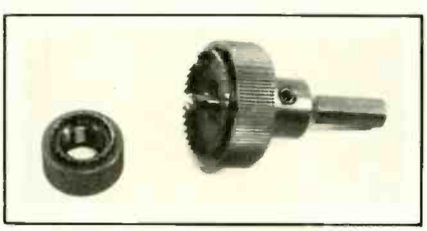
completely recharged by the holder/battery charger unit in four hours.

Other features of the iron include: a rigid coaxial tip which can be rotated to any desired working position; a touch-to-use switch which conserves battery power; and a narrow-beam light which provides illumination of the area being soldered.

Price of the Model 200 Quick-Charge Cordless Soldering Station is $19.95.

ANTENNA HOLE SAW KIT 146

A new device that speeds the cutting of holes in car and truck bodies for permanent mount mobile antennas has been introduced by the *Utility Tool Corp.* Called the Cablematic HSK Hole Saw Kit, the product features a special guide on the drill bit that limits the depth of the hole to ⅛-inch to prevent damage to underlying headliners, and also scores the paint for better grounding of the antenna. The new saw bit also incorporates a special



guide on the drill bit that restricts "walking" of the saw. The kits are available in ¾-inch and 1 and 5/16 inch sizes, and are designed for use with ⅜ inch or larger electric drills.

TUNER CLEANER 147

A new high density, low surface tension, ultrasonic-type cleaner containing a high temperature silicone grease is now available from the *Rawn Company*. Designated the Super Line Heavy Tuner Cleaner, the new product is said to fill the need where extreme temperatures, both high and low, and high moisture are factors. The cleaner, which is said to be safe for

plastics, has good water washout resistance and lubrication abilities from −65°F to 300°F, and will maintain viscosity through this temperature range without solidifying or melting.

TV INTERFERENCE FILTER 148

A new low pass filter for use with CB transceivers and Amateur Radio systems operating below 30 MHz has been introduced by *HME*. The new filter is inserted between the antenna

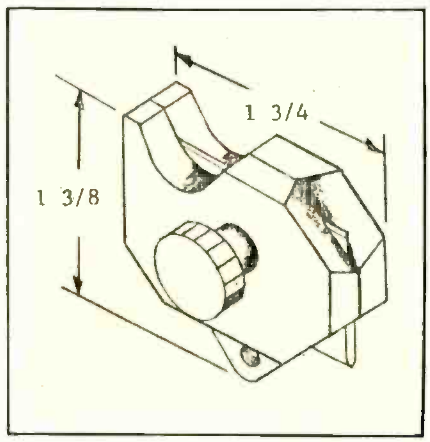
and the transceiver (or amplifier) to suppress undesired radiation by at least 60 dB's. Insertion loss at the operating frequency is less than 0.25 dB. The new filter, which handles up to 500 watts, may be used with AM, SSB, CW, or FM systems. It is said to pass all frequencies up to 30 MHz, but passes no signal beyond 32 MHz. Screwdriver adjustment allows for transceiver/filter match.

NEW INTEGRATED CIRCUITS 149

Fifteen new integrated circuits have been added to the *General Electric* replacement line for the repair of TV and other consumer electronic products. Added for FM stereo are: a multiplex decoder with lamp driver, a demodulator with phase locked loop, a multiplex demodulator/two-channel amplifier, and a demodulator to drive head phones. Other additions are: an AM/FM IF amplifier/detector/AF amplifier, general purpose transistor array, a pre-amp for stereo tape recorders, plus eight devices for color TV. The ICs for TV include: a color bandpass amplifier; two vertical osc., AFC/vertical drivers; video amplifier; AGC gate/amplifier color takeoff; vertical deflection and pin cushion; chroma demodulator and amplifier; and sound IF amplifier/limiter/detector/audio pre amp. List prices range from $6.95 to $18.48.

INSULATION SLITTER & STRIPPER 150

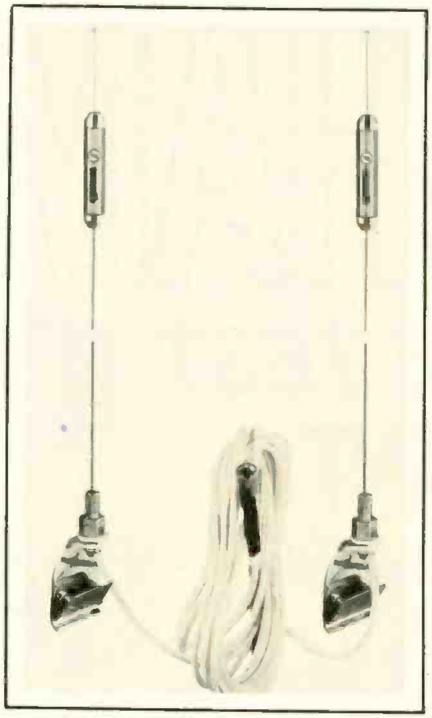
A new tool designed to easily remove insulation from wire and cable up to 1 inch in diameter has been developed by *Lumia Prodcuts*. It is actually a 'guide' for a single edge cutting blade. The V-notch guides the blade lengthwise along the centerline of the cable, and the semicircular notch in



the holder guides the blade around the wire or cable. It is especially useful for coaxial cable, multiconductor cable, Romex cable and high voltage wire with thick-walled insulation. The blade is a standard single edge type and the body is made of ABS plastic. The blade is adjustable for various insulation thicknesses. A tab with a hole in it is included for handing the guide on a tool board or chain. It lists for $1.25.

DUAL CB ANTENNA SYSTEM 151

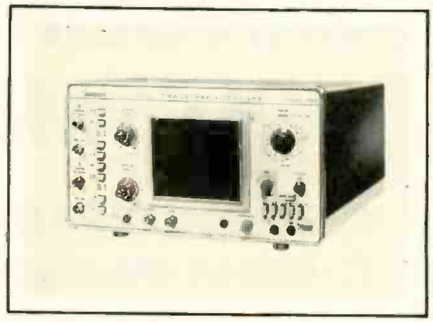
A new co-phased dual antenna systems for mobile CB installation is now available from *Avanti Research*. Named the AV-535, the new system consists of two 48 inch stainless steel, top-loaded antennas with chrome



plated steel gutter clip mounts and a 24 foot co-phasing harness. The new system is said to increase performance approximately 25% over a single antenna, and to minimize the problem of a skewed or shifted radiation pattern. The system is removable for easy transfer from one vehicle to another.

DUAL TRACE TRIGGERED-SWEEP SCOPE 152

A new dual-trace scope for the design, development and service of digital circuitry, as well as general communications, audio and TV equipment, has been introduced by *Simpson Electric*. Designated the model 452, the new scope features a triggered sweep and a 15 MHz bandwidth plus all solid-state and IC components. Differential vertical amplifier stages give

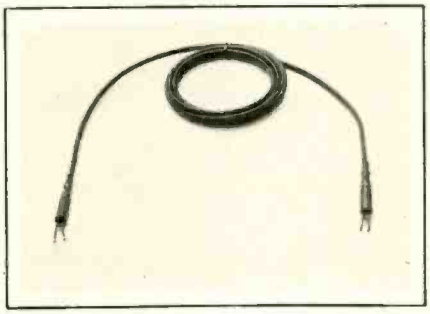


the scope wide bandwidth (DC coupled, DC to 15 MHz; AC coupled, 2 Hz to 15 MHz) with smooth roll-off through 27 MHz. Triggering is internal or external with sync positions for TVV, TVH and VITS. Sensitivity is 5 mV/cm and rise time is 24 nsec. The new scope automatically shifts from "chop" to alternate on faster sweeps. It is able to display Channel A, Channel

B, A & B, A+B (add) or A−B (subtract). The scope is 6½ inches high by 12 inches wide by 16 inches deep, weighs 20 lbs., and is priced at $635.

TVI FILTER CABLE FOR CB 153

A new filter cable that reduces or eliminates the 2nd and 3rd harmonic interference to TV channels 2, 5 and 6, from CB transmissions has been introduced by *Vitek Electronics*. This new cable for CB transceivers looks like an ordinary piece of 50 ohm coaxial cable but built inside the cable are multiple distributed resonators to trap 54MHz and 81MHz. The cable is designed to be connected in line between the CB transceiver and the CB antenna. It does not require the use of a jumper cable to make connection with the transceiver. The cable comes in two lengths; a 6-foot size, designed to be connected to an existing CB system, and an 18-foot length, designed to replace the RG coaxial cable commonly used in mobile CB.

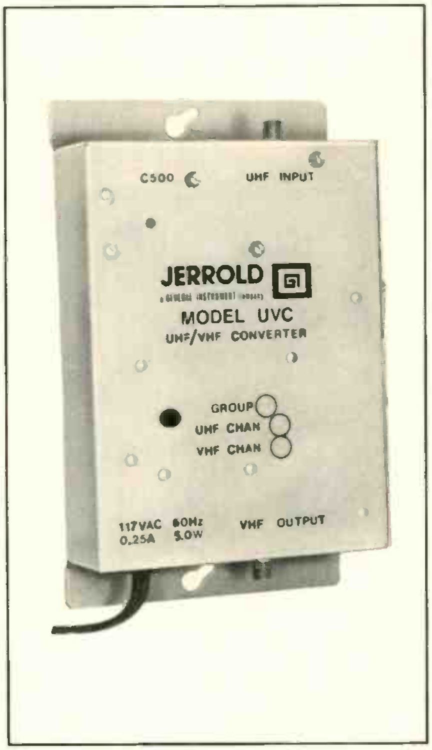


DELAYED TIMEBASE OSCILLOSCOPE 154

A new 25 MHz dual timebase portable oscilloscope, the PM 3214, has been announced by *Philips Instruments*. The new scope features alternate timebase display, allowing full screen display of both main and delayed timebases for both channels simultaneously, resulting in four traces. The 18.5 lb. portable scope has fully calibrated delay, as well as full trigger facilities for both timebases. Main timebase triggering modes are auto, AC, DC, TV line or frame and source selection from Channel A or B, composite, external and from the line. Delayed timebase triggering is also AC or DC coupled with full level control and source selection is main timebase with calibrated delay, Channel A, Channel B, composite and external source. PM3214 is priced at $1,395.

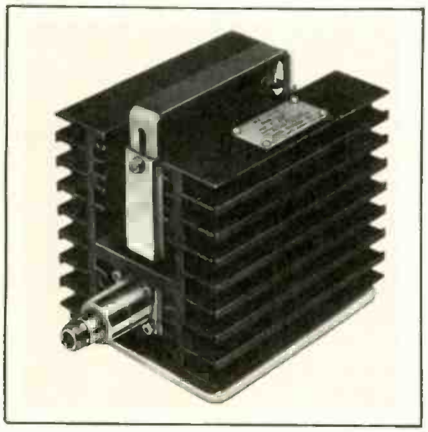
SOLID-STATE U/V CONVERTER 155

A new series of solid state UHF to VHF TV channel converters for use in MATV systems has been developed by *Jerrold Electronics*. Designated UVC, the new converter series can be used to distribute UHF channels on unused VHF channel frequencies. For example, UHF Channel 48 can be converted to VHF Channel 10 and distributed on that frequency throughout the MATV system. TV sets connected to the MATV system can then view Channel 48 by setting their VHF Channel selector to Channel 10. Converting UHF channels to VHF frequencies makes large MATV distribution systems more economical, since cable losses are much lower at VHF than at UHF. The new converters exhibit highly stable tuned L-C oscillator operation over a wide temperature range. The noise figure is low (10.5 dB) and output capability is high (+40 dBmV). UVC converters are designed for indoor use. Available at list price of $175.85.



DRY RF COAXIAL LOAD 156

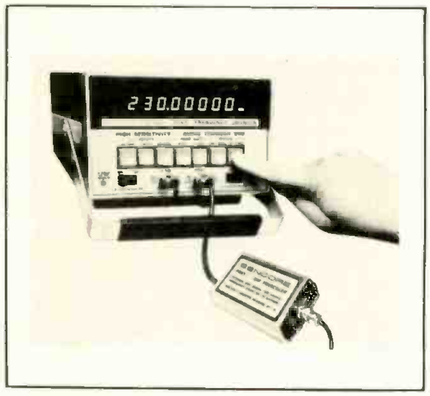
A new 200 watt, dry RF coaxial load that is designed to dissipate up to 200 watts of R.F. energy in a small space has been introduced by *Coaxial Dynamics*. Designed as a "dummy load" for the adjustment, testing and alignment of transmitters from DC through 512 MHz, the new unit is a 'dry' load, thus it can operate at full rating in any position and cannot leak messy oil. Designated Model 4260, the



load features a low VSWR (under 1.1 to 1.0), providing a non-reflective termination for RF transmitters with average power outputs up to 200 watts and peak powers up to 1000 watts. Special CDI resistors provide extrememly low harmonic generation as compared to carbon film resistors. Model 4260 is priced at $148.

PORTABLE DMM 157

A 3½ digit portable DMM costing only $99.95 has been announced by B&K-Precision. The new DMM, Model 2800, is a full-feature instrument that provides a wide range of voltage, current and resistance measurements. Twenty-two ranges are featured, measuring as high as 1000 VDC or VAC, or up to 40,000 VDC with an optional PR-28 probe. Resolution is to 1mV, 1μA, or 0.1 ohm. Typical DC accuracy is 1% with an input impedance of 10 megohm. The 2800 also features auto-zeroing and 100% overrange reading on all ranges. Overrange reading capability allows the user to read to 1999 on a scale normally limited to a maximum reading of 1000, reducing frequency range changes. Out-of-range indication is clearly indicated when the overrange is exceeded. The 2800 comes complete with test leads, detailed operating manual and spare fuse.

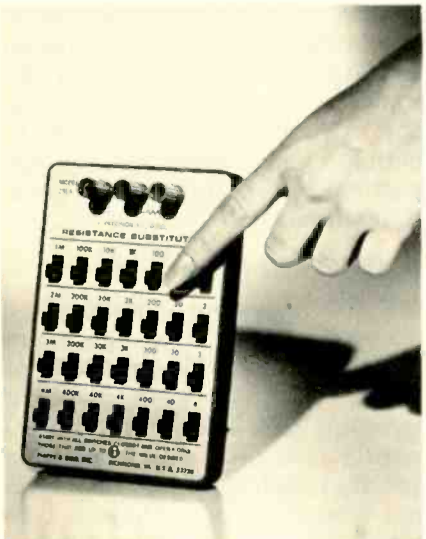


FREQUENCY COUNTER FOR AUDIO THRU VHF 158

A new frequency counter with continuous frequency checking capability from audio through VHF and UHF bands is now available from *Sencore*. Designated the FC45, the new counter features a direct-reading, eight-digit display with pushbutton action. The FC45 is said to be highly sensitive with 25 milliVolts average throughout the band, with a pick-up loop that won't upset the circuit during frequency tests. Accuracy is one part in one million tolerance. A crystal checker is an integral part of the FC45, plus all test leads. The new counter is priced at $395. An optional PR47 prescaler is also available for $125.

RESISTANCE SUBSTITUTION UNIT 159

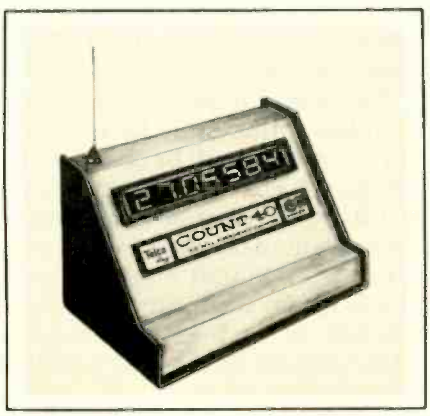
A new pocket-sized, slide-switch, resistance substitution unit with a range of over 11 million resistance steps is now available from *Phipps & Bird*. The new hand-held unit has been designed for use in circuit design, development, instrument repair and



troubleshooting. It is housed in aluminum and features three binding posts, one to ground case. The slide-switch uses one-half watt resistors with 1% tolerance with an accurate range from 1 to 11, 111, 110 ohms, in one-ohm steps. The unit is priced at $58.

FREQUENCY COUNTER 160

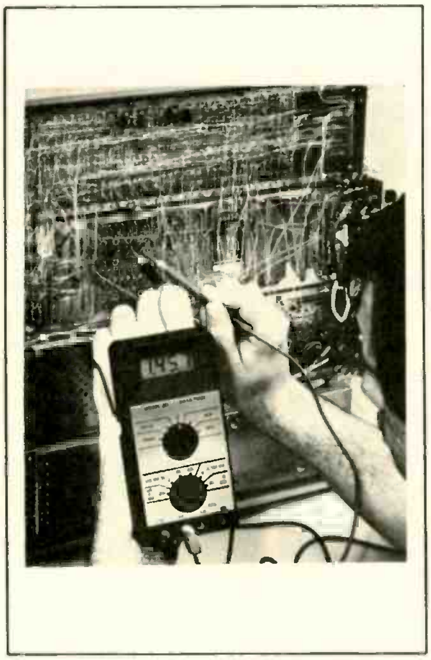
A new digital frequency counter, priced at $99 is available now from *Telco Products*. Called the Count-40, the new counter features large half-



inch-high LED, 7-digit displays with polarizing lens. It is crystal controlled with accuracy up to 40 MHz, and 1 MV sensitivity provides pick-up and display of low power transmission without the need for coax connection. The Count-40 is designed for portable use and may be used for either base or mobile on-the-air frequency verification. It will operate on 12 VDC or 117 VAC, and comes with a 117 volt power adapter.

PORTABLE DIGITAL MULTIMETER 161

A new portable, 3½ digit multimeter that operates for 200 hours on one set of batteries has been introduced by *Data Tech*. Designated the Model 22, the new instrument measures DC volts from 100 µV to 1KV; AC volts from 100µV to 750V; DC and AC current from 100nA to 20A; and resistance from 100µΩ to 20 MΩ. Basic ac-



curacy of readings on DCV is 0.1% ±1 digit. Model 22 features a large .5 inch LCD display, uses standard size disposable batteries and provides overload protection. It will also operate with rechargeable batteries or on AC. Priced at $234.

AGC SYSTEMS

continued from page 33

a test probe to many circuits encapsuled inside the chip necessitates treating the IC as a complete functional unit instead of discrete stages, and secondly, the electric delicacy of the microcircuitry requires extra care in testing or fixing.

The best technique for troubleshooting the IC and its associated module is probably a combination of signal tracing and DC voltage measurements. With correct DC voltages and proper input signals applied to the IC, if there is no expected output, or if the output is distorted, the IC is probably defective. Of course, the components connected to the IC on the module should be checked out before replacing the IC since a defective component sometimes makes the IC look bad, and at times it may actually damage the IC. Replacing a socket-mounted IC is no problem, but changing a soldered IC requires time and patience. An alternative to the defective *soldered* IC is to replace the whole module.

To illustrate what possible steps may be taken in trouble-shooting an IC AGC circuit, the circuit shown in Fig. 5 is chosen for an example. The troubleshooting chart shown in Fig. 8 is by no means to be used rigidly step-by-step for all circuits. The conceptual framework of the chart and the circuit shown in Fig. 5, however, can be adopted to deal with other similar situations with just a little modification.

In Conclusion

The AGC is a feedback, regulator closed-loop control system that maintains constant picture and sound quality for the TV receiver under varying signal conditions. Advances in solid state electronics have revolutionized many aspects of the AGC system. It is important that the principle and the purpose of the circuit be thoroughly understood before undertaking any troubleshooting task. ■

AUDIO TEST

continued from page 27

mation with the maximum signal (or power) level. The ratio of the voltages across the output load is converted to a Signal to Noise Ratio (S/N) with the following equation: $S/N = 20 \log_{10} V_p/V_n$. ($V_p$ is the maximum power voltage and V_n is the noise voltage.)

Sensitivity

Measurements for sensitivity determine how much signal, or voltage you must apply to each amplifier input terminal to drive the amplifier to its rated output. The setup for sensitivity measurements, using a LF spectrum analyzer, is shown in Fig. 18. The DPDT switch is convenient but not absolutely necessary.

Now, with the gain or loudness control set at maximum, and starting with any amplifier input, a 1000 Hz tone from the audio generator is applied to drive the amplifier to its rated power output. When rated power output is reached, you bypass the amplifier by switching to the analyzer input. The input signal level displayed is the sensitivity of the amplifier for that input. The figure shown will be given in either millivolts or microvolts for each input. The measurement for sensitivity is then tabulated with the chart shown in Fig. 19.

Crosstalk

Crosstalk is the measurement of how much signal from one channel in a stereo amplifier breaks through, or spreads, into the other channel. In a quadriphonic system, it is a measure of how much signal breaks into a channel from all other channels combined. The setup for crosstalk measurement, using a spectrum analyzer, is shown in Fig. 20.

First, each channel is driven to its rated power output, and its response is displayed as a reference level (shown in Fig. 21). Then, the channel being tested has its input disconnected, while its output is displayed.

The input of a channel being tested for crosstalk should be terminated with a resistor with a value that is the rated input impedance of that channel input. The resistor should be carefully shielded, and that shielding should be grounded.

A typical spectrum analyzer display showing crosstalk indication is shown in Fig. 21. Maximum crosstalk separation will be somewhere in the mid-range, or as shown in Fig. 21, at 500 Hz. At both lower and higher frequencies, particularly the latter, the separation is reduced.

Finally—Some Useful Hints

In this series, we have described ways of using the spectrum analyzer to provide professional audio tests and measurements in terms of EIA standards, or FTC regulations. We should caution you that such legal test results do not always agree with your customer's listening desires or requirements.

To make a "legal" measurement, an amplifier must be tested with an accurate resistance load. But your customer does not listen to a resistance. He listens to his loudspeakers.

Although a spectrum analyzer will also measure the *damping factor*, which shows an amplifier's capability of feeding a loudspeaker rather than a resistor, you may get more informative results by repeating some of the tests we have described with the loudspeaker connected, in place of the prescribed resistance load.

The reason a resistance load is specified is that, only by using it, can power output be accurately measured. This applies especially to IMD and frequency response measurements. However, you never listen to that kind of power, so it is useful to acquire some proficiency in at least estimating what happens in the real world of customer sound. ■

DEALER SHOWCASE

Descriptions and specifications of the products included in this department are provided by the manufacturers. For additional information, circle the corresponding numbers on the Reader Service Card in this issue.

RECHARGEABLE NINE-VOLT BATTERY 139

A new nickel-cadmium 9-volt size battery, capable of being recharged up to 1000 times has been added to the *General Electric* line of rechargeable batteries. The new battery can be charged on the same miniature charger used with the firm's AA, C and D size rechargeable batteries. A

snap-on module connects the 9-volt size battery to the Model BC3 miniature charger. The battery and snap-on module is blister-carded for dealer display and carries a suggested retail of $9.49. Extra blister-carded batteries alone have a suggested retail of $8.99 each.

SHOPLIFTING ALARM 140

A new alarm device to protect high value display merchandise from shoplifting is being introduced by *Mountain West Alarm*. Called the Ell Label Alarm, the new device can be used on all types of merchandise. An adhesive tag attaches directly to the back or bottom of an item. When tag is removed, torn or cut, a loud alarm in the control box sounds. The label contains a concealed printed electric circuit. One side of the label has a removable protective covering that exposes an adhesive that is applied to the merchandise. Cutting or tampering with the wires also sounds the alarm.

RECHARGEABLE BATTERIES FOR CB 141

A new 12-volt rechargeable battery for portable CB use has been introduced by *Globe-Union*. Rectangular in shape and small in size, the high capacity (4.5 ampere hours) unit gives

good operating time with SSB and AM CB equipment. Under proper conditions, it is said that the new battery, GC-1245, will power a CB transceiver for a full day before charging becomes necessary. Up to 300 days of such use is said to be possible if done within a five-year period of time. In combination with a small charger, the GC-1245 could be used as a main power supply for a base station or as a stand-by power source. The battery is of compact rectangular configuration for easy fit into portable briefcase CB units.

INDOOR TV/FM ANTENNAS 142

A new line of antennas for TV and FM reception has been introduced by *Antennacraft*. The line includes four UHF-VHF-FM consoles, an FM stereo consolette and a specialty UHF antenna for channels 14 through 83. The new line is called Color King.

GIANT SCREEN TELEVISION 143

A new giant screen television system that utilizes RCA XL-100 color television units and the Kodak Ektalite screen is being introduced by *Projecta-Vision, Inc*. The new system, which is portable and suitable for home use, is said to be available for little more than the cost of a color console. It is also compatible with all makes and models of video tape cassette players and recorders, plus remote control units and electronic TV games. Giant screen sizes are 4 foot, 5½ foot and 8½ foot. A distributor network now being developed has possible openings.

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TV REPAIR business, shop, van, equipment, and furnished home. Shop in drive-in basement of home. Everything for $68,000. Home five years old and appraised at $42,000. Thirty miles north of Pittsburgh, PA. Write % Electronic Technician/Dealer, Box 106, 1 East First St., Duluth, MN 55802. 5/77

TV Picture tube rebuilding operation, includes four position, automatic oven. Only one going in area. $12,000. Building available. Details: 2333 Compton, St. Louis, MO 63104. 6/77

ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details **FREE.** Aviation Employment Information Service, Box 240 Y, Northport, New York 11768. 6/77

MAKE BIG MONEY! Rent, lease or sale. New and reconditioned TVs! Anyone can do it. Easy to start and operate. Part or full time; even operate from your home. Send $4.00 for details, Perry's TV Leasing, 308 N. McCelland, Santa Maria, CA 93454. 5/77

T. V. Business For Sale. South Florida. Zenith-RCA. Unlimited Potential For Right Party. Write Sam, 142 N. E. 122 Street, N. Miami, Florida 33161. 6/77

Construction Plans

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

Alarm Systems

CALL THE POLICE (or anyone else) AUTOMATICALLY. Model 672 dailing unit $29.95. Send today for your free catalog of high quality burglar and fire alarm equipment at low prices. S&S Systems, 5619 E St. John, Kansas City, MO 64123. 3/77

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LINEAR AMPLIFIER for C.B., 2-meter, walkie-talkie. Tiny Solid-State Portable Unit produces 100 Watt PEP from Milliwatts and can be inserted inside existing unit. Build for about $20. Send $5.00 for plans to: J. Martin Peter, P. O. Box 07071, Milwaukee, WI 53207. 7/77

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

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For Sale: Hewlett Packard Model 606B Signal Generator complete—used four times—cost me $3744.00—make offer. John DeGroot, 3900 Erie St., Racine, Wisc. 53401. 1-414-639-4850. 5/77

RADAR DETECTORS are Big Business! Dealers can buy the **LONG RANGER RADAR RECEIVER** with light & buzzer & cigarette lighter connector for $62.50 each. Retails for $89.95 to $99.95. Distributor by Ronkel, Inc., P.O. Box 13151, Arlington, Texas 76013. 5/77

FOR SALE: UHF TUNERS. Complete line of solid state plus some RCA KRK66AM and Philco UT-51. $10.00 plus postage and handling. Metropolitan TV, 3341 Kensington Ave., Philadelphia, PA 19134. Phone 215 423-2502. 10/77

C.R.E.I. home study course in electronics and broadcasting. Covers solid state and microtechnology. Includes scope, breadboard design module, VOM, hundreds of parts for experiments and design projects. Original cost $1500.00, asking $800.00. Steve Walker, 916 Owen St., N.W., Cedar Rapids, Iowa 52405 (319) 396-3069. 5/77

Look no further for CB transistors. Delivery from stock. Write or telephone for lowest prices possible. American Microsemiconductor Inc., 145 Main St., Madison, NJ 07940, (201) 377-9566. 5/77

TUNER SUBSTITUTION UNIT complete with batteries and ready to use but without cabinet or knobs, only $13.95 **PREPAID**. This is not a gimmick. Try it for 10 days and if not **COMPLETELY** satisfied, return for full refund. **TEXAS TUNER SERVICE**, 4210 N. E. 28th Street, Fort Worth, Texas 76117. 5/77

ELECTRONIC TECHNICIAN/DEALER

is not responsible for any of the items, plans, courses or quality of products offered through our classified section.

Latest FCC questions, answers, "explanations" compiled from technical schools, colleges, avionics companies across the country. $11.00. S. Mager, Box 26151, Los Angeles, California 90026. 5/77

For Sale: TV Test equipment and parts—over $15,000.00 worth—make offer. Phone 503 842-7848, or write J. W. Smith, 518 Elm Ave., Tillamook, Oregon 97141. 5/77

QUITTING BUSINESS. Selling 1,000 SAMS, 400 tubes, large stock of test equipment, B & K 747 tube tester, 1076 TV Analyst, 415 Sweep Marker Generator, RCA Scope, much more. Asking $3,500. For complete list write Bob King, Desert Aire, Othello, Wash. 99344 or call 509-932-4631. 5/77

ONE MAN TV CART. YES now one man can pick up a 6 foot tv stereo consul or any other standard tv from the customer's home into the truck and to the work bench **BY HIMSELF.** Professional TV, Box 296, Mt. Pleasant, Utah 84647, 810 462-2553. 5/77

Wanted

Wanted: Battery operated radios, horn speakers, tubes, parts, radio magazines and books, all before 1930. G. Schneider, 6848 Commonwealth Blvd., Parma Hgts., Ohio 44130 216-845-4358. 5/77

WANTED—USED REPAIRABLE TVS, TRADE INS. East Coast—NY, NJ, PA, DEL, MD—25 to 100. Want steady supplier. Charles Kirby, Kirby TV, Route 3, Box 176. Chestertown, MD 21620. 5/77

SEEKING ORIGINAL JAPANESE TRANSISTORS, IC, FET AND DIODES FOR CB REPAIR USE? Write or call for our list and compare prices. Fuji-Svea Enterprise, Dept. ET, P.O. Box 40325, Cincinnati, OH 45240. (513) 874-0220. 7/77

Wanted to buy: Sams Photofacts, from 800 up to date. Miler, 5177 Somerton, Troy, Mich. 48098. 313-689-5019. 5/77

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GROUP **297**

1691

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B/W TV Chassis
T3N3

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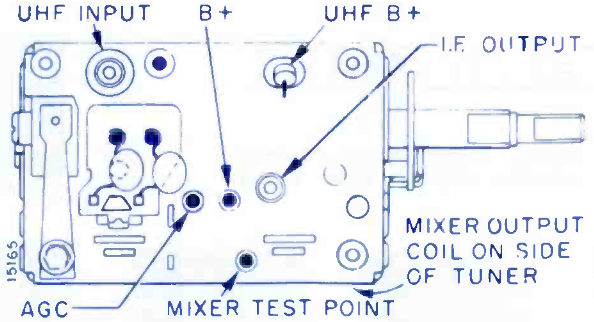
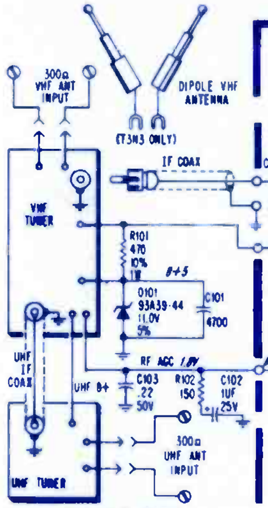
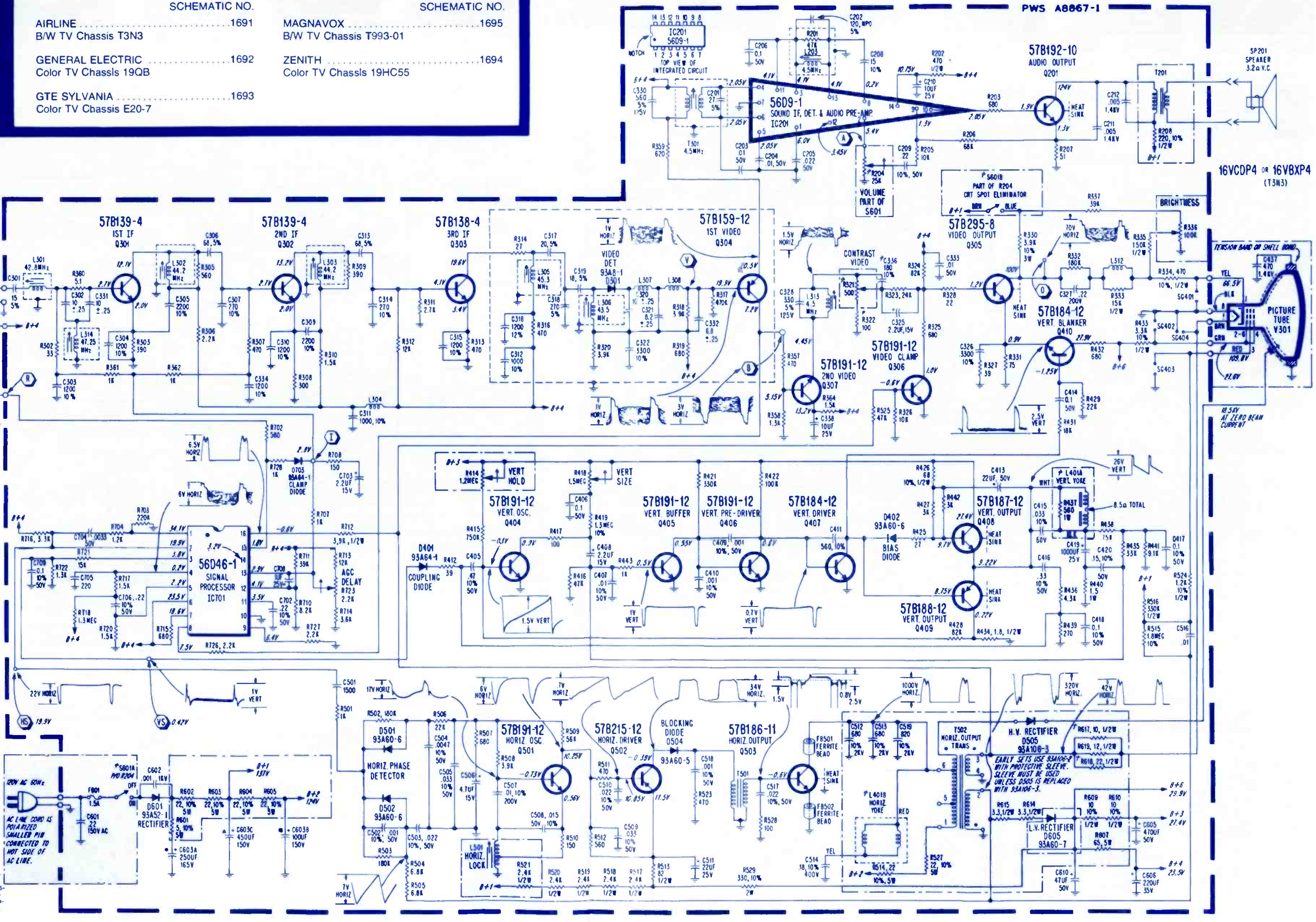


VHF TUNER (94A611-1)





SCHEMATIC NOTES
(UNLESS OTHERWISE INDICATED)

RESISTOR VALUES IN OHMS-5%, 1/4W

CAPACITOR VALUES OF 1 OR HIGHER ARE IN PF, LESS THAN 1 ARE IN UF, ±20%.

COILS RESISTANCE VALUES LESS THAN 1 OHM NOT SHOWN.

COMPONENT NOT MOUNTED ON PRINTED CIRCUIT BOARD.

COMMON GROUND (B-)

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

WARNINGS

USE ISOLATION TRANSFORMER WHEN SERVICING WITH CABINET BACK REMOVED.
WHEN SERVICING, USE EXACT REPLACEMENT PARTS (SEE "SAFETY CRITICAL COMPONENTS" NOTICE).
ALSO PERFORM ALL SAFETY CHECKS SPECIFIED UNDER "IMPORTANT PRODUCT SAFETY INFORMATION" IN SERVICE MANUAL.

TRANSISTOR CAUTIONS

TO AVOID TRANSISTOR DAMAGE DO NOT ARC 2ND ANODE LEAD OR PICTURE TUBE TO GROUND. DISCHARGE THROUGH 10K RESISTOR. DO NOT TURN SET ON WITH TRANSISTOR(S), PICTURE TUBE, OR LEADS REMOVED OR UNSOLDERED. BE CAREFUL NOT TO ACCIDENTALLY SHORT BETWEEN COMPONENT TERMINALS OR TO COMMON GROUND. MAKE CONTINUITY AND RESISTANCE MEASUREMENTS WITH A VTVM, FIELD EFFECT METER, OR OTHER HIGH INPUT IMPEDANCE METER. DO NOT USE A VOLT-OHMMETER HAVING LESS THAN 100K OHMS/VOLT FOR RESISTANCE MEASUREMENTS.

VOLTAGE & WAVEFORM INFORMATION

DC VOLTAGES TAKEN WITH TVTM, WITH RESPECT TO COMMON GROUND (B-). DC VOLTAGES, WAVEFORMS AND P-P VOLTAGES TAKEN WITH 120V AC INPUT. VOLTAGES SHOWN IN BLOCKS TAKEN WITH TV SIGNAL. OTHER VOLTAGES TAKEN WITH VHF ANTENNA TERMINALS SHORTED, CHANNEL SELECTOR SET ON UNUSED VHF CHANNEL, VOLUME CONTROL MINIMUM, BRIGHTNESS AND VIDEO/CONTRAST CONTROLS MAXIMUM, ALL OTHER CONTROLS IN NORMAL OPERATING POSITION. ON-SIGNAL VOLTAGES AND WAVEFORMS TAKEN WITH TRANSMITTED, NOISE FREE SIGNAL PRODUCING 2.8 TO 3.5 VOLTS AGC AT TEST POINT R. VIDEO/CONTRAST AND BRIGHTNESS CONTROLS AT MAXIMUM. ALL WAVEFORMS TAKEN WITH WIDE-BAND OSCILLOSCOPE.

AGC DELAY ADJUSTMENT

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

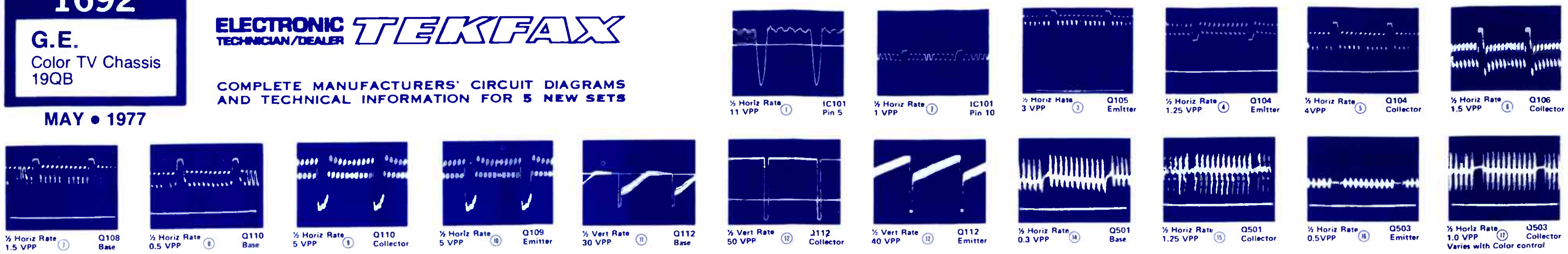
1692

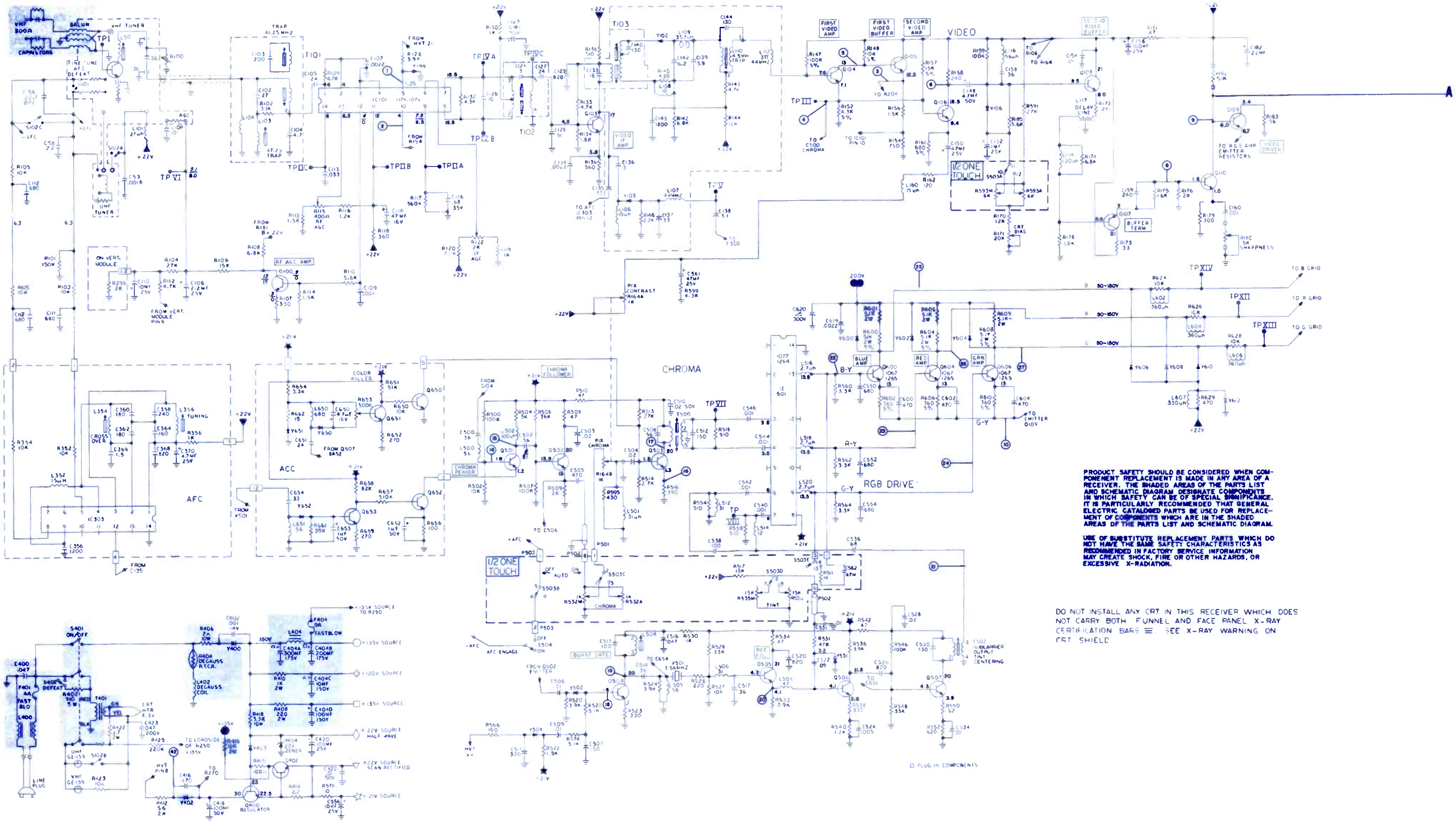
G.E.
Color TV Chassis
19QB

MAY • 1977

ELECTRONIC TECHNICIAN/DEALER TEKFAX

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





PRODUCT SAFETY SHOULD BE CONSIDERED WHEN COMPONENENT REPLACEMENT IS MADE IN ANY AREA OF A RECEIVER. THE SHADED AREAS OF THE PARTS LIST AND SCHEMATIC DIAGRAM DESIGNATE COMPONENTS IN WHICH SAFETY CAN BE OF SPECIAL SIGNIFICANCE. IT IS PARTICULARLY RECOMMENDED THAT GENERAL ELECTRIC CATALOGED PARTS BE USED FOR REPLACEMENT OF COMPONENTS WHICH ARE IN THE SHADED AREAS OF THE PARTS LIST AND SCHEMATIC DIAGRAM.

USE OF SUBSTITUTE REPLACEMENT PARTS WHICH DO NOT HAVE THE SAME SAFETY CHARACTERISTICS AS RECOMMENDED IN FACTORY SERVICE INFORMATION MAY CREATE SHOCK, FIRE OR OTHER HAZARDS, OR EXCESSIVE X-RADIATION.

DO NOT INSTALL ANY CRT IN THIS RECEIVER WHICH DOES NOT CARRY BOTH FUNNEL AND FACE PANEL X-RAY CERTIFICATION BARS ☰. SEE X-RAY WARNING ON CRT SHIELD

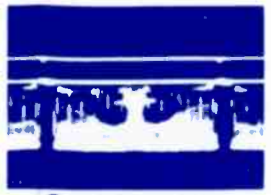
1695

MAGNAVOX
B/W TV Chassis
T993-01

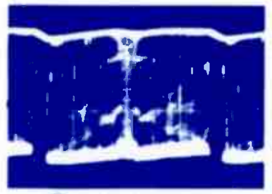
MAY • 1977

ELECTRONIC TECHNICIAN/DEALER TEKFAX

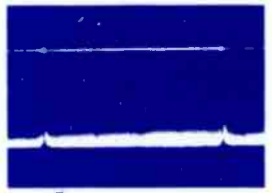
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS



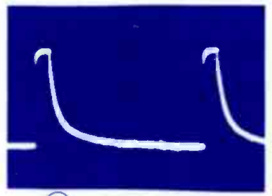
(1) 1.7Vp-p (V)



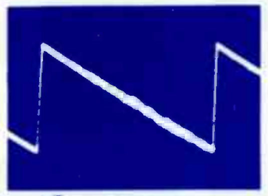
(2) 50Vp-p (V)



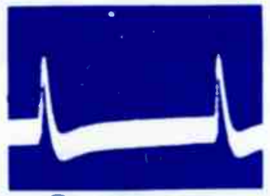
(3) 10Vp-p (V)



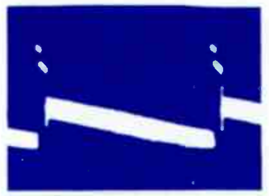
(3) 10Vp-p (H)



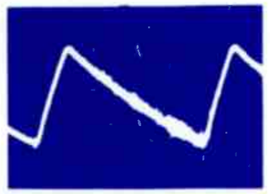
(4) 1Vp-p (V)



(5) 0.2Vp-p (V)

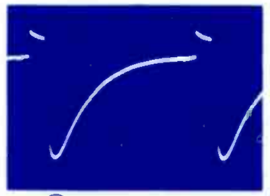


(6) 10Vp-p (V)



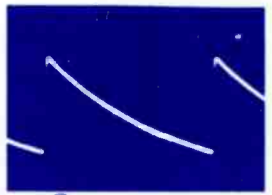
(7) 2Vp-p (H)

(8) 1Vp-p (H)

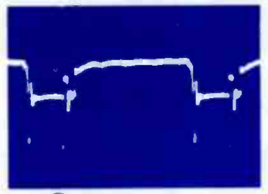


(9) 5Vp-p (H)

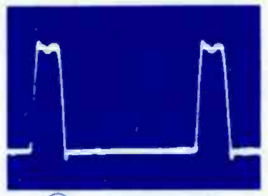
(10) 15Vp-p (H)



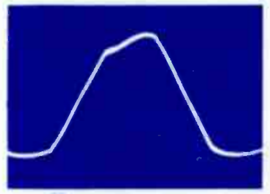
(11) 4Vp-p (H)



(12) 8Vp-p (H)

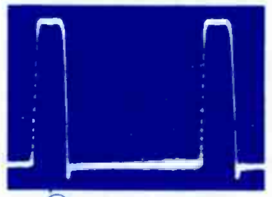


(13) 110Vp-p (H)



(14) 23Vp-p (V)

(15) 0.05Vp-p (V)

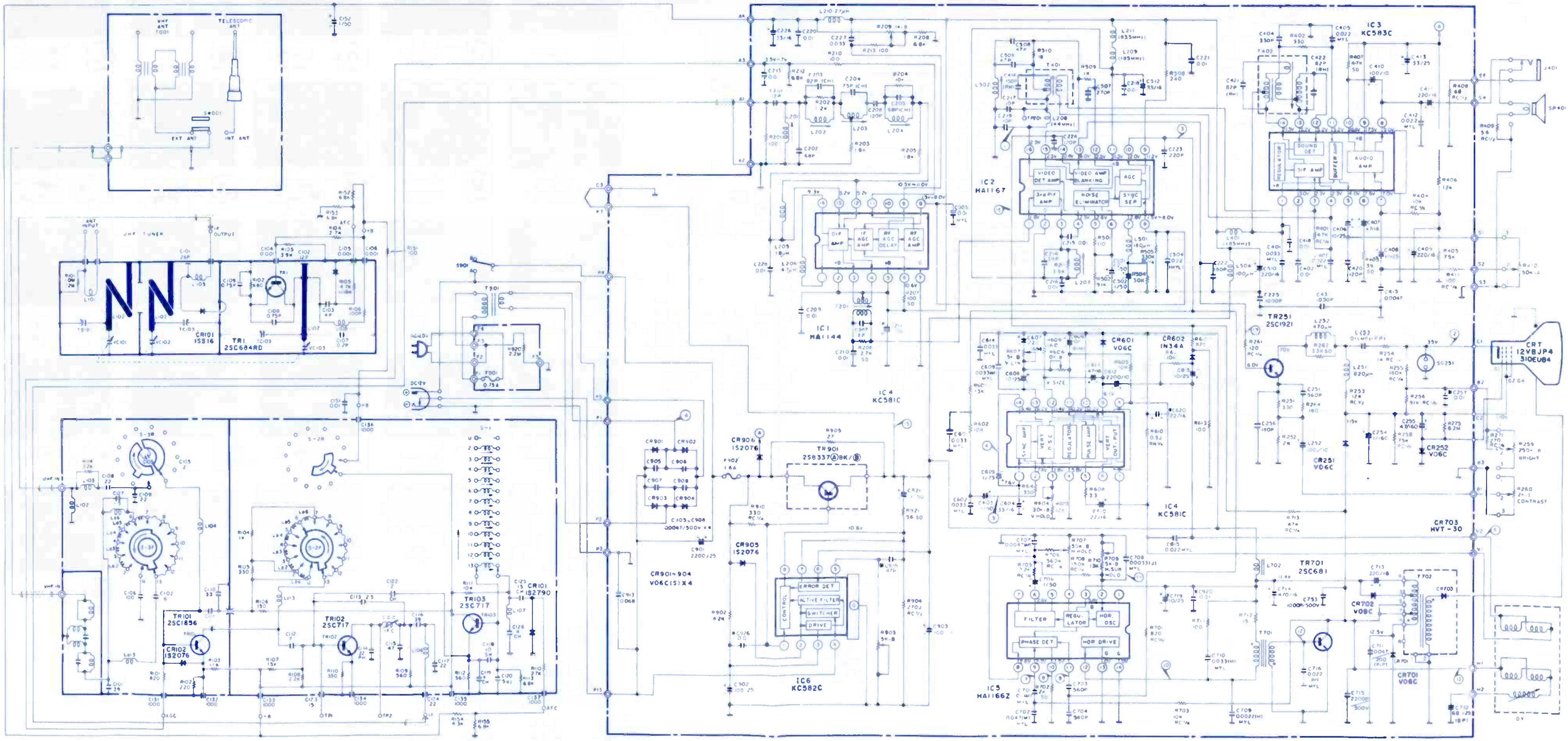


(16) 1.5Vp-p (H)

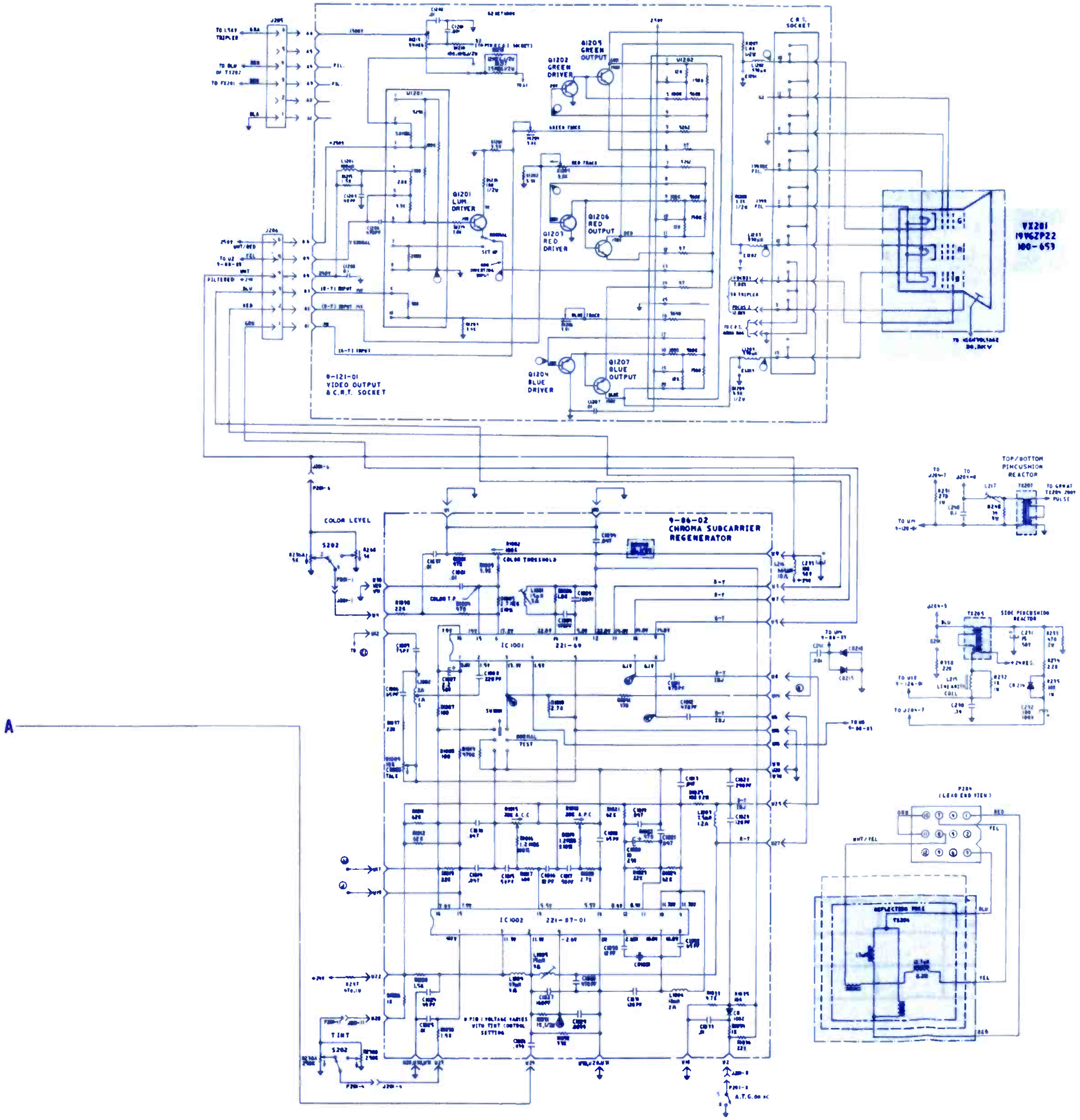
(17) 6Vp-p (H)

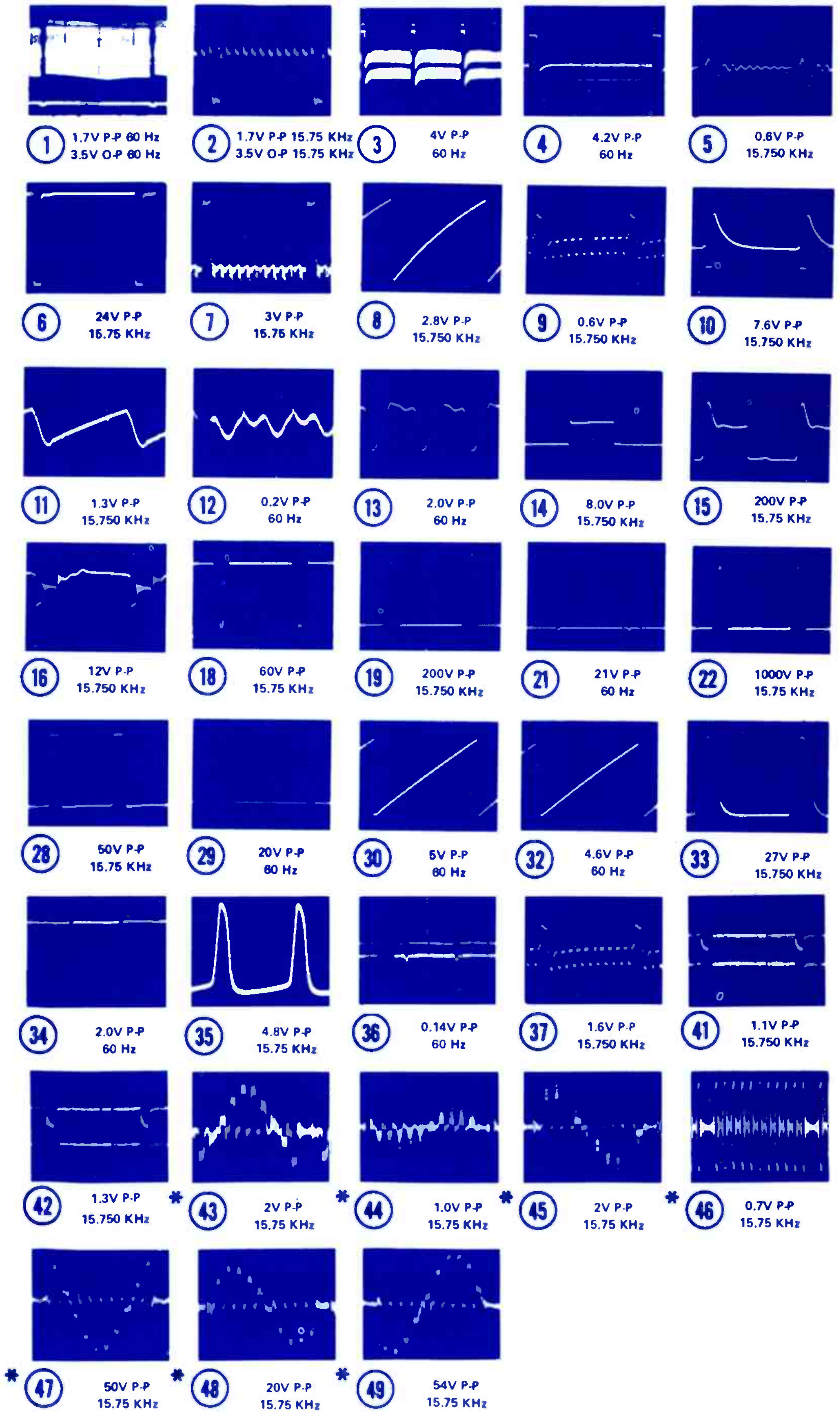
NOTE:

1. ▬ LOCATED COPPER SIDE OF BOARD.
2. ALL CAPACITANCE VALUES ARE IN MICROFARAD UNLESS SPECIFIED.
3. ALL VOLTAGES ARE MEASURED UNDER NO SIGNAL CONDITIONS.



ZENITH
Color TV Chassis
19HC55





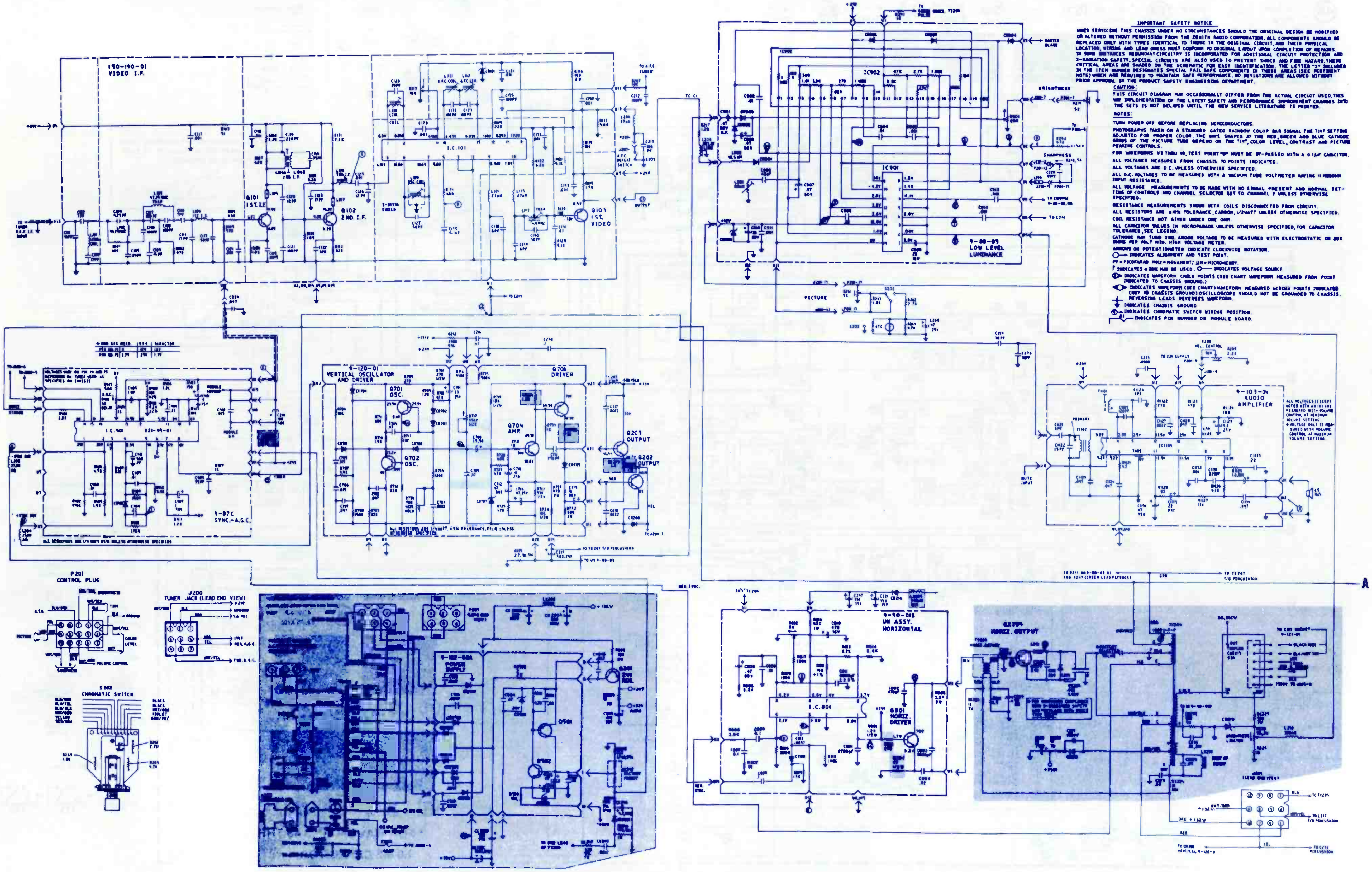
1694

ZENITH
Color TV Chassis
19HC55

MAY • 1977

ELECTRONIC TECHNICIAN/DEALER TEKFAX

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



IMPORTANT SAFETY NOTICE

WHEN SERVICING THIS CHASSIS UNDER NO CIRCUMSTANCES SHOULD THE ORIGINAL DESIGN BE MODIFIED OR ALTERED WITHOUT PERMISSION FROM THE ZENITH RADIO CORPORATION. ALL COMPONENTS SHOULD BE REPLACED ONLY WITH TYPES IDENTICAL TO THOSE IN THE ORIGINAL CIRCUIT, AND THEIR PHYSICAL LOCATION, WIRING AND LEAD DRESS MUST CONFORM TO ORIGINAL LAYOUT UPON COMPLETION OF REPAIRS. IN SOME INSTANCES REDUNDANT CIRCUITRY IS INCORPORATED FOR ADDITIONAL CIRCUIT PROTECTION AND X-RADIATION SAFETY. SPECIAL CIRCUITS ARE ALSO USED TO PREVENT SHOCK AND FIRE HAZARD. THESE CRITICAL AREAS ARE SHADED ON THE SCHEMATIC FOR EASY IDENTIFICATION. THE LETTER "X" INCLUDED IN THE ITEM NUMBER DESIGNATES SPECIAL FAIL SAFE COMPONENTS IN THESE AREAS (SEE PERTINENT NOTE) WHICH ARE REQUIRED TO MAINTAIN SAFE PERFORMANCE. NO DEVIATIONS ARE ALLOWED WITHOUT PRIOR APPROVAL BY THE PRODUCT SAFETY ENGINEERING DEPARTMENT.

CAUTION:

THIS CIRCUIT DIAGRAM MAY OCCASIONALLY DIFFER FROM THE ACTUAL CIRCUIT USED. THIS WAY IMPLEMENTATION OF THE LATEST SAFETY AND PERFORMANCE IMPROVEMENT CHANGES INTO THE SETS IS NOT DELAYED UNTIL THE NEW SERVICE LITERATURE IS PRINTED.

NOTES:

TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS.

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

FOR WAVEFORMS V1 THRU V8, TEST POINT "B" MUST BE BY-PASSED WITH A 0.1µF 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 3 UNLESS OTHERWISE SPECIFIED.

RESISTANCE MEASUREMENTS SHOWN 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 2ND 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 WAVEFORM CHECK POINTS (SEE CHART WAVEFORM MEASURED FROM POINT INDICATED TO CHASSIS GROUND.)

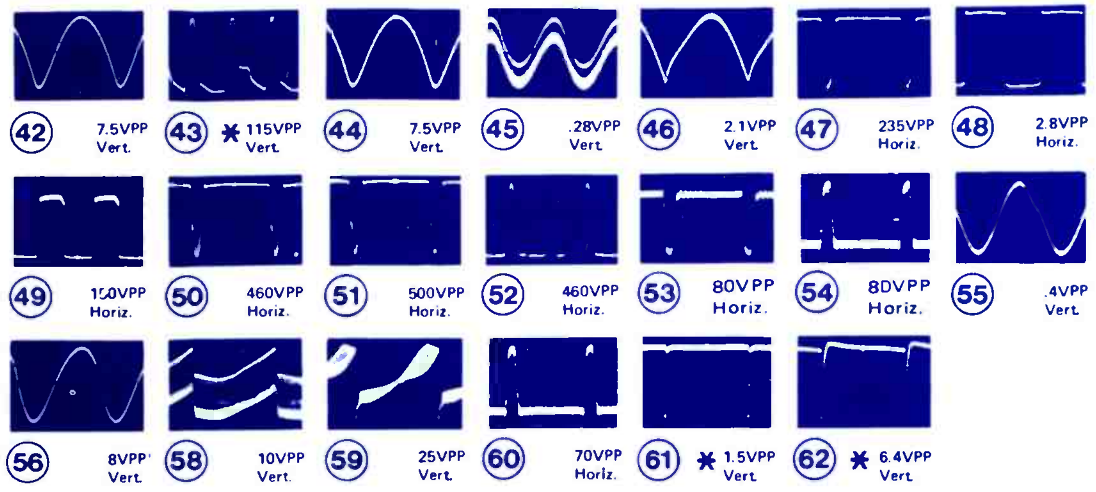
INDICATES WAVEFORM (SEE CHART) WAVEFORM MEASURED ACROSS POINTS INDICATED (NOT TO CHASSIS GROUND) OSCILLOSCOPE SHOULD NOT BE GROUNDED TO CHASSIS. REVERSING LEADS REVERSES WAVEFORM.

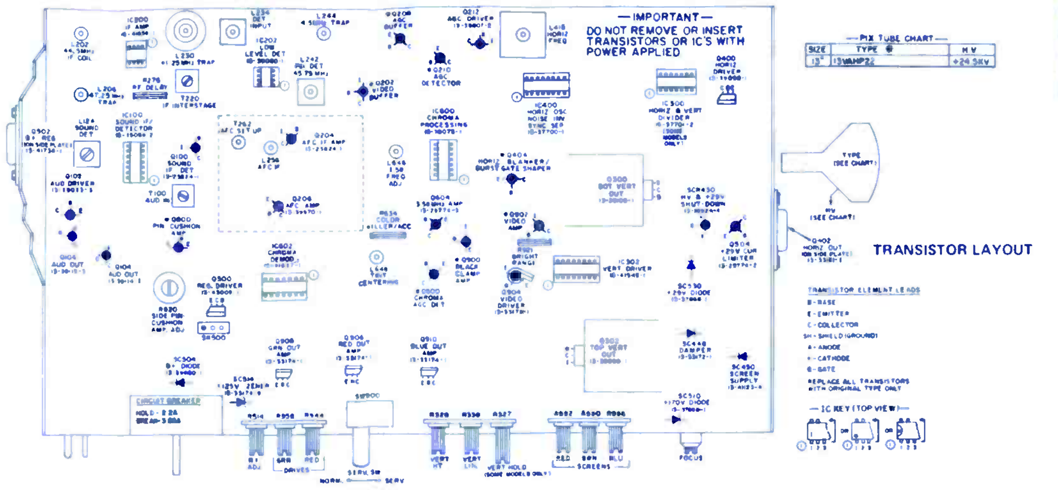
INDICATES CHASSIS GROUND

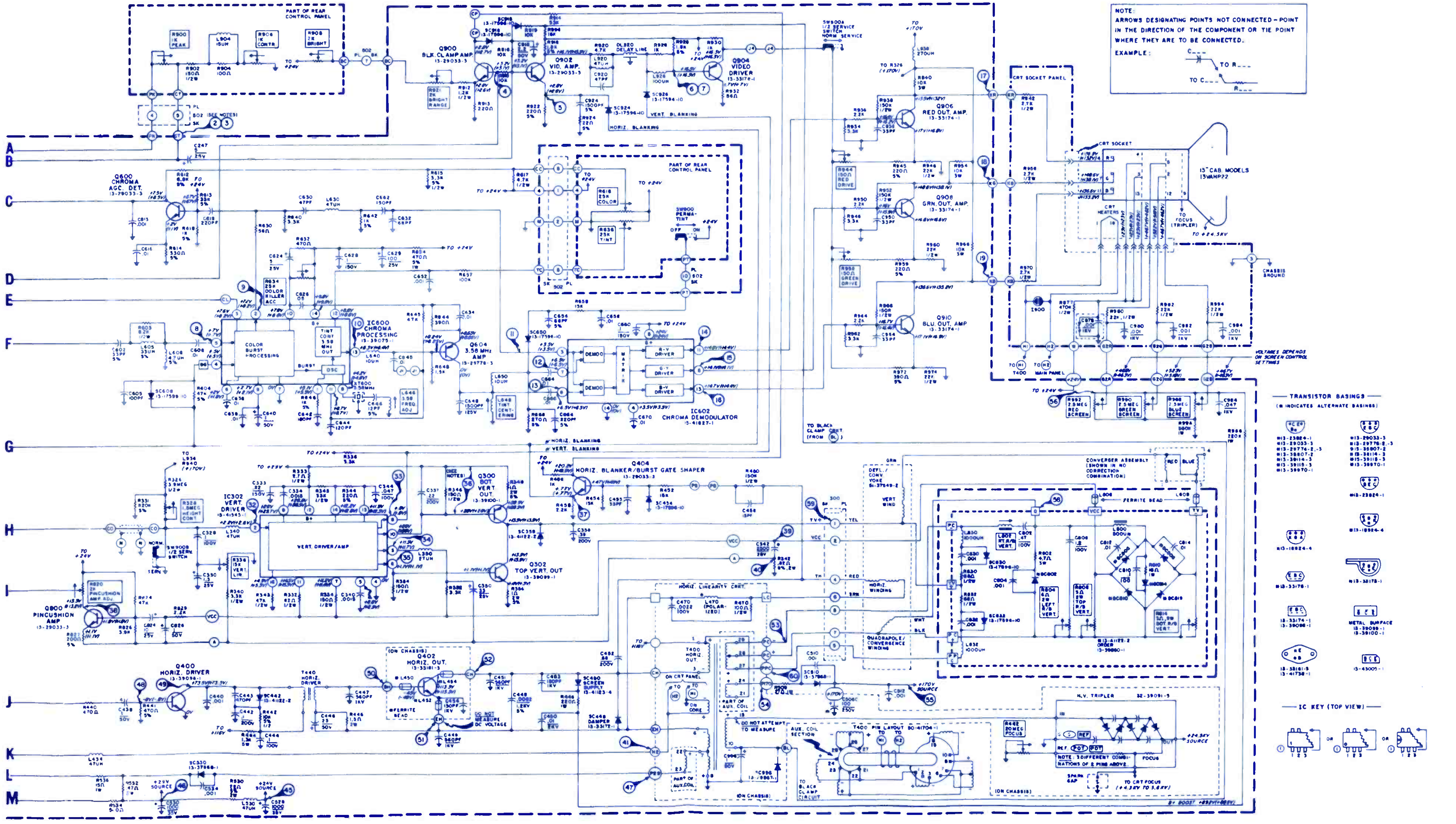
INDICATES CHROMATIC SWITCH WIRING POSITION.

INDICATES PIN NUMBER ON MODULE BOARD.

SYLVANIA
Color TV Chassis
E20-7







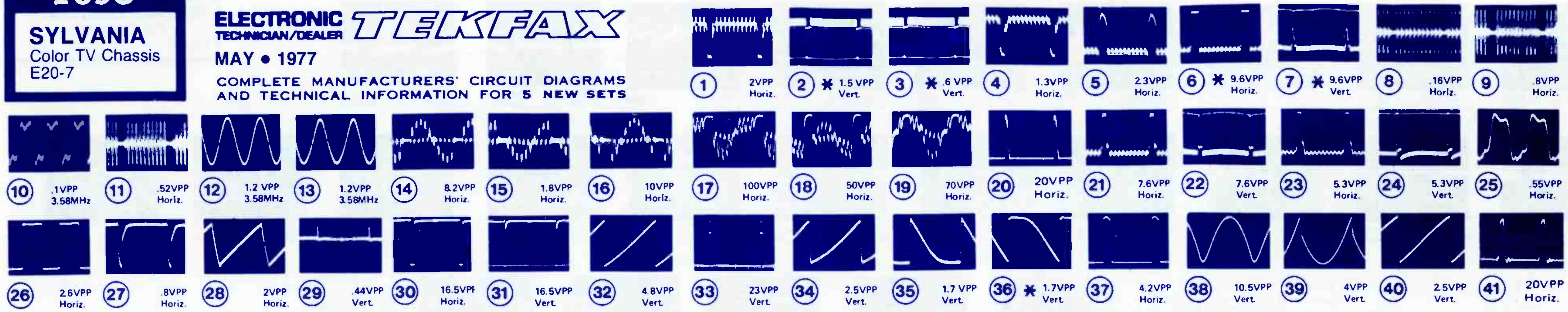
1693

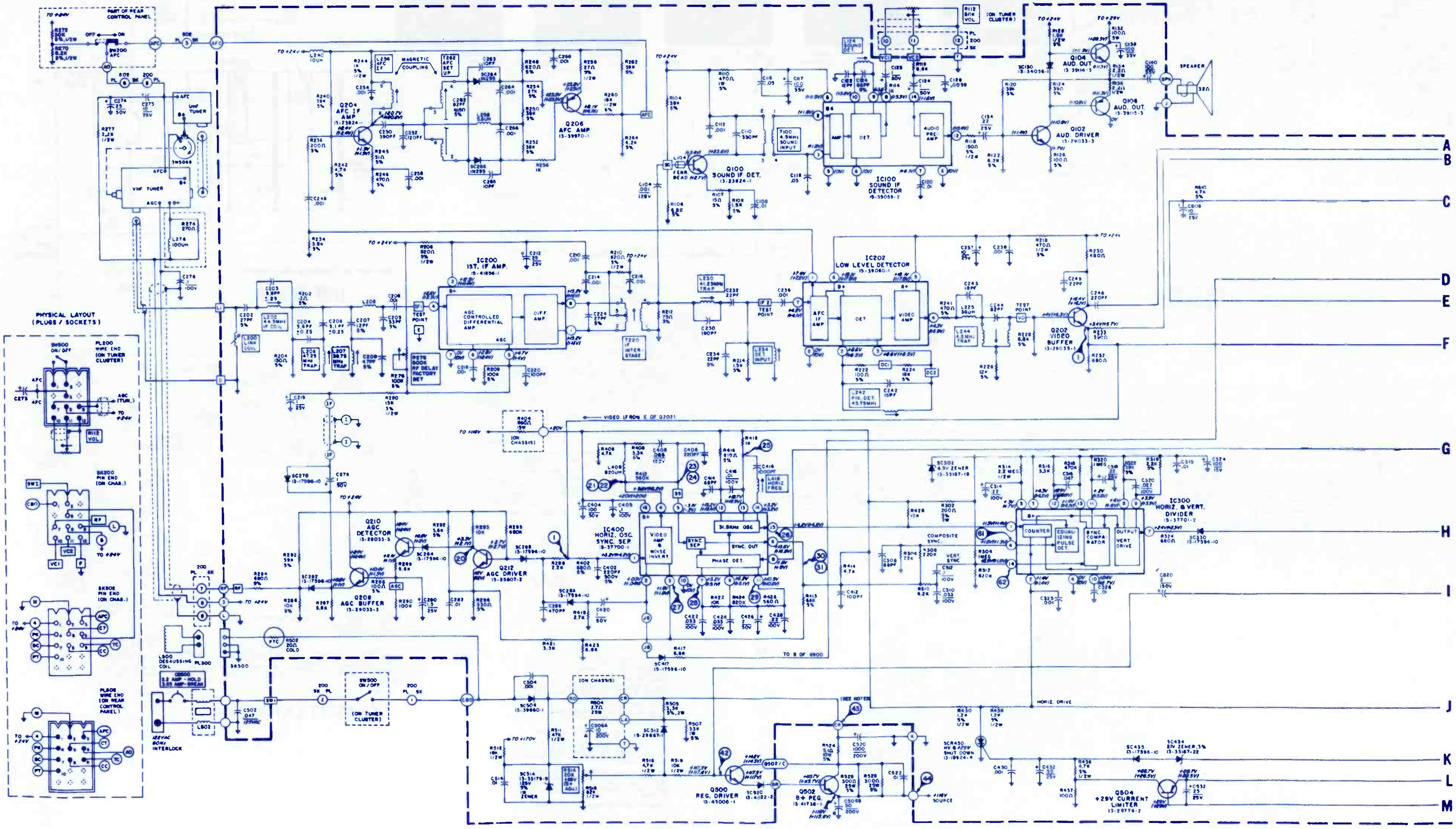
SYLVANIA
Color TV Chassis
E20-7

ELECTRONIC TECHNICIAN/DEALER TEKFAX

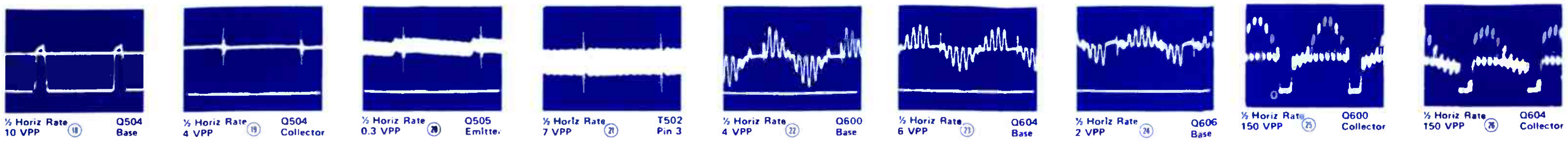
MAY • 1977

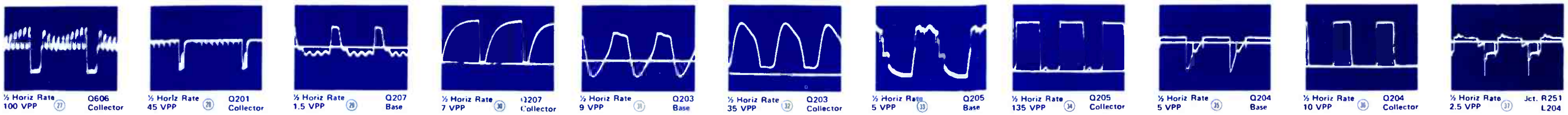
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS

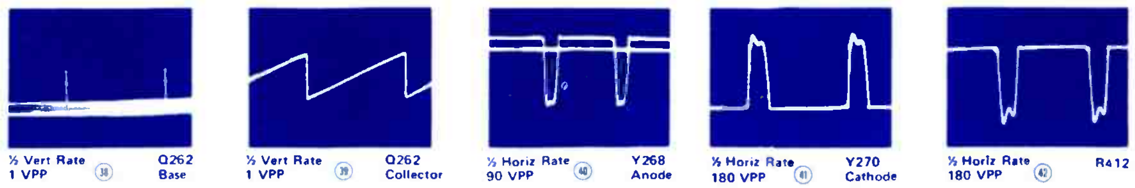


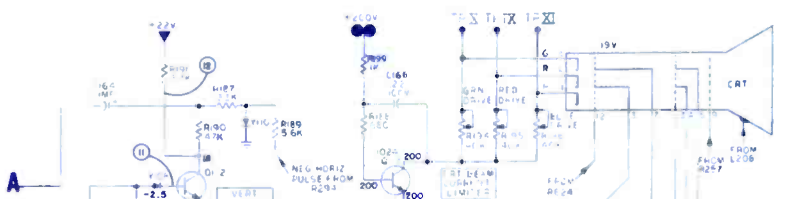


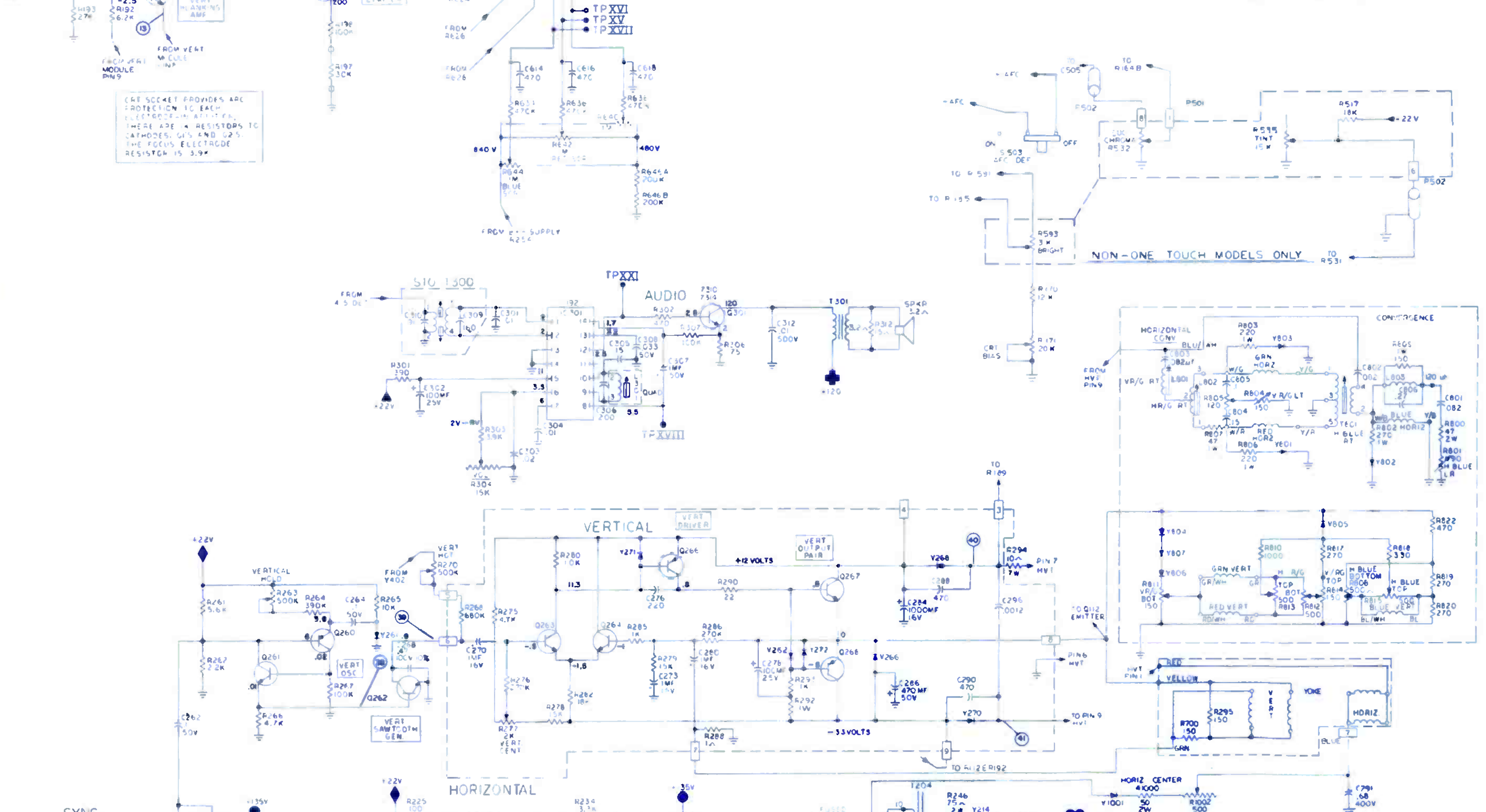
GENERAL ELECTRIC
Color TV Chassis
19QB

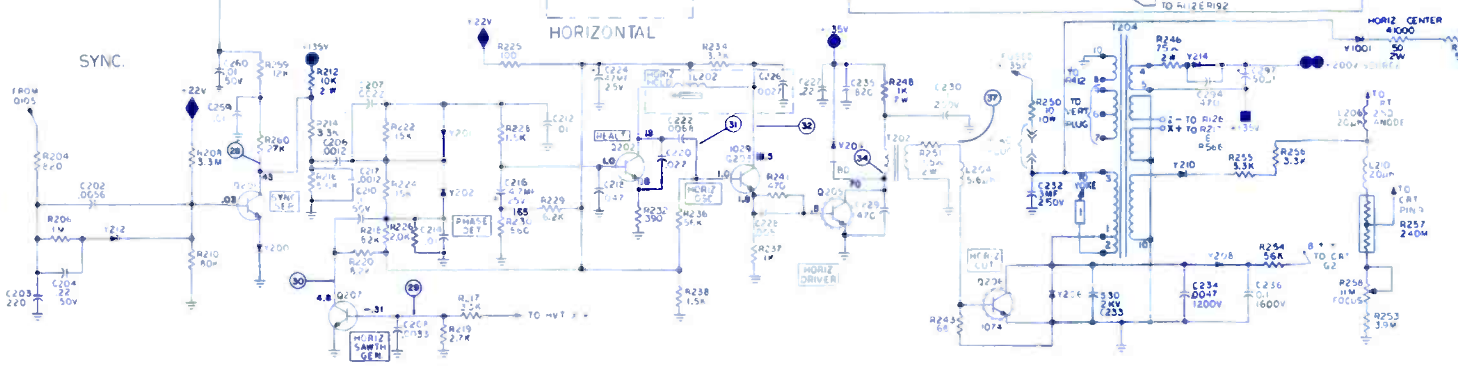












UNLESS OTHERWISE NOTED
K=1,000 M=1,000,000
CAPACITORS MORE THAN 1=uuf=pf
CAPACITORS LESS THAN 1=uf
RESISTORS ARE 1/2 WATT

VOLTAGE MEASUREMENTS MADE WITH A VTVM WITH RESPECT TO CHASSIS. RECEIVER SET FOR NORMAL OPERATION. MEASUREMENTS MAY VARY ±10% AT 120V AC LINE VOLTAGE.

WHERE ON-SIGNAL AND OFF-SIGNAL MEASUREMENTS DIFFER, ON-SIGNAL VOLTAGE APPEARS IN *ITALICS* OVER OFF-SIGNAL VOLTAGE.

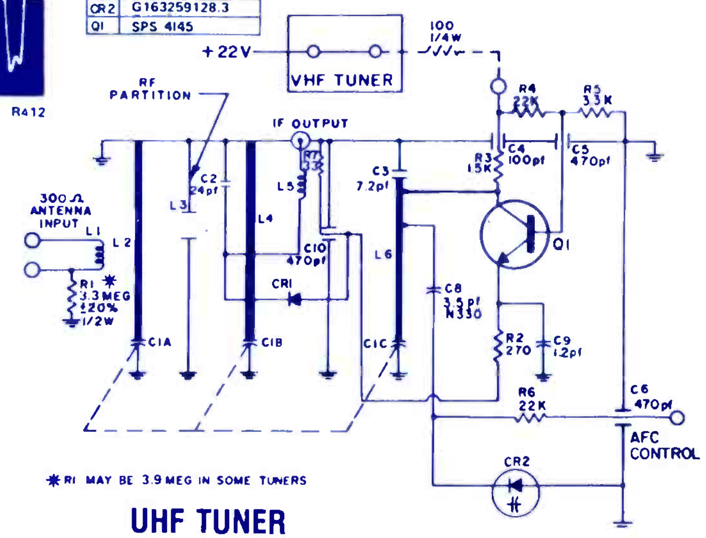
ON-SIGNAL VOLTAGES AND WAVE SHAPES TAKEN WITH A NOISE FREE SIGNAL.

VOLTAGES ON THE TERMINALS OF Q107, Q108, Q109 AND Q110 MAY VARY WITH PICTURE CONTENT AND BRIGHTNESS, CONTRAST AND BRIGHTNESS CENTERING CONTROL SETTING.

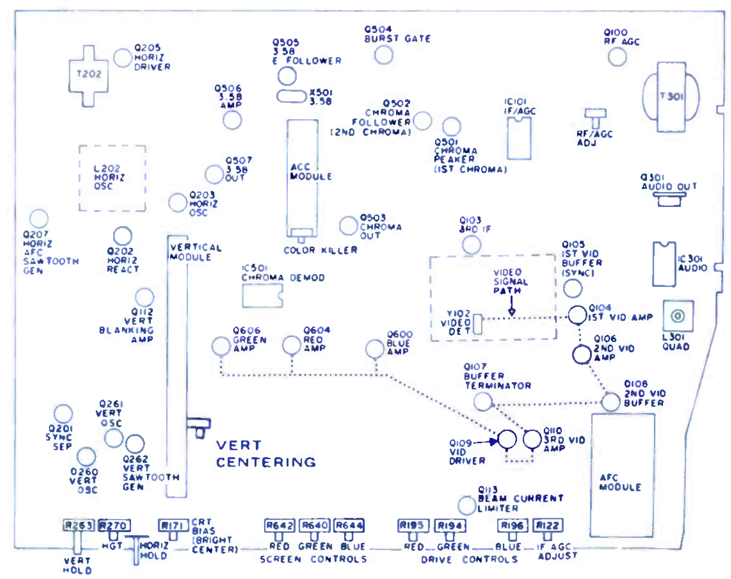
VOLTAGES ON THE TERMINALS OF Q600, Q604, Q606 AND THE CRT CONTROL GRIDS MAY VARY WITH PICTURE CONTENT AND BRIGHTNESS, CONTRAST, BRIGHTNESS CENTERING, AND COLOR CONTROL SETTINGS.

CIRCLED NUMBERS ◎ REFER TO WAVE FORMS

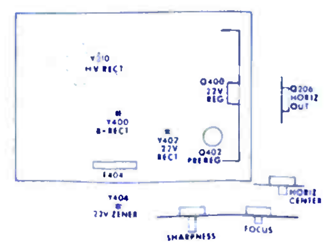
DEVICE CHART	
CR1	SDH 2HC
CR2	G163259128.3
Q1	SPS 4145



UHF TUNER



CHASSIS LAYOUT



Six important questions to ask of any DMM that claims to be designed for field service.

We give you a choice of 3½ or 4½ digits, manual or autorange.

At Fluke, we've been building DMMs for a long time. We're the leader.

And if there's one thing we've learned over the years, it's that what works for the bench doesn't always work for the field.

But a lot of companies don't understand that. They'd like you to believe their DMM is perfect for field service. Just because they've put it in a different case.

Here's how to tell the difference:

1) Is the size and shape designed for the field?

How do you carry your tools? We designed the 8030A/8040A DMMs into an ideal shape after we researched the requirements of field service work. It's sized to fit in a case. And it's rugged, to take the beating field instruments must survive.

If it doesn't fit here, it's not for field service.

2) Does it have true rms ac?

Make sure you get usable accuracy. You'll need true rms ac to eliminate errors when measuring distorted waveforms. (And if you don't understand the importance of true rms, write for our bulletin on True RMS Measurement.)

3) Does it give full performance?

Just because it's a field instrument, you shouldn't sacrifice performance. Demand five measurement functions in 26 ranges. Top specs, like our 8040A basic dc accuracy of ±0.05% or our 8030A basic dc accuracy of ±0.1%. And the specifications are guaranteed for one year. Important extras, like diode test for measurement of semiconductor junctions in-circuit, high voltage protection, and self test feature. And a complete line of accessories: various battery options, and probes for measurement of rf voltages, high current ac, high voltage dc and temperature.

4) Do you have a choice of manual or autorange?

We offer two versions: the 8030A 3½ digit and the 8040A 4½ digit with autoranging. Because we know not all field service applications are alike.

5) What is the price?

A field service DMM is a tool, and should carry a practical price. Our 3½ digit 8030A is $250.* Our 4½ digit 8040A is $440.* Check around and you'll see how practical that is.

6) Do you trust the company that builds it?

We became the leader in DMMs for one reason only. We build digital multimeters that people trust and continue to use, year after year. We've sold hundreds of thousands of DMMs.

And every bit of that experience has gone into the 8030A and 8040A DMMs.

For data out today, dial our toll-free hotline, 800-426-0361. John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043. Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Phone: (013) 673-973 Telex: 52237.

*U.S. price only.

The field service DMMs for field service people.

FLUKE®

...for more details circle 103 on Reader Service Card