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Testing Bipolar Transistors In & Out Of Circuit / Annual Subject Reference Index

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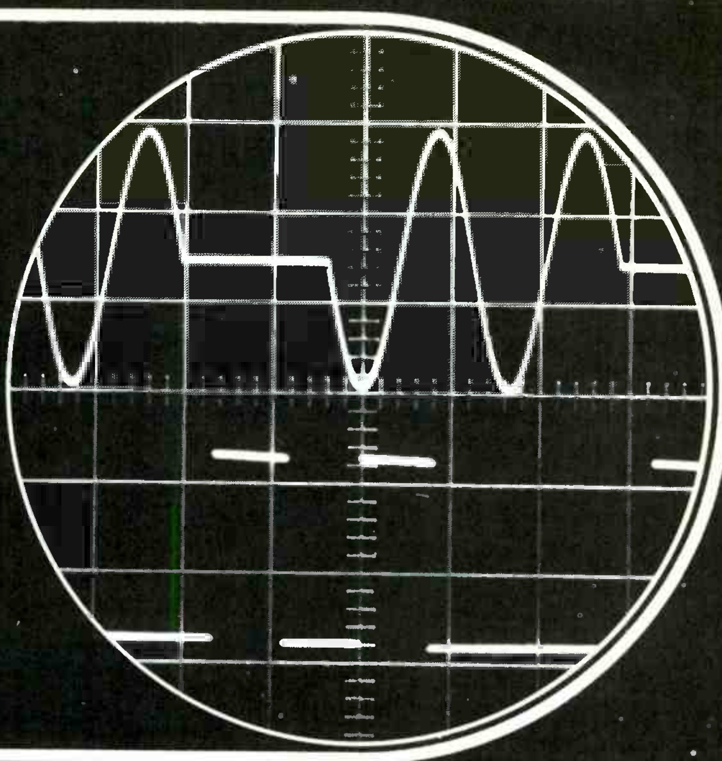

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JANUARY 1975 • VOLUME 97 NUMBER 1

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FEATURES

DEPARTMENTS

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EDITOR'S MEMO

CONTRIBUTING EDITORS

■ Beginning with this issue, two additional names—Joseph J. Carr, CET, and Bernard B. Daien, CET—appear on the masthead of ET/D.

Articles by these two knowledgeable and experienced technicians have been published in recent issues of ET/D and, because they were so well received by ET/D readers, we asked Mr. Carr and Mr. Daien to become contributing editors for ET/D. As such, they will author one article in each issue and will function in an editorial advisory capacity as well as serving as additional "eyes and ears" in their respective areas of the country for the Duluth-based editorial staff.

Joe Carr has 15 years experience as an electronic technician and, while attending college, was an active partner in an auto radio servicing business. He has authored many books and articles about electronics and electronic servicing and is a Certified Electronic Technician (CET). Mr. Carr presently is a technician in the bioelectronics laboratory of George Washington University Medical Center in Washington, D.C.

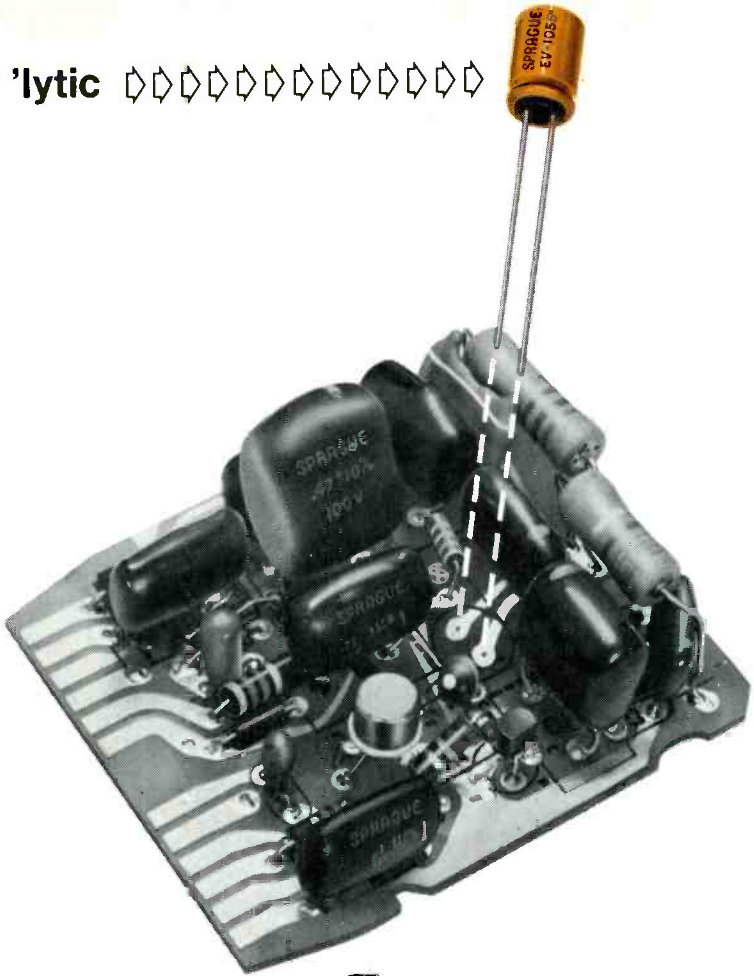
Bernard Daien has over thirty years' experience as an electronic technician, engineer, teacher and author. He is a Certified Electronic Technician and holds commercial and amateur radio licenses. Mr. Daien previously was a senior systems engineer for Motorola Semiconductor Products Division in Tempe, Arizona, and now writes about and services electronic products in Phoenix, Arizona.

A SPECIAL "THANK YOU" TO ET/D READERS

On behalf of the entire ET/D staff, I want to thank the many readers who responded to the Reader Preference Survey in the November issue. Your cooperation in making ET/D even more responsive to your needs and interests is appreciated. Again, thank you. ■

J. W. Phipps

Type EV —
the space-saver 'lytic



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See these "new era" capacitors at your Sprague distributor's. Or, get the full story by writing for Brochure M-951 to: Sprague Products Co., 65 Marshall Street, North Adams, Mass. 01247.

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NEWS OF THE INDUSTRY

Audio Product Sales Up in October But Overall Sales of Entertainment Electronic Products Sagged During First 10 Months of 1974

Although total sales to dealers of all audio categories of entertainment electronic products were up in October, sales of all entertainment electronic products except home FM radios during the first ten months of 1974 were below levels achieved during the same period in 1973, as revealed by the following statistics released by the Marketing Services Department of the Electronic Industries Association:

	FIRST 10 MONTHS		%
Television	1974	1973	CHANGE
Monochrome	4,840,057	5,524,854	−12.4
Color	6,466,745	7,306,308	−11.5
TOTAL TELEVISION	11,306,802	12,831,162	−11.9
Radio			
AM	9,782,411	13,133,771	−25.5
FM	15,714,544	14,415,804	+ 9.0
TOTAL	25,496,955	27,549,575	− 7.5
AUTOMOBILE	8,753,638	10,439,759	−16.2
TOTAL RADIO	34,250,593	37,989,334	− 9.8
Phonograph			
Portable & Table*	3,328,513	4,463,144	−25.4
Console	641,978	676,059	− 5.0
TOTAL PHONOGRAPH	3,970,491	5,139,203	−22.7

*Includes compact and component systems.

Sylvania Warranty Department at New Address

The Labor Warranty Department of GTE Sylvania has been moved to 700 Ellicott St., Batavia, N.Y. 14020. All warranty labor claims and questions about warranty labor should be sent to this new address.

New York Fair Trade Law Upheld

The New York Supreme Court, in a fair trade case involving Matsushita Electric Corporation of America (Panasonic) and three stores of the JGE retail chain, has ruled that the Fair Trade Laws of New York State are not unconstitutional.

The Court has issued injunctions against the three JGE stores, restraining them from price cutting activities which the Court felt were jeopardizing the effectiveness of Matsushita's Fair Trade program in New York state.

1975 Consumer Electronics Show in Chicago June 1-4

The ninth annual Summer Consumer Electronics Show, sponsored and produced by the Consumer Electronics Group of the Electronic Industries Association, will be held June 1-4 at McCormick Place in Chicago.

Over 400 manufacturers and marketers of consumer electronic products will exhibit their new 1976 lines at the trade show, which is open to retailers, distributors, sales representatives and manufacturers. Retail-oriented audio, video and calculator conferences will be held during the show.

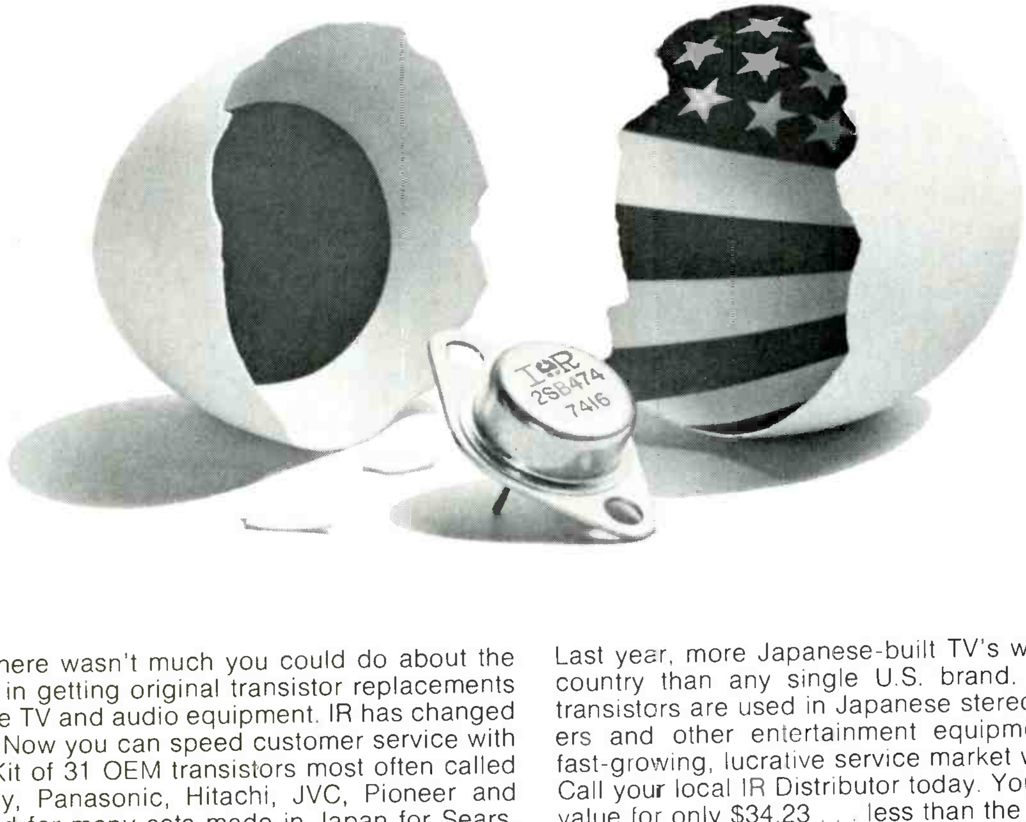
OSHA Recordkeeping Forms Revised

Beginning this month, employers who have eight or more employees are required to record occupationally related injuries and illnesses on a revised form which categorizes lost work days into two types: "days away from work" and "days of restricted work activity."

"Days away from work" are defined by the U.S. Department of Labor as any days on which an employee would have worked but could not because of occupational injury or illness.

"Days of restricted work activity" are defined by the Labor Department as days during which an employee was assigned to another job on a temporary basis, or worked at his regular job less than full time, or worked at his regular job but could not perform all duties normally connected with it because of occupational injury or illness. ■

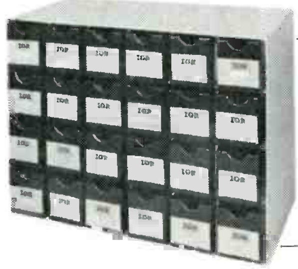
How to crack the Japanese original equipment transistor problem.



Until now, there wasn't much you could do about the long delays in getting original transistor replacements for Japanese TV and audio equipment. IR has changed the picture. Now you can speed customer service with IR's DK22 Kit of 31 OEM transistors most often called out by Sony, Panasonic, Hitachi, JVC, Pioneer and Toshiba, and for many sets made in Japan for Sears, Penney's, Montgomery Ward and others.

These are not "Universal Replacements." They are exactly the same parts used in original equipment. They're made in Japan, but are now as close to you as your local IR Distributor. Each DK22 Kit contains one each of the 31 types listed in the box at right to put exact replacements right at your fingertips.

Last year, more Japanese-built TV's were sold in this country than any single U.S. brand. And the same transistors are used in Japanese stereos, tape recorders and other entertainment equipment. Crack this fast-growing, lucrative service market with a DK22 Kit. Call your local IR Distributor today. You'll get a $42.78 value for only $34.23 . . . less than the price you'd pay Japanese factory distributors.



DK22 Kit Japanese Transistors:

2SA495	2SC281B	2SC535B	2SC710
2SA564A	2SC372	2SC536	2SC717
2SB186	2SC373	2SC537B	2SC772
2SB187	2SC380AO	2SC538A	2SC828A
2SB367A	2SC403A	2SC633A	2SC829B
2SB405	2SC454B	2SC634A	2SC838
2SB474	2SC458B	2SC644	2SC945
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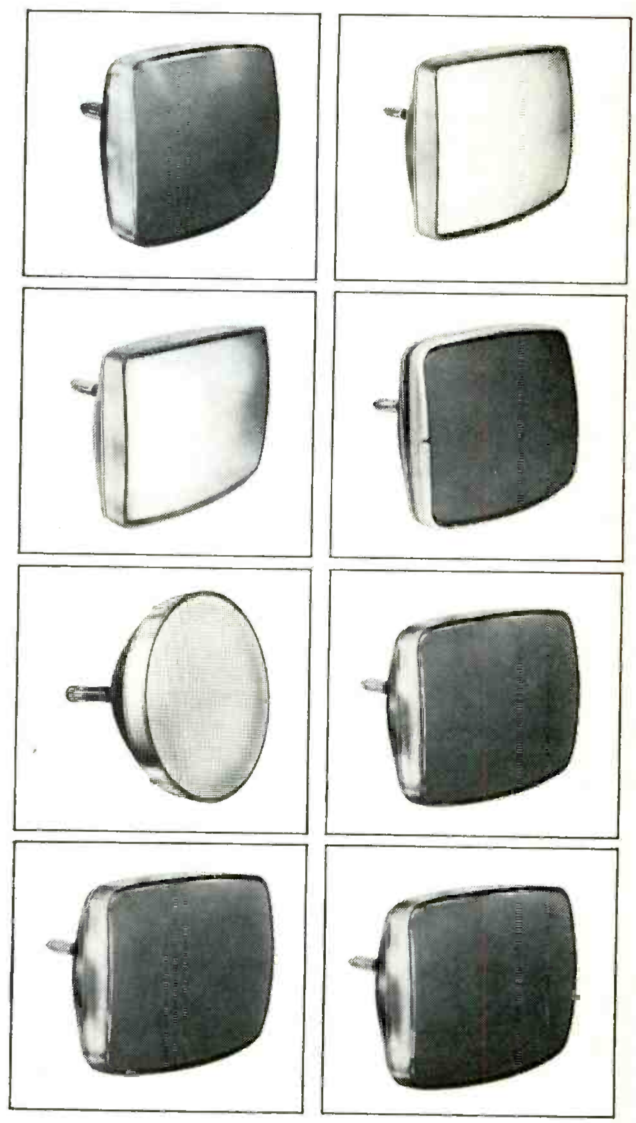
That's the kind of socket coverage you can count on from this popular new "middle line" of RCA replacement color picture tubes. With just eight Colorama A types, you can cover almost all of the replacement market with "Grade A" performance at a price your customers can afford.

Every tube in the RCA Colorama A line is totally remanufactured. That's why they all can carry RCA's 18-month inboarded warranty plus the option for an additional 12 months. Each has a completely new gun and a completely new screen made of the latest all-new rare-earth phosphors. In addition, every "V" type is made of advanced x-ray glass.

The RCA Colorama A line includes three Matrix types: CA-21VAKP22, CA-23VALP22 and CA-25VABP22. These advanced RCA Matrix tubes are as much as 100 percent brighter than any equivalent non-Matrix picture tube in RCA history.

So why not give your customers the "Grade A" choice. Choose Colorama A at your RCA Distributor today.

Remember, RCA is the world-wide leader in picture tubes, with over 65 million produced to date.



RCA

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ELECTRONIC ASSOCIATION DIGEST

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

ETG of Rhode Island Elects New Officers

The Electronic Technicians Guild of Rhode Island, meeting in Pawtucket on Nov. 6, elected the following new officers, whose terms of office begin this month: Paul F. Kelley, Warwick, president; Donn C. DiBiasio, Providence, vice president; William Botelho, Warwick, secretary; Norman L. Lemieux, Attleboro, Mass., treasurer; and Thomas J. Plant, Jr., Pawtucket, corresponding secretary.

Pennsylvania ISCET Chapter Receives Charter, Elects Officers

The Pennsylvania Chapter of the International Society of Certified Electronics Technicians (ISCET) recently received its charter at a luncheon meeting in the Hilton Inn in Scranton.

Russell Scarpelli, owner of Scarpelli Electronics Service, Blakely, chairman of the new chapter, was presented the charter by John Risse of International Correspondence Schools, who represented Dick Glass, ISCET executive vice president. Other officers of the newly organized state chapter are: James Ibaugh, RCA, Lancaster, vice chairman; Ronald Lettieri, Tobyhanna Army Depot, Dunmore, secretary; and Hank Govan, Weston Instruments, Olyphant, treasurer.

FESA Chapter Sponsors Consumer "Hot line"

The Dade County Chapter of the Florida Electronics Service Association (FESA) has installed a consumer "hot line" telephone in the office of the chapter's recording secretary, John W. Dole, Dole TV & Radio, Miami.

The "hot line," which is connected to a telephone answering machine, was installed when the chapter reportedly found that the local Better Business Bureau was taking up to two months to handle consumer complaints. The "hot line" telephone number is listed in the Yellow Pages and has been publicized by local newspapers and radio and TV stations.

ESETRA Formed to Cope with Warranty-Related Problems

Elected officials of the National Appliance and Radio-Electronics Dealers Association (NARDA Inc.), the National Alliance of Television and Electronic Service Associations (NATESA), and the National Electronic Service Dealers Association (NESDA) recently met in Louisville, Kentucky to form a special "blue-ribbon" committee which will attempt to come up with solutions to warranty-related problems.

Nolan Boone, president of the Television Service Association of Arkansas, was appointed coordinating chairman of the special national committee, which has been given the name "Eastern States Electronics Technicians Regional Alliance" (ESETRA).

In addition to the chairman, the committee consists of two elected officials from each of the three national associations (NARDA, NATESA and NESDA).

Included among the warranty-related problems the committee will study are labor rates, parts availability, slow payment by manufacturers, and the additional costs of in-warranty servicing. ■

TECHNICAL LITERATURE

Alarm/Security Cable

A revised 12-page expanded catalog of electronic wire and cable for alarm/security applications has been published. The catalog simplifies selection of wire and cable by installers, specifications and systems engineers, systems contractors, and maintenance personnel concerned with surveillance, detection, alarm, and communications equipment. More than 100 individual wire, cable, and cord designs are included in the catalog. Catalogued for the first time are 42 vinyl-insulated multiple-conductor control and audio cables (not paired), seven single-conductor hook-up wire designs, and three portable cord constructions. **Belden Corp.**, Advertising Dept., 2000 S. Batavia Ave., Geneva, IL. 60134.

Semiconductors and Accessories

A 148-page SK-Series Top of the Line Replacement Guide, No. SPG-202P, is now available. The guide lists 87,000 SK-Series solid-state replacements which include transistors, rectifiers, thyristors and integrated circuits. The guide is a comprehensive and accurate source of solid-state replacement information. The 87,000 semiconductor devices are cross-referenced to the SK-Series replacement semiconductors. The Replacement Program is composed of devices for uses as replacements in entertainment and industrial type equipment. Price $.90. **RCA/Distributor Products Marketing,** Route 202, Somerville, NJ. 08876.

Radio/TV Repair Course

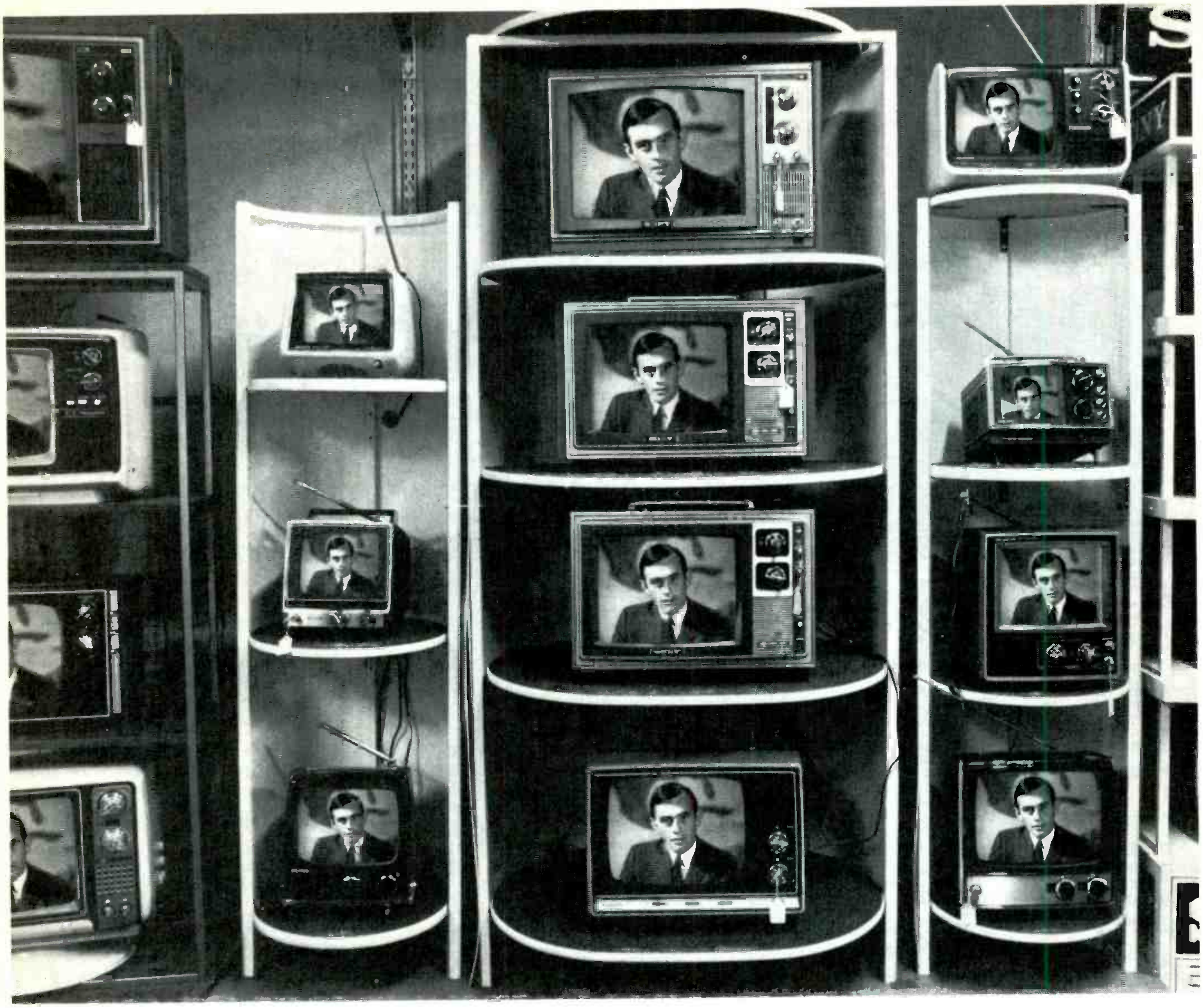
A 6-page pamphlet describing its radio and TV service and repair course is now available. It briefly discusses course topics and career opportunities for individuals interested in working directly in radio and TV service and repair as well as in related fields. Advance Schools, Inc., is a national home-study school accredited by the accrediting Commission of the National Home Study Council. **ASI Marketing Communications,** Dept. TV, 5900 Northwest Highway, Chicago, IL. 60631.

Professional Tools and Safety Equipment

An 80-page catalog of specialized professional hand tools and safety equipment is now available. The catalog is organized for easy reference and fully indexed—both alphabetically and by product number. Tools and safety equipment are illustrated with large photographs and drawings. Many illustrations utilize a second or third color for added clarity of special features. Concise product descriptions, specifications, and catalog numbers make selection simple. **Mathias Klein & Sons, Inc.,** 7200 McCormick Road, Chicago, IL. 60645.

Solid-State Product Guide

A 40-page Solid-State Product Guide No. SPG-201K is now available. This booklet contains abbreviated data for the commercial solid-state products available from the RCA Solid State Division. Data is given for Integrated Circuits (Linear and Digital) and discrete devices (power transistors, RF transistors, MOS transistors, triacs, silicon controlled-rectifiers, diacs, and rectifiers. Complete data on individual devices can be obtained by reference to the technical bulletins listed by file number or to the RCA Solid-State DATABOOK Series (SSD-2001); the publications are available from **RCA Solid State Division,** Box 3200, Somerville, NJ. 08876. ■



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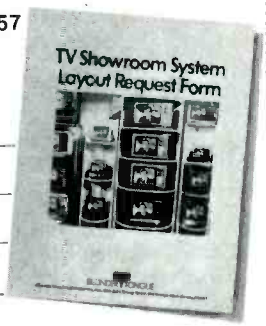

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Testing Bipolar Transistors In and Out of Circuit

By Bernard B. Daien, ET/D Contributing Editor

Tips about the simple resistance and voltage measurements you probably are using to uncover most defective transistors

■ A vacuum tube "wears out" over a period of time because the coating on its cathode becomes "depleted," reducing the number of electrons emitted from the cathode to the plate.

Transistors do not "wear out." If a transistor is normal when it is installed in a circuit, it usually will continue to perform within its design limits until some circuit defect or abnormal operating condition causes excessive voltage across or excessive current through one or more of its three junctions (emitter-base, base-collector or emitter-collector). The excessive voltage and/or excessive current will cause either 1) catastrophic failure of the junction (it becomes open or shorted) or 2) the transistor will develop excessive leakage or noise.

Most transistor failures are "complete" shorts or opens, either base to emitter, base to collector, or emitter to collector. (The emitter-to-collector short can exist even though the emitter-to-base and collector-to-base junctions test normal for both forward and reverse conduction. So never omit testing for shorts between collector and emitter, even if you have made the other tests.)

The incidence of leakage in most modern transistors is not as prevalent as it was in germanium devices made several years ago. Unfortunately, you may run across an older receiver which uses the early germanium transistors, or you may have some old stock on hand. It is good practice to discard any transistors bought prior to 1965, or, at least, put them into your "private" collection or use them for "home brew" projects. It isn't worth risking a callback for a device that can be bought today for a dollar or so.

An unusually noisy transistor should also be replaced, because there is a direct connection between noisy transistors and premature failures.

If a circuit failure subjects the transistor to a substantial overload, it is a good practice to replace the transistor, because gain, leakage, and junction voltage drops might be adversely affected.

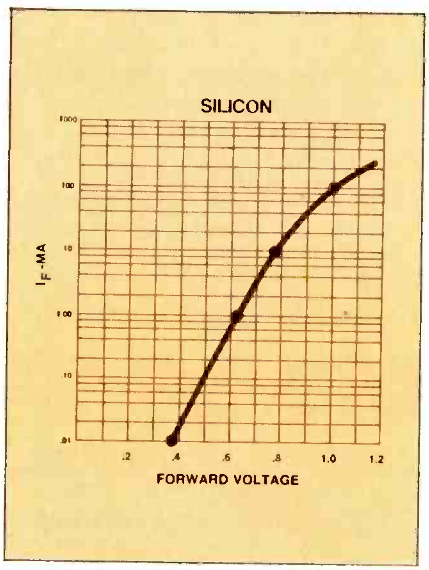

Fig. 1—Forward voltage—forward current curve of a typical silicon bipolar transistor.

OUT-OF-CIRCUIT TESTS

Although it is recommended that the *voltages* across the junctions of the transistor be measured before the transistor is removed from the circuit for ohmmeter tests, in this article ohmmeter tests will be discussed first because a thorough understanding of the junction characteristics involved in ohmmeter tests make it easier to understand and interpret the causes of abnormal voltages across the transistor junctions.

First, let us look at the forward voltage drop across a basic silicon junction with various levels of current through it. Fig. 1 shows that different levels of current cause different voltage drops. At 0.01 ma we read about 0.38 volts. At 1ma, 0.62 volts. At 10ma, 0.78 volts. At 100ma, 1.0 volts. Note that although the current through the junction has been increased by a factor of 10,000 (from .01ma to 100ma) the voltage drop across the junction has increased by a factor of only less than 3. This reveals that the resistance (E/I) of the junction is nonlinear; that is, an increase of current through the junction does not produce a *proportional* increase in the voltage drop across it.

The junctions of germanium transistors also exhibit nonlinear resistance characteristics, as revealed by the forward voltage-forward current curve in Fig. 2.

The nonlinear resistance charac-

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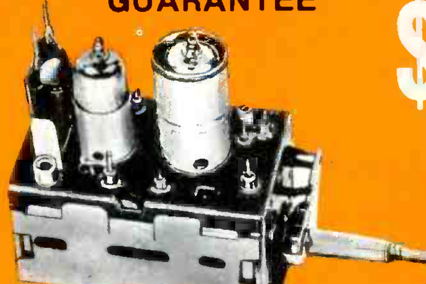

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- Fast, efficient service at our conveniently located Service Centers.
- All tuners are ultrasonically cleaned, repaired, realigned, and air tested.

REPLACE

UNIVERSAL REPLACEMENT TUNER $12.95 (Canada $15.95)

- This price buys you a complete new tuner built specifically by Sarkes Tarzian Inc. for this purpose.
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- Specify heater type parallel and series 450 mA. or 600 mA.

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	BURLINGAME, CALIF. 94010	1324 Marsten Road	Tel. 415-347-5728
	MODESTO, CALIF. 95351	123 Phoenix Avenue	Tel. 209-521-8051
FLORIDA	TAMPA, FLORIDA 33606	1505 Cypress Street	Tel. 813-253-0324
	HIALEAH, FLORIDA 33013	906 East 25th Street	Tel. 305-836-7078
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ILLINOIS	CHAMPAIGN, ILLINOIS 61820	405 East University Street	Tel. 217-356-6400
	CHICAGO, ILLINOIS 60621	737 West 55th Street	Tel. 312-873-5556-7
	SKOKIE, ILLINOIS 60076	5110 West Brown Street	Tel. 312-675-0230
INDIANA	HAMMOND, INDIANA 46323	6833 Grand Avenue	Tel. 219-845-2676
	INDIANAPOLIS, INDIANA 46204	112 West St. Clair Street	Tel. 317-632-3493
KENTUCKY	LOUISVILLE, KENTUCKY 40208	2920 Taylor Boulevard	Tel. 502-634-3334
LOUISIANA	SHREVEPORT, LOUISIANA 71104	3025 Highland Avenue	Tel. 318-861-7745
MARYLAND	BALTIMORE, MARYLAND 21215	5505 Reisterstown Rd., Box 2624	Tel. 301-358-1186
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teristic of transistor junctions and the fact that each range of an ohmmeter applies a different value of current to the junction are the reasons that the amount of resistance measured across a transistor junction depends on which ohmmeter range is used. This is illustrated in Tables 1, 2 and 3, which list the resistances of forward and reverse biased junctions of typical germanium and silicon power transistors. (The resistances were measured with a Simpson Model 260 VOM, which has 20,000 ohms/volt input resistance, a 50 microamp meter, and produces about 50ma of current through the junction in the RX1 range, about .50ma in the RX100 range and 50 microamps in the RX10,000 range.)

Note that in Table 1 the base-to-emitter and base-to-collector forward resistances are the same. Also note in Table 1 that, because of the inherently higher leakage of germanium transistors, the RX1 and RX10K ranges produced completely misleading readings for the germanium junctions (RX10K range falsely indicates shorted junctions) and less than conclusive readings for the silicon junctions. On the other hand, the RX100 range provides relatively accurate readings which would clearly reveal a shorted or open junction.

Note in Table 2, which lists the reverse bias resistances for the same junctions, that the RX100 range again produces conclusive readings which would clearly disclose open or shorted conditions, while the RX1

TABLE 1

FORWARD BIASED JUNCTION RESISTANCES

METER	GERMANIUM		SILICON	
RANGE	B-E	B-C	B-E	B-C
RX1	4 ohms	4 ohms	9 ohms	9 ohms
RX100	100 ohms	100 ohms	550 ohms	550 ohms
RX10K	0 ohms	0 ohms	7000 ohms	7000 ohms

TABLE 2

REVERSE BIASED JUNCTION RESISTANCES

METER	GERMANIUM		SILICON	
RANGE	B-E	B-C	B-E	B-C
RX1	Inf.	Inf.	Inf.	Inf.
RX100	50K ohms	50K ohms	Inf.	Inf.
RX10K	150K ohms	150K ohms	1.5 meg ohms	Inf.

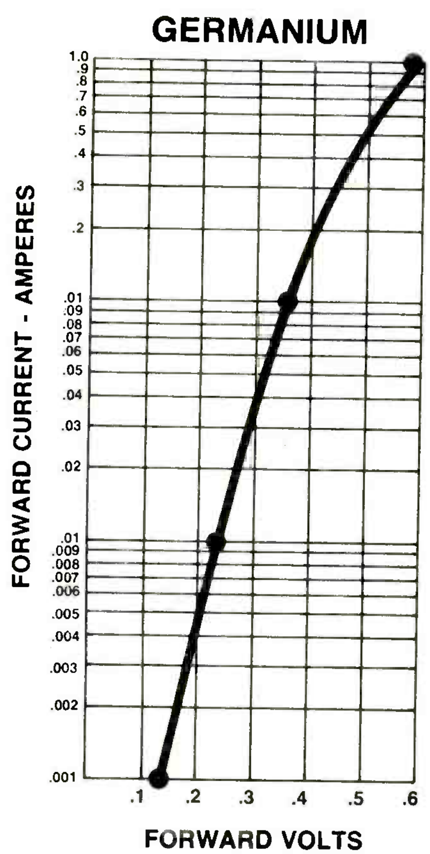

Fig. 2—Forward voltage—forward current curve of a typical germanium bipolar transistor.

TABLE 3

EMITTER-COLLECTOR JUNCTION RESISTANCES (REVERSE BIAS ON COLLECTOR)

METER RANGE	GERMANIUM E-C	SILICON E-C
RX1	400 ohms	Inf.
RX100	50 ohms	Inf.
RX10K	0 ohms	Inf.

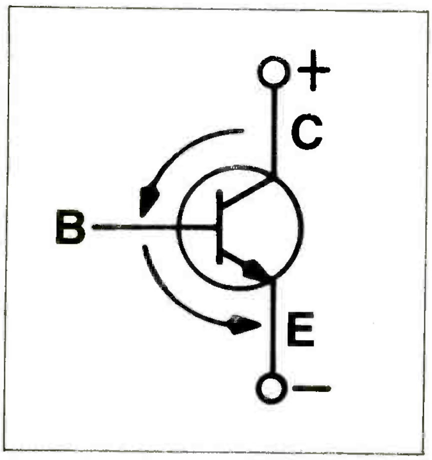

Fig. 3—The leakage current indicated by the arrows is the reason that germanium power transistors inherently have low reverse-bias emitter-to-collector resistance.

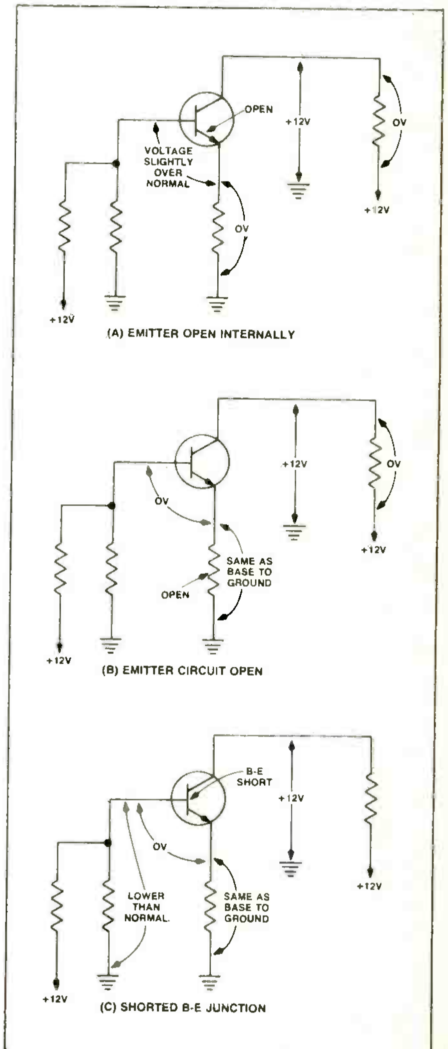

Fig. 4—Typical emitter-related defects and associated voltage symptoms in a common-emitter circuit.

and RX10K ranges again produce inconclusive or misleading readings.

Table 3 lists the emitter-to-collector resistances of the same transistors, with the collector reverse biased just as it would be during normal in-circuit operation. Note that the inherently higher leakage of the germanium transistor produced a completely misleading reading on the RX10K range, but, again, the RX100 range produced a conclusive reading which would reveal a short or open condition, if either existed.

To understand why germanium power transistors have such low emitter-to-collector resistance when reverse biased, refer to Fig. 3. Note that any leakage across the base-to-collector junction has nowhere to go if the base is open (or if there is a very high resistance between base and emitter). The leakage therefore crosses the forward-biased emitter-to-base junction in order to complete the circuit. Any current flowing through the emitter-to-base junction is amplified by the transistor, and a larger current then flows between emitter and collector. Thus, when the base is open, the collector junction leakage is amplified by the current gain of the transistor and the emitter-to-collector path becomes a low resistance.

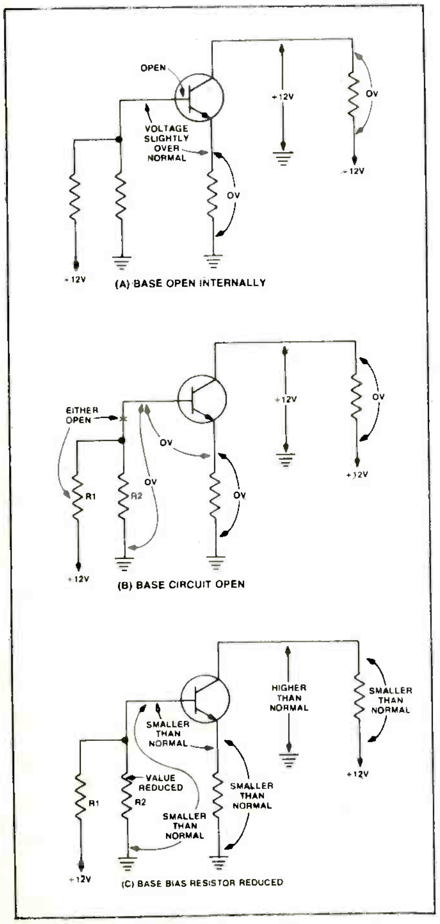

Fig. 5—Typical base-related defects and associated voltage symptoms in a common-emitter circuit.

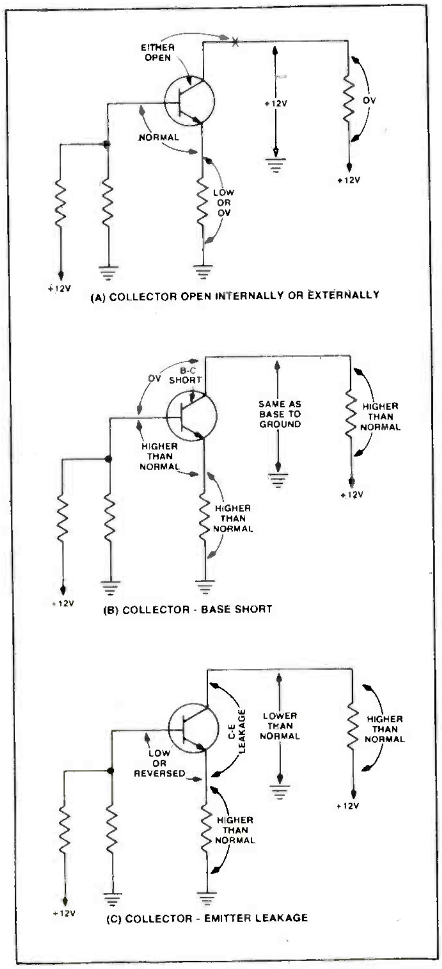

Fig. 6—Typical collector-related defects and associated voltage symptoms in a common-emitter circuit.

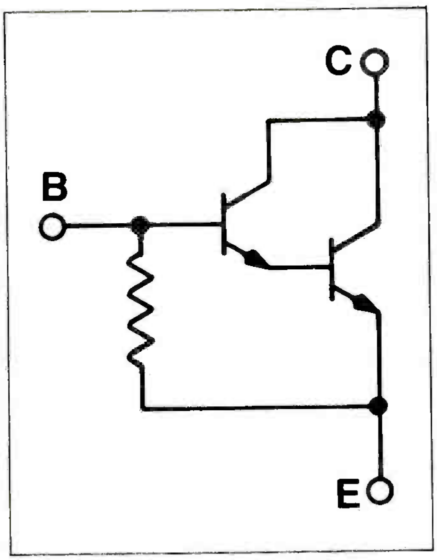

Fig. 7—Internal circuitry of a Darlington transistor.

Even modern germanium transistors have higher leakage than silicon transistors, and power transistors have higher leakages than small-signal transistors. Therefore, the leakage of a germanium power transistor can be considerable. If you stick with the RX10 or RX100 ranges (whichever your meter has) you will avoid most of the leakage problems.

Semiconductors are temperature sensitive devices. Leakage doubles for every 10-degree C temperature rise. Therefore, transistors operating in circuit will have greater leakage than that measured "cold" out of circuit. Typically the junction temperature for germanium transistors may go as high as 70 degrees or more, representing an increase in "hot" leakage current of about 15 times over "cold" junction leakage.

To make matters worse, the emitter-to-base junction has a negative temperature coefficient (as the temperature increases the required forward bias decreases). Thus, for a given bias, collector current tends to increase as the temperature increases. The combination of these two effects causes significantly higher currents to flow in a leaky transistor as it heats up. If you find a transistor that appears to have more leakage than similar devices, and you are doubtful about it (remember, it's going to get worse as it heats up in the set), replace it and save yourself a callback. This applies particularly to germanium devices used in auto radios, some portable radios and in older sets. Modern silicon transistors tend not to leak. They are either normal or open or shorted, and not much else.

Another reason for using only the RX10 or RX100 range of your VOM is that the RX1 range of many VOM's applies 100ma or more of current to a junction under test. This level of current is sufficient to damage the base-to-emitter junction of some low-power transistors and the junction of signal diodes.

If you are not already thoroughly familiar with the junction resistance readings produced by your VOM, use it to make readings of the forward- and reverse-biased junction resistances of known-good germani-

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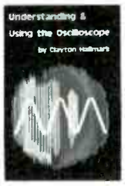

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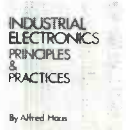

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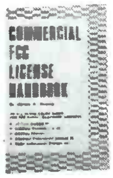

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um and silicon transistors and list them on a small chart pasted to the side of your VOM.

Two other notes of caution: 1) Check the voltage between the test leads of your ohmmeter. Some ohmmeters have 6 or more volts between their test leads in the high-ohms ranges. This amount of voltage can damage some "delicate" transistor junctions. 2) Check the polarity of your ohmmeter test leads. Some multimeters are designed so that the polarity of their input is reversed in the ohms function; the positive test lead becomes negative and the negative becomes positive.

IN-CIRCUIT TESTS

As stated previously, the very first step in testing semiconductors should be in-circuit voltage checks. When this is not possible, as in the case of power supply short circuits, or when the collector voltage is a high voltage at a high frequency (flyback circuits, etc.), ohmmeter checks should be made first.

In a normally operating circuit, there should be approximately 0.6 volts across the emitter-to-base junction of a silicon transistor and about 0.2 volts if the transistor is a germanium type. If this voltage is incorrect, do not assume that the transistor is defective until you have checked the various supply voltages. Often a voltage regulator or rectifier failure or a short elsewhere on the same supply line drastically alters supply voltages. For this reason, it is a good practice to always check supply voltages first.

Figs. 4, 5 and 6 illustrate the voltage conditions which will be present as a result of various defects in a common-emitter circuit equipped with an NPN transistor. (The same circuit equipped with a PNP transistor would display the same symptoms.) The common-emitter circuit was chosen as an example because it is used more often than the other two basic configurations. Although a few of the defects in Figs. 4, 5 and 6 will cause different voltage symptoms in common-base and common-collector circuits or if different bias and stabilizing networks are used, the causes and symptoms in Figs. 4, 5 and 6 can be "transposed" to these circuit configurations by using the following general diagnostic guidelines:

- If the base-to-emitter junction does *not* have the correct forward-bias (about .2 volts for germanium and .6 volts for silicon) and there is *no* evidence of current flow in the collector-to-emitter circuit (lack of voltage drop across resistors in *series* with the collector-to-emitter circuit and the supply source), check for defects in the base and emitter circuits.
- If the base-to-emitter junction *is* correctly forward biased but there is *no* evidence of current flow in the collector-emitter circuit, check for an *open* in the collector circuit.
- If the base-to-emitter junction does *not* have correct forward bias and there *is* evidence of current flow in the collector-to-emitter circuit, check for a *short* or *leakage* in the collector-to-emitter circuit.

The preceding guidelines presume that supply voltages have been checked and are normal.

Some technicians short the base-to-emitter leads and look for a reduction in the collector current as an indication of a good device. There are some pitfalls in this method, not the least of which is the possibility of destroying the transistor if you short the wrong leads, and the ever present hazard of your hand slipping and shorting to adjacent circuits. For such tests, I prefer to use an insulated mini-clip with extendable hooks which can be clipped right onto the transistor leads with little danger of shorting, even in tight spots.

Occasionally, you will run across a circuit in which the *bias* is incorrect but everything else in the set is normal with the transistor removed, and the transistor itself checks normal out of the set. In such cases, look for oscillation. An oscillating IF stage is common when someone has "tweaked" an alignment adjustment. Sometimes, other stages will oscillate at any frequency from audio to UHF if a bypass capacitor in a decoupling circuit opens. Use your scope and low capacitance probe to quickly spot such oscillations.

In many sets, several transistors are DC coupled in "chains." If one transistor is defective or the bias of a stage at the front of the chain is incorrect, the entire chain will display abnormal voltages. In such cases, you can save time by removing the transistors one at a time, for individual testing. If you find a defective one do not stop. Continue testing until you have examined the entire chain. Such circuits often have more than one defective transistor, because one failure triggers more.

Some modern circuits use *Darlington* transistors, which are really two cascaded transistors in one package, as shown in Fig. 7. Because they have three terminals, as any other transistor, it is rather mystifying to find about 1.3 volts between base and emitter. In Fig. 7 you will see that there are two emitter-to-base junctions in series between the base terminal and emitter terminal, which accounts for the base-to-emitter voltage being *twice* that of the usual bipolar device.

A shorted power transistor in an audio output stage will cause blown fuses. An open device might not be so obvious because one half of a push-pull, transformer-coupled stage will still operate, although the audio will be distorted. OTL (output transformerless) complementary symmetry stages, on the other hand, do not function at all with one transistor defective.

Defective IF or RF stages might not completely eliminate a *strong local* signal, just as in vacuum tube-equipped circuits. There is enough capacitive feedthrough in a "dead" transistor to produce a degraded, snowy picture or, in the case of AM or FM radios, a weakened or noisy signal.

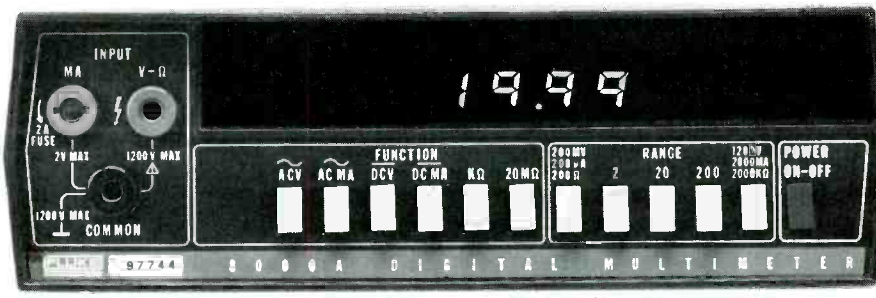
In resistance-coupled stages, certain defects will cause the base and collector voltages to shift significantly either above or below normal. However, in transformer-coupled RF, IF or AF stages there might not be sufficient load resistance to cause a noticeable DC voltage drop. In such cases, the voltage drop across the emitter resistor can be used as a quick and convenient means for calculating the transistor collector-to-emitter current. ■

Your VTVM is obsolete!

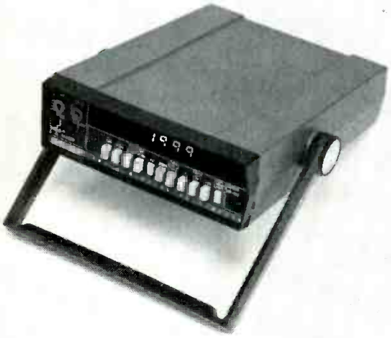
This may sound like a harsh claim, but it's true. Thousands of TV technicians are using instruments designed in the 1950's to trouble-shoot circuits designed in the 1970's.

And now, most color TV's have solid state circuits. So use of out-of-date test equipment just compounds the problem.

The generation gap has grown too big.



Resolution is 100 microvolts, 100 nanoamps and 100 milliohms



The Fluke 8000A 3½ digit multimeter

Solid state calls for new performance standards.

Your "old fashioned" test equipment simply doesn't measure up to today's requirements. For example, the typical VTVM gives you 5% accuracy and 2% resolution. In the old days, that was good enough. Not so today.

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

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You need a test instrument that gives you 0.1 ohm resolution so you can reliably measure resistance of switch contacts, circuit breakers, and low value resistors.

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The 8000A has an AC frequency response from 45 Hz to 20 KHz and, with accessory probes, to 500 megahertz. Resistance measuring capability ranges from 100 milliohms to 20 megohms. It offers a 15°C to 35°C accuracy temperature span. And a 1-year accuracy time span, meaning it seldom needs calibration.

Unlike other DMM's the 8000A has fast response time—3 readings a second. And the bright, digital readout means that no interpolation is necessary.

The 8000A measures high voltages, too.

Our 8000A is designed to answer *all* the needs of an electronic service technician.

One very important (and talked about!) safety requirement is that the picture tube anode voltage must not exceed the maximum specified by the manufacturer. Our 8000A has an optional high voltage probe that gives you guaranteed accuracy of 1% at 25,000 volts. The probe also extends the capability of the 8000A to 40,000 volts to measure the high voltage in the new 32,000 volt chassis.

No other DMM's offer this feature.

High voltage probe accessory gives you 1% accuracy at 25,000 volts

Get the most up-to-date instrument available.

Don't be caught in the typical trap. Many electronic service shops don't really update their equipment when they decide to update. Switching to a TVM or a FET voltmeter doesn't really give you the accuracy and resolution you need today, or for that matter, tomorrow.

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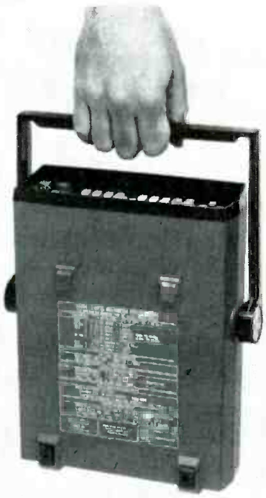

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Profitable and Competitive Pricing of Home Service Calls

By J. W. Phipps

How to use your hourly service labor rate to compute the flat rate you should charge for home calls

■ Profitable pricing of both in-shop and in-home servicing requires that you determine precisely what it costs you to produce a *manhour* of service labor. Regardless of the particular *method* of service labor pricing you use—whether it is flat-rate (by the job or function), hourly (actual time involved), or some combination of the two—the *basis* of your pricing structure is the *service labor manhour* and what it *costs you* to produce and sell it. This applies to both in-shop and in-home servicing.

TABLE 1

COSTS OF PRODUCING SERVICE LABOR

TECHNICIAN WAGES & PAYROLL EXPENSES		
Technician Wages	$44,720	
Employer Social Security Contribution	1,230	
Employer Unemployment Contribution	895	
Employer Life & Medical Insurance Contribution	1,200	
Employer Pension Contribution	474	
		$48,519
GENERAL AND ADMINISTRATIVE EXPENSES		
Secretary/Bookkeeper Wages	$ 8,320	
Employer Social Security Contribution	229	
Employer Unemployment Contribution	166	
Employer Life & Medical Insurance Contribution	300	
Employer Pension Contribution	100	
Building Lease	3,600	
Utilities (including heating & air conditioning)	1,500	
Telephone	500	
Office Equipment Depreciation	100	
Office Supplies	600	
Advertising Expenses	1,000	
Legal/Auditor Fees	400	
Insurance (All other than employee)	800	
Taxes (all other than Fed. & State income tax withholding)	800	
Interest & Bank Charges	800	
Misc. (Assoc. dues, subscriptions, license fees, etc.)	300	
		$19,515
OPERATING EXPENSES		
Owner's Salary	$18,000	
Social Security Contribution	990	
Unemployment Contribution	360	
Life & Medical Insurance Premiums	400	
Pension Premium	300	
Vehicle Operating & Maintenance Expenses	1,800	
Vehicle Depreciation	2,400	
Shop Equipment Depreciation	1,000	
Expendable Items, Shop (cleaners, solder, tape, etc.)	400	
Service Literature	100	
		$25,750
TOTAL SERVICE LABOR BUSINESS COSTS		$93,784

The procedure for computing the hourly service labor rate you must charge to recover all business expenses *and* realize a specific margin of profit was outlined last month in an article titled *Profitable and Competitive Pricing of Service Labor*. This procedure involves the following steps:

1) Computation of the total expenses incurred in the operation of your business (Table 1)*

2) Computation of desired profit (Table 2)*

3) Computation of gross service labor income required to recover expenses and produce the desired profit (Table 2)*

4) Computation of the total manhours which will be available for *direct* billing to customers (Table 3)*

5) Computation of hourly service labor rate by dividing the required service labor income by the number of manhours available for direct billing to customers (Table 4)*.

The resultant hourly service labor rate should serve as a basis for *both* in-shop and in-home servicing. The reason for this is that many of the expenses incurred in the operation of your business are "shared" by both in-shop and in-home servicing and cannot be accurately apportioned between the two without the use of a very detailed and complex cost accounting system, which, for most shops, would be so inconvenient and time consuming that it would be self-defeating. For example, although expenses such as technician wages and payroll expenses, vehicle depreciation and vehicle operating and maintenance usually can be accurately apportioned between in-shop and in-home servicing, others such as building lease, telephone, office equipment and test instrument depreciation usually cannot be accurately apportioned between the two types of servicing. Therefore, unless you already have a *proven* cost accounting system which permits you to apportion shared expenses with an acceptable degree of accuracy and without consuming too much of your time and that of your technicians, you probably should combine *all* expenses related to service labor and compute a single service labor hourly rate based on the *combined* expenses.

APPLYING YOUR HOURLY SERVICE LABOR RATE TO IN-HOME SERVICING

After you have computed the hourly service labor rate you must charge to recover *all* business expenses and realize a specific margin of profit, you are ready to compute what *you* must charge for a home service call.

There are at least three tried-and-proven methods for flat-rate pricing of home service calls:

1) You can charge a flat rate which covers the time it takes you or your technicians to travel to the customer's door plus a specific increment of service time in the home (usually 30 minutes). Time consumed in the home in excess of the specified increment allowed by the flat-rate charge is charged the customer on an hourly basis. For example, if the technician spends an hour in the home and your flat-rate home-call charge includes only the first 30 minutes, the additional 30 minutes is charged the customer by multiplying the shop hourly service labor rate by .5 (one half hour).

2) You can flat-rate only the time it takes the technician to travel to the customer's front door and then charge *all* service labor time in the home on a straight hourly basis.

3) You can flat-rate the technician's travel time and use it as your home-call charge and then charge the customer separate flat rates for each separate function the technicians perform in the home.

You can adopt any one of the preceding methods and make it work for you if the *basis* of all three methods—*your hourly service labor rate*—accurately reflects *your* business costs and the margin of profit *you* desire.

The only other factor which will significantly affect the profitability of your home-call operation but which is not directly accounted for in your hourly service labor rate is the *travel time* between service calls. Profitable and competitive flat-rate pricing of home service calls requires that you be able to predict, with reasonable accuracy, the amount of time *typically* required for your technicians to travel from one call to the next. (Your hourly service labor rate tells you how much you must *charge* for this time, but it does not tell you *how much time* is involved.) There are two generally accepted methods which you can use to determine how much travel time you should "build into" your flat-rate home-call charge.

The most accurate method is called *averaging*. During a period of time (the longer, the more accurate), each home-call technician maintains a log on which he records the times he leaves one call and arrives at another. At the end of the sampling period, the travel times recorded on the logs are totaled and then divided by the number of calls made. This tells you what the *average* travel time per call was during the period. You then multiply the average travel time (in increments of an hour) by your hourly service labor rate. For example, assume that the average travel time between service calls for your technicians is 20 minutes (.33 of an hour) and your hourly service labor rate is $20.00. Your minimum flat-rate for home service call travel then would be .33 x $20, or $6.60. If your home service call rate includes 30 minutes of service time in the home, you add to the $6.60 "travel charge" an amount equal to .5 (one half hour) x your hourly service labor rate, which in this example is .5 x $20, or $10.00. The total of the two produces a home service call charge of $16.60.

The other method of computing travel time is to determine the *maximum,* or worst-case, time your technicians would spend traveling from the geographical center of the area in which you offer service to the farthest point in the area. You then multiply your hourly service labor rate by this hourly increment of travel time.

The *averaging* method usually produces a more realistic and more competitive home service call charge

TABLE 2

ANNUAL SERVICE LABOR RECEIPTS REQUIRED FOR DESIRED PROFIT

1) TOTAL SERVICE LABOR COSTS (TABLE 1) $93,784

2) DESIRED PROFIT EQUALS 20% GROSS SERVICE LABOR INCOME

3) $\dfrac{\text{TOTAL SERVICE LABOR COSTS (TABLE 1)}}{4}$ = DESIRED PROFIT, or

$$\frac{\$93,784}{4} = \$23,446$$

4) DESIRED PROFIT + TOTAL SERVICE LABOR COSTS = REQUIRED ANNUAL GROSS SERVICE LABOR INCOME, or
$23,446 + $93,784 = $117,230

TABLE 3

SERVICE LABOR MANHOURS AVAILABLE FOR DIRECT BILLING TO CUSTOMERS

TOTAL SERVICE LABOR HOURS PER YEAR PER TECHNICIAN		2080 Hrs.
NUMBER OF FULL-TIME TECHNICIANS		× 4
TOTAL SERVICE LABOR MANHOURS PER YEAR		8320 Hrs.
MANHOURS DEDUCTED FOR PAID VACATIONS & HOLIDAYS		
Vacations (2 wks. per year per technician)	320 Hrs.	
Holidays (5 days per year per technician)	160 Hrs.	
TOTAL	480 Hrs.	
Service Labor Manhours Per Year		8320 Hrs.
Service Labor Manhours Deducted for Vacations & Holidays		− 480 Hrs.
TOTAL Manhours Technicians on Job		7840 Hrs.
LABOR Recovery Rate (80%)		× .80
TOTAL SALEABLE MANHOURS		6272 Hrs.

TABLE 4

SERVICE LABOR HOURLY RATE REQUIRED

$$\frac{\text{SERVICE LABOR INCOME REQUIRED (TABLE 2)}}{\text{TOTAL SALEABLE MANHOURS (TABLE 3)}} = \frac{\$117,230}{6272\text{ Hrs.}} = \$18.70 \text{ per Hr.}$$

than that produced by the *worst-case* method. For this reason, most shop owners prefer to use the averaging method for computing the "travel portion" of their home service call charge. The worst-case travel time then is used only as a reference against which to compare the effectiveness of their call routing and dispatching techniques, as described later.

Regardless of which method you use to compute the travel time between home service calls, it will be valid only if you establish a definite geographical area for the travel time study, and apply the resultant flat-rate home call charge only to calls made within that area. Because calls beyond this area will require additional travel time, the charge for such calls should be your flat-rate charge *plus* an extra charge based on the miles (or increments of a mile) the call is located outside your normal operating area.

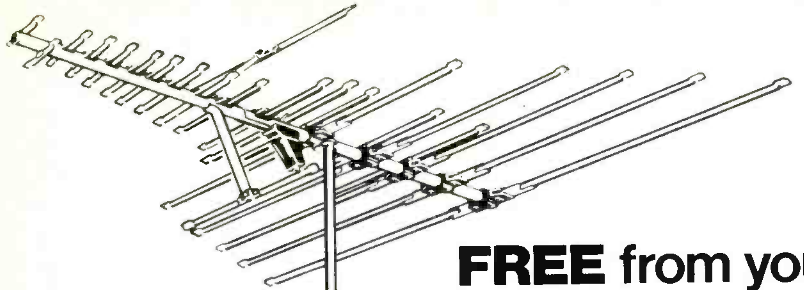
PERIODIC EVALUATION OF YOUR HOME CALL RATE

Because a significant portion of your cost of producing a home service call is attributable directly to *travel time* between calls, periodic re-evaluation of average travel time is essential for continued profitability of your home-call servicing. For this reason, it is recommended that you have your home-call technicians maintain a daily travel log on which is recorded the exact time they *leave* one home and *arrive* at the next. The log should clearly reveal the travel time between calls, the number of calls, and the time spent in the home. Weekly or monthly assessment of the logs will tell you whether or not the average travel time between calls is exceeding the average time on which your home-call charge is based. If it is, you either will have to improve your routing and dispatching techniques to reduce the travel time or you will have to recompute your home-call charge so that it is based on the *increased* average travel time. As a general rule of thumb, anytime your *average* travel time between calls exceeds one half your worst-case travel time, you should improve your routing and dispatching techniques to reduce it.

Another method of evaluating the validity of your home-call pricing structure is to: 1) Add up the travel and in-home time recorded on your technicians' travel logs during a specific period, 2) multiply this total time by your hourly service labor rate, and then 3) compare the resultant total with the gross income (minus parts income) you actually received from home call servicing during the period. If the total arrived at in step 2 does not equal or exceed the actual "service labor" income received from home-call servicing during the period, either your hourly service labor rate or your home-call rate (or both) is not adequate to recover all service-labor expenses and produce the profit you desire. You then should recompute both your hourly service labor rate and your home-call rate. ■

IN MARCH: Incentive Pay Programs for Your Technicians.

**The specific amounts listed in these tables are intended merely as examples and are not representative of those incurred in any particular business.*



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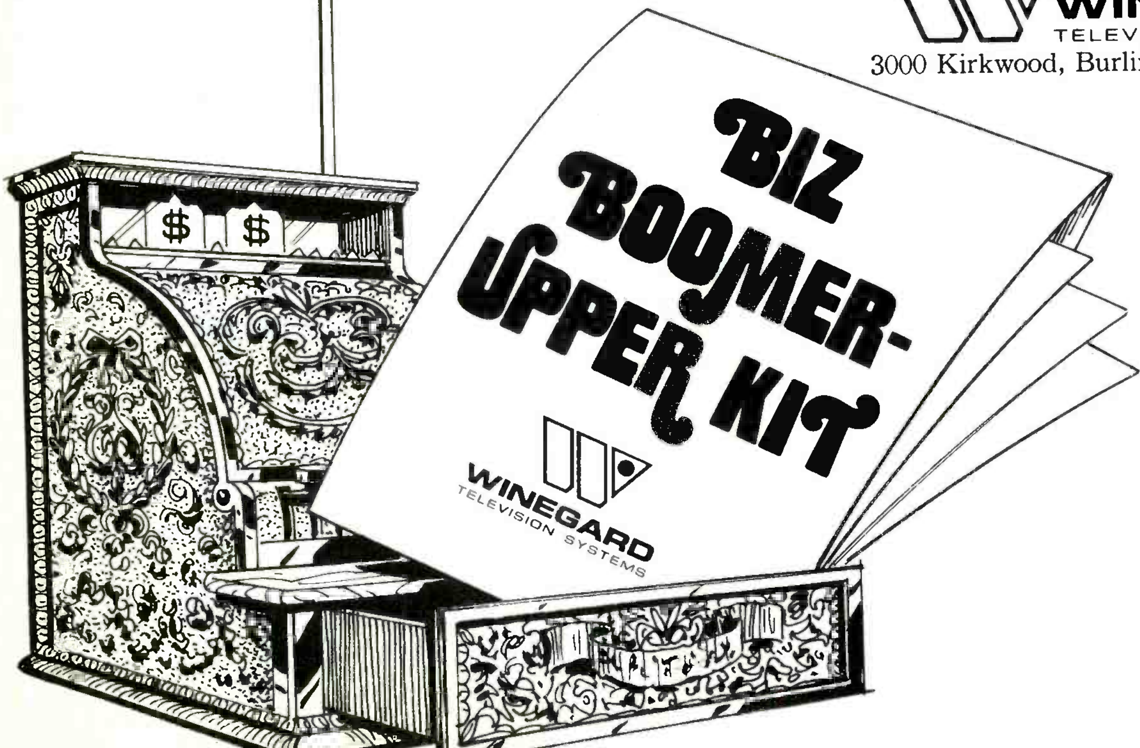


New in Color TV for 1975–Part 5

By Joseph Zauhar

Continuation of a series which analyzes the new and significantly changed circuits in 1975 color TV receivers. This month we will review RCA's T-Line Series chassis.

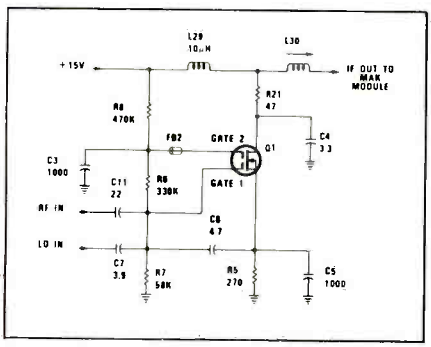


Fig. 1—The two-transistor, "cascode-type" VHF mixer has been replaced with a dual-gate MOSFET mixer. *Courtesy of RCA.*

■ Six chassis are employed in RCA's color TV line: The CTC58, 68, 71, and 72 are all-solid-state chassis. Two continued hybrid chassis, the CTC51 and CTC53, manufactured prior to the transition of RCA to an entirely solid-state line, are used in the 14-inch and 18-inch (measured diagonally) screen sizes.

The XL-100 chassis series used in the new line have many common features: modular construction, a MOSFET mixer used in the VHF tuner, negative matrix picture tube and screen temperature setup to 6500° Kelvin, rather than the 9300° K used previously.

CTC68 CHASSIS

The CTC68 chassis was first introduced in the RCA S-Line series of color chassis but many refinements in its design have been made. The design changes include new, but compatible, audio output and kine driver modules, elimination of the standby filament power consumption, an improved tuner, digital channel indication in some models, and a different remote control system in some models.

VHF Tuner

The two-transistor, "cascode-type" mixer that was used previously in the KRK205 tuner, employed in the early S-Line chassis has been replaced by a MOSFET device using a similar circuit configuration. The KRK211 tuner shown in Fig. 1 uses a dual-gate MOSFET mixer which provides high input impedance, a good noise figure, and low susceptibility to cross-modulation.

Low Voltage Power Supply

To conserve energy, the "Instant-Pic" has been eliminated from all T-Line color TV receivers.

A few early-production chassis will have the standby filament transformer that was used in S-Line chassis, but the wiring has been changed as shown in Fig. 2.

Two slightly different power transformer circuits are used in the CTC68 chassis. In some early production chassis the "Instant-Pic" feature is eliminated by changing the primary lead at the standby filament transformer (T104) to the off side of the line switch and the transformer is energized only when the on/off switch is switched on. In the majority of the chassis, the new design power transformer (T103) is used, providing the 6.3 volt source for the picture tube filament and transformer T104 is eliminated.

If either transformer is replaced in chassis which have both be sure to maintain the correct phasing of the filament winding (following the color coding). If the winding connections of either transformer is reversed, the two filament voltages will be out of phase and the *on* filament voltage will drop to about four volts,

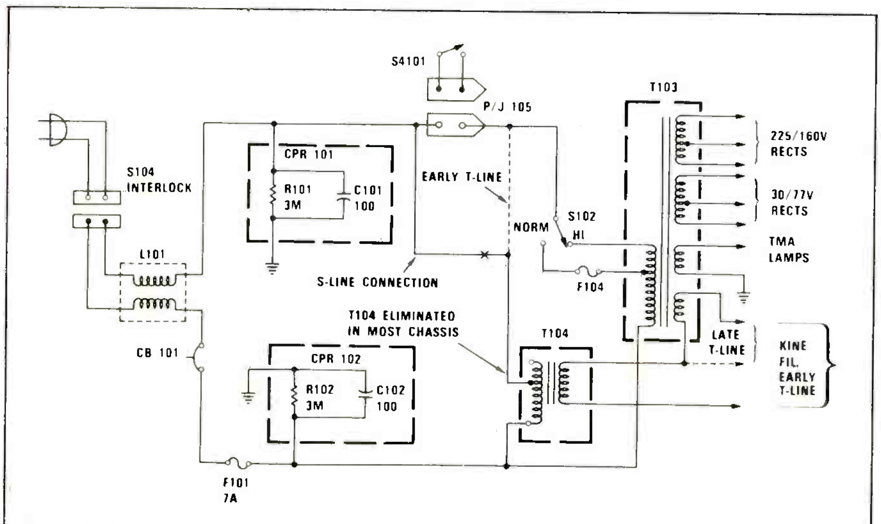


Fig. 2—Schematic diagram showing the changes made in the power supply employed in the CTC68 color TV chassis. *Courtesy of RCA.*

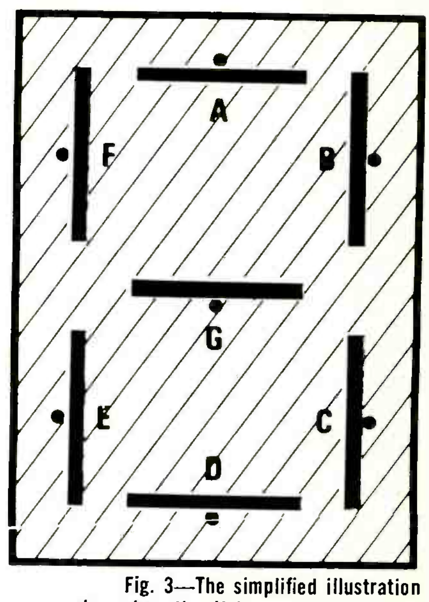


Fig. 3—The simplified illustration shows how the digits zero through nine can be formed by illuminating various sections of the seven-segment display forming channel numbers. *Courtesy of RCA.*

producing a symptom resembling a low-emission picture tube.

Digital Channel Indication

Various T-Line models using the CTC68 chassis have digital channel indication by using seven-segment, gas-discharge lamps, indicating both VHF and UHF channel numbers. A separate pair of neon lamps are used to indicate VHF or UHF operation.

Digits from zero through nine can be formed by illuminating various sections of the seven-segment display Fig. 3. When a particular cathode of a gas-filled indicator lamp is energized, it glows to make that segment visible and the numeral 8 is formed by energizing all seven segments.

A simple switch is shown in Fig. 4, with contacts connected to illuminate sections B and C of the lamp; the B+ input, which is common to all elements (anode connection), is supplied through a dropping resistor to the indicator lamp unit. The cathode elements B and C within the lamp are connected to ground through the switch contacts, energizing them and forming the numeral one.

Proper indication of all VHF and UHF channels requires the use of two indicator lamps encased in the same assembly and are labeled "tens" for the left-side indicator, and "units" for the right-side indicator.

UHF Indicating System

Shown in Fig. 5 is the Units section of a simplified UHF Indicating System which is an equivalent switch circuit, providing UHF channel indication. If a ground is connected to the lamp segments B and C through the isolation diodes B and C, diode CR6202 and switch Sf002 we will get a numeral "1." In this position all other contacts of the switch are in the open position.

The "tens" switch and diode assembly is not shown but it is basically the same as the "units" section. Because of the VHF switching contact sequence, isolation diodes are only required for the B and C segments. The "tens" switch also uses diode CR6202 and switch S4002 to complete its path to ground in the UHF mode. This connection is indicated in the schematic by the "common" line on the right side of the schematic.

Switch S4002 is located on the VHF tuner shaft and disconnects the common ground connections from the UHF indicator switches for VHF reception. It also operates the two neon lamps for UHF or VHF indication.

The UHF switch assembly consists of two rotating discs, each in contact with an eight-contact wiper assembly (one common and seven switched leads).

VHF Indicating System

The operation of the VHF channel indicator switch is similar to the "units" section of the UHF switch, and seven of its output leads are connected to the "units" lamp for number indication of channels 2 through 9. The "common" side of the VHF switch (Fig. 6) connects directly to ground, and has eight switched contacts. The eighth switched lead is connected through isolating diodes to the A and B segments of the "tens" lamp. The addition of this eighth contact to the switch simplifies the system, and eliminates the need for a separate VHF "tens" switch. All contacts are open in the UHF position.

VHF/UHF Mode Indicators

The VHF/UHF Mode Indicators employ a simplified system of indication. The VHF or UHF functions operate in conjunction with switch

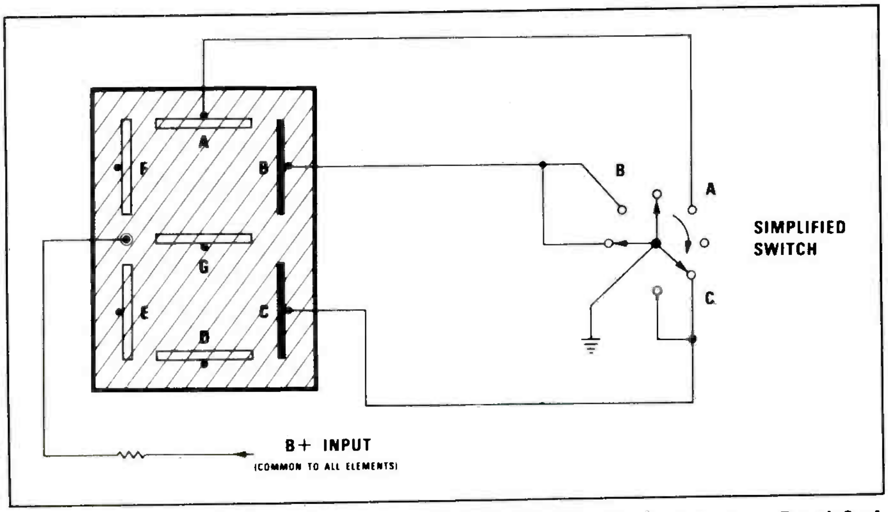


Fig. 4—A simplified indicator switch, with contacts connected to illuminate sections B and C of the lamp. *Courtesy of RCA.*

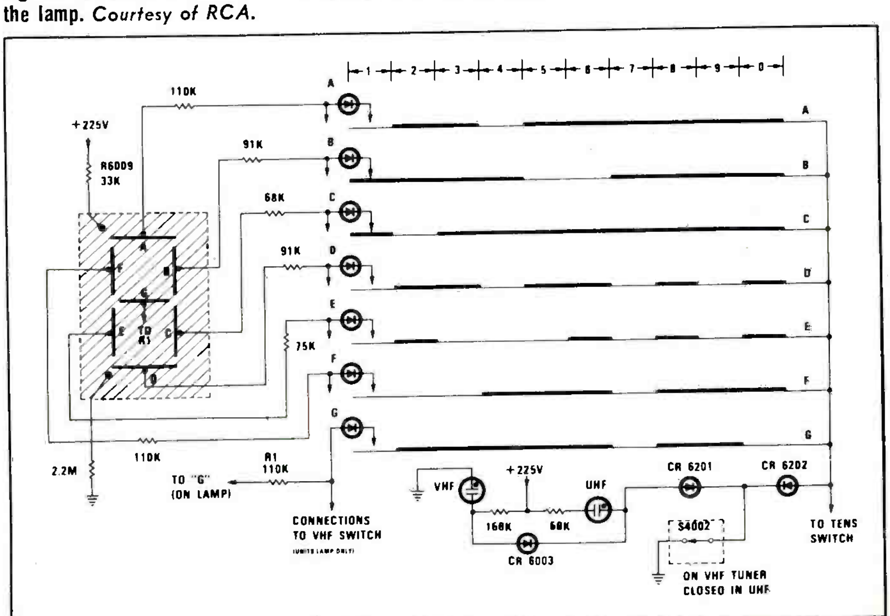


Fig. 5—Simplified illustrations showing the Units section of the UHF Indicating System. *Courtesy of RCA.*

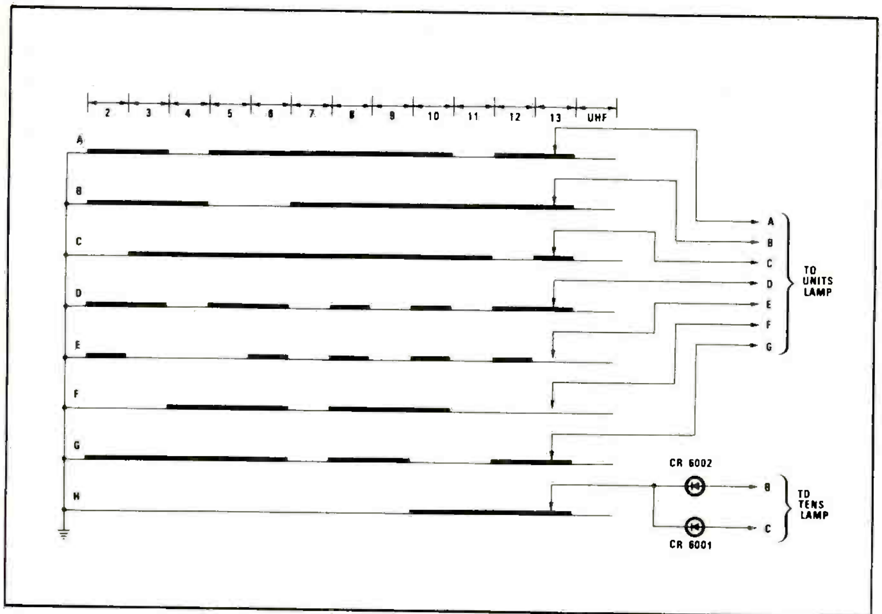


Fig. 6—Simplified schematic diagram showing the VHF Channel Indicating System. It is similar to the units section of the UHF switch. *Courtesy of RCA.*

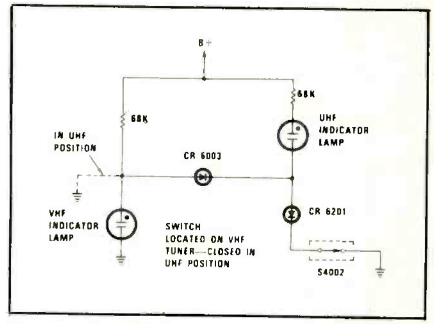


Fig. 7—Simplified schematic diagram showing the separate pair of neon lamps used to indicate VHF or UHF reception. *Courtesy of RCA.*

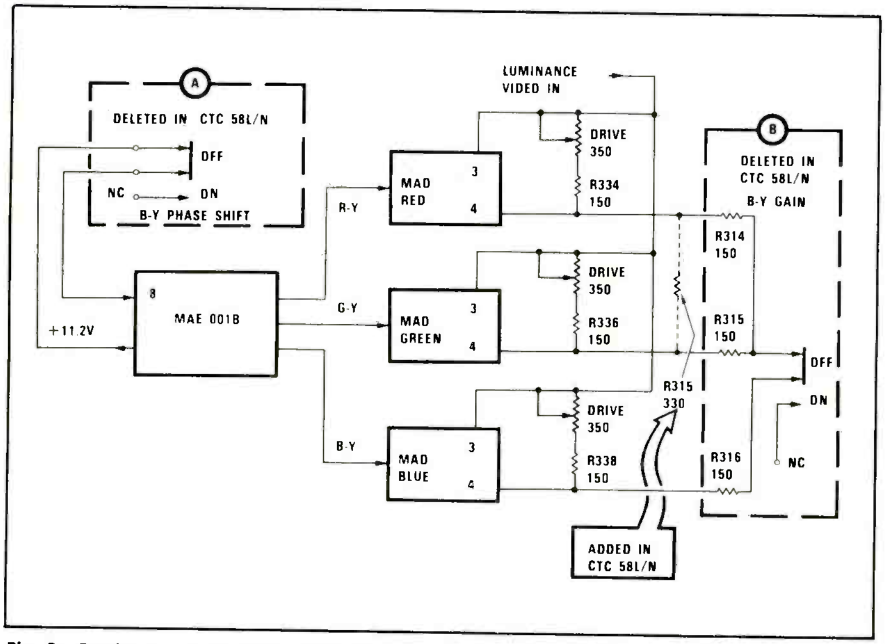


Fig. 8—Partial schematic of the ACM IV circuit used in other XL-100 color TV chassis, with the CTC58 chassis noted. *Courtesy of RCA.*

S4002 which is found on the VHF tuner. To indicate VHF or UHF reception a separate pair of neon lamps are used as shown in the simplified schematic diagram Fig. 7. The VHF/UHF Indicator Lamp Switching is shown in the UHF position. Switch S4002 is closed, completing a path from the cathode of diode CR6201 to ground. The circuit is completed to illuminate the UHF indicator lamp through the 68K resistor to B+. The dotted line connection to ground shows the condition of the VHF lamp when in the UHF position and diode CR6003 is conducting, therefore, both sides of the VHF lamp are grounded.

As the VHF tuner is rotated from the UHF position, switch S4002 opens, and the two diodes switch off, and the ground connection is removed from the high side of the VHF indicator lamp, permitting it to illuminate. The UHF lamp is defeated because no ground return connection is available to diode CR6201.

CTC58 CHASSIS

Two types of the carry-over CTC58 chassis will continue in the T-Line Series for 1975. The chassis will be employed in 21- or 25-inch (measured diagonally) console and table model TV sets.

Both chassis versions are electrically identical except for changes in the section of the power transformer circuit supplying the picture tube filament voltage. This change was made because the Instant-Pic feature was eliminated.

Another significant change made in the CTC58 chassis is the removal of the ACM IV switch, but two of the AccuMatic B-Y phase angle change and the B-Y demodulator gain change functions have been retained. These functions effectively provide the optimum color demodulator characteristics of the ACM IV system used in other chassis. Shown in Fig. 8 is a partial schematic of the ACM IV circuit used in other XL-100 color chassis, with the CTC58 chassis changes noted.

In the CTC58L and N chassis, removal of the "A" section of the ACM IV switch effectively turns on the B-Y phase shift circuit on the MAE001B module.

Removal of the "B" section of the switch, in conjunction with the new value of R315, adjusts the kine drive characteristics to yield the reduced B-Y demodulator output—as though the ACM function were turned on.

The tuners used with the CTC58 chassis will include the KRK199 VHF and KRK207 UHF units.

CTC71 CHASSIS

The CTC71 chassis is continued in the T-Line for 1975. This chassis will be used in several non-remote table models featuring a 19-inch (measured diagonally) screen.

The PW300 signal circuit board uses the same module complement as that of other current XL-100 chassis. The MAC002A Chroma-1 module has been superseded by the new MAC002B module, employing an advanced phase-locked-loop IC for the 3.58 MHz subcarrier regeneration. It is a direct replacement for the earlier "A" version. This module is common to all 1975 XL-100 chassis.

The horizontal-deflection system uses the transistorized sweep circuits first introduced in the CTC60 chassis. This chassis develops 27 kv of high voltage through a silicon tripler, the horizontal-deflection system is powered from a regulated 125-volt source and overload protected by an integral current-limiter circuit.

In comparison to its predecessor CTC60, most of the hold-down circuitry is contained on the MAH004 horizontal-oscillator module, rather than on the PW400 deflection board.

The vertical deflection system in the CTC71 uses the familiar MAG001 module and chassis-mounted vertical output transistors.

The tuners used in this is MOSFET mixer KRK199 VHF tuner and the digital-indicator KRK-207, 70-detent UHF tuner. Accu-Matic IV, AFT, and extended life neon pilot lamps are used in color TV sets employing the CTC71 chassis.

CTC72 CHASSIS

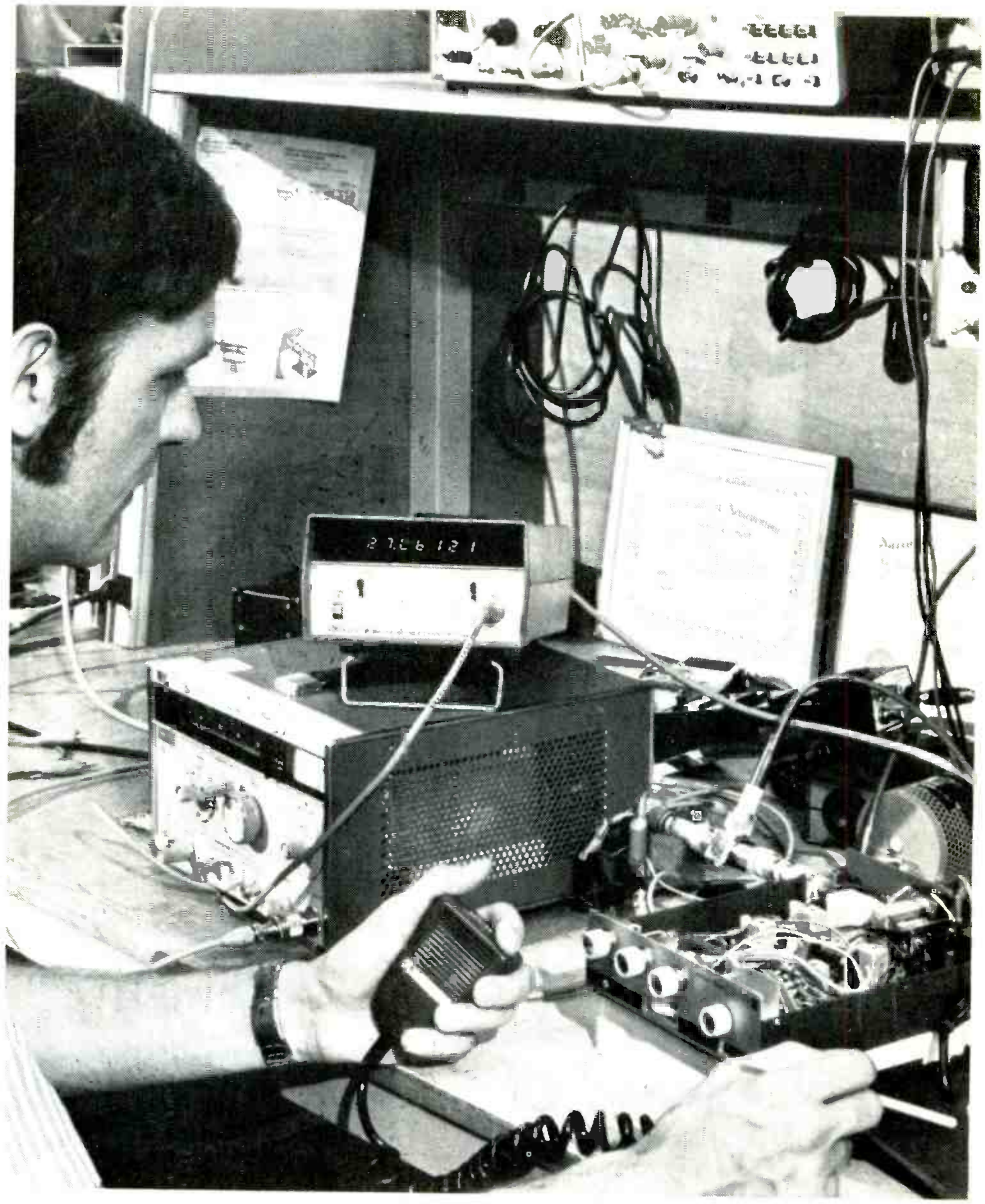
Three different versions of the CTC72 introduced in March and June will be used with portable and table model color TV receivers. The three types include the CTC72B which is used in non-remote 15-inch (measured diagonally) TV sets, and the CTC72N for non-remote 17-inch (diagonal) screen size TV sets.

All TV models introduced in March featured a negative-matrix precision in-line (AccuLine) color picture tube, digital UHF tuning, and AFT.

In June, a remote-control 17-inch (measured diagonally) TV set, Model ET396R, was introduced. This chassis includes all of the above features plus remote control functions for channel and volume change and on/off.

The remote control used in the CTC72R chassis is the familiar two-function type, which remotely controls a 20-detent channel-selection system used previously, and a volume-stepper circuit which allows three preset volume steps and "off."

The CTC72 chassis is electrically similar to the CTC62 that it replaces, only the Instant-Pic feature has been eliminated, requiring a few minor changes in the power switching circuit. ■



Digital Frequency Counters for Servicing–Part 1

By Joseph J. Carr, CET, ET/D Contributing Editor

Operation, specifications and applications

■ Until recently, digital frequency and period counters have been high-cost, exotic instruments associated with "high-dollar" communications shops, government financed R & D laboratories and test equipment/metrology facilities.

Modern electronic technology has changed all of that, allowing manufacturers to offer, at substantially lower cost to the user, quality digital counters whose performance often exceeds that of all but the best previous designs. As an example of this trend, consider those highly accurate, FCC-type-accepted counters often seen in mobile radio repair shops.

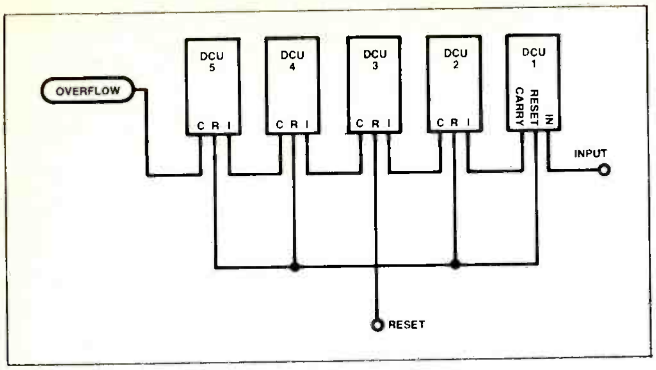


Fig. 1—A decimal counting assembly (DCA) consists of several decimal counting units (DCU's) in cascade. Each DCU counts from 0 to 9 and controls one digit of the multi-digit display.

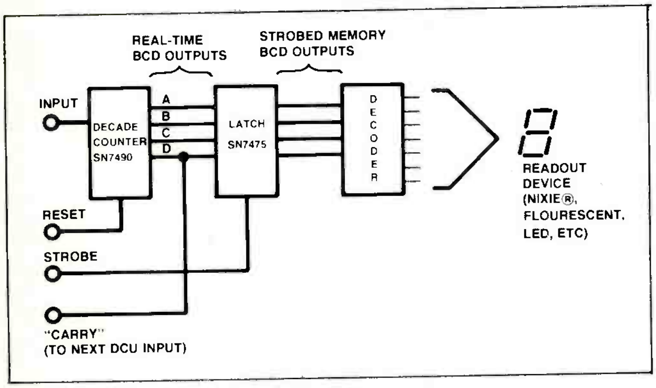


Fig. 2—Simplified block diagram of a low-cost TTL decimal counting unit capable of counting to over 20 MHz. The latch circuit keeps the display stable.

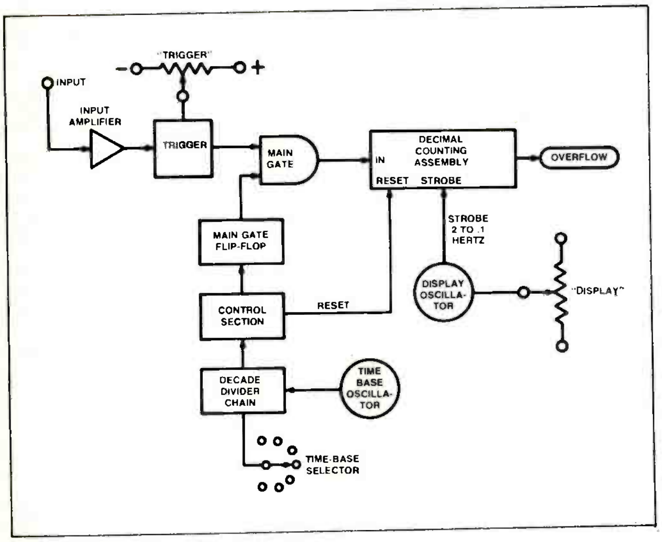


Fig. 3—Block diagram of a typical frequency counter.

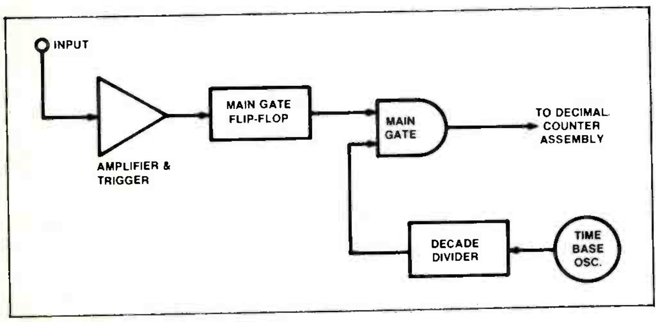


Fig. 4—Block diagram of period counting functions. Period counters measure the time interval between the beginning of successive pulses by reversing the function of the input amplifiers and the time base viz a viz the control flip-flop.

Just a few years ago, such instruments carried price tags of between $1800 and $4000. Today, at least one instrument in that class can be purchased for less than $800. Some non-type-approved digital counters sell for less than $100, while a few still carry prices in the multi-kilobuck range. The cost of digital counters has decreased to the point that some top-dollar signal generators are equipped with a built-in frequency counter which functions as the dial read-out.

In this two-part series, the internal circuitry of digital counters will be examined and their utility of application around almost any electronic service shop will be demonstrated. We also will give you some insight into digital counter terminology and specifications, so that you can make intelligent purchase decisions which avoid the pitfalls of "creative spec" writing.

DECIMAL COUNTING UNITS

The real heart of the digital counter is a digital electronic circuit which accumulates pulses and drives a readout device which tells the outside world how many pulses (from 0-9) have been counted. Such circuits, called decimal counting units (DCU's), can be cascaded to provide a wider counting range (i.e., 0-99, 0-999, etc.). A bank of several DCU's in cascade, as shown in Fig. 1, is called a decimal counting assembly (DCA). One DCU is required for each digit in the DCA.

One of the factors which pushed up the price of counters in previous years was that the DCU was made of (then) very expensive digital-logic integrated circuits. A typical digital counter IC then cost more than $15.00. Or they were equipped with transistorized flip-flops, which were equally expensive. When the transistor design was used, four flip-flops were needed per digit. And the transistor type of DCU often proved difficult to decode, making it even more costly to use. All DCU's, incidentally, require decoding because the counters operate in *binary coded decimal* (BCD). In that number system, four "bits" (voltage levels) are presented, each on separate lines, to represent the decimal digits between 0 and 9 (i.e., 2 = 0100, 6 = 0110, 9 = 1001; where binary 0 is either "ground" or some negative voltage, and binary 1 is either a positive voltage or a negative voltage, depending upon the system).

Fig. 2 shows the partial schematic of a relatively common DCU using transistor-transistor digital logic (TTL) integrated circuits. At one time, these devices cost an arm and a leg, but they now are relatively cheap. The SN7490P decade counter, for example, can be purchased for $1.00 to $4.00, depending upon the source.

The type of decade counter used in Fig. 2 can count to speeds somewhat in excess of 20 MHz, while certain high-speed TTL chips count to 50 or even 80 MHz. The internal circuitry of the SN7490 includes all of the flip-flops and gating needed to form a decimal counter.

In many counters, especially in older designs or a few newer but very low-cost types, the decade counter directly feeds the binary coded decimal (BCD) lines to the decoder circuit. This design produces a rolling display that is a little hard to read. You can actually see the digital readout of these instruments change as pulses are accumulated much in the same manner as the digits on a gasoline pump "roll" as price is accumulated.

To keep the display steady, most modern counters, even those of modest cost, use a four-bit memory, called a *quad latch,* between the counter and decoder circuits. A latch circuit "remembers" the BCD state which existed at its input the last time the strobe terminal was enabled (turned on). This design allows the display to be "instantly" updated at a rate determined by the repetition rate of the display multivibrator, which is set by a control on the front panel. In some low-cost designs, the display is still fed by a latch, but the display *rate* is *fixed.* You can tell whether or not a counter is equipped with a latch. If it is, the display update will occur all at once; the new digits seem to pop "pre-counted" onto the readout. Non-latched types will exhibit the "roll" symptom.

FREQUENCY COUNTER DESIGN

Fig. 3 is the block diagram of a typical digital frequency counter. Although this particular design is not found in *all* digital frequency counters, it is sufficiently representative to be used for explanatory purposes. The differences between the design in Fig. 3 and other designs usually involves special features in special-purpose counters (i.e., high-resolution types) or, in low-cost types, deletion and/or automation of some of the features in Fig. 3.

In counter jargon, the term "frequency" is called *events per unit of time* (EPUT). Remember, before they changed the jargon, *frequency* was "cycles (events) per second (unit of time)." Any EPUT counter requires a *main gate,* which allows pulses being counted into the DCA. The gate is opened and closed by a train of pulses from a *time base circuit.* These pulses also are used to reset the DCA to zero state, so that a true count is obtained. Without a main gate, the DCA would simply continue to accumulate input pulses with no relationship to *time.*

PERIOD COUNTER DESIGN

A *period* counter (Fig. 4) is used to measure the amount of *time between* successive pulses. This can be accomplished by merely reversing the functions of the input amplifier and the time base. The main gate flip-flop will be enabled by a pulse from the input amplifier, and closed by the next pulse. Time base pulses are passed through the gate to the DCA. If a 1000-Hz time base signal is used, the period is measured in *milliseconds.* Many counters allow selection of the time base frequency.

There are many uses for a period counter, but the two main applications are in measuring low-frequency signals (less than 100 Hz) or higher frequencies where much greater resolution than 1 Hz is required. An example of the latter use is in electronic

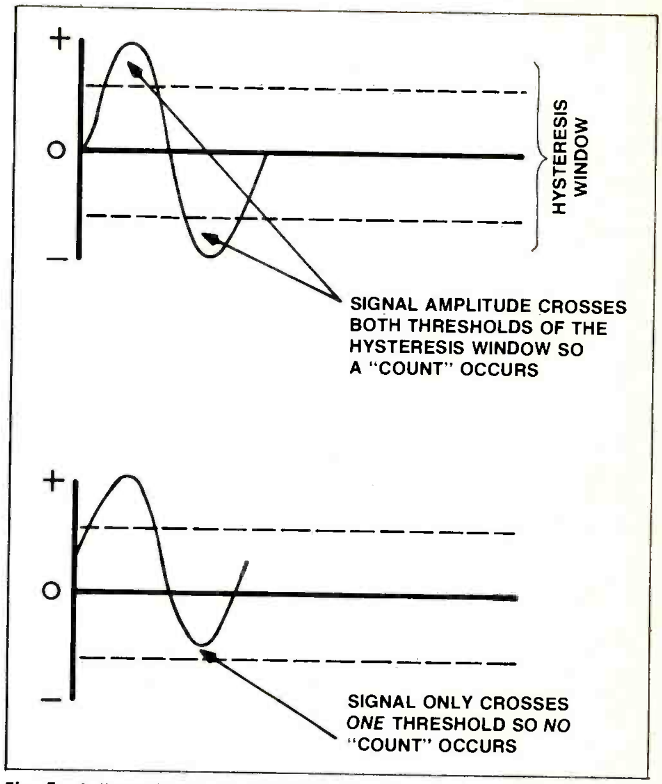


Fig. 5—A "count" can be achieved only when the input signal crosses both the upper and lower bounds of the trigger's hysteresis window.

musical instruments, in which certain of the tones are specified to within three decimal points of one hertz. In such cases, you simply choose a time base frequency high enough to give the desired resolution, and then perform this arithmetic:

$$\text{Freq. (Hz)} = \frac{1}{\text{Period (sec)}}\text{, or}$$

$$\text{Period (sec)} = \frac{1}{\text{Freq. (Hz)}}$$

TIME BASE CIRCUITS

The *length of time* that the gate stays *open* is a function of the time base frequency. A time base is a precise crystal-controlled oscillator followed by some TTL *decade dividers* (the same SN7490P IC used in the DCU, but without decoding). Typically, 1-MHz oscillators are used, but 3-, 4-, 5- and 10-MHz types are occasionally used.

Some counters provide a switch which allows the user to select time base intervals between .0000001 (.1 microsec) and 10 seconds. This is done by selecting frequency through choice of division ratio. (Each SN7490P will provide an output frequency 1/10 of the input.) Typically, 10 MHz gives gate times of .1 microsecond, 1 MHz yields 1 microsecond, 1 Hz gives 1 second, etc. Many of the lower-cost counters provide limited manipulation of the time base through a "Hz/KHz" or "KHz/MHz" switch.

One of the principal counter specs is *time base stability* and *accuracy.* Although the inclination may be to buy a counter with top time base specs, this can needlessly overprice your instrument. Where exceptional accuracy is not needed, a non-compensated, room-temperature

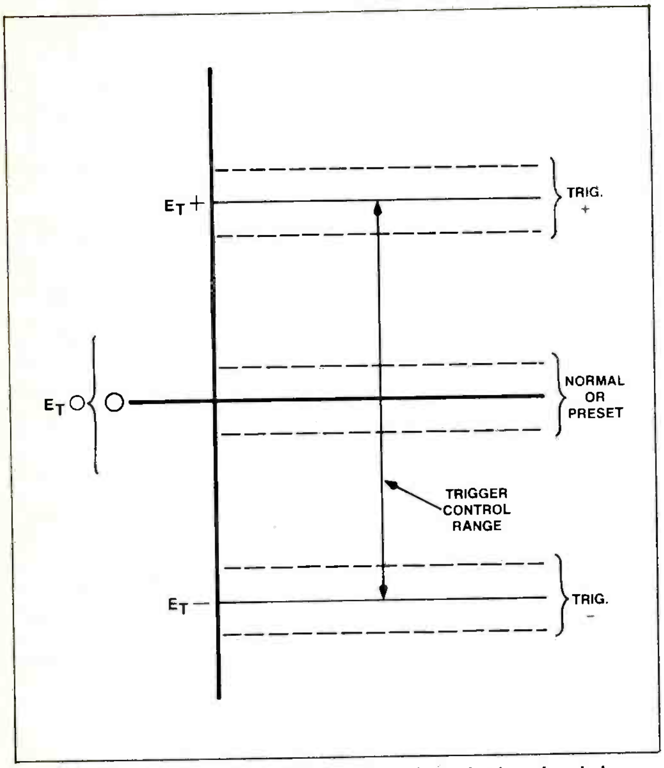


Fig. 6—Trigger controls vary the position of the hysteresis window up and down on a voltage scale so that signals of either polarity, with or without a DC component, can be counted.

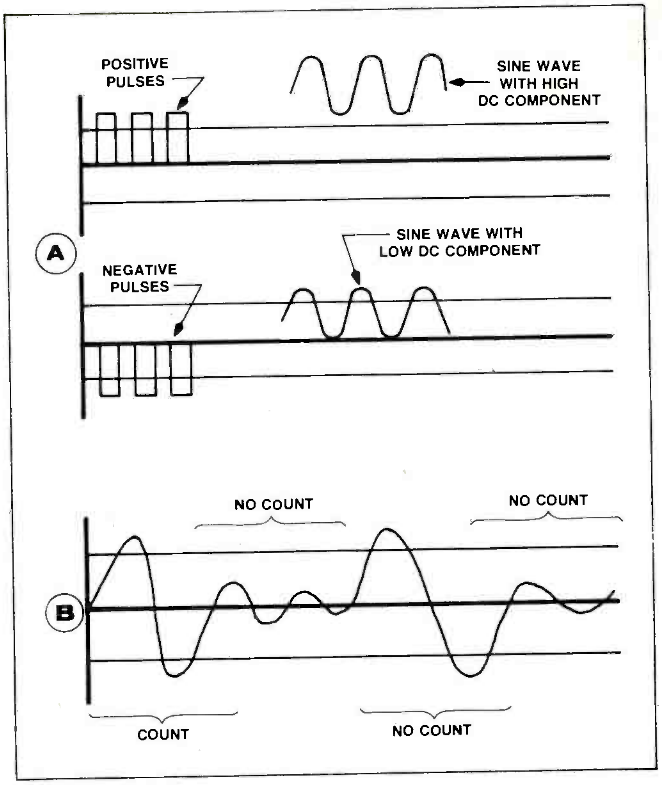


Fig. 7—Several of the waveforms which cannot be counted by a digital counter with a fixed hysteresis window.

time base usually will suffice. These circuits can offer stability figures on the order of 5×10^{-6}. A step better, offering five times the stability, are temperature-compensated crystal oscillator (TCXO) designs. In some cases, TCXO counters are accurate and stable enough to receive FCC type approval.

Oven-controlled oscillators offer the best stability. Simple thermostat-controlled oscillator ovens offer better stability but are still somewhat inferior to those using *proportional control* ovens. This design produces a more constant temperature. A single-oven proportional control oscillator can keep the frequency within $\pm 5 \times 10^{-8}$. The most stable and accurate counters use double oven oscillators, which have the actual crystal oven inside a second oven. Such arrangements are capable of maintaining crystal temperature within .01° C, producing a frequency stability of 5×10^{-11}. Of course, expect double-oven time base oscillators only in the most expensive counters.

TIME BASE AGING

Crystal oscillators, even high-grade types, always drift over a period of time. This slow drift is usually predictable and is expressed as an *aging rate*. This is the reason for periodic trips to the calibration laboratory or manufacturer, if it is desired to keep the instrument up to its original specs. How *often* calibration is needed is a function of the aging rate.

Keep in mind that even the best counters with really good stability figures have an aging rate. Also, their normal stability cannot be expected until the instrument has been on for at least 24 continuous hours. Because of this, many counters use a special power supply for the time base oscillator. This accomplishes two things: 1) The power supply regulation is improved because the loading is essentially constant, and 2) the oscillator supply can be left on even when the counter is turned off. If you cannot keep your instrument plugged in (so that the oscillator will run continuously), it may be necessary to buy one with at least one order of magnitude better stability than would otherwise be needed. Some battery types are good in this respect because they can be left with the oscillator on during unplugged periods (i.e., in your service truck between jobs). The standard of accuracy for a counter is not less than *five times* the accuracy required of the frequency under examination. For example, a Citizens-Band transmitter must be within ± 50 ppm (5×10^{-5}); consequently, a counter for CB servicing should have an accuracy not worse than 10 ppm, with 5 ppm being best.

TRIGGER CIRCUITS

Most counters are equipped with Schmitt trigger circuits which have both upper and lower *threshold bounds* (see Fig. 5). An input signal must cross *both* threshold levels if the DCA count is to be affected. The difference between these limits is called the *hysteresis window*. Its function is to allow only *one pulse* to be generated for *each input cycle*. Otherwise, it would be possible for non-sinusoidal waveforms to falsely trigger the DCA. The trigger control varies the position of the window relative to a minus-zero-plus voltage scale, so that a variety of input signals not centered about zero can be counted. Otherwise, a signal with a DC component might not be counted even though its own relative amplitude is greater than the advertised sensitivity of the counter. Fig. 6 shows the action of the trigger control. Fig. 7 shows several types of waveforms which *cannot* be counted on an instrument with a *fixed* hysteresis window.

Some counters do not have a continuously variable trigger control but, instead, are equipped with a three-position switch typically labeled either "+, 0, −" or "+, present." In many applications, this arrangement is less desirable than a continuous control, but is better than no control at all. A trigger control is almost a necessity for TV applications because the pulses encountered may have either polarity, with or without a DC component. The rarely seen *trigger amplitude* control does not affect the "center" position of the window, but does vary its "width."

COUNTER SENSITIVITY

One parameter which, like hi-fi power output, has been subjected to a lot of "creative" spec writing is *sensitivity*. On the surface, it might appear that the more sensitivity, the better. However, this is not always true. Sensitivity is the *minimum amplitude* of signal which can *reliably* trigger the counter. If the sensitivity is too great, noise might falsely trigger the instrument; if the sensitivity is too low, desired signals might be ignored.

Sensitivity is often expressed in either RMS volts or in a certain pulse amplitude (also volts). In any event, most trigger circuits have a *pulse* sensitivity that is 2.82 times the RMS figure. If both figures are specified, be a little wary of the instrument which has a *ratio* significantly different than this value, because there might be something wrong with the sensitivity at higher frequencies.

It is difficult to state a specific optimum counter sensitivity. All that is possible are some general sensitivity guidelines, which are dependent on input impedance. Sensitivity values which usually are acceptable are 25-100 millivolts RMS for 1-megohm inputs, and 10-50 millivolts RMS for 50-ohm inputs. Generally, counters under 200 MHz have high-impedance inputs, and those over 200 MHz have a 50-ohm input.

VHF COUNTING TECHNIQUES

Common TTL digital IC's are capable of counting up to about 80 MHz. IC's in the ECL family are capable of being operated at twice this frequency, but are neither as cheap nor are they directly compatible with TTL. Very special (and expensive) ECL types can count in excess of 500 MHz. Beyond these limits, or even up to them if cost is a factor, other techniques must be applied. There are at least three methods for achieving a high-VHF/UHF counter: *direct counting, prescaled counting,* and *heterodyne counting.*

Direct counting is the normal mode of operation for digital frequency counters. Most common counters can direct count to around 80 MHz. If an ECL first stage is used, this "normal" limit is pushed to 180 MHz. Keep in mind that direct counting (also called real time counting) is possible to over 500 MHz if one wishes to pay a premium price.

A prescaled counter divides the input frequency by some integer, then counts the resulting frequency. If the selected division ratio is ten, to "read" the actual frequency you merely remember to move the decimal point on the readout one place. One reason for using this technique is that several lower-cost IC's will divide by ten up to 500 MHz, but not in a circuit that is easy to decode for display purposes. Fig. 8 shows a popular prescaled system.

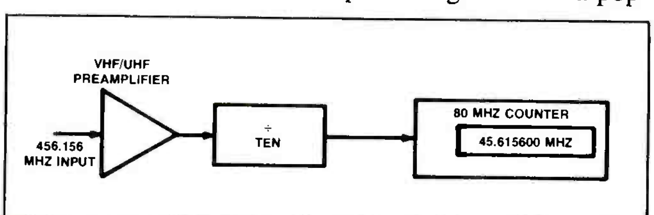


Fig. 8—Prescaling is a technique which makes it possible to measure frequencies in the VHF and UHF ranges with an instrument designed for a lower range of frequencies.

The third method mentioned is the heterodyne system, shown in Fig. 9. In this type of counter, the input frequency is translated to a lower frequency within the range of the instrument. The "local" frequency source can be a separate crystal oscillator, but usually is a frequency multiplier chain or phase-locked-loop (PLL) controlled oscillator, either of which can be driven or synched by the time base oscillator.

If the "local" frequency source in a heterodyne counter is designed to produce frequencies as high as 400 MHz, and the basic counter is capable of direct counting to 80 MHz, the counter will be capable of measuring frequencies in the mobile radio bands up to 480 MHz because it will actually be measuring $F_{in} - F_{local}$. Counters well into the microwave (GHz) range are possible by use of this technique.

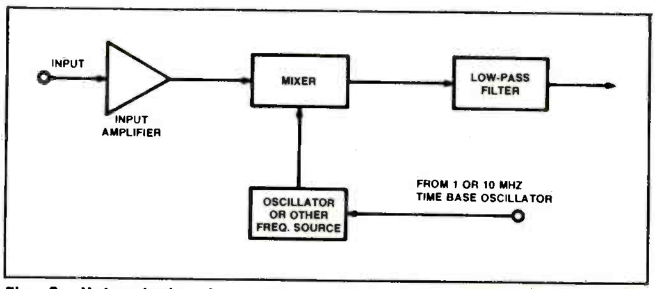


Fig. 9—Heterodyning is another method of extending the frequency range of a digital counter.

COUNTER ERROR

All of those pretty digits displayed by a counter might tempt one to make the same error made by high school physics students working problems with a sixteen-digit calculator: forgetting that only a *portion* of the total display is valid. For all counters in which the main gate circuitry does not synchronize the time base with the input signal (which is just about all counters), the display accuracy is ± the last (least significant) digit. This makes the overall accuracy equal to the time base error ± one count of the LSD.

NEXT MONTH: Specific applications of digital counters in the service shop, and what specs are desirable for each. ■

Condensed from a single chapter of a recently introduced TAB book, by permission of TAB BOOKS, Blue Ridge Summit, Pa. 17214

Troubleshooting Horizontal Deflection & High Voltage Circuits - Part I

THE DEFLECTION CIRCUITS

■ The deflection circuits are comprised of four major stages: the horizontal output stage, the horizontal output transformer, the deflection yoke, and the damper. All four of these work together to control the horizontal deflection of the electron beam.

A simplified schematic of a typical horizontal deflection system is shown in Fig. 1. The output of the horizontal oscillator drives the grid of the horizontal output tube, which is class C biased by the grid circuit. Plate voltage for the output stage is provided by the charge across C1. How this charge is developed is easier understood after looking at the operation of the four stages.

With no signal applied to the grid, V1 is cut off, and no current flows in the transformer or yoke. No magnetic field will be developed without yoke current; therefore, the beam is at the center of the screen. As the output stage is brought into conduction, current flows through V1, through the transformer, through the yoke to the positive B-boost charge on C1, from the capacitor to the B+ supply, and through the supply to ground. The corresponding CRT trace is shown as vector A in Fig. 1B. As the current through V1 and the yoke increases (shown as A in Fig. 1C), the beam is drawn farther to the right.

When the waveform at the grid of V1 starts going negative, V1 is suddenly cut off. This sudden stopping of V1 current causes the magnetic field about the transformer to collapse, inducing a current in the yoke in the same direction as that supplied by V1. However, instead of flowing into C1, the current charges the yoke capacitors. Tube V2 cannot conduct, due to the high positive potential on the cathode. When the yoke field is fully dissipated, there is no more yoke current; therefore, the beam returns rapidly to the center of the screen.

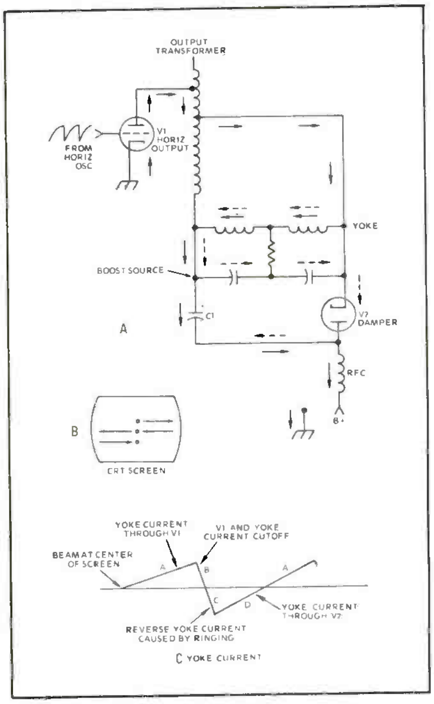


Fig. 1—Horizontal deflection circuit.

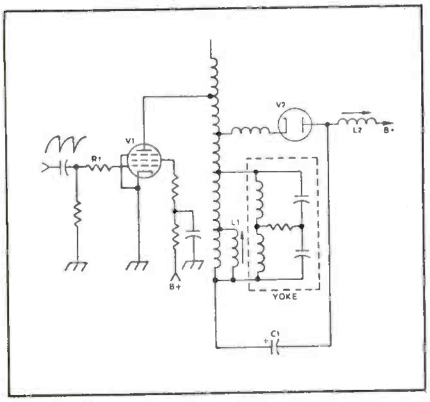


Fig. 2—Horizontal deflection circuit, showing linearity control.

As the ringing action of the yoke continues, the charge across the yoke capacitors starts to discharge through the yoke coils. This causes a reverse yoke current, and the beam is deflected to the left of the CRT, as shown by vector C in Fig. 1B. During this cycle, the cathode of the damper is gradually becoming less positive; and when the coils of the yoke begin to discharge into the capacitors once again, the cathode is negative with respect to the plate.

As the coils discharge back into the capacitors, yoke current flows once again, moving the beam to the center of the tube. As this current increases, V2 conduction continues to increase, gradually dampening the ringing action of the yoke (shown by dotted lines in Fig. 1A). When the beam approaches the center of the tube, the waveform at the grid of V1 is sufficiently positive to cause V1 to conduct, and the cycle starts over again.

The plate supply for V1 is the B-boost voltage across C1. Each time V2 conducts, its plate voltage drops. This AC voltage at the plate of V1 causes a charging current to flow into C1. The plate circuit sees C1 in series with the B+ supply and, therefore, the voltages are additive, resulting in a high DC voltage at the junction of C1 and the yoke. Each time V1 conducts, the charge across C1 is reduced, to be replaced each time V2 conducts.

A more complete schematic of the horizontal deflection circuits is shown in Fig. 2. Bias for V1 is developed across R1, holding V1 in cutoff until the oscillator output is sufficiently positive to cause conduction. Operation of the damper and yoke stages is the same as described earlier. Coil L1 is provided in some sets as a horizontal width control. Coil L2 is a linearity control. This control tunes the horizontal output circuit to provide minimum loading of the output stage. It is more correctly called horizontal efficiency, because it has very little control over linearity.

An example of a solid-state horizontal deflection system is shown in Fig. 3. The operation is generally the same as that of the tube-type circuits, with exception of considerations necessary for solid-state circuits. The deflection yoke coils have

From Chapter 11, LOGICAL COLOR TV TROUBLESHOOTING, by Ben Gaddis, TAB BOOKS, Copyright 1974. A review of the complete book follows part 2 of this article.

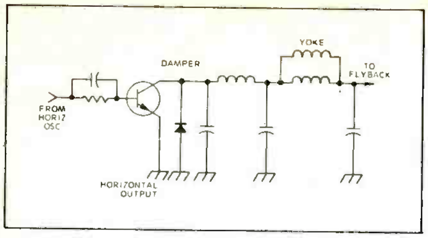


Fig. 3—Solid-state horizontal circuit.

been placed in parallel in this example to reduce to total inductive load on the output transistor. In some models, a buffer or driver transformer is located between the oscillator and the output stage to prevent loading of the oscillator. To provide the relatively high power output required of this stage, two transistors operating in parallel are sometimes used. Conduction of the output transistor causes beam deflection from the center of the screen to the right, and damper current moves the beam from the left to the center, just as in the previous circuits.

There are usually several other output taps on the flyback transformer in addition to those already presented here. The high-voltage circuit takes power from some of these taps, while others are used for horizontal blanking, AGC, AFC, and color-gating signals.

THE HIGH VOLTAGE CIRCUITS

For the purposes of our discussion here, the high-voltage circuits include two separate high-voltage supplies: the second-anode supply, and the focus supply. Some sets use one common high voltage supply with a voltage divider to produce the two DC voltages, while others make use of a high B-boost voltage as the source of focusing voltage. Two separate supplies are shown in Fig. 4.

Separate windings on the flyback transformer supply filament voltage for the two rectifiers. These circuits function similar to a conventional half-wave rectifier power supply. When oscillator action causes V1 to cut off, the collapsing magnetic field in the flyback transformer induces a voltage in the transformer winding that produces a high DC voltage pulse at the plates of the rectifiers. This pulse is stepped up by the autotransformer action of the flyback. Rectification is achieved by the rectifiers, and a high DC voltage is produced at the cathodes. By means of L1, the impedance in the cathode

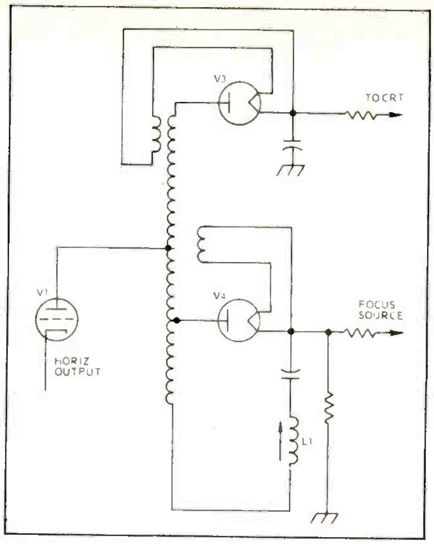


Fig. 4—High voltage supplies.

circuit of V4 can be adjusted to set the focus voltage at the prescribed level. Adjustment of the second-anode supply is usually made in the high-voltage regulator circuit, which will be discussed later.

Solid-state high-voltage diodes generally employ high-voltage solid-state rectifiers that function similar to their vacuum tube counterparts. One type of solid-state supply, shown in Fig. 5, uses a voltage tripler circuit. In this example, a high-voltage pulse is generated in the transformer and appears at the anode of X1. As X1 conducts, a charge is developed across the parallel capacitor. After several cycles, all capacitors are charged and the charges appear in series, adding to the total DC voltage available at the second anode.

In a television set, the high-voltage output of the second-anode supply will vary with the brightness of the scene. This is due to the fact that during the reproduction of high brightness areas the CRT is drawing a relatively heavy current, placing a load on the high-voltage supply. As scene brightness decreases, the load on the supply decreases, and, as a result, the high-voltage output increases. Due to the lower amount of beam current drawn by b-w receivers, this fluctuation can be tolerated. However, the heavier beam currents of the color CRT causes these variations in the high voltage to be excessive, and cause a decrease in picture width due to the loading placed on the horizontal output stage. Other circuits in the color receiver also draw DC or signal voltages from the horizontal output;

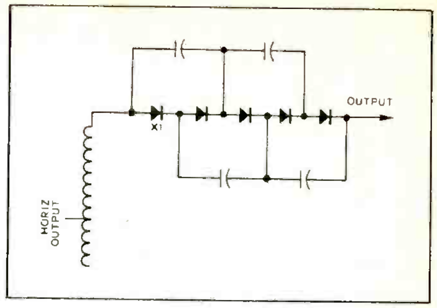


Fig. 5—Solid-state high-voltage supply.

therefore, loading of the output stage cannot be tolerated in the color set. To overcome the loading effect on the horizontal output stage, color receivers employ a regulated high-voltage supply. Basically, this supply is the same as the one just discussed except for a regulator stage placed somewhere in the high-voltage generating chain.

Regulator Stage

The shunt-type regulator has long been the most popular of the high-voltage regulators. A simplified version of this circuit is shown in Fig. 6A. Operation of this circuit is based on the premise that the output stage and flyback transformer function as a constant-current source; that is, a steady value of DC current is drawn from the transformer. The regulator tube in parallel with the load (the CRT) controls the amount of current shunted around the load, thereby regulating the voltage across the load.

In the figure, a high-voltage triode is tied between the high-voltage supply and B+. The grid is connected to the B-boost source through a voltage divider, one resistor being adjustable to furnish a high-voltage adjustment. The function of the triode is to furnish a variable load across the high-voltage output, in parallel with the CRT. As the load of the CRT decreases, the load furnished by the regulator tube increases and, as the CRT load increases, the load furnished by the regulator decreases. Thus, a constant load is reflected to the power supply.

Assume that the scene brightness suddenly increases, causing beam current to increase. This causes a heavier load to be placed on the flyback, and the voltage output starts to decrease. The heavier load will also cause a decrease in the boost voltage. As boost voltage decreases,

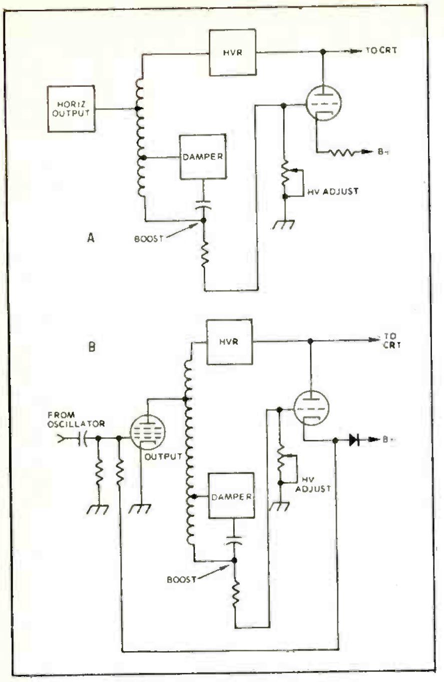


Fig. 6—Shunt-type high-voltage regulators. A) Without holddown provision. B) With holddown provision.

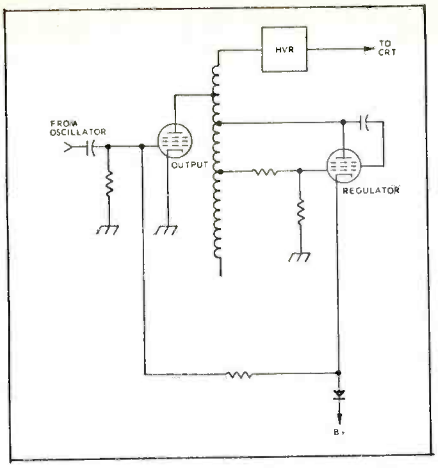


Fig. 7—A pulse-type high voltage regulator.

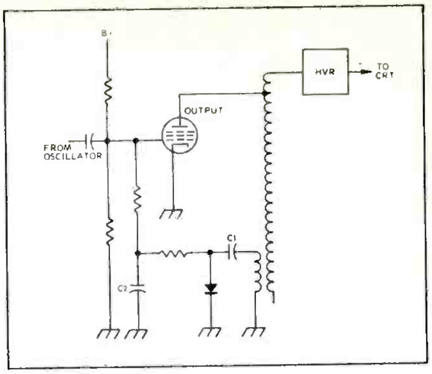


Fig. 8—Diode feedback high-voltage regulator.

the bias on the regulator tube is increased (made less positive), causing the tube conduction to decrease. Conduction of the regulator tube decreases until a point is reached where the high voltage is returned to normal. Boost voltage will again be at its normal level.

If the scene brightness should decrease, the high voltage will attempt to increase due to the decrease in beam current. The decrease in load also causes an increase in boost voltage. This positive-going voltage causes the regulator tube to increase conduction, restoring the normal load on the transformer, and the high voltage and boosted B+ return to normal.

It must be remembered that this type of regulator circuit is designed to function within certain specified limits. Should the current in the load vary to a point outside these limits, as would be caused by opens in the load or a low resistance to ground, the regulator tube will not be able to control the high voltage. In cases of excessive high voltage, as could be caused by a failure of the regulator tube itself, there is the danger of X-radiation. Therefore, some modern shunt regulators use the modified circuit shown in Fig. 6.

Improved Regulator Circuit

In this example, a diode is placed between the B+ supply of the regulator and the cathode of the regulator tube. The B+ for the output stage is also drawn from this same diode. In this circuit B+ will be available to bias the output tube into conduction only if the regulator tube is conducting. If the regulator fails, no current flows through the diode, and the bias on the grid of the output tube is lowered due to the absence of the B+ voltage. There will still be a high-voltage output, but it will be below normal.

One disadvantage of this circuit is that if the high-voltage regulator tube shorts—a common occurrence—the diode will probably short also. When the regulator tube is replaced to restore normal operation, all will appear well, even though the diode is shorted. However, the safety feature will now be inoperative because B+ will be available to the output stage at all times, regardless of the conduction of the regulator. When regulator tubes are replaced in this type of circuit, always check the diode for shorts.

Another disadvantage of this type of regulator is the amount of power wasted. Since operation of the shunt regulator is based on the fact that the flyback must supply a constant current, power dissipated by the regulator tube during periods of low brightness is wasted. This results in the transformer supplying a full load current at all times.

A better method would be one in which the transformer supplied only the amount of current required in any one instance. Such a circuit is shown in simplified form in Fig. 7. This circuit is called a *pulse regulator,* due to the fact that it functions on pulses from the flyback transformer. Control grid, screen grid, and plate voltages for the regulator tube are all received in the form of positive pulses during the retrace time. If the brightness of the scene decreases, the high voltage attempts to increase. At the same time, the amplitude of the pulses at the various transformer taps also tries to increase. This increase in the positive pulses applied to the pulse regulator tube causes the tube conduction to increase and load the transformer, decreasing the transformer efficiency and current. If the high voltage decreases, so do the pulses to the regulator. The regulator conducts less, causing less loading of the flyback and an increase in efficiency. As in the shunt regulator, a protection diode is included in the cathode circuit.

Feedback Regulator

An even more efficient method of regulating the high voltage would be to regulate the current available to the transformer. Regulators using this principle employ a feedback system similar to automatic gain control. An example of the feedback regulator is shown in Fig. 8. This circuit is sometimes called a *grid regulator,* but its use with solid-state circuits as well as tube circuits makes the name *feedback regulator* more appropriate.

Normal operating bias for the tube is supplied by a grid leak circuit and the voltage divider between B+ and ground. As the high voltage tends to increase, the amplitude of the pulse applied across the diode also tends to increase. This pulse is rectified by the diode, and the filter action of C2 causes a charge to be developed across C2. With an increasing pulse, the negative voltage applied to grid resistor R1 increases, causing the tube to decrease conduction, and, consequently, the high voltage is lowered.

Continued next month in Part 2

ET/D 1974 SUBJECT REFERENCE INDEX

The **first numerical** group following each listing indicates the **month** of the issue in which it appeared, and the **second numerical** group indicates the **page** on which coverage of the topic appears or begins. The two-letter **alphabetical** code in parenthesis immediately following some listings indicates coverage in one of the following ET/D regular departments: COLORFAX (CF), Dealer Showcase (DS), New Products (NP), TEKLAB (TL), Technical Digest (TD), Test Instrument Report (TR)

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TEST INSTRUMENTS

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TEST INSTRUMENT REPORT

Tekelec Model TA 357 Digital Multimeter

■ Equipped with a 3½ digit, field-effect, transmissive, liquid crystal display, the Model TA 357 multimeter is capable of measuring DC and AC voltages ranging from 100 microvolts to 19.99 Kv (50 Kv with optional probe), DC and AC currents ranging from 100nA to 199.9ma, and resistances ranging from .1 ohms to 199.9 K ohms. In addition, a special + 10v DC output permits measurement of leakage currents and conductance (up to 200×10^{-6}mho).

Functions and ranges are selected by eight interlocked pushbuttons on the front of the instrument. Selection of either the voltage or current measuring function is accomplished by pushing in the buttons labeled "V" or "I," respectively, and then either pushing *in* the AC/DC button for AC measurement or releasing it to the *out* position for DC measurement. Illumination of the letters "AC" or "DC" on the right of the numerical display automatically tells you whether the instrument is in the AC or DC measuring mode. In the DC mode, the polarity of the voltage or current is automatically indicated by the appearance of either a — or + sign on the left of the numerical display. In the current measuring mode ("I" button pushed in), the letters "mA" also appear to the right of the numerical display. Selection of the resistance measuring function is accomplished by pushing in the button labeled "Ω," which causes the designation "KΩ" to appear to the right of the numerical display.

Selection of one of the four ranges of the TA 357 is accomplished by pushing in either the ".2," "2," "20" or "200/LINE TEST" buttons. The decimal point in the display is automatically positioned by the range pushbuttons.

Zeroing of the instrument is accomplished by a thumbwheel type control labeled "Zero" on the top of the instrument.

If the quantity being measured exceeds the full-scale capability of the range selected, the display flashes on and off, clearly indicating the over-range condition.

The TA 357 is designed to be powered by 117 VAC, 60 Hz but is available in an optional version which operates on 220 VAC, 50 Hz. The line voltage applied to the instrument is automatically measured and displayed without external probe connections when the ON/OFF/TEST switch is pushed down to the spring-loaded TEST position and the V, 200/LINE TEST and AC/DC BUTTONS are pushed in.

The multimeter is protected by a .25-amp fuse in the primary of the power supply and a .25-amp fuse in the input circuit. Both fuses plus a spare are located beneath a slide-out panel on the bottom of the instrument.

Input impedance in the voltage measuring modes is 10 megohms shunted by less than 100 pf of capacitance. The frequency range for AC voltage and current measurements is 40 Hz to 20 KHz.

Current through resistances being measured is 1 mA in the ".2" and "2" ranges, and .01 mA in the "20" and "200" ranges. The maximum voltage which can be safely applied to the input circuit in the voltage and resistance measuring modes is 480 volts p-p. In the current measuring modes, the input circuit appears as a short to input voltages in excess of 3.6 volts.

Tekelec's Model TA 357 is housed in a high-impact cycolac case which is 2⅜ inches high by 5¼ inches wide by 9½ inches deep.

Price of the TA 357 is $179, complete with test leads and a 100:1 high-voltage (20 Kv) probe. An optional 50 Kv high-voltage probe is available for $39.95. ■

For more information about this test instrument, circle 900 on the READER SERVICE CARD.

TECHNICAL DIGEST

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

MAGNAVOX

Radio Chassis R331/332—Diode Reversed

The Audio Driver modules used in these chassis, Part No. 703688-1, have diode D403 incorrectly screened on the PC board. Because of this error, the initial production of these chassis has the diode installed backwards. The symptoms that may occur are bass distortion and possible Automatic Protection Circuit Activation. Production is now installing the diode correctly. The correct polarity of the diode is cathode of D403 to emitter of Q408. These chassis are used in Model KE1570 and KE1580.

Radio Chassis R286—Schematic Correction

The schematic in Service Manual 1526 has two errors in the audio output section. Resistor R230 should be in parallel with D202 instead of D206. Resistor R231 should be in parallel with D203 instead of D207. The copper layout in the manual is correct.

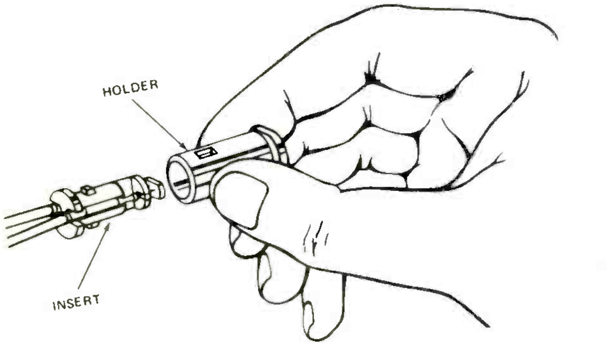
Color TV Chassis—High Voltage Rectifier/Tripler Short

In cases of high voltage/tripler failure in early production TV sets using these chassis, there is a possibility that the horizontal output transformer, T302, and other associated components may be damaged. Other components to check when this type of failure occurs include: Capacitor C104, resistor R140, the power supply diodes, and the Video Delay module.

The possibility of multiple component failure can be prevented by changing R140 to a carbon film type 1K ohm resistor (Part No. 230214-1025). Whenever these early production units are in the shop, R140 should be changed to a carbon film type resistor as preventative maintenance. Elevate the resistor ¼-inch above the PC board. Current production (identified by the numeral 2 as the last digit of the model number such as CE4360WA12) uses a carbon film resistor for R140.

Videomatic TV Sets—New LDR Holders

A new LDR holder assembly has been developed to minimize the possibility of LDR damage from static discharges. The new assembly is made of two parts—the holder (Part No. 143593-1) and the insert (Part No. 143592-1). The entire assembly is still removable from the front of the instru-



ment as usual, but to separate the holder from the insert the holder must be gripped as shown in illustration and squeezed to unlock it. This new assembly may be used to replace all original holders with the part number 142848 or 143290. ■

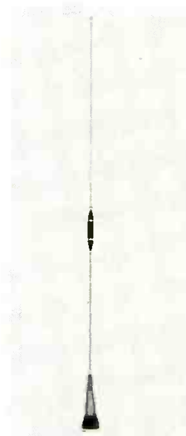
NEW PRODUCTS

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.

UHF MOBILE ANTENNA 700

Combines the most desired operating characteristics

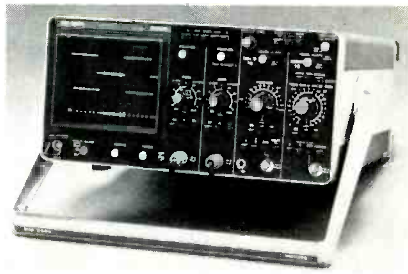
The Antenna Specialists Co. has announced the development of a new antenna which combines all of the most frequently desired operating characteristics for UHF mobile antennas into one design. The Model ASP-830 features over 5 dB of gain and can handle 150 w of RF power continuously. It maintains a VSWR of less than 1.5:1 over a wide working bandwidth of at least 9 MHz, making it ideal for use in repeater systems or for broadband monitoring. It achieves its performance characteristics through the use of a pair of 5/8-wavelength radiators in a collinear design. Phasing is accomplished with a phasing coil assembly that is one-piece molded to the radiators. A threaded metal insert in the molded base provides the extra strength and durability of a metal-to-metal fitting.



OSCILLOSCOPE 701

Compact size and lightweight

A compact 50 MHz dual-trace oscilloscope was introduced by **Philips Test & Measuring Instruments, Inc.**, a subsidiary of North American Philips Corp. Designated the Model PM3240, the oscilloscope employs DC switching

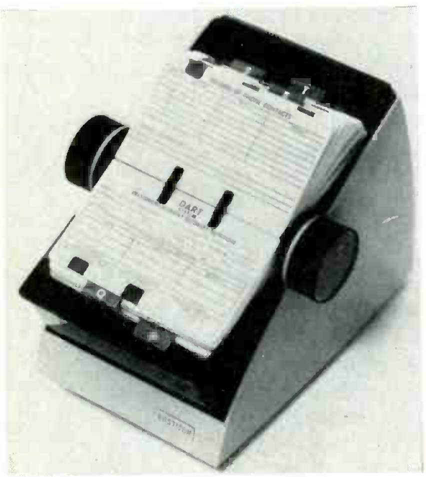


for all functions. A magnesium alloy casting and a switching power supply serve to reduce the size and weight. Basic specifications of the oscilloscope includes 5 mV/div. sensitivity at full bandwidth and 10 nanosecond/div. maximum sweep rate. The 50 MHz bandwidth and 7 nanosecond risetime can be displayed separate, alternate, chopped and X-Y modes. The high 1 MHz chopping rate helps to eliminate interference with displayed signals. The attenuator eliminates the need for external measuring of the X axis input. A separate delay timebase control has intensified screen indication and a 0.5 sec/div. to 10 nsec/div. range. A full 8 by 10 centimeter screen with a 10 kv accelerating potential enables easy and detailed viewing at even the narrowest one-shot pulses. Price is $1470 without probes.

ACCOUNT COLLECTION SYSTEM 702

Simplifies follow-up and speeds payment of overdue accounts

Ever Ready Label Corp. has developed the DART (Delinquent Account Recovery Technique). The system is an extension of their line of collection stickers. In addition to the three Collection Stickers, other components of the system are: a rotary desk file with 3 by 5 Follow-Up Cards, and three small colored labels coordinated with the colors of the three Collection Stickers. When an account is overdue, basic data is entered on the Record Card and slipped onto the rotary file. Collection Sticker #1 (blue) is affixed to the statement to be mailed. The small colored label (also blue) is affixed to the edge of the card and becomes an indexed marker. The same



procedure is repeated with Collection Stickers #2 and #3, coordinated with the appropriate colored small labels. The Follow-Up Record Cards are printed on both sides and provide for the necessary current information. It also allows for personal phone contacts between statements. As partial payments are made, they can be posted. And when payment is made in full, the card is easily pulled from the file. Price is $79.95.

DIGITAL MULTIMETER 703

Features a frequency counter and can measure capacitance

A digital multimeter, featuring a 4½-digit Sperry planar display in 44 ranges has been announced by **PECK/BOSS, Inc.**, Electronic Div. The Model 390 multimeter is a versatile bench type meter, a frequency counter and it can measure capacitance in seven ranges from 1 nano farad to 100 micro farads. The instrument has eight resistance scales from .1 ohms to 1000

continued on next page

NEW PRODUCTS...

continued from preceding page

megohms full scale. Other features are 10,000 megohm input impedance on 10 v DC. Eight ranges of DC current from 1 μa DC to 1 a full scale. The unit is overload protected by a fuse.

ANTENNA PREAMPLIFIER 704

Gain of over five times its input level

ACM has added a Model AA37, Antenna Preamplifier to its line. The unit has a 300-ohm antenna input and a 75-ohm output for use with MATV systems or in areas with high noise levels. The preamplifier boosts the signal at

the antenna where they are strongest and free from interference. The unit provides a gain of 16 dB or over five times the input level.

PORTABLE SOLDERING IRON KIT 705

Features pushbutton operation and is rechargeable overnight

General's Electric's Tube Products Dept. is making available to independent service dealers a cordless, portable soldering iron kit. Offering high wattage performance at low power, the iron's "Iso-Tip" soldering tip construction eliminates electrical leakage, need for grounding and possibility of damage to highly sensitive electronic components. Ready for use in 3-5 seconds, the iron features pushbutton operation, built-in work and pilot light and is rechargeable overnight. The kit includes case, battery charger and one regular tip. Price is $19.95. ■

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.

4-CHANNEL TURNTABLE 706

Completely equipped and priced at under $100

BSR has introduced the Model 4310X 4-channel automatic turntable. The turntable comes completely equipped with a molded base with walnut trim, removable hinged tinted dust cover, and an Audio Technica AT-12S CD-4 magnetic Shibata diamond stylus cartridge and all necessary 4-channel

cables. The unit comes completely assembled, adjusted and packed in a single carton. It also features a shielded anti-magnetic steel platter, stylus force adjustment, anti-skate control, viscous-damped cue/pause control, jamproof tone arm with automatic arm lock.

COLOR TV 707

Features in-line picture tube and all solid-state modular chassis

A new 19-inch color TV model that comes complete with super bright in-line picture tube, 100% solid-state modular chassis and matching swivel base has been added to the **Magnavox** line. The unit, Model 4352, comes

complete with matching swivel base. Other features include 185 square inch picture, automatic fine tuning, automatic color, 70 detent UHF tuning and 13 detent VHF tuning, sharpness control and lighted channel indicator. Price is $449.95. ■

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Wanted: An extra instruction manual for Winston Electronics Corporation DYNAMIC SWEEP CIRCUIT ANALYZER Model 820, or the present address of the Winston Electronics Corporation of Philadelphia. Philip Butler, Box 581, West Brookfield, MA 01585.

Wanted: Picture tube rebuilding equipment and supplies. Call or write: George Antimisiaris, 20 Coleville Road, Wayne, NJ 07470. (201) 839-4925.

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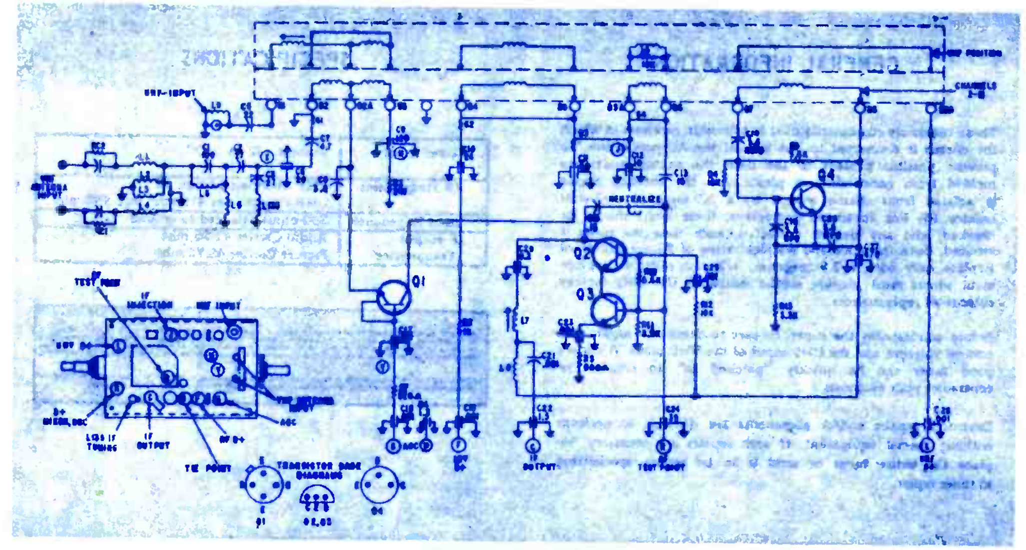
GROUP 269



SCHEMATIC DIAGRAM

1563
GENERAL ELECTRIC
TV Chassis XA

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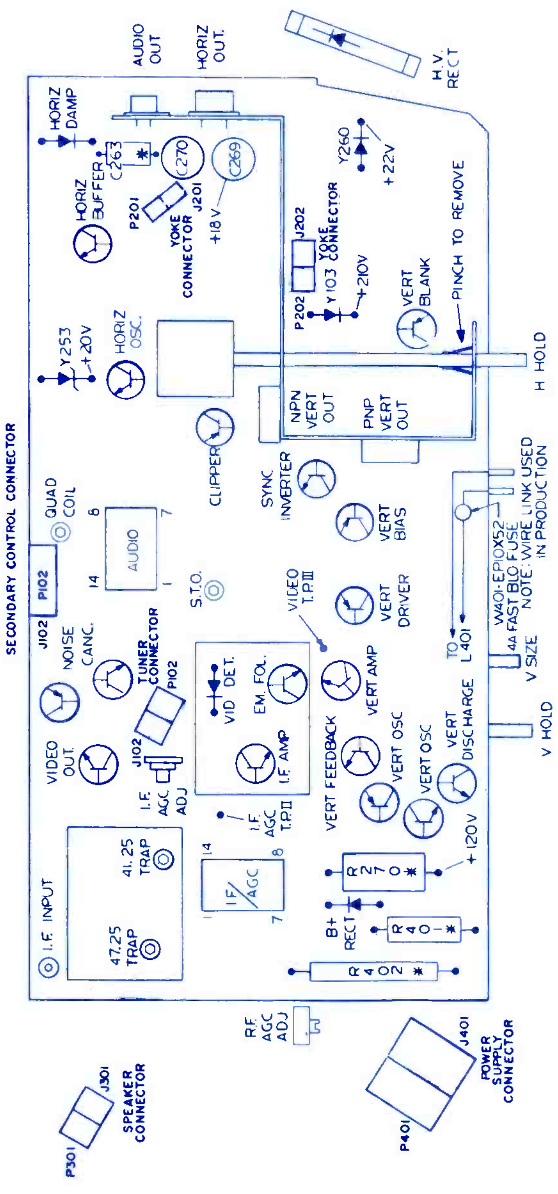
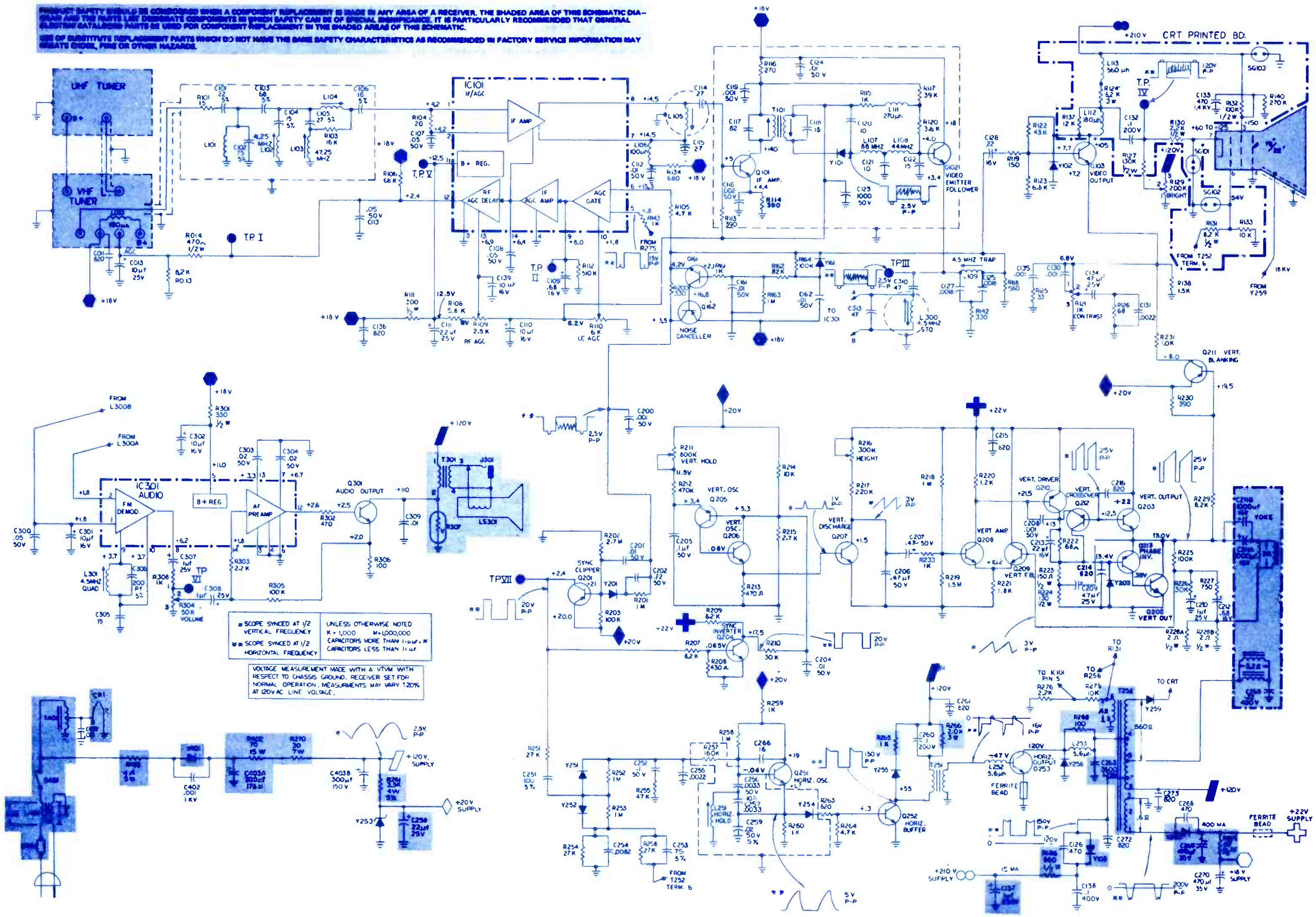


CHASSIS LAYOUT



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AIRLINE

Color TV Model
GAI-12925A

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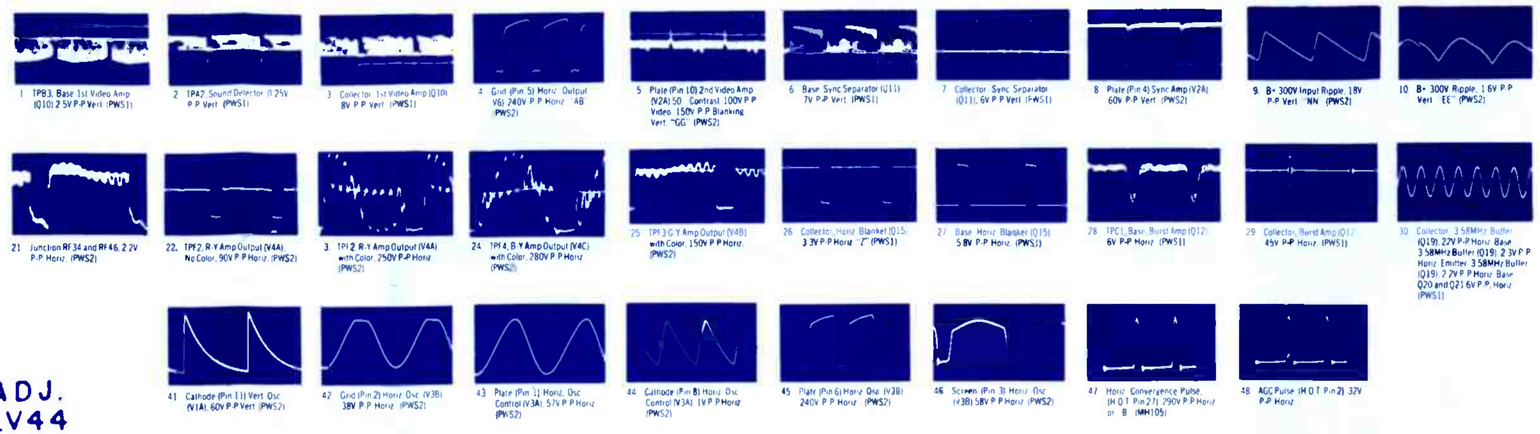
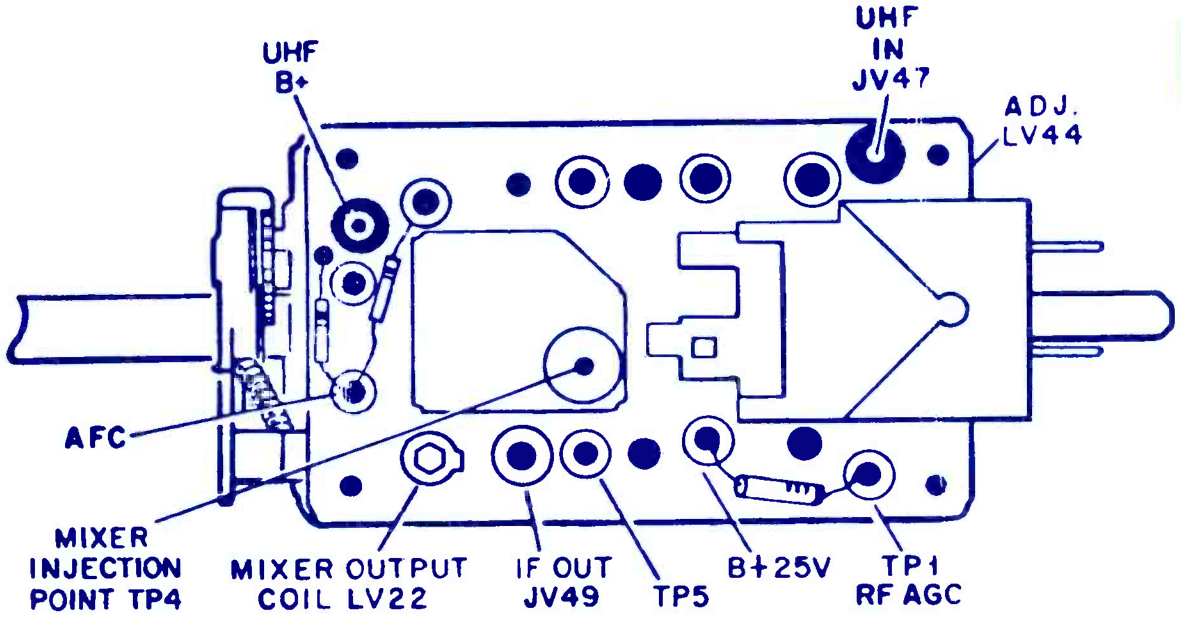
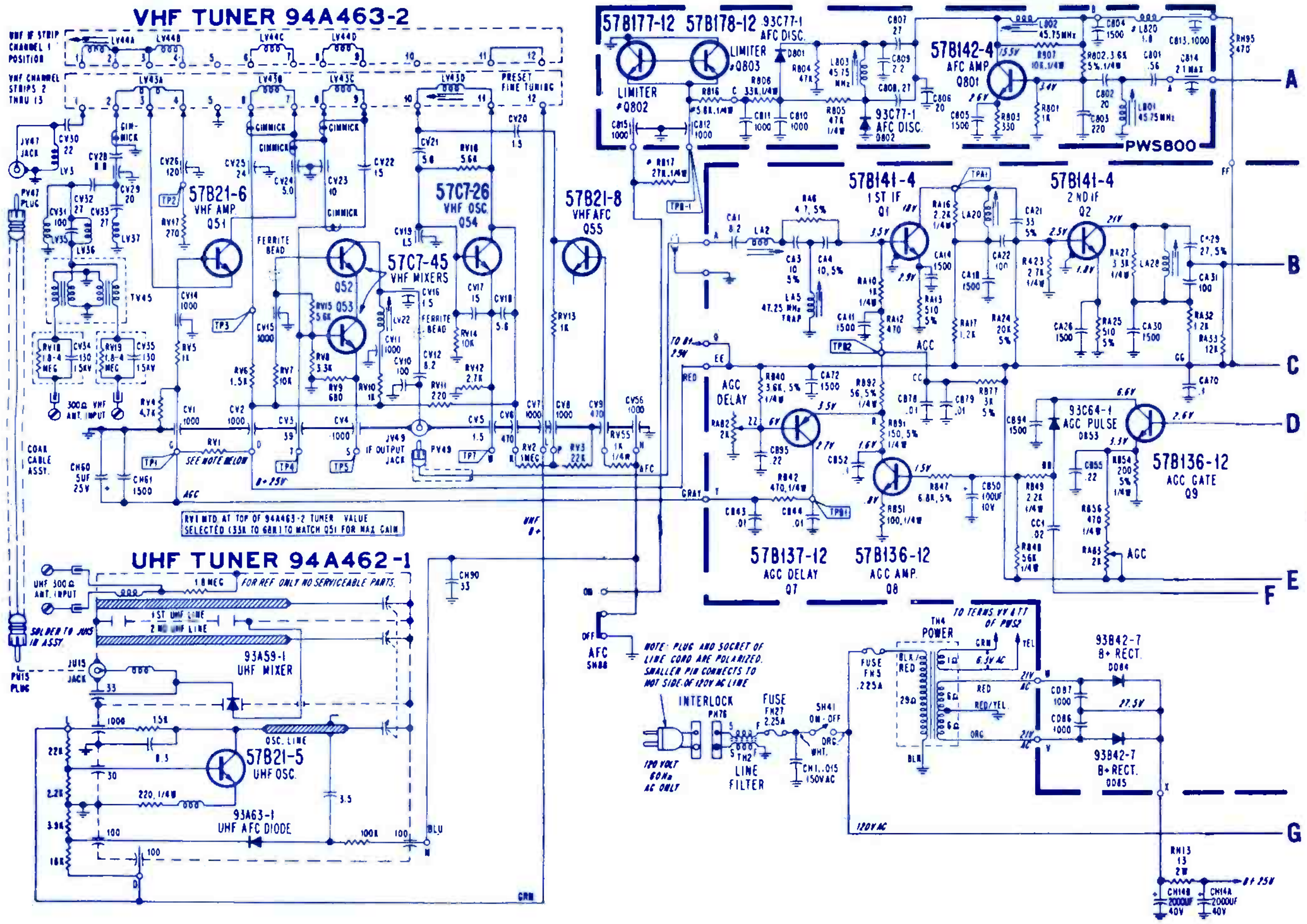
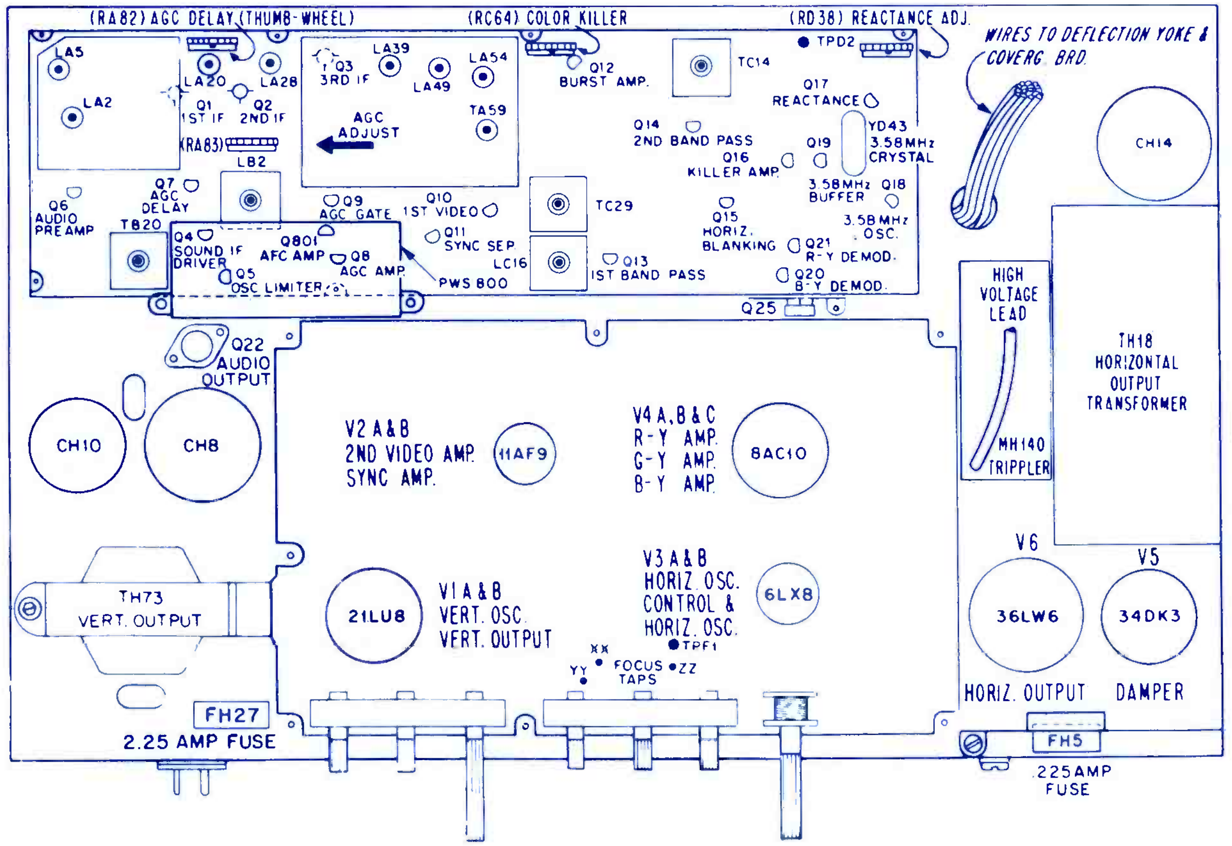
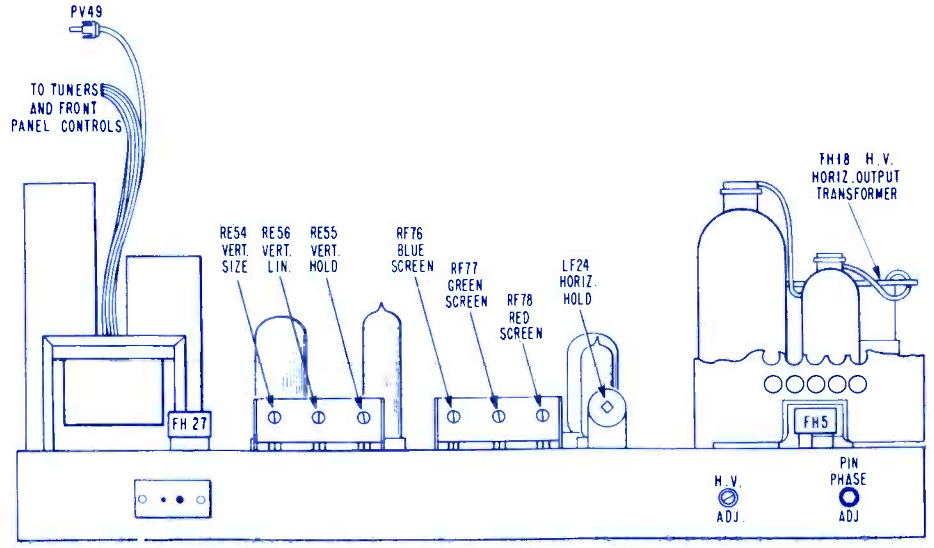


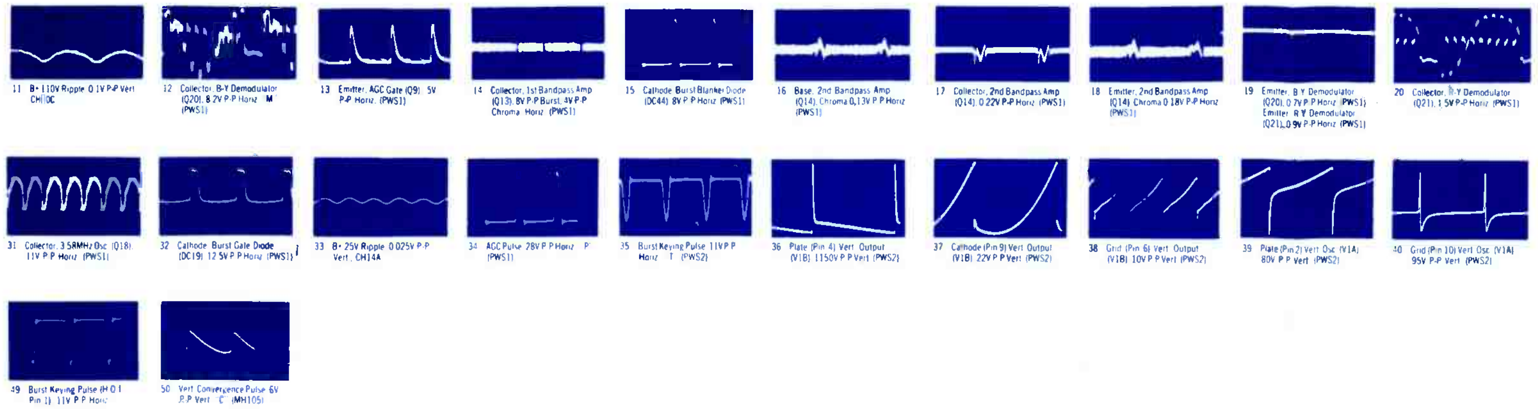


VHF Tuner Top View



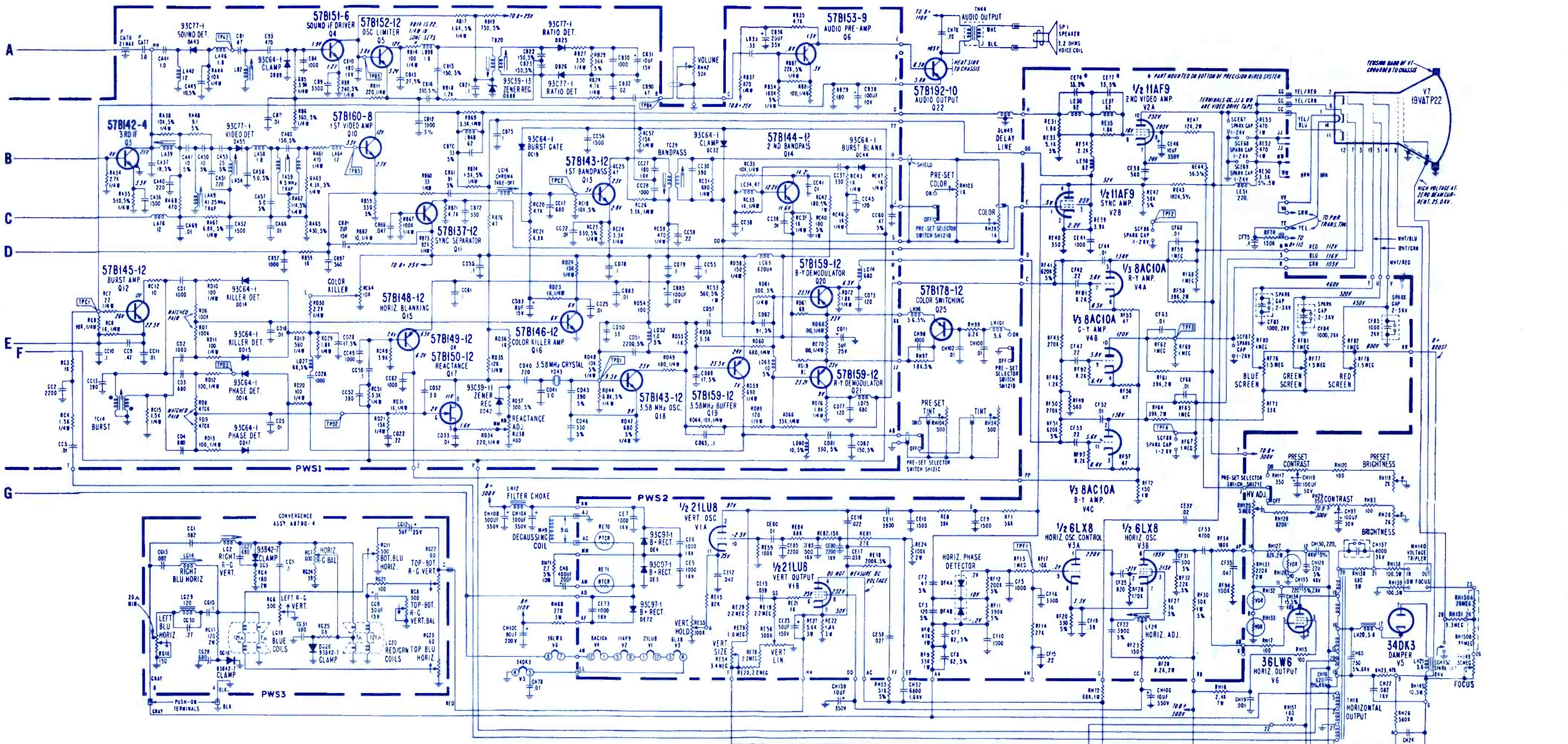


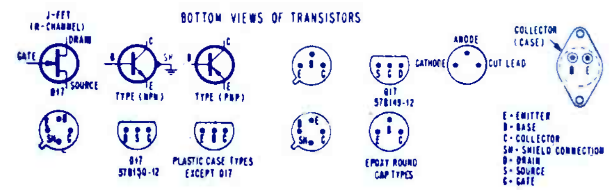




SYMBOL DESCRIPTION	AIRLINE PART NO.
CH10A, B, C, D—300µf/350v, 300µf/350v, 80µf/200v, 10µf/350v elect	67A15-415
CH14A,B—2000µf/40v, 2000µf/40v elect	67A15-413
RH150A, B—bleeder focus module	61A71-1
RA82—2K AGC delay	75A101-31
RA83—2K AGC	75A101-31
RC64—10K color kill	75A101-18
RE54—3.4M vert size	
RE55—100K vert hold	75A95-18
RE56—300K vert lin	
RH28—2K brite	75A140-25
RH29—350Ω contrast	75A140-26
RH39—1K color	75A175-12
RH42—50K vol W/SH41	75A140-31
RH125—5M high volt adj	75A135-57
RH149—30M focus adj	75A108-8
LC16—coil chroma take-off	72A329-1
LD52—coil 1µh, 3.58MHz output	73A55-37
LF24—coil horiz adj	94A351-1
MH57—deflect yoke	94A571-2
TA59—xformer, 4.5MHz trap	72A216-7
TB20—xformer ratio detect	72A318-1
TC14—xformer burst	72A325-3
TH2—xformer line choke	73A31-16
TH4—xformer power	80A108-14
TH18—xformer horiz output	79A169-3
TH44—xformer audio output	79A141-4
TH73—xformer vert output	79A165-1
FH5—fuse .225a chemical	84A28-12
FH27—fuse 2.25a chemical	84A28-16
tuner VHF	94A463-2

AIRLINE Color TV Model GAI-12925A





BOTTOM VIEWS OF TRANSISTORS

NOTES: UNLESS OTHERWISE SPECIFIED RESISTANCE VALUES ARE IN OHMS, 10%, 1/2 WATT. CAPACITANCE VALUES 1 OR HIGHER ARE IN PF; CAPACITANCE VALUES LESS THAN 1 ARE IN UF. INDUCTANCE VALUES ARE IN UH. ⏚ INDICATES CHASSIS GROUND. Hz INDICATES CYCLES PER SECOND.

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

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

TRANSISTOR CAUTION: TO AVOID DAMAGE TO TRANSISTORS, DO NOT OPERATE CHASSIS WITH PICTURE TUBE DAG DISCONNECTED FROM CHASSIS GROUND. DO NOT TURN SET ON WITH TRANSISTOR (S), TUBE(S) OR LEADS REMOVED OR UNSOLDERED. DO NOT ARC 2ND ANODE LEAD TO CHASSIS GROUND. DISCHARGE 2ND ANODE ONLY TO PICTURE TUBE DAG OR DAG GROUND. USE CAUTION TO PREVENT ACCIDENTAL SHORT BETWEEN COMPONENT TERMINALS OR TO CHASSIS GROUND. DO NOT APPLY EXCESSIVE HEAT TO TRANSISTOR LEADS. DO NOT USE AN ORDINARY OHMMETER FOR RESISTANCE MEASUREMENT, USE VTVM OR R×100 RANGE OR HIGHER.

RUN NUMBER INDICATES CHANGE (S) INCORPORATED AS GIVEN UNDER THAT RUN NUMBER, AS WELL AS ALL LOWER RUN CHANGES.

SYMBOLS IN RECTANGLES INDICATE TEST POINT CONNECTIONS.

HEXAGONS IDENTIFY WAVEFORM OBSERVATION LOCATIONS. CONDITIONS FOR TAKING WAVEFORM MEASUREMENTS ARE GIVEN WITH WAVEFORM PHOTOGRAPHS.

RUN CHANGES:

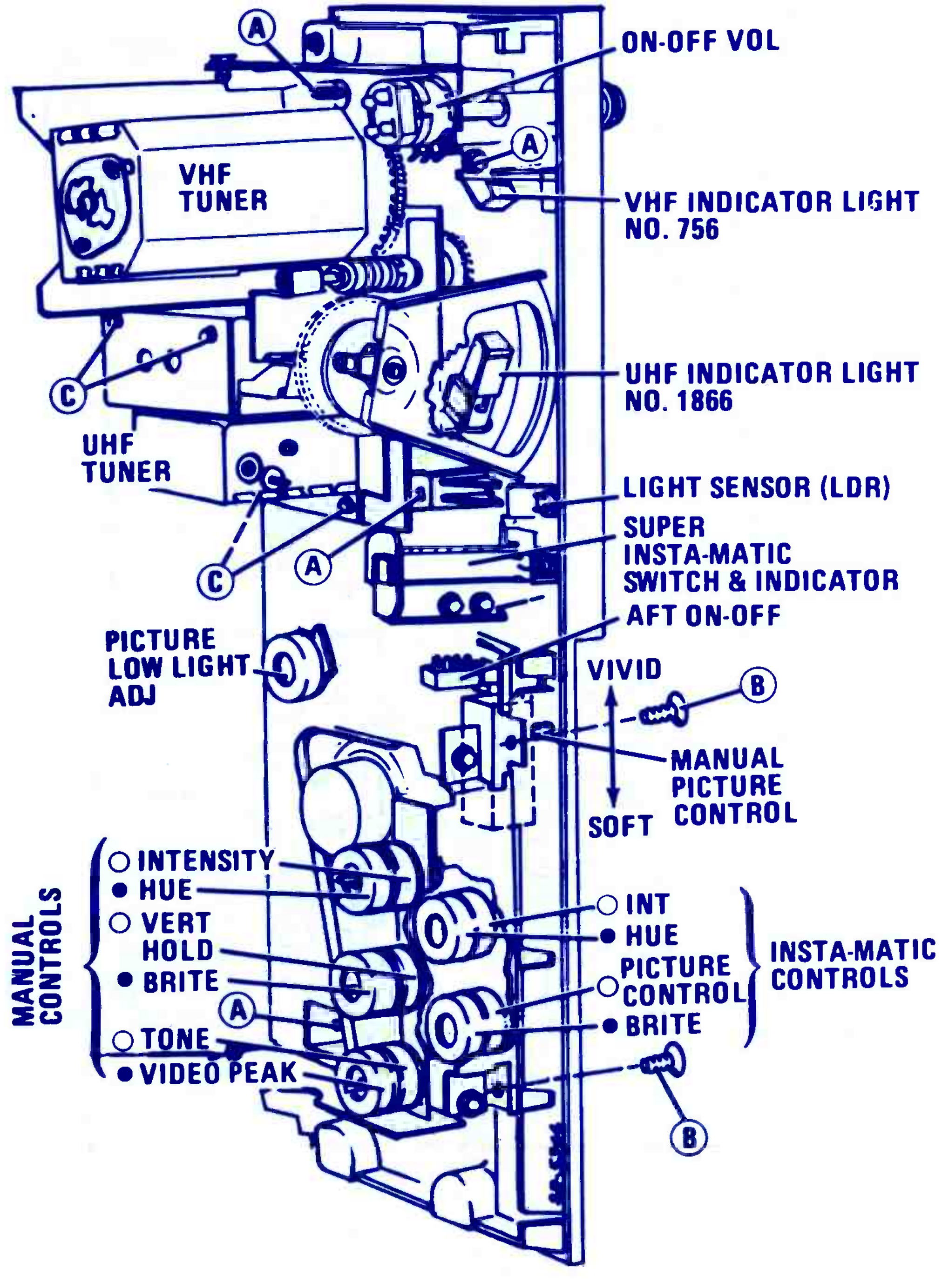
10 START OF PRODUCTION

QUASAR
Color TV Chassis
ATS, CTS, TS-942

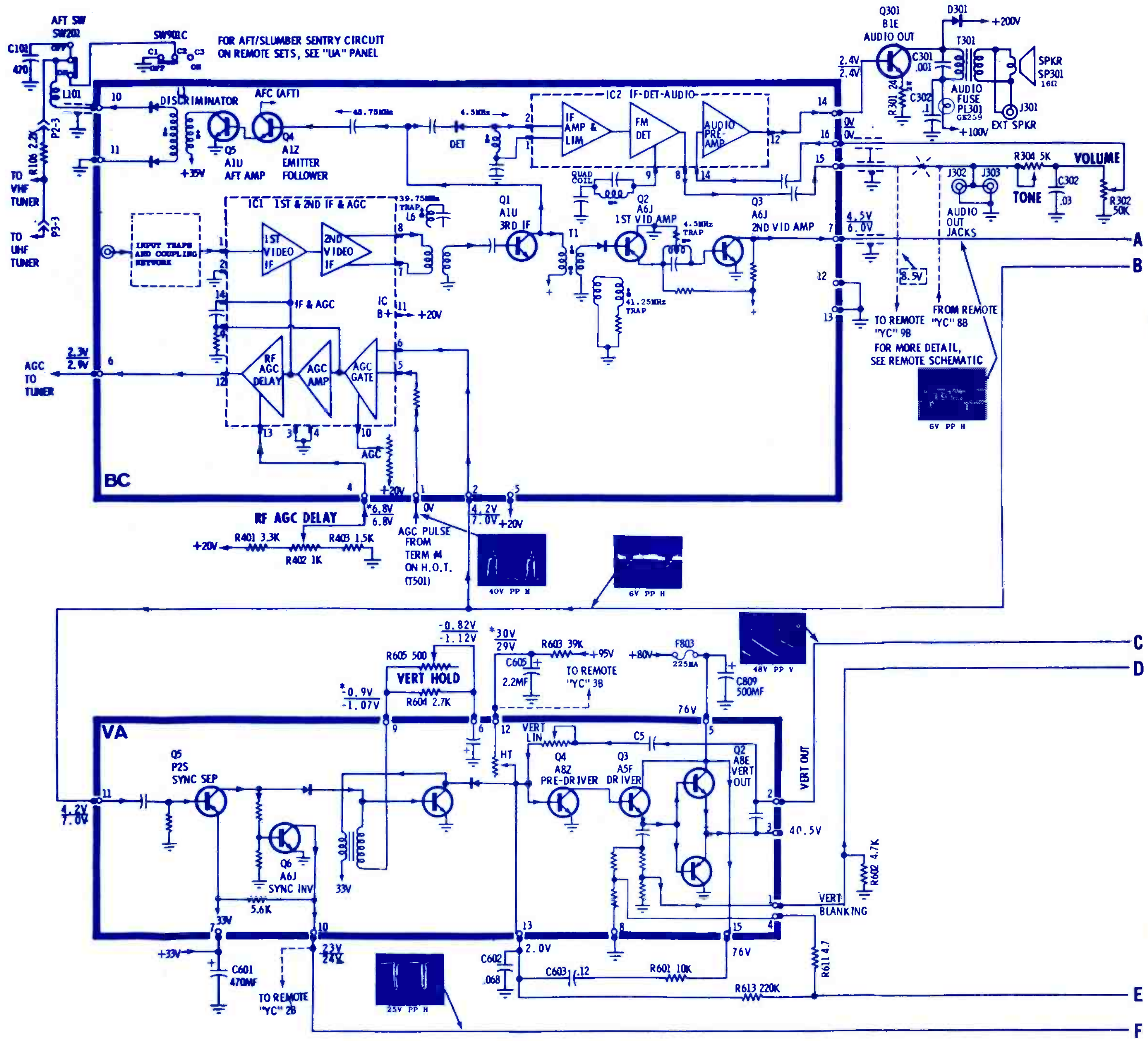
ELECTRONIC TECHNICIAN/DEALER TEKFAX

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

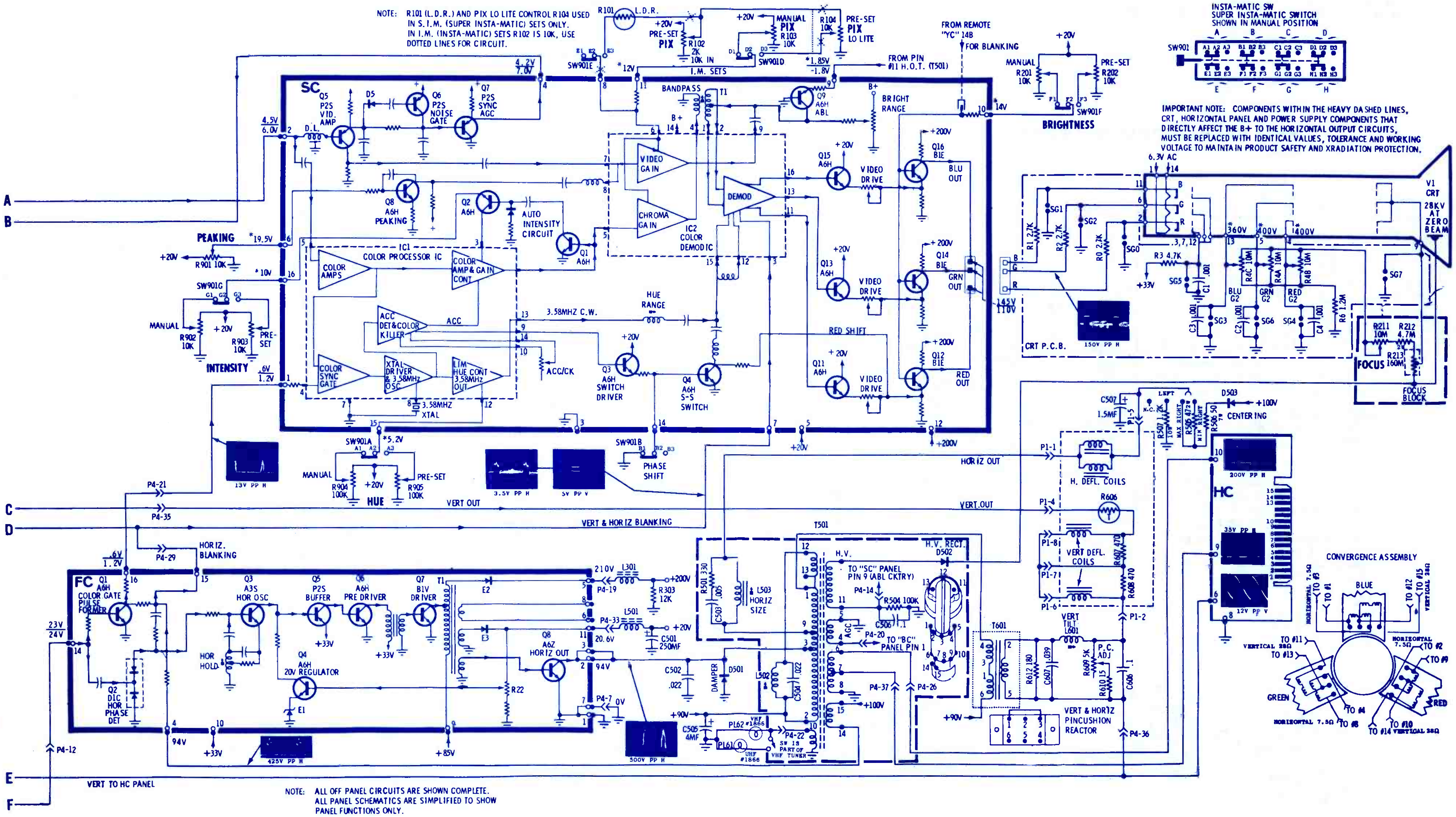
JANUARY • 1975



TS-942 Front Panel



QUASAR
Color TV Chassis
ATS, CTS, TS-942



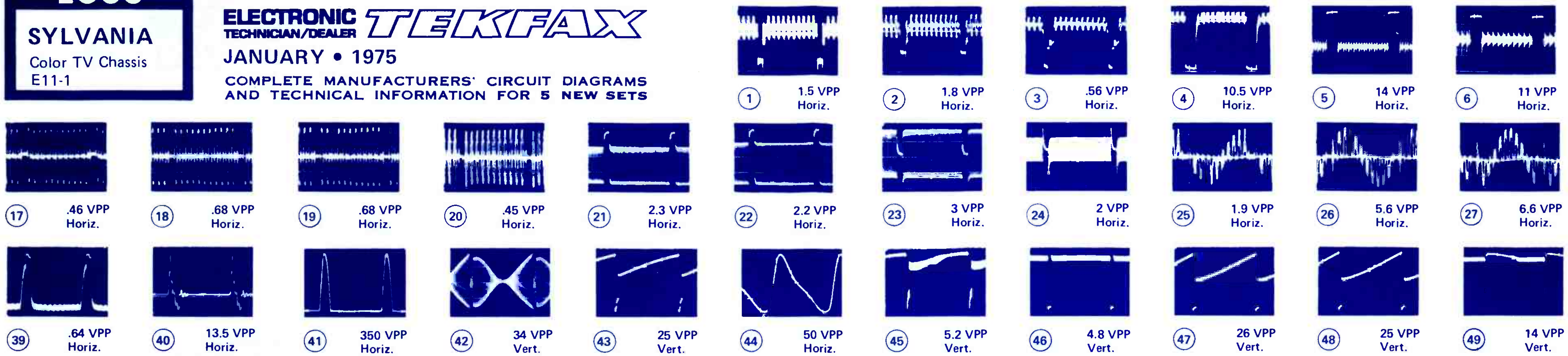
1566

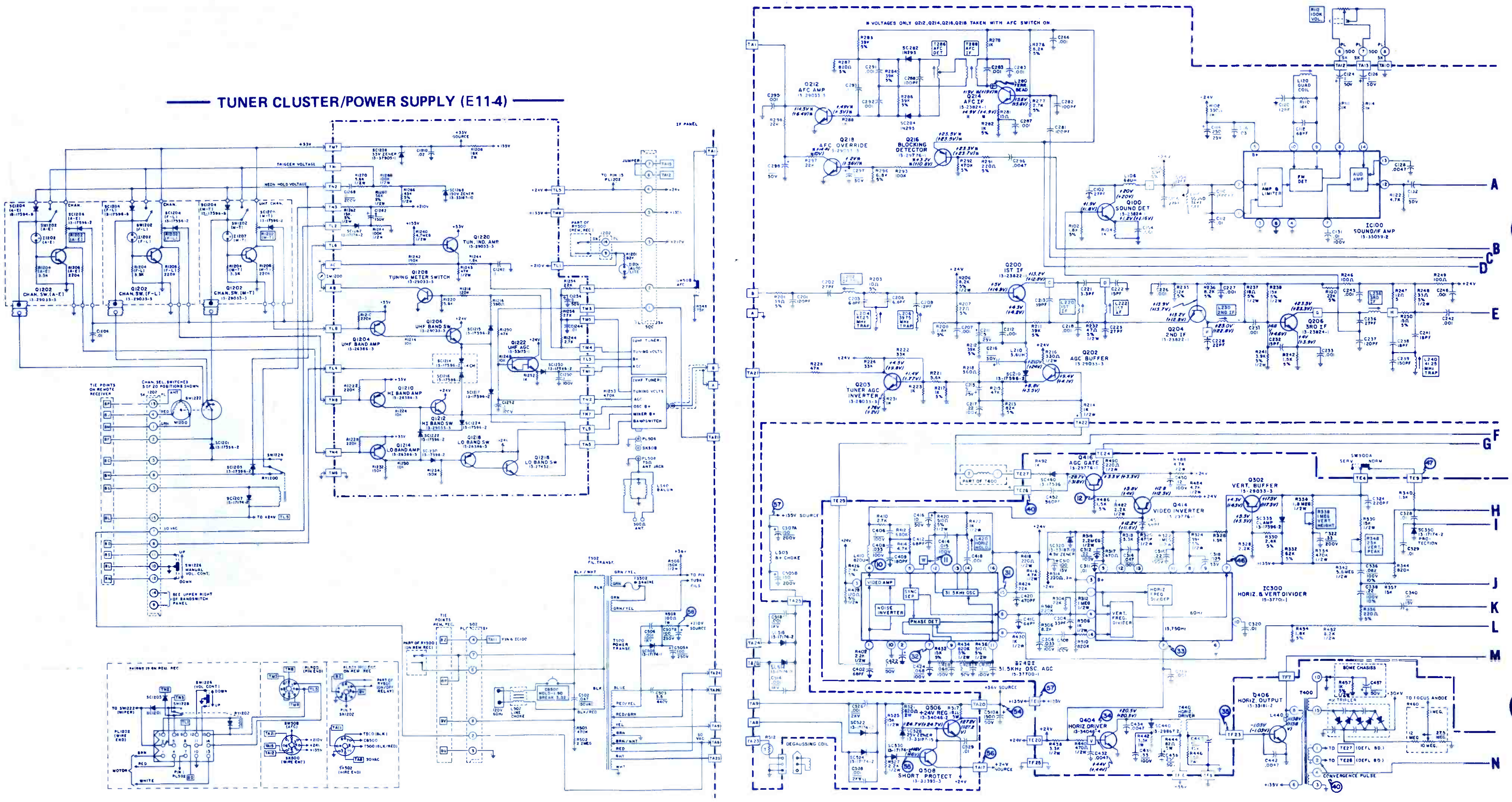
SYLVANIA
Color TV Chassis
E11-1

ELECTRONIC TECHNICIAN/DEALER TEKFAX

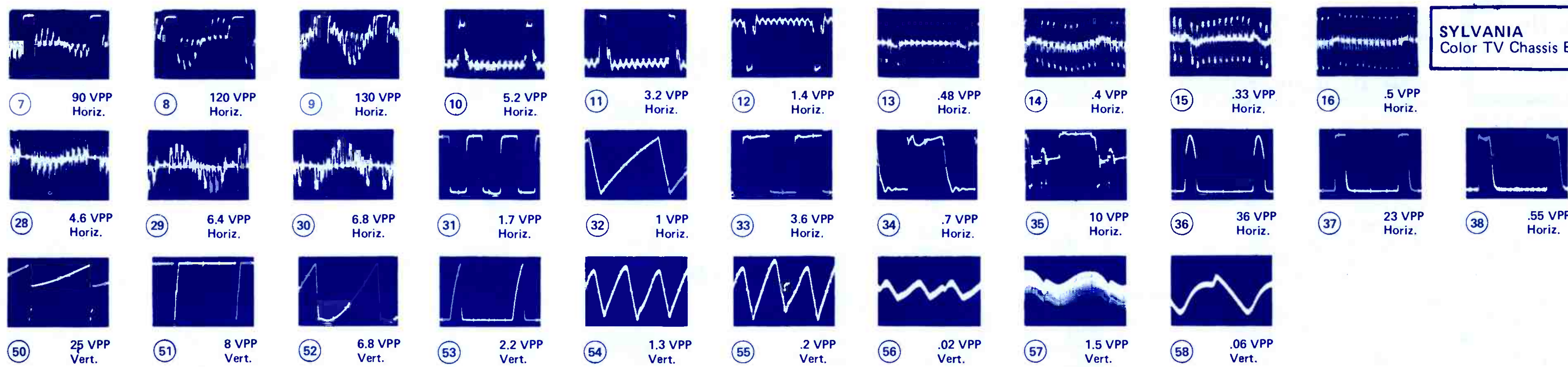
JANUARY • 1975

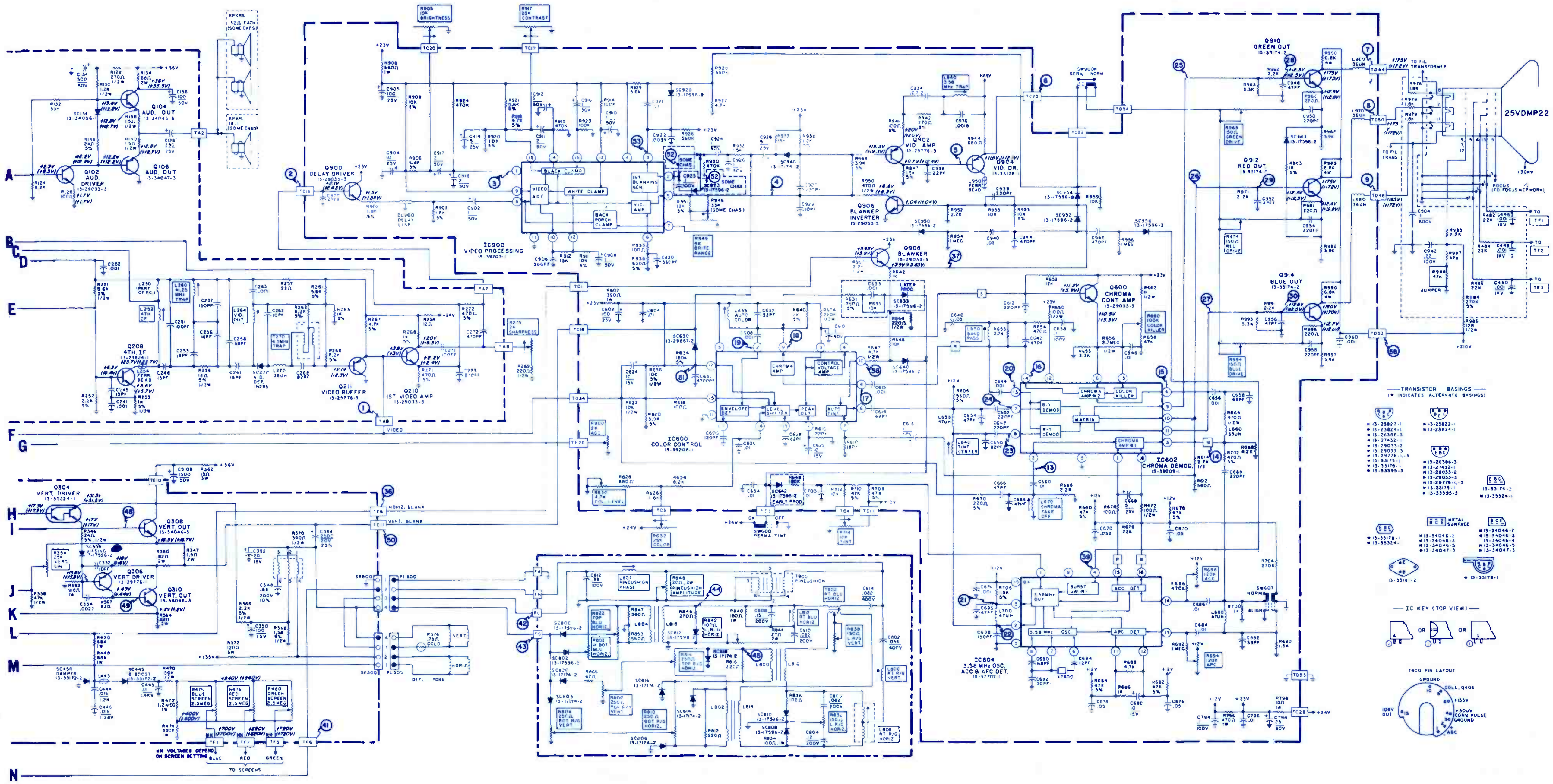
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS





SYLVANIA
Color TV Chassis E11-1





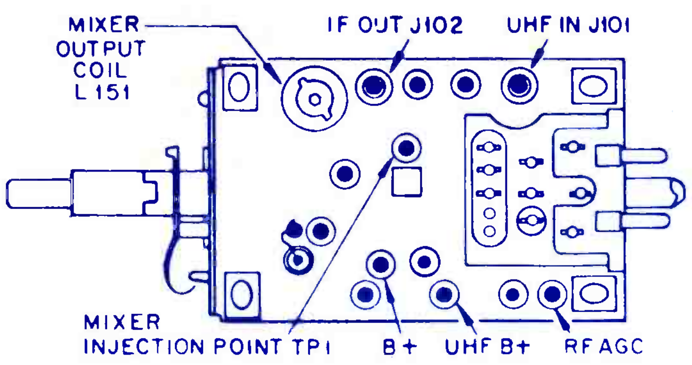
AIRLINE

TV Models
GAI-11245A,B
GAI-11265A,B

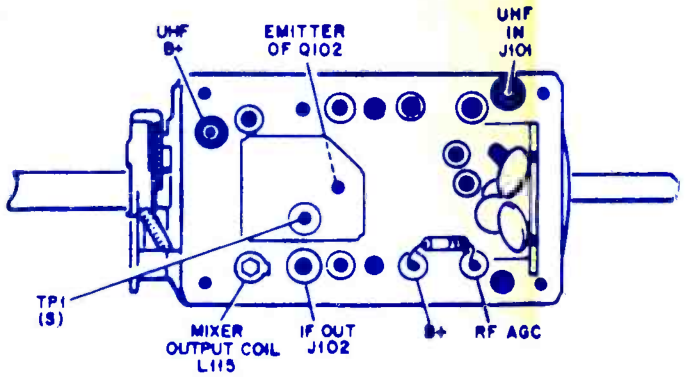
JANUARY • 1975

ELECTRONIC TECHNICIAN/DEALER TEKFAX

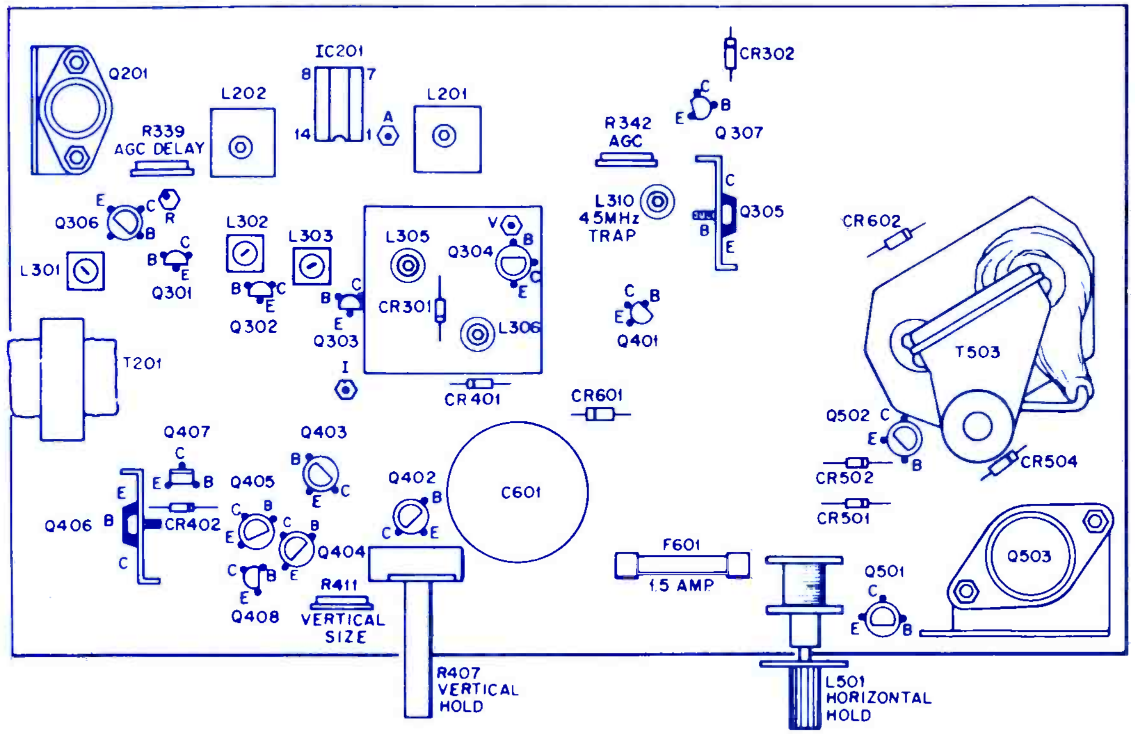
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 5 NEW SETS



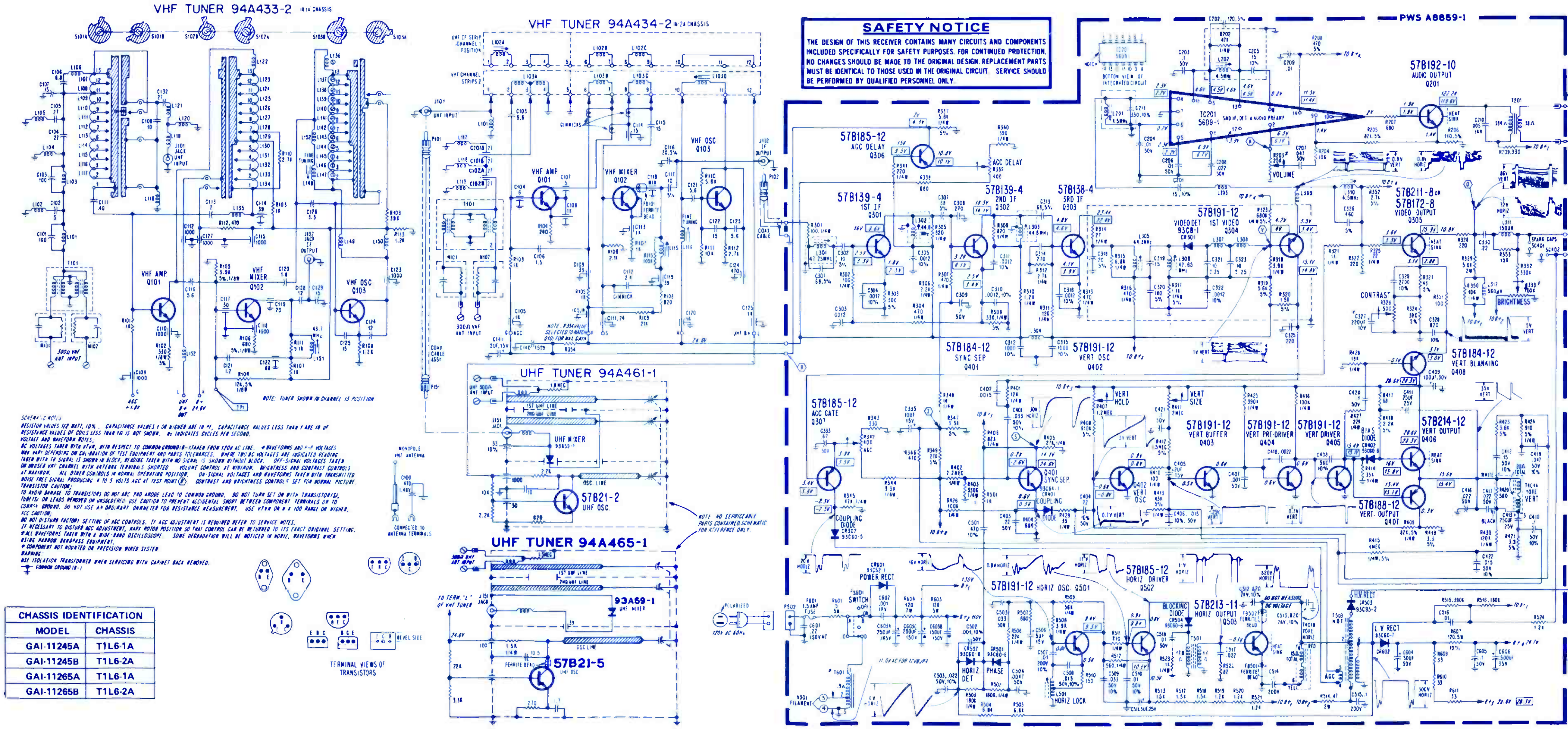
Top View of VHF Tuner (94A433-2) Showing Test Point and Alignment Locations



Top View of VHF Tuner (94A434-2) Showing Test Point and Alignment Locations



Top View of Chassis Showing Alignment Locations and Test Points



SAFETY NOTICE

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

CHASSIS IDENTIFICATION	
MODEL	CHASSIS
GAI-11245A	T1L6-1A
GAI-11245B	T1L6-2A
GAI-11265A	T1L6-1A
GAI-11265B	T1L6-2A

Jim is one of the busiest antenna installers in Pennsylvania. He does work for 17 major appliance dealers. But the bulk of his antenna sales come from his own advertising, yellow page listings and word-of-mouth recommendations from satisfied customers.

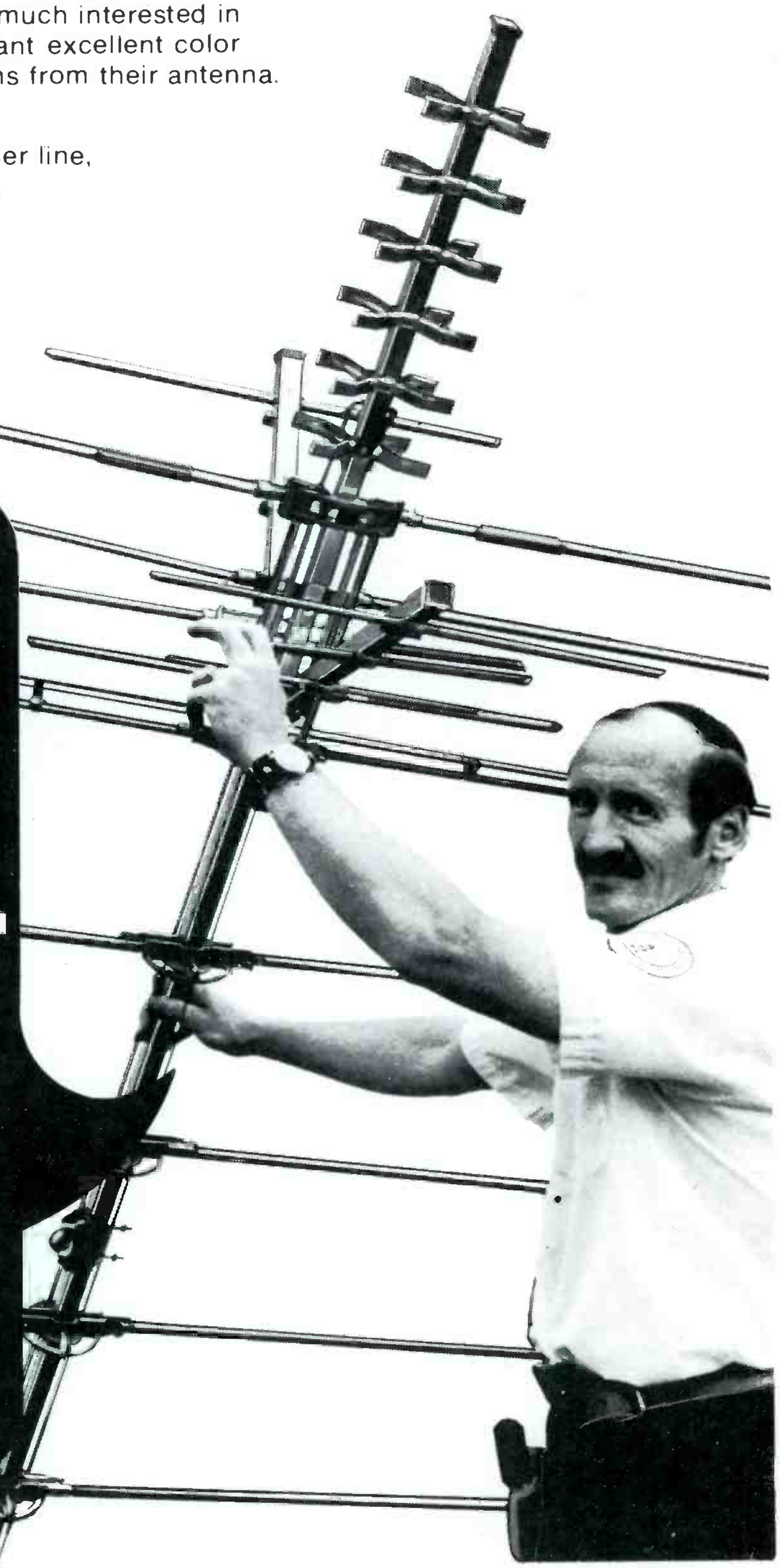
JERROLD
a GENERAL INSTRUMENT company

Jim doesn't try to be the cheapest — only the best. He stresses quality of workmanship plus quality of materials. With this philosophy and a lot of hard work, Action Sales has doubled sales volume each of the four years since Jim started the business.

"My reputation means everything to me," says Jim. "That's why I'm so delighted with the performance and durability of the Jerrold Super VU-Finder line. My customers aren't much interested in the technical specifications. But, they do want excellent color quality without interference and no problems from their antenna. And that's what Super VU-Finder delivers."

For more information on the Super VU-Finder line, contact your local Jerrold Distrubutor or . . .

JERROLD ELECTRONICS CORPORATION
Distributor Sales Division
P.O. Box 350
200 Witmer Road, Horsham, Pa. 19044



THE JERROLD SUPER VU-FINDER IS THE FINEST ANTENNA EVER BUILT!

SAYS JIM WELLENER
ACTION SALES
FEASTERVILLE, PA.

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The easy-to-read 630 makes learning easy.

The Model 630 V-O-M is priced at a thrifty $72.

The rugged, general purpose Triplett Model 630 is the kind of dependable V-O-M that both teachers and students appreciate. And for the same reasons the electronic and electrical maintenance professionals do. Uncompromising accuracy. Sturdy lightweight (only 3 lbs. with batteries). Simplified single switch operation holds errors to a minimum, and diode overload protection for the meter suspension movement reduces the chance of tester damage when mistakes do occur.

With long, clean scales covering 27 ranges in only four arcs, the Triplett Model 630 is remarkably easy-to-read.

It's packed with major features:

1. **Diode overload-protected suspension movement V-O-M; single range switch minimizes error.**
2. **4 Ohmmeter range with 4.4 ohms center scale.**
3. **Simplified scale—only 4 arcs for all 27 ranges.**

Sensitivity is 20,000 Ohms per Volt DC, 5000 Ohms per Volt AC. Accuracy is an excellent 2% on DC, and 3% on AC. Measures resistance to 100 megohms, with 6,000 Volt AC and DC capability.

Handles DC microamperes 0-60, and DC milliamperes 0-120, both at 250 mV, and can read DC amperes 0-12.

Rugged black molded plastic case with removable black leather carrying strap. All this for just **$72.**

Get the same convenience and operating advantages plus 1½% DC accuracy and mirrored scale with the Triplett Model 630-A, priced at only **$83.**

For more information or a free demonstration, call your Triplett distributor or sales representative. For the name of the representative nearest you, dial toll free (800) 645-9200. New York State, call collect (516) 294-0990. Triplett Corporation, Bluffton, Ohio 45817.

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