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ELECTRONIC TECHNICIAN/DEALER

WORLD'S LARGEST TV-RADIO SERVICE & SALES CIRCULATION



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3. PTS uses only ORIGINAL PARTS! No homemade or make-do, inferior merchandise (this is why we charge for major parts!). You get your tuner back in ORIGINAL EQUIPMENT condition.
4. PTS is recommended by more TV Manufacturers than any other tuner company.
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UV-COMBO	17.95
IF-SUBCHASSIS	12.50

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1. FREE TRIAL OFFER

Data Technology's Model 21 is unique. There's no question about it: a palm-sized 3½ digit DMM that measures capacitance along with AC and DC volts and resistance. Send for the Model 21 now and use it daily in the field or at your bench. Carry it around, knock it around, use it hard, work it long, and if at the end of two weeks you don't think it's worth the \$269.00 we're asking, send it back. And you won't spend a dime.

2. DELIVERY WITHIN 14 DAYS

We understand. Once you've decided you want an instrument, especially a piece of equipment as new and exciting as the Model 21, you don't want to have to go through the old, tedious, inquiry run-around. Mail in the coupon. Before fourteen days have passed, you'll be using your Model 21.

3. SMALL LIGHTWEIGHT PORTABILITY FOR HANDHELD OPERATION

What do you need in a portable DMM? How about a palm-sized unit that fits comfortably in your hand? We've fit all of the range and function features you wanted into a package that slips into a pocket. Only 12 ounces in a case 6.80 inches by 3.25 inches by 1.75 inches.

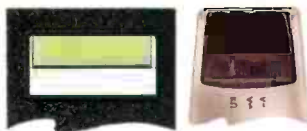
4. UNIQUE CAPACITANCE READINGS



Model 21: Only handheld portable DMM to measure capacitance.

Data Technology's Model 21 is the first, and only, handheld digital multimeter to give the capability of measuring capacitance, along with AC and DC volts and resistance. Two meter capability for the price of one.

5. MOMENTARY OR CONTINUOUS ACTION



Battery charge life is conserved by push-to-read switches on the case side and optional push-to-read probe. For a hands off "ON" state, slide the push-to-read switch into its "locked-on" position.

6. 0.270 INCH LED READOUT

Immediately and easily visible whatever the light conditions, not like reflective liquid crystals, or small LEDs. In a digital multimeter, what could be more important than an easy-to-read display?



7. 3½ DIGITS FOR FULL 2000 COUNT

8. FLASHES OVER RANGE

The last three digits flash automatically when you are out of range. No reading errors due to the wrong range.

9. IMPACT RESISTANT

Rugged construction, inside and out, absorbs physical shock. It'll get dropped. And banged. But, anytime, anywhere your work requires, it'll keep working.



10. ACCURACY

Here are accuracy comparisons between the Model 21 and its volts and ohms competitors, the HP 970A and the Danameter. We offer this comparison because we know variety of function and range is important, but accuracy is crucial. There are four Model 21 ranges for each function. DC voltage: 2V, 20V, 200V, and 1,000V. AC voltage: 2V, 20V, 200V, and up to 1,000 peak. Resistance: 2K Ω , 20K Ω , 200K Ω , 2,000K Ω . Capacitance: 2nFd (2,000pFd), 20nFd, 200nFd, and 2,000nFd (2 μ Fd).

FOUR DC VOLTAGE RANGES



FOUR AC VOLTAGE RANGES



FOUR RESISTANCE RANGES



FOUR CAPACITANCE RANGES



11. USE YOUR CREDIT CARD OR P. O. NUMBER

Just fill in BankAmericard, MasterCharge or P. O. number, and give us your signature authorizing charge. In 15 days, when you're a happy man, we'll submit an invoice. Or you can include a check or money order with your order.

12. \$525 SPECIAL DEAL (SEE COUPON)

13. JUST FILL IN SELF MAILER BELOW

Pick up a pen or pencil and get started, so that we can send you a Model 21. But, if you're still not convinced, our strongest kickers are yet to come.

Name

Company

Address

City State Zip

- Send a Data Technology Model 21 for \$269. If I am not completely satisfied, I may return the Model 21 within 15 days and owe nothing.
 Recharger: 100V 115V 230V
- Two of us would like to order Model 21's, so pass the savings on. Two Model 21's for \$525: save \$13.00. That's special.
- I'd like the push-to-read option for \$10.
- I'll take a high voltage probe for \$15.
- Data Technology's product line sounds interesting. Send me additional literature on these product lines.

I prefer to be billed: MasterCharge BankAmericard P. O.
 Your credit card or P. O. Number. (Include four digit bank number if MasterCharge):

Signature (please sign here)

*State and local taxes, if any, will be added.

 data technology corporation

14. SPECIFICATIONS COMPARABILITY

Okay, for all of you who have been saying, "Enough words, show me the facts." Here they are.

	MODEL 21	HP 970A	DANA 2000
D.C. VOLTS			
Ranges	2V, 20, 200, 1000	1V, 10, 100, 1000 (500 max)	2V, 20, 200, 1000
Resolution	1mV	100µV	1mV
Input Protection	1000V	1000V	1000V
Accuracy	±(0.1% Rdg. + 0.5% FS)	±(0.7% Rdg. + 0.2% FS)	±(0.5% Rdg. + 0.5% FS)
Polarity	Auto	Auto	Auto
Input Resistance	10 meg	10 meg	10 meg
NWR	2V to 20V Range 30dB @ 60Hz All others 18dB @ 60Hz	Not Specified	50dB @ 60Hz
Temperature	±0.1%/°C Rdg. ±0.02%/°C FS	±0.5%/°C Rdg. +0.02%/°C FS	Not Specified
Input Current	±7nA max	Not Specified	Not Specified
A.C. VOLTS			
Ranges	2, 20, 200, 1000 (pk)	1V, 1, 10, 100, 1000 (500 max)	2V, 20, 200, 1000
Resolution	1mV	100µV	1mV
Input Protection	1000Vpeak	1000V peak	1000V peak A.C. or 250 VDC
Accuracy	All Ranges 50 to 500Hz ±(0.5% Rdg. + 0.1% FS)	1V to 1000V, 45 to 1KHz ±(2% Rdg. + 0.5% FS) 1V (>3mV) Range ±(2% Rdg. + 0.5% FS) 1V to 1000V, 1KHz to 3.5KHz ±(3% Rdg. + 0.5% FS) 1V (>3mV) Range ±(5% Rdg. + 0.5% FS)	All Ranges to 5KHz ±(1.5% Rdg. + 1.5% FS)
Response Time (5 Volt step)	<0.3 sec	Not Specified	Not Specified
Temperature	±0.3%/°C Rdg. ±0.1%/°C FS	±(0.05% Rdg. + 0.05% FS)/°C	Not Specified
Input Impedance	10 meg in parallel with 40pF	10 meg in parallel with 30pF	2 megohms
OHMS			
Ranges	2KΩ, 20K, 200K, 2M	10KΩ, 100K, 1000K, 10,000K	200Ω, 20K, 2M, 200M, 0
Resolution	1Ω	1Ω	0.1Ω
Input Protection	20V max	(fused) <115V/RMS for 1 min <250V/RMS for 10 sec	250V RMS or D.C.
Accuracy	±(0.15% Rdg. + 0.05% FS)	±(1.5% Rdg. + 0.2% FS)	±(2% Rdg. + 15% FS)
Response Time	<0.5 sec	Not Specified	Not Specified
Temperature	±0.02%/°C Rdg. ±0.005%/°C FS	±(0.05% Rdg. + 0.02% FS)/°C	Not Specified
CAPACITY			
Range	2nF to 20, 200, 2000	Does not measure capacitance	Does not measure capacitance
Resolution	1pF		
Accuracy	±(0.15% Rdg. + 0.05% FS)		
Internal	4pF		
Capacity Offset	±(0.15%/°C Rdg. +0.005%/°C FS)		
Temperature			
Input Protection	20V max		

15. FLIP-UP STAND

16. BATTERY OPERATED

When operated in push-to-read mode, the internal NiCad batteries provide typically more than 2,000 readings from the rechargeable battery pack.

17. SELF-CHARGING

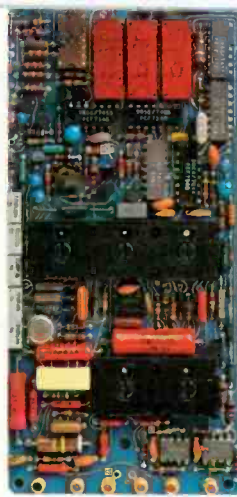
The internal battery pack recharges overnight. Please specify 100, 115, or 230 volts when ordering your Model 21.

18. HANDY BELT CARRYING CASE

Included as standard equipment.

19. CONSTRUCTED FOR FIELD CONDITIONS

Out in the field there's nothing to worry about; it's constructed for the toughest conditions. Yes, Data Technology's Model 21 had to be small, portable and multi-talented. But, what good would all that be if it was temperamental?



20. SOLID STATE SINGLE BOARD, STANDARD COMPONENTS DESIGN

Inside the high impact polycarbonate case, the Model 21 uses a single PC board that performs to your highest expectations with the fewest components. All components laid down to withstand impact, shock and abuse.

21. FIVE STEP SIMPLIFIED CALIBRATION

Only 1 adjustment for each function, plus a zero adjustment. It's less than a 15 minute job, first time.

22. HIGH VOLTAGE PROBE OPTION

If you take high voltage readings, an extra \$15 will extend your Model 21 voltage measurement capabilities to 30,000 volts.

23. PUSH-TO-READ PROBE

For an extra \$10, we'll include a push-to-read probe. Standard test leads are provided free.



24. BUILT BY DATA TECHNOLOGY CORP.

25. 1-YEAR FACTORY REPAIR

Data Technology Corporation warrants that every Model 21 Digital Multimeter meets its published specifications before it is shipped from the factory. The Model 21 is warranted against defects in materials and workmanship for a period of one (1) year from the date of delivery.

26. COST: LOW PRICE FOR PERFORMANCE

We can't help repeating ourselves: at \$269.00 it's like receiving two digital meters for the price of one. You get AC and DC volts and resistance measurement, just like our competitors offer, plus capacitance measurement. At a great price: \$269.00.

27. READY TO MAIL WON'T COST YOU A STAMP



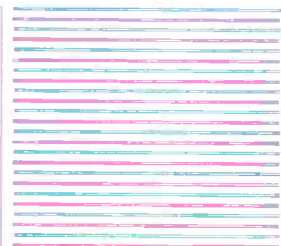
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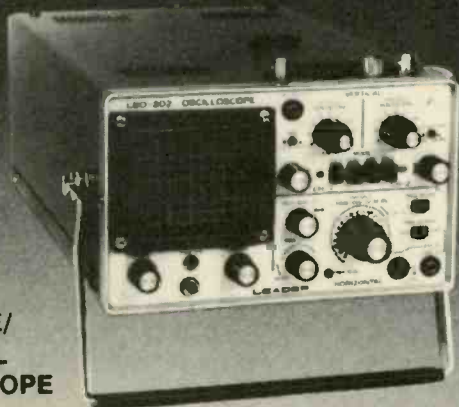


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Clovis, New Mex. 88101

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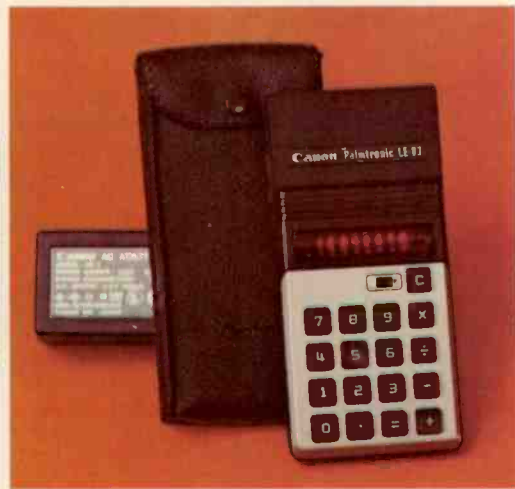
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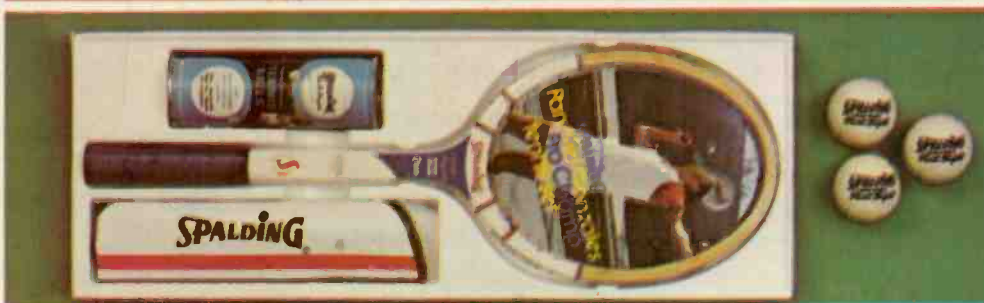


Sea King — Stalwart Bulova Sea King, 17 jewel precision timepiece, water-resistant with luminous dial. **FE-12280 Value: \$65**
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Pancho Gonzales "Pro Champ" racket, waterproof racket cover, plus three Pancho Gonzales tennis balls.
FE-531053 Value: \$18.65

TECHNICAL DIGEST

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

ADMIRAL

Tape Player Chassis 8Y6—Motor Failure

Admiral console stereo Models KS821, KS823, KS828, KS833 and KS843M were produced with alternate 8-track tape player chassis 8Y6 instead of the specified 8G6A. The chassis number is stamped on the player chassis.

If you encounter any 8Y6 tape players with motor failure caused by the motor fan rubbing or stalling on the bottom motor bracket, replace the motor with the 700A858-516 motor, which has been modified to prevent this type of failure.

MAGNAVOX

New "CE" Color TV Models—Modifications

Last year, the 10-digit, alpha-numeric model numbering system was put into effect. Models introduced in 1973 were identified by the letter "D" in the model number, such as the color TV model CD4730WA11. Since the first of this year, several models have been shipped with the second letter updated to "E," such as CE4731WA11, to indicate 1974 model introductions. Certain color TV models which use the T989 chassis and carry the "E" designation have been modified in the following ways:

First, the wiring for the AFT switch has been altered to enhance the benefits provided by the Videomatic feature. Formerly, the AFT circuit could be switched on or off only when the VIDEOMATIC button was in the on position. With Videomatic off, the AFT circuit was inoperative. This switching action has been reversed in the "CE" models so that AFT is always on when Videomatic is on, regardless of the AFT switch position. When Videomatic is off, the AFT circuit may be turned on or off as desired. The AFT switch is located on the front panel of "E" models and on the secondary control (rear) panel of "D" models.

A second change concerns the HIGH BRIGHTNESS ADJUST (on the rear apron of the chassis), which has been deleted in the "CE" models. One PRESET BRIGHTNESS control has been retained for Videomatic set up, and is positioned behind the customer-operated BRIGHTNESS control. This preset control should be adjusted for the desired brightness level with the VIDEOMATIC switch in the on position and with the customer BRIGHTNESS control set at the 12 o'clock position.

Also, a PRESET CONTRAST control has been mounted behind the main CONTRAST control. Similar to the other preset adjustments, the PRESET CONTRAST control is adjusted through the hollow shaft of the customer-operated CONTRAST control, and it is set for the desired contrast level with the VIDEOMATIC switch in the on position and the customer CONTRAST control set at the 12 o'clock position. Stereo theatre models which use the 704078 remote control do not have the PRESET CONTRAST control, because the PRESET COLOR control occupies this position.

Color TV Chassis T989—Digital Channel-Indicator Dimmer Circuit

Color TV models which use the T989 chassis and the 704084-1 Six-Function Remote Control system have a dimming circuit to control the brilliance of the channel-indicator lamps. In normal operation, the proper combination of lamps is switched in for each position of the channel-selector knob to indicate the channel number. When a

channel is first switched in, the selected channel-indicator lamps glow at maximum brilliance for several seconds. At the end of this time, a dimmer circuit switches the lamps to a half-power condition so that the channel number becomes less noticeable during normal viewing.

There have been cases reported where the lamps remain at full brilliance all of the time. In each instance, the problem was traced to a shorted or leaky diode, D20, on the Remote Receiver module. The diode is made of germanium, rather than silicon, and this fact is important to the correct operation of the remote system. Should diode D20 require replacement, be sure to use the correct replacement—Part No. 530092-1001.

RCA CORPORATION

"Triple-Branded" 6MJ6/6LQ6/6JE6C Horizontal Deflection Tube

The new RCA 6MJ6, which has been triple-branded to include 6LQ6 and 6JE6C, is a double-ended, high-perveance, beam power tube of the novar type with a T-12 envelope. This tube type is specifically designed to be an ultra-reliable field replacement for the older 6LQ6 and 6JE6C tubes in horizontal deflection amplifier service in color TV receivers.

This new horizontal-output tube has an integral envelope top-cap assembly which eliminates loose top-caps and minimizes glass dome failures.

The design also assures reduced microphonics and improves the ability to withstand shock and vibration. Other improvements allow this type to endure the excessive plate dissipation encountered during receiver fault conditions. Control testing assures that the tube can withstand a 200-w plate dissipation for a continuous or accumulated exposure time not exceeding 40 seconds, which should be sufficient time to permit conventional receiver protection devices to function.

The sharp high-voltage cutoff characteristic and the high transconductance (gm) of the tube assure low retrace conduction levels even in TV receivers with reduced drive voltage.

A plate connector cools the plate by conduction, resulting in lower plate operating temperatures and longer life. The special plate structure is designed to minimize secondary-electron emission from the plate and "knee" discontinuities in the zero-bias region of the $E_p - I_p$ characteristic. A separate base-pin connection to grid No. 3 is provided so that positive voltage can be applied to grid No. 3 to minimize interference from "snivets" and to increase power output. ■



"Electronic discoveries are being made daily so I don't want to make a definite diagnosis until I've consulted other specialists."

TECHNICAL LITERATURE

Speakers

A 2-page, two-color data sheet describes the company's Magneplanar Tympani line of loudspeakers. It describes five different speaker models and includes detailed specifications on performance as well as physical factors. Audio Research Corp., 2843-26th Avenue South, Minneapolis, Minn. 55406.

Industrial SCR's

A brochure describing SCR's Triacs and Ignistors designed for industrial equipment is now available. Included are products suitable for power controllers, inverters, induction heating, radar pulse modulators and high-power welding. Bert Green, Product Manager, Power Tubes and Devices, Amperex Electronic Corp., Hicksville, N.Y. 11802.

Industrial Tubes and Semi-Conductors

A 48-page wholesale industrial type electron tube and semiconductor directory is available. Listing over 20,000 entertainment, industrial, power conductors, such as diodes, transistors, SCR's, FET's and integrated circuits. Communications, Inc., 2115 Avenue X, Brooklyn, N.Y. 11235.

Voltage Regulator Diodes

An 8-page, short-form catalog of voltage regulator diodes is now available. The catalog provides technical data on more than 100 types of zener diodes, reference diodes, and stabistors available from Amperex. Included in the catalog are charts showing temperature coefficients and derating factors, noise generation, and stabistor conductance characteristics. Amperex Electronics Corp., Solid State and Active Devices Division, Slatersville, Rhode Island 02876.

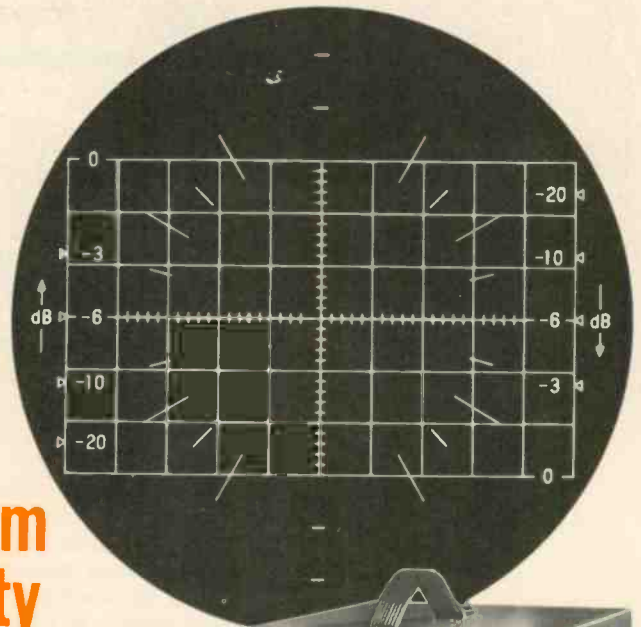
Sound Equipment

A 124-page catalog of sound equipment and accessories describes in detail the product lines of 48 leading manufacturers. The publication is illustrated throughout, and products are indexed by both category and manufacturer. Net prices are provided, completely up-to-date and current as of press time. Sound Foyer, 1521 South Hill St., Los Angeles, Calif. 90015. ■

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NEWS OF THE INDUSTRY

PTS Electronics Opens Three New Tuner Service Centers

PTS Electronics, Inc., an Indiana-based tuner repair company, has announced the opening of three new service centers, in Miami, Florida (12934 N.W. 7th Avenue); Detroit, Michigan (13709 W. 8 Mile Rd.); and Memphis, Tennessee (3614 Lamar Ave.).

Consumer Electronic Sales During First Four Months of 1974 Below Levels of Same Period in 1973

Total U.S. sales to dealers of all categories of consumer entertainment electronic products during the first four months of 1974 were substantially below sales in the same period of 1973, according to a report issued recently by the Electronic Industries Association's (EIA) Marketing Services Department.

Color TV sales to dealers were down 7.6 percent in the first four months of 1974 over sales in the same period last year. Monochrome TV sales to dealers were down 11.5 percent in the same period. Total TV set sales to dealers were down 9.3 percent in the first four months of 1974 from the level of sales in the same period in 1973.

WESCON '74 Sept. 10-13

The 1974 Western Electronic Show and Convention (WESCON) will be held September 10-13 at the Los Angeles Convention Center.

Exhibitors at WESCON include a number of manufacturers who produce products and test instruments for consumer electronic servicing.

Zenith '75 Color Line Includes Only One Tube Type Chassis

Of the approximately 52 color TV models introduced by Zenith in the company's 1975 product line, only one, a hybrid 16-inch portable receiver, contains receiving tubes. The others are all-solid-state.

By June 1975, the complete Zenith color TV line will be all-solid-state, according to Walter C. Fisher, Zenith sales and marketing executive vice president.

RCA to Phase Out Home Audio Products in 1975

RCA Consumer Electronics has announced that it will phase out of the home audio products business by next year and will concentrate solely on television-related home entertainment products.

The 1975 line of home audio products will be the last such line of radios, audio tape players and recorders, and phonograph equipment, including home stereo systems, to be offered by RCA.

William C. Hittinger, RCA executive vice president, Consumer and Solid State Electronics, said the decision to drop the home audio line "will enable us to marshal our technological and marketing resources behind television-related products which continue to offer superior profit potential and an excellent worldwide growth outlook."

Teledyne Packard Bell Phasing Out Production of Home Entertainment Electronic Products

Teledyne Packard Bell has announced that it plans to discontinue the production of home entertainment products. The phase out of television and stereo manufacturing at its plants in Nogales, Mexico, and Los Angeles, California, reportedly began in May. Marketing of Teledyne Packard Bell products will continue for the present through existing channels of distribution.

Packard Bell also announced that its retail dealers will continue to receive product support, parts availability and warranty service through Teledyne Service Company, which has ten parts depots and 55 service branches located in major cities throughout the United States.

Vermont Passes TV Technician Licensing Law

The Vermont State Legislature has passed a bill which provides for the licensing of radio and television technicians, effective January 1, 1975. The bill recently was signed into law by Vermont Governor Thomas Salmon. ■

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.

New York EASAC Elects New Officers

The Electronic & Appliance Service Association Council, Inc., (EASAC) Albany, New York, has announced election of the following new officers: Henry Wawryck, Hicksville, president; Thomas Delaney, Long Island City, executive vice president; Hy Latman, Brooklyn, vice president-appliances; Warren Baker, CET, Albany, vice president-electronics; and Hy Sheffron, Brooklyn, treasurer.

EIA and AEM Agree on Merger

The Electronic Industries Association (EIA) has announced that it has agreed in principle to a merger of the Association of Electronic Manufacturers (AEM) into the Distributor Products Division (DPD) of EIA.

The EIA approval of the merger in principle follows similar action by each of the two AEM Divisions, Eastern and Central, at their respective June 4 and June 5 meetings. A joint EIA/AEM Merger Committee has been meeting frequently since the beginning of the year to reach agreement on the principle terms of the merger, which have been identified as membership eligibility requirements, dues rates, and the organizational structure of the merged organizations. Agreement on these matters, as well as a merger timetable, was reached by the Merger Committee on June 10.

NARDA Institute of Management

The National Appliance and Radio-TV Dealers Association's (NARDA) 20th annual Institute of Management will be held August 11-16 at the University of Notre Dame Modern Center for Continuing Education, near South Bend, Indiana.

The six-day Institute, which focuses on both fundamental and advanced techniques for managing consumer electronic retailing and servicing businesses, offers three levels of study: the First Year Class, for those attending for the first time; the Advanced Class, for everyone who previously attended the First Year Class; and the Graduate Class, for those who have participated in two or more Institutes.

Topics which will be covered include: *Watch Your Expenses*, *Sales Budgeting Effectively*, *Problem Solving in the Service Department*, *How to Organize and Profit from a Critique Group*, *Getting the Most Out of Your Cost-of-Doing-Business Survey*, *Looking at Your Store Image*, and *Using Financial Statements More Effectively*, plus many other management-oriented topics.

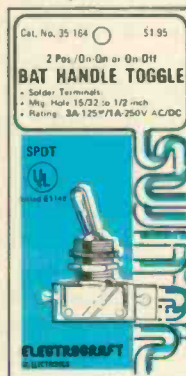
Instructors include a number of nationally known management authorities, including Dr. William R. Davidson (Management Horizons), Drs. Bernard J. Kilbride and John J. Malone (Notre Dame), Dr. Martin L. King (University of Tennessee), and Dr. James Owens (American University).

Cost of the Institute is \$180 for NARDA members and \$225 for nonmembers, and includes tuition, housing (two in a room), all meals and all materials. Registration can be made in advance or at the Notre Dame Residence Hall (Juniper Road) on August 11. For more information, contact: NARDA (Phone 312-726-5583). ■

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Sony's Wide-Angle Trinitron Color TV

by G. P. McGinty

GCS equipped horizontal output, a unique low-voltage regulator system and a 114-degree Trinitron Color CRT



Sony's Model KV-1722 Color TV, which is equipped with the 114-degree Trinitron color picture tube.

■ Most color TV receivers employ some type of power supply regulator to compensate for variations in line voltage. The Sony Model TV-1722 employs a new type of switching-mode regulation which is driven by the horizontal oscillator and is not only very efficient but takes up very little cabinet space. The Gate Controlled Switch (GCS) used in the regulator circuit operates like an SCR except that it can be turned off by reverse current drive to the gate terminal. Another GCS is used in the horizontal-output circuit.

This chassis also employs a new Excess Voltage Protection circuit which monitors the B+ voltage and, in case of a shorted circuit, the auxiliary circuit functions as a shut-down circuit to prevent damage to the GCS and other sections of the TV receiver.

The Trinitron color picture tube has a deflection angle of 114 degrees and a cylindrical face plate

using continuous, vertical phosphor strips.

The 114-Degree Trinitron Picture Tube

Like the earlier Trinitron picture tubes, the 114-degree version features a cylindrical face plate using continuous, vertically oriented phosphor stripes which are backed by an aperture grille indexing mask that employs continuous, unbroken slots. The gun structure is shorter than that of previous Trinitrons, which, together with the 114-degree deflection angle, permits much shallower cabinet designs. In addition, the shorter distance between the muzzle of the electron gun and the phosphor surface reduces the amount of electron beam divergence caused by mutual repulsion of electrons within the beam. This factor, aided by the reduction in beam diameter made possible by passing all three beams through a common, large electron-

focusing lens, produces a very small and dense beam at the points where the electrons strike the phosphors. This, in a nutshell, is why the Trinitrons produce relatively sharper focus at high levels of brightness and contrast.

Purity and Convergence

Purity and convergence adjustments are simple and straightforward in the Trinitrons because the vertical phosphor stripes are continuous and the tiny vertical errors in beam landing that can cause purity problems in delta-type phosphor dot tubes have no effect. (The same phosphor stripes are hit, just higher or lower.) Thus, purity adjustments are reduced to side-to-side aiming only.

Because the electron beams are horizontally in line, convergence is also simplified. There is only one static convergence control, adjustment of which brings all three beams

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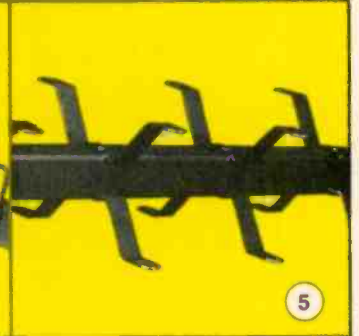
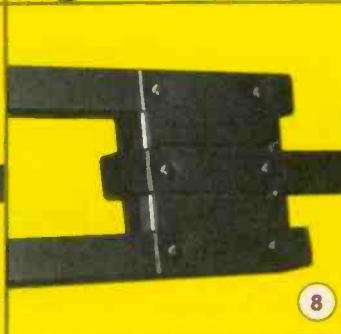
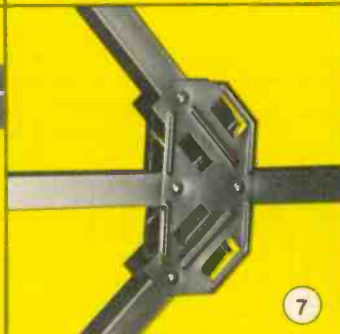
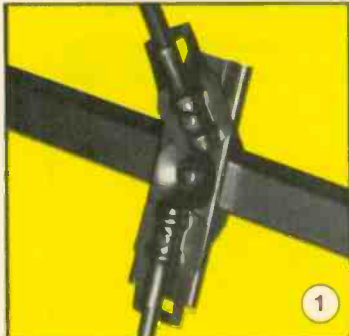
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together at the screen. Called the H STAT control (see Fig. 1), it varies the DC voltages applied between the inner and outer deflecting plates at the muzzle of the electron gun. In addition to this primary control, there are two magnetic trim tabs, mounted on the neck assembly, which correct for static errors in twist or unequal spacing of the three beams within manufacturers' tolerances.

There is only one dynamic convergence knob to adjust, the TILT control. Minor changes in horizontal and vertical dynamic amplitude are made by wire-link selection on the deflection PC board. Although the basic setup adjustments are simple and straightforward, there is no difficulty in determining when you have set the controls to the optimum points. Small disc magnets and permalloy strips cemented to the yoke housing and tube funnel correct any small areas of misconvergence at the corners of the tube. The technician's only concern with these "doodads" is when the picture tube needs to be replaced. If you're going to service the Trinitron, it is a good idea to have a few disc magnets and permalloy strips on hand. You can

get new ones from Sony or you can reuse those you save from dud tubes.

Serviceability

Chassis layout is clean, with all printed-circuit boards positioned for easy accessibility. They are mounted foil-side-out to permit easy troubleshooting, and silk-screened solder resist is used to label components. The all-solid-state circuitry employs 26 transistors, 33 diodes, seven integrated circuits (with the equivalent of 244 transistors), three gate-controlled switches and one FET. All of these components are soldered in, and there are no plug-in modules. The tuners, the speakers and all circuit components which are not mounted on the PC Boards are readily accessible (see Fig. 2.) Because coupling between the tuner and the IF circuits is accomplished by a flat, 75-ohm system (not the conventional link-coupled over coupled stage), IF realignment is not required when the tuner is replaced.

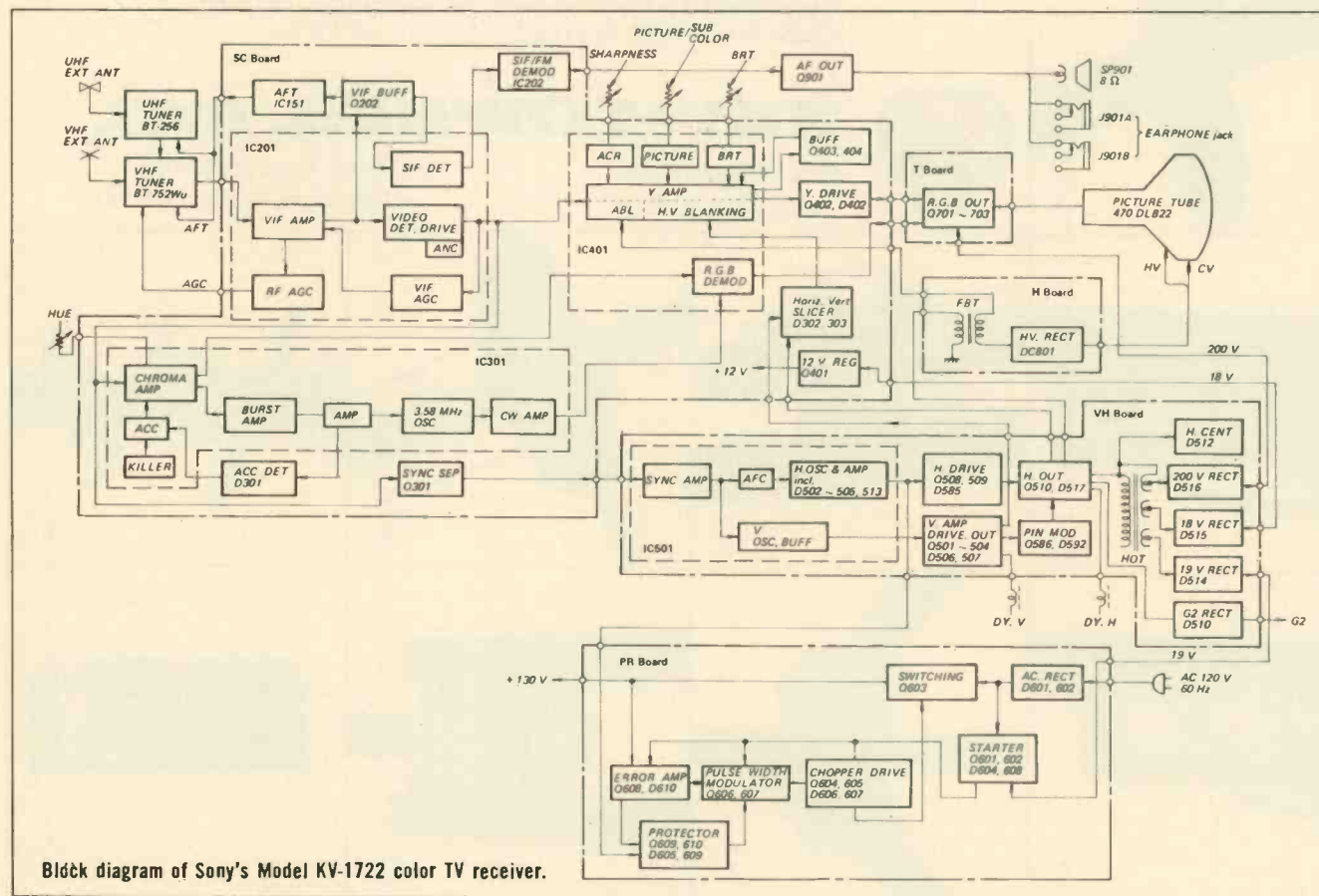
GCS Horizontal Output

A new type of semiconductor device is used in the horizontal-output stage. This is a gate-controlled switch (GCS) which operates like

an SCR except that it can be turned off by reverse current drive to the gate terminal. (Once an SCR is turned on it can be turned off only by reducing the cathode to anode forward current.) The GCS permits efficient switching of the large currents required for deflection, and withstands high anode voltages during flyback. The GCS is driven by the current waveform shown in Fig. 3. The small positive spike on the leading edge of the pulse turns the GCS on during the trace interval, and the large negative spike on the trailing edge is required to divert sufficient cathode current through the gate to turn off the GCS at the end of the trace. One vital factor, from a troubleshooting standpoint, is that loss of drive to the GCS while it is powered causes it to latch up in the *on* state. This causes immediate failure on the GCS. If you have to replace a defective GCS, be sure the correct drive waveform is being applied to the replacement before B+ is applied to the output stage—more about this later.

Switching-Mode Power Supply

All Sony TV receivers use a power supply regulator to ensure opti-



Block diagram of Sony's Model KV-1722 color TV receiver.

imum performance and correct raster size throughout the expected variation in line voltage. Conventional series regulators are wasteful of both power and space. The pass transistor must dissipate quite a bit of power and, consequently, is usually mounted on a sizable heat sink. The KV-1722, and the larger KV-1920, employ a new type of switching-mode regulator that is extremely efficient and takes up little space. It uses a GCS as the switching element. When used as an on/off device, the GCS consumes little energy—when on, its voltage drop is close to zero; when off, no current flows. If the transition between on and off is rapid, the total power consumed is very small.

The switch, Q603 in Fig. 4, is in series with a 60-Hz voltage doubler, which produces about 303 volts, and the load, which requires a B+ of 130 volts. On/off control for Q603 is applied at the line rate of 15,750, and the control circuitry regulates the duty cycle of the switch. Because the supply operates at 15,750 Hertz, all ripple components are in sync with the horizontal deflection and, consequently, filter components can be quite small. The output is some-

what like a 300-volt (p-p) square wave, but with the on time slightly shorter than the off time. Output after filtering becomes 130 volts. Regulation is achieved by controlling the percentage of on time for each cycle.

A block diagram of the control circuit is shown in Fig. 5. The key to control of the duty cycle is the pulse-width modulator (PWM). This is a monostable multivibrator that is flipped into its unstable state by a trigger obtained from the horizontal drive stage in the deflection system. The duration of the unstable state is determined by the Error Amp. This block compares the DC output of the supply with a Zener reference voltage and supplies a voltage proportional to error. The error voltage, in turn, alters the bias on the cutoff transistor in the PWM during its unstable state and determines how soon the PWM will flip back into its stable state. A rectangular-wave signal from the PWM is amplified by the regulator drive stage and applied to the gate of the GCS through a transformer. This permits the entire gate circuit to float above ground.

The basic operation of the control

loop is as follows: If output voltage should increase for some reason, the Error Amp detects the increase and sends a larger positive voltage to the PWM. This shortens the duration of the unstable state of the PWM multivibrator which, in turn, reduces the on time of the series-switching GCS. We will return to the Build-Up circuit and EVP trigger later in the analysis.

The PWM circuit is shown in Fig. 6. Bias for the base of Q606 is obtained from the collector of Q607, so that, in the absence of drive, the stable state is Q607 on and Q606 off. A 15,750-Hz drive pulse, from the horizontal deflection system, is applied to Q606 through a 560-pF capacitor and an isolating diode. The pulse turns on Q606, the collector voltage of which then decreases to near zero. Capacitor C614 now discharges, applying a negative-going pulse on the base of Q607, turning off Q607. This is the unstable state of the multivibrator, and it lasts until C614 is discharged sufficiently to permit Q607 to again conduct. However, the off period for Q607 is also affected by the voltage developed at the emitter of the Error Amp, transistor Q608. If the error

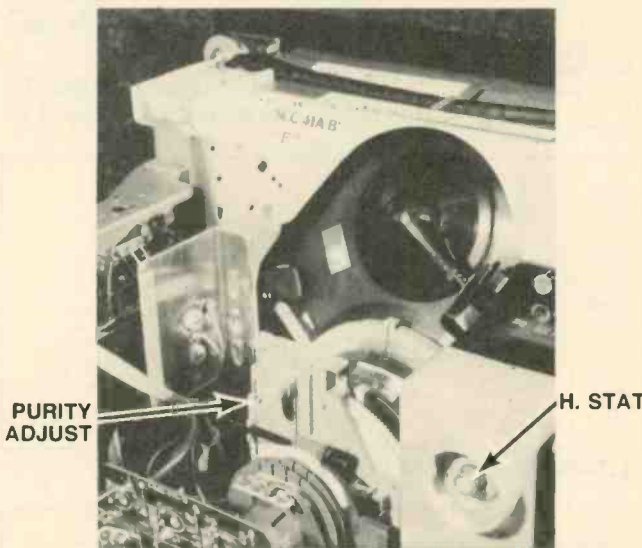


Fig. 1—Purity and single convergence adjustment. (Horizontal Stat.)

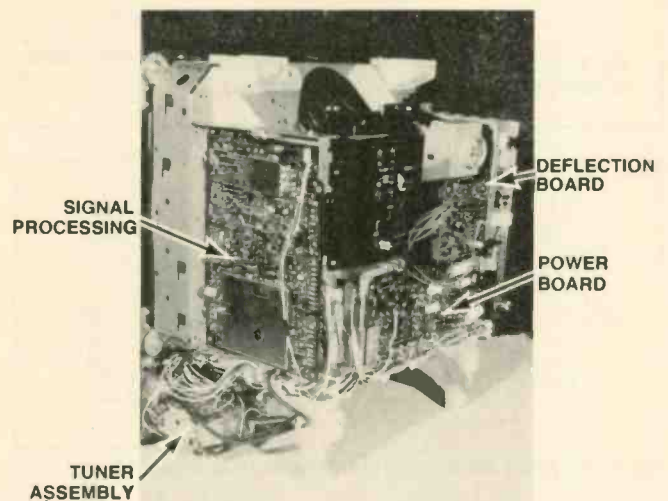


Fig. 2—The layout of the chassis provides easy access to all boards and components.

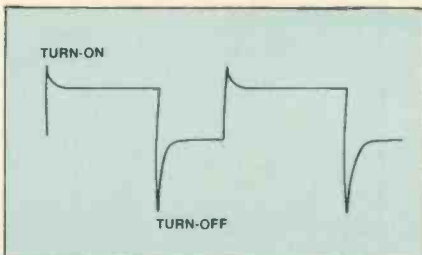


Fig. 3—Current waveform obtained at the GCS gate.

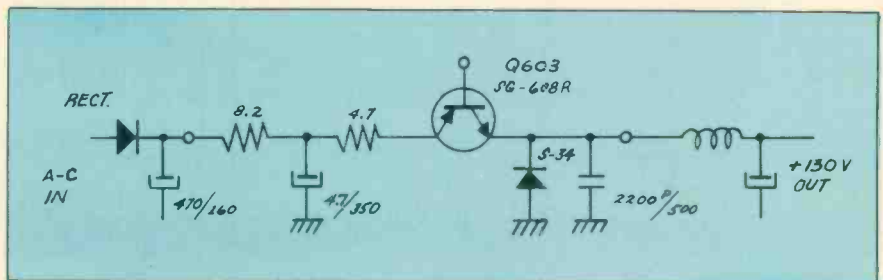


Fig. 4—Simplified schematic of the Gate Controlled Series Switch circuit.

This system monitors the 19 volt line as follows. If the 19-volt line is low, Zener diode D610 does not conduct and Q601 remains off. With Q601 cut off, the gate of Q602 (another GCS) is biased on and a path exists from the 303-volt line through R608, Q602, and D605 to the +19-volt line. This circuit helps support the +19-volt line until it is supplied by the normal source. It also provides support for the +19-volt line if the set is switched off and on again rapidly. Under such conditions, kick-start capacitor C605 does not have a chance to discharge and therefore will not draw sufficient current when power is applied. (Caution: The kick-start circuit will not function if the input line voltage is increased slowly by using a variac.)

When the +19-volt line begins receiving a normal flyback pulse input, Zener diode D610, in the base circuit of Q601, conducts, turning on Q601. Conduction of Q601 grounds the gate of Q602, and the auxiliary starting circuit is discon-

nected from the +19-volt line.

The auxiliary starting circuit also functions as a special shut-down circuit, to prevent the destruction of the GCS if its drive is lost. Thus, special consideration must be given to killing the horizontal-output stage supply voltage before the drive voltage is lost. To effect this condition the +19-volt line is held constant (to keep the oscillator running) while the +130 v supply is "dumped." This function is accomplished by the auxiliary starting circuit. At turnoff, a decrease in the +19-volt line turns off the zener diode transistor and Q601, switching Q602 on, and the +130-volt supply is then fed into the +19-volt line through R642, D604, Q602 and D605.

When troubleshooting the power supply it is important to remember that the auxiliary starting circuit will try to support the +19-volt line if it is not receiving its normal input voltage. For example, if horizontal drive is lost and the flyback input pulse to the +19-volt rectifier is absent, the

auxiliary starting circuit will be on and will try to keep the +19-volt line constant. This causes overheating of resistor R608 because it is not rated for continuous duty.

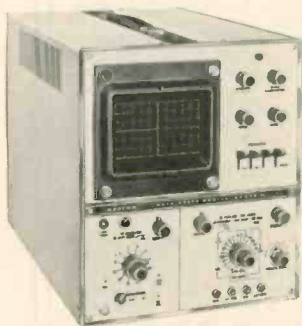
Excess Voltage Protection Circuit

In a switching regulator circuit with an approximate 50-percent duty cycle, a shorted series switch will increase the B+ voltage to nearly the full DC input (about 300v). This might cause failure of large sections of the television receiver. To prevent such damage, the B+ is monitored by transistor Q609 and Q610, shown in Fig. 9. If a shorted regulator causes the B+ voltage to increase above 150 volts, Q609 conducts and saturates Q610, shorting the output of the horizontal oscillator to ground. As a result, the horizontal-output GCS shorts and the main fuse is opened.

Troubleshooting the Power Supply

Although the switching-mode power supply seemingly is complex, *continued on page 52*

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Replacement Color Picture Tubes -- Propping Up Servicers' Profits

by Richard Deutsch

Increased income from the sale and installation of replacement picture tubes can help offset decreasing income from sources which are drying up because of technological, economic and marketing changes



■ My father-in-law once owned a small resort hotel. One day, his brother, a successful businessman in South America whom he had not seen for 30 years, arrived for a one-month visit. Day after day, the rich brother watched my father-in-law as he catered to guests, fixed leaky faucets, did small carpentry jobs, worked the check-in desk and supervised his small staff. Finally, in exasperation, he said, "Harold, I don't understand you. You're always so busy. When do you have time to think about ways of making more money?"

I think this true story accurately describes the situation of many consumer electronic servicers and dealers today: They are so busy with the day-to-day operation of their business they don't take the time to look at the big picture, to analyze the movement of the industry they're in, and to examine their own situation and future prospects in that industry. And that, after all, is what going to determine how much money they're going to make 5 years from now,

or whether they'll even be in business at that time.

The consumer electronic sales and service market has and is changing, and will continue to change. These changes are, and will continue to, affect the income of dealers and servicers. The sooner they recognize the changes and adjust their business to them, the less severe will be the impact of the changes on their income.

The Impact of Technology

Solid-state technology and a byproduct of it, modular design of chassis, is, and will continue to, affect the consumer electronic servicing market in three principal, direct ways:

● *Incidence of service need reduced by improved reliability*—The inherent reliability of solid-state devices, combined with effective quality control at the manufacturing level, promises to significantly reduce the incidence of need for service. This eventually will significantly affect service labor income.

● *Reduction of receiving tube sales*—Although there is still a significant number of tube-type consumer electronic products in use, as the ratio of all-solid-state vs tube-type products in use shifts in favor of all-solid-state products, as it will be doing in the next 5 to 6 years, the reduction in profit from sales of receiving tubes, already felt by many servicers, will accelerate.

● *All-electronic TV tuners will reduce tuner cleaning income*—Almost all of the major manufacturers of TV receivers have introduced all-electronic tuners in at least one or two of their color TV models, particularly those sets that are remotely controlled, and this trend seemingly will gradually include all black-and-white and color TV receivers. As it does, income from tuner cleaning and replacement will be reduced at an increasing rate.

The Impact of Marketing and Pricing Changes

Two principal trends related to the methods of marketing and pricing of consumer electronic products will have an increas-

ing effect on dealers and servicers alike:

● *Mass merchandising*—An increasingly larger percentage of the total volume of consumer electronic products is being marketed through mass merchandising and so called "discount" outlets. Continuation of this trend undoubtedly will significantly reduce the retail income of independent consumer electronic dealer/servicers, whose relatively smaller volume will not permit them to price their merchandise competitively with that of mass merchandisers and discounters.

● *The effect of lower-priced products on servicing*—Technology and manufacturing economies have gradually reduced the retail price of many consumer electronic products and, despite inflation, will continue to do so on a relative basis. Already, many consumer electronic products, such as personal portable and table model radios, have been effectively priced out of the servicing market, and the prices of many personal portable black-and-white TV receivers are not far from the level at which servicing of them will not

The author is vice president of Picture Tube Operations, Channel Master Division, Avnet, Inc.

"FIX IT OR JUNK IT?"— FACTORS IN THE EQUATION

These are the elements that help determine whether or not the consumer is likely to replace his old picture tube or junk the set and buy a new one. Sometimes the decision is as much the technician's as it is the customer's.

● **Age of existing set.** (The older it is, the less likely the consumer is to keep it.)

● **Type of set.** (A quality console with attractive wood cabinetry is often hard to part with, and the owner may be a better-than-average prospect for a replacement picture tube.)

● **Life expectancy of set.** (Regardless of actual age, some sets are just too "used-up" to bother with, but others may be usable for many years with a new CRT, an

extended warranty and some occasional routine service. Your professional evaluation here is important to the customer.)

● **Cost of the replacement picture tube.** (Flexibility in quoting labor charges may make the difference between an order to "fix it" and "forget it.")

● **Cost of a new set.** (Many new color portables carry low price tags, and might look attractive to the customer compared to the cost of a CRT replacement. However, the customer may not be too happy about exchanging his old 21- or 25-inch set for a smaller portable—and once he starts thinking about a large new console, that's the time for the technician to point out how much cheaper it is to replace only the picture tube, not the complete set. For those servicers/dealers who also sell new sets, it

should be pointed out that the profit from replacing a color CRT is considerably greater than the profit from selling a new portable, especially if you've got to price your sets competitively with the mass merchandisers.)

● **"Capture of the consumer."** (The picture tube extended warranty is a form of service contract that keeps the old set in operation, protects the consumer against very large, unexpected service costs over a 3-year period, gets you a service order, and gives you a "captive" customer who will call you first whenever future service is required on that set. The servicer/dealer should weigh these valuable benefits against the alternative of having the consumer leave his store and buy a new set and service contract elsewhere.)

be economically feasible.

Action Now

These trends, although well established, to date have had only a relatively minor impact on the income of consumer electronic servicers and independent dealers. However, because all of these trends are accelerating, servicers and dealers should begin now their strategy for coping with the effects of them. As some traditional sources of income begin to decrease, other sources must be sought to offset such decreases, or existing sources of income which are affected less by these trends should be more fully exploited to take up some of the slack.

A Continuing Stable Income Source: Replacement Picture Tubes

One such existing source of income which not only will continue to exist but will *grow* despite present trends is the sale and installation of replacement picture tubes. It will continue as a profitable source of income for servicers and dealers during at least the next ten years and probably longer because

there is now no practical alternative to the present basic form of picture tube, nor is there a practical one on the drawing boards of industry. And the potential market for replacement picture tubes will *increase* because the number of sets in use will continue to increase.

In addition to being a continuing, stable source of income, sales and installations of replacement picture tubes also serve the interest of the consumer electronic servicer by keeping customers with serviceable sets in the *service* market. Every time a customer decides to scrap his set instead of replacing the picture tube, the servicer gets it in the neck *twice*: first, when he loses the picture tube replacement; and second, when he loses all the future service business the set would normally be expected to generate if it remained in use.

Color set owners, faced with high replacement expenses when a CRT fails, are scrapping their sets in increasing numbers and buying new sets instead. Set scrapping in the past 3 years has steadily climbed from 15% to 19% to 24%. Most of these are

good, serviceable sets. Why are they being junked? Because the cost of a color CRT replacement is often more than the customer wants to spend, in view of some new set prices. "Why," he asks, "should I pay \$200 to put a tube into my old set, when I can go down to the local mass merchandiser and get a new color portable for as little as \$250?" And the older his set, the more persuasive this argument becomes.

It is especially disturbing when you consider that most sets scrapped because of customer fear of high CRT replacement costs are actually serviceable sets, capable of providing many additional years of satisfactory operation.

In other words, serviceable TV sets are dying early, needless deaths—and we've all been letting it happen.

What the consumer electronic service business has needed is a way that will make it attractive for a color TV owner to keep his set, even when he has to replace the picture tube.

The CRT "Double" Warranty

One way that CRT

manufacturers have attempted to accomplish this has been with extended warranties. Channel Master, as a pioneer in this area, has taken a somewhat different approach with its new "Opti-Vue Plus" color picture tube warranty program. It works like this:

Every top-of-the-line "Opti-Vue Plus" color picture tube carries *two* guarantees. The first one guarantees the tube unconditionally for 3 years. This is a "total" guarantee; if the replacement tube becomes defective any time within 3 years, a brand new "Opti-Vue Plus" will be given to the servicer/dealer at no cost.

The second guarantee says that if the tube fails any time *after* 3 years—for the life of the set while in the hands of the present owner—Channel Master will replace it with another 3-year tube at a *guaranteed fixed cost* to the dealer and the consumer. The consumer will pay \$69.95 (plus installer's labor, of course); the *dealer* will pay \$46.95, giving him a *33 percent gross profit*.

This guarantee will stand regardless of inflation, and

continued on page 52



Effective Advertising For The Service Dealer

by William (Mac) Walker

Five tricks of the trade can help you write a better ad

■ What determines the effectiveness of your advertising? Size? Humor? An elaborate layout? Eye-catching illustrations?

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What do they most often need? How can you help them? What can you—and no one else—offer them? Do you carry a special brand of goods? A special service? A lower price?

Your business undoubtedly has advantages that no competitor can match. It's your job to decide what they are and to state them briefly, succinctly.

This is your headline. It can be catchy or clever. It can be a simple, direct statement. But, without bragging or shouting, it should quickly make clear how the reader will gain from doing business with *you*. This holds true for all forms of advertising.

One note of caution: Don't use your firm's name and telephone number as your headline. Yes, these are important, but they will not by themselves sell a prospect—especially a prospect who does not know your firm by name. Stress benefits first. Then tell your name.

Next, answer all of your customer's other questions:

- What can you offer? (Describe your products and services.)
- Who sells it? (You do.)
- Why should I buy from you? (Again, the advantages of your product or service.)
- How and where is it available? (Your location and telephone number.)



The Author: William (Mac) Walker is a Vice President and Account Group Supervisor for Cunningham & Walsh, Inc., one of the nation's leading advertising agencies. He draws his advice about effective advertising from 20 years of experience handling a variety of accounts—from grocery products, encyclopedias and appliances to building materials, beer and golf equipment—for major ad agencies. At Cunningham & Walsh, he helps prepare attention-getting advertising for some of America's biggest corporations with annual programs worth millions of dollars.

• When? (Your hours.)

2) *Choose a Single Selling Message.* Less information is often best in advertising. Fight the temptation to tell all. If you give too many facts, you may wind up with an ad that emphasizes nothing and repels rather than attracts prospects.

Your ad should have a single theme, emphasized in all of its elements—layout, headline, copy, and illustrations.

If your major advantage is a wide range of products or services, build your ad on that theme. Tell the buyer he can find almost anything under your roof. Stress variety, completeness.

If you have an exclusive franchise or offer special service in one area, make this the highlight of your ad. This can give you the edge—especially over competitors who make completeness their selling message.

If you sell or service brand name products, emphasize that. Use trademarks in your ad to attract brand-conscious buyers.

3) *Match the Message to the Medium.* Where does your selling message belong?

Every ad medium worth its salt



If your advertising is on target, it will reach your best prospects who will read it and buy from you, not your competitors.

has facts and figures about its audiences. Not only the number of people, but their age, sex, income, education, hobbies, and occupations.

Before writing your ad, study as much of this data as you can get. Match the audience offered by the medium with what you have to sell. Then, choose the media that will reach your best prospects at lowest cost.

But remember: each medium—newspapers, magazines, radio, Yellow Pages or television—has a unique “selling contest.” That’s the particular blend of news, entertainment, education or basic information that appeals to its audience. In newspapers, for example, the context is *news*. With radio, it’s *entertainment*. With the Yellow Pages, it’s *directional information*.

Write your ad to fit into the selling context of the medium. For newspapers, make your ad timely, newsworthy. Stress a current sale, new product, special service. For the Yellow Pages, stress basic information. Give the facts that persuade prospects to call you, not your competitor. Make sure your ad speaks right to the need that brought the prospect to the classified directory.

4) *Mix Your Media Well.* No one medium is likely to reach all your best prospects all the time. So you’ll want to concoct a “media mix”—a combination that will reach as many prospects as possible with minimum overlap of audiences.

You might use some newspaper or radio advertising for news: to promote a special sale or weekly special. Direct mail to send a specific offer to a selected audience. Or magazine ads to build an image of quality and service.

Whatever your choices, back up

all your advertising with a permanent local reference, such as a telephone directory ad. This will be ready and waiting for prospects who may want what you offer, but are not ready to buy when one of your other ads appears.

Like all your advertising, this Yellow Pages ad should be tailored to its medium—and its place in your media mix. Aim to help prospects who are pre-sold by your newspaper or broadcast advertising. When they consult the telephone directory, prospects are ready to buy. So remind them of the advantages of doing business with you.

Such a year-around reference can make all your advertising more effective by giving it longer life.

5) *Make Your Ad Special.* How do you make your ad stand out from all the other advertising your prospects see?

Give your ad a special character and appearance. Make certain every word and illustration is appropriate to your business and your prospects. Then follow these tips:

Keep your layout simple. Use lots of open space. Arrange the ad to lead the eye logically through the message: From attention-getting headline or illustration. To the reasons why people should buy. To a call for action by your prospects. And to your name, address, and telephone number.

Keep your copy short. Write it for quick, easy understanding. Avoid flowing phrases or fancy adjectives. Each word should expand the basic promise of your headline. Otherwise, it doesn’t belong in your ad.

With these tricks of the advertising trade, you can be sure you’ll get more for every ad dollar you spend. ■

Field-Effect Transistor Fundamentals

by B. B. Dee

■ Compared to field-effect transistors (FET's), conventional bipolar transistors have relatively low input resistance, high input capacitance, relatively high output-to-input feedback capacitance, and cross-modulation and inter-modulation characteristics which can be troublesome in some applications. A tendency to oscillate at high frequencies unless well loaded, cross-talk in transistor tuners operating in the vicinity of a strong station and the large impedance transformations required in interstage coupling are examples of the problems associated with the inherent characteristics of conventional bipolar transistors.

Conventional bipolar transistors also have a very limited AGC capability, and when they are gain controlled, it is usually at the cost of increased noise or other adverse effects.

The FET, on the other hand, has a very high input resistance, low input capacitance, low feedback capacitance, superior cross-modulation and overload capability and excellent AGC characteristics. In fact, the FET has all the advantages of a vacuum tube without the tube's disadvantages of aging and filament power requirements.

Also, FET's are available in several different designs, each of which offers unique advantages for different applications. This design variation is not duplicated to an appreciable extent by bipolar devices.

FET THEORY

Fig. 1 is a cross-sectional view of an elementary type of FET. The device consists of a bar of "N" type material, with two sections of "P" type material opposite each other part way up the bar. If we connect a 10-volt battery to the bar so that the top is +10 volts and the bottom is zero volts, the potential at the center of the bar will be somewhere between zero and +10 volts. We will assume that the "N" type material in

the vicinity of the P type material is at +5 volts.

If we now connect a negative source of voltage to the "inserts" formed by the P type material, a reverse-biased pair of junctions is formed, with current being repelled at the junction barriers, just as in any reverse-biased diode. You will recall from previous articles about semiconductor junctions that the field extends into the material for some distance. Thus, the repelling effect of each "diode" extends throughout the shaded areas in Fig. 1, and, therefore, current cannot flow in these areas. Notice that the two shaded areas almost touch each other, severely restricting the flow of current from one end of the bar to the other. If we increase the negative potential applied to the P type material, we can get these areas to "touch" each other, thereby cutting off current flow almost completely. Conversely, if we reduce the negative potential on the P type material, current flows more freely as the channel becomes wider.

Terminology

At this point, we should get our terms straight. The *bottom* of the bar corresponds to the *emitter* of a bipolar transistor, and is called the

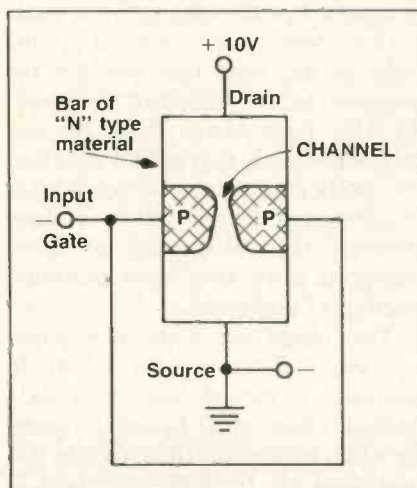


Fig. 1—Cross-sectional view of a junction type field-effect transistor.

source. The *top* of the bar corresponds to the *collector* of a bipolar, and is called the *drain*, while the *input*, or control, element, which corresponds to the *base* of a bipolar transistor, is called the *gate*. The material through which the current flows, between *source* and *drain*, is called the *channel*. In the FET illustrated in Fig. 1, the *channel* is made of N type material, so the device is called an *N channel FET*.

Biasing

Note that the FET in Fig. 1 operates with the gate *reverse* biased, while a bipolar transistor operates with the base forward biased. And there is no collector junction at all. Therefore, the only junction, the gate, is always biased in one direction, in comparison to a bipolar transistor, which has two junctions, one forward biased and the other reverse biased. Because the one junction of the FET is controlled with one polarity of voltage, we call it a *unipolar* device (one polarity), while the conventional transistor is called a *bipolar* (two polarity) device.

The output current of the FET shown in Fig. 1 is reduced as the negative input voltage (bias) is increased. Because of this, it is called a *depletion mode* device. The use of the word *depletion* is used to indicate that an increase in gate voltage *reduces* the current through the device. (Note that the input signal can never forward bias the gate junction, just as the input signal cannot reverse bias the base of a bipolar transistor in normal operation.) Because the gate is a reverse-biased *junction*, this device is also called *junction FET*. Putting all of the descriptive terms together, we have been looking at an *N-channel, depletion mode, junction FET*. (The term *junction FET* is usually abbreviated to *JFET*.) By reversing the polarities of the materials used in the junctions, we can also create a P-channel

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JFET, just as we have PNP and NPN bipolar transistors.

Note that the channel of the FET in Fig. 1 is narrower at the top than at the bottom. The reason for this becomes evident if we consider the channel to be a resistive path. A comparison of the potentials at several points throughout the resistive path reveals that the voltages at the bottom will be small, with increasingly larger voltages toward the top. If we assume that the gate junctions are at a level of +5 volts, then the top area of the gate will be at a higher potential (+6V), and the bottom area of the gate at a lower potential (+4V). If we assume that the gates are at zero, or ground potential, then the center of the gate would be at 5

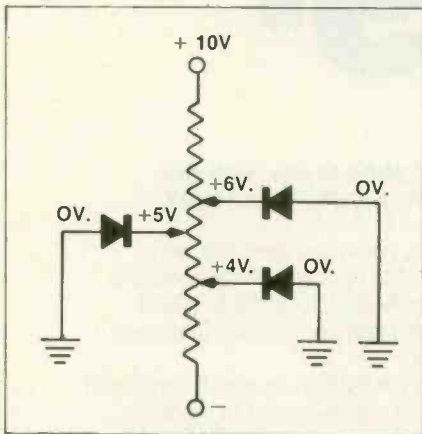


Fig. 2—Illustration which reveals the resistive nature of the channel of the JFET and how it affects the action of the gate electric field. See text for complete explanation.

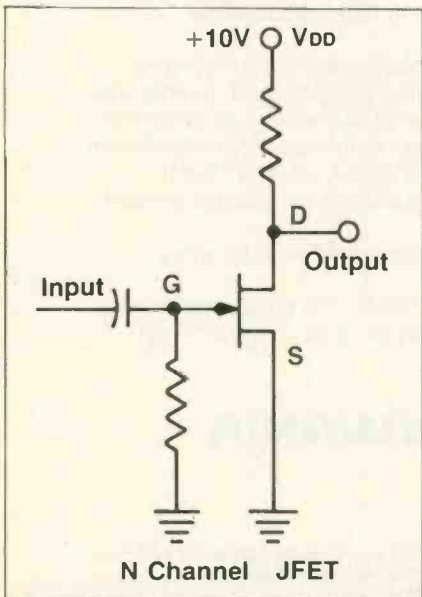


Fig. 3—Simplified diagram of an audio amplifier equipped with an N-channel JFET.

volts reverse bias, the top at 6 volts reverse bias and the bottom at 4 volts reverse bias. This is shown as three separate diodes in Fig. 2 for simplification.

Because the top of the gate has the highest reverse potential, the depth of the electric field is greatest;

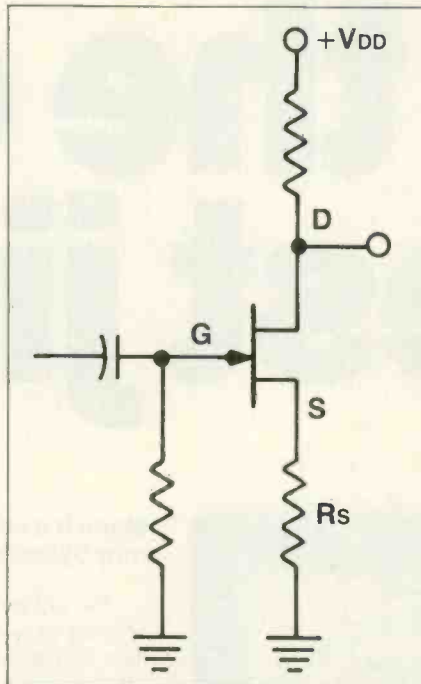


Fig. 4—Adding a resistor (R_s) in the source circuit of the JFET changes the amount of bias applied to the gate and thereby establishes a different operating point for the JFET.

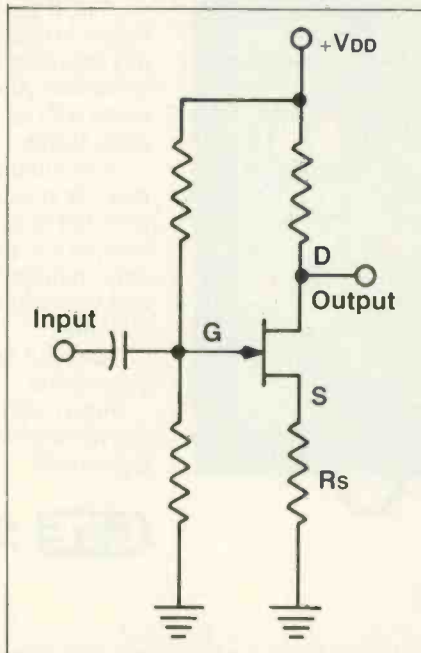


Fig. 5—The addition of a resistor between the gate and V_{DD} forms a voltage divider between V_{DD} and ground which, like R_s , also changes the operating point of the JFET.

therefore, the channel restriction is greater at the top than at the bottom. If you see this effect in FET diagrams in other literature, you now will understand the reason for it.

Shown in Fig. 3 is a simple N-channel JFET audio amplifier. The source, gate and drain are labeled S, G and D, respectively, and the supply voltage is labeled V_{DD} . The gate arrow points inward, indicating that this is an N-channel device (similar to the emitter arrow pointing inward on an NPN bipolar transistor), thus requiring a positive drain voltage (also similar to the collector voltage requirement of NPN bipolars). A P-channel JFET would have the gate arrow pointing outward (as with a PNP bipolar), and would require a negative V_{DD} . The gate symbol represents a diode (junction), which it is, and, because in a JFET it is always reverse biased, it reveals the polarity requirements of the JFET.

Notice that simply returning the gate to ground produces a reverse bias, as was explained earlier in reference to Fig. 2. The amount of the reverse bias applied when the gate is tied to the source depends only on the supply voltage. Because the gate voltage is physically tapped off of the voltage divider formed by the channel, much as a voltage divider with a fixed tap, the voltage at the tap varies with the voltage applied to the top of the divider (in this case, V_{DD}). Therefore, increasing the applied voltage (V_{DD}) will increase the reverse bias on the gate and will cause the channel current to be pinched off—and that is exactly what this phenomenon is called—pinch-off.

To control the pinch-off action, the bias applied to the gate can be varied by adding a resistor, as shown in Fig. 4. The resistor is placed in the source lead, as with emitter resistor biasing of a bipolar. Fig. 5 shows a divider added between $+V_{DD}$ and ground to further control the applied gate voltage in the desired manner. Any or all of these are effective methods of controlling the gate voltage. Sometimes a resistor is placed between the drain and the gate to provide DC inverse feedback for stabilization of the operating point, as is done with both vacuum tubes and bipolar transistors.

As you can now see, the JFET is not radically different from devices you are accustomed to, even though it operates on the principle of a *voltage* input applied to a *reverse-biased* junction as opposed to a bipolar transistor which operates with a *current* input applied to a *forward-biased* junction. Consequently, the JFET has an extremely high input impedance compared to that of a bipolar transistor.

THE DUAL-GATE JFET

Because the input signal is applied to both gates of the FET to produce a *pinch-off effect*, it is possible to design a FET with a *separate* J lead for each gate, with one used for signal input and the other for AGC or for mixing two signals. Fig. 6 shows the symbols for such a device, which is known as a *dual-gate* JFET. Gate 1 (G1) is either the bottom gate or the "front" gate on the symbol, with gate 2 (G2) at the top or "back" of the symbol. Gate 1 is usually the signal input, with gate 2 the AGC or modulating signal, although they may be used otherwise to achieve other desired results.

THE MOSFET

Conduction of the FET is controlled by the electric field produced by the gate, as described previously. The electric field can be produced by a capacitor as well as a reverse-biased junction. Fig. 7 shows an *Insulated-Gate Field-Effect Transistor (IGFET)*. Notice that the gate electric field is coupled through a *capacitor* symbol instead of a reverse-biased junction symbol. In modern IGFET's the capacitor is formed by depositing an ultra thin insulating layer, as shown in Fig. 8. Modern IGFET's are usually called MOSFET's, because the insulated gate capacitor is formed by depositing *metal* on an insulating *oxide* layer, thereby forming a *semiconductor field-effect transistor*. The first letters of the italicized words form the acronym *MOSFET*.

MOSFET's are fabricated in the same way modern integrated circuits are—by starting with a basic material called a *substrate* and then depositing other materials on top of the substrate or diffusing other materials into it. Usually, all fabrication

is performed on one side of the substrate, with the substrate on the bottom, as in Fig. 8. Many such devices are made at once, on a 2- or 3-inch diameter wafer. Because each device is small, thousands are made at one time on a single wafer, thus reducing the price by mass production. The wafer is then scribed with a diamond point, and the devices are broken apart, in the same way that a pane of glass is cut. With this

method, no other elements can be fabricated on the edges of each device, because there are no separate edges until the finished device is broken off the wafer.

The type of material used in the channel of a MOSFET is indicated by the direction in which the arrow on the substrate element points—in for *N* channel, and *out* for *P* channel, just as for bipolars and JFET's. A wafer of *P* type material has a

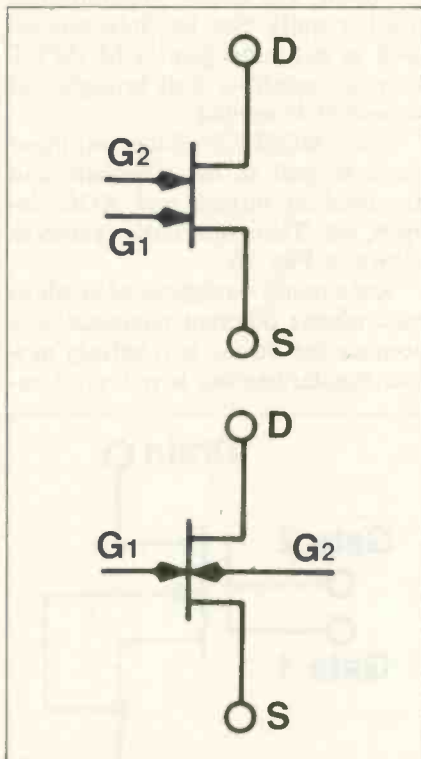


Fig. 6—Two common schematic diagram symbols for a dual-gate JFET.

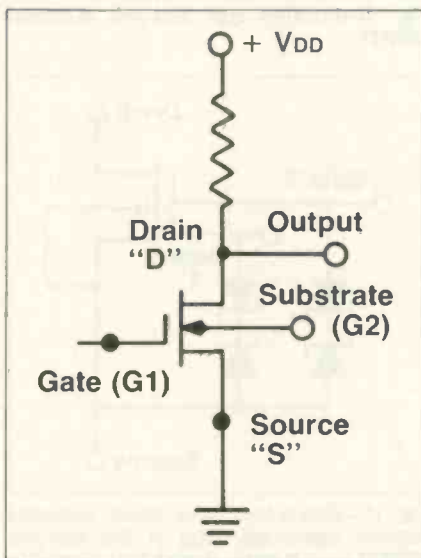


Fig. 7—An N-channel, insulated-gate, field-effect transistor, or MOSFET.

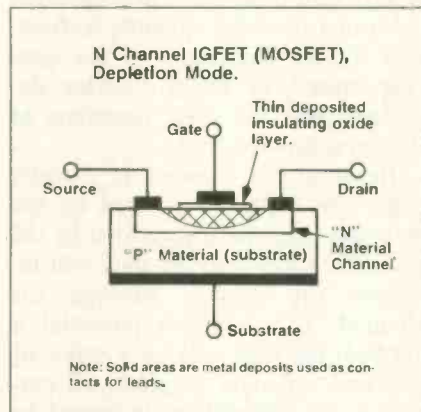


Fig. 8—End view of MOSFET illustrating construction.

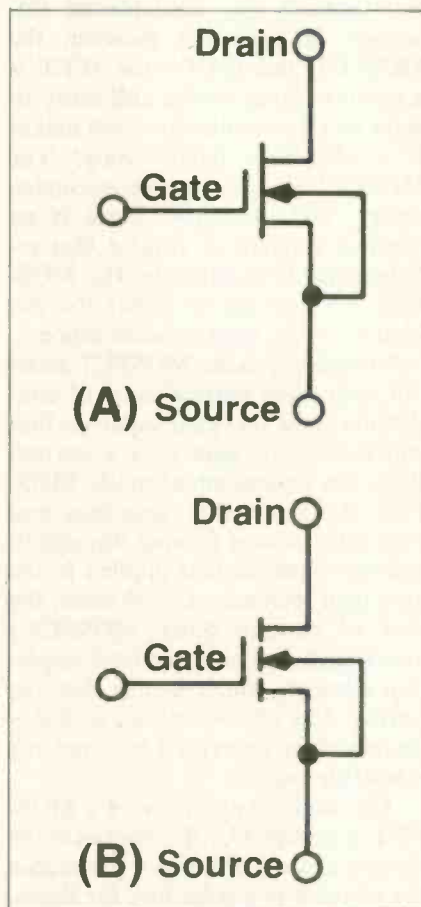


Fig. 9—Two types of N-channel MOSFET's. A) Depletion type. B) Enhancement type.

lead connected to its bottom, as shown in Fig. 8. A layer of N type material then is diffused into the top of the P type substrate, forming a junction. This is why the substrate of the MOSFET still retains the arrow-type junction symbol, even though the signal input terminal (gate) is a capacitor. Note in Fig. 7 that the substrate of the FET forms a second gate (G2), as in the JFET.

Two metal, deposited contacts are formed at each end of the N channel, for the *source* and *drain* leads. A very thin layer of insulating oxide is formed over the channel, to function as the dielectric of the gate "capacitor." A metal contact deposited over the glass functions as the capacitor electrode.

Because the channel is directly under the capacitor formed by the gate, any electric field created by the potential applied to the gate will influence the current through the channel. If a negative potential is applied, the field will be a repelling one and will tend to pinch off current in the channel, as indicated by the shaded area in Fig. 8. Thus, we have a *depletion mode* device again. But there is one fundamental difference in operation between the MOSFET and JFET—the JFET is a *junction input* device and must *always* be *reverse* biased, which makes it a *depletion* device *only*. The MOSFET is a *capacitance-coupled* device, and, therefore, there is *no* inherent forward or reverse bias requirement. Consequently, the MOSFET can operate in either the *depletion* or the *enhancement* mode.

A *depletion-mode* MOSFET starts out with some desired level of conduction, and the gate input or bias can reduce, or *deplete*, the current flow. An *enhancement* mode MOSFET starts out with zero bias and very little current flowing through it, and the signal or bias applied to the gate then increases, or *enhances*, the flow of current. Some MOSFET's are designed as *enhancement/depletion* devices, which means that the normal flow of current can be *either* increased or decreased by applying a suitable bias.

The mode of operation of a MOSFET is revealed by the symbol of the device, as shown in Fig. 9. Note that the channel is a *solid* line for *depletion* type devices, and an *interrupted* line for *enhancement* types. One con-

venient method for remembering which is which is: A *solid* line indicates *conduction*, which can be *reduced*. An *open* circuit, represented by the *interrupted* line, has no way to change but to *increase*.

Some MOSFET's have only three terminals brought out, with the substrate tied internally to the source. Because many MOSFET's are used in circuit configurations which require that the substrate be connected to the source, it makes little difference whether it is done internally or externally. For circuit configurations which require that the substrate be used as a second gate, a MOSFET with the substrate lead brought out separately is needed.

Some MOSFET's have two input gates as well as the substrate, and are used as mixers and AGC devices, etc. Their schematic symbol is shown in Fig. 10.

Some minor variations of symbols exist among different manufacturers because the device is relatively new and standardization is not yet com-

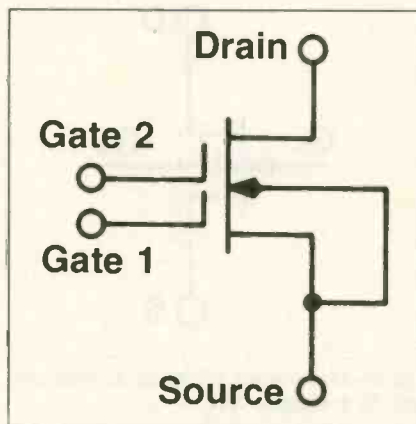


Fig. 10—Depletion type, dual-gate, N-channel MOSFET.

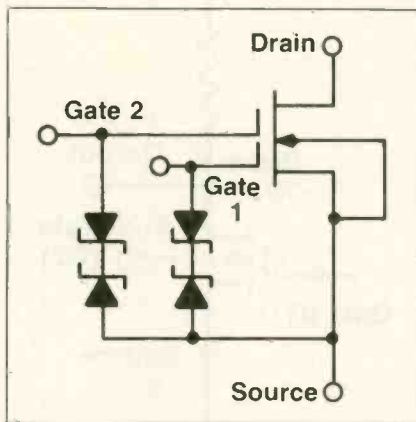


Fig. 11—Back-to-back zener diodes connected between source and gates of this dual-gate MOSFET prevent static charges from puncturing the gate insulation and thereby destroying the MOSFET.

plete, but technicians should have no trouble determining the mode of operation of the MOSFET if they analyze the symbol on the schematic diagram of the circuit being tested.

Until recently, MOSFET's had one very severe handicap: Because the gate insulation is very thin, it can be punctured easily and, once punctured, like any capacitor, it is destroyed. Static charges incurred in handling are capable of puncturing the gate insulation. Consequently, to avoid such damage, MOSFET's were mounted in conductive plastic. Even so, many were ruined, both in and out of circuit. Newer MOSFET's have diode protected gates, as shown in Fig. 11. Each gate has two back-to-back zener diodes connected between gate and source. If the input voltage, regardless of polarity, exceeds a certain level, the diodes conduct and clamp the input voltage to a safe level. This is easily understood when you recall that a zener conducts in the forward direction as any diode, but, when reverse biased, it conducts at a predetermined design level. Because the diodes are reverse connected, one is always forward biased and the other reverse biased for any signal. The total drop is therefore the zener voltage plus one forward diode drop. This seemingly has solved the biggest problem inherent in MOSFET's.

Because MOSFET's do not draw input current, and because enhancement-mode MOSFET's draw no output current until turned on, they are extremely efficient low-current-drain devices. For this reason, MOS technology is used increasingly in systems in which power drain and heat dissipation are important and expensive factors. They are also used more and more in integrated circuits (IC's), which are becoming increasingly complex. An IC today has the ability to replace thousands of discrete devices—just one 4000 bit MOS memory integrated circuit contains over 14,000 transistors. Obviously, with that many transistors on a single chip, each must draw only microwatts of power or the total power dissipation will overheat the small IC. Technicians will see increased application of MOS devices in automotive use, in motor controls in home appliances, in test equipment and a host of other ever-increasing applications. ■

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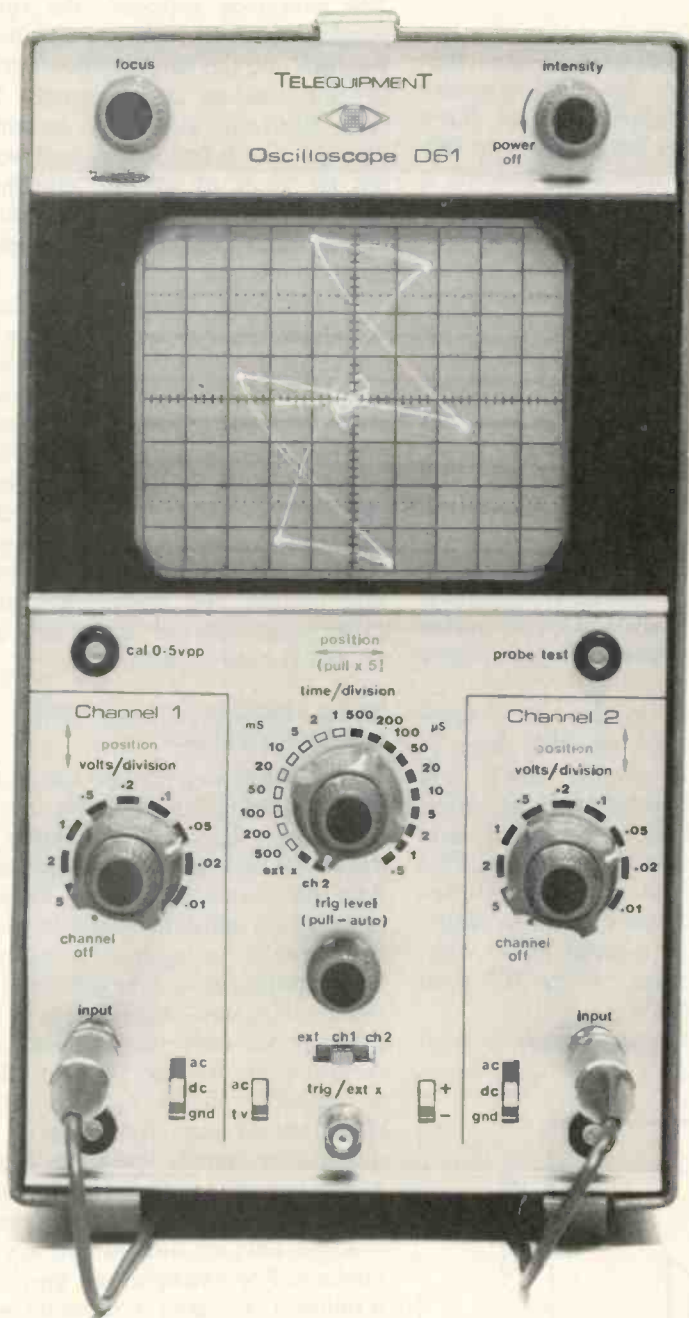
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Selecting Commercial Audio Amplifiers

by Jack Hobbs

Avoid being entrapped in the "power-doubling muddle"

■ Previous articles in these pages have made it clear that once a commercial audio installation survey is completed and necessary speakers selected, we are then in a position to select a suitable amplifier. But all we know at this point is the amplifier's total output requirement in watts. And before we can discuss the basic, overall considerations involved in the selection of present-day commercial audio amplifiers, we may need to reorient our thinking in certain technical areas which have undergone near-revolutionary changes with the development of modern solid-state audio circuitry.

The Impact of Solid-State Audio Circuitry

A few years ago an outstanding audio authority saw fit to reevaluate certain conventional audio distribution techniques which had been employed for many years with commercial electron-tube audio equipment. His conclusions were revealing: Development of modern solid-state audio circuitry has now made available to the audio technician and service-dealer more efficient audio distribution methods at lower cost in dollars-per-watt. Hence, in selecting an amplifier for a given installa-

tion, especially the small- and medium-size jobs, we must consider these new techniques. In fact, there is a chance that employment of this new approach may soon become a competitive necessity on many jobs.

Transistorized audio amplifiers are available with low impedance outputs for driving speakers directly. In low- and medium-powered installations not involving a large number of speakers, the amplifier output can be fed directly to speakers in series, parallel or series/parallel configurations. You may find many audio-installation jobs where this method of distribution will prove satisfactory—eliminating the cost of line-speaker matching transformers. This method of driving speakers also provides a significantly higher power efficiency.

In reference to these new techniques, however, we will need to brush up on simple math and knowledge of impedances in series, parallel and series/parallel, and power division in these circuits. This is especially true if we want to provide different power levels to different speakers in a given group without having to use "T" or "L" pads or transformers.

As one example, suppose a small

installation calls for five speakers. (See Fig. 1.) If the five speakers are all of the same impedance, the three shown in parallel will run close to four times the power of the two in series/parallel. If we use 16-ohm speakers the total, or net, load impedance will be near 4.5 ohms. If 28w power is supplied, the three parallel speakers will run at about 8w each and the two in series/parallel will run at approximately 2w each. With this illustration in mind, you can take it from there and work out all kinds of speaker combinations to match the direct output of one or more available transistorized audio amplifiers.

At this point, some cautious, conservatives among us may wish to sound a quiet, skeptical note of warning. Indeed, it is too early to conclude that new solid-state techniques are infallible, fail-safe and actually better than the older methods employing CV (constant-voltage) distribution or other methods. Old conventions die hard and only the passage of time and many application experiences will tell if the new approach is really worthwhile.

Basic Amplifier Requirements and Specifications

Obviously, in a general sense, the type of amplifier needed for any installation is determined primarily by the individual system requirements. And this includes, of course, distinctions which must be made between fixed installation equipment and portable equipment such as that used on automobiles and "sound" trucks for PA (public-address) applications. Additionally, we may wish to select an amplifier having 5, 10 or more watts output than immediately required—to handle possible future expansion of a system. And there are other important considerations—some obvious and others not so obvious. For example, we must determine if we need a separate pre-amp/mixer/control unit to be used with a separate power amplifier, or will it prove adequate if we select a combination (or package) unit with everything on one chassis? For most jobs, we can choose the latter. For the "big jobs," we might have to select or even design a preamp/mixer/control unit to be operated separately from the power amplifier. For

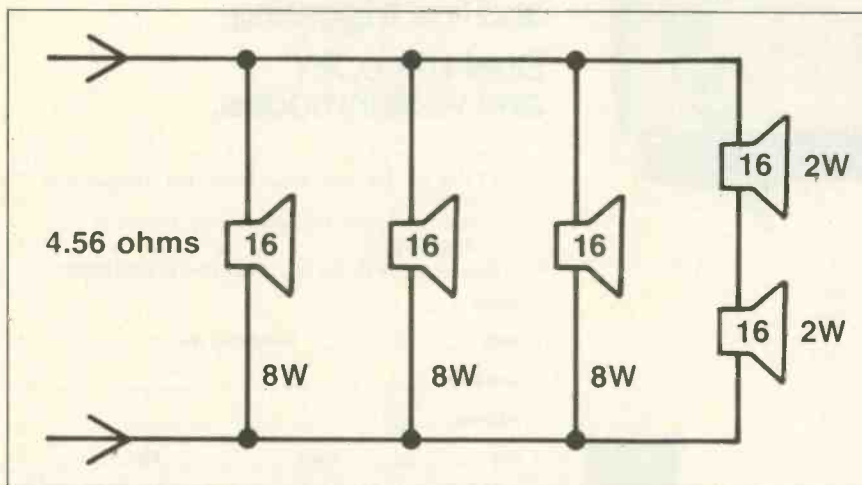


Fig. 1—Five 16-ohm speakers connected in this manner will provide four times more power to the three in parallel than the two in series/parallel.

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How much performance can you expect from a package just 1 $\frac{3}{4}$ " high, 5" wide and 7 $\frac{3}{4}$ " deep that snugles nicely into the place of a few tubes in your caddy? Plenty—like a broadcast-stable 10,000 μ V signal with four rock-steady patterns so jitter-free that you can expand and examine the quality of the color subcarrier with an oscilloscope. And that's unique.

Why is it so stable? Because all video, sync, blanking and color signals are derived from a crystal-controlled 4.751748MHz master oscillator. Because of the progressive scan system, which presents the same signal on each field. Because all counting functions and signal processing are performed by accurate, reliable digital integrated circuits. And because the ripple-free regulated power supply maintains generator stability even under abnormal line conditions. No expensive batteries to replace, either.

Plenty of good reasons to get your hands on one today. In stock at your distributor or write DYNASCAN.

MODEL 1230 \$96.00

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AUGUST 1974, ELECTRONIC TECHNICIAN/DEALER | 35

very long microphone cables, we might need a small, separate preamp close to the mike.

What kind and how many preamp inputs do we need? Here we might require either high- or low-impedance mike inputs or both. Do we need high-level phono, tape-head or AM/FM radio inputs? We might also have to give special consideration to the sensitivity of some inputs. Do we need individual gain controls on all preamp inputs? Separate controls will usually be desirable. It should be mentioned, at this point, that some packaged equipment is available which has a variety of plug-in input modules.

One difficult job, caused by the lack of uniform industry specification and test standards, is translating manufacturers' specifications into significant and meaningful intelligence. Here we must question closely the individual manufacturer. In most cases, you will find amplifier manufacturers cooperative. Obtain and carefully study their product catalogs and spec sheets.

Once again, job requirements will vary. One job may require an amplifier having a total harmonic distortion (THD), or total harmonic content (THC), specification of

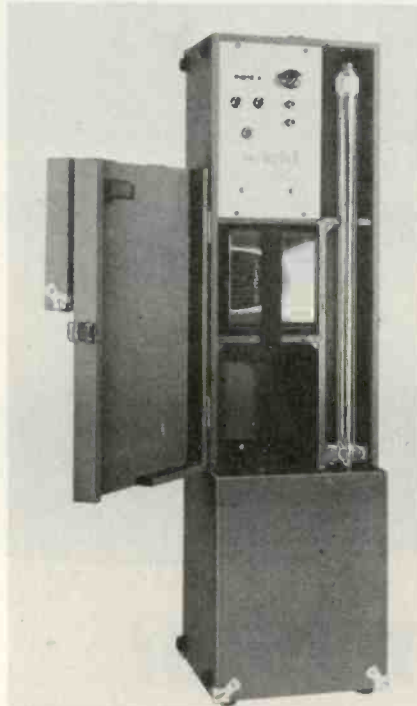
"one percent or less." A THD of "five percent or less" may be adequate for another—other factors being equal. Likewise with FR (frequency response). But here, things really get fuzzy. An amplifier having a specification of "50Hz to 15KHz" may actually be better than one which is said to have an FR from "50Hz to 20KHz." You are seldom informed how flat the FR is or how the test was made. If the manufacturer specifies "flat across the FR

spectrum plus or minus somewhere between 1 to 3 dBm," this would appear adequate for the "average" application. And again, an amplifier rated at "200Hz to 10KHz" may provide better voice intelligibility for straight PA work than one rated over a much wider spectrum.

Based on the job, of course, amplifiers are available for a continuous duty cycle. They will run continuously without being switched off. And inquire if a particular amplifier's total output rating in watts is based on continuous, RMS sine-wave power. Inquire what protective provisions are designed into an amplifier to guard against shorts or other overload conditions to protect amplifier output circuit components, speakers, etc. Hum and noise should be down -70 dBm or more.

The "Power-Doubling Muddle"

Now, we must remind ourselves of a few important facts, so we can avoid that old pitfall which has embarrassed and frustrated many un-

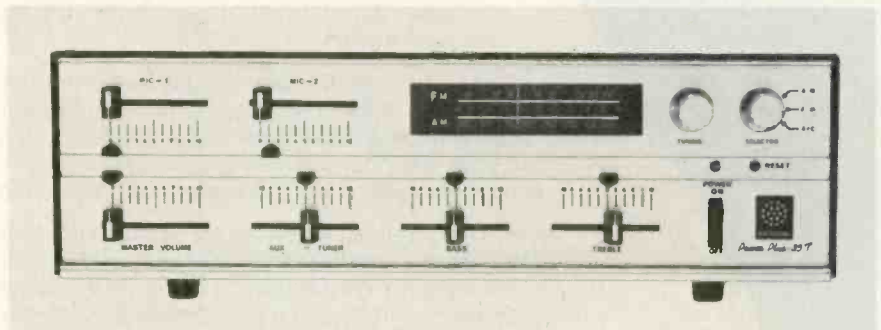


Argos Model PVD 5060A portable lectern PA system.



Bell P/A modular amplifier.

dBm/Power/Voltage Chart		
dBm	Power	Volts
0	1.000mw	0.775
1.0	1.259mw	0.869
2.0	1.585mw	0.975
3.0	1.995mw	1.094
4.0	2.512mw	1.228
5.0	3.162mw	1.377
6.0	3.981mw	1.546
7.0	5.012mw	1.736
8.0	6.310mw	1.947
9.0	7.943mw	2.184
10.0	10.000mw	2.449
20.0	100.000mw	7.746
30.0	1.000w	24.49
40.0	10.000w	77.46
50.0	100.000w	244.90
60.0	1000.000w	774.60



Fanon/Courier Model 35T package includes AM/FM tuner.



Altec Model 1593B 50w power amplifier.



Bogen's 60w amplifier features built-in microphone compressor.

wary audio technicians. It's known as the "power-doubling muddle."

As we know, the Weber/Fechner law tells us that the human ear responds to changes in volume levels in a predictable way. Tests made with "normal" human ears reveal that, beginning at a certain audible level, the ear can detect a change in that level, say an increase, of about 25 to 30 percent. But then the ear is "stuck" and cannot detect a comparable increase unless the next increase and subsequent increases in level include the 25 to 30 percent accumulatively. For example, beginning with a reference level of 5w, this power would have to be increased about 1.5w to, say, 6.5w be-

fore the increase becomes detectable to the ear. Then, for the next increase to be detectable, the power would have to be increased about 2w, to 7w. The next significant increase would be 9w, and so on. Hence, as we are reminded, the human ear responds exponentially, or logarithmically, to power level changes. That is why the dBm system is used to determine audio levels. (Zero dBm reference of 1 milliwatt at 0.7746v across 600 ohms.) A 3dBm increase in level closely represents doubling the power. And a 1dBm increase roughly represents increasing the power one third.

Study the accompanying dBm/

power/voltage chart. Note that the original power is increased 10 times for the first 10dBm increase in level. And the 60dBm level (1kw) represents a one-million times increase in the original level of 1mw. So, if you run into a problem, especially in large indoor or outdoor areas, don't try to solve it necessarily by doubling the power; instead, concentrate on proper placement of the correct number of specialized speakers. If voice intelligibility is degraded because of long reverberation times, solve the problem by revamping the acoustical character of the location—never try increasing power under these conditions. Otherwise you may end up by doubling and doubling and doubling—throwing ineffective power to the ceiling, the walls, the winds and wide-open spaces.

Figures in the dBm/power/voltage chart closely conform to $P = \frac{E^2}{R}$, $E = PR$, $\text{dBm} = 10 \log \frac{P_2}{P_1}$ and were derived by employing a five-place common logarithm table. Of course, here "P" must be figured in watts or decimal fractions and "E" in volts the same way. "R" remains constant at 600 ohms, and P_1 at 0.001w.

For those not familiar with these processes, note that the reference power has increased exponentially; at 10dBm, 10 times; at 20dBm, 100 times; at 30dBm, 1,000 times, and so on. Note also that the voltages increase in like manner but in 20dBm increments.

And voltage gain can be translated to dBm by employing the formula $\text{dBm} = 20 \log \frac{E_2}{E_1}$, where E_1 , 0.7746v (0.775v is close enough), remains constant. The even numbered dBm/power/voltage relationships have been more closely refined than the odd dBm lines simply because the even numbered 2dBm

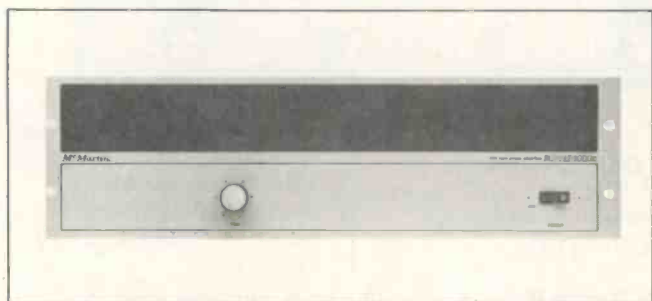
continued on page 53



Toa Electric's amplifiers are available with a variety of plug-in input modules.



Perma-Power/Chamberlain Model 5-400 has been replaced by a newer unit, Model 5-410, for which a photo was not available at press time.



McMartin Model LT-1000C 100w amplifier.



Dukane Model 1A778 50w amplifier.

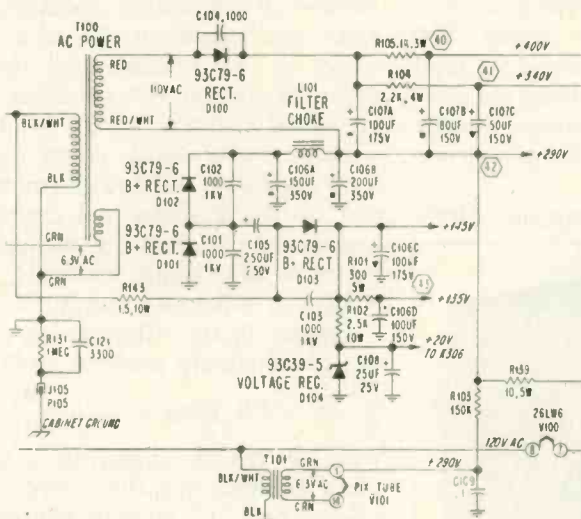
COLORFAX

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

ADMIRAL

Color TV Chassis K19 Series—Hum Bar in Picture at 60 Hz Rate

The possible cause of an hum bar in the picture can be

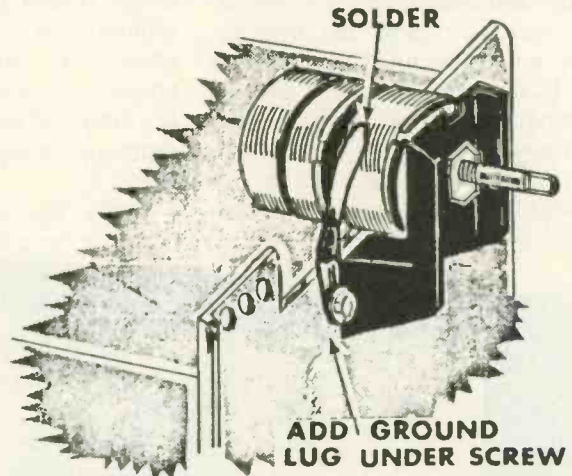


an open electrolytic capacitor on the 20v B+ supply—Part No. 67A200-250-4.

If you encounter a set with this problem, the ripple on the higher B+ supplies will appear normal. Checking the waveform at the plate (pin 2) of the Video Amplifier tube, 11CH11, will confirm the defective capacitor; you will observe 60 Hz on the video signal.

Color TV Models 5L5851, 5L5853, 5L5855—Loss of Sound

There has been a few reports of loss of sound in color TV Models 5L5851, 5L5853 and 5L5855 which are equipped with the 8T9A, 8-track tape player. The TV sound signal in these models is amplified by the left chan-



nel amplifier of the tape player, so component failure in the audio section of the tape player can also cause loss of TV sound.

Investigation of these reports showed that the sets were,

More for your money - \$189.00* - than any other Color Bar/Pattern Generator

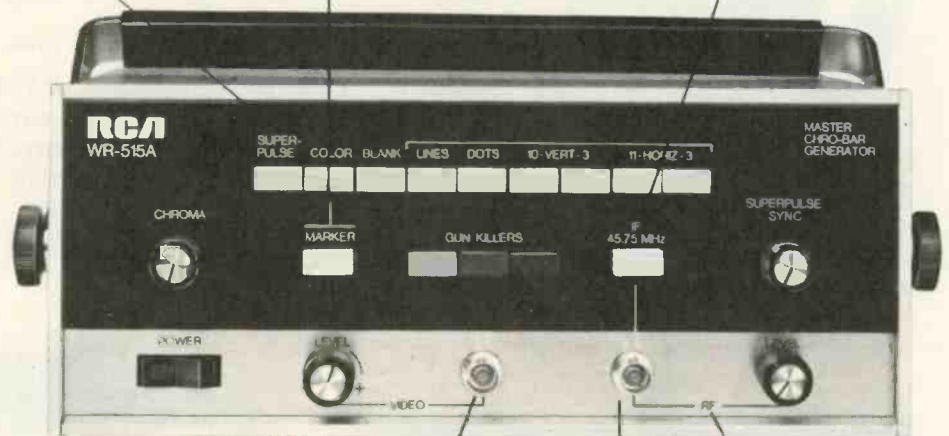
Superpulse — Provides a big, fat square pulse for easy CRO tracing in the set, and a white window pattern for quick checks of gray-scale tracking, smearing, and ringing right on the TV screen.

Bar Marker — Identifies color bars, 3, 6, 9—a "must" on overscanned sets.

IF Output — at 45.75 MHz for troubleshooting in mixer and IF stages. Excellent for servicing "modular" solid-state sets.

The RCA WR-515A offers time and money-saving returns in fast diagnosis and adjustment in both home TV or commercial/industrial broadcast installations, including VTR's and video monitors. More details at any of the more than 1,000 RCA Distributors worldwide. Or, write: RCA Electronic Instrument Headquarters, 415 S. Fifth Street, Harrison, N.J. 07029.

Specialists demand the best tools of their trade.



*Optional Price

Video Output — 2 volts, max. "+" and "-" at 75 ohms for commercial/industrial closed-circuit TV.

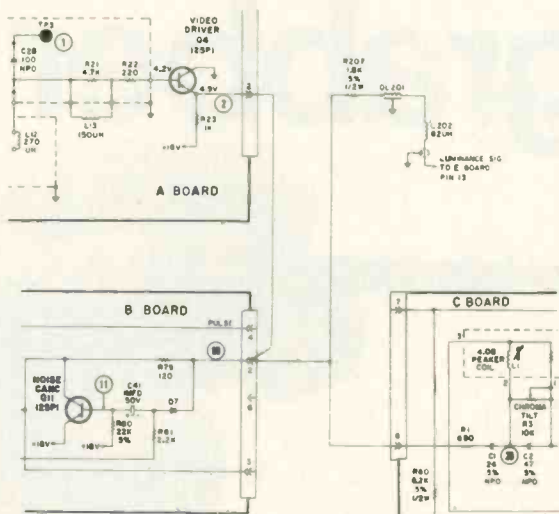
75- and 300-Ohms Output — at both RF and IF. Snap-on BNC heads for fast impedance changes. RF works into MATV, CATV systems.

100% Digital ICs — Computer-type counters need no adjustments — ever! Patterns stay locked-in.

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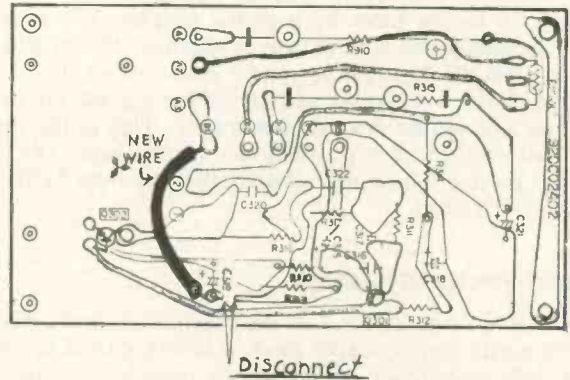
RCA Electronic Instruments

when the wire from pin 6 of the "C" board is erroneously connected to pin 3 of the "B" board instead of to pin 2. The result is that the video signal is routed through R79



Buzz

This condition is commonly called "sync buzz" or "vertical sync buzz" and is caused by vertical sync feeding into the audio circuits. If the television is operated in a quiet room with the volume at low levels, a few customers may object to the level of buzz that can be heard. The problem



on the "B" board before being applied to the video stages. R79 introduces a small pulse into the video signal. The solution is to remove this wire from pin 3 of the "B" board and connect it to pin 2.

MGA

Color TV Models CH160, CH190, CH191—Sound Problem

A small percentage of these models may develop an unusual sound condition after a period of use by the customer. Two distinct and separate problems can occur: 1) buzz, 2) squeal or loud growl.

can be corrected by performing the following steps: 1) Clip the ground lead connected to terminal B4 on the audio board. 2) Insert and solder a 2-inch length of #18 insulated wire in series with the ground lead. 3) Dress the insulated loop along the yoke housing and move it around until a position is found in which the vertical buzz is reduced to a minimum. 4) Tape the loop to the yoke housing at the point of minimum buzz, using black vinyl electrical tape.

Squeal or Loud Growl

This condition will also occur at low settings of the VOLUME control but it requires a different correction than that

SYSTEMS SCOPE

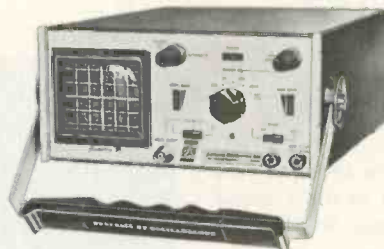
have... you need!

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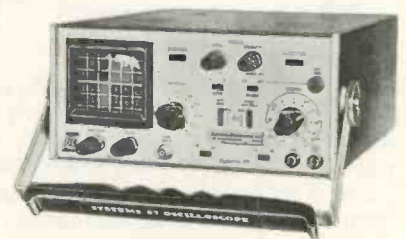
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SYSTEMS 27 SOLID STATE DC-2.5 MHz SERVICE SCOPE
 FEATURES: • 13 cm (5") CRT • Solid state circuitry • High sensitivity • TV line and field synchronization • Elegant finish • Easy-grip handle-cum-tilt stand • Compact size • Low cost.



SYSTEMS 37, 5 Hz-2.5 MHz MINI SCOPE
 FEATURES: • 7 cm (3") CRT • High sensitivity • Elegant finish • Attractive metallic brush-finish anodized front panel • Truly portable • Low cost • Easy-grip handle-cum-tilt stand.



SYSTEMS 57 PORTABLE DC-3 MHz TRIGGERED SCOPE
 FEATURES: • 7 cm (3") CRT • High sensitivity • Portability • Low cost • Elegant finish • Easy-grip handle-cum-tilt stand.

It's time a Lab or Service Tech owned one!



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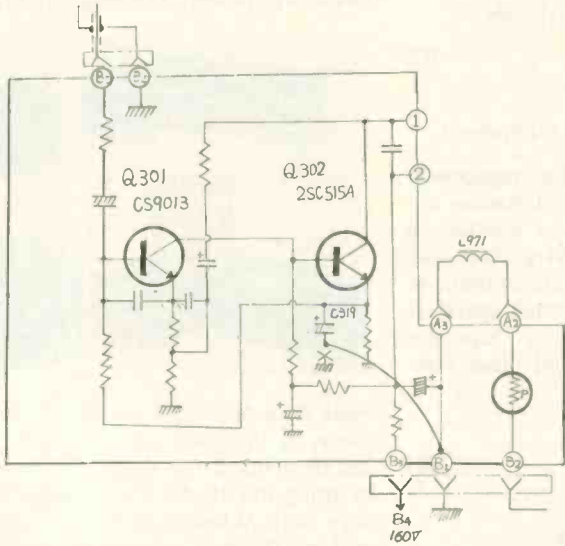
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... for more details circle 134 on Reader Service Card

of the first buzz problem.

Study the accompanying drawing of the audio board—the top schematic shows the electrical layout and the bottom drawing shows the mechanical layout.

Disconnect the negative side of capacitor C319 on the PC board. The easiest way is to cut the printed circuit at

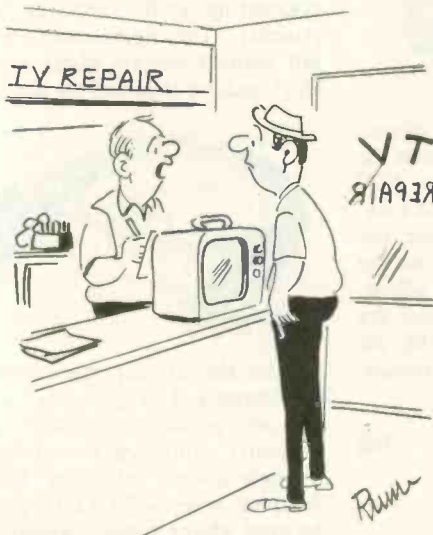


the negative end of C319, as shown in the mechanical drawing.

Add a short piece of new wire from the negative side of C319 to terminal B1 on the PC board.

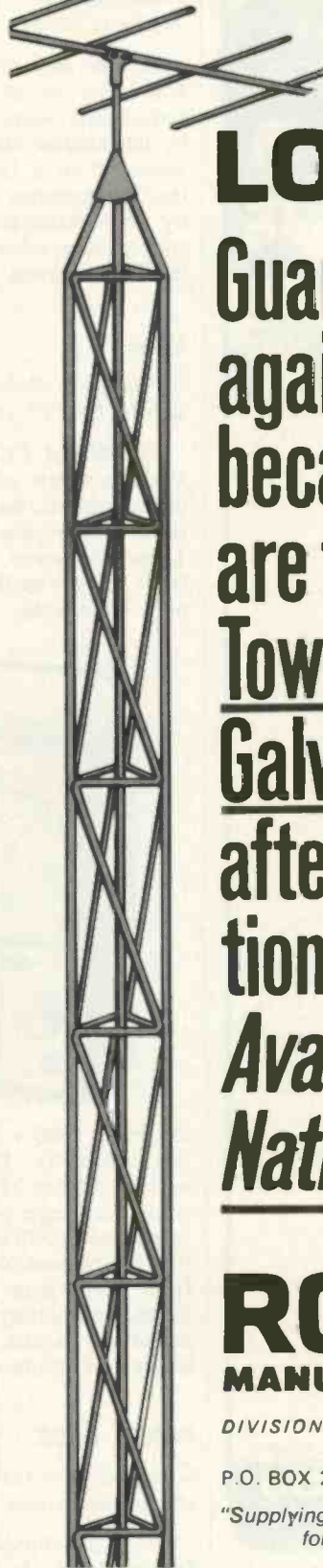
Remove the five-connector plug on the audio board and clean the contacts at ground terminal B4. Using a tuner cleaner that does not attack plastics, clean contact B4. Also, visually inspect and do whatever else is necessary to be absolutely certain that contact B4 is making positive contact.

After completing the previous steps, follow the brown lead from contact B4 to a male-female disconnect plug that also contains a green wire going to the VOLUME control. Check the contacts within the molex plug at both the brown wire point and the green wire point going to the VOLUME control. Make certain that the pins are fully seated and secured within the plug. Check to see that pins are not loose or bent. Exercise the necessary technical checks, including continuity tests and perhaps soldering, to assure that all audio circuit connections through the plug are making positive contact. ■



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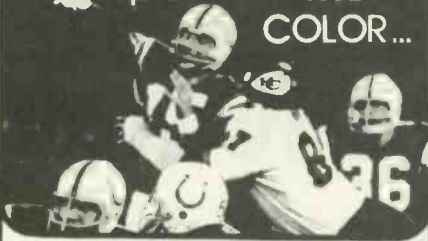
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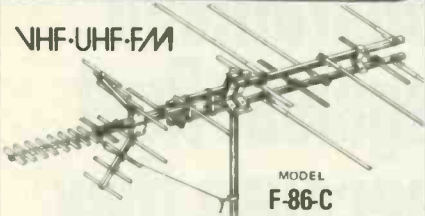
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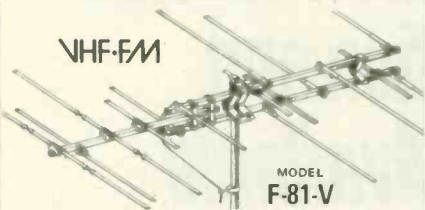
VHF-UHF-FM



MODEL
F-86-C

- MODEL F-89-C
54 Elements VHF-UHF-FM
CX-F-89-C (75 OHM)
- MODEL F-88-C
47 Elements VHF-UHF-FM
CX-F-88-C (75 OHM)
- MODEL F-87-C
33 Elements VHF-UHF-FM
CX-F-87-C (75 OHM)
- MODEL F-86-C
27 Elements VHF-UHF-FM
CX-F-86-C (75 OHM)
- MODEL F-85-C
21 Elements VHF-UHF-FM
CX-F-85-C (75 OHM)

VHF-FM



MODEL
F-81-V

- MODEL F-84-V
34 Elements VHF-FM
CX-F-84-V (75 OHM)
- MODEL F-83-V
28 Elements VHF-FM
CX-F-83-V (75 OHM)
- MODEL F-82-V
20 Elements VHF-FM
CX-F-82-V (75 OHM)
- MODEL F-81-V
14 Elements VHF-FM
CX-F-81-V (75 OHM)

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... for more details circle 109 on Reader Service Card

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.

TRANSISTORS 700

*Transistors for major
Japanese entertainment equipment*

A new line of original equipment transistors for all major Japanese entertainment equipment is announced by International Rectifier Corp. The line, packaged in a DK20 kit, consists of the 24 transistors most often specified by the manufacturers of Japanese stereos, tape recorders and other electronic equipment.

VOM 701

*Incorporates stable
differential FET amplifier*

The Model FET-300 transistorized VOM is a new addition to Mura's line of multimeters. Basic to the circuit is a stable differential FET amplifier. There are seven DC voltage ranges from 250 mv to 1000 v, with 10 M input impedance. Five AC voltage



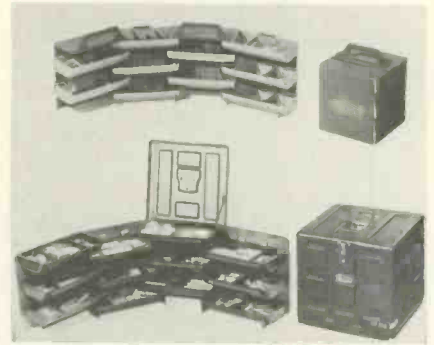
ranges to 1000 v have a 5000 ohms/volt sensitivity. DC current can be measured from 25 μ a to 250 ma. Five resistance ranges permit accurate measurements to 500 M. A mirror arc, on-the-spot calibration adjustments on the front panel, zero center scale adjustments, and battery check facilities are important factors which add to the utility and accuracy of the instrument.

PARTS CASE 702

*Can be used in the
shop or on service calls*

The Tube Products Department of General Electric Co. is offering service

dealers two new folding parts cases for use in the shop or on service calls. The small, compact case (ETRS-5980) offers adequate room for hundreds of resistors, capacitors, semiconductors and other parts required in servicing electronic equipment. The case, which has

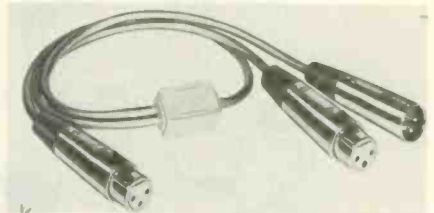


more than 500 cubic inches of storage space, is equipped with ten trays that can be divided into three sections each by using the 20 dividers supplied with each unit. When closed, the high-impact polystyrene case forms an 8-cubic-inch square. The larger case (ETRS-5981) features 12 trays which can be divided into four sections each by using the 12 dividers included with each unit. Both cases are available through your local authorized GE distributor. The compact case (ETRS-5980) is \$5.95, the large case (ETRS-5981) is \$29.95.

AUDIO ADAPTERS 703

*Interconnects almost
any audio equipment*

New, versatile audio "Y" adapters for interconnecting almost any audio equipment are introduced by Switchcraft, Inc. The 391Q "Q-G" (Quick-Ground) Y Adapters give the audio engineer, sound installer and technician wide flexibility in adapting and connecting audio circuitry and components. Three-pin male and three-pin contact female plugs (or equivalent) can be supplied in any combina-



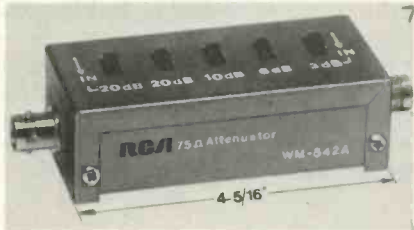
tion for the adapter, for shielded audio connections. For example, outputs of two microphones are easily and conveniently connected in parallel and to a single output using the 391Q23 Y-Adapter; a series 391Q Y-Adapter can be used where a single audio output is required to drive two extension speakers. The cable used has two conduc-

tors, is shielded with a durable gray outer jacket and is two feet long with a molded Y-junction at the center point. Price is \$16.10.

MATV/CATV ATTENUATOR 704

Simplifies CATV and MATV signal equalization problems

A new shielded attenuator designed for use in both low-level signal calibration of test equipment and MATV/CATV installation and service applications is announced by RCA Electronic Components. The RCA WM-542A 75-Ohm Attenuator is a valuable aid for



MATV/CATV TV installation and servicing when it is desirable to equalize signal levels at various outputs. The attenuator permits adjustment of signal output levels as low as 1 microvolt from suitable signal generating equipment. This five-step attenuator has stepswitches arranged in a convenient 3-6-10-20-20 dB sequence, providing a selection of the most used attenuator values from 3 dB to 59 dB. Attenuation of RF signals with a one dB accuracy up to 250 MHz is provided and is usable for signals up to 900 MHz. The unit measures 1 1/8 inch by 1-3/16 inch by 4-5/16 inch and weighs approximately 6 1/2 ounces. Price is \$29.50.

CONTACT CLEANER 705

Leaves no residue to interfere with electrical properties

A non-flammable, non-crazing contact cleaner that is harmless to most plastic is announced by 3M Company. "Scotch" brand Premium Contact



Cleaner 1613 is formulated for cleaning switches, brushes, solenoids, generators, circuit breakers, computer heads, gold and low-voltage contacts,

etc. It dries instantly and leaves no residue to interfere with electrical properties. The aerosol cleaner is formulated to provide solvent action for removing oil, grease and dirt without harm to metals and is virtually non-toxic.

DISTRIBUTION AMPLIFIERS 706

Features high input and output

A new line of distribution amplifiers, called the Metro-Line, is introduced by Winegard Co. The line is especially designed for areas in cities or suburbs with strong signals. There are



five DA models to choose from—three VHF/FM models and two VHF/UHF/FM models. The compact amplifiers offer economical solutions to design problems in homes, small com-

mercial systems and CATV systems. Extended bandpass (54 to 300 MHz) covers the mid-band and super-bands, making the amplifiers compatible with CATV inputs. The amplifiers are housed in a steel box and contain a lightning protection diode. They feature low noise figures, which helps to eliminate ghosts or snowy pictures. The Model DA-215 (shown in picture), for VHF/FM, provides an output of 53 dBmv, input of 40 dBmv, 13 dB gain, 75-ohm impedance and 4.8 dB noise figure.

INVERTER 707

Powers AC equipment from 12 v battery

The Model TI-250B Inverter introduced by EPS Co., Inc., powers AC



equipment directly from your 12 v DC battery. Exclusive features include *continued on next page*

BOTTOMS UP



Start saving the gray bottom flaps with the GE monogram from GE entertainment receiving tube cartons. They're worth valuable awards to independent service dealers and technicians in a fabulous gift bonanza program from General Electric.

The gift list includes some 43 items ranging from sporting equipment to home appliances, from diamond jewelry

to distinctive luggage, from globes and books to calculators and Attend-a-Phones. It even includes the much prized Polaroid SX-70 camera and American Experience weekend vacations at any one of 101 prestigious resorts.

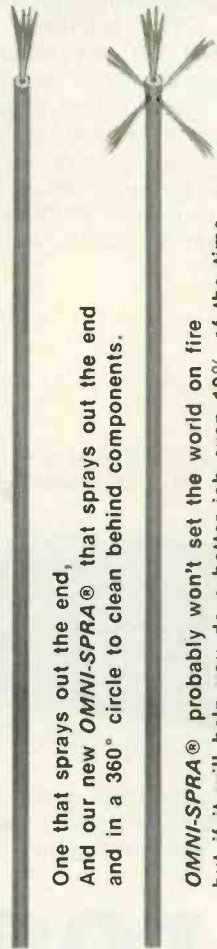
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ONE FOR THE BENCH AND ONE MORE FOR THE ROAD.....



automatic overload protection—inverter shuts off when output is accidentally shorted or overloaded, thereby preventing damage to inverter or appliance. A charge-indicator light glows while inverter is operating to indicate low-charge warning and condition of battery. Immediate starting for hard-to-start motors and loads is provided by the "start" switch. Unique power transformer and solid-state design provide maximum frequency stability and longer dependable service. The unit measures 4½ inches high by 10 inches wide by 7½ inches deep.

OSCILLOSCOPE 708

25-MHz bandwidth
and five display modes

Scopes Unlimited, Inc., has introduced a new medium-bandwidth, dual-trace, portable oscilloscope. Among the features of the scope are an internal, parallax-free, 6 X 10 cm CRT grati-



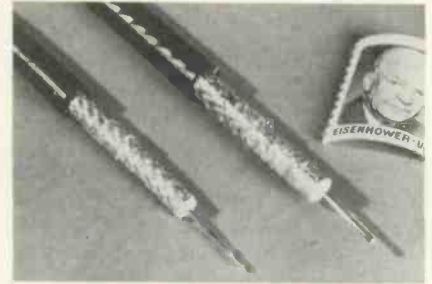
cule, a 1 mv sensitivity on both vertical channels with a full 25-MHz bandwidth, 5 display modes and a stable, high-speed, gated trigger capable of locking virtually any signal from DC to 40 MHz, including TV line and frame. Any special operating requirement is obtained by pressing the appropriate button. The unit also is equipped with internal delay lines. An optional battery pack is available. Price is \$1150.

CATV DROP CABLE 709

New design
reduces installation costs

New CATV drop cables developed by Belden Corp. are equipped with a bonded-foil shielding method that simplifies connector installation and lessens chances of faulty termination. The CATV drop cable series features new Duobond shielding, an overlapping aluminum foil tape bonded by a special process directly to the cable's polyethylene insulation core for 100 percent coverage. The tight shield-to-core bond is designed to overcome impaired shield effectiveness that might occur at the termination when an F connector is forced onto a cable shielded with

conventional laminated foil. Bonding the tape to the core prevents the shield from being forced back, exposing the



core as the connector is pushed on. With the shield remaining intact inside the connector, radiation leakage and signal pickup at the termination is minimized. The cables are available in RG-59/U type and RG-6/U type constructions, including messengered, siamese, and siamese/messengered configurations.

PORTABLE TESTER 710

Performs many tests previously
requiring larger and expensive
equipment

Elimination of costly equipment and rapid fault analysis in both digital and analogue circuits found in computer and data communications electronics is accomplished through the use of Lisson Electronics, Versi-Probe multi-function tester. This compact, self-powered



unit can perform many tests previously requiring larger, more expensive equipment such as an oscilloscope. The lightweight, 3 inch by 5 inch tester is designed for field service and test applications. It employs a unique combination of audio and LED indicators to test digital circuits such as TTL, DTL, RS232 and CCITT interfaces, communications loop and VF circuits, as well as normal component testing. Specifications for the tester include: 3 v source to generate input levels; 1-megohm input impedance; bandwidth to 2 megahertz; 50 v peak input; and tri-state indications. The price is \$59.

For more details circle 136 on Reader Service Card

TELEPHONE ANSWERING/ RECORDER SYSTEM 711

*Stores fifteen incoming
messages up to thirty seconds long*

The Memory Phone by Ford Industries, Inc., is a uniquely designed dial-in-handset telephone with the capacity



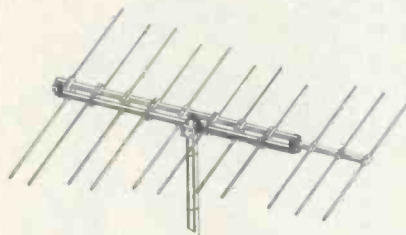
to automatically answer your telephone, deliver a short message in the subscriber's own voice to persons calling, and then record the caller's message for playback at the subscriber's convenience. Designed especially for the home and small office, the system provides a full time answering service when the subscriber is away and eliminates the necessity for answering the telephone when the subscriber wishes not to be disturbed. With the device switched off, the system operates as a normal telephone. The unit stores fifteen incoming messages up to thirty

seconds long, with full telephone fidelity, and provides visual indication of the number of messages recorded. The unit comes in three colors: white, beige and green.

FM ANTENNA 712

*Log-Periodic design provides
uniform impedance over entire band*

Two new antennas for the FM broadcast band are announced by Blonder-Tongue Laboratories, Inc. Both the eight-dipole Stereo-Eight and five-dipole Stereo-Five are log-periodic designs with dipole elements which operate on the half-wave mode. This log-periodic design provides good gain, clean patterns and impedance which



is essentially uniform over the entire band. The Stereo-Five provides 4 dB of gain across the band and has a front-to-back ratio of 16 dB over the entire FM band. It has a beamwidth

of 70 degrees and measures 67¼ inches long by 68 inches wide and is priced at \$27.28. The higher gain of the Stereo-Eight averages 6.5 dB across the band, and the antenna also has a higher front-to-back ratio (26 dB min.) and a narrower horizontal beamwidth (60 degrees). It measures 104¾ inches long by 68 inches wide, and is priced at \$40.29. Both models feature the lightness, strength and low wind resistance of dual-boom construction.

OSCILLOSCOPES 713

*Solid-state units with
DC to 15 MHz range*

Systems Electronics, Inc., has introduced two portable, solid-state DC-to-15 MHz triggered oscilloscopes. The single-trace Systems Scope, Model 77, is shown on left in picture and the dual-trace Model 87 is on the right. The units include color-coded vertical and horizontal controls for rapid reading, plus an "easy-grip" carrying handle that doubles as a three-position tilt stand. Features of the scopes include: a flat-face 8 div. by 10 div. CRT; full 15-MHz bandwidth; vernier controls on the Model 77 and push-button controls on the Model 87; and vector scope capability. Characteristics of the

continued on next page

4 Money-saving reasons to buy EICO's Solid State Test Equipment.



EICO 242 FET-TVOM. Peak-to-peak measurements of AC volts and milliamps. 6½" meter. 7 non-skip ranges. High input impedance. Low 1 volt scale. DC/AC Multi-Probe. AC or battery operated. Kit \$89.95, Wired \$129.95.

EICO 330 RF Signal Generator. 5 bands cover a range from 100 kHz to 54 MHz. Calibrated modulation adjustment control. 400 Hz audio output. Provision for modulating RF with internal or external signal source. Kit \$79.95, Wired \$119.95

EICO 379 Sine/Square Wave Generator. Simultaneous sine and square wave outputs. Covers 20 Hz to MHz in five ranges. Low distortion sultzer feedback circuit. Square wave rise time better than 0.1 microseconds. Kit \$89.95. Wired \$129.95.

EICO TR-410 Triggered Sweep Scope. 100% solid state. DC to 10MHz bandwidth. Sweep synchronized gate output. Z-Axis input. Use as vectorscope for color TV servicing. One probe for direct and 10:1 measurements. Wired \$439.95.

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or ask your distributor. Who knows what's in your tube caddy right now?

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GTB SYLVANIA

These new IR devices make replacing Zenith Semiconductors a local buy... everywhere!



Now you can buy International Rectifier's "Guaranteed" replacements for the most popular Zenith semiconductors right at your local IR distributor. Besides cutting days from the usual ordering-shipping cycle, they're priced locally too — more than competitive with the Zenith pricing structure.

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Right now you can pick up a kit* of 23 IR semiconductors, and save an additional 10%.

Add it all up: Local availability. Local price. Guaranteed IR replacements for Zenith semiconductors. You can't lose.

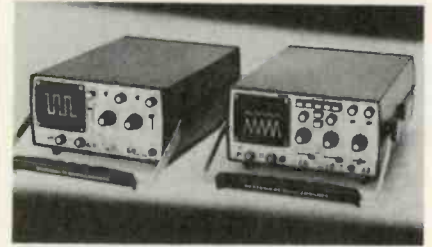
* 13-Transistors; 5-ICs; 3-Rectifiers; 1-Diode; 1-Crystal.

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

continued from previous page
vertical deflection system are: 10mV/div. to 10mV/div. in 10 calibrated steps, selected in 1-2-5 sequence, with an uncalibrated continuously variable control which covers the range between steps; ± 5 -percent accuracy; DC to 15 MHz with DC coupling, and 5



Hz to 15 MHz with AC coupling; a rise time of less than 23.3 nsec; and an input impedance of one Megohm shunted by 35 pF. Horizontal control characteristics include: sweep rates of 0.2 sec./div. to 0.5 μ sec/div., in 17 calibrated steps, selected in 1-2-5 sequence, with an uncalibrated full sweep to cover steps in between, ± 5 -percent accuracy; and sweep expansion through a five-times magnification switch that extends the sweep range to 0.1 μ sec/div. Price is \$550 for Model 77 and \$625 for Model 87.

MATV HEAD ENDS

714

*Factory assembled to
fit any specification*

A factory assembled, fully tested, custom MATV Head End is available from Jerrold Electronics. The custom Head End consists of a Jerrold Channel Commander II Signal Processor or Modulator for each channel to be carried over the system. The Channel Commanders are rack- or cabinet-



mounted and pre-wired, with all necessary mixing. Each piece of equipment is tested individually for compliance with video specifications such as frequency response, sync compression, noise performance and color capability. Then, the entire unit is checked for proper carrier levels and overall capability on 10, 12 or up to 30 channels. A particularly significant test is used as a conclusive proof of performance: All channels except one are modulated with video. A TV receiver is connected to the Head End and tuned to the un-

modulated channel. To pass this test, the unit cannot cause discernible beats, lines or patterns; the screen must be completely blank.

SWEEP/FUNCTION GENERATOR

In the price range of low-frequency sine/square-wave oscillators **715**

A sweep/function generator in the price range of low-frequency sine/square-wave oscillators is introduced by Exact Electronics, Inc. The Model 195 Sweep/Function Generator, housed in a compact case, produces sine, square, triangle and swept waveforms as well as fixed-amplitude pulses. It has a fre-



quency range from 2 Hz to 200 KHz in three ranges, with a linear/logarithmic frequency control. An internal sweep generator will sweep 1000:1 (three decades) on any of the three main frequency ranges. The generator has three 1000:1 sweep rates: slow, medium and fast. High- and low-level

sine outputs, with amplitude control of both, are provided. A voltage-control frequency (VCF) input permits controlling the frequency from an external source. Sweep rates are specified as "slow," at 25 seconds/sweep; "medium," at 250 msec; and "fast," at 2.5 msec/sweep. Frequency accuracy is ± 2 percent of full scale. The instrument measures 7 $\frac{3}{8}$ inches wide, by 2 $\frac{7}{8}$ inches high, by 8 $\frac{1}{2}$ inches deep, and weighs 2 pounds. Price is \$149.50.

VOM **716**

Drop resistant with a virtually indestructible case

A "drop-resistant" rugged version of its hand-sized Model 310 VOM, the Model 310-Type 3, is introduced by Triplett Corp. It features a virtually indestructible thermoplastic case with an easy-to-grip "finger tread" finish, a high-impact resistant clear thermoplastic polycarbonate front cover, and an easy access battery and fuse compartment with a simple, positive-lock slide latch. To free one hand, the unit can be converted into a common probe by simply unscrewing the tip from the black lead and placing it into a special jack on the top of the tester. The meter movement is diode-protected against accidental overloads, the R X 1 ohms range is guarded by a fuse, and

the voltage ranges are protected by high impedance. The unit features a spring-back jewel meter movement that provides 20,000 ohms per volt DC and 5,000 ohms per volt AC sensitivity,



ty, with 18 ranges that can be clearly read on only three arcs. The unit is self-shielding, to provide accurate readings in strong magnetic fields. Price is \$48.

HEAD DEMAGNETIZER **717**

Removes residual magnetism from heads, capstans and guides

Nortronics Company, Inc., is introducing a head demagnetizer which is designed to remove residual magnetism from recording heads, capstans and guides. Designated Model QM-202, the unit generates a controlled 60-Hz

continued on next page

WINEGARD AMPLIFIED PRODUCTS PROVEN IN OVER 1,000,000 INSTALLATIONS.

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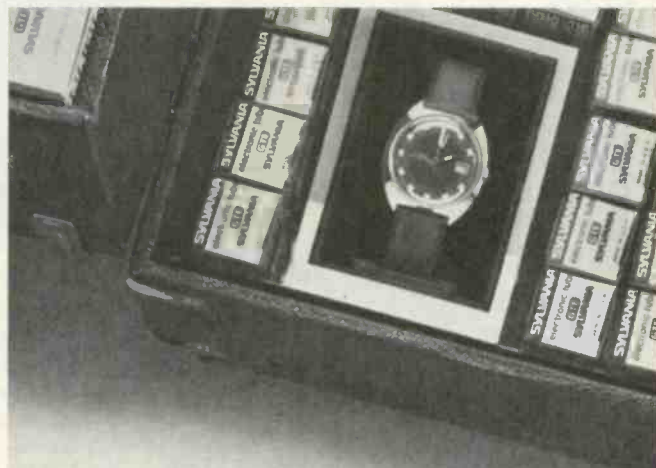
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Is there a calendar watch in your tube caddy?

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GTE SYLVANIA

DELUXE DIGITAL COLOR CONVERGENCE GENERATOR

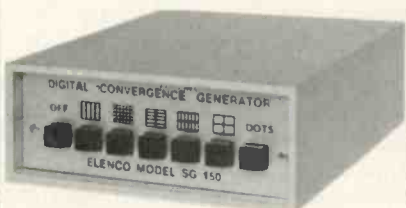
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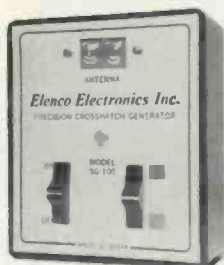
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DISTRIBUTORS' INQUIRIES INVITED

continued from previous page
magnetic field which is strong enough to effectively demagnetize, without being so strong that additional residual magnetism is created. Its primary function is to demagnetize active pole pieces and faces in recorder playback heads, preventing hiss, noise and possible erasures which can be caused by magnetized head. It features a flexible probe which will flex to reach usually inaccessible recorder/player parts. The magnetic field radiates from the tip of this probe, which is designed to contact sensitive areas without danger of physical damage.

FIELD-STRENGTH METER 718

Features precision gear drive with 1 dB accuracy

Sadelco, Inc., has introduced the Model FS3B VHF/UHF Professional Field-Strength Meter, which features a built-in speaker and precision gear drive with 1 dB accuracy. Other features include a logarithmic scale that cuts attenuator manipulations in half. Direct-reading VSWR and return-loss



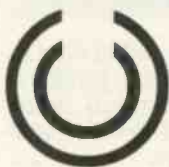
scales extend this instrument's capabilities when used in conjunction with Sadelco's Spectrum Analyst. It has a voltage-regulated battery supply, gold-plated attenuator switches and a safety switch that turns off power when the cover is closed. Another safety feature is built into the on/off switch: When in the off position, the meter is automatically shorted, reducing the possibility of damage during transit.

For more information on these

NEW PRODUCTS

See pages 55-56

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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.

SPEAKER 719

Operates within temperature ranges from 150° F to -30° F

Atlas Sound is manufacturing the first temperature-rated, "Voice-Control" speaker models for application as audible signal appliances in conjunction with life-safety and fire alarm signaling



systems. The high efficiency, 15 watt rms, re-entrant type models, AP-15TU and AFP-15TU, comply with National Fire Protection Association.

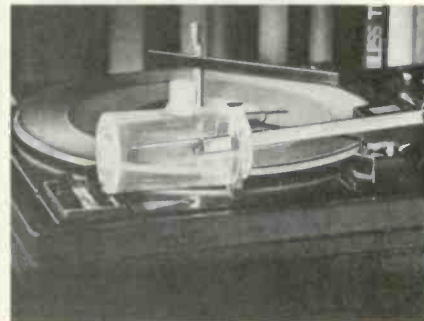
Within temperature limits ranging from 150° F to -30° F, the speakers will operate without loss of signal, and they are designed for application in electronically supervised alarm facilities. The Model AP-15TU, shown in picture, is designed for surface installation or can be strap-mounted on columns or beams and is equipped with an omni-purpose mounting bracket. Frequency response is from 275-14,000 Hz. The flange-mounted Model AFP-15TU can be installed directly in wall or ceiling and offers unlimited selection of aesthetic appearance. The speakers produce 114 dB output on axis at 10 feet distance at rated power with input from standard 25 v or 70 v audio amplifier.

STEREO NEEDLE LOCK 720

Helps eliminate shrinkage, damage and theft

Diamond needle cartridges can now be protected from damage or theft and left in place, for immediate stereo demonstrations, with a locking device introduced by Se-Kure Controls, Inc. Called "Diamond Needle Lock," the safeguard consists of a heavy-duty, durable plastic shield which slips over the record player arm and locks. The needle cannot be used, removed

or tampered with while the locking device is in place, yet it can be quickly unlocked and released by using a master key. The device is a universal de-



sign which will fit most tone arms and requires no special tools to install. The tone arm, the needle and cartridge are visible through the clear, sun glow amber-colored, durable plastic construction.

PARTS RACK 721

Inventory control system for fast-moving RCA parts

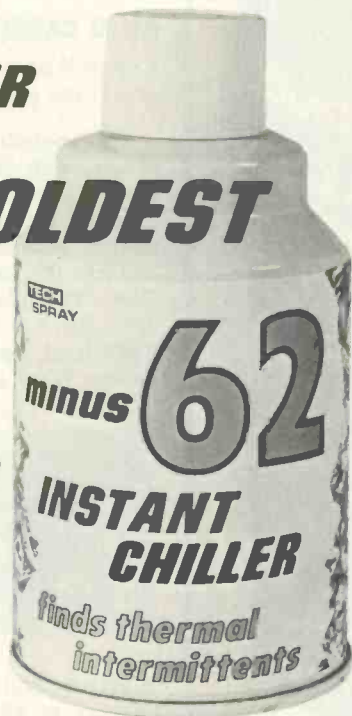
The RCA QT parts rack is designed to hold the parts included in the RCA Dealer QT (quick turnover) Parts Program. The rack is a parts inventory control system that makes it easy for *continued on next page*

COLD

COLDER

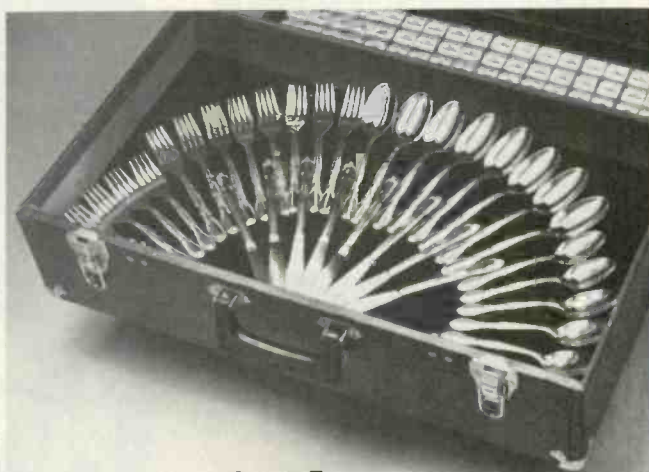
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**Is there
a dinner service in
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There could be. We award one for 345 "Wal-tham" address tabs from Sylvania entertainment receiving tube boxes. Other awards range from table lighters to a weekend holiday at a famous resort. Write for an award catalog

or ask your distributor. Who knows what's in your tube caddy right now?

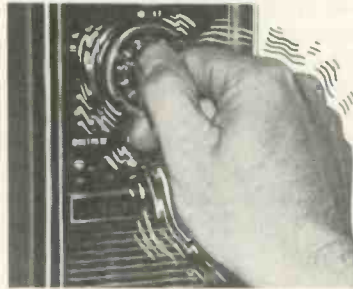
Sylvania SAV-A-TAB program, Sylvania Award Hq., P.O. Box 1000, Fenton, Mo. 63026.

GTE SYLVANIA

HOW TO RESTORE TV TUNERS



DIRTY, CORRODED OR GUNKED-UP TUNER CONTACTS MEAN SNOWY PICTURES.



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Just spray TUN-O-POWER on tuner contacts and rotate the tuner. Within 5 seconds, contacts will be clean and shiny. shiny. Detent action will be smooth as silk. Most important, you'll get sharp pictures on all channels, without wiggling knobs.

TUN-O-POWER works so well, (even on the worst tuners) it's hard to believe. Unless you try it yourself.

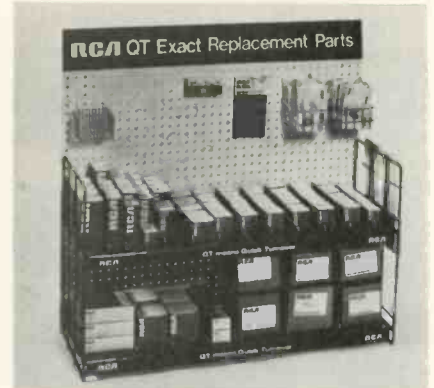
Offer to restore the tuner of every set you service— for an extra charge of \$5.00 or more, depending on how hard it is to get at the tuner. Your customer will appreciate the extra service because the set will work like new. You'll improve your reputation as well as your profit margin.

Only TUN-O-POWER restores TV tuners. Try it... you'll love it!

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continued from previous page
servicing dealers to manage their replacement parts more efficiently. The rack is extremely easy to set up and stands 30 inches high and 36 inches wide. The shelves measure 11¼ inches deep. The rack can be set up on a countertop or workbench or it can be wall mounted. It comes with 18 removable wire dividers, which are used

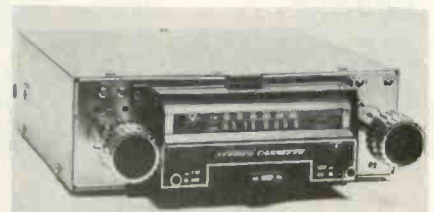


to keep the QT parts in their specific locations on the shelves. Two special steel hanger brackets are supplied to accommodate blister packed parts. Included with the rack are two wire baskets for convenient storage of parts packed in pouches. A special "reorder" basket is also supplied to hold empty pouches and box tops as a reminder to reorder out-of-stock parts. The list of QT parts is updated every six months, with faster-moving parts added and slower-moving parts dropped.

AUTO CASSETTE TAPE PLAYER

Compact unit with radio **722**
dial in the cassette door

An in-dash stereo cassette tape player, with AM/FM/FM stereo radio, is announced by Lear Jet Stereo. The unit features fast forward and fast rewind, automatic and manual reject, and has the radio dial in the cassette door. The player, designated Model A-72, has 5 w RMS per channel, 10 w RMS total, and 30 w of Peak Music Power. Wow and flutter are less than



.3-percent and signal noise and crosstalk are at 45 dB. The all-solid-state unit has a distant/local switch and adjustable shafts for simplified installation. The unit has a standard nose piece for custom in-dash installation,

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

and special custom installation pieces can be obtained by the customer from the manufacturer at no charge.

8-TRACK CARTRIDGE RECORD DECK 723

Incorporates automatic noise reduction circuits

JVC is introducing their Model ED-1245, an 8-track record/playback deck with built-in automatic noise reduction circuitry (ANRS). In addition to ANRS, it has a special fast-forward switch, a pause control, two professional VU meters and two record-



level controls. The unit also has selectable automatic program repeat and automatic or manual cartridge ejector. Price is \$249.95. □

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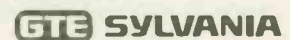


Is there a grandfather clock in your tube caddy?

There could be. We award one for 345 "Waltham" address tabs from Sylvania entertainment receiving tube boxes. Other awards range from table lighters to a weekend holiday at a famous resort. Write for an award catalog

or ask your distributor. Who knows what's in your tube caddy right now?

Sylvania SAV-A-TAB program, Sylvania Award Hq., P.O. Box 1000, Fenton, Mo. 63026.



Replacement Tubes...

continued from page 25

no matter how high future market prices might go.

To see what such a policy can mean to the servicer or dealer, let's examine it within the context of a typical service situation when a color tube replacement is required:

The first out-of-warranty CRT replacement in a color set usually comes when the set is between four and six years old. At that point it usually isn't too difficult to sell the owner on a \$175-200 replacement, especially if the dealer points out that the tube will be guaranteed (exclusive of labor) for 3 full years. This is the kind of protection that customers are looking for today.

At this point, however, the servicer/dealer should be looking ahead into the future. Why should he guarantee to sell another picture tube 5 or 6 years later for only \$69.95 plus labor and lose out on another \$200 sale? You already know the answer to that one. Later on, the set will be 10 to 12 years old,

and the customer will probably be unwilling to spend that kind of money, as the climbing scrappage rates clearly show. The customer will be faced with the choice of investing \$200 in an old set that will probably require additional service from time to time, or going out to buy a brand new set. The dealer, on the other hand, will be faced with the choice of losing the customer completely (for both present and future service), or installing a cheap tube of doubtful quality, with a limited guarantee or none at all (a step many dealers would rather avoid).

The Channel Master guarantee program was developed to solve all of these dilemmas for the benefit of both the servicer and his customer.

The picture tube extended warranty is an effective marketing tool for the servicer/dealer. It offers the customer protection, and removes much of the fear he might have about keeping an old set in use. It also gives the dealer additional options: 5 years later, for example,

he is in a position to "deal" more flexibly with his customer, by offering a top-of-the-line color tube (with another 3-year guarantee) for as little as \$99 installed, or some other "bargain" price. It might not produce the initial gross profit he would like, but it's a lot better than losing the sale to the new-set discount.

And it offers these other important advantages to technicians:

- 1) It provides a good reason for the customer to keep and repair his present set, and to buy a top-of-the-line picture tube instead of a cheaper one.
- 2) It practically guarantees the servicer/dealer first crack at future service business on that set, because his name is on the guarantee.
- 3) The protection it offers the consumer arms the servicer/dealer with an effective counterweapon against the service contracts sold by captive service organizations and large chain retailers. With the independent servicer or dealer holding the warranty on the number one cost item in TV set repair, the pic-

ture tube, the customer is not likely to see much percentage in buying a service contract elsewhere.

4) It gives the independent servicer/dealer the inside track on future new set sales. There is, of course, a good chance that many set owners will still prefer to purchase a new set a few years later, even in preference to the \$69.95 replacement. In this case, the whole issue would be academic, and the servicer/dealer will at least get a shot at selling his customer a new set.

Helping the Independent

Extended warranties, when properly understood and used by the independent servicer/dealer, can be effective tools in helping him cope with market conditions that he cannot possibly control by himself. Manufacturers committed to the continued profitability and growth of independent consumer electronic servicers and dealers are obliged to do everything in their power to develop products and policies that assist servicers and dealers in adapting to a changing market. ■

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Sony...

continued from page 19

it is not too difficult to troubleshoot. However, it is necessary to break the feedback loops. The best way to accomplish this is to troubleshoot the power supply separately using an external 19-volt supply. A bench type power supply with a capability of providing 19 volts at about 2 amperes will do the job. This supply voltage is applied between pin 16 of the PR (power regulator) Board (positive) and ground. It is then possible to trace the drive pulse from the horizontal oscillator through the PWM to the gate-cathode circuit of the GCS regulator transistor. The normal gate waveform at Q603 is a 12 microsec under these conditions, and a narrow pulse (4 microsec) indicates excessive load on the power supply, such as a

shorted horizontal output stage.

Before putting the set back into operation, check the drive voltage at the gate of the horizontal-output stage.

An elaborate check-out procedure for this system is available from Sony if you run into a difficult problem. ■

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... for more details circle 124 on Reader Service Card

Selecting Amplifiers . . .

continued from page 37

steps appear to be more useful in practice. The odd numbered dBm line figures are all close enough, however, for practical work.

Installation Basics

Perhaps the first consideration for a fixed installation is a centrally located, enclosed, clean area for the equipment—preferably a small, well-ventilated, close-size room having a locked door. In addition to space for amplifier or amplifiers, space should also be allowed for input, or program source, equipment—AM/FM tuner, tape player, phono or whatever is required for the particular installation. And, of course, the room should be provided with a sufficient number of proper 117VAC power outlets.

If you contract for and survey a job in an already completed structure, you would determine how much speaker wiring is necessary, the B&S gage of wire required, whether the building code requires that it be run in rigid conduit, BX cable or whether balanced or unbalanced lines are appropriate, and then you must determine the best way to install it. In new construction, you would normally work with the construction architects during the planning phase and then farm out speaker and other necessary cabling to subcontracting electricians. All input cables, including microphone, should be shielded and made as short as possible.

Servicing Considerations

The straight technical aspects in servicing commercial audio equipment, whether solid-state or electron-tube type, are similar to those most technicians are already familiar with. Whether you lease or sell an installation outright will determine to some extent your servicing procedures. Since most serious breakdowns require shop work, you would normally have an amplifier replacement on hand, to provide the customer with uninterrupted service. In a leasing arrangement, you would usually include an additional charge for servicing. All of this, however, is spelled out along with other business and maintenance problems beginning on page 57 in the August 1972 issue of **ELECTRONIC TECHNICIAN/DEALER**. ■



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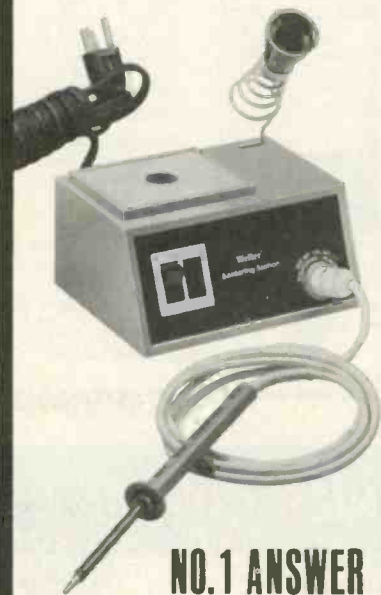
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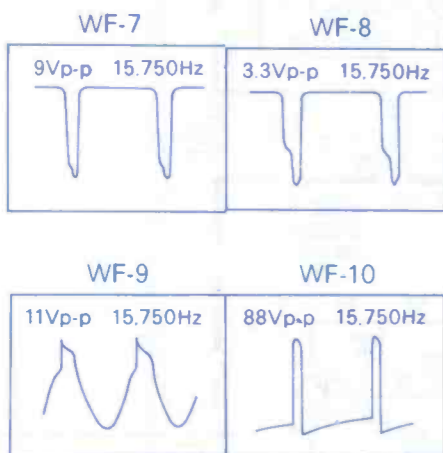
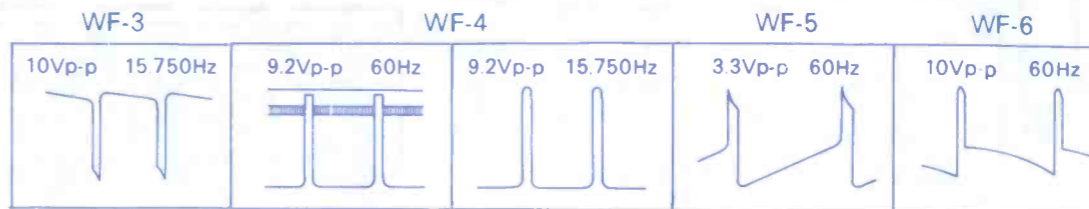
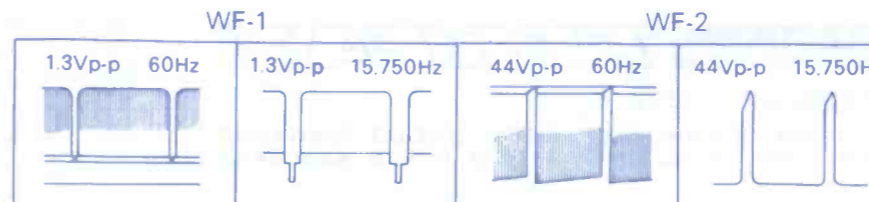
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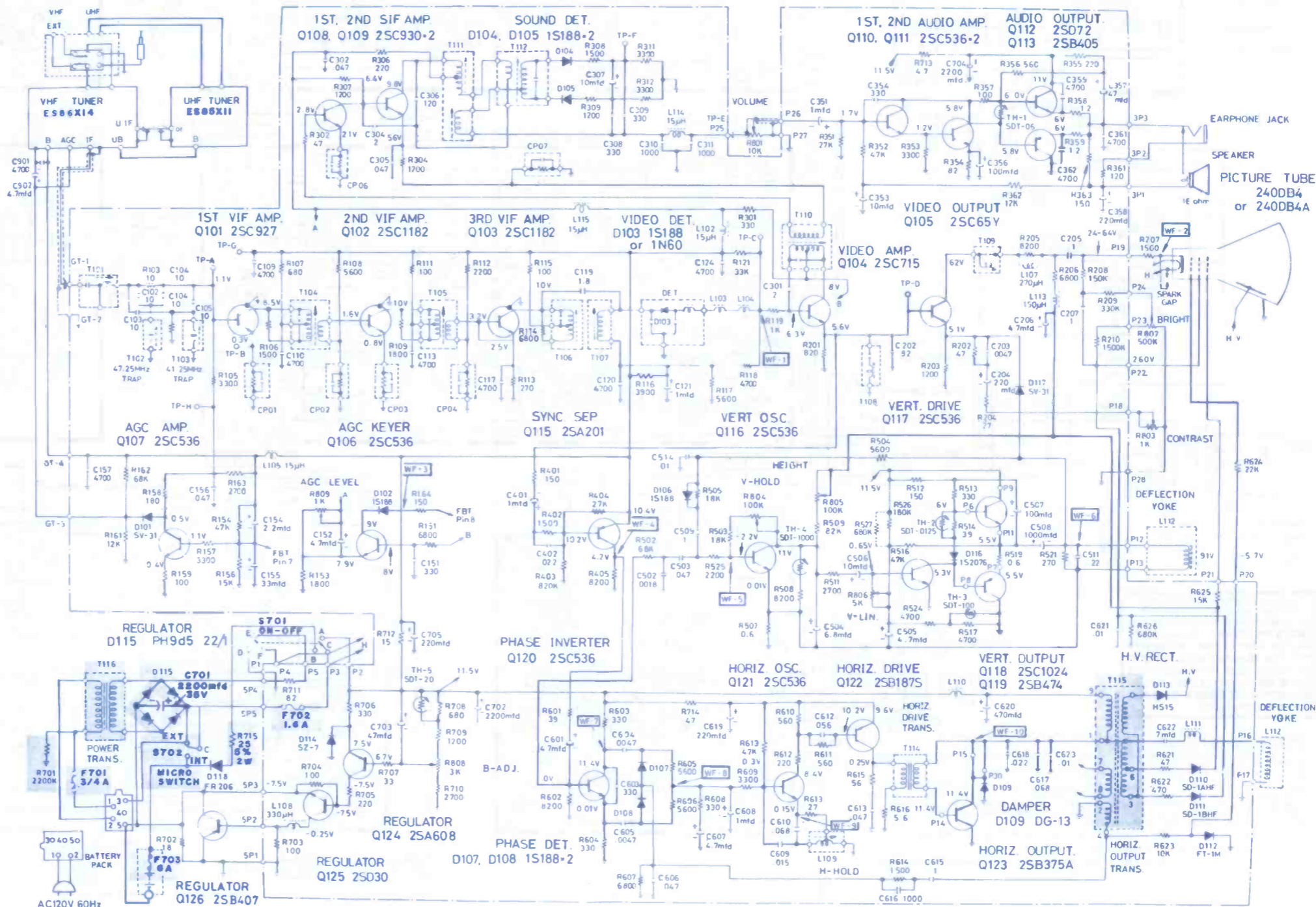
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GROUP
264

SCHEMATIC NO.	SCHEMATIC NO.
ADMIRAL Color TV Chassis M24 1540	PHILCO-FORD Color TV Chassis 3CS45 1542
AIRLINE TV Model GAI-17025A 1541	ZENITH TV Chassis 19FB12, 13 1543
GENERAL ELECTRIC TV Chassis R-2 (Late Production) 1539	



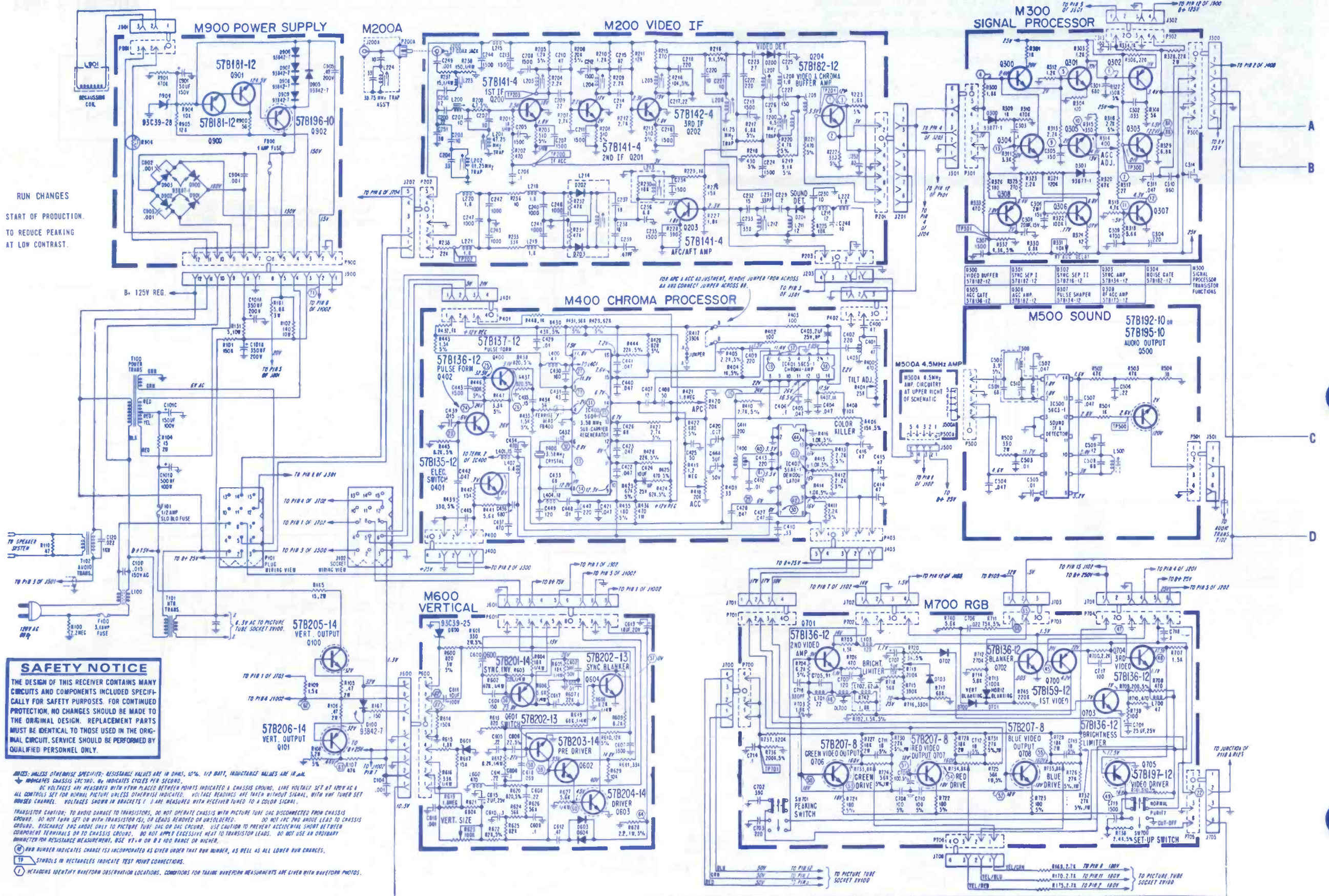
SYMBOL	DESCRIPTION	GENERAL ELECTRIC PART NO.
L109	coil horiz osc	ES35X6
L110	coil horiz filter choke	ES36X93
L112	deflect yoke	ES76X7
T102	x-former 47.25MHz trap	ES36X97
T108	x-former 4.5MHz trap	ES36X104
T109	x-former 4.5MHz	ES36X66
T110	x-former audio take off	ES61X14
T111	x-former audio detect	ES61X15
T112	x-former audio detect	ES56X3
T115	x-former HV assembly	ES77X13
T116	x-former power	ES88X3
	fuse .75A fast blo F701	ES10X8
	fuse 1.6A slo blo F702	ET10X6
	fuse 6A fast blo F703	ES10X14
	tuner UHF	ES85X11
	tuner VHF	ES86X14

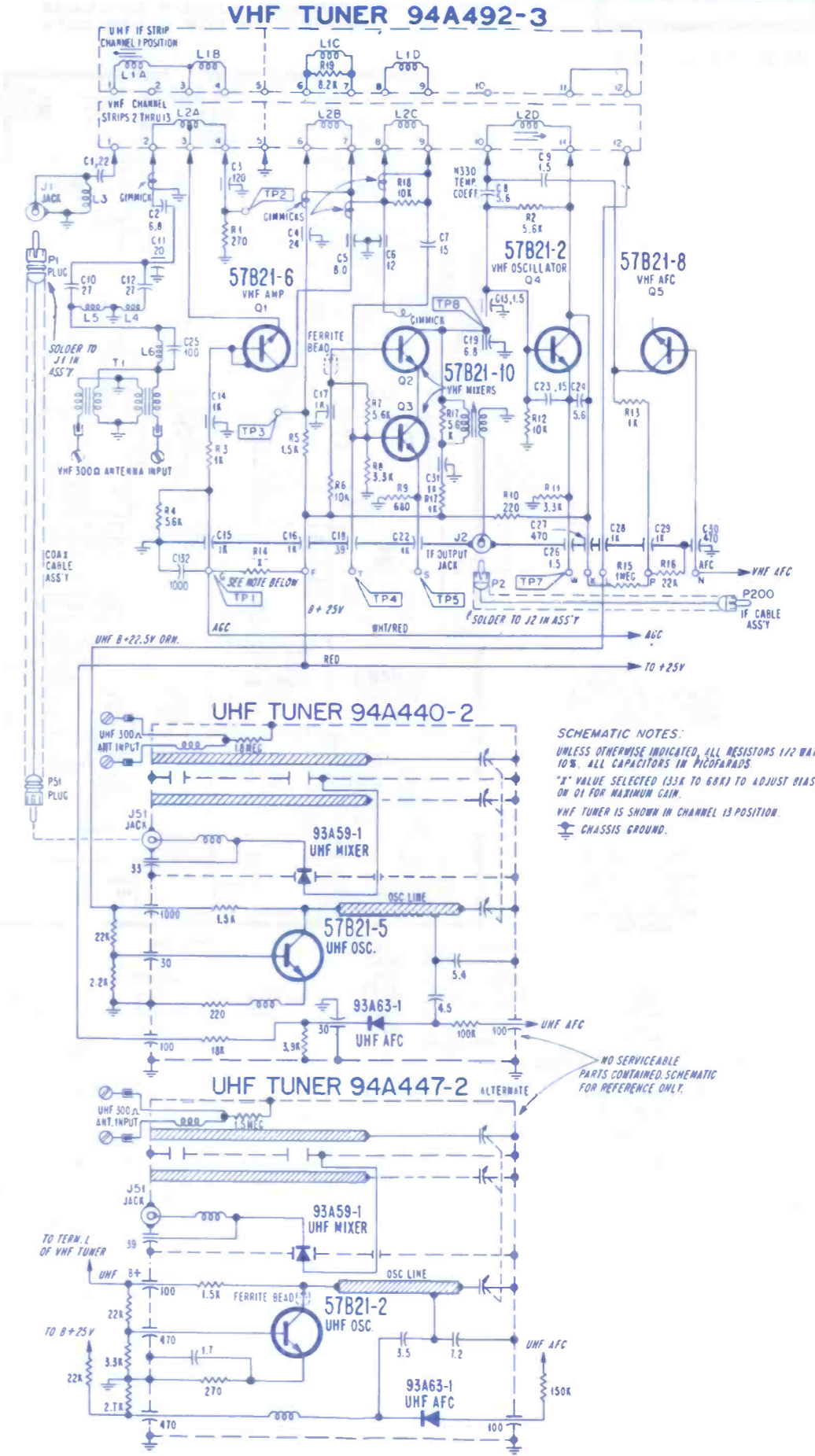
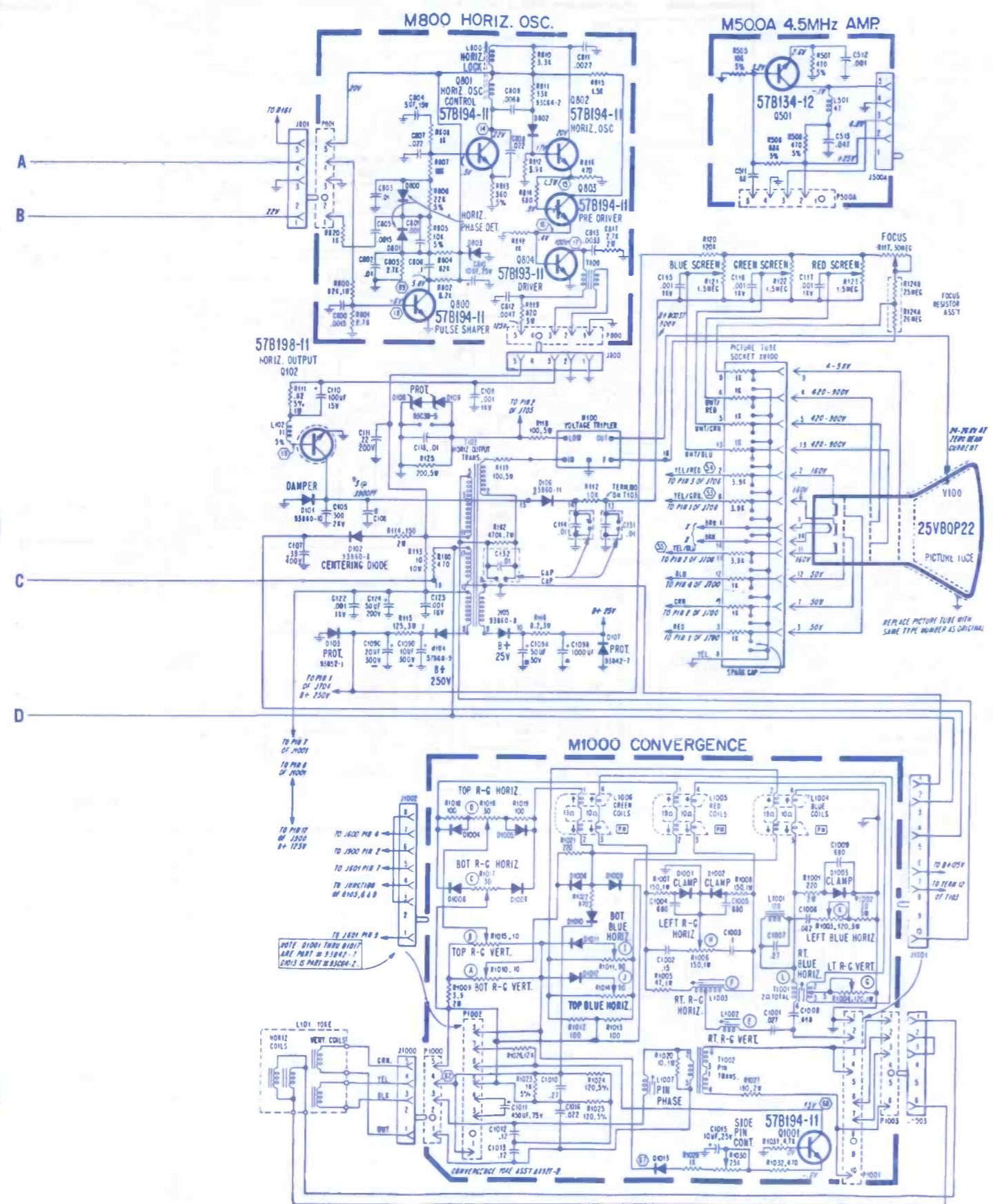


SYMBOL	DESCRIPTION	ADMIRAL PART NO.
C, D	100A, B - 350 μ F/200V, 350 μ F/200V	67A15-421
R	15M focus control	75A108-8
L	100 - choke AC line	73A31-22
T	100 - power xformer	80A124-1
T	101 - filament xformer	80A119-2
T	102 - audio xformer	79A171-3

T103	- horiz output xformer	79A178-1
L206	- coil 41.25MHz trap	72A316-12
T200	- xformer 4.5MHz trap	72A329-10
R314	- 400n AGC adj control	75A101-53
R331	- 10n AGC delay adj control	75A101-25
R401	- 25K tilt adj control	75A101-26
R408	- 10K color killer control	75A101-25
R418	- 20K ACC adj control	75A101-46

L403	- coil chroma take off coil	73A135-3
L400	- xformer chroma bandpass	73A134-2
L500	- coil sound quad xformer	72A329-1
T500	- xformer 4.5MHz	72A316-6
T623	- 100K, vert size control	75A101-60
R719	- 200K, brightness limiter control	75A101-26
L800	- coil horiz osc lock	94A351-3
T800	- xformer horiz drive	79A167-2





SCHEMATIC NOTES:
UNLESS OTHERWISE INDICATED, ALL RESISTORS 1/2 WATT, 10%. ALL CAPACITORS IN PICOFARADS.
"X" VALUE SELECTED (13K TO 68K) TO ADJUST BIAS ON DI FOR MAXIMUM GAIN.
VHF TUNER IS SHOWN IN CHANNEL 13 POSITION.
⊥ CHASSIS GROUND.

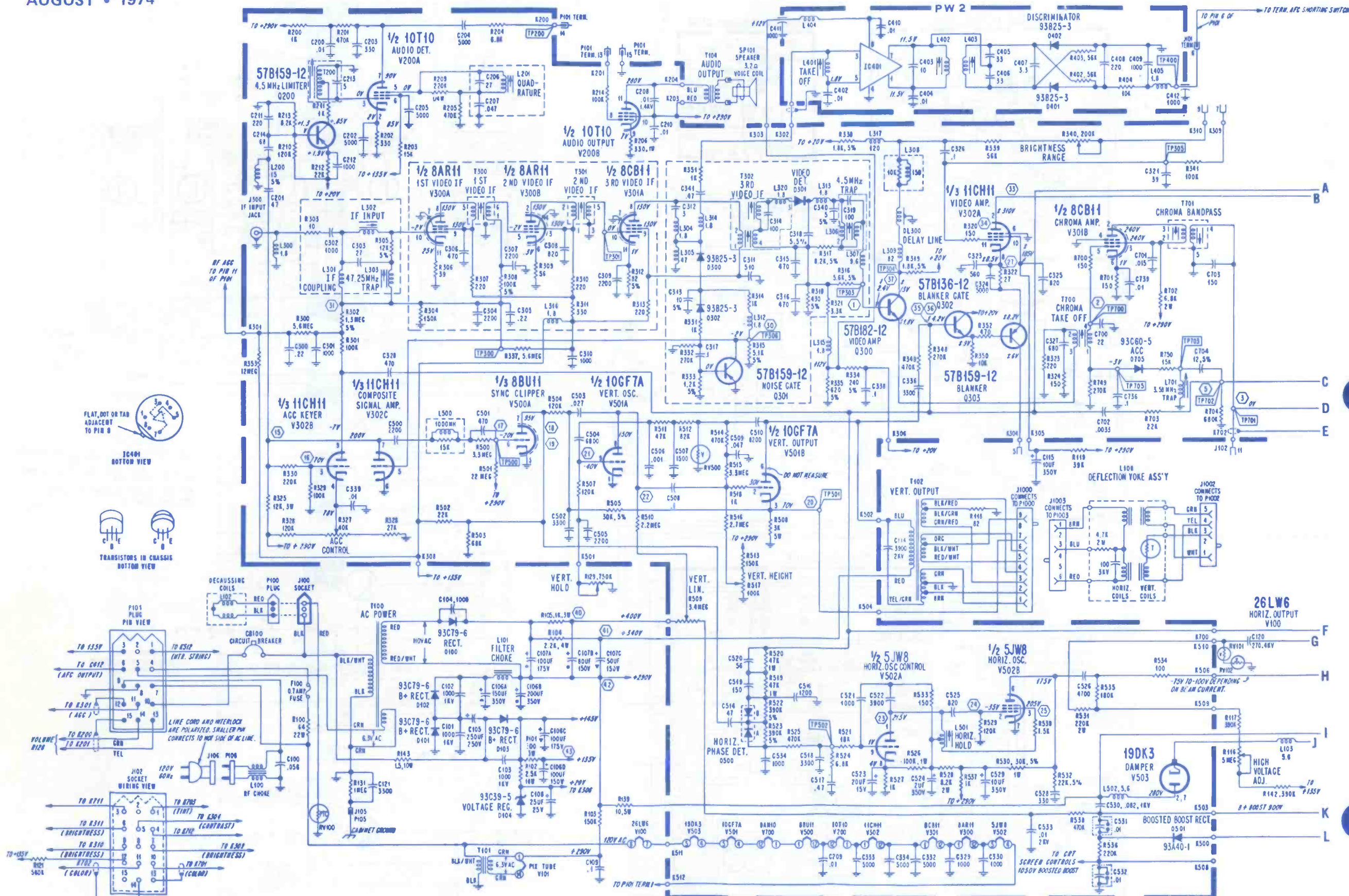
NO SERVICEABLE PARTS CONTAINED. SCHEMATIC FOR REFERENCE ONLY.

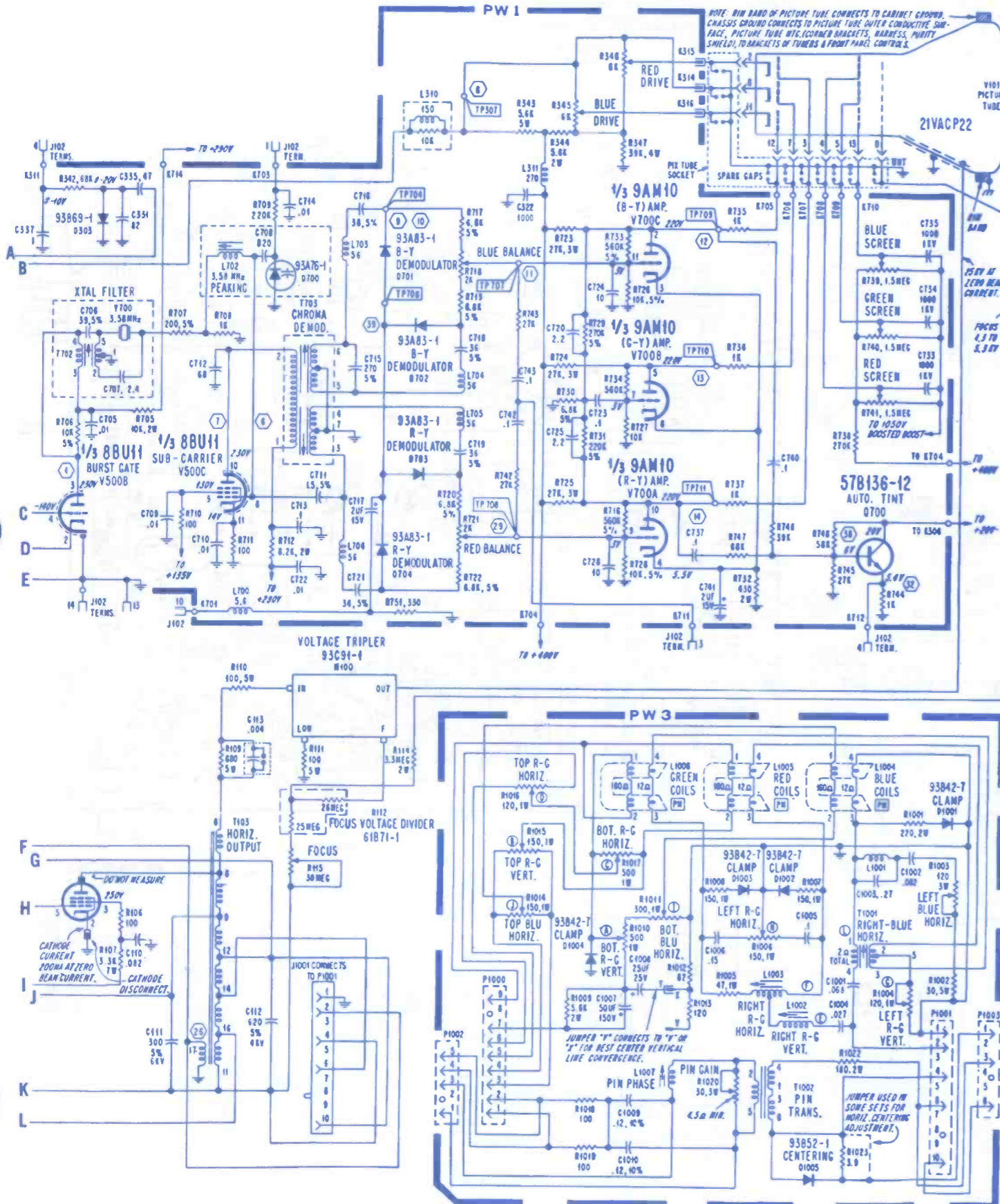
ELECTRONIC **TEKFA**
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COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS
AND TECHNICAL INFORMATION FOR 5 NEW SETS

SYMBOL	DESCRIPTION	AIRLINE PART NO.
C106A	150 μ f, 250v, electrolytic	75A195-1
C106B	200 μ f, 350v, electrolytic	75A189-18
C106C	100 μ f, 175v, electrolytic	75A135-46
C106D	100 μ f, 150v, electrolytic	75A155-9
R115	control focus 30M	75A155-9
R116	control high voltage adj 5M	75A155-10
R124A,B	control contrast 700n/700n	75A155-10
R125A,B	control brightness 200K/200K	75A155-10
R126A,B	control color 1K/1K	75A155-10
R127A,B	control tint 100K/100K	75A195-1
R128	control volume 1M	75A189-18
R129	control vert hold 750K	75A135-46
R327	control AGC 40K	75A155-9
R345	control blue drive 6K	75A155-9
R346	control red drive 6K	75A155-9
R340	control brightness range 200K	75A155-10
R509	control vert lin 3.4M	75A155-10
R517	control vert height 100K	75A155-10
L106	coils deflect yoke assembly	94A460-1
L201	coil quad	72A366-1

L501	coil horiz hold	94A351-1
T100	x-former, power	80A116-3
T103	x-former horiz output	79A164-3
T104	x-former audio output	79A88-7
T200	x-former 4.5MHz sound driver	72A303-17
T700	x-former chroma take off	72A368-1
T703	x-former chroma demod	72A357-1
M100	voltage tripler	93A91-1
CB100	circuit breaker 2.6a tuner UHF	84A17-15 94A440-1
	tuner VHF	94A421-1





NOTES: UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS, 10%, 1/2 WATT; CAPACITANCE VALUES 100 HIGHER ARE IN PF; CAPACITANCE VALUES LESS THAN 1 ARE IN UF; INDUCTANCE VALUES ARE IN UH.

⊕ INDICATES CHASSIS GROUND, ⊕_C CABINET GROUND, ⊕_F CYCLES PER SECOND.

DC VOLTAGES ARE MEASURED WITH VTVM 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.

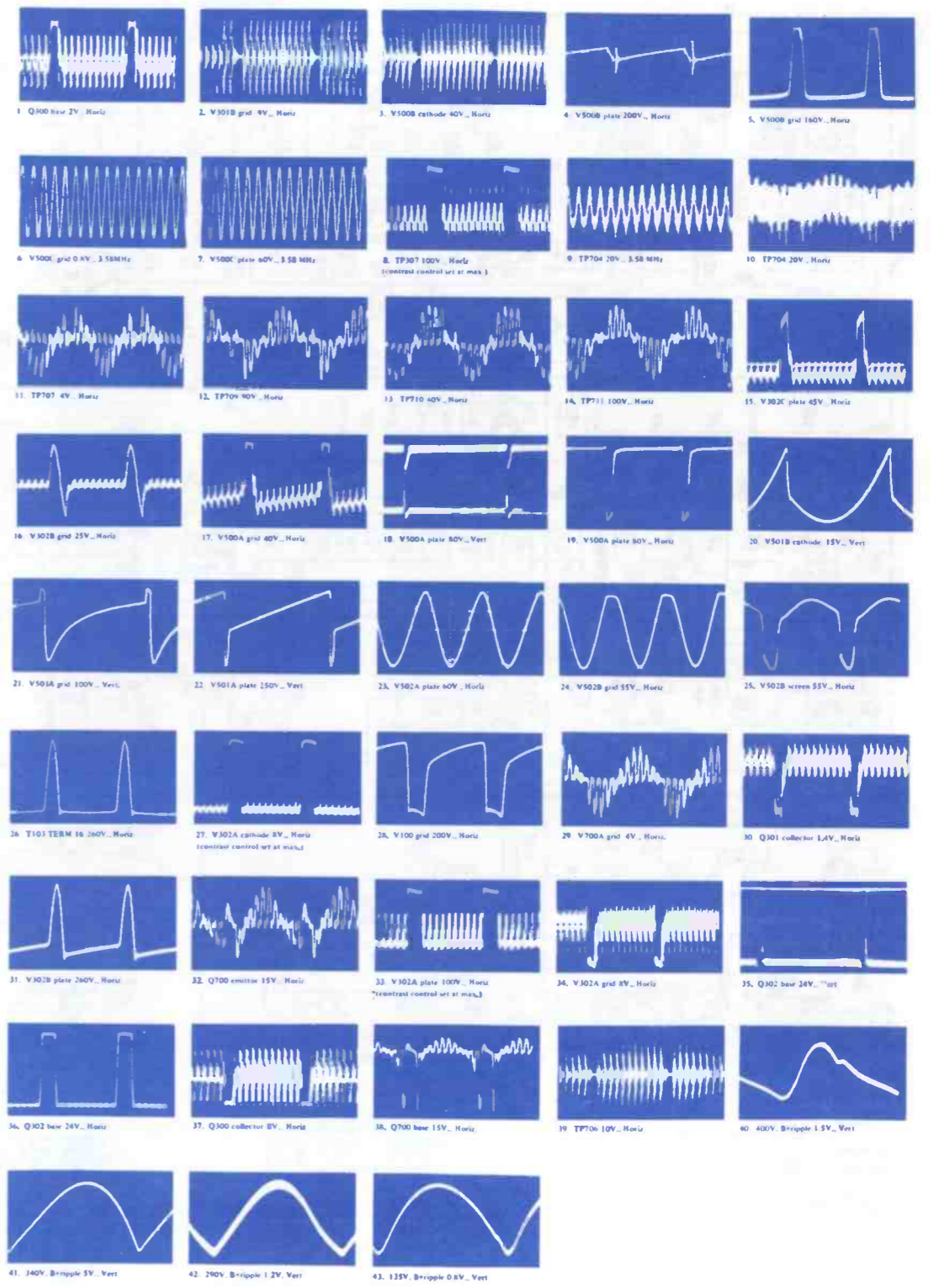
⊕ INDICATES THESE VOLTAGES MAY VARY WITH VIDEO CONTENT OF THE PROGRAM BEING RECEIVED AND ARE AVERAGE READINGS.

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 TRANSISTORS, 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 R100 RANGE OR HIGHER.

TP SYMBOLS IN RECTANGLES INDICATE TEST POINT CONNECTIONS.

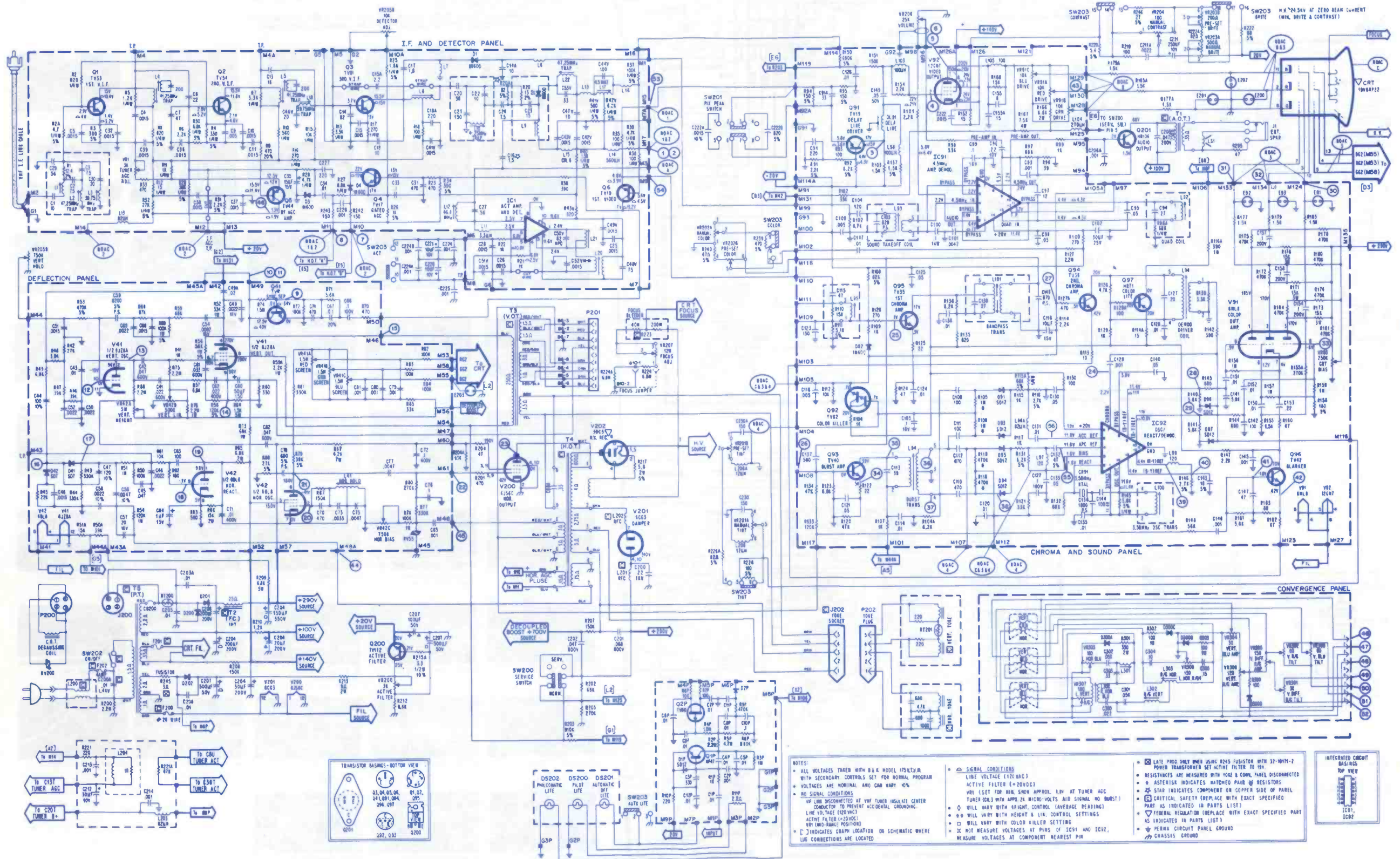
(1) HEXAGONS IDENTIFY WAVEFORM OBSERVATION LOCATIONS. CONDITIONS FOR TAKING WAVEFORM MEASUREMENTS ARE GIVEN WITH WAVEFORM PHOTOS.

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.



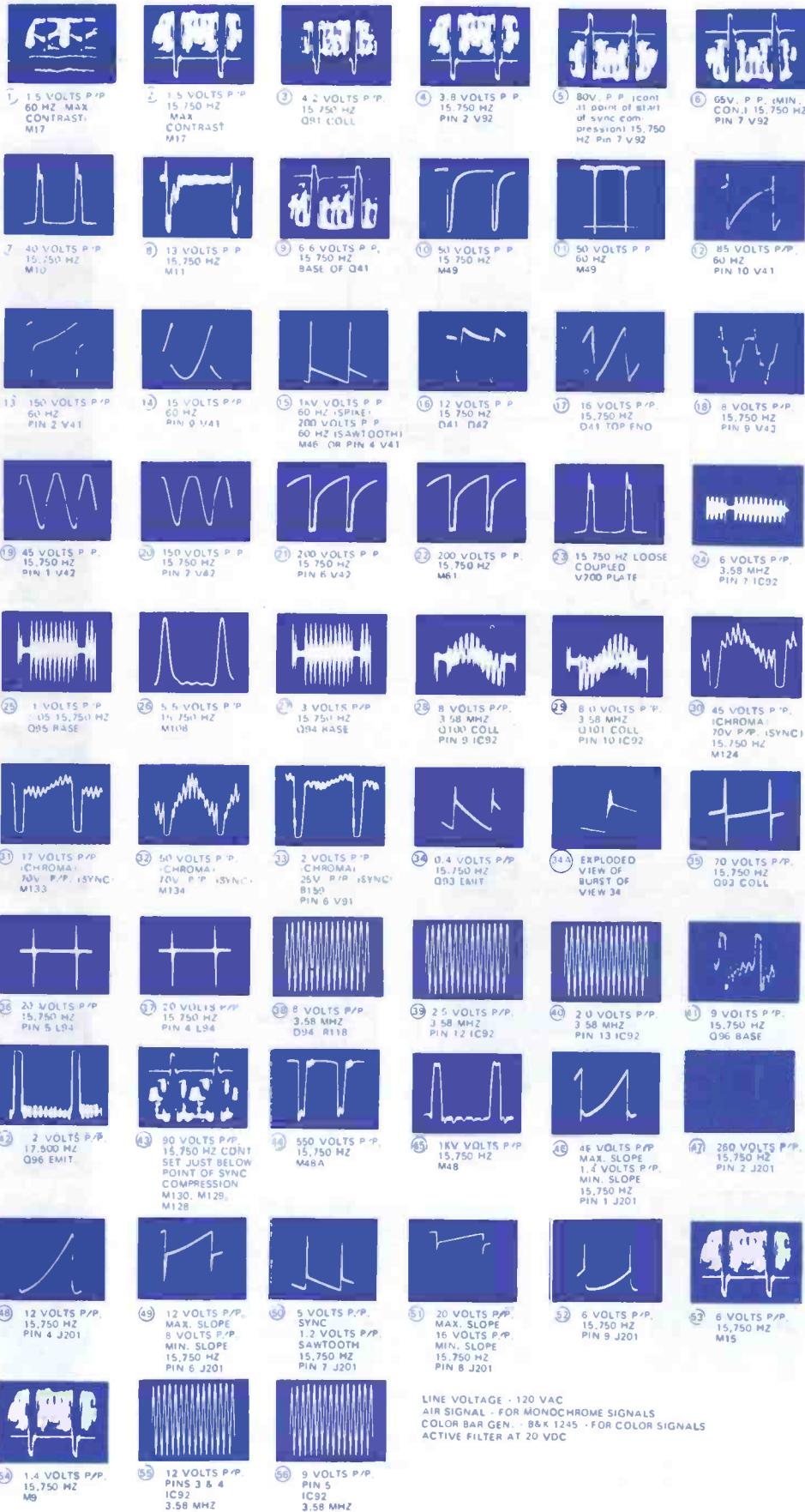
SYMBOL	DESCRIPTION	PHILCO-FORD PART NO.
C204A	—200µf/200v, 150µf/350v, 20µf/200v thru D—50µf/200v, B+ filter	30-2625-3
C207A	—500, 500, 100µf/50v, +20v supply	30-2625-2
B, C	—active filter base & emit	46-5002-6
CB200	—power AC	42-2136-10
IC1	—act IC	46-5002-8
IC91	—IC-8, aud./i.f./det IC	46-5002-1
IC92	—IC-21, osc/react/det IC	46-5002-2
L41	—horiz hold coil	32-4891-2
L92	—sound quad, coil	32-4876-1
L93	—sound T.O. coil	32-4936-3
L94	—burst xformer	32-4931-1
L95	—chroma T.O.	32-4878-3
L100	—3.58MHz osc out coil	32-4932-2
L101	—bandpass xformer T.O.	32-4929-1
R223	—focus bleeder	33-1390-1

R245	—3n fusistor	33-1381-5
RV55	—horiz bias varistor	33-1379-2
RV200	—degaussing coil	33-1379-1
SW202	—on/off power AC	42-2167-4
T1	—audio output xformer	32-10156-1
T2	—filter choke	32-10155-3
T3	—vert output xformer	32-10167-1
T5	—power LP	32-10171-2
T5	—power EP	32-10171-2
VR42	—A-vert ht, B-lin, C-horiz bias	33-5627-3
VR93	—CRT bias	33-5628-12
VR202A, B	—500n, color, manual & preset	33-5644-20
VR203A, B	—brightness manual & preset	33-5644-18
VR204	—100n contrast	33-5655-6
VR205A, B	—750K, vert hold 10K, det adjust	33-5644-21
VR206	—25K, volume	33-5656-1
	tuner ITT152CD UHF	76-13827-13
	tuner TT191C VHF	76-14296-4

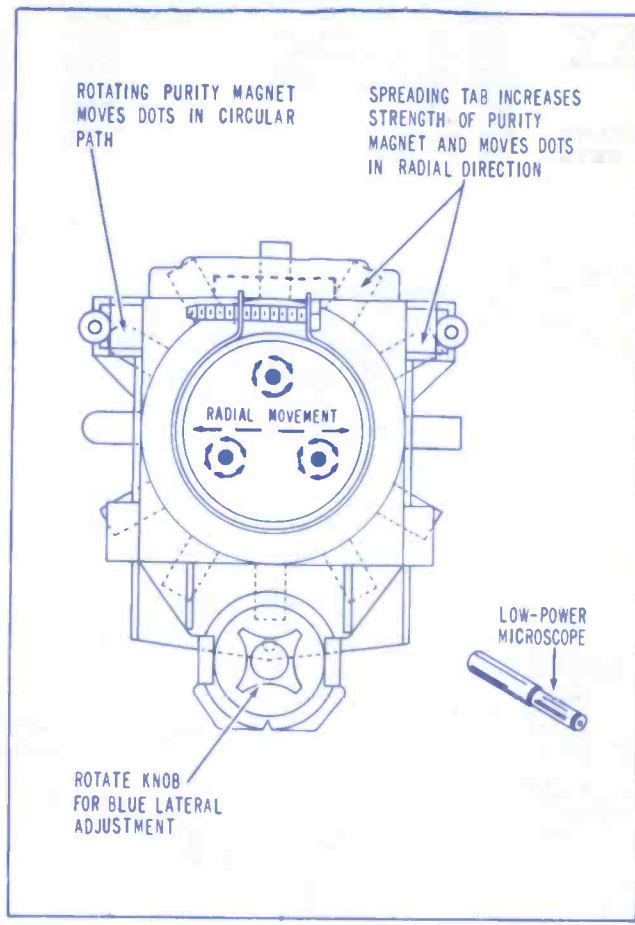


OSCILLOSCOPE WAVEFORM PATTERNS

These waveforms were taken with the receiver AGC control adjusted for an approximate peak-to-peak output of two volts at the video detector, using an air signal. Do not reset AGC control when using color bar generator. All monochrome voltages taken with average air signal and all chroma voltages taken with a color bar generator connected to the antenna input terminals. The chroma peak-to-peak voltages were taken with the chroma control set for 0.3V peak-to-peak at center tap of chroma control or M102 and the tint control set for proper color bars (approximately mid-range). color bar generator output set for 11.5 VDC at M109, all other controls set for normal viewing. The frequencies shown are those of the waveforms. ... not the sweep rate of the oscilloscope. All voltages taken with a wide band scope having a 5 MHz bandwidth similar to B&K Model 1450. Line voltage 120V

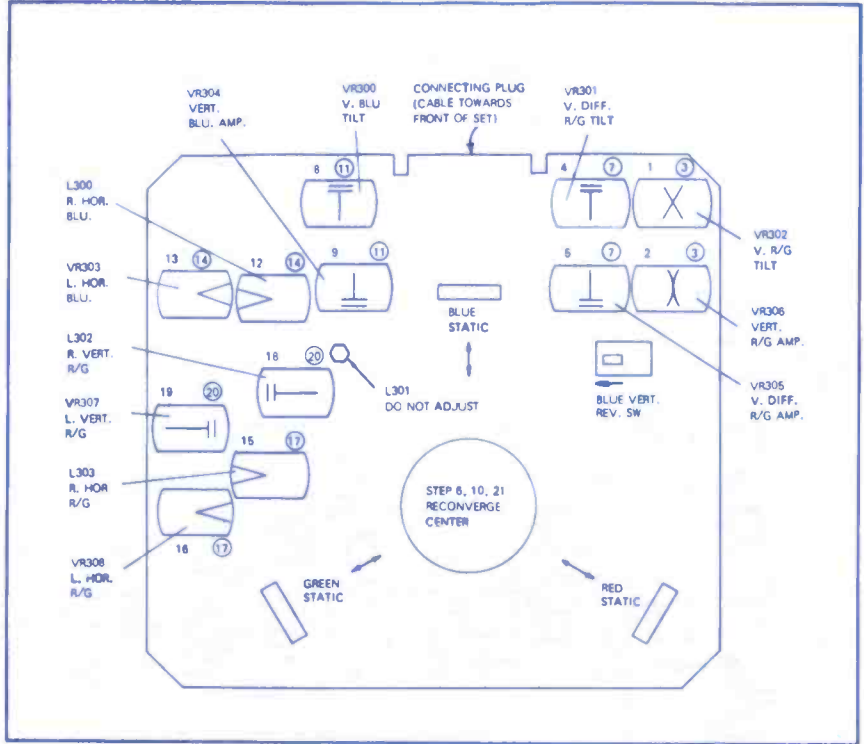


LINE VOLTAGE - 120 VAC
AIR SIGNAL - FOR MONOCHROME SIGNALS
COLOR BAR GEN. - B&K 12-45 - FOR COLOR SIGNALS
ACTIVE FILTER AT 20 VDC



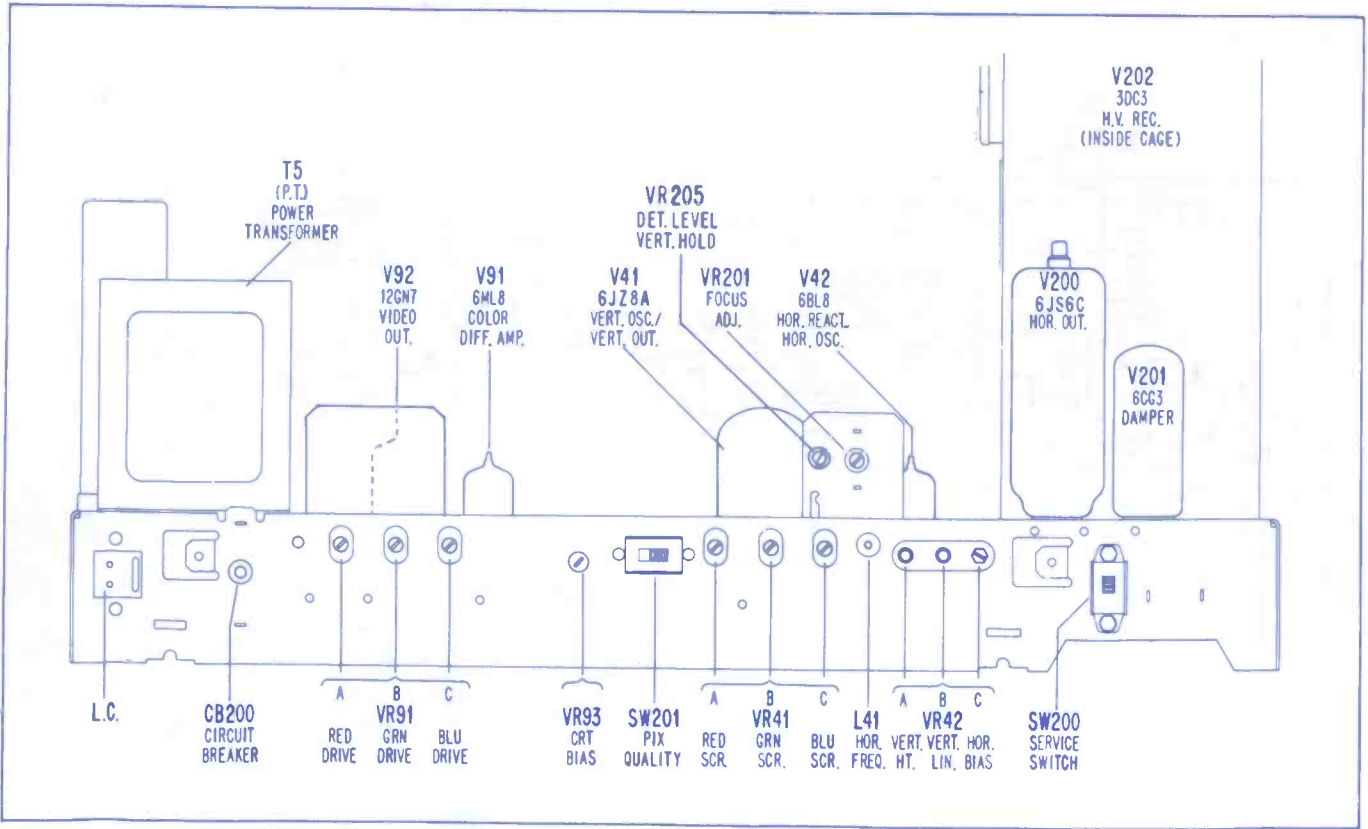
CENTER LANDING ADJUSTMENTS

PHILCO-FORD
Color TV Chassis 3CS45



CRT	
PIN	VOLTAGE
2 R R	-270
3 R G1	-50
4 P G2	40, 10, 66.
5 G G2	44, 10, 66.
6 G A	270
7 G G1	84
11 B A	270
12 B G1	0
13 B G2	44, 10, 66.

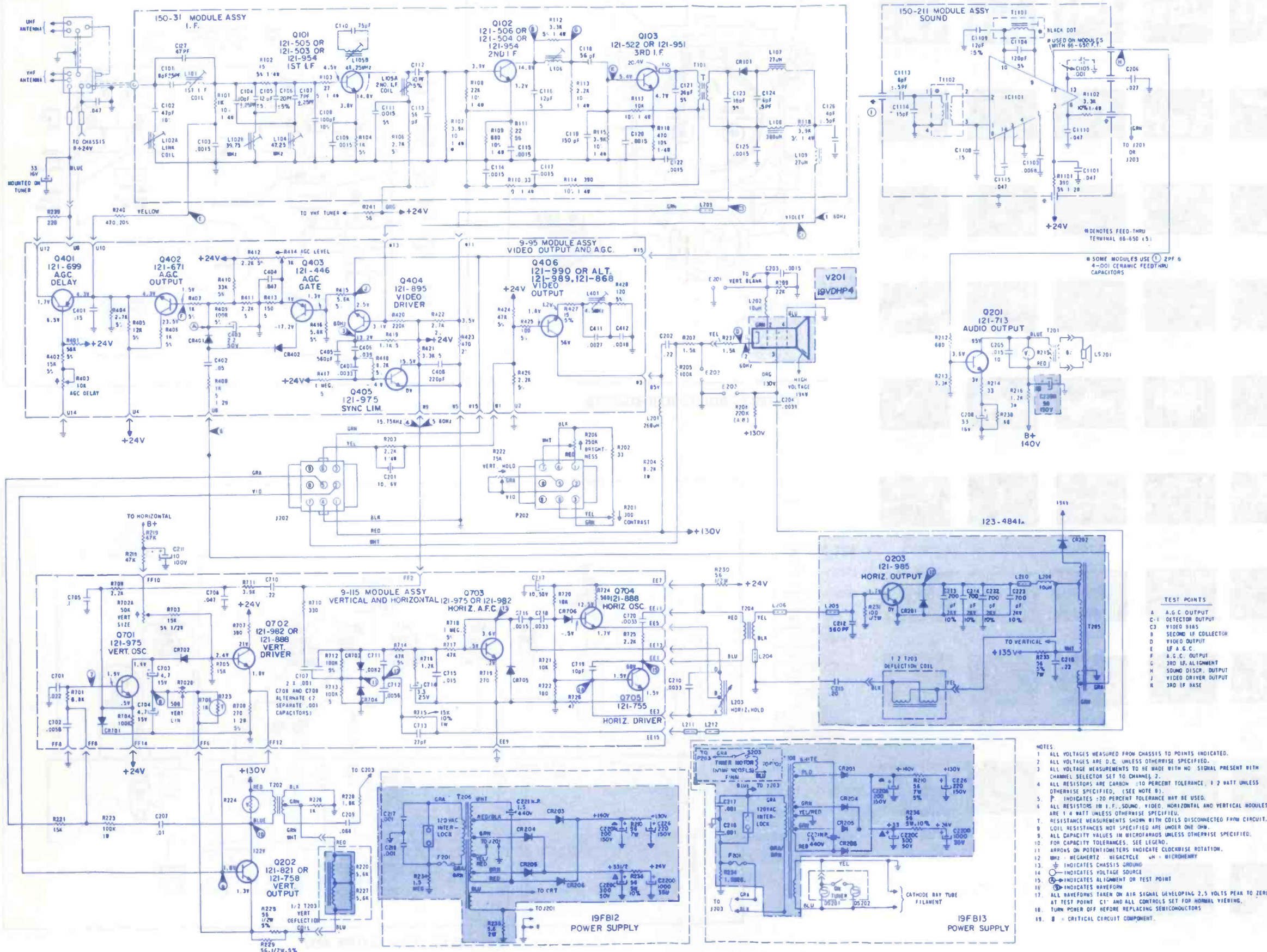
NOTES
CRT BIAS BRIGHTNESS MAX FULL CGR
CONTRAST FULL CGR
LUMINA NORMAL
SERVICE SW. NORMAL
LINE VOLTAGE 120VAC



CRT COLOR TEMPERATURE ADJ.

SYMBOL	DESCRIPTION	ZENITH PART NO.
C220A	—200µf elect capacitor 150v	22-7314
C220B	—50µf elect capacitor 150v	22-7314
C220C	—300µf elect capacitor 50v	22-7314
C220D	—1000µf elect capacitor 35v	22-7314
R215	—varistor	63-5440
R224	—varistor	63-10281
R723	—thermistor	63-10290
L203	—horiz hold coil	95-3100

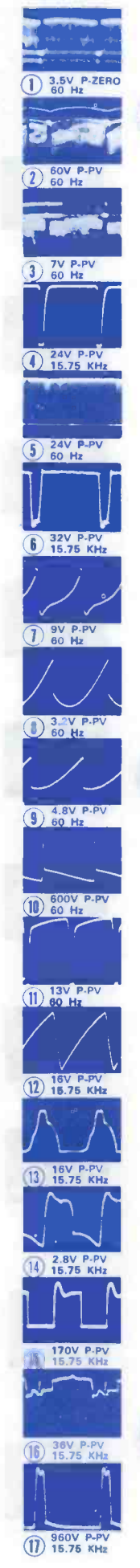
T201	—audio output xformer	95-3120
T202	—vert output xformer	95-3094-01
T203	—yoke assembly	S94147-01
T205	—horiz output xformer	S-97079
T1102	—quad xformer	95-2620
CR202	—high volt rectifier	103-258
IC1101	—integ circuit	221-48
F201	—fuse .61 slo blo	136-108

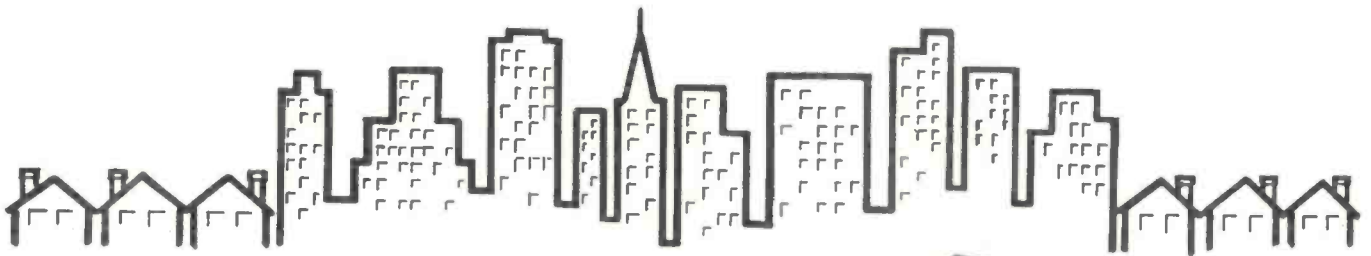


TEST POINTS

A	A.G.C. OUTPUT
C	DETECTOR OUTPUT
D	VIDEO BIAS
E	SECOND IF COLLECTOR
F	VIDEO OUTPUT
G	IF A.G.C.
H	A.G.C. OUTPUT
J	3RD I.F. ALIGNMENT
K	SOUND DISCR. OUTPUT
L	VIDEO DRIVER OUTPUT
M	3RD I.F. BASE

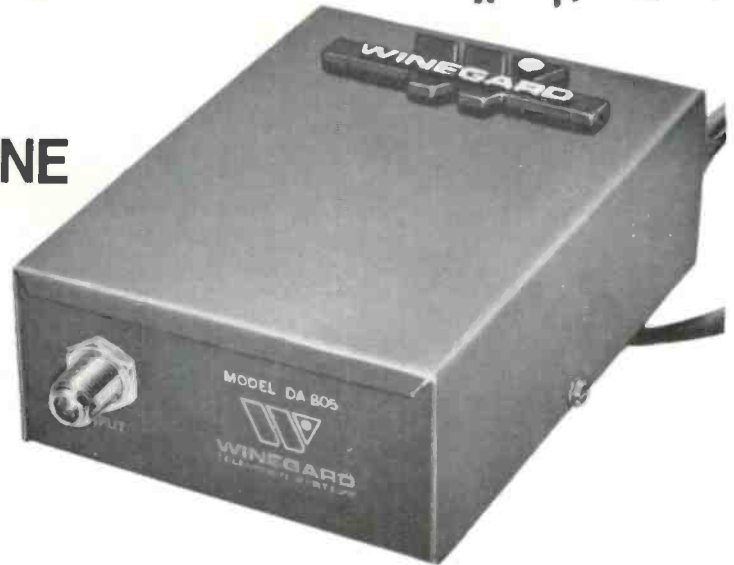
- NOTES**
- ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.
 - ALL VOLTAGES ARE D.C. UNLESS OTHERWISE SPECIFIED.
 - ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT WITH CHANNEL SELECTOR SET TO CHANNEL 2.
 - ALL RESISTORS ARE CARBON 10 PERCENT TOLERANCE, 1/2 WATT UNLESS OTHERWISE SPECIFIED. (SEE NOTE 8).
 - P INDICATES ±20 PERCENT TOLERANCE MAY BE USED.
 - ALL RESISTORS IN I.F. SOUND, VIDEO, HORIZONTAL AND VERTICAL MODULES ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
 - RESISTANCE MEASUREMENTS SHOWN WITH COILS DISCONNECTED FROM CIRCUIT.
 - COIL RESISTANCES NOT SPECIFIED ARE UNDER ONE OHM.
 - ALL CAPACITY VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
 - FOR CAPACITY TOLERANCES, SEE LEGEND.
 - ARROWS ON POTENTIOMETERS INDICATE CLOCKWISE ROTATION.
 - MHz = MEGAHERTZ Mcycle = MEGACYCLE
 - ⊕ INDICATES CHASSIS GROUND
 - ⊖ INDICATES VOLTAGE SOURCE
 - ⊙ INDICATES ALIGNMENT OR TEST POINT
 - ⊞ INDICATES WAVEFORM
 - ALL WAVEFORMS TAKEN ON AIR SIGNAL UNLESS OTHERWISE SPECIFIED. PEAK TO ZERO AT TEST POINT C1 AND ALL CONTROLS SET FOR NORMAL VIEWING.
 - TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS.
 - ⊞ = CRITICAL CIRCUIT COMPONENT.





Announcing the WINEGARD METRO-LINE TV-FM DISTRIBUTION AMPLIFIERS

...the first high input,
high output, low-cost
MATV system amplifiers
for strong signal areas



Winegard's new Metro-Line amplifiers are specifically engineered to accommodate strong signals and eliminate overload economically and efficiently. Because they have the same commercial quality construction and circuitry as the DA-830, DA-825B and DA-851, they are ideal for home, hotel, apartment and office building systems.

Check these other important performance features:

- High output capability makes a Metro-Line your best db buy
- High input solves distortion and overload problems common in strong signal areas
- Lightning protection diode
- 82 channel models have separate VHF and UHF amplifier stages
- Extended band pass (54 to 300MHz) includes mid and super band coverage making Metro-Line approved for CATV use
- Eliminates multiple outlet charge for extra sets or MATV systems on cable TV
- UL listed
- Easy for any competent TV service dealer to install
- Choose from 3 VHF-FM and 2 VHF-UHF-FM models; suggested list prices from \$30.85 to \$47.30

		DA-203	DA-205	DA-215	DA-803	DA-805
OUTPUT PER CHANNEL*	VHF	46dbmv	46dbmv	53dbmv	43dbmv	45dbmv
	UHF	NA	NA	NA	35dbmv	35dbmv
INPUT PER CHANNEL*	VHF	31dbmv	31dbmv	40dbmv	31dbmv	31dbmv
	UHF	NA	NA	NA	26dbmv	26dbmv
GAIN	VHF	15db	15db	13db	12db	14db
	UHF	NA	NA	NA	9db	9db
IMPEDANCE		300 ohm	75 ohm	75 ohm	300 ohm	75 ohm
Bandpass	VHF	54 to 300MHz	54 to 300MHz	54 to 300MHz	54 to 300MHz	54 to 300MHz
	UHF	NA	NA	NA	470 to 810MHz	470 to 810MHz
NOISE FIGURE	VHF	4.2db	3.3db	4.8db	4.3 db	3.3db
	UHF	NA	NA	NA	10.0db	7.3db
POWER REQUIREMENTS		117VAC, 60Hz, 2.3 watts	117VAC, 60Hz, 2.3 watts	117VAC, 60Hz, 2.3 watts	117VAC, 60Hz, 3.5 watts	117VAC, 60Hz, 3.5 watts

*7 channels VHF, 5 channels UHF 0.5% Cross Modulation

For additional information and sample system layouts, request New Product Bulletin No. 24.



WINEGARD TELEVISION SYSTEMS
Winegard Company / 3000 Kirkwood Street
Burlington, Iowa 52601

... for more details circle 141 on Reader Service Card

The easy-to-read 630 makes learning easy.

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

The rugged, general purpose Triplet 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 Triplet 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 Triplet Model 630-A, priced at only \$83.

For more information or a free demonstration, call your Triplet

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. Triplet Corporation, Bluffton, Ohio 45817.

TRIPLET
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Triplet. The easy readers.

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