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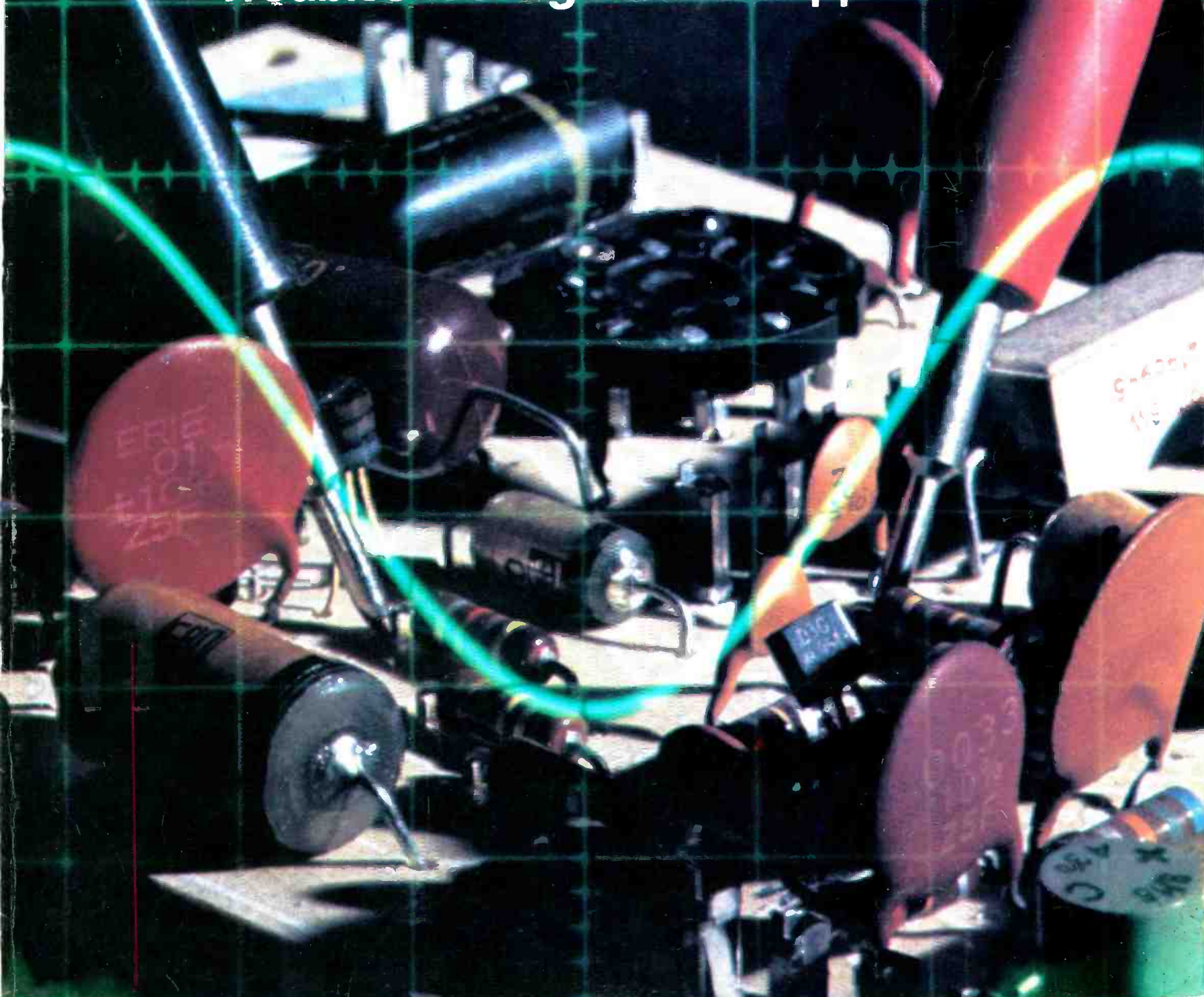

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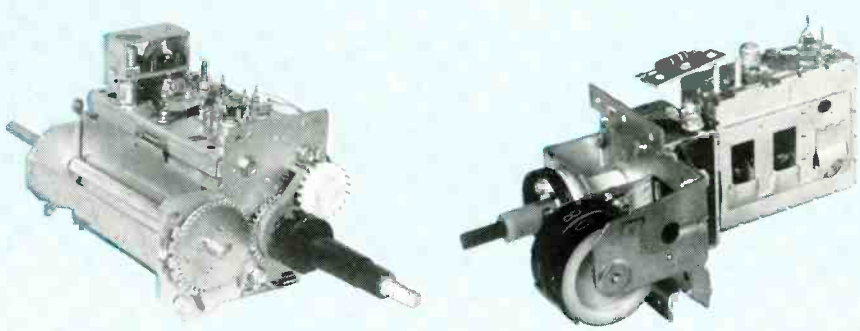

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EDITOR'S MEMO

On June 7 of this year, the Federal Communications Commission issued a Notice Of Inquiry into its Radio Operator Licensing program.

The purpose of this Notice Of Inquiry was "to solicit comments or recommendations from interested parties concerning changes or revisions which the public believes should be considered by the Commission in its review of the relevancy of its radio operator rules to the current state of the communications industry."

Specific questions asked by the Commission in its Notice Of Inquiry are:

• Should the Commission drop its requirement that the adjustment, repair and maintenance of radio transmitting equipment be performed only by a person holding either a First or Second Class Radiotelephone License? (The Commission refers to such licensed service technicians as 'Service Operators')

• If the 'Service Operator' license requirements are retained, to what degree should the 'Service Operator' be held responsible for the technical performance of transmitting equipment which he installs and/or services? (The Commission's present position is that the 'ultimate responsibility' for the proper technical performance of the equipment rests with the equipment owner, or licensee).

• Do current First and Second Class Radiotelephone License examinations accurately reflect the knowledge required to install and service today's communications equipment?

• Would it be more realistic for the Commission to issue a 'basic operator/technician' class of license with optional specialized endorsements for specific classes of equipment such as AM Broadcasting, TV Broadcasting, Land Mobile, etc.?

• If retained, should the 'service operator' type of licenses be issued for the lifetime of the holder, or, as is current policy, should they be issued for a five-year period with no re-examination required for renewal, or should a five-year re-examination be implemented to determine whether or not the technician's ability has kept pace with technology?

The deadline originally set by the FCC for comments and recommendations regarding these questions was September 1, but, at the request of the National Association of Broadcasters and the Land Mobile Communications Section of the Electronic Industries Association, the deadline subsequently was extended to November 1.

For some as yet unexplainable reason, few members of the consumer electronic service industry were notified of this official FCC inquiry. In fact, the editorial staff of ET/D did not learn of the Notice Of Inquiry until November 9, when Merrill See, the owner/operator of an electronics service firm in Kalamazoo, Michigan, called us to solicit our comments.

Although the deadline for 'official' comments has passed, I nevertheless will take this opportunity to make the following personal observations regarding the areas covered by the Commission's inquiry:

ASSIGNMENT OF LEGAL RESPONSIBILITY—If the transmitter performance criteria established by the FCC is really necessary to insure both optimum utilization of the RF frequency spectrum *and* quality communications with minimum man-made interference, then *somebody* has to be held *legally responsible* for insuring that the performance of the transmitting equipment continues to meet established criteria after it is purchased and put into use.

Responsibility Of The Owner—Unless the owner of the equipment (licensee) is assigned some degree of legal responsibility for the technical performance of his or her transmitting equipment, there will exist no real motivation for him or her to have it serviced except when it fails to provide the minimum quality of communications which he or she expects—and we all know that most types of transmitting equipment can 'fail' in a manner which causes interference with other users of the frequency spectrum, yet still provides the owner (or operator) the minimum quality of communications he or she expects.

However, because most owners (and operators) of transmitting equipment have neither the knowledge nor technical skill needed to accurately determine whether or not their equipment is performing in accordance with FCC criteria, they realistically should not be held legally responsible for making such a judgment. Instead, their legal responsibility in the event of 'obvious' equipment failure or upon notification of equipment performance in violation of FCC criteria should be limited to the requirement that they immediately turn off the equipment and turn it over to a technician qualified to repair it.

Responsibility Of The Technician—Unless the servicing technician also is assigned some degree of legal

continued on page 46

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THE COVER: The scope and circuit highlight the subject of two scope-related articles in this month's issue—TV Power Supply Troubleshooting, on page 14, and Scope That Power Supply, on page 31.

DEPARTMENTS

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NEWS OF THE INDUSTRY

Texas Survey Provides An Electronic Service Dealer Profile

A survey of Texas area electronic service dealers conducted by the Texas Electronic Association (TEA) earlier this year, and reported in *TEA Times*, revealed that:

*Home service calls in Texas cities over 100,000 were priced from $10.95 to $30, with an average of $18. In cities less than 100,000 the rates ranged from $7.50 to $28.50, with an average of $14.

*50% of the dealers were mainly in service with some sales—27% were strong in both sales and service—and 23% were service only.

*The average service-only dealer in the survey reported a net profit of 10%. The average sales *and* service dealer reported a net profit of 6%—and 75% of all surveyed said they made more money in 1975 than in 1974.

*The largest operator in the survey employed 11 outside technicians, but the average shop had only one outside technician.

*A 40-hour work week for service personnel was reported by 61% of the dealers with answers varying from 35 hours to 60 hours.

*The average service calls per day in large cities was 8—and in small communities, 7.

*Outside accountants were employed by 77% for the firm's bookkeeping.

*42% had been in business 5 years or less—10% had been in business from 5 to 10 years—17% from 10 to 20 years—and 28% for more than 20 years.

GTE Sylvania Will Realign TV Manufacturing Operations To Meet Foreign Competition

An effort to "meet unfair price competition from foreign sources" is the reason given by GTE Sylvania for their consolidation of all color TV final assembly operations in one U.S. facility. GTE Sylvania is a subsidiary of General Telephone & Electronics Corporation.

Frank R. Lann, senior vice president of the company's Entertainment Products group, said that all final assembly of Sylvania and Philco color television sets in the U.S. will be consolidated in the group's Smithfield, N.C. manufacturing facility beginning Jan. 1, 1977.

"The increasing penetration of the U.S. color television market by certain Japanese manufacturers, using unfair competitive practices, is forcing American set manufacturers to adopt extreme measures to remain competitive," Lann said. "We intend to meet this competition. However, to do so we are forced to make internal adjustments in our production strategy."

"We deeply regret that this decision to consolidate will require the layoff of 488 hourly and salaried employees of the current 1,200 Batavia employees," Lann said.

Headquarters for the Entertainment Products Group, however, will remain in Batavia.

FCC Says Most CB Interference Of TV Is Caused By TV Set Design

The FCC decision in October that generally upheld CB rules on radiation standards and denied the television industry's petitions for stricter CB radiation standards contained a condemnation of the interference susceptibility of TV receivers. As reported in *TV Digest*, a memo from the Safety & Special Bureau of the FCC said, "Although it is quite true that harmonic radiation from some Class D transmitters causes TV interference some of the time to some TV receivers, it is equally true that the majority of complaints received by the FCC result directly from poor TV receiver design, lack of adequate filtering in TV receivers presently on the market, and inability of TV receivers adequately to reject unwanted or adjacent-channel signals."

A spokesman for the FCC, according to the report, expressed hope that TV manufacturers would voluntarily improve designs, in that the FCC currently has no jurisdiction over the aspect of TV receiver design.

Whirlpool To Sell TV Business of Warwick to Sanyo

Pending stockholder and government approval, the Whirlpool Corporation has agreed to sell the controlling interest in the TV business of their subsidiary, Warwick Electronics, to Sanyo Electric. According to *Consumer Electronics Daily*, "Sanyo will acquire all of Whirlpool's stock interest in the new subsidiary for $10.3 million, or $4.16 a share, and Sanyo will offer to buy the stock interest of other shareholders with the exception of 25 per cent interest held by Sears, Roebuck.

Channel Master Announces A "Retrofit Or Swap" Option To Cb'ers

Another CB manufacturer, Channel Master, has announced a program to convert their

23-channel models to 40-channel operation. The Channel Master approach will allow purchasers of 23-channel sets the conversion privilege over the next 2½ years, or until June 30, 1979. The buyer has the option of either returning his 23-channel unit for conversion to 40 channels, or he can return the receiver in exchange for a comparable 40-channel model. Depending on the model, conversion prices will be $39.95 and $44.95, and exchange prices will be $69.95 and $74.95.

RCA Continues to Convert Factory Distributorships To Private Ownership

RCA has converted their factory-branch distributorship for TV receivers and other products in Atlanta to private ownership. The Atlanta operation is the fifth branch of the RCA Distributing Corporation to be turned over to independent ownership in the past two years. The new distributor, the Southco Sales Corporation, will be headed by William T. Blamire, president, who had been with RCA since 1967.

Only three RCA-owned distributorships are left in the country now. They are in Detroit, Los Angeles and San Francisco.

The Winter CES For 1977 In Chicago Is Sold Out

The fifth annual Winter Consumer Electronics Show, January 13-16, at the Conrad Hilton Hotel in Chicago promises to be the largest Winter Show ever held. "We're sold out," Bill Glasgow, show manager, said, "with over 325 exhibitors in the show this year compared to 275 last year—and we have a waiting list of over 30 exhibitor applicants.

Part of the Show's expansion is attributed to the increase in CB radios and accessories exhibitors which total more than 100. Also, more than 15 exhibitors of video home games have signed up.

Newcom '77 To Place More Emphasis On Industrial Electronics

The 1977 Newcom Show, to be held in Las Vegas, May 1 to 5, will focus more attention on the industrial electronics segment of the industry, with panel discussions planned for OEM and MRO distributors. In a report in *Electronic Buyers' News*, Newcom Show executive vice president David Fisher said that "industrial electronics distributors at last year's Newcom—which comprised about one-third of the exhibitors—were overwhelmed by the frenzy created by citiziens' band radio exhibits."

New Trade Show Just For Audio Dealers To Make Debut In 1977

Billed as the "first trade event ever devoted wholly and entirely to the audio industry," Audex will make its debut April 25-28 in Las Vegas. A spokesman for the sponsoring organization, the International Audio Exposition, said that with an annual volume of over 6.3 billion dollars, "the audio industry needs its own trade show where the display and demonstration of its products are primary and not subordinated to the exhibit of extraneous and incompatible items."

To learn more, write: Audex, 311 Madison Ave., New York, N.Y. 10017.

ISCET Yearbook To Include Directory of CET's

The International Society of Certified Electronic Technicians (ISET) will add a CET Directory system to the 1977-78 Electronic Service Industry Yearbook, soon to be published. A recent survey by ISCET indicated that a majority of CETs consider a national directory of CETs would be of value. All CETs who want to be included in the directory are asked to send their name, address, telephone number, and CET number, along with $5.00 to: ISCET, 1715 Expo. Ln., Indianapolis, IN 46224. Deadline is Jan. 1, 1977.

PTS Opens Two New Servicenters For A Total of 42

New servicenters in Chicago and Omaha bring the total of tuner servicenters owned and operated by PTS in the United States and Canada to 42. The Chicago servicenter, now located in the suburb of Berkeley, was formerly Central Tuner Service, which PTS recently purchased. The new PTS servicenter in Omaha is located at 5008 Dodge St., and serves Nebraska and parts of Iowa.

National headquarters for PTS are in Bloomington, Indiana.

Co-op Advertising For CB To Increase

According to a report in *Consumer Electronics Daily*, retailers, distributors and manufacturers of CB radio are now relying more on co-op advertising to get the brand names before the public, now that the CB boom has leveled off a bit. "Many distributors and retailers are only now taking advantage of the co-op money available. When times were good," the report indicated, "there was little need to advertise and the paperwork just wasn't worth the trouble. Most CB suppliers have co-op programs—some very elaborate, but each with its own little wrinkle." ■

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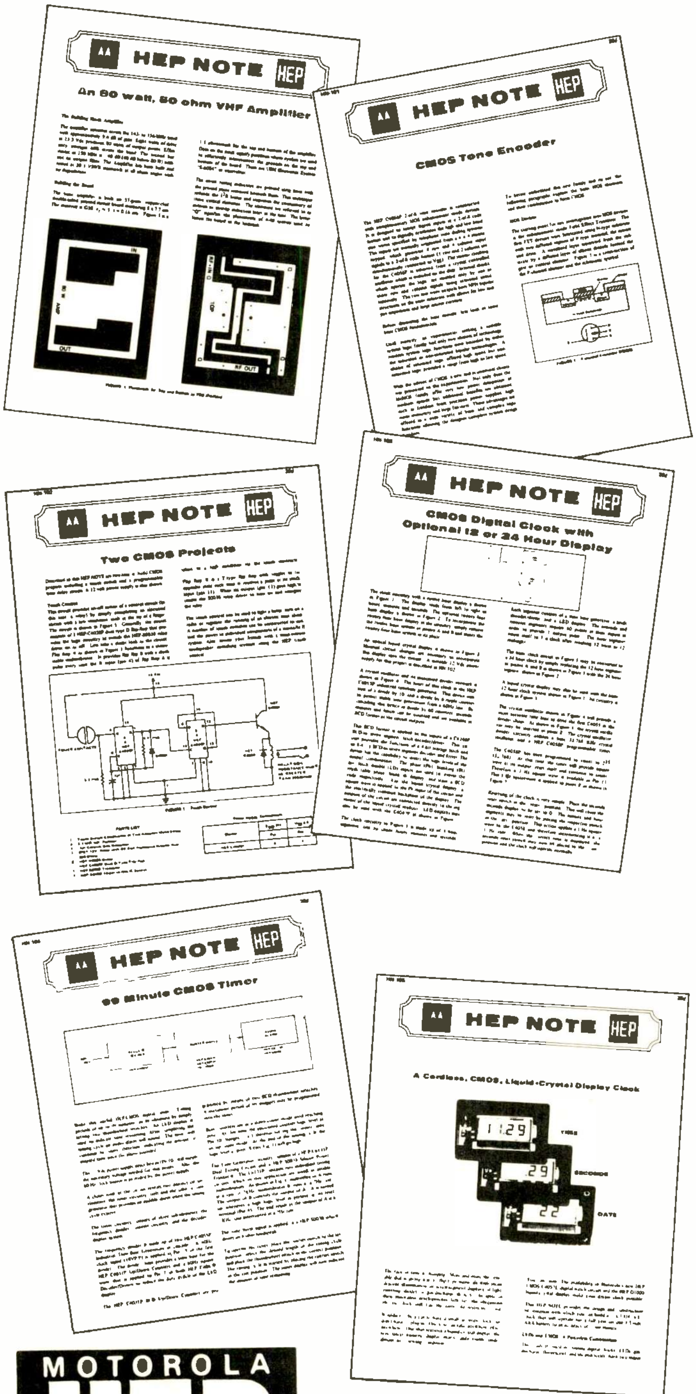

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TECHNICAL LITERATURE

Sound Systems And Components are presented with photos and descriptions in a new 12-page, 3-color catalog from Argos Sound. Included is a selection of sound columns, a portable sound system, baffle/speakers, wall baffles and CB base and mobile speakers. Specification include weights and measures in standard and metric systems. Free from *Argos Sound*, 600 South Sycamore, Genoa, Ill 60135.

RF Semiconductors for linear applications are described in a new 12-page booklet form TRW. The booklet contains complete data for hybrids and discretes for RF linear applications from microwatts to kilowatts of output from 1 MHz to 4 GHz. It includes specifications, application block diagrams and reliability notes. Available free from *TRW RF Semiconductors*, 14520 Aviation Blvd., Lawndale, Calif. 90260.

Test Instruments for industry, education and service are fully described and pictured in the 1976/77 catalog from Leader. Included complete with specifications, illustrations and prices is the firm's complete line of oscilloscopes/vectorscopes, multimeters, color bar and pattern generators, DVM's, millivolt meters, signal generators, wattmeters, sweep/marker generators and accessories. Available for $1.00 from *Leaders Instruments Corp.*, 151 Dupont St., Plainview, N.Y. 11803.

Do-it-yourself Electronic Kits, Tools and Supplies are illustrated and described in the latest catalog, No. 21-1976, from Conar. The new catalog lists hundreds of items for young people, electronic servicers and hobbyists, including test instruments, sound systems, clocks, electronic kits, automobile troubleshooting equipment, and hobbyist books. Prices and mail-order instructions are included. Available free from *Conar Division*, National Radio Institute, 3939 Wisconsin Avenue, Washington, D.C. 20016.

CB Antennas, in full color, are described in the latest catalog from Avanti. Included are antennas that utilized the Avanti principle of co-induction, including the omni-directional Astroplane and the direction Astrobeam, PDL-II, and Moonraker. Facts about CB mobile and base antennas, the principle of co-induction, and full specifications are included. Free from *Avanti Research & Development*, 340 Steward Avenue, Addison, Ill. 60101.

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

A New Audio Connector Series with 7-circuit capability for multi-circuit interconnecting is described in a new product bulletin from Switchcraft, Inc. The 7-pin "Q-G" connector series is presented in response to requests for multi-circuit interconnecting applications such as instrumentation systems, computer peripheral equipment, audio-visual systems, audio consoles, and amplification systems. Included in the series are 13 straight and right angle cord plugs and receptacles and inserts for chassis and special purpose mounting. Available free from Sales Dept., *Switchcraft, Inc.*, 5555 No. Elston Ave., Chicago, Ill. 60630.

Air Suspension Speakers for home and auto hi-fi are described and illustrated in a new min-brochure from the Quam-Nichols Company. The leaflet highlights nine different Quam home and auto high fidelity speakers, indicating the size, frequency response, power handling capacity, voice coil impedence and voice coil diameter, magnet weight, depth and shipping weight, as well as the list price. Notes indicate which speakers have been given a "big bass sound" designation and which incorporate a "whizzer" cone or an integral tweeter. For free copies of the Form 76-4 leaflet, write to: *Quam-Nichols Co.*, 234 E. Marquette Road, Chicago, Ill. 60637.

The 1976 Heathkit Christmas Catalog, describing nearly 500 electronic kits for every do-it-yourself interest, is now available. Product categories include: amateur radio, hi-fi components, color TV, test instruments, digital clocks and weather instruments, radio control equipment, marine, aircraft and auto accessories. New products described are: synthesized 2-meter transceiver, a totally programmable color TV system, an audio control center, scanners, and a freezer alarm. Available free from *The Heath Company*, Benton Harbor, Mich. 49022.

Pricing Methods For Small Business Operators are described in a new booklet from the U.S. Small Business Administration. Titled "A Pricing Checklist for Small Retailers," the 8-page booklet provides a checklist for the owner-manager of a small retail business with 52 questions that probe those considerations—from markup to pricing strategy to adjustments—that lead to correct pricing decisions. Available free from field offices and headquarters of the *U.S. Small Business Administration*, Washington, D.C. 20416.

Business Letters—They're Easier Than You Think—is the topic of a new booklet produced for electronic service shops by Dick Pavek of Tech Spray. While it has nothing to do with the firm's products, it does provide a lot of good hints on effective business letter writing, including collection letters, parts order communication and promotional letters. The suggestions in the booklet take the ineffective stuffiness out of traditional business letters. Free from *Tech Spray*, P.O. Box 949, Amarillo, Texas 79105.

Professional Electronic Tools and Safety Equipment are catalogued and described in the latest 80-page catalog from Klein Tools. The book is organized for easy reference and fully indexed and contains product descriptions, reference tables, information on OSHA and ANSI regulations and tips on proper use of hand tools. Products listed include: pliers, wrenches, screwdrivers, saws, hammers, measuring tapes, knives, and bull pins. Available free. Ask for Catalog 120 from *Klein Tools, Inc.* 7200 McCormick Rd., Chicago, IL 60645.

Microphones, Antennas, Test Equipment and Accessories for CB are listed and pictured in the latest booklet from Mura Corp. Included in the booklet are variable gain power microphones, three-level gain power microphones and base-station power microphones. A selection of mobile and base station CB antennas and test equipment such as meters, impedance matchers, and multitesters is also included. Free from *Mura Corporation*, 177 Cantiague Rock Road, Westbury, N.Y. 11590. ■

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Discrete AGC In Solid-State Color TV

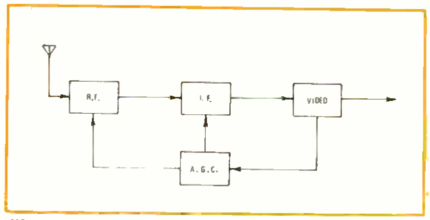

Fig. 1—Illustration of the 'closed loop' configuration of AGC system employed in most color TV receivers.

By Paul Shih

How various discrete designs function, and generalized procedures for servicing them

■ The principal function of the automatic gain control (AGC) system in a TV receiver is to maintain the "average" output of the video detector at a constant level regardless of fluctuations in the strength of the received signal. Without an effective AGC system, the picture contrast and level of sound produced by the TV receiver would fluctuate in direct proportion to the strength of the received signal. Also, the sync stability would be reduced.

As illustrated in Fig. 1, the AGC systems in modern all-solid-state color TV receivers are closed-loop types in which the level of the horizontal sync pulses in the composite video output of the video amplifier is "sampled" and used to develop a DC control voltage which, in turn, is used to vary the *gain* of the RF and video IF sections in *inverse proportion* to the strength of the received signal.

REVERSE VS FORWARD AGC

The gain of a tube-equipped video IF stage is controlled by varying the amount of negative (reverse bias) voltage applied to the control grid. Increasing the negative voltage reduces gain.

However, because application of reverse bias to the base-emitter junction of a bipolar transistor-equipped stage completely cuts off the stage, AGC voltage in the form of reverse bias is not used in receivers with bipolar transistor-equipped RF and video IF stages.

Instead, as illustrated in Fig. 2, the gain of RF and video IF amplifiers equipped with bipolar transistors is controlled by shifting the *forward* bias of the base-emitter junction either above or below the value which provides maximum gain. In the method called *'reverse'* AGC, the gain of the stage is decreased by *decreasing* the forward bias. In the method called *'forward'* AGC, the gain of the stage is decreased by *increasing* the forward bias above the value which provides maximum gain.

Despite the fact that the increase in base-emitter junction capacitance caused by forward AGC can attenuate the high-frequency components of a signal, thereby reducing the bandwidth of the stage, forward AGC is nevertheless the most prevalent type employed in today's all-solid-state color TV receivers, principally because, as evident in Fig. 2, it produces a more linear and more gradual reduction in gain than does reverse AGC.

To minimize the bandwidth-reducing characteristic of forward AGC, some color TV designers use both forward and reverse AGC—forward for the first gain-controlled video IF stage, and reverse for the second stage.

NEGATIVE VS POSITIVE AGC VOLTAGE

The polarity of the DC control voltage developed by the AGC system in an all-solid-state TV receiver depends upon the "polarity" and type of RF and video IF transistors to which it is applied.

If the gain-controlled stage is equipped with an *NPN* bipolar transistor, the polarity of AGC voltage applied to the base will be *positive*. Conversely, if it is equipped with a *PNP* bipolar transistor, the AGC voltage applied to the base will be *negative*.

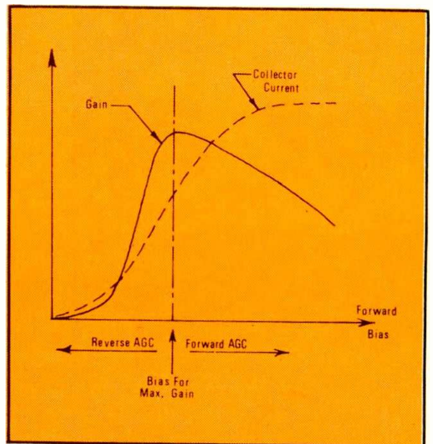

Fig. 2—Graph which illustrates that the gain of a transistor can be reduced by either increasing ('forward' AGC) or decreasing ('reverse' AGC) the base-emitter forward bias.

If, as is becoming more common, the gain-controlled stage is an N-channel dual-gate MOSFET, the AGC voltage applied to the "second" gate of the MOSFET will be *negative* if the device is a *depletion* type and will be positive if the device is an *enhancement* type. (The polarities of AGC voltages applied to P-channel dual-gate MOSFETS are opposite those applied to N-channel devices of like types.)

KEYED AGC

The 'keyed' type of AGC system probably is used in more existing TV receivers than any other basic type. Fig. 3 is a simplified schematic diagram of a typical keyed AGC system equipped with and used to control the gain of bipolar transistors.

AGC keyer transistor Q3 in Fig. 3 conducts only when it is "keyed on" by the *simultaneous* presence of a negative-going flyback-originated pulse on its collector and a negative-going horizontal sync pulse in the composite video applied to its base. Fig. 4 is a photo of these two pulses as displayed on the screen of a dual-trace scope.

A negative voltage developed

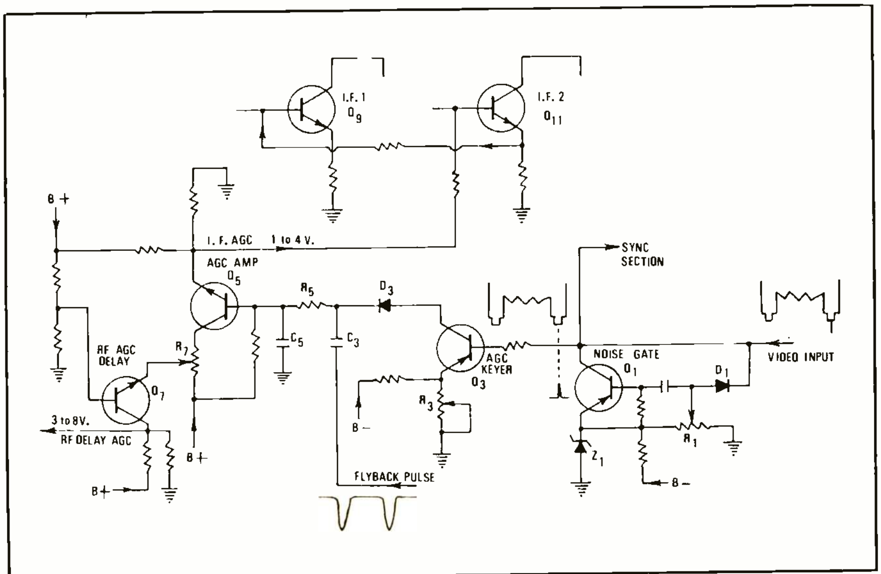

Fig. 3—A typical all-solid-state keyed AGC system.

across a voltage divider in the emitter circuit of Q3 reverse biases the base-emitter junction, holding Q3 in a cut-off condition until the amplitude of the negative-going horizontal sync pulse on the base exceeds the negative voltage on the emitter by .6 volt. Because the level of the negative voltage on the emitter is dependent on the setting of AGC control R3, this control therefore determines at what amplitude of the horizontal sync pulse Q3 will begin to conduct. And, because the amplitude of the horizontal sync pulse on the base of Q3 is directly proportional to the strength of the received signal, the conduction of Q3 and the AGC voltage developed by its conduction will be directly proportional to the strength of the received signal.

Conduction of Q3 charges up coupling capacitor C3, and the DC voltage thus developed across the capacitor is directly proportional to the amplitude of the horizontal sync tip on the base of Q3, which, in turn, is directly proportional to the strength of the RF carrier.

Video information, as well as noise pulses between the horizontal sync pulses, can not affect the AGC voltage, because the keyer, in the absence of the flyback keying pulse on the collector, does not conduct during the horizontal scanning period. In addition, any strong noise pulse that may be present during the horizontal sync period will be effectively cancelled out by noise gate Q1, which is ahead of AGC keyer Q3.

Pulse diode D3 performs two functions: It rectifies the flyback pulse, and also prevents the charge in C3 from leaking through the base-collector junction of Q3.

The voltage appearing across C5 is the initial AGC voltage.

The time constant of filter R5/C5 can be made very short because the lowest ripple frequency component needed to be filtered out is the horizontal pulse rate of 15,750 Hz, not the 60-Hz field rate as in simple non-keyed AGC circuits. With a short time constant, the keyed AGC system is capable of responding to fast signal variations (such as reflected signals from a passing airplane), thus providing more stable operation.

Video IF AGC

AGC amplifier stage Q5 steps up the AGC current capacity. The amplified AGC voltage for application to the video IF section is taken from the emitter of Q5 because it provides better low-impedance matching into the base circuit of the 2nd video IF stage. The positive AGC voltage may vary from 1 volt for a weak signal, to 4 volts for a strong one.

The IF AGC voltage can be applied to the bases of the 1st and the 2nd IF amplifiers either in parallel or in series. The series connection shown in Fig. 3 minimizes the loading effect between the two stages.

Delayed AGC To RF Amplifier

Application of AGC control voltage to the RF amplifier in the tuner is delayed until the input signal becomes relatively strong. The reason for this is that the RF amplifier, being the first stage and having the lowest level of input signal, must be allowed to operate at its maximum gain, for a favorable signal-to-noise ratio. The level of the signal at the output of the RF amplifier must be high enough to override the noise generated in the mixer stage. No AGC voltage is applied to the tuner as long as there is no danger of overloading the mixer stage, and the IF AGC is still able to adequately control the gain of the IF stages.

However, an exceptionally strong signal can cause overloading in the mixer (in the form of crossmodulation) or in the IF stages (in the form of signal clipping or distortion). Before this happens, AGC voltage must be applied to the RF amplifier, to reduce its gain. Once this takes place, the RF AGC voltage normally increases more rapidly than does the IF AGC, to prevent the onset of overloading.

There are several ways to delay the application of AGC voltage to the RF amplifier.

The simplest way is to insert an opposite-polarity DC voltage on the RF AGC line through a high-value "bucking" resistor. Before it can impose control action on the RF stage, the AGC bias must exceed the level of the inserted opposite-polarity voltage.

Other designs of delay circuits employ conventional or zener diode clamping networks connected to the AGC bus line to produce the delaying action.

In the keyed AGC system in Fig. 3, a separate amplifier stage, Q7, is used to delay the application of AGC voltage to the RF amplifier. Q7 does not conduct until a strong signal is received and the collector voltage drops on Q5 due to a high collector current. Once Q7 begins to conduct, its collector voltage, or the RF delayed AGC voltage, increases from 3 to 8 volts. This 'forward' AGC is applied to the NPN transistor in the RF stage, decreasing its gain. RF AGC delay control R7 is provided for setting the conduction point of Q7 to assure snow-free reception from weak stations and no overloading from strong ones.

NON-KEYED AGC PEAK DETECTION

A somewhat unconventional

AGC circuit is used by Sony in a number of their color chassis. A simplified schematic of such a circuit is shown in Fig. 5.

The composite video signal from the first video amplifier is fed to a pair of AGC amplifiers, Q209 and Q210. The output from Q210 is then peak detected by a diode, D202, and the current through the diode charges up capacitor C237. The average DC voltage developed across C237 is directly proportional to the amplitude of the incoming sync tips.

If a positive noise pulse with a greater amplitude than that of the sync tip arrives at the input of Q209, it will pass through diode D204 and turn on Q208. With Q208 saturated during the noise pulse period, the base of Q209 is effectively grounded, resulting in the removal of the video signal to the AGC and sync systems. The cutoff of the input signal is so short that no change in the sound or the picture can be perceived. This noise immunity system prevents the noise pulses from interfering with the operation of the AGC and sync systems.

The AGC voltage across C237 is amplified by Q304. The output at the collector is filtered by C337 and applied to the 2nd IF amplifier, Q601. The level of this control voltage can be adjusted by IF AGC control R304.

The IF AGC voltage is routed from the emitter of Q601 to the base of Q603, the 1st IF video amplifier. During reception of a strong signal, the resultant increased conduction of Q603 causes its collector voltage to decrease (become less positive). The less-positive voltage, in turn, switches on the RF AGC gate, Q955. The output from Q955 is amplified by the VHF AGC amplifier, Q953, and then is coupled to the "AGC control" gate of a MOSFET RF amplifier in the VHF tuner. The voltage from Q953 is inverted, and its amount of variation is reduced by UHF AGC amplifier Q954. An NPN RF amplifier in the UHF tuner is controlled by this inverted AGC voltage from Q954.

Controls R953 and R954 are provided to vary each of the RF delay AGC voltages. They are normally adjusted for maximum contrast and minimum snow in the picture during reception of weak VHF and UHF stations, respectively.

TROUBLESHOOTING DISCRETE AGC SYSTEMS

The AGC voltage in a closed-loop AGC system directly controls the operation of the IF and RF stages and also can affect the functioning of the video, noise gate, and sync circuits. In turn, the operation of all these circuits in the loop can affect the function of the AGC system. Troubles anywhere in the loop can cause reactions along the entire loop.

Trouble Symptoms And Typical Causes

Some of the more common trouble symptoms caused by faults in the AGC system are: no sound and no picture, weak or washed-out picture, overloaded or dark picture with or without sound buzz, picture bending or 'flagwaving', poor vertical locking, busy background or snow on strong channels, co-channel interference and cross modulation, video flutter, line flashing, and picture shading.

Overload and bending of the picture is associated mostly with *insufficient* AGC action, while "washed-out" or "snow" symptoms are the result of *excessive* AGC control. Spurious AC signals riding on the DC AGC voltage can cause picture shading, unstable sync, horizontal line flashing and other 'odd' symptoms.

Preliminary Troubleshooting Procedures

The trouble symptoms described previously are by no means unique to AGC defects. Similar symptoms could be caused by troubles in any stage within the AGC loop system. It is, therefore, important that: 1) the symptom itself be carefully diagnosed, and 2) a logical, systematic procedure be used to isolate the trouble to a particular section during the early stage of troubleshooting.

As a preliminary assessment of the functioning of the AGC system, closely watch the picture while rotating the video IF AGC control. The quality of the picture should vary from "washed-out" at one end of control rotation, to over-contrast, bending or black out at the other end of rotation. The RF delay AGC control can be checked by turning it CCW on a weak signal while noticing the increase of snow in the picture. The RF AGC control can also be checked on a strong signal by turning it CW while watching for the effects of overloading and cross-modulation in the form of picture streaks following the sound information.

If rotation of the AGC control(s) affects the picture quality in a normal manner and reduces or eliminates the trouble symptom, attempt to adjust the control(s) in the manner and sequence specified in the service literature.

Some receivers do not have any AGC control, while a few have as many as three AGC-related controls. Most receivers have one IF AGC control and one RF AGC Delay control. Whenever possible, the adjustment procedure outlined by the manufacturer should be followed.

The generalized procedure for most sets is as follows: 1) tune in a strong station and turn the contrast control fully CW; 2) advance the AGC level control CW to a point where the picture just begins to bend or distort and then rotate the control CCW slightly; 3) switch the channel selector to a weak station and rotate the RF delay control CW until snow just disappears from the picture; and, finally, switch the receiver back to a strong station again and check for overloading. If overloading or distortion does occur, rotate the RF control CCW slightly and then repeat the IF and RF AGC control adjustments. When consistent, maximum contrast is obtained on all active channels, the contrast control then can be rotated away from its full CW position, if necessary, for normal viewing.

The interaction between the AGC controls and the noise gate control, if one is provided, should

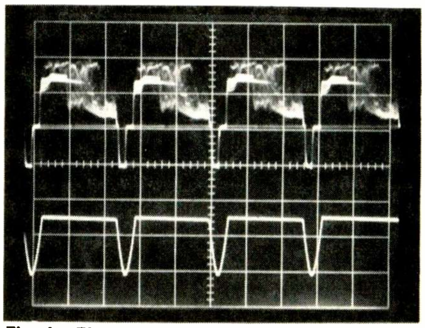

Fig. 4—Photo of the two 'keying' pulses required for conduction of AGC keyer transistor Q3 in Fig. 3. Top) Negative-going horizontal sync pulses in composite video signal applied to base of Q3. Bottom) Flyback-originated negative-going horizontal pulses applied to the collector of Q3.

not be overlooked. Rotating the noise gate control should produce voltage variations in the AGC system. Improper adjustment of the noise gate control can render the AGC and sync sections inoperative. Proper setting of the noise gate control can be accomplished by first turning it fully CCW and then performing the AGC control adjustments outlined previously. Then, slowly advance the noise gate control CW to the point where the video just begins to break up, then rotate it CCW slightly.

Localizing And Isolating The Trouble

If adjustment of the AGC-related controls does not completely eliminate the trouble symptom(s), scope the composite video waveform at a test point in the video section, such as the output of the video detector or the first video amplifier. The amplitude and shape of the waveform should agree with what is specified by the manufacturer. Also, a DC voltmeter connected between the AGC test point and ground should indicate voltage variations when the receiver is tuned from an unused (or weak) channel to a strong one. (A weak station may be simulated on a strong channel by disconnecting and loosely coupling the antenna leads to the receiver.)

If rotation of the AGC controls produces erratic or abrupt increases or decreases of the AGC voltage and/or the amplitude of the video waveform, a defective AGC control should be suspected.

If the video waveform and AGC voltage are both abnormal and adjustment of the AGC controls does not eliminate the abnormality, there undoubtedly is a defect somewhere in the AGC loop. To isolate the trouble, the AGC source in the loop must be overridden temporarily by an external bias voltage, such as that provided by a bias box.

The reason for using the external bias source is to 'break' the AGC loop. By doing so, the trouble can be narrowed down to one half of the loop—either the *controlling* stages, or the *controlled* stages.

The polarity and the amplitude of the bias to be used generally can be determined quickly by studying the schematic. A general rule of thumb is that a *positive* bias voltage is required for video IFs equipped with NPN transistors or N-channel *enhancement* type MOSFETs, whereas a *negative* voltage is required for video IFs equipped with PNP transistors or N-channel *depletion* type MOSFETs.

To avoid damaging the transistor or FET, the amplitude of the external bias should be initially set at minimum and then gradually increased to the correct value.

If overloading of the external bias source is evident, disconnect the external bias and look for a short somewhere along the AGC bus line or in the input circuit of the controlled stage.

To avoid excessive loading of the AGC, RF and video stages in certain receivers, it is necessary to open the AGC bus line before inserting the external bias in the IF or RF input circuit.

If the insertion of the external bias fails to eliminate the trouble symptom, a defect in the IF or RF section is evident. The best way to deal with a defect in these sections is to measure the DC voltages on the elements of each transistor, along with signal tracing in the associated stage. Incorrect DC voltages or missing or distorted waveforms are key clues.

The most common defective AGC-related components are shorted or leaky transistors, defective by-pass or decoupling capacitors, and an open component in the signal path, such as a coupling capacitor or a peaking coil.

Trouble in the AGC circuit is indicated if application of the external bias clears up the trouble symptom. Observe the video sync or flyback pulses on the AGC keyer or on the peak AGC detector, in addition to standard DC voltage measurements. If a pulse is missing, signal trace back to its origin. If a distorted pulse or incorrect DC voltage is encountered, focus your attention on the associated transistor and its directly related components.

There should be no pulses or AC ripple on the AGC bus line. If horizontal pulse components are observed on the bus line, look for an open AGC filter capacitor or a defective pulse diode. A defective AGC DC power supply filter capacitor can cause either 60- or 120-Hz ripple voltages to appear in the AGC source. Other common defects beside the filter capacitor are a shorted pulse diode, a leaky or open transistor, a defective "bucking" resistor or clamping diode, and a flyback AGC pulse winding connected in reverse during transformer replacement.

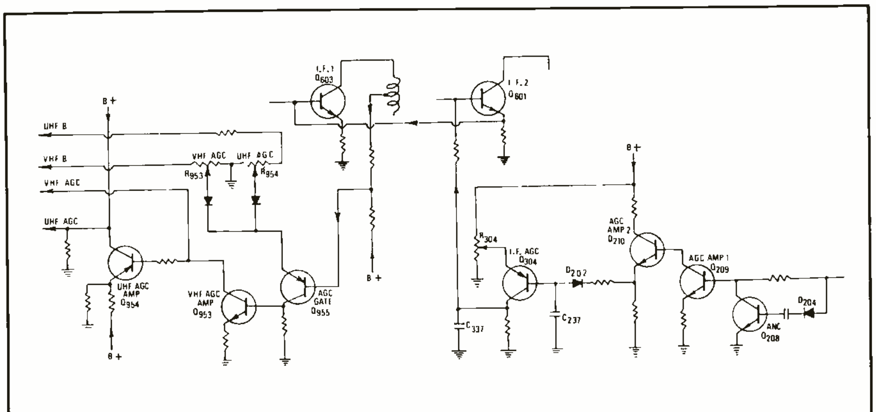

Fig. 5—Simplified schematic diagram of peak detection AGC system used in some Sony color TV receivers.

'AGC' Troubles Caused By CATV

Defective components in the chassis are the most common causes of what are or appear to be AGC troubles. However, there are certain types of 'AGC' trouble symptoms that are not caused by defects in the chassis, but, instead, are caused by the antenna distribution system. This is particularly true in CATV systems in which excessively strong signals are present. These can overload receivers which have 'marginal' AGC systems. A simple remedy to this problem is to add a resistive-pad or attenuator in the cable, to reduce the signal to a level which the AGC system in the receiver can handle.

NEXT: IC-Equipped AGC Systems—An analysis of the theory of operation of integrated-circuit AGC systems and procedures for troubleshooting them will be presented in a near-future issue of ET/D. ■

TECH BOOK DIGEST

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TV Power Supply Troubleshooting

CONSTANT-VOLTAGE TRANSFORMER

■ Many of the newer color sets are incorporating the *constant-voltage power transformer* regulation system. This transformer self-regulates all of its secondary voltages. Within the constant-voltage transformer (CVT) the primary and secondary windings are loosely coupled. This is accomplished by placing the windings on separate legs of the core. The regulating circuit consists of an extra winding connected to the high-voltage secondary and a capacitor shunting the total secondary winding.

This CVT system eliminates the need for any additional transistors, zener diodes, or semiconductors to regulate the DC voltages of the power supply. The CVT will also suppress transient pulses from the incoming AC power line. For example, should a 30V transient appear in the primary for approximately 2 seconds, it will appear on the output secondary at less than 15V in amplitude for a duration of only about 100 msec. This helps reduce semiconductor failure in the receiver chassis due to spikes. Since there are no zener diodes or regulator transistors in the power supply, the possibility of a voltage increase due to a zener diode or transistor failure is eliminated. The CVT helps smooth out any voltage surges.

CVT Operation

In a conventional power transformer, the primary is tightly coupled to the secondary. Probably the most frequently used method is for the secondary coil to be

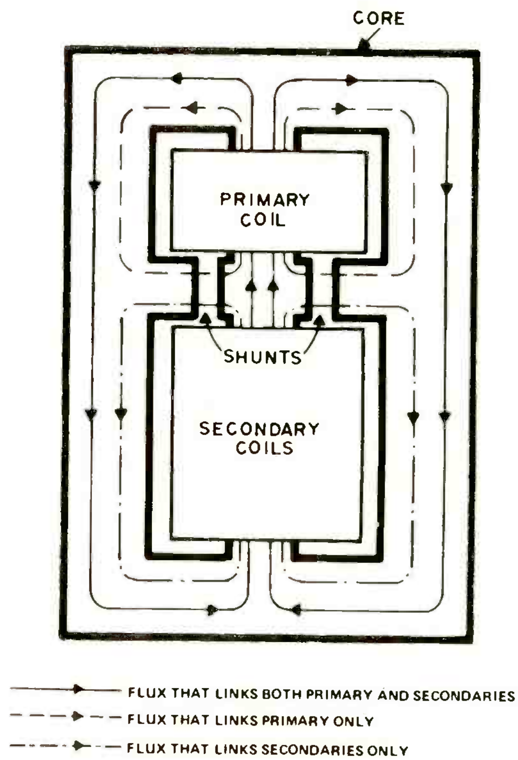
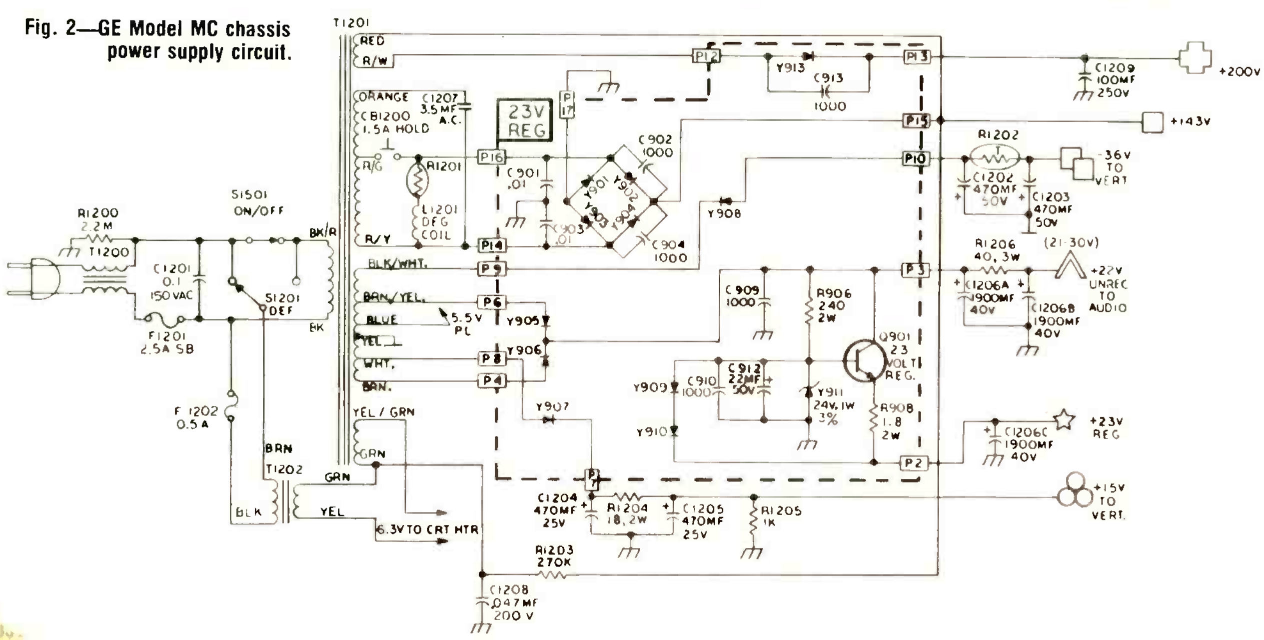


Fig. 1—Constant-voltage transformer construction.

Fig. 2—GE Model MC chassis power supply circuit.



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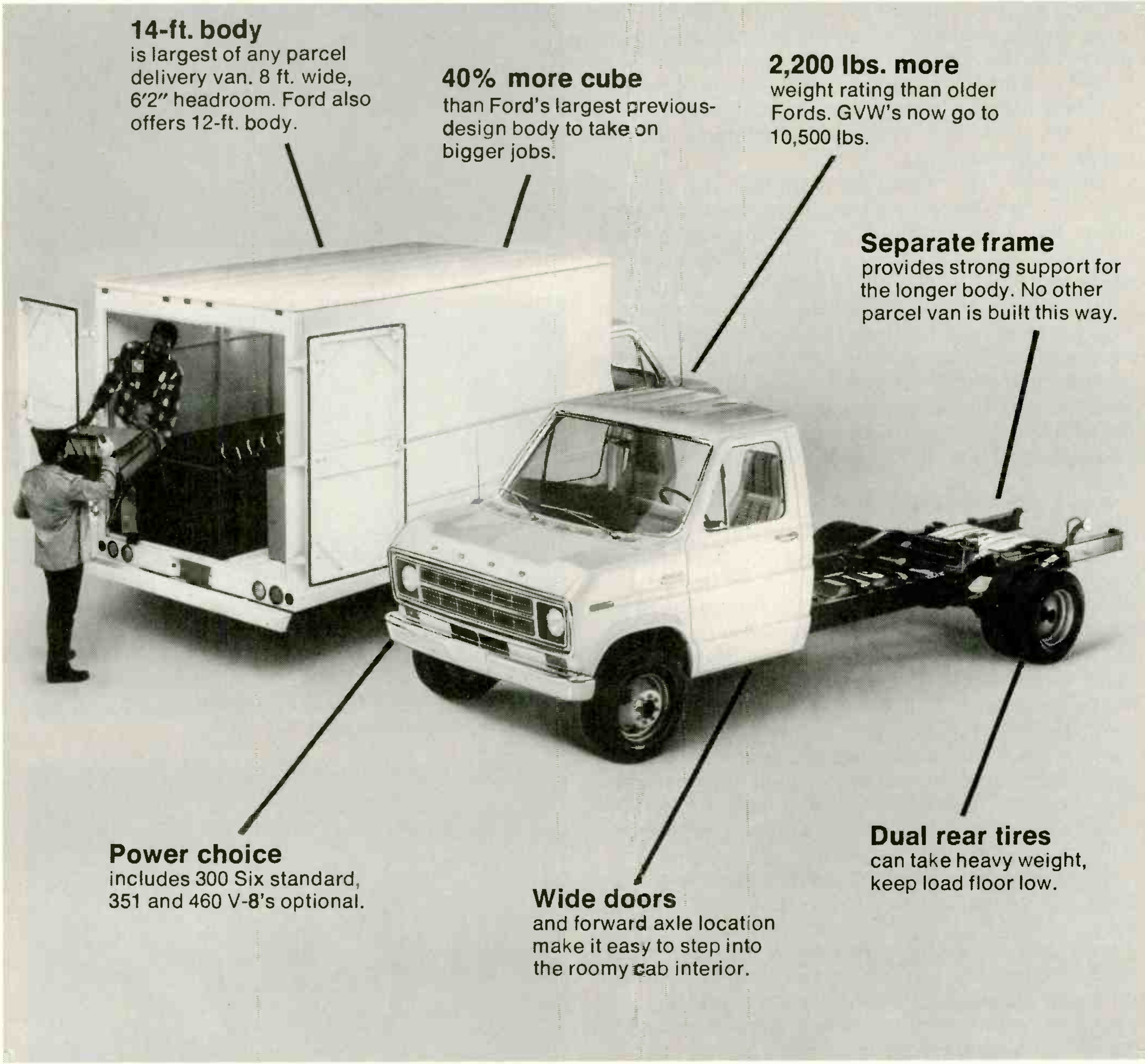

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wound over the primary coil on the same leg of the magnetic core. If the AC line voltage changes, then the secondary voltage will change in a linear manner. There is no voltage regulation with a conventional power transformer.

In order for a power transformer to regulate, it must operate in a nonlinear manner. The secondary voltage must not change even though a change does occur in the primary voltage. These conditions are met with the constant voltage transformer illustrated in Fig. 1. The obvious difference in construction between the conventional transformer and the CVT are the *shunts* between the primary and secondary coil windings.

There are three different magnetic flux paths in the CVT. As in the conventional transformer, there is a flux that links both primary and secondary windings, and this sets up the output voltage from the secondary. But in the CVT, the shunts permit the establishment of two other flux paths. As shown in Fig. 1, one set of flux lines remains around the primary coil only, and another set remains around the secondary coil only. It can be said that these two latter sets of flux lines are isolated from each other; therefore, a certain amount of isolation exists between the primary and secondary coils (because of the shunts).

When a capacitor is connected across the secondary output, a capacitive current flows throughout the entire secondary winding. The current flow sets up a flux that is in phase with the flux in the primary winding; this effectively adds to the flux in the core of the secondary. The two fluxes combine to drive the secondary windings into saturation. Since the primary core is not saturated, we have a nonlinear device. Changes in the primary voltage (above certain lower limits) will not affect the secondary, because the secondary coil is already saturated. By keeping the primary unsaturated, we will not draw excessive line currents. With a normal load, the saturated secondary will maintain a constant output voltage over wide ranging primary voltages.

The output wave shape at the secondary winding of the CVT used in some TV receivers is a modified square wave. With 70V AC on the primary, the transformer core under the secondary winding is nearly saturated and the 140V DC supply will be at 80% of its rated value. At 105V AC on the primary, the secondary core is saturated and remains saturated for any further increase in primary voltage.

The operating temperature of the CVT will be higher than a conventional power transformer due to continuous operation in a saturated condition. Thus, the excessive heat does not indicate a defective transformer.

AC Voltage Checks and Square Waves

If AC measurements are made on the regulated secondary windings, you should use a meter that reads true RMS, or use an oscilloscope for peak-to-peak readings. The reason to be particular about the meter is that a *square* wave is present on the CVT secondary winding. You may recall that most

(From Chapter 11, Troubleshooting With The Dual-Trace Scope, by Robert L. Goodman, TAB BOOKS, Copyright 1976. A review of the complete book follows this article.)

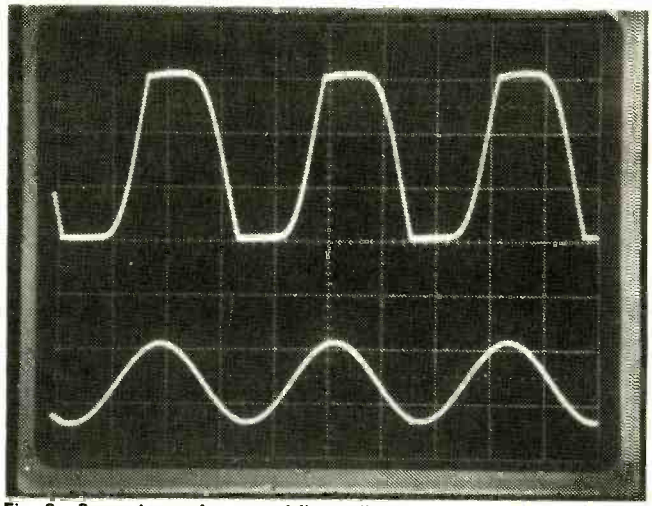

Fig. 3—Scope traces for normal line voltage.

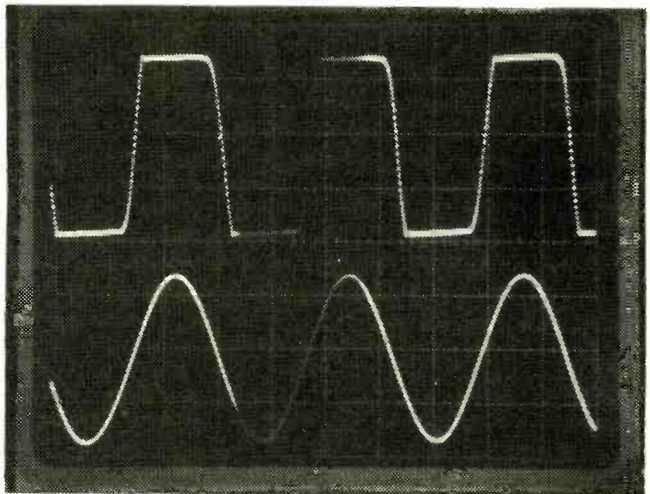

Fig. 4—The AC line voltage set at 60V.

Fig. 5—Good picture even at a line voltage of 60V.

general-purpose instruments are peak-reading meters with a calibrated RMS scale, and do not provide true RMS readings. With the improper meter, the voltage reading at this point will vary with the *peak-reading* type of meter used, and the voltages read will not give a true indication of the circuit conditions.

The oscilloscope can be used with this regulation system. As shown in the power supply schematic in Fig. 2, connect one probe of the dual-trace scope to the AC line voltage input and the other probe to the secondary of power transformer T1201. The bottom waveform in Fig. 3 is the normal 120 V AC line

Fig. 6—Viewable picture even at a line voltage of 50V.

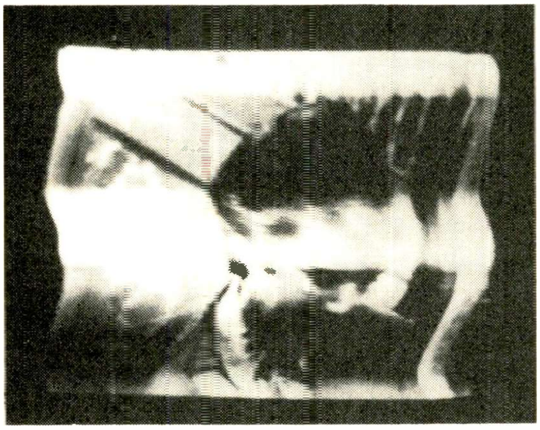

Fig. 7—Ragged picture at a line voltage of less than 50V.

Fig 8—Small picture caused by open C1207.

voltage sine wave fed to the transformer primary. At the same time, the top trace in Fig. 3 shows the square wave output of the secondary to be 150V p-p. The input AC voltage was lowered to 60 volts AC with an autotransformer. This action is shown in the bottom trace of Fig. 4, but the secondary square-wave voltage shown in the top trace is still approximately 150V p-p. With the AC line voltage down to 60V, a normal, bright picture is still seen, as shown in Fig. 5. Even with the line voltage down to 50V, the picture is pulled in slightly but still viewable (Fig. 6). Below 50V the system cannot properly filter or regulate and the picture looks quite ragged (as viewed in Fig. 7).

CVT Troubleshooting

Several circuit faults could cause the circuit breaker to trip. A heavy overload of the +143V supply by circuits within the chassis will trip the breaker. A shorted 3.5 mfd timing capacitor (C1207, Fig. 2) will blow the line fuse. The same is true if similar conditions would occur in the +22V or +23V lines. Shorted diodes Y901 through Y904 will cause a heavy overload and blow fuse F1201.

Since there is a chance that 3.5 mfd timing capacitor C1207 may fail, it should not be overlooked during circuit diagnosis. If all B+ voltages and the CRT filament voltages are about 20% low, chances are the resonant circuit, which is formed with a 3.5 mfd capacitor across the total secondary winding, is open. If this capacitor is faulty (open), the picture will be pulled in from the sides, top, and bottom (Fig. 8).

A voltage measurement between the orange and red/yellow leads from the transformer is a good check. This voltage should be approximately 300V RMS under normal conditions. In the event this capacitor fails, it is important to replace it with the correct GE part. Any variation will affect power supply and receiver performance. A higher value will increase the B+ voltage, and this may result in excessive X-radiation.

The circuit schematic in Fig. 9 shows another portion of the power supply system used in GE chassis. Filter choke L1702 and filter capacitors C1702A and B are used on the +143V line in conjunction with the saturable reactor high-voltage regulation transformer. A B+ voltage regulating circuit is not required in this chassis because of the CVT. A similar saturable-core regulation system (Fig. 10) is used in some Zenith color chassis.

If the filter choke (L210, Fig. 10) becomes faulty, it may be difficult to locate, as the only noticeable difference from a perfect picture is a slight vertical bending of the picture. If the picture moves to the right as shown in the photo in Fig. 11, the cause is a shorted filter choke. There is a slight bending on the left edge of the picture raster. Using a dual-trace scope with the probes at the input and output of the filter choke, the ripple trace voltages will look identical on the scope if the choke is shorted. If the choke is good, the input waveform will have some ripple but the output will show a smooth scope trace.

If zener CR211 opens, the picture will pull or weave and produce the same symptoms as an open filter capacitor in a tube-type chassis. Some regulator zeners have been known to oscillate, and this may produce a faint white horizontal bar across the screen that will roll through the picture. A scope can be used to locate this oscillation. If the zener opens, the +24V supply line will measure slightly more than +24V. A faulty Q212, the +24V regulator transistor, will cause a hum in the sound and some hum bars across the screen.

Another version of the saturable-core reactance power transformer is used in the Quasar TS-942 color chassis. Output voltage of this supply is regulated to maintain about 100V throughout the range of AC line voltages normally encountered.

As shown in Fig. 12, the transformer secondary and capacitor C802 form a resonant circuit. Under normal conditions, the secondary circuit has a high circulating current, resulting in partial saturation of the specially designed core of the transformer. This makes output voltage relatively independent of line voltage variations.

Increased load current reduces the Q of the resonant circuit resulting in decreased saturation of the core and increased transfer of energy from the primary to the secondary. The reverse action occurs for a decreased load. Thus, the supply regulates output voltage for both line and load variations. A circuit breaker in the AC line and fuses in the supply lines protect against excessive currents.

HORIZONTAL SCAN RECTIFICATION

Many modern TV chassis now combine a half- or full-wave rectifier system with a scan rectifier that is needed for the lower regulated DC voltages.

Scan rectification is an efficient method of converting horizontal sweep energy into a DC voltage. A typical circuit, the GE JA color chassis power supply, is shown in Fig. 13. To accomplish the conversion, a winding on the horizontal output transformer inductively transfers horizontal sweep voltage to the scan rectifier, Y402. The sweep voltage is then rectified by Y402 during the relatively long scanning period.

Diode Y402 is reverse biased and does not conduct during the short duration of the retrace pulse (as illustrated in Fig. 14). The output of Y402 is then filtered by capacitor C418 and regulated by Q400 and its associated components to produce the +22V source.

Regulator Q400 is series operated without feedback. A stable 22.5V reference is developed on the base of Q400 by zener Y404, through the path provided by Y403 and R416. The circuit composed of Y404, R418, and C420 also doubles as a separate +22V supply to the sweep circuits in the receiver. Transistor Q400 regulates by operating as a variable resistance. With an increase in circuit current, emitter voltage begins to decrease due to the increased voltage drop across Q400. This condition increases the forward bias on the base—emitter junction of Q400, causing it to conduct more heavily. Greater conduction by Q400 is comparable to a decrease in its resistance, thus restoring the supply voltage to normal. For decreases in circuit current, the reverse effect occurs. R414 and Y405 are for a measure of protection against momentary short-circuit conditions in the 22V line by limiting the amount of current through Q400 in overload conditions. The most common fault in this circuit is a shorted Y402 diode, and that will probably open resistor R412. Leakage in Q400 and faulty Y404 zeners have also caused some problems. Use the oscilloscope to check for the correct pulse (see Fig. 14) that will be found in R412.

There are several different circuit designs that use the stored energy available in the horizontal output transformer to supply low-voltage power to several circuit systems. As shown in the simplified circuit in Fig. 15, energy from the sweep transformer is available during the scan interval and is rectified by diode CR208 to provide a 20V source. This source is resistively divided to provide an additional 12V supply. Power input from the AC line through a half-wave rectifier provides the higher 115V DC requirements.

ELECTRONIC REGULATION

Because ICs and other solid-state devices are sensitive to excessive voltages, a regulation system is needed in the power supplies. The regulators use a zener diode or a zener-controlled transistor to smooth out the DC voltages and keep the output constant under changing load conditions. These regulators react to changes so rapidly that they are sometimes called electronic filter circuits. Extensive filtering

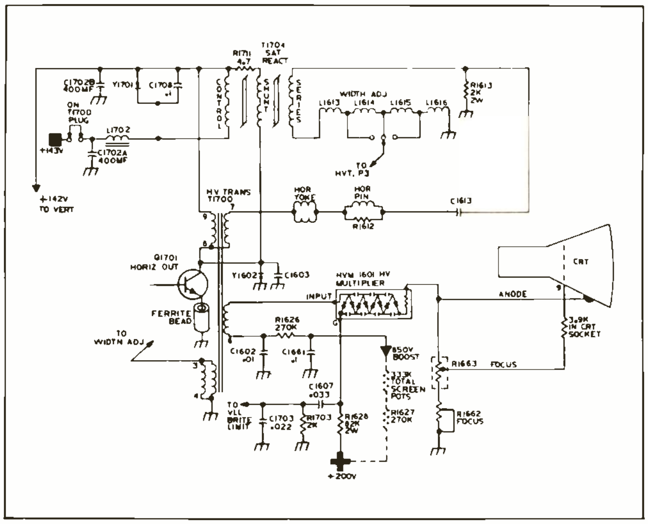

Fig. 9—GE MC chassis filter and high-voltage circuits.

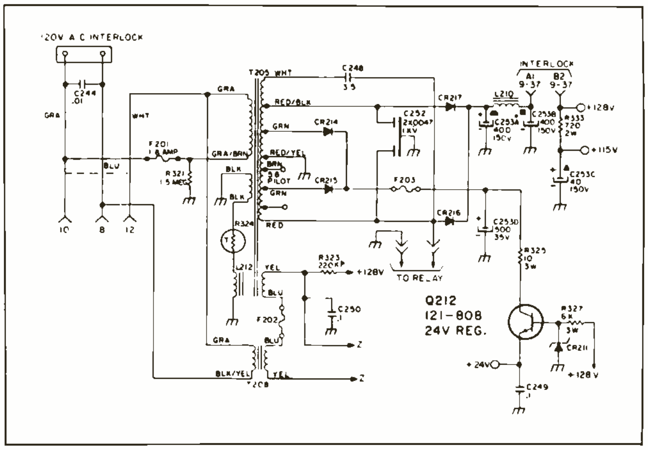

Fig. 10—Zenith 25DC56 power system.

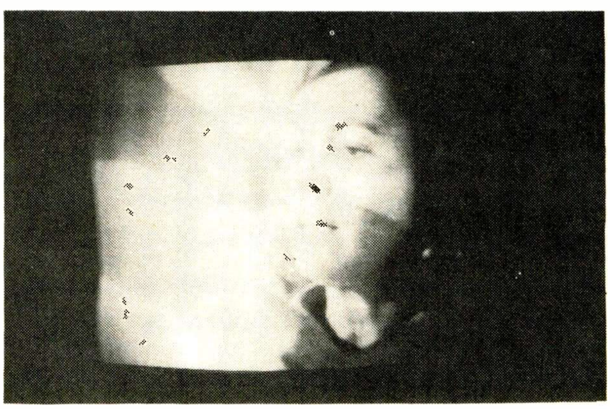

Fig. 11—Slight picture bend due to shorted choke.

with heavy chokes and large capacitors are a thing of the past. Some regulated circuits may have a small 200 mfd filter capacitor; but without the solid-state electronic filter, a huge 10,000µF capacitor would be required to do a comparable job.

Shunt Regulator

A simple zener regulator circuit is shown in Fig. 16. It is called a shunt regulation system because the regulating device is in parallel with the load. Basic considerations for the shunt regulator circuit require that when no load is applied, the zener must pass the amount of current the load would require, and also an additional amount of current that would keep the zener regulating when the load is applied.

This total amount of current is determined by the value of R_S. If the value of R_S increases, the available current to the load and zener would be less. The R_S resistance value must be small enough to maintain zener regulation during maximum current drain of the load. Shunt regulation is not very efficient because there is always current flowing through the zener that is of no value to circuit operation.

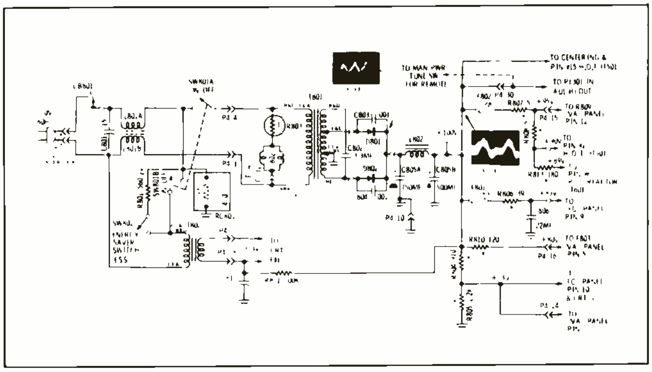

Fig. 12—Motorola TS-942 regulated power supply.

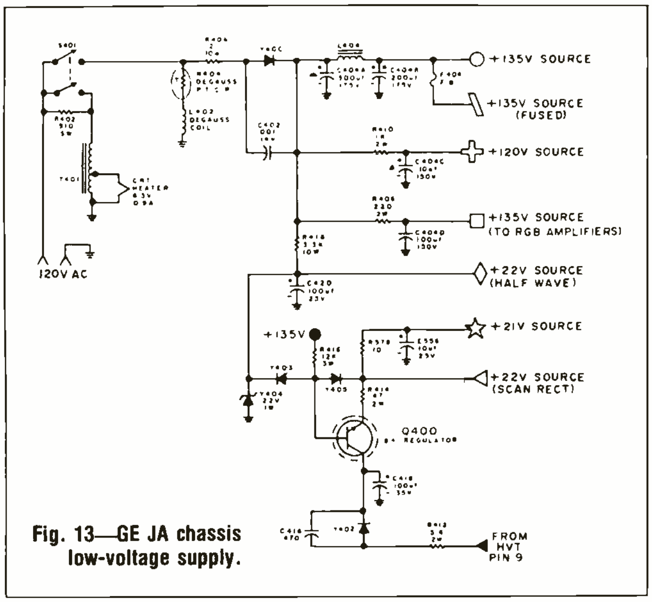

Fig. 13—GE JA chassis low-voltage supply.

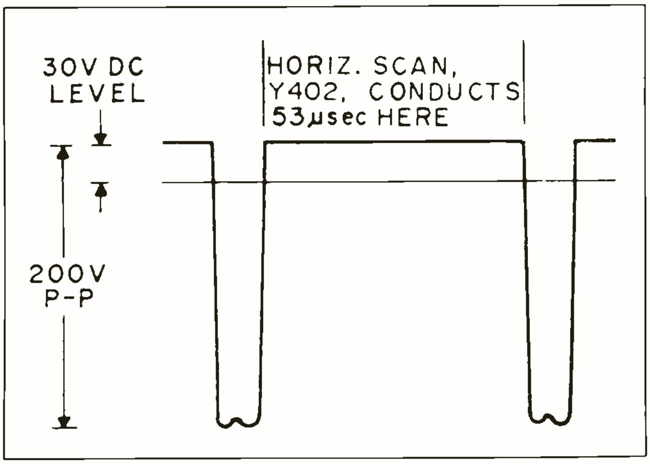

Fig. 14—Horizontal retrace pulses used in scan rectification.

Series Regulator

A more efficient regulator system is the series-type zener regulator. A series regulator system (Fig. 17) requires a control device, such as power transistor Q212, to be in series with the load. The majority of the current flows through Q212. A change in current flow through the transistor will tend to cause a voltage change at the collector. Since the base is biased at a constant voltage by CR213, the change in potential from the base to the collector will affect the current flow through the transistor. This, in turn, automatically restores the emitter output voltage to +24V. Because the transistor is used as an emitter follower, the emitter will remain very close to the zener rating, provided the load does not draw excessive current. In this circuit the zener draws very little current. If a short occurs in the load circuit and heavy current is drawn, the transistor would be damaged if it were not for limiting resistor R322.

Darlington Regulator

One way of increasing current gain and maintaining voltage regulation is to use a Darlington circuit such as that shown in Fig. 18.

The advantage of a Darlington regulator is that a large amount of current can be handled with good voltage regulation. In the typical 125V regulator, more than 500 mA is the normal current flow. This means the current in the base circuit of the regulator driver will be near 0.5mA. To achieve a reasonable percentage of voltage regulation, the current through the zener should be at least twenty times greater, or 10 mA. Therefore, the wattage rating of the zener would have to be at least 3W. Because of several factors, in particular the temperature characteristics, a zener with a 0.5W rating is much more desirable than a 3W zener. A 0.6W zener has more temperature stability and a greater degree of built-in temperature compensation. In this configuration, the driver transistor operates in the same manner as the series regulator transistor. However, its emitter provides base bias for the regulator transistor, and this controls the current flow through the regulator transistor.

RECTIFIER SYSTEMS

The output frequency of a half-wave power supply is 60Hz. A smoother DC voltage can be obtained from a full-wave supply because its output frequency is 120Hz, so a smaller filter capacitor system is required. In Fig. 19, diode D1 conducts when the top of the secondary winding of T1 is positive. This provides a charge to filter capacitor C1. During the next half-

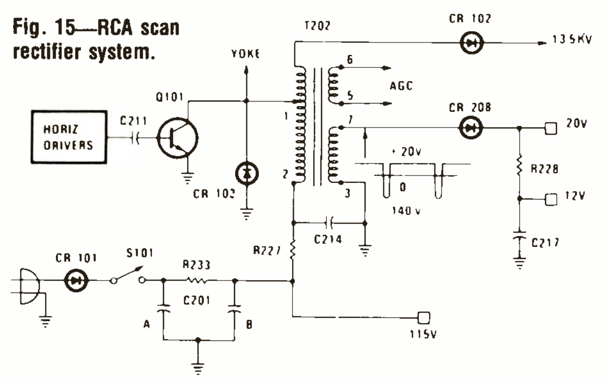

Fig. 15—RCA scan rectifier system.

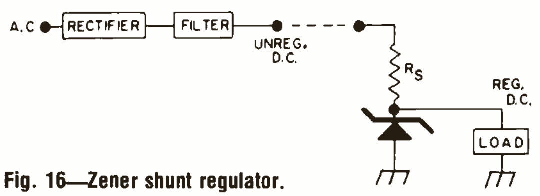

Fig. 16—Zener shunt regulator.

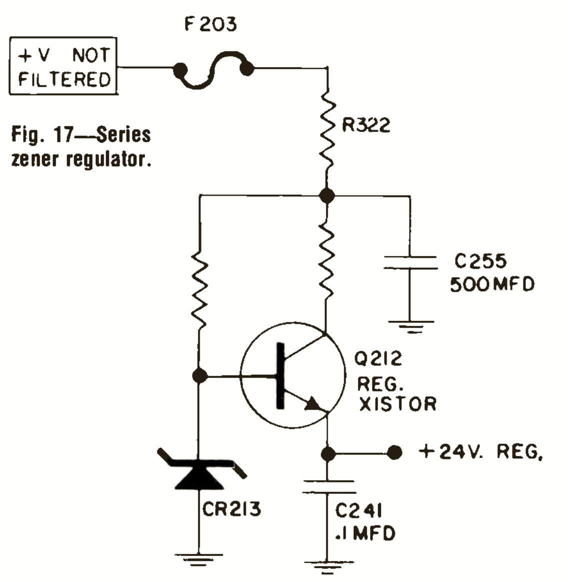

Fig. 17—Series zener regulator.

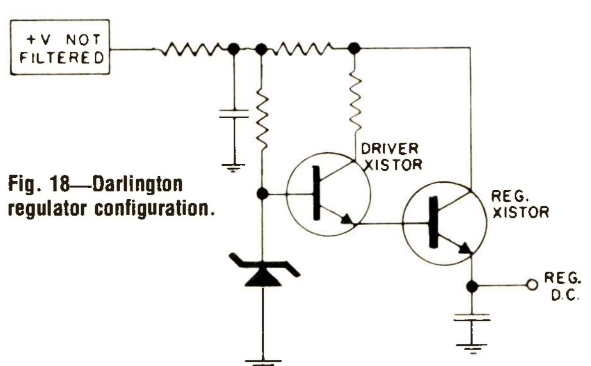

Fig. 18—Darlington regulator configuration.

cycle, diode D1 is reverse biased and is cut off. At this same time, the bottom half of the secondary is positive, diode D2 conducts, and capacitor C1 is further charged. One diode will always conduct, regardless of the phase of the incoming AC.

The full-wave power supply has an output ripple frequency of 120 Hz because the output from the diodes occurs on each half-cycle of the incoming AC. The big advantage of a full-wave rectifier system is that the 120 Hz ripple is much easier to filter than the 60 Hz ripple.

If either diode shorts, a short will exist across the power transformer secondary and the fuse will blow. If the input filter capacitor C1 opens, the output DC voltage will be considerably lower, and a high ripple will be seen by a scope check of the B+ line.

Bridge

The full-wave bridge rectifier system is now found in most color TV receivers. The bridge circuit (Fig. 20) requires four diodes but does not need a centertapped power transformer secondary. In this circuit, the chassis ground is the *negative* terminal, and it receives a *charge* on each half-cycle of the incoming AC. As the top lead of the transformer secondary goes positive, the bottom lead will be going negative. Thus, diodes D2 and D3 will conduct—D2 providing a negative charge to ground, and D3 providing a positive charge to the output circuit. During the next half-cycle, when the top lead of the secondary is negative and the bottom lead is positive, diode D1 conducts negative to ground, and diode D4 feeds a positive voltage into the output circuit. For each half-cycle of the AC input, the output line is positive.

Voltage Doubler

A full-wave voltage doubler circuit is shown in Fig. 21. The C2 capacitor has a different function than a filter capacitor. Operating with D1, C2 charges to the peak value of the applied AC voltage. The second rectifier, D2, charges C1, also to the peak value of the applied AC voltage. Since these two capacitors are connected in series, the voltage across both of them, from point W1 to ground, is equal to the sum of the individual voltages. The DC obtained is nearly two times the RMS value of the supplied AC voltage from the secondary of the transformer.

Some of the normal scope waveforms are shown with the circuit schematic. Because this is a full-wave circuit, the output will have a ripple frequency of 120 Hz. W2 should have an amplitude of less than 2V peak-to-peak, while W1 should be double that of W2.

POWER SUPPLY FILTER SYSTEM

A smooth DC voltage is required for nearly all electronic devices, especially those that use solid-state components. To develop this smooth DC voltage after the AC has been rectified, a filter choke (or a resistor) and filter capacitors are required. A power supply filter circuit is shown in Fig. 22. This is a *capacitive*-input pi circuit using two capacitors and a filter choke. The first capacitor filters the pulsating

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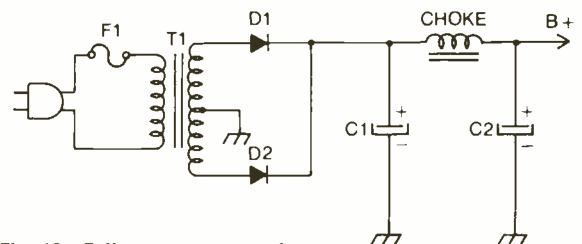


Fig. 19—Full-wave power supply.

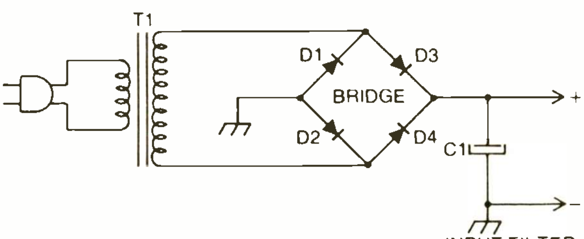


Fig. 20—Full-wave bridge circuit.

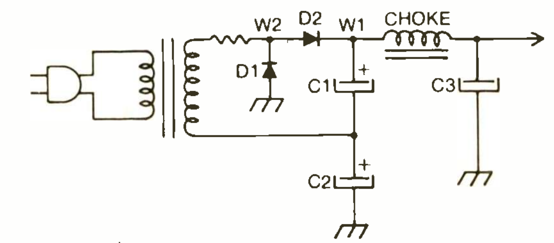


Fig. 21—Full-wave doubler circuit.

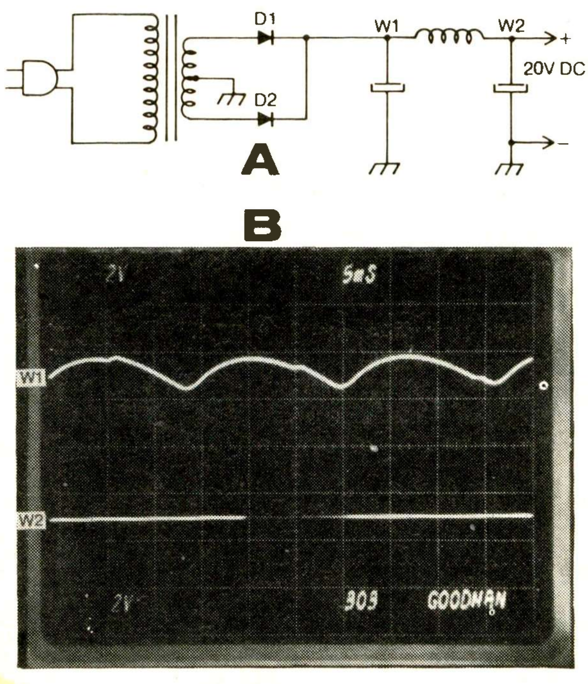


Fig. 22—Low voltage power supply with scope traces.

DC as it comes from the diodes. The choke opposes any change in current, resulting in a relatively smooth DC flow. The output capacitor further tends to keep the voltage constant. A resistor is occasionally used in place of the choke, but it has no filtering characteristics. The choke and filter capacitor values are chosen for a balanced system and efficient operation.

The dual-trace scope can be used to quickly check out the choke and filter capacitor circuits. The two probes from the dual-trace scope are connected to each side of the choke (input and output) at points W1 and W2, as shown in Fig. 22A. Under no-load conditions in a properly operating system, the display will be as shown in Fig. 22B. In Fig. 23 the choke has a 3 mfd capacitor across it. With the scope probes connected as shown, and a load applied to the power supply, the scope display in a good system will be as shown in Fig. 24. If either the choke or the capacitor across the choke is shorted, the waveforms on the dual-trace scope will be identical, as shown in Fig. 25.

A three-section filter system is shown in Fig. 26 along with the scope waveforms that should be found. The choke and capacitors are considered the primary filter circuits. Capacitor C1 refines the pulsating DC to a ripple of not more than 10%. Capacitor C2 and the choke reduce this ripple to about 4%. Capacitor C3 produces a relatively smooth DC voltage. Capacitor C3 also bypasses to ground any stray signals that may be picked up along the supply line. If C3 should open, the scope would display some ripple on the waveform.

TECH BOOK REVIEW

TITLE: *Troubleshooting With The Dual-Trace Scope* (TAB BOOK No. 772)
AUTHOR: Robert L. Goodman
PUBLISHED: 1976
SIZE: 224 pages, 252 illustrations
PRICE: $5.95 softbound, $8.95 hardbound

Veteran servicer Goodman's new book tells all about the dual-trace scope and its features, how to use the triggered-and automatic-sweep modes, dual-alternate and dual-chopped sweep modes, and all the

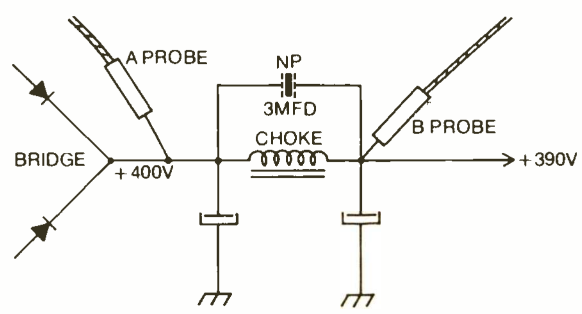


Fig. 23—Dual-trace connections for checking the filter system.

other features of these instruments. Each Chapter is packed with color TV troubleshooting tips, and how the dual-trace scope can be used to locate a whole host of problems, from one end of the receiver to the other. The first Chapter describes several of the various models of dual-trace scopes available; it lists features, and defines the specialized operation of these scopes and their application to color TV and hi-fi stereo system troubleshooting.

The author provides tips on locating the specific problem, tells how to use a dual-trace scope to trouble-track and fault-isolate in a quarter of the time required for single-sweepers. The reader will learn the most important specs to look for before buying a dual-trace scope, such as horizontal sweep speed, vertical amplifier frequency response, rise time, sensitivity, and all the other factors important in TV service work. Uses for the dual-trace scope are described in detail, such as stereo channel comparison testing, stage-gain measurements, comparison of pulse widths, checking countdown and frequency-divider circuits, time measurements in delay lines, timing checks, and many more applications.

A good part of this book deals with troubleshooting various sections of modern color TV receivers. The author takes the reader step by step through a variety of specific color TV modules to show how each troubleshooting sequence is performed. His systemized procedure can be applied to any make, any model, to cut troubleshooting time by 75%! Over 125 photos of actual scope traces illustrate both abnormal and normal waveforms. Circuits and circuit modules are carefully analyzed and explained. A multitude of typical problems are discussed, along with the procedures for isolating those problems to specific components. This is an invaluable guide for anyone who now owns, or is considering purchasing, a dual-trace scope.

CONTENTS: Introduction to the Dual-Trace Oscilloscope—Triggered-Sweep Scope Features—Waveform Observations—Convergence and Pincushion Circuit Troubleshooting—Horizontal AFC Circuit Analysis—Solid-State Push-Pull Vertical-Sweep System—Conventional Solid-State Sweep Systems—Solid-State Horizontal-Sweep System Module Service Techniques—IF and Video Amplifier Systems—Troubleshooting the Chroma Circuits—Analyzing and Checking the Power Supply System—Vertical Internal Reference and Test Signals. ■

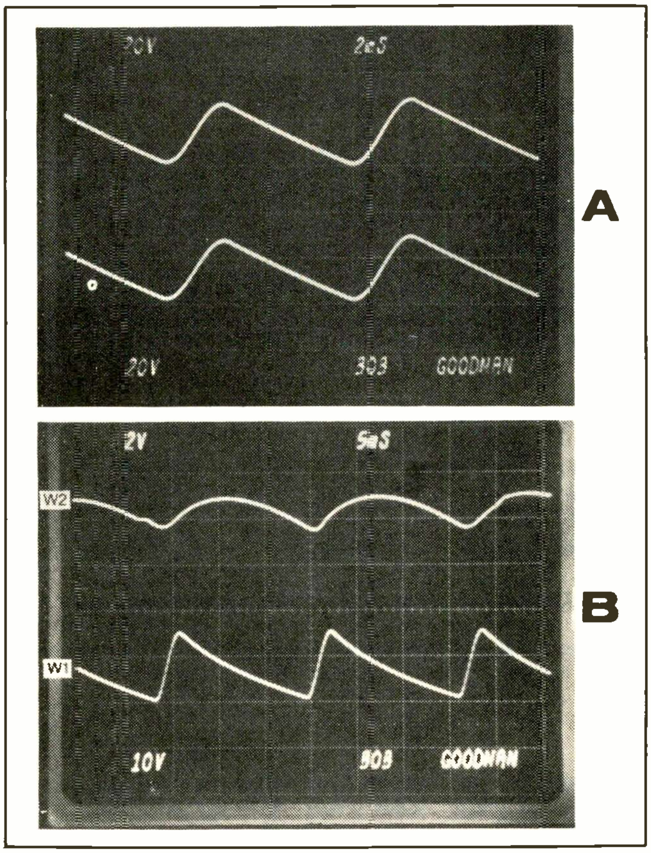


Fig. 25—Waveforms indicate a shorted choke.

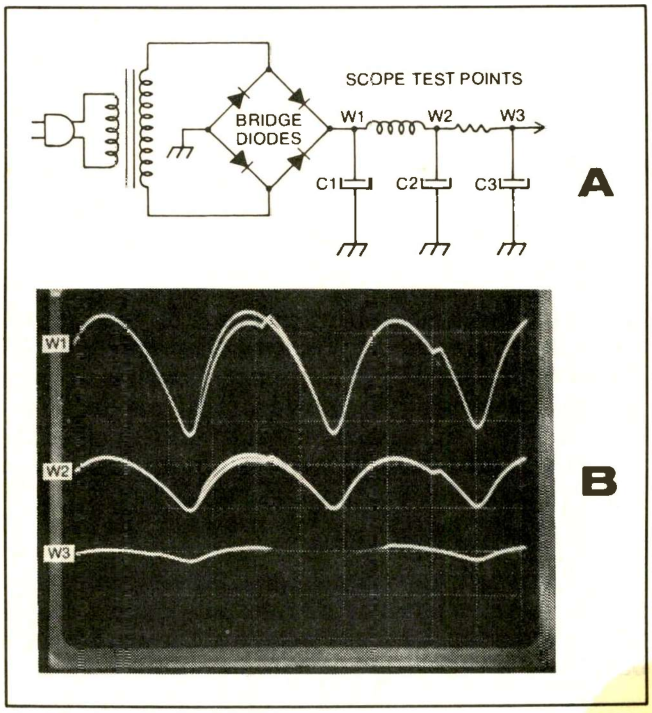


Fig. 26—Three-section filter system.

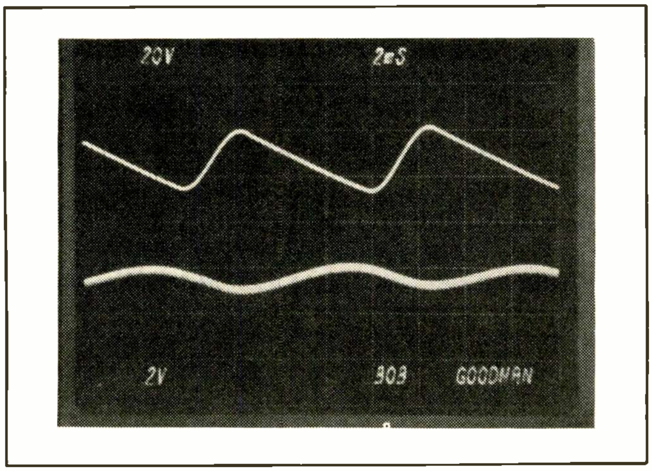


Fig. 24—Normal scope waveforms.

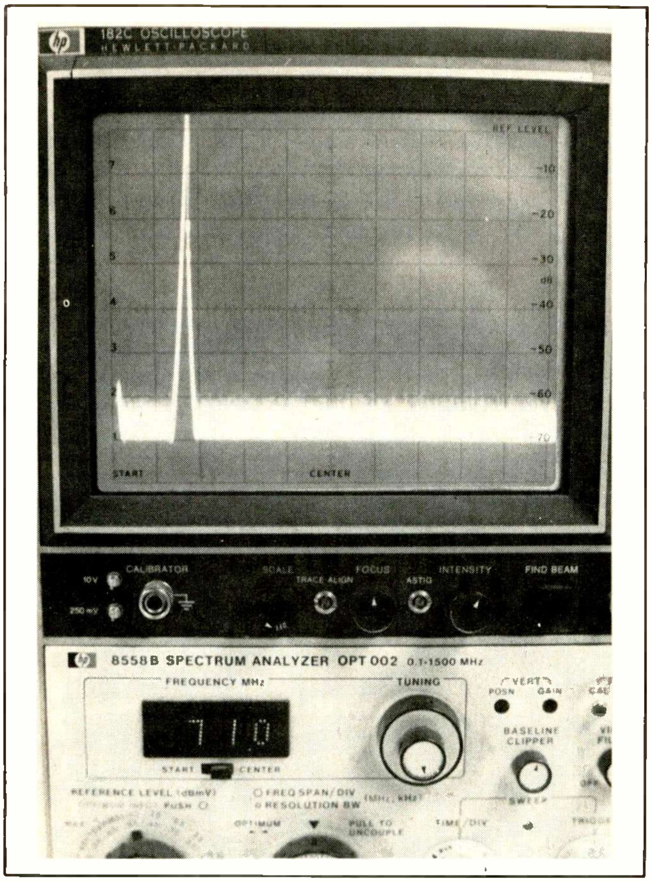


Fig. 1—The trace appearing on a spectrum analyzer shows white noise along the frequency base line. Broad-band noise appears like grass, as if one were looking at a cross-section of thick turf. On a TV picture tube, it appears as snow. From a loudspeaker, it is a frying noise.

Noise and Noise Figure

By James E. Kluge*

How the "noise figure" of an antenna system is determined and what it means to the TV picture quality

■ Noise Figure is the term of measurement that indicates how much noise is contributed by the transistors and/or tubes in the circuitry of an antenna preamplifier or other MATV amplifier. The Noise Figure rating is developed by comparing the device to be measured with a perfect—but non-existent—amplifier that would be able to amplify the input signal without adding any noise of its own.

Antenna Provides Input Signal

Let's start with the input signal, which is generally the voltage developed by the antenna as it intercepts the electromagnetic-wave energy in the air. Looking back 'into' a VHF antenna from its output terminals

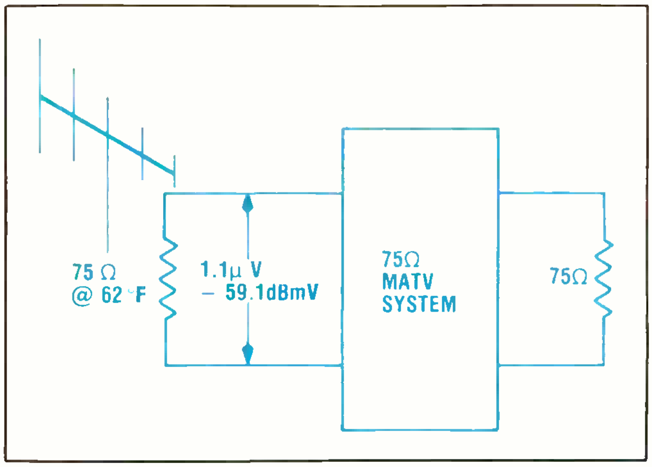


Fig. 2—Diagram of 75-ohm matched impedance MATV system showing that theoretical-minimum thermal-noise voltage is 1.1 μV/ch (−59.1 dBmV) at room temperature.

we see a 75-ohm device. The pre-amplifier input to which the antenna is to be connected also 'looks' like 75 ohms. When we connect the 75-ohm antenna to the 75-ohm input of the preamp, we say they are properly matched for maximum signal-energy transfer from antenna to preamp.

Now suppose that instead of connecting the antenna to the preamp input we simply connect a 75-ohm resistor to the preamp. The preamp doesn't know (and doesn't care) whether its input is terminated by a 75-ohm antenna or a 75-ohm resistor. Since the preamp has no eyes to see with, it doesn't know what's connected to its input, except that the device "feels" like a 75-ohm resistance, which "pleases" the preamp.

Resistors Are Noise Generators

Now, because the resistor is not an antenna, it cannot generate a TV signal voltage at the preamp input.

However, if we look at the voltage at the preamplifier output terminals with an oscilloscope or spectrum analyzer we will see what engineers and technicians commonly call "grass".

This "grass", which is seen at the bottom of the scope in Fig. 1, is comprised of millions of tiny sine waves of infinite frequencies all added together to create a uniform low-level signal across the entire frequency range. The technical name for this "grass" is *white noise.*

It is termed "white" because like white light, which consists of energy at all the frequencies of the visible spectrum, it is comprised of energy at all the frequencies of the RF spectrum.

Electron Motion Generates Noise Voltage

You might ask at this point "Where do all these voltages come from?" It is a phenomenon of nature that in any finite resistance (which includes most known materials) the rate of electron motion in the resistance is a function of the temperature of the material. For this reason, it is termed *thermal noise.* The higher the temperature, the faster the electrons move, and the higher is the white-noise energy and voltage across the resistance. By restricting the frequency bandwidth with such things as filters and measuring instruments we reduce the noise voltages

**The author is a technical editor for the Winegard Company*

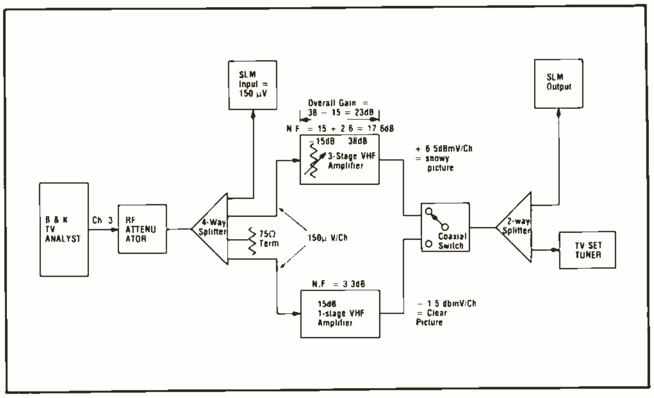


Fig. 3—An illustrated block diagram demonstration of noise-figure vs gain to show how high-gain amplifier with a poor noise figure causes picture-quality deterioration. The moral is: 1) don't try to distribute TV signals less than 1000 μV (0 dBmV) and, 2) use an amplifier having maximum gain more equal to what is required rather than padding down the input of high-gain amplifiers, thus increasing their noise figure.

and thus eliminate the characteristic of white noise.

Mathematical Relationship For Thermal Noise

It may be of interest to know that there is a mathematical formula for the determination of thermal noise. The formula, or equation reveals that any increase in resistance, temperature or bandwidth causes a corresponding increase in the thermal-noise voltage across the resistance. The mathematical expression for this open-circuit voltage is: $E^2 = 4kRT(BW)$. Across a matched load impedance it is: $E^2 = kRT(BW)$. The values are as follows:

E^2 = mean value of the squares of all the individual noise voltages.
K = Boltzmann's constant, named after the physicist who developed this physical constant = 1.38×10^{-23} Joules/K.
R = resistance (in our case, 75-ohms).
T = temperature of the resistance material in Kelvins (generally considered 290K = 62°F as standard).
BW = frequency bandwidth = 4.2 MHz for TV channels.

Shot-Effect Noise From Transistors

It is also important to mention at this point that up until now, we have been talking only about thermal noise which characterized itself as uniform snow throughout the TV picture or a constant hissing or frying noise from the speaker.

A second source of noise is the transistor. Bias current in transistor and diode junctions generate "shot-effect" noise as well as thermal noise in the base resistance.

Electromagnetic Noise

Other types of noise not generated in the amplifier are: 1) man-made electrical noise from brush-type motors, diathermy machines and auto ignition; 2) atmospheric noise from lightning, corona, and other electrical discharges in the atmosphere characterized by random momentary streaks in the picture or crackling in the speaker; 3) galactic noise (sun spots and solar-flare activity). All these "other" types of noise exist as electromagnetic energy which is generated outside of and picked up by the antenna along with the TV signal.

Noise figure is concerned only with thermal and "shot-effect" noise generated in the amplifier's semiconductor devices and associated resistances. *The major contribution is from shot-noise.*

Minimum Antenna Noise

Noise voltage caused by thermal agitation of electronics in a 75-ohm antenna or terminating resistor is about 1.1 μV/Ch, or −59.1 dBmV at room temperature, as illustrated in Fig. 2. At −25°F it drops to −60 dBmV (1.0 μV) and rises to −58.6 dBmV (1.175 μV) at +140°F. So, for all practical purposes, we can consider the minimum noise voltage in round numbers as 1 μV/Ch, or −60 dBmV across 75 ohms. This means that there will always be a theoretical, bare-minimum noise level of 1 μV/Ch of thermal noise measured anywhere in a 75-ohm system from the antenna to the TV set.

For this reason, the signal voltage generated by the antenna must be sufficiently higher than the noise (and maintained so throughout the system) to provide a snow-free picture at the TV set. A 100 μV (−20 dBmV) signal then provides only a 40-dB signal-to-noise ratio (S/N). This is a marginal signal level which does not provide for amplifier noise, fading and system losses. For this reason, we strive for a minimum 1,000 μV (0 dBmV or S/N = 60 dB) signal level at the antenna and throughout the system until it reaches the TV-set tuner.

Noise Figure Degrades S/N

The noise figure of a good low-noise preamp is typically 4 to 5 dB at VHF and 7 to 8 dB at UHF. A 1,000 μV signal at the antenna has a S/N of 60 dB. A 100 μV signal at the antenna has a S/N of 40 dB. Running these signals through an antenna preamp having a 10 dB noise figure will reduce the S/N to 50 dB for the 1000 μV signal and 30 dB for the 100 μV signal. A S/N of 45 dB is considered an excellent picture with no snow, while a S/N of 30 dB is a marginal-quality picture with objectionable show.

Fig. 4—Photo shows good picture quality resulting from a 150 μV (−16.5 dBmV) signal amplified through a single-stage 15-dB amplifier with a rated N.F of 3.3 dB, which provides the tuner with an 840 μV (−1.5 dBmV) signal.

Now, you can begin to see why noise figure in an antenna preamp is so important in a weak-signal area. The noise figure of a preamp will degrade the S/N by adding shot noise to the signal while it is

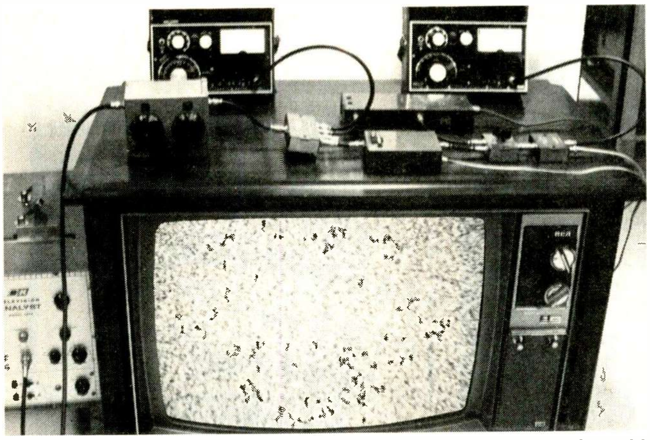


Fig. 5—Photo of a snowy picture resulting from using an amplifier with excessive gain (38 dB) and N.F. rating of 2.6 dB. Input gain control was turned down 15 dB, amplifying the 150 µV input signal 23 dB (or 14 times) to provide the tuner with a 2100 µV (+6.5 dBmV) signal.

undergoing amplification in the transistors. However, if the S/N at the input is excellent (i.e., 45 dB or higher), a good quiet preamp will have little effect on picture quality.

It should also be understood that the antenna preamp will establish the maximum S/N for the entire system. That is, *the S/N coming out of the preamp can not be improved*—that's it! The most important thing you can do is to *preserve* it.

Any passive (non-amplifying) device causing attenuation or loss in the system is considered to have a noise figure in dB equal to that loss in dB. For example, a 6-dB pad can be considered to have a noise-figure of 6 dB. This is so because it attenuates the signal 6 dB, thereby reducing the S/N by 6 dB. For example, a 6 dB pad ahead of a preamp with a 6 dB noise figure yields an overall noise figure of 12db. This is why it is so important to amplify a weak antenna signal *before* it experiences any attenuation caused by pads, cable, connectors or a mismatch of impedances.

If you have a weak signal, it is best to amplify it up to 0 dBmV with an amplifier having as low a noise figure as possible. In order to preserve the low noise figure of the amplifier there should be a very minimum of loss between the signal source and the input amplifier. If the amplifier has too much gain, pad down the amplified signal *after* the amplifier—not ahead of it. Better yet, choose a smaller amplifier having the right amount of gain. Some distribution amplifiers have a variable gain control that can be used to increase their input-signal handling capability at the input. Attenuating the input signal this way is acceptable in the case of strong or high-level signals, but not for weak ones.

Antennas Considered Noiseless

All antennas are considered to be noiseless and lossless, or, in other words, their noise figure (NF) is 0 dB. They do not attenuate or amplify voltages. The more signal you can get from the antenna, the better your TV picture will be. In contrast to a preamp, a larger antenna will increase the signal without increasing the noise.

Measuring Noise Figure

Noise generated in the transistors and/or tubes of an amplifier appears throughout the various stages and will appear as a single combined noise voltage in the output load. It is accepted practice to refer this noise voltage (or power) back to the input by dividing it by the overall gain of the amplifier. Normally, we refer to noise in terms of power, but in a 75-ohm MATV system we can treat it and measure it as a *voltage* across a 75-ohm matched-load resistance.

Noise figure is measured by terminating the amplifier *input* with 75 ohms and measuring the noise power across a 75-ohm output load. Then a 3-dB matched attenuator is inserted ahead of the load and a 75-ohm calibrated noise generator is connected to the input in place of the terminating resistor. The noise-generator output signal then is increased until the original noise-power reading is obtained in the output load. The noise-generator output then is equal to the noise figure of the amplifier.

This measurement must be made in a shielded enclosure (screen room) so that the noise power reading is the noise generated in the amplifier, and from the calibrated noise generator only—not from direct pickup of extraneous signals and/or noise.

Tuner N.F. Notoriously Poor

TV-set tuners should also be an important consideration regarding picture quality. They are notorious for having poor noise figures (e.g. 15 dB). Therefore, it is important that they be fed at least 100 µV/ch, so that the signal-to-noise ratio at the TV set antenna terminals will be 55 dB or better, for a snow-free picture.

Almost every TV set has a lossy balun between the 300-ohm antenna terminals and the 75-ohm input of the tuner. To make things worse, a 75-ohm coax downlead requires an external balun before connecting to the receiver's 300-ohm antenna input terminals.

For this reason, it is desirable to provide a 75-ohm connector at the rear of the set, and then use a short length of coax to connect it directly to the tuner input. This method not only eliminates the loss in two back-to-back baluns which results in degradation of tuner noise figure but also frequently eliminates leading ghosts caused by direct signal pickup in the short, unshielded 300-ohm line between the antenna connections of the set and the TV tuner.

Summary

Let's summarize the important points made in this article:

* Noise figure indicates the relative amount of noise added by the amplifying devices (i.e., tube or transistors) in an amplifier.
* Noise-figure contribution is mainly shot noise from tubes and transistors.
* The S/N ratio of the signal applied to the receiver's antenna input terminals cannot be improved by the receiver circuitry.
* Use a preamp to compensate for losses in the downlead, splitters, couplers, etc. between the antenna and next amplifier in the system, which in many cases will be the tuner in the TV set.
* Because of poor noise figure of most tuners it is important that you have at least 1000 µV of signal at the TV set to achieve a clean picture. ■

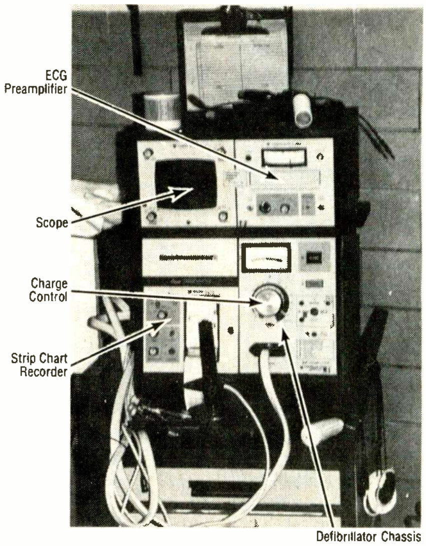


Fig. 1—A typical defibrillator resuscitation cart.

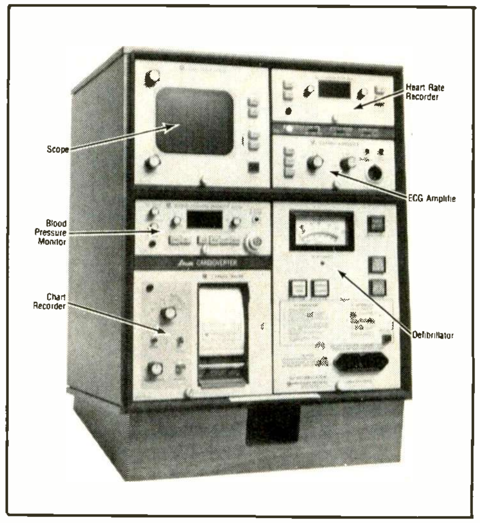


Fig.2—A bedside defibrillator and monitoring package. *(courtesy of American Optical)*

Intro to Defibrillator Servicing

By Joseph J. Carr, C.E.T.

A look at another source of business and profit for electronic technicians

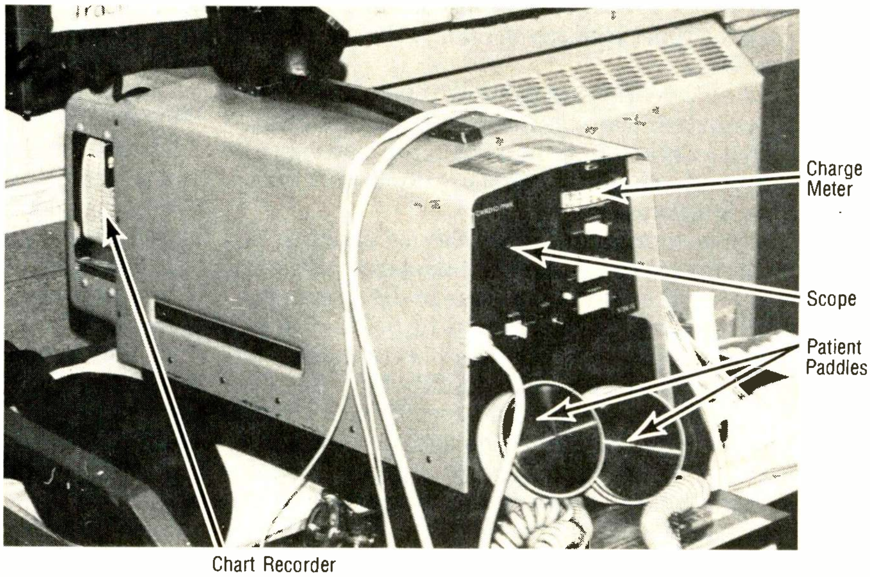


Fig. 3—A battery-operated portable defibrillator.

■ Defibrillators are a relatively simple medical instrument and are amenable to servicing by local, independent technicians and service firms. The simplicity of most such instruments and the speed with which they must be serviced makes it more attractive for a hospital to have a local independent electronics servicer handle these instruments, rather than the somewhat slower factory or authorized factory service contractor.

Defibrillators are used to shock a heart attack victim's heart so that normal rhythm can be restored. The electrical charge is stored in a capacitor, which is connected across the patient paddle electrodes and is delivered to the patient when the operator presses a discharge switch located either on the front panel or the paddle assembly itself.

The name 'defibrillator' is derived from the particular fatal cardiac arrhythmia the instrument is designed to correct—ventricular fibrillation, a condition in which the patient's heart is quivering rather than beating, and where contractions are too shallow to produce effective blood pumping action.

Typical Defibrillators

Figures 1, 2, and 3 show several typical defibrillators as might be found in a typical hospital. Fig. 1 shows a resuscitation cart. Storage cabinet drawers in the lower section are used for keeping drugs and supplies needed during the emergency. The actual defibrillator chassis is the unit in the lower right hand corner of the upper section. Next to the defibril-

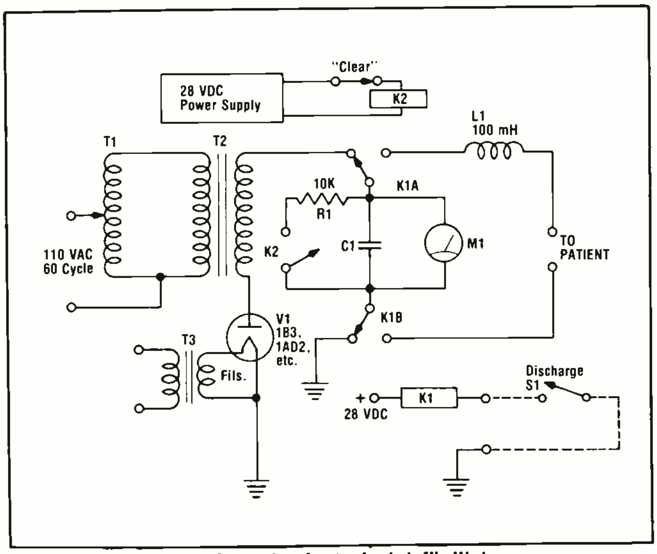


Fig. 4—A simplified schematic of a typical defibrillator.

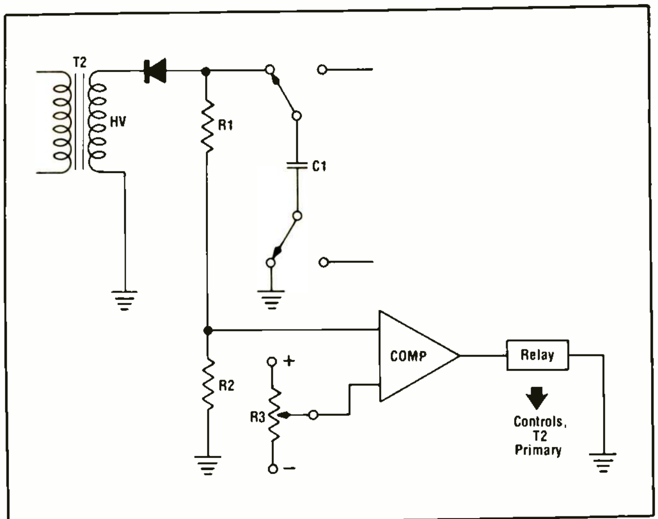


Fig. 5—A simplified schematic of the automatic charge control circuit in a defibrillator.

lator chassis is a strip chart recorder which is used to draw a permanent record of the patient's ECG waveform on a piece of thermally sensitive graph paper. In the upper right hand corner we see an ECG preamplifier chassis. A patient cable attached to electrodes on the victim's chest or limbs acquires the tiny ECG voltages which are processed by this amplifier.

The oscilloscope is a special medical type which is very much like any other scope except that the CRT uses a special long persistance phosphor such as the P7. The input to this oscilloscope is connected in parallel with the input to the strip chart recorder.

The size of the charge to be stored in the capacitor is determined by the charge control knob on the front panel and is read from the calibrated panel meter. Fig. 2 shows a similar instrument but of more recent vintage. The charge control knob in this later instrument has been replaced by pushbutton switches.

The model in Fig. 3 is a battery operated portable. This model uses the defibrillator paddles to also acquire the patient's ECG signal which saves time over the method of using a separate patient ECG cable.

Portables have become much publicized in recent years by TV shows such as "Emergency" and the proliferation of rescue squad paramedic teams. The portables are also popular in smaller hospitals where one instrument must be used to serve several areas of the building and must be hand carried to the location of the emergency.

Defibrillator Circuitry

A simplified defibrillator circuit is shown in Fig. 4. The main charge is stored in capacitor C1, which is usually a 16µf, high voltage, oil-filled capacitor. Relay K1 is a high voltage, vacuum type of relay such as the Torr model TMR10. When the defibrillator is turned on, relay K1 connects the capacitor across the high voltage DC power supply for charging. Then, when the "discharge" button is pressed, the energized relay coil connects the capacitor across the output circuit consisting of a 100mH choke coil, L1, and the patient's body resistance which has about 50 ohms nominal value.

Relay K2, as a safety feature, clears the capacitor charge when the machine is turned off, or when the operator presses a special "clear charge" switch (S2). The relay connects a 10k/50 watt bleeder resistor, R1, across the capacitor for a safe discharge. Some technicians who work on difibrillators carry with them a bleeder resistor with well-insulated alligator clip leads in case they find an open bleeder resistor on the instrument itself.

The high voltage DC power supply circuit consists of variac T1, high voltage transformer T2 and a rectifier, V1. The rectifier in many older instruments will be a TV-type, such as the 1B3 or 1AD2, while in more modern instruments it will be a solid-state diode stack not unlike some of those seen in TV chassis. The variac in this case is mounted to the front panel and is the "charge" knob from Fig. 1.

The meter in the circuit, M1, is actually a kilovoltmeter, but the face is calibrated in watt-seconds or joules (lj = lw−s).

A partial schematic of another type of defibrillator control circuit is shown in Fig. 5. In this case, a comparator circuit, which might be an IC such as the LM311 or discreet components, is used to compare a sample of the capacitor voltage obtained from voltage divider R1/R2 to a reference voltage from potentiometer R3. When the two voltages are equal the comparator output goes high and turns off the AC primary voltage applied to transformer T2. Potentiometer R3 is mounted to the front panel and replaces the variac as the charge control.

The inner works of the AO defibrillator in Fig. 1 are shown in Fig. 6, to give you an idea of the size of the main capacitor. *Make no mistake about it–that capacitor stores a potentially LETHAL charge!* Always work on these instruments using good high voltage technique just as if you were working on a high power radio transmitter, or other similar device.

Testing Defibrillators

Several techniques can be used to check defibrillator performance. The simplest method is to use a kilovoltmeter to measure the voltage across the capacitor at full charge. This voltage level is computed from: $E = \frac{2S}{C}$. S is the stored charge in watt-seconds (joules) and C is the capacitance in farads. For a 16µf capacitor charged to 400 watt-seconds the value of E will be 7.07 Kv.

There are two serious limitations to this first test method, however. One is the uncertainty of errors in the typical low-cost kilovoltmeter and the other is the fact that *static* testing of high voltage devices is not nearly as good as *dynamic* testing. Many components test out all right under static conditions but fail badly in actual operation.

A better way to test these instruments is to use a dynamic defibrillator tester. One of the testers available uses a 50 ohm dummy load to absorb the power, and it contains an integrating voltmeter to compute the deliv-

continued on page 47

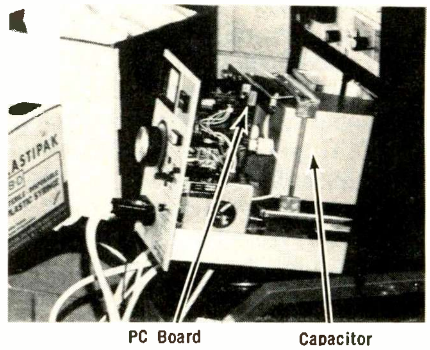


Fig. 6—The inner works of the defibrillator shown in Fig. 1, to illustrate the relative size of the capacitor.

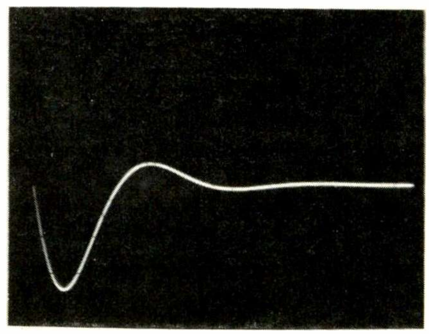


Fig. 7—A typical waveform taken across a 50 ohm dummy load in a properly operating defibrillator.

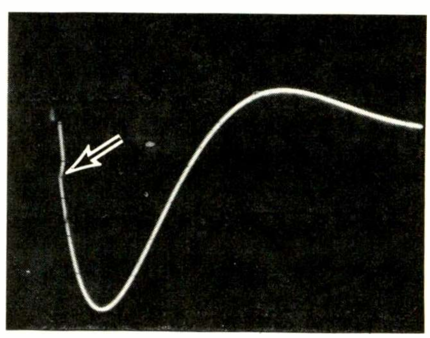


Fig. 8—This is an expanded scope display of the left portion of the waveform in Fig. 7. Arrow points to the "glitch" caused by a defective HV relay.

Scope That Power Supply

By Joseph J. Carr, C.E.T.

How to use the oscilloscope for fast, accurate diagnosis of power supply troubles.

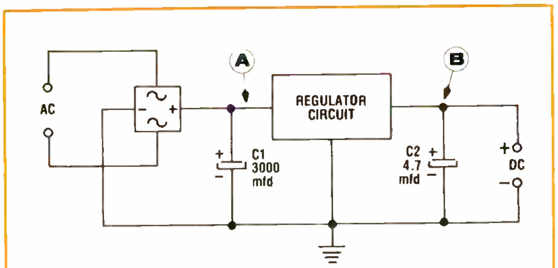


Fig. 1—A functional block diagram of a typical electronically regulated power supply.

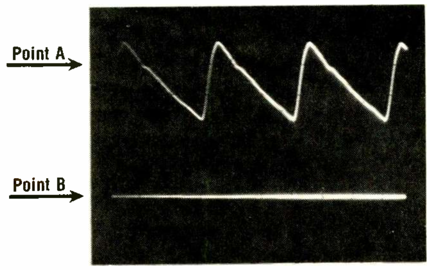


Fig. 2—Waveforms produced by the power supply circuit shown in Fig. 1. (A) shows the ripple present at point A in Fig. 1. (B) shows the waveform at point B in Fig. 1, after regulation.

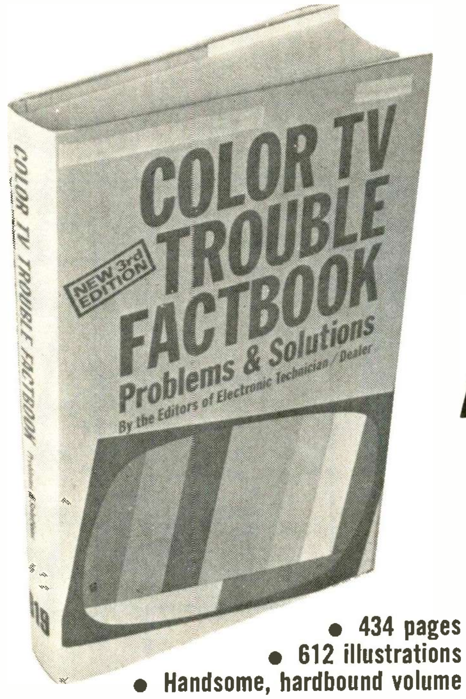
■ Let me pose a question to you. How often do you examine the output of a power supply circuit with an oscilloscope? If you're like many servicers (myself included), the answer is probably "not often enough." Most of us tend to take the power supply for granted. If it's producing DC, we look elsewhere for the trouble. The truth of the matter is, examining the DC voltage with a scope—and *knowing what to look for*—can lead to the solution of many "tough dog" problems.

A lot of modern electronic equipment is operated from internal regulated power supplies. One feature of such power supplies is that almost all of the AC ripple normally encountered in rectifier circuits is suppressed by the regulator. Fig. 1 shows a functional block diagram of an electronically regulated supply. The waveforms to be found at points A and B are shown in Fig. 2. (The vertical amplifiers in the dual-trace oscilloscope have been adjusted to have the same sensitivity so that the relative amplitudes of two voltages can be compared.)

The top waveform in Fig. 2 shows the ripple present at point A in Fig. 1. This point is at the output of the rectifier bridge and before the regulator circuit. The lower waveform shows the ripple present at point B, after regulation. Note that, on the same voltage scale, this waveform appears very nearly pure DC. To be sure, if we amplified the lower trace quite a bit we would be able to see plenty of ripple. It is, though, so low as to be almost ineffectual in most circuits.

If the regulator circuit were to become inoperative because of a shorted series pass transistor, we would find the high ripple component on *both* the A *and* the B waveform. Also, the DC voltage at point B would be excessive. To the TV servicer this would cause, at the least, a heavy 120 Hz hum bar in the picture, plus whatever other symptoms that might accompany high ripple and excessive DC supply voltages. To the industrial, medical, test equipment, digital or communications servicer these problems might produce any number of unusual symptoms.

We should also be interested in what happens in the DC power supply at the instant of turn-on. This is a dynamic time in many electronic circuits, and may be the root cause of many difficult-to-find problems. Fig. 3 shows the normal rising waveform of a positive



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Here it is—the hottest all-makes problem-and-cure guide ever—the fully updated master guide to troubles and circuit problems in American-made color TV receivers—the guidebook that can save you hours (and even days!) of troubleshooting time! This valuable book packs more facts per page than any other, and it describes in words, diagrams, and schematics the kinds of troubles you don't ordinarily see in books—like original-set wiring errors, corrections to manufacturers' printed schematics, maker-originated modifications to improve set performance, and scores of service tips for individual models of specific makes. It's a fully indexed all-in-one reference guide to color-set troubles and recommended solutions, manufacturers' service notes, and production change data—all alpha-numerically arranged by manufacturer and model. This low-cost handbook contains service tips, troubleshooting data, and a wealth of special problem-solving aids for all popular U.S. and Canadian color TV makes and models, from A (Admiral) to Z (Zenith).

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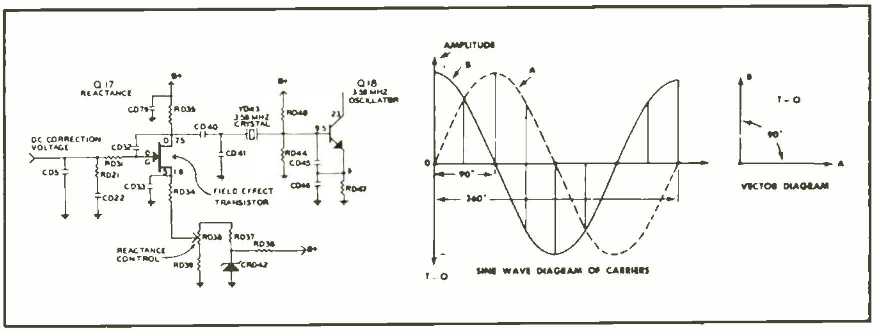

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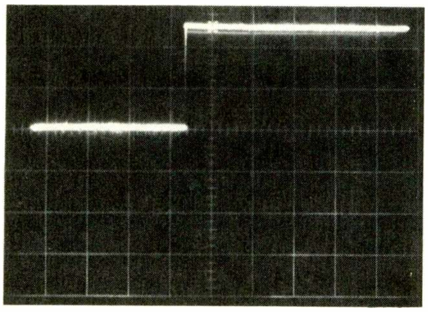


Fig. 3—A normal rising waveform of a positive power supply that is mostly resistive.

power supply that is mostly resistive. Fig. 4, on the other hand, shows the slightly damped waveform to expect when turning on a high capacitance power supply. This particular waveform was taken from a power supply with a 2000 Mfd capacitor.

Ordinarily, this information is of little interest, but every now and then we see a piece of equipment which seems to become latched up on turn-on. Such circuits generally use dual polarity power supplies and may use op-amps, or other linear IC devices, or they may use regular transistors and diodes. The problem is caused by having one of the two opposite polarity supplies lag a little behind its companion when turning on. An open capacitor will substantially reduce the turn-on time constant and that is the root of these problems. This can be diagnosed by using a dual trace scope with one input on each of the two supplies. Examine the rise times to see that they are approximately equal.

Similarly, we should also consider what happens at turn-*off*. This is especially true in dual supply IC circuits—in fact, it is often critical.

Most IC devices have PN junctions between the active transistors and other components of the device and the substrate of the IC. In normal operations, these PN junctions (in effect, diodes) are reverse biased, so they are inert in the circuit.

In some IC circuits, particularly those with dual-polarity DC power supplies, certain conditions can

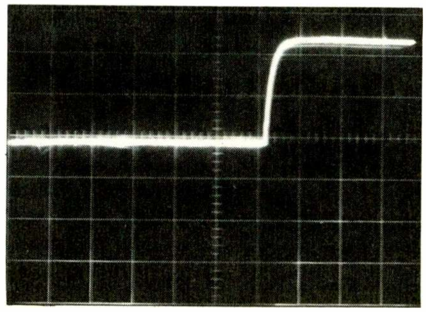


Fig. 4—A slightly damped waveform produced at turn-on in a high capacitance power supply.

cause this PN junction (or "diode") to become inadvertently forward biased. Under this condition, if sufficient current flows, the IC would be destroyed.

A common type of IC linear circuit configuration is shown in Fig. 5. U1 is an IC amplifier or signal processor device. For purposes of this discussion we will not specify which type it is, because the problem is almost generic to dual-polarity linear ICs.

In this particular circuit, there are three sources of rather substantial current flow: Vcc(+), Vee(−), and the current stored in capacitor C1. If the Vcc and Vee voltages decay unequally, then there might exist a brief moment in which the voltage between one power supply terminal and the top of C1 is opposite its normal relationship. In most cases, especially op-amp circuits, the actual failure mode is the reversal of the relationship of the Vee-C1 voltage. This may forward bias the substrate "diode" and allow a current to flow that is great enough to cause permanent damage. In this type of failure, the probability of damage is directly proportional to the length of the decay time lag and the value of C1. Large capacitors for C1 store more current and discharge more slowly.

If an oscilloscope examination reveals a substantially unequal decay time for Vcc and Vee, then suspect this as the possible cause of recurrent IC failure.

The cure for this problem might be to find the reason why the power supplies decay unequally. In normal operation we can rea-

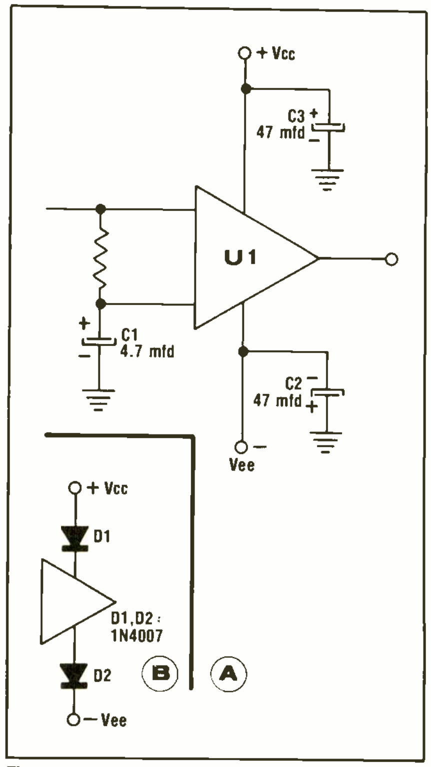


Fig. 5—This is a common type of IC linear circuit configuration, serving as an IC amplifier or signal processor device.

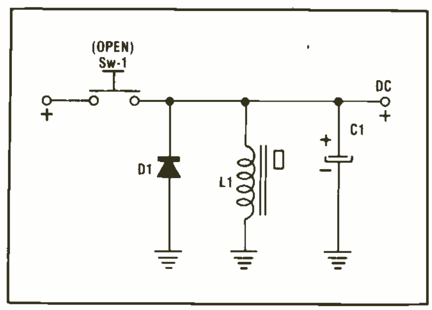


Fig. 6—Diagram of an inductive power supply circuit that could be a solenoid, relay coil, flyback coil, or deflection yoke.

sonably expect both supplies to decay evenly. A defect in an electronic regulator, or an open filter capacitor, may tend to upset this delicate balance.

Another cure, although this may also be classified as a modification, is to series connect a rectifier diode in each of the two power supply lines. These diodes are connected with their polarity arranged so that only current of the right polarity can pass (see Fig. 3B).

Now let's consider the type of power supply circuit shown in Fig.

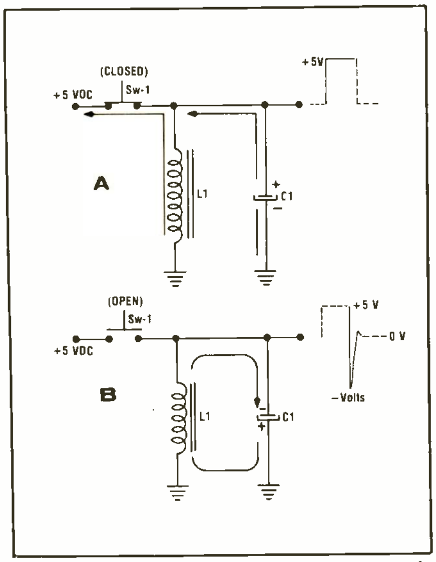


Fig. 7—Diagrams of an inductive power supply circuit without a suppressing diode, in the 'on' position (7A) and the 'off' position (7B).

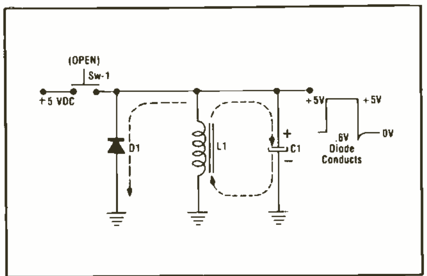


Fig. 8—The inductive power supply shown in Fig. 7 with the suppressing diode added to the circuit in the 'off' position.

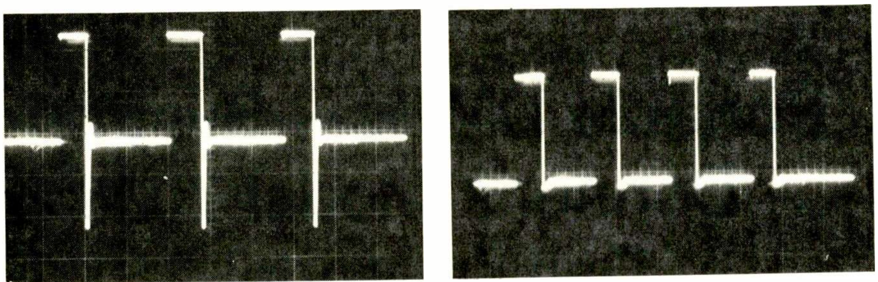


Fig. 9—Waveforms of an inductive power supply produced during several on/off cycles. Fig. 9A shows the negative spike produced when the suppressing diode is open or missing. Fig. 9B was produced by a power supply circuit with a properly operating suppressor diode.

6—an inductive circuit that includes a switch (S1), a diode (D1), a capacitor (C1), and a coil (L1). The coil could be a solenoid or a relay coil—or in a more abstract sense—a flyback coil or deflection yoke. What the circuit amounts to is a high inductance hit by a repetitive DC step voltage that is produced by depressing and releasing the pushbutton switch, or in other words, turning on and turning off the circuit.

A diode (D1) is usually placed in this kind of inductive power supply circuit to eliminate, or suppress, the so-called inductive kick, or "spike" which occurs each time the circuit is turned off. If the diode were to open, and the spike was not suppressed, you could easily end up with blown transistors, diodes, or IC devices. In digital circuits, the spike could also create a "glitch" that would reset flip-flop or register circuits—or gate them on or off at inappropriate times.

To better understand where the "negative spike" comes from and how a diode serves to eliminate or suppress the spike, let's take a look at Figs. 7A and 7B which show the on and off operations of a power supply circuit without the suppressing diode.

In Fig. 7A, the switch (SW1) is depressed and the circuit is turned on. The applied voltage of +5 VDC charges the capacitor C1 and creates a magnetic field around the coil (L1). The output voltage of the power supply circuit at this point is +5VDC. A drawing of the waveform produced at the moment of turn-on is shown at the right of the diagram.

In Fig. 7B., the switch is released and the circuit is turned off. The capacitor (C1) discharges and the field around the coil collapses. The combined current of the capacitor discharge and the counter electromotive force (CEMF) of the collapsing field of the coil (CEMF is series-aiding to the discharge current of the capacitor) produces a negative spike (or inductive kick). The negative spike that is produced is shown in the waveform drawing to the right of the diagram in Fig. 7B.

In Fig. 8, a diode (D1) has been added to the circuit. Now, when the switch is released and the circuit is turned off, the capacitor (C1) discharges and the field of the coil collapses as before, but now, when the voltage produced reaches −.6VDC, the diode starts to conduct and returns the voltage to ground, eliminating, or suppressing, the negative spike. The waveform produced by this circuit is representated by the drawing to the right of the circuit diagram in Fig. 8.

Actual photographs of the waveforms produced by connecting an oscilloscope input across the power supply circuit at capacitor C1 during several on/off cycles are shown in Figs. 9A and 9B. Please note that the leading edge of the waveforms is missing in the photographs because of a slow rise time in the particular scope used.

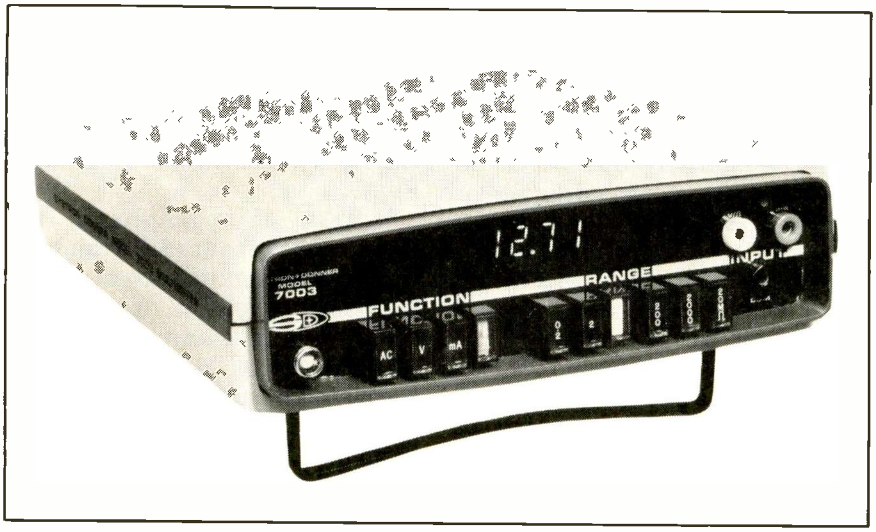
Fig. 9A is the waveform, complete with negative spike, produced when the diode is either open or missing. Fig. 9B is the waveform produced by a power supply circuit that includes a properly operating suppressor diode.

As we said in the beginning, using an oscilloscope to examine power supply circuits—and knowing what to look for—can solve a lot of your "tough dog" problems. In fact, it probably is safe to say that the scope is a necessary piece of equipment for truly successful power supply troubleshooting.

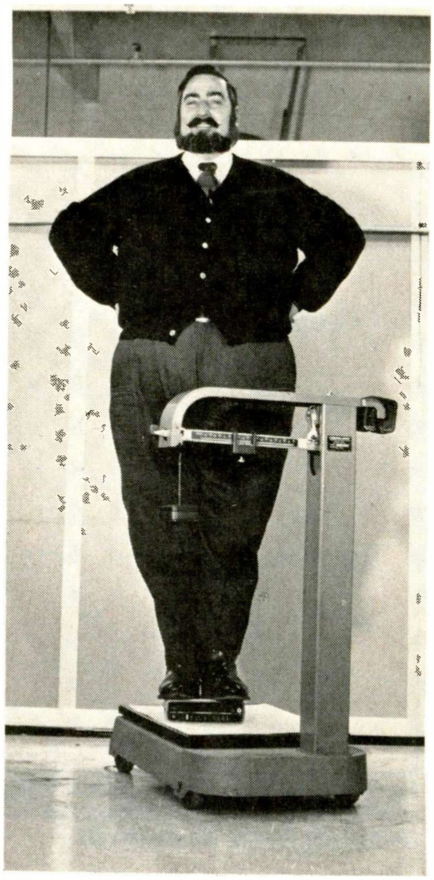
Of course, as is the case with other electronic circuits and devices, if the problem still can't be solved with the knowledge and equipment you have at hand—a call or a letter to the manufacturer's service department, or even the engineering department, might be necessary. It's possible that this has been a recurring problem with this particular device and the manufacturer may be able to recommend a cure. ■

TEST INSTRUMENT REPORT

Portable DMMs—Systron-Donner's Model 7003 & Dana's Model 2100A



Systron-Donner Model 7003 Digital Multimeter. For more information about this test instrument, circle number 144 on Reader Service Card.



Not even the 355 pounds of Systron-Donner design engineer Phil Kearney can crush the clamshell-shaped Cycloy case of the Model 7003.

SYSTRON-DONNER MODEL 7003

■ If you've been looking for a portable digital multimeter which is not only 'drop-proof' but also virtually crush-proof, Systron-Donner's Model 7003 could be the answer.

As shown in an accompanying photo, the clamshell-shaped, Cycloy case of the 7003 easily supports the 355 pounds of Systron-Donner design engineer Phil Kearney. (Cycloy is an ABS/Polycarbonate plastic alloy which also is used in professional football helmets and in the bumper assemblies of 1976 cars.)

The 7003 is equipped with a 3-½ digit LED display with .4-inch-high orange numerals against a black background and is capable of measuring DC voltages from .1mV to 1000 volts, AC voltages (*true RMS readout*) from .1mV to 500 volts, DC current from .1µA to 1999mA, AC current *(true RMS readout)* from .1µA to 1999mA, and resistances from .1 ohm to 19.99 megohms. (Specific ranges, accuracies and other electrical characteristics of the 7003 are detailed in the accompanying specifications table.)

Display features of the 7003 include automatic polarity indication, with both positive and negative indicators; automatic positioning of the decimal point for each of the six range pushbuttons; automatic zeroing on all functions and ranges; and automatic overrange indication (flashing of the entire display). In addition, the word "ERROR" is illuminated to the right of the main display when the wrong combination of function and range is selected.

Input to the 7003 is via three jacks in the upper right-hand corner of the front panel—the red jack, labeled 'V/Ω', is used in conjunction with the 'COM' jack for voltage and resistance measurements, and the white jack, labeled 'mA' is used in conjunction with the 'COM' jack for current measurements.

The 'mA' input circuit is protected against currents exceeding 2 amps by an externally resettable circuit breaker, the reset button of which is conveniently positioned above the input jacks on the front panel.

As is evident in the accompanying close-up photo of the 7003, the four function and six range pushbuttons are grouped separately on the front panel under conspicuous 'FUNCTION' and 'RANGE' labels. In addition, a white, green, gold, blue, or orange 'panel' automatically appears behind the clear plastic of the pushbuttons whenever they are pushed in, providing a clear visual indication of which function and range has been selected.

The basic version of the 7003 is AC powered, but it also is available optionally with a built-in rechargeable nicad battery pack/charger system which provides six hours of continuous operation be-

SPECIFICATIONS SYSTRON-DONNER MODEL 7003 DIGITAL MULTIMETER

DC VOLTAGE
Fullscale Ranges: +199.9 mV (0.2), +1.999V (2), +19.99V (20), +199.9V (200), +1999V (2000)

Resolution: 100 µV to 1V

Polarity Selection: Automatic with plus and minus indicator.

Input Impedance: 10 megohms all ranges

Accuracy (1 year):
0.2 range (25+5°C): +0.2% rdg. + 2 counts
2, 20, 200 and 2000 range (25 +5°C): +0.1% rdg. +1 count

Maximum Input: +1000VDC or Peak AC

DC CURRENT
Fullscale Ranges: +199.9 µa (0.2), +1.999 mA (2), +19.99 mA (20), +199.9 mA (200), +1999 mA (2000)

Resolution: 100 nA to 1mA

Polarity Selection: Automatic with plus and minus indicator

Accuracy (1 year):
0.2, 2, 20, and 200 ranges (25 +5°C): +0.5% rdg. +2 counts 2000 range (25 +5°C): +1.0% rdg. +3 counts

Terminal Voltage:
0.2, 2, 20, 200 ranges: 0.2V at F.S.
2000 range: 0.6V at F.S.

Maximum Input: +2000 mA. Circuit breaker protected (Operates under 3A load for 6 seconds)

AC VOLTAGE
Fullscale Ranges: 199.9 mV (0.2), 1.999V (2), 19.99V (20). 199.9V (200), 1999V (2000)

Resolution: 100 µV tp 1V
Input Impedance: 10 MΩ in parallel with 100 pF

Frequency Range: 50 Hz to 10kHz

Accuracy (1 year):
0.2 and 2000 ranges (25 +5° C): +1% rdg. +3 counts (applies 1% F.S.)2, 20, and 200 ranges (25 +5° C): +0.75% rdg. +3 counts (applies 1% F.S.)

Maximum Input: 500V (RMS)

AC CURRENT
Fullscale Ranges: 199.9 µA (0.2), 1.999 mA (2), 19.99 mA (20), 199.9 mA (200), 1999 mA (2000)

Resolution: 100 nA to 1 mA

Frequency Range: 50 Hz to 10 kHz

Accuracy (1 year):
0.2 and 2000 ranges (25 +5° C): +1.5% rdg. +3 counts (applies 1% F.S.)
2, 20, and 200 ranges (25 +5° C): +1% rdg. +3 counts (applies 1% F.S.)

Terminal Voltage:
0.2, 2, 20, and 200 ranges: 0.2V at full scale
2000 range: 0.6V at full scale

Maximum Input: 2000 mA (Circuit breaker protected)

RESISTANCE

FULLSCALE RANGES	CURRENT THRU Rx	RESOLUTION	F.S. VOLT DROP
199.9Ω (0.2)	1mA	0.1Ω	.1999
1.999KΩ (2)	1mA	1Ω	1.999
19.99KΩ (20)	100µA	10Ω	1.999
199.9KΩ (200)	10µA	100Ω	1.999
1999 KΩ (2000)	1µA	1KΩ	1.999
19.99MΩ (20 M)	0.1µA	10KΩ	1.999

Accuracy (1 year) (25 +5° C):
0.2 range: +0.4% rdg. +2 counts
2 range: +0.3% rdg. +2 counts
20 and 200 ranges: +0.2% rdg. +2 counts
2000 range: +0.4% rdg. +3 counts
20 M range: +0.5% rdg. +4 counts

Maximum Open-Circuit Voltage: 4 volts

Voltage Protection (without damage): 250 Vrms

GENERAL
Size: 2. in. high x 8.75 in. wide x 10.88 in. long

Weight: w/out battery option, 3 lbs. 3 oz; w/battery option, 4 lbs

Power Requirements: 110-115 VAC (RMS) or 200-230 VAC (RMS), choice selected by jumpers on main printed-circuit board

tween recharges. The built-in charger continuously recharges the battery pack whenever the instrument is plugged into an AC source, regardless of whether the instrument is on or off. Complete recharging is accomplished in 16 hours. The brightness of an internal ballast lamp, viewable through the rear panel vent, indicates the rate of charge and, therefore, the state of charge of the battery pack—a dim lamp indicates a slow rate of charge and, therefore, a fully charged battery pack.

Access to the battery pack, the line fuse (⅛-amp Slo-Blo, for 115 VAC operation) and the circuitry of the 7003 is accomplished by removing six screws on the bottom of the instrument and lifting off the top half of the case. The optional battery pack is securely mounted to the underside of the top half of the case.

The case of the instrument has a built-in handle at the rear, and an adjustable stand is supplied with the instrument, for insertion in slots in either the front or back underside of the case. Also supplied with the 7003 is a plastic protective cover which slips over the front panel of the instrument.

The price of the basic (AC power only) version of the Model 7003 is $295, and the AC/DC-powered version with built-in battery pack/charger is $340. Other options available include test leads, two types of carrying cases, 30-KV high-voltage probe, and a rack mounting kit.

DANA MODEL 2100A

'A truly portable, 3½ digit, all-solid-state digital VOM' is an apt description of Dana's Model 2100A (Danameter II).

Included among the design features which have earned the Model 2100A its 'truly portable' label are its:

• *Small size*—its 4 in. x 7¼ in. x 2¼ in. dimensions are only slightly larger than an outstretched hand.

• *Light weight*—a mere 1 lb., including battery.

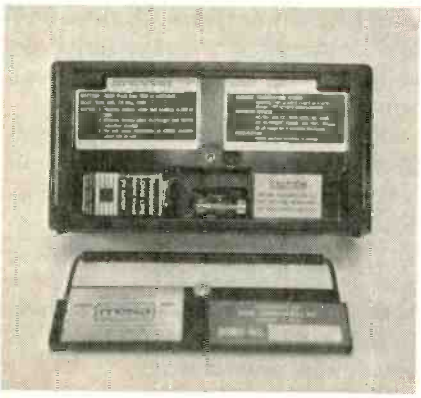
• *Rugged construction*–a virtually unbreakable Cylocac™ case with molded shoulders which protect the readout window and single operating switch, combined with solid-state circuitry, make the Model 2100A capable of withstanding the extreme abuse which test instruments inevitably are subjected to in off-the-bench and out-of-shop servicing situations.

• *Extended-operation capability from a built-in power source*—powered by a single non-chargeable 9-volt 'transistor radio' battery, the Model 2100A is capable of performing about 3000 hours (or about one year) of in-spec measurements before battery replacement is necessary.

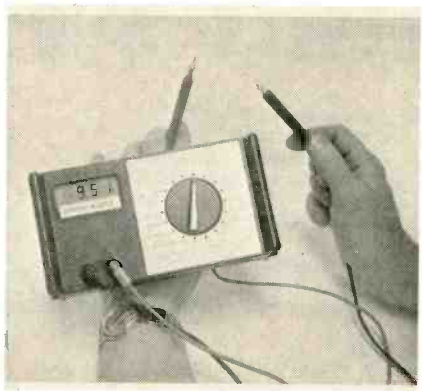
Complementing the preceding 'portability' features of the 2100A are: 1) *a 3½ digit liquid crystal display (LCD)*—which can be read easily in dimly lighted environments, as well as in bright sunshine; 2) *a versatile measuring capability*—DC voltages from 1mV to 1000 volts, AC voltages from 1mV to 700 volts RMS, DC current from .01µA to 1.999A, and resistances from 1 ohm to 19.99 megohms; and 3) *single-switch operation*—all functions and ranges, including on/off and battery test, are selected by one large 18-position switch on the front panel.

Other ease-of-operation features are: *automatic zeroing, automatic decimal positioning, automatic polarity indication* (depending on the polarity of the DC voltage or current being measured, either a negative (−) or plus (+) sign is displayed on the left side of the readout, eliminating

Dana Model 2100A Digital VOM. For more information about this test instrument, circle number 145 on Reader Service Card.



Rear view of Dana Model 2100A Digital VOM with cover of battery/fuse compartment removed. Single non-chargeable 9-volt battery provides one year of operation.



In awkward servicing situations the Dana Model 2100A can be worn on the back of a hand like a wrist watch, freeing both hands for test lead placement.

the need for reversing the test leads), and *overrange indication* (if the quantity being measured exceeds the capability of the selected range, the letters 'OL' are displayed by the readout, indicating the need to select a higher range).

Overload protection of all voltage and resistance ranges and 20μA current range, up to the associated maximum input levels indicated in the accompanying table of specifications, is provided by the inherently high input impedances of these functions and ranges.

Overload protection for the 2mA, 200mA and 2A DC current ranges is provided by a 2½ amp fast-blow fuse, which, along with the battery, is housed in a compartment in the back of the instrument. (Access to the fuse or battery is accomplished by loosening the single screw which secures the cover of the battery/fuse compartment and then sliding the cover up and out.)

Another design feature which enhances the ease with which the 2100A can be used in off-the-bench applications is a built-in, two-position, bail-type stand on the back of the instrument. In addition to serving as a stand which can be tilted to two positions for ease of viewing on the bench, the bail also makes it possible to wear the 2100A on the back of one hand like a wrist watch in awkward servicing situations, thereby freeing both hands for test lead positioning.

Price of the Model 2100A, complete with test leads, is $199.50.

Accessories available on an optional basis include shunts for AC current measurement, a 50-KV high-voltage probe, a 200-MHz RF probe, and a carrying case. ■

SPECIFICATIONS DANA MODEL 2100A DIGITAL VOM

DC VOLTAGE

Full-Scale Ranges: +1.999V (2V), +19.99V (20V), +199.9V (200V), +999V (1000V)

Resolution: 1mV to 1V

Polarity Selection: Automatic with plus and minus indicator

Input Impedance: 20 megohms, all ranges

Accuracy (1 year 20° C −30° C):
2V range: +(.25% rdg. + 1 count)
20V, 200V, 1KV: +(.35% rdg. + 1 count)

Maximum Input: +1000 VDC or PEAK AC

AC VOLTAGE

Full-Scale Ranges: 1.999V (2V), 19.99V (20V), 199.9V (200V), 999V (1000V)

Resolution: 1mV to 1V

Input Impedance: 2 megohms in parallel with 50 pF

Accuracy (1 year, 20°C−30°C):
45Hz to 400 Hz: .5% rdg + 2 counts
400Hz to 4KHz*: 1.5% rdg. + 2 counts
*2KHz on 2V range

Maximum Input: 1000V PEAK AC or 250VDC

DC CURRENT

Full-Scale Ranges: +19.99μA (20μA), +1.999mA (2mA), +1.99.9μA (200mA), +1.999A (2A)

Resolution: .01μA to 1 mA

Polarity Selection: Automatic with plus and minus indicator

Accuracy (1 year, 20°C−30° C): +(.5% rdg. + 2 counts) for all ranges except 2A

Maximum Input:
Voltage: 250VDC or AC RMS (5 sec. max. on 20μA range)
Current: 2 amps (fuse protected)

RESISTANCE

FULL-SCALE RANGES	CURRENT THRU RX	RESOLUTION
1.999KΩ (2KΩ)	100μA	1Ω
19.99KΩ (20KΩ)	100μA	10Ω
199.9KΩ (200KΩ)	10μA	100Ω
19.99megΩ (20megΩ)	1μA	10KΩ

Accuracy (1 year, 20°C−30°C):
2K, 20K, 200K ranges: .5% rdg. + 2 counts
20megΩ range: .75% + 1 count

Maximum Open-Circuit Voltage: 4V

Maximum Input Voltage: 250VDC or AC RMS

GENERAL

Size: 4 in. high x 7¼ in. wide x 2¼ in. deep

Weight: 1 lb. (including battery)

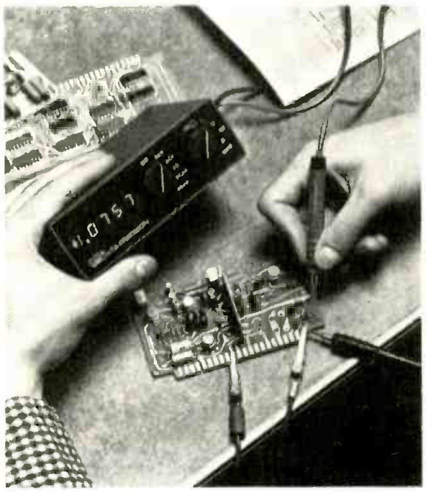
Power Requirements: One 9V dry cell (NEDA No. 1604)

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.

MINIATURE DIGITAL MULTIMETER 127

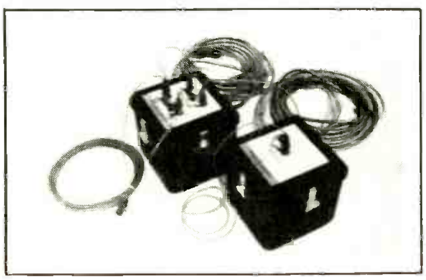
A miniature portable digital multimeter which is said to be the first miniature to provide high accuracy and sensitivity with true RMS measurement of AC volts and current has been introduced by *Data Precision Corporation*. Measuring 1¾ inches high, 5½ inches wide and 3½ inches deep, the Model 248 is a full-function,



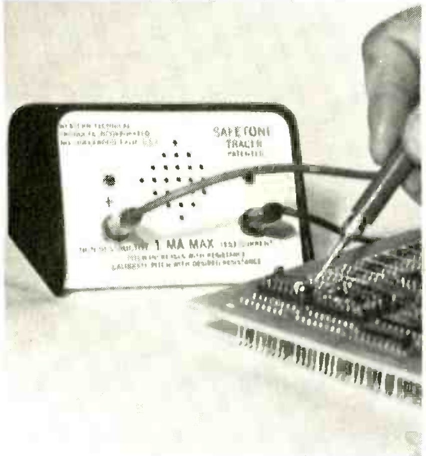
high-resolution unit offering 4½ digit resolution on all parameters. It is convertible for bench use with an optional bench stand, and features 10 microvolt sensitivity DC and AC and basic one-year accuracy of ±0.05% of input. Most logic components in the Model 248 are contained in a single LSI chip. It has only two controls, function and range. Priced at $345.

MAGNETIC VEHICLE DETECTOR 128

A loop vehicle detector, designed for direct burial in the earth, parking lot, or other surface, has been introduced by *Mountain West Alarm Supply*. Called the T10 detector, the new device is said to be ideal for unattended use in surveillance of remote access areas or perimeters, and for use in urban environments for surveillance



or to alert attendants while on duty. The detector provides coverage of from a few feet to more than 400 feet with a single unit. Signal recognition circuitry coupled with adjustable sensitivity provides for detection of targets ranging from small magnets and bicycles to motorcycles, snowmobiles, and automobiles, while rejecting false alarms. Sells for $680.00.



AUDIBLE CIRCUIT TESTER 129

A new current-limited audible circuit tester for rapid tracing of electronic circuits is being introduced by *Western Technical Products*. Called the Safetone Tracer it has been designed for rapid tracing or troubleshooting of circuits, IC's, semiconductors, logic components, harnesses, pots and relays. Unlike ohmmeters, test lights, buzzers, and high current testers, the new tracer will not degrade or damage components, according to the manufacturer. While listening to the tone pitch, which increases with resistance, the user is able to sweep rapidly across circuits with freedom of eye and body. Replaceable test leads can be extended to allow for 2-man testing. The tracer uses two standard size D batteries. Retail price is $29.50.

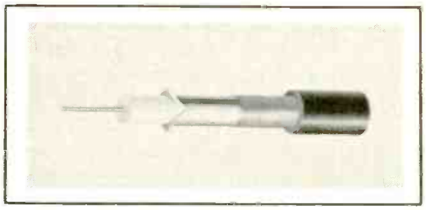
SEALED LEAD-ACID CELLS & BATTERIES 130

A new line of rechargeable sealed lead-acid (SLA) cells and batteries has just been released by *General Electric*. They feature the same type of wound-plate construction used in GE's nickel-cadmium batteries. The first units marketed will be the "D" size; high capacity "X" cells will be available shortly. These new cells are sealed so they can be used in any position, but a resealable safety vent is provided to prevent cell bursting under extreme abusive use. The "D" cells provide 2.5 ampere-hours capacity at the 250 milliampere discharge rate. They are capable of delivering continuous current up to 40 amps or

momentary currents (one second) of 75 amps. Standard batteries made from "D" cells are also available in 6 and 12 volt designs. Dimensionally, the batteries will be interchangeable with batteries of other manufacturers. The "D" cells are priced from $2.49 to $4.80, depending on size of order.

ALUMINUM FOIL-SHIELDED CB CABLES 131

A new line of CB cables with an aluminum foil-shield is being introduced by *Columbia Electronic Cables*. The bonded feature of the new foil-shielded cable, called Stat-Stop, is said to prevent shield pushback during connector application. Shield pushback and the resultant gap in the shield and connector are common



causes of poor reception. The new cable consists of a 20 AWG bare copper conductor insulated with cellular polyethylene. The shield is wrapped and adhesive bonded over the insulation. A 95% tinned copper braid shield supplies additional shielding and the entire assembly is protected by a black vinyl jacket with a nominal overall diameter of 195 inches.

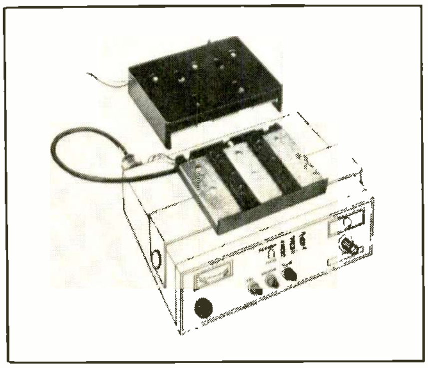
DIGITAL MULTIMETER 132

A new battery/ac portable 4½ digit, five-function digital multimeter that features a 'touch-hold' probe as an accessory is being introduced by *Hewlett-Packard*. The 'touch-hold' probe allows the user to freeze the reading on the display when probing closely-packed circuit boards. Called the Model 3465B, the meter has a DC measurement range from 1 microvolt to 1 kilovolt with a mid-range accuracy of ± (0.02 of rdg. ± 0.01% of range) for one year. AC measurement range is 10 microvolt to 500 volts with a mid-range accuracy of ± (0.15% of rdg. ± 0.05% of range) over a 40 Hz to 20 kHz bandwidth. AC and DC current

measurement range is from 10 nanoamps to two amps. The DMM, with rechargeable nickel-cadmium batteries, sells for $500. The touch-hold probe sells for $40.

MAGNETIC CB MOUNT 133

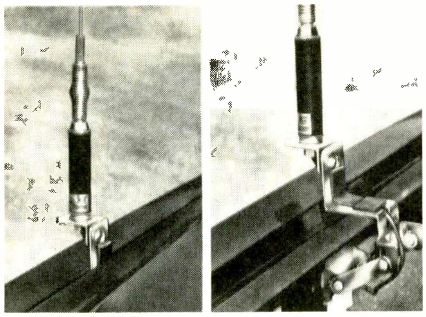
A new two-way radio mount that uses magnetic power to hold the transceiver in place has been introduced by *Cornell-Dubilier Electronics* (CDE). The new mount also provides a quick connect/disconnect system for antenna and power. Called the Easy Mount, the new device uses three powerful permanent magnets to make positive contact, assuring maximum signal transfer with perfect VSWR match. Installation is simple and gives a flush mount appearance. User has choice of dash or transmission hump



installation. Contacts are cadmium plated, main frame is molded of ABS filled high impact plastic. Magnet structure is U-channeled permanent ceramic. The mount weighs 1.25 lbs, and comes with a full year warranty.

"UNDER COVER" CB ANTENNAS 134

A new line of full-sized, 40 channel, coil-loaded whip antennas that can be



flipped down and hidden in the automobile trunk when not in use is being introduced by *Channel Master*. Base-loaded and center-loaded models are available, mounted on a heavy gauge, two-way 'under-cover' bracket, which allows the user to mount the antenna in a perfectly vertical position, regardless of the slope of the car's rear deck, and also allows the antenna to fold down into the trunk, completely out of sight. Within in the trunk, the bracket keeps the antenna suspended horizontally, out of the way of luggage. The chrome-plated bracket serves as a self-grounding base.

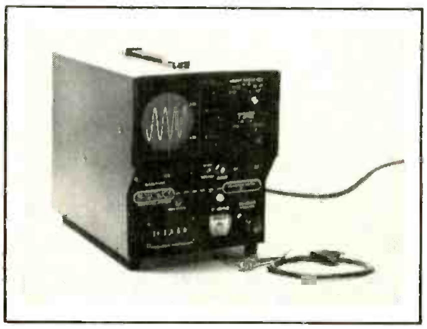
TUNER CLEANER/DEGREASER 135

A new tuner cleaner/degreaser called Big Bath has been introduced by *GC Electronics*. The new cleaner comes in a 24 oz. aerosol can that re-

leases a high pressure stream which is said to penetrate through dirt, dust and grime to protect tuners from corrosion. According to the manufacturer, Big Bath will not harm plastics, will not detune and will not cause residue build-up. Introduction of this new item includes a premium offer of a 6-piece color TV alignment kit for every 5 Big Bath labels sent in to manufacturer.

FM DEVIATION METER 136

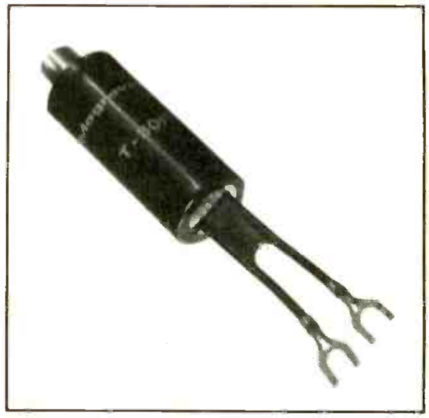
A new FM deviation meter that can double as a signal generator is now available from *Bi-Tronics*. The unit has been designed for use in repair and maintenance of VHF FM marine and VHF/UHF land mobile transceivers. Instantaneous peak deviation is measured on a graticule scale in the front



of a 3 inch cathode ray tube. This permits the wave form to be observed so that identification of distortion and hum can be visibly noted. Accurate modulation measurement is obtained. Each unit, which also functions as a monitor receiver with .0005% accuracy, includes an external uncalibrated attenuator which permits unit to be used as a signal generator. The meter is warranted, part and labor, for 90 days. Sells for less than $1100.

CB INTERFERENCE SUPPRESSOR 137

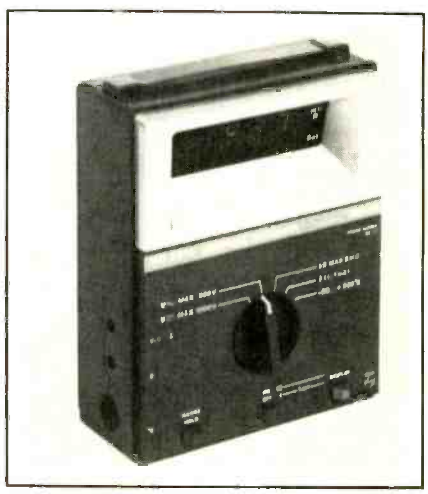
A T-30F matching transfomer with high pass filter for the suppression of interference from CB transceivers has been introduced by the *Magnavox CATV division*. Designed to block sub-low interference, the T-30F prevents signals in the 5-30 MHz range from disturbing 50 to 300 MHz TV reception. Transformer specifications in-



clude: high phase balance, low insertion loss, effective filtration and voltage blocking capacitors. The unit has a die cast metal casing and plastic cover, plus heavy-duty twin leads with soldered and crimped lugs.

AUTO-RANGING VOLT OHMMETER 138

A new 3½ digit auto-ranging volt ohmmeter with temperature measuring capability has been introduced by *Philips Test & Measuring Instruments*. The instrument incorporates an 11 mm LED display with polarity indication. Overloading is indicated by a flashing display and lead changing is eliminated since the same input sockets are used for voltage and resistance measurements. Functions are selected with a rotary switch. Automatic decimal point positioning provides maximum resolution for each measurement. Auto-ranging can be stopped at the last range in use by



means of a range hold button. This PM2514 meter also has a low battery indication separate from the numeric display, and has an optional external power supply for use off the line. Priced at $255.

QUICK-CHANGE STORE SIGNS 139

A new line of low cost, changeable message signs for retail businesses is being introduced by *Berloc Signs*. Constructed of rugged aluminum and guaranteed for 20 years, the new signs are available in assorted styles. The

baked enamel finish can include store name and emblem in choice of colors, and each sign comes with 150 unbreakable aluminum letters and numbers. Sizes range from 8 ft by 44 in. to 14 ft. by 7 ft. Signs are shipped fully assembled and ready for immediate use. Price is from $307.

REFLEX HORN SPEAKER 140

A 5½ inch reflex horn speaker for CB radios, for paging and patio use is now available from *RMS Electronics*. Constructed of heavy duty aluminum, the speaker is anodized for indoor and

outdoor use. It is rated at 8 ohms, 8 watts, and is for use on cars, trucks, vans, boats and at home. Comes complete with mounting bracket and long hook-up cable. Priced at $12.95.

AUTO AND CB SECURITY SYSTEM 141

A new anti-theft alarm system for cars that is easy and quick to install has been developed by *Harcor International*. The new "quick connect" system, Model 3001, is triggered by the

current flow that occurs when any light in the auto is turned on—such as when a car door or trunk lid is opened. Upon triggering, an integrated circuit in the unit beeps the car horn for 2½ minutes, then shuts itself off and automatically rearms itself. Solderless connectors and a simple 3-wire hookup allow installation in less than 30 minutes. By connecting a fourth wire, the unit will disable the car's ignition when the alarm switch is activated. A delay circuit allows the car owner from 7 to 10 seconds to disarm the device in case of accidental triggering. Sells at retail for $17.95.

TV INTERFERENCE FILTERS FOR CB 142

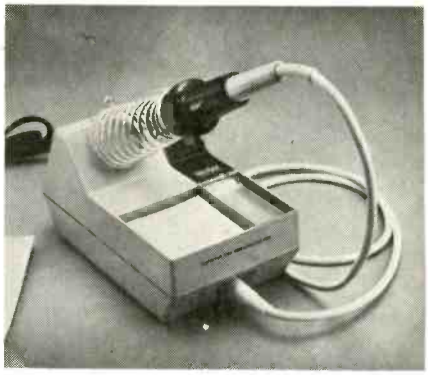
Three new interference filters that prevent CB transmissions from bothering TV reception have been introduced by *Avanti Research and Development*. The new filters are designed for interference problems at the transceiver, the TV set or the AC power line. The model AV-800 Low Pass Filter is for use when the transceiver is radiating harmonics of the same frequency assigned to one or more of the local TV channels. The model AV-811 filter is installed on the TV lead-in if the problem is at the TV

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

receiver due to so-called "front end" overloading—and model AV-820 AC line filter is for interference caused by transmission of the CB signal through the AC power lines.

SOLDERING STATION 143

A new controlled output soldering station has been introduced by *Weller*. The new model, WTCPN, is a transformer-powered unit complete with a low voltage, temperature controlled soldering pencil with heat shield. The unit features a "closed loop" method of controlling maximum tip temperature, protecting heat-



sensitive components while the ground tip protects voltage and current-sensitive parts. It utilizes an assortment of 17 types of replacement tips, each available in 600°, 700° and 800° F, heavily iron plated with an anti-oxidation coating.

UPCOMING IN THE JANUARY ISSUE OF ET/D:

- TV Warranty Servicing: Profit Source Or Necessary Evil?
- Professional Audio Tests & Measurements
- Noise Sources In Auto Electronics
- Annual Subject Reference Index

EDITOR'S MEMO

continued from page 1

responsibility for the technical performance of the transmitting equipment he installs and/or services, his only real motivation for insuring that it adheres to FCC performance criteria is the possibility of loss of the business of a customer who has been cited (and perhaps fined) by the FCC for equipment performance violations.

However, failure of a transmitting system to meet FCC performance criteria can be, and often is, caused by 'normal' degradation resulting from 'normal' use or from abuse or illegal modification or misadjustment by the operator. Therefore, the technician's legal responsibility should be limited to insuring that the equipment meets FCC performance criteria at the time he completes the installation and/or servicing of it and 'returns' it to the owner.

In my opinion, this 'shared but divided' method of assigning equipment performance responsibility to both the owner and the servicing technician is the most realistic approach to effective enforcement of transmitter performance criteria.

SERVICE TECHNICIAN LICENSING —So long as transmitting equipment must meet specific performance criteria established and enforced by the FCC, with legal responsibility for meeting such criteria assigned to the owner and/or service technician, and so long as there exists the possibility that such performance criteria can be adversely affected by installation and/or servicing, in my opinion, there will continue to exist the need for some method of evaluating and 'certifying' the competency of technicians who wish to undertake the installation and servicing of transmitting equipment.

However, I believe that the 'all-encompassing' type of Radiotelephone licenses and related exams presently administered by the FCC are unrealistic, principally because, on the one hand, they require some areas of knowledge which are not relevant to the servicing of particular types or classes of equipment and yet, on the other hand, they fail to adequately evaluate some areas which are relevant.

The 'basic operator/technician' license with class-of-equipment options, as proposed by the Commission in its Notice of Inquiry, in my opinion, would be much more realistic for everyone concerned—equipment owners, service technicians and the FCC. ■

J. W. Phipps

DEFIBRILLATOR

continued from page 30

ered energy, which should not be less than 70% of the stored energy found by static testing of the capacitor voltage.

There are a number of suitable defibrillator testers on the market today, but I do not recommend the use of the simple flashing lamp type of tester, as I feel they give false indications.

The best way to test a defibrillator is to use a tester with an oscilloscope waveform jack and an oscilloscope equipped with a camera. If you don't have a scope with a camera, it is possible to accomplish much the same thing with a relatively low-cost hand-held Polaroid CR9A. Typical waveform photographs taken with a hand-held Polaroid are shown in Figs. 7 and 8. The waveform in Fig. 7 is normal, and that in Fig. 8 shows a defibrillator with an impending HV relay failure. The condition is serious enough to warrant replacement of the relay, but allows time for parts ordering before becoming critical. This machine passed the test using only a defibrillator tester but failed when the expanding scale waveform was viewed on an oscilloscope.

IN SUMMARY

To give you some idea of what service work you're liable to run into when servicing defibrillators, here is an excerpt from the author's repair log on defibrillators for one major East coast hospital. It shows 29 defibrillator failures in an 18 month period.

They break down as follows:

- 13 open 'patient cables'
- 2 bad HV vacuum relays
- 6 bad LV control relays
- 8 miscellaneous problems

Obviously, from the above log, a defibrillator serviceman should carry with him an ohmmeter to check patient cable continuity, a HV relay, a collection of common small relays, and that bleeder resistor mentioned earlier.

Servicing defibrillators can be a relatively easy job—and there is a real need for this service. Most hospital people become a little nervous if their defibrillator equipment is out of service. They will probably be happy to know that a responsive and responsible local servicer is available to handle repairs.

Be aware, however, that few markets are as critical as the medical market. You can ruin all opportunities if you find yourself offering excuses in place of good service. Try offering the old "awaiting parts" story to a coronary care unit head nurse and you will find out fast how critical the business really is. ■

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WANTED: PICTURE TUBE REBUILDING EQUIPMENT in good working condition. Call or write, Atoll TV, 6425 W. Irving Park, Chicago, IL 60634. (312) 545-6667, between 1PM-8PM. 1/77

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ELECTRONIC TECHNICIAN/DEALER TEKFAX

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

GROUP **292**

SCHEMATIC NO.		SCHEMATIC NO.	
GENERAL ELECTRIC VIR Module (Employed in some color TV models equipped with YM and YC-2 TV chassis)	1670	RCA B/W TV Chassis KCS201T/U	1674
QUASAR Color TV Chassis TS-958	1671	ZENITH Color TV Chassis 23HC45	1673
QUASAR Color TV Chassis TS-959	1672		

1670

G.E.
VIR Module
(YM & YC-2 Color TV Chassis)

DECEMBER • 1976

ADJUSTMENTS
(Set Must Be Receiving a VIR Signal)

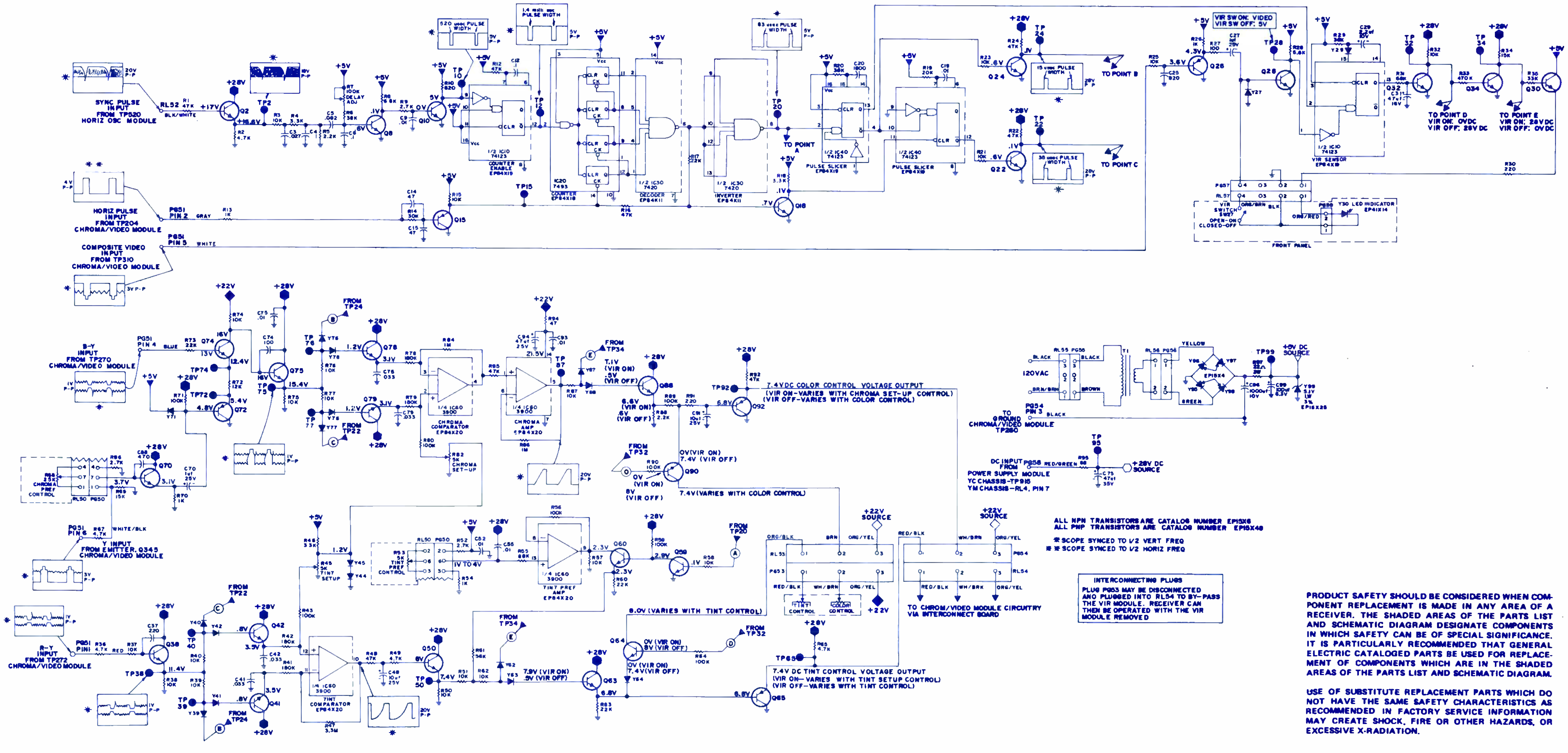
COLOR PREFERENCE – With the VIR SWITCH ON, adjust the COLOR PREFERENCE CONTROL for desired color amplitude.

TINT PREFERENCE – With the VIR SWITCH ON, adjust the TINT PREFERENCE CONTROL for desired color fleshtones.

COLOR SET UP (R82) – (NORMALLY FACTORY PRE-SET.) With the VIR SWITCH ON and COLOR PREFERENCE set to mid-range adjust for desired color amplitude.
NOTE: If set too high chroma level will not track properly with Custom Picture Control.

TINT SET UP (R45) – (NORMALLY FACTORY PRE-SET.) With the VIR SWITCH ON and TINT PREFERENCE set to midrange adjust for desired color fleshtones.

DELAY (R7) – NORMALLY FACTORY PRE-SET.) With the VIR SWITCH ON, set the DELAY ADJUSTMENT to midrange position, "rock" the control around the center position until proper automatic operation is achieved.



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

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

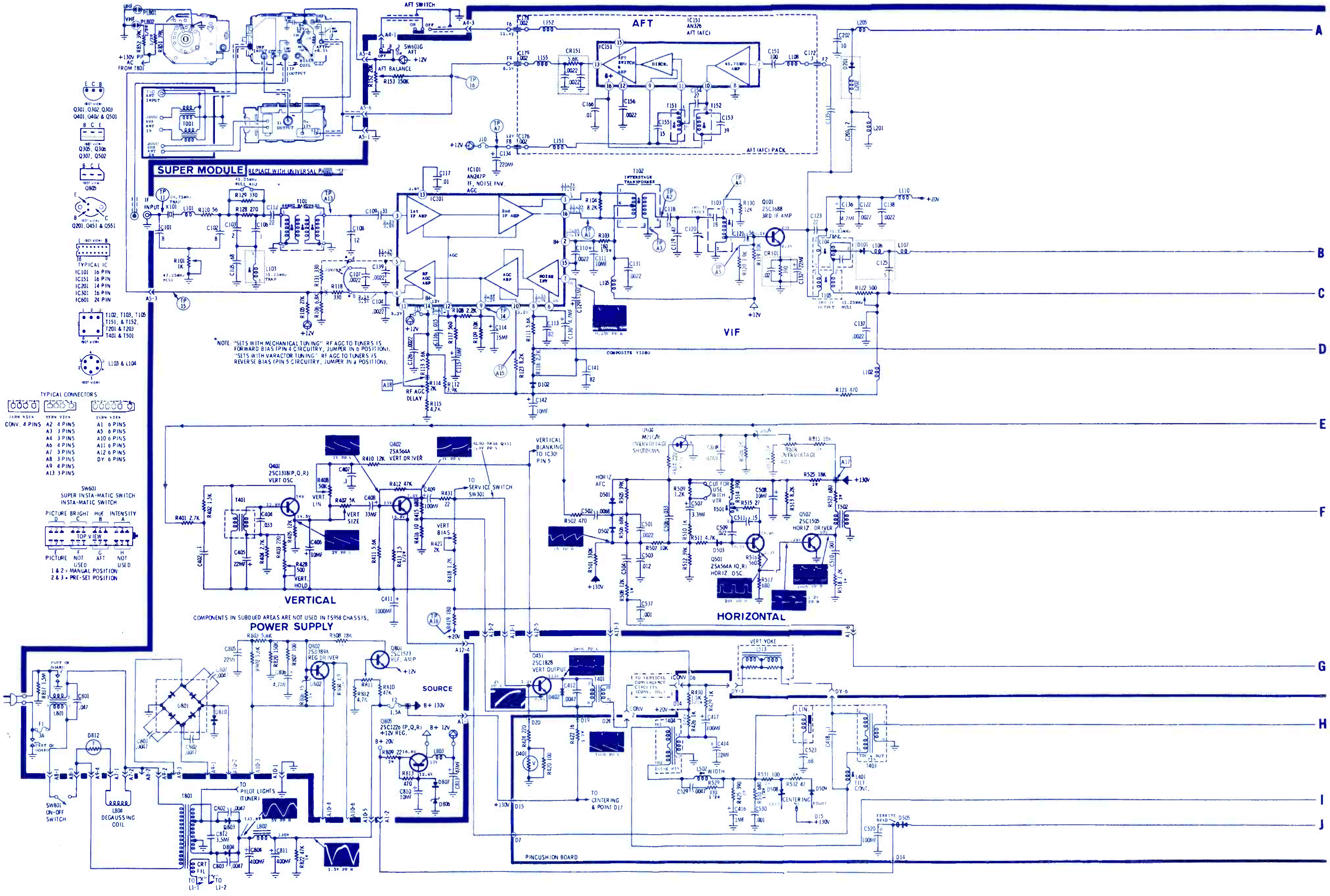
1671

QUASAR
Color TV Chassis
TS-958

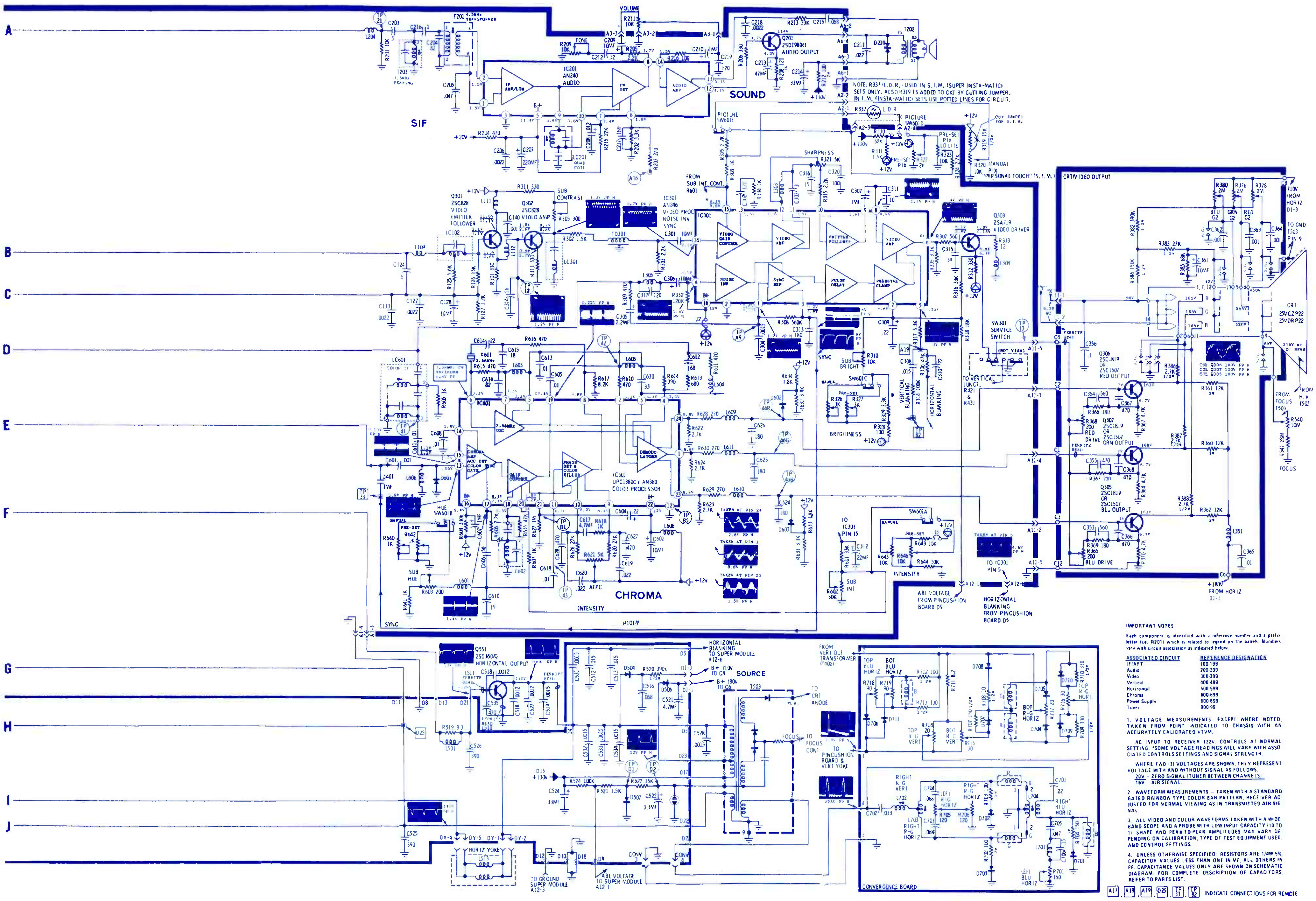
ELECTRONIC TECHNICIAN/DEALER TEKFAX

DECEMBER • 1976

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



QUASAR
Color TV Chassis
TS-958



IMPORTANT NOTES

Each component is identified with a reference number and a prefix letter (i.e. R201) which is related to legend on the panels. Numbers vary with circuit association as indicated below.

ASSOCIATED CIRCUIT	REFERENCE DESIGNATION
IF/AFT	100 199
Audio	200-299
Video	300-399
Vertical	400 499
Horizontal	500 599
Chroma	600 699
Power Supply	800 899
Tuner	000 99

1. VOLTAGE MEASUREMENTS, EXCEPT WHERE NOTED, TAKEN FROM POINT INDICATED TO CHASSIS WITH AN ACCURATELY CALIBRATED VTVM.

AC INPUT TO RECEIVER 122V. CONTROLS AT NORMAL SETTING. *SOME VOLTAGE READINGS WILL VARY WITH ASSOCIATED CONTROLS SETTINGS AND SIGNAL STRENGTH.

WHERE TWO (2) VOLTAGES ARE SHOWN, THEY REPRESENT VOLTAGE WITH AND WITHOUT SIGNAL AS FOLLOWS:
20V – ZERO SIGNAL (TUNER BETWEEN CHANNELS).
16V – AIR SIGNAL.

2. WAVEFORM MEASUREMENTS – TAKEN WITH A STANDARD GATED RAINBOW TYPE COLOR BAR PATTERN. RECEIVER ADJUSTED FOR NORMAL VIEWING AS IN TRANSMITTED AIR SIGNAL.

3. ALL VIDEO AND COLOR WAVEFORMS TAKEN WITH A WIDE BAND SCOPE AND A PROBE WITH LOW INPUT CAPACITY (10 TO 1). SHAPE AND PEAK TO PEAK AMPLITUDES MAY VARY DEPENDING ON CALIBRATION, TYPE OF TEST EQUIPMENT USED, AND CONTROL SETTINGS.

4. UNLESS OTHERWISE SPECIFIED: RESISTORS ARE 1/4W 5%. CAPACITOR VALUES LESS THAN ONE IN MF, ALL OTHERS IN PF. CAPACITANCE VALUES ONLY ARE SHOWN ON SCHEMATIC DIAGRAM. FOR COMPLETE DESCRIPTION OF CAPACITORS, REFER TO PARTS LIST.

A17, A18, A19, D25, TP 33, TP 82 INDICATE CONNECTIONS FOR REMOTE

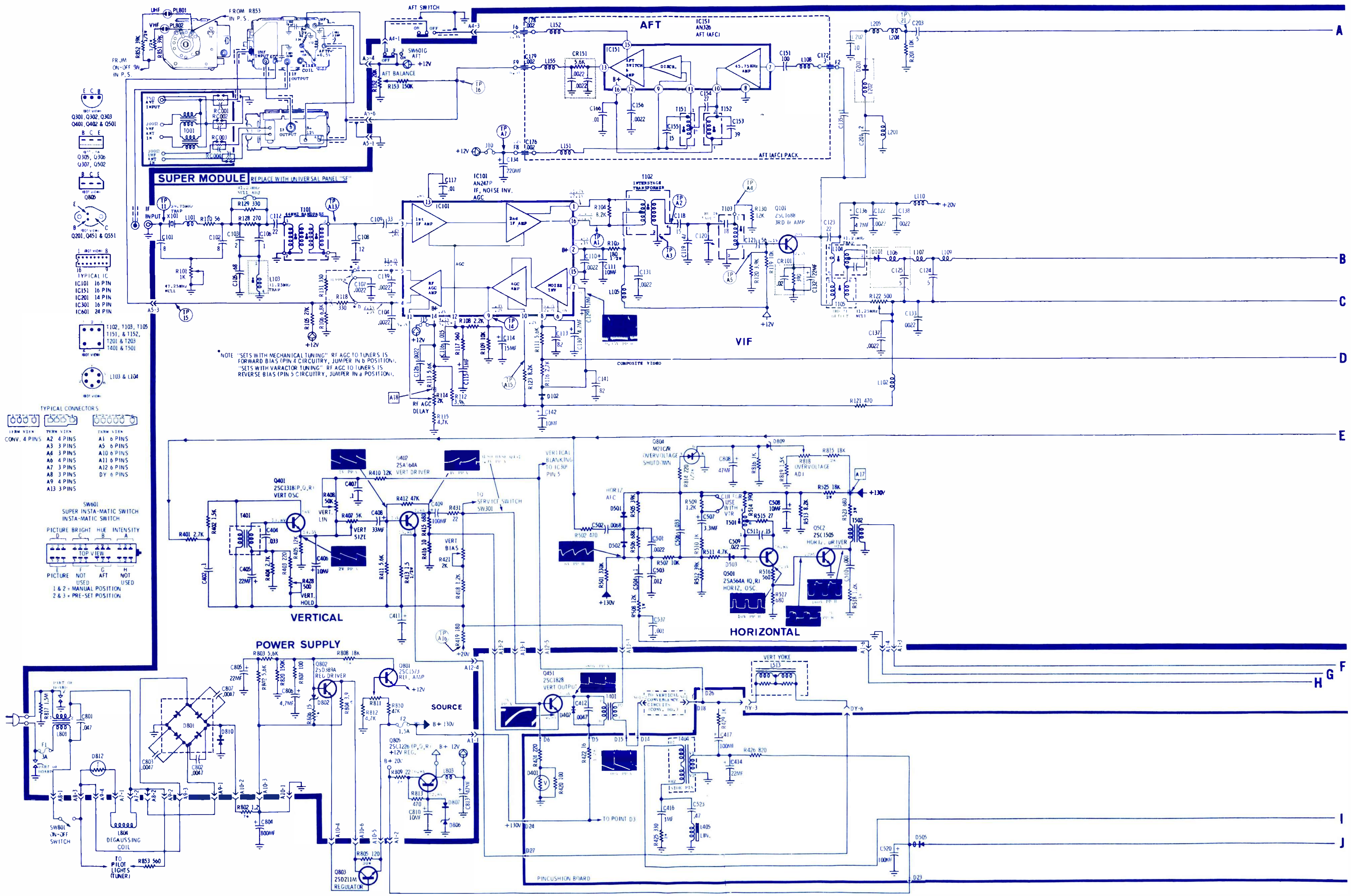
1672

QUASAR
Color TV Chassis
TS-959

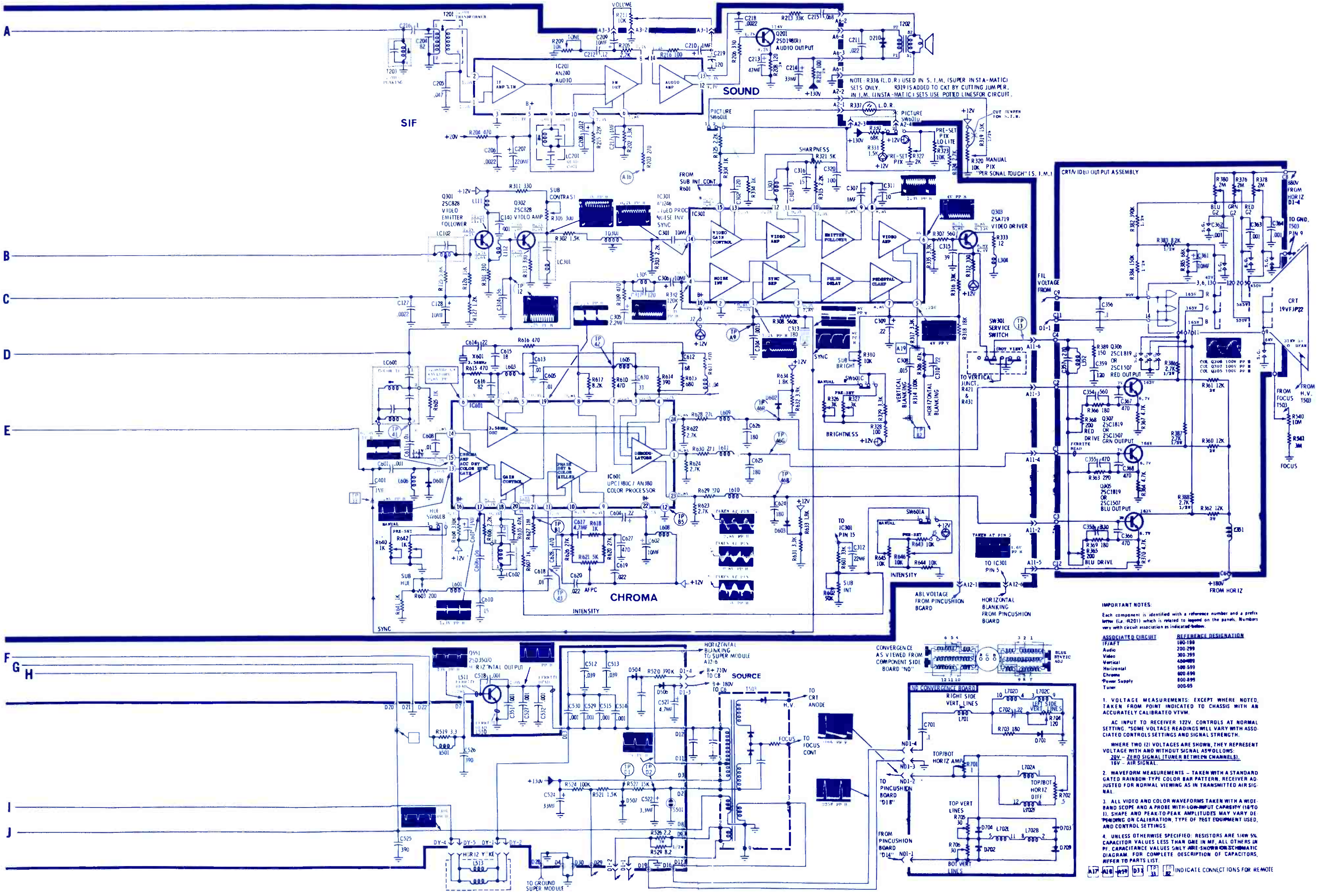
ELECTRONIC TECHNICIAN/DEALER TEKFAX

DECEMBER • 1976

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



QUASAR
Color TV Chassis
TS-959



IMPORTANT NOTES:

Each component is identified with a reference number and a prefix letter (i.e. R201) which is related to legend on the panels. Numbers vary with circuit association as indicated below.

ASSOCIATED CIRCUIT	REFERENCE DESIGNATION
IF/AFT	100-199
Audio	200-299
Video	300-399
Vertical	400-499
Horizontal	500-599
Chroma	600-699
Power Supply	800-899
Tuner	000-99

1. VOLTAGE MEASUREMENTS: EXCEPT WHERE NOTED, TAKEN FROM POINT INDICATED TO CHASSIS WITH AN ACCURATELY CALIBRATED VTVM.

AC INPUT TO RECEIVER 122V. CONTROLS AT NORMAL SETTING. *SOME VOLTAGE READINGS WILL VARY WITH ASSOCIATED CONTROLS SETTINGS AND SIGNAL STRENGTH.

WHERE TWO (2) VOLTAGES ARE SHOWN, THEY REPRESENT VOLTAGE WITH AND WITHOUT SIGNAL AS FOLLOWS:
20V – ZERO SIGNAL (TUNER BETWEEN CHANNELS).
16V – AIR SIGNAL.

2. WAVEFORM MEASUREMENTS – TAKEN WITH A STANDARD GATED RAINBOW-TYPE COLOR BAR PATTERN. RECEIVER ADJUSTED FOR NORMAL VIEWING AS IN TRANSMITTED AIR SIGNAL.

3. ALL VIDEO AND COLOR WAVEFORMS TAKEN WITH A WIDE-BAND SCOPE AND A PROBE WITH LOW INPUT CAPACITY (10 TO 1). SHAPE AND PEAK-TO-PEAK AMPLITUDES MAY VARY DEPENDING ON CALIBRATION, TYPE OF TEST EQUIPMENT USED, AND CONTROL SETTINGS.

4. UNLESS OTHERWISE SPECIFIED: RESISTORS ARE 1/4W 5%. CAPACITOR VALUES LESS THAN ONE IN MF, ALL OTHERS IN PF. CAPACITANCE VALUES ONLY ARE SHOWN ON SCHEMATIC DIAGRAM. FOR COMPLETE DESCRIPTION OF CAPACITORS, REFER TO PARTS LIST.

A17 A18 A19 D33 TP 33 TP 82 INDICATE CONNECTIONS FOR REMOTE

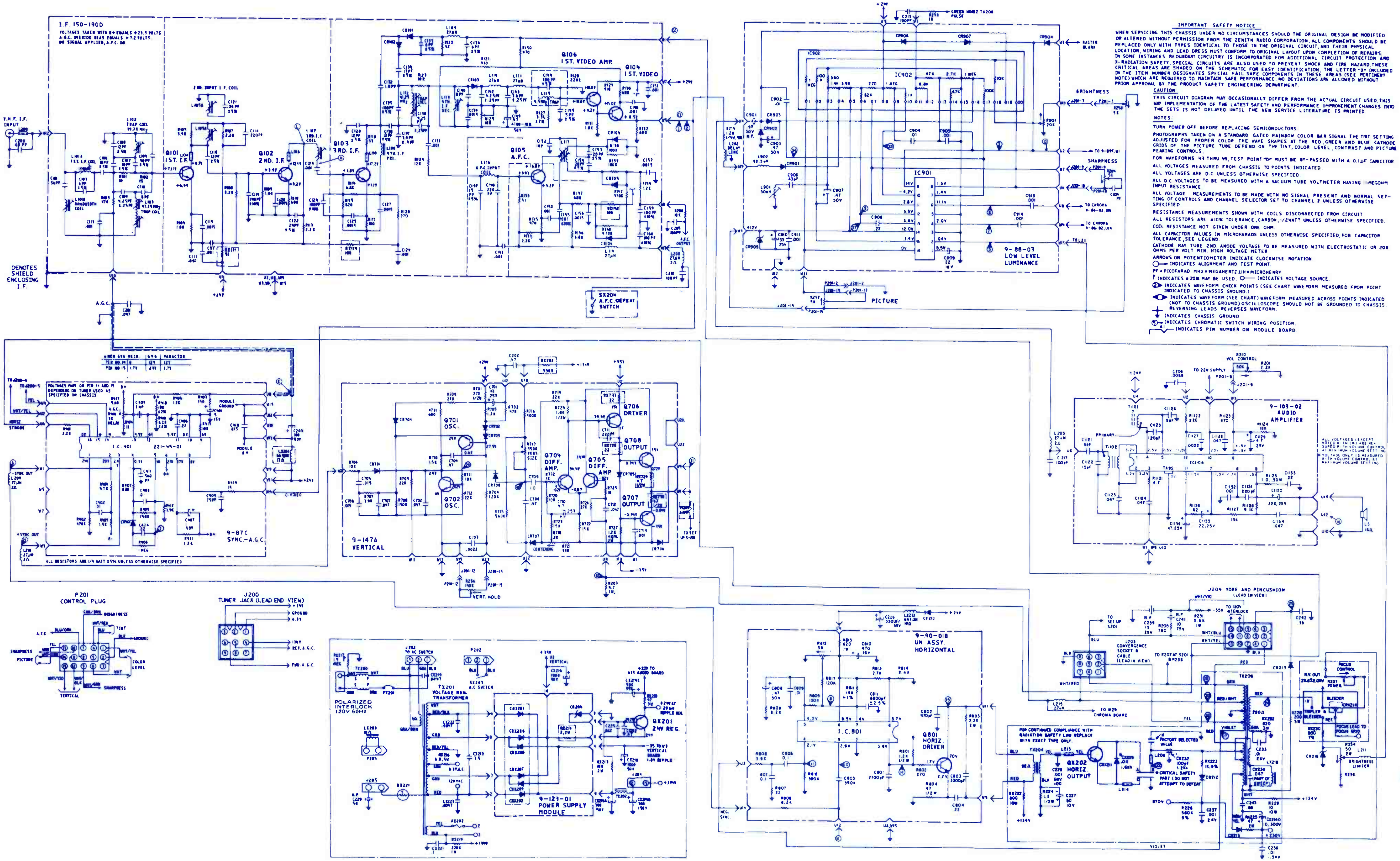
1673

ZENITH
Color TV Chassis
23HC45

DECEMBER • 1976

ELECTRONIC TECHNICIAN/DEALER TEKFAX

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



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

CAUTION:

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

NOTES:

TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS

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

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

ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.

ALL VOLTAGES ARE D.C UNLESS OTHERWISE SPECIFIED.

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

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

RESISTANCE MEASUREMENTS SHOWN WITH COILS DISCONNECTED FROM CIRCUIT

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

COIL RESISTANCE NOT GIVEN UNDER ONE OHM.

ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED, FOR CAPACITOR TOLERANCE, SEE LEGEND.

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

ARROWS ON POTENTIOMETER INDICATE CLOCKWISE ROTATION.

○— INDICATES ALIGNMENT AND TEST POINT.

PF = PICOFARAD MHz = MEGAHERTZ µH = MICROHENRY

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

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

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

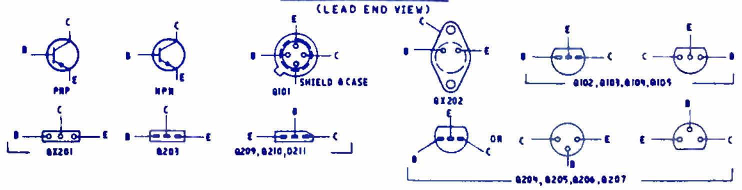
INDICATES CHASSIS GROUND

INDICATES CHROMATIC SWITCH WIRING POSITION.

INDICATES PIN NUMBER ON MODULE BOARD.

ZENITH
Color TV Chassis
23HC45

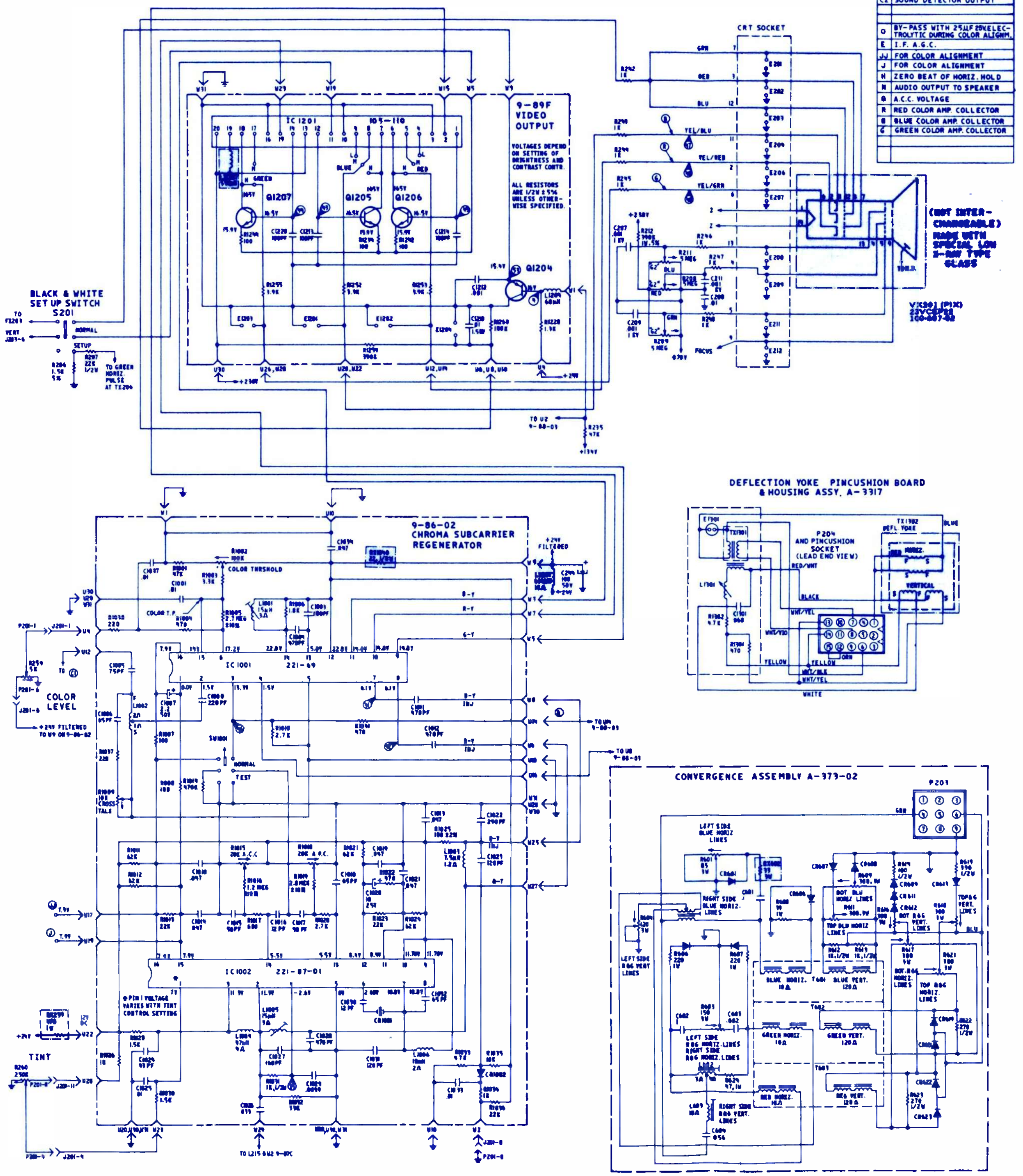
BASING OF TRANSISTORS (LEAD END VIEW)

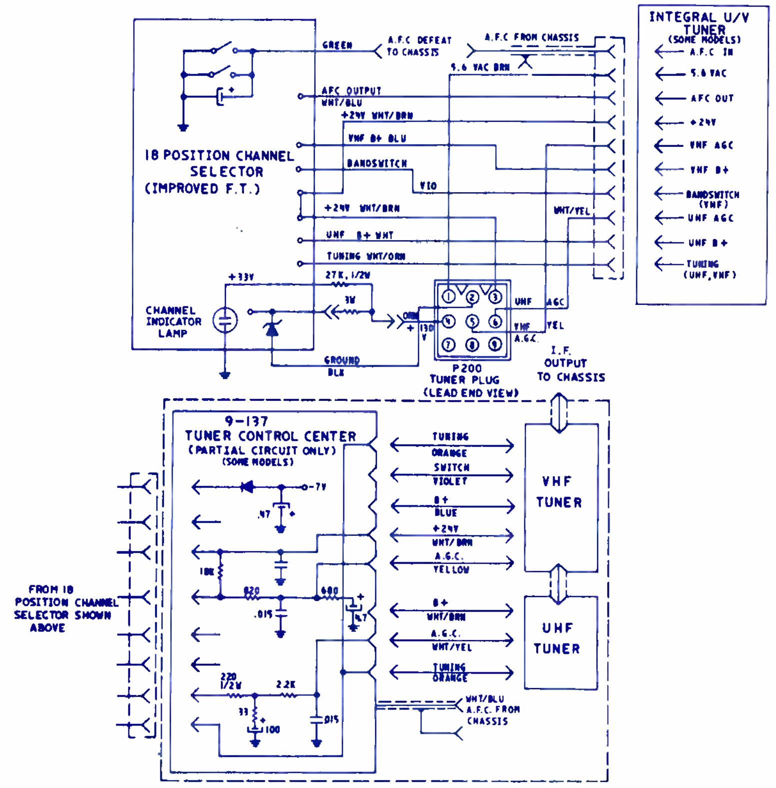


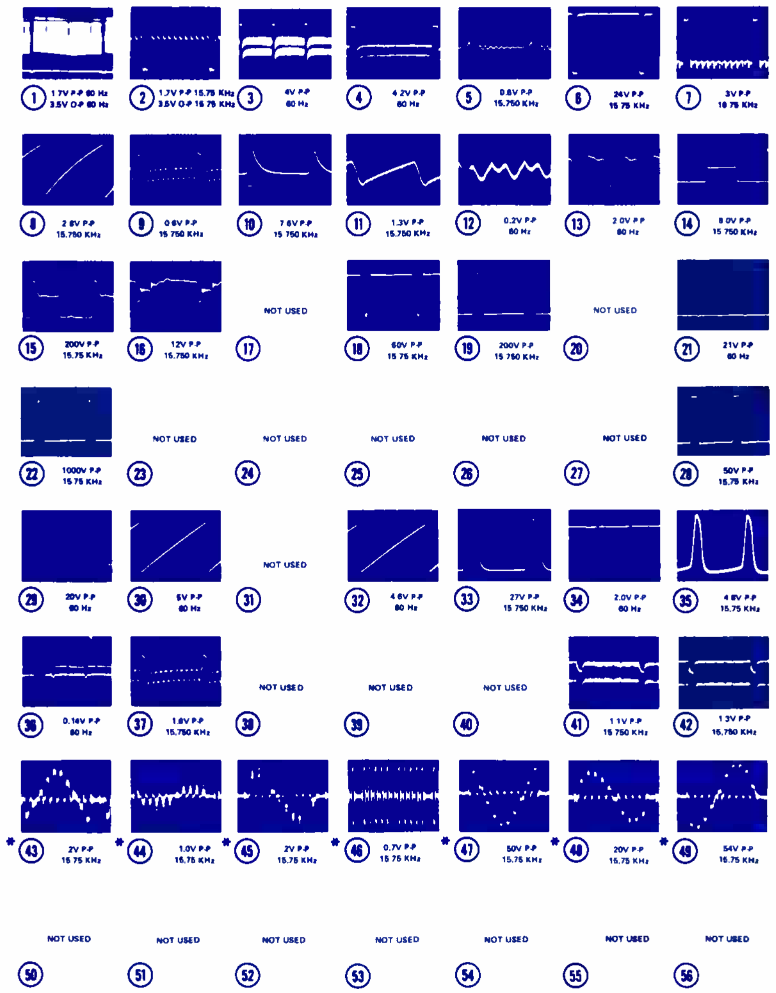
MODULES

MODULES USED	ALTERNATES	DESCRIPTION
9-86-02		CHROMA
9-87C	9-87, -87A	AGC
9-88-03		LOW LEVEL LUM
9-89F	9-89E, -89-01C	VIDEO OUTPUT
9-90-01B		HORIZ
9-147A	9-147, -92B, -92C	VERT
9-103-01		AUDIO
9-123-01		POWER SUPPLY
9-126-01		ZOOM
150-190D	150-190C	VIDEO I.F.

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







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

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RCA
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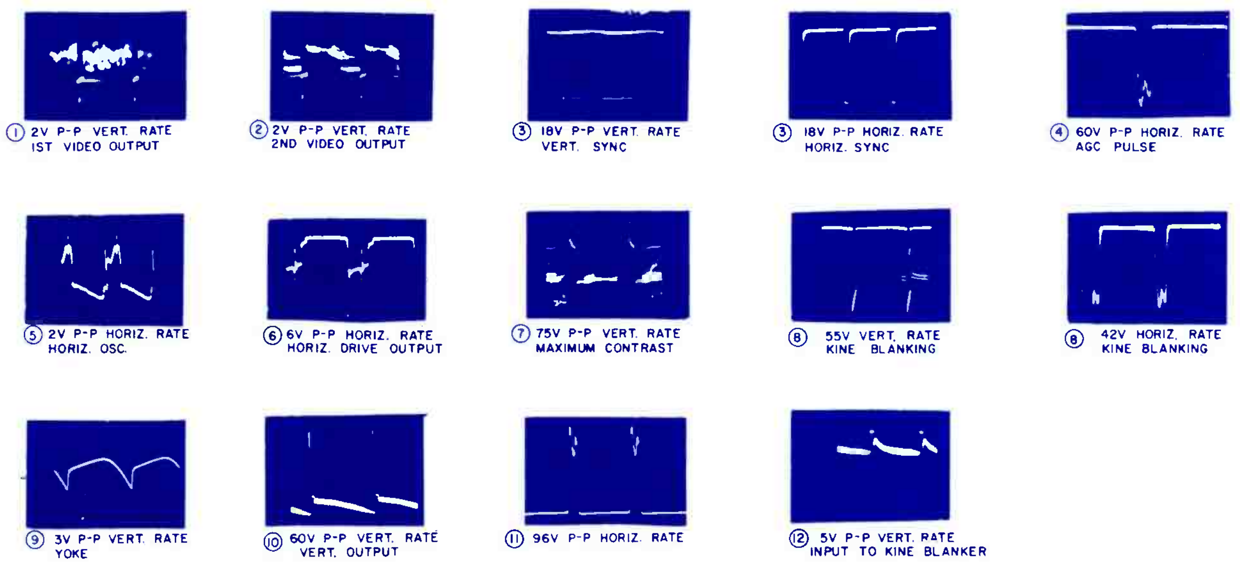
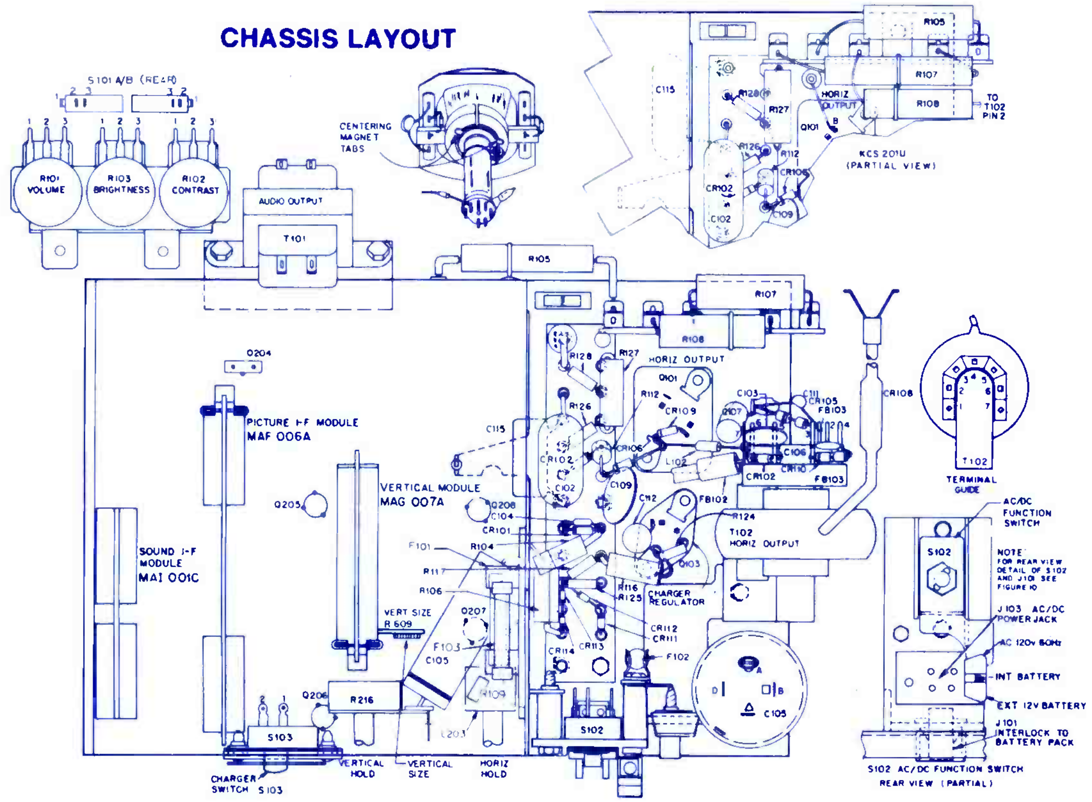
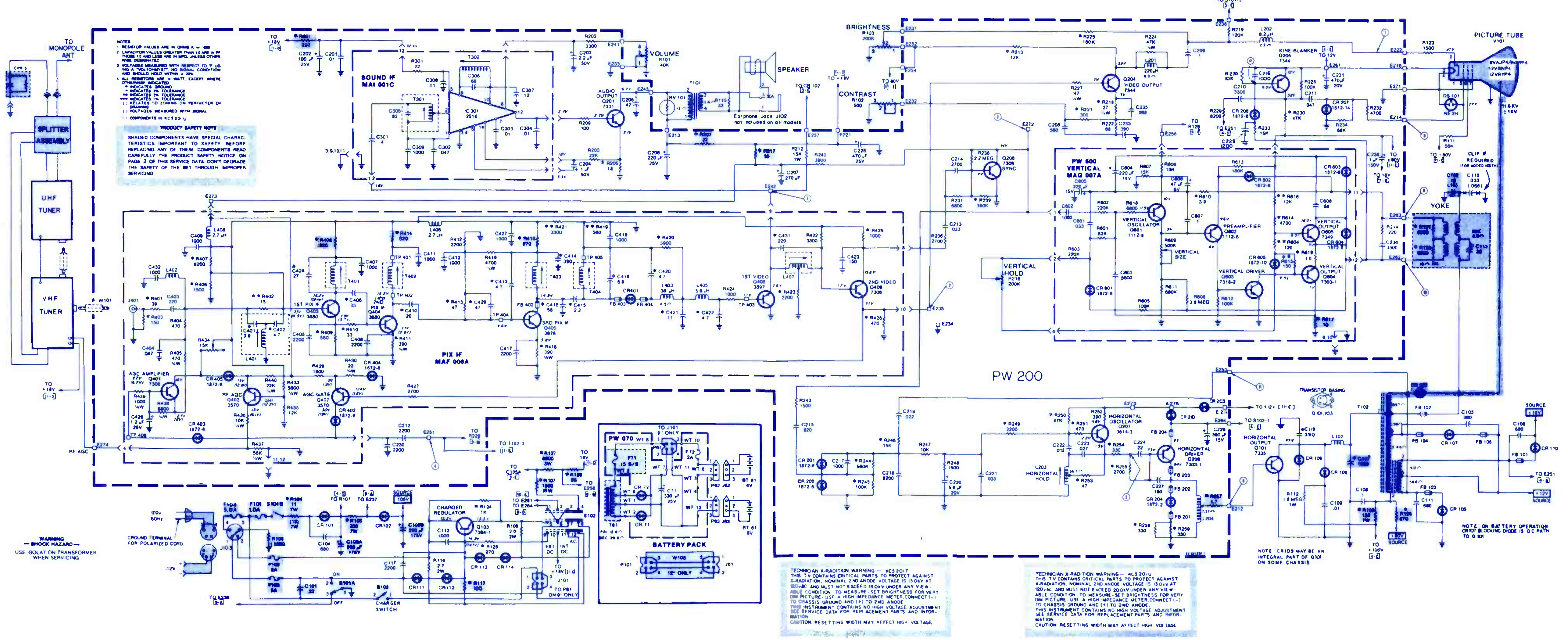


CHASSIS LAYOUT





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