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...for more details circle 102 on Reader Service Card

LETTERS

AN OVERLOOKED ADVANTAGE OF WARRANTY SERVICING

I've read your editorial and the article about TV warranty servicing in the January 1977 issue of ET/D (What Servicers Say About TV Warranty Servicing') and want to congratulate the ET/D editorial staff for throwing some badly needed light on a subject which for a long time has needed this type of exposure.

However, there is one advantage of warranty servicing which was not mentioned in the article: the 'you scratch my back and I'll scratch yours' relationship which can and frequently does evolve between the warranty servicer and distributor and factory service people.

The resultant exchange of technical information helps all parties involved, and has proven more valuable to me than the gross income I've received from in-warranty servicing.

Consequently, I'll knowingly undertake a money-losing in-warranty service problem for any of my distributor service manager friends because I know that they in turn will help me with any difficult-to-diagnose servicing problem which I might encounter—regardless of whether it is an in- or out-of-warranty situation.

Bob Baker, CET
Bob's TV Service
Billings, Montana

BEFORE TACKLING DEFIBRILLATOR SERVICING

I would like to point out that servicing defibrillators is not as simple as Mr. Carr would have us believe ('Intro To Defibrillator Servicing, by Joseph J. Carr, December 1976 ET/D).

The simplified schematics in the article do provide a basic understanding of how a defibrillator operates, but will be virtually useless to a repairman confronted with an actual unit. The designs of defibrillators vary from one manufacturer to another....

Schematics and service manuals help alleviate this problem, but few hospitals have this type of information, and most defibrillator manufacturers are hesitant about sending such information to 'just anyone.'

Another point that should be brought out is the legal aspect of repairing medical electronic equipment...the technician who repairs any piece of medical equipment in most cases is then legally liable for the performance of that equipment.

The technician must keep in mind that: 1) he is dealing with emergency resuscitation equipment, 2) people's lives depend on the equipment to operate properly and efficiently, 3) he may not be able to obtain the information necessary to repair such equipment, and 4) he can be held legally responsible for the operation of the equipment.

I suggest to any technician who is interested in entering the medical electronics field that he first obtain the necessary training before offering his services to any health care institution. After all, he'll not only be dealing with sophisticated equipment, he'll also be dealing with human lives.

Jerry L. Painter, President
Central Iowa Biomedical Electronics Society
Iowa Lutheran Hospital
Des Moines, Iowa

EXTENDED PARTS WARRANTIES FURTHER DECREASE SERVICERS' DWINDLING PARTS INCOME

In the article about TV servicers' attitudes toward warranty servicing in the January 1977 issue, you forgot to ask the surveyed servicers how they feel about the long warranty periods manufacturers have applied to parts such as CRTs and modules...

Most TV parts warranties are so long that by the time the warranty expires it is time for the owner to buy a new set...

Two manufacturers for whom I have done warranty servicing recently sent me the 'good news' that they now provide 'lifetime' warranties on their products. (Does this mean that I will have to wait until the customer dies before I can service his or her set on an out-of-warranty basis? If so, how do I contact them in heaven or hell to offer out-of-warranty service on their sets?)

I have given up all in-warranty servicing because, for example, I can't afford to repair a stereo for a service labor charge of $9.50-$12.50, including removing the defective parts and mailing them back to the manufacturer, who hopefully will send me a 'genuine replacement part' in return.

Jim Covoserio
Rainbow TV Service
Richmond Hill, NY

WANTED: YOUR COMMENTS & OPINIONS..

We at ET/D invite you to share with other ET/D readers your comments and opinions about controversial issues and/or business-related problems confronting the electronic service industry. Send them to:
LETTERS TO THE EDITOR, ET/D, 1 East First St., Duluth, MN 55802. (Only signed letters will be considered for publication.)

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THE COVER: The photo is of a typical electronic servicer using a field-strength meter to check TV antenna system performance. Twenty ways to use an FSM are described in the article which begins on Page 20.

DEPARTMENTS

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NEWS OF THE INDUSTRY

Punctuality On TV Repairs Is Major Goal of New RCA Consumer Program

The RCA Service Company has launched a nationwide program to make certain that TV repair service is provided on the day agreed to with the customer. The new consumer program was announced by Sigmund Schotz, vice president, consumer affairs, of RCA. "When we make a date to visit a customer's home, we'll keep that date," Schotz said. "If we fail to keep it, the customer will pay no labor charge."

"We know there are few things more frustrating than waiting around for a repairman who never shows up," he added. "We decided that the surest way to keep this from happening would be to penalize ourselves by not making a labor charge if we miss an appointment."

The campaign involves over 2,500 technicians at 164 RCA branches nationwide, and includes service on RCA television sets and other home entertainment products, as well as Whirlpool appliances.

RCA Enters the Video Game Field

National distribution of a home TV programmer, called "Studio II", by RCA will begin about the middle of 1977. The new product can be programmed to reproduce games and instructional material on the screen of any size black-and-white or color TV set.

The new RCA unit has five games built into its control console and includes a provision for add-on cartridges. The five programs built into the console are: bowling, freeway, patterns, doodles and a competitive math game. The first cartridges offered will be in three series: TV School House, TV Arcade and TV Casino.

Admiral To Drop Out As U.S. TV Manufacturer

According to *TV Digest*, Admiral TV will "rely on the Taiwan plant for the manufacture of their portable and color console chassis in 1977," and will restrict "operations at their Harvard, Ill. plant to the mating of imported chassis with U.S.-made cabinets and picture tubes."

FCC To Allow Eased Radiation Standards For Remanufactured 23-channel CB

The 23-channel CB radios turned in to manufacturers for conversion to 40-channel models during 1977 will be permitted chassis radiation as high as 50 mv, instead of the standard emission limit of 5 mv. The easing of radiation standards was a partial answer to a petition from the Electronic Industries Association (EIA) for action to prevent the dumping of 23-channel models this spring.

The relaxing of radiation standards, however, does not apply to new 40-channel units to come onto the market during the year, or 23-channel models not capable of remanufacture to 40-channel operation.

NEDA Electronic Distributor Firms Show 90 % Sales Growth

In an analysis report for the membership of the National Electronic Distributors Association (NEDA), member firms showed a 90% growth over the past four-year period and an increase of 11.23% during the last fiscal year.

Gene Chaiken, chairman of NEDA's report committee, pointed out that "NEDA firms showed the 90% growth versus 82% for all electronic parts and equipment wholesalers as reported by the Bureau of the Census."

In the NEDA report, firms are classified by size, location and product category emphasis (General line/industrial, OEM/MRO, dealer service). "The 82 firms submitting data for the report represent a good cross section of all classifications," according to Chaiken.

Switchcraft Is Bought By Raytheon

The acquisition of Switchcraft, Inc., Chicago, has been completed by the Raytheon Company. Switchcraft, whose sales were $27 million in 1976, will be operated as a wholly-owned subsidiary of Raytheon. It is the manufacturer of switches, jacks, plugs, audio connectors and related equipment.

NESDA Service Management Schools Will Coincide With CB Training Workshops

An agreement has been reached between the National Electronic Service Dealers Association (NESDA) and Forest Belt, sponsor of the CB Training Workshops program, to offer NESDA's Profitable Service Management Schools immediately preceeding each of the 12 week-long CB service training workshops to be held around the country. (See 'The CB School Bells Are Ringing'; News of Industry, Jan. ET/D.)

Cost of the 1-day PSM School, to be conducted on Sundays, will be $20 to CB Training

A message from RCA Consumer Electronics

No. 1 in a series

"There is no excuse for discourteous service to a customer. They are the only reason for us to be in business."

"A lot of people in the service industry visit our place. I like sharing ideas; it makes the industry stronger as a whole."

"The flexibility of our routing system means we can handle two or three extra calls a day per man. We increase gross revenue and save mileage."

"We don't just have a repair shop; we have a service system."

John Sperry, Sperry TV, Lincoln, Nebraska.

"We don't view our relationship with customers as 'us' vs. 'them'; we both want the same thing. Their satisfaction with our work. We want them to remember us if they need service again." That philosophy has contributed a lot to the growth of Sperry TV in Lincoln, Nebraska. Management is so progressive that they've become a model for others in the industry.

Sperry TV is a large operation with 35 employees, 25 of whom are technicians, operating in facilities that cover 8,400 square feet. Eleven radio equipped trucks carry the Sperry logo in and around Lincoln. A good first impression is created when carry-in customers are met by skilled, concerned personnel.

Organization is the key to Sperry's success. He has worked out a detailed and highly efficient routing system. It is very flexible to meet changing schedule demands. At the heart of the system is the Job Control Center which handles incoming calls, radio traffic, counter traffic, routing and dispatching service orders to the trucks in their zoned areas.

Operations Manager Norman Foreman (standing right) oversees the Work Control Center with rotating board which gives each member of the call duty crew ready access to the job cards.

All service requests begin as information on a special service tag bearing the customer's name, address, make of set and service request. Each card is processed in the customer history file for warranty information, service of a repetitious nature and credit information.

The card is then routed to the dispatch board by area and time specified when the call is to be made. Field techs can check their next-day work schedule at a glance. Shop repairs are made on a pre-date system. The customer is given a completion date and called if the date can't be met for any reason. Once repairs are completed an invoice is filled out and the work order is scheduled for delivery or recorded alphabetically for over-the-counter pickup. Rotary-file trays place service history records at the fingertips of technicians and scheduling people.

The television service area is divided into five work areas including an overhead test console, up and out of the way. The idea is to move the equipment to the set rather than the set to the equipment. It's a real time saver. In addition, there are three individual radio service sections.

Sperry's trucks have been carefully organized for efficiency, neatness, and each carries a complete range of parts and test equipment.

Training includes technical matters, customer relations, personal dress, attitude, truck preparedness and paperwork.

Sperry developed a standardized pricing system and has published a book including flat rate schedules covering each step of a repair on a hourly charge basis. His technicians have been using the system for five years and agree that it makes their job easier. For your copy write: Sperry Tech, Inc., P.O. Box 5234, Lincoln, NE 68505.

Sperry travels extensively to promote his system and discuss it with other servicers. "I don't believe that by helping someone else I'll be creating competition. In fact, anything I can do to improve the industry will make business better for me as well as my competition," he stated. "I conduct perpetual studies about my business; every bit of information I collect is used to make my business more efficient and profitable.

"Our plans for the future include expanded facilities, computerized recording of service data and a video readout system linked to the computer downtown." The key to Sperry's success is his attitude. His mind is always working on new concepts, new methods, new equipment—all geared to making the service industry better.

Service Manager Robert Tigeris (left) telephones to order a part while Technician Norval Huff checks a TV chassis at one of their specially-designed moveable service consoles.

RCA

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

Better Service Through Better Communications

...for more details circle 125 on Reader Service Card

Workshop attendees, and $30 to others.

The announcement was made by Dick Glass, NESDA executive vice president, who said, "Hundreds of good servicers have failed in business because of their lack of management ability. The PSM Schools have helped thousands of service dealers gain the necessary management skills to operate a successful business."

For further information contact: NESDA, 1715 Expo Lane, Indianapolis, Indiana 46224

TV Set Sales—Color & B&W—Expected To Improve Very, Very Slightly

Two forecasts of what 1977 will produce in TV set sales—both close to each other—indicate that there won't be much difference between 1976 and 1977. The first forecast is one from the TV industry itself. It calls for color sales to dealer in 1977 of 8.05 million and black & white sales of 5 million. (See EIA figures for the end of 1976 below)

The second forecast is one made by *TV Digest*, calling for 8.25 million new color sets and 5.2 million black & whites. Other parts of the *TV Digest* 1977 forecast include: "Color TV prices will rise slightly as cost pressures continue"; "It seems more likely than not that Sony will buy former Westinghouse picture tube plant"; and "At least one more TV maker will follow GE into VIR-controlled color, and there'll be more emphasis on digital tuning."

The Second Sony Plant At Dothan, Alabama Is To Be Added

Sony Corporation of America has announced the addition of a second manufacturing facility at Dothan, Alabama, bringing the total plant investment in that city to $21 million. The second plant, to be constructed for $4 million, will occupy about 26,000 square feet will manufacture plastic shells for Betamax videocassettes. The plant will be completed by next October.

Research Firm Predicts 30 Per Cent Growth In CB Sales By 1980

A major U.S. research firm, Arthur D. Little, Inc., is looking beyond 1977 and is predicting that factory sales of citizens band radio will extend into the $1.3 to 1.8 billion range by 1980, up from the $1 billion estimated for 1976. "The existing CB ownership base is now so large that growth percentages won't be as spectacular as the seven-fold increase the industry experienced between 1973 and 1975, or the doubling expected for the current year," Clifford Bean, study director, observes.

Bean said that he "believes the principal factor which could limit future growth of the CB industry is the number of frequencies available." He said "this situation was only partially alleviated by the FCC's decision last summer to expand to 40 channels."

The research report indicates that all of the forces that contributed to past growth are still operating in the marketplace—simplified licensing procedures, wider availability in general merchandise retail outlets, aggressive merchandising, and CB radio clubs.

According to Bean, "CB's usefulness in public safety, stressed by law enforcement officials as well as CB safety organizations, has really lifted CB out of the realm of gadgetry."

NESDA To Hold 1977 National Convention In Orlando, Florida In August

Over 700 dealers, technicians and family members are expected to attend the 1977 NESDA convention at the Sheraton Twin Towers in Orlando, Florida, from August 16 through August 20. Some of the events will include: 'A College of Service Knowledge', 'The Wonderful World Of Service', 'The Magic Kingdom of Electronics,' and a Manufacturers/Dealers golf tournament sponsored again by Electronic Technician/Dealer magazine and hosted by ET/D publisher Al Menegus.

The Game's The Same But The Name Has Changed

In reorganizing Part 95 of the CB Rules and Regs, the FCC has changed the name of the Citizens Radio Service division of the FCC to Personal Radio Services. Likewise, the Class A Citizens Radio Service has been changed to the General Mobile Radio Service; the Class C Citizens Radio Service to the Radio Control (R/C) Service; and the Class D Citizens Radio Service to the Citizens Band (CB) Radio Service. Also revised are the rules for keeping Rule Part 95 in possession. Now CB'ers need only have in possession the subparts of Rule 95 that apply to them.

GTE Sylvania Announces New Five-Year Warranty Program On Color Picture Tubes

A 5-year warranty program for one series of color picture tubes has just been announced by the Replacement Markets operation of the Electronic Components Group of GTE Sylvania. The new, longer warranty program covers everything but installation for the firm's Colorbrite 85 series of replacement color picture tubes. ■

Ben Hyek,
Edna Texas.

Dean Johnson and Pete Childers,
Joliet, Ill.

John Buckner,
Lyndon, Ky.

Vic Hyek,
Nada, Texas.

Bill Hughes,
Niceville, Florida.

Andy Winters,
and Don Boogar,
Palmyra, New Jersey.

WINEGARD WORKS...For Me!

Here are 10 of the reasons why WINEGARD WORKS...For ME!

1. Winegard PRODUCTS work for me. Variety as well as quality in the complete line of TV reception products is important to me. I can take care of my customers, with confidence. Winegard engineering research innovates new products to solve problems, or improve TV reception, as I found with the new low noise UHF preamp-antenna combination.

2. The Winegard NAME works for me. It gives me the top national brand name in my business, to sell, install, and recommend. When you are in your own business, you have to have a manufacturer back of you that you can depend on.

3. The Winegard REPUTATION works for me. Most all my customers and prospects know the Winegard name, and know their products are excellent. This consumer acceptance makes my selling job easier than it would be with an unknown or lesser known brand.

4. Winegard's MARKETING works for me. Their advertising, publicity and promotions reach customer prospects and create sales opportunities for me. Winegard helps build my business.

5. Winegard INFORMATION works for me. Winegard communicates with me, through distributor meetings, trade advertisements, product announcements, technical articles by their engineers, and with their Dealer Newsletter.

6. Winegard DISTRIBUTION works for me. My local distributor carries Winegard products in stock so I can always get what I need, fast.

7. Winegard PROFITABILITY works for me. Winegard has stayed in business for over 20 years because they make the finest products, and because they make a profit. They expect me to make a profit, too. With the right products, and my experience, I *do* make a good profit.

8. Winegard SALES HELPS work for me. Literature, sales tools, ad materials and displays are available to me, to promote and secure new business. My store, truck, and uniform also identify me as a Winegard antenna dealer. This all helps me cash in on Winegard advertising.

9. Winegard RELIABILITY works for me. Winegard's manufacturing facilities, research capabilities, product testing, quality control, and delivery via their own truck fleet are aimed at getting to me the kind of reception products I need to satisfy my customers. They count on me. I count on Winegard.

10. Winegard INSTALLATIONS work for me, too. Whenever I install Winegard products, I can count on the customer being satisfied. I also expect to get additional business from that customer's neighbors and friends. And that's the best part . . . when you your customers recommend you.

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

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...for more details circle 137 on Reader Service Card

TECHNICAL LITERATURE

Discrete Semiconductor Test Instruments are highlighted in a new six-page, full-color brochure available now from B&K-Precision. The new literature describes the firm's complete line of semiconductor test instruments, including the Model 530 lab-quality tester that features a unity-gain frequency measurement capability up to 1500 MHz and non-destructive semiconductor breakdown voltage testing. Three other B&K Precision semiconductor testers are described, along with a detailed analysis of the Dynapeak digital-pulse testing technique. The new brochure, B&K-500, is available free from *B&K-Precision*, 6460 W. Cortland Avenue, Chicago, Illinois 60635.

An ECG Semiconductor Replacement Guide Supplement, listing over 3,000 devices used in 139 brands of consumer electronic equipment, is now available from GTE Sylvania. The line includes both encapsulated thick film integrated circuits (modules) as well as the more popular monolithic integrated circuits. The new supplement lists all part numbers in alphanumeric order and is cross-referenced to equivalent Sylvania ECG replacements. Part numbers are also indexed by equipment brand name. Copies of the supplement, as well as the master guide, are available at *GTE Sylvania* distributors.

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

Equipment For MATV Systems is illustrated and described in the new 1977 Systems catalog from Channel Master. The new literature covers the products in line with the firm's new Total Systems Concept. Included is information and specifications for antennas, balun-antenna joiners-traps, the Join-tenna system, antenna amplifiers, signal processing equipment, distribution amplifiers, power supplies and accessories. The new catalog also covers coaxial cable tools, cable connectors, test equipment, and coaxial cable. Available free from *Channel Master*, Ellenville, New York 12428.

Loudspeakers For Public Address, background music and general sound systems are described in a new specification sheet from Quam-Nichols. The new literature provides specifications on the firms line of eight-inch speakers such as single cone PA speakers, single and dual cone background music speakers, flame retardant models and standard variants for intercom and outdoor use. The new spec sheet, Form 77-1, is available free from *Quam-Nichols Company*, 234 East Marquette Road, Chicago, Illinois 60637.

Do-it-yourself Electronic Kits are described in the latest 96-page catalog from the Heath Company. New products introduced in the new literature include: a 3-way bookshelf speaker system, a battery monitor device for radio control modelers, 40-channel CB radios, a two-way freezer alarm and a mount-anywhere touch control light switch. The new catalog, No. 814, is available free from *Heath Company*, Benton Harbor, Michigan, 49022.

Communications Test Instruments and Test Instruments are covered fully in two new catalogs available now from Leader Instruments. The folder on communications instruments describes the firms line of antenna couplers, SWR wattmeters, RF power meters, dip meters, antenna impedance meters, and the CB harmonic meter. The 1976-77 catalog covers specifications and prices for the firm's complete line of test instruments including oscilloscopes, multimeters, color bar and pattern generators, signal generators and accessories. Both catalogs are available now from *Leader Instruments Corp.*, 151 Dupont Street, Plainview, N.Y. 11803.

Citizens Band Radio Accessories are described in a new catalog from Siltronix. The 12-page catalog features meters, antennas and antenna accessories, speakers and accessories such as a desk microphone and mobile mounting kit. Prices are included. Available free from *Siltronix*, 330 Via El Centro Avenue, Oceanside, CA 92054.

The New Electronics Catalog from Mouser Electronics is now available. The 64-page catalog features a wide variety of electronic components, transformers, electronic tools, test equipment, hardware and related items. Capacitors, resistors, potentiometers, and switches are featured in a range of sizes from sub-miniature to full size. Complete with prices.

Available free from *Mouser Electronics*, 11511 Woodside Avenue, Lakeside, CA 92040.

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

RF Semiconductors for linear applications are described in a new 12-page booklet from 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.

A Guide to CB and Scanner Semiconductor Replacements is now available from General Electric. This first edition of the guide is designed for the technician now entering CB and scanner work. The guide covers the parts and devices contained in GE's new CB scanner semiconductor kits. Cross-referenced between original brand part numbers and GE replacement parts. Free from GE distributors, or Tube Products Dept., *General Electric Co.*, Owensboro, Ky. 42301.

Microphones, Antennas, Test Equipment and Accessories for CB are listed and pictured in the latest booklet from Mura Corp. Included 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. 11490.

CB Antennas And Accessories are described completely in a new 16-page catalog from Antenna Incorporated. Complete specifications on the firm's line of mobile and base station CB antennas, replacement parts and accessories, along with an easy-to-read format, are included in the new literature, Form SP-17. Available free from Randall J. Friedberg, *Antenna Incorporated*, 23850 Commerce Park Road, Cleveland, Ohio 44122. ■

BE COMPETITIVE

40 CHANNEL CAPABILITY
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SENCORE CB42 AUTOMATIC CB ANALYZER

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

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

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

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

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

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

$AVE ON TIME CONSUMING CONNECTIONS:
Three cables, provided with your CB42, do the entire job; audio cable, transmitter cable, and receiver cable.

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

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

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

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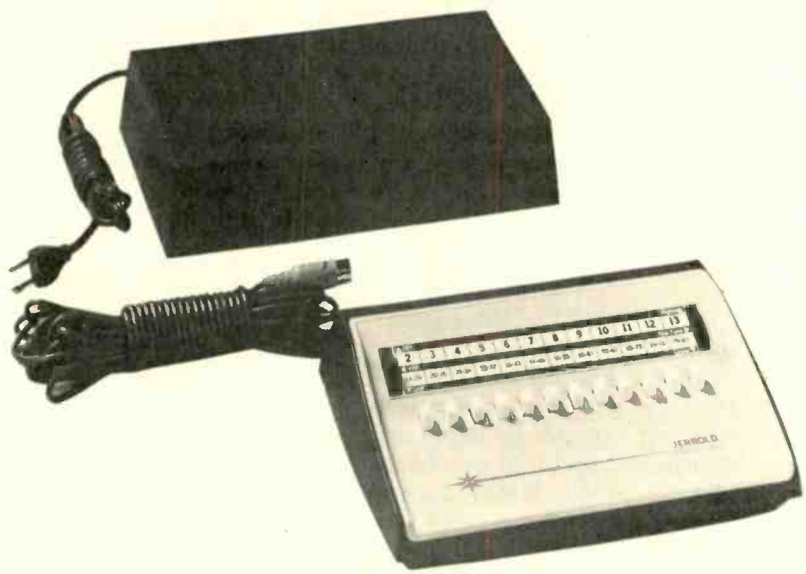
...for more details circle 130 on Reader Service Card

Jerrold's Universal All-Channel TV Remote Control System



Principal components of Jerrold's new Model TRC-82 Universal All-Channel TV Remote Control system. Unit at top is frequency converter, which can be mounted on back of TV receiver or placed in an inconspicuous location reasonably close to the receiver, and bottom unit is control unit, which can be placed in any location convenient to the user. For more Information about this product, circle number 157 on the Reader Service Card in this issue.

■ Jerrold Electronics recently introduced the first TV 'wired' remote-control system capable of providing remote pushbutton selection of all VHF and all active UHF TV channels, plus remote turn-on and turn-off of the receiver.

Designed for use with any TV receiver—b/w or color—and any antenna system—75 or 300 ohm—Jerrold's new Model TRC-82 All-Channel TV Remote Control system consists of two units: a frequency converter unit and a remote-control unit, which are interconnected by an easily concealed, 25-foot, plug-in control cord. (A 5-foot length of 75-ohm coax with connectors and a 75-to-300 ohm matching transformer also are supplied with the TRC-82.)

Two versions of the TRC-82 are available: one for use with the TV receiver tuner in the Channel 3 position (TRC-82-3) and one for use with the receiver tuned to Channel 4 (TRC-82-4).

Installation of the TRC-82 is simple and, as evident from the following description of the installation procedure, can be performed either by the selling dealer or by the purchaser:

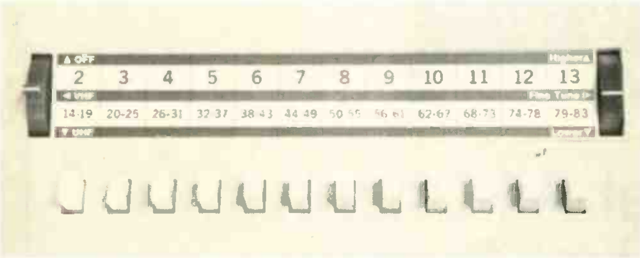
1) Tune the receiver tuner to the channel on which the particular TRC-82 is factory tuned to operate (either Channel 3 or 4)

2) Plug the receiver's power cord into the AC receptacle on the back of the TRC-82 converter unit

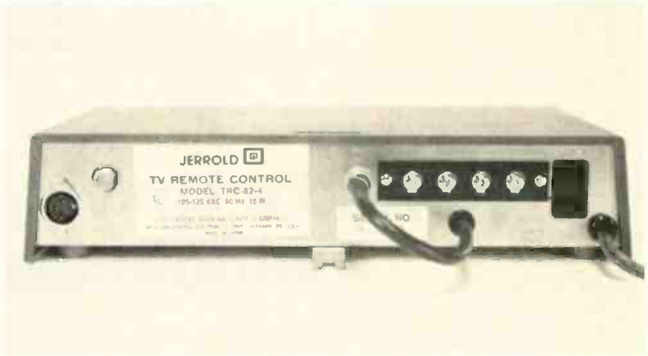
3) Connect the coax or twin-lead from the antenna or MATV system to the appropriate antenna input plug or terminals on the back of the TRC-82 converter unit. (For operation from a 75-ohm antenna system, the external coaxial jumper on the back of the converter is unplugged from the converter's 75-ohm antenna input jack and the coaxial connector from the antenna or MATV system is plugged directly into this jack. For operation from a 300-ohm antenna system, the converter's external coaxial jumper is left plugged into the 75-ohm antenna input jack and the 300-ohm antenna lead-ins are connected to the screw-type VHF and UHF connections on the back of the converter.

4) The 75-ohm output of the converter unit is then connected to the antenna input jack or terminals of the receiver via the 5-foot coaxial cable supplied with the TRC-82. (If the receiver is equipped with only 300-ohm antenna inputs, the 75-to-300 ohm matching transformer supplied with the TRC-82 is employed between the 75-ohm coax and the 300-ohm terminals of the receiver.)

5) The 25-foot line from the control unit is plugged into the control input jack on the back panel of the



Close-up of the TRC-82 control unit. Three-position switch on left turns on receiver and selects either VHF or UHF reception. Thumbwheel on right functions as fine tuning control. Although control unit comes from factory with pushbuttons programmed to select segments of the UHF TV band in the UHF mode, it can be easily re-programmed by the dealer or purchaser so that the pushbuttons select specific UHF stations. Only a small screwdriver is required for UHF re-programming.



Close-up of the rear panel of the TRC-82 converter unit. Built-in 75- and 300- ohm antenna inputs and matching transformer permit use of TRC-82 with any TV antenna or MATV system.

converter unit.

6) The final step is to plug the AC power cord of the converter unit into a convenient AC receptacle—channel selection and turn-on and turn-off of the receiver are now controlled from the TRC-82 control unit.

As shown in the accompanying close-up photo of the front panel of the TRC-82 control unit, a three-position switch on the left of the panel controls the receiver on/off function and determines whether the twelve pushbuttons select corresponding VHF channels or corresponding segments of the UHF band.

In the 'VHF' (middle) position of the OFF/VHF/UHF switch, the receiver is turned on and the pushbuttons select VHF Channels 2-13, with fine tuning provided by the thumbwheel control on the right of the panel.

In the 'UHF' (lower) position of the OFF/VHF/UHF switch, the twelve pushbuttons select corresponding segments of the UHF band and precise tuning to a specific UHF channel within the selected portion of the band is provided by the 'FINE TUNING' thumbwheel on the right of the panel.

Alternatively, the UHF tuning portion of the control unit can be easily re-programmed by the dealer or the purchaser so that in the UHF tuning mode the pushbuttons can be used to select specific locally active UHF channels, not just segments of the UHF band. (Peel-off, self-stick UHF channel numbers are furnished with the TRC-82 for application to the UHF portion of the channel indicator panel when the control unit is re-programmed to provide pushbutton selection of specific UHF channels.)

In addition to the obvious conveniences inherent in remote turn-on and turn-off of the receiver and instant, pushbutton selection of a desired channel without the need to 'cycle through' a number of undesired channels, the TRC-82 remote system also provides a minimum 6dBs of signal amplification—which, along with no degradation of the noise figure of the receiver, in many reception areas can mean the difference between unstable, snowy pictures and clean, clear, stable reception. And, because use of the TRC-82 permits the tuner of the receiver to be operated on an inactive channel, any ghosting and other picture degradation caused by direct-pickup or co-channel interference are eliminated.

The suggested list price of the TRC-82 is $124.50. (Optionally available for resale at a suggested list of $8.95 is a 25-foot extension control cord, complete with male and female connectors, for extending the 'control range' of the TRC-82 beyond the 25 feet provided by the control cord supplied with the remote system.) ■

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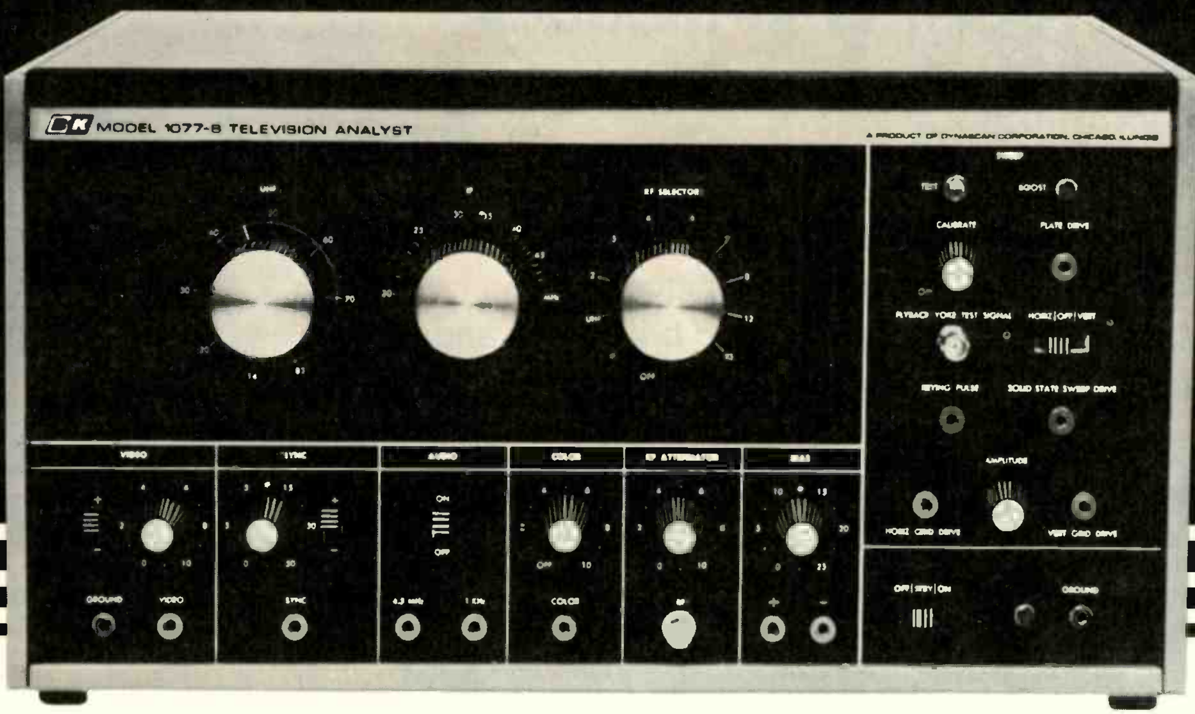

Model 1077B
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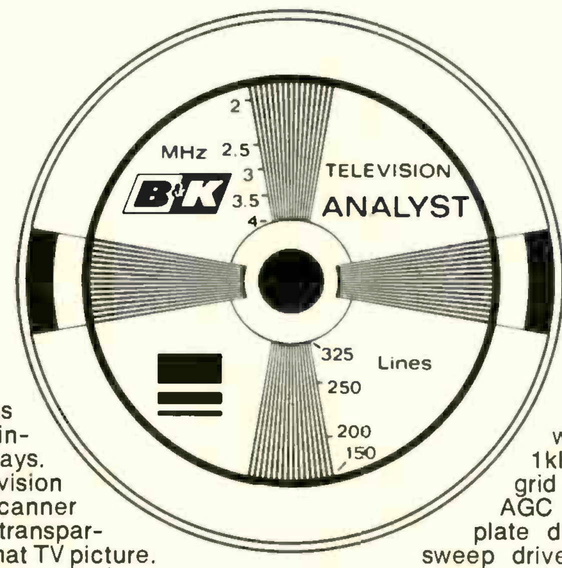

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Luminance Circuits And Problems In Modular Color TV

By Don W. Mason

How the luminance circuitry of a typical modular color TV chassis functions—and manufacturer-recommended techniques for troubleshooting problems affecting brightness and video quality.

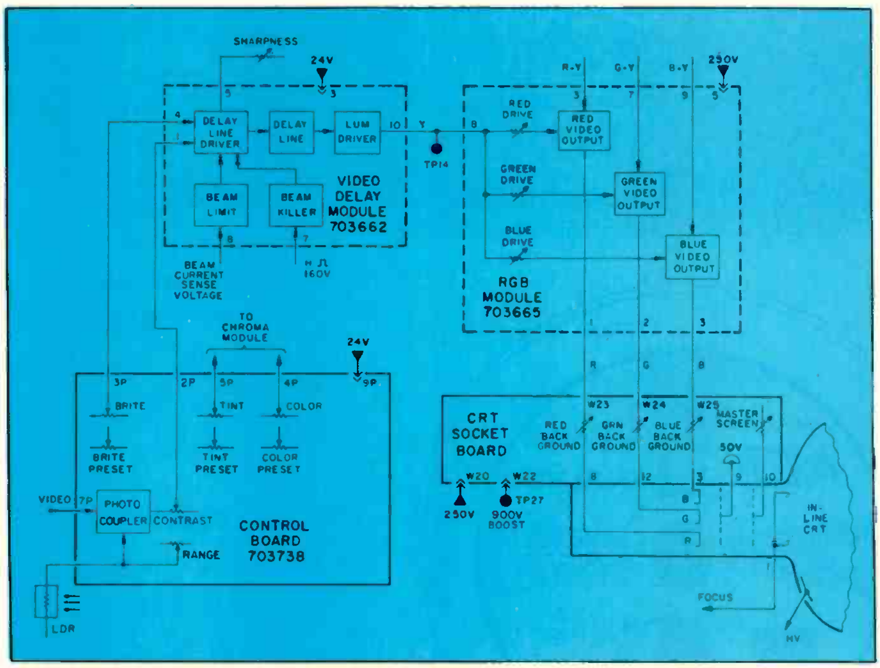

Fig. 1—A block diagram of modular luminance circuitry used in Magnavox color TV chassis T991.

■ The luminance circuitry that produces the black and white portion of a color TV picture has been modularized in most of today's color TV chassis. Because it is somewhat typical of the luminance circuits used by a number of different manufacturers, we'll take a look in this article at the modular luminance circuitry used in the Magnavox T991 chassis—how it works, what kind of problems can appear, and how to troubleshoot those problems.

PROCESSING THE LUMINANCE SIGNAL

The simplified block diagram in Fig. 1 shows the path of the signal through the luminance circuitry. The model used for our article includes the Magnavox *Videomatic* feature, which uses a photo-coupler on control board 703738 to increase or decrease the amplitude of the video signal to compensate for changes in room lighting as sensed by the light dependent resistor (LDR).

Control Board Circuitry

The circuits of the control board are shown in Fig. 2. The main operating controls are for contrast, brightness, color and tint. Preset controls for brightness, color, tint and the Videomatic range are accessible through the hollow shafts of the main operating controls. The LDR is located on the front of the set. The Videomatic switch is located off the control board and is connected to it through a plug-in cable.

The luminance signal, or composite signal, is DC coupled from the video detector on the IF module to a voltage divider network on the control board. Included as part of the input circuit on the control board is the photo-coupler, which we've already mentioned. The photo-coupler consists of the LDR and a Light Emitting Diode (LED), which is connected to the LDR through resistor R432. The LDR is in series with the Contrast control. The resistance of the LDR decreases when room lighting increases and in turn applies more voltage to the LED. As the light from the LED increases, it causes the resistance of the LDR to decrease and thus, apply more video signal to the contrast control and the picture tube. And since DC coupling is used throughout the luminance channel, brightness is also increased.

The Brightness, Color and Tint controls, along with the Preset controls, are simply voltage dividers connected between a DC source and ground. The output voltages at the 'arms' of the controls connect through the Videomatic switch to their respective modules. When the Videomatic switch is in the ON position, the Preset controls become the primary adjustments, while the main operating controls act as vernier adjustments.

Video Delay Circuits

The luminance signal coming from the Contrast control on the control board is coupled to the Delay Line Driver stage, Q1, which is on the Video Delay module 703662, as seen in Fig. 3. After amplification, the luminance signal is delayed approximately 1 microsecond by delay line TD1 so that the signal arrives at the video output stages in time with the color signal. The Video Driver stage, Q2, is operated as an emitter-follower and its output drives the Video Output stages.

The Beam Limiter, Q4, which is

normally biased to cut-off, performs the job of limiting beam current in the picture tube to prevent blooming, poor focus, high voltage loading and other effects that would result from excessive beam current. Whenever the beam current exceeds about 1.5 ma, the voltage from the Tripler ground return circuit become less positive and Q4 starts to conduct. This makes the emitter of Q1, the Delay Line Driver, and the picture tube cathodes, go more positive—and this in turn opposes, or limits, further increases in beam current. If the Beam Limiter, Q4, were to become leaky, it would cause a reduction in brightness.

A Beam Killer stage, Q5, is also included in the luminance channel to protect the picture tube from phosphor damage that may result from the loss of horizontal sweep voltage.

The RGB Module and CRT Socket Board

The T991 chassis, which uses an in-line CRT, uses the RGB method of matrixing the luminance and color difference signals prior to application to the CRT. The circuits of the RGB module and the CRT Socket Board are shown in Fig. 4.

The luminance signal coming from the Video Delay module is coupled to the emitter of each output stage. The three detected color-difference signals from the Chroma module are then applied to the base of their respective amplifiers. These input signals combine then to produce the red, green and blue drive signals for the picture tube cathodes.

The CRT Socket Board is mounted onto the base of the picture tube. The DC voltages needed to set up white balance are provided by three Background controls and a Master Screen located on the socket board.

When the Service switch is placed in the Service position, a fixed bias is applied to the emitters of the Video Output stages and then the cathodes of the picture tube. The set up adjustment is simplified by D1, which switches out the Drive controls while the Background controls are adjusted for low lights. At high brightness

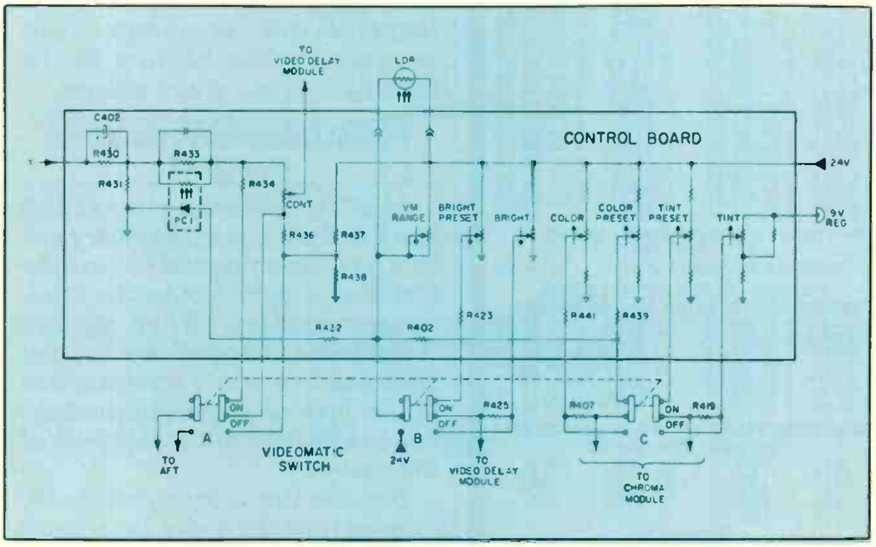

Fig. 2—Control Board circuitry in the T991 chassis.

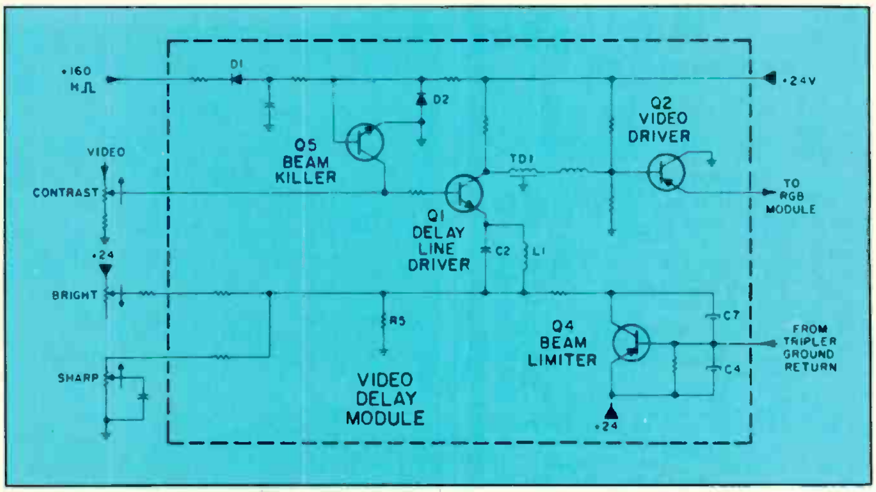

Fig. 3—Diagram of circuitry used on the Video Delay Module of the T991 chassis.

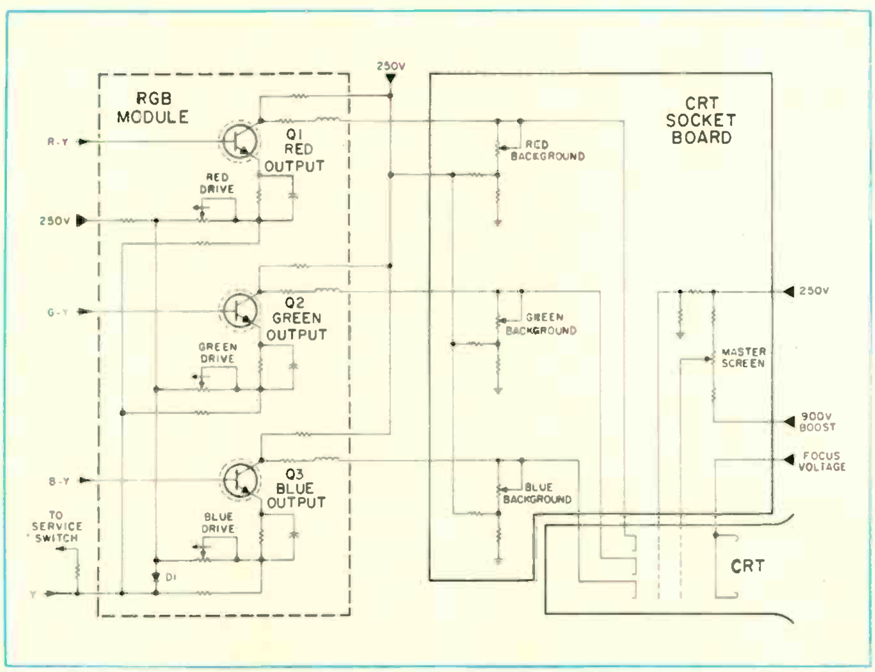

Fig. 4—Circuit diagram of the RGB module and the CRT Socket Board.

settings, the Drive controls are reconnected with the emitter circuit to control white balance in the high light areas of the picture.

TROUBLESHOOTING LUMINANCE CIRCUITRY

Most brightness changes—a black or dark screen, a smeary picture, or a blooming raster—are the result of some defect in the luminance circuitry. When we say "brightness changes" we are not referring to a white screen which is the lack of video information, but to a change in the intensity of the raster.

Because the video circuit is DC coupled from the Video Detector to the CRT (see Fig. 1), any DC voltage change along the circuit will cause a DC voltage change at the CRT cathodes and this will cause the raster to be darker or brighter. A more positive voltage anywhere from the Brightness control to the CRT cathodes will increase the bias between the cathodes and the grid and this will produce a darker raster. On the other hand, if this voltage becomes less positive, the cathodes also become less positive, the CRT bias voltage is lowered and the raster gets brighter.

With the grid, however, the opposite is true. When grid voltage increases, bias is reduced and the screen gets brighter—and when grid voltage decreases, the raster gets darker.

Although a defect in the lumi-

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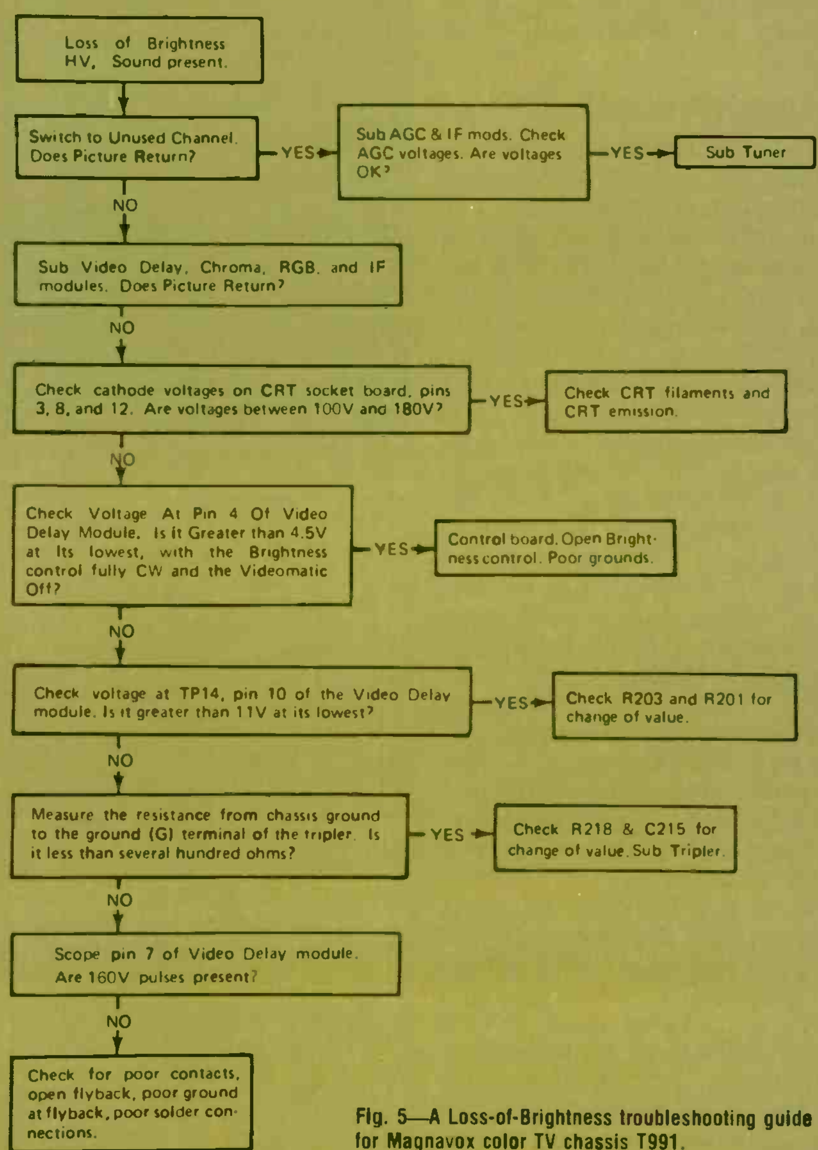

Fig. 5—A Loss-of-Brightness troubleshooting guide for Magnavox color TV chassis T991.

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Twenty TV-Related Uses For A Field-Strength Meter

How to use the field-strength meter in TV antenna system performance testing and troubleshooting.

By James E. Kluge*

Fig. 1—A typical signal-level/field-strength meter, Winegard Model FS-780B, that provides measurements of all VHF (± 1 dB), UHF and FM carriers in the 10-microvolt to 2-volt range.

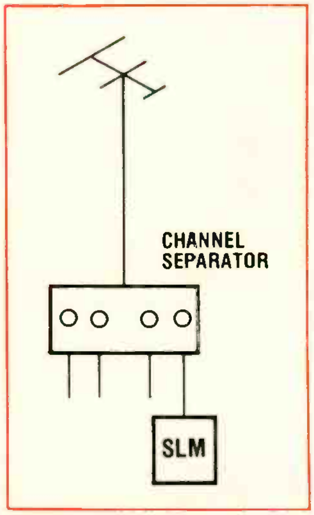

Fig. 2—A diagram of the set-up for balancing channels.

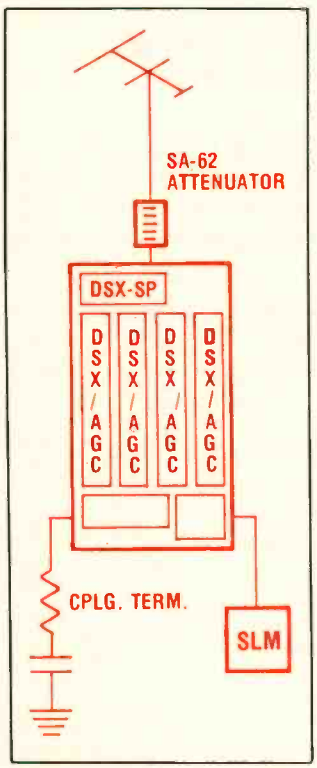

Fig. 3—The set-up for the measurement and adjustment of AGC amplifiers.

■ The field-strength meter (FSM) could probably be called more correctly a signal-level meter (SLM) (Fig. 1). It is basically a tuned-RF voltmeter with a scale that is calibrated in *microvolts* or in *decibels referred to 1 millivolt* in 75 ohms (dBmV).

A signal-level meter does *not* indicate the field strength of radiated electromagnetic energy expressed in *microvolts per meter*. Only a field-strength meter does that. However, it is fair to say that there is a relationship between signal strength and field strength when the instrument is matched to a calibrated dipole antenna and properly oriented. Because the instrument is seldom, if ever, used that way, we will for the purposes of this article refer to it as a signal-level meter (SLM).

WHAT IS AN SLM?

Basically, the SLM simply measures the *voltage level* across a 75-ohm impedance at the frequency to which it is tuned. When the meter is connected to a 75-ohm coaxial cable, tap, or amplifier, its 75-ohm input impedance properly terminates the device to which it is connected.

TWENTY WAYS TO USE AN SLM

Common applications for the SLM include orienting antennas and measuring relative signal levels at various locations in an MATV system. The other eighteen applications presented in this article should also make your instrument far more useful and valuable to you in terms of saving time and effort when making measurements and adjustments.

Number One—Orienting An Antenna

For antenna orientation, connect the SLM to the antenna or downlead through a suitable matching transformer, as the SLM "wants to see" 75 ohms. Tune the SLM to the picture carrier of the weakest channel received and turn or move the antenna to achieve maximum signal.

Number Two—Measuring Relative Signal Levels

With the SLM still connected to the antenna, tune the SLM to the picture carrier of each channel to be received, and note the signal level indicated.

Number Three—Balancing Channels Out Of Headends

Connect the SLM to the output of each single-channel amplifier or channel separator panel in turn and note the relative signal levels. Plug in the appropriate

pads in each channel to bring all channel levels within 2 to 3 dB of each other. (Fig. 2).

Number Four—AGC Settings And Measurements

When the AGC strip amps must be adjusted to compensate for varying input levels, the SLM may be used to measure the upper and lower levels of AGC effectiveness. (Fig. 3)

Connect the SLM to the headend output test jack and tune to the interested channel. Insert external attenuation ahead of the AGC-amplifier input until the SLM reading drops ½ dB. Note the attenuation. It will equal the amount that the input signal level can drop before losing AGC. Now take out attenuation until the SLM reading increases ½ dB and then note the attenuation. (In case there is insufficient input signal to cause the ½ dB increase, add a small amount of amplifier gain ahead of the input.)

Remember, the difference in attenuation equals the total AGC range. In other words, attenuation *added* equals the amount the input-signal level may decrease before losing control; and attenuation *removed* equals the amount the input-signal level may increase before losing control. Procedures for making the AGC adjustments vary with the different models and manufacturers, but the SLM can be used to monitor the input and/or output levels while making any adjustments.

Number Five—Setting Tap Isolation

Line taps come in 3 varieties—fixed, selectable and variable isolation. Connecting an SLM to the tap (Fig. 4) will indicate the signal level. By clipping out fixed resistors (selectable) or turning the screwdriver adjustment shaft (variable) the isolation can be varied to provide the desired level. Fixed-isolation taps must be interchanged to adjust the level.

Number Six—Measuring Insertion Loss

Connect the SLM to the cable entering a device such as a tap or a filter and measure the input level (Fig. 5). Then connect the SLM to the output of the device and reconnect the cable to the device input. The difference in level between the input and output is the insertion loss.

Number Seven—Measuring Gain Of Amplifier

Connect the SLM to the amplifier output, and note the level. (Fig. 5) Transfer the SLM to the cable previously connected to the amplifier input. The difference in readings gives the amplifier gain.

Number Eight—Determining the Tilt-Compensator And Line-Amp Location

An SLM aids in properly locating tilt compensators and line amplifiers in a trunkline. By connecting the SLM to the output jack (Fig. 6) of various drop-line taps, the level can be measured until it falls below a level considered inadequate for tap isolation. Then, ahead of this tap, locate a tilt compensator followed by a line amplifier and then, the drop-line tap.

To determine the amount of tilt compensation, measure the level at the lowest and highest channels. The difference equals the tilt compensation required. VHF tilt compensators have a linear slope between channels 2 and 13; UHF models slope between channels 14 and 83. With the aid of a simple graph the correct tilt compensator can be selected for the channels actually used. The tilt of other channels added at a future date will be automatically and correctly

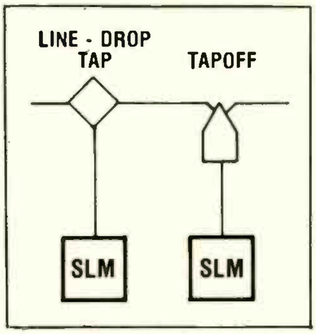

Fig. 4—The set-up for the adjustment of variable isolation on taps.

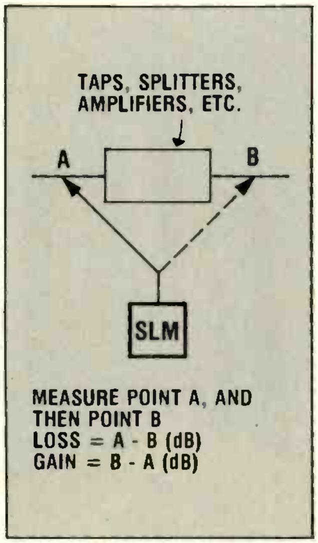

Fig. 5—The set-up and method for measuring insertion loss and amplifier gain.

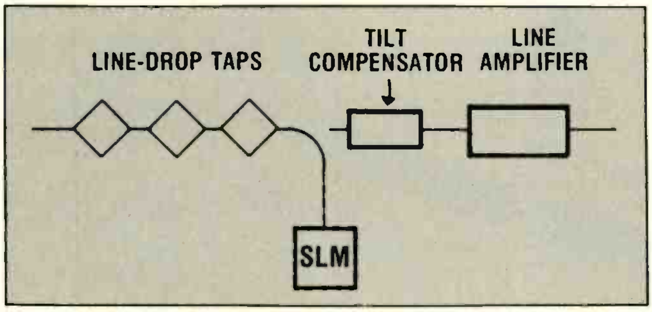

Fig. 6—Set-up for determining tilt-compensator and line-amp location.

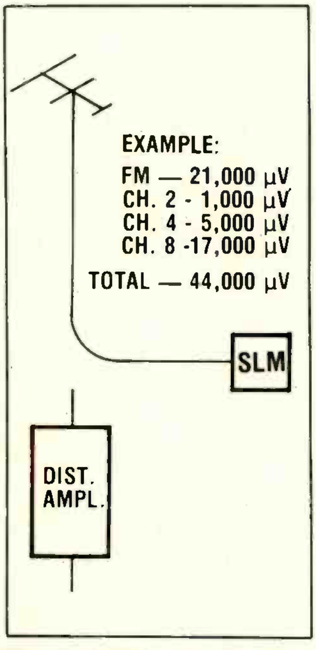

Fig. 7—Arrangement for measurement of total signal input to prevent overload or crossmodulation.

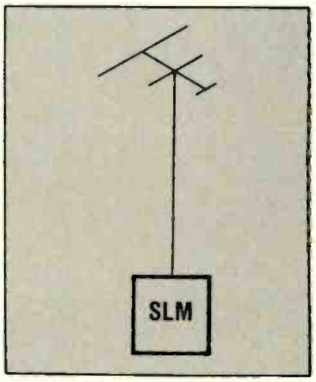

Fig. 8—The set-up for identification of interfering signals prior to purchase of factory-tuned traps.

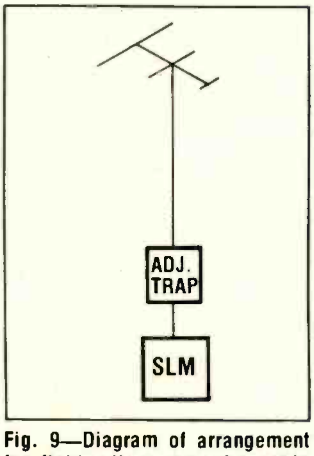

Fig. 9—Diagram of arrangement for field adjustment of tunable traps.

compensated.

Number Nine—Measuring Total Signal Input To Prevent Overload Or Crossmodulation

SLM's permit the reading of individual channel levels so that by totaling the individual *voltages*, the total voltage level applied to a distribution amplifier, or such, can be determined and, thus, avoid overload and consequent crossmodulation problems (Fig. 7).

Number Ten—Identifying Interfering Signals

Interfering signals can be located, frequency-wise, by tuning the SLM until a signal is indicated at a frequency where no signal should be (Fig. 8). Diagnosing the picture or listening with the SLM earphone while tuning will usually help an experienced technician to identify or determine the approximate frequency of an interfering signal. Verifying the frequency with an SLM then allows one to select a trap, an antenna configuration, or an orientation to minimize the interference.

Number Eleven—Tuning Taps In The Field

SLM's permit coarse- and fine-tuning adjustments of the picture-carrier or aural-carrier traps in the field (Fig. 9). By tuning the SLM to the carrier or interfering signal to be tapped out, the trap may then be inserted and tuning adjustments may be made to null the interfering signal level as indicated on the SLM.

Number Twelve—Monitoring Relative Field Strength

An SLM connected at any point in the MATV

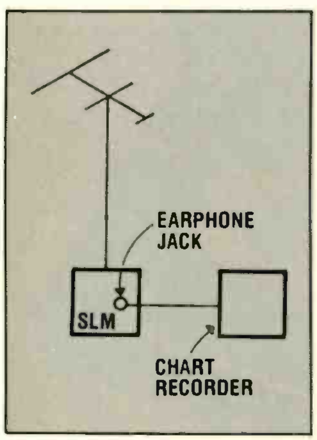

Fig. 10—Set-up for the monitoring of relative field strengths.

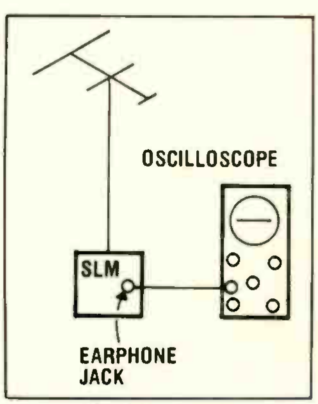

Fig 11—Method of performing visual observation of carrier modulation.

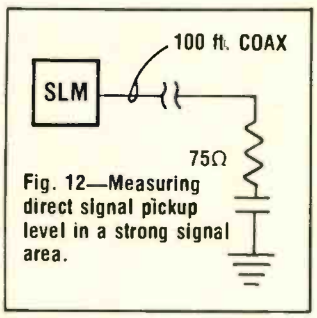

Fig. 12—Measuring direct signal pickup level in a strong signal area.

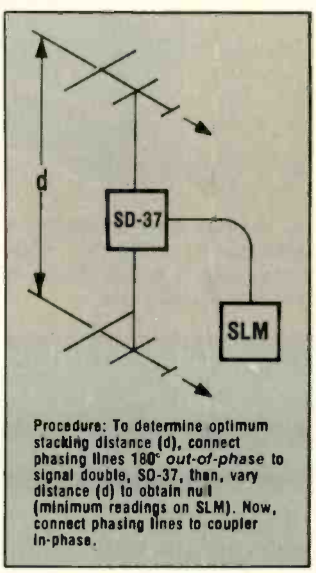

Fig. 13—Procedure for determining optimum stacking distance, phase and alignment.

system (AGC circuits must be disabled) permits monitoring of relative field strength by monitoring the actual signal levels at that point (Fig. 10). Since the field strength, as seen by the antenna, is proportional to the voltage level at the antenna terminals, the voltage levels anywhere in the system are also proportional to field strength at the antenna. Thus, any variation in field strength at the antenna (in dB) causes a corresponding voltage-level change (in dB) anywhere in the system. Unattended monitoring of relative field strength is accomplished by connecting a suitable chart recorder to the earphone jack on the SLM.

Number Thirteen—Visual Observation of Carrier Modulation

Most SLM's have a jack to which both an oscilloscope and an earphone can be connected (Fig. 11). By connecting the oscilloscope input to this jack, the picture or sound carrier modulation can be observed, and with an earphone or audio-amplifier/speaker, the modulation can be heard.

Number Fourteen—Measuring Direct Signal Pickup

In areas where the signals are strong enough to be picked up directly in the coaxial cable, the SLM can be used to measure the level (Fig. 12). Connect a 100-foot length of cable to the SLM and terminate the free end of the cable. Tune the SLM to channels of interest and note the direct-pickup levels for the 100 feet of cable. Like any antenna, the distance from the signal source, orientation and positioning will affect the pickup level.

Number Fifteen—Stacking and Phasing Antennas

The spacing and aligning of vertical stacked antennas to achieve maximum gain is generally a "cut and try" situation except when one uses an SLM. To easily find the optimum spacing, purposely connect the antennas out-of-phase (Fig. 13). Then, by observing the SLM connected to the coupler, vary the spacing or alignment to get a null on the SLM. Then, reconnect the antennas in phase. You could also seek a maximum reading with the antennas in phase, but it would only be a 2 or 3 dB increase, compared to a 20 or 30 dB sharp null with the antennas out-of-phase. To determine the correct phasing of two antennas, observe the SLM for the highest of two readings (in-phase versus out-of-phase connections).

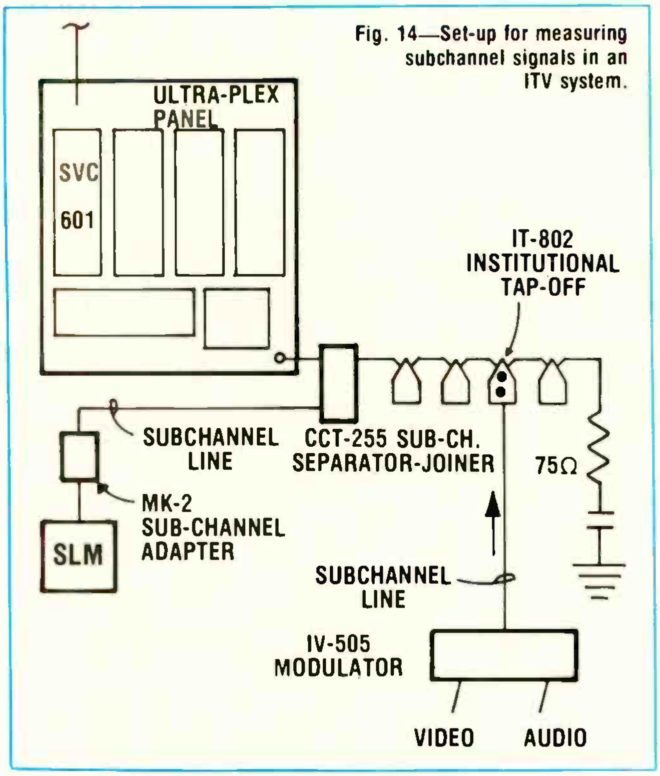

Fig. 14—Set-up for measuring subchannel signals in an ITV system.


Fig. 16—This Spectrum Analyst, Model 260A, emits a continuous, flat signal from 4.5 to 300 MHz, uniform to within ±1dB throughout its frequency range. A built-in 75-ohm comparison bridge permits direct measurements of return loss.


Fig. 15—A typical low-frequency adaptor, MK-2, that converts incoming 4.5 to 54 MHz frequencies to 115 to 164 MHz, which are then read on the SLM's midband scale. Battery powered, the unit slips into the accessory compartment of the FS-780B SLM.

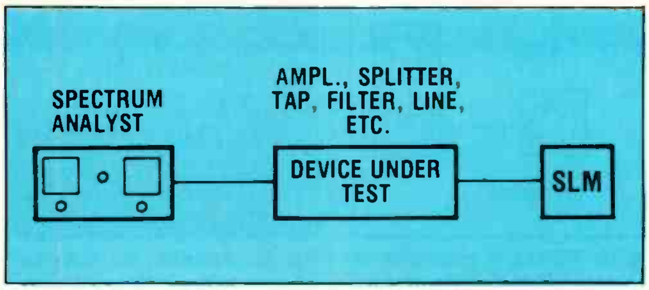

Fig. 17—Diagram of the set-up for measuring frequency response.

Number Sixteen—Measuring Subchannel Signals In ITV Systems

Institutional TV, as used in schools, hospitals and office buildings, employs subchannel signals from 17 to 48 MHz to distribute music, announcements, CCTV, and other special program material throughout the facility via MATV cable. To measure these signal levels with an SLM, a separator-joiner (CCT-255) is required to tap into the ITV system at some point, preferably at a cable connection (Fig. 14). Some SLM's may also require a low-frequency adapter (Fig. 15) if they cannot be tuned down to subchannels.

Number Seventeen—Measuring Frequency Response

By connecting an SLM to the output of a device such as an amplifier, filter or tilt compensator, and supplying the device input from a flat, broadband signal source such as a Spectrum Analyst (Fig. 16), you can measure the frequency response of the device (Fig. 17). When you tune the SLM over the bandpass of the device you'll get voltage-versus-frequency data from which you can construct a VHF frequency-response curve. This curve will be within the accuracy limitations of the SLM and the flat-

Fig. 18—This is a Porta-Bridge, Model PB-1, a portable 75-ohm comparison bridge that also generates a continuously flat signal (±1.5dB) to permit direct measurements of return-loss and VSWR.

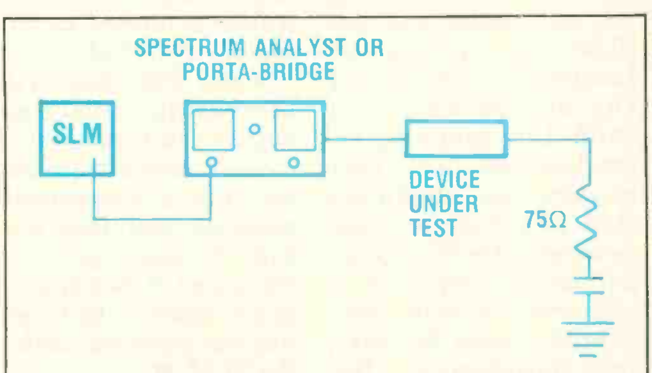

Fig. 19—This Is the equipment set-up for the measurement return loss and VSWR for individual components of a trunk of a system.

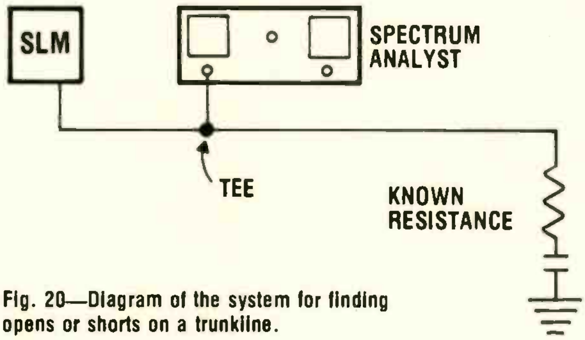

Fig. 20—Diagram of the system for finding opens or shorts on a trunkline.

ness of the source voltage.

Number Eighteen—Measuring the Return Loss Or SWR

When used with a Spectrum Analyst or a Porta-Bridge (Fig. 18), the SLM allows you to measure the standing wave ratio (SWR) of an individual device such as an amplifier, cable, or tap filter, or an entire system. By connecting the SLM to the Porta-Bridge or Spectrum Analyst (Fig. 19) and setting the output to 1000 μV, the SWR of the device or system can be read directly off the meter scale. Using the chart of *Return Loss vs. VSWR*, shown in Table 1, SWR can be converted to return loss.

Number Nineteen—Locating Cable Faults

Again, using a Spectrum Analyst or a Porta-Bridge in combination with an SLM, shorts or opens in coaxial cable can be located up to 500 feet away from the test point. (Fig. 20). Using a simple tee, inject the wideband output from the Spectrum Analyst or Porta-Bridge into the cable where the SLM is connected. Starting at the low-frequency end of the band, tune the SLM until a null is located, and note the frequency. Then, increase the tuning frequency until another null is located and note that frequency. The difference between these two frequencies will tell you at which frequency the cable distance to the fault is an electrical half-wavelength. The distance to the short or open can be calculated from a chart or graph prepared by the instrument manufacturer.

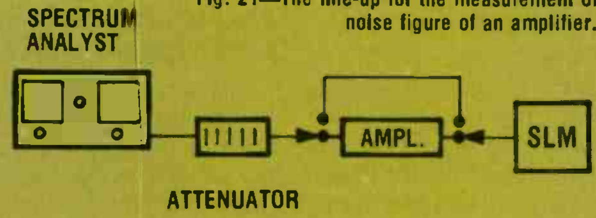

Fig. 21—The line-up for the measurement of noise figure of an amplifier.

Number Twenty—Measuring Noise Figure

The noise figure of amplifiers can be measured with an SLM, (Fig. 21) with certain limitations. Because the bandwidth of the SLM is, in nearly all cases, narrower than the unit under test, the SLM will determine the bandwidth over which the measurement is valid. Low-gain amplifiers (less than 35 dB) may require post amplification to obtain a noise reading on the SLM. If an additional amplifier is required, its noise contribution must be taken into consideration. Determining the noise figure consists of three steps:

- With the SLM connected to the output of the amplifier, or post amplifier, terminate the amplifier input with its characteristic impedance (usually 75 ohms) and read the SLM in dBmV.
- Compute the theoretical noise level (in dBmV) at the input termination and add to it the gain (in dB) of the amplifier. i.e.,

$E_N = KT°R\Delta f$, where:

E_N = Noise level in volts rms

K = Boltzmann's constant = 1.38×10^{-23}

T° = Temperature in Kelvins

R = Characteristic impedance = 75 ohms

Δf = Bandwidth in hertz

(Use a Spectrum Analyst or Porta-Bridge as a broadband signal source to measure the gain of the amplifier.) The result is the noise output if the theoretical input noise were amplified without any noise contribution by the amplifier itself. Remember, the computed input-noise level is a function of bandwidth which is limited in this case by the SLM

- The difference in dB between the actual noise output (as measured in step 1) and the noise output from a theoretically noiseless amplifier having the same gain (as measured in step 2) is the noise figure of the amplifier *over the bandwidth of the SLM.* ■

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

Test Instrument Source Guide

For Entertainment/Two-Way Communication Electronics Servicers

A list of the most common generic types of electronic test instruments typically employed in the servicing of entertainment and/or two-way communications electronic products and the most prominent* manufacturers and/or marketers of such test instruments.

This directory consists of two sections: 1) A test instrument-to-manufacturer/marketer cross reference in which the generic types of instruments are grouped according to the general categories of entertainment and/or two-way communication electronic product servicing for which they are designed and/or in which they typically are employed. (Those types listed under 'GENERAL APPLICATIONS' are applicable to the servicing of most types of entertainment and two-way communication electronic products.) 2) An alphabetized listing of the names, addresses and phone numbers of the most prominent* manufacturers and/or marketers of electronic test instruments specifically designed for or typically used in the servicing of entertainment and/or two-way communications electronic products.

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Cleveland, OH 44106
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201-335-0900

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Bradenton, FL 33506
813-792-5566

Letrotech, Inc.
5810 North Western Ave.
Chicago, IL 60659
312-769-6262

Logimetrics, Inc.
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Plainview, NY 11803
516-681-4700

Mura Corp.
177 Cantiaque Rock Rd.

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ELENCO					•						
HEATH		•			•	•				•	
HEWLETT-PACKARD										•	
HICKOK					•	•					
JERROLD		•	•								
JOHN FLUKE										•	
LEADER		•			•	•				•	
LECTROTECH	•	•			•	•	•			•	•
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AUDIO APPLICATIONS

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DATA TECHNOLOY				•				
EDISON				•				
EICO	•			•	•	•		
EXACT				•	•			
GC		•				•		
HEATH	•	•		•	•			
HEWLETT-PACKARD	•		•	•	•	•		
HICKOK					•			
JERROLD			•					
JOHN FLUKE				•				
LAMPKIN LABS		•		•				
LEADER	•				•		•	•
LOGIMETRICS				•	•			
PHILIPS				•	•			
SENCDRE		•		•	•	•		
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JOHN FLUKE	•	•		•
LAMPKIN LABS	•	•		
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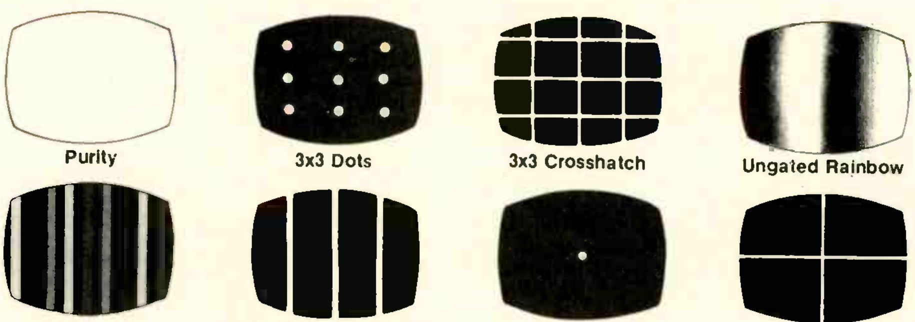

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B&K PRECISION	•				•		•									
BIRD ELECTRONICS								•	•						•	•
COMMANDO					•		•								•	
CUSHMAN	•	•	•	•	•	•			•	•	•	•	•	•		
DANA LABS					•											
DATA TECHNOLOGY	•	•	•	•	•			•		•	•	•	•			
EDISON										•						
EICO	•				•		•		•	•	•	•	•		•	
ELENCO							•									
GC						•	•	•	•						•	
HEATH					•		•	•		•	•	•	•			
HEWLETT-PACKARD	•	•	•	•	•		•		•	•	•	•	•	•	•	
HICKOK	•				•		•	•	•	•					•	
JERROLD					•											
JOHN FLUKE					•		•									
KEITHLEY							•									
LAPP							•	•	•	•	•	•	•		•	
LAMPKIN LABS	•	•	•	•		•			•	•	•	•	•			
LEADER					•			•	•	•					•	
LECTROTECH	•	•			•		•	•	•	•	•	•	•		•	
LOGIMETRICS										•	•	•				
MURA	•								•						•	
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PHILIPS					•	•	•			•	•	•	•			
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GENERAL APPLICATIONS

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B&K PRECISION	•		•		•	•	•	•	•	•	•	•		
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COMMANDO												•		
DANA LABS			•											
DATA PRECISION	•		•					•						
DATA TECHNOLOGY		•	•					•						
EDISON												•		
EICO	•	•	•	•	•	•	•	•	•	•	•	•		
FINNEY												•		
GC						•		•		•		•		
HEATH	•	•	•		•	•	•	•	•	•	•			
HEWLETT-PACKARD		•	•	•	•	•	•	•			•			
HICKOK			•		•	•	•	•	•		•			
JAMES G. BIDDLE								•			•		•	
JERROLD												•		
JOHN FLUKE			•											
KEITHLEY			•					•			•			
LEADER	•	•		•	•			•	•	•	•	•		
LECTROTECH					•	•	•		•					
MURA											•	•		
NOBLE											•			
NON-LINEAR			•					•						
PHILIPS			•	•	•			•		•	•			
PHIPPS & BIRD	•													
PTS ELECTRONICS												•		
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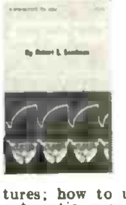

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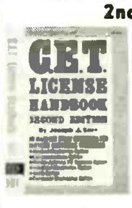

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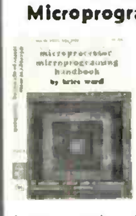

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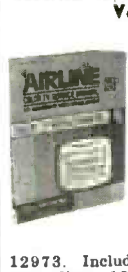

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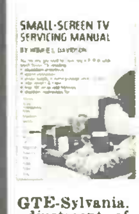

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Scope Facts For Techs

Specs, characteristics and features which a service tech should consider during the selection of a scope

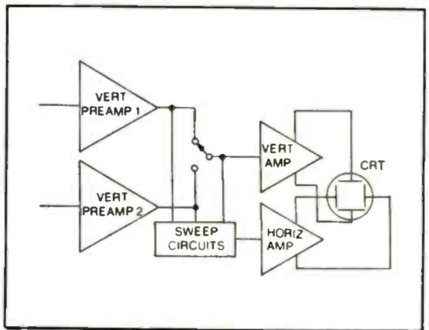


Fig. 1—Simplified block diagram of a recurrent, single-trace scope.

■ As a result of continuing advances in solid-state technology, the prices of medium- and high-performance oscilloscopes have been decreasing dramatically, making available to service technicians scopes with specs and operating features which heretofore were found only in the most sophisticated, high-cost 'lab' scopes.

Today, for slightly over $200, a service technician can purchase a 10-MHz triggered scope equipped with a calibrated vertical input attenuator and time base. Thus, service technicians today are suddenly face to face with operating features such as 'dual-trace', 'sweep magnifiers', 'auto' and 'normal' triggering, and a host of other features and operating controls which, although they increase the ease and accuracy of measurements and make the scope a much more versatile test instrument, nevertheless also make its selection and operation more complex.

For these reasons, to insure that he selects a scope which is suited for his needs and budget, it is more important than ever that a technician be thoroughly familiar with the specs and operating features available in modern scopes.

The following review of scope fundamentals and related specs, features and general characteristics is intended only as a 'refresher!'

SCOPE FUNDAMENTALS

Fig. 1 is a block diagram of a basic oscilloscope. The oscilloscope consists of a cathode-ray tube (CRT), a vertical amplifier, a horizontal amplifier, and sweep circuits.

Amplifiers

Vertical and horizontal amplifiers increase small electrical signals sufficiently to deflect the electron beam vertically and horizontally over the CRT screen. Typically a CRT will require a voltage between its vertical plates of 100V to deflect the beam across the tube. Oscilloscope input levels will be more like 100 mV, thus requiring a gain of 1000 in the amplifier.

Sweep Circuits

A sweep circuit is used to cause a horizontal displacement of the beam on the face of the CRT that is proportional to time. The sweep circuit generates a waveform (Fig. 2) which rises linearly with respect to time and then suddenly drops to zero; it waits for some definite time, then begins to rise linearly again. This signal is commonly called a sawtooth, or ramp.

Time Base

The ramp signal is used to drive the horizontal amplifier. The initial beam position will be at the left edge of the CRT. As the sweep circuit's output voltage increases,

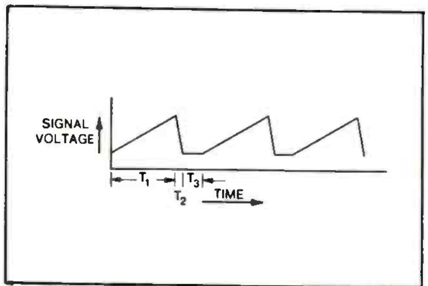


Fig. 2—Three cycles of the waveform generated by the sweep circuits of an oscilloscope. The duration indicated by t_1 is the highly linear ramp which deflects the beam across the face of the CRT, creating the time axis of a graph. The duration indicated by t_2 is the retrace time, when the beam is being moved back to its starting point. The duration indicated by t_3 is the holdoff time. Holdoff time is zero on a recurrent sweep oscilloscope and a fixed value dependent on sweep speed, plus a random variable time for triggered oscilloscopes.

the beam is driven to the right; when the peak of the ramp is reached, the beam is at the right edge of the CRT. The beam then rapidly returns to the initial point as the sweep voltage returns to zero. When the horizontal amplifier is driven with such a linear sweep signal, the horizontal displacement of the beam may be equated to time. This gives the oscilloscope a time base. For example, the center of the CRT represents 0.5 sec of elapsed time with respect to the left edge of the CRT if the period of the ramp is 1 sec.

The ramp must be synchronized to the vertical signal. In other words, it must start at the same point every time on the input waveform. If this did not happen, the displayed waveform would start randomly, and a jumbled display would result. Synchronization, or triggering circuits are employed to prevent this.

Recurrent Sweep

In the simplest oscilloscopes the

(From Chapter 4, "Understanding & Using Modern Electronic Servicing Test Equipment," by Charles M. Gilmore, TAB BOOKS, Copyright 1976. A review of the complete book follows this article.)

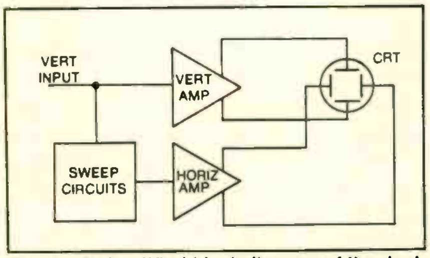


Fig. 3—A simplified block diagram of the dual-trace oscilloscope. Note that a standard CRT with a single set of horizontal- and vertical-deflection plates is used. Signals to operate the vertical switch are derived from an oscillator in the chopped mode and from the sweep signals in the alternate mode.

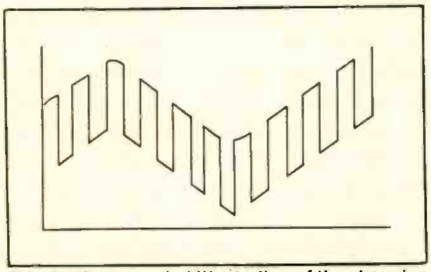


Fig. 4—An expanded illustration of the chopping technique for displaying two separate signals (a sine wave and a triangle wave) on a dual-trace oscilloscope. This technique is used when the writing rate using alternate modes will allow one trace to fade before the other has been completed. The chop rate is usually sufficiently high. There are at least 100 samples of each waveform per sweep. The vertical transisitions between traces will either be blanked or made at such a high speed that the beam cannot write.

sweep generator consists of a free-running oscillator which generates the ramp waveform. The free-running oscillator is synchronized to the vertical signal by adjusting the sweep generator until its frequency is identical to, or a submultiple of, the frequency of the vertical signal. With the oscillator and vertical-amplifier signals at approximately the same frequency, a small amount of the vertical signal is injected into the sweep oscillator. The sweep generator will lock or synchronize, tending to assume the frequency and phase of the vertical signal. Obviously this method of synchronization is somewhat crude; however, until recently it has provided the lowest cost method for deriving a synchronized horizontal time base. For some forms of work this is entirely satisfactory. This elementary time base, called *recurrent sweep*, has some rather severe limitations: It can only synchronize an integral number of vertical cycles; it is virtually impossible to change the point at which the triggering starts; and unless some separate form of time measurement is available, the period of the sweep signal is unknown.

Triggered Sweep

All of these problems may be solved through the use of a calibrated triggered sweep. With triggered sweep, the sweep generator is converted from a free-running oscillator to a single-shot generator; that is, the oscillator will produce one single ramp of a known period when the appropriate trigger signal is applied. With this time base the user may select the exact period of sweep and, through various amplification and comparing circuits, the exact point on the input wave at which he desires the sweep to start. Given a time base of this sophistication, there are many applications for the oscilloscope which were simply not available with recurrent sweep.

Blanking

The rapid retrace of the beam from the right side of the CRT to the left can cause undesirable traces on the display. To eliminate this effect a special signal is developed just before the end of each sweep signal. This signal *blanks*, or turns off, the beam in CRT. The blanking signal prevents the undesirable retrace signals from appearing on the face of the CRT. Normally the trace is blank until a new sweep is under way. This permits the ramp to become fully linear, which it may not be in the first few percent of its rise.

Some oscilloscopes have provisions for external input to the blanking circuits so that the blanking may be controlled externally for special applications.

Dual-Trace

On the simple oscilloscope of Fig. 1, the vertical movement of the beam is governed by the signal in the vertical amplifier. Such an oscilloscope is called a single-trace oscilloscope. This simply means that all vertical deflection is a function of one input to the scope.

Frequently, when working with an electronic circuit, it is desireable to determine cause and effect—that is, to compare the input and output signals of the circuit. This may be done with a single-trace oscilloscope by first observing the input signal, then moving the probe to the output and observing the output signal. Obviously this process is difficult. As neither trace remains on the screen permanently, one has to remember each small variation of each waveform to compare them.

This problem has been more popularly solved with the dual-trace oscilloscope (Fig. 3). This oscilloscope is similar to the single-trace oscilloscope; however, two vertical preamplifiers are employed, and a switch connects the main vertical amplifier to either input 1 or input 2. This switch is controlled by the time base circuitry or an internal oscillator. The switch operates in one of two modes.

In the *alternate mode* the switch is changed from one input to the other following each horizontal sweep. On the first sweep, input 1 is displayed; on the second sweep, input 2 is displayed. On the third sweep, input 1 is again displayed, and so on. The alteration is rapid enough to keep the trace presented by one input from fading during the time the other input is writing.

At sweep rates of sufficiently long duration to cause a flickering problem, a different mode of dual-trace display is used. In this, the *chopped mode*, the switch is no longer operated by successive cycles of the time base, but is alternated by a high-frequency oscillator, generally in the 50-200 kHz region. This produces a trace as demonstrated in Fig. 4. The time intervals in the figure are considerably exaggerated. In actuality, even at quite short time base periods, one must carefully scrutinize the trace to observe the chopping effect.

Trigger Selection

With the dual-trace oscilloscope a question presents itself: Where should the trigger signal be taken from? Most oscilloscopes using dual vertical channels have a switch permitting the user to select either input 1 or input 2. In some products the user is offered a third option: that of triggering on the combined signal available after the switch.

Delay Lines

If the triggered oscilloscope is used with very short periods of horizontal sweep (generally under 10μsec or so) and the user desires to observe either the leading or trailing edge of a pulse in some detail, there is a new problem. Most trigger circuits are incapable of producing any sweep before the first few hundred nanoseconds of the vertical signal has actually arrived at the vertical-deflection plates. Therefore the signal that caused the triggering—say, the leading edge of a fast pulse—generally reaches the deflection plates a few hundred nanoseconds before the sweep actually starts. When this occurs the initial part of the signal is completely lost. To avoid this the signal in the vertical amplifier must be delayed. The most common technique is to use some form of transmission line to slow the signal. The signal in the vertical amplifier must be delayed enough to permit the trigger and then the sweep circuits to respond. To achieve these considerably long delays without limiting the frequency response of the vertical amplifier, rather specialized transmission lines are employed. Delay lines certainly add to the oscilloscope's performance and obviously add to its cost.

XY Oscilloscopes

Occasionally it is desirable to make certain measurements by comparing two external signals, one of them on the *Y* or vertical axis and the other on the *X* or horizontal axis. When the oscilloscope is used in this mode, the internal sweep circuits are no longer employed. With the simple oscilloscope, X Y operation is achieved by applying one signal to the vertical input and the other signal to the external-input connection of the horizontal amplifier. Horizontal amplifiers do not usually have calibrated attenuators, nor will they accept a wide range of input signal levels. When the oscilloscope is either a dual-trace or dual-beam type, two identical vertical amplifiers are available. Such oscilloscopes often have an *XY* mode, in which one of the vertical-input amplifiers remains connected to the vertical-deflection plates, and the other vertical-input amplifier is connected to the horizontal plates. This provides the user two wide-range inputs with calibrated attenuators.

VERTICAL AMP SPECS

Vertical Bandwidth

Vertical bandwidth is one of the most fundamental specifications of an oscilloscope. This specification, more than any other, will determine the suitability of a particular oscilloscope for the job at hand. Oscilloscope manufacturers try to create a vertical amplifier whose frequency response is constant until an upper frequency limit is reached, where a controlled rolloff (decrease in gain) starts. The bandwidth of the oscilloscope is defined as the point at which the displayed vertical signal has been reduced by 3 dB with respect to some low-frequency reference point. As vertical signals continue higher in frequency, the oscilloscope response should continue to roll off at a rate slightly greater than 6 dB per octave. This controlled rolloff is necessary to provide proper vertical-amplifier response to complex signals.

Oscilloscopes having a vertical-frequency response which rolls off at a rate considerably greater than 6 dB per octave will not faithfully reproduce the high-frequency components of complex waveforms. On the other hand, oscilloscopes with insufficient high-frequency attenuation will tend to create *overshoot*, or excessive high-frequency response on pulse signals.

Note that a signal reduced by 3 dB is at its half-power point, not its half-voltage point. At −3 dB the voltage is 70.7% of the reference value. Furthermore, a signal reduced in amplitude by 3 dB because of an increase in frequency has a large phase shift with respect to the reference point, normally in the area of 45°.

Occasionally the vertical bandwidth of an oscilloscope is specified with a deflection limitation. Such a specification might read: 10 MHz at 4 cm deflection, 8 MHz at full deflection. This specification indicates that the oscilloscope may not be used at its full bandwidth if full deflection must be utilized. This specification is popular with some solid-state oscilloscopes, which may have a limited vertical-plate driving capability. Generally speaking, most higher cost modern oscilloscopes are not specified in this manner. However, one should watch out for a deflection limitation when purchasing a unit if this would result in application limitations.

Oscilloscopes come with vertical amplifiers that are only AC coupled and with vertical amplifiers having both AC and DC coupling, usually switch selectable. The AC—DC coupling is the more versatile, but AC-only is generally lower in cost. When an oscilloscope is operated in AC-coupled mode, it will have an upper −3 dB limit set by the vertical-amplifier high-frequency rolloff and a lower −3 dB limit set by the low-frequency reactance of the AC input coupling capacitor. The 3 dB lower frequency limit is usually 2—10 Hz. With AC coupling, the highest potential that may be applied across the input coupling capacitor must be specified, This is usually 400V—600V. This specification is peak AC plus DC, *not* just DC.

The input mode selector may also have a third position in addition to the AC and DC positions described above (Fig. 4). This third position, usually described as GROUND, disconnects the input connector from the input amplifier; the input to the vertical amplifier is grounded. This feature is frequently used to note the 0V height of the CRT trace.

Rise Time

Closely related to vertical bandwidth is vertical rise time. Rise time is defined as the time required for the signal to increase in amplitude from 10% of its total value to 90% of its total value (Fig. 5). The rise-time of an oscilloscope is important in determining the limits of rise-time measurements that may be made by the oscilloscope. Rise-time t_r (in microseconds) is directly related to bandwidth f_{MHz} by the formula

$$t_r = 0.35/f_{MHz}$$

An oscilloscope which meets a given rise-time requirement will have proper high-frequency roll-off.

Rise time is especially important if the oscilloscope is to be used for pulse analysis. Then the oscilloscope should ideally have a rise time that is 20% of the value of the pulse to be measured.

Deflection Sensitivity

Vertical-deflection sensitivity ranks equally with vertical bandwidth as an important oscilloscope specification. Both of these limitations can prevent a measurement from being made.

The deflection or input sensitivity specification indicates the smallest voltage that will produce a standard deflection, usually one vertical division on the CRT. Stated in another way, deflection sensitivity indicates the maximum vertical amplification available. As a typical example, an oscilloscope might have a sensitivity of 10 mV. This oscilloscope would display a 10 mV peak-to-peak specification, not RMS. A 10 mV RMS sine wave would cover approximately 2.82 divisions, as a 10 mV RMS sine-wave signal is a 2.82 mV peak-to-peak signal. Sensitivity obviously costs money; therefore, the amount of sensitivity required must be weighed against the cost of the oscilloscope.

Often the oscilloscope is used with an accessory probe which acts as a voltage divider, reducing the input signal by a factor of 10 or more. If this is the case, one must remember that the oscilloscope sensitivity is effectively reduced by the same factor.

To obtain maximum sensitivity, some models offer increased sensitivity at a reduced bandwidth. Oscilloscopes offering this feature typically give an additional gain of 10 with a bandwidth reduced by a factor of 4. For example, a 10 MHz oscilloscope might maintain 10 MHz bandwidth at 10 mV per centimeter, however, the input attenuator may be adjustable to 1 mV per centimeter, but with a bandwidth of only 2.5 MHz. Often this bandwidth is quite different, as high-frequency signals may not be of interest at high-sensitivity levels.

Input Attenuator

The maximum sensitivity of an oscilloscope cannot be utilized on all measurements. For example, in a 10 mV per centimeter oscilloscope with 6 cm of total vertical display, the electron beam will go off the screen for signals in excess of 60 mV. To overcome this problem, an input attenuator is provided. This is usually one of two types. On the simplest oscilloscopes it may be nothing more than a variable control, or at best, a 3-position switch labeled ×1, ×10, ×100. In such oscilloscopes the amount of attenuation and the vertical sensitivity are generally uncalibrated. The more sophisticated oscilloscopes have an attenuator with steps calibrated in the resultant vertical deflection sensitivity. This is usually in a 1—2—5 sequence, although occasionally a 1—3—10 sequence is used.

Because of high impedances and stray capacitances, a simple resistance divider will not maintain the same attenuation at high frequencies as at DC. To correct this, the input attenuator must be capacitively compensated. With compensated attenuators the attenuation is constant at all frequencies.

The step attenuator has a disadvantage in that it will not allow signals of any arbitrary amplitude to be made exactly full scale or some other desired size. To permit such operation, most oscilloscopes include a variable control that adjusts the effective attenuation between the indicated value and its next highest position. For example, an oscilloscope used at 500 mV per division can be adjusted continuously between 500 mV per division and 1V (1000 mV) per division by this control. This variable control will have a CALIBRATED position (normally extreme clockwise). In the CALIBRATED position, the deflection factors indicated on the attenuator positions fall within the accuracy limits set for the oscilloscope. Accuracy of attenuation is normally +3% to +5%. Vertical-accuracy specifications also include any inaccuracies found in the vertical amplifier. Accuracies are frequently not specified at the high-frequency limits, at temperature extremes, nor on extremely low cost instruments.

Input Impedance

For most servicing applications a high input impedance is desirable. One megohm has been chosen as a standard. As was noted, there is compensating capacitance involved with attenuators. Therefore, the input impedance of an oscilloscope includes the value of capacitance found in parallel with the IM resistance. This capacitance usually lies in the area of 20-40 pF if the oscilloscope is designed to be used with a divider probe. Obviously, the lower the capacitance the better. Other impedances have been used. Some of the older, very low cost oscilloscopes have inputs ranging from 100K to 10M. Some of the very sophisticated high-frequency oscilloscopes built today have a nonreactive input.

Vertical-Delay Lines

To allow for trigger and sweep startup, a delay line is inserted in the vertical-amplifier circuit. The object of the delay line is to uniformly delay signals of all frequencies by an amount slightly greater than the time required to permit triggering, startup of the sweep circuits, and an unblanking of the tube before the triggering signal is presented to the CRT. Specifications will indicate the amount (number of nanoseconds) of pretriggered waveform which will be displayed.

Delay lines are essential for good pulse analysis. They are especially important with digital circuitry, in which the measurement of pulse rise times may be critical to proper operation.

TIME BASE SPECS

As noted earlier, recurrent sweep is the simplest form of time base available. The recurrent sweep time base offers no way to make calibrated time measurements except by comparison. The recurrent-sweep-generator specifications indicate the upper and lower frequencies of the sweep oscillator. The frequency can be changed with a variable control within a decade range, and over multiple decades in switched steps. Sweep oscillator frequency range from 5 Hz to 500 kHz is typical. Converted to time per division, assuming 10 horizontal divisions, this gives an equivalent range of 20 msec per division to 200 nsec per division. A few oscilloscopes have provisions to lower the sweep oscillator frequency by use of an external capacitor.

The recurrent sweep time base may also have a control to adjust the amplitude of the synchronizing signal injected into the sweep oscillator from the vertical amplifier. Switch selection of a positive- or negative-going synchronizing signal is frequently made available. Often this same switch will permit positive or negative synchronization by an external signal or a sample of the power-line frequency.

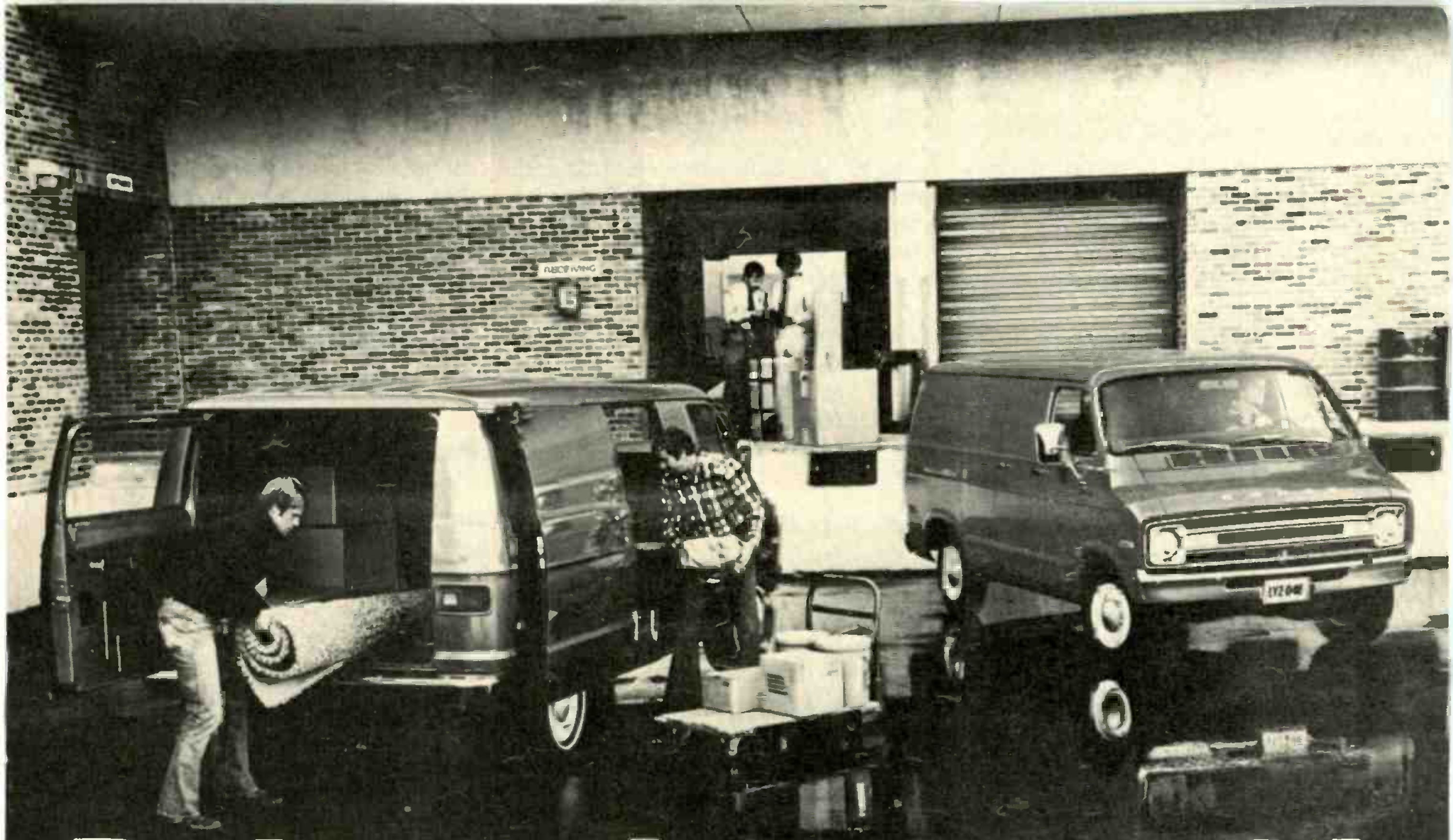
Calibrated Sweep

Calibrated sweep yields a time measurement device. The period of the time base is selected as a time per division. (The majority of oscilloscopes use the centimeter as the basic horizontal and vertical division. There are some oscilloscopes with vertical divisions slightly longer or shorter than a centimeter. For this reason the general term *division* will be used.) The switching is either in decades (on lower cost oscilloscopes) or a1-2-5 sequence.

Slowest sweep speeds vary with the manufacturer and the price of the oscilloscope, but usually they are in the vicinity of 200 msec per division to 2 sec per division.

The fastest sweep speed is dependent upon the bandwidth limit of the oscilloscope. A rule of thumb is that the fastest sweep speed should present no less than three complete cycles of a waveform whose frequency is identical to the vertical bandwidth of the oscilloscope. For example, a 10 MHz oscilloscope would require an upper sweep speed $3 \times 1/(10 \times 10^6)$ sec = 300 nsec for the full horizontal span, or 30 nsec per division. This requirement would be met by an oscilloscope time base having a maximum speed of 200 nsec per division and a × 10 magnifier yielding to 20 nsec per division display.

For low-bandwidth oscilloscopes (3-5 MHz), fastest sweep speeds in the area of 0.5-1 µsec are typical. Sweep speeds of 0.05-0.2µsec per division are common on 50 MHz oscilloscopes.



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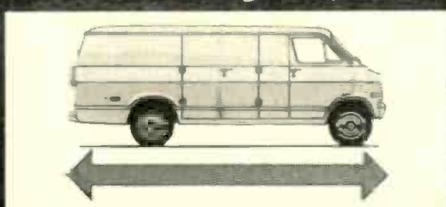

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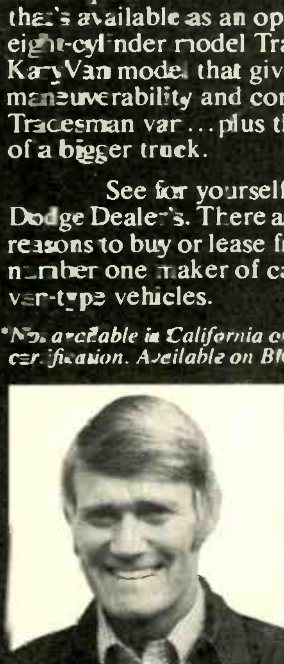

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Although the time per division may be stepped in either a 1-2-5 or 1-10-100 sequence by the time base switch, there is usually provision to vary the time per division continuously between steps with an uncalibrated control. Accuracy of the time base is usually +5% to +3%. Time base speeds are often affected by temperature, line voltage variations, and age, so they should not be used as ultimate standards of time comparison.

Triggering Controls

The triggered oscilloscope gains much of its flexibility from the various modes of operation which may be selected for the trigger circuits. The trigger signal, taken from the vertical amplifier, is used to start the sweep generator. Variations of triggering include selection of positive or negative triggering, level of triggering, AC or DC coupling, high- or low-frequency filtering, and selection of trigger source (including an external source, the power line, and the vertical-amplifier channels). Each of these features adds to the ability to observe complex waveforms.

Older oscilloscope designs also incorporate a STABILITY control which assists in proper operation of the trigger circuits. The STABILITY control is adjusted prior to using the TRIGGER LEVEL control. Generally speaking, STABILITY controls are not found on modern oscilloscopes.

The methods of defining trigger sensitivity and triggering bandwidth are not consistent. The following are Heath Company standards for such measurements. *Trigger sensitivity* indicates the smallest deflection (or external input level) that will permit a stable trace on the face of the CRT. Sensitivity of one division or less is desirable. An oscilloscope requiring more than one division of vertical deflection for a stable display does not have sufficient trigger sensitivity for many applications.

Trigger bandwidth can be defined as the highest frequency at which a stable trace can be maintained with some nominal deflection (often one division). Trigger bandwidth determines the ease with which the oscilloscope will trigger on complex waveforms and what the stability of high-frequency signals will be. An oscilloscope with a trigger bandwidth twice the vertical bandwidth provides exceptional triggering performance, while one with a triggering bandwidth of less than its own vertical bandwidth creates difficulties when high-frequency or complex waveforms are being observed.

Time Base Modes

The time base generator usually has two modes of operation. In the *normal* mode the sweep generator is cycled by a trigger pulse, which follows the sweep and holdoff periods. In the *automatic (auto)* mode the oscilloscope automatically generates trigger pulses in the absence of a signal in the vertical amplifier. This provides baseline (trace) in the absence of a vertical signal rather than the blank CRT seen in the *normal* mode.

Some oscilloscopes provide a time base mode called *single sweep*. This permits the operator to select a set of conditions that will trigger the sweep and then to "arm" the sweep. When the set of conditions occurs, the time base will be activated for one sweep and then will remain locked out until rearmed. This mode is especially useful when attempting to observe fast events occuring randomly and at widespread intervals.

HORIZONTAL AMP SPECS

Although the primary source of horizontal signals is the sweep circuit of the oscilloscope, there are occasions requiring the horizontal deflection signal to be derived from an external source.

Horizontal Bandwidth

As the only requirement of the horizontal amplifier is to pass the sweep signals with reasonable fidelity, the bandwidth of this amplifier is generally not great. Bandwidths of the order of 1-3 MHz are quite common. Occasionally a high-frequency signal must be handled, and at such times the horizontal bandwidth of the oscilloscope must be considered.

One should also remember that when specifying a limit of horizontal bandwidth, such as -3 dB at 3 MHz, the manufacturer is also specifying a phase shift. In certain measurements (especially phase measurement), phase shift in the horizontal amplifier can cause measurement errors.

External Horizontal Input

The input impedance of a horizontal amplifier varies from oscilloscope to oscilloscope. However, for most oscilloscopes it is specified as 100K or 1M with some shunt capacitance. On more elaborate oscilloscopes, the horizontal-sensitivity specification may also include specifications for a horizontal attenuator and a variable gain control. The most limited oscilloscopes have only a fixed amplitude specified for horizontal sensitivity. External horizontal-input connectors will normally be the same as those for the vertical input.

CRT SPECS & CHARACTERISTICS

A limitation on the high-frequency capability of the oscilloscope, above that of the bandwidth of the vertical amplifier, is the ability of the CRT to write (produce traces) at high speeds. That is, the phosphor must be sufficiently sensitive and the electron beam sufficiently intense to cause the phosphors to emit light in the time the beam strikes them. At higher and higher rates of trace deflection, this becomes more and more difficult, until a point is reached where the CRT is unable to display the signals in the vertical amplifier.

Another situation causing this same condition is a moderate to fast sweep speed, with infrequent sweep triggering caused by the low rate of the desired waveform. An example of this is a 60 Hz waveform being observed at a 10 μsec/cm setting. In such a case the phosphors are being refreshed only infrequently (once every 16 msec), and unless the oscilloscope CRT has good writing speed, the trace will be very faint. Unfortunately, the writing speed of an oscilloscope is not easily specified. Generally speaking, the higher the accelerating potential, the better the writing speed.

Acceleration

Two different types of CRTs are available. The simplest is what is known as a *monoaccelerated* tube, in which all the electron beam acceleration takes place within the gun assembly before the deflection plates, usually with voltages of 2kV or less. The most common circuits use 1.4 kV acceleration.

Postdeflection Accelerator

In more sophisticated oscilloscopes, a more expensive tube with *postdeflection acceleration* (PDA) is used. Tubes with PDA will generally exhibit much better writing characteristics as much higher voltages are used, generally between 4 and 20 kV. Generally speaking, oscilloscopes with a vertical bandwidth exceeding 10 MHz should use a PDA tube for optimum results.

Rectangular and Flat Tubes

The original oscilloscope tube looks somewhat like a wine bottle. This tube has served for many years, despite the generally preferred viewing area being a rectangle. With the round-face tube, a portion of the corner display area is lost (see Fig. 6), and there is a large unused portion of the screen. While many oscilloscopes today still have round tubes, they are frequently masked off to show a rectangular viewing area. Generally speaking, this is of no detriment to the oscilloscope user. The rectangular tube also makes more efficient use of the front-panel space.

A rectangular tube requires a control for trace rotation. This control—which is not needed on the round tube, as it may be simply rotated to produce a horizontal trace—rotates the electron beam with a magnetic field produced by a DC current in a coil wrapped around the tube. True rectangular tubes are generally of the PDA type and represent a significant increase in construction cost.

The original oscilloscope tube had a slightly convex display area. This was necessary so the beam would remain focused on the face of the CRT at any position. A convex tube face leads to errors due to parallax. So this CRT has been replaced by the flat-face tube. The flat-face tube has its focusing problems corrected by the internal mechanics of the CRT and eliminates the parallax error.

Viewing Area

The viewing area of the CRT is generally divided into squares, with the most common being 8 x 10 or 6 x 10 cm. However, some oscilloscopes use smaller units of measurements, sometimes as small as 0.6 or 0.8 cm per division; and some oscilloscopes use larger divisions, such as 1.2 cm per division. Generally speaking, the larger the screen size, the more easily the oscilloscope is read.

The extremely small tubes, those using 0.6 and 0.8 cm per division, were popular with some of the early portable solid-state oscilloscopes, in which it was difficult to obtain large deflection voltages. The 8 x 10 cm screen is by far the most popular today, although the 6 x 10 screen is also common. Generally speaking, the 8 x 10 screen with 1.2 cm per division is only available on high-priced oscilloscopes. On some low-priced oscilloscopes the diameter of the tube is given. This is usually 5 in. or 3 in. A 3 in. tube will give a small display and should be considered only when small size of portability is a necessity. A 5 in. diameter tube will give an 8 x 10 cm rectangular display (see Fig. 6).

Graticules

The graticule is a thin window placed over the face of the CRT. It bears the lines defining the rectangular divisions. The oscilloscope manufacturer constructs the oscilloscope so the graticule lies as close as possible to the face of the CRT. This is required to minimize the parallax error between the trace and graticule. This problem can be absolutely minimized by etching the lines on the inside of the faceplate of the CRT. Such internal graticule tubes are expensive, and thus this feature is found only on higher priced oscilloscopes.

To make the lines of the graticule stand out, the more expensive oscilloscopes have an illuminated graticule. This can be achieved by simply flooding the graticule with the light generated by a lamp similar to a pilot lamp, or it may be accomplished by grinding the edge of the graticule (or the faceplate of the CRT on an internal-graticule tube) and illuminating this ground edge. If the lines have been scribed in the graticule rather than painted on, extremely uniform illumination of each of the marks and lines will result. If scale illumination is available, a control is normally provided to vary the intensity.

Phosphors

The phosphor on the inside of the CRT face turns the electron beam into a visible trace. There are three different types of phosphors common to oscilloscopes. Type P1 is the most common phosphor on the low-cost, round CRTs. The P1 phosphor emits a yellow-green light, has a moderate resistance to burns, and has a decay to 0.1% of maximum light output in 95 msec. Wherever possible, the P1 phosphor is being replaced with a newer phosphor, the P31. The P31 phosphor emits a yellow-green light similar to that of the P1 but at nearly twice the intensity. The burn resistance of P31 is considerably better than that of P1, an important consideration as this is a frequent cause of damage. The P31 phosphor will appear to flicker at a much faster sweep repetition rate than will the P1, though, as it has only a 32 msec life of 0.1% output:

The P7 phosphor appears in a few special-purpose oscilloscopes where long persistence is required. Decay to 0.1% output is nearly 1.5 sec, and under low-level lighting conditions, a trace can be seen over a full minute. The P7 phosphor fluoresces with a blue light when excited and then emits a yellow phosphorescent glow. Light output of the P7 is the lowest of all the phosphors, and it can be easily burned.

All phosphors can be damaged by permitting a high-intensity trace to remain in one spot too long. Make a habit of turning down the intensity or of defocusing an oscilloscope when it's left on for long periods of time. A single small spot left on the face of the CRT will damage the phosphor very rapidly, especially if the P7 or P1 type is used.

OPERATING FEATURES

Most of the previously described scope characteristics, or specifications, can be defined, and therefore evaluated, in terms of specific numerical quantities. However, other equally important scope characteristics cannot be defined and evaluated in such specific, easy-to-compare terms but, instead, must be evaluated on the basis of their contributions to ease of operation and display interpretation and to what degree they expand or enhance the versatility of the scope. The more important of these characteristics, which usually are referred to as 'operating features', are described in the following paragraphs.

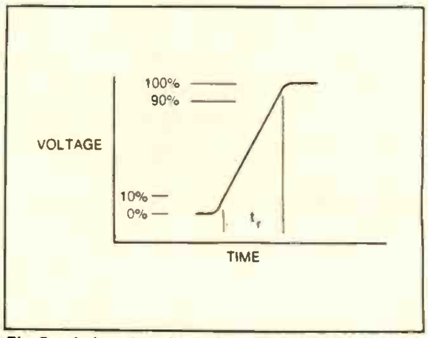


Fig 5—A drawing depicting the definition of rise time. Fall time is defined in a similar manner.

Calibrators

Voltage calibrators are generally found on all high-priced oscilloscopes, and to varying degrees and with varying quality, they are found on low-priced oscilloscopes.

A voltage calibrator which provides a square wave of reasonable rise time (at least a microsecond or two) and a calibrated voltage waveform serves a number of purposes. It permits the user to check the amplitude accuracy of the vertical amplifier he desires. It permits him to establish a gain level using a variable vertical-gain control. And it permits compensation of oscilloscope probes to insure the frequency response of the probe is matched to the particular oscilloscope input.

On the simpler oscilloscopes, the only waveform made available may be a sinusoidal waveform with known vertical amplitude. In extremely simple oscilloscopes that only have a simple vertical attenuator and an uncalibrated amplifier, this may be used to establish the amplitude of the measured waveform by relative measurements. Outside voltage sources may be used to calibrate

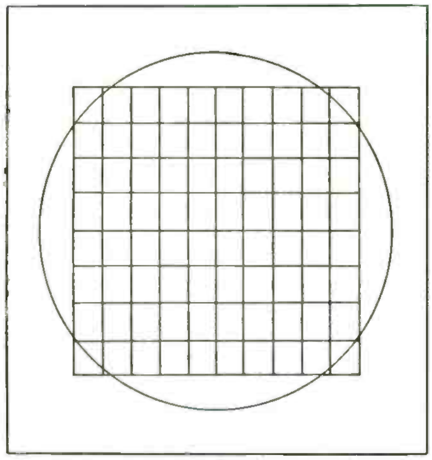


Fig. 6—A maximum-sized rectangular graticule placed on a round-faced CRT. Note that the outermost squares at each corner are lost due to the round edge on the tube. A 5 in. round tube will give an 8 x 10 cm graticule. Although some squares are lost, these are rarely needed to make a usable display.

the oscilloscope; however, the vertical calibrator signal is always a desirable feature when it can be obtained.

Magnifiers

Often it is desirable to observe a signal in more detail. With a triggered oscilloscope this generally is accomplished by increasing the sweep speed. However, there are occasions when a magnifier is used instead. Most magnifiers have magnification factors of 5 or 10, although sometimes a factor of 2 is used. There are two forms of magnifiers, horizontal and sweep.

A horizontal magnifier, by far the more common, extends the length of the sweep by the magnification factor. Thus, a ×10 magnifier effectively makes a 10-division trace 100 divisions long. Using the HORIZONTAL POSITION control, different 10-division sections of the 100-division waveform can be observed. Effectively, the time per division is shortened by a factor of 10, so a 10 µsec per division sweep speed is effectively made 1 µsec per division with a ×10 horizontal magnifier. The trade will tend to dim when a horizontal magnifier is in use, as the beam is on the screen on the CRT only one-tenth as often as it would have been without the use of the magnifier. A sweep magnifier multiplies the repetition rate of the sweep circuit by the magnification factor, and the trace does not dim. The effect, in terms of sweep speed per division, is still the same. As noted before, sweep magnifiers are rather uncommon. Frequently magnifiers contribute additional error, often as much as +2-3%.

XY Mode

An XY mode is a feature occasionally found on single-trace scopes and more frequently found on dual-trace models. Accompanying the XY feature is a specification indicating the degree of differential phase shift between the X and Y channels. This may be something like 3° at 100 kHz. The XY mode is frequently used for making phase measurements. Therefore, with an oscilloscope that has 3° differential phase shift at 100kHz, a measurement indicating a 45° phase shift at 100 kHz between the signal supplied to the X and Y inputs could be in error by 3° , or 7%. Oscilloscopes with vertical-delay lines present an additional problem, as the delay line itself creates an effective added phase shift and must be compensated for in the horizontal amplifier, or the user must tolerate the added phase shift contributed by the delay line.

Regulated Supplies

The accuracy and stability of the oscilloscope are directly related to the stability of its power supplies. The deflection sensitivity of the CRT is directly dependent upon the accelerating potentials supplied to it, and the accuracy of the vertical deflection is directly proportional to the stability of the deflection sensitivity. The accuracy of the oscilloscope thus becomes dependent upon the stability of the high-voltage power supplies. Regulated high-voltage power supplies tend to be expensive, and some manufacturers forego regulation to produce lower cost oscilloscopes. As a result, traces bounce or jump and reductions in horizontal and vertical accuracy occur with power line variations. A good specification to look for is one indicating the range(s) of power line voltages over which the oscilloscope may be operated. Generally, the wider the range, the better the regulation.

TECH BOOK REVIEW

Title: *Understanding & Using Modern Electronic Servicing Test Equipment* (TAB BOOK No. 777)
Author: Charles M. Gilmore
Publisher: TAB BOOKS, Blue Ridge Summit, Pa. 17214
Size: 252 pages, 125 illustrations.
Price: $5.95 paperback; $8.95 hardbound

This is not a textbook. It is designed, rather, as a reference book for the technician to consult whenever a question arises as to the theory behind, or application of, a particular test instrument. Each of six chapters is devoted to a different group of instruments. Each chapter starts with a review of the fundamentals behind the instrument, then discusses in detail specifications of each instrument group, and finally takes a thorough look at the applications of each instrument.

The book approaches the application of the instruments in two ways—first, the useful applications of each instrument, and secondly, the errors which creep into a measurement made by the instrument. Errors are divided into operator errors and instrument errors.

The book is well-supplied with schematic drawings and photographs of the test instruments covered, and a 42-page appendix contains front-panel photographs of a number of instruments and their specifications. All of the instruments covered in this book are available for under $1000.

CONTENTS: Electronic Analog Multimeters,—Voltmeters—Digital Frequency Counters—Oscilloscopes—Curve Tracers—Test Leads and Probes—Appendix A, Decibel Ratios—Appendix B, Characteristics of Commonly Used Coaxial Cables—Appendix C, Specifications of Low-cost Instruments. ■

Weston Model 6000 Autoranging Digital Multimeter

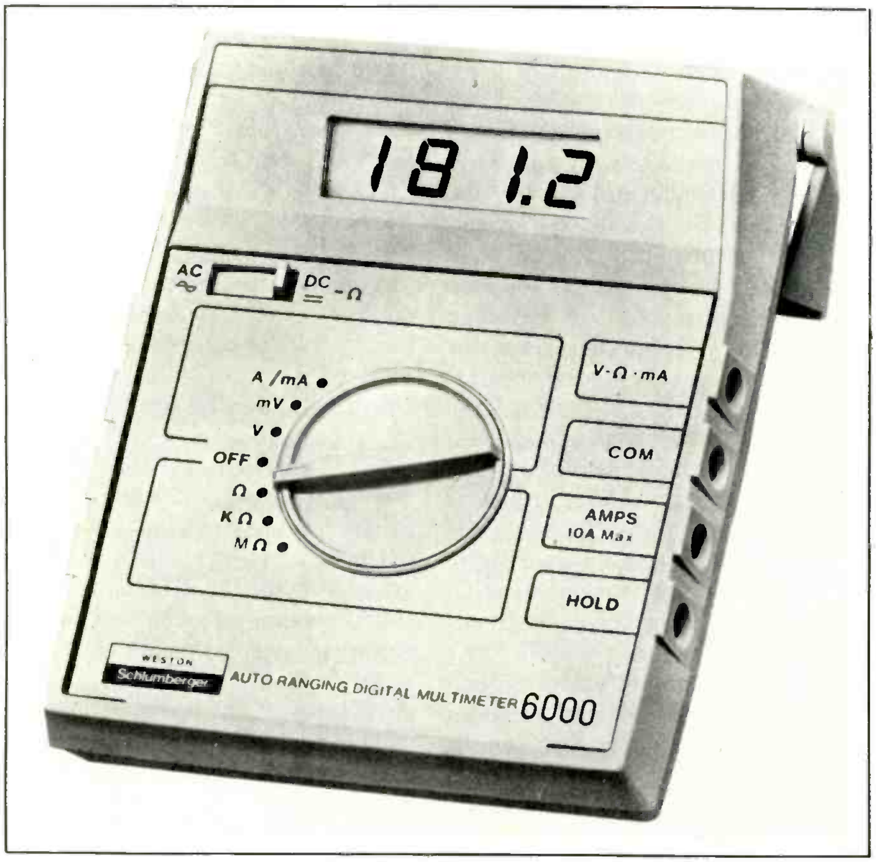


Fig. 1—The new Weston Model 6000 Autoranging Digital Multimeter, that features a 3½ digit liquid crystal display, and covers voltage, current and resistance in 26 ranges. Circle Number 156.

■ The new auto-ranging and auto-zeroing digital multimeter, Model 6000, from Weston, is a portable, self-contained instrument with a liquid crystal 3½ digit readout. Designed for use on the bench or in the field, the Model 6000 combines the convenience and accuracy of automatic digital measurements with the economy and broad-range coverage of analog VOMs.

Five AC and DC voltage ranges, five AC and DC current ranges and six resistance ranges—a total of 26 ranges—are provided by the Model 6000's auto-ranging circuitry and its six switch-selectable measurement functions: volts, millivolts, milliamperes, amperes, ohms, kilohms and megohms. The 0-200 mV and 0-200 ohms ranges are selected by separate positions on the function switch, while selection of either AC or DC measurements is accomplished by a two-position slide-type switch.

The Model 6000 also offers a 'Display Hold' feature that allows a given reading to be retained indefinitely after the probe is removed from the circuit. With the use of an optional 'Hold Probe,' or a user-furnished SPST switch, the technician can concentrate on the placement of the test probe in crowded or hazardous circuitry and still be able to read the display after the probe is withdrawn.

A reflective, field-effect liquid crystal display provides readability over a wide range of ambient light levels. The height of the display numerals is 0.5 inch.

A single pair of banana-type

continued on page 54

SPECIFICATIONS

WESTON MODEL 6000 AUTORANGING DIGITAL MULTIMETER

DC VOLTAGE
Ranges: +199.9 mV, +1.999V, +1000V
Accuracy: (90 days, 23°C +5°C) 0.35% Rdg.+2d
Input Impedance: 10 MΩ, all ranges
Resolution: 100 µV
Overload Rating: 1500 V peak

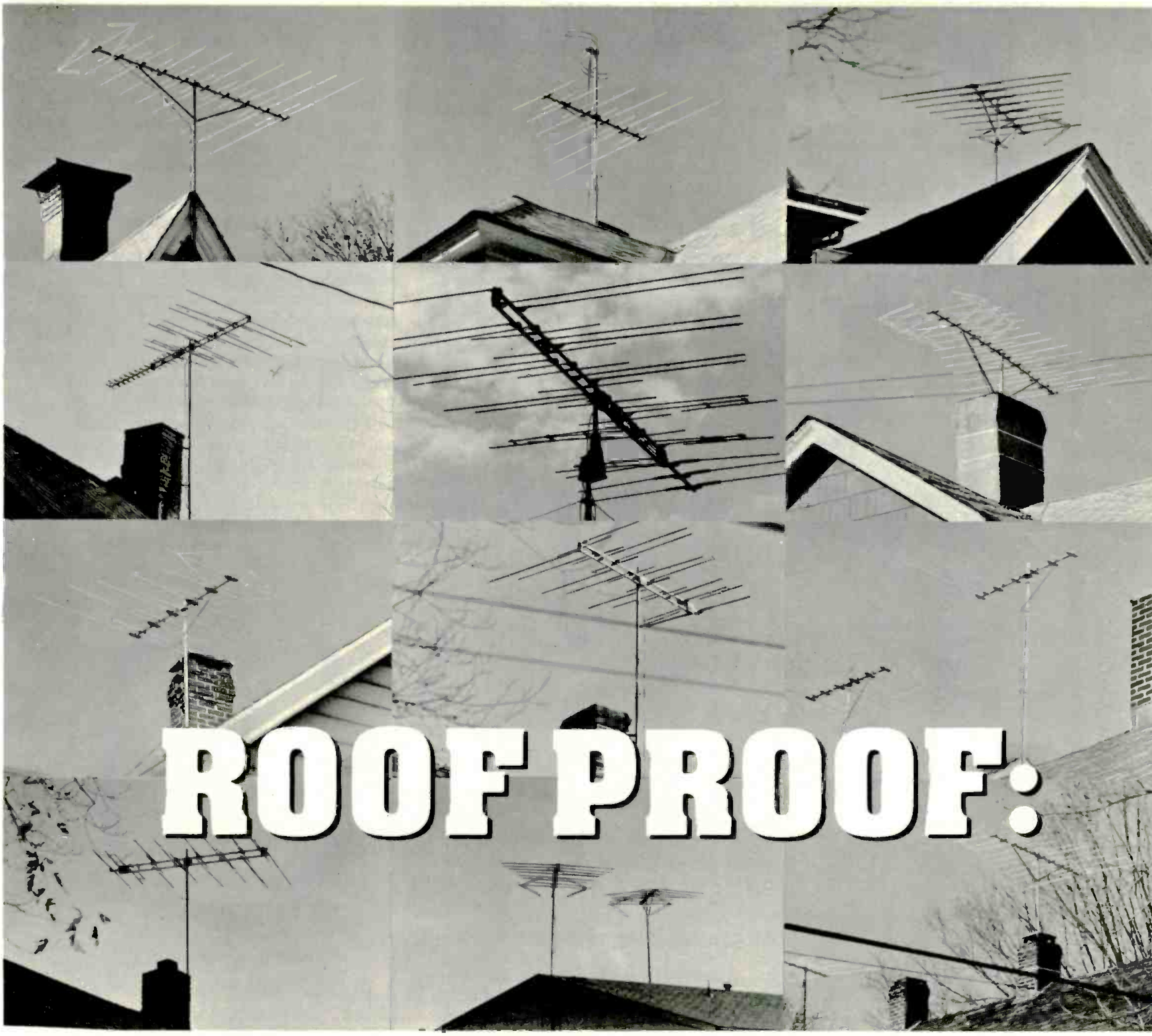
AC VOLTAGE
Ranges: 199.9mV, 1.999V, 1000V
Accuracy: (90 days, 23°C+5°C) 0.5% Rdg.+5d, 40 to 400 Hz, + (2% Rdg. +5d) for 1000 VAC range.
Input Impedance: 9 MΩ /39pF
Resolution: 100µV
Overload Rating: 1000 V (1500V peak)

DC CURRENT
Ranges: +1.99 mA, +19.99 mA, +199.9mA, +1.999 A, +19.99 A
Accuracy: (90 days. 23° C+5° C) 0.75% Rdg. +3d
Input Impedance: 10Ω, except 0-2A/10A ranges: 0.01 ohm input, 15A maximum
Resolution: 1 µA
Overload Rating: 1/4 A /250 V fuse, except 0-2A/10A ranges: 0.01 ohm input, 15A maximum

AC CURRENT
Ranges: 1.999 mA, 19.99 mA, 199.9 mA, 1.999 A, 19.99 A
Accuracy: (90 days, 23°C+5°C) 1.5% Rdg. +5d, 40 to 400 Hz, +2% Rdg. 5d for 0 to 1000 VAC range
Input Impedance: 10 Ω, except 0-2A/10A ranges; 0.01 ohm input, 15A maximum
Resolution: 1µ A
Overload Rating: 1/4 A/250V fuse, except 0-2A/10A ranges: 0.01 ohm input, 15A maximum

RESISTANCE
Ranges: 199.9Ω, 1.999 KΩ, 19.99 KΩ, 199.9 KΩ, 1.999 MΩ, 19.99 MΩ
Accuracy: 0.5% Rdg. +1d, +1% Rdg.+ 2d and 2000 ppm/°C for 200 Ω range
Resolution: 0.1Ω
Overload Rating: 250V (350V peak)

GENERAL
Operating Power: Two 9V "transistor" batteries
Battery Life: 200 operating hours (350 hours with alkaline batteries)
Size: 7" x 5.75" x 2.25"
Weight: 22 oz., incl. batteries
Price: $195



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The right combination for every location

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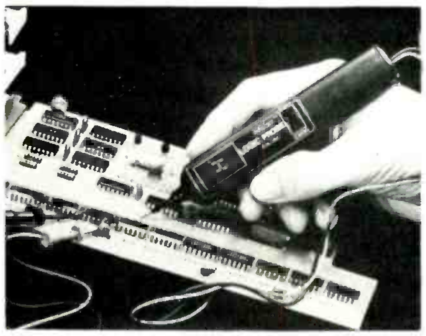
...for more details circle 109 on Reader Service Card

NEW PRODUCTS

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

LOGIC PROBE 138

A new logic probe that tests both TTL/DTL and CMOS logic systems has been introduced by *Control and Information Systems*. Called the Probit, the device detects pulses down to 35 nano-seconds and accurately checks for valid and abnormal logic levels. No loading is added to the circuit under test because of a high input impedance, and protection against over-voltage inputs is provided along



with reverse voltage protection to 100V. A seven segment display indicates "H" for logic high, "L" for logic low and a period for pulse detection. Display is blank for abnormal logic levels. Micro-hooks are used for test connection and the probe tip is detachable. Priced at $34.95.

CEILING LOUDSPEAKERS 139

Decorator-styled ceiling loudspeakers, pre-packaged to look and install like recessed lighting, are being introduced by *Atlas Sound*. The new DC-10 series loudspeakers are completely factory-assembled including backbox, an installation frame that acts as template for acoustic ceiling tile, a

5-inch loudspeaker, and decorative diffuser ring. Recessed torsion-spring mounting eliminates visible hardware. The finish of the assembly is brushed aluminum with circular diffuser in matte black. Power handling capacity of the speaker is 10 watts and frequency range extends from 225 to 12,000 Hz.

SHIELDED POWER CORDS 140

Two versions of new, UL-listed shielded power cords and cord set, designed to minimize electronic interference in power supplies of business machines and test equipment, have been introduced by *Belden*. The new cords reduce the need for filtering devices on sensitive electronic test equipment and office machines, such as microprocessors. Two types of shielding are available—Beldfoil with a drain wire, or copper serve shielding. Beldfoil consists of aluminum/polyester film wrapped around the conductors. Copper serve shielding is

formed by spiralling copper wire around the conductors. Cords are SJT-type, 14 to 18 gage, with three stranded copper conductors. Heavy-duty vinyl plugs are molded onto the cords.

WIRELESS RADIO LINK ALARM SYSTEM 141

A new wireless radio link alarm system that utilizes frequency shift keying (FSK) to eliminate interference-caused false alarms has been introduced by *Mountain West Alarm*. The brains of the system, the L4 receiver/control, can accept alarm signals from any number of L4 panic or alarm transmitters. The control contains a loud siren and has terminals to connect an external 12V standby battery and a 12 VDC bell. Features include: on/off power switch, delayed instant mode switch, entry time delay, reset button, and entry and exit time delays. Designed for use in small homes,

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Sencore TF40 Pocket Cricket Portable Transistor & FET Tester

One simplified, safe test for all transistors and FETs. 99.9% reliable with complete leakage test on meter. And the Pocket Portable is the only one that has it. No set-up information is needed. Total test takes seconds. Identifies transistor polarity, FET or bipolar transistor. Identifies all 3 leads everytime. Includes test tone indicator.

CB41 Portable CB Performance Tester

Tests SWR, RF power and % modulation. Tells if a CB rig is getting out as far as possible . . . if it needs servicing.

CB42 Total CB Automatic Analyzer

The complete CB service bench, simplified for quick troubleshoot ng and performance testing. Performs 12 receiver tests; 12 transmitter tests. Single digital readout for all tests. Combines five units in one: 1) Frequency Counter; 2) RF-IF Generator; 3) Audio Generator; 4) Digital RF Wattmeter; and 5) special CB Tester.

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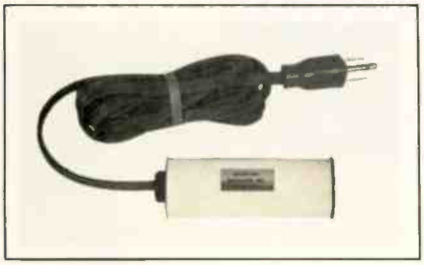
apartments and office, the new system is priced at $335.

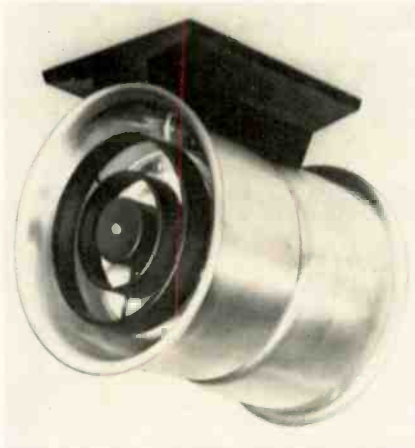
CB POWER LINE FILTER 142

A new CB power line filter has been introduced by *Electronic Specialists*. The new filter has been designed for use where CB interference enters TV, FM or stereo equipment through the power line. This 100 watt unit can bring the filter as close to the equipment as needed, and is also useful in some CB base installation where interference enters the power line directly from the CB equipment. The 2-connector model is priced at $10.50 and the 3-conductor model at $13.50.



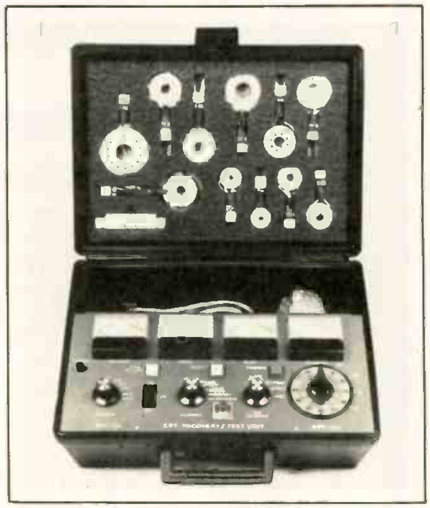
TWIN BIDIRECTIONAL LOUDSPEAKER 143

A new 30 watt bi-directional loudspeaker with individual volume selectability of up to 15 watts in each direction is being introduced by *Atlas Sound*. The all-metal loudspeaker, model APT-15, is designed for both indoor and outdoor installation in large open spaces, hallways, or corridors. Each speaker includes two complete compression-drivers and re-entrant assemblies and provides up to 15 watts of individually adjustable power output in each direction. Housing is of heavy gauge brushed aluminum with black diffusers. Includes mounting base and subplate.



CRT RECOVERY/TEST SET 144

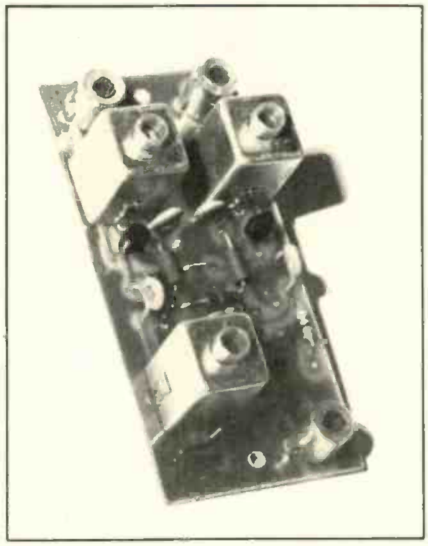
A new CRT Recovery/Test Set for testing and rejuvenating TV picture tubes is being introduced by *SYT Electronics*. The new unit, Model 84-1/A, is said to use lower filament voltages,



lower restoration currents, and a longer restoration cycle to restore gun structures in color and black and white TV. Model 84-1/A, in the test function, checks the color guns simultaneously; with emission characteristics displayed on separate meters. The unit includes a Life Test Function, and comes complete with 13 separate test adapters. A self-test adapter is also included for checking the unit's performance.

PULSE-SWEEP FUNCTION GENERATOR 145

A new function generator that offers sine, triangle, and square wave outputs is being introduced by *Helectronix*. Designated Model L-15, the unit is also a pulse generator offering a variable duty cycle pulse. All outputs are short circuit proof and capable of being swept. The voltage controlled sweep input at the back of the instrument allows a precise sweeping of all three outputs. Frequencies of lower than 1Hz and greater than 100 KHz are obtainable with minor adjustments. Priced at $75.

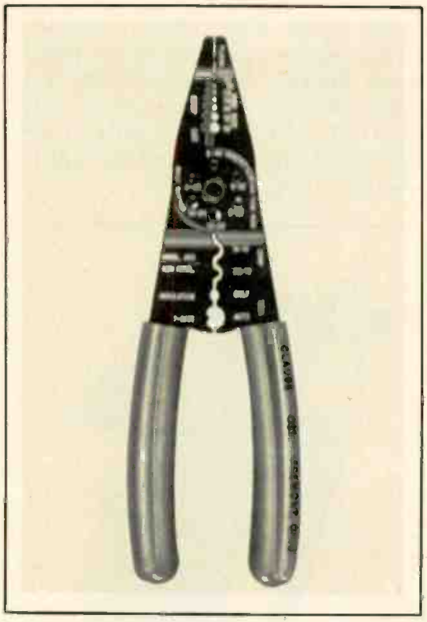


RECEIVE MULTICOUPLER 146

A new dual output FET preamplifier which provides low noise gain and power splitting to drive two receiver inputs from one antenna has been introduced by *Hamtronics Inc*. The new unit, called the P13 Receive Multicoupler Unit, gives about 15 dB of gain in each of the two channels. If desired, outputs can be on somewhat different parts of the band with some reduction in gain. Standard models are available for any segment of the 26-230MHz vhf range. Prices are: $12.95 for the P13 Receive Multicoupler kit; $24.95 for the P24 wired and tested model; and $49.95 for the P50 model, housed in a die-cast box with BNC connectors.

WIRE CUTTER-CRIMPER TOOL 147

A new wire cutter-crimper tool that performs seven different tasks for professional and home use is now available from *Clauss Cutlery Company*. Called the Model CS-8 cutter/crimper, the new tool features a compact design to allow work in cramped quarters. The features include: scissors action and stripping ability; bolt cutter for sizes 4-40 and 10-24; crimp stations for non-insulated electrical wire sizes



7mm to 12-x0 and insulated wire size 2w-20 to 12-10. The CS-8 also has a serrated jaw needle-nose plier and an "up front" wire cutter for tight spaces, and a hardened pivot bushing for easy, precise adjustment.

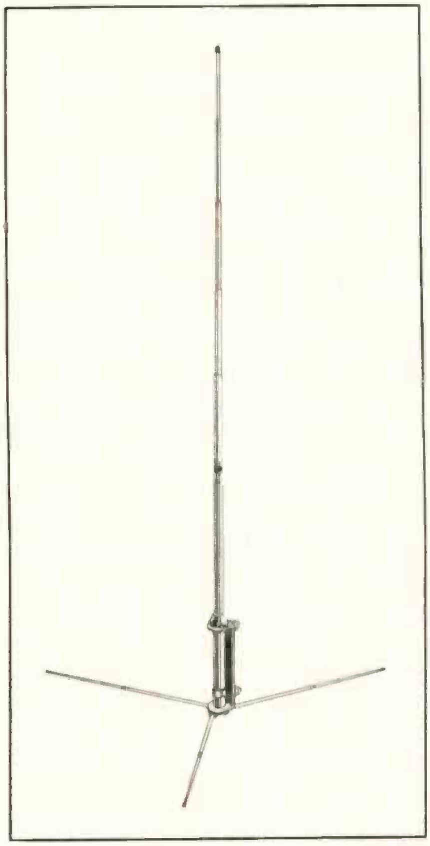
DIGITAL MULTIMETERS 148

Two new five-function digital multimeters that offer a 30,000 count display, large half-inch digits, automatic or manual range selection, high/low ohms, and 2 or 4-terminal resistance measurements have been introduced by *Keithley Instruments*. Both of the units—models 172 and 173—measure DC voltages from 10μV per digit to 1200 volts, AC voltages from 10μV to 1000 volts rms and resistance from 10

milliohms per digit to 300 megohms. The units differ only in their current measuring capability. The 172 handles AC and DC currents from 10μA/digit to 2 amps while the 173 offers a broader span of 10 nanoamps/digit to 3 amps. Both are fully overload protected. Model 172 sells for $499 and Model 173 sells for $625.

CB BASE STATION ANTENNA 149

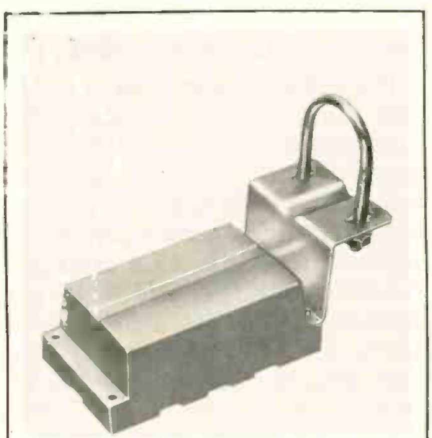
A new CB base station antenna, based on the .64 wavelength principle used in commercial broadcast practice, has been introduced by *New-tronics Corporation*. The new design of the Hustler "Super Swamper" Model 27-TD is in line with FCC rules



changes that permit greater antenna heights for CB Radio. The .64 wavelength, 22 ft. radiating element of the antenna is said to substantially improve performance to extend AM and SSB two-way, all directional radio communications over greater distances. The "Super Swamper" also has extremely low SWR for total coverage of existing and proposed CB channel expansion operation. Price is $52.95.

ANTENNA COUPLER 150

A new antenna coupler, designed to combine signals from separate 300 ohm VHF and UHF antennas into a single 75 ohm output, is introduced by the *Winegard Company*. The input connections on the new coupler, Model CA-2830, are 300 ohm no-strip screw type and the output is a standard 75 ohm F-type connector. Model CA-2830 features a low insertion loss. On VHF, it averages −.6cB and on UHF it averages −1.5dB. The coupler also has an excellent match, 1.2:1 at VHF and 1.3:1 at UHF. Isolation is high, 30dB or greater on both VHF and UHF. It is AC/DC passive on the VHF side. Model CA-2830 lists at $13.75.

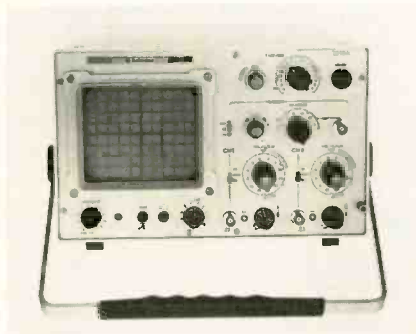


FUNCTION GENERATOR 151

A new low-price function generator, available in kit form, or wired, is offered now by the *A E Corp*. Designated Model 12, the new unit features simultaneous sine, triangle and squarewave outputs, with 0 to 20 Vpp amplitude. The selectable output has continuously adjustable dc offset and will drive 5 Vpp into 50 ohms. The frequency range covers 1 Hz to 1 MHz with 200 PPM/°C frequency stability. The sine wave distortion is less than 2% from 1 Hz to 100 KHz. External frequency sweeping permits FM control of all waveforms. The kit price is $79.95, and wired, it is priced at $124.95.

DUAL-CHANNEL OSCILLOSCOPE 152

A new dual-channel oscilloscope with a vernier on the two vertical amplifier range switches has been introduced by *Ballantine Laboratories*. Designated the Model 1010A, the new scope has a 10 MHz bandwidth and 2 mV/cm sensitivity. It fullfills field



service, maintenance and production test requirements for industrial, commercial and government applications. Model 1010A has a maximum sweep speed of 1 us/cm, expandable to 100 ns/cm with a X100 magnifier.

Trigger coupling is ac, ac fast (low frequency reject) and TV frame. The triggering source can be internal or external. It is capable of X-Y operation and its passband in this mode is dc to 500 kHz. Priced at $595.


TEST LEAD RACKS

TEST LEAD BENCH RACKS 153

A new series of bench racks to hold test leads, cords, co-ax cables, BNC plugs and adapters, as well as round chassis punch sets, are now available from *Herman Smith, Inc.* The new racks have been designed for laboratory, test station and service bench. Included are three racks for test leads, patch cords, jumpers and co-ax cables with cable diameters up to 7/32 in., in 7-slot, 14-slot and 21-slot models. The racks can be mounted side by side in mixed lengths to suit any space requirement. Width is 3-¾ in.

AC LINE FILTER FOR CB 154

A new AC line filter, designed to overcome television interference caused by CB transmission through AC power lines, has been introduced by *Avanti Research*. The new filter, AV-820, is installed at the CB transmitter or at the TV set. The unit plugs into a wall receptacle and has a receptacle for the TV or CB plug-in.

TEST INSTRUMENT REPORT

continued from page 46

input jacks on the right-hand side of the Model 6000 handle all functions except the current-measuring ranges, which are provided through a separate jack.

Two disposable, 9-volt zinc carbon batteries provide more than 200 hours of operation, and circuitry is included that gives a "low battery" warning during the final 10 hours of battery life.

Model 6000 is housed in a tough polycarbonate plastic case which features a carrying handle that folds forward to provide protective cover for the display window and, in addition, can be folded backward to serve as a stand for bench-top viewing. A color-coded range plate is easily removed for battery replacement and access to the input fuse.

The price of the Weston Model 6000 is $195.00. A high-voltage probe is also available on an optional basis. ■

LUMINANCE CIRCUITS

continued from page 18

nance circuitry is usually the cause of brightness problems, it should be remembered that troubles in other circuits can sometimes cause the same kind of symptoms. For example, a severe AGC overload could cause the screen to "black out" completely—or a power supply failure could produce excessive or low brightness—or low emission, an internal short, or open filaments in the CRT could cause brightness changes.

Checking the Luminance Circuit

If the AGC is operating properly and there is high voltage, the luminance circuits should be checked out. Modular circuitry makes this task relatively simple because it mainly is a matter of module substitution. For example, substituting the Video Delay module replaces most of the luminance circuit components. The next step is to substitute the IF module which contains the Video Detector and the Video Output transistor. If the trouble is not corrected, the RGB module should be substituted, and finally, the last of the four possible modules is the Chroma module. This contains the Blanker and related components which can cause brightness problems when defective.

If substitution of these four modules does not solve the problem, the trouble is with either the main PC board components or the power supplies. This usually can be determined with a few voltage checks.

CRT Voltages

All voltages on the CRT socket board, which is mounted directly to the base of the picture tube, can be measured directly on the socket pins, except for the anode voltage. With the negative lead of the meter grounded to the chassis, the CRT grid should read 50V. This is a fixed voltage and should remain constant. The CRT cathodes, pins 3, 8 and 12 (Fig. 4), should read between 115V and 170V, depending on the setting of the Brightness control and the background controls. Other voltage checks are included in the Brightness Troubleshooting Guide in Fig. 5.

Intermittent Problems

Troublesome intermittent problems with the T991 chassis can usually be localized by wiggling, tapping, and pulling wire bundles, boards, modules and sockets until a sensitive area is located. Intermittents will usually be caused by one or more of the following: broken or crystalized solder connections, loose plug and socket connections, broken wires, or corroded module or switch contacts. Problems that can't be visually observed will probably require the cleaning or replacement of a switch, or the tightening of all pins on a plug.

Because so many circuits are involved, brightness problems represent a good percentage of TV problems. In modular construction, such as with the T991 chassis, troubleshooting boils down to just a couple of steps—module substitution and systematic DC voltage checks of the luminance and CRT circuits—plus one more important ingredient—a thorough understanding of how the circuits work. ■

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REPLACEMENT COLOR YOKES-DEALERS ONLY. Zenith 95-2501-2532-2638-2667-S89633 etc. $14.95. Magnavox 361380-1 $18.95 etc. Sylvania, G.E. etc. $14.95 to $19.95. Request for price list on your letterhead. David Sims Enterprises, Inc., 665 Jerricho Turnpike, Huntington Station, N.Y. 11746. TF

Fully depreciated test instruments we no longer need. Write or call for list and prices. Frazier Electronics, 105 Church St., Fredericktown, MO 63645. 314-783-5732. 4/77

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

RF Sig. Gen. Knight 83Y145 $18.00; Audio Gen. Knight 83Y137 $18.00; Audio Voltmeter RCA WV-73A $18.00; Freq. Meter LM-13 $30.00; Freq. Meter TS-175/U $40.00; Heath TV Align. Gen./SWP TS-4A $25.00; Heath TV Post Marker/SWP Gen. IG-57A $80.00, all postpaid. Rubarts, Route 2, Box 104-B, Blountsville, AL 35031. 3/77

CB ENGINE NOISE AND TV INTERFERENCE STOPS HERE: Free brochure describes nine **EMI-LINE** filters providing complete coverage of mobile engine noise and base TV interference problems. Easy do-it-yourself installation. Dealers wanted. Marine Technology, ET. 2780 Temple Ave., Long Beach, CA 90806. (213) 427-6443. 3/77

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

TEN FIXES for b/w, color TV's. Send $1.00 and SASE to: **TERRY**, Box 209A, Park Ridge, Illinois 60068 (Out-of-state residents only). 3/77

OFFICIAL IRS TAX AUDIT GUIDE BOOKS I AND II, $11.55. Order from J. Fowler 145 N. Douglas, Los Angeles, California 90026. 4/77

RCA EXACT REPLACEMENT PARTS. Largest stock. Green Tele-Radio Distributors, 172 Sunrise Highway, Rockville Centre, NY 11570. UPS, C.O.D. 4/77

READER SERVICE INDEX

ADVERTISER'S INDEX

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ELECTRONIC TECHNICIAN/DEALER
TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 4 NEW SETS

GROUP 295

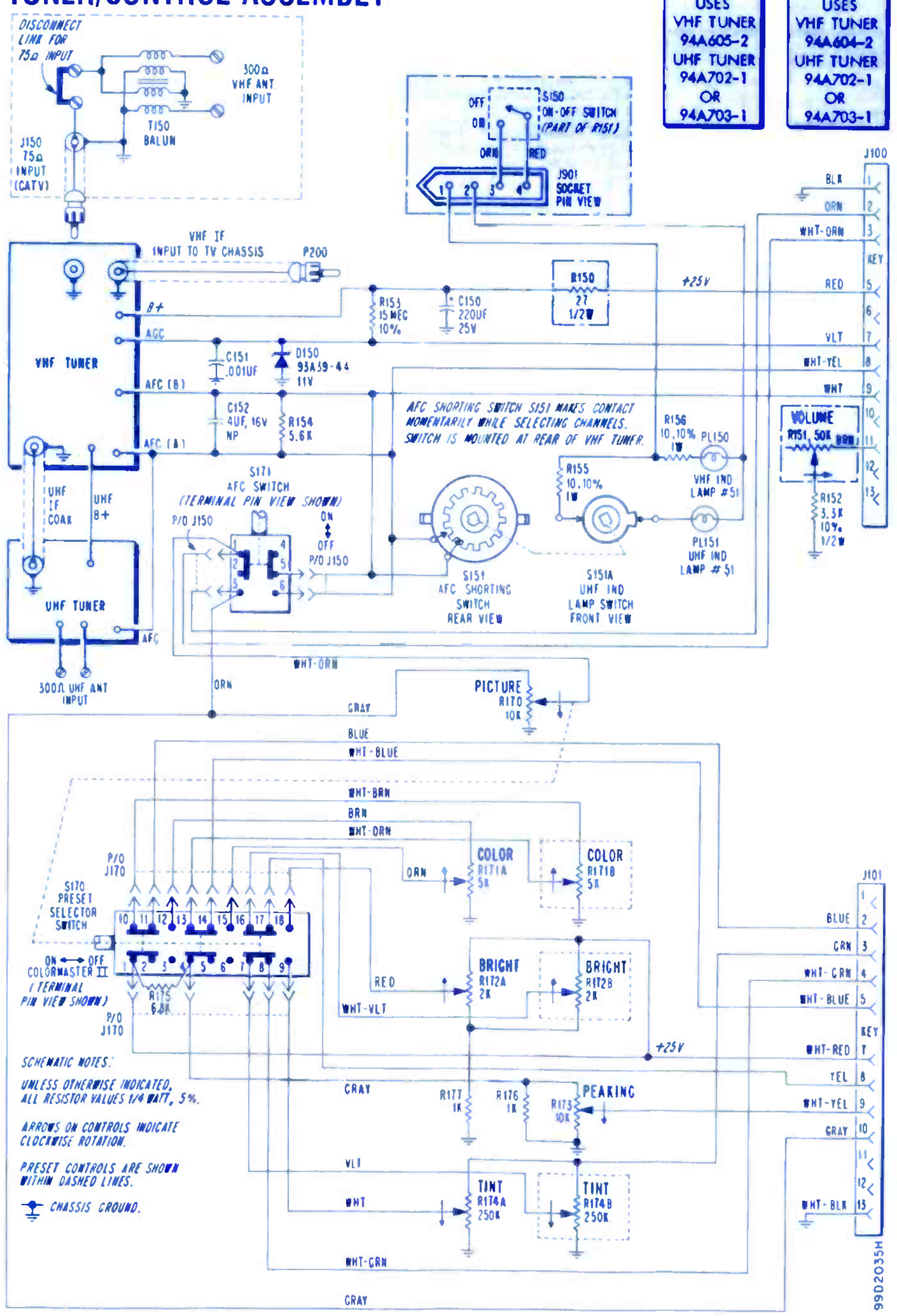
1683

ADMIRAL
Color TV Chassis 9M50

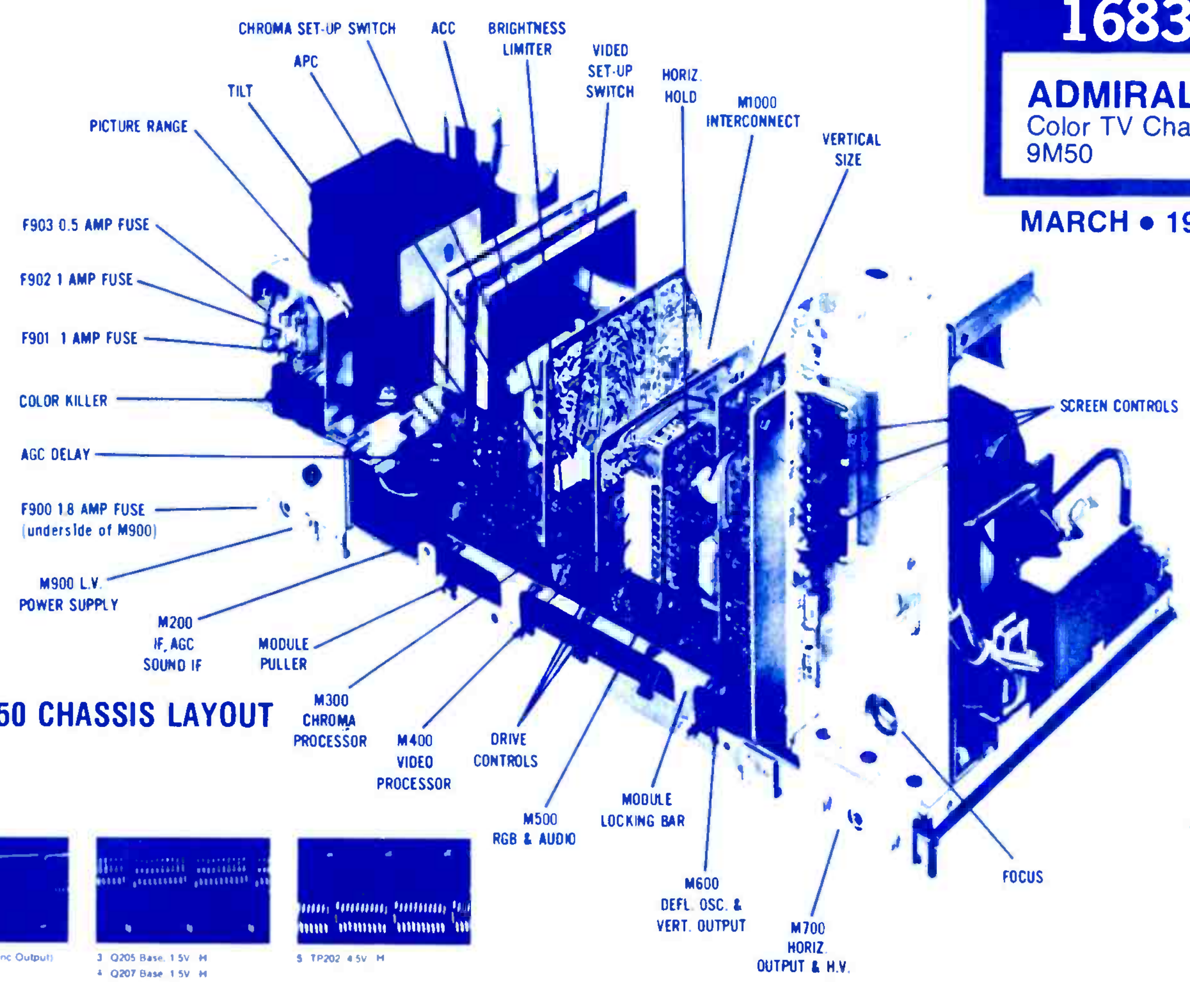
MARCH • 1977

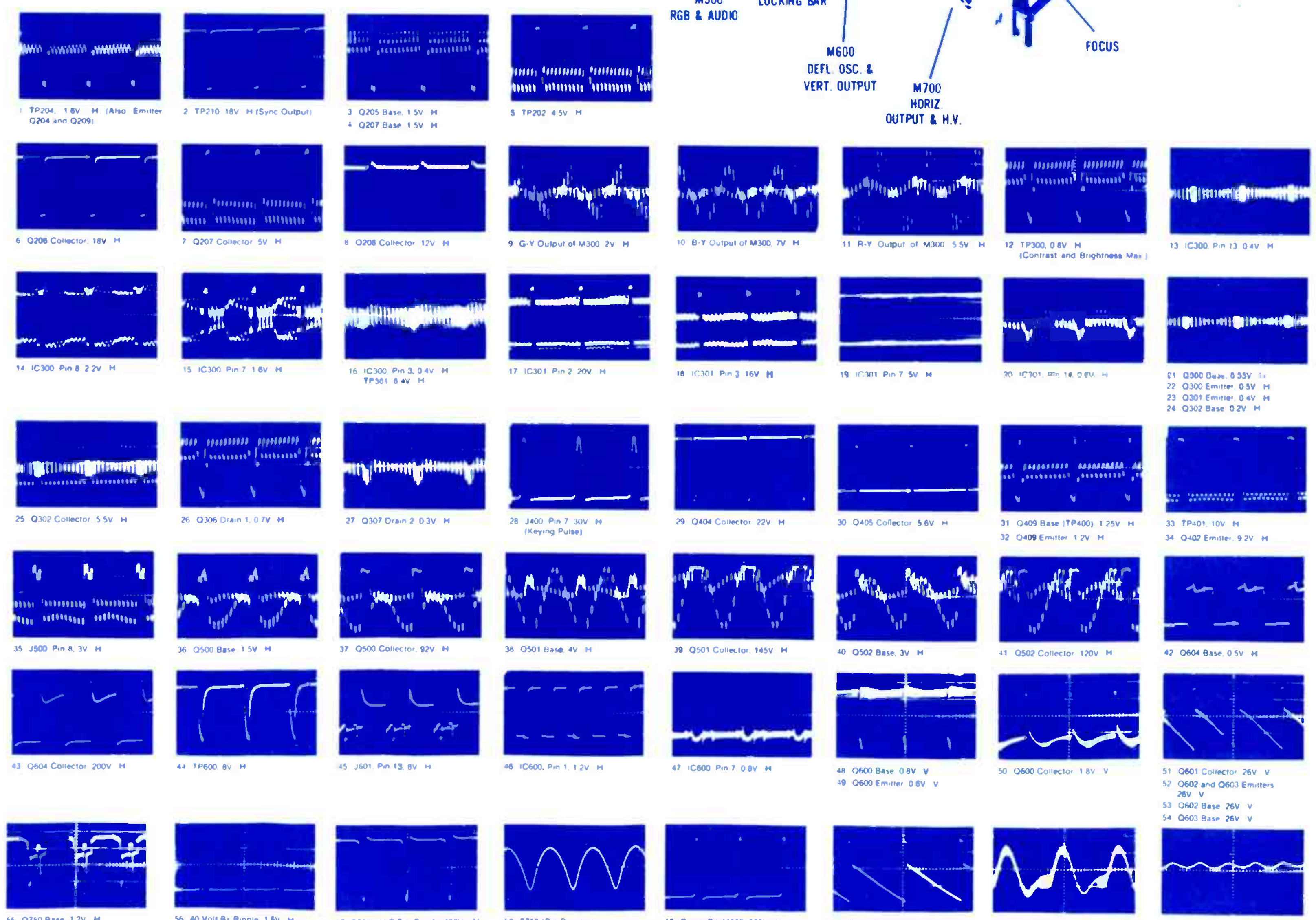
TUNER/CONTROL ASSEMBLY

NC2832-1 USES	NC2838-1 USES
VHF TUNER 94A605-2 UHF TUNER 94A702-1 OR 94A703-1	VHF TUNER 94A604-2 UHF TUNER 94A702-1 OR 94A703-1



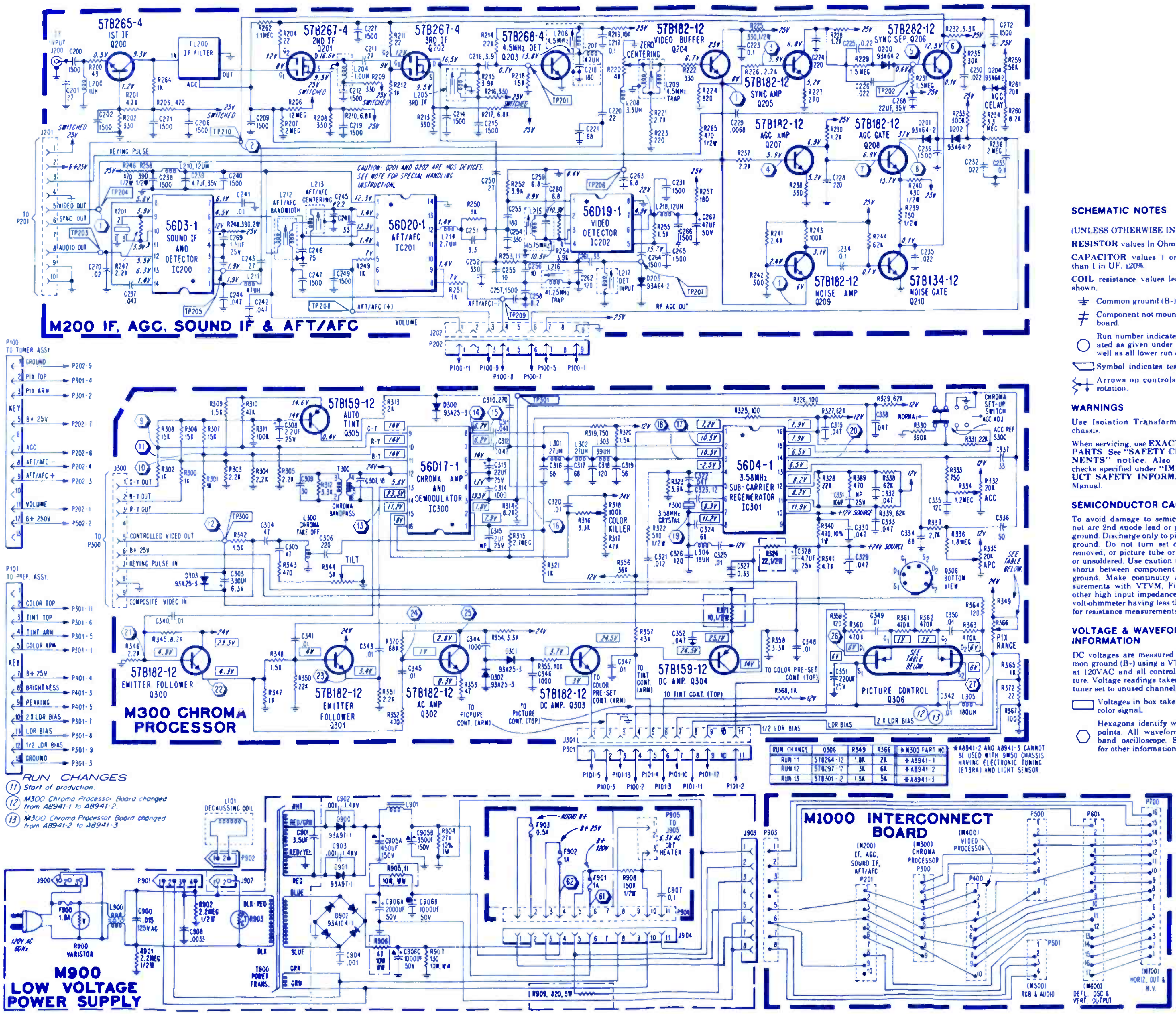
9M50 CHASSIS LAYOUT





1 TP204, 1.8V H (Also Emitter Q204 and Q209)
2 TP210 18V H (Sync Output)
3 Q205 Base, 1.5V H
4 Q207 Base 1.5V H
5 TP202 4.5V H
6 Q208 Collector, 18V H
7 Q207 Collector 5V H
8 Q208 Collector 12V H
9 G-Y Output of M300 2V H
10 B-Y Output of M300, 7V H
11 R-Y Output of M300 5.5V H
12 TP300, 0.8V H (Contrast and Brightness Max.)
13 IC300 Pin 13 0.4V H
14 IC300 Pin 8 2.2V H
15 IC300 Pin 7 1.8V H
16 IC300 Pin 3, 0.4V H TP301 0.4V H
17 IC301 Pin 2 20V H
18 IC301 Pin 3 16V H
19 IC301 Pin 7 5V H
20 IC301, Pin 14, 0.8V, H
21 Q300 Base, 0.55V H
22 Q300 Emitter, 0.5V H
23 Q301 Emitter, 0.4V H
24 Q302 Base 0.2V H
25 Q302 Collector, 5.5V H
26 Q306 Drain 1, 0.7V H
27 Q307 Drain 2 0.3V H
28 J400 Pin 7 30V H (Keying Pulse)
29 Q404 Collector 22V H
30 Q405 Collector 5.6V H
31 Q409 Base (TP400) 1.25V H
32 Q409 Emitter 1.2V H
33 TP401, 10V H
34 Q402 Emitter, 9.2V H
35 J500, Pin 8, 3V H
36 Q500 Base 1.5V H
37 Q500 Collector, 92V H
38 Q501 Base, 4V H
39 Q501 Collector, 145V H
40 Q502 Base, 3V H
41 Q502 Collector 120V H
42 Q604 Base, 0.5V H
43 Q604 Collector 200V H
44 TP600, 8V H
45 J601, Pin 13, 8V H
46 IC600, Pin 1, 1.2V H
47 IC600 Pin 7 0.8V H
48 Q600 Base 0.8V V
49 Q600 Emitter 0.6V V
50 Q600 Collector 1.8V V
51 Q601 Collector 26V V
52 Q602 and Q603 Emitters 26V V
53 Q602 Base 26V V
54 Q603 Base 26V V
55 Q750 Base 1.2V H
56 40 Volt B+ Ripple 1.5V H
57 T700 (H.O.T.) Pin 5 120V H
58 T750 (Pin Reactor) Pin 6 50V H
59 Point B M800 200V H
60 Point C M800 25V V
61 120V B+ Ripple 1.0V V
62 25V B+ Ripple 0.1 V

ADMIRAL
Color TV Chassis
9M50



RUN CHANGE	Q306	R349	R366	*M300 PART NO
RUN 11	57B264-12	1.8K	2K	*A8941-1
RUN 12	57B297-12	3K	6K	*A8941-2
RUN 13	57B301-2	1.5K	5K	*A8941-3

*A8941-2 AND A8941-3 CANNOT BE USED WITH 9M50 CHASSIS HAVING ELECTRONIC TUNING (ET3RA) AND LIGHT SENSOR

SCHEMATIC NOTES

(UNLESS OTHERWISE INDICATED):

RESISTOR values in Ohms, ±5%, 1/4W.

CAPACITOR values 1 or higher in PF, less than 1 in UF, ±20%.

COIL resistance values less than 1 Ohm, not shown.

- Common ground (B-)
- Component not mounted on printed circuit board.
- Run number indicates change(s) incorporated as given under that run number, as well as all lower run changes.
- Symbol indicates test point connections.
- Arrows on controls indicate clockwise rotation.

WARNINGS

Use Isolation Transformer when servicing chassis.

When servicing, use **EXACT REPLACEMENT PARTS** See **"SAFETY CRITICAL COMPONENTS"** notice. Also perform all safety checks specified under **"IMPORTANT PRODUCT SAFETY INFORMATION"** in Service Manual.

SEMICONDUCTOR CAUTIONS

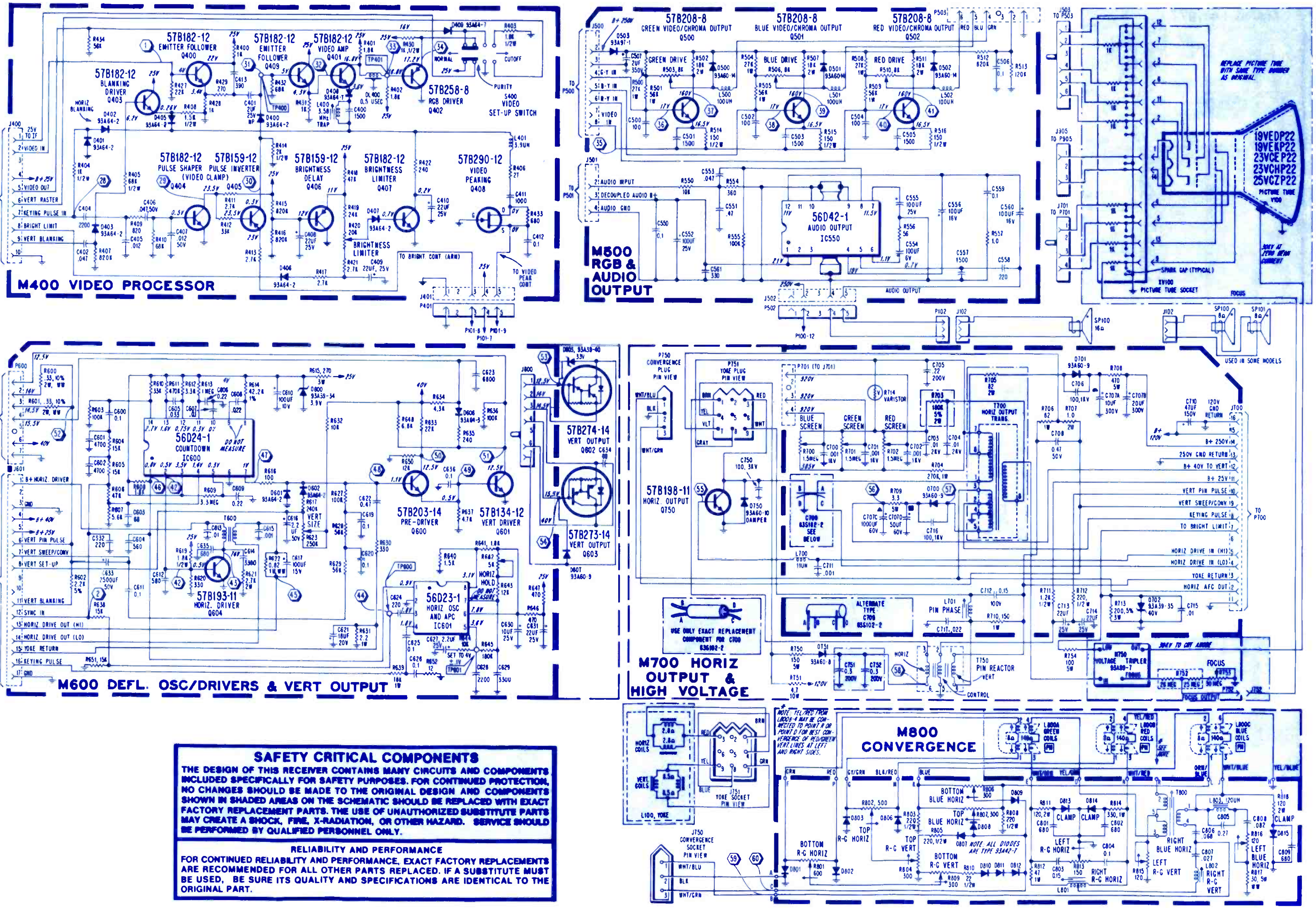
To avoid damage to semiconductor devices, do not arc 2nd anode lead or picture tube anode to ground. Discharge only to picture tube dag or dag ground. Do not turn set on with transistor(s) removed, or picture tube or other leads removed or unsoldered. Use caution to prevent accidental shorts between component leads or to chassis ground. Make continuity and resistance measurements with VTVM, Field Effect Meter, or other high input impedance meter. Do not use a volt-ohmmeter having less than 100K Ohms/Volt for resistance measurements.

VOLTAGE & WAVEFORM INFORMATION

DC voltages are measured with respect to common ground (B-) using a VTVM, line voltage set at 120VAC and all controls set for normal picture. Voltage readings taken without signal and tuner set to unused channel.

- Voltages in box taken with set tuned to a color signal.
- Hexagons identify waveform observation points. All waveforms taken with wide band oscilloscope. See waveform pages for other information.

ADMIRAL
Color TV Chassis
9M50



SAFETY CRITICAL COMPONENTS

THE DESIGN OF THIS RECEIVER CONTAINS MANY CIRCUITS AND COMPONENTS INCLUDED SPECIFICALLY FOR SAFETY PURPOSES. FOR CONTINUED PROTECTION, NO CHANGES SHOULD BE MADE TO THE ORIGINAL DESIGN AND COMPONENTS SHOWN IN SHADED AREAS ON THE SCHEMATIC SHOULD BE REPLACED WITH EXACT FACTORY REPLACEMENT PARTS. THE USE OF UNAUTHORIZED SUBSTITUTE PARTS MAY CREATE A SHOCK, FIRE, X-RADIATION, OR OTHER HAZARD. SERVICE SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

RELIABILITY AND PERFORMANCE

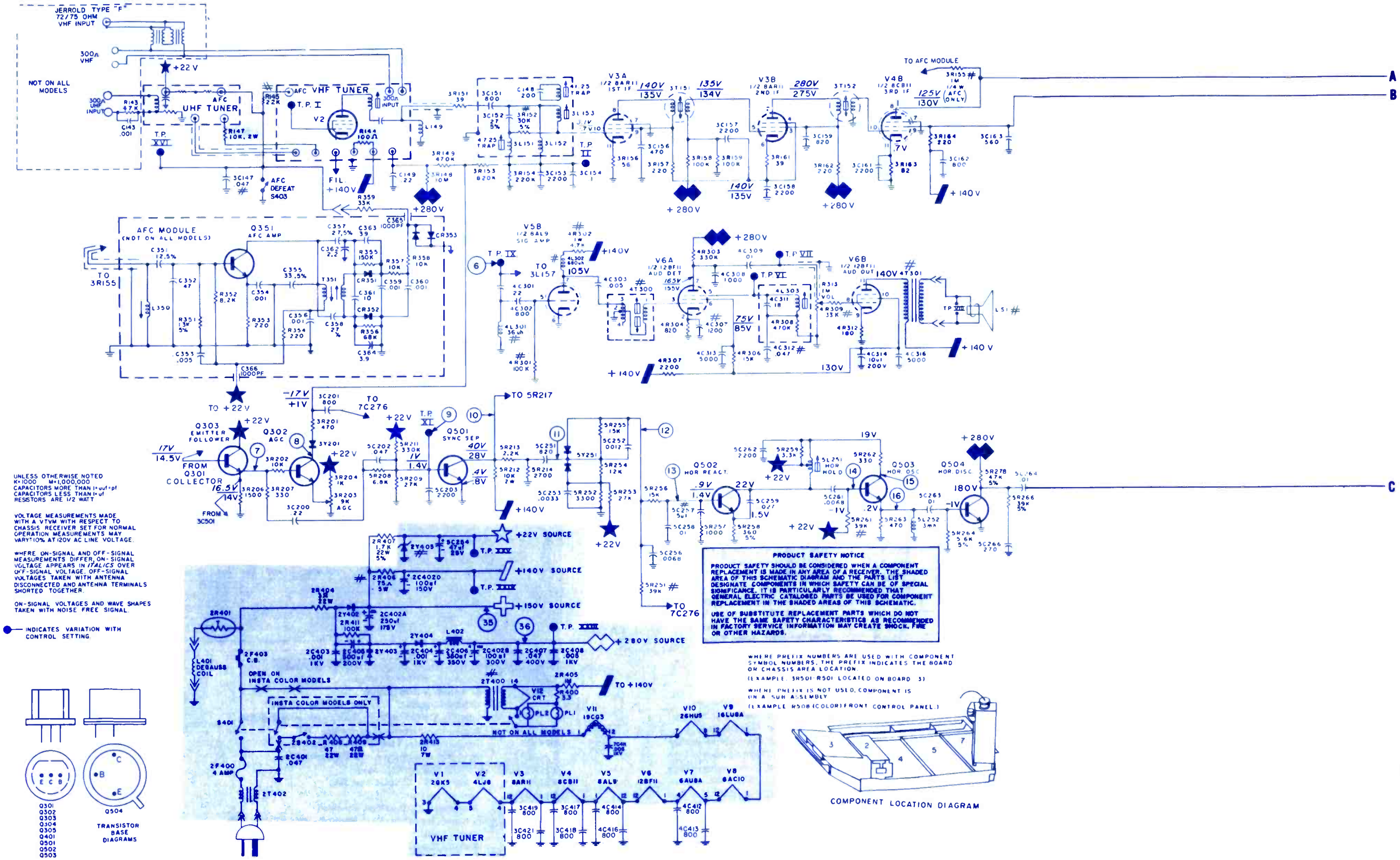
FOR CONTINUED RELIABILITY AND PERFORMANCE, EXACT FACTORY REPLACEMENTS ARE RECOMMENDED FOR ALL OTHER PARTS REPLACED. IF A SUBSTITUTE MUST BE USED, BE SURE ITS QUALITY AND SPECIFICATIONS ARE IDENTICAL TO THE ORIGINAL PART.

1684 GENERAL ELECTRIC Color TV Chassis CD/LB

MARCH • 1977

ELECTRONIC TECHNICIAN/DEALER TEKFAX

COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 4 NEW SETS



UNLESS OTHERWISE NOTED
K=1000 M=1,000,000
CAPACITORS MORE THAN 1=uuf=pf
CAPACITORS LESS THAN 1=uf
RESISTORS ARE 1/2 WATT

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

WHERE ON-SIGNAL AND OFF-SIGNAL MEASUREMENTS DIFFER, ON-SIGNAL VOLTAGE APPEARS IN *ITALICS* OVER OFF-SIGNAL VOLTAGE. OFF-SIGNAL VOLTAGES TAKEN WITH ANTENNA DISCONNECTED AND ANTENNA TERMINALS SHORTED TOGETHER.

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

●— INDICATES VARIATION WITH CONTROL SETTING.

PRODUCT SAFETY NOTICE

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

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.

WHERE PREFIX NUMBERS ARE USED WITH COMPONENT SYMBOL NUMBERS, THE PREFIX INDICATES THE BOARD OR CHASSIS AREA LOCATION.

(EXAMPLE. 3R501-R501 LOCATED ON BOARD 3)

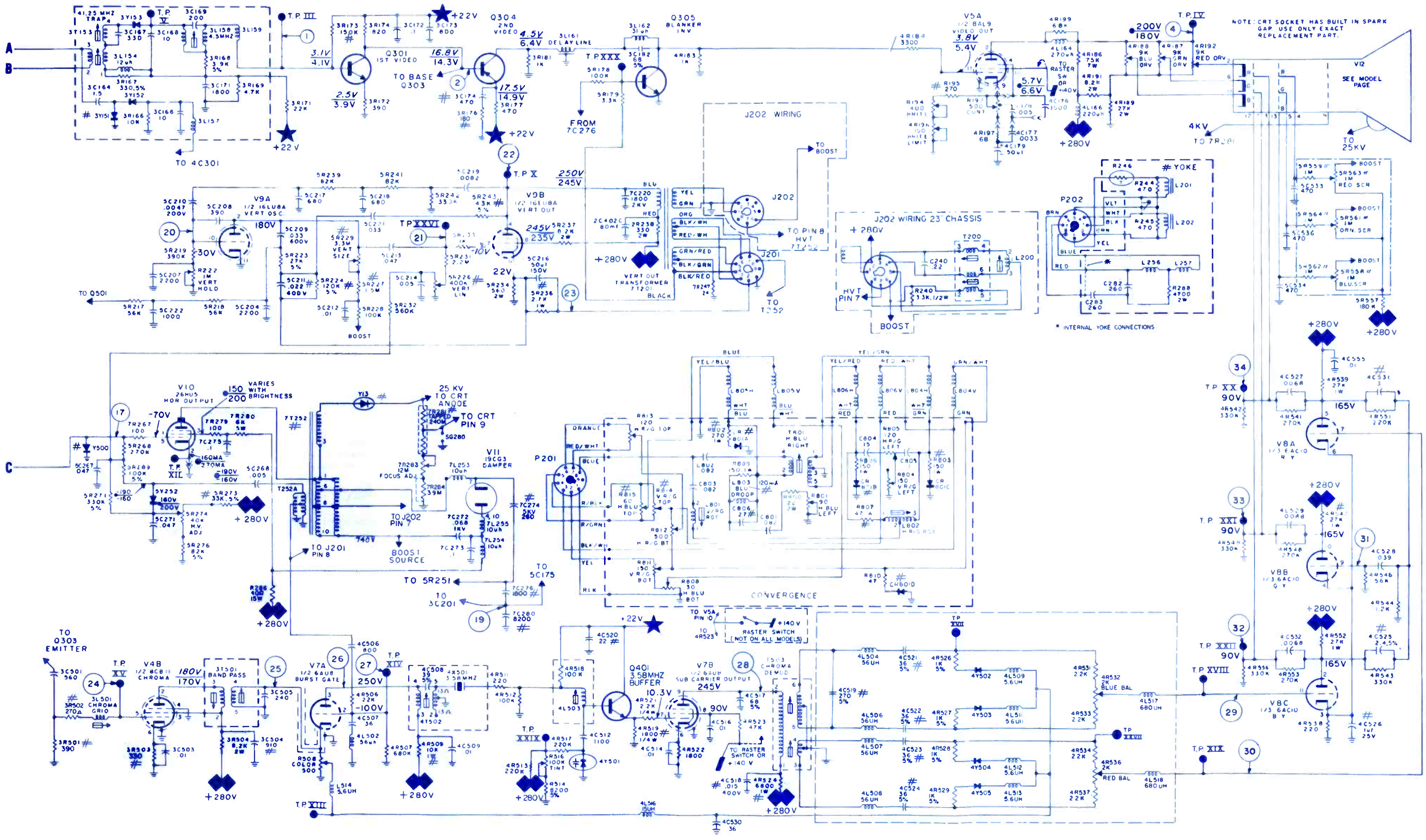
WHEN PREFIX IS NOT USED, COMPONENT IS ON A SUB ASSEMBLY

(EXAMPLE R508 (COLOR) FRONT CONTROL PANEL.)

Q301 Q302 Q303 Q304 Q305 Q401 Q501 Q502 Q503 — Q504 — TRANSISTOR BASE DIAGRAMS

COMPONENT LOCATION DIAGRAM

GENERAL ELECTRIC
Color TV Chassis
CD/LB

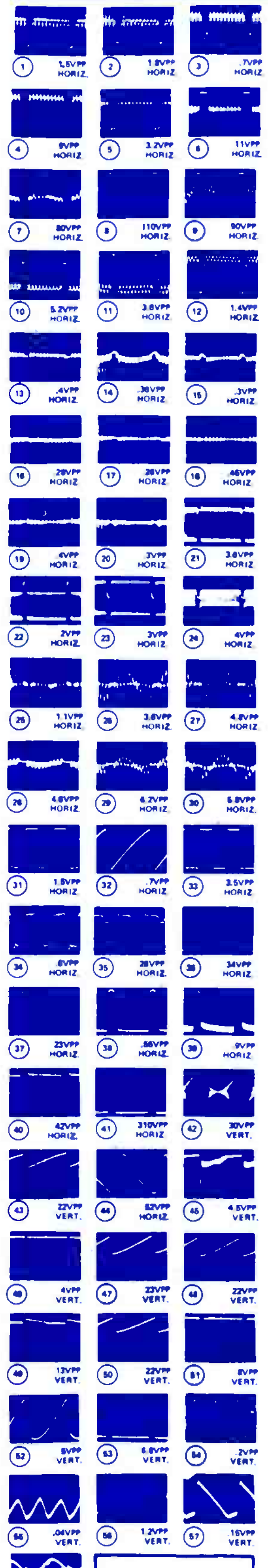


1685
GTE SYLVANIA
Color TV Chassis E42-3

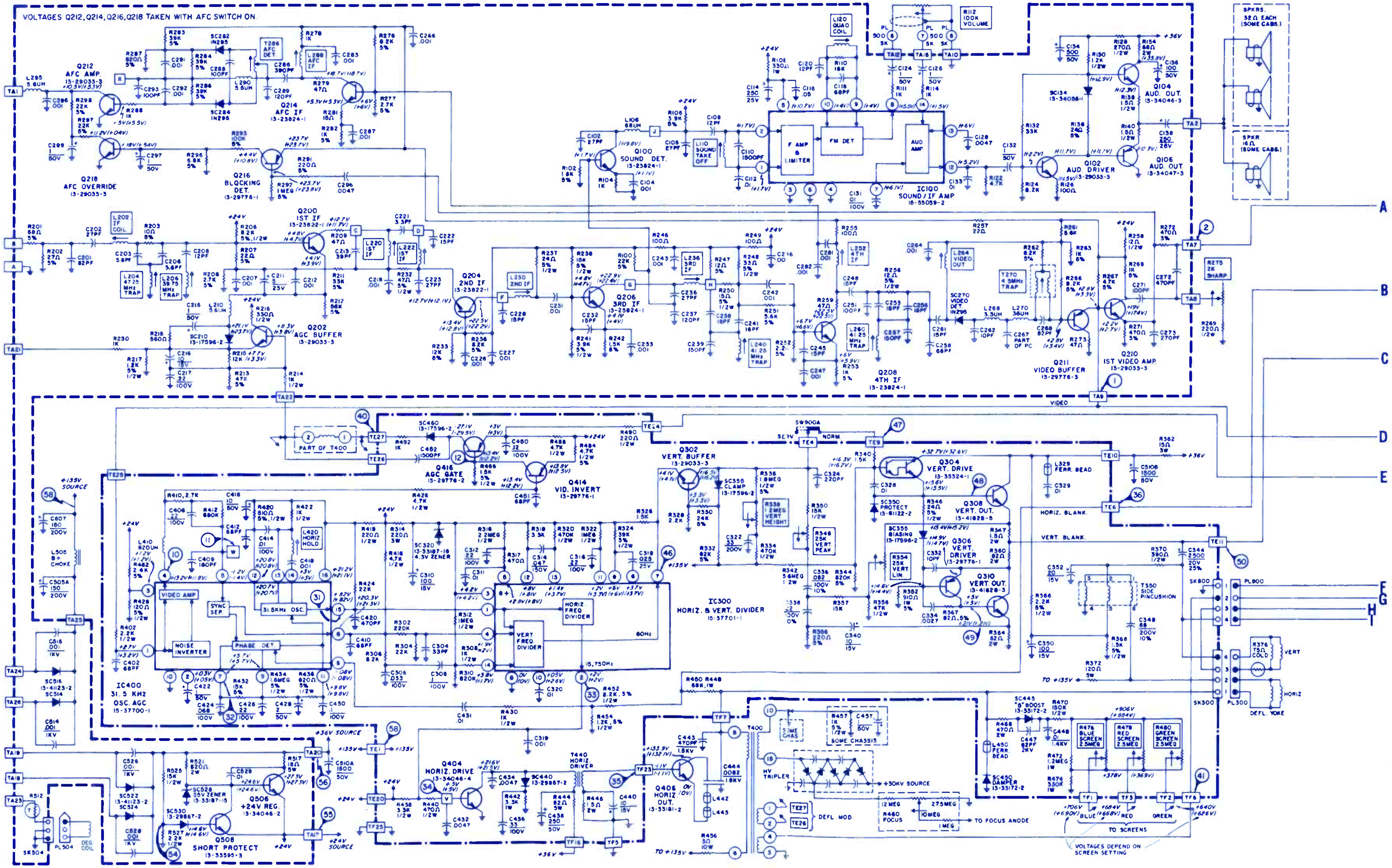
ELECTRONIC TECHNICIAN/DEALER TEKFAX

MARCH • 1977

COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR 4 NEW SETS



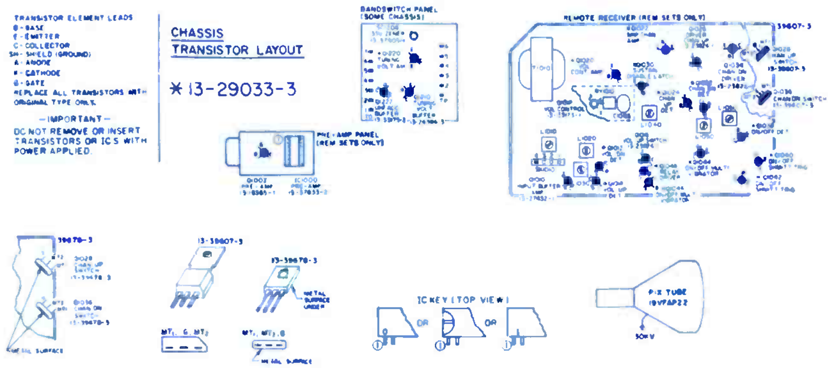
WAVEFORMS

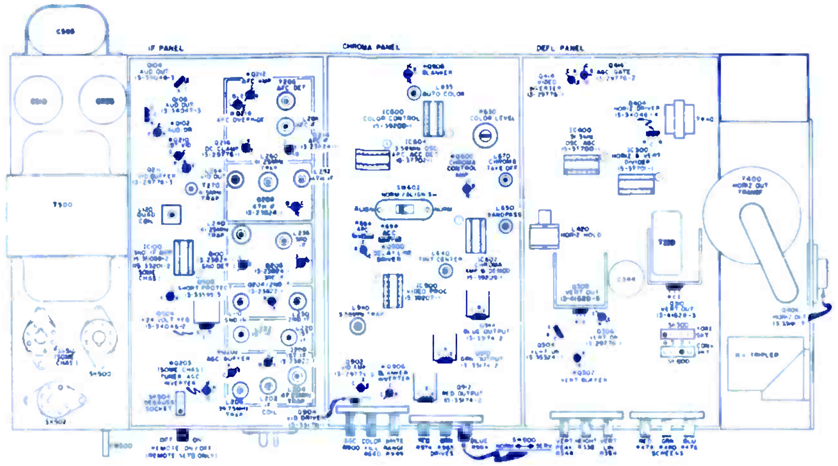


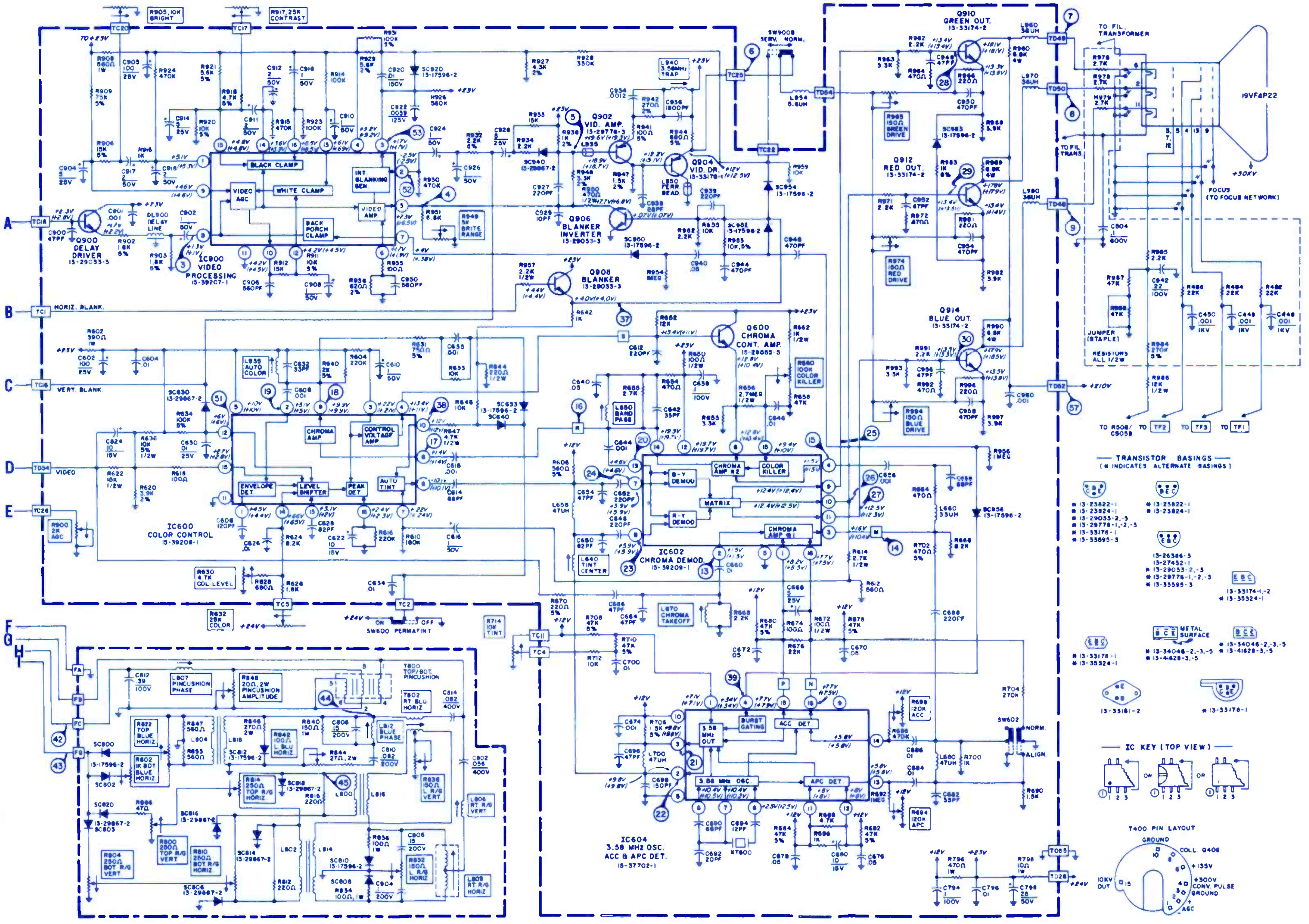
GTE SYLVANIA
Color TV Chassis
E42-3

TRANSISTOR LAYOUT

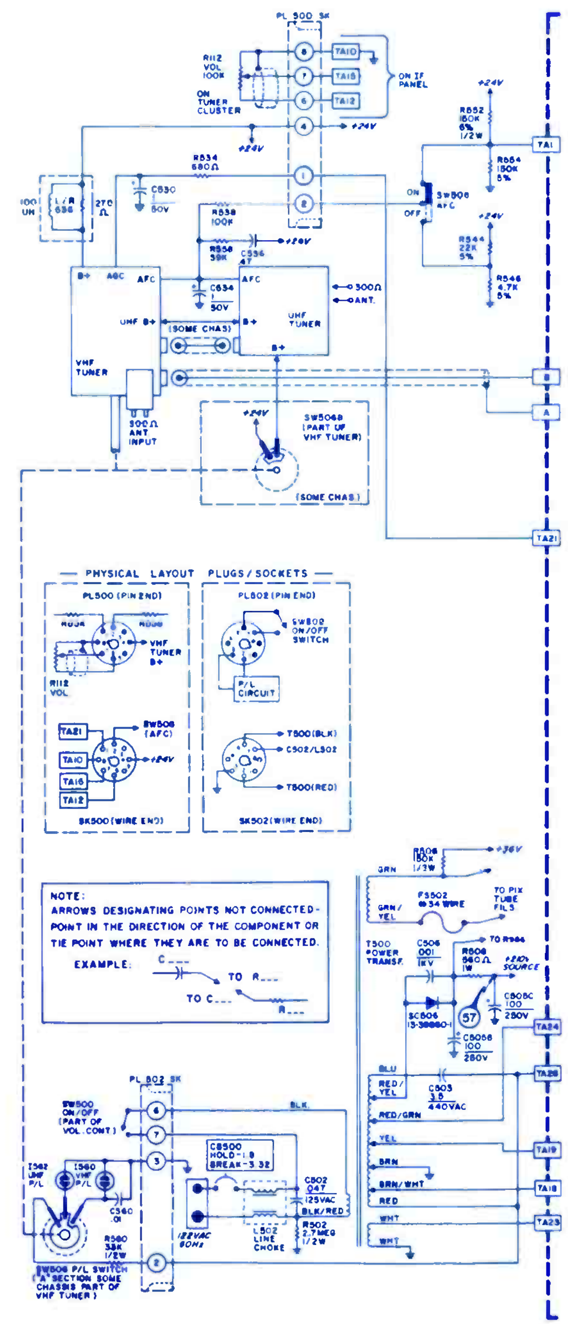
NOTE: DUE TO NORMAL PRODUCTION CHANGES, GENERAL LAYOUT AND ORIENTATION MAY CHANGE SLIGHTLY.







TUNER/CONTROL ASSEMBLY

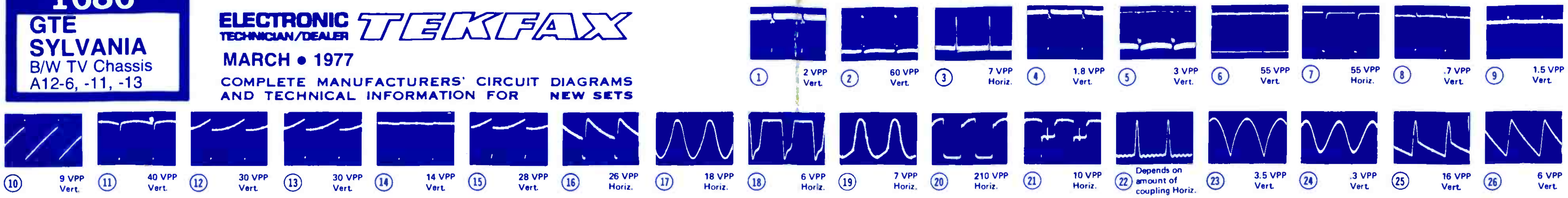


1686
GTE SYLVANIA
B/W TV Chassis
A12-6, -11, -13

ELECTRONIC TECHNICIAN/DEALER TEKFAX

MARCH • 1977

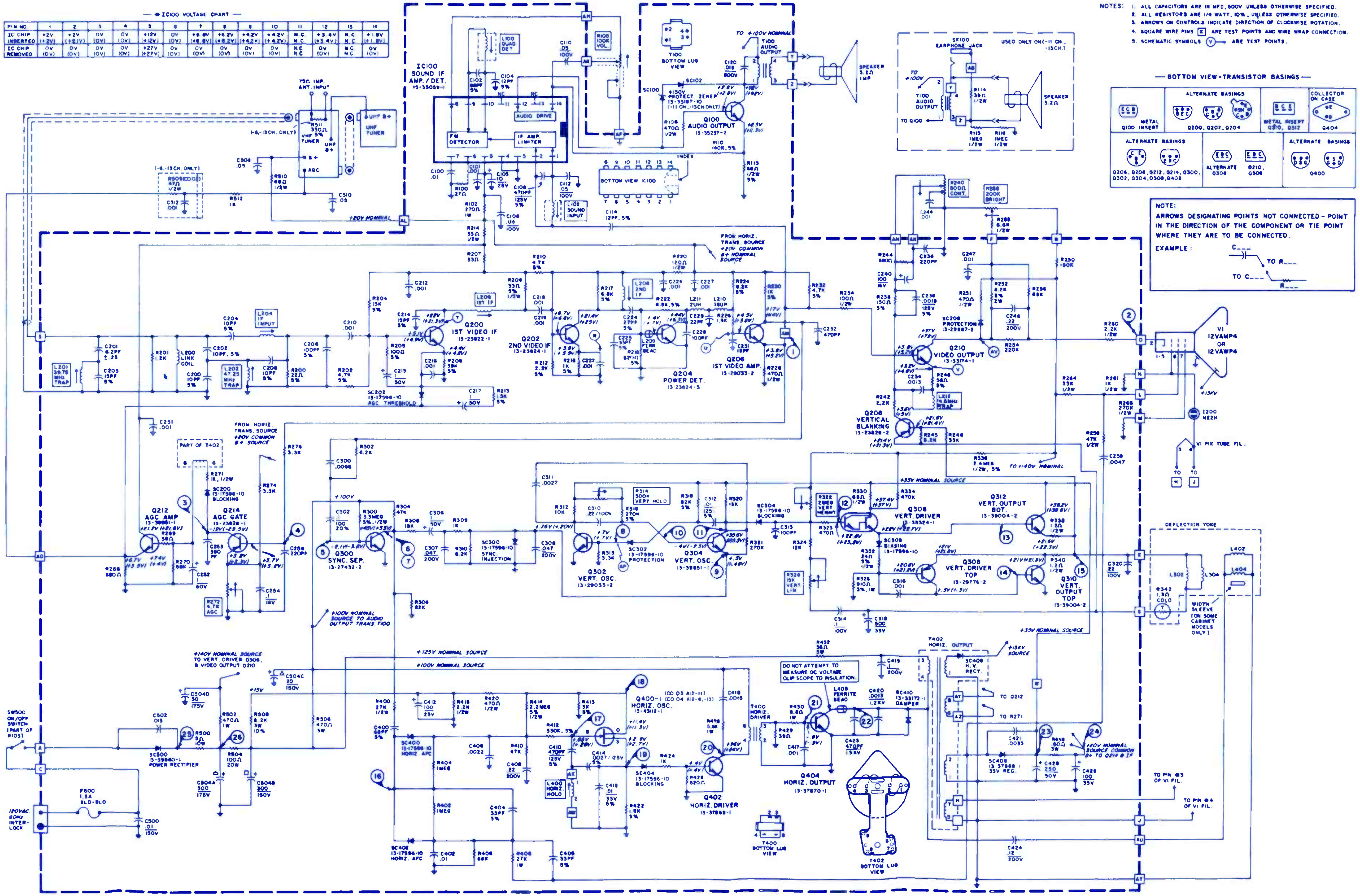
COMPLETE MANUFACTURERS' CIRCUIT DIAGRAMS AND TECHNICAL INFORMATION FOR NEW SETS

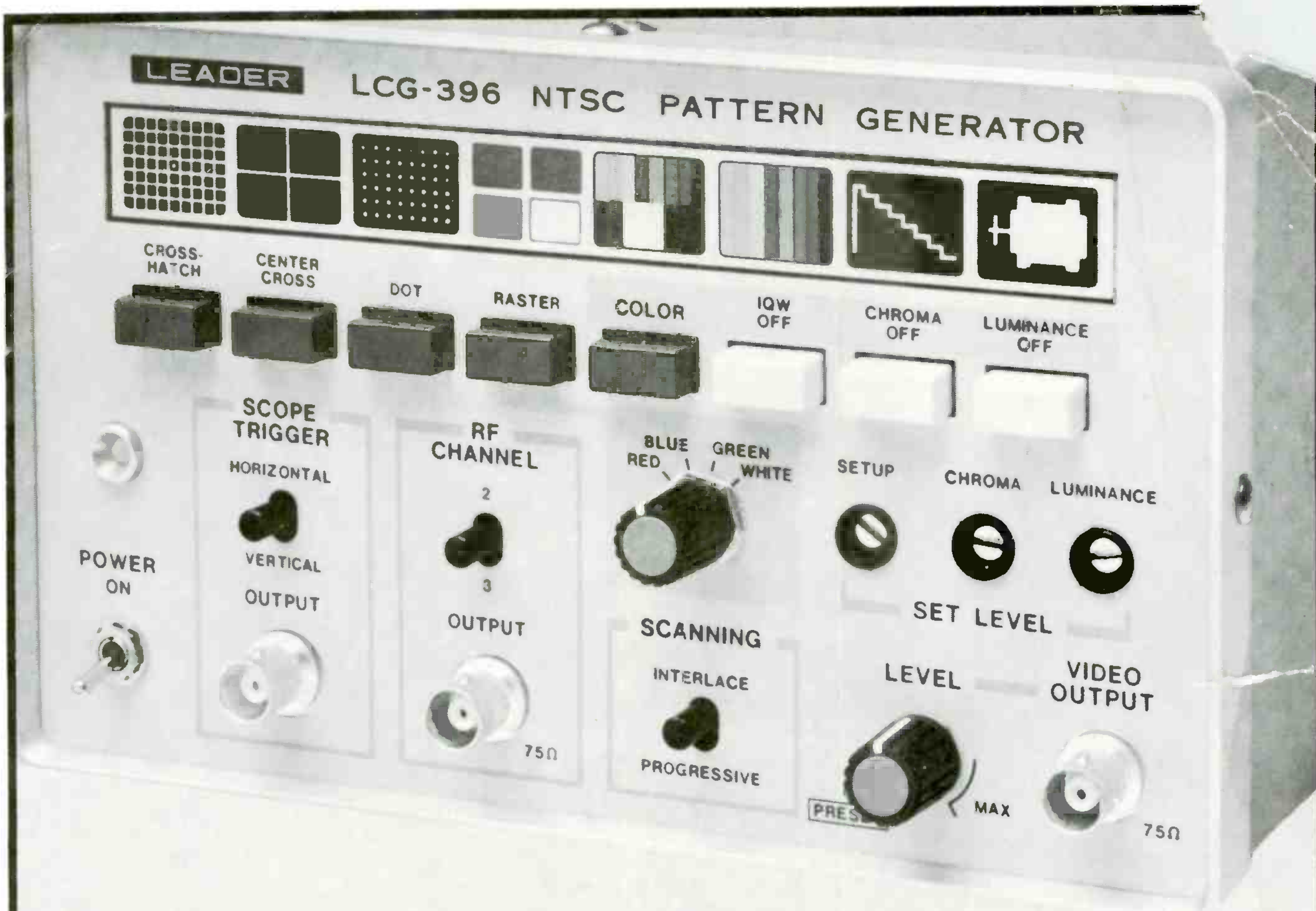


— * IC100 VOLTAGE CHART —

PIN NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IC CHIP INSERTED	+2V (+2V)	+2V (+2.1V)	0V (0V)	0V (0V)	+12V (+12V)	0V (0V)	+6.8V (+6.8V)	+6.2V (+6.2V)	+4.2V (+4.2V)	+4.2V (+4.2V)	N.C. N.C.	+3.4V (+3.4V)	N.C. N.C.	+1.8V (+1.8V)
IC CHIP REMOVED	0V (0V)	0V (0V)	0V (0V)	0V (0V)	+27V (+27V)	0V (0V)	0V (0V)	0V (0V)	0V (0V)	0V (0V)	N.C. N.C.	0V (0V)	N.C. N.C.	0V (0V)

NOTES:
1. ALL CAPACITORS ARE IN MFD, 600V UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE 1/4 WATT, 10%, UNLESS OTHERWISE SPECIFIED.
3. ARROWS ON CONTROLS INDICATE DIRECTION OF CLOCKWISE ROTATION.
4. SQUARE WIRE PINS [X] ARE TEST POINTS AND WIRE WRAP CONNECTION.
5. SCHEMATIC SYMBOLS (V)— ARE TEST POINTS.





LEADER LCG-396

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The New NTSC Color Bar Pattern Generator Designed For The Newest VTR Systems!

- Provides all signals necessary to precisely time, test, evaluate and judge all standard NTSC, MATV, CATV, color and b&w video.
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At the bench . . . away from the bench . . . This super-compact five function, 22 range DVOM has all the features you'd expect from Triplett. Like 3½ digit hi-intensity LED display, rechargeable snap-in Ni Cad Battery Pac™ with an AC charger. And, you get all the "automatics" that make life a lot simpler: Auto-zeroing, auto-polarity and auto low-battery warning. The red and gray probe includes a switch with momentary "ON" and lock "ON" and "OFF" positions for convenient operation.

1. HAND-SIZE, 3½ DIGIT–Easy operation with 22 ranges and Hi/Low Power Ohms. Auto-zeroing and Auto-polarity.
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Price does include Ni Cad batteries and AC Charger.

Ask your Triplett distributor to demonstrate the rugged little Model 3000 DVOM and show you our complete line of handy accessories, too.

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