The how-to magazine of electronics...

ELECTRONIC™

Servicing & Technology

SEPTEMBER 1986/$2.25

TV tests and measurements with a multimeter

What do you know about...More low-frequency amplifier testing?

New GPS Series: Tek sets the pace with SmartCursors™ and push-button ease.

Work faster, smarter, with two new general purpose scopes from Tektronix. The four-channel, 100 MHz 2246 and 2245 set the new, fast pace for measurements at the bench or in the field. They're easy to use and afford, by design.

On top: the 2246 with exclusive integrated push-button measurements. Measurements are accessed through easy, pop-up menus and implemented at the touch of a button. Measure peak volts, peak-to-peak, ± peak, dc volts and gated volts with new hands-off convenience and on-screen readout of values.

SmartCursors™ track voltmeter measurements in the 2246 and visually indicate where ground and trigger levels are located. Or use cursors in the manual mode for immediate, effortless measurement of waveform parameters.

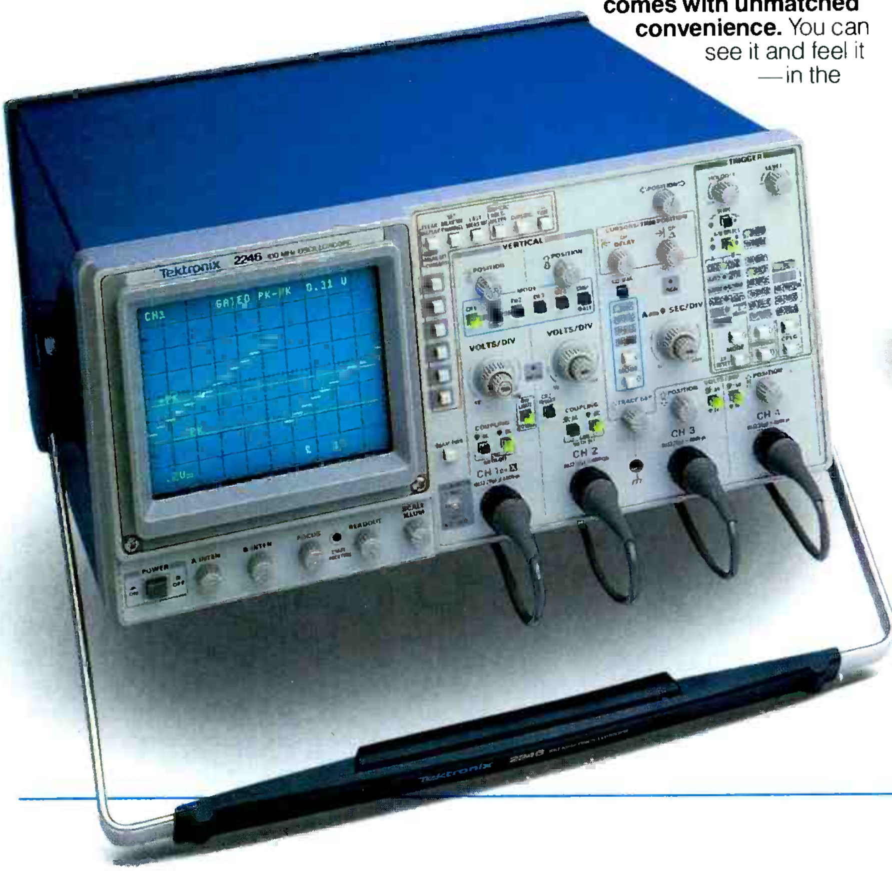
Both scopes build on performance you haven't seen at the bandwidth or prices. Lab grade features include sweep speeds to 2 ns/div. Vertical sensitivity of 2 mV/div at full bandwidth for low-level signal capture. Plus trigger sensitivity to 0.25 div at 50 MHz, to 0.5 div at 150 MHz.

Accuracy is excellent: 2% at vertical, 2% at horizontal. And four-channel capability includes two channels optimized for logic signals.

Best of all, high performance comes with unmatched convenience. You can see it and feel it—in the responsive controls and simple front-panel design, in extensive on-screen scale factor readouts, and in simplified trigger operation that includes Tek's Auto Level mode for automatic triggering on any signal.

Contact the Tektronix office or sales representative nearest you for complete details. Each scope is backed by Tek's three-year warranty, plus excellent documentation, training programs and outstanding service support—worldwide.

Features	2246	2245
Bandwidth	100 MHz	100 MHz
No. of Channels	4	4
Scale Factor Readout	Yes	Yes
SmartCursors™	Yes	No
Volts Cursors	Yes	No
Time Cursors	Yes	No
Voltmeter	Yes	No
Vertical Sensitivity	2 mV/div	2 mV/div
Max. Sweep Speed	2 ns/div	2 ns/div
Vert/Hor Accuracy	2%	2%
Trigger Modes	Auto Level, Auto, Norm, TV Field, TV Line, Single Sweep	
Trigger Level Readout	Yes	No
Weight	6.1 kg	6.1 kg
Warranty	3-year on parts and labor including CRT	



Featuring four channels, flexible triggering, extensive CRT readouts and push-button ease of use, the new Tek 2246 (left) and 2245 (above) bring high-quality, low-cost analysis to diverse applications in digital design, field service and manufacturing.

Tektronix
COMMITTED TO EXCELLENCE

Circle (1) on Reply Card

The how-to magazine of electronics...

ELECTRONIC Servicing & Technology

Volume 6, No. 9 September 1986

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Buying a DMM
By Patrick Chu

There is a digital multimeter to fit every technician's needs, but first, *specific* service needs must be determined. The article includes a model to follow for making purchase decisions in selecting the optimum DMM without spending too little (expensive in the long run) or more than is necessary.

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Test your electronic knowledge
By Sam Wilson

Our faithful readers should score 100% on this month's quiz that reviews questions from previous issues of ***ES&T.*** The answers may be found on pages 70 and 71.

page 12
When shopping for a DMM, you'll be money ahead if you match the many options to your working needs. *(Photo courtesy Beckman Industrial Corporation.)*

page 7
Built-in automation features speed up and simplify measurements when using these portable, new-generation oscilloscopes. *(Photo courtesy Tektronix.)*

Departments:

26
TV tests and measurements with a multimeter

The little but mighty multimeter is the workhorse of the electronics world, and in some cases may be the only test instrument required for routine TV checks and measurements, according to this article selectively excerpted from an excellent book.

66
What do you know about electronics?—More low-frequency amp testing
By Sam Wilson

Tests for linear distortion, plus an update on frequency shift keying are both discussed, and there's a certificate to earn!

SHOCK ABSORBER.

RCA's Power Safe surge suppressors absorb voltage surges before your customers' electronics get damaged.

Now you can help your customers protect their expensive electronic equipment from sudden shock with two new surge suppressors from RCA.

The Power Safe (SK406) protects TVs, computers, microwaves and more by absorbing transient voltage surges resulting from nearby lightning strikes, load switching and other causes before the surge hits the equipment. Handsomely designed and easy to install, this handy six-outlet strip simply plugs into any grounded wall outlet.

The Power Safe Plus (SKF406) protects every way the Power Safe does, plus it filters out electronic noise interference. The suppressor's high-frequency bi-directional filter senses, absorbs, and dissipates noise interference before it can reach the equipment.

Together, they have the potential to become powerful profit builders for you.

To learn more about this shock-absorbing team, see your RCA Distributor. Or contact RCA Distributor and Special Products Division, Deptford, NJ 08096-2088.

RCA Distributor and Special Products Division

Circle (4) on Reply Card

Editorial

Taking the measure of measuring

When a technician touches the probes of his DMM to the test points in a circuit, reads a value of voltage or resistance, and notes that it's different from the reading he expected, then does some mental gymnastics to determine what the problem is and how to fix it, the process seems natural and straightforward.

The idea of measurement isn't natural, though, any more than driving a car or dialing a phone is natural. It's just that we've been doing such things for so long that they *seem* natural. The technician's act of measuring circuit parameters actually represents a long distance traveled by humankind down the road of intellectual and technological development.

The art and science of measurement has been developed and refined over many centuries. Some of the development of measurement has occurred out of necessity: If someone is going to exchange pretty stones or clamshells or some other currency for cows or chickens or bananas, it is important to be able to count how many of the one should be exchanged for what quantity of the other.

It is said that the Egyptians developed trigonometry in response to an important measurement need. The farms on the fertile Nile River delta flooded every spring, wiping out all fences, markers or anything else that would demarcate whose land was whose. Every year after the floods, the Egyptians had to remeasure and re-mark these parcels of land. Trigonometry was developed to aid in this process.

Once humans got the idea of measuring, it became an end in itself, as well as a means to an end. How tall is the highest mountain? How long is the longest river? How much does the earth weigh? The answers to these questions are not of critical importance, but humans are consumed with curiosity about such things, and have gone to great lengths to ascertain them.

In many cases, even though the answers to questions of measurement weren't of immediate importance, knowing the answers eventually proved very valuable and spurred still further inquiry.

Back in the third century B.C., a knowledge of the circumference of the earth wasn't of great value to anyone. Still, Eratosthenes, a director of the library at Alexandria, Egypt, was curious about it and found a method of measuring it. He was not the first to do so, merely the best known.

Eratosthenes noticed that on the longest day of the year, in the town of Syene (now Aswan) the sun at noon was directly overhead, casting no shadows. At exactly the same moment directly north of Syene, in Alexandria, the sun cast distinct shadows. The angle of these shadows was measured to be seven degrees. From this information, Eratosthenes surmised that the distance between Syene and Alexandria was equal to seven degrees of arc of the earth's surface, or 1/50 of the earth's circumference. It was simplicity itself, then, to multiply the distance from Syene to Alexandria by fifty to determine the circumference. The figure obtained by Eratosthenes was 24,647 miles.

It is now known that Aswan and Alexandria do not lie directly north-south. Furthermore, the distance measured between the two cities was not exactly accurate. And the sun was not quite directly overhead at Syene when the measurements were made. Apparently some of these errors canceled out, as Eratosthenes' value was in error by less than 250 miles.

Of course in modern times, the value of the circumference of the earth is critical to shipping, to air travel, to space exploration, to satellite TV, just to name a few. And, no doubt, the sheer knowledge that it was possible to determine something as apparently difficult to determine as the circumference of the very globe on which we stand led to further inquiry and discovery.

Measurement techniques have become so exotic and so exacting that now we can measure distances to the farthest stars, we know the strength of the earth's magnetic field, the intensity of the solar wind. Who knows what we'll be measuring next, and with what accuracy.

Today's measuring equipment, whether it's a device to measure the mass of a newly discovered galaxy or the voltage on an IC pin can trace a long lineage back to the first halting steps of humans in measuring the world around them.

Nils Conrad Persson

Fluke breaks the old mold.

The Fluke 37. A bold new shape emerges with more features for the money than any other bench DMM. Period.

Dollar for dollar, the new Fluke 37 is unbeatable. In addition to its breakthrough design — with built-in handle and storage compartment — it has all the high-performance features of the world's best, most reliable 3½ digit DMMs.

Autoranging, to eliminate guesswork. Audible Continuity, so you don't have to look at the display. An exclusive analog *and* digital display, for the best view of the signal being measured. Superior EMI shielding. And user-friendly features like auto self-test, auto battery test and auto-polarity. All this, *plus* a two-year warranty.

And, how many other $229 bench meters give you these features? Min-Max recording, for monitoring signals. 38 components dedicated exclusively to input protection. Relative mode, to help you calculate changes in readings. And Fluke's patented Touch Hold, to give you an extra set of hands when you're taking critical measurements.

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For your nearest distributor or a free brochure, call toll-free *anytime* **1-800-227-3800, Ext. 229.** (Outside the U.S., call 1-402-496-1350, Ext. 229.)

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Circle (5) on Reply Card

News

Paper schematics to supplement RCA microfiche service data

Based on cost advantages to servicing dealers, RCA Consumer Electronics is converting its offering of service subscriptions to microfiche beginning in 1987. The advantages of microfiche over paper have been increasing at the servicing dealer level since RCA first offered microfiche service data in late 1984, according to Gene Eddy, vice president, Warranty Programs and Training.

Paper schematics for most circuit boards will continue to be included in RCA microfiche service data, Eddy said.

Technicians Association forms satellite division

According to President Dick Glass, the Electronics Technicians Association, International has formed a separate division specifically for satellite installers and technicians. This was accomplished at the ETA annual convention in Des Moines.

ETA is a nine-year-old professional association for electronics technicians. Its other divisions are Electronics Educators, Communications, Certified Technicians, Canadian and Shopowners Division.

By forming the STD Satellite Division, ETA provides an organization that addresses the specific interests of TVRO technicians.

Mr. Glass noted that the STD branch of ETA is not an attempt to fill the void now existing for a national dealer organization. Rather, STD intends to serve as a partner with the dealer groups. TVRO dealers can become members of ETA (Shopowners Division) and it is hoped that dealers will encourage their TVRO installers and techs to become professional members who eventually will become certified by ETA.

Divisions have two officers who automatically become members of ETA's board of directors. The new chairman of STD is Fred Roeser, CET. Roeser is an electronics instructor at Central Community College in Grand Island, NE. He and CCC will be hosting a SAM (Satellite, Antenna, MATV) seminar October 24 & 25 at CCC.

(See Workshop information in the next news item.)

Roeser was one of the first TVRO experimenters in the area, having built a spherical satellite system more than five years ago. The vice chairman of STD is Larry Miller of Larry's Satellite in New Albany, IN. Larry is also vice president of the Indiana Satellite Dealers Association (ISDA).

Electronics/computer technicians workshop topics announced

The Electronic Technicians Association International invites members and nonmembers to attend the unique school aimed at updating the skills and knowledge of working technicians.

The intensive 2-day classroom schedule at Central Community College, Grand Island, NE, includes "Preventing Static Damage to Computers," "Teaching Methods in Today's Time-Crunch school environment," "TV-Radio Servicing in Today's Times," "Programmable Controllers," "Robotics Concepts," "How Computer PC Boards are Made," "VCR Servicing," "Artificial Intelligence" and "Time and Labor Management in a Service Business."

CET exams also will be offered.

For further information about the Workshop and/or a free brochure about ETA, write to:

ETA-I
604 N Jackson St
Greencastle, IN 46135 ES&T

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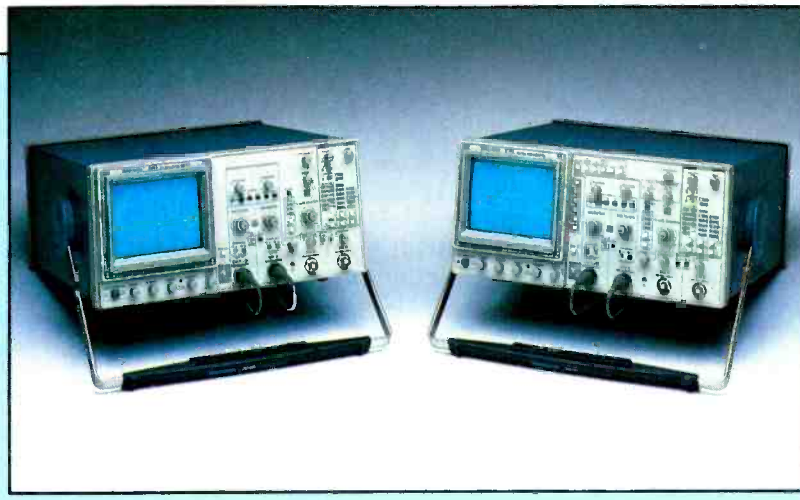
INTERTEC PUBLISHING CORPORATION

Technology

Portable oscilloscopes have extensive built-in automation

A new generation of oscilloscopes features single-button setup, SAVE/RECALL setup memory, setup sequencing, setup transfers without a controller, and increased bandwidth. These are Tektronix' 2445A/2465A Family members: 4-channel oscilloscopes with dual-delaying time bases and on-screen measurement cursors. They include the 150MHz 2445A, the 250MHz 2455A (export), and the 2465A-based models with bandwidth increased from 300MHz to 350MHz. Bandwidth improvements include carrying the full bandwidth to the probe tip, even at 2mv/div sensitivity.



Automation speeds, simplifies

Most significant, however, are built-in automation features that speed and simplify scope measurements. More waveforms can be examined quickly, measurements are made faster, and automated systems are easier to configure.

AUTO SETUP provides single-button setup of the entire scope for conventional displays of waveforms from one to all four channels. Touch the scope probe to a test point and press AUTO SETUP. The scope senses the signal level, period, duty cycle, and trigger requirements for automatically setting up a usable display, even for low duty factor pulses. Not only does this feature simplify scope usage to pressing a single button, but it substantially speeds up circuit checks, measurements, and troubleshooting.

Frequently used setups also can be stored, providing one more level of simplification and time savings. There's enough nonvolatile memory for 20 complete front-panel setups, including individual alphanumeric labels or comments.

Complete front-panel setups can be saved and recalled in any order desired for complex test procedures by combining them into sequences. A single button provides sequence stepping, or a foot switch can be plugged into a rear-panel jack for *hands-free* setup sequencing. Users have a substantial built-in automation in a high performance oscilloscope, automation that does not require a controller or software development.

A variety of options

The GPIB option also allows stored setups to be exchanged between these scopes without having to use a controller. For example, this allows testing technicians to update other technicians quickly or test bay scopes with new or modified setups.

Other available options integrate more advanced measurement performance and greater ease of use into the 2445A/2465A Family of scopes. These options provide programmable DMM and counter/timer functions, enhanced triggering, word recognition for digital applications, and video measurement capabilities. Any or all five of these options can be combined for still more power.

Three special configurations of the 2465A and its options are the 2465A CT for use with communications, office and computer-related equipment, the 2465A DM for government/military electronics and ATE stations, and the 2465A DV for use in the development and manufacturing of video devices.

Software is available to drive 2445A/2465A scopes with various controllers, and measurement packages combine hardware and software into complete, ready-for-use systems. ES&T

Feedback

Letter to Kirk Vistain

As a subscriber to your usually professional magazine, I was a little puzzled by Kirk Vistain's article on audio servicing in the June issue. Kirk is obviously not a big fan of distortion analyzers; specifically, he thinks they are not cost effective, since "most" problems can be spotted with a good oscilloscope and tone generator. I agree with the "most" part here, but he is dispensing fundamentally bad advice.

In 13 years of fixing and testing amplifiers, I haven't found all that many that would look good on the scope, but fail a THD or IM test (I test every amp I fix). There have been a few, however, and I have to ask myself: would it have been fair to fix a $1,500 amplifier and not be able to verify factory specs?

My answer is that it would be unfair, if not dishonest and unprofessional. My customers deserve better than that. I don't think it's unreasonable that all high technology amplifier manufacturers require service centers to have all the equipment necessary to ensure their products will perform correctly after a repair.

Finally, lest the argument of how much distortion is acceptable cloud this issue, I think that it's not my job to decide whether or not you can hear the difference between .001% and 0.1% distortion; I'm paid to fix equipment so it performs the way it was designed to. If I can't do that, I shouldn't charge people for my services.

Steve Stoeckel
Charlotte, NC

Thanks for your comments. I can tell that you are sincerely interested in providing your customers with the best possible service. If you'll read the column closely, you'll notice that I never advise anyone against buying the THD analyzer. In fact, I indicate that it is necessary equipment for any shop wanting to become a warranty station for most hi-fi manufacturers.

But I think the point you brought up is important. Where do you draw the line in servicing? Should one remove and test every transistor for leakage and adherence to specs? That would save some repairs, especially in circuits employing negative feedback, which masks component problems.

Or, more realistically, if the technician wants to accurately test an amplifier's adherence to power and distortion specifications, he must use the same method, mandated by regulations of the Federal Trade Commission, which the manufacturer does. This means preconditioning each unit for one hour, then allowing it to run at full rated power for five minutes at the frequency of interest before taking a distortion measurement. This must be done at the low end and high end of the advertised power band, and in the middle for good measure. When finished, repeat the distortion measurements at 250mW. So here we've just spent an hour and a half of bench time to verify manufacturer's specs. As you pointed out, if you don't go through the whole FTC routine, some marginal units will inevitably slip through. Is it OK to let this happen to a few because the technician wants to save time?

Where does one stop verifying performance? What about tone control response, filter action, input sensitivity, RIAA conformance, etc? These are questions only an individual shop manager or technician can answer.

To make an intelligent decision requires an understanding of the shop's clientele, their technical needs, and their ability to pay. Service is a business, not a crusade. In business, the final criterion is customer satisfaction. The best way to accomplish it is something we all must decide for ourselves.

Kirk Vistain

Letter to Sam Wilson

You know electronics, but you certainly do not know horology. In the "Test your electronic knowledge" feature in the January 1986 issue, the correct answer to Question 9 is B. If you will look up *circular error* in almost any good textbook on clocks, you will find it explained that the motion of a pendulum is not pure harmonic motion, and so the period is not independent of the arc. Or ask your local clockmaker, if he is knowledgeable.

The matter is not unrelated to electronics, since there are many battery pendulum clocks around with a transistor switching the coil current: How else do you explain why these gain as the battery voltage drops?

I agree it is a good idea to keep in touch with the basic principles of physics: Someone in your organization hasn't done so.

F. Cecil Grace

...Let me start by giving you a direct quotation from the book titled "An Introductory Course in College Physics" by Newton Henry Black:

> "We are all familiar with the pendulum as a means used to regulate the motion of clocks. It was long ago discovered by Galileo that the successive small vibrations of a pendulum are made in equal times and *that the time of vibration does not depend* on the weight or nature of the bob or *on the arc of the swing* but does vary directly as the square root of the length of the pendulum and inversely as the square root of the acceleration of gravity. This is expressed in the following formula, which will be derived in section 218:
>
> $$t = 2\pi \sqrt{\frac{1}{g}}$$
>
> where t is the time in seconds of a complete vibration, 1 is the length of the pendulum in centimeters, g is the acceleration of gravity in centimeters-per-second, and π is 3.14."

I have many other physics books that say the same thing. You must understand that they are always talking about a simple pendulum.

The period will NOT be dependent on the length of arc provided the following conditions are met:

- *The pivot point must be frictionless.*
- *The suspension must be rigid.*
- *It must be possible to consider that all of the mass is in the bob.*
- *The length of the arc must be small compared to the length of the pendulum.*

AWS SNAP-AROUNDS

DSA-7610 DIGITAL VOLT-AMMETER

Take hold of the future with this streamline, lightweight, yet extremely rugged AC volt-ammeter. Count on features such as high accuracy; autoranging; instant audible continuity buzzer; UL1244 type test leads; electronic overload protection and electronic data-hold switch; low battery indicator; electronic circuit protection; positive action On/Off switch. **Ranges:** 0-200/500Vac; 0-200/300Aac; audible and visual continuity. **$89.95.**

OHM-300 VOLT-OHM-AMMETER WITH SWIVEL CASE

Economy and quality are combined in this extremely popular service instrument. The meter compartment swivels to 5 different positions so the scale always faces the user. Insulated tapered jaws; safety screw-in test leads; wrist strap; fused Ohmprobe battery attachment. **Ranges:** 0-150/300/600Vac; 0-60/300Aac; 25Ω mid-scale. **$70.95.**

SPR-300 ROTARY SCALE VOLT-OHM-AMMETER

The industry's most popular general purpose snap-around. Covers the full span of daily testing needs with features like insulated tapered jaws; pointer lock; distortion-free window; safety screw-in test leads; wrist strap; fused Ohmprobe battery attachment; easy to read rotary scale; rugged double chassis inner case; perfectly balanced. **Ranges:** 0-150/300/600Vac; 0-6/15/40/100/300Aac; 25Ω mid-scale. **$71.85.**

SPR-1030 "BUS-BAR" ROTARY SCALE VOLT-OHM-AMMETER

Now take heavy current measurements on round cable or up to 3" Bus-Bar. Features include large insulated jaws; pointer lock; safety screw-in test leads; wrist strap; fused Ohmprobe battery attachment; 8 range rotary scale; rugged double chassis inner case. **Ranges:** 0-150/300/750Vac; 0-10/30/100/300/1000Aac; 25Ω mid-scale. **$106.95.**

SDC-701 DC ROTARY SCALE VOLT-OHM-AMMETER

Specifically engineered for DC measurements. Besides being rugged, well-balanced and reliable you'll find features such as large, insulated jaws; pointer lock; distortion-free window; safety screw-in test leads; wrist strap; fused Ohmprobe battery attachment. **Ranges:** 0-3/30/300Vdc; 0-30/75/150/300/600Adc; 25Ω mid-scale. **$319.95.**

TD-6 SLIM-SNAP™ VOLT-OHM-AMMETER

AWS' famous 'Tear Drop' jaw design make working in tight, crowded boxes a snap. Slim, compact and pocket-size, the Slim-Snap features a pointer lock; safety screw-in test leads; wrist strap; fused Ohmprobe battery attachment with 600V AC rated fuse. **Ranges:** 0-150/300/600Vac; 0-6/15/60/300Aac; 25Ω mid-scale. **$82.95.**

SPR-931 ROTARY SCALE VOLT-OHM-AMMETER

High AC measurements are at your fingertips with this reliable and accurate meter. Designed to handle heavy-duty field use this powerhouse features an oversize jaw opening; easy-action trigger; pointer lock; UL1244 type test leads; wrist strap; fused Ohmprobe battery attachment; **Ranges:** 0-150/300/750Vac; 0-10/30/100/300/900Aac; 25Ω mid-scale. **$94.85.**

SJ-100 MINI-PROBE™ VOLT-AMMETER

Don't be fooled by its small size, this little volt-ammeter is plenty rugged, both electrically and mechanically. Designed and built with the latest circuitry usually found only in more expensive instruments, you'll find big features such as Twist and Lock safety test leads; shock resistant ABS plastic housing; easy to read 2 color scale; single AC volts and AC amps ranges to help prevent burn-out; compact pocket size. **Ranges:** 0-250Vac; 0-100Aac. **$36.75.** (Also available models SJ-25 and SJ-50).

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Circle (6) on Reply Card

These conditions can be very closely approximated with today's technology. Textbooks on clocks usually deal with practical pendulums, so, the above conditions are not met. That is why books on horology do not agree with the books on physics....

Sam Wilson

Letter to Sam Wilson

I have thoroughly enjoyed your magazine ever since I started my subscription several months ago. I especially enjoy the opportunity to test my electronic knowledge with the examination your magazine provides. I also enjoy the section "What do you know about electronics?" As I am still an electronics student, I find the article highly enlightening and an enriching addition to my education.

I am not sure if you are the right person to send this to. Please accept my apologies and sincerest appreciation for forwarding this letter to the proper department. Now, I may be wrong, but in the June 1986 issue, in the "What do you know about electronics?" section, I believe there is an error in the equation to solve for the temperature coefficient of the second capacitor, K_2. I believe the equation should read:

$$K_2 = [K_t(C_1 + C_2) - K_1 C_1]/C_2.$$

I arrive at this equation through an algebraic manipulation of the equation previously offered for the combined temperature coefficient:

$$K_t = \frac{1}{C_1 + C_2}[K_1 C_1 + K_2 C_2] \Rightarrow$$

$$K_t(C_1 + C_2) = K_1 C_1 + K_2 C_2 \Rightarrow$$

$$K_2 C_2 = K_t(C_1 + C_2) - K_1 C_1 \Rightarrow$$

$$K_2 = [K_t(C_1 + C_2) - K_1 C_1]/C_2$$

Thank you for your time.

Jim Rice
Ft. Leavenworth, KS

You're right!

I have mixed emotions about your letter.

I am very unhappy about being caught in a careless mistake. At the same time, I am very pleased that there are top-level technicians, like you and the others who wrote, who are reading the articles.

Thank you for correcting the equation.

Sam Wilson

Letter to Sam Wilson

There are many things that I enjoy seeing each month in ***Electronic Servicing.*** I think the "News" section is especially useful in keeping up with our rapidly changing business. You have done an excellent job of presenting clear concise articles on new technology that keeps a technician up to date.

I especially enjoy Sam Wilsons "Test Your Electronic Knowledge" series. The questions presented are a great ongoing review of information many of us haven't thought about in years.

I would like to make one suggestion regarding Sam's series. I'd like to see more explanation of the correct answers to the questions. The explanations to answers in the February '86 issue were very helpful, but the March '86 test just gave the correct answer without explanation.

Thank you for an excellent magazine, and you can count on me to be a subscriber for many years to come.

Jude K. Huckaby
Eunice, LA

Your comment about an explanation of the answers in the "Test your electronic knowledge articles" is well taken. Actually, I had already decided to make comments. You noticed the result in the February issue. However, on the quizzes that were made from previous articles I only gave the location of the reference article. After I read your letter, I decided to give details on those answers too.

I submit the articles two or three months ahead of the date when they are actually printed. So, you should have started to see the change in the June or July issue. If there are any of the answers given in previous issues that you would like to have discussed please write to me.

Sam Wilson

ES&T

*Do you have a question or an idea for an article you would like to see in **ES&T?** Your comments are always welcome. Please write to: Nils Conrad Persson, Editor, Electronic Servicing and Technology, P.O. Box 12901, Overland Park, KS 66212.*

Two companies make CRT Readout Scopes. Both offer a 3-year warranty. But...

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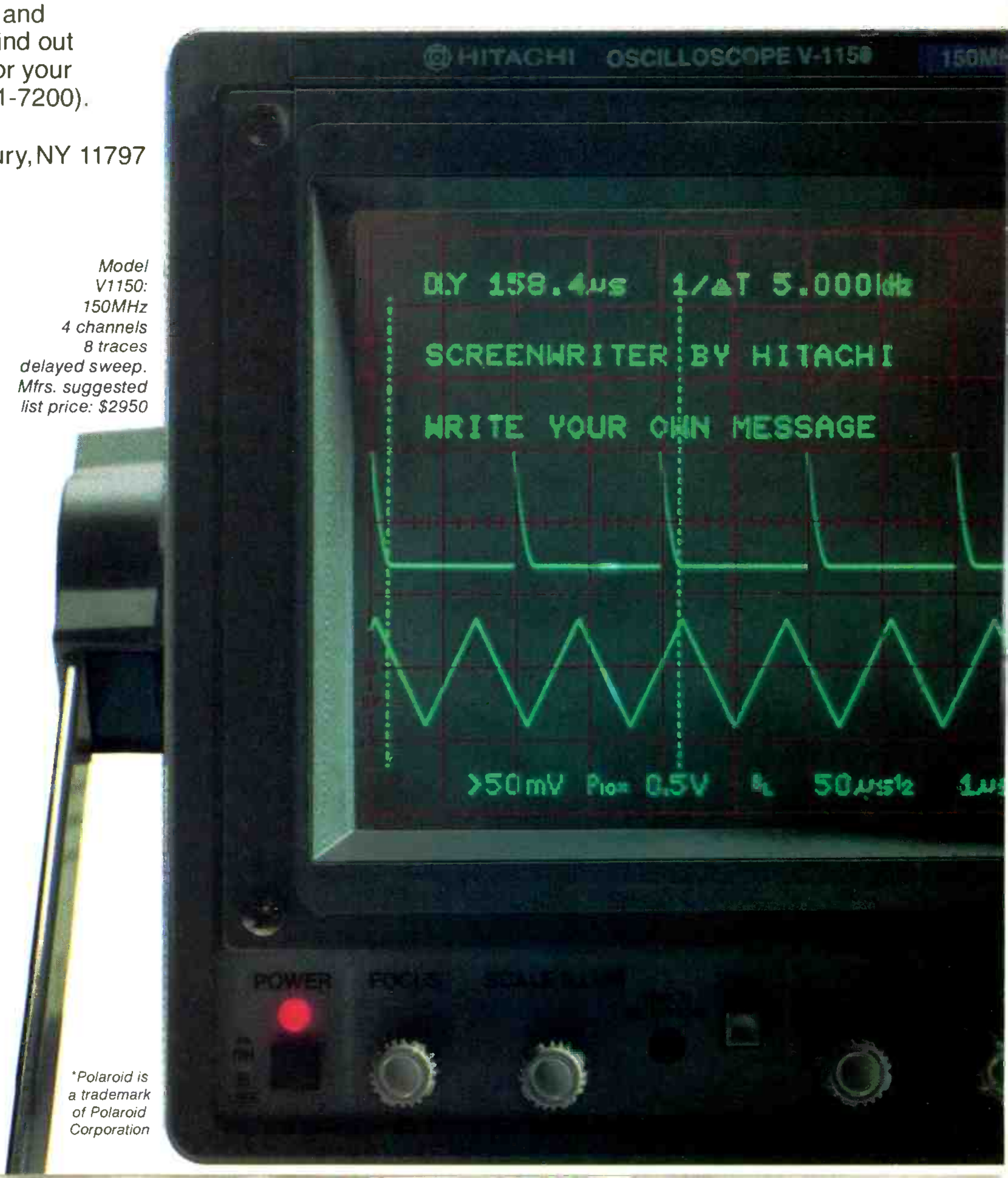

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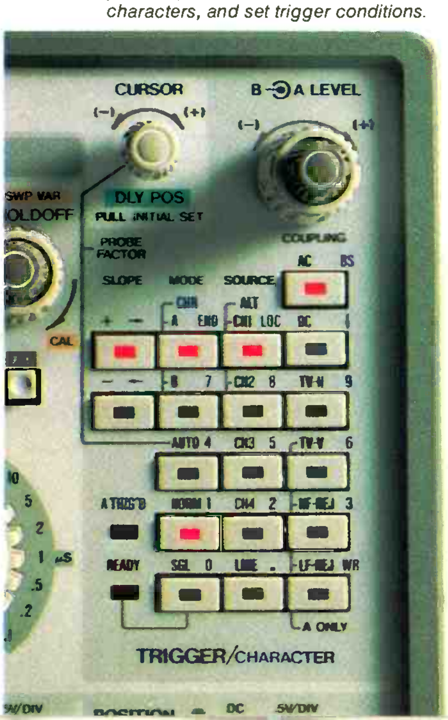

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Buying a DMM

Purchasing digital multimeters (DMMs) and other general-purpose gear can follow a step-by-step decision process.

By Patrick Chu

Specifying and buying diagnostic tools such as digital multimeters (DMMs) is one of the servicing technician's major concerns. You need to know that you've picked the right tool for the job–at a cost that is justified by specific service needs.

When making these buying decisions, the following formal decision process can be applied to develop buying strategies for DMMs and other general purpose measuring instruments used by most technicians.

Decision strategy

Using this decision process or model can help you to refine your service needs into specific DMM requirements and specifications. These specifications are then matched with the features and options of different DMM models.

Among DMM models, broad categories include low-cost (mostly imports, $40 to $100); professional ($100 to $300); and heavy-duty or ruggedized ($150 to $300). Within these categories, and even among the offerings of a single manufacturer, there can be a wide variety of features and performance specifications.

A major goal, of course, is to find the product that does the job at the lowest cost. But, considering price alone can be a real pitfall. For such an essential service tool, a low-cost DMM can be worse than useless in some applications. If you don't match your choice carefully to your requirements, the meter might not perform needed functions, might give inaccurate readings, might fail under conditions that you consider normal, or might even be a safety hazard in some uses.

Chu is a product manager for Beckman Industrial Corporation, Brea, CA, a digital multimeter manufacturer.

In such situations, the unexpected costs could far outweigh the cost of a better alternative. If a DMM doesn't do the job or fails in the field, you could waste time and then have to repair or replace the meter.

On the other hand, there's no point in spending perhaps $50 per unit extra for non-essential features.

You can minimize these risks by analyzing your needs and making a thorough evaluation of the alternatives. The decision model presented here will help you look at the situation objectively.

Decision model

The process or model for decision making is shown in Figure 1. The core of the model is a sequence of seven steps:

1. State your need as a desired outcome.
2. Define the application and its scope.

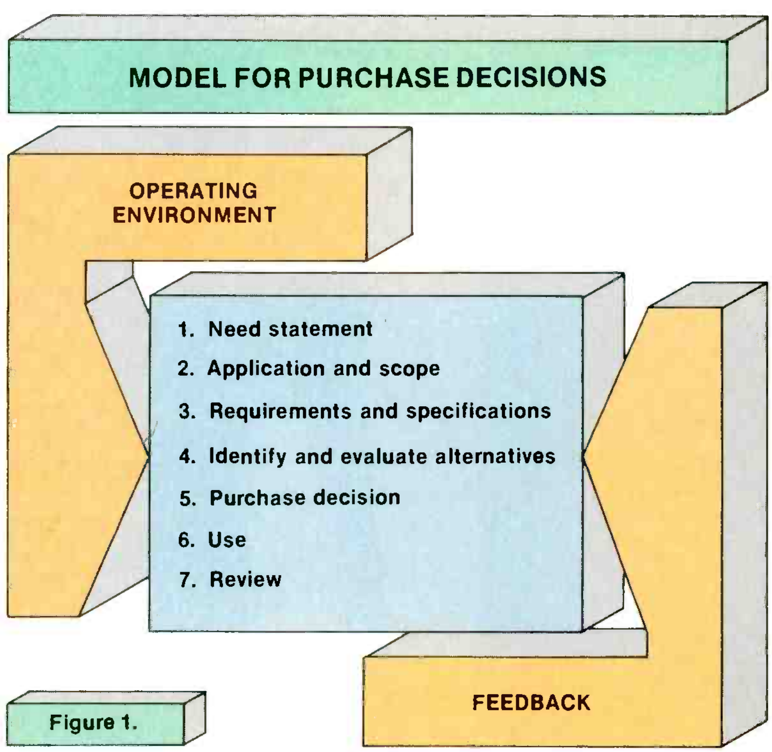
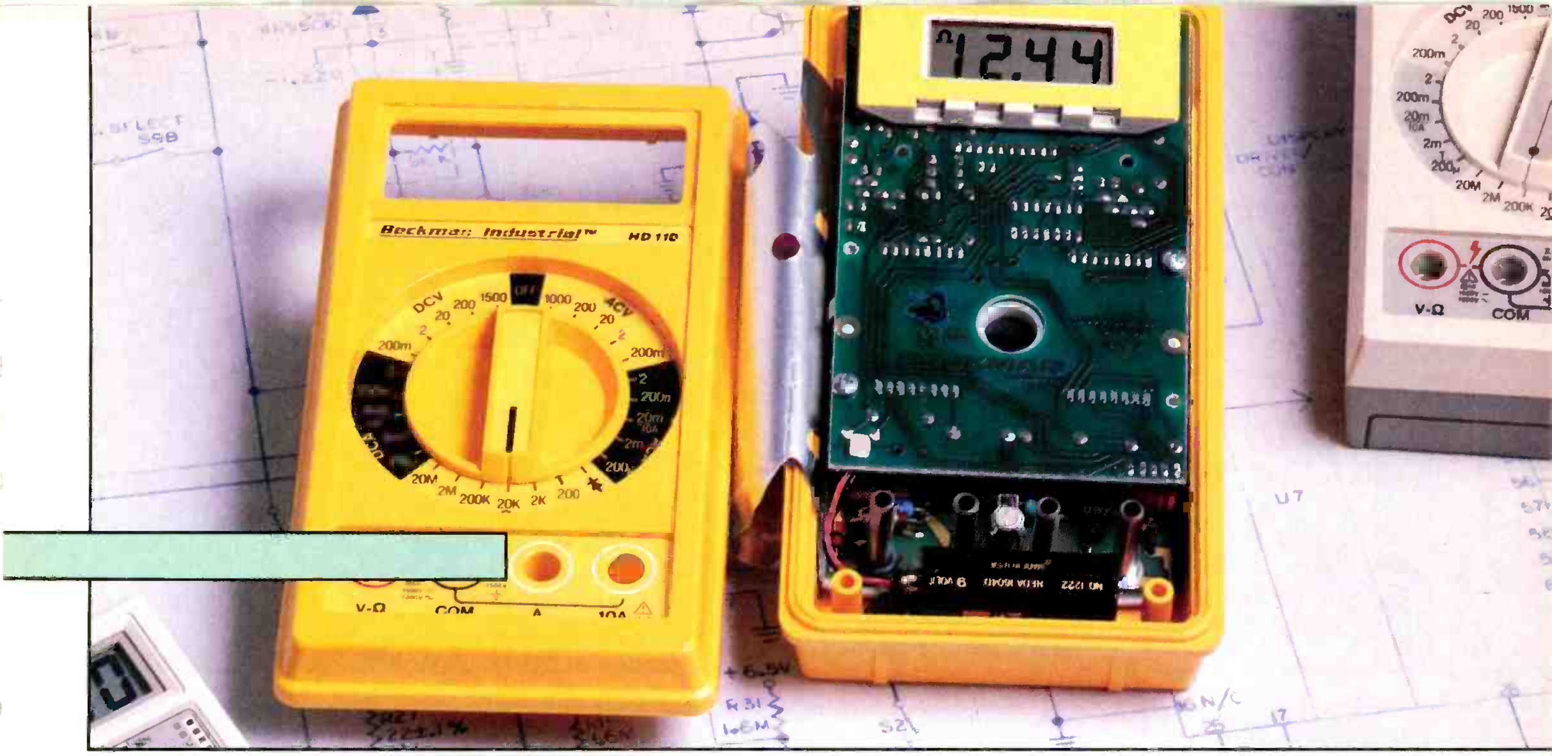


Figure 1.



3. Identify requirements and write specifications.
4. Identify and evaluate alternatives.
5. Make a purchase decision and procure the product.
6. Put it to use.
7. Review results.

Note that two sets of arrows feed off the decision process. These arrows represent factors that can influence your decision. These influences are:

- feedback;
- operating environment.

Feedback loops are caused by intermediate results that trigger reevaluation of a prior step and another cycle of the decision process. Also, your own situation will affect the process at each step. Examples of how these factors might affect your decision are included in the following description.

Need statement

In the first step, you state your needs in terms of a desired outcome, or intended result:

Equip your shop for preliminary troubleshooting of electrical and electronic component failures in microcomputers, televisions, stereos, VCRs, printers and modems.

Note that this concise statement will shape your thinking from the outset. Your eventual decision might be completely different if you stated your needs some other way.

Note the difference in size and mechanical ruggedness of the heavy duty DMM (left), the professional DMM (middle), and the low cost DMM at the right.

Even though you want to be as precise as possible, being able to state your needs doesn't mean that you must have all the answers before you start. The process model helps you derive the answers because you can go through it repeatedly until satisfactory results are achieved. That's the function of the feedback arrows on the right of the model diagram. At any point, if you reach a conclusion that doesn't fit your requirements, you can back up, change your assumptions and repeat the process.

The first time through, for example, you can identify your *ideal* requirements and extend them to actual costs. This trial result, however, might exceed your budget. In a second pass, you can try to focus on requirements that are essential, such as safety in measuring high-voltage power circuits or exceptional accuracy.

The arrows on the left side of the diagram show that conclusions at each step will be affected by the way your company does business. If you don't take these factors into consideration, your decision might be fine – for somebody else.

Application and scope

Based on your need statement, this step involves identifying the service procedures in the application. You also will want to think about the scope of your decision, including short- or long-term goals and purchase quantities.

Let's continue with the example of needing to troubleshoot microcomputers in the field. A review of routine service procedures might produce the following list: (pg. 18)

DMM Options

In today's test-equipment market, hand-held digital multimeters (DMMs) have largely replaced conventional voltohmmeters (VOMs) as general purpose measurement devices. Reasons include increased performance, convenience and reliability at modest cost, benefits of all-solid-state microprocessor technology and digital sampling techniques.

Recent technical advances also promise to shape future DMM products. Some remarkable product enhancements may be seen in the following areas:

Input Protection—Fuses probably will become physically smaller, with higher voltage ratings, providing increased safety and meter reliability. Increasingly, fuses will be incorporated on all current ranges, especially in heavy-duty industrial models.

A valuable feature that is found in some of today's more sophisticated DMMs is the metal oxide varistor (MOV), which protects against high voltage electrostatic transients, often up to 6,000V. Formerly, this protection was provided by a spark gap, which can be a hazard, especially if the meter contains a low-cost exposed type spark gap and the meter is used in the presence of explosive gas or dust, as in a coal mine. The trend in MOVs will be to still higher voltage protection.

Switching—A likely trend will be toward electronic switching, thereby reducing mechanical switch movements and the number of contacts. Microprocessor-controlled switching would permit autoranging, in which the user selects a function and the meter selects the appropriate range upon sensing the input. Elimination of mechanical switch contacts also would *design out* some of the potential sources of DMM failure such as corrosion, dirt and wear of contacts. Where it is impractical to eliminate mechanical switching, contacts will be gold-plated and will have a wiping action to minimize these factors.

Also, watch for DMM switches to be replaced with a keypad-style switch similar to that used on pocket calculators. Switch types include conductive rubber pads and bubble-type switches sealed in vinyl.

A/D Conversion and Measurement—CMOS chip technology has produced microprocessors with low current drain, greatly improving battery life. In 1979, Beckman Industrial Corporation introduced LSI technology in the multiprocessor used in its professional and heavy-duty DMMs. This technology extended battery life to 2,000 hours. Equivalent battery performance was achieved by other DMM manufacturers about 1983.

DMM designers foresee a trend toward more custom chips. Silicon-foundry technology should make relatively low production runs feasible. The result will be more proprietary designs to suit specific needs. Product differentiation should increase, and the diversity of offerings should expand. In short, users will have more choices.

Display—These changes in chip technology also should increase the flexibility of display formats. Some existing DMM designs handle analog-to-digital (A/D) conversion, measurement and display control all within the same chip. Future DMM designs may separate these functions between at least two chips, one for A/D conversion and one for meter operation and display control. Having a separate chip for display control means that meters can be customized further. The number of available display formats may increase, with features tailored more closely to specific applications. Users may be able to control output formats through soft-touch buttons.

An extra display feature on some DMMs is a bar graph that supplements the numeric reading. This simulates d'Arsonval needle (analog) movement and provides for quick visual checks. With new display-controller chips, bar graph gradations will become finer, permitting more accurate representation. Other features might be user-selectable temperature readings in either Fahrenheit (°F) or Centigrade (°C); decibel measurement; relative readings and min/max memory.

LCD (liquid-crystal display) technology also is changing. Use of these devices in DMM displays was a major advance that replaced light-emitting diodes (LEDs). LCDs using CMOS technology require less current and promote longer battery life. But there is room for improvement. Display formation depends on the characteristics of liquid-crystal flow, which becomes impaired at extremes of temperature. Cold-weather exposure causes extremely slow display performance. At below-freezing temperatures, the liquid ceases to flow and produces no reading. Hot environments also

Looking At The Future --- From The Past

The closed loop circuits in late model TV sets are becoming more and more difficult to service. Just when you feel you have a handle on the parts that repeatedly fail in any given chassis, and think to yourself that you have solved your start up and shut down problems for awhile, a totally different string of parts begin to show up in that same chassis that cause the same identical symptom. In spite of the fact that the same symptom is on the screen (usually nothing more than a very quiet, blank screen), the new wave of parts failures turn out to be in an entirely different portion of the horiz, hi-voltage, LV, LV regulator circuit, or in some scan derived B+ source that no one would ever suspect, much less consider.

Before they can even begin to function, many (or most) late model TV sets first require a "start up" B+ pulse for the horiz oscillator, and another such "short term" supply of initial B+ voltage for the horiz driver stage. Both of these "initial" start up pulses must be supplied by the primary low voltage power supply. Specifically, they must originate from some point in the LV supply that is located between the LV rectifiers and the B+ side of the primary winding of the horiz sweep transformer.

Once the horiz osc/driver stages begin to cycle, the secondary side of the flyback must begin to provide its own B+ voltage, which will then be used to **keep** the horiz osc/driver stages running once the initial start up B+ source has been depleted. Thus, as a technician, when it comes to troubleshooting the horiz oscillator or driver stages, you are now dealing with four totally independent circuits (the start up circuit, scan B+ "run" circuit, the oscillator, and the driver circuit), and not just the horiz oscillator and driver circuit.

But, it doesn't end there!

The low voltage regulator circuit in most late model TV sets will employ any number of shut down sensors. If for example, the video output stage is shorted, the start up circuit will still start the oscillator/driver stages, the horiz output stage will still "cycle" the primary of the flyback, the flyback will still begin producing scan derived voltage, but the secondary winding of the flyback that supplies B+ voltage for the video output stage will be "loaded down" by the shorted video output transistor. That secondary winding will run into magnetic saturation, the entire iron core of the flyback will "saturate", the output level of the flyback will be low, the insufficient output of the flyback will "trigger" any one of four or five LV regulator shut down circuits, the LV regulator will promptly shut down, and, --- the technician who is witnessing this sequence of events will have no possible way of knowing whether the oscillator failed, the driver failed, the start up circuit failed, the LV regulator, primary B+ or the flyback itself has failed!

It still doesn't end there!

Many late model sets now employ a "sustaining pulse" circuit that takes a 60 hz pulse from the **vertical** output circuit, and applies this same 60 hz pulse to the LV regulator drive circuit.

At first glance, it almost appears that the design engineers are creating these "special effect" circuits just to make service more difficult for field technicians.

--- NOT TRUE!

In fact, such circuits are nothing less than a stroke of genius once you analyze their purpose and function.

Based on the law of physics, anything that either loads, or unloads one secondary winding of a transformer, will effectively produce the same results at all other secondary windings with regards to voltage output. That is, if you "short out" one winding, you will drastically reduce the voltage output of all other windings. If you "open" a given winding, you will drastically increase the voltage output of all other windings. Its all a matter of volts/amps, which is the primary design criteria of **all** transformers.

This in itself tells you that "opening" or "shorting" a secondary winding that for example feeds the vertical output stage, will have a much greater effect on all other secondary windings, than doing likewise to a secondary winding that supplies nothing more than an agc pulse. **WHY!** Because the vertical output stage requires far more amperage to drive it than does the agc circuit.

Why were sets designed this way?

Imagine a TV set in which all of the circuits, except for the horiz output stage, operate off of a wide assortment of scan derived B+ sources. This same TV set is running along just fine, when suddenly, the vertical output or the R-B-G video output stage becomes open due to an open resistor or transistor.

Continued on page 17

must be avoided. Tomorrow's DMMs should be able to produce readings even after being subjected to freezing weather or to the heat of the sun for extended periods.

Flexible materials should replace the glass that is currently used for the face of the display. This feature has already appeared on some pocket calculators. On a DMM, this means enhanced durability, safety and reduced size. DMMs also will have luminescent displays. Illuminated displays today depend on lighting or backlighting with conventional bulbs that can drain the battery rapidly. Instead, in future meters, the display itself will glow.

Display readouts today are available in 3½ digits (0-1,999 counts) or 4½ digits (0-19,999 counts). Providing the extra counts requires more expensive electronics. Low-cost alternatives in the future will increase the range of the first count to 3½ digit displays. Options should include 0-2,499, -2,999 or -3,999 counts.

Batteries — This year should see the introduction of new lithium batteries from Kodak and other suppliers. Barriers to this technology have been the toxicity of lithium. Recent advances protect the user against exposure to the chemical if the battery becomes damaged. Lithium batteries could power DMMs for more than twice the life of conventional alkaline batteries.

Meter Output — Some DMMs, especially the autorange types, put out 3V to 4V in resistance mode. This voltage is sufficient to switch *on* diodes in the circuit under test, perhaps causing malfunction or accidental system activation. Future DMM circuits will overcome this problem by incorporating more complex processing logic.

Casing — New plastics promise to enhance the durability of DMM casing materials. These plastics offer better resistance to solvents and physical impacts. Cases made of these materials should hold their shape even at relatively high temperatures: if a DMM were set on the dashboard of a car on a hot summer day, for example.

The prospects for the future of DMMs are for enhanced convenience, durability and reliability. Users will have a greater number of product choices, including many models that are tailored more closely to specific applications.

Continued from page 15

In less than a heartbeat, what used to be a +26 volt scan B+ source that supplies the tuner, IF, video, chroma circuit, suddenly surges to something over sixty volts. Should this happen, it doesn't take much imagination to realize what will happen to most (or all) of the solid state devices in ali of the stages that are connected to the +26 volt source (which is now producing some + sixty volts)?

On the other hand, if the set had employed a 60 hz "sustaining" circuit for the purpose of supervising the LV regulator, the LV regulator would have immediately shut down as soon as the vertical output stage died, and no surge would have occurred on the +26 volt line.

The application is wide and varied.

Some sets employ as many as ten or eleven totally unrelated shut down circuits. Some of which may be used to shut down the horiz oscillator, others to shut down the LV regulator, and others to shut down the horiz driver. All ten circuits can come into play simultaneously, or they can also be activated on an individual basis.

Some LV regulator drive circuits are known to employ as many as seven totally unrelated shut down circuits, each independently activated by a totally unrelated event (i.e. a shorted video stage, an open vertical stage, excessive hi-voltage, excessive brightness, an inoperative ABL circuit, any type of a short in any circuit that relies on scan derived B+ voltage). A shorted LV regulator in turn may activate yet another shut down circuit that will saturate the base of the horiz driver transistor with positive voltage until all scan sources are dead, and the entire TV set is likewise dead.

Now, - - - let's analyze the above.

A TV set comes into your shop with a "dead set" symptom on its screen:

1. Did the Horiz oscillator die?
2. Did the horiz driver die?
3. Is the LV regulator in shut down?

1800 TIMES FASTER . . . THAN YOU

TRY ONE IN YOUR TV SHOP WITH NO "UP FRONT" MONEY

AS SOON AS YOU PUSH THE TEST BUTTON

The defective component will light up in the Eliminator's generic schematic,

A light will tell you whether that component is open or shorted,

Another light will tell you what effect the defective component has had on the overall circuit (I.E. LV short, inductive short, no start up, LV reg. shut down, horiz drive shut down, lost scan B+ source etc).

An instruction will light up telling you how to verify the findings of the Eliminator by taking just one voltage reading at a "land mark" test point (without pulling the chassis).

4 Did the LV regulator circuit simply die?
5. Did the horiz osc/driver die, or is one or both of them in shut down?
6. Could the safety capacitor be open?
7. Is the flyback defective, or is it a shorted vertical, video, R-B-G output stage, or the HV multiplier that is causing the flyback to "appear" to be defective?
8. Is the vertical output circuit functional?
9. Did the initial start up pulse occur?
10. Is the scan B+ "run" voltage present?
11. Is the flyback circuit open, shorted, is it simply not being driven, or is the flyback itself just defective?
12. Is the LV regulator working?
13. Is the circuit not working due to a defect in the horiz drive or LV regulator circuit, or is it in shut down due to a short or open condition in a circuit that utilizes scan derived B+?
14. Is the circuit defective?
15. Is the set in shut down?
16. Or could it be that it never really started up in the first place?
17. On the other hand, perhaps it started up; but did not receive any "run" B+ voltage.

The list of questions goes on and on.

In the case where the set is blowing a fuse, is it doing so because of a short in the LV supply? or, is it due to a short in the flyback related circuitry?

Allowing that a short, **or**, an open circuit almost anywhere in the TV set can cause either overall shut down, or failure to start up, or "failure to run" symptoms (which amount to nothing more than a dead set), and considering that an open or shorted primary LV supply will cause the same symptom, it's sometimes difficult to establish a starting point. It is **literally impossible** for any technician to establish **any** type of an organized troubleshooting routine, and **virtually** impossible for him to economically complete such repeairs without an absolute stroke of luck with regards to "stumbling" over the defective part while chasing the elusive failure (usually in a circular motion).

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- test power supply for function and output;
- measure surface temperature of boards and IC;
- check for shorts and leaks;
- check for presence of digital signal at outputs or on the data bus;
- test cooling fan power circuit.

For each of these tests, you should be able to identify specific measurements. For each type of measurement, you can determine the range and accuracy required. This information is fed to the next step, in which you develop a set of requirements and specifications for your purchase.

Requirements and specifications

For DMMs, your application requirements can be defined in terms of measurement functions and desired test capabilities.

In this step, the specific types of tests that you've identified are matched with specific DMM functions. Most DMMs, for example, measure Vac, Vdc, Aac, Adc and ohms. Many of these meters also will perform continuity and diode tests. These basic functions will be found on DMMs in all price ranges, although some models might not include all of them.

Special functions, which might be found on a few DMM models, include true rms, temperature, frequency, capacitance, conductance, transistor gain (hFE), decibels (dB) and logic.

DMM options and individual cost items correspond to some of these functions. For temperature measurements, special thermocouple test probes must be used. Some high-voltage measurements require special probes. Logic probes also are special-purpose devices, and may be separate from the DMM. Frequency functions on hand-held DMMs are needed mainly in the field for preliminary measurements, because a bench instrument, a frequency counter, is typically used to perform more detailed tests in the lab.

Surveys of DMM users in service operations indicate that the following requirements are among the most important:

- size;
- ease of use;
- protection;
- performance.

Size.—Many technicians prefer to carry a meter in a shirt pocket or in a notecase or briefcase. Some low-cost DMMs are exceptionally compact, about the size of small calculators, and are well-suited to these preferences. Professional and heavy-duty DMMs, on the other hand, tend to be larger, because of the thicker plastic materials and case designs needed to protect internal electronics.

Although heavy-duty DMMs tend to be bulkier than other types, some are more compact

Compare the difference between the low cost DMM shown on the left in the gray case and the heavy duty DMM shown in the yellow case. The heavy duty DMM has RFI shielding that wraps completely around the module of the DMM, while the low cost DMM has only a shield protecting the component side of the PCB.

Shown left to right are the bottom cases of three DMMs. The major factor of mechanical protection is case design, including the number of internal ribs supporting the case, thickness of the material and number of screws holding the case together. For protection from contaminants such as water, a gasket is needed, as shown in white on the yellow heavy-duty meter.

Continued from page 17

In order to effectively troubleshoot any bonifide start up, or shut down, or any type of flyback circuit related failure in a modern TV set, you would have to **simultaneously** determine whether the start up pulse occured, whether the oscillator/driver circuits are functional, whether the scan B+ "run" voltage is being provided, whether any shorted or open conditions exist on the secondary side of the flyback, whether the LV supply is open or shorted, whether the LV regulator is working, and whether or not "how many" of the above circuits are capable of working with each other!

Unless you gathered every bit of the above information simultaneously, the problem or defect would come into play, and you would not be able to ACCURATELY gather any of it. In order to demonstrate this, consider a TV set that starts up with a burst of hi-voltage then promptly dies. Which circuit is defective, the osc/driver, the start up circuit, scan B+ circuit, LV regulator circuit, vertical circuit, primary LV supply, safety capacitor, flyback, or is it nothing more than a shorted R-B-G video output circuit? Could it be a shorted CRT?

The fact is, any of the above circuits could cause the exact same symptom that was given, and we defy any human technician to come up with any type of systematic method of separating the possibilities of failure. Like we said, unless you can gather **all** of the above information simultaneously, and do so during the very first one hundredth of one second of circuit operation, you will not be able to gather **any** of it, on **any** type of a systematic basis.

If you have been having problems with start up and shut down circuitry, at least now you know why. You should also be aware at this point that every technician who is working on them is also "donating" much of his time for the same reasons.

In order to solve the above problems once and for all, we at **DIEHL** designed a digital computer that does indeed gather all of the above information, plus some ten times as much "other" information within the first one hundredth of a second of operation.

In the next one hundredth of a second it will compare everything that did, and everything that did **not** happen in the entire low voltage, hi-voltage, horiz osc/driver, LV regulator, start up, shut down, flyback transformer, and any circuit that relies on scan derived B+ (including external and internal HV multipliers and picture tube), including the vertical, video, R-B-G video output circuits (from a current consumption standpoint), then organize and discern all of the above with absolute 100% accuracy.

In the next one hundredth of a second, our latest diagnostic computer will tell you exactly and precisely which type of a circuit condition, or circuit failures exist. For example, it will tell you if the LV supply is open or shorted, if the LV regulator is open or shorted, if the main filter capacitor in the LV supply is open or shorted, if the pin cushion, H. yoke, centering diode, H. yoke discharge capacitor, or damper diode is open or shorted, likewise for the primary winding of the flyback.

It will then tell you whether the initial start up circuit, horiz osc/driver, and scan derived "run" B+ source is open or shorted (including any rectifier, resistor, capacitor, or transformer in this circuit). It will pinpoint shorted horiz driver transistors. It will also pinpoint any open or shorted rectifier or filter capacitor in any B+ path (scan or otherwise). The Mark VII-E will also tell you **if** either the LV regulator or the horiz osc/driver is in shut down. Not only that, it will also tell you **why** it is in shut down.

If any type of a short or open exists in any portion of the flyback circuitry, it will pinpoint that condition.

In the event it encounters an open safety capacitor or damper diode, it will automatically "bridge in" its own substitution component, light a lite telling you that it has done so, then continue with its scan as though nothing were wrong regarding the safety cap or damper

Continued on page 53

PROVE IT TO YOURSELF

WITH AN ELIMINATOR There Is No Such Thing . . . As A Dog

Phone (806) 359-0329 And Try One Yourself

FOR START UP/SHUT DOWN PROBLEMS OR ANY LV, HV, FLYBACK RELATED FAILURE

In any eight hour day, one Eliminator will accurately identify more defective components (ones that will actually repair the TV set), than any ten technicians who are presently working anywhere in the TV service industry. (Even if it is being operated by an amateur)

Rather tan "mumble to yourself
"IT CAN'T BE DONE"
Why not try one in your own shop

than others. Some of the larger units have two parts: the meter itself and a protective plastic holder. This holder adds to the physical bulk of the meter.

Ease of use. – Both reliability and convenience are enhanced if the DMM has a single rotary switch for selecting functions and ranges. The rotary switch makes it possible to turn the meter on and to select the desired function and range in a single action. By contrast, DMMs that use push-button selectors typically require three steps: Turn the meter *on*, select ac or dc measurement and select function and range.

Another consideration is the readability of the meter's display. Two factors are important: the size of the digits and how well they contrast with the background of the LCD. Larger digits with good contrast make it possible to read the display from different angles, especially when working in cramped spaces or in adverse lighting conditions.

You should determine whether the meter comes with convenience features such as a tilt bail, anti-skid pads on the back of the case, and even a spare fuse inside.

Protection. – Types of protection needed in some DMM applications include mechanical, environmental and electrical.

Mechanical protection. – This requirement relates to the meter's impact resistance, or ability to withstand dropping or vibration. Some ruggedized DMMs are guaranteed to withstand a 10-foot drop to a concrete surface.

Mechanical protection is largely a matter of case design. A major factor is the thickness of the plastic housing. The thickness and the degree of protection provided varies even within the offerings of a single manufacturer – low-cost (0.08-inch), professional (0.14-inch) and heavy-duty (0.18-inch).

Other indications of the degree of mechanical protection provided include the number of internal ribs that support the various parts of the case and the number of screws that are used to hold the case and the internal modules together. The greater the number of rib supports and screws the better the durability, or ruggedness, of the meter.

A stringent guideline in this area is MIL-T-28800 for Style A, Class 2 instruments. This military specification sets standards for resistance of test instruments to mechanical shock and vibration. Some heavy-duty DMMs meet this specification.

Other mechanical protection features include shock mounting of the LCD and recessing the glass face plate of the display below the surface of the meter's face. To prevent damage, the rotary function switch also should be recessed.

Environmental protection. – Meters that must hold up under routine field use should be sealed against external contaminants such as dirt and dust and also should resist penetration by moisture, flammable gases and liquids. This protection can be provided by using gaskets at case seals and O-rings at case openings, such as input jacks. Also, fewer case openings minimize the number of places where contaminants might get inside.

Another environmental hazard that can affect a DMM's accuracy is radio frequency interference (RFI). Inside the case, RFI shielding for meter electronics may be necessary, both to shield the DMM from interference from the circuit under test and to prevent RFI generated by the DMM from causing disturbances in external circuits.

In general, demanding requirements for environmental protection point up the need for a heavy-duty DMM.

Electrical protection. – Protection against electrical overload is important for the safety of the operator, as well as to prevent damage to the DMM itself. This is a point for careful consideration, because such protection often is sacrificed for cost savings in low-cost models.

Professional and heavy-duty DMMs often use metal oxide varistors (MOV) as protection devices against static discharge. A MOV goes into low impedance conducting state if the voltage exceeds a certain value. In a DMM, the MOV is put directly across the input leads, usually in a series with a resistor. The MOV typically conducts at about 1,700V, clamping the voltage transient and protecting the meter and its user.

Most DMMs have a fuse to protect the meter's current ranges. The fuse is placed in series with the probes. The higher its current rating, the higher the fused rating of the meter.Fuses also should have high voltage withstand capability when blown so that protection is provided throughout the duration of any overload.

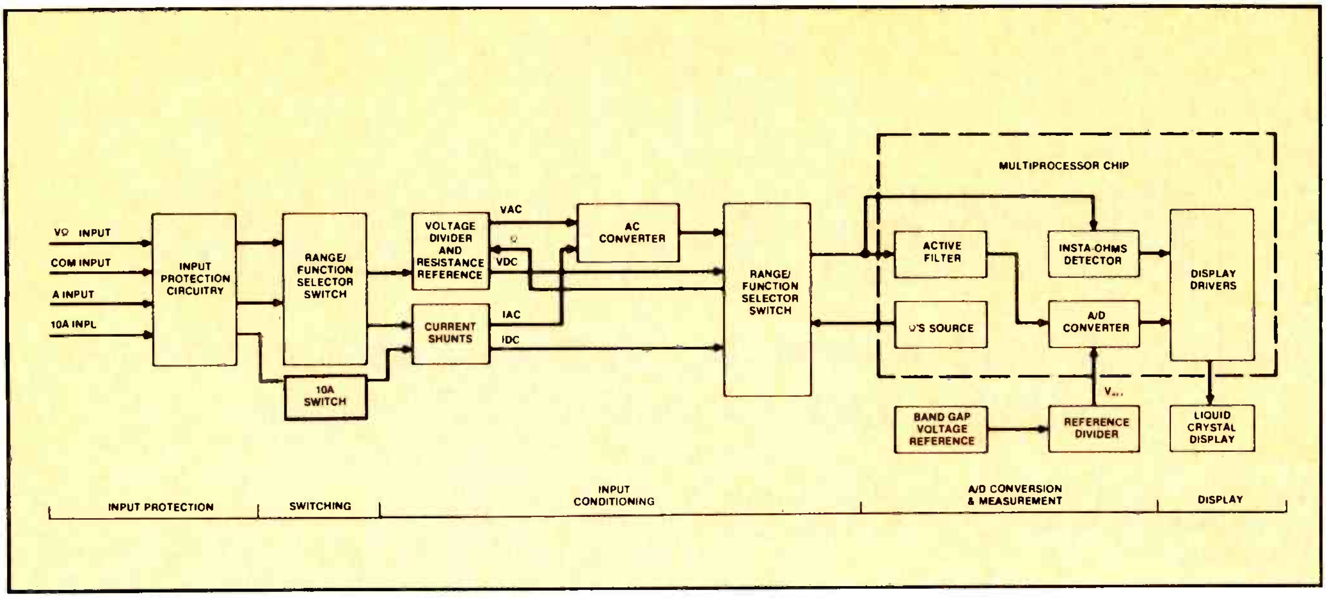
Most DMMs have fused 2A ranges. Some heavy-duty DMMs are fused even in the 10A range. Meters without a fused 10A range rely on the current ratings of their electronic components, which *might* help to protect the operator but won't prevent damage to the meter itself. A stringent spec for a ruggedized DMM would be a fused rating of 15A/600V in the 10A range.

Better-quality DMMs have cases that are made of self-extinguishing plastic. A relevant spec for fire-retardant plastic is UL 94V.

Other electrical protection considerations include the maximum allowable voltage in resistance mode and maximum overvoltage protection. Probes should have recesses and sleeves to prevent fingers from slipping and accidentally touching any conductors. For the same reason, input jacks should be recessed into the case.

Performance. – Factors that affect DMM performance in specific applications include resolution, accuracy and bandwidth.

Resolution. – The resolution of a DMM is determined by the number of digits in the display and the number of ranges available within each function. DMMs that display



The basic modules within the circuitry of a DMM are shown in this block diagram.

four digits are said to have *3½-digit displays,* because the first (left-most) digit is either 0 or 1. Similarly, higher-priced DMMs that show five digits have *4½-digit displays.*

DMM measurement functions are subdivided into ranges. The range selected determines the position of the decimal point in the display and the interpretation of the reading. The more ranges that are provided for each function, the more precise the measurement.

Accuracy. – Closely related to resolution is the overall accuracy of the DMM. Specifications for accuracy usually are expressed as a percentage of the reading, plus or minus a number of digits.

Another factor that affects the accuracy of the DMM is the sampling method used for measuring ac voltage. Low-cost models typically use an averaging method, which is less accurate than a true root-mean-square (rms) formula. True rms measurements are needed when working with switching power supplies, SCR- or TRIAC-controlled power supplies or distorted signals.

Bandwidth. – Another DMM performance specification is bandwidth, or the frequency range within which readings can be sensed. Costlier DMMs have bandwidths of 10kHz, perhaps even 40kHz. Low-cost models generally have bandwidths of 500Hz to 1kHz. Responsiveness to high-frequency signals often is needed in microcomputer and video service applications.

Once you've identified all requirements and specifications, you're ready to look at specific DMM models.

Identify and evaluate alternatives

This is the *shopping* phase of the process. As you gather data on different products, you might compile the specifications in a comparison chart.

You can evaluate these alternatives by weighing their costs and benefits against one another. Techniques for performing such evaluations include rating each alternative against a checklist of ideal requirements, assigning and tabulating point scores for requirements met by each product, or actually testing product samples in the lab or in the field.

Another advantage of actually obtaining a sample of the product is to get a *feel* for its quality and reliability. Are the graphics well protected, or might they be rubbed or scratched off easily? On opening the case, is the PCB paper-based and/or phenolic or glass-based? Are switch contacts gold? Is the PCB soldering clean?

At this point, it is not uncommon to find that no single product meets all your requirements or that meeting all stated requirements will strain your equipment budget. Feedback loops from this step carry results back to your definition of requirements, causing another cycle of decision steps.

Purchase decision

In making your selection, remember that the alternative with the highest rating or lowest cost isn't necessarily the most favorable. If an alternative has a high overall rating but does not meet a critical requirement, such as overload protection or durability, it's probably a poor choice. That's why it's important to make a distinction between *ideal* and *must-have* requirements. For example, the extra cost of a 4½-digit display might not be justified unless you require up to four decimal places in the reading. (In the 2V range, the least significant digit would represent tenths of a millivolt, or 1/10,000V.)

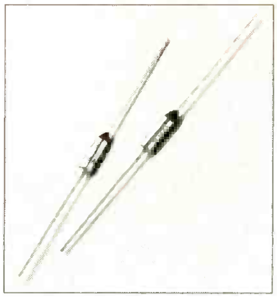
Use

Use on the job will determine whether your selection meets the needs that you outlined in the first step and the requirements that you have identified for the application.

Review

Evaluation of results comes after the equipment has been in use for a year or so. Decisions about basic tradeoffs will be confirmed in practice. For example, your decision might have been to buy a low-cost DMM on the assumption that it will be less costly over the long term to replace a broken unit than to repair it. In practice, there is a precise breakeven point at which higher-priced, repairable units become more economical. ES&T

ECG® Thermal Cut-Offs

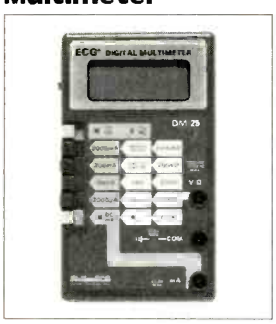


Industrial equipment should be protected from temperature overload, as well as current overload. Philips ECG Thermal Cut-Offs are fuses that react to temperature, instead of current, to prevent equipment from overheating. The thermal cut-offs offered by Philips ECG operate within a tolerance of +0 and −4 degrees Celsius of their nominal value. They are available in 20 temperature values ranging from 66°C (151°F) to 240°C (464°F).

Common applications:
All types of heaters, cookers and distilling apparatus as well as motors for fans, drills, saws, tools, coffee pots and hairdryers.

Circle (44) on Reply Card

ECG® Digital Multimeter



No need to read between the lines with this accurate DM-25 Multimeter. The parameter value appears on the 3½-digit LCD readout. One of a new line of meters for service technicians being offered by Philips ECG, the DM-25 can be carried easily in pocket or tool box.

In spite of its small size, the DM-25 has 14 ranges: DC voltages from 1mV to 1000 Volts in 4 ranges. DC current from 2000 microamps to 2000 milliamps (2 amps) in 4 ranges. AC voltages to 750 VAC on 2 ranges. Resistance from 1 Ohm to 2 Megohms in 4 ranges. Basic DC accuracy is ±0.5%.

Input impedance is 10 Megohms on DC and 4 Megohms on AC, to prevent overloading the circuit under test. The input has overload protection on all ranges. No need to fear hooking it up backwards, as it has an auto-polarity feature.

Not only do you get 2000 hours of operation from a 9 Volt alkaline battery, you also get a warning flag when the battery life is down to 10%. In addition, the DM-25 comes with carrying case, battery, test leads and instruction manual. It's one of the five new multimeters being supplied by Philips ECG. For more information, see your local Philips ECG distributor, or circle the reader service card number.

Circle (43) on Reply Card

ECG® Made-to-Match Wrenches for VCRs

Those special adjustment requirements on VCRs have finally met their match. Philips ECG offers 8 special wrenches designed to match the configuration of the recesses that adjust tape feed, tape tensions and other functions.

Made-to-match for both VHS and Beta units, there are VHS wrenches for tape feed guide, tape tensions, control head and control head phase, plus audio head and audio head phase. While for Beta, wrenches are for the audio and control heads. One tape transport adjuster wrench works on both VHS and Beta.

Philips ECG has also simplified and speeded up the diagnosis and repair of torque problems in VCRs. Torque Meter Cassettes for PLAY and FAST-FORWARD/REWIND, for both VHS and Beta VCRs, give you a fast and accurate diagnosis of the problem.

Circle (45) on Reply Card

ECG® Dual and Quad Head Assemblies for VCRs

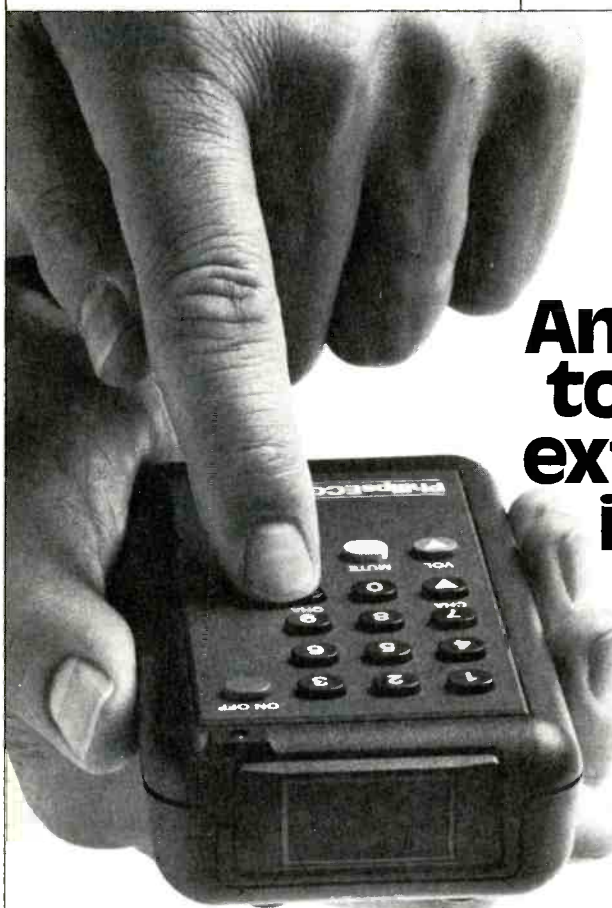
Philips ECG offers a high-quality line of drop-in replacement heads for both VHS and Beta VCR equipment.

Included in the new line are dual and quad heads for VHS, and dual heads for Beta VCRs.

Because they equal or surpass original manufacturer's specifications, these Philips ECG heads can be used to replace the heads in VHS units sold by Curtis Mathes, GE, Penney, Magnavox, Panasonic, Philco, Quasar, RCA, Sylvania, Akai, Hitachi, JVC and Mitsubishi. Beta heads are available for VCRs by Marantz, Toshiba, Sony and Zenith.

When you have to replace a head, just check out the replacement you need in the comprehensive cross-reference section in the Philips ECG Audio and Video Brochure, or call your local Philips distributor. You'll find a replacement head that fits and works, fast.

Circle (46) on Reply Card



Another way to program extra profits into your TV/VCR service calls.

Now you can replace defective remote control transmitters.

Our replacement Remote Control Transmitter is a good deal for your customer. It's a good deal for you, too. You get the extra profit and the extra convenience of just 71 Philips ECG RCTs that cover hundreds of TV/VCR models and chassis. And they're easy to find in our cross-referenced Philips ECG Remote Control Guide.

It's the same happy story with a whole range of electronic replacement parts from Philips ECG. There are hundreds of Philips ECG distributors, nationwide, who offer you fast service on over 3,600 different ECG devices that replace more than 227,000 industry types. All meet or exceed JEDEC specs.

From RCTs to microprocessor ICs, your Philips distributor has your replacement part. He'll put it in your hands fast. He also has a copy of the new Philips ECG Remote Control Guide, as well as other manuals and reference books that help you find the right part.

If you can't find a Philips ECG distributor in your local yellow pages, let your fingers do the talking and punch up the toll-free number for information on replacement parts or reference books. 1-800-225-8326

If it's ECG, it fits. And it works.

PhilipsECG

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Circle (11) on Reply Card

Test your electronic knowledge

By Sam Wilson

This quiz is made up entirely of questions from past quizzes. If you have been taking these quizzes and checking your answers you may be 100% right on this one.

Many readers have complained to me that I sometimes give the answer without an explanation. I've stopped doing that. Also, for this quiz, I picked questions for which I did not give explanations in the past.

1. Which of the following is a circuit used to eliminate undesirable turn-on in an SCR circuit?
   A.) Antitrigger
   B.) Gate blanking
   C.) Snubber
   D.) Differentiator

2. Current television systems use 525 or 625 lines. A recently developed high-definition TV system (HDTV) in Japan uses
   A.) 875 lines
   B.) 975 lines
   C.) 1,075 lines
   D.) 1,125 lines

3. A graph showing the gain of an amplifier over the range of frequencies it is designed to cover is called a
   A.) Fourier analysis.
   B.) stability plot.
   C.) peaking graph.
   D.) gain graph.
   E.) Bode plot.

4. An advantage of a closed-loop switching regulator over a closed-loop analog (continuous) regulator is greater
   A.) efficiency.
   B.) output voltage.
   C.) output current.
   D.) output power.

5. A ferroresonant transformer in a power supply circuit is used for
   A.) closed-loop power supply regulation.
   B.) open-loop power supply regulation.
   C.) oscillator feedback.
   D.) amplifier coupling.

6. Which of the following would be useful for eliminating parasitic oscillations?
   A.) An LDR
   B.) A ferrite bead
   C.) A diac
   D.) An LAD

7. From the standpoint of efficiency, it is more desirable to have a power factor of
   A.) 1.
   B.) 0.

8. Is this statement correct: An SCR can be tested with fair accuracy using a high-power ohmmeter.
   A.) The statement is correct.
   B.) The statement is not correct.

9. Is this statement correct: For soldering in modern circuits you should use a solder made up of lead, tin and about 3% zinc.
   A.) The statement is correct.
   B.) The statement is not correct.

10. Is this statement correct: If you remove a chip from a circuit board, it can be used again if it is first cleaned thoroughly with alcohol.
   A.) The statement is correct.
   B.) The statement is not correct.

Answers are on pages 70 and 71

TV Tests and Measurements

Multimeters are the Swiss Army knives of the electronics business. They're compact, can be easily carried and give you a number of functions. You can use one to check for the presence or absence of a voltage, check for proper voltage levels, measure resistance, check continuity and a whole lot more. Of course, a multimeter can't provide the troubleshooting functions possible with an oscilloscope, a TV analyzer or some of the other more sophisticated items of test equipment, and should be abandoned if it doesn't point quickly to the solution to the problem. But more often than not, a multimeter is the first item of test equipment brought to bear on the problem and frequently is the only piece of test equipment necessary.

This article is an adaptation of "Television Tests and Measurements," from the book, "101 Ways to Use Your VOM, TVM & DVM," by Robert G. Middleton, reprinted with permission of the publisher, Howard W. Sams & Company of Indianapolis. It presents a number of tests you can make on televisions using a multimeter.

To measure the sensitivity of a TV receiver

Equipment: An AM signal generator.

Connections required: Connect output from the signal generator to the input of the RF amplifier; connect an ac voltmeter at the output of the video amplifier.

Procedure: Tune the generator to the center of the chosen VHF channel. Set the generator for 1,000μV output and 75% modulation. Turn the contrast control to normal operating position.

Evaluation of results: A typical small TV receiver will produce 50V p-p at the video-amplifier output when 1,000μV is applied to the receiver input. Typical stage gains are indicated in the accompanying diagram. Individual stage gains are measured to best advantage by signal-substitution (signal-injection) methods.

A note on input and output impedances

Calibrated AM signal generators usually have either a 50Ω or 75Ω output impedance, whereas standard TV receivers have a 300Ω input impedance. For most accurate measurement, an impedance transformer (such as a balun) should be connected between the generator output cable and the antenna-input terminals of the TV receiver. Unless the impedances

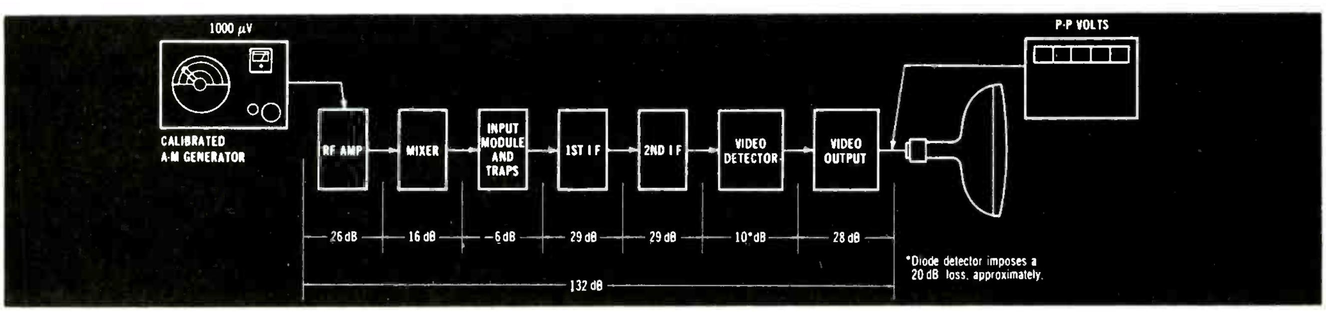


Figure 1. A 1,000V input produces a 50Vp-p output in a typical small TV receiver.

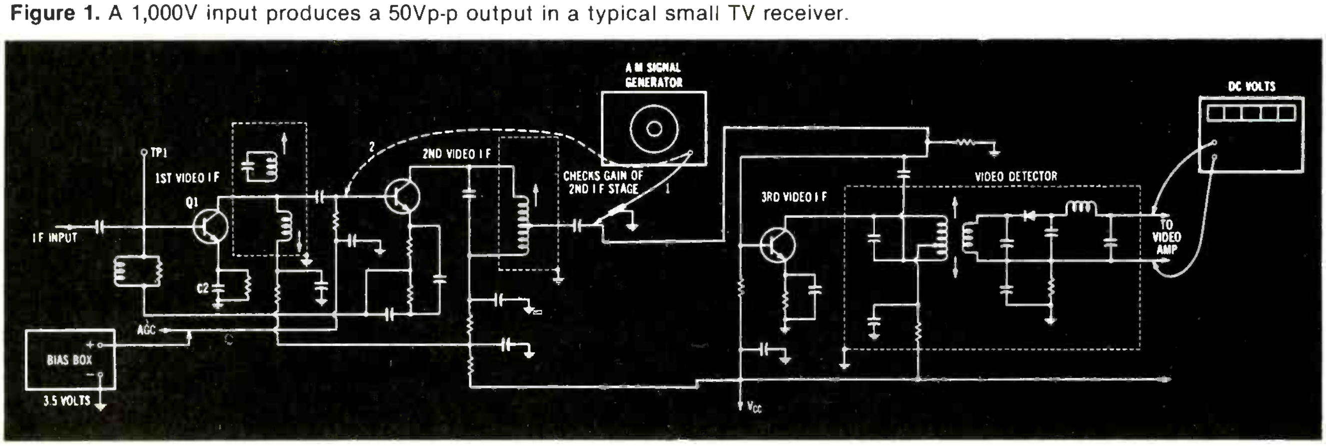
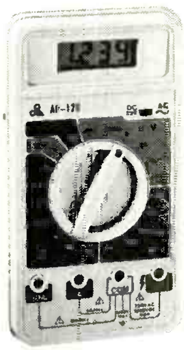


Figure 2. Setup for the measurement of IF stage gain.

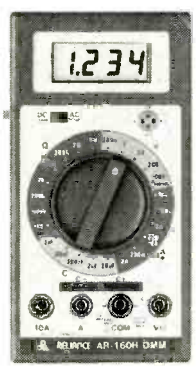
AMERICAN RELIANCE DMM'S

Better meters for all reasons

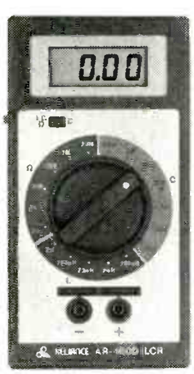
When it comes to digital multimeters, no one can beat AR's variety, selection, quality and price.



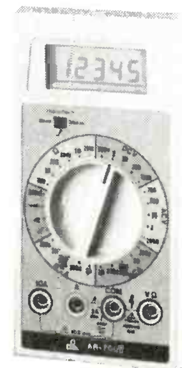
THE AR-120 is our best seller. It's loaded with the best features—0.5% accuracy, audible continuity check, ACA & DCA up to 10A and resistance measurements up to 20MΩ. It can also measure ACV, DCV and function as a diode tester. $49.95 suggested retail.



The AR-160H is unique in the industry and includes capacitance measurement, and the best transistor socket available in its price range. $89.95 suggested retail.



The AR-460D is the industry's first handheld LCR meter with DISSIPATION factor. It's an essential tool for the engineering lab, quality control and amateur radio applications and it's competitively priced, too. $199.95 suggested retail.



American Reliance's 700T is a feature-loaded unit with 4-1/2 digits, true RMS measurement, frequency counter (up to 200 kHz) and more. $199.95 suggested retail.

Last but not least, **the AR-230S**, a 4-1/2 digit DMM, 0.05% accuracy for under $100. It's fast, rugged and accurate. Perfect for a wide variety of applications. $99.95 suggested retail.

Every multimeter is carefully designed, quality constructed, assembled and QC'd to meet exacting performance specifications. It's what you'd expect in a DMM from American Reliance. Besides, our modern, efficient, manufacturing methods allow for extremely competitive pricing.

For complete information, contact

AMERICAN RELIANCE INC.

Suite 201, 9241 E. Valley Blvd.,
Rosemead, CA 91770
or ☎ (818) 287-8400.
Toll-free (outside CA) 800-654-9838.
Distributor inquiries invited.

Please ship me the following DMM:
Model # ______________ Quantity ______
Name ______________
Company ______________
Street ______________
City ______________ State ______ Zip ______
Phone ( ) ______________
Enclose check or money order.
California residents add 6.5% sales tax.
☐ Master Card ☐Visa
Card # ______________ Expiration Date ______
Signature ______________
Please send complete information. I am particularly interested in model # ______________. (Fill in or attach your business card.)

Circle (13) on Reply Card

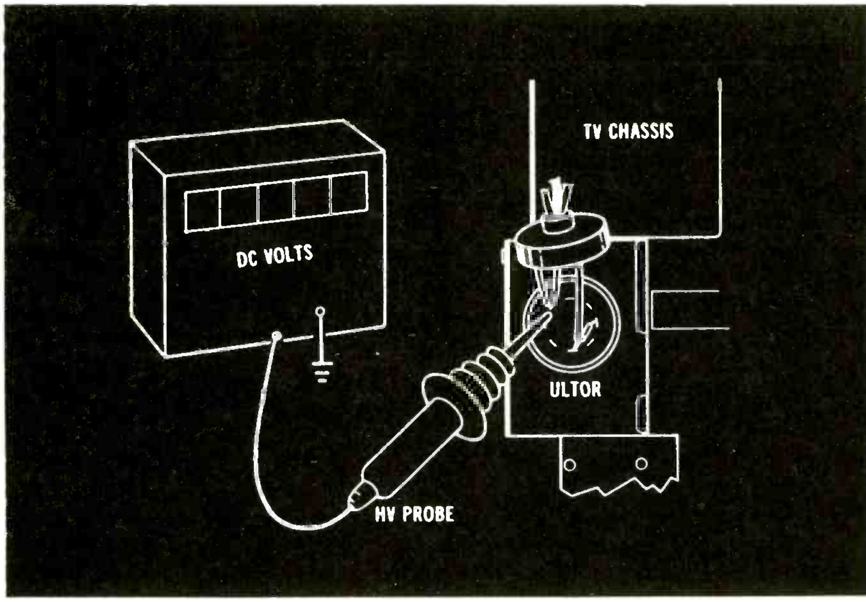


Figure 3. Configuration for measurement of high voltage at the picture tube.

are matched, an appreciable VHF power loss will occur making the receiver *appear* to be less sensitive than it is in fact.

To measure the signal-voltage gain in an IF stage

Equipment: Signal generator with output in the 40MHz range, and a bias box.
Connections required: As shown in the accompanying diagram, connect the dc voltmeter at the output of the picture detector, and connect the bias box (in suitable polarity) between the AGC line and ground.
Procedure: Apply a modulated output from the generator to the output of the particular stage, and adjust the output level for a reading of 0.1V on the meter. Then, transfer the generator output lead to the input of the stage, and observe the meter reading. The bias-box voltage should be set to the value specified in the receiver service data.
Evaluation of results: The ratio of the second voltage reading to the first voltage reading is equal to the stage gain. Measured values in AGC-controlled stages will depend considerably upon the value of the override bias that is used.

A note on erroneous results in stage-gain measurements

Erroneous results will be obtained in stage-gain measurements if the test signal level is excessive and overloads a transistor. In case that the signal generator is not provided with an output blocking capacitor, a 0.1μF fixed capacitor should be connected in series with the *hot* output lead in order to avoid drain-off of dc bias voltage. The generator should have an output impedance of 50Ω or 75Ω, and the generator output cable should be properly terminated. Subnormal gain often is caused by a defective transistor; if a transistor is replaced, be careful not to interchange the emitter and collector leads. If this error is made, the stage gain will typically be reduced to one-half, and the technician will have a "tough-dog" situation to contend with.

To check the high voltage at the picture tube

Equipment: A high-voltage probe to match the dc voltmeter.
Connections required: Clip the ground lead from the dc voltmeter to the TV chassis or to the common ground bus. Connect the high-voltage probe to the picture-tube ultor anode terminal, as shown in Figure 3.
Procedure: Operate the dc voltmeter on the proper range for the probe. Consult receiver service data for specific procedure, such as setting the brightness control.
Evaluation of results: The correct value of high voltage will be indicated in the receiver service data. In the case of a color receiver, high-voltage regulation also may enter into the test. For example, the service data may instruct the technician to turn the brightness control to minimum, at which setting the voltage value is normally 21.5kV, with a permissible tolerance from 20kV to 22.5kV. Then, as the brightness control is rotated through its range, the high-voltage value may decrease as much as 3kV, and the regulation is acceptable. In this example, if the high-voltage value is below 20kV at minimum setting of the brightness control, the technician is advised first to remove a jumper that ordinarily short-circuits a resistor in the high-voltage network. Then, if the high-voltage value falls within the range from 20kV to 22.5kV, the system is regarded as acceptable. Otherwise, the technician must proceed to troubleshoot the high-voltage circuitry.

To measure the AGC voltage and check the AGC action

Equipment: A test-pattern generator.
Connections required: Connect output cable from the generator to the antenna-input terminals of the receiver. Connect dc voltmeter to the IF AGC line and, then, to the RF AGC line.
Procedure: Measure the voltages on the AGC lines with no signal applied, and check against the values specified in the receiver service data. Then, advance the signal output from the generator to the point where specified output is obtained from the video amplifier. Measure the voltages on the AGC lines again. Finally, increase the generator output appreciably, after which the voltages on the AGC voltages normally will measure as specified in the receiver signal applied to the receiver, the AGC voltages normally will measure as specified in the receiver service data (within a reasonable tolerance). With sufficient signal applied to obtain a normal output from the video amplifier, the AGC voltages will shift significantly as a rule (direction of shift depends on whether forward or reverse AGC is employed). Finally, with a strong input, signal, the AGC

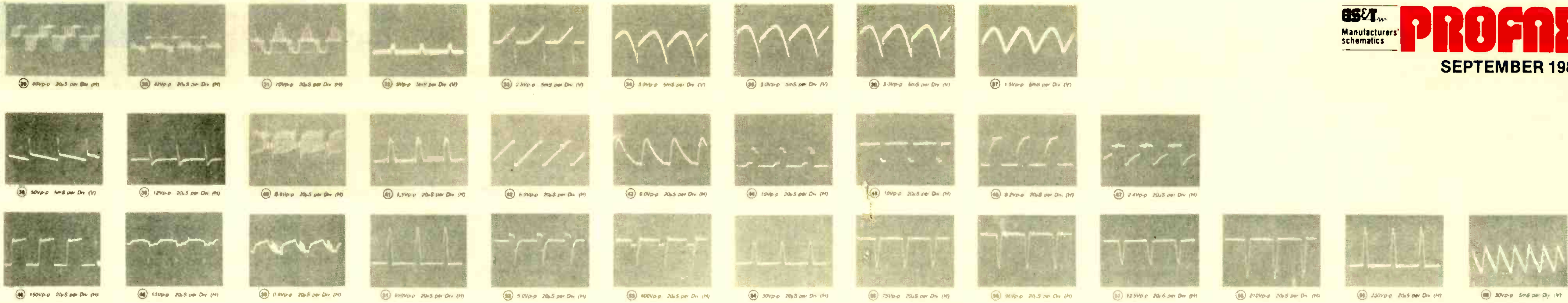
Continued on page 54

ES&T Manufacturers' schematics **PROFAX**

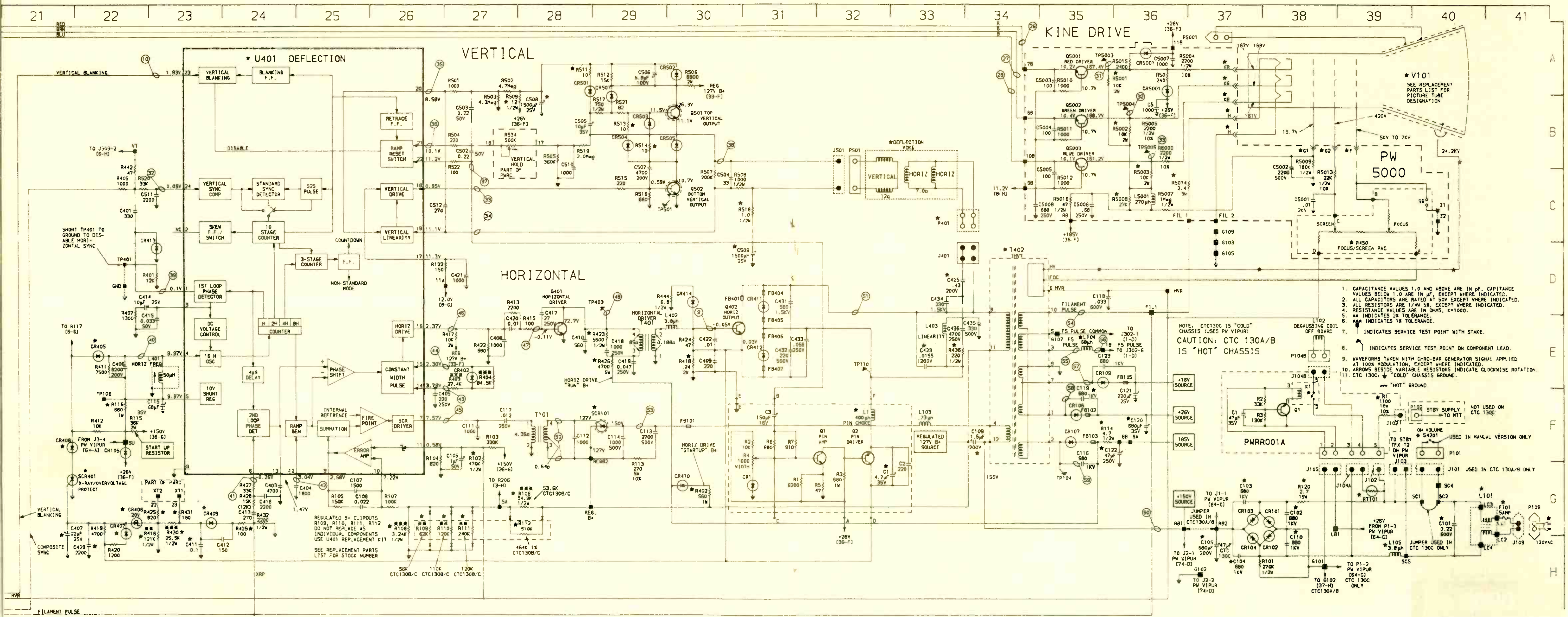
SEPTEMBER 1986

2090

RCA
CTC 130-S1 chassis
Color TV



CTC130 DEFLECTION AND POWER SUPPLY SCHEMATIC



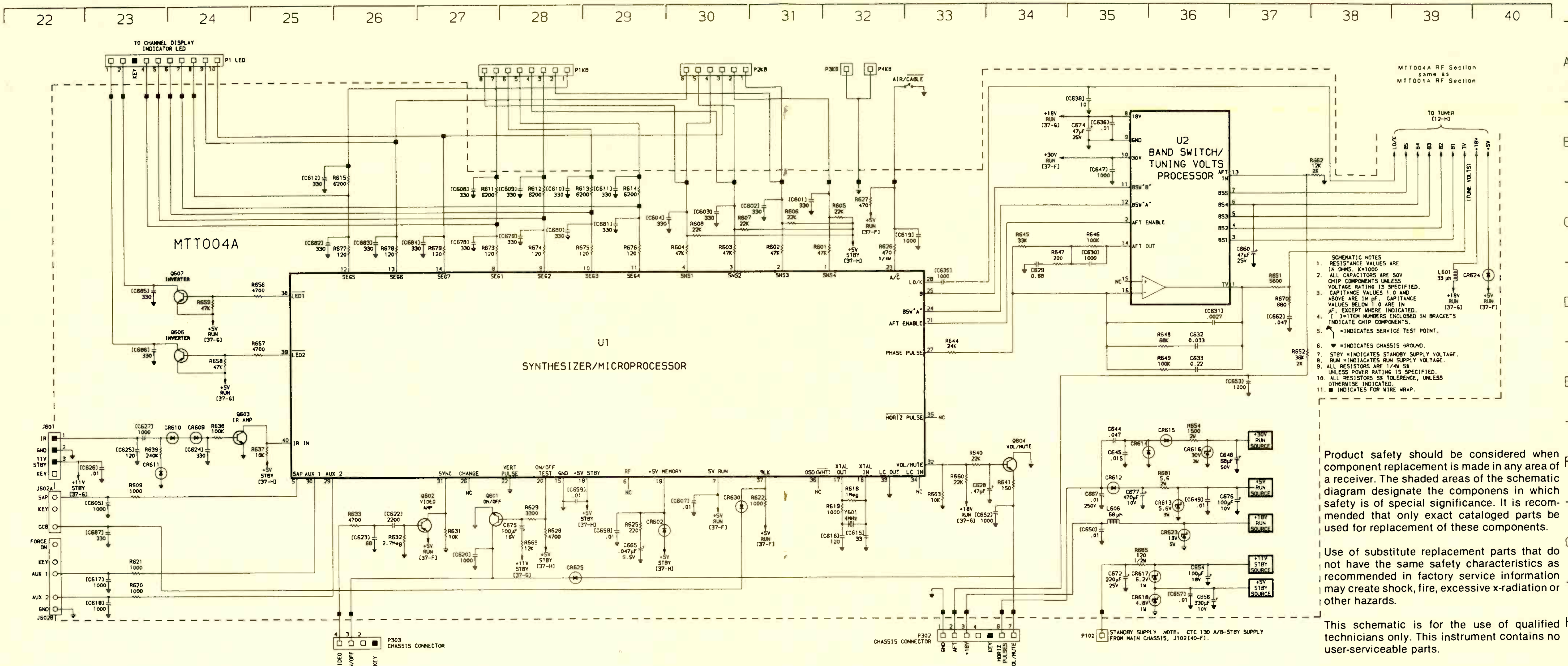
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

The other portions of this schematic may be found on other Profax pages.

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the componens in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

MTT004A TUNE SYSTEM (CONTROL SECTION) SCHEMATIC



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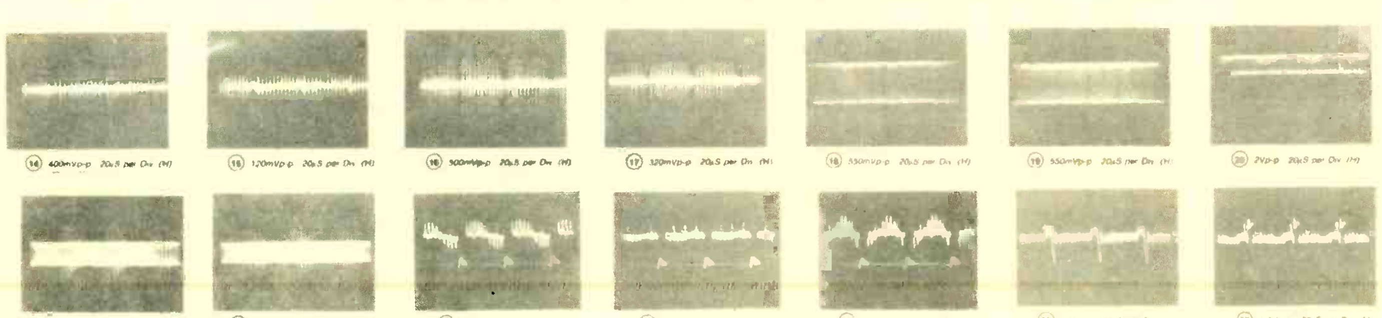
SEE SIGNAL CIRCUIT SCHEMATIC FOR LOCATION OF WAVEFORMS



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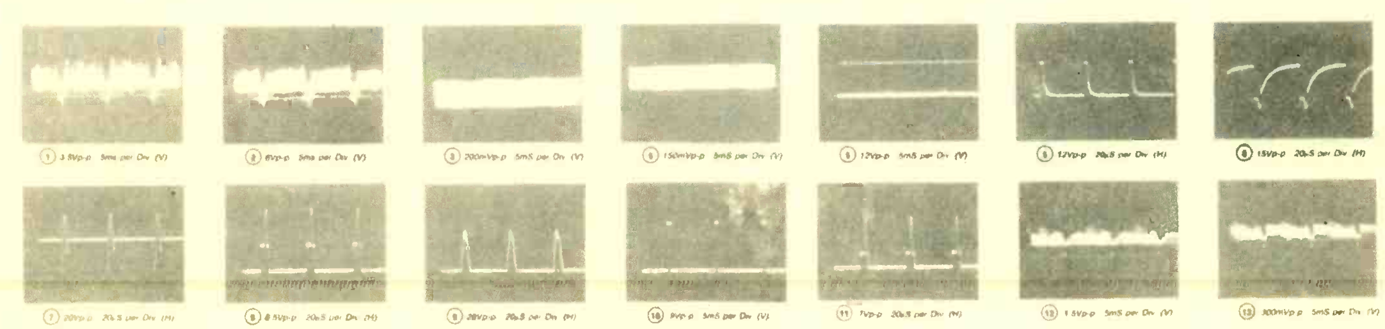
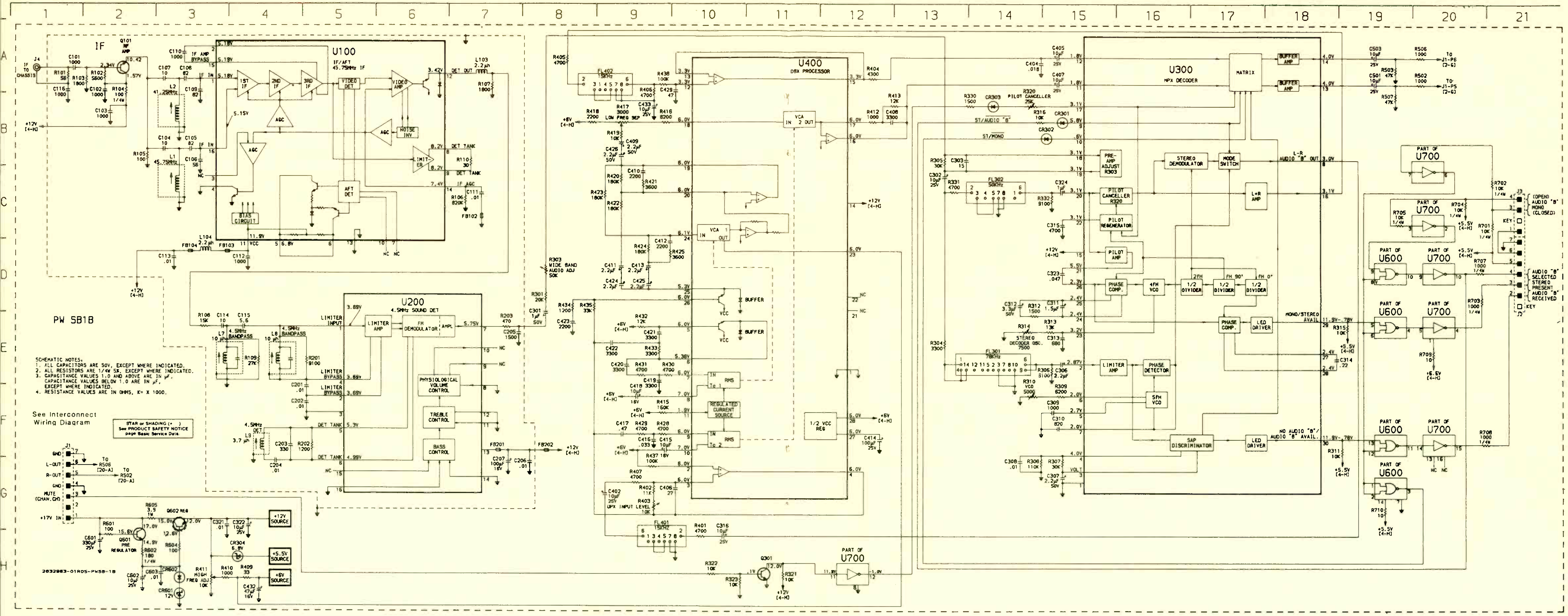
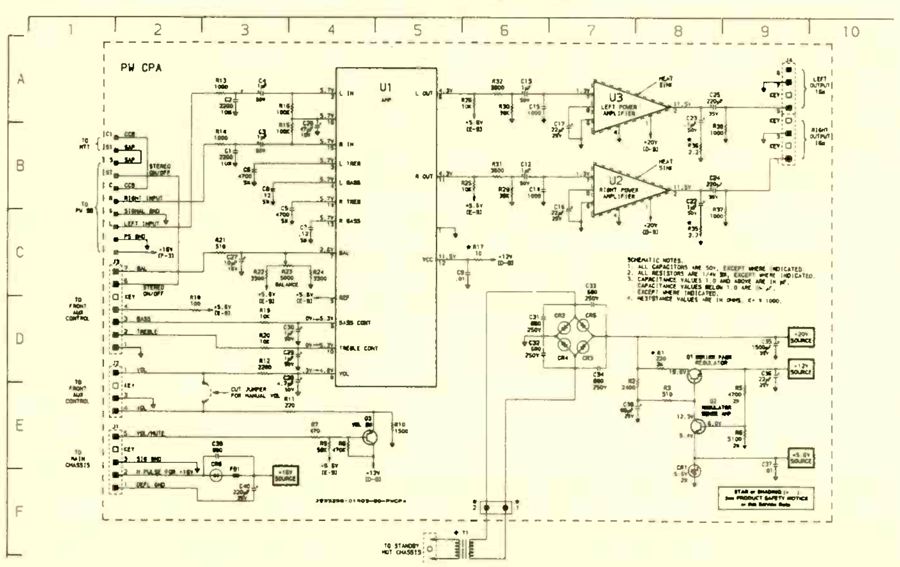


PW SB-1B STEREO BROADCAST SCHEMATIC



PW CPA STEREO POWER AMP SCHEMATIC



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ES&T Manufacturers' schematics PROFAX

SEPTEMBER 1986

Schematic No.

RCA
Color TV, CTC 130-S1 chassis 2090
(includes stereo schematics)

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the componens in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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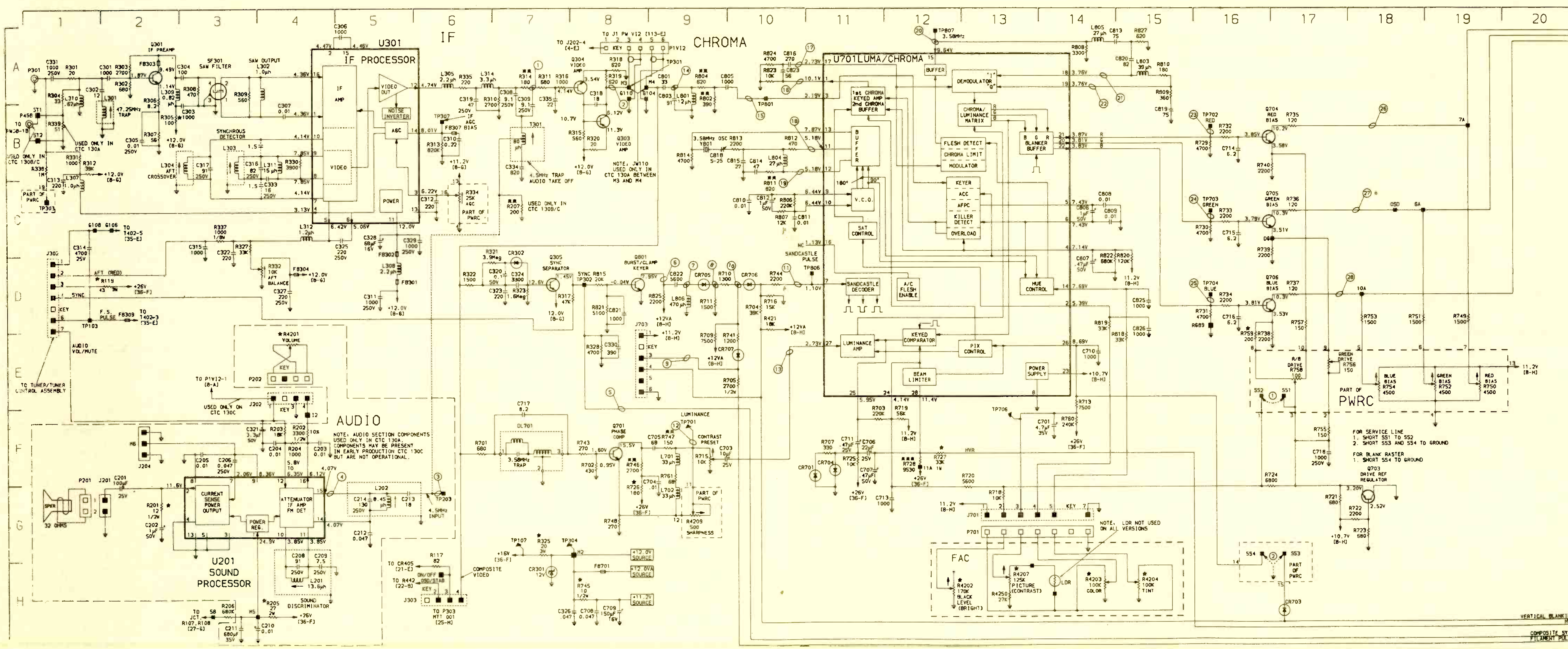
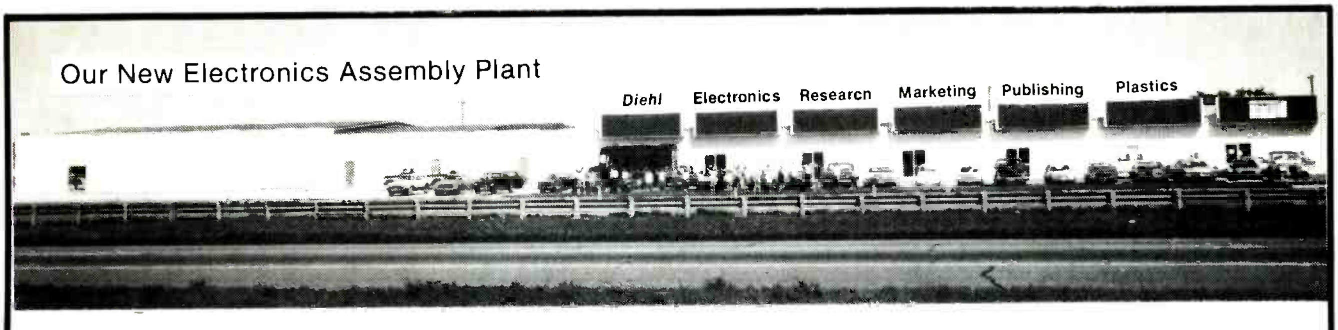
CTC130 SIGNAL CIRCUIT SCHEMATIC





In August of this year, *Diehl* doubled its capacity to manufacture diagnostic computers. We would like to take this opportunity to thank our 15,000 plus loyal customers who made it all possible. Without **Y O U**, we could not have survived.

Continued from page 19

diode. (without our computer, you would lose the horiz output transistor and perhaps the damper diode at the very first sign of an open safety capacitor).

Not only will our computer tell you the exact nature of the failure with regards to precisely which circuit has failed, and the condition that has been induced, it will also (in that same one hundredth of one second), tell you exactly **which** component in that circuit has failed.

In order to make absolutely certain that you do not think the previous sentence contained some sort of a typographic error, we will now repeat it.

Our new Mark VII-E Diagnostic Computer will pinpoint the exact component that has failed, and do so within one hundredth of one second of operation.

Furthermore, it will not only pinpoint the exact **nature** of the circuit failure, pinpoint the exact **component** that has failed, and tell you whether that component is now open or shorted, - - - it will also give you a brief **instruction** that will tell you how to **prove** beyond any possible doubt that the decisions made by the Mark VII-E are 100% correct with regards to which type of circuit condition exists, and exactly which component has failed. This instruction will in every instance tell you how to prove the findings of the Mark VII-E by measuring nothing more than the collector of just one "land mark" test point (i.e. the collector of any R-B-G video output transistor).

The mark VII-E works on any TV set that employs either an N-P-N transistor, or a single SCR as a horiz output device. No programming is required. Everything you need comes with it. Almost no instructions are required. The top of its case houses an 8"x11" display panel which contains a generic schematic for LV, LV regulator, H. osc/driver, output, flyback, yoke, scan B+ circuits, etc., etc. All instructions are contained within the generic schematic, but not visible until they are illuminated by the VII-E.

As soon as you push the test button, the defective component will lite up amber, the circuit condition will lite up red, and the instruction will lite up yellow. As a result, the Mark VII-E may well be the only piece of major test equipment that you can take out of its box and immediately begin using (without reading anything), since it provides its own instructions as you go.

With regards to exactly which circuit has failed, and exactly what type of circuit condition exists, the Mark VII-E can **never** be wrong. As to exactly which component has failed, it may occassionally miss by no more than one or two components. If so, the TV set will pass the test that is given by the instruction. In this event, the next time you push the test button, the Mark VII-E will automatically "step" to the next lower "odds" circuit, lite the next likely suspect component, and a brand new instruction for proving or disproving the new "suspect" component. In almost no instance will you ever have to so much as look at more than three components. By the time the Mark VII-E has "stepped down" to its third odds circuit, it is greater than 99% accurate. The "odds of probability" are displayed on the front panel of the computer for each individual finding.

To operate a Mark VII-E, simply plug the TV set into its female AC outlet (front panel), interface the horiz output device, push the test button, and read the generic schematic. If you hook it up wrong, the "hook up" light on its front panel will come on, and the Mark VII-E will shut itself and the TV set off until you correct the error.

For obvious reasons we call it the **"Eliminator"**. If you earn your living repairing TV sets - - - You need one! They sell for only $3,495^{00} and are now available. Visa and Master Card welcome, short term/long term financing is available. With approved credit, we'll even let you try one in your own shop for fifteen days with no up front money. Call (806) 359-0329 for more information, or write ***DIEHL*** Industries, 6661 Canyon Drive, Amarillo, Texas 79110.

Diehl will pay $100,000^{00} to any technician, engineer, factory representative, or to any **group** of technical personnel, who can effectively compete against an eliminator with regards to speed and accuracy, no matter how much "other" test equipment they care to use, no matter how much it costs (We'll even give them two to one odds). This is a serious offer. If you or anyone you know would like to take us up on it, we will be pleased to send you an application to do so. When it comes to start up and shut down related circuitry, nothing on earth will compete with **DIEHL'S** Mark VII-E Eliminator. - - - Nothing! For that very reason, you truly need one.

Wait till you see *Diehl's* Mark VII
V I D E O   A N A L Y Z E R

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Circle (8) on Reply Card

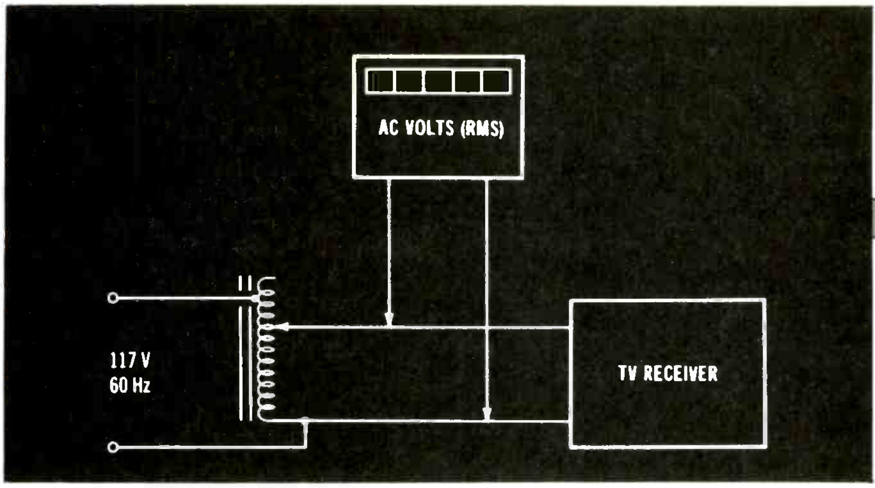


Figure 4. Circuit connections for a line-voltage variation check.

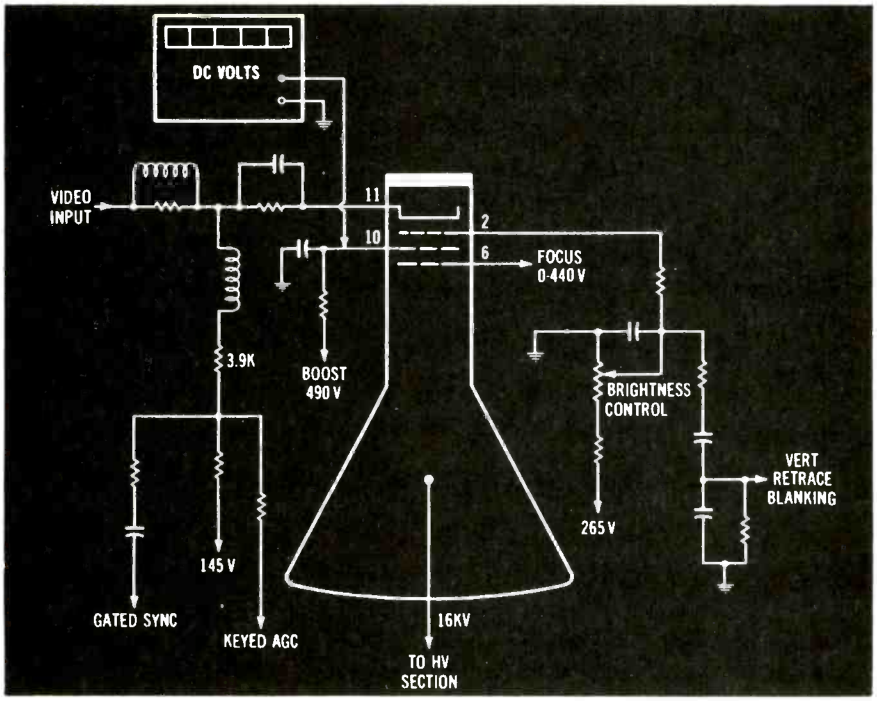


Figure 5. Arrangement for checking the terminal voltages of the picture tube.

Continued from page 28

voltages normally will shift again substantially, whereas, the video amplifier output level will increase only to a minor extent.

To check picture-detector voltage under normal-signal, no-signal, and marginal-signal conditions

Equipment: A lab-type AM generator.

Connections required: Connect the output cable from the pattern generator to the antenna-input terminals of the receiver. Connect a dc voltmeter across the picture-detector load resistor.

Procedure: With no signal applied to the receiver, measure the noise voltage at the output of the picture detector. Apply a 30% modulated VHF signal to the receiver and advance the generator output until the meter reads 1V above the noise-level voltage. Adjust the generator output so the meter reads double the noise-level voltage.

Evaluation of results: The noise voltage with no input signal applied is normally quite low. (In case of any doubt, make a comparative measurement on a receiver that is in satisfactory working condition.) Next, the number of microvolts of input required to produce a detector output that is 1V above the noise-level voltage is defined as the *sensitivity* of the receiver. Finally, the number of microvolts required to double the noise-level voltage represents the marginal-signal condition (picture barely usable). Note that an excessive noise output generally results from transistors that have leaky collector junctions, or from deteriorating resistors located in the front end or first IF section.

To determine the permissible line-voltage variation for a TV receiver

Equipment: Variac.

Connections required: As shown in Figure 4, connect the variac between the line cord and the TV receiver. Connect the ac voltmeter across the output terminals of the variac.

Procedure: Operate the ac voltmeter on its rms function. With the variac adjusted for 117V output, tune the receiver to a TV station. Then, reduce the setting of the variac until the picture reproduction is marginally acceptable, and note the meter reading.

Evaluation of results: As the line voltage is reduced, a point will be reached at which the picture has a subnormal width and also tends to lose horizontal sync. The contrast and brightness also may be impaired, and focus may become poor. When one or more of these parameters becomes marginally acceptable, the lower limit of the line-voltage variation is indicated.

A note on limits of line-voltage variation

No attempt should be made to determine the permissible upper limit of line-voltage variation because a destructive test would be required. Manufacturers typically rate their receivers for an upper line-voltage limit of 120V, and this value should be accepted without any experimental operation of the receiver at a higher line voltage.

To check picture-tube terminal voltages

Equipment: None.

Connections required: Connect a dc voltmeter from the individual

terminals of the CRT to ground. (A high-voltage probe must be used to measure the picture-tube accelerating voltage.)

Procedure: Check the terminal voltages against the values specified in the receiver service data. A comparative test also can be made with respect to a similar receiver that is in good working condition.

Evaluation of results: There is a reasonable tolerance on picture-tube terminal voltages. However, a substantial departure from rated values can cause a dark screen. The voltage on the control grid *will vary considerably* with rotation of the brightness control. *Normal brightness* is generally obtained with the control grid set to 35V negative with respect to the cathode. When incorrect terminal voltages are measured, look first for leaky capacitors. If the capacitors are normal, check for off-value resistors. Note that occasionally an interelectrode short in a picture tube will cause a subnormal terminal voltage.

To measure peak-to-peak waveform voltages in TV circuitry

Equipment: None.

Connections required: Connect test leads of peak-to-peak voltmeter from the waveform source terminal to ground, as specified in the manufacturer's receiver service data.

Procedure: Observe the meter readings.

Evaluation of results: In most situations, a peak-to-peak DVM will be direct reading. However, if the waveform is a narrow pulse, or if the waveform has a narrow-pulse component, *check the operating manual for the DVM.* It may be necessary, in some cases, to apply a corrective factor to the meter readout, depending upon the pulse width. (A very narrow pulse contains little energy, and may not be able to supply the full demand of the instrument circuit.)

To measure peak-to-peak waveform currents in TV circuitry

Equipment: Current probe (see accompanying diagram).

Connections required: Connect the output from the current-probe amplifier to the input of the peak-to-peak voltmeter. Clamp the current probe around the lead under test (such as a lead to the deflection yoke.)

Procedure: Observe the reading of

the peak-to-peak ac voltmeter.
Evaluation of results: A standard current probe provides 1mA output for 1mV of current flow. Thus, if there is a 100mA p-p current flow in a lead, the peak-to-peak DVM will read 100mV (0.1V).

A note on peak power in the horizontal-deflection circuit

In some color-TV receivers, the apparent peak power in the horizontal-deflection circuit may be as high as 1,000VA, and the peak-current flow may be approximately 4A. B&W receivers generally have lower values of peak current in the horizontal-deflection coils.

To measure signal-developed bias voltages

Equipment: A test-pattern generator.
Connections required: Connect a dc voltmeter between the source of signal-developed bias and ground. Connect the test-pattern generator to the antenna-input terminals of a TV receiver.
Procedure: Advance the output from the test-pattern generator, observing the corresponding change in the reading of the dc voltmeter.
Evaluation of results: The value of signal-developed bias (or combined signal-developed bias and fixed bias) should be the same as specified in the receiver service data. For example, with reference to Figure 6, the base voltage on transistor Q2 is specified at 0.2V, with normal signal level applied to the base. Under no-signal conditions, the base voltage on transistor Q2 is zero (except for noise voltages). Observe that the signal-developed bias of 0.2V at the base of transistor Q2 is produced by an input signal of 8.5p-pV. This is the normal level of input signal, which will change in case that the AGC system is not operating properly.

To check out an AFT unit

Equipment: None.

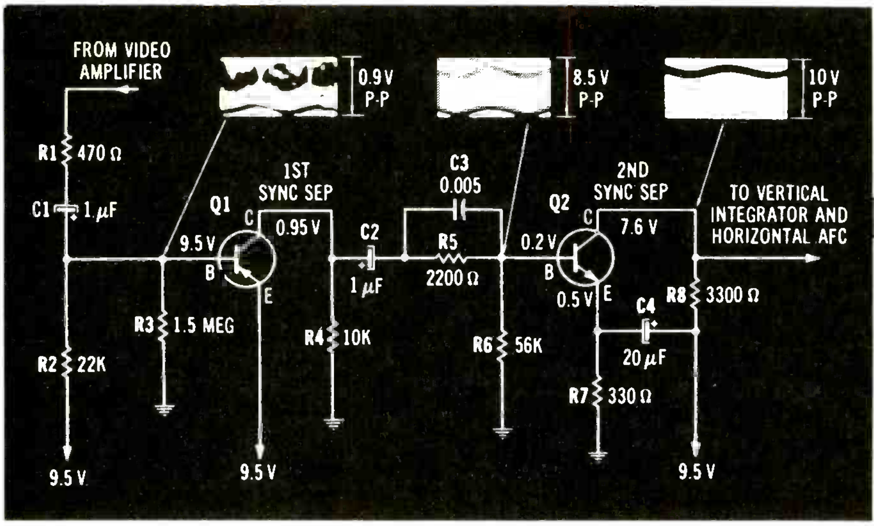


Figure 6. An example of signal-developed bias voltages. Note waveforms.

Connections required: Apply DVM test leads as required)refer to accompanying diagram).

Procedure: Set the AFT switch to its *on* position. Check all specified voltages and currents on the AFT IC unit. If the voltage and current values are within normal tolerances, check the AFT align-

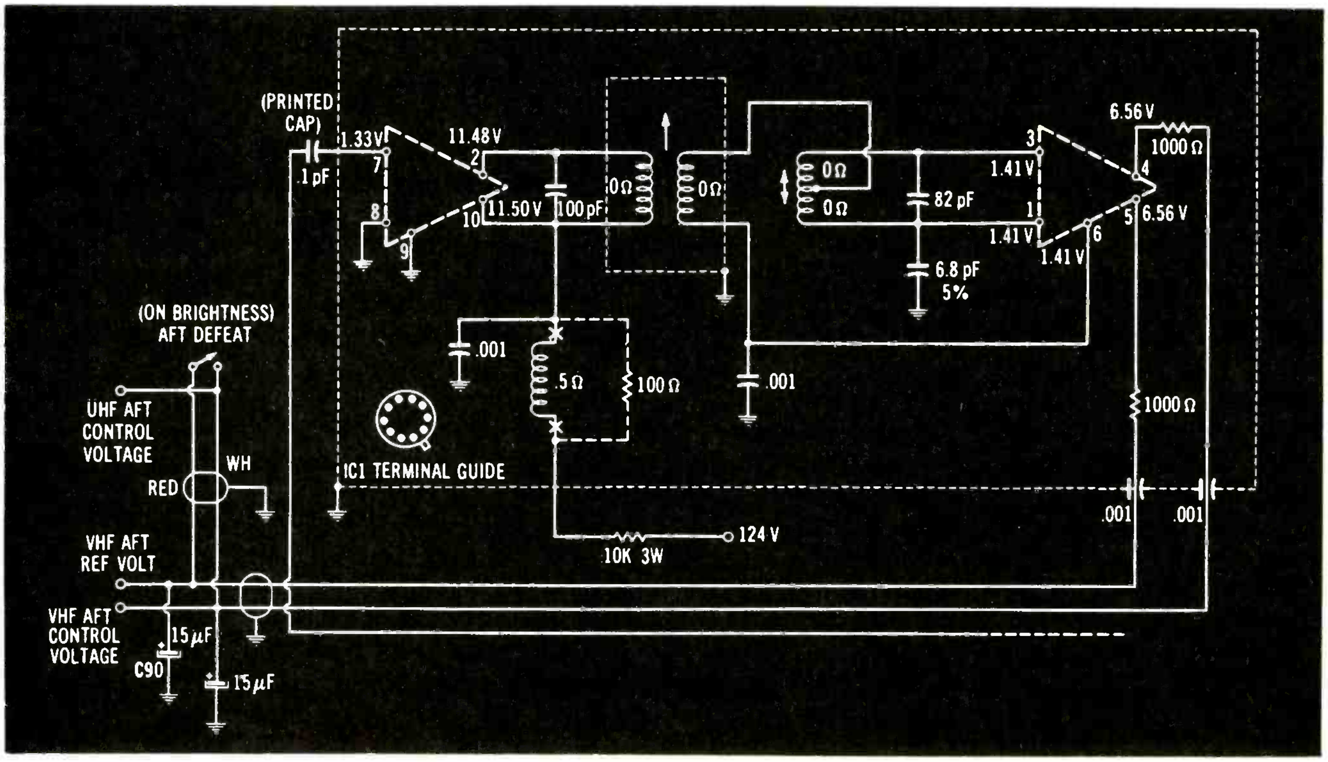


Figure 7. Here is an example of a typical AFT IC network.

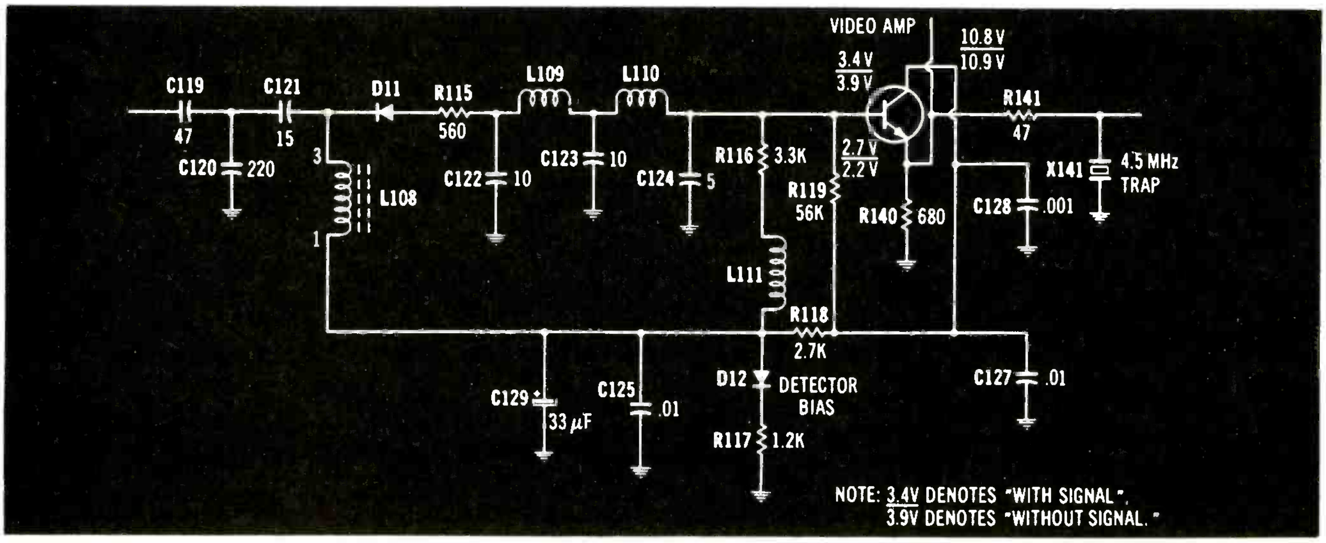


Figure 8. This shows a typical detector bias-diode circuitry.

ment as specified in the receiver service data.
Evaluation of results: Abnormal voltage and/or current values in the foregoing tests may indicate a defective AFT IC unit, or a fault in an associated component. In case that the AFT alignment cannot be made as specified, the AFT IC unit may be defective, or an associated component may be faulty. In the event that AFT alignment can be properly completed, but AFT trouble symptoms persist, the AFT IC unit and its associated circuitry in the RF tuner should be checked.

A note on checking signals in an AFT IC unit

Before concluding that an AFT IC unit is defective, eliminate the possibility of trouble in the remaining portions of the IF/audio strip. For example, check for presence of an audio signal at the IC output terminal. Then, if no signal is present, check for possible shorted components in the associated output circuit. However, if the output is not shorted, check for an IF signal at the second sound IF transformer. Absence of signal at this point could indicate a faulty IC or an associated component defect. Also check the sound IF transformer, and check voltages at the IC terminals, paying particular attention to the supply voltage and the current demand.

To check the detector bias-diode action

Equipment: None.
Connections required: Connect the test leads of a dc voltmeter to the video-amplifier base terminals (see diagram, Figure 8).
Procedure: Measure the base voltage at the video-amplifier transistor, first with no signal (antenna-input terminals shorted), and then with a moderately strong TV-station signal.
Evaluation of results: Check your measured values against the receiver service data. In a typical receiver, the base voltage is 3.9V

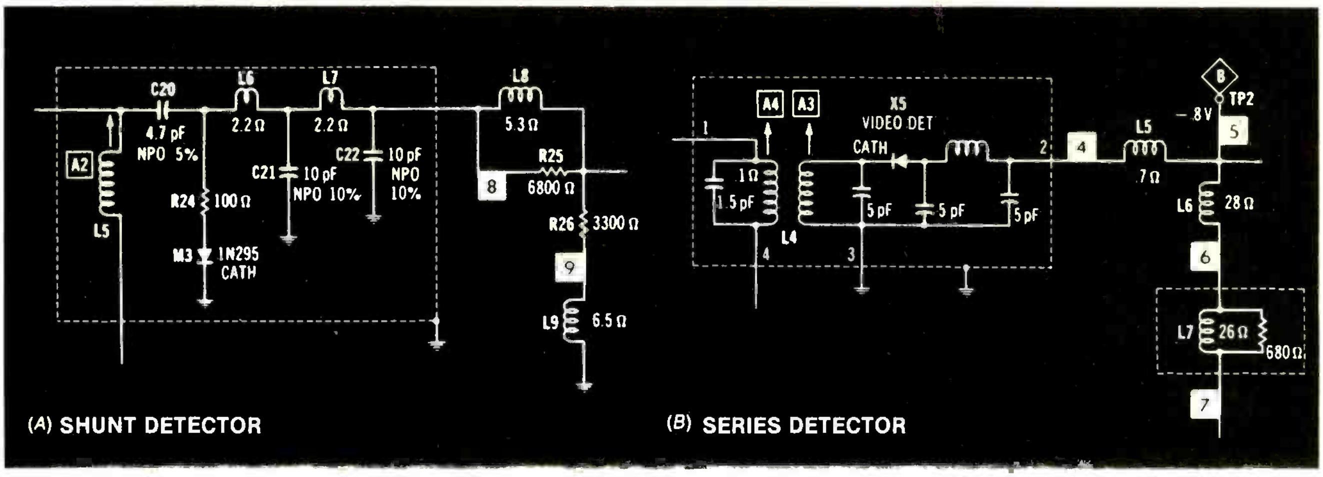


Figure 9. This schematic shows a picture-detector diode circuitry.

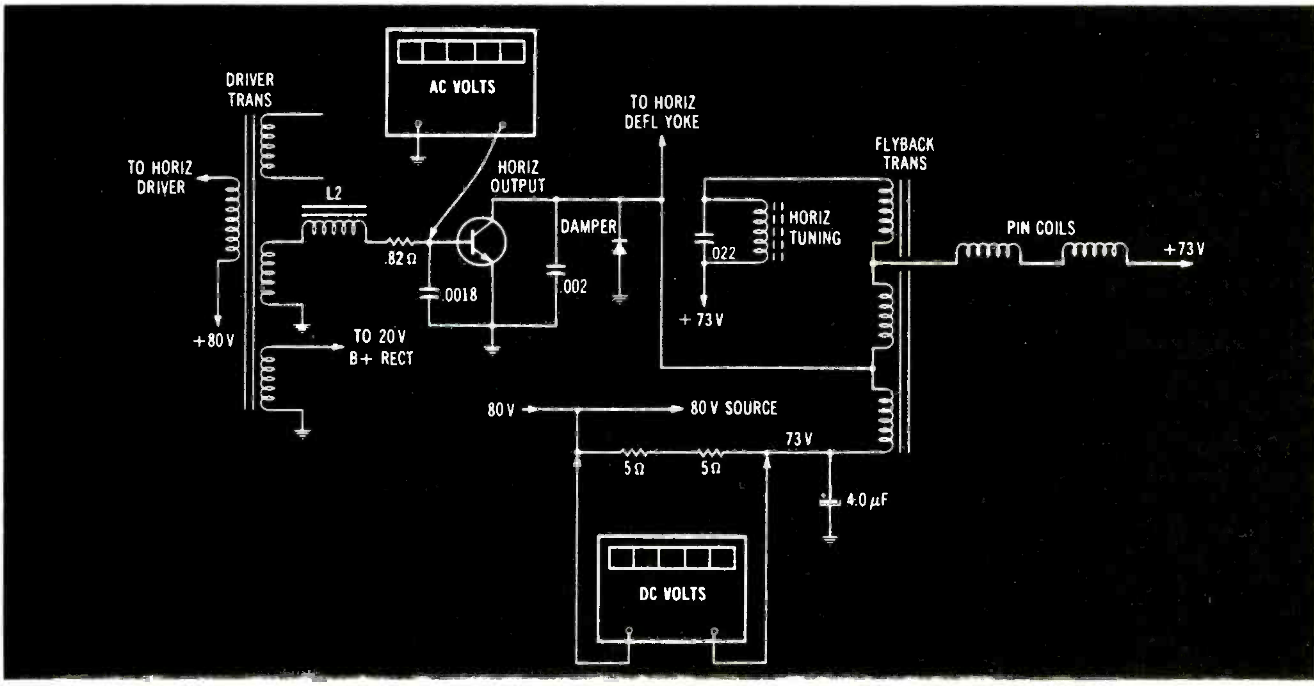


Figure 10. Monitoring an intermittent fault in the circuit of the horizontal-output transistor.

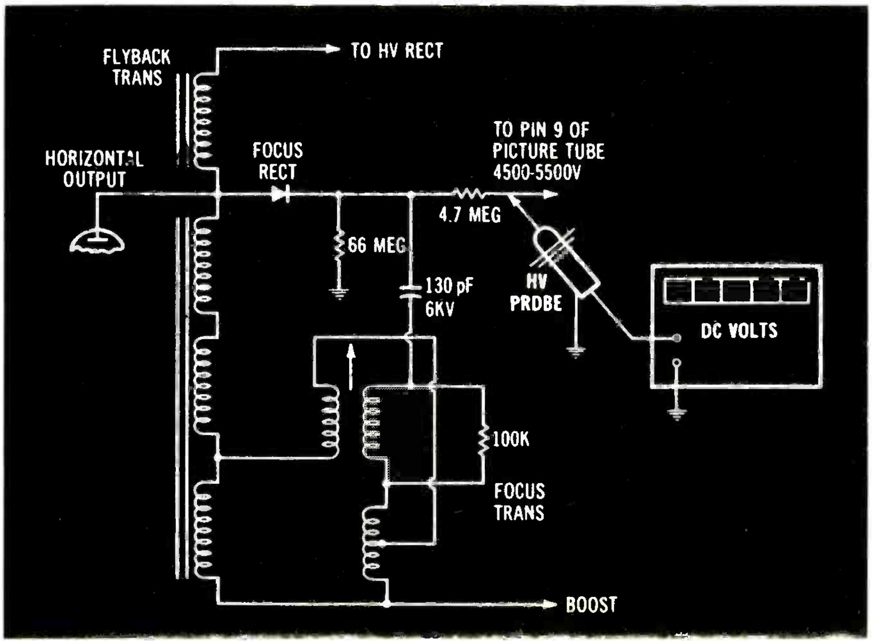


Figure 11. Checking the focus voltage with a high-voltage dc probe.

in the absence of a signal, and is 3.4V in the presence of a signal. In the event that either or both of the measured values are incorrect, check the detector bias diode for its front-to-back ratio. However, if the bias diode is normal, look for a defect in an associated component or device in the detector network. A defective video-amplifier transistor also can cause an apparent bias-diode malfunction.

A note on picture-detector diodes

Although series picture-detector diodes are generally employed in TV-receiver circuitry, the technician also will find shunt picture-detector diodes, as shown in Figure 9. The circuit action is essentially the same in either case; however, the shunt detector has a higher output impedance than the series detector.

To distinguish between a focus-circuit and a picture-tube problem

Equipment: A high-voltage probe.
Connections required: Connect the high-voltage probe between the focus output lead and ground.
Procedure: Observe the focus-voltage reading with the brightness control turned to minimum and, then, turned for normal screen brightness.
Evaluation of results: The focus voltage should agree with the value specified in the receiver service data, and it should not change substantially as the brightness control is advanced. If the focus voltage is incorrect, and remains reasonably constant as the brightness control is varied, the trouble will be found in the focus circuit. On the other hand, if the focus voltage is normal with the brightness control turned down, and becomes substantially subnormal when the brightness control is turned up, the picture tube is most likely to be defective or failing.

A note on loading of focus circuit

Because practically no current is drawn by a normally operating focus system, it often is designed with extremely high internal resistance (Figure 11). In turn, to avoid undue circuit loading, use a high-voltage dc probe with the DVM, and operate on a suitably low dc-voltage range. This type of test effectively increases the input resistance of the DVM by an amount equal to the value of the multiplier resistor in the probe.

ES&T

Troubleshooting Tips

No picture or sound
General Electric AB-C
(Photofact 1978-3)

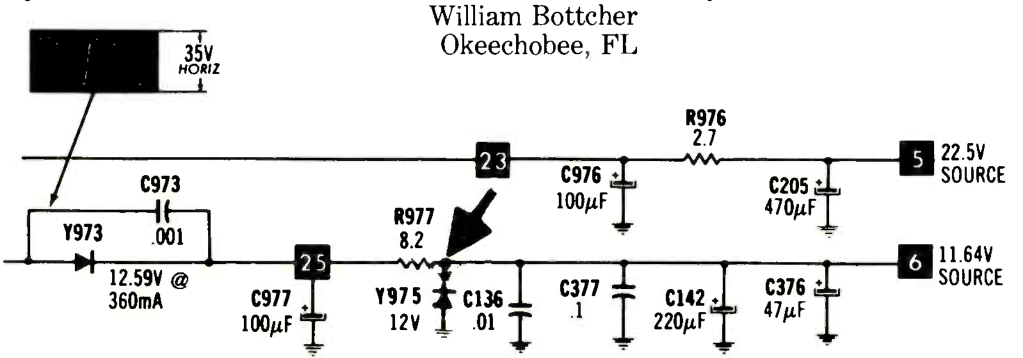
The color receiver powered-up normally, but had no sound or picture. Because the griplets (that join top and bottom circuit wires) are the most common source of problems with this model, these were all soldered carefully first. Soldering all the pairs of griplets has resulted in customer satisfaction because several kinds of intermittent operation are eliminated, and the work requires less than one-half hour. In the past, this routine maintenance work has proved both efficient and worthwhile. However, the problem remained this time.

I decided to check source voltages first and started with the voltage that supplied IC120, the IF AGC video-detector IC. Dc voltage at zener Y975 measured only +5.8V instead of the nearly +12V of a normal receiver. Also, R977 (the Y975 current limiter) was discolored by the excessive current in the load or zener. R977 was disconnected and found to be within tolerance.

The next suspect was IC120, but it was removed from the circuit and the +12V line did not rise above +5.8V. Y975 zener was replaced with a new one, but no improvement was noticed. This problem was getting serious. A resistance check between the +12V line and ground showed almost 0Ω. Then I noticed that the same +12V supply also powered IC300 in the chroma section. After IC300 was removed, the resistance from the +12V line to ground increased to more than 1,000Ω. A new IC300 was installed. Picture and sound were restored to normal operation, the +12V source was stabilized at the correct voltage, and I replaced R977 as a precautionary measure.

Some time was wasted in this repair by using our shop's standard procedure of checking for adequate voltage supplies first, but signal tracing probably would have taken much more time and *then* required analysis of the dc-voltage supplies anyway. In most repairs, our standard sequence (starting with measurements of the low-voltage dc-voltage supplies) locates the defect in less time than any other system we have tried.

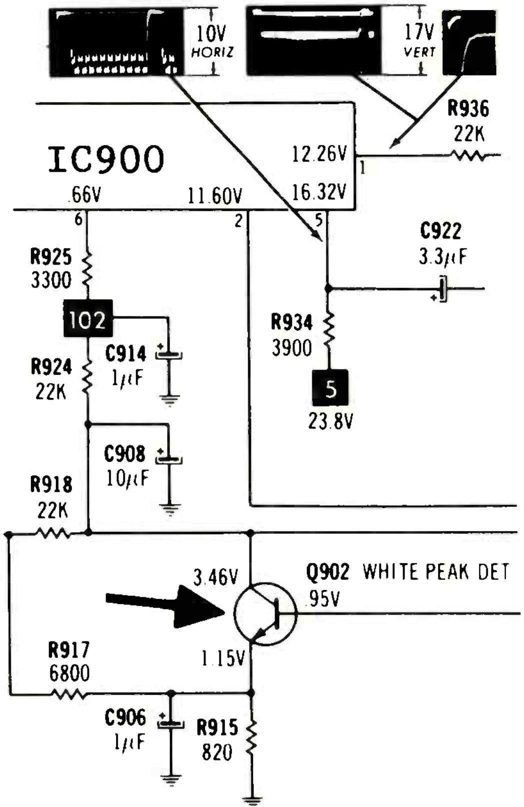
William Bottcher
Okeechobee, FL



Insufficient contrast
Sylvania E-32-4
(Photofact 2034-1)

A moderately good picture was shown by this color receiver, but the contrast was slightly weak. Even with the picture control turned up all the way, the picture tube could not be overdriven on contrast scenes.

IC900, the auto video/chroma processor, was replaced, but the problem was unchanged. Next, most IC900 dc voltages were measured; I found none that would account for the lack of contrast. Dc voltages also were checked at transistors near the IC. The collector voltage of Q902, the white-peak detector transistor, measured only +2V, although the schematic called for +3.46V; in most receivers, the Q902 collector operates between +4V and +5.7V. When the Q902 base was shorted to its emitter (to turn off the C/E current), the collector voltage was unchanged.



After a few more tests, Q902 was removed from the circuit for more-accurate leakage tests and was found to have excessive leakage. *Replacement of Q902 restored normal contrast to the picture.*

William A. Grimm
Uniontown, PA

Write for guidelines for submitting Troubleshooting Tips and Symcures

Books

Editor's note: Periodically ***Electronic Servicing & Technology*** *features books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given, rather than to us.*

Electronics Math—2nd edition, by Bill R. Deem; Prentice-Hall; 602 pages, $32.95 hardbound.

This is another book that is suitable for the classroom, but is an excellent source of technically specific math for the person studying alone. The mathematical topics chosen are those that are most useful in solving electronics problems, with self tests at the end of each topic and practice problems throughout the text.

Chapters one through 15 deal with aspects of math necessary to solve dc circuit problems. Chapters 15 through 20 cover those elements of algebra and trigonometry necessary to the solution of ac circuit problems, with practical applications presented. The final four chapters deal with common and natural logarithms and their applications, and basic logic functions inherent in all logic circuits, giving theorems, laws and postulates used in the simplification of logic expressions.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632; 800-223-2336

Video-Cable TV Workbook II, by Sandra Tuller Fleming; Carter-Craft; 44 pages, $4.95 paperback.

An expanded version of Workbook I, this reference source includes more detailed instructions, step-by-step guidelines and illustrations for hooking up televisions, stereo-simulated televisions, videocassette recorders, videodisc players and other audio-visual equipment. There are essential tips on dubbing, camera/camcorders and preventive maintenance. An accessory guide, glossary of terms and maintenance record should also be useful.

Published by Carter-Craft, 1916 11th St., Rockford, IL 61101; 815-397-3200. ES&T

Symcure

These symptoms/cures are somewhat different from the type we ordinarily present in that there are no schematic diagrams accompanying them. In this case, however, schematics were not applicable. If any of you find these Symcures useful, or if you find them of little use, please let us know.

Videocassette Symcures

These units were manufactured by Matsushita and distributed in large numbers under various brands, such as RCA and Panasonic. (Panasonic PV-1000; PV-1100; PV-1200; PV-1210 and PV-1650. RCA VCT-200; VCT-201; VCT-300; VBT-625; VDT-201 and VDT-400.)

Symcure 1. Symptom: VCR displays clocks, but no functions operate. Power light and sensor lamp are not lighted.
Cure: The sensor lamp is open; replace it.

Symcure 2. Symptom: The cassette cannot be loaded or unloaded, but usually the motor can be heard running.
Cure: A plastic loading gear is broken; replace it.

Symcure 3. Symptom: No sound during recording or playing; might have buzz during playing.
Cure: The audio play/record switch is open; replace it.

Symcure 4. Symptom: After running normally for a time, the VCR goes into stop mode.
Cure: The play-pulley unit and/or the arm unit and play idler might be defective. (The felt clutch tends to lose torque with age). Replace defective components.

Symcure 5. Symptom: The picture is snowy without color, or color noise is intermittent. Cleaning the video heads does not improve the performance.
Cure: Replace the upper cylinder with its video heads.

Symcure 6. Symptom: A few seconds after loading, the VCR goes into the stop mode.
Cure: Replace the defective counter or counter belt. The counter might be stuck (the bottom of the counter has a Hall generator to detect tape movement).

VCR Component Stock Numbers

	Panasonic-C	RCA
Counter belt A (larger)	VDV0075	144260
Counter belt B (smaller)	VDV0076	144261
Reel belt A (larger)	VDV0072	144258
Reel belt B (smaller)	VDV0076	144261
Capstan belt	VDV0094	144606
Loading belt	VDV0074	144259
Sensor lamp	XAM0019	149389
Loading gears		
Large bottom gear	VDP0615	N/A
Small upper gear	VDP0614	N/A
*Loading gear unit	VXP0225	144207
**(This unit replaces above gears and comes as a complete loading assembly)*		
Audio switches		
Small switch (audio)	VSS0037	144895
Large switch (audio & video)	VSS0036	144894
Video heads (upper cylinder unit)	VEH0070	144257
Play pulley unit	VXP0233	*146786
Play arm unit	VXL0406	*(Unit kit)
Play idler	VXP0213	144265

Literature

See more than 200 additions to **Keystone Electronic's** component and hardware lines in the "1986 New Product Supplement."

The 12-page catalog details all technical data, specifications and illustrations on nine major new product groups. The publication also details expanded listings of battery holders, battery clips, plugs and jacks, fuse clips, washers and grommets.

Circle (125) on Reply Card

The 12-page Electrical Connector Bulletin EC779-1 gives complete specifications and ratings for **Superior Electric's** Supercon electrical connectors, 5-Way binding posts and test probes. Included are descriptions of limited opening binding posts: standard hex and fluted nut, miniature fluted nut, all-metal grounding and double assembly types.

The electrical connector section describes panel board plugs and receptacles having 25, 50, 100 and 250A capacities. Also described are 5-Way test probes used for making fast, positive connections to PC boards and components.

Circle (126) on Reply Card

A 164-page summer '86 catalog for electronic technicians, engineers, maintenance repair organizations and hobbyists has been published by **Fordham Radio.**

The catalog contains almost 2,000 brand name products that are illustrated and have complete descriptions, specifications, applications and pricing.

Circle (127) on Reply Card

The supply may be somewhat limited, but there is a booklet to send for that answers hundreds of questions about how computer diskettes are made, and about how they work. It is called the "Diskette Guide Book" from **BASF Corporation**. These booklets are available in quantity (and in English) for the first time in North America.

Circle (128) on Reply Card

ES&T

What do you know about electronics?
More low-frequency testing

By Sam Wilson

In the previous article, we discussed the square wave test. It is used on low-frequency amplifiers to determine if frequency distortion exists. Also discussed were the *sawtooth* test and the *sweep* test.

In this article we will look at some tests for linear distortion.

Intermodulation distortion

Assume that you have two sine wave voltages with different frequencies. You wish to amplitude modulate the higher frequency with the lower one, so, you connect both voltages across the same resistor, as shown in Figure 1.

Of course, no modulation will take place. *The only way modulation can take place is by mixing them in a non-linear device or circuit.*

In the same way, applying two frequencies to the input of a perfectly linear amplifier will *not* result in one being modulated by the other. (For the purpose of this article, a *linear* amplifier has an output waveform that is identical to the input waveform.)

If the amplifier is *not* perfectly linear the two input frequencies will intermodulate or heterodyne. In that case, the output will be the two frequencies, their sum and their difference.

When two signal frequencies combine in an amplifier that is supposed to be linear, that amplifier is said to have *intermodulation distortion.*

Intermodulation distortion presents a problem when electronically reproducing music. If one instrument is producing a 200Hz note and the other is producing a 2,000Hz note, it would be nice if only those two frequencies were heard in the output.

However, if the lower frequency modulates the higher frequency, as a result of amplifier nonlinearity, you will hear more frequencies in the output than were in the original orchestrated material.

It is a simple matter to test an amplifier for intermodulation distortion. The test setup is shown in Figure 2. Simply apply the two frequencies to the amplifier and use a spectrum analyzer to show the frequency domain display of the output.

If only the two frequencies are present on the oscilloscope display, there is no intermodulation distortion.

One of the problems with this test is that the engineers and other people involved with testing low-frequency amplifiers can't make up their minds about which frequencies to use.

There are two schools of thought to begin with. One says that you use a low frequency and a high frequency and look for modulation. The other says to use two frequencies close to each other in the high-frequency range and look to see if there is a *difference* frequency.

Both of those methods work. Nobody denies this. But which one produces the better result? That is where there is disagreement. In order to have a legitimate rating of intermodulation distortion, it is necessary to agree on the kind of test and the frequencies to use.

Figure 3 shows examples of test results on a frequency domain display. These are ideal test displays. In practice, there may be additional modulation between the frequencies shown. Also, there likely would be an indication of noise.

In Figure 3(a), a low frequency, f(1), is used to modulate a higher frequency, f(2). The presence of sidebands around f(2) indicates that intermodulation distortion is present.

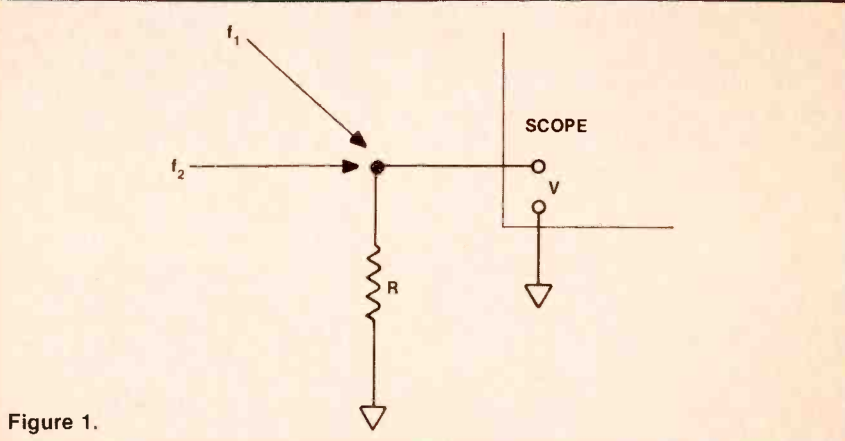


Figure 1.

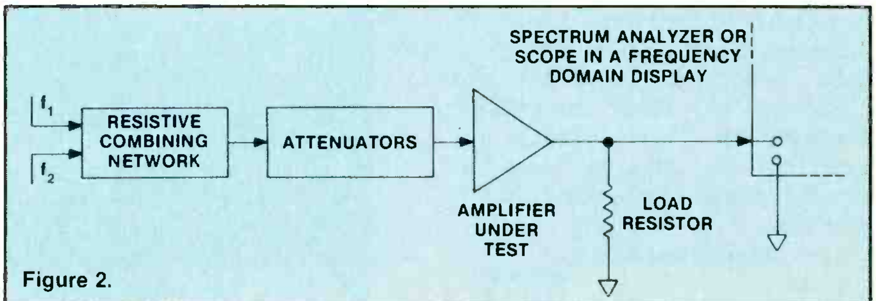


Figure 2.

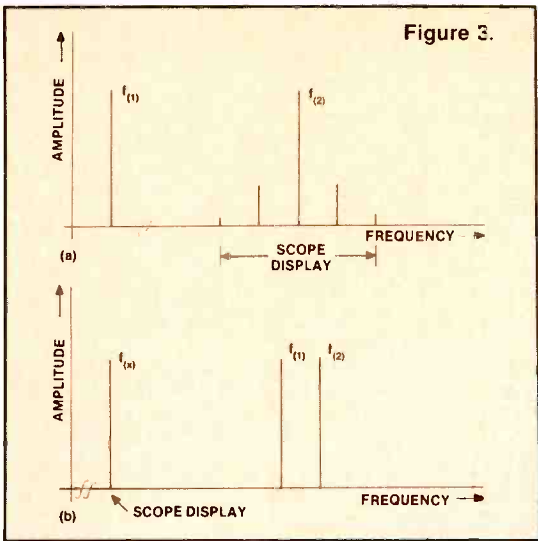


Figure 3.

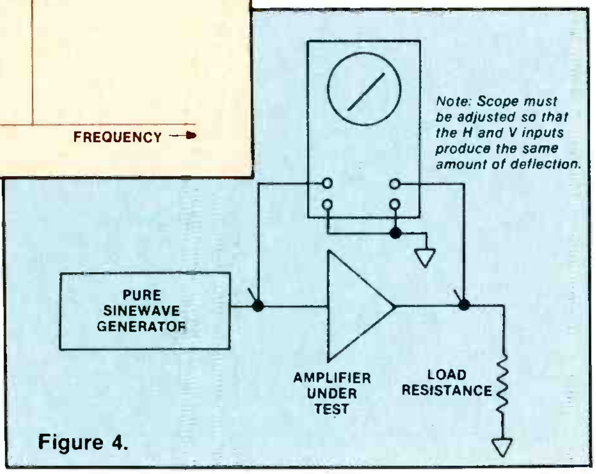


Figure 4.

In Figure 3(b), the two high frequencies, f(1) and f(2), are present in the amplifier. The presence of the difference frequency (f(x)) indicates an intermodulation distortion problem in the amplifier.

Objections

In theory, both tests will show intermodulation distortion. In practice, both leave something to be desired.

Suppose, for example, that a certain amplifier displays intermodulation distortion using one of these tests. How much distortion can be tolerated?

The truth is that an amplifier can fail the test and still be useable, or it can pass the test and not be useable. In fact, the only practical test seems to be to use the amplifier for sound reproduction and use a highly qualified listener to evaluate the reproduced sound.

A skilled musician may give a better indication of intermodulation distortion than either of the test setups.

Both tests require the use of input voltages that are pure sine waves. Any distortion in those waveforms can give the erroneous results.

Consider the cost of the equipment and the cost of the labor involved in setting up these tests. It is obvious that in a repair shop they can't be justified for anything less than special equipment. This is especially true because the results are not definite.

To summarize, I think that the intermodulation distortion tests are not conclusive, but can be helpful in an overall test of a low-frequency amplifier.

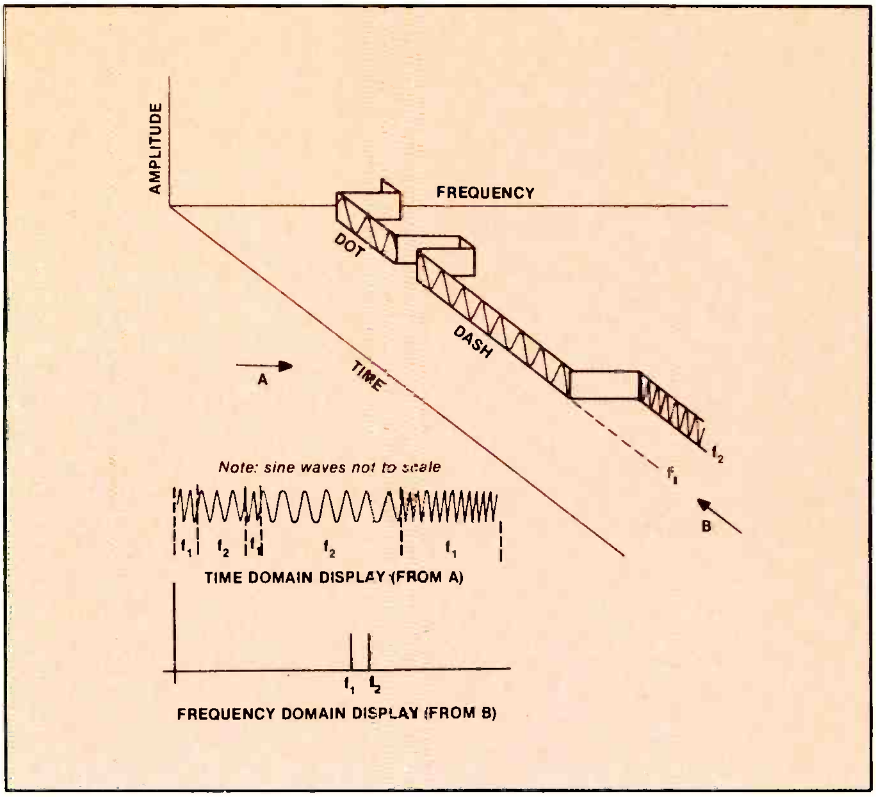
A qualitative test

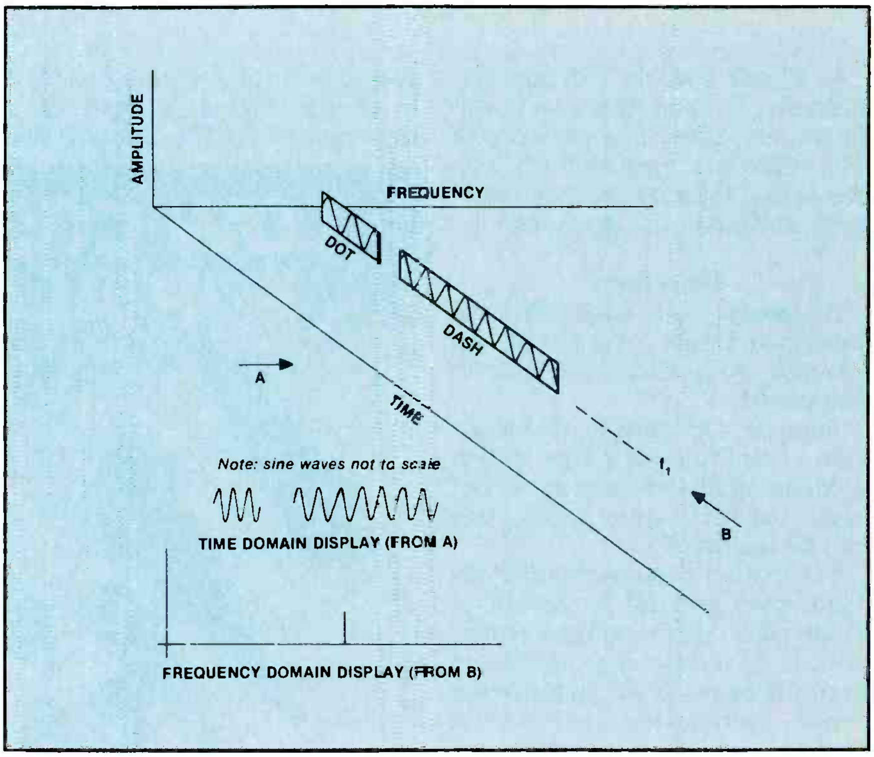
Intermodulation distortion can appear only in non-linear amplifiers or devices. A test for amplifier linearity would be one way to tell (indirectly) if the amplifier is capable of producing intermodulation distortion.

The test setup is illustrated in Figure 4. It involves making a Lissajous pattern by using the input and output signals of the amplifier.

Every school boy knows that the input and output signals of an amplifier are either in phase or 180% out of phase, depending upon how many stages there are in the amplifier. If the amplifier is perfect, comparing the two frequencies on a Lissajous pattern should result in a perfectly straight line as a display.

Any deviation from that straight





line indicates non-linear distortion in the amplifier.

This is a quick test. It is not useful for testing high-quality equipment. Always be aware of the tradeoff between the costs of high-quality tests and the less precise results of a cheaper test.

In future articles, I will discuss some other low-frequency amplifier tests.

FSK is not just for hams

The expression *frequency shift keying* (FSK) is likely to bring amateur radio to mind. But there also are modern applications, such as modems, that use FSK.

Figure 5 shows the FSK signal on a 3-dimension graph. The illustration shows how an FSK signal is used to transmit the Morse Code for letter A.

Figure 7.

By comparison, Figure 6 shows the same type of graph for a CW signal. Again, the signal for the letter A is shown.

With the CW signal, the carrier is turned *on* and *off* to make the signal. This method presents a problem in the receiver. Every time the signal goes *off* the AGC circuit starts to crank up the receiver gain. When the next signal arrives, the gain has to be cranked down again.

Delayed AGC helps, but longer pauses in the transmission gives the same unstable receiver gain.

The FSK method of transmission does not lose control of receiver gain because there always is a transmitted signal.

In a modem, the FSK signal may be used to send coded pulses. The presence or absence of a pulse represents a logic 1 or logic 0. They are grouped together in combinations to form *words* that can be transmitted on a telephone line. This is called *serial transmission*.

Can you earn this rare certificate?

I always have taken special care to avoid technical errors in my writing. Any mistake, even a careless mistake, causes me to go into a deep-blue funk.

In the June issue I made a careless error in a math equation. When the letters started coming in, I almost went over the edge.

How could this be happening?

Well, thinking back, I realized that I've made a basic change in the way I double check for errors. Now I've gone back to the old way.

You don't believe me?

Well, here's what I'm going to do. If you catch me in a technical error in any of the next six issues, I'll send you a certificate similar to the one in Figure 7. It will be printed on an 8½" x 11" sheet.

There have to be some rules. I mean only technical errors – not matters of opinion. Also, you can't use errors in spelling or grammar. Professional writers or editors are not eligible.

If you should happen to get one of these certificates I'd advise you to hang onto it. It may be worth a lot of money some day. After all, it will be very rare.

ES&T

Answers to the Quiz

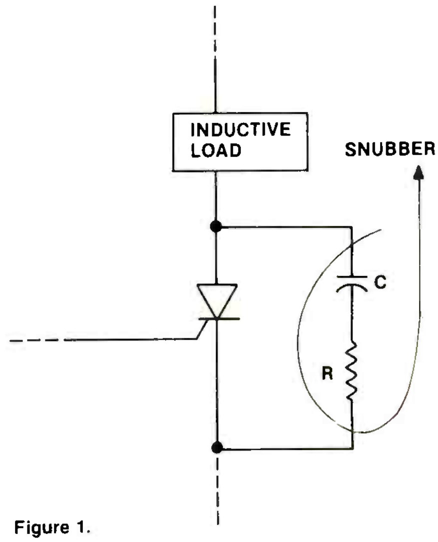


Figure 1.

Questions are on page 24

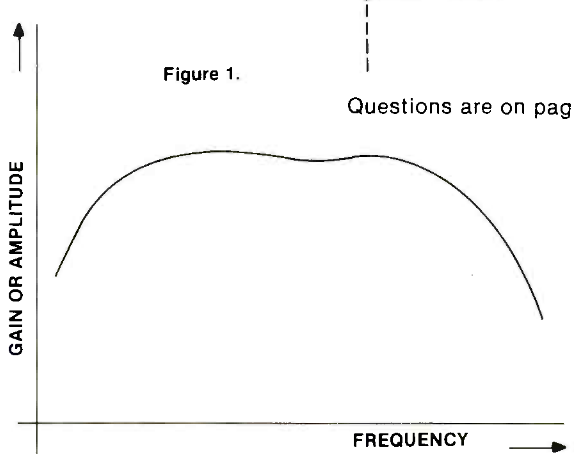


Figure 2.

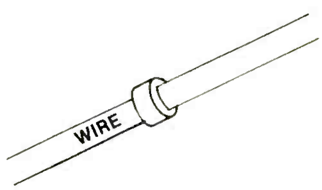
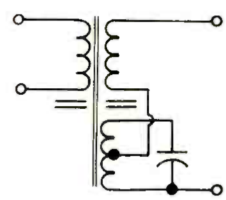


Figure 4.



FERRORESONANT TRANSFORMER

Figure 3.

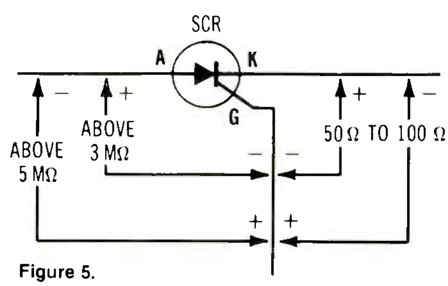


Figure 5.

(Courtesy of SRA, Inc.)

1. C (From the April 1986 issue.) Undesirable turn-on is likely to occur when an SCR (or triac) has an inductive load as shown in Figure 1. When the current is switched *off*, the counter voltage (created by the collapsing magnetic field) can be high enough to turn the SCR *on*. This undesirable turn-on occurs even though the gate voltage is zero. The R-C snubber circuit filters the undesirable counter voltage.

2. D (From the April 1986 issue.) The U.S. 525-line system uses only about 480 *active lines* to make the picture. That isn't enough to produce high-quality pictures on a large screen. Changing to more lines would involve changing the FCC rules.

3. E (From the February 1986 issue.) Actually, formal Bode plots show two things: gain vs. frequency and phase shift vs. frequency. Figure 2 shows a typical Bode plot. When you sweep align an amplifier, the Bode plot appears on the scope screen. From a previous article, you will recognize this to be a frequency domain display.

4. A (From the March 1986 issue.) Electronic systems (like humans) always work more efficiently if you give them rest periods. Switching the regulator *on* and *off* produces output pulses that must be filtered, but that is a small price to pay for the higher efficiency.

5. B (From the March 1986 issue, see Figure 2.) A ferroresonant transformer goes into saturation on the peaks of each half-cycle. An L-C resonant circuit is used to drive the transformer into saturation. When the transformer saturates, there can be no further increase in the output. So, the output is regulated to the saturation point.

6. B (From the March 1986 issue.) Ferrite beads are very small donut-shaped beads that slip over a wire as shown in Figure 4. They have the same effect as an inductor in series with the wire.

7. A (From the March 1986 issue.) Power factor is simply the cosine of the phase angle between the voltage and current. The highest efficiency occurs when the voltage and current are in phase – when the phase angle is zero. The cosine of 0 is 1. Power factor is sometimes multiplied by 100 to give the answer as a percent value.

8. A (From the April 1986 issue.) In an article by Homer L. Davidson the illustration shown in Figure 5 was given. It shows high-power ohmmeter readings. Note the + and – signs indicating ohmmeter polarities.

9. B (From the June 1986 issue.) An article by Conrad Persson explains that the solder should be made with tin, lead, and about 3% silver. The small amount of silver reduces migration when soldering silver-palladium fired on conductive surfaces such as used with ceramic capacitors. Ordinary tin/lead is not good enough for this.

10. B (From the June 1986 issue.) In the article by Conrad Persson it is stated that chip components must *never* be reused. ES&T

Products

3½-Digit DMM has memory mode

Mercer Electronics introduces a pocket-size, low-cost autoranging digital multimeter with unexpected features.

The model 9370 offers autoranging or manual selection of voltage and resistance ranges. It measures up to 1,000Vdc (five ranges), 750Vac (four ranges), 10A ac and dc (two ranges), 2MΩ (five high-power and four low-power ranges).

The memory mode provides up to 99 counts of zero offset. Also included is an audible continuity indication. Basic Vdc accuracy is 0.5%. Low and high energy fusing are provided.

Circle (75) on Reply Card

Six-pack introduced

Chemtronics has introduced a six-pack carton of one of its products, Freez-it circuit refrigerant. The package includes a Chem-Gun handle for easier application of the product.

Chem-Guns are molded anatomically designed handles that fit on all conventional aerosol cans. They enable the user to squeeze the trigger handle, making application more precise and with less effort than pushing the valve on the top of the can.

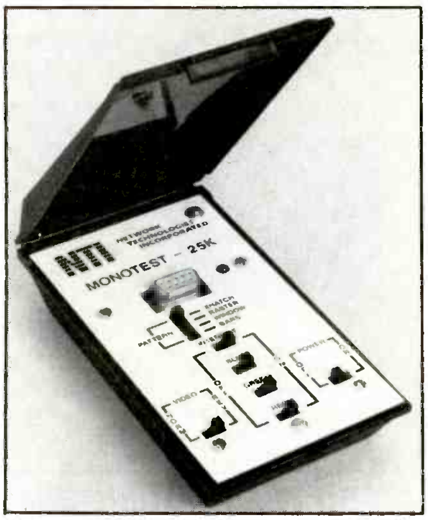
The six-pack includes six cans of the 14-ounce size product packaged in a new type of can that features a safety-release bottom. Because circuit refrigerants are extensively used in field service applications, they often are left in service vehicles during hot summer months, creating a potential for a dangerous rupture of the can as the ingredients expand.

Testing showed normal 3-piece cans may explode at temperatures exceeding 120°F. But the exclusive valve in the new Freez-It can slowly and safely releases the contents, according to the manufacturer.

Circle (76) on Reply Card

Portable video generator

Network Tech announces the Montest-25K, a battery-powered instrument that tests the AT&T PC6300 color or monochrome CRTs. Its four different patterns and pocket size, make it a necessity for anyone who services or installs PCs.

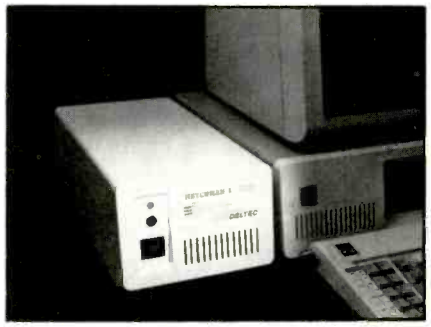


The instrument generates RGBI, horizontal and vertical sync, TTL compatible signals. Output is via a 9-pin D connector. Monitor connection is made with an adapter cable, with extra wires for externally powering the monochrome display. The horizontal scanning rate is 25.8kHz; vertical rate, 59.8Hz and there are 400 displayed lines.

Circle (77) on Reply Card

Standby power systems

Watchman I is the first in a series of small standby power systems available from *RTE Deltec.* These self-contained units include 20 minutes of battery back-up time to protect personal computers or other critical loads from the effects of power failures.



Should the utility power fail, an alarm sounds, a red LED flashes, and the unit takes over with up to 20 minutes of ac power for the critical load. When utility power is again available, the system automatically switches to a standby mode and recharges its battery. The units are compatible with computers from IBM, Apple, Compaq, AT&T, Kaypro, Commodore, and many others.

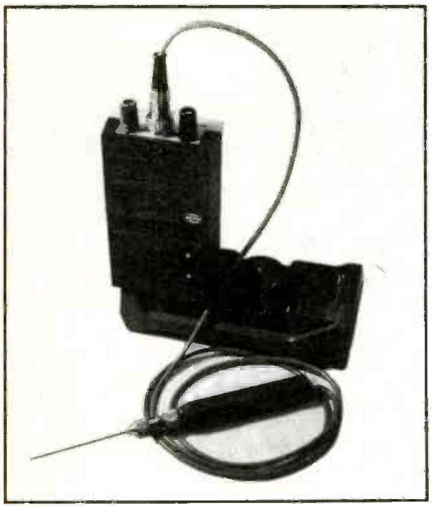
Circle (78) on Reply Card

Expand MM or display capability

Any multimeter or display can become a multifunctional unit by using *AEMC Corporation's* Add-a-Function modules with an interface adaptor. Sixteen add-a-function modules are available for a variety of applications, including measurement of temperature, HVAC parameters, relative humidity, frequency, capacitance, a range of ac and dc current measurements, light intensity, fiber-optic power, ground resistance and sound level, as well as process signal generation and RTD simulation.

There are two adapters available to render any multimeter compatible with these interchangeable modules. Interface Adaptor model IA plugs directly into the standard

¾-inch jack of most multimeters for in-field instrument use. The model BA attaches with standard test leads via 4mm banana jacks, for use as a bench-type unit with instruments such as oscilloscopes, recorders and dataloggers.



Circle (79) on Reply Card

Specialty chemical line

CRC Chemicals has presented a line of chemical specialties specifically formulated to meet the needs of the electronics industry.

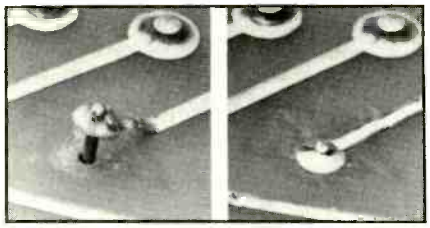
CRC Heavy Duty Electronic Degreasing Solvent, Flux Remover, Freeze Spray, and Anti-Stat join an existing line of electrical and industrial cleaners, lubricants and anti-corrosive coatings.

Circle (80) on Reply Card

Printed circuit repair modification kit

Bishop Graphics has introduced the E-Z CIRCUIT Printed Circuit Repair & Modification Kit.

This newest addition to E-Z CIRCUIT's adhesive-backed copper products line utilizes conductive copper tape, donut pads and sheets. It provides the electronic engineer or service techni-



cian with a quick, reliable and cost-effective method of repairing or modifying burnt, broken and lifted PCB circuitry either on-the-spot or in-shop.

Circle (81) on Reply Card

Continuity tester audible/visual

Model 137 continuity tester from *Desco Industries* is a self-powered tester for use on unpowered circuits. It provides both audible signal and visual indicator when the resistance between the probes is less than 150Ω.

Both probe ends of the 137 will accept a variety of test probes that are designed to fit wire wrap posts, aircraft connectors and other common test points. Needle point probes also are available for surface-mount application.

Circle (82) on Reply Card

Three position soldering station

Hexacon's Select-O-Trac soldering station exceeds MIL Spec requirements for controlled heat soldering stations. Select-O-Trac is the latest in the Therm-O-Trac line of controlled heat soldering stations.

This soldering station can be calibrated exactly at each of the set points. Calibration covers both the critical tip temperature of the hand tool and the entire station. Calibration can be performed in the field without any special components or tools. The stations are constructed so that there is no static (ESD) hazard in any of their parts.

Circle (83) on Reply Card

Semi-automatic distortion meter

Leader Instruments presents a semi-automatic distortion meter, model LDM-171.

Distortion measurements on all types of audio equipment are simplified by the LDM-171's automatic-nulling feature. Once the operator obtains a reading of less than 1% THD, this instrument will automatically complete the measurement, eliminating almost all manual tuning. The meter also features S/N measurement and ac signal level measurement capabilities. A high pass filter and monitor output terminals are provided.

Circle (84) on Reply Card

Philips announces new DMM

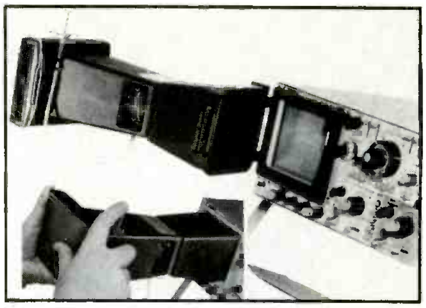
Philips Test & Measuring Instruments has announced a new series of DMMs designated Series 18. The three models in the series 18 family cover applications from general purpose testing, communications and digital trouble shooting to laboratory standard measurements.

Custom LCD displays give the Series 18 DMM a 4-plus digit readout with full enunciation including high voltage and crest factor overload warning signs.

Circle (85) on Reply Card

Oscilloscope/VDT camera

The relatively low-cost Prime-Line model 7000 oscilloscope/video display tube camera has been introduced by *Soltec Distribution.*



The 7000 camera provides a permanent record of data displayed on oscilloscopes, test instrumentation such as logic analyzers and timing scopes and computer terminals (up to 12 inches diagonal).

The 7000 Camera can be hand held when used with a large selection of hoods to fit display screens from 8cm x 10cm to 12 inches diagonally, or can be bezel mounted to most oscilloscopes when used in conjunction with specific bezel adapters. It uses standard color and/or B&W Polaroid film.

Circle (86) on Reply Card

Photofact

These Photofact folders for TV receivers have been released by Howard W. Sams since ES&T's last report.

AOC
C9621RA, C9622RA 2429-1

CAPEHART
1900A0, 7900A0 2431-1

EMERSON
B121 2427-1

GENERAL ELECTRIC
Chassis 25PC-E/-F/-H 2428-1

K-MART
KMC1954 2425-1

KTV
KT-526 2429-2

MGA/MITSUBISHI
CS-1 342R, CS-1 343R, CS-1 344R 2428-2

MAGNAVOX
Chassis 19C602, 20C601/04 2427-2

MAGNAVOX
Chassis 25C502/05/06/12/13/18/29/38/58 2430-1

PANASONIC
CTF-2077R, CTG-2077R 2426-1

SANYO
Chassis A6E-47200 2425-2

SANYO
Chassis A6E-35100 2430-2

SEARS
564.49061450 2425-3

SONY
Chassis SCC-548X-A/Y-A, SCC-552M-A 2426-2

SONY
Chassis SCC-448W-A 2429-3

RCA
Chassis CTC-123A 2431-2

SAMSUNG
CT-330TM 2431-3

Audio Corner

By Kirk Vistain

On a bench cluttered with more test gear, chemicals and old parts than ought to be there, alongside a $2,000 distortion analyzer from which I dust the cobwebs every couple of weeks, sits an unpretentious $35 box I wouldn't troubleshoot without – a Heath IT-12 signal tracer. It won't appear on the list of required test equipment the manufacturers' technical reps flaunt when we're petitioning for warranty station status. But it's repaid me many times over. All it asks in return is an occasional 12AX7 and a shot of control cleaner.

Technique

Signal tracing is a common troubleshooting technique, usable provided that the power supply is more or less working and that there are no B+ shorts in the device under test (DUT). For video and TV work, the oscilloscope is the instrument of choice. But in audio, why not take advantage of our ability to hear?

Signal tracing is a common troubleshooting technique, usable provided that the power supply is more or less working.

An aural (audio) signal tracer is merely a high-gain amp, enclosed with a small speaker, a volume control and, sometimes, a level meter. Early designs used an electron tube, usually a dual high-gain triode, such as a 12AX7. Modern builders prefer FETs, noted for their high input impedance, an advantage they share with vacuum tubes.

Most are equipped with a dual-purpose probe. In the NORMAL (or AUDIO) position, the signal is fed to the amplifier's input. When set to RF, the probe demodulates the signal, with a simple AM diode detector, before routing it to the amp. FM signals can be detected too. Even though the tracer uses only a simple diode detector, it will still demodulate an FM signal, albeit poorly, due to a phenomenon called *slope detection*.

Some troubleshooters prefer sine waves for testing, and this is OK when tracing with a scope. But when doing it by ear, I feel that music makes a better signal. For one thing, it isn't as nerve-wracking as a pure tone. For another, it tests a broader frequency spectrum, so amplitude differences are more audible.

With an aural tracer, you keep your eyes on the circuit. It's quicker and safer....

You're probably wondering why not just use an oscilloscope. It is true that you can more easily measure the absolute amplitude of the signal, but every time you look at the scope, you're taking your eyes off the probe tip. How many times has that tip slipped and added a little extra trouble to the unit? With an aural tracer, you keep your eyes on the circuit. It's quicker and safer than using a scope. Most of the time, absolute measurements are not needed, and the convenience of the signal tracer wins out over the precision of a scope.

Using your bench receiver as a signal tracer

So, what to do if you don't want to spend money on another piece of test equipment? Simple, just use your bench receiver. Anybody set up to do audio servicing on a regular basis needs a small stereo receiver to provide program audio for testing, as well as providing a test bed for servicing phono equipment. It's also handy for testing speakers, and providing a little background music to calm your nerves after spending a couple of hours on a recalcitrant unit.

One advantage that a receiver has over a dedicated signal tracer is frequency response adjustment via the tone controls.

The typical receiver has several inputs that can be used for tracing. For signal levels above 50mV or so, use the AUX or TAPE MONITOR inputs. The more sensitive PHONO or MIC inputs are best used with signal levels below 50mV. One advantage that a receiver has over a dedicated signal tracer is frequency response adjustment via the tone controls.

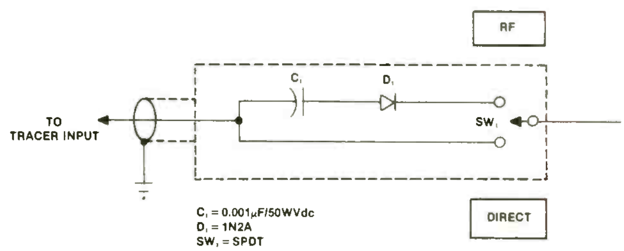


Figure 1. COMBINATION RF/AUDIO PROBE

You easily can make a probe for the receiver, using spare parts. Take a look at Figure 1. A spent pen-type oiler is the body, and a nail is the tip of this inexpensive switchable demodulator probe. You can terminate the cable with whatever type of connector fits your system. We have everything wired through a patch panel in our shop, and opted for dual banana jacks, because it's easy to stack them.

D1 is the detector diode. A germanium is preferred, because the voltage drop across it is a third as much as for a silicon device. This diode strips the modulation from the signal. C1 ac couples the remaining AF signal to the amp. SW1 selects either direct or demodulated output. Of course, for anything in the audio range, you'll be using the direct setting. For modulated RF, you need the RF mode.

Take care to avoid using the probe in circuits con-

taining voltages that exceed the ratings of its components.

Tracing vs. injecting

The flip side of signal tracing is injection. In this process, you use a source to input a signal at various spots in the circuit while monitoring the output. For some reason, injection is a more troublesome technique than tracing. Part of the problem has to do with impedance matching and part relates to the different amplitudes required at various injection points. This is complicated by the fact that some ac signals have a dc component that is difficult to simulate. For these reasons, I prefer signal tracing.

The flip side of signal tracing is injection.

First of all, the test signal is connected to the normal inputs of the DUT, more closely simulating actual operating conditions. Secondly, the correct signal level for these inputs is usually specified by the manufacturer, which eliminates guessing. Furthermore, being a high impedance device, the signal tracer does not usually load the circuit and change its operation. One caution though: When tracing in a low impedance circuit, such as a speaker output, the high impedance of the tracer may fool you with false positive results. The circuit may have plenty of voltage to drive a 1MΩ load, simultaneously having a defect that prevents it from producing the current needed to drive a low impedance. In general, ensuring that the output of the DUT is properly terminated eliminates false results. In some cases, it may be necessary to clip a resistor in parallel with the tracer input to get a valid result, but this is uncommon.

Aural signal tracing is a useful technique, which can save you plenty of time on the bench. It is easy to implement, using either a commercial instrument or your own home-brew. Because it frees your eyes to watch the circuit, and avoid inadvertent slips of the probe, it makes for safer and more efficient servicing. ES&T

Readers' Exchange

Wanted: Sencore portable TF46 transistor tester; Sencore CR70 CRT tester with original cartons and manuals. *Chuck Vostry, 3030 James Lovell, San Antonio, TX 78219; 512-661-0766.*

For Sale: B&K 1470 dual trace scope with two probes, $275; B&K 162 transistor I/O-of-circuit tester, $95; B&K 1801 frequency counter with probe, $125–all complete with manual, schematic, like-new condition; Sencore FP201 and 39G89 probes, half-price. *Long's TV, 720 Goshen St., Salt Lake City, UT 84104; 801-595-8442.*

For Sale: Sams Photofact folders No. 1369, 1400, 1521, 1580, 1698 and 1970; 90° color brightener; 110° B&W brightener; RCA 1466328 flyback; GE EP77X13 flyback; GE ES76X11 yoke. Call or write for prices. *Kevin Carney, 91 Fostertown Road, Newburgh, NY 12550; 914-561-4549, after 5:00.*

For Sale: Used TV parts–box of yokes, $35; box of flybacks, $15; box of transformers, $15; test equipment–Simpson model 340 signal generator, $35; Jackson No. 665 multimeter, $20. *David A. Frankenberry, R.D. No. 3, Box 407, Eighty-Four, PA 15330.*

For Sale: AKAI reel-to-reel tape recorder–built-in speakers have been replaced, the head has been scratched by improper cleaning and high end sounds terrible, but otherwise O.K., with factory service information, $50 plus 25 lb. shipping; Sams CB service manuals, volumes 1-89, most in new condition, $5 each, postage paid. *C. England, 98 Montague, Zanesville, OH 43701.*

Needed: Manual for B&K 470 tester rejuvenator. **For Sale:** B&K model 415 sweep marker generator, complete, $150. *Bill Polera, 747 Wyngate Drive W., North Valley Stream, NY 11580; 516-825-5895.*

For Sale: Used picture tubes–part No. 280TB4, 320CB22, 310EDB4, 370AUB22, all in fair condition. **Needed:** Horizontal output transformer for Broadmoor TV model 3513, part No. 09270776M or TCF-11. *George Saylor, 2319 Parrish St., Philadelphia, PA 19130.*

Wanted: Sams Photofact CB Radio series No. 158, 170, 180, 187, 190, 207, 219, 221, 229 and 251. **For Sale:** Sams Photofact CB Radio series No. 35, 59, 72, 74-78, 87, 112, 120, 168 and 288, all in like-new original condition, $6 each. *S.H. Zagar, Swan Lake Enterprises, Box 384, Pengilly, MN 55775; 218-885-3710.*

For Sale: 271 Sams AR manuals; 85 TSMs; 3 MHFs. Also Sams Photofact folders No. 541 to 1857, including 19 filing cabinets. Make offer for these as lots, or all together. *James H. Sigmon, P.O. Box 115, Claremont, NC 28610; 704-459-7231.*

Wanted: Schematic and operations manual for Philco model S8200 service oscilloscope. Xerox copy acceptable. Send price and ordering information. *C.E. Arthur, 2300 Sixth St., Ashland, KY 41101.*

For Sale: EICO model 667 tube tester, mint condition, $100. **Wanted:** PC130 assembly for model T055 Lectrotech oscilloscope, or will buy a Lectrotech T055 or T060 scope for parts. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235; 412-242-4701.*

For Sale: Sencore VA48, B&K 1077B analyzer, B&K 415 sweep generator and much more radio and TV equipment, all reasonably priced. Send s.a.s.e. for prices and details. *Dwain C. Ludlow, P.O. Box 552, Stigler, OK 74462; 918-967-8002.*

For Sale: Sencore equipment–VA48, $700; SG165, $500; CA55, $250; TF46, $75; SC60, $1,200; TC162, $75; SuperMac, $500; DVM38, $200. All were purchased new, and have all accessories and literature. *Bill Leer, R840 Emerald Lane, Edgar, WI 54426; 715-257-7214, evenings.*

For Sale: Used radio and TV servicing course by NRI, including NRI Discovery Lab FETVOM, model 212, and frequency counter, model 202. All books in binders. Make offer. ZX81 computer IKMEM, new, still in box. Past issues of *Radio-Electronics*, *Popular Electronics*, *Electronics Tech/Dealer* with schematics. *Yusuf, 6525 S. Gessner, No. 2043, Houston, TX 77036; 713-771-1278.*

For Sale: New Leader model LSW333 all-channel sweep marker generator, never used, with manuals and test leads, $550. *WHITT's, 1006B Market St., Baytown, TX 77520; 713-420-3989.*

Needed: Flyback for Admiral chassis No. 28M5552-1, manufacturer's part No. 79A208-1, or 79D208-1, new or used. *Tex-Tech Electronics, Route 4, Box 1369, Nacogdoches, TX 75961.*

For Sale: Sams Photofact folders No. 566 to 1486, $750; B&K 1077B TV analyst, $225; Heath IG-37 FM stereo generator, $95; Dumont electronic switch (converts single-trace scope to dual trace) and square wave generator, $95; Hewlett-Packard 300B distortion analyzer, $135. **Needed:** 19VHBP22, 370WB22, 330LB22; 525V to 600V electrolytic cans; KT88s, EL34s, 6550s, etc. (audio output); collection of wood and/or bakelite knobs for antique radios (or information about sources). *Gerald Shirley, 133 Sagamore Road, Tuckahoe, NY 10707.*

For Sale: TV shop equipment, all you need to get started. Sams Photofact folders and some parts. Send s.a.s.e. for complete list. *Smart's TV Repair, Box 162, Charleston, ME 04422.*

Needed: Pincushion transformer, part No. 95-3004 for Zenith model 23DC14. I have been told it is no longer available from the manufacturer. *Charles E. Hess, 201 S. Oak St., Buchanan, MI 49107.*

For Sale: B&K 1077B TV analyst, $250; Sencore model CG141 color generator, $50. Both include manuals and leads. Heathkit model IP-17 power supply, with manual, $125. *Dennis Dillon, 1616 S. 94th St., West Allis, WI 53214; 414-774-2255.*

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Needed: Schematics/service manual for PACO transistor and diode tester, model T65; Precision Apparatus VTVM; model 98; High-voltage power supply, model D6, manufactured by Oregon Electronics; EICO signal generator, model 320; EICO multisignal tracer, model 145; Conar VTVM, NRI model 211 (need assembly instructions and schematic); Realistic stereo amplifier, model SA 350 (need two audio output transformers and schematic); B&K TV analyst, model 1076. *Kenneth L. Mixon, 401 E. San Pedro Ave., Perry, FL 32347; 904-584-2116.*

Needed: Microfiche viewer/enlarger in good working condition. Send size of viewing screen. *A&B Television Service, 1158 Jericho Turnpike, Commack, NY 11725.*

Wanted: Heathkit IB-1103 9-digit frequency counter; Heathkit IG-72 audio oscillator. Must have manuals and schematics, and be in good working condition or repairable. Also interested in buying solid-state Heathkit scope, at least 10MHz, and Heathkit solid-state distortion meter. *Lloyd Spivey, WLLS AM/FM, Highway 231 South, Hartford, KY 42347; 502-298-3268.*

Needed: Schematic for Sears color TV chassis 562 70480, model 4132. Will buy or copy and return. *Wes Knox, 4822 Mt. Casas Drive, San Diego, CA 92117.*

Wanted: Schematic for an old RME communication receiver. Tunes 500kHz to 31MHz in six bands. Probably made between 1935 and 1942. *Caltronics Service Company, 16412 Del Mar Lane, Huntington Beach, CA 92649.*

Wanted: Cartridge headshells for Garrard A-2 changer. **For Sale:** Digital color generators–RCA WR502A, Leader LG-380, $30 each, postage paid. *Jim Farago, P.O. Box 65701, St. Paul, MN 55165.*

Wanted: Any information, manuals, schematics, etc., for Bell & Howell Schools oscilloscope, model 10D-4540. Will buy or copy and return. *Larry N. Jackson, Route 2, Box 299J, Hamptonville, NC 27020.*

Wanted: Schematic or service manual for Allied radio stereophonic receiver, model 498. Will buy or copy and return. *John Takish, 3415 173rd Place, Lansing, IL 60438; 312-895-3118.*

For Sale: EICO resistor-capacitor bridge analyzer, model 950B, $45; Mercury tube tester, model 1000, $45; Sams Photofact folders, No. 69 through 496, $1 each, or all 280 sets for $175; Sams Record Changer service manuals, CM-2 through CM-9, RC-11 and RC-12, $2.50 each, or all 10 for $20; Philco wideband oscilloscope amplifier, model 8300, $10. Add shipping charges to all prices. *John Brouzakis, 247 Valley Circle, Charleroi, PA 15022; 412-483-3072.*

For Sale: B&K dual-trace oscilloscope, model 1471B, 10MHz with two probes and manual, $250; Sony Sterecorder reel-to-reel tape recorder, model 300 with manuals, $100; RCA crystal-calibrated marker generator, model WR89A with probes and manual, $75. All in good working condition. *Frank N. Sachs, 6803 Navajo Drive, Baltimore, MD 21209.*

Needed: Service manual or schematic for Emerson model 5100R solid-state AM-FM/FM stereo/cassette tape recorder/player. Will copy and return. (Information is not available from Emerson or Sams.) *A. Edward Ruppel, 1207 Adams St., Saginaw, MI 48602; 517-793-7204.*

Wanted: Power transformer from Sony clock radio, model TFM-660W, part No. 1-442-109-11; cassette motor from Panasonic model SE-1040, part No. MHT-515. *M.B. Danish, Mike's Repair Service, P.O. Box 217, Aberdeen Proving Ground, MD 21005; 301-272-4984, evenings.* ES&T

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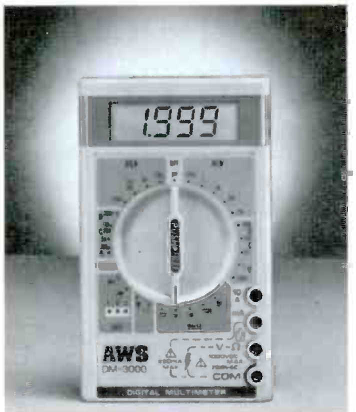

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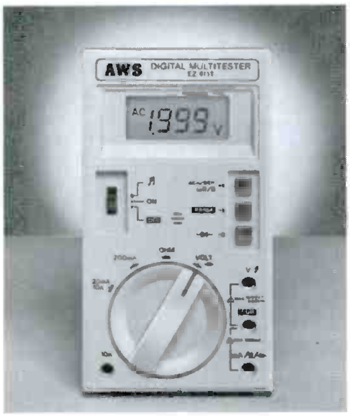

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