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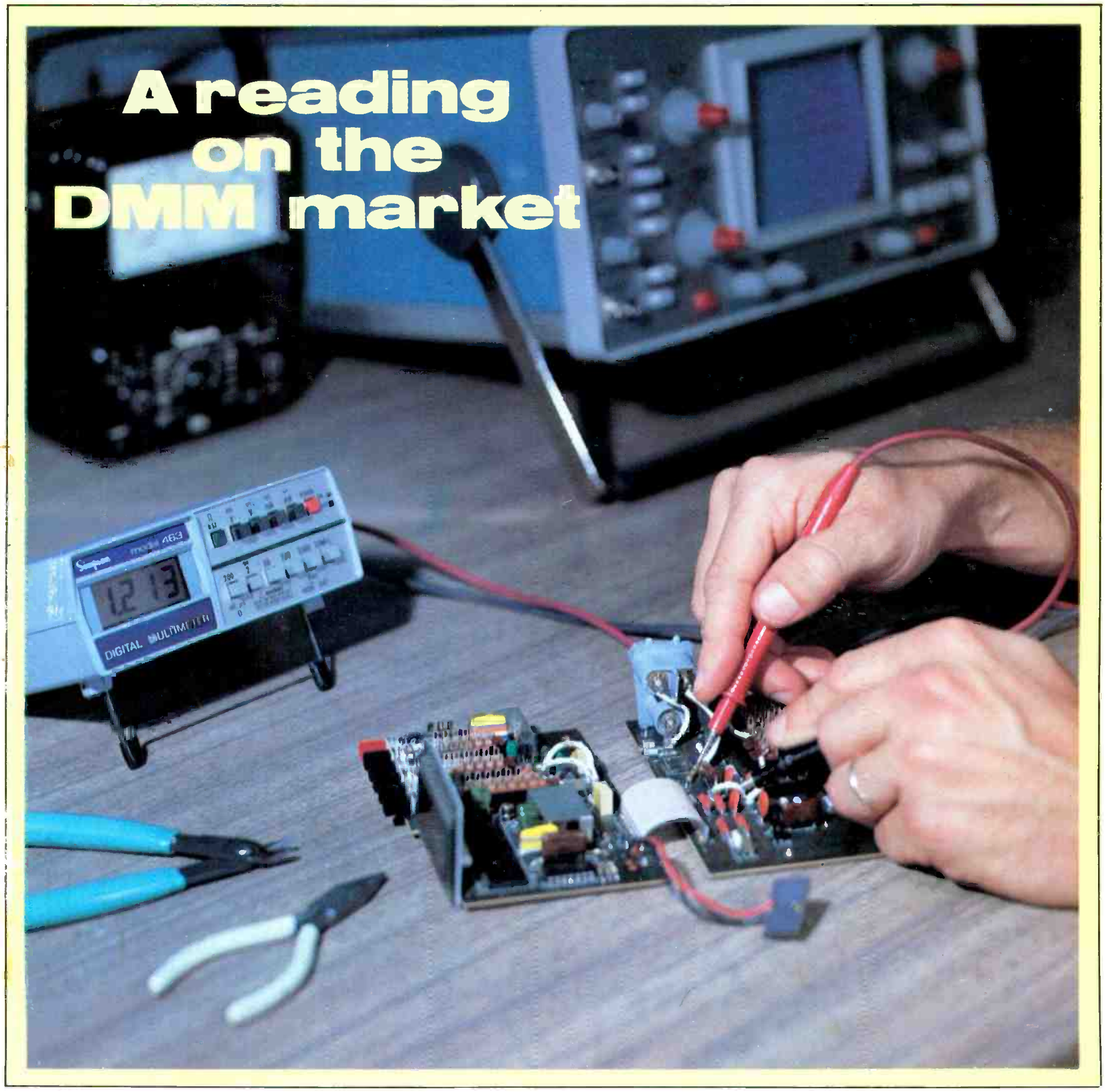
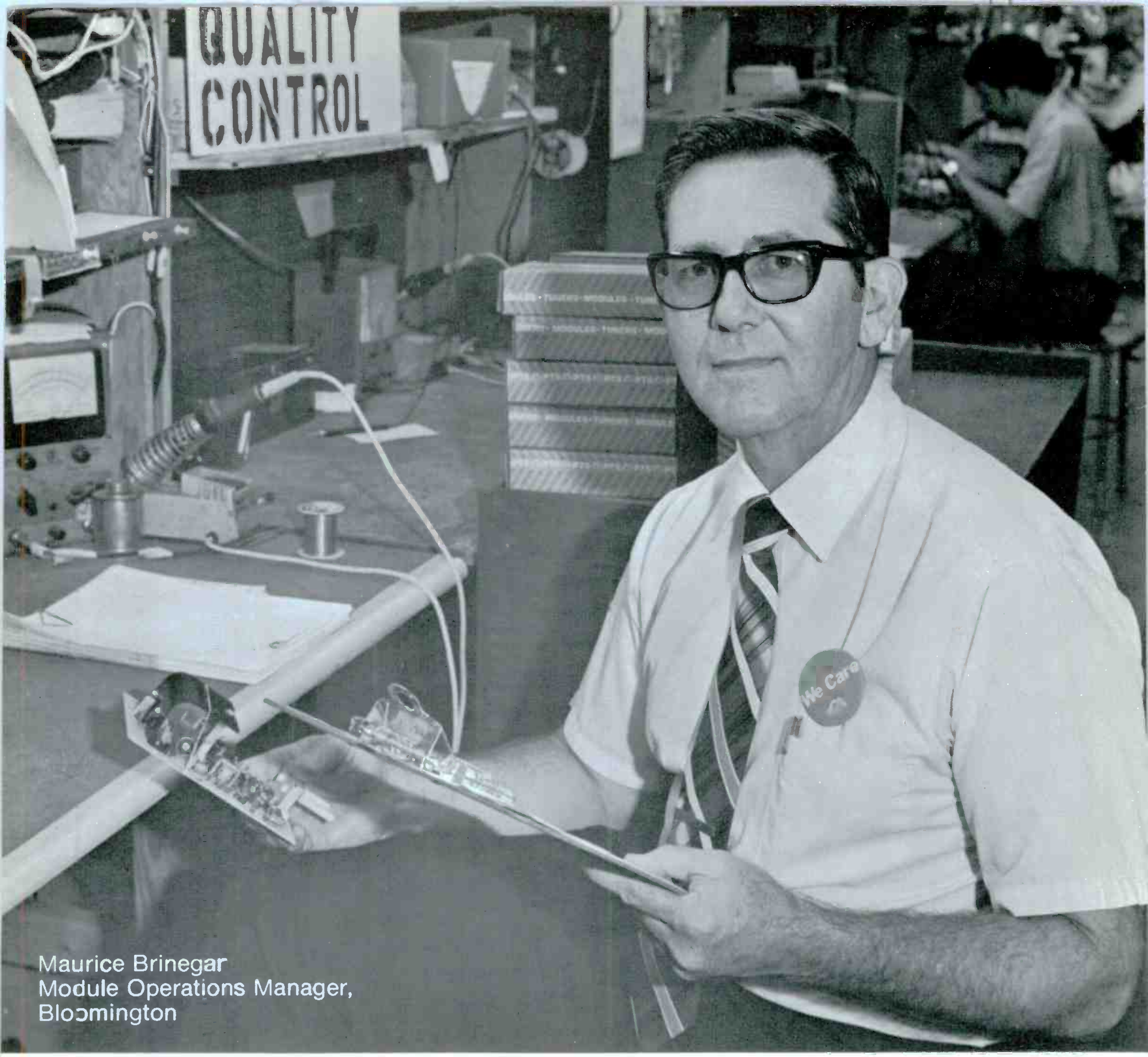
SEPTEMBER 1982/$2.25

Servicing conduction-time regulation

Average or true RMS: Which is right for you?





Maurice Brinegar
Module Operations Manager,
Bloomington

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Servicing & Technology

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The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

September 1982
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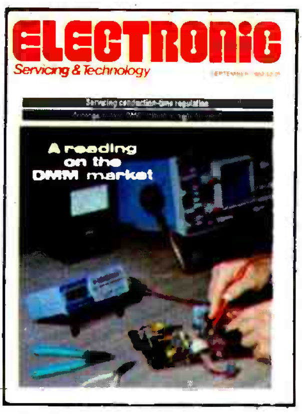
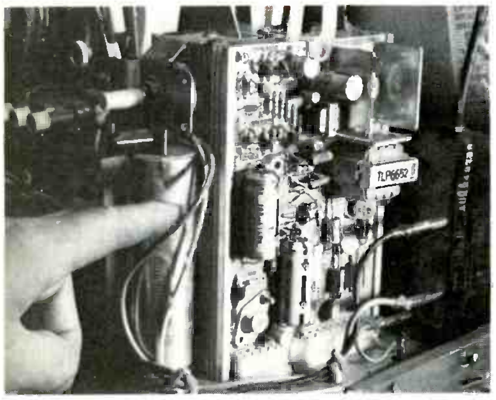


Digital multimeters are changing to meet the growth of electronic technology. See story on page 46. *(Photo courtesy of Simpson Electric.)*



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Departments

Next month...

Profax. Readers have asked for TV schematics, similar to those included in Electronic Technician/Dealer, and they will begin in the October issue. Each issue will include an 8-page pull-out of comprehensive schematics from major TV manufacturers, which can be filed away for future reference.

ES&T Manufacturers' schematics PROFAX

EDITORIAL

Technological growth demands adaptability

In *Time* magazine, the issue of the week of July 12, 1982, there was an article on the last page that discussed the attitudes of executives to computers. It revealed an incredible resistance on the part of people who would normally be expected to be very flexible in accepting new and unfamiliar equipment.

For example, the article described a financial executive in a U.S. firm who insists that all reports that he reads be typed on plain white paper. He says he simply will not trust anything he reads on green and white striped computer printout paper.

The article goes on to discuss the fact that in spite of the savings in time and effort that might be netted by an executive who used a personal computer, or a terminal in his office, it's rare to see one on an executive's desk.

The article concludes with the suggestion that younger people, who are growing up with computers, will probably bring computers with them when they move into the executive suite.

Humans are among the most adaptable animals on earth (perhaps outdone in adaptability only by the shark, the cockroach and a handful of other creatures), able to exist in desert or rainforest, mountains or seacoast, tropical heat or artic cold. But as evidenced by the executives' reticence when faced by computers, when man's own technology begins to develop too rapidly and becomes too complex, that ability to adapt begins to falter.

Nowhere, today, is the pace of change more rapid than in the area of electronics. The problems surrounding the computer have already been alluded to here. But that's only part of the story. Other rapid developments are forcing all of us, like Alice in Wonderland, to run ever faster just to stay in the same place. In fact it sometimes seems that no matter how hard we run, the current pace of change in electronics is going to leave us panting in the dust.

As an example, digital circuitry is being introduced in to all manner of equipment from television and radio to sophisticated industrial equipment. And more digital is coming. Commercial availability of compact digital recordings is a year or two away. Yet most of us still think analog. How many servicers know how to use a logic probe, or a logic analyzer?

Most electronic servicers must have made the commitment at some point in their careers to continue learning – that has always been the nature of a dynamic technology like electronics. Now that electronics is changing more rapidly than ever, the time is here to reaffirm that commitment, not abandon it.

Manufacturers' schematics to be added to ES&T

Since we brought up the subject of commitment, let us **(ES&T)** reaffirm our commitment to provide readers with the kind of information they need. Beginning with our October issue, we will be including eight pages of manufacturer's schematics and service data. This new pull-out section, entitled "Profax," will provide easy reference *roadmaps* for your servicing needs. To long-time **ES&T** subscribers this will be a new service that's sure to make **ES&T** more valuable. To those subscribers who came to use from *ET/D* it's a reinstatement of the kind of schematics that *ET/D* used to run, back by popular demand.

Nils Conrad Persson

FEEDBACK

Stereo amplifier repair

I read with great interest the article by Carl Babcoke in the April issue, "Stereo amplifier repair," and wish you would include more articles concerning audio servicing, as there is very sophisticated hi-fi equipment in need of servicing, and when the price of equipment is taken into consideration, very profitable repairs could be made.

I do have one question, or rather one comment, to make concerning the test "hook-up" of the dummy load resistor, capacitor and series resistor with the test speaker paralleling that 8Ω load resistor. No mention was made of impedance-matching considerations, and it has always been my practice, especially when servicing OTL circuits, to always terminate with this thought in mind. So I am wondering if this was done, or if under the circumstances of reduced line voltage this is not necessary. I would appreciate a comment, however brief it is.

I also realize that it is not possible to cover everything in a short article and that it must be assumed the readers have some knowledge of theory, and while this in no way should be taken as any criticism, it has me somewhat puzzled. I guess we all find ourselves bothered by small insignificant things at times.

Thomas Hurley
Montara, CA

Reply

Impedance matching between amplifier output and a load, such as a speaker, is desirable for several reasons. In general, matching impedances of any source and its load provides max-

imum transfer of power to the load. Amplifier power is expensive and should not be wasted by mismatching. With transistor amplifiers, the situation is more complicated. A 4Ω load on the 8Ω output of an amplifier provides higher-than-normal wattage, but at increased distortion. A 16Ω load on the same 8Ω output will receive decreased power, but the distortion is the same or lower. Amplifier matching is not a precise science.

Also, the value of the amplifier load often affects stability and frequency response. When the load has several times the correct impedance or is open, a poorly designed amplifier might become a generator of a full-power inaudible supersonic signal that could destroy the output transistors. A scope is needed here. Other inadequate amplifiers might motorboat or develop excessive distortion when load impedance is too high.

Low-impedance loads produce other problems. The output wattage and negative feedback are reduced. If attempts are made to restore the lost volume by turning up the gain control, the dissipation rating of the output transistors is exceeded and a sudden catastrophic failure is very likely.

Remember also that speakers *never* have a constant impedance over the frequency range. In general, the impedance rises somewhat with frequencies higher than 400Hz, and a definite large increase of impedance occurs at the natural cone-resonant frequency. For example, an 8Ω speaker might have minimum impedance of 7Ω at 300Hz or 400Hz, rising to 15Ω at 10kHz, and showing a 40Ω peak at the 70Hz resonant point. How should such a speaker be matched? Often, the impedance at 400Hz is used as the speaker impedance rating.

Returning to your question about amplifier-output matching of the dummy load in the April **ES&T** article, beginning on page 12, the matching is not so incorrect as you assumed. Refer to the Figure 4 schematic on page 16. The major load is the 8Ω noninductive power resistor. Paralleling it are the speaker, a 10μF capacitor and a 27Ω resistor in series. At 400Hz, the 10μF capacitor has a capacitive reactance of 39.8Ω. The sum of these three components, therefore, is 27 + 39.8 + 8, or a total of 74.8Ω. At extreme high frequencies the sum is about 40Ω, and in the bass range the impedance is several hundred ohms (which can be neglected). When 74.8Ω is paralleled across the 8Ω load, the resulting impedance becomes 7.23Ω.

Therefore, the reduction of right-channel output load was insignificant at middle and bass frequencies. No mismatching danger was produced by this speaker-protecting test circuit, particularly since the volume never was operated for maximum undistorted output at any time.

Carl Babcoke
Customer Servicing Consultant.

ELECTRONIC SCANNER

Biddle Instruments offers technical courses

Biddle Instruments will offer a selection of technical courses for fall at their school in Jenkintown, PA.

"Earth Resistance Testing" will be offered Sept. 2-3; "Power-Cable Fault Location" will be taught Sept. 20-23; "Partial Discharge (Corona) Detection in Insulation Systems" will be held Oct. 25-29 and "dc Testing of Power Apparatus Insulation" is scheduled for Nov. 15-18.

For more information, contact Biddle Instruments, 510 Township Line Road, Blue Bell, PA 19422; 1-215-646-9200.

ICS offers course on microprocessor troubleshooting

Integrated Computer Systems is offering a course entitled "Hands-On Microprocessor Troubleshooting" that provides participants with the opportunity to learn practical troubleshooting techniques. These techniques are reinforced by in-class training with test equipment specifically intended for microprocessor applications.

The course, priced at $895, will be held in Boston Oct. 5-8, in New York City Nov. 2-5, in Washington, DC Dec. 14-17, and in Los Angeles Jan. 25-28.

For more information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., P.O. Box 5339, Santa Monica, CA 90405, 1-213-450-2060.

New venture to allow for direct-to-home programming

The Aluminum Company of America and Nippon Electric Company of Japan have formed a new corporation to assemble and market TV receiver systems that will make it possible for individual homes and apartments to obtain TV programming directly from broadcast satellites.

The new company, ALCOA-NEC Communications Corporation will draw upon the resources of Alcoa in the manufacture of aluminum and NEC in the manufacture of telecommunications equipment, computers and semiconductors.

ES&T

ASSOCIATION NEWS

NATESA suggests use of satellites in training

The National Television & Electronic Servicers of America (NATESA) organization has released this announcement:

"In an industry such as consumer electronics, where major technological changes occur so often, prompt training to enable efficient service operations is essential.

"We recognize problems of set producer/marketers in bringing prompt training sessions to all servicers quickly. The problem of training distributor people, who then are to train servicers in their area, calls for large numbers of trainees of servicers. It calls for authorized warranty servicers to travel considerable distances and it delays training of independent servicers.

"We believe the cost of training in time and dollars can be greatly reduced by use of satellite communications. Simultaneous sessions could be held in all parts of the nation. This could reduce size of training staffs and positions becoming very hard to fill. To make use of this new technology, changes in training to substitute a major degree 'hands on' techniques will need to be developed.

"We are proposing to producer/marketers that this new concept be explored. We have explored services of this general nature and ask for further study by EIA and its consumer electronics service managers."

EIA/EAC jointly support technical education bill

The Electronic Industries Association (EIA) along with Electronic Association of California (EAC) offered their support to a congressional bill (HR 5820) designed to increase the supply of trained technicians in the U.S. high-technology industry.

Testifying jointly in San Francisco before a subcommittee of the House Committee on Education and Labor, James Conway, president of EAC and Gary Petersen, vice president of human resources for GTE and chairman of a special manpower task force of EIA, noted, "We are the world's leader in technology and we must maintain that lead for economic stability and national security. We can only do this with a solid base of scientific and technological skills and literacy at all levels in the United States. HR 5820 represents an effective step in ameliorating the serious shortage of skilled and technical manpower available to the high technology industries."

The pair disagreed, however, with a small point in the legislation: its contention that "The expansion of these industries within the United States is dependent on their ability to attract competent employees."

Attracting them is really not the problem according to the industry executives. Instead, the industries' ability to expand is dependent on a "trained pool of personnel available for employment."

ES&T

"Is it wishful thinking to want a 50 MHz portable scope with 1 mV/div sensitivity for under $2,000?"

HITACHI HEARD YOU.

Not since Hitachi introduced the dual trace, delayed sweep V-509. For only $1,895 you get a dynamic range of 8 full divisions. Sensitivity to 1 mV/div at 10 MHz. And sweep times down to 10 ns/div. For today's sophisticated electronics, computers and VTRs, it's the perfect field service tool.

Weighing a mere 11 pounds, in an 8.5″ x 4.3″ x 13.8″ package, the V-509 is, nevertheless, a heavyweight when it comes to performance. Auto focus, a built-in TV sync separation circuit and Channel 1 DVM output are standard. There's even a single-sweep function to reliably measure one-time events. Plus AC/DC operation and an optional battery pack, so you can take the V-509 wherever it's needed.

Hitachi's human engineering is evident in every facet of V-509 design. Its bright, 3.5″ diagonal CRT is easy to read. Functionally grouped front-panel controls make for fast, efficient use.

Also from Hitachi is the V-209, list price $995. A 20 MHz, dual trace, mini-portable scope with many of the same performance and ease-of-use features as the V-509.

So if you're thinking about purchasing a mini-portable scope, you know who to think of. Hitachi Denshi America, Ltd., 175 Crossways Park West, Woodbury, NY 11797. (516) 921-7200. Offices also in Chicago, Los Angeles, Atlanta, Cincinnati, Dallas, Denver, Seattle and Washington, D.C.

Circle (6) on Reply Card

The Thomas 4754 talking DMM

Figure 1 This digital multimeter announces in words the same reading shown by the LCD display. The 3½-digit DMM has a speech synthesizer with a vocabulary of more than 14 words. The external transformer (shown here) provides ac operation, or five hours of operation can be obtained from the internal NiCd batteries after each charging.

By Carl Babcoke, CET

Each report about an item of electronic test equipment is based on examination and operation of the device in the **ES&T** *laboratory. Personal observations about the performance and details of new and useful features are spotlighted, along with tips about using the equipment for best results.*

Talking digital multimeter

Talking toys, video games and computers are no longer news. Digital multimeters often have an audio tone that varies in frequency according to the relative reading. However, the Arthur M. Thomas Company model 4754 is the first digital multimeter (to our knowledge) that speaks the reading in understandable English.

Thomas model 4754 (Figure 1) appears to be a conventional DMM. The sample examined in the **ES&T** Test Lab appears to be a pre-production sample, because some of the panel markings are glued to the material. There is little about the appearance of the meter to indicate anything unusual, although one panel marking shows *4754 TMM* (which probably stands for *talking multimeter)* and one control is labeled *volume.*

Basic specifications

Model 4754 is a 5-function DMM that measures ac and dc voltages, ac and dc current, and resistances in 22 ranges. Maximum panel markings show ranges of 0.2, 2, 20, 200 and 2000, but the maximum readouts are one digit less. In addition, the ac and dc voltage ranges have maximum safe readings.

Input resistance is 10MΩ for all ac and dc voltage ranges, which have accuracies of ±0.15% at full scale. Maximum displays are 1.999V, 19.99V and 199.9V for all but the 1999V ranges. Maximum safe input voltages are 1000Vdc or 500Vac (allowing for the peak voltages).

The accuracy of each current range is different from the others. Accuracies of the dc and ac current ranges are ±0.5% for the 0.1999mA ranges, ±0.15% for the 1.999mA ranges, ±0.25% for the 19.99mA ranges, ±0.75% for the 199.9mA ranges and ±2.5% for the 1999mA ranges.

Rated accuracy is ±0.50% for the 0.1999K (199.9Ω) resistance range, ±0.25% for the 1.999K range, and ±0.15% for the 20K, 200K and 2000K ranges.

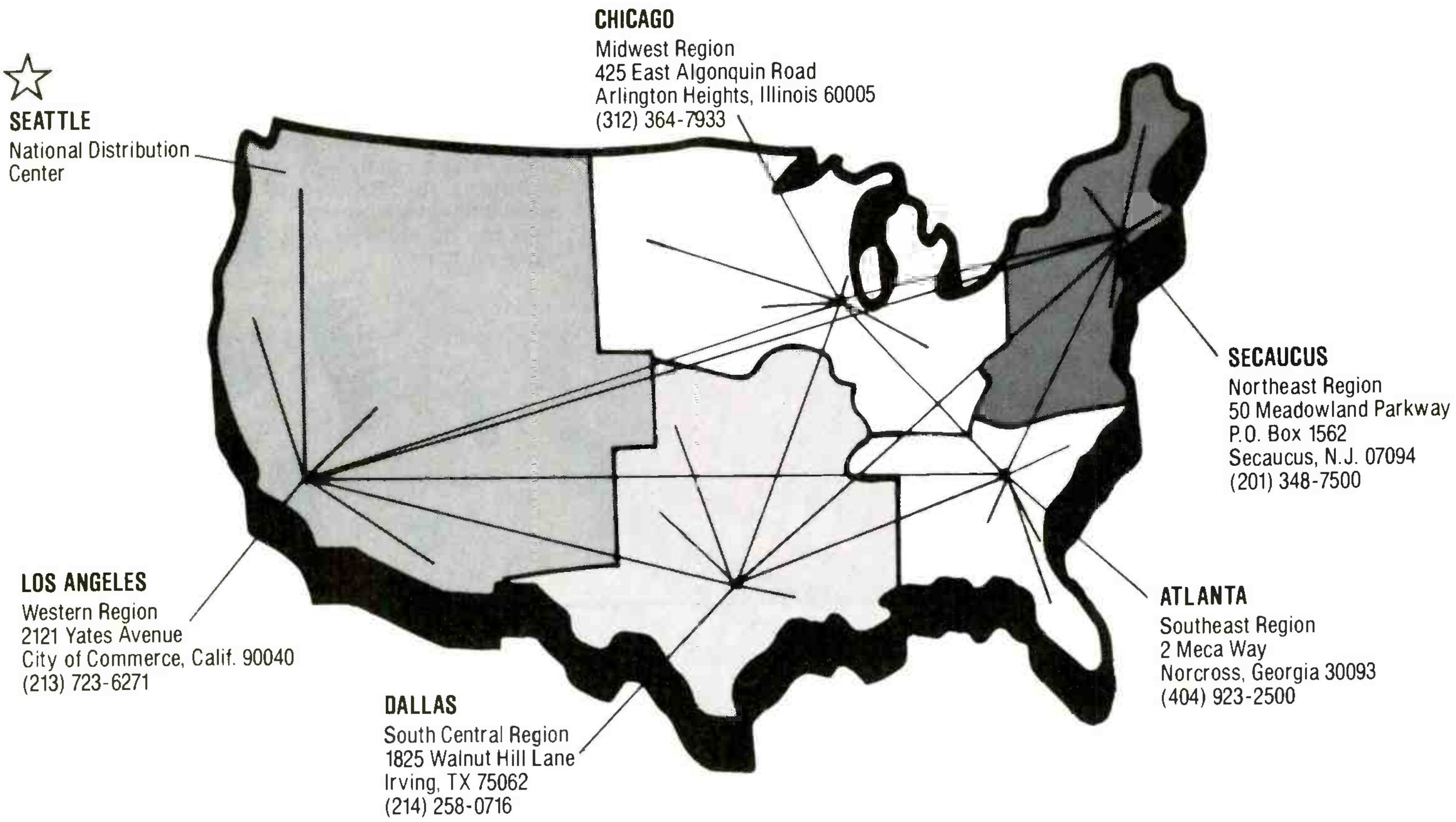
Six push-buttons on the left side of the panel (Figure 2) select resistance, ac and dc voltage, or current measurements, and turn operating power on and off. The LCD 3½-digit readout is at the center, with five push-buttons on the right of the panel for selecting the ranges (Figure 3). Above the range buttons is a rotary control marked *volume.* The two jacks for test probes are at the upper right corner. Except for various identifications, these are the only items on the front panel. On the back panel are three jacks, one each for external power/charger, earphone and talking-initiation control.

Included with the DMM are one pair of test probes, one earphone for listening to the verbal readout and a transformer-type battery charger. Optional accessories are a foot-operated switch and a probe with switch for activating the verbal speech on command.

Talking readouts

Understandable synthesized English words corresponding to the digital readout are heard automatically when the volume control is turned up. Unless the optional speech-control switch is activated, the digital reading freezes and the talking words are heard about once per seven seconds.

Panasonic has just put Seattle on its map



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- **Automatic substitutions**
- **Automatic replenishment of regional stocks**
- **On line status information**
- **Panafax facsimile network linking the regional depots together**

The overall result is a binding together of our resources in order to service you better. In addition we have:

- **A central parts depot with 170,000 individual parts on file and in addition five regional parts depots with 25,000 part numbers in stock**
- **Toll free calls connect Panasonic distributors and authorized servicenters to automatic facsimile machines located at regional parts depots, allowing us to receive orders 24 hours a day, 7 days a week.**
- **One hundred independent part distributors conveniently located to bring needed parts and accessories closer to the customer**
- **Plus a toll free number (800-447-4700) for the location of the nearest authorized Panasonic parts distributor. Except for Illinois: (800-322-4400)**

Our system is designed to get parts to a customer more quickly and easily than ever before. At Panasonic, we never stop trying to think of ways to better serve our customers.

Panasonic
just slightly ahead of our time

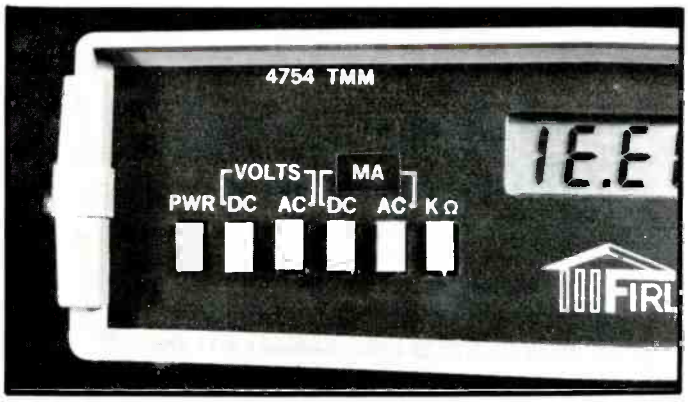


Figure 2 Six push-buttons on the panel at the left select five functions and control the power on/off. The LCD readout is at the center of the panel.

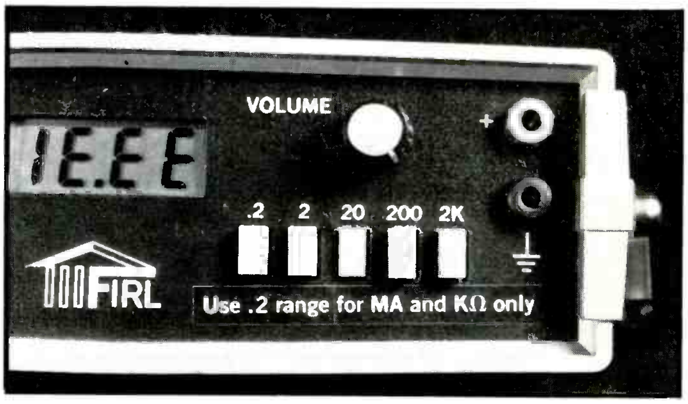


Figure 3 Five push-buttons at the right on the panel select ranges. Volume control for the audible readout is above the buttons. Turning down the volume control eliminates the audible words. An earphone can be used in noisy locations to provide private loud and clear talking readouts.

When the control switch is turned on, the frozen display and the vocal readout occur almost instantly and continues to repeat until the switch is turned off. A momentary pressure on the switch produces one complete readout, then the voice is heard every seven seconds, unless activated by the control switch again.

The synthesized voice has an unemotional quality with a hint of buzz in it, as though made by modulated hum. However, it is completely understandable, even when heard for the first time. For noisy locations, or when privacy is desired, an earphone can be plugged in the rear panel to provide loud, clear sounds with a minimum of environmental noise.

A single word is provided for each item on the LCD reading, including the four 7-segment digits, the positive sign, the negative sign and the decimal.

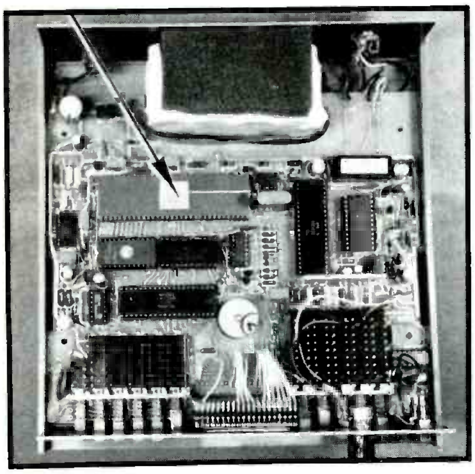


Figure 4 An arrow points to a 64-pin IC that probably contains the speech synthesizer. Additionally, 4 small ICs and 5 medium-sized ICs are included. The round white circle below the center is the magnet of a small speaker that speaks through the cases's bottom. Notice the absence of shielding, which might allow external radiations to affect some readings in certain environments.

The minus and plus words are used only with dc voltage and current. They do not appear on other functions because the readout does not show any polarity. *Only those things that appear on the LCD readout are verbal.*

When measuring a resistor, the LCD readout might show 2.92 when the 20K button is pressed, and the voice says, "Two point nine two." (However, the *nine* sounds very much like *times*.) The operator must keep in mind that the announced resistance reading is always in thousands (k).

Any overrange, including open test probes during resistance measurements, produces an LCD readout of 1EEE (with a decimal according to the range selected) and the voice constantly says, "Over, over, over."

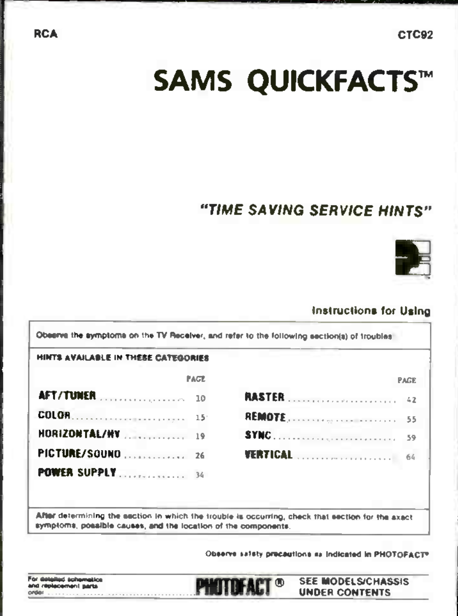
Comments

This model adequately performed all the standard five functions. There is only one omission that *could* cause false readings around radio transmitters or the high-voltage section of color receivers: No electrostatic or RF shielding is supplied inside the plastic cabinet (Figure 4).

Of course, the unique feature of model 4754 is the synthesized speech that audibly announces the same reading shown by the LCD digital readout. This audible readout can have great value in several situations, including making measurements in crowded circuit boards (where the slightest slip of a test probe can destroy valuable solid-state components), because the technician can watch the test probes constantly without being forced to look at the DMM readout. It is also valuable when operating in dim light or in a location where the operator cannot see the DMM readout, or when the technician has vision problems.

The Thomas model 4754 talking multimeter (TMM) can be helpful to many technicians. To others, it might be indispensable.

Sams offers a cure for your troubleshooting symptoms



RCA CTC92

SAMS QUICKFACTS™

"TIME SAVING SERVICE HINTS"

Instructions for Using

Observe the symptoms on the TV Receiver, and refer to the following section(s) of troubles

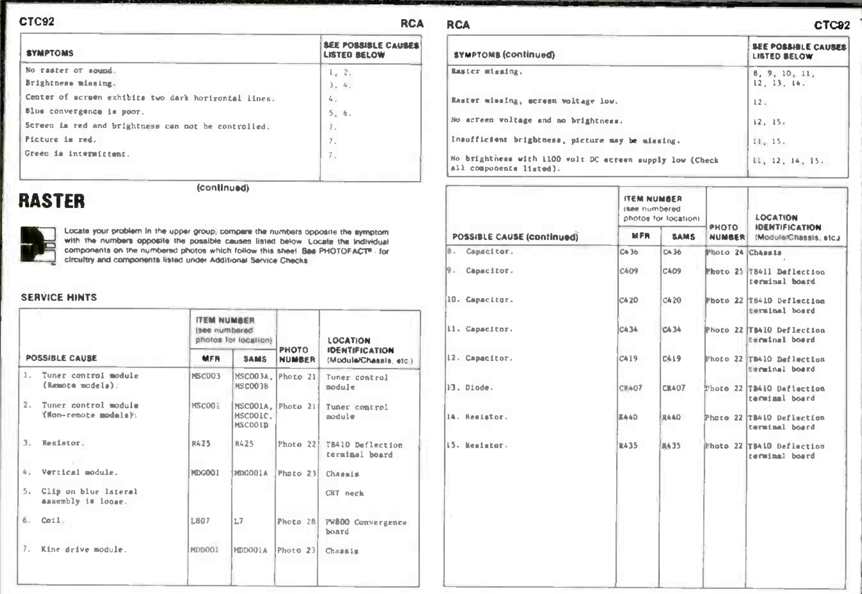
HINTS AVAILABLE IN THESE CATEGORIES

After determining the section in which the trouble is occurring, check that section for the exact symptoms, possible causes, and the location of the components.

Observe safety precautions as indicated in PHOTOFACT®

For detailed schematics and replacement parts order .... PHOTOFACT® SEE MODELS/CHASSIS UNDER CONTENTS

The symptom list for a specific television directs the user to the appropriate page.



CTC92 RCA

SYMPTOMS	SEE POSSIBLE CAUSES LISTED BELOW
No raster or sound.	1, 2.
Brightness missing.	3, 4.
Center of screen exhibits two dark horizontal lines.	4.
Blue convergence is poor.	5, 6.
Screen is red and brightness can not be controlled.	7.
Picture is red.	7.
Green is intermittent.	7.

(continued)

RASTER

Locate your problem in the upper group, compare the numbers opposite the symptom with the numbers opposite the possible causes listed below. Locate the individual components on the numbered photos which follow this sheet. See PHOTOFACT® for circuitry and components listed under Additional Service Checks.

SERVICE HINTS

POSSIBLE CAUSE	ITEM NUMBER (see numbered photos for location) MFR	SAMS	PHOTO NUMBER	LOCATION IDENTIFICATION (Module/Chassis, etc.)
1. Tuner control module (Remote models).	MSC003	MSC003A, MSC003B	Photo 21	Tuner control module
2. Tuner control module (Non-remote models).	MSC001	MSC001A, MSC001C, MSC001D	Photo 21	Tuner control module
3. Resistor.	R425	R425	Photo 22	TB410 Deflection terminal board
4. Vertical module.	MDG001	MDG001A	Photo 23	Chassis
5. Clip on blue lateral assembly is loose.				CRT neck
6. Coil.	L807	L7	Photo 28	PW800 Convergence board
7. Kine drive module.	MDD001	MDD001A	Photo 23	Chassis

RCA CTC92

SYMPTOMS (continued)	SEE POSSIBLE CAUSES LISTED BELOW
Raster missing.	8, 9, 10, 11, 12, 13, 14.
Raster missing, screen voltage low.	12.
No screen voltage and no brightness.	12, 15.
Insufficient brightness, picture may be missing.	11, 15.
No brightness with 1100 volt DC screen supply low (Check all components listed).	11, 12, 14, 15.

POSSIBLE CAUSE (continued)	ITEM NUMBER (see numbered photos for location) MFR	SAMS	PHOTO NUMBER	LOCATION IDENTIFICATION (Module/Chassis, etc.)
8. Capacitor.	C436	C436	Photo 24	Chassis
9. Capacitor.	C409	C409	Photo 25	TB411 Deflection terminal board
10. Capacitor.	C420	C420	Photo 22	TB410 Deflection terminal board
11. Capacitor.	C434	C434	Photo 22	TB410 Deflection terminal board
12. Capacitor.	C419	C419	Photo 22	TB410 Deflection terminal board
13. Diode.	CR407	CR407	Photo 22	TB410 Deflection terminal board
14. Resistor.	R440	R440	Photo 22	TB410 Deflection terminal board
15. Resistor.	R435	R435	Photo 22	TB410 Deflection terminal board

A symptom chart lists possible symptoms and directs the technician to possible causes below.

In October of 1981, Howard W. Sams & Company, Indianapolis, IN, conducted a national survey designed to determine the desire of electronics service technicians to purchase a quick-repair service hint product. The results of the survey were design criteria that called for a final product reflecting the following characteristics:

- simple and quick to use
- portable
- technically accurate
- moderately priced
- comprehensive
- appealing to specialty shops
- cross-references
- photo identification of devices
- organized by manufacturer trade name
- provide additional technical data as warranted
- updatable

The engineering staff set out to embody these criteria into a new concept of service documentation.

This product, called Quickfacts, consists of a series of soft-covered, plastic-bound, 8½" x 11" books containing symptom/cure information on TV sets. Zenith, Magnavox, RCA and GE are currently available in the series. Sams reports that they will be covering additional manufacturers on a monthly basis. They also state that they will issue supplemental updates to current volumes, as necessary.

Each volume contains, according to the publisher, "time-saving service hints" on TV sets made by one manufacturer. For example the RCA Quickfacts, which is in two volumes, contains information on RCA chassis CTC68 through CTC91 in Volume 1, and chassis CTC 92 through CTC 108 in Volume 2.

A technician using Quickfacts turns to the contents page to locate the model or chassis number of the television being serviced (a model-to-chassis cross reference is included). Once the technician has turned to the page indicated by the table of contents, he will find a list of symptom categories to choose from. These may include AFT/tuner, AGC, color, horizontal/HV, picture/sound, power supply, raster, remote, sync, vertical or miscellaneous.

As a specific example, if you were troubleshooting an RCA set with chassis CTC92, you would use Volume 2 of the RCA Quickfacts. The contents pages would direct you to page 9, and if your problem was with the raster, you would then be directed to page 42. At the top of page 42 and succeeding pages are symptom descriptions such as "No raster or sound," "Picture is red," etc. One or more numbers associated with each symptom description direct you to the module/component that should be checked.

Photos, drawings, circuit board patterns and other aids are included to help direct the servicing technician to the area that needs to be checked.

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Digital building blocks:
The Schmitt trigger

By Bernard Daien

One way of considering digital integrated circuits is that they are *functions,* and should be treated as such. The system designer simply buys the ready-made function he needs, plugs it in, and discards it when it fails to perform its function properly.

Using this philosophy (employed by many IC troubleshooters), we can practically eliminate the need for Boolean Algebra, Veith Charts, Karnaugh Maps, etc., and, with the aid of a simple truth table, put our analog skills to work in digital systems. But, in order to accomplish this, we need to know what the various digital building blocks do. Obviously these ICs were developed and marketed because there was a need for them. We will examine them, one at a time, starting with the Schmitt trigger in this article.

The Schmitt trigger is versatile enough to be employed in both computers and control systems, and in many odd places, too. It has been traditionally dismissed with a few sentences in most digital texts, but you will see it in many schematic diagrams, generally with little explanation as to why it is there.

The Schmitt trigger can be used as a switching contact debouncer, for signal conditioning, as a level detector, and in control systems, to prevent hunting. It is also used to convert triangular and other odd-shaped waves into square waves.

Not-so-ideal digital pulses

It is usually assumed that digital signals have nice clean "highs" and "lows" (ones and zeros). Unfortunately, this is not always the case. The high frequency digital pulses, often at frequencies exceeding several megahertz, are really radio frequencies. They are not sine waves, which means they are loaded with harmonics, extending even higher in frequency.

Such signals must be piped around on transmission lines, which should be matched in impedance to both the generator and the load in order to prevent standing waves and other undesirable effects. Unfortunately, the bus lines, connectors and loads used in digital systems are usually far from ideal transmission lines. As a result, the clean rise and fall times of the digital pulses become slow rising and falling ramps, and there is often ringing.

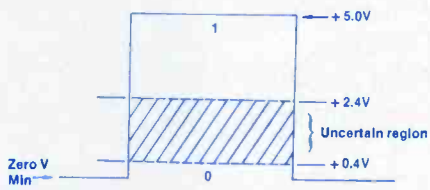

Figure 1. An ideal digital pulse for driving TTL logic circuitry. (The rise and fall times should be less than 150ns in order to maintain noise immunity.) The signal may not exceed +5.0V, nor go below zero.

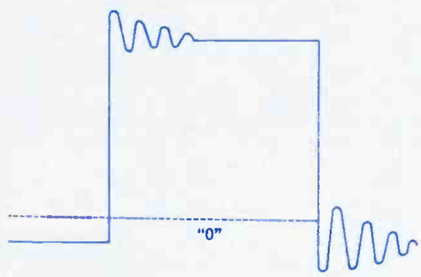

Figure 2. "Ringing" degrades the idealized digital pulse. This is due to stray inductance and capacitance forming a resonant circuit, or to reflections on a misterminated bus (transmission line). "Level-triggered" digital circuits will be subject to an uncertain "0" input level. The maximum level also exceeds +5.0V and the minimum level goes below zero volts, which is not permissible with TTL digital circuits.

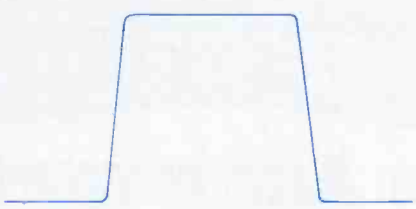

Figure 3. Long rise and fall times degrade this digital pulse, and may cause problems with edge-triggered TTL circuits. The time spent in the uncertain region is increased, with resulting noise problems and the possibility of circuits oscillating while in the linear mode.

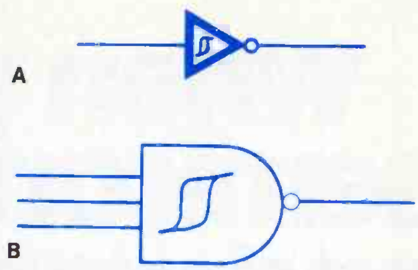

Figure 4. The symbology for Schmitt trigger digital ICs shows a Schmitt trigger inverter (A) and a 3-input NAND gate Schmitt trigger (B).

Some digital circuits are edge triggered on the rising edge of the pulse, and some are edge triggered on the falling edge of the pulse. Other circuits are level triggered on a one, and some are level triggered on a zero. Degraded digital pulses cannot trigger these various circuits properly.

Figure 1 shows the idealized digital pulse for triggering the transistor-transistor logic (TTL) family of digital integrated circuits. This is the largest, most useful and most inexpensive family of logic integrated circuits, and it operates from a standardized 5V single power source. Notice that the high state is clearly indicated and the low state is also defined. There is a region between the high and low states that is a "forbidden zone" so far as input and output signals are concerned. This prevents the digital circuits from being in an uncertain state.

Now what if ringing is introduced in the idealized pulse? Figure 2 indicates that the signal is alternating in and out of the uncertain zone, with unpredictable results in triggering level-triggered circuits.

Figure 3, with sloping rise-and-fall ramps introduced by the effects of capacitance and resistance (RC time constants), and with cumulative delays caused by passing through several circuits, will similarly cause unpredictable results in triggering edge-triggered circuits.

Many of the problems in digital systems arise, not from the presence or absence of such pulses, but rather from distortions or delays in the pulses. In clocking,

for example, the clock pulse *must* arrive at precisely the right time in order to synchronize the system. Of course, the clock pulse must be effective in triggering the circuitry involved.

Effects of non-ideal pulses

When a level-triggered circuit is held in the high state or the low state, it is either in saturation, in cutoff, or in a predictable and stable condition, functioning as a switch. But when the circuit is held in the uncertain region, it is neither fully on nor fully off, but in the linear region. As such, it functions as an amplifier with high gain, and the output therefore may be quite noisy. The circuit may actually oscillate at some parasitic frequency. Switches do not have these undesirable problems but linear amplifiers do, and digital integrated circuits were never designed to function as linear amplifiers.

The edge-triggered circuits have their own problems. When the rise and fall times are too long, the exact moment that the trigger point

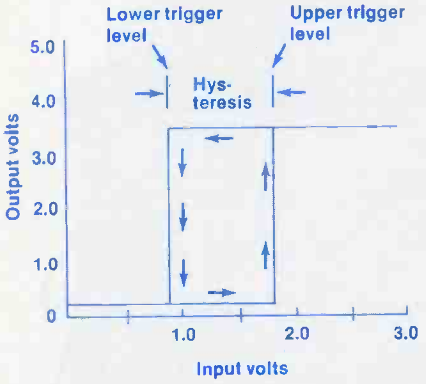

Figure 5A. The Schmitt trigger upper and lower trigger levels for the 7414 TTL IC (note hysteresis).

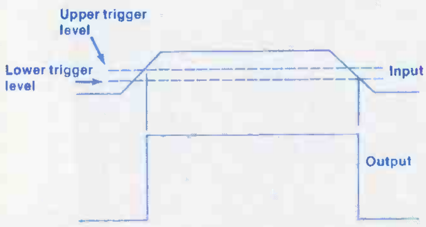

Figure 5B. The result of a slowly rising and falling input, for a non-inverting Schmitt trigger. The output goes high when rising input exceeds upper trigger level. The output goes low when the falling input goes below lower trigger level. For an inverting Schmitt trigger, the output state is reversed.

(Continued on page 22.)

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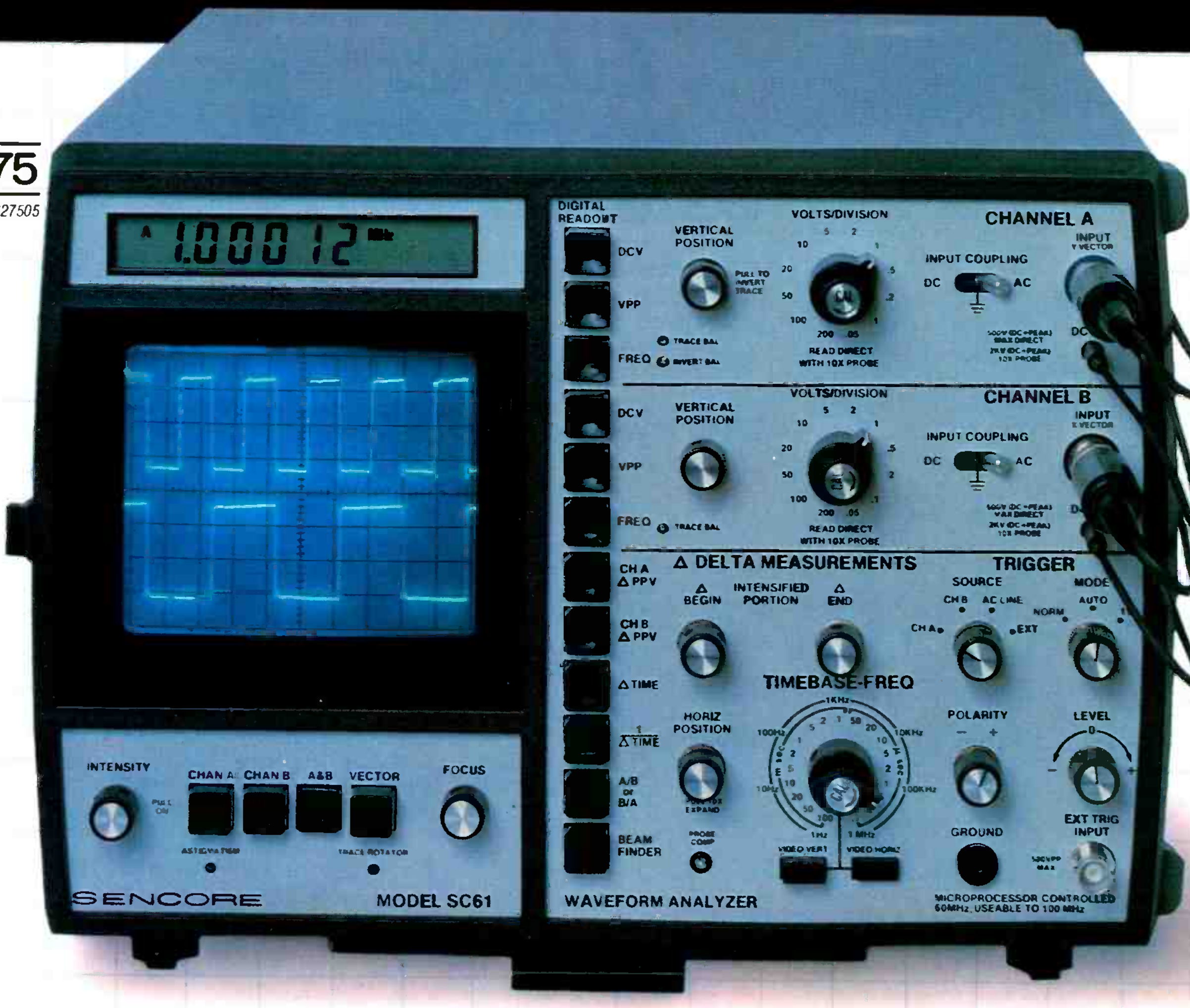

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(Continued from page 17).

occurs cannot be accurately predicted, and in fact, some circuits may not trigger at all.

With many edge-triggered circuits in a system, the cumulative delays may be so great that the system becomes totally unreliable. Of course this would be an intolerable situation, but careful examination of the pulse waveforms, expanded on a good, high frequency oscilloscope, will reveal this situation *if* a good sync source can be found. Remember, many digital pulses in a system are not repetitive (incoming data, for example). In such cases you may have to find a source of a good sync repetitive waveform somewhere in the system, through programming or in clocking, to observe the deterioration of the waveform.

This is where the Schmitt trigger can be useful. Before the signal is allowed to deteriorate too far, the Schmitt can 'condition' it to be as good as new.

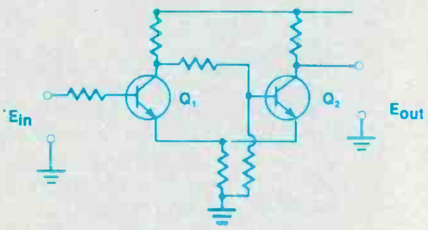

Figure 6A. The discrete version of a Schmitt trigger (conventional schematic).

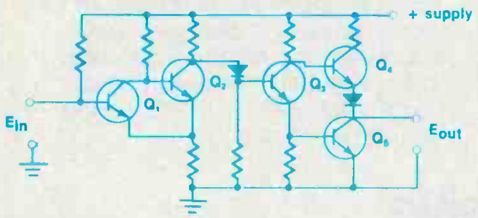

Figure 6B. A simplified schematic of an IC Schmitt trigger. *Note:* Q_1 and Q_2 are the Schmitt trigger, while Q_3, Q_4 and Q_5 are the standard TTL output circuitry.

How the Schmitt works

The Schmitt trigger is a form of flip-flop, but unlike the more familiar bistable and monostable flip-flops, the Schmitt trigger has two levels of triggering: an upper level and a lower level. When the input signal is above the upper level, the circuit is in one state. When the input signal falls below the upper level, the circuit remains in the same state, but when the signal falls below the lower trigger level, the circuit changes state. Conversely, if the input rises above the lower level, nothing happens until the signal rises above the upper level, when a change of state again occurs. This is called *hysteresis,* and a hysteresis loop forms the symbols for a Schmitt trigger, as shown in Figure 4. The various triggering levels are shown in Figure 5.

This principle is familiar; it is used in many common control systems. The thermostat on the wall that controls the heating or cooling system is an example. If it is set to turn on the heat at 70°F, the heat will stay on until the thermometer reads 72°F, at which time the system will shut down. It will stay off until the temperature drops below 70°F, at which time it will again turn on and repeat the cycle.

There is a good reason for this. If this 2° of hysteresis were omitted, the furnace would turn on at 70°, promptly turn off again as soon as the temperature rose above 70°, then turn on again as soon as the temperature dropped to 70°, and repeat endlessly. The furnace simply would be oscillating on and off at some low frequency, hovering around the 70° mark but never stable. Of course the same thing will happen in any digital (switching) system because there are only two states: on and off. Thus your air conditioner turns on and you complain about the cold air on your neck, then it shuts off and you feel warm. Thermostats have a small adjustable hysteresis, which prevents the rapid cycling of such systems, reducing quick wearout of valves, switches, etc.

The Schmitt trigger has a defined hysteresis, and when electrical control signals for turn-on and turn-off are supplied to the Schmitt, it provides for a *dead band,* similar to the two degrees in the thermostat. Remember, the system turned on at 72°, and off at 70°, but absolutely nothing happened within those two degrees.

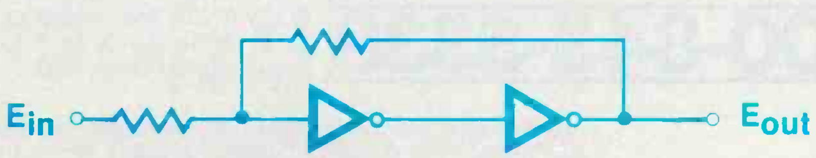

Figure 6C. A Schmitt trigger made of TTL family inverters.

Circuitry

The conventional schematic for a Schmitt trigger made of discrete parts is shown in Figure 6A, the internal circuit of an integrated Schmitt trigger in 6B, and a Schmitt trigger made of two logic gates in 6C, but they all operate similarly.

An input resistor should be used in series with the Schmitt input. In some cases, this resistor partially determines the operating points of the circuit. It is preferable to drive the Schmitt from a low impedance source, such as a logic IC, so that the driving source resistance does not affect the operating points. Some Schmitt ICs have an internal input resistor.

The Schmitt trigger can also be implemented with a single operational amplifier and a few resistors, but that circuit rightly falls under op-amp applications, which is a non-digital subject.

All of these circuits simply use dc *positive* feedback. In the discrete version, we use two transistors in an emitter-coupled, bistable flip-flop, modified so that the trigger level changes, depending upon which side of the flip-flop is cut off. The IC version uses essentially the same circuit, with a totem-pole digital output. The Schmitt, made of two TTL inverters in series, functions like a single, non-inverting, gain stage (which is the reason the op-amp can be used).

The integrated CMOS Schmitt triggers use more complex and varied circuitry internally. Different manufacturers use different circuits. This is partially due to the fact that CMOS is "Complementary MOS", with P-channel and N-channel devices in series across the power supply. At any rate, the CMOS Schmitts in integrated form do not resemble the previously described circuits, although they perform the same function.

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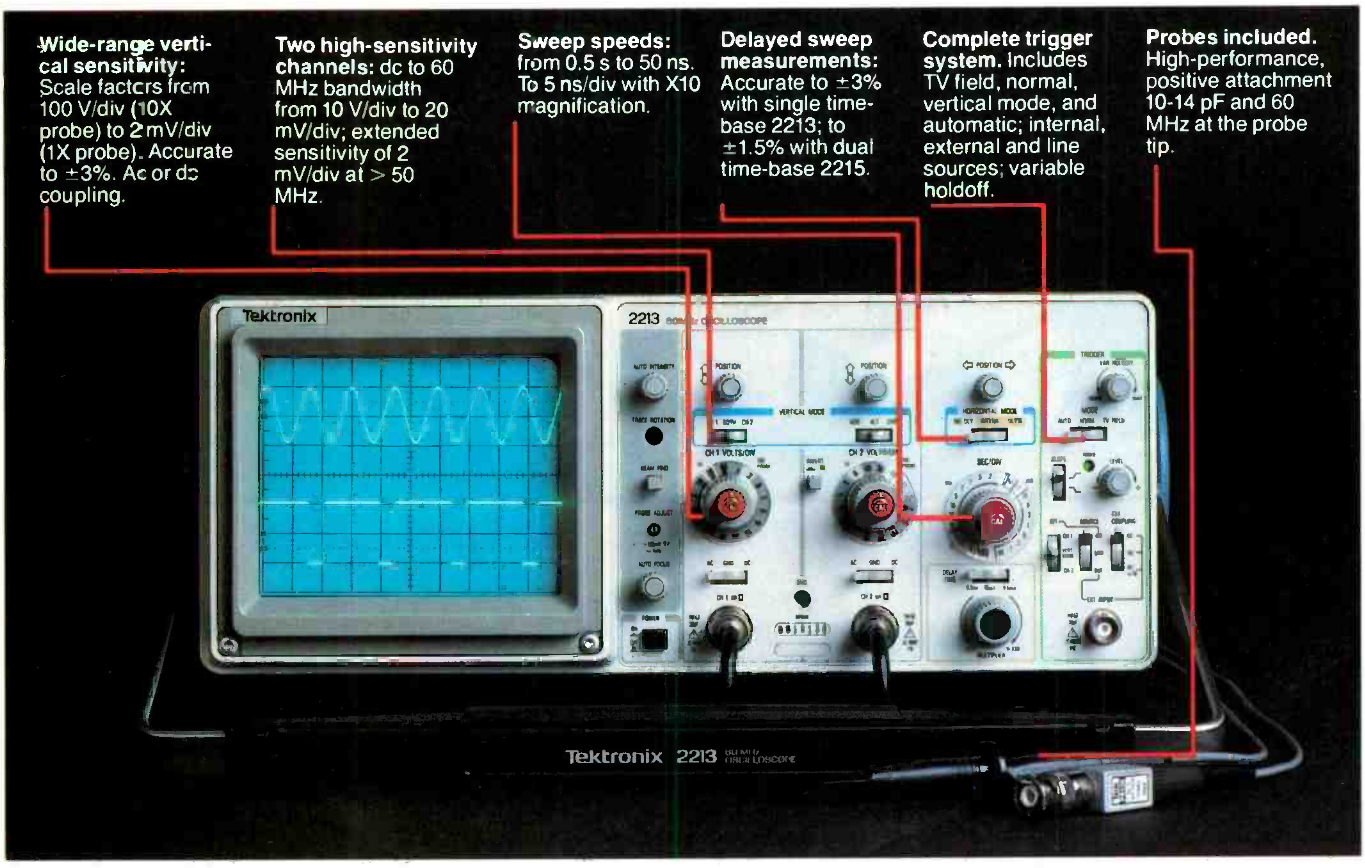

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Remember, *CMOS does not operate from a fixed 5V supply,* but can work from 3V up to about 20V. The trigger levels will shift accordingly, so be careful to check the power source if the CMOS Schmitt does not trigger at the expected points.

Both the discrete and the logic gate circuits have adjustable triggering, depending on the resistor values, while the TTL Schmitt IC has fixed levels. This is because the internal resistors cannot be changed and the supply voltage is fixed at 5V. (The CMOS Schmitt trigger levels vary with the applied supply voltage in discrete, gate and IC versions).

The output of the Schmitt consists of fast-rising and fast-falling waveforms, which are well suited to driving edge-triggered circuits in digital systems. Thus the Schmitt provides near-ideal digital pulses for both level-triggered and edge-triggered circuitry. Because digital systems are intended for use with properly shaped pulses, the coupling capacitors are large enough to pass such waveforms. If the digital signal is allowed to deteriorate sufficiently, pulses will have rise and fall times too long to pass through the coupling capacitors. Stated another way, the capacitors may be too small to accommodate the pulse waveshape.) The Schmitt restores the waveshape before it is degraded to the point where problems arise.

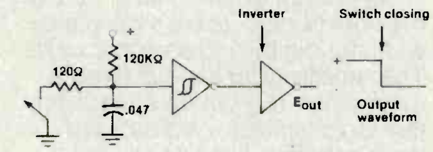


Figure 7A. Switch contact bounce eliminators; normally open switch contact circuitry.

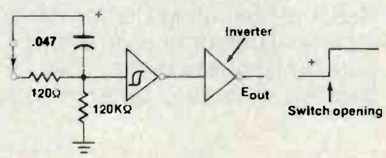


Figure 7B. Normally closed switch contact circuitry. *Note:* The inverter is used in these circuits because the Schmitt trigger shown is an inverter (which is common). The output would therefore be an inversion of the input if the second inverter was omitted.

Integrated circuits

Schmitt triggers are readily available in IC form. In transistor-transistor logic (TTL) the 7413, 7414 and 74132 are common. The 7413 is a dual, 4-input, NAND-gate Schmitt. The 7414 is a hex package, with single-input Schmitt inverters. The 74132 is a quadruple, 2-input, NAND Schmitt.

In CMOS, the 4093 is a quadruple, 2-input, NAND Schmitt. The 4584 is a hex package, with six Schmitt inverters.

It should be noted that there are Schmitt triggers available with tri-state outputs, for those into computer circuitry. It is a simple matter to deactivate the tri-state feature, however, in which case the trigger operates like a conventional dual-state-logic IC.

Contact debouncing

Digital systems use many mechanical switches and relays. The keyboards on some machines have many such contacts, and there are switches in the power

supply lines and other locations. These switches tend to bounce for milliseconds before settling down, particularly if they are snap-action switches, such as toggle switches.

Of course these multiple openings and closings wreak havoc in a digital system. The Schmitt offers a quick, simple and inexpensive solution. Figure 7 shows circuits for debouncers on normally open and normally closed momentary contact switches, such as might be encountered on keyboards. The RC networks provide smooth rise and fall times of the switch output, but the Schmitt converts these to nice square wave pulses without any bounce.

As indicated in the caption of Figure 7, Schmitt triggers are often inverting circuits and many therefore require another inverter to prevent voltage waveform inversion.

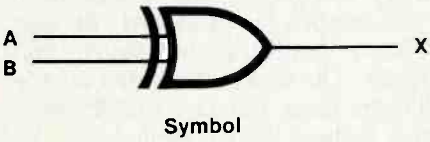


Figure 8A. An exclusive 2-input OR gate.

Exclusive 2-Input OR Gate Truth Table

Inputs A	Inputs B	Output X
0	0	0
0	1	1
1	0	1
1	1	0

Figure 8B. An exclusive 2-input OR gate truth table. *Note:* The table shows that the output goes high when either input goes high. The output is low when neither input is high or when both inputs are high. No inversion takes place. This differs from a simple 2-input OR gate, which has a high output when both inputs are high.

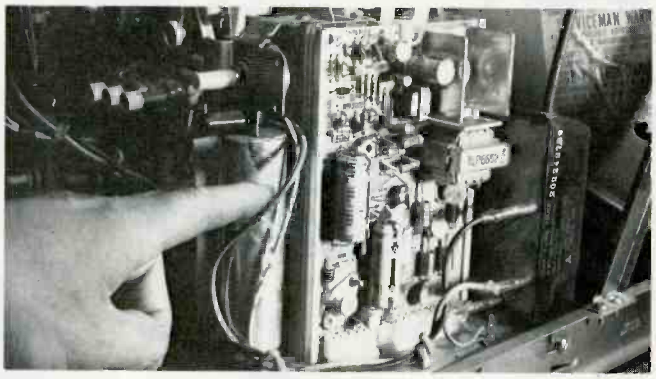
Truth tables are simply tables listing the output states for every combination of inputs. Thus, if we have a 2-input gate, there are four input combinations (1-1, 0-0, 1-0 and 0-1) with an output for each of these combinations. This is simple, but what if you have a circuit with many inputs, two outputs and clocking? The truth table makes things quite clear, in an easy-to-use format. In this series, the truth table will be stressed as an essential working tool.

Figure 8 shows the truth table for a commonly used TTL digital circuit, along with explanatory notes, which make the use of the table obvious. A Digital Circuits Data Book, either TTL or CMOS from one of the major semiconductor manufacturers is recommended. (They all have them for free or a small charge.) Study the truth tables for the simpler circuits at first, then the more complex ones, until you can understand them without difficulty. They are the starting point for a digital education.

ES&T

Servicing conduction-time regulation

By Homer L. Davidson



The power-supply module S in J.C. Penney models 2868 and 2888 is mounted on the chassis side near the horizontal-sweep section. This position allows many voltage, waveform and resistance tests without removing the module. A technician's finger points to filter capacitor C853.

When a technician analyzes a defect in an unconventional electronic system, his knowledge about its purpose and the circuit-operation theory can be valuable. This is the case with B+ regulation in the J. C. Penney "S" module. Penney models 2868 and 2888 (Photofact 1370-1) and several Panasonic color-TV receivers use the S module.

Regulator purpose and theory

Regulation of the B+ applied to the horizontal-output transistor also regulates horizontal sweep and high voltage. If the regulated supply voltage becomes too high, the horizontal transistor and other components can be damaged. When the regulator output is too low, the picture is small or missing. Therefore, correct operation of the regulator is vital.

Figure 1 has simplified schematics that illustrate the basic principle behind S module regulation. The Figure 1A schematic shows how an adjustable dc voltage can be produced by varying the on-time duty cycle of relay contacts that control application of dc voltage to an integrating capacitor (C853 in the S module). For example, if the relay contacts are closed for 10% of the total time, the output voltage will be about 10% of the supply voltage.

However, several conditions must be fulfilled. A current-limiting resistance or inductance is required between the supply voltage and the switching contacts or other switching device. Without the current-limiting inductance (a resistor would produce excessive voltage drop here), the circuit would be peak-reading, and the storage capacitor would charge to the full supply voltage, preventing any significant voltage variation when the duty cycle is varied.

Also, the repetition rate vs. the storage-capacitor capacitance must be within certain limits. Faster repetition rates allow the use of a smaller capacitance, while a slower repetition rate demands a larger capacitance for acceptable operation.

The previous circuit has no provision for automatic regulation of voltage. Additional circuit elements needed for regulation are shown in Figure 1B. Unregulated and unfiltered 120Hz parabolic dc-voltage pulses from the bridge rectifiers are the input power source to the L801 current-limiter inductance. An SCR replaces the previous relay, giving the necessary precise and fast switching. Turn-on point of the SCR must be synchronized to the 120Hz ripple frequency. This synchronism is accomplished by a sample of the input voltage that is fed to one of the triggering transistors.

Remember that the SCR is triggered by a gate-to-cathode positive pulse. After triggering, it remains conductive until the anode voltage (parabolic-waveshape dc voltage) falls below the desired +122V at the SCR cathode and C853.

Regulation of the +122V is produced by varying the turn-on point of SCR TR805 on each SCR-anode parabolic cycle. As shown in the Figure 1C drawings, a light load on the regulator output (or a higher input voltage to L801) triggers the SCR on later in the cycle, reducing each conduction time.

At the other extreme, a heavier load on the regulator output (or a reduced voltage at the input of L801, perhaps from low line voltage) causes the circuit to trigger the SCR earlier in each cycle. Of course, longer conduction times supply more total current and higher voltage during each cycle.

Figure 2 shows the entire regulator schematic (from Photofact 1370-1). Transistor TR801 receives a sample of the input parabolic waveform, and a sawtooth waveshape is produced at the TR801 collector by C807 and R808. The sawtooth is fed to the TR802 base, but the TR802 emitter voltage is controlled by the C853 voltage through R816 115V

control and reference-amplifier transistor TR804. Therefore, the TR802 (PNP-type) cut-off bias is changed to forward bias (thus causing TR802 C/E current) at a point on the negative-going sawtooth (at its base) that moves according to the TR802 emitter voltage. Voltage variations at C853 determine when (during each cycle) TR802 draws C/E current. In other words, the conduction time varies in phase according to the C853 voltage.

Each pulse of TR802 collector current is moderately short. The waveshape is sharpened by the small-value C808 coupling capacitor, and the *effect* of the waveshape is narrowed even more by the absence of any forward bias at the TR803 base (except the signal itself). The resulting narrow negative-going pulses at the TR803 collector are coupled and phase-inverted by triggering transformer T801, which delivers a positive-going pulse to the SCR TR805 gate sometime during each cycle of the 120Hz ripple. As explained, a lower voltage at C853 forces these gate pulses (that start the SCR conduction) to appear earlier in each cycle, producing a longer time of TR805 current flow into filter capacitor C853.

SCR conduction causes the right-angle notch on the parabolic waveforms in Figure 1C. Until SCR TR805 conducts, it is an open circuit, and the anode waveform follows the parabolic shape. When TR805 conducts, it becomes the equivalent of a near short between anode and cathode. The anode sig-

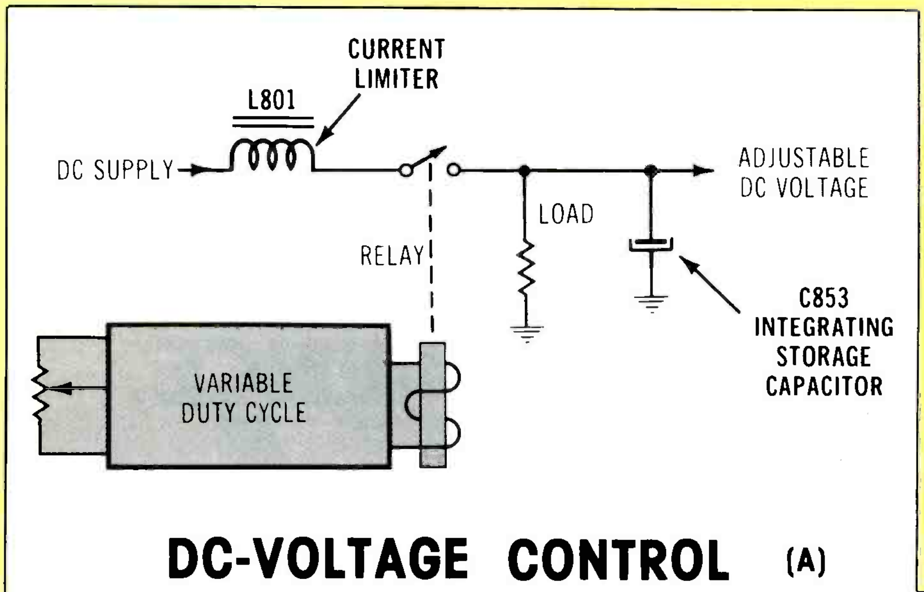
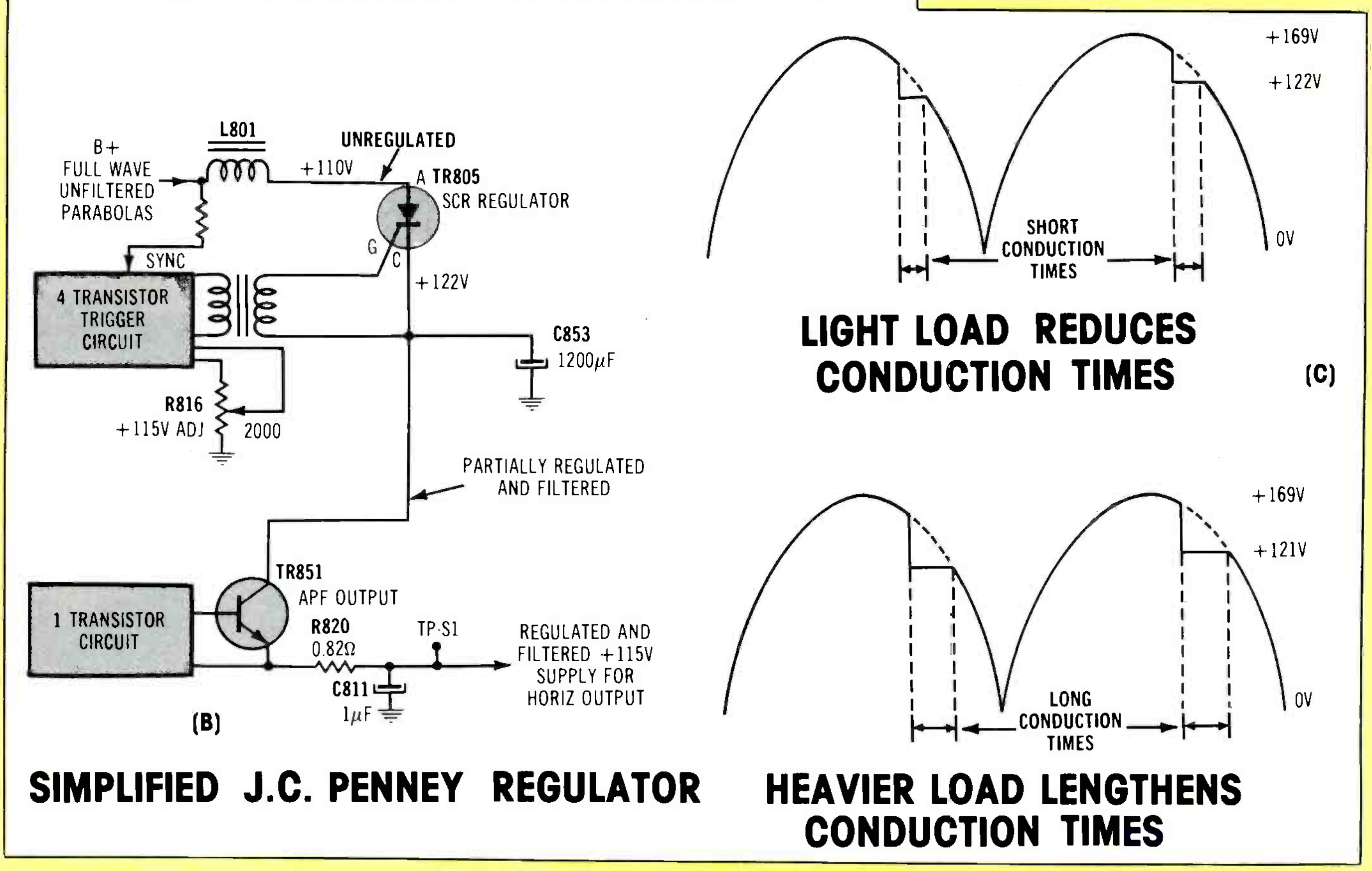


Figure 1 These schematics and drawings explain how variable times of power-supply conduction can produce regulation. Left, variable dc voltage can be obtained by this circuit, which varies the duty cycle (on-time) of power applied to storage capacitor C853. However, there is no automatic regulation. Below left, automatic regulation is performed by a triggering circuit synchronized to the 120Hz ripple frequency. SCR TR805 is forced to conduct earlier in each 120Hz cycle when more power is needed. A power-filter circuit completes the regulation and filtering. Below, these drawings show idealized waveforms at the SCR TR805 anode during light and heavy loads on the power supply. The anode waveform follows the ripple until the SCR conducts, and then it is connected to the C853 voltage. This accounts for the missing sections.



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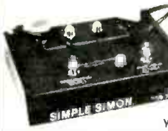

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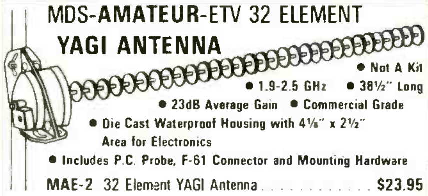

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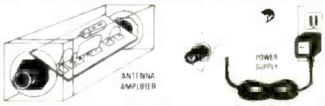

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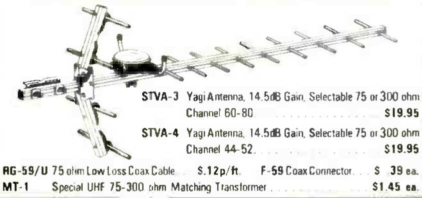

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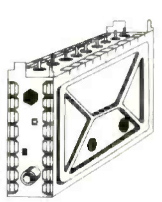

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9	CC33-SW	Ceramic Disk Capacitor Kit, 50 W.V. 33-pieces	7.95
10	CT-SW	Varible Ceramic Trimmer Capacitor Kit, 5-65pfd, 6-pieces	5.95
11	L4-SW	Coil Kit, 18mhs 2-pieces, .22µhs 1-piece (prewound inductors) and 1 T37-12 Fernte Torroid Core with 3 ft. of #26 wire	5.00
12	ICS-SW	I.C. Sockets, Tin inlay, 8-pin 5-pieces and 14-pin 2-pieces	1.95
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14	MISC-SW	Misc. Parts Kit Includes Hardware, (6/32, 8/32 Nuts, & Bolts), Hookup Wire, Ant. Terms, DPDT Ant. Switch, Fuse, Fuseholder, etc.	9.95

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2	2CB1-PWD	Printed Circuit Board, Pre-drilled	18.95
3	3TP11-PWD	PCB Potentiometers 4-20K, 1-.5K, 2-10K, 2-5K, 1-1K, and 1-50k (11 pieces)	8.95
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13	13SR-PWD	Enclosure with PM Speaker and Pre-drilled Backpanel for mounting PCB and Ant. Terms	14.95
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Circle (14) on Reply Card

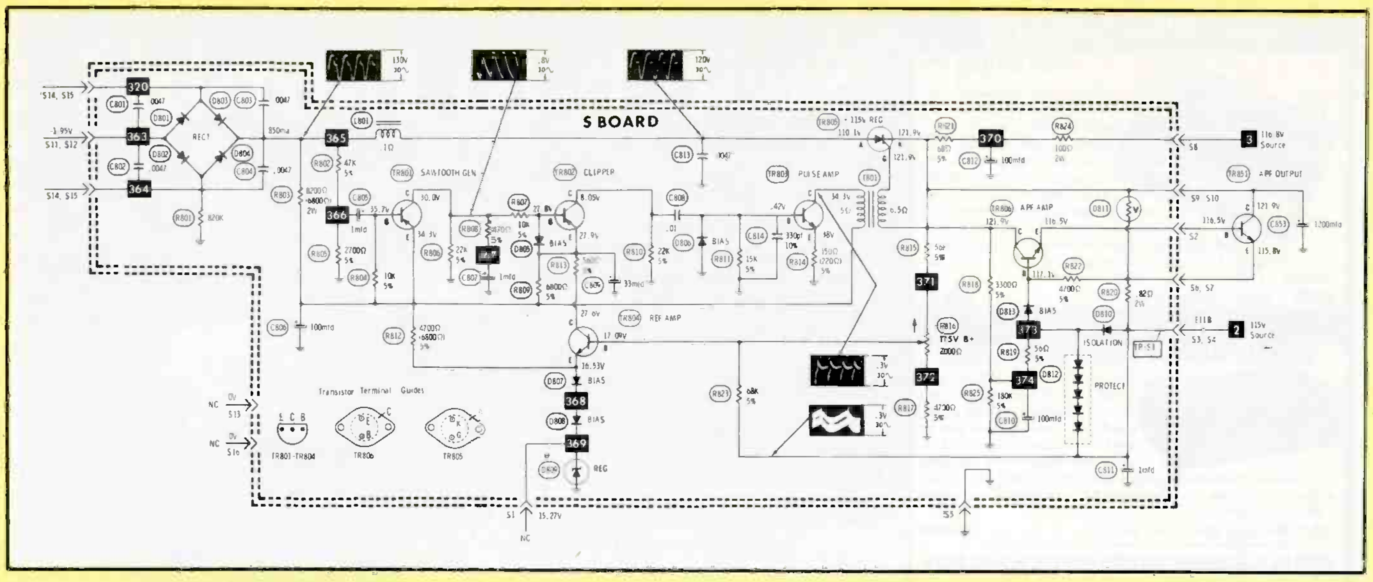


Figure 2 The entire S module power-supply circuit is shown here from Photofact 1370-1. Follow the circuit as theory and servicing information are discussed.

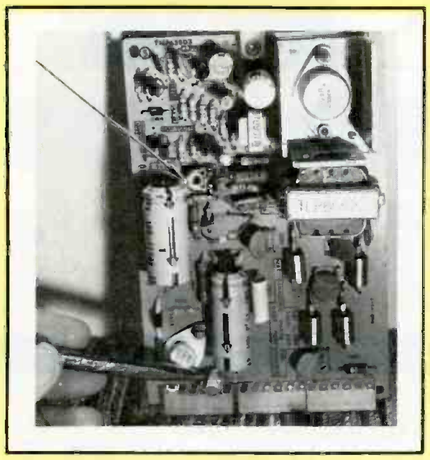


Figure 3 A pen at the bottom points to testpoint TP-S1, where the +115V should be. Just above it is power-transistor TR806. Voltage control R816 is pointed out by the arrow.

nal comes through inductance L801; therefore, the maximum instantaneous current is limited. Because the anode current is limited, but the cathode current is not (1200 F can store a large potential current), the anode assumes the cathode and C853 waveform (nearly pure dc voltage, or a straight horizontal line on the scope screen). This horizontal line is retained until the input parabolic voltage drops below the +122V at the SCR cathode. At that point, SCR conduction ceases, and the anode-voltage waveform once again follows the parabolic shape.

Therefore, the width of this missing section indicates the time of C853 charging. A narrower section proves the regulator action is operating below maximum, perhaps because the horizontal-sweep load is low. A heavier load on the +115V supply forces a normally operating regulator to increase the time duration of SCR conduction, thereby widening the notch in the anode waveform.

Incidentally, the actual SCR-anode waveform is not a true parabola because L801 integrates the bridge-output parabolic waveshapes to more nearly resemble sinewaves. Of course, this slight discrepancy has no effect on the circuit operation.

To summarize: Regulation of the B+115V supply in the Penney/Panasonic S module is accomplished by triggering-on an SCR for varying lengths of time according to the current demands. Therefore, a shorted SCR or a permanent conduction through the SCR will increase the +115V supply to a level that probably will ruin some horizontal-sweep or high-voltage components. If the SCR is not triggered on at *any* time, the +115V supply will have no voltage (there is no parallel path). Of course, erratic triggering can produce a varying or low voltage from the +115V supply. These condensed symptoms will help technicians know what voltages and components to check when the regulator malfunctions.

Some ripple and line-voltage bounce is present at C853. Therefore, an automatic power filter (APF) consisting of transistor TR806 and power transistor TR851 was added (Figure 1B). The failure of TR851 to pass sufficient current also can eliminate or reduce the +115V supply. If TR851 is shorted between collector and emitter or is biased into saturation, the +115V output will be slightly high.

Isolate the problem

Several tests should be made before the S module is replaced or removed for repair. Excessive horizontal-output transistor current might be loading down the +115V source. Also APF transistor TR851 might be defective in a way that would destroy some components of a replacement module.

TR551 horizontal-output transistor and TR851 APF transistor are located on the chassis heat sink behind the S module. Both transistors should be removed and tested externally before any other tests are made. Check particularly for leakages after the usual evaluations are made.

After it is certain the APF transistor (TR851) is in perfect condition, reinstall it (or a new replacement), but do not reinstall the horizontal-output transistor until the +115V-supply voltage has been measured at testpoint TP-S1 (Figure 3). Zero or low voltage there indicates a defect in the S module.

A visual inspection of the module should be made to find any burned resistors or other apparent defects. Voltage and waveform tests can be made easily because the

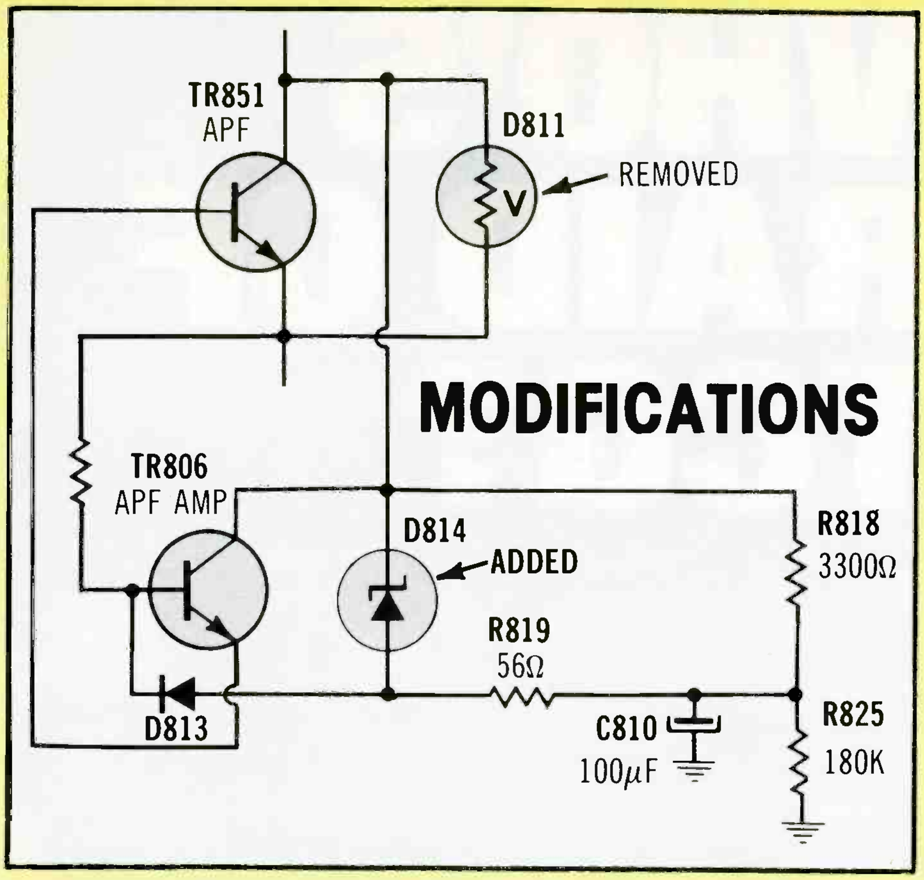


Figure 4 Some Penney Panasonic modules have modifications that remove diode D810 and varistor D811 while adding protective zener diode D814.

module is accessible at the end of the chassis. Applications of heat and coolant have been effective in locating thermally intermittent components on these modules.

Zero or low voltage

When voltage measurements at TP-S1 show low B+ voltage, first measure the dc voltages at anode and cathode of SCR TR805. If low or no voltage is found at the anode, the problem is almost certain to be in the bridge rectifier or ac-input circuits. Of course, the module input connections and L801 should be tested for continuity. Also, test all diodes of the bridge rectifier.

Scope the TR801 collector for the sawtooth waveform. A proper waveform clears the TR801 stage of suspicion. A reduced-amplitude or incorrect waveform at the collector might indicate a bad TR801 transistor or it might be caused by a defective component in the base circuit. Overloading of the +115V supply also might interfere with the sawtooth waveform.

Of course, an improper sawtooth waveform at the TR801 collector will prevent all following voltages and waveforms from being normal. In-circuit transistor tests should be made; They are often sufficient to locate a defective transistor.

Overloads sometimes overheat R819 and R818, so they should be tested and replaced if out of tolerance.

Symptoms of a defective C853 filter capacitor vary greatly, depending on the exact defect. Excessive leakage reduces the +115V supply voltage and increases the ripple. A shorted filter should trip the circuit breaker. Insufficient capacitance also reduces the +115V supply voltage. Some versions of the circuit had an 800μF filter instead of 1200μF. When paralleling the old filter with a new one, connect it when the power is turned off, turn on the power and notice any change or improvement, and then turn off the power before disconnecting the test capacitor. Use a capacitor of at least 800μF during the test.

Hum bars

The most likely cause of hum bars in the picture is a bad TR806 APF transistor. Internal C/E leakage reduces the electronic filtering without removing the supply voltage. Sometimes the transistor will test good (even out-of-circuit) but apparently break down under load. Replace it when there is any doubt.

Some modules have been modified by addition of D14 (Figure 4), a 15V zener. When D14 is added, diode D810 and varistor D811 are removed. Check D814 and D812 when the raster shows hum bars.

Narrow raster

A narrow picture can be caused by either insufficient regulated voltage or problems in the horizontal-sweep circuits. Therefore, the +115V supply voltage should be tested first.

In one case of narrow picture, the regulated-output voltage was very low. When the R816 +115V adjustment control was rotated, a maximum of only +98V was obtained at the cathode of SCR TR805, and even lower voltage at TP-S1.

All dc voltages in the entire regulator circuit measured low. But there was a more important clue: Resistor R819 (56Ω) was excessively hot and this indicates a problem with filter capacitor C853. Paralleling C853 with another another 1200μF capacitor eliminated the narrow picture.

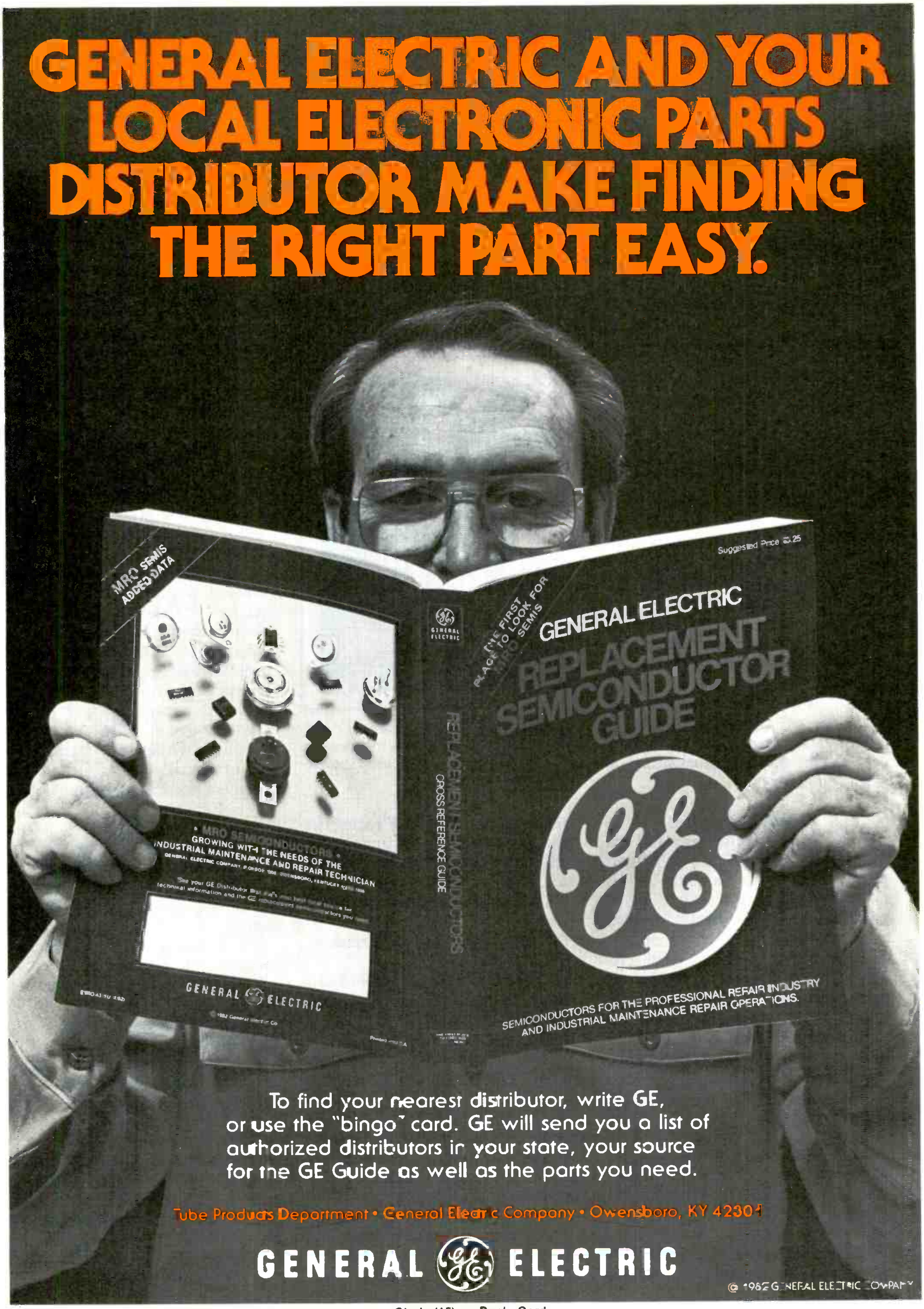
A *Christmas Tree* or other unstable flashing raster is another symptom of an open or partially open C853.

Intermittent raster

Another Penney 2888 television developed an intermittent raster. When the raster disappeared, the +115V became zero. At the same time, the emitter and base of TR801 checked the same +43V, with a collector voltage of +19V. Also, TR802 had about the same voltage at all three leads. TR801 and TR802 were replaced, but the voltages still were wrong, and the intermittent continued.

When canned coolant was sprayed on C805 (Figure 5), the raster and the +115V supply returned. C805 was warmed slightly, and the raster disappeared. No doubt remained; C805 was intermittent. A new capacitor cured the problem.

Since that time, several other 2888 chassis were cured of intermittent operation by replacement of C805. When C805 opens, no



Circle (15) on Reply Card

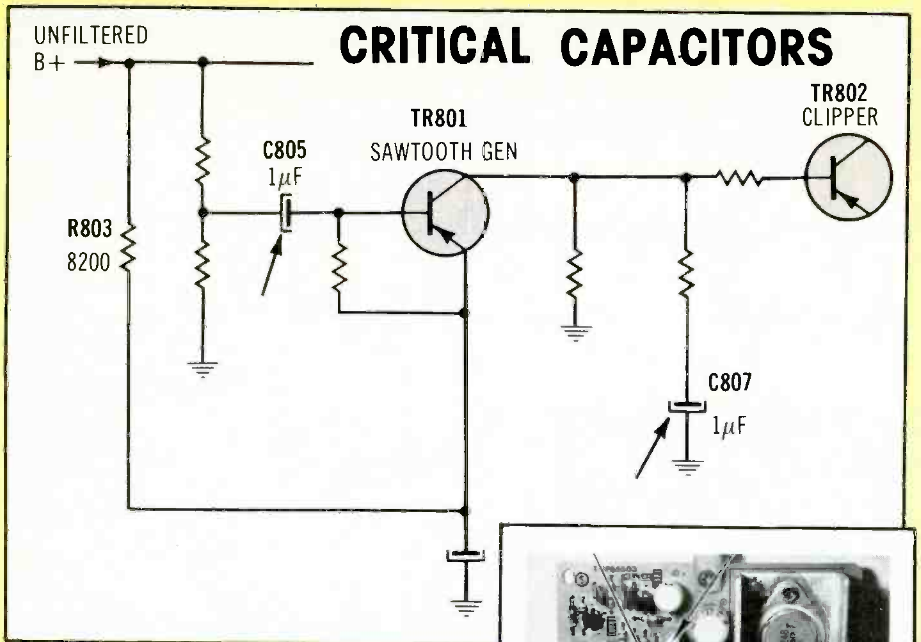


Figure 5 Capacitors C805 and C807 are responsible for most cases of flashing raster and intermittent raster.

120Hz parabolic waveform can reach the TR801 base, no sawtooth can be formed by C807 at the TR801 collector and no TR803 pulse can be produced, so SCR TR805 is not triggered into conduction and no voltage can reach filter C853.

One warning: Replace C805 only with the specified 1μF value; a larger capacitance (perhaps 5μF or 10 μF) can cause motorboating or self-oscillation.

A flashing raster

Regulator-circuit capacitors usually are responsible for flashing rasters in these models. Check C805 (already mentioned), C807 at the TR801 collector circuit (arrows in Figure 6 point to these capacitors) and C810 in the TR806 circuit. In fact, it is wise to replace all three and thus save valuable testing time.

Electrolytic capacitors tend to lose capacitance by drying out. Testing with a digital-capacitance or an ESR meter is strongly recommended.

Poor regulation

Visual proof of poor +115V-supply regulation is a noticeable change of raster size between low and high brightness scenes.

These are some components that have caused poor regulation in the past:

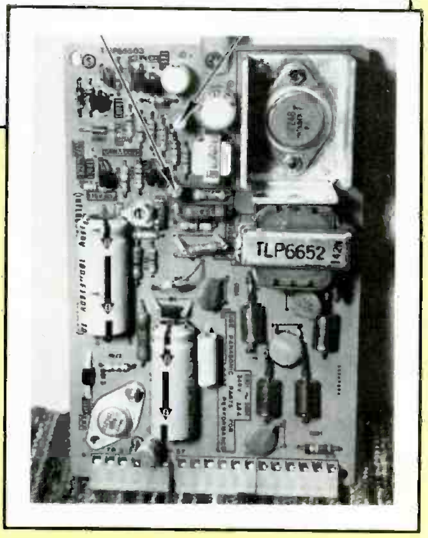


Figure 6 The arrow at top points to C807, and the lower arrow shows the location of C805 on the J C Penney S power-supply module.

- zener diode D809 (15V rating) in the TR804 emitter return,
- TR803 pulse-amplifier transistor,
- TR804 reference-amplifier transistor,
- bias diode D806 (base circuit of TR803) and
- resistor R817 (which is between R816 adjustment control and ground).

In addition, corroded and erratic contacts inside R816 adjustment control can produce mysterious voltage variations. R817 is 1800Ω and R816 is 500Ω in some S modules, while LR817 is 4700Ω and R816 is 2000Ω in others. Of course, these ratios must be maintained during replacements.

Alternate warming and cooling of suspected capacitors often will force the symptom to appear or disappear. This is sufficient proof for replacement.

Replace any resistors that appear burned or discolored. R817 and R815 are the ones most often ruined.

Critical components

Repairs made on the Penny S module over the years have shown several components that often become defective. Therefore, many modules can be repaired by routinely replacing those few components.

Transistors TR851 APF output and TR806 APF amplifier often become leaky and therefore should be checked for resistance. TR851 should be removed from its socket for these tests. But if R818 and R819 show signs of discoloring or overheating, TR851 should be replaced without further tests. When TR851 is shorted, often TR806 also is shorted.

SCR TR805 usually can be tested sufficiently by removing it from its socket and measuring the various resistances. Typically a 50Ω reading is obtained between gate and anode. Readings below 40Ω can indicate a problem. Between cathode and anode, a typical TR805 tests 100 MΩ or higher. Resistance of less than 50 MΩ calls for replacement.

Critical capacitors and burned resistors have been mentioned previously. Other less critical components usually can be tested with sufficient accuracy in circuit.

Conclusion

For symptoms of no raster and no high voltage, first measure the voltage at testpoint TP-S1 (Figure 3). If the reading is +115V or slightly higher, the regulated supply is normal and the problem is in the horizontal-sweep circuit.

When the TP-S1 voltage is very low or zero, measure the dc voltage (and scope the waveform) at SCR TR805 anode (case). Normal dc voltage and waveshape at the anode indicates the defect is in the +115V regulator, and further tests should be made there.

When all repairs are thought to be finished, the R816 adjustment control should be rotated to produce +115V at TP-S1. If this cannot be done, the repair is not completed. The final step should be obtaining the correct +115V regulated voltage at TP-S1.

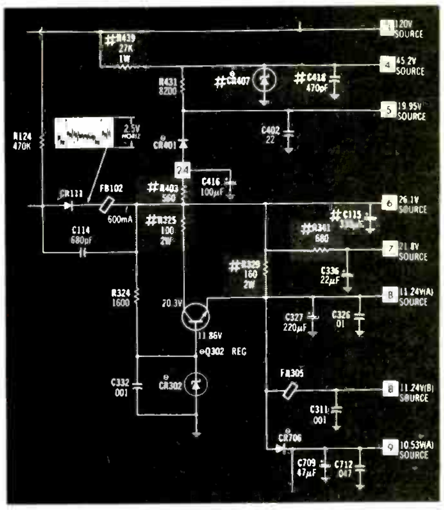
ES&T

TROUBLESHOOTING TIPS

No picture and no sound
RCA CTC108A
(Photofact 1937-3)

A preliminary inspection verified the lack of sound and high voltage. The F101 5A line fuse was blown, the Q412 horizontal-output transistor had a C/E short and a Ringer test showed the flyback had shorted turns. I had found dozens of shorted-turn flybacks in this model, so it is one of the first components tested when there is no high voltage.

After the fuse, transistor and flyback were replaced, I used an isolation transformer and variable-



line-voltage-type transformer (similar to a Variac) to apply a low line voltage to the television. As the line voltage was increased slowly, no excessive current was measured, but the screen remained dark, and no sound could be heard at line voltages up to about 110Vac. However, the CRT heater was lighted and almost normal HV was present.

As the line voltage approached 120V, the shut-down circuit activated and eliminated all horizontal sweep and high voltage.

These symptoms proved the horizontal-sweep operation was normal. The most likely cause of these non-connected failures was trouble in one or more power sources.

Power-supply voltages at Circuitraces 9, 8, 7 and 6 were zero. Of course, the Circuitrace 9, 8 and 7 voltages come from the Circuitrace-6 source, so the lack of +26.1V at Circuitrace 6 apparently was responsible. Ohmmeter tests around the +26.1V supply at Circuitrace 6 quickly located an open CR111 diode rectifier. Replacement of CR111 restored a normal picture with good sound and allowed operation at any reasonable line voltage without shut-down.

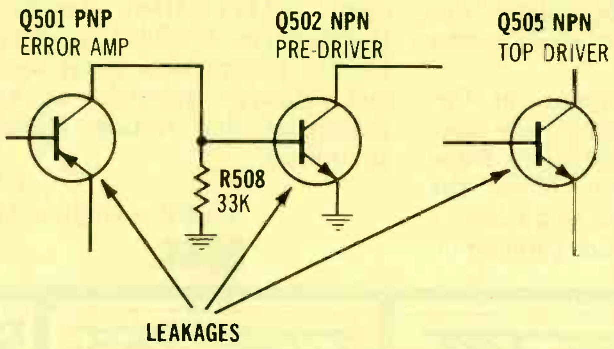
J. T.
Fort Washington, MD

ES&T

SYMCURE

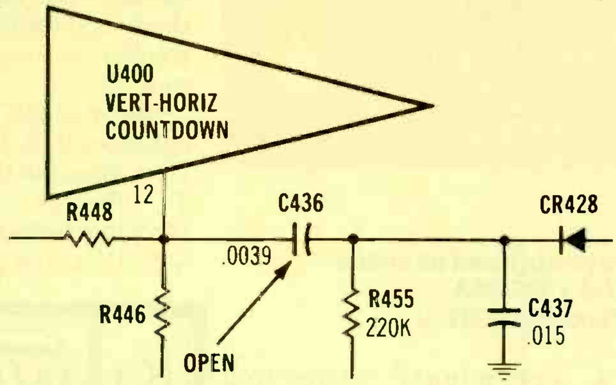
Symptoms and cures compiled from field reports of recurring troubles

Chassis – RCA CTC101 1
PHOTOFACT – 1945-2



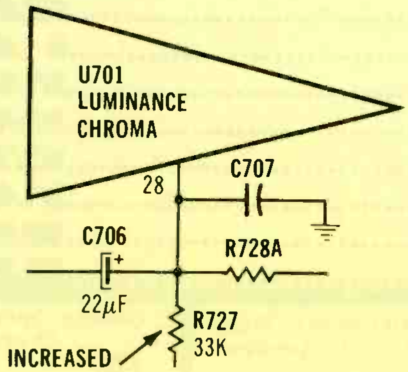
Symptom – Vertical linearity is poor with slight foldover at center and faint retrace lines at top
Cure – Check for leaky junction in transistors Q501, Q502, Q505 and Q506, and replace any defective ones

Chassis – RCA CTC101 (or CTC99) 2
PHOTOFACT – 1945-2 (1895-1)



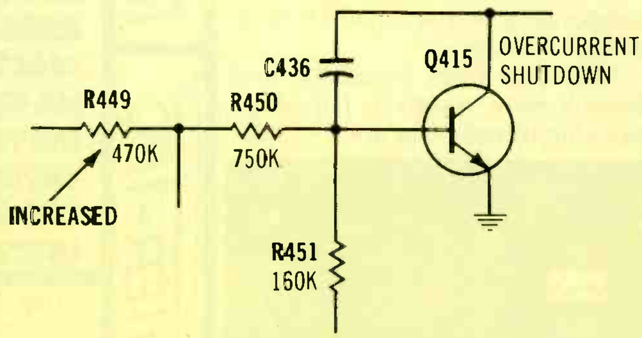
Symptom – Horizontal locking is critical, and start-up is erratic
Cure – Check capacitor C436 and replace it if out of tolerance

Chassis – RCA CTC108 3
PHOTOFACT – 1937-3



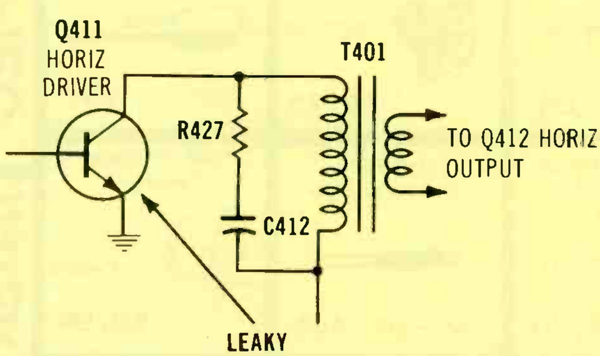
Symptom – Erratic shut-down at high brightness
Cure – Check resistor R727 and replace it if out of tolerance (increased)

Chassis – RCA CTC109 4
PHOTOFACT – 1952-1



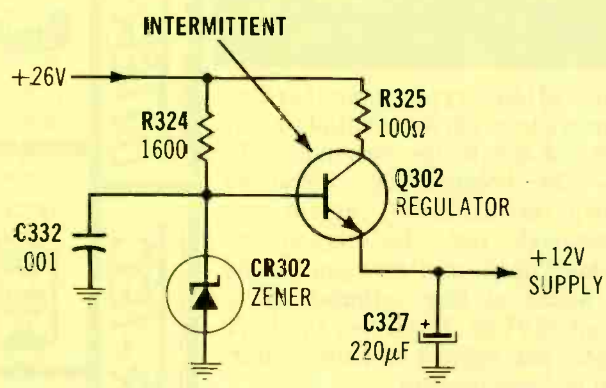
Symptom – Marginal HV regulation, slight blooming at high brightness
Cure – Check resistor R449 and replace it if out of tolerance (increased)

Chassis – RCA CTC109 5
PHOTOFACT – 1952-1



Symptom – Bands of noise at top and bottom of picture
Cure – Check and/or replace horizontal-driver transistor Q411

Chassis – RCA CTC109 6
PHOTOFACT – 1952-1



Symptom – No color or intermittent color
Cure – Check regulator transistor Q302 and replace it if erratic

BOOKS

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

The Master Handbook of IC Circuits, by Thomas R. Powers; Tab Books; 532 pages; $22.95 hardbound, $14.95 paperback.

Crammed in this encyclopedia are over 900 different circuits, using more than 200 popular ICs. It contains designs, ideas and projects that anyone can build in a home workshop at low cost.

Novice hobbyists and advanced experimenters both know the headaches involved in trying to find the correct circuit for a specific job. With literally thousands of circuits on the market, it's been virtually impossible to easily determine the chip needed for a specific application.

Now it's no longer necessary for someone to spend hours attempting to dig up the right literature on one particular circuit; this book shows which chip is right for any job in just minutes. Detailed descriptions of circuit applications for all kinds of discrete components were compiled from hundreds of data sheets, application books and many other sources.

Contained here is information on such integrated circuits as linear, TTL, CMOS, voltage regulator and special-purpose types. The step-by-step instructions, coupled with almost 1000 drawings and schematic diagrams, make this an easy book to use. The schematics are provided in numerical order for each IC, allowing anyone with a particular integrated circuit to find its proper use.

Published by Tab Books, Blue Ridge Summit, PA 17214.

A reading on the DMM market

Not too many years ago, electronic multimeters were generally quiet, mundane instruments. You would plug the probes into the appropriate plugs for the function to be measured, set the function and range switches, touch the probes to the test points and watch the needle move.

As you know, things have been changing. LCD digits have, to a great extent, replaced meter movements, autoranging in many meters has eliminated the problem of exceeding the selected range, audible beeps give continuity indications, alarms tell you when you're overrange and autopolarity makes it unnecessary to switch probes when you come across a negative value. One meter even contains a voice synthesizer and will give you a verbal reading: great when you're taking readings on an IC and one slip to look at a reading can mean disaster.

As electronics technology has moved ahead by leaps and bounds, it has changed not only the instruments we use to measure, but also the circuitry to be measured. With more consumer electronic products featuring digital circuitry, for example, it becomes necessary to provide the means with which to measure the parameters of these circuits. Meter manufacturers have responded with newer meters capable of measuring these quantities: logic probes, signature analyzers and more.

The following pages contain a sampling of the many multimeters available today. Some features these instruments offer over their predecessors are smaller size, lighter weight, more capabilities in a single package, greater ruggedness and higher accuracy.

Extech International

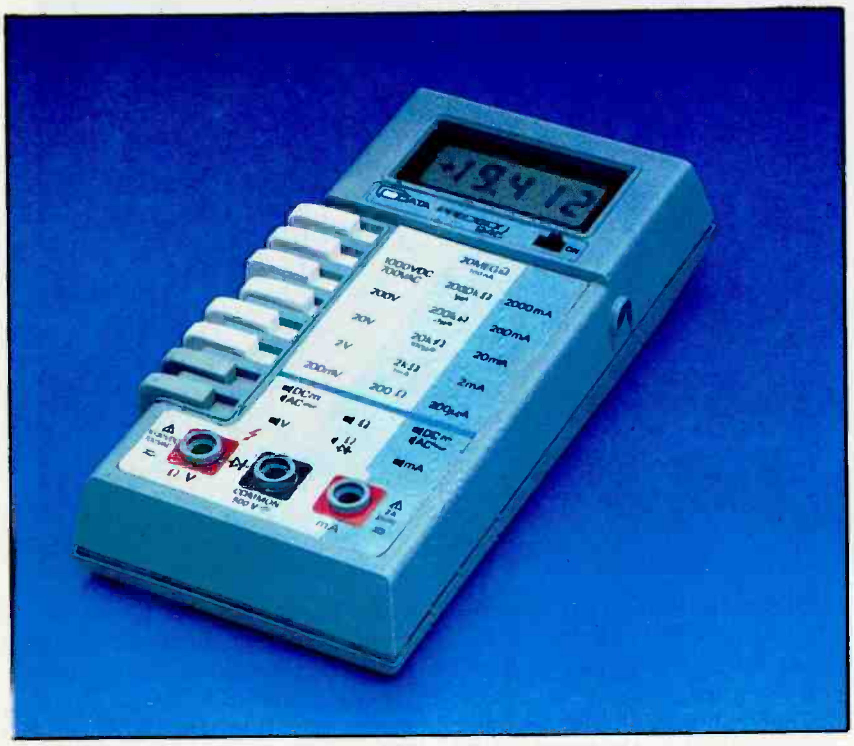
A new hand-held, LCD-display, precision digital multimeter has been introduced by Extech International.

The multimeter features 0.1% dc voltage accuracy; full ranges of Vdc, Vac and mA, Ohm; 200μA range for lower power circuits; overload protection on all ranges; and transient protection to 6kV. In-line, color-coded push-buttons are easy to use, and the function panel allows fast range selection.

Other features include a 3½-digit LCD display with auto zero, auto polarity and low battery; high voltage for diode test; low range for in-circuit measurement; recessed input jacks; all functions and specifications traceable to NBS; and a tilt stand.

Circle (113) on Reply Card

Data Precision



The model 945 is a full-function, 4½-digit multimeter packaged in a high-impact plastic case. With a high-contrast LCD display, 26-range capability and battery operation, it is ready to go where you go – into tight racks or crowded equipment bays – out to production or into the lab.

The unit gives added sensitivity on all functions and an improved accuracy spec. The Model 945 closely matches bench-top models in performance and offers the convenience of 1-hand operation.

As an example, look what the added 200mV, full-scale range buys you in making critical low-level dc voltage measurements. This same advantage of added sensitivity is available on all functions.

The 945 has additional circuitry that blends the patented Ratiohmic technique with a constant current source. The result is accuracy and stability plus knowledge of the exact conditions under which resistance measurement is made. The test current is independent of the device under test and is determined only by the range selected. Similarly, the displayed reading is not just the resistance of the device under test, it is also the *voltage across* the device under test. (Full scale is always 2.0000V.) These features allow increased versatility of measurement in the resistance mode. For instance, the forward V-I characteristic of diodes can easily be measured by selecting the resistance range having the test current of interest and recording the displayed reading (voltage, ignoring the decimal point).

In-circuit measurements are made by selecting resistance range so that the displayed reading is less than 2500 counts, which allows the test voltage to be less than 250mV and any silicon semiconductors will not be biased into conduction. The results of such a measurement are shown here for an IN 4148 silicon diode.

There is no need to zero the 945, and polarity sensing and display are automatic. Because of the patented Isopolar reference circuitry, accuracy and linearity are as good for negative voltages as for positive.

All the functions and ranges of the unit are overload protected. Any dc voltage range will withstand ±1000V. The ac voltage ranges are protected to 700V rms and ±630dc (±1kVdc above the 2V range). Resistance ranges will accept 250Vdc as well as Vac, and all dc and ac current ranges are protected with a 2A, 250V fuse. A spare fuse is shipped inside each case.

Optional accessories are available to increase the versatility of the unit. In addition to a battery eliminator and vinyl carrying case, optional probes extend dc voltage measurements to ±40kV, ac voltage to 500MHz, dc current to ±100A and ac current to 1000A.

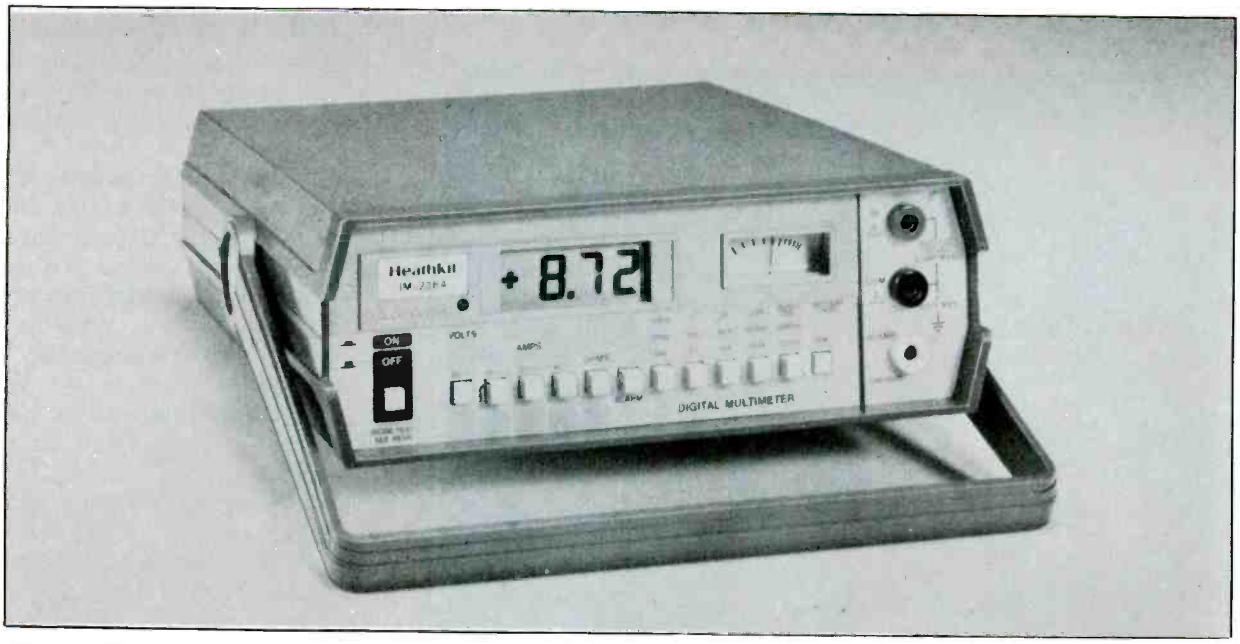
An optional semiconductor temperature probe is also available for measurements from −65°C to 150°C with ±1°C basic accuracy. A thermocouple adapter (TP161 J or K) allows you to measure temperature from −85°C to 800°C within 2°C accuracy.

All specifications of the 945 are warranted for one year of operation. (The instrument itself is guaranteed for two years.) All units are subjected to a burn-in cycle before calibration, and final test certification is supplied with each unit that is shipped, as well as a Certificate of Conformance showing NBS traceability.

Should your 945 ever need servicing, a complete operating and service manual is provided. Only standard commercial components are used in the 945, and accessibility is excellent. Four non-interactive adjustments accomplish a complete recalibration in less than five minutes.

Circle (111) on Reply Card

Heath Company



Heath Company has added two new models to its line of portable digital multimeters, the IM-2262 and the IM-2264.

Designed for the laboratory, service technician or hobbyist, both the IM-2262 and IM-2264 feature low-profile cabinets, multiple measurement ranges and excellent performance, according to a company spokesman. True RMS capability provides accurate ac readings from both sine-wave and non-sine-wave inputs.

Measuring 3"x8.5"x11" with handle folded, both feature a special color-coded front panel with push-button switches for additional convenience and easy of use.

The IM-2262 measures voltage from 200mV (full scale) up to 1000Vdc and 750Vac, dc and ac current from 200μA (full scale) up to 10A, resistance from 200Ω to 20 MΩ (full scale). The resistance function includes a low (0.2V) test voltage, up to 2000kΩ range, to allow in-circuit measurement of circuits using semiconductors. A diode test function allows checking the forward and reverse conduction of semiconductor junctions. An MOS/LSI (metal-oxide semiconductor/large scale-integration) IC has the dual-slope, analog-to-digital conversion circuitry.

When calibrated to laboratory standards, the IM-2262's full scale accuracy is 0.25% dc and 0.5% ac (with frequency response specified up to 20kHz). Built-in references, which allow fast, easy calibration in the field, provide full-scale accuracies of 0.5% dc and 1% ac (with frequency response to 10kHz).

The IM-2264 deluxe multimeter features extended measurement capabilities and additional convenience features. It measures voltage from 200mV to 1000Vdc/750Vac, current from 200μA to 10A, resistance from 200Ω to 20MΩ and semiconductor conduction (both forward and reverse).

In addition, a flashing crest-warn LED alerts the operator when the crest factor of ac inputs is excessive, which could lead to possible measurement error for non-sine wave inputs. A switch-enabled alarm function allows quick testing of voltage and continuity, without having to view the display, and an auxiliary, auto-polarity analog meter reflects 0 to full-scale measurements to supplement the digital display, making nulls, peaks and measurement trends easier to follow.

All of the IM-2262 and IM-2264 measurement functions are fully protected from overloads. The dc and ac current ranges (except the 10A range) are protected by diode and fuse circuits, with an easily accessible fuse. A resettable rear panel circuit breaker provides protection on current measurements from 200μA to 2000mA, making fuse replacement for moderate overloads unnecessary. Resistance ranges are electronically protected to 350V (peak). Floating measurements up to 500V (peak) from earth (power line) ground can be made with the unit's fully isolated circuitry.

Both the IM-2262 and IM-2264 operate on six carbon-zinc, alkaline or nickel-cadmium batteries (not included), or on 120Vac, 60Hz power with the optional Heathkit PS-2404 battery eliminator. Both instruments also have a battery test circuit, a low-battery indicator and a circuit to recharge nickel-cadmium batteries in 24 hours (when the unit is off).

Circle (116) on Reply Card

B&K Precision

B&K Precision has added two digital multimeters to its line of DMMs for lab or bench work: the 2801 and 2805.

Model 2801 is a 3½-digit DMM for field, shop and hobby applications. The unit takes advantage of the latest IC and display technology to achieve the lowest possible component count, ensuring reliability, accuracy and stability.

A 9V battery provides power, and low-battery warning indication is automatic. It comes with test leads, carrying case, operation manual and a spare fuse, and it measures ac and dc voltage, dc current and resistance.

Ranges are 0-2, 20, 200 and 1000V for dc; 0-200V and 0-500V for ac; and 90-2, 20 and 200mA for dc current. Input impedance is 10MΩ dc and 200KΩ on 200V range, 2MΩ on 500V range. Circuit protection is ±1000Vdc or dc plus ac on all ranges. Overrange is indicated when the range limit is exceeded. The frequency response is 40-500Hz.

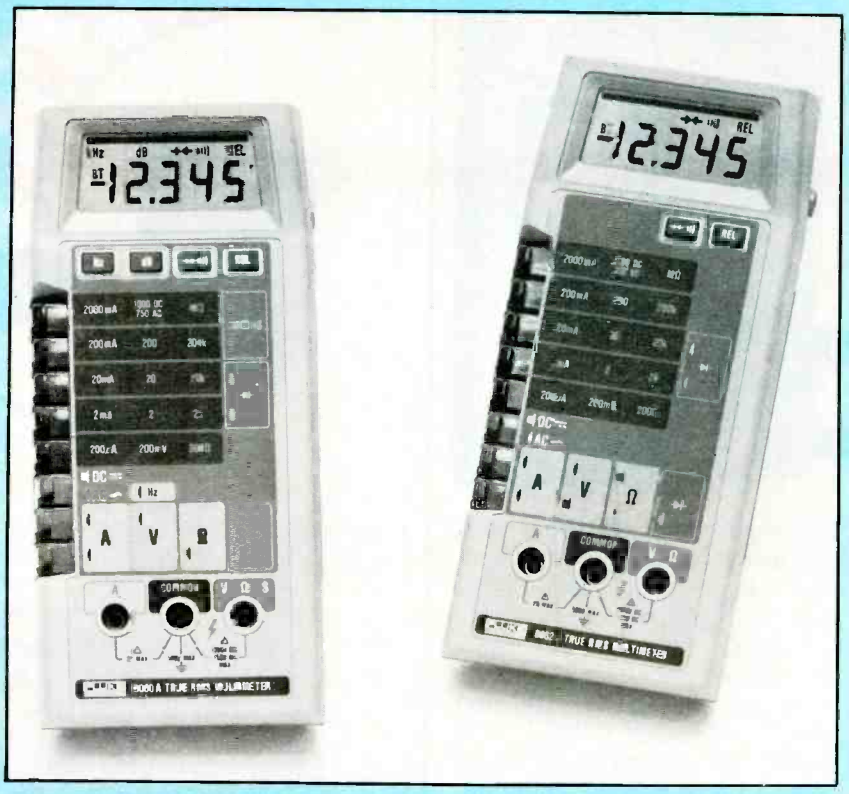
The model 2805 offers autozeroing to minimize set-up time and 22 ranges spanning up to 1000Vdc, 10Aac and 20M. High-energy fusing protects against damage from high level transient signals and LSI integrated circuit technology reduces the overall component count.

Ranges are 0-200mV; 2, 20, 200 and 1000V for ac and dc voltage. The dc current ranges are 200μA, 2, 20 and 200mA; ac current ranges are 1000mA, 10A without shunt.

Input impedance is 10MΩ (ac and dc) and circuit protection is ±1000Vdc plus ac peak, 700V rms. Overrange is indicated when range is exceeded, and frequency response is 40-500Hz.

Circle (105) on Reply Card

John Fluke Manufacturing



Fluke Manufacturing has announced a 4½-digit hand-held DMM that should find its way into toolkits of computer, communications and audio technicians. Engineering and calibration labs, where price and portability are secondary considerations, have relied on 4½-digit multimeters to provide high resolution and accuracy. But today, due to rapid increases in the use of computer peripherals, digital networks, telecommunications links and video/audio transmission, there is a need for precision high-resolution measurements in the field and shop.

The Fluke 8060A true RMS multimeter fills this void in hand-held instrumentation. The 8060A uses a 4-bit microcomputer coupled with custom LSI to go beyond traditional 5-function applications. Now, technicians can directly measure output frequencies of touch-tone oscillators and audio amplifier bandwidth with a hand-held multimeter.

Two major components make up the 8060A measurement system: a 4-bit CMOS microcomputer and a custom CMOS LSI chip. The heart of the chip is a dual-slope analog-to-digital converter and a digital control logic section. The digital control logic section includes a buffer and decoder, read/write logic, status and control registers, and logic control for the continuity function. (The chip even generates the continuity tone indication by supplying a square wave to the external piezoelectric transducer.) The microcomputer and the chip communicate over a 4-bit bidirectional bus and four control lines. The microcomputer selects the appropriate measurement function according to the buttons and switches depressed by the user, and sends a conditioned input signal to the LSI chip. The microcomputer also controls the measurement cycles, performs calculations on measured data and drives the LCD display.

Any reading on the display can be stored as an offset, or "relative reference." All subsequent readings are displayed as deviations from the stored reference. This feature is particularly useful when the absolute value of readings is less important than the amount of change. The relative function greatly simplifies this type of measurement by zeroing the initial value and displaying only the positive/negative amount of change on subsequent readings. These relative reference readings are also easier to record and later manipulate for test data verification.

When the unit is first turned on, the microprocessor tests the digital interface and illuminates all LCD elements for 1.6s. Two additional diagnostic tests can be initiated by the ratio test and a switch decoding test. The ratio test checks the A/D converter for functionality independent of any input circuitry. The switch decoding test indicates if the microcomputer is interpreting each of the eight switches and four push-buttons correctly. The microcomputer also monitors the internal (battery) power, and lights a display (BT) when 80% of the battery life has been expended.

The 8060A measures dc voltage in five ranges: 200mV to 1000mV, all full scale. Input impedence, fixed at 10MΩ in all ranges, can be increased to greater than 10,000MΩ in the 200mV and 2V ranges. This allows nonloading measurements in high-impedance circuitry. The ac voltage measurement capabilities are also found in five ranges to 750V RMS.

The true RMS monolithic converter provides accurate voltage measurements of nonsinusoidal waveforms. Displayed ac readings can be in volts, relative dB, or in dB referenced to 600Ω. The instrument computes these dB readings from the linear voltage reading by a segmented curve matching algorithm. This means of dB calculation is more accurate than the traditional log conversion, that is usually implemented in hardware.

Frequency readouts from

12Hz to 200kHz are provided in four ranges, which are fully autoranged under the control of the microcomputer. Frequency resolution is 0.01Hz in the lowest (200Hz) range, and readings are updated at a once-per-second rate. The ac voltage function can be used to verify sufficient voltage (20mV sensitivity to 20kHz) for a valid frequency reading. Because the frequency function uses the multimeter front end, frequencies at 750V are safely measured.

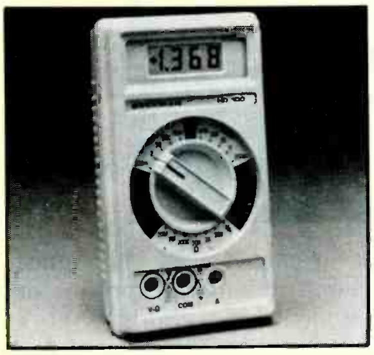
The ac and dc current measurements can be made from 0.01μA (10nA) to 2A in five ranges. Resistance is measured in a ratiometric mode, comparing the external unknown resistance to an internal reference resistor. All resistance measurements from 0.01Ω to 200kΩ are low power so that resistances can be measured in-circuit. Output voltage is less than 250mV and will not turn on semiconductor junctions. In addition to the four selectable resistance ranges, the meter autoranges from 100kΩ to 300MΩ.

The 8060A continuity function is user selectable for visual (LCD) or visual/audible (LCD/tone) indication to allow checking of wiring and PCB traces for shorts, opens or continuity without needing to watch the meter. To check semiconductor junctions, a constant current diode test function is provided. There is even one range of conductance, 2000nS. The conductance function, basically an inverse resistance range spanning from 500kΩ to 10,000MΩ is particularly useful for making component leakage measurements or checking the conductivity of fluids and solids.

High-voltage probes, high-frequency probes and a variety of cables and adapters are available. Two optional temperature probes convert the 8060A into a direct-reading (C or F) digital thermometer. Power is supplied by a common 9V alkaline battery or an optional battery eliminator.

Circle (114) on Reply Card

Beckman Instruments



The HD-100 from Beckman Instruments is waterproof and dustproof to resist the elements and can withstand the physical impact of accidental drops.

Voltage inputs are protected to 1500Vdc or 1000Vrms. Current ranges are protected to 2A/250V, while resistance ranges are protected to 500Vdc.

The O-ring-sealed ABS plastic case is fire retardant, with ribbed side walls.

The bright "NATO" yellow case is highly visible–easy to spot in a tool box or before leaving a job. Inside, the electronics, including the "large area" LCD and battery, are shock-mounted to resist damage from impact.

A 9V alkaline battery provides up to 2000 hours of continuous operation and up to two years of life under normal operating conditions.

The single rotary switch allows you to quickly switch to the function and range you are seeking.

A visual continuity test function called Insta-Ohms enables you to check electrical continuity with the speed and ease of an analog-type multimeter. In any resistance range, an ohms symbol (Ω) appears in the LCD when continuity is detected.

Each HD-100 comes with a 1-year limited warranty, and a complete line of Beckman accessories are also available for use with the HD-100. They include a clip-on vinyl case, two ac current clamps, a deluxe test-lead kit, an RF probe and a high voltage probe.

Circle (107) on Reply Card

Hewlett Packard

Hewlett-Packard has announced its first instrument that combines signature-analysis (SA), frequency-counter and digital-voltmeter functions with complete HP-IB (IEEE 488) programmability.

Designed for manufacturing and field service areas, the HP 5005B signature multimeter provides a technique for faster and more thorough testing of digital products.

All front-panel functions and measurements are completely HP-IB programmable. The programmability provides automated controller-prompted troubleshooting. Its advantages include faster troubleshooting, high productivity and the use of lower-skilled operators.

This new rack-and-stack measurement tool has a feature set including 10 measurements for digital troubleshooting.

- Two modes of SA for simplified, component-level fault isolation in synchronous digital circuitry.
- Time interval and totalize measurement capabilities to check the various portions of asynchronous digital circuitry in a product.
- A 50MHz frequency counter to verify critical clock circuitry.
- A 4½-digit dc and differential voltmeter to measure power-supply voltages and voltage drops within a circuit.
- An ohmmeter to verify circuit continuity and shorts.
- A peak-voltage measurement function to check the logic-high and logic-low voltages of active digital signals.

A single multifunction probe within the HP 5005B enhances digital-troubleshooting productivity because the 10 separate measurements can be made without changing probe or equipment connections.

All signal multiplexing to the various measurement functions is done automatically inside the HP 5005B. With a small switch located on the probe, an operator can trigger all measurement functions.

Completion of a measurement is indicated by a programmable, dual-volume, audible-alarm beeper. This direct feedback improves the measurement efficiency of an operator during the troubleshooting process.

The 25MHz clock rate extends the power of SA into higher-performance digital assemblies.

Faster fault isolation can be achieved through the use of the qualified mode of signature collection. This mode helps isolate faulty nodes by enabling signature collection only while specific test conditions exist. A fault now can be isolated systematically without modifying the test-stimulus routine.

Another important feature is the ability to select one of three preset logic thresholds (TTL, ECL or CMOS) or a variable threshold level (−12 to +12V). This threshold-selection flexibility ensures coverage of both current and future logic families.

Circle (117) on Reply Card

Hickok Electrical Instruments

The MX series of digital multimeters, from Hickok Electrical Instrument Company, provides 0.1% basic accuracy, 10MΩ input impedance and overload protection.

The premium version, the MX 333, contains two unique features. They are the Vari-Pitch, a built-in audible signal that changes frequency in proportion to digital readings, and Logi-Trak, a self-contained logic testing capability that combines the features of a high performance logic probe and voltmeter in one function.

Vari-Pitch functions on all voltage, current, resistance and diode test ranges. Audio response is instantaneous, proportionate and accurate for rapid indication on repetitive measurements. Wide-range audio output on each selected range provides excellent audible resolution. Thus, with a little practice, the operator can literally "troubleshoot by ear" without taking his or her eyes off the probe or waiting for digital readings to settle.

On resistance measurements, lower readings (e.g. continuity) produce the highest pitches. On volts and current ranges, higher inputs produce higher pitches. Vari-Pitch also responds to inputs above overrange and can be turned on or off for any range or function, with no effect on the accuracy of digital readings. It even provides analog-like audible response to variations for quick and easy adjustments and nulling.

Logi-Trak is a built-in logic testing capability that combines the features of a high-performance logic probe and voltmeter in one convenient function. It is activated by pressing a logic button on the MX 333. This automatically sets the Vari-Pitch tone range for maximum audible resolution of logic level voltages and sets the multimeter to provide direct display of the actual voltage (0-19.99V). Any 10:1 high-frequency scope probe may be plugged into the safety-insulated BNC input for measurement of all logic signals and dc voltages from 10mV to 20V. It is also used to find logic

GC Electronics

The GC Electronics digital multi-tester is designed to meet the growing need for a rugged, portable tester to help speed field servicing on the growing number of sophisticated digital electronics systems in large appliances, video games and home entertainment systems.

The tester features dual dial settings that combine for a 26-range capacity, ± 2% dc voltage accuracy, 1A capability, 10MΩ input impedance and a 3½-digit display.

For added safety in case of accidental overload, all current inputs feature fuse protection. Circuits are designed to prevent nuisance fuse blows in voltage and ohm ranges.

The unit operates on a standard 9V transistor radio battery and a spare battery compartment lets you keep an extra battery handy for easy replacement in the field. A low battery indicator warns you before the battery power drops below a critical level (approximately 3 hours of battery life remaining).

This meter measures 6"x3¾"x1½" and weighs 12oz, making it easy to carry in its hard-sided carrying case. But despite the small size, large rotary selector switches allow for easy, positive range selection with either hand.

Circle (115) on Reply Card

pulses as narrow as 5ns.

Variable pitch audible response provides accurate indications of logic levels, with greater precision than the high/low thresholds of an ordinary logic probe. Marginal and faulty logic states such as shorts and opens are readily identified through variations of pitch. Square waves, pulse trains and individual pulses are identified by characteristic sounds. And, because audible response permits pulse detection with a minimum of attention being paid to the instrument, pulse memory is unnecessary. Using the digital readout only for verifications, the operator can perform logic troubleshooting without taking his eyes off the circuit.

Hickok MX-Series multimeters are designed to provide maximum accuracy and convenience when used on a bench, in the hand or even attached to a belt. The rugged construction, with suspended PC boards in a high-impact plastic case, compact size and unique sloped display make this possible. Belt clips are furnished with the units, and safety test leads plug into the side so they are out of the way and resist pull out.

Circle (118) on Reply Card

Leader Instruments

Leader Instruments Corporation now offers a 3½-digit digital multimeter that fills the need for both laboratory and field work. The LDM-855 offers automatic ranging, semi-automatic zeroing and a large LCD display for hands-free operation.

When manual range or function selection controls have been changed, a momentary audible tone is heard. When used in the resistance mode or for checking continuity, the tone is sounded continuously when short-circuit conditions occur. This enables the operator to make tests without having to constantly look at the meter to see if continuity is present.

Other features include an automatic polarity indicator, ac and dc measurement functions, a LO-OHM mode to provide a lower test voltage and a low battery warning incorporated into the LCD.

The dc voltage range is 0.1mV to 1000V with an accuracy of ±0.5% of reading ±0.2% full scale on the 0.2 to 200V range. On the 1000V range, input impedance is 10MΩ, overload protection is 1000V dc and ac peak.

The ac voltage range is 1mV to 1000V. Accuracy for the 2V range is ±1% reading ±0.4% full scale at 40 to 500Hz. At 0.5 to 1.0kHz, accuracy is 1.5% reading ±0.4% full scale. On the 20 and 200V ranges, accuracy is ±1% of reading ±0.25% full scale for 40 to 500Hz, and ±1% of reading ±0.25% full scale for 0.5 to 1.0kHz. On the 1000V range, accuracy measures in at ±1.5% of reading ±0.25% full scale at 40 to 500Hz. Input impedance is 10MΩ and overload protection is 1000V rms.

Circle (121) on Reply Card

Weston Instruments

Weston Instruments has announced the availability of the new model 6502 "educated" digital multimeter. This 4½-digit, 5-function DMM is designed for applications that can benefit from the higher accuracy, wider bandwidth, and lower cost of its average-responding ac voltage and current ranges.

The model 6502 standard features include six versatile computing functions not available on similarly priced competitive instruments. A total of 14 push-buttons, combined with a self-prompting display, provide flexibility in the manipulation and recording of data. Two storage registers allow a display to be scaled by any slope and offset. A single NULL key stores a display as a "zero" value and automatically subtracts this value from all subsequent measurements.

Two keys store any entered

Triplett Corporation

A new addition to its "true hand-size" DMM line, the Triplett model 3400, type 2, 3½-digit, 24-range digital multimeter features improved basic dc accuracy to 0.15%; ac dc voltage measurement to 1000V; 500-hour typical battery life and improved overload protection on all volt and ohm ranges to 1000V without fuse blow, plus protection to 600V on all current ranges.

The 6-function, battery-operated test instrument also provides additional features such as auto-zeroing, auto-polarity, auto-low battery and auto-overrange indication, and both hi and low power ohms.

It is designed for electronic and electrical test and measurement uses, such as circuit design, field service, production and maintenance work, vocational technical training schools, television and communications equipment repair and other applications.

The hand-size DMM has a ½-inch LCD display providing three readings per second at a full range of 1999 counts and a single dial range and function selector. The ON/OFF switch is also part of the range switch. Overrange indication is vividly shown to the user by the DMM's display going completely blank except for the ½ digit.

Polarity is displayed during the overrange condition, and three readings per second is the reading rate for the test instrument. A 2A, 600V fuse is provided in the unit for current ranges.

The unit weighs 10oz with battery and comes complete with a 1-year warranty, 36-inch-long test leads, screw-on insulated alligator clips, a wire tilt stand, 9V battery and instruction manual.

Circle (132) on Reply Card

value as a reference and display future measurements as a percentage deviation from that value. High and low limits can also be stored and a LIMIT key then allows the display of values within these limits, or HI and LO annunciators if the measured value is outside of the limits.

A START key initiates the continuous storage of maximum and minimum values. Pressing a MAX key displays the maximum value, without disturbing the continued accumulation of values, and a MIN key similarly displays the minimum value. A RESET key allows the instrument to temporarily return to the normal DMM mode without losing any programmed computation.

A FILTER mode activates a binary weighted average of the last four measurement conversions, assuring more accurate and stable readings in the presence of noise. To assure a rapid response to step changes, the filter function is automatically inhibited when successive conversions differ by more than 2% of full scale. All computing functions may be operated singly or chained, if desired, to perform more complex multiple operations.

The average-responding detector of model 6502 is calibrated to display the equivalent RMS value of a sinewave. Full-scale decade voltage ranges of 200mV to 2000V are provided with an accuracy of 0.2% ±10 digits to 200V (0.5% ±10 digits, to 2000V) over a 50Hz to 10kHz bandwidth; accuracy is 0.5% ±15 digits over the full bandwidth of 30Hz to 20kHz. The ac current ranges are 200μA to 2000mA full scale with a midrange accuracy of 0.3% ±10 digits.

The model 6502 also provides dc voltage ranges from 200mV to 2000V, with constant 0.03% ±2digits accuracy, dc current ranges from 200μA to 2000mA and resistance ranges from 200Ω to 20MΩ.

Circle (135) on Reply Card

For more information on DMM products...

Although every effort has been made to ensure completeness and accuracy of this listing, the publishers cannot be held responsible for omissions.

Alco Electronic Products
Circle (104) on Reply Card

B&K Precision
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Ballantine Labs
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Beckman Instruments
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Boonton Electronics
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DeForest
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Data Precision
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Hickok Electrical Instruments
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Julie Research
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Keithley Instruments
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Systron-Donner
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Tektronix
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Triplett Corporation
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VIZ Manufacturing
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Universal Enterprises
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Weston Instruments
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Workman Electronics
Circle (136) on Reply Card

ES&T

Previewing the GE 1983 line

By Carl Babcoke, CET

General Electric's 1983 line of TV and video products was shown to a group of electronic-magazine writers and service-association officials at the Portsmouth, VA, GE factory on May 7, 1982. In addition to the usual product-line general information, new electronic circuits and other advanced features were discussed and demonstrated.

Portable combinations

Road Show Portable Entertainment Center is the large name for three small GE combination television, FM-stereo, AM-radio and stereo-microcassette tape recorder/player machines.

Model 3XM3214E (Figure 1) has a vertical format with front-mounted controls. Black-and-white TV programs are viewed on a 3-inch screen. The microcassette recorder is not removable.

Step-up model 3XM3226X has the same basic features in a horizontal format with most controls on top. In this unit, the capstan-drive stereo microcassette recorder can be removed for external operation, powered by two AA batteries. Two condenser microphones allow recording in monaural or stereo. When the unit is operated outside of the combination, playback is possible through stereo headphones, which are supplied. Of course, when the recorder is plugged into the combination, all tape sounds are heard through the two stereo speakers.

Notice that the microcassette format has very small cassettes that are not interchangeable with conventional audiocassettes. Prerecorded music tapes in microcassettes are becoming available, or blank tapes in 15-, 30-, 45- and 60-minute lengths can be recorded by the user.

Model 4CM3326X (Figure 2) has a 4-inch color picture tube in addition to the FM-stereo, AM-radio and detachable microcassette recorder (as described previously.)

TV receivers

More than 50 new color TV receivers are offered in the 1983 GE line, including three 10-inch, four 13-inch, 11 19-inch, 31 15-inch, one 4-inch (previously described) and two projection models. Three 12-inch and two 3-inch b&w models also are offered. One of the high-end 19-inch color receivers is shown in Figure 3.

About 70% of the color receivers have quartz-controlled electronic tuning, and about 50% have remote control (Figure 4). Four types of channel-selection systems

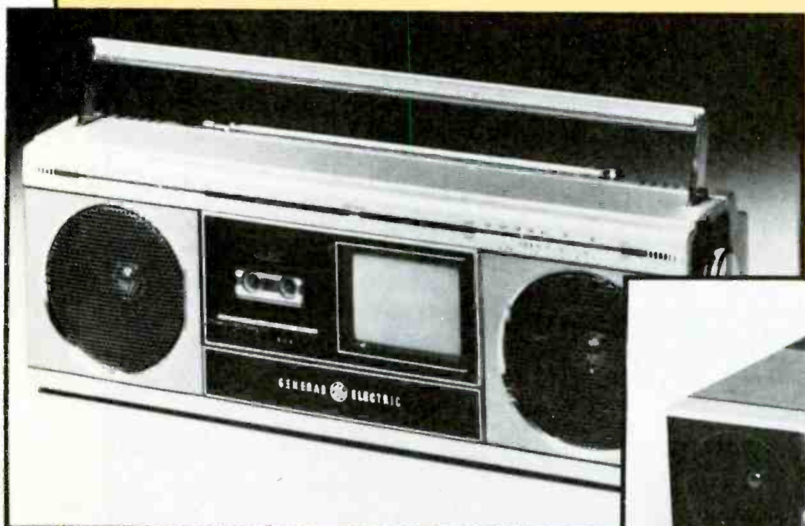


Figure 1 Model 3XM3214E from General Electric for 1983 has a 3-inch b&w television, FM-stereo and AM-radio reception, plus a stereo microcassette recorder/player. A step-up model with similar general features permits the microcassette to be removed when desired for headphone listening while jogging.

Figure 2 A 4-inch color television is the main feature of GE model 4CM3326X, which also has FM-stereo and AM-radio reception and a removable microcassette recorder/player. Lightweight headphones are included for the microcassette machine.

are included. These are explained later in the technical section.

Receivers with the dual-mode keyboard/scan tuning system have a feature called *Channel Block-Out* that allows elimination of any channels for up to 12 hours. For example, if a parent is to be away from home for the evening, but wants to prevent the children from watching an X-rated cable program, that channel can be deleted by keying in a certain code. Any of the 112 channels can be eliminated. Restoration of the channel is automatic after 12 hours, but it can be brought back sooner by again keying in the same code. This feature is in 12 19-inch and 25-inch models.

Color Monitor (automatic color-adjustment circuit) is in 18 models from 13-inch to 25-inch color receivers. The VIR system is in five 19-inch and 18 25-inch models. This system automatically adjusts the color saturation and hue according to the vertical-interval reference (VIR) signal that is included in many broadcast signals.

Owners of VCRs or videodisc players need convenient storage space for this extra equipment.

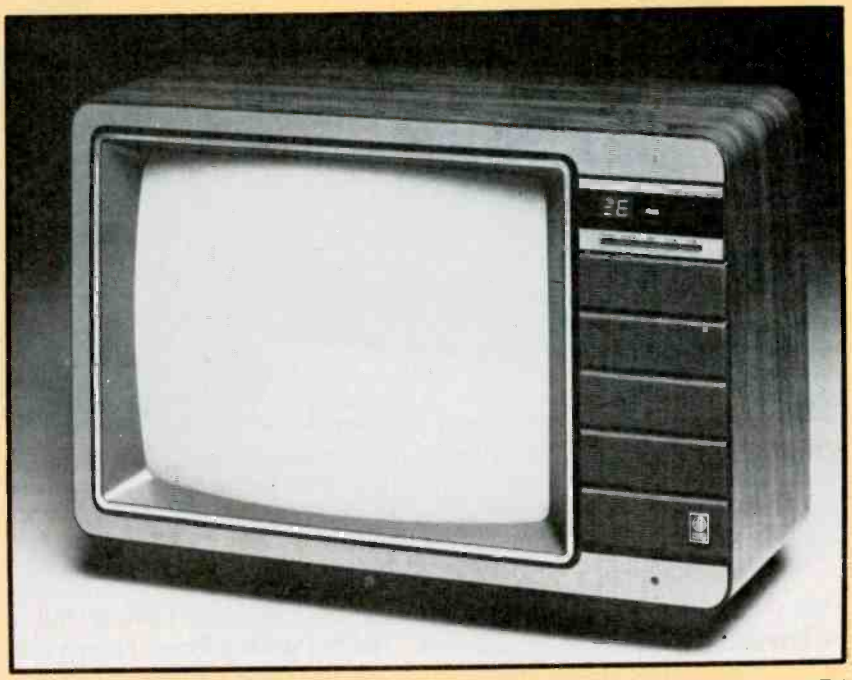
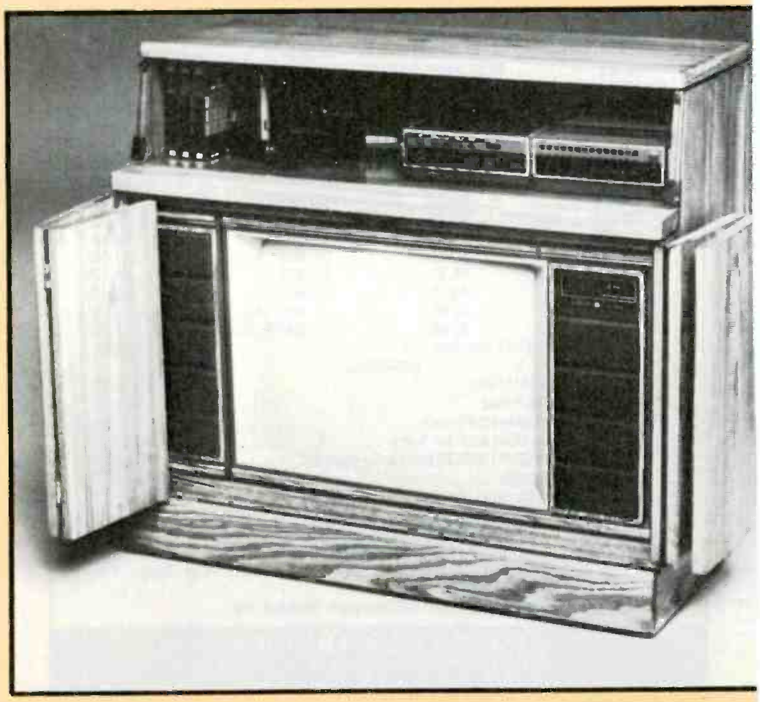


Figure 3 Model 19PC3744W is General Electric's top-of-the-line 19-inch color TV receiver. Some features are VIR Broadcast-Controlled color, Color Monitor, Room-Light Sensor, Programmable Scan Remote Control, Quartz Electronic Tuning with 112 channels and digital channel readout, and other features of the PC chassis.

Figure 4 Random access and up/down channel scanning are both possible with the remote control at left. Power on/off, up/down volume, and the programming of active channels can be done with this remote. GE models with Favorite-Channel Programmable Scanning can be programmed from the remote (right). All but the mechanical-tuner models have PLL-type electronic tuning.



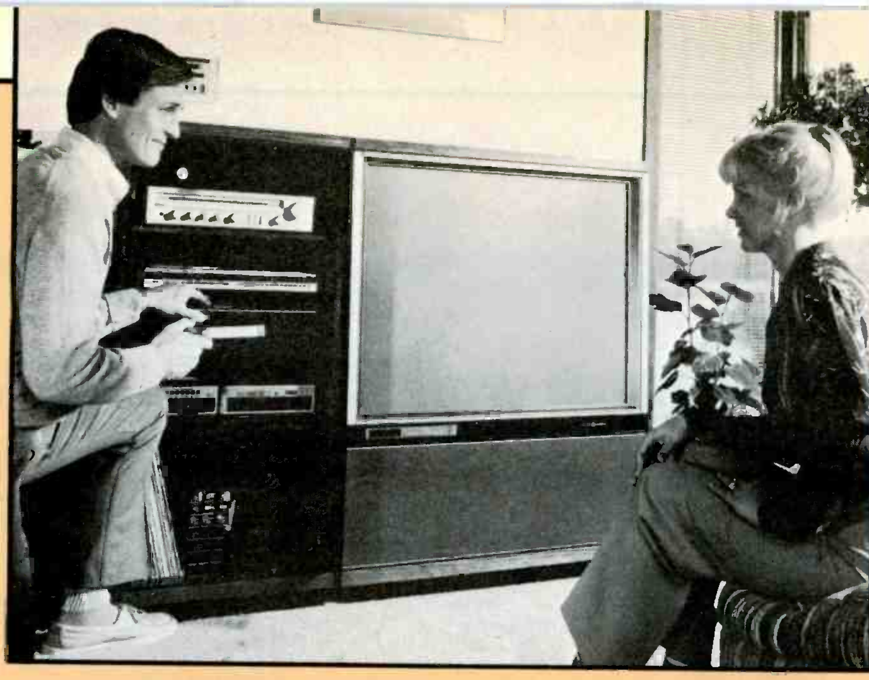


Figure 6 New for 1983 is the GE Widescreen-40, which has a 4-inch-diagonal rear-projection screen and three projection picture tubes. An optional cabinet for storage of audio and video accessories matches the size and appearance, as shown. Widescreen-1000 (1000 square inches) is continued in the GE line.

Two cabinet styles in the *Video-Classics Collection* are offered. One hides the video equipment behind a roll-top, while the other (see Figure 5) has contemporary styling with a glass door. These 25-inch models have a full jack-pack for easy direct connections of VCR, videodisc or a separate audio amplifier. Internal dual-channel amplifiers and dual-speaker systems allow true stereo sound when connected to a stereo-signal source.

Two large-screen projection color receivers in the 1983 line are the Widescreen-1000 and the new compact version, the Widescreen-40, with a 40-inch rear-projection screen (Figure 6). The cabinet of the new version is only 36 inches wide, 24 inches deep and 45 inches high. Three 5-inch projection tubes provide maximum brightness, while other top-of-the-line features include a comb filter, VIR color control and infrared remote control for 112 channels, Channel Block-Out, full video and audio jack pack, and dual-channel amplifiers for stereo sound from videodiscs or VCRs that have stereo signals. An optional storage cabinet is available in size and style to match the television.

Videocassette recorders

Four table-type VCRs are in the new GE line. All are 8-hour VHS models with electronic TV-station tuning of VHF channels (some have four UHF channels, also) and a digital clock display that

operates with the station programming. Model 1VCR3000X has a 1-event, 10-day programming feature and a remote-operated pause control. Model 1VCR3010X (Figure 7) has 3-event, 10-day programming plus a 9-function wired remote control. The Model 1VCR3014W has similar features, but with a program-search mode, audio dubbing and 5-event, 7-day programming. Top-of-the-line model 1VCR3018W has four video heads for special effects, wireless remote control, a second audio track for stereo-sound applications, and 8-event, 3-week programming.

Model 1CVD3020X is a VHS lightweight portable VCR with a rechargeable battery for up to 100 minutes of recording between charges. Weight with battery is only 8½ pounds. Features include three speeds for up to 8 hours of recording/playing per tape, special effects in the EP mode, freeze frame with frame-by-frame advance, video scan up to nine times normal speed, and an LCD digital tape counter with memory search. A special ac adapter fits into the battery compartment. Five types of power can be used.

Because portable VCRs normally do not include TV tuners or timers, two optional tuner/timer units are offered for use with this model.

Color video cameras

Color camera models in the line are the 1CVC3030E and 1CVC3035E. Both have an adjustable viewfinder, infrared automatic focusing, a fast f1.4 lens with automatic iris control, variable-speed 6:1 power zoom,

Figure 7 For 1983, the GE line includes four videocassette recorders and one portable. Pictured is model 1VCR3010X, which has 3-event, 10-day programming with a 9-function wired remote control. All VCRs are VHS types capable of recording for 8 hours maximum per cassette.

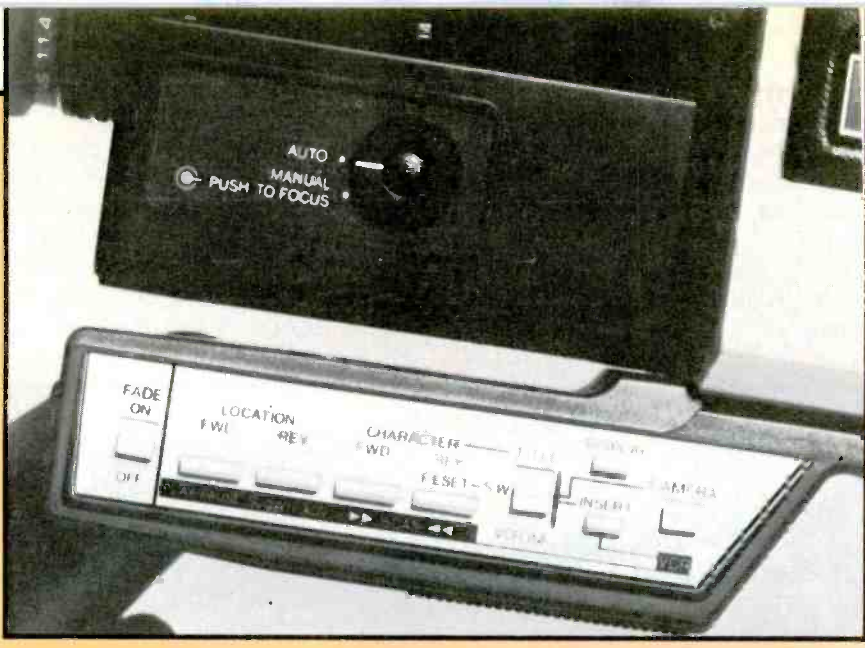


Figure 8 This is a closeup photograph of the operating controls on the 1CVC3035E GE color camera. Functions of fades, character generator and stopwatch are controlled by push-buttons. The portable VCR can be started and stopped from the camera.

macro-focusing to 1 inch, automatic white-balance control, extendable boom microphone, tally lamp, shoulder rest and a standby power switch.

Also, model 1CVC3035E has a Newvicon camera tube, fade-in or fade-out control, CRT viewfinder, character generator, stopwatch with on-screen readout, and a positive/negative switch for recording color negatives or slides. A panel on the shoulder rest (Figure 8) has push-button switches for camera and VCR control. The character generator can be used to insert titles or comments on any scene during recording.

Technical details

The three new chassis are PC, 25PC (for larger screen models) and PW for the Widescreen-40 projection model. The PC chassis replaces the former EC in most 19-inch color receivers.

One interesting circuit function in the PC and 25PC chassis is the +116V power-supply regulator that indirectly regulates the picture width and high voltage. Previously, the EC-chassis regulator used the collector-to-emitter path of a power transistor as a variable resistance to develop a voltage drop (from the current). As the input voltage or the load current changed, the circuitry forced the transistor resistance to produce whatever voltage drop was required to maintain a specific unvarying output voltage. Although the voltage drop and load current varied somewhat during normal operation, they were relatively constant. A transistor dissipates power unless it is cut off or totally

saturated. In the previous regulator, transistor resistance and the resulting voltage drop never approached zero. This loss produced a significant waste of power as it added heat to the chassis.

A different basic principle is used in the PC-chassis regulator circuit. Voltage regulation is obtained by variations of the time duration that a filter capacitor receives replenishing charges of power. In other words, it is another way of producing a specific dc voltage by using a storage capacitor to integrate *pulses* of dc voltage. The general method is shown in Figure 9.

Switching of the capacitor-charging voltage in the PC regulator is in the negative (rather than the positive, as in the simplified example), but the principle is the same. Figure 10 is a simplified schematic of the PC-chassis regulator. A silicon controlled rectifier (SCR) replaces the relay contacts to provide rapid, bounceless switching. Notice that the triggering is synchronized to

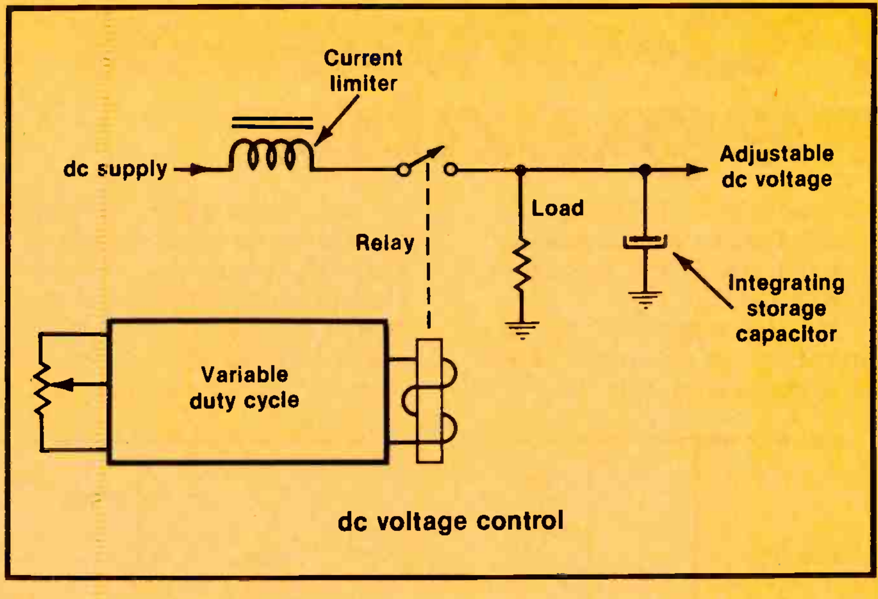


Figure 9 Regulation of high voltage and picture width in the PC chassis is accomplished by regulation of the +116V supply for the horizontal-output transistor. Variable (but not regulated) dc voltages can be produced by this theoretical circuit (which is not the one in the PC chassis). When dc power is brought through a constant-current or current-limiting device (an inductance is used here), and the duty cycle of the relay-contact *on* time is varied, these pulses of dc voltage are integrated by a storage capacitor into a filtered *dc voltage equal to the average voltage of the pulses*. Of course, narrower pulses (shorter duty cycle) have a lower average voltage, therefore, the integrated and stored voltage will be lower than that from wider pulses. Although this block diagram illustrates the basic principle (variation in the time duration of applied power), the actual GE regulator block diagram (Figure 12) is different in details. For example, the on/off keying of input dc power is accomplished by an SCR. Also, the keying is in the negative leg of the input power, not the positive.

PC-chassis regulator

Several basic facts must be clarified before the operation of this GE circuit can be understood properly.

The dc voltage in an integrating or storage filter capacitor varies according to the width (duty cycle) of current-limited dc-voltage pulses that are applied to it (see Figure 11). Well-filtered dc voltage comes from the bridge rectifier and C902. L909 is the current-limiting inductance, C904 is the storage or integrating capacitor and SCR903 is the electronic switch.

Secondly, an SCR (silicon controlled-rectifier) has a regenerative action that allows rapid and dependable switching of considerable power. SCR conduction must be initiated by a positive gate voltage (relative to its own cathode). After conduction is operating, the gate voltage has no effect on the current. Therefore, the A/C path current continues until the current is brought to zero or the anode becomes at least slightly negative relative to its cathode.

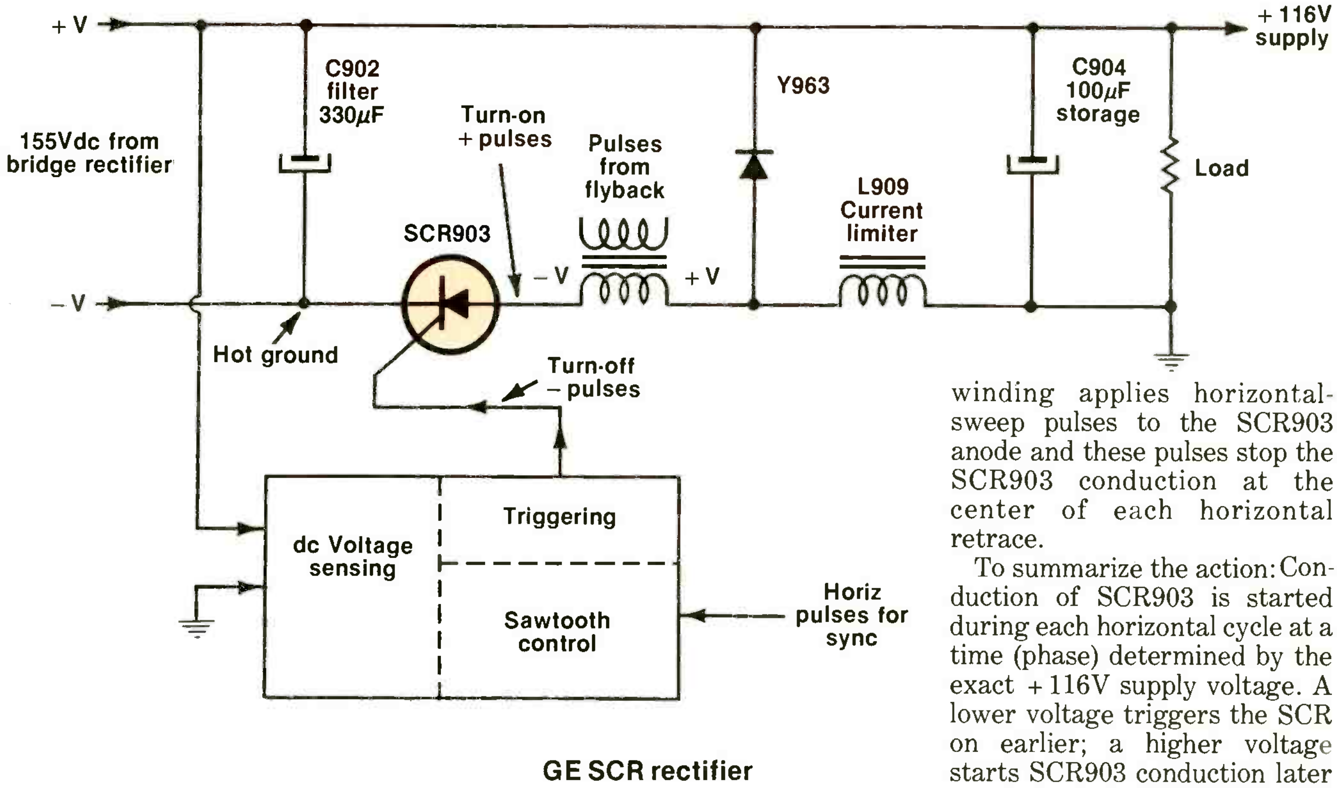


Figure 10 This simplified schematic of the PC-chassis regulator shows details of circuit regulation.

Notice that the switching SCR is in the negative leg of the +155V supply between hot ground and chassis ground. Voltage between the +116V supply and ground is monitored by two transistors that form a voltage sawtooth waveshape whose slope varies in step with the +115V supply. The starting of each sawtooth is initiated by a pulse from the horizontal-sweep circuit.

Conduction of SCR903 begins when the sawtooth's instantaneous voltage reaches a level that produces a triggering pulse from the third transistor. SCR903 conduction then passes a negative voltage to the grounded end of C904, the storage capacitor. Maximum current is limited by L909, otherwise, the circuit would be peak reading and little voltage variation would be possible. Unless something stops SCR903 from conducting, the output voltage soon would reach +155V, the input supply voltage. However, a flyback winding applies horizontal-sweep pulses to the SCR903 anode and these pulses stop the SCR903 conduction at the center of each horizontal retrace.

To summarize the action: Conduction of SCR903 is started during each horizontal cycle at a time (phase) determined by the exact +116V supply voltage. A lower voltage triggers the SCR on earlier; a higher voltage starts SCR903 conduction later in each cycle. Conduction of SCR903 is ended at the *same* time in each horizontal cycle. A low +116V level lengthens the conduction time of each cycle, while a voltage higher than +116V shortens the SCR conduction times. In other words, the precise +116V level is maintained by variations of the SCR903 conduction times.

Incidentally, sudden cessation of the SCR903 current produces a voltage pulse across L909, so diode Y963 has been added to rectify these kick-back pulses, thus making the regulation more efficient and reducing the ripple on the +116V supply line. The starting circuit is not shown here; refer to the GE schematic for those additional components.

the horizontal-sweep frequency and that negative-going horizontal pulses are provided at the SCR anode to stop its conduction at the same point of each horizontal cycle. Other details of circuit operation are given with the Figure 10 schematic. This regulator reduces the line wattage and the chassis heat.

An interesting new component is the flyback used in PC and 25PC chassis. The windings are stack-wound to give maximum protection against arcs and shorts while allowing a smaller overall size. Diode rectifiers are integrated with the windings. Focus and CRT-screen controls have thick-film construction and are included inside the overall insulation. The flyback is mounted directly to the circuit board.

A narrow-neck, black-matrix picture tube with bi-potential guns and fast-warmup cathodes is standard in all PC models. The previous type of simplified convergence and purity is continued.

These new picture tubes have internal features that are said to reduce the current of any HV arcs to a fifth or an eighth of the arc current in conventional tubes. This should minimize CRT damage from arcs.

The mini service manual (which has been included in a rear-panel compartment of GE color receivers for several years) is supplied again in the 1983 line. This feature has been popular with technicians.

A servicing position has been provided for the chassis (Figure 11) to permit top and bottom circuit-board instrument tests and visual examinations. Copper wiring is on one side of the board only, and this should enhance the reliability as well as simplifying the finding of test points.

Remember that chassis ground

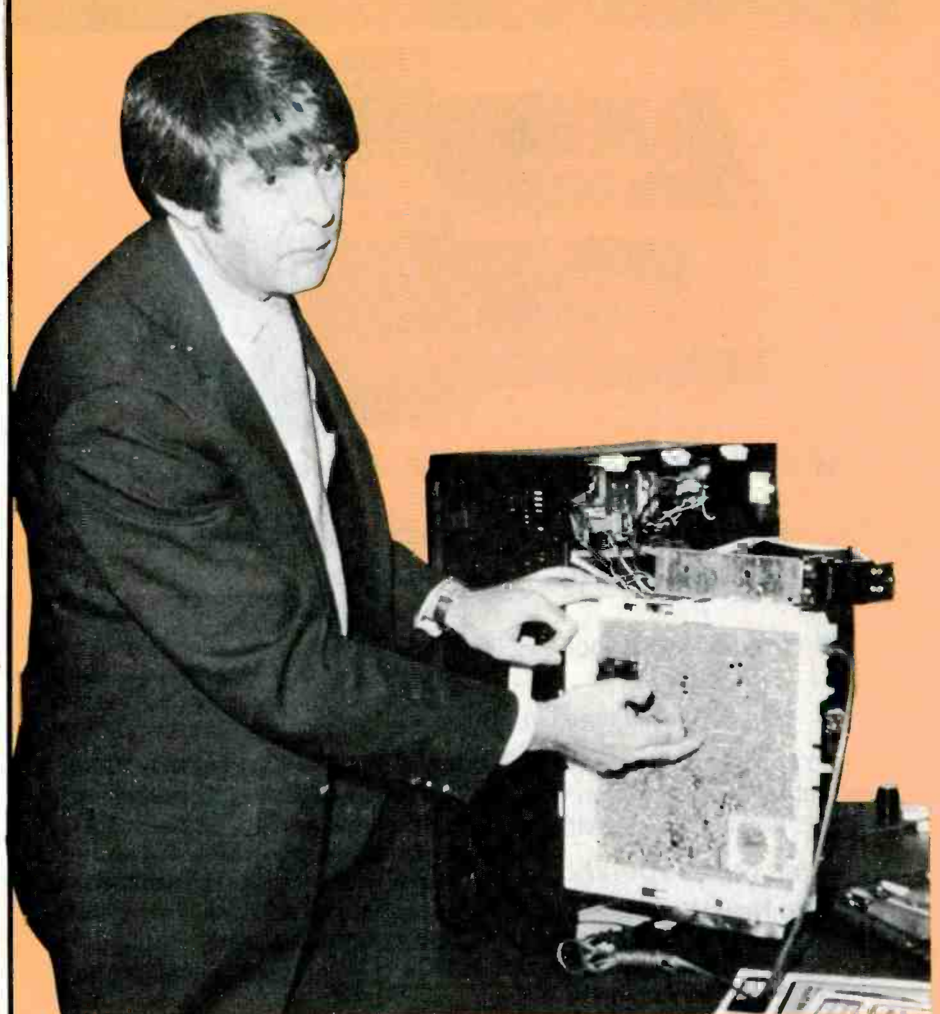


Figure 11 Allen Nelson demonstrated many serviceability features of the new GE PC chassis. The color receiver is shown on its side, with the chassis in the convenient service position.

costly) damages to the test equip-

band and the divider ratio in the

System LMP91 also covers 82 TV-broadcast and nine cable channels, but it operates by scanning up or down through all programmed channels in sequence. Scanning and volume control can be operated from the TV panel keyboard or the remote.

The KMP91 system provides keyboard random selection of 91 channels, but has no remote control. AFT search for off-frequency signals is initiated for each channel selection.

Most 25-inch models and a few 19-inch models include one of the following 112-channel tuning systems. KMP112 is the GE state-of-the-art electronic tuning system, which is the basis for the other three 112-channel systems (LMP112, SET112 and MP112). Special resistors and capacitors are used instead of conventional ones. They are called *chips* because they have no pigtail lead wires and so are soldered directly to the circuit. The reduced component inductances contribute to the efficiency and stability of these critical circuits.

The KMP112 has random access to all channels only by the receiver keyboard. There is no remote control feature.

SET112 has up-and-down scanning of all programmed channels, without remote.

The LMP112 has up-and-down channel scanning, similar to that of the SET112, but with remote control of all channels, including programming.

MP112 has all features, including random access and scanning of programmed channels (dual-mode operation) from the receiver panel and also from the remote-control transmitter. Other push-buttons switch the power on or off, and raise, lower or mute the audio volume. This is the only GE tuning system that includes the

CALENDAR OF EVENTS

September

14-16
Wescon '82, Anaheim Convention Center, Anaheim, CA. For more information call 1-800-421-6816.

14-16
Mini/Micro Computer Conference and Exhibition, Disneyland Hotel, Anaheim, CA. Contact Electronic Conventions, 999 Sepulveda Blvd., El Segundo, CA 90245, 1-800-421-6816 (in California, 1-213-772-2965).

October

11-13
EIA Fall Conference, Century Plaza Hotel, Los Angeles. For more information, contact the Electronic Industries Association, 2001 Eye St., N.E., Washington, DC 20006.

November

1-2
15th Annual Connector Symposium, sponsored by the Electronic Connector Study Group, with the cooperation of more than 50 connector manufacturers, Franklin Plaza Hotel, Philadelphia. Contact Electronic Connector Study Group, P.O. Box 167, Fort Washington, PA 19034.

30-Dec. 2
Midcon/82 High-Technology Electronics Exhibition and Convention, Dallas Convention Center. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245, 1-800-421-6816 (in California, 1-213-772-2965).

January

18-20
Southcon/83 High-Technology Electronics Exhibition and Convention, Georgia World Congress Center, Atlanta. Contact Electronic Conventions, 999 N. Sepulveda Blvd., El Segundo, CA 90245, 1-800-421-6186 (in California, 1-213-772-2965).

Circle (36) on Reply Card

Average or true RMS: Which is right for you?

By Jim Smith, Sales Engineer, Sencore

Average RMS or true RMS: Which ac voltage measurement is the right one for you? Is one more important, or are they equally important? These are typical questions asked by technicians across the country.

These questions are compounded by the fact that meter manufacturers offer both types of ac voltage measurements: average RMS in one model and true RMS in another model. They leave it up to you to make a decision as to which meter you should purchase. It's not that these manufacturers cannot make up their minds; there are good reasons for both types of measurements. Let's take a look at the two types of ac voltage measurements and see what they are, where they are used and where they are important to you.

What is average RMS?

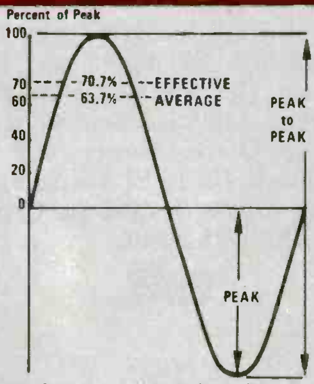
Average RMS is derived by measuring the average voltage of a pure sine wave and multiplying the results by 1.11 to obtain the RMS value. This is based upon the mathematical relationship between the two quantities in a pure sine wave. Average ac voltage is easy to measure with a bridge rectifier and a damped dc meter. Both the rectifier and meter are average responding so the resultant reading on the meter will be the average, or 63.7%, of the peak voltage applied.

However, average ac has no real meaning because it is not used in electronic measurements. The average ac can be converted to RMS by multiplying by 1.11. Most meters use average detection and multiply the results by 1.11 with an amplifier before applying it to the digital readout, because it is less expensive than a true-RMS detector.

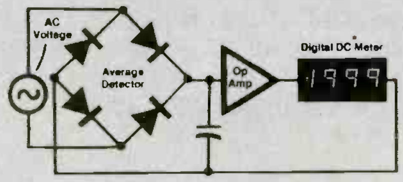
Using average detection and multiplication to obtain average RMS is acceptable as long as you are dealing with pure sine waves, such as the output of power transformers. However, if the sine wave becomes distorted, or if you measure other ac voltages, such as a square wave or pulses, the 1.11 multiplier no longer holds true. A good example of the error that can be introduced can be seen when you measure a square wave. The average and the RMS values of a square wave are equal. If your DVM multiplies the average results by 1.11, you will find that the voltage you measure from the square wave will be 11% higher than the actual RMS voltage.

The average-RMS meter will always give a different reading than the true-RMS voltage when you measure ac voltages that are not a pure sine wave. This is why most engineers specify a meter that reads the true-RMS ac voltage and not average RMS.

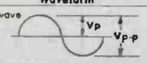
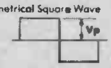
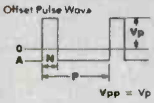
When measuring ac voltages around the ac input and power supply and comparing them to a schematic, you must have average RMS, because there is usually some distortion in the ac line signal, with additional distortion added by the transformer, RF line filters, etc. The original values marked on schematics were taken with average RMS, and the distortion errors must be matched with the measurements that you are taking. If you use a true-RMS meter, your readings may not correspond to the schematic values and will cause confusion. You will not know if there is a problem in the circuit or whether the reading differences are being caused by your meter.



A pure sine wave showing the relationship of the RMS and average values in percentages.



This simple circuit is used to measure the average-RMS value of a sine wave ac voltage.

Waveform	RMS Value	Average Value	RMS to P-P
Sinewave 	0.707Vp or 0.353Vp-p	0.637Vp or 0.3185Vp-p	2.828
Symmetrical Square Wave 	Vp or 0.5Vp-p	Vp or 0.5Vp-p	2
Offset Pulse Wave  Vpp = Vp + A	$\sqrt{T} \cdot Vp$ $T = \frac{N}{P}$	$Vp \cdot T + (1-T)A$ $T = \frac{N}{P}$	$RMS \cdot \sqrt{\frac{N}{P}}$ (A = 0)

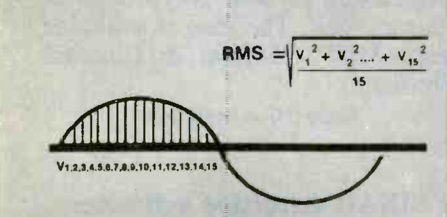
The comparison of the various waveforms and how they relate to the peak-to-peak, RMS and average ac voltages.

What is true RMS?

True RMS or *root mean square* is defined as the *effective* value of an ac voltage that will produce the

same heating effect as a similar dc voltage. RMS is the square root of the mean (or average) of the squares of the instantaneous values of the segments of the ac voltage (or *root mean square*).

One way to measure the true RMS of an ac voltage is to take the sine wave or other waveshape and break it into many segments. Each segment of voltage is squared and then added to the squares of all the other segments. To find the average squared value of the ac voltage, divide the total of all the segments squared by the number of segments. The square root of this value is the RMS value.



To measure true RMS, you must break the waveshape into small segments, square these instantaneous voltages, average them together and take the square root of the result.

Mathematically, true RMS is 70.7% of the peak value of a pure sine wave. In a square wave, the RMS value is 50% of the peak-to-peak, and in a triangular wave, the RMS value is 57.7% of the peak value. True RMS for non-regular waveforms is not a simple mathematical derivation of the peak of the ac voltage and depends upon the peak amplitude as well as the overall shape and time duration of the voltage.

True RMS requires a more complex and expensive circuit to convert the ac voltage being measured into its RMS value than used by average-detecting meters. These complex circuits are generally combined into a special IC called an *RMS converter*. These ICs are not found in most DVMs due to the high cost of the IC itself. Some more expensive models may include the RMS converter IC, but do not include the average detection circuit to provide you with both types of ac measurements.

True-RMS ac voltage measurements are important when you are dealing with power delivered to a load. One example is in the newer TV sets and video monitors using scan-derived CRT filaments. The CRT filament is heated with a pulse taken from a winding on the flyback transformer. This pulse should be measured with a true-RMS meter to be sure that the voltage applied to the CRT is producing the required 6.3V of RMS heating energy. If the voltage is measured with an average-RMS meter, the readings may be anywhere from 3.5V to over 8V, depending upon the meter used.

The horizontal output transformer of a TV set is a type of switching power supply. Switching power supplies of this type can be found in many applications, such as radar, video monitors and computer displays. Most of these will heat the CRT filament with a pulse from the switching power supply transformer, making the ability to measure for true RMS important.

There are many other applications that use non-sinusoidal signals and require true-RMS measurements to determine the heating effects of this signal, such as motor controls and heating elements in dryer systems. True-RMS ac voltage measurements are the only answer for these applications, because average-RMS measurements will give incorrect readings of the distorted ac voltage waveforms present.

Which RMS measurement?

There is no *correct* answer to this question because we are in a period of transition. Service literature published during the past 30 years will generally be referenced to an average-RMS meter, whether or not the readings represent the actual power delivered by the circuit. Much new literature is beginning to show values referenced to true RMS, and the average-reading meters will show an error when making measurements here. In addition, we must face the fact that more and more of the signals encountered in power supplies are no longer sine waves. Switching power supplies, flyback-powered circuits, and SCR or TRIAC controlled supplies are becoming commonplace in almost every industry and none deliver sine waves.

Both average and true-RMS are important in order to work with the circuits of the '80s and not restrict applications in older circuits. Some DVMs offered today make it possible to measure both.

NEW PRODUCTS

Pin tip probe

A flexible pin tip probe has been developed by *ITT Pomona Electronics*. The probes, available in three models, are made of brass with gold-plated tips. The probes

attach easily to the ends of the ITT Pomona Electronics line of test probes.

Circle (66) on Reply Card

5-way binding post

OK Machine and Tool Corporation has just introduced its new "BP" series of binding posts. Equally suited to amateur and industrial applications, the binding post can accept a phone plug, banana plug, alligator clip, spade lug or wire strands directly. Mounting hardware supplied in-

cludes plastic washers for complete insulation from PC board or chassis. Available in red, yellow, green and black, the binding posts are offered one of each color to a package for amateur or lab applications, and 100 of one color to a package for industrial volume users.

Circle (65) on Reply Card

Tool case

The Tranny Caddy T10 weighs 11 pounds when empty, and has clear plastic lids and a lift-out tray inside. Features include reinforced

hinges and riveted polypropylene construction. The case is available from *MHP* (Medical & Hospital Products).

Circle (71) on Reply Card

SINAD distortion voltmeter

The HF Signalling model 826 SINAD distortion voltmeter is a combination SINAD distortion meter and ac voltmeter that can be taken anywhere. Just connect receiver audio to the detachable shielded input cable and read SINAD distortion directly, because there are no frequency, null or level adjustments to make. It is also an accurate audio ac voltmeter with nine ranges from

10mV to 100V full scale and allows the user to check audio levels from the microphone to the speaker, easily and quickly.

Circle (57) on Reply Card

Antenna and amplifier packages

Two combination antenna and preamplifier packages have been added to the *Winegard* line. The amplified outdoor antenna packages are the PR-8687, which

includes Winegard's Prostar PR-860 VHF/UHF/FM antenna with the GA-8700 high-input preamplifier, and the PR-8888 package, which includes the PR-880 VHF/UHF/FM antenna and GA-8800 high-gain, low-noise preamplifier.

Both packages provide long-distance reception of all TV channels (2-83) plus FM and FM stereo, and are designed to reduce or eliminate TV snow, interference and ghosting. The preamps strengthen distant signals, improving weak channels.

Circle (79) on Reply Card

Microprocessor interfacing course

A microprocessor interfacing course, for use in classroom teaching or individualized learning situations, is being introduced by *Heathkit/Zenith Educational Systems.*

The EE-3402 microprocessor interfacing course is designed for students or employees with a working knowledge of microprocessor fundamentals who desire to gain additional knowledge about microprocessor interfacing techniques and more advanced microprocessors, according to a company spokesman.

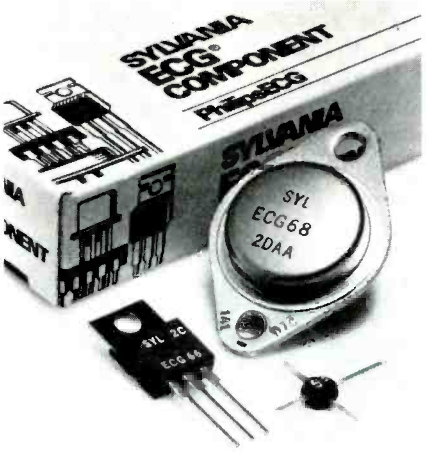
A 750-page text, divided into 11 learning units, concentrates on teaching advanced microprocessor interfacing techniques. It also provides in-depth coverage of the 6800 family of microprocessors and introduces the student to the powerful 6809 and 68000 microprocessors.

Circle (80) on Reply Card

Transistors

The addition of seven new transistors to the Sylvania ECG semiconductor replacement line has been announced by the Distributor & Special Markets Division of *Philips ECG.*

The new types include three microwave transistors. ECG63 is an amplifier/mixer, ECG64 an amplifier and high speed switch, and ECG65 an amplifier for CATV and MATV. Application is in the

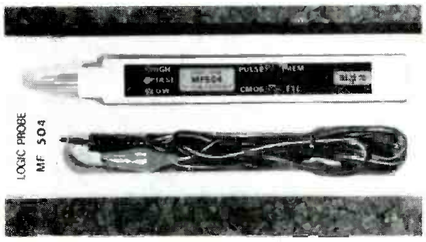


2.5 to 5GHz range for the many varieties of satellite reception equipment, UHF and microwave installations.

Circle (77) on Reply Card

Digital pulser

Etronix has introduced the model MF 512 logic pulser. The MF 512 is designed to inject pulses into logic nodes without cutting



traces or removing ICs and to monitor circuit response with a logic probe to locate logic, connective or component faults. The pulser produces high-energy, short-duration voltage pulses of a logic state opposite to that of the node under stimulation. Features include a capability to override TTL logic nodes with narrow pulses of automatically controlled voltage, polarity and width.

Circle (78) on Reply Card

CW transceiver package

Dentron Radio Company has introduced a new 3-band, 25W CW transceiver and accessory package designed to help the novice learn CW operation or to allow the experienced ham keep in touch when he's away from a traditional power supply.

The transceiver covers 80, 40 and 15 meters and will receive SSB as well as CW. A bright LED display gives a positive frequency reading to aid the novice in tuning.

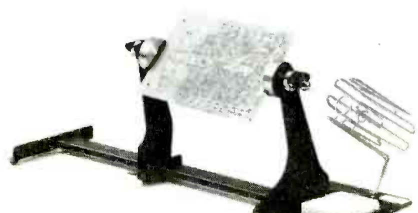
In addition to the transceiver, the complete package includes a

code key, 3-band dipole antenna, head set, log book, an ARRL license manual and a complete radio and code course on cassette tape.

Circle (81) on Reply Card

Printed circuit board holder

This compact and rugged printed circuit board holder and solder station, from *OK Machine and Tool*, is designed especially for



laboratory, prototype and repair work, as well as light production applications. The self-locking end support slides easily to suit board width, and board holders are spring loaded for easy board removal and replacement without re-adjustment. The board may be rotated 360 degrees for access to both sides, and may be locked at any angle for optimum operator efficiency. The unit includes a soldering-iron holder and a tip-cleaning sponge.

Circle (74) on Reply Card

Powerline surge suppressors

The protection of semiconductor components and circuits in com-

puters and other delicate electronic devices can be achieved by the use of plug-in surge suppressors, from *Atlantic Scientific,* capable of clamping at the proper voltage. The fast response time (picoseconds) makes them particularly effective as protection against surges with sub-microsecond risetimes.

A complete line of ac, data, signal and video suppressors are available in models from 5 to 1300Vdc or Vac, single or three phase with protection up to 800,000V (44,000J).

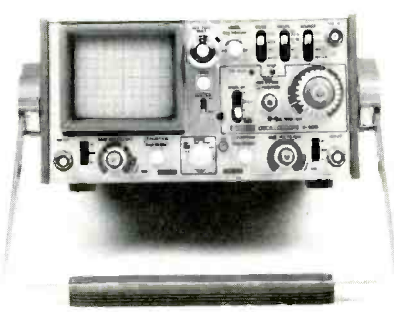
Circle (72) on Reply Card

Dual-trace oscilloscope

Hitachi Denshi Test & Measurement Division has announced the new V-509, 50MHz, dual trace oscilloscope.

The 11-pound mini-portable, with calibrated delayed sweep, offers the field engineer a bright 12kV CRT, operation from ac/dc or optional battery pack, plus such features as single-shot trigger, variable hold-off, auto focus and full TV triggering.

The V-509 offers a 3½-inch rectangular mesh-type CRT with



metal-backed P31 phosphor and an internal graticule. The mini scope has a convenient channel 1 DVM output. This useful feature eliminates T-connector cabling and time-consuming cable switching.

Circle (73) on Reply Card

Universal test lead system

Simpson Electric Company has introduced a new universal test lead system, designed to expand the measuring capabilities of all VOMs and DMMs with standard- or reverse-type banana jacks.

The 23-piece system consists of color-coded (red and black) pairs of

48-inch long test leads, test lead extenders, probe-type test prods for general-purpose testing, and 6-inch spring-tip hook-on probes for no-slip connections.

Circle (70) on Reply Card

Semiconductor curve tracer

A new semiconductor curve tracer is available from the *B&K-Precision Product Group* of Dynascan Corporation. The instrument, designated model 501A, is designed to work in association with an oscilloscope to display characteristic curves for a wide variety of discrete semiconductor devices.

The 501A displays the unique characteristic curves for each type of semiconductor device. By examining these curves, the user can determine all significant operating characteristics of the device under test. Test parameters measured include gain (beta), cutoff current, leakage current, output admittance and breakdown voltage. The

instrument can be used to evaluate bipolar and FET transistors, diodes, SCRs, diacs, triacs and other devices.

Circle (71) on Reply Card

Dual-time base oscilloscopes

Leader Instruments Corporation has announced two dual-trace, dual-time base, 35MHz oscilloscopes, the LBO-524 and LBO-524L. The units are designed to meet applications in design, testing, and service of both analog and digital circuits and equipment.

The comprehensive triggering controls, including variable holdoff, alternate triggering and delayed-sweep triggered functions, permit stable display for

even the most complex signals. With 500μV sensitivity, extremely low level signals can easily be observed. A channel-one output is available on the rear panel to drive other less-sensitive instruments, such as a frequency counter with an input level as low as 500μV. The dual-time base permits accurate observation and time interval measurements of complex waveforms.

Circle (75) on Reply Card

ES&T

Circle (32) on Reply Card

Circle (33) on Reply Card

Circle (34) on Reply Card

READERS' EXCHANGE

Needed: Power transformer, servicing schematic and any other data for an AM radio, ERC, model 8360. These units were used in Drug Fair stores around Maryland. Will pay all charges. *Charles Harris, 1042 Ellicott Drive, Baltimore, MD 21216, 1-301-624-1914.*

Needed: Time leaves and holder bracket for Panasonic clock radio, model RC7254C; please state price. Also schematic or service information for Zenith radio, models RE-94y (Sams TSM-154), F474W (Sams 1501), RF-B6y (Sams TSM 159) and RC-72y (Sams TSM0155). Will buy or pay other costs. *Able TV and Electronics, Rt. 4, Box 764, Panama City, FL 32405.*

Needed: B&K model 520B transistor tester. State condition and price. *Max Emerson, 1923 N. Texas, Weslaco, TX 78596, 1-512-968-2913.*

Needed: Used, reasonably priced, battery-powered UHF/VHF solid-state TV signal strength meter to be used in rural CATV/MATV measurement applications. *Joe Waters, P.O. Box 387, Fossil, OR 97830, 1-503-763-2954.*

Needed: Heath model 5G-5257 post marker/sweep generator. Power supply, B&K model 1640 or Hickok model 244. Also Sams Photofact SD-13. *Caswell Davis Jr., 601 Delmar, Apt. 2, San Antonio, TX 78210.*

Needed: Horizontal output transformer for Philco Predicta, model 10143. Philco part number 32-8899-1, merit part number HVO-215, Triad part number D226. *Audio Associates, P.O. Box 2634, Zanesville, OH 43701.*

Needed: Audio output transformer for Sansui stereo receiver, model 1000-A. *Bob Sweet, Sweet Electronics, 400 Superior Ave., Bogalusa, LA 70427.*

Needed: Address for company named Knapp Monark, or information on the company. *W. W. McGehee, 633 5th St. SW, Grand Prairie, TX 75050.*

Needed: TAB TV service manuals in good condition. Need RCA color volume 2 (#578), GE color volume 2 (#609), Admiral color volume 2 (#641) and Magnavox color volume 3 (#770). Also interested in any other TAB foreign TV manuals and CB radio manuals. *Charles E. Norris, TV-Radio Service, Box 105, Airedele Road, Ridge, MD 20680.*

Needed: Schematic or the address for a Dynaco Stereo 120, 60W amplifier. *Joseph Vaccarella, 15 Laidlaw Ave., Jersey City, NJ 07306.*

For sale: Bell & Howell GR-2000 25-inch color TV kit, fully assembled but not working. Included are on-screen clock and channel readout and contemporary cabinet. Like new, never used. With manuals, $250. *Robert Griffith, 2 Stoney Creek Drive, Dauphin, PA 17018, 1-717-921-8747.*

For sale: Two B&K TV Analysts: 1075 for $50 and 1076 for $100, plus postage. Both in working condition. *Carl Ahlberg, 10 Phelps St., St. Catharines, Ontario, Canada L2P 2H4.*

For sale: 300 recent **ET/D** schematics plus Tekfax 113, 114 and 115. Best offer. *W. Perkins, 3 Allston Court, Cambridge, MA 02139.*

For sale: Tekfax diagrams, December 1952 through August 1979; 1212 diagrams for $240 plus shipping. Also radio and TV textbooks, booklets, pamphlets, and back issues of **Electronic Servicing, PF Reporter** and **Electronic Technician/Dealer** magazines. *Max Seligsohn, 1455 55th St., Brooklyn, NY 11219.*

For sale: Will give away to anyone who will pick up or pay freight on old issues of **Electronic Servicing** and other servicing magazines, going back many years. *A. J. Tryba, Rt. 2, Benton, IL 62812, 1-618-627-2435.*

For sale: Sencore TC162 tube tester, used only three months, new condition, $220. *Alan R. Salvatori, c/o Universal TV Service, 34 Cedar Lane, Closter, NJ 07624.*

For sale: Bird model 4351 RF wattmeter, $70; Heathkit model HD-15 hybrid phone patch, $50; Heathkit model HD-1250 solid-state dip meter, $75. *William Shevtchuk, 1 Lois Ave., Clifton, NJ 07014, 1-201-471-3798.*

For sale: Texfax volumes #8 (1966), 111 (1973), 112 (1975) and 115 (1979). Make an offer. *Benjamin Halfin TV, 603 Ivey Ave., Colonial Heights, VA 23834.*

For sale: Sencore YF33 ringer and flyback checker in exchange for old-type B&K 1076 analyst. *Frank M. Lurry, 7805 Grand Ave., North Bergen, NJ 07047, 1-201-861-4055.*

For sale: Sencore P29 scope with probes and manual, guaranteed, like new, $365; Optoelectronics digital capacitance meter, guaranteed, like new, $135; VIZ VOM, 50,000Ω/V, with case, guaranteed, like new, $40. *William Bernstein, 215 Middle Neck Road, Bldg. 7, Great Neck, NY 11021.*

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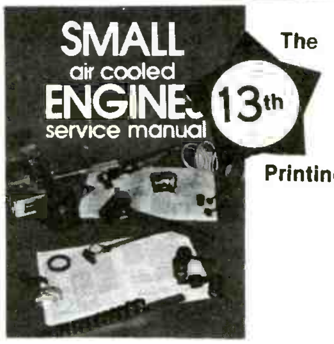

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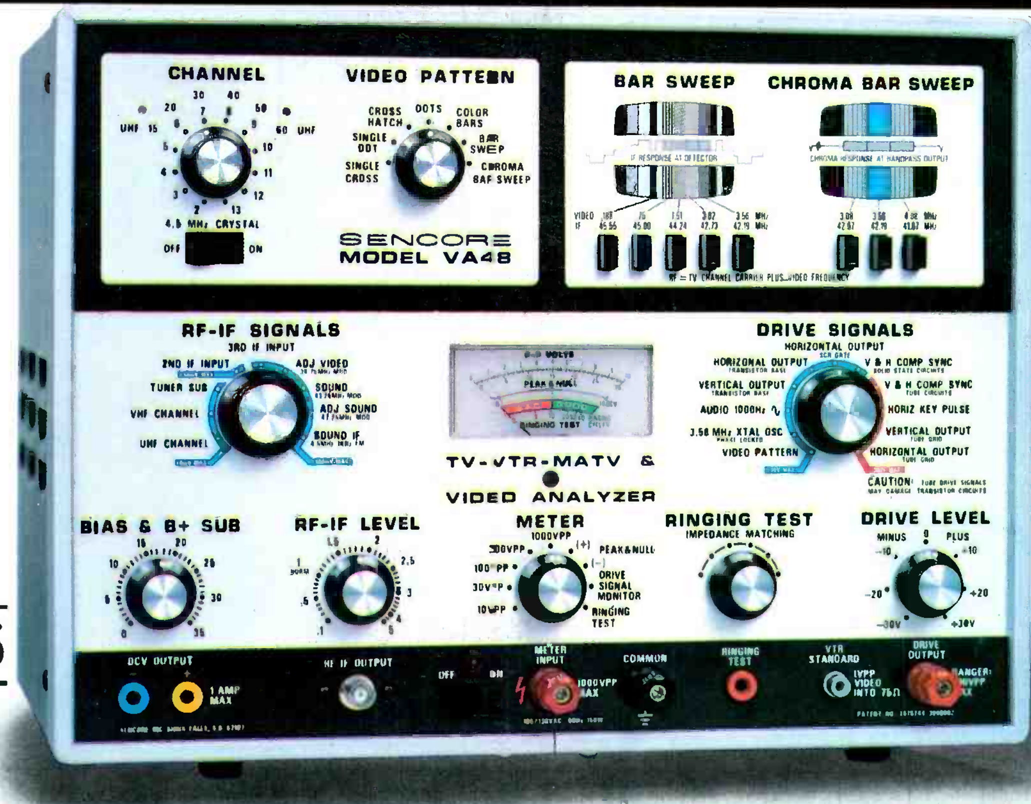

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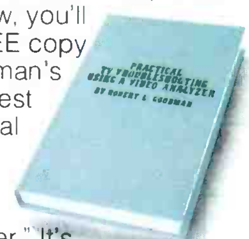

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