

# ELECTRONIC

## Servicing & Technology

September 1987/\$2.25

Don't let shutdown circuits shut you down

What do you know about...do-it-yourself test equipment

### Analog or digital, which DMM is best?



# More Functions. Smaller Budget.

## Beckman Industrial Circuitmate™ DMMs put hFE, Logic, Capacitance, Frequency and True RMS In Your Hand. For Less.

**Get more, for less. It's a simple definition of value.** For DMMs, value means finding the combination of capabilities that meets your needs at the right price. Without losing sight of accuracy and reliability. If you want more functions at a low price, Beckman Industrial's Circuitmate™ Digital Multimeters are the best value around.

From the pocket-sized DM20L to the DM850, with true RMS capability and accuracy to 0.05% ± 1 digit, Circuitmate DMMs give you the functions you need.

For instance, the DM20L puts both a Logic Probe, a transistor gain function (hFE), and a full range of DMM functions in the palm of your hand. For only \$69.95.

Then there's the DM25L. Where else does \$89.95 buy you a Logic Probe, capacitance measurement, transistor gain function (hFE), and 24 DMM ranges including resistance to 2000 megohms? Nowhere else.

When high accuracy counts, there's the DM800 with a 4 1/2 digit display. The DM800



### DM20L Pocket-Size w/Logic \$69.95\*

TTL Logic Probe: 20MHz  
Hi/lo/off indications  
Detects 25ns pulse widths

hFE (NPN or PNP):  
1 range (1000)

DMM: Input Impedance—  
10 Megohms  
DCA/ACA-5 ranges  
(200µA to 2A)

Ohms-8 ranges (200 ohms  
to 2000 Megohms)

Continuity beeper



also gives you frequency counting. A full-function DMM, and more, doesn't have to cost over \$169.95. If it's a Circuitmate DM800.

Or, for a few dollars more, get true RMS (AC coupled) to let you accurately measure non-sinusoidal AC waveforms, and all the capability of the DM800, in the DM850.

Of course, there's a whole range of Circuitmate DMMs and service test instruments, including the DM78 autoranger that

### DM25L Capacitance, Logic, hFE \$89.95\*

TTL Logic Probe: 20MHz  
Hi/lo/off indications  
Detects 25ns pulse widths

Capacitance: 5 ranges  
(2nF to 20µF)

hFE (NPN or PNP):  
1 range (1000)

Continuity beeper

Built-in bail

Anti-skid pads

### DM850 True RMS

4 1/2 digits. DCV accuracy is .05% + 3 digits

True RMS

Frequency counter to 200KHz

Data Hold display capability

Continuity beeper

Built-in bail

Anti-skid pads

Price: DM850 (True RMS) . . . \$219.95\*  
DM800 (Average) . . . \$169.95\*



fits in a shirt pocket, yet gives you a full size 3 1/2 digit, 3/8" readout. Not to mention a complete line of accessories like test leads, current clamps, even probes that can extend your DMMs range and sensitivity. All designed to work flawlessly with your Beckman Industrial Circuitmate DMM.



See your Beckman Industrial distributor and discover more DMM performance. For less.

\*Suggested list price (\$US) with battery, test leads and manual.

In Service Instruments, We're The One.

## Beckman Industrial™

Beckman Industrial Corporation Instrumentation Products Division  
A Subsidiary of Emerson Electric Company  
3885 Ruffin Rd., San Diego, California 92123-1898  
(619) 565-4415 • FAX (619) 268-0172 • TLEX 249051

© 1987 Beckman Industrial Corporation

Circle (1) on Reply Card



# Now! 100 MHz. Cursors. CRT readout. Four channels. All for just \$2400.

The NEW Tek 2246 and 2245 set the pace in fast, accurate measurement. And immediate, easy delivery. Take a close look. At their unmatched price/performance. At versatile, on-site/at-bench convenience. At Tek SmartCursors™ a 2246 exclusive. All backed by a 3-year warranty and 30-day free trial on approved credit. Don't settle for less. Get out in front with scopes that set the pace. Return the card or call Tek direct:

**1-800-433-2323**  
Or call collect  
**(503) 627-9000**



Features	2246	2245
Bandwidth	100 MHz	100 MHz
No. of Channels	4	4
SmartCursors™	Yes	No
Time/Volts Cursors	Yes	No
Voltmeter	Yes	No
Scale Factor Readout	Yes	Yes
Vertical Sensitivity	2 mV/div	2 mV/div
Max. Sweep Speed	2 ns/div	2 ns/div
Accuracy: Vert/Hor	2%/2%	2%/2%
Warranty	3-year on parts and labor, including CRT	
Price	\$2400	\$1775



- 1 SmartCursors™ track trigger level, ground level or peak voltages.
- 2 CRT readout of scale factors and results.
- 3 Menu functions controlled by top row of push-buttons.
- 4 Gated voltage mode intensifies the portion of a waveform or which voltage measurements are being made.
- 5 Versatile triggering lets you trigger the main or delayed sweep.
- 6 Backlit control buttons.

**Tektronix**  
COMMITTED TO EXCELLENCE

## 10

### Analog or digital, which DMM is best?

*By Mike Hahn*

It's often not a matter of best, but of better in certain circumstances. Whether you choose digital or analog may depend on what you'll be troubleshooting.



page 10

The main advantage of the digital multimeter is its easy-to-read display.

## 18

### Don't let shutdown circuits shut you down

*By Greg Carey, CET*

The first of a 3-part series, this article gives you a step-by-step guide to troubleshooting safety shutdown circuits, from identifying the circuit to defining the symptom and isolating the cause.



page 18

Shutdown circuits can be complicated to troubleshoot, but once you know how they work, you can quickly zero in on the problem.

## 58

### Test your electronics knowledge

*By Sam Wilson, CET*

Can you answer a typical second-class FCC license test question? If you're not sure, this month's quiz will be a good study guide.

## 60

### What do you know about electronics? – do-it-yourself test equipment

*By Sam Wilson, CET*

Sometimes the perfect piece of test equipment just isn't being manufactured. With a little spare time at the bench, you can create some simple but useful tools. Also, a note on the potentiometric method.

## Departments:

- 4 Editorial
- 6 News
- 8 Photofact
- 33 Profax
- 49 Literature
- 57 Books
- 64 Video corner
- 66 Audio corner
- 67 Products
- 68 Computer corner
- 70 Readers' Exchange
- 72 Advertisers' Index



# LEADER



**NOW  
Battery  
Powered!**

Choose the New LBO-315 for ac/dc,  
or the current LBO-325 for ac only.

**Sometimes it's hard to  
go back for a scope!**

**60-MHz full-function  
field-service Attache Case  
Oscilloscope is so light and  
small it will be taken  
everywhere, every time.**

LBO-325 packs all the power and performance of a cumbersome, backbreaking, 60-MHz workbench oscilloscope into an easy-to-carry, ultra-compact, featherweight unit. Although its 3½-inch CRT is as big and clear as screens on large field-service scopes—LBO-325 weighs only 9 lbs. So it won't weigh field-technicians down, no matter how far afield they go! LBO-325 is so small it fits inside a 3-inch deep attache case with room to spare for a multimeter, service manuals and some tools. The ideal full-function scope for a cramped work area or crowded bench.

**Reduces the cost of  
service calls.**

Time is money. A scope left in the vehicle takes time to retrieve. One kept in the shop causes repeat service calls. The LBO-325



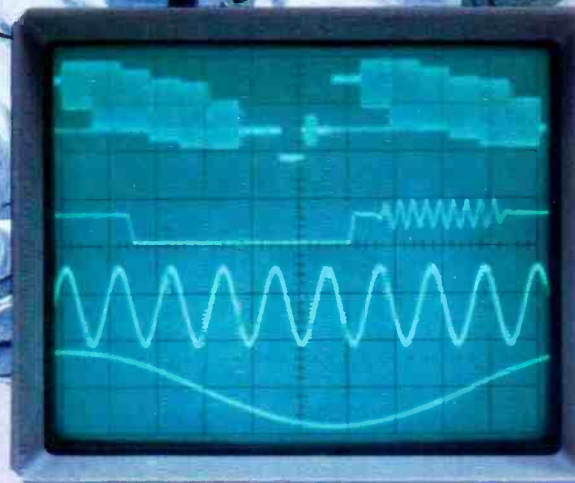
Attache Case Oscilloscope is so easy to carry and use, techs will take it everywhere, every time. And the time saved translates into extra profits for years to come.

**Outperforms all other  
portables:**

- 60 MHz • Dual channel • ALT TIME BASE simultaneously displays main waveform and any expanded portion
- ALT TRIG for stable display of 2 asynchronous signals • Bright, sharp 12-kV trace • Large 3½-inch PDA CRT • Illuminated graticule
- Comprehensive triggering • TV-V and TV-H sync separators • Variable trigger hold-off • Delay line shows sharp leading edges • CH-1 output drives low-sensitivity instruments
- Measures only 3 x 9 x 11⅞ inches • Weighs 9 lbs.

**Two-year warranty.**

Built tough to provide long life, LBO-325 is backed by Leader's 30-year reputation for reliability and by factory service depots on both coasts.



LBO-325 CRT is shown actual size.

Call toll-free  
**(800) 645-5104**  
In NY State  
**(516) 231-6900**

Request an evaluation sample, our latest Test Instrument Catalog with over 100 outstanding products, the name and address of your nearest "Select" Leader Distributor, or additional information.

For professionals  
who  
know  
the  
difference.

**LEADER**  
Instruments Corporation

380 Oser Avenue  
Hauppauge, New York 11788  
Regional Offices: Chicago, Dallas  
Los Angeles, Boston, Atlanta  
In Canada call Omnitronix Ltd.  
(514) 337-9500

For Demonstration Circle (43) on Reply Card

## Helping us help you

Consumer electronics technology continues to advance at a breakneck pace. Not only are manufacturers producing a stream of new products, such as digital audio CD players and, more recently, digital audiotape, but the technology of the old standbys, such as television and stereo, are constantly being updated.

Take, for instance, one of today's high-end TV sets. You'll find it full of integrated circuits that give it excellent picture quality and allow you to tune the set remotely or view a program from one channel inset with a picture from another channel. These modern sets have startup and shutdown circuitry that provide additional safety factors.

All of this new technology is of great benefit to consumers, but it frequently causes additional problems for servicing technicians. When a TV set fails, for example, is it a simple problem with one of the TV circuits, or did something trigger shutdown? Or did the startup circuitry fail to operate properly for some reason? What's inside one of the ICs, and how do you tell when one is malfunctioning? And how does that digital circuitry operate?

These questions and more have been asked by readers in letters, in phonecalls and in some of the questionnaires we have included in past issues of *ES&T*. One of this issue's articles, "Don't Let Shutdown Circuits Shut You Down," is in direct response to an overwhelming number of reader requests that we publish articles on that subject. In the future we'll be running more articles on subjects that have been specifically requested by readers.

This issue presents an especially good opportunity for readers to tell us what kind of articles they want to see in *ES&T*. We are, at this moment, planning the articles that will be published next year. To help us find out what articles *you* want, we're running a special questionnaire on one of the pages of heavier paper in this issue, page 45. The answers to that questionnaire will provide us with important information about you and your information needs. Won't you take just a moment to complete that questionnaire?

Another important source of information that helps us know more about our readers is the Reader Service card in every issue. It gives you a convenient way to request

additional free information from advertisers or companies whose products or literature are mentioned in the issue, and it tells us more about you: the type of business you're in, your position, the type of work you do. This information is also vital to us in planning what types of articles to publish. If you do send in a Reader Service card, won't you fill out those spaces and tell us that valuable information?

There is one more piece of information that you can easily communicate to us if you use the Reader Service card. We really want to know what you think about this issue and every issue of *ES&T*. The box on the address side of the Reader Service card provides a space for you to say a few words about whether or not the issue fulfilled your needs for information and if it appealed to you. Won't you take a few moments to fill it in?

Below that is another space where you can tell us what kind of articles you'd like to see in future issues of *ES&T*. In the past, comments in that space have led to specially commissioned articles about frequently requested information. Tell us what you want to see and we'll try to oblige.

### Readers' Exchange

Readers' Exchange is a free service that we provide to *ES&T* readers. Judging by the number of items we publish each month, it's a popular service. It allows readers to contact each other in order to buy and sell equipment and share information.

If you wish to make use of this service, there are only two things we ask: 1) Please limit your For Sale or Wanted items to only three. Space in the magazine is limited and we can't possibly publish someone's long list of items. 2) Please type your Reader's Exchange items when possible, and if that isn't possible, please print carefully and legibly. Please spell out names of manufacturers and products, and if there's any possibility of miscommunication, please provide any clarifying remarks that might be necessary. If we can't read an item, we'll return it and ask that it be resubmitted, and that wastes your valuable time.

*Nile Conrad Pearson*



**SCOPE 3½ Digital Multimeters**



**Model DVM-638**  
**\$7995**

- Test leads included
- 11 function, 38 ranges
- Logic level detector
- Audible visual continuity
- Capacitance and conductance measurement

**Model DVM-634**  
**\$5275**

- 7 function, 32 ranges
- Transistor measurement

**Model DVM-636**  
**\$5875**

- 8 function, 37 ranges
- Capacitance measurement

**SCOPE 3½ Digit Capacitance Meter**



**Model DCM-602**  
**\$5500**

- Test leads included
- 8 ranges with full scale values to 2000 uF
- LSI circuit
- Crystal time base
- Frequency range 800 Hz to 8Hz

**SCOPE Pocket Sized Audio Signal Generator**



**Model RC-555**  
**\$4995**

- Test leads & 9V battery included
- Low distortion sine-wave signal
- 46 step selected frequency
- x1 range 20 Hz to 1.5 KHz
- x100 range 2 KHz to 150 KHz

**SCOPE 4½ Digit LCD Bench Digital Multimeter**



**Model DVM-6005**  
**\$19995**

- Test lead set 6, "D" size batteries included
- 0.4" high characters
- Conversion period: 500 milliseconds
- Automatic, negative polarity

# Mini-Meters with Maxi-Specs

**SCOPE 3½ Digit LCD with 8 Full Functions**

**Model DVM-632**

**\$4495**  
OUR PRICE

Measures only 5 5/8" x 2 13/16" x 1 1/4"

- Deluxe test leads included
- 0.5% accuracy
- Transistor gain test
- Audible continuity checking & diode test
- 10 Amp measurement

Zipper Carrying Case CC-30 **\$450**



**SCOPE 3½ Digit LCD**

Measures only 5" x 2 3/4" x 1 1/8"



**Model DVM-630**  
**\$2995**

- OUR PRICE
- Test leads included
- 0.5% accuracy
- 6 functions, 19 ranges
- Automatic zero adjust
- Low battery indication

Zipper Carrying Case CC-30 **\$450**

ASK FOR FREE CATALOG.

Money orders, checks accepted. C.O.D.'s require 25% deposit.



# Fordham

260 Motor Parkway, Hauppauge, NY 11788

Toll Free **800-645-9518**  
In NY State **800-832-1446**

**Service & Shipping Charge Schedule Continental U.S.A.**

FOR ORDERS	ADD
\$25-\$100	\$4.50
\$101-\$250	\$6.00
\$251-\$500	\$8.00
\$501-\$750	\$10.50
\$751-\$1,000	\$12.50
\$1,001-\$1,500	\$16.50
\$1,501-\$2,000	\$20.00
\$2,001 and up	\$25.00

Circle (5) on Reply Card

## DAT legislation on hold

In response to the controversy surrounding digital audiotape (DAT) recorders and the CBS anti-taping chip's audible distortion of music, the congressional committee studying the problem has asked the National Bureau of Standards (NBS) to test the chip. NBS is expected to conduct the test within the next few months. CBS has refused to release the exact specifications of its system unless assured that NBS will keep them confidential.

In a related development, the Home Recording Rights Coalition (HRRRC) has been joined by several recording artists in the fight against legislation that would prohibit for three years the U.S. manufacture, sale, resale, lease or distribution of DATs that do not contain an anti-taping chip.

## EIA publishes consumer electronics sales figures

Sales of color televisions expanded during the first half of 1987, according to the Electronics Industries Association (EIA), Washington, DC.

Color TV sales to U.S. dealers totaled nearly 8.8 million units during the January to June period, as compared with 8.1 million during the first half of 1986. June sales topped 1.7 million units, a 10% improvement over the same month last year. EIA predicts that at least 18.3 million color sets will be sold in 1987, which would make this the biggest sales year in the product's history.

In terms of percentage growth, however, the hottest video hardware product is the camcorder (camera/VCR combinations for family movie-making). For the first six months of this year, camcorder sales totaled more than 580,000 units—a 49% jump over the same period a year ago.

For the first half of the year, almost 5.7 million videocassette recorders (VCRs) were sold to dealers, off fractionally (0.5%) relative to the January to June 1986 period. EIA predicts that 13.7 million VCRs are likely to be sold during 1987, which by year's end will extend VCR penetration to 50% of the U.S. households.

### Consumer electronics sales June 1987 vs. June 1986

	Jan.-June 1987	Jan.-June 1986	Percent change
Color television	8,768,844	8,113,441	+ 8.1
B&W television	1,415,623	1,744,956	- 18.9
VCRs and camcorders	5,690,707	5,716,562	- 0.5
Camcorders only	583,229	390,929	+ 49.2

The how-to magazine of electronics

# ELECTRONIC

*Servicing & Technology*

Editorial, advertising and circulation correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664. Home office fax: 913-888-7243; Home office telex: 42-4156 INTERTEC OLPK

## EDITORIAL

Nils Conrad Persson, *Editor*  
 Carl Babcoke, *Consumer Servicing Consultant*  
 Dan Torchia, *Group Managing Editor*  
 Marjorie Riggan, *Associate Editor*  
 Alisa Carter, *Associate Editor*  
 Joy Culver, *Editorial Assistant*  
 Darryll Fortune, *Editorial Assistant*  
 Ramona Vassar Isbell, *Editorial Assistant*

## CONSULTING EDITORS

Homer L. Davidson, *TV Servicing Consultant*  
 Christopher H. Fenton, *Circuit Fabrication Consultant*  
 Victor Meeldijk, *Components Consultant*  
 Kirk G. Vistain, *Audio Consultant*  
 Sam Wilson, *Electronics Theory Consultant*

## ART

Kevin Callahan, *Art Director*  
 Tim Lynch, *Graphic Designer*

## BUSINESS

Cameron Bishop, *Group Vice President*  
 Eric Jacobson, *Publisher*  
 Greg Garrison, *Sales Manager*  
 Stephanie Fagan, *Promotions Manager*  
 Kelly Hawthorne, *Promotions Coordinator*  
 Dee Unger, *Advertising Supervisor*  
 Julie Chilson, *Advertising Coordinator*

## ADVERTISING

Regional advertising sales offices are listed in classified pages.

## ADMINISTRATIVE

R. J. Hancock, *President*  
 Doug Riemer, *Circulation Director*  
 Jo Ann DeSmet, *Circulation Manager*  
 Dee Manies, *Reader Correspondent*



Member, Audit Bureau  
of Circulation



Member, American  
Business Press



Member, Electronic  
Servicing Dealers  
Association

**ELECTRONIC SERVICING & TECHNOLOGY** is the "how-to" magazine for technicians who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts, who repair and maintain audio, video, computer and other consumer electronics equipment.

**SUBSCRIPTION PRICES:** one year \$18, two years \$30 in the USA and its possessions. Foreign countries: one year \$22, two years \$34. Single copy price \$2.25; back copies \$3.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks for new subscriptions.

**PHOTOCOPY RIGHTS:** Permission to photocopy for internal or personal use is granted by Intertec Publishing Corp. for libraries and others registered with Copyright Clearance Center (CCC), provided the base fee of \$2 per copy of article is paid directly to CCC, 21 Congress St., Salem, MA 01970. Special requests should be addressed to Eric Jacobson, publisher.  
 ISSN 0278-9922 \$2.00 + 0.00

©1987 All rights reserved.



# Introductory offer!\*

12,000 V FOR THE  
BRIGHTEST TRACE!



Available  
Oct. 1st

Unbelievably  
low price of  
**\$1,895.\***  
Kenwood's CS-8010  
Digital Storage Scope

- 10 M samples/sec.
- The "read-out" function provides digital display of scale factors such as attenuator or time base setting
- The "cursor" function provides digital display or cursor measured values for voltage, time, and frequency
- 8 bit voltage resolution and 2048-word memory size for each channel
- 20MHz Real Time

Offer expires Dec. 1, 1987

Contact your nearest Kenwood Authorized Distributor for more information, for a specific instrument demo, or to place your order today!

**ALABAMA**  
Muscle Shoals  
Jones Electronics  
205-383-8188

**ARIZONA**  
Phoenix  
Tri-Tek, Inc.  
602-371-0860

**ARKANSAS**  
Texarkana  
Booth & Harris  
Electronic  
Distribution  
501-773-0800

**CALIFORNIA**  
Chatsworth  
I.T.C.  
818-700-0900  
Costa Mesa  
Marvac  
714-540-3280  
El Monte  
Marshall Industries  
818-459-5605  
Los Angeles  
I.T.C.  
213-338-5416  
Modesto  
Inland Electronic  
Suppliers  
209-524-7945  
Oxnard  
I.T.C.  
805-983-4115  
Riverside  
Electronics  
Warehouse  
714-686-6186  
San Francisco  
Zack Electronics, Inc.  
415-626-1444  
San Jose  
Quement Electronics  
408-998-5900  
Sunnyvale  
HSC Electronic  
Supply  
707-792-2277

**Torrence**  
I.T.C.  
213-370-6211  
Van Nuys  
Testek Corporation  
818-786-6890

**COLORADO**  
Denver  
Aurora Marketing Co  
303-758-3051  
CW Electronic Sales  
303-832-1111

**CONNECTICUT**  
Wallingford  
Midstate Electronics  
203-265-9900

**FLORIDA**  
Tampa  
Specialty Distributor  
813-870-3315

**ILLINOIS**  
Countryside  
Pacific Indicator Co  
312-352-3500  
Niles  
Joseph Electronics  
312-297-4200  
Skokie  
Sargent-Welch  
Scientific Co.  
312-677-0600

**INDIANA**  
East Chicago  
Acro Electronics  
219-397-8681  
Evansville  
Ohio Valley Sound  
812-425-6173  
Indianapolis  
Mar Electronics, Inc.  
317-633-6699  
Terre Haute  
Ohio Valley Sound  
812-235-6025  
Vincennes  
Ohio Valley Sound  
812-882-3615

**KANSAS**  
Wichita  
RSC Electronics, Inc.  
312-267-5213

**KENTUCKY**  
Louisville  
P.J. Burks  
502-589-3960  
Owensboro  
Ohio Valley Sound  
502-683-6727

**MARYLAND**  
Silver Springs  
Products  
International  
301-587-7824

**MASSACHUSETTS**  
Burlington  
Excalibur Electronic  
617-273-5858  
North Billerica  
Electra Test, Inc.  
617-667-8541  
Waltham  
Calibron Instruments  
617-894-6440  
Worcester  
Coghlin Electric/  
Electronics, Inc.  
617-791-7861

**MISSISSIPPI**  
Meridian  
Hooper Electronic  
Supply  
601-693-2716

**MISSOURI**  
Kansas City  
Electronics Supply  
816-931-0250  
Tupelo  
Pate Electronics Inc.  
601-842-2576

**NEBRASKA**  
Lincoln  
Scott Electronic  
Supply  
402-466-8221

**NEVADA**  
Las Vegas  
Kiesub  
Corporation  
702-733-0024

**NEW JERSEY**  
Camden  
GRS Electronic  
609-964-8560  
Clarksburg  
Accutest  
Instruments  
609-259-0460

**NEW YORK**  
Great Neck  
Instrument Mart, Inc.  
516-487-7430  
Brooklyn  
Panson Electronics  
718-383-1550  
Lindenhurst  
KSM Electronics, Inc.  
516-226-7405  
New York  
Taft Electronics  
212-575-5194  
Staten Island  
BJM Electronics  
718-442-0223

**NORTH CAROLINA**  
Greensboro  
Guilford Electronic  
Supply, Inc.  
919-275-1385

**OHIO**  
Cleveland  
Brodhead-Garrett  
Company  
216-341-0248

**OKLAHOMA**  
Oklahoma City  
Radio Supply, Inc.  
405-232-6127  
Tulsa  
Tri-State Instrument  
Laboratory Inc.  
918-836-0286

**PENNSYLVANIA**  
Erie  
J.V. Duncombe  
Electronics  
814-454-5278  
Greensburg  
Scott Electric  
412-834-4321  
Wayne  
Peak Electronics  
215-293-9000

**RHODE ISLAND**  
Providence  
Wm. Dandreta Co.  
401-861-2800

**TENNESSEE**  
Jackson  
Townsend Electronic  
Supply  
901-422-6585

**TEXAS**  
Austin  
Wholesale  
Electronics Supply  
of Austin  
512-478-9568  
Corpus Cristi  
Douglas Electronics  
512-883-5103  
Dallas  
M. Hutton and Co.  
214-484-0580  
Wholesale  
Electronics Industrial  
Supply  
214-824-3001  
Houston  
A&M Electronics  
Supply  
713-937-1900  
San Antonio  
Sherman Electronics  
Supply, Inc.  
512-224-1001

**Tyler**  
Wiltronics Supply  
214-597-6316

**VIRGINIA**  
Annandale  
Arcade Electronics  
703-256-4610  
Richmond  
Avec Electronics  
804-359-6071  
Meter Metrics  
804-275-1431

**WASHINGTON**  
Redmond  
Vanguard Electronic  
Tool Co.  
206-823-4111

**WEST VIRGINIA**  
Huntington  
State Electric Supply  
304-523-7491

**Nationwide Rental  
of Kenwood Test  
Instruments**

Genstar Rental  
Electronics, Inc.  
Woodland Hills, CA  
800-331-3440 in CA  
800-227-8409  
Orlando, FL  
800-432-0612 in FL  
800-327-0302  
Gaithersburg, MD  
800-638-4040  
Carrollton, TX  
800-492-9021 in TX  
800-323-8964

**CANADA**  
Rexdale  
800-268-4939  
Montreal, Quebec  
514-337-5573

## KENWOOD

KENWOOD U.S.A. CORPORATION  
2201 E. Dominguez St., Long Beach, CA 90810  
P.O. Box 22745, Long Beach, CA 90801-5745  
213-639-9000

(Ask for "Test Equipment")

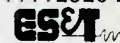
Specifications and price subject to change without notice or obligation.  
\*This introductory Offer expires Dec. 1, 1987.

Circle (6) on Reply Card

# Photofact

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

<b>GENERAL ELECTRIC</b> CHASSIS X110-A ..... 2516-1	<b>PANASONIC</b> CTH-1040R, CTJ-1040R (CH. NMX-K10D) ..... 2522-2
<b>HITACHI</b> CT2065W ..... 2518-1	<b>SEARS</b> 564.40551650/51, 564.40560550 ..... 2517-2
<b>HITACHI</b> CT1367 ..... 2521-1	<b>SEARS</b> 564.42861650/51/52 ..... 2519-1
<b>HITACHI</b> CT226714 ..... 2522-1	<b>SHARP</b> 25KT15 ..... 2516-2
<b>MAGNAVOX</b> CHASSIS 25C802/803/805/819, 26C801/802/803/810/811/812/813/815/818 ..... 2521-2	<b>SONY</b> KV-2775R (CH. SCC754B-A) ..... 2518-2
<b>PANASONIC</b> CTG-1311, CTH-1311 (CH. GP113/NMX-L4) ..... 2517-1	<b>SHARP</b> 14KV455, 14KV465 ..... 2519-2
<b>PANASONIC</b> CTH-2560R (CH. GXLHM) ..... 2520-1	<b>SHARP</b> FF25664, 25KT55 ..... 2520-2



## DIGITRON ELECTRONICS PRESENTS...

### HIGH VOLTAGE TRIPLERS/ MULTIPLIERS

REPLACEMENTS FOR ECG®...  
GE®... SK®



TYPE NO	3 MIN	100 MIN
500A/GE527... SK3304	7.90	6.95
523/GE528... SK3306	7.75	6.50
526A/SK3306	7.75	6.50
528/SK3906	8.75	7.75
529/GE529... SK3307	8.75	7.75
NEW 559	18.95	16.95
NEW 560	17.75	16.25
NEW 561	18.45	12.95

### FLYBACKS



ORDER TYPE	DESCRIPTION	PRICE
FLY 200	SANYO #4-2751-60108	7.95
FLY 205	SANYO #4-2751-48600	7.95
FLY 210	SANYO #4-2751-48500	7.95
FLY 215	SANYO #F0-192	11.95
FLY 220	SANYO #F1123	11.95
FLY 225	SANYO #F0-239	12.75
FLY 230	IBM #74730102538	22.50
FLY 235	SHARP #RTRNF2037TAZZ	12.95
FLY 235	SAMPO #8FT046	12.95

### FOCUS DIVIDERS



<b>FD100</b>	REPLACES SANYO & SEARS #ESPA-98-F1 • #Z0064 • ESPA-94	8.95
<b>FD200</b>	REPLACES SANYO & SEARS #ESPA-91	8.95

### OUTPUT TRANSISTORS



TYPE	10	50	100
165	1.99	1.75	1.55
238	1.99	1.75	1.55
283	2.49	2.25	1.65
389	2.95	2.75	2.25
2SD1341P	1.65	1.45	1.35
BUY69A	2.49	2.25	1.65

### ADDITIONAL REPLACEMENT FOR POPULAR ECG® TYPES

TYPE	10	50	100	TYPE	10	50	100	TYPE	10	50	100
85	17	16	15	171	30	28	25	291	45	43	39
102A	25	22	19	172A	12	11	09	292	45	43	39
116	07	06	05	184	30	28	25	319P	24	20	18
123A	14	12	10	185	30	28	25	331	40	38	35
123AP	08	07	06	194	10	09	08	332	40	38	35
125	07	06	05	196	38	34	30	375	45	43	39
128	29	26	23	197	38	34	30	376	48	44	40
129	29	26	23	198	44	39	36	379	1.45	1.35	1.25
152	25	22	18	199	10	09	08	394	1.95	1.85	1.75
153	25	22	18	233	10	09	08	396	75	68	60
154	49	45	40	234	10	09	08	397	75	68	60
156	19	17	15	261	39	36	33	398	55	49	45
157	38	34	30	262	42	39	36	399	39	36	30
158	30	28	25	263	39	36	33	506	48	38	29
159	10	09	07	264	42	39	36	552	28	24	19
162	1.80	1.65	1.45	265	36	33	30	712	85	75	65

### MORE SAVINGS

	10	50	100
LA1365	85	75	65
2SD1398	1.95	1.85	1.75
2SD313	40	38	35
2SB324	35	28	25
2SD613	48	44	38
2SD401A	85	75	65

PRICES SUBJECT TO CHANGE WITHOUT NOTICE. OFFER GOOD WHILE SUPPLY LASTS. ECG is a Trade Mark of Philips ECG, Digitron Ele. not associated with Philips ECG.

MINIMUM ORDER \$25

**DIGITRON ELECTRONIC CORPORATION** 110 HILLSIDE AVENUE • SPRINGFIELD, NEW JERSEY 07081  
201-379-9016 • 201-379-9019 • 1-800-526-4928 • TLX 138441 • FAX 201-467-8065

Circle (20) on Reply Card





### \$75 DMM MEASURES CAPACITANCE, TRANSISTOR HFE, MORE...

B&K-PRECISION'S new 2905 is a more-than-full-  
3½ digit DMM, at a surprisingly low price. Features include 0.5% VDC accuracy; 100 µV, 0.1 µA, 0.1 Ω, resolution. Measures capacitance to 20nF with up to 1pF resolution. Audible continuity and diode junction tests are built in. For field survivability, it features a drop resistant case, reverse polarity and overload protection and high-energy fusing. Contact: B&K-PRECISION, 6460 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

B&K-PRECISION'S new 2905 is a more-than-full-  
feature 3½ digit DMM, at a surprisingly low price. Features include 0.5% VDC accuracy; 100 µV, 0.1 µA, 0.1 Ω, resolution. Measures capacitance to 20mF with up to 1pF resolution. Audible continuity and diode junction tests are built in. For field survivability, it features a drop resistant case, reverse polarity and overload protection and high-energy fusing. Contact: B&K-PRECISION, 6460 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.

### FREQUENCY COUNTER AND DATA HOLD HIGHLIGHT NEW 4½ DIGIT DMM

For engineers in need of a high-accuracy 4½ digit DMM and a low range frequency counter the 2940 is made to order. DC voltage accuracy is 0.05%. Resolution is 10µV, 10nA, and 0.01Ω. Frequency measurements span from 20Hz to 200kHz with up to 1Hz resolution. The 2940 features a drop resistant case with full internal circuitry protection.

**\$155.00** Contact: B&K-PRECISION, 6460 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.



### HAND-HELD TEST BENCH READS VOLTAGE, RESISTANCE, CURRENT, HFE TEMPERATURE AND LOGIC.

The new 2906 3½ digit DMM from B&K-PRECISION is virtually a hand-held test bench, with a remarkable range of functions. °C and °F temperature measurements cover from -20C to 1000°C. The logic capability is ready for TTL and CMOS circuits. Other features include drop resistant case, reverse polarity and overload protection; plus high-energy fusing. DC accuracy, 0.25% VDC. **\$95.00** Contact: B&K-PRECISION, 6460 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.



### TRUE RMS DMM OFFERS PEAK HOLD, CAPACITANCE, AND LOGIC

3½ digit true RMS handheld DMM featuring 0.1% DC accuracy. Housed in an ergonomic, drop-resistant case, the 2907 offers many functions and a low price. Resolution is 100µV, 0.1µA and 0.1Ω. Capacitance to 20µF with 1pF resolution. Peak hold feature freezes transient readings. Fully protected. Also checks logic, continuity and diodes. **\$190.** Contact: B&K-PRECISION, 6460 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.



### 4½ DIGIT TRMS DMM READS FREQUENCY AND TEMPERATURE

The new 2945 is well suited for both the analog and digital worlds. DCV accuracy is 0.05%, with 10µV, 10nA, 0.01Ω resolution. Data hold freezes voltage and current readings. °C and °F temperature readings are from -20° to +1000°C. frequency from 20 Hz to 200kHz. AC voltage and current are read in true RMS. Also checks continuity and diodes. **\$250.00** Contact: B&K-PRECISION, 6460 W. Cortland Street, Chicago, IL 60635 (312) 889-9087.



*RT Check out these features & prices. wow! FL*

# THE BEST DMM BUY? NOW IT'S B&K-PRECISION

- Better specs
- Lower prices
- More features
- More capabilities
- More circuit and safety protection
- Ruggedized case with safety test leads

Five all-new models step ahead of the competition with better specs and higher performance per dollar. We've also packed more features than ever into every model.

All five instruments measure voltage, current and resistance, check continuity and diodes, and feature a new ergonomic case with angled LCD readout. Depending on model, additional capabilities include logic level, capacitance measurement, transistor gain, true RMS, frequency measurement, high-current measurement, data hold, peak hold and even temperature.

Like all B&K-PRECISION instruments, these new meters are made for the real world. They offer a drop-resistant case and the triple protection of reverse polarity protection, overload protection, and high-energy fusing.

Best of all, the B&K-PRECISION DMM you want is already in stock at your local distributor. Call today for full details



6460 West Cortland St. • Chicago, IL 60635 • 312 889-9087

International Sales, 6460 W. Cortland St., Chicago, IL 60635

Canadian Sales, Atlas Electronics, Ontario

South and Central American Sales, Empire Exporters, Plainview, NY 11803

Circle (42) on Reply Card

# Analog or digital, which DMM is best?



It depends on what you'll use it for

By Mike Hahn

Analog VOMs long have been used in the repair and maintenance of consumer electronics products. However, developments in digital meters and in the equipment to be serviced have eroded the foundation of the analog meter. There are still applications, however, in which analog meters excel. Before Hahn is manager of test and evaluation at Triplett.

examining these areas, I'd like to give an overview of the current state of digital and analog products.

Although commercial-grade instruments were available to the industry in the early '60s, digital meters for use in servicing consumer electronics products were not abundantly available until the late '60s and early '70s. These

meters initially resembled their analog counterparts in both form and function.

Several restrictions did apply, however. These early DVMs were tied to a 110Vac power cord. They had limited resolution (about 2½ digits), were not very reliable, and often behaved unpredictably. DVM portability was achieved by using power inverters to raise bat-



tery voltages up to the potentials required to operate nixie tubes. Considering these limitations, analog meters had the edge.

In these "medieval" times, meter circuitry was usually discrete, being overpopulated with resistors, capacitors and transistors. Some designs compressed the components into standing-room-only areas, which made the circuit boards look as if they were covered with miniature cordwood. Integrated circuits gradually reduced the component count by replacing sections of the analog front-end with op-amps and sections of the digital circuitry with RTL and DTL logic devices. Similarly, the 3½-digit voltmeter came into being.

Although modernized, today's 3½-digit meter is much the same in concept as its predecessors. The slope integration technique, then and now the typical method of measurement, was reduced to microchip and resulted in *voltmeter-on-a-chip* ICs. The large majority of 3½-digit meters manufactured prior to about 1980 were based on these chips. Consequently, most digital meters from that era bear very similar characteristics, the most notable being the familiar 200mV basic range with 2,000-count resolution. All higher ranges fit this form with a simple 10:1 resistive divider between the ranges. An instrument with readouts of 0.2V, 2V, 20V and 220V is common.

In search of new capabilities, several meter manufacturers moved into custom LSIs. True rms ac circuitry became possible when Analog Devices developed a chip that contained all the necessary circuitry. Coincident with these developments, offshore competition, mostly from Japan, was becoming a threat to American manufacturers. Many American digital meter manufacturers, unable to compete with the offshore products, simply began marketing the offshore products,

with new labels bearing the American companies' logos.

#### American vs. Japanese

The outcome of this situation is a schism in product offerings to service and repairmen. Today, digital meters, with few exceptions, are manufactured offshore. These products often use a chip set developed in Japan. As with the American voltmeters-on-a-chip, these Japanese chips also are recognizable by their behavior. They are 3½-digit voltmeters with autoranging and extremely high impedance on the dc basic range. Because these chips have some features that can be programmed during manufacturing, some variations exist, but in general the chip architecture limits the amount of customizing that can be done, and consequently most of the products incorporating these chips behave similarly.

So, on the one hand we have the digital meters based on Japanese chips, and on the other hand we have American meters based on American standard ICs or custom ICs. The two groups are outwardly recognizable by the features on the meters. Of course, this basic division of meter types does not include all of the myriad possibilities. There are some offshore meters using American chips and some American meters using what appear to be Japanese chips.

#### New features

Meters with 4½-digit resolution also are commonly available. Again, there are American chips and Japanese chips to accomplish this function. One interesting 4½-digit, hand-held meter provides autoranging in volts and ohms as well as true rms ac, a built-in frequency counter, a digital thermometer, a continuity beeper, a dBm range, RELative measurements, Data Hold and Peak Hold.

The A/D converter is also a 25,000-count unit, as opposed to a 20,000-count unit. This allows the

# Performance Tools.

**Our AR-130A is always ready**— thanks to intelligent Auto-Power-Off circuitry.

- Ideal multi-purpose meter.
- 20 Amp AC/DC capability
- Transistor hFE measurement
- Gold plated PC board reliability



AR-130A

**Our AR-170 NL sets new standards**—

in telecommunications & audio equipment testing.

- Direct dBm reading (600 ohms) of systems noise level measurement
- True RMS AC measurement
- High accuracy: 20 nV, 20 μA and 20 ohm range
- .1% DC accuracy



AR-170 NL

**Our AR-690 LP conserves precious bench top space**— ideal for PC, CD and VCR service.

- 25 MHz TTL logic probe with multiple audible tones
- Special Peak Hold feature measures voltage and current



AR-690 LP

**THE American Reliance line of Test and Measurement Equipment has been getting the job done all over the world for nearly a decade. Contact us for more information.**

## 800-654-9838

American Reliance Inc., 9241 E. Valley Blvd.  
Rosemead, CA 91770 • FAX: (818) 287-8855



ARI / THE MEASURE OF QUALITY

Circle (7) on Reply Card

# AMERICAN RELIANCE INC.

## Digital multimeters

- A 3½-digit or 4½-digit meter usually is adequate. Choose one that has the greatest number of counts on each range, as this increases the accuracy and resolution.
- $\mu$ P-controlled meters often offer additional features such as autoranging and a variety of measurement functions.
- Particularly useful when troubleshooting linear ICs, they are even more useful when used in conjunction with an oscilloscope.
- Unless they are adequately shielded, they usually are susceptible to interference from extraneous noise sources.
- DVMs offer 10M $\Omega$  or more of input impedance.
- Their price ranges from \$30 to \$700 for general-purpose troubleshooting.

## Analog multimeters

- They are subject to the destruction of meter movement because of excessive current flow through the circuitry. Choose one that offers a lot of input protection.
- Usually the least susceptible to interference from extraneous noise sources, they can malfunction around an RF transmitter.
- Because of their lower input impedance (50k $\Omega$ /V) and consequent ability to inhibit noise pickup, they are often the best choice for servicing appliances.
- Incorporating multiple scales, they make several related readings available simultaneously.
- Their built-in electromechanical integration smooths jittery readings.
- They vary in price from \$10 to about \$400.

meter to measure with 5½-digit resolution (when compared to a 200,000-count, 5½-digit meter) between 20,000 and 25,000 counts. For example, a 20k count voltmeter would measure 2.2 volts as 2.200V (1mV resolution). A 200k count voltmeter would measure 2.2 volts as 2.2000V (100 $\mu$ V resolution). A 25k count voltmeter would measure 2.2 volts as 2.2000V (100 $\mu$ V resolution), or with the equivalent resolution of a 5½-digit, 200k count meter.

A more sophisticated benchtop meter has these capabilities and more. Among its features is the user-definable *comparator*. This feature allows the user to select, via the keyboard of the meter, acceptable limits to an anticipated measurement. A simple example of such a function would be the

sorting of resistors for a particular value. The meter could be set to accept only 10,000 $\Omega \pm 0.1\%$  resistors. When various resistors are connected to the meter, the meter's display indicates the resistor's value and informs the user, via annunciators in the LCD display, whether the resistor is high or low in value or is within the acceptable limits. If the resistor is acceptable, a beeper sounds. So, resistors easily can be graded as to their value. The high and low signals, as well as the *go* (acceptable) signal is available on the back panel of the meter so that external equipment, such as a sorting gate, can be controlled.

### Similarities/differences

Several basic similarities exist among hand-held digital meters.

The LCD has displaced all other technologies for readout display, primarily because of LCDs' low power consumption, which greatly extends the battery life of hand-held meters. The LCD also allows manufacturers to customize the aesthetics of their particular product by providing specialized displays for various measurement functions. Perhaps the most flamboyant display of this ability is found on a French meter that generates an analog-like meter scale on the LCD.

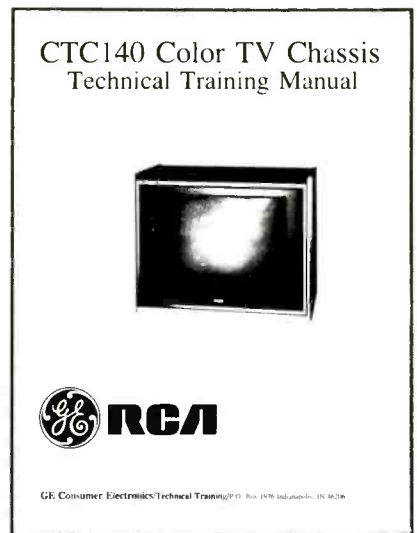
Another similarity exists in the method of powering hand-held meters. Most fall into one of two categories, either 3V power (from two AA or button cells) or 9V power (from a standard 9V transistor radio battery). The battery life is usually somewhere between 200 and 2,000 hours. Most meters are limited to a 1,000Vdc input or 750Vac input. In fact, examination of hand-held meter specifications will undoubtedly reveal more similarities than differences. Again, this results from the chips used to construct the meter.

Some differences are noted in available features. The ability to measure transistor gain and capacitance or to act as a logic probe is found on some meters. In general, these features, when included in a DMM, do not perform as well as a product dedicated to performing these tasks. They are included to broaden the appeal of the product to the user.

Some not-so-obvious differences in meters include the ability to withstand mechanical and electrical abuse. Beckman markets a line of meters advertised as being water- and drop-resistant. This is accomplished with seals and internal supports to improve mechanical stability. Fluke states that a large percentage of the circuitry in its hand-held meters is dedicated to input protection. Typical protection devices include varistors, zeners, current limiting resistors, PTCs, clamp transistors, clamp diodes, fuses, gas discharge tubes and spark gaps.



# You are only one manual away from knowing how the new technology in RCA's CTC 140 color TV chassis operates and how to service it!



Some servicers were expecting tomorrow's high-tech color TV chassis to have a lot of technician-obsoleting, expensive black boxes . . . The CTC 140 is a high-tech color TV chassis, but it doesn't have any black boxes. It is a state-of-the-art unitized chassis with advanced technology that can be easily and economically serviced by professional consumer electronic technicians . . . As a professional technician you need to learn how the new technology in the CTC 140 operates and what strategies we recommend you use to proficiently service it. That's why you should buy and carefully read the CTC 140 Color TV Chassis Technical Training Manual. Its price of \$19.95 is an excellent investment in professional upgrading . . . And to make the learning easier, we've included the companion Technical Training Workbook content at no extra charge. You get both the manual and the workbook information in one manual for only \$19.95.

## ORDER FORM

Complete this order form, make check payable to "RCA Consumer Electronics" for full amount, and send this form and check to:

RCA Technical Training/1-450/P.O. Box 1976/Indianapolis, IN 46206

Send me \_\_\_\_\_ copies of the RCA CTC140 Color TV Chassis Technical Training Manual with Workbook content @ \$19.95 ea.

Enclosed is my check for: \_\_\_\_\_ copies X \$19.95 = \_\_\_\_\_ total

NAME \_\_\_\_\_

STREET ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

ES0987

Circle (8) on Reply Card

September 1987 *Electronic Servicing & Technology* 13



Another area of difference, seldom mentioned, is the product's ability to perform in environments permeated with RF, such as in close vicinity to TV or radio transmitters. Because the hand-held meter's case is plastic, RF susceptibility will be affected by internal shielding and RF noise filtering.

Benchtop service industry meters are quite similar to the hand-held meters in function and often differ mostly in physical form. The most obvious difference is in the type of readout used. Because 110Vac is available to power the instrument, LEDs, gas discharge, fluorescent and Numitron displays may be used in place of LCDs.

Benchtop meters are often, *although not necessarily*, more accurate. Specifications should be examined closely to determine the performance of any product considered for purchase. In 3½-digit meters, accuracy usually varies from 0.5% to 0.1% on dc ranges; 4½-digit meters are usually accurate to 0.05% on dc. Prices range from about \$30 for an inexpensive 3½-digit pocket meter to about \$700 for a 4½-digit benchtop

meter with some additional measuring features.

#### New ideas in analog

Analog VOMs have remained unchanged in function for years. However, some imaginative ideas have surfaced in their packaging. This is exemplified by the fold-up meter introduced by Metrawatt and later offered by Radio Shack.

Early design goals of analog VOMs centered upon extending the measurement range of the instrument while reducing the loading of the circuit under measurement. This resulted in the *vacuum-tube voltmeter*. The concept, although viable, produced a meter with unusual power requirements (plate and filament voltages) and sometimes bias supplies.

Portable VTVMs used multiple batteries to supply these needs. Some used special batteries that contained all the necessary voltages in one *block* consisting of several types of batteries in a single cardboard container. The modern version of this meter is transistorized or uses ICs. It is sometimes known as a transistorized voltmeter (TVM) or FET VOM.

Another design goal was the development of drop-resistant VOMs. The Triplett Model 60 series is an example of this technology. During in-depth testing, these meters are subjected to several 5-foot, free-fall drops onto a concrete floor. They are expected to survive with only cosmetic damage.

Perhaps the most devastating failure that can befall an analog VOM is the destruction of the meter movement by way of excessive current flow through the circuitry. This happens most often when the user inadvertently applies 110Vac to the X1 or X10 ohmmeter range. The result is a bent meter pointer and some toasted resistors. In an attempt to prevent such failures, most better-grade VOMs incorporate fuses, clamp diodes, zeners, gas discharge tubes or relays to limit or prevent damage.

#### Analog vs. digital

The cost of digital and analog meters overlap each other, inasmuch as prices range from \$30 to \$700 for a digital and \$10 to \$400 for an analog model. This can complicate choosing which meter to purchase. Following are some guidelines.

First of all, as with all products, manufacturers try to convince users that newer is better. Although there is a certain amount of truth to this claim, one should be aware that not all innovations can be used effectively for all types of electronic servicing. A case in point is the analog vs digital controversy or old-against-new technology.

For years, servicing of household appliances relied on measurements taken with non-electric analog meters. Most of the voltages measured were 110Vac, 220Vac or 24Vac. About the only resistance measurements necessary were continuity and leakage resistance from the electrical components to the case of the appliance. Analog meters served this purpose well and they continue to



satisfy the test requirements. On the other hand, digital meters or electronic VOMs actually can deceive the user. Because of their high input impedance, these meters will measure stray 60Hz noise in the air, producing readings of voltage when connected to de-energized open lines. This can be misleading to someone unfamiliar with this type of instrument.

Although appliances are using more and more electronics, most service technicians who work on this type of product consider the electronics as replaceable modules. It is therefore unnecessary to have a meter capable of troubleshooting electronic circuits. Given this criterion, a non-electronic analog meter is the best choice. It is easy for the user to understand, and it creates the fewest measurement eccentricities.

Consumer entertainment electronics, on the other hand, poses a different problem. Present designs rely on precision voltages, currents and resistances. Troubleshooting this type of equipment requires a meter with accuracy and resolution. Although a 3½-digit meter is adequate in most cases, 4½-digit meters offer a greater level of confidence in measurement accuracy. This is particularly true when measuring voltages around an IC or tuning voltages in a voltage-tuned RF stage. As with all electronic troubleshooting, it is not wise to rely upon one source of instrumentation. A good meter is the basis of a technician's required equipment, but an oscilloscope is just as useful, and in many cases, more useful. Try to troubleshoot a digital circuit without a scope!

#### Drawbacks with digital

Still, there are times when servicing consumer equipment that a digital meter is a hindrance rather than a help. A digital meter is useless for measuring quantities that change quickly over a large range of amplitudes. The user would see a constantly changing group of numbers on a digital

meter. An audio voice or music signal is a good example of such a quantity. Analog meters, called VUs (volume units), were developed years ago to measure audio signals of this type. They have standardized sensitivity and ballistic characteristics that define how the meter must respond to con-

stantly changing complex signals.

Digital meters are also a nuisance when trying to peak or null a circuit. This situation might arise when you attempt to align tape heads or an RF circuit. Although it is quite easy to understand how an analog meter shows a peak or null, these types of measurements on a

# Lose weight fast



TEST INSTRUMENTS, LOGIC PROBES, OSCILLOSCOPE PROBES, AND SOLDERING STATIONS FOR SERVICE ENGINEERS

Light weight reliable instruments and tools, portable enough to be a help, not a hindrance, affordable enough to turn a profit, not a loss.

If your solution calls for ultra-portable test instruments, universally adaptable oscilloscope probes or test lead kits, logic probes or solder/desolder equipment, call OK Industries today. We serve the U.S. with a network of over 750 distributors.

**CALL OK TODAY**

**800 523-0667**

**IN NEW YORK STATE DIAL (914) 969-6800**

**BEING THE BEST IS A MATTER OF BEING OK.**



4 Executive Plaza, Yonkers, New York 10701 USA  
Telex 125091 OK NYK, Telex 232395 OK NY UR  
Phone (914) 969-6800  
Fax (914) 969-6650



Circle (9) on Reply Card



## Good as Gold.

### The 70 Series Multimeter: The Shining Standard By Which Others Are Measured

These multimeters give you solid value for your money. A 3-year warranty keeps you from paying the price over and over for lesser quality meters.

Choose from either the basic 73 or the feature-rich 75 and 77. You'll find the features you need at the price you can afford. Touch Hold™ for holding readings. Audible tones for continuity checks. Autoranging for simple operation.

Uncompromised quality at competitive prices. Get your hands on a 70 Series Multimeter at leading electronics distributors nationwide. Or call toll free **1-800-227-3800, ext. 229** for more information.

FROM THE WORLD LEADER  
IN DIGITAL MULTIMETERS.

#### FLUKE 73, 75, 77

\$79, \$109, \$145	3-year warranty
0.7%, 0.5%, and 0.3% basic dc accuracy	Audible continuity (75 & 77)
Analog/digital display	Range hold (75 & 77)
Volts, ohms, 10A, diode test	Multipurpose holster (77)
Autorange	Touch Hold function (77)
2000+ hour battery life	



© 1987, Fluke

Circle (45) on Reply Card



digital meter require the user to calculate mentally whether a reading is greater than or less than the previous reading.

This is relatively simple to do, but it does represent additional mental fatigue if the user is performing such measurements continually. Makers of digital meters have recognized this problem and have introduced models with analog bargraphs in the LCD display in addition to the typical digital readout. Fluke hand-helds are noted for this feature.

The multiple-scale feature of analog meters, although initially confusing to someone not familiar with multimeters, has several advantages. The pointer of the meter intersects all scales simultaneously. It is therefore possible to indicate quantities that change mutually on two different scales, one above the other. For example, when you measure sine waves, rms and peak-to-peak voltages can be shown on the meter dial and indicated simultaneously. Consequently, it is unnecessary to perform calculations to convert from rms to

p-p or vice versa. On a meter that measures temperature, Fahrenheit and Celsius can be indicated simultaneously. Resistance and semiconductor material also can be indicated simultaneously.

Analog meters also have some advantages in terms of response time, depending upon the user's requirements. Because of the ballistics of the meter movement, a typical VOM will integrate the signal applied to it. In fact, this property is exploited in the ac circuit of the meter. After rectification of the input signal, there is no capacitive filtering. The meter movement itself, in effect, filters the signal, integrating the signal peaks into a smooth reading. Depending upon the update interval and amount of R/C time constants in the signal chain of a digital meter, the reading may change continuously, never stabilizing.

Personally, I use both analog and digital meters for troubleshooting consumer electronics products, selecting whichever meter best suits my intended use.

**ES&T**

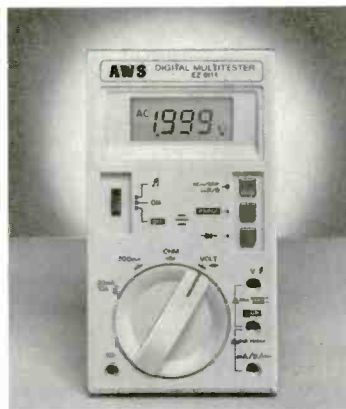


# AWS MULTIMETERS



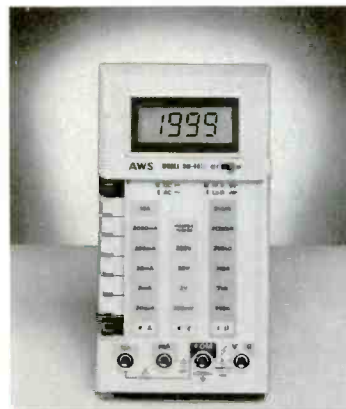
## DM-3000 3 1/2 DIGIT ROTARY SWITCH DMM

Just one of three DMM's in our Economy Series that combines quality with economy. Features include built-in HFE, battery and diode testing; conductance function; 300 hour battery life, 10A dc range; electronic overload protection on all resistance ranges; pocket-sized. (Also available models DM-1000 & 2000).  
**Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ; 1.5V battery test; 0-1000 Hfe test; 2KΩ diode test.  
 DM-1000: \$39.95 / DM-2000: \$54.95 / DM-3000: \$69.95



## EZ-6111 3 1/2 DIGIT AUTORANGING DMM

Unique and sophisticated in design, you'll find measurement taking a breeze. Loaded with features like autoranging in volts and ohms; manual range selection in all functions; diode test function; audible continuity indication; normal and low power ohm ranges; 10Aac/dc range; overload protection on all ranges; 300 hour battery life. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-2/20/200/600Vac; 0-20m/200m/10Aac/dc; 0-200/2K/20K/200K/2MΩ; 0-2K/20K/200K/2MΩ LoΩ. \$104.95



## DM-3010 3 1/2 DIGIT PUSH BUTTON DMM

The standard in tough, job-proven digital multimeters. Housed in shock resistant ABS plastic, you'll find safety was a prime design consideration. Also equipped with overload protection on all ranges; special electronic protection to 500Vac/dc on resistance ranges; UL1244 type test leads; normal and low power ohm ranges; 10Aac/dc range; auto zero and auto polarity; built-in tilt stand. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/2/10Aac/dc; 0-200/2K/20K/200K/2MΩ. \$80.00



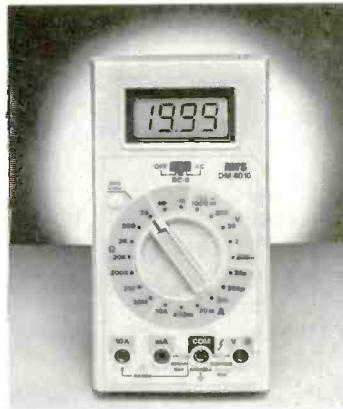
## DM-6500 3 1/2 DIGIT AUTORANGING DMM

This sensitive yet rugged instrument is loaded with features you'd expect to pay much more for. The 6500 offers autoranging; low battery consumption; fuse protection; safety test leads; audible continuity buzzer; auto zeroing; shock resistant housing. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-2/20/200/600Vac; 0-200m/10Aac/dc; 0-200/2K/20K/200K/2MΩ. \$99.95



## DM-7010 4 1/2 DIGIT ROTARY SWITCH DMM

High accuracy readings in the laboratory or in the field. Features include 4 1/2 digit 19999 max. display; built-in frequency counter to 200KHz and conductance function; 0.05% basic dc volts accuracy; overload protection on all ranges; special electronic protection to 250Vac/dc on resistance ranges; UL1244 type test leads; diode and continuity tests.  
**Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/2/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ; 0-200nS conductance; 0-20K/200KHz frequency. \$170.00



## DM-8010 3 1/2 DIGIT ROTARY SWITCH DMM

This easy to use DMM features a dc Volt accuracy of 0.25% of reading; overload protection on all ranges; special electronic protection to 500Vac/dc on resistance ranges; instant audible continuity buzzer; UL1244 type test leads; auto zero and auto polarity; diode test function; built-in tilt stand. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-20μ/200μ/2m/20m/200m/10Aac/dc; 0-20/200/2K/20K/200K/2M/20MΩ. \$84.95



## DM-6592 ELECTRO-PROBE™ DMM

One of the smallest, most convenient hand-held DMM's you'll ever own. It's both autoranging and manual and is the perfect instrument for taking readings easily and accurately in hard to reach areas. Other features include instant audible continuity buzzer; one-hand operation; electronic overload protection on all ranges; data-hold button. **Ranges:** 0-200m/2/20/200/500Vdc; 0-2/20/200/500Vac; 0-200/2K/20K/200K/2000K/20MΩ. \$70.00



## DM-1 POCKET-PRO™ DMM

Big features are packed in this pocket-calculator sized DMM. You'll find autoranging; electronic overload protection on all ranges; auto-polarity; audible and visual continuity indication; built-in test leads; "booklet-type" carrying case is designed to fit easily in shirt pocket. **Ranges:** 0-2000m/20/200/400Vac/dc; 0-200/2000/20K/200K/2000KΩ; 0-200Ω continuity. \$29.95

# A.W. SPERRY INSTRUMENTS INC.

For more information see your local distributor or contact A.W. Sperry Instruments Inc.  
 245 Marcus Blvd., Hauppauge, N.Y. 11788 • 800-645-5398 Toll-Free (N.Y. and Alaska call collect 516-231-7050).

Circle (10) on Reply Card

*This is the first of three articles explaining how to isolate high-voltage problems related to startup, shutdown and regulator circuits. Troubleshooting these circuits is complicated because all three circuits cause nearly identical symptoms. And, when shutdown happens, it does so in the blink of an eye, leaving you with a dead set and few clues.*

*Part I covers the safety shutdown circuits. Part II will concentrate on startup circuits and Part III will look at the regulator circuits, which intermingle with the other two. These three articles will combine to give you a full understanding of modern television horizontal output circuits.*

Shutdown circuits protect the owner of the TV receiver in several ways. First, they prevent excessive x-ray emission if the high voltage goes over its normal limits. Second, they reduce the chance of fire caused by a major failure. Third, they prevent a defect in one circuit from causing damage to other components.

Safety shutdown circuits became popular when manufacturers eliminated the bulky and expensive power transformer. The iron-core transformer developed the many power supply voltages, but it was always a source of wasted energy. However, the transformer also acted like a big sponge to soften surges in the ac line. With the transformer gone, some other means of protection was needed.

The horizontal output stage has suddenly taken over all the responsibility of power distribution and surge protection. The power handled by the flyback and output transistor is increased, because every microampere of current needed to operate the set now comes through them via scan-derived supplies. Surges on the ac line, including those induced by nearby lightning strikes, must now be absorbed by the output stage and its voltage regulator. All these things make the output stage more subject to damage and harder to repair.

The basic operation of the safety

# Don't let shutdown circuits shut you down

**Learning how shutdown circuits work and how to diagnose them will allow you to get TV sets back in operation quickly.**

By Gregory D. Carey, CET



shutdown circuit is really quite simple. A circuit senses an electrical parameter such as voltage or current. If the parameter exceeds a safe limit, the circuit interferes with the operation of the horizontal circuits. This sound simple, but

there are many factors to complicate matters. The circuits are easier to understand if you look at the different kinds of sensors first, and then look at the different ways the circuits interrupt the horizontal stages.



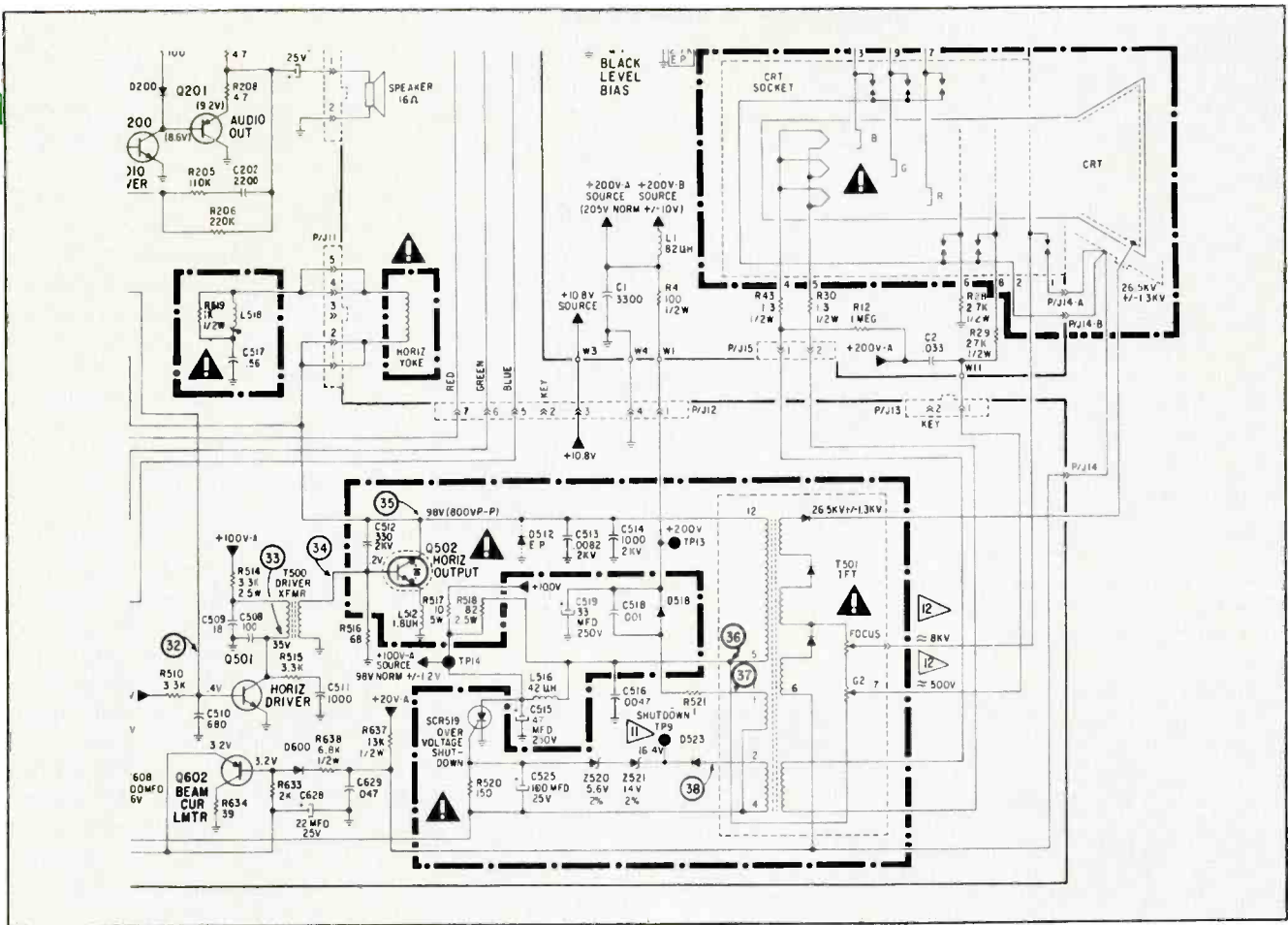


Figure 1. A simple but effective detector consists of a winding on the flyback that feeds to a level detector. This circuit shuts down the set if the flyback pulse is larger than the two zener voltages. (Schematic diagram courtesy of NAP)

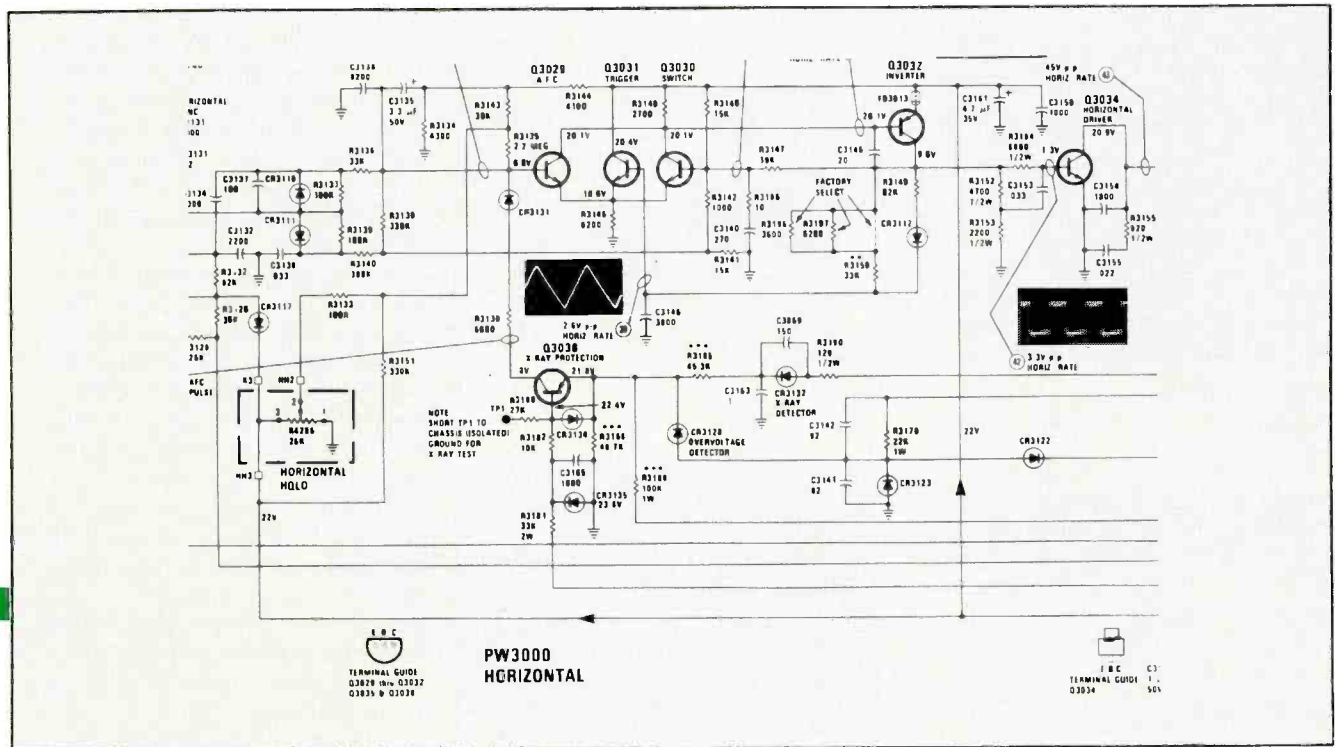


Figure 2. In some chassis, such as this RCA chassis, dc voltage from power supplies, CRT biases and high-voltage returns can be used to trigger shutdown. (Schematic diagram courtesy of RCA)

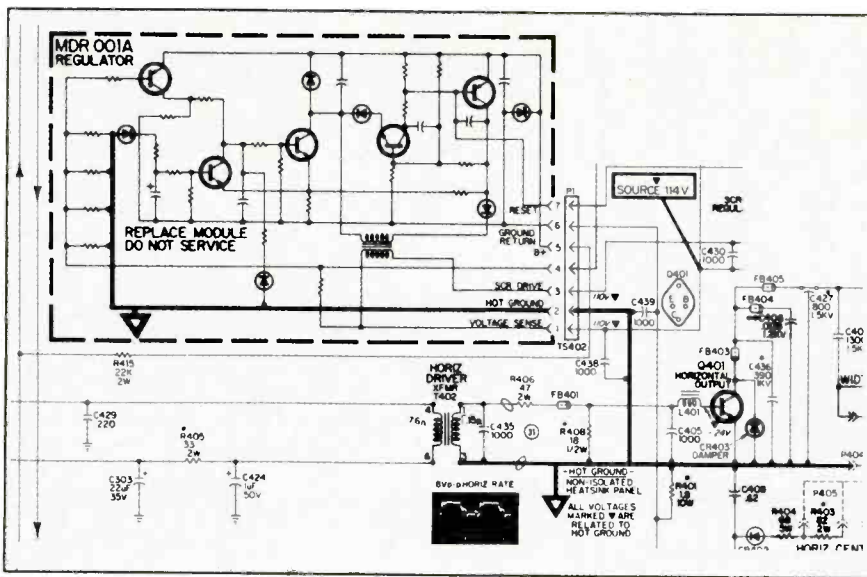


Figure 3. RCA models with a separate hot and cold ground also sense the current in the horizontal output stage by means of the 1.8Ω resistor used as a current shunt. (Schematic diagram courtesy of RCA)

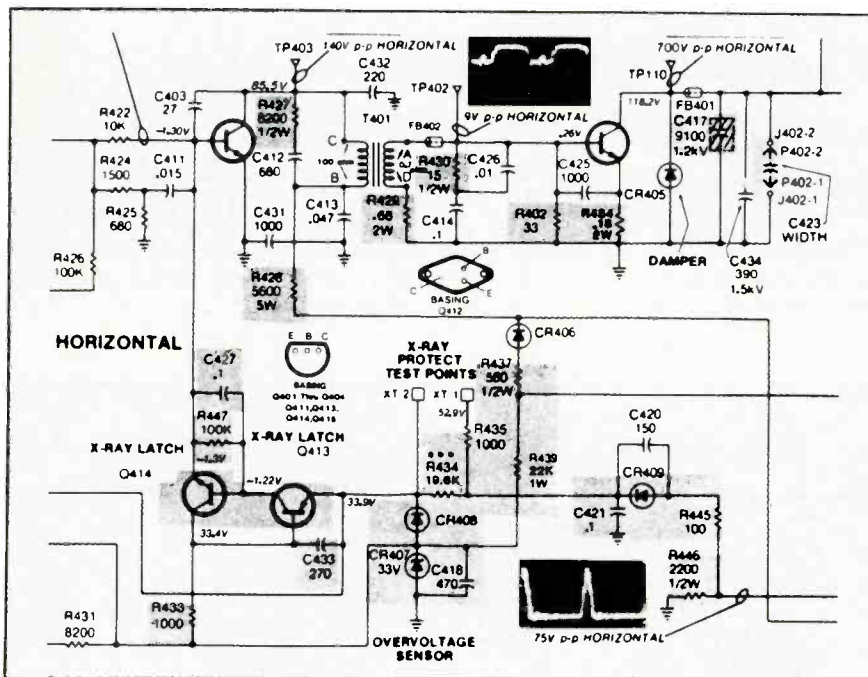
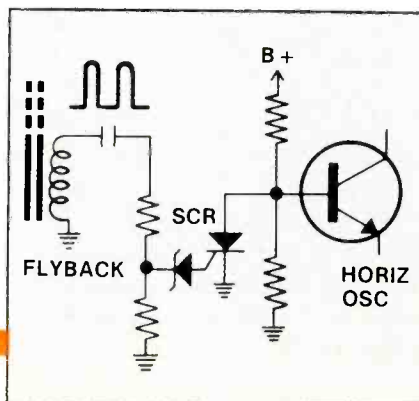


Figure 4. The most common method of shutting down the circuits is to block the drive to the horizontal output circuits. (Schematic diagram courtesy of RCA)

Figure 5. Some units use an SCR to short the drive signal to ground when a trigger signal has been applied to its gate.



### The sensors

Shutdown circuits need a method of sensing when something has gone wrong. Three methods are commonly used: sensing a flyback pulse, monitoring a dc voltage and sensing the horizontal output transistor current. All these sensors detect whether an ac or dc signal is larger than a particular level. Sometimes a single sensor has inputs from two or three sources, allowing several test points to be monitored simultaneously.

The most common sensor is a winding on the flyback transformer that feeds to a level detector. Excessive amplitude of the pulses from this winding means voltages at the other flyback outputs are too high. Shutdown occurs.

The winding usually connects to a transistor, diode or zener diode that has been biased just below the winding's normal pulse amplitude. If the pulse exceeds the normal level, it causes the diode or transistor to conduct, which in turn activates the circuits that interfere with the horizontal stage.

Figure 1 (page 19) shows a common version of this sensing technique used in the NAP 19C7 chassis. The zener diodes (CR520 and CR512) normally do not conduct because the pulses coming from pin 2 of the flyback are lower than the zener breakover voltage. If the pulses become larger than 19.6V (the two zener voltages), the zeners conduct, firing the shutdown SCR (SCR519), shutting down the output stage.

Safety sensors may also monitor dc voltages. Some RCA chassis, for example, sense a regulated dc power supply, the beam current coming back from the CRT, and the dc at the CRT screen grid. If any of these voltages climbs too high, the set shuts down.

Figure 2 (page 19) shows the method RCA used in the CTC97 chassis to combine a pulse detector and a dc level detector in a single transistor. The dc arrives through the emitter resistor (R3198), which comes from the low side of the high voltage flyback winding. This signal represents the total beam current drawn by the CRT. If the dc is too high, the x-ray protection transistor (Q3080) turns on. The same transistor also monitors two puls-



# Philips ECG



## Unveiling America's best value in Multimeters!

Now at your Philips ECG Distributor the best-performing, competitively priced new line of ECG Multimeters.

Now your multimeter dollars buy you the best values when you invest them in our new line of ECG multimeters. Whether you need one or fifty, for bench work or on-site testing, Philips ECG gives you accuracy, performance and quality features at a very competitive price. Call your Philips ECG distributor today. He has the widest range of best alternatives in multimeters.

Your opportunity to get the best alternative at competitive prices is repeated again and again in a wide range of electronic replacement parts from Philips ECG. And there are hundreds of Philips ECG distributors nationwide who offer you fast service and great prices on over 4,000 different types

of ECG devices that meet or exceed original equipment specs and replace more than 240,000 industry types.

From Multimeters to micro-processor ICs, your local Philips ECG distributor has the equipment, replacement parts and cross-reference manuals you need. He'll put them in your hands fast. Call him today.

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

# Philips ECG

*A North American Philips Company  
Dedicated to Excellence.*



**CALL 1-800-225-8326 FOR YOUR NEAREST PHILIPS DISTRIBUTOR**

Circle (18) on Reply Card

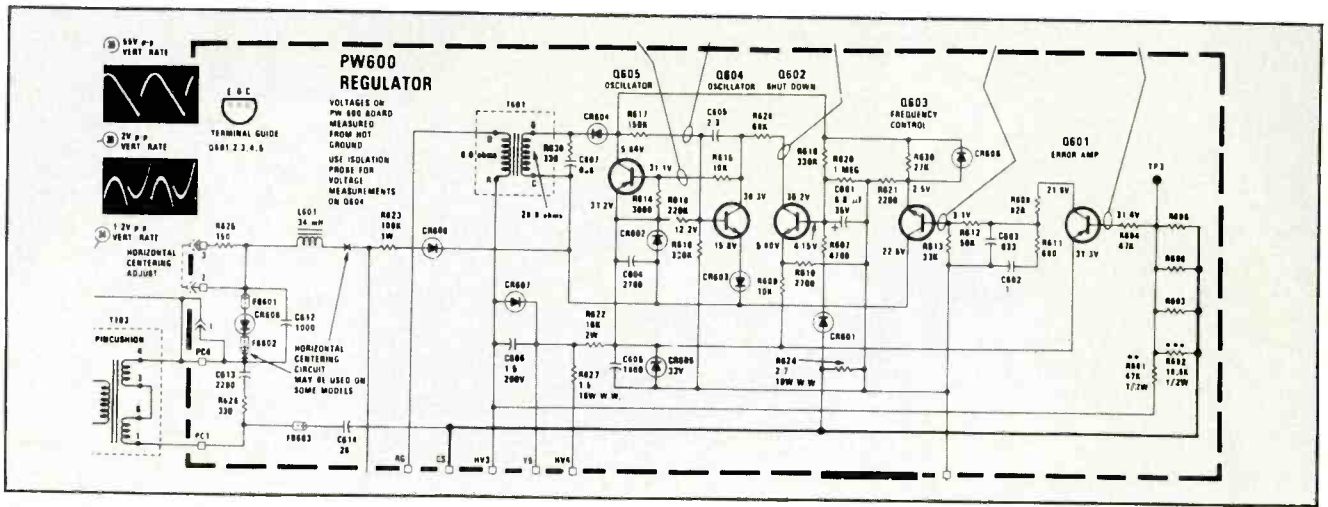


Figure 6. Many RCA chassis also include an extra safety circuit that shuts down the power supply oscillator during some overload conditions. (Schematic diagram courtesy of RCA)

es from the flyback, which enter through the x-ray detector diode (CR3132) and the overvoltage detector diode (CR3120). If either pulse is large enough to cause the transistor to conduct, the set goes into its protection mode.

A third kind of sensor monitors the current drawn by the horizontal output transistor. Figure 3 (page 20) shows how the RCA CTC89

chassis does this. The 1.8Ω resistor (R401) is between the emitter of the output transistor and the negative side of its power supply. The resistor acts as a current shunt. If the voltage across the resistor is too high, we know (from Ohm's Law) that the transistor is conducting too much current. There must be something wrong in the output stage, so the set shuts down

to prevent damage to other components.

Some receivers use only one of these sensors. If so, it is generally the pulse sensor connected to the flyback winding. Some chassis, however, use two or three sensing methods. Because each sensor may monitor several test points, as many as six different circuits may trigger a shutdown. In any case,

# CIRCUIT TRANSPORT CASES

## Physical and static protection for valuable circuit boards.

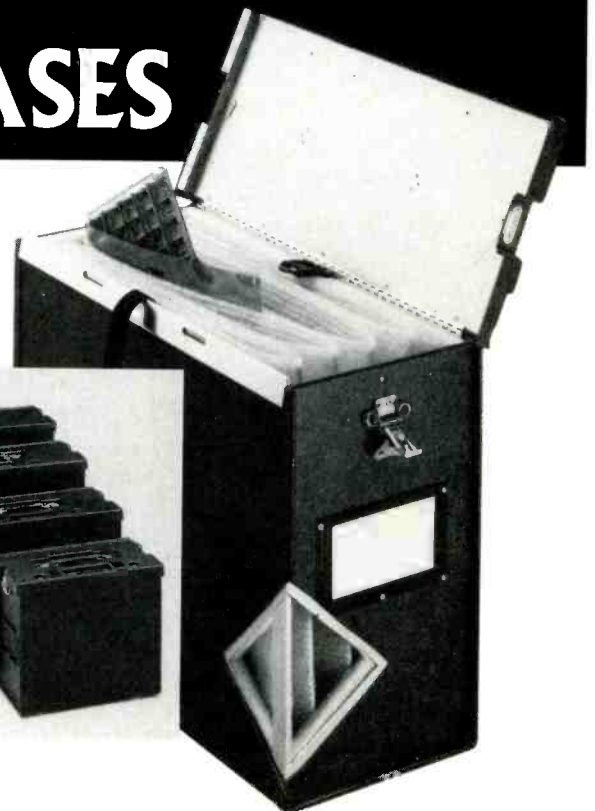
Put tough protection around your expensive circuits during transit and storage with economical "Fortress" cases from Atrix. These double-wall units guard against static, RF and EMI, as well as mechanical stress.

- Rugged layered construction — ABS plastic over aluminum
- Sizes to suit various circuit boards — 24 models from 12 x 14 to 18 x 24 inches, all 8-inches wide, custom sizes also available
- Supplied with static dissipative Z-fold foam packing and tie-down straps
- Flush handle, sealable latches, stackable in any combination of sizes, with case-to-case grounding

Call the Atrix Easy-Order 800 Number for fast service.

 ATRIX, INC 14221 Ewing Avenue South Burnsville, MN 55337

(612) 894-6154 1-800-222-6154 FAX (612) 894-6256 Telex 9102400139  
Circle (12) on Reply Card





the horizontal stage is affected.

### Affecting the horizontal

Sensing a problem is only half of the job. The sensor must, in turn, do something to the horizontal circuits to affect their operation. There are three methods used: blocking the drive, interrupting the power supply and throwing the horizontal oscillator out of sync.

The most common shutdown circuit blocks the drive to the horizontal output stage. Figure 4 (page 20) shows how the RCA CTC108 accomplishes this. If the safety transistor (Q414) is turned on, it drives the horizontal driver (Q411) into saturation, which blocks the output of the horizontal oscillator. Some chassis may use an SCR in a similar manner, where the SCR diverts the drive signal to ground, as Figure 5 (page 20) shows.

The second kind of shutdown circuit interrupts the power supply. RCA blocks the oscillator that operates the regulator oscillator, as Figure 6 shows. The NAP 19C7 chassis shown in Figure 2, by comparison, uses an SCR to divert the power around the output circuit in a crowbar fashion. If the SCR (SCR519) turns on, it grounds pin 5 of the flyback, which is the B+ source for the output stage.

The third method was used by RCA for many years (see Figure 7, page 24). Instead of shutting down the chassis, it only throws the horizontal circuits a long way off frequency. This may not seem effective, unless you remember that the amount of high voltage depends on the repetition rate of the flyback stage. Lowering the operating frequency prevents the voltage from getting too large. It also ensures that the set's owner will seek service, because adjusting the horizontal hold control has no effect on the picture.

Sets that use the out-of-sync scheme often include additional shutdown circuits as well. Some problems trigger the circuits that cause complete shutdown; other problems cause the horizontal to operate at the wrong frequency.

### What causes shutdown?

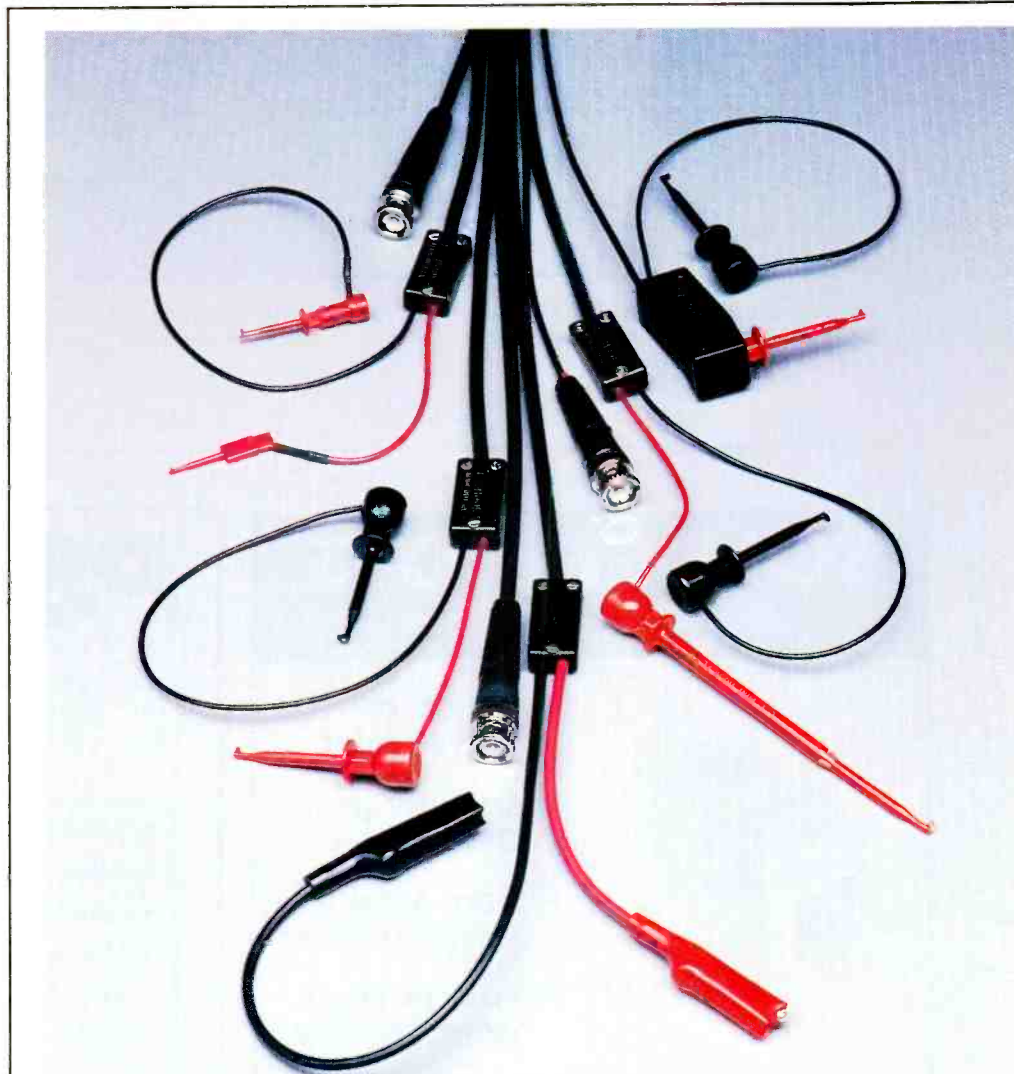
A few circuit failures cause most shutdowns and would cause unsafe conditions if allowed to continue. Knowing these causes helps you

find the shutdown problem faster.

Defective voltage regulators are common causes of shutdown. Regulators commonly short, applying raw dc to the output transistor instead of the reduced dc that should be there. If allowed to operate like this, the high voltage would rise dramatically. If, for example, the set normally uses 30kV, a shorted regulator may produce voltages of over 40,000V. X-ray emission may double, arcing may occur and the yoke or flyback may burn out.

High voltage may also rise if capacitance between the emitter and the collector of the horizontal output transistor becomes too small. Some sets use a single *safety capacitor*, while others use several capacitors in parallel. A single capacitor may change in value, or one of the multiple capacitors may open. (See Figure 8, page 50.)

Reduced capacitance causes the flyback pulse to become too narrow. Because the high voltage is based on the *rate of change* of the



## PROBES AND LEADS ANYWAY YOU WANT THEM. STANDARD.

From our 112-page Catalog, or to suit your special needs. Unequaled reliability, immediate shipment, service and selection.

# E-Z-HOOK

E-Z HOOK, A Division of Tektest, Inc., 225 North Second Ave., Arcadia, CA 91006

P.O. Box 450, (818) 446-6175. TWX 910-582-1614.

Circle (13) on Reply Card

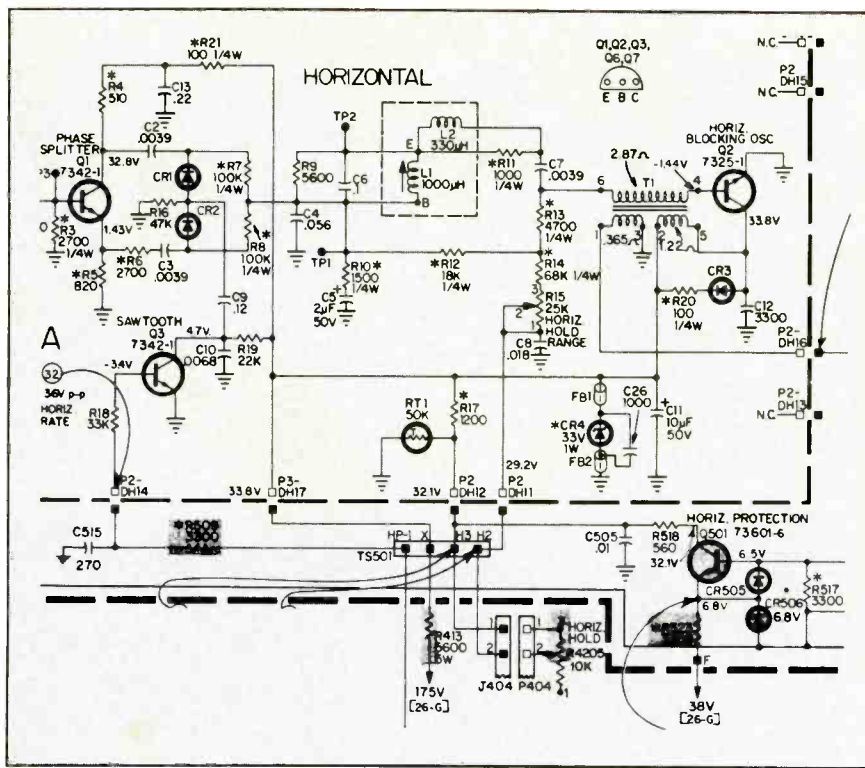


Figure 7. Many older RCA chassis had a third type of safety circuit that applied dc to the horizontal oscillator frequency control in order to shift its operating frequency. (Schematic diagram courtesy of RCA)

flyback current, a narrow pulse causes the voltages to rapidly increase.

If one of the flyback loads opens, the voltages at the other flyback outputs may increase. This is especially true if the open load normally carries heavy current, such as a power supply for the vertical output or the video output stage.

Sometimes the problem is in the shutdown circuits themselves, leading to nuisance shutdowns. A critical component, such as a transistor or SCR, may short, causing the chassis to shut down every time it is turned on. Or a zener diode may change in value just enough to cause random shutdowns. In such cases, the set may work for hours or even days at a time and then shut down for no apparent reason, or the chassis may work at reduced ac line voltage, but shut down when the voltage increases.

*Continued on page 50*

## SOLDER POTS

Standard & Custom



- Round or Rectangular
- Shallow or Deep
- Iron, Steel or Stainless Steel
- Low or High Watt Density

ALSO: Wire Strip, Dip Coat, Wax, Glue, Etc.

CAIG Solder Pots are available with full heat operation, thermostat controls or SCR time proportional controls. Many wattages and voltages are available with temperatures up to 1,100°F.

**CAIG LABORATORIES INC.**

1175 O Industrial Ave., (P.O. Box 2) Escudido, CA 92025 0051 U.S.A. • (619) 743 7143

Circle (14) on Reply Card

## PSP

Service Software System  
only \$495.00  
all this for one low price!

- Tracking through complete repair cycle...
- Billing (automatically tabulates interest)...
- Aged Receivables...
- Manages & tracks Technician's workload...
- Assigns information to Warranty forms...
- Handles Consignment or Rental of parts & equipment...
- Generates: Receipts, Inventory Control Sheets, Status Reports, Authorization Slips, Daily Repair Reports, etc....
- And more!!

For any IBM Compatible from PC to AT.  
Minimum: 10 meg-hard disk & 256K RAM

PSP, 3840 S. Palo Verde, #204, Tucson, AZ 85714  
(602) 889-8888

Circle (15) on Reply Card



# Literature

## Test equipment catalog

*Leader Instruments* has published a test and measurement instrument catalog that details features, specifications and applications on more than 100 products, including 18 new products. Equipment available through the catalog includes oscilloscopes, signal and NTSC pattern generators, waveform monitors and power supplies.

The catalog also includes a section providing information on programmable RGB generators, designed to meet manufacturers needs for testing and aligning high-resolution RBG video and computer monitors.

Circle (125) on Reply Card

## Relay guide

*Philips ECG* has released a pocket-sized relay selector guide that describes the company's electro-mechanical and solid-state relay devices. The 75-page guide provides all the information necessary to quickly and accurately identify the correct replacements for a wide variety of relays. Pictorial and tabular selector guides present different relay case styles and basic parameters in a quick-reference format. A 2-part cross-reference section contains industry part numbers sorted alphanumerically and by manufacturer. Individual numbers in both sections are crossed to the appropriate replacement relays.

Circle (126) on Reply Card

## Data communications products and test equipment catalog

The 1987 Data Direct Sales Catalog from *International Data Sciences* is an 80-page catalog that covers the IDS line of hand-held test sets, modems, multiplexers, converters, data switches, soft switches, cables, data comm accessories and more. Descriptions, specifications, illustrations, photographs, schematics, pricing information and a glossary for reference is included.

Circle (127) on Reply Card

## Test and measurement catalog

This 36-page, 15th annual direct mail catalog from *Extech Instruments* provides complete specifications and pricing for a wide selection of new, low cost measurement, calibration and testing instruments for the laboratory, field and plant. Major product headings include Ther-

mometers, Humidity Meters, Panel Indicators, Multimeters, Tachometers, pH Meters, Conductivity Meters, Dataloggers, Timers and Pocket Computers. Most all products feature digital LCD or LED displays and are available in hand-held, bench or panel versions.

Circle (128) on Reply Card

**ES&T**

**CALL TOLL FREE**

Include work address and phone number for Free Catalog.

**800-824-2873**

### DIGITAL MULTIMETERS

#### BECKMAN

*Beckman Industrial*

- All 300, HD, and Circuitmate series
- All accessories in stock

MODEL	PRICE
HD100	\$169
HD110	\$199
HD130	\$259
HD140	\$279
300	\$179
310	\$145
320	\$179
330	\$219
350	\$229
360	\$289
4410	\$239

#### FLUKE

- Autorange  Analog display
- Touchhold function
- 0.3% accuracy  Heavy duty

MODEL	PRICE	MODEL	PRICE
21	\$ 99	75	\$109
23	\$145	77	\$145
25	\$229	8010A	\$289
27	\$259	8012A	\$359
37	\$215	8020B	\$199
52	\$189	8024B	\$249
73	\$ 79	8050A	\$399

FLUKE 77 Digital Multimeter

**SALE \$119**

LIST \$145

### WAYNE KERR

MODEL	PRICE
4210	\$2200
4225	\$1500

### SCOPES

#### HITACHI

 Hitachi

Denshi America, Ltd.

- All 20 models in stock
- 2-3 year warranties
- 20-100 MHz

MODEL	PRICE
VC6041	\$3900
V209	\$798
V222	\$575
1050	\$1299
1100A	\$2490
422	\$740
425	\$845
680	\$1275

HITACHI V-509

Portable Dual Trace Scope

**SALE \$1199**

LIST \$1445

#### IWATSU



- All 14 models in stock
- 2-3 year warranties
- 20-250 MHz

### IWATSU (CONT.)

MODEL	PRICE
5702	\$ 535
5705	\$ 899
5706	\$ 749
5710	\$1245
5711	\$1695
5712	\$2999

### POWER SOURCES

#### POWER DESIGNS

- Low and high voltage power sources
- 1-5 year warranties

MODEL	PRICE
TP340	\$750
TP343A	\$795
TW347	\$590
TW5005W	\$505
TW6050A	\$748
2K20	\$695
2020B	\$750
4050	\$560
6150	\$615

### SOLA POWER

MODEL	PRICE
SPS800	\$ 873
63-13-114	\$ 237
63-13-150	\$ 456
63-13-175	\$ 580
63-13-210	\$ 672
750VAUPS	\$1976
750VAUPSI	\$2580

**USED TEST EQUIPMENT, TOO!—OVER 3,000 MODELS AVAILABLE AT HUGE DISCOUNTS WITH WARRANTIES!**

■ Quantity Discounts Available ■ Dealers Welcome ■ Freight and Tax Extra ■ Immediate Availability of Equipment

**US United States Instrument Rentals, Inc.**

A U S Leasing Company  
2988 Campus Drive  
San Mateo, CA 94403

Circle (16) on Reply Card

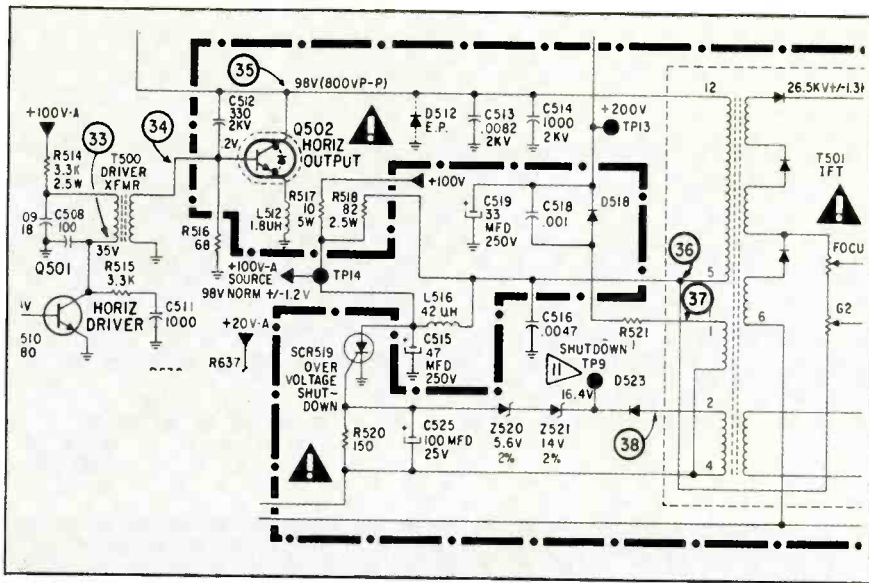


Figure 8. The high voltage tries to increase if the amount of capacitance between the collector of the output transistor and ground is reduced. (Schematic diagram courtesy of NAP)

that you can observe what happens when you slowly change the voltage. This may sound complicated, but it's really not if you use the right equipment.

You need a source of adjustable voltage from an isolated ac power supply. The isolation is essential, because almost all chassis that use shutdown circuits are also hot chassis using full-wave bridge rectifiers. You cannot connect a grounded piece of test equipment (such as an oscilloscope) to full-wave circuits without shorting out one of the TV's power diodes, along with other components. Isolation prevents this damage.

First, plug the TV into the ac supply and connect the dc voltmeter to the collector of the horizontal output transistor. Be certain that your meter has enough protection, because voltage spikes of more than 1200V are normal at

Continued from page 24

The biggest trouble with shutdowns is that they happen so fast you can't tell one problem from another. You need a way to put the

circuits into "slow motion" to give you time to isolate one probable cause from another. The best way to do this is to take manual control of the main voltage regulator, so

Factory Authorized Parts Distributor For

**FISHER SANYO PANASONIC  
QUASAR (MSC) ZENITH SYLVANIA  
PHILCO MAGNAVOX (NAP)  
GENERAL ELECTRIC & RCA**

stocking large inventories...  
all in stock orders shipped the same day  
(if called in by 2:30 New York time)  
also stocking

**Sharp Samsung Sony Sampo Goldstar  
MGA/Mitsubishi AOC and now JVC**

For parts orders call:  
(National Hotline)  
**1-800-874-1765**  
(New York Only)  
**1-800-874-1764**

For all other calls  
(info, pricing, availability,  
cross referencing, call)  
**1-516-585-8111**

**G M B Sales Inc.**

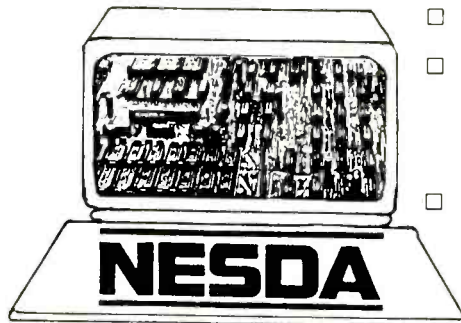
2700 MIDDLE COUNTRY ROAD  
CENTEREACH, N.Y. 11720

**I am IMPORTANT when you need PARTS  
...place me by your PHONE**

Circle (17) on Reply Card

## NESDA Computer Group

COMPUTER SALES AND SERVICE DEALERS  
WORKING TOGETHER



- Service training.
- Assistance in selecting in-house equipment and software.
- Specialized software for service management.

- Factory contacts for service literature and parts.
- Involvement in a stable and productive national trade association.

FOR MORE INFORMATION SEND BUSINESS CARD TO:  
**NESDA COMPUTER GROUP, 2708 WEST BERRY STREET  
FORT WORTH, TEXAS 76109; PHONE (817) 921-9061**



New from PTS

# How to make top VCR profits with no investment and no headaches.

Now you can immediately offer complete VCR remanufacturing service to your customers.

#### All makes. All models.

Any VCR. VHS, Beta. You name it. Send it to your authorized PTS Servicer and you'll get complete remanufacturing service.

#### Fast turnaround. Dependable service.

Your customer wants it fixed now. PTS has the world's largest VCR parts inventory. Fully equipped test positions are manned by factory trained technicians.

You get (and give your customers) fast, guaranteed service.

#### Famous PTS quality backed by a 90 day PTS warranty.

Every remanufactured VCR gets:

- Complete, thorough cleaning with special PTS approved nonabrasive chemicals and cleaning materials.
- Demagnetization of all metal parts and heads.
- Lubrication of all mechanical parts
- Tape guide alignment.
- Head and tracking alignment.
- Latest manufacturer's updates, defective and worn parts replaced.
- Historically high failure parts automatically replaced regardless of condition.
- Complete electronic tests and checks.
- Air test and burn-in.
- PTS' 3 stage quality test and spec performance guarantee.

All services backed by PTS' exclusive full 90 day parts and labor limited warranty.

#### Guaranteed price guarantees your profit.

One low, flat rate includes parts and labor.

**\$64<sup>.95\*</sup>**

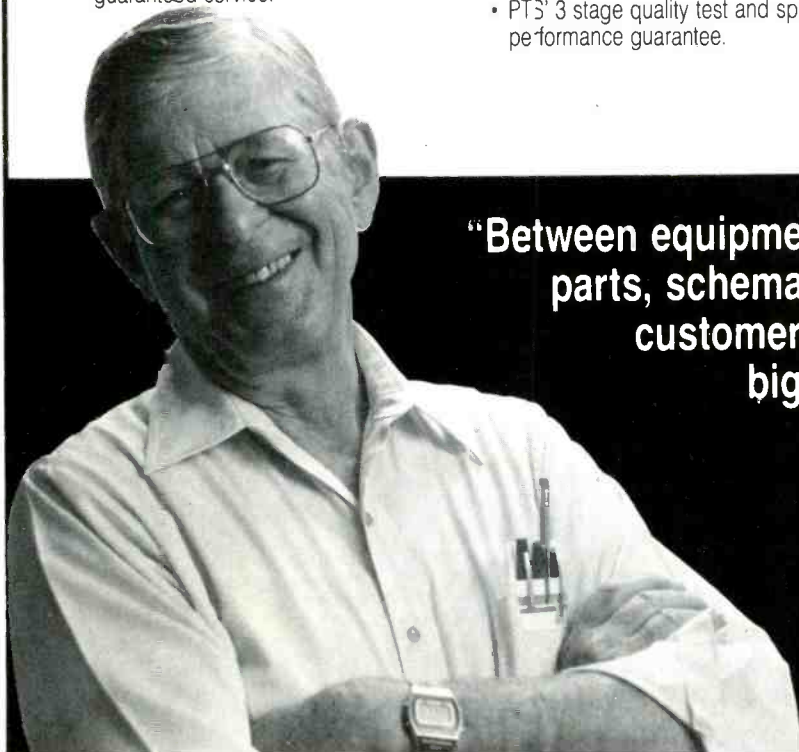
Suggested retail \$89.95.

\*Repair price excludes VCR heads, motors, baskets, and cosmetics. These items billed at cost subject to dealer approval. Minimum bench charge of \$24.95 may apply.

Mutilated units and/or previously reworked units by technicians outside of PTS will be subject to a \$24.95 surcharge. PTS reserves the right to return any units with repair costs in excess of unit replacement value.

Get in on the nation's premier VCR profit program. Try PTS' VCR remanufacturing today.

**PTS Corporation™**



**"Between equipment costs, training, parts, schematics, and impatient customers, VCR repair was one big headache. With PTS I'm making the same profit with no investment and no headaches. Thanks PTS."**

For more information or the Servicer nearest you contact PTS Customer Service at (812) 824-9331.

Circle (44) on Reply Card

September 1987 *Electronic Servicing & Technology* 51

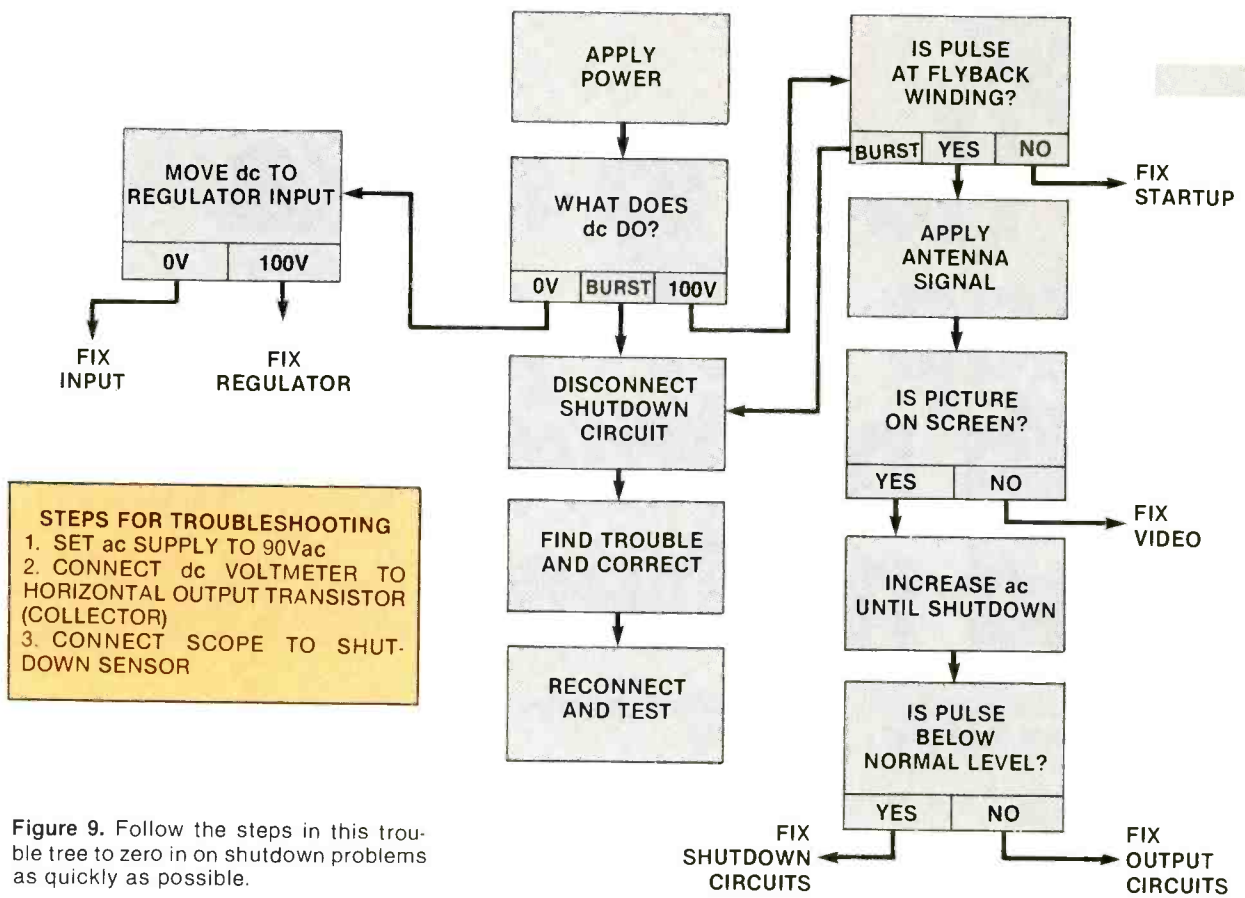


Figure 9. Follow the steps in this trouble tree to zero in on shutdown problems as quickly as possible.

# HAMEG

Instruments

**HM 205-2**  
the new Digital Storage Oscilloscope  
with 5 MHz sampling rate and 2 x 1024 / 8 bit storage  
realtime bandwidth DC-20 MHz **\$888.00**

**HM 8148**  
the new intelligent Graphic Printer  
firmware for time, date, interval, linear interpolation  
zooming function **\$788.00**

**DSO Software**  
with 13 programs  
incl. IEEE BUS card **\$480.00**

**call toll free**  
**(800) 247-1241**  
**HAMEG, Inc.**  
88-90 Harbor Road · Port Washington, N.Y. 11050  
Phone (516) 883-3837 · Telex (023) 497.4606

Circle (19) on Reply Card



this test point. With the TV turned off, set your ac power supply for an output of about 90V. This voltage is high enough to let the circuits operate, but below the point where the regulator is working.

Second, connect an oscilloscope to the winding on the flyback transformer that feeds to the safety circuits. If your scope has adequate protection (at least 1200Vpp) you can connect the second probe to the output transistor, along with the voltmeter.

Watch the dc voltmeter at the output transistor carefully as you turn on the set. One of three things will happen: the voltage will remain at zero, there will be a momentary burst of voltage that will then disappear, or the voltage will be at a level below the normal dc supply voltage. Your next step depends on which of these three things took place. (See Figure 9 for a troubleshooting flowchart.)

#### No dc

Absence of dc at the output transistor means you don't actually have a shutdown problem. Move your dc probe from the output transistor to the regulator input (the main power supply filter). If the meter shows about 100V, you know that the main power supply is good, so the trouble is in the regulator. (Details on regulators will be covered in a later article.) If there is no dc voltage here either, you have confirmed a defective power supply. Check the rectifiers, fuse and ac line choke.

#### Momentary dc

This indicates a shutdown has taken place that involves the power supply. Remember that some receivers use power supply interruption as a shutdown method. The high-voltage circuits should not be producing excessive output when operating at a 90Vac input. Shutdown could indicate a defective shutdown circuit. The exception is when a sensor monitors the emitter current from the output transistor. In this case, the shutdown could be caused by a short in the output circuits.

#### Constant dc

A voltage of about 100V confirms that the power supply and regulator are both working. At

this point, you need to determine if the horizontal stage is running.

Check the scope connected to the flyback's safety winding. If you see pulses, you know the horizontal circuits are operating. You should apply a test signal to the antenna to check that the video, color and sound circuits are all working. In many cases, you will learn that you don't really have a startup or a

shutdown problem at all. A dead video amplifier or similar trouble may cause a blank screen, even if the horizontal circuits are working fine. A problem in one of the low-voltage power supplies may also cause whole sections of circuitry to be inoperative.

If the output is dead, you need to know what happens when you first apply power. If you are lucky

... Over 3,000,000 Sold and Still The Best General Purpose Multimeter! ...



The Reason Is Clear...

## Simpson 260<sup>®</sup> VOM

Has Features No Digital Can Match!



Latest 260<sup>®</sup> Series 7 \$124.00

- "Instant" null, peak, trend and continuity indications
- High immunity to transients, RF interference
- dB measurement capability at no extra cost
- Resistance indication from zero to infinity
- Self-powered voltage, current and dB ranges—no batteries to fail
- Reliable, accurate performance even under extreme environments
- Easy, low-cost maintenance—no expensive "chips" to fail
- UL Listed per UL-1244 Standard for Safety—Electrical and Electronic Measuring and Testing Instruments
- Complete line of UL recognized accessories
- Options include mirrored scale, extra overload protections, roll top carrying case

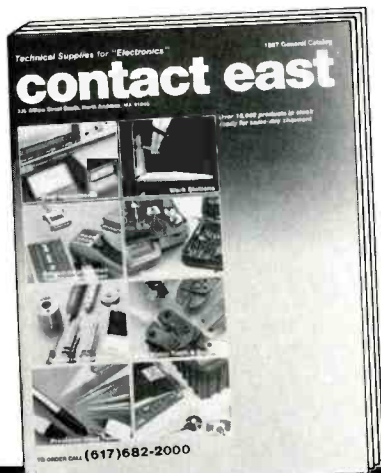
See the World Famous 260 Series 7, the 260-6XL, the 270 and the Pocket-Size 160<sup>®</sup> at Leading Electronics/Electrical Distributors



#### SIMPSON ELECTRIC COMPANY

853 Dundee Avenue, Elgin, IL 60120  
(312) 697-2260 • Telex 72-2416 • Cable SIMELCO  
Canada: Bach-Simpson Ltd., London, Ontario  
England: Bach-Simpson (U.K.) Ltd., Wadebridge, Cornwall

Circle (11) on Reply Card



## FREE CATALOG SERVICE TOOLS & TEST INSTRUMENTS

Packed with over 5,000 quality products for testing, repairing, and assembling electronic equipment. A full selection of test instruments, power protection equipment, precision hand tools, tool kits, soldering supplies, and much more. Products are shown in full color with detailed descriptions and pricing. All products come with a 100% satisfaction guarantee. SAME-DAY shipment program.

In a hurry to receive your catalog?

Call (800)-225-5370

In Massachusetts call (617)-682-2000

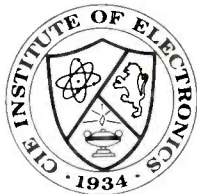
Contact East, Inc., Dept. R411

P.O. Box 786, No. Andover, Ma 01845

Circle (21) on Reply Card

## CIE Cleveland Institute of Electronics

Accredited Member National Home Study Council



CIE is the world's largest independent study electronics school. We offer ten courses covering basic electronics to advanced digital and microprocessor technology. An Associate in Applied Science in Electronics Engineering Technology is also offered.

Study at home — no classes. Programs accredited and eligible for VA benefits.

CIE Cleveland Institute of Electronics  
1776 East 17th St., Cleveland, Ohio 44114

YES! I want to get started. Send me my CIE school catalog including details about the Associate Degree program.

Print Name \_\_\_\_\_

Address \_\_\_\_\_ Apt. \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Age \_\_\_\_\_ Area Code/Phone No. \_\_\_\_\_

Check box for G.I. Bulletin on Educational Benefits

Veteran  Active Duty MAIL TODAY!

AES-26

Circle (22) on Reply Card

enough to be using a combination scope/digital readout, you can watch the scope CRT when you first apply power. If you are working with a separate scope and voltmeter, you may have to turn off the power, let the filters discharge (as indicated by the dc voltmeter dropping to near zero) and then watch the scope as you apply power a second time.

If the horizontal circuits produce no ac output at all, you have a problem in the horizontal stage or in the startup circuits. (These problems will be covered in the second installment of this series.) If, on the other hand, you see the pulses build for a short time and then disappear, you have confirmed that the circuits started and were then shut down.

### Isolating the problem

If the set operates with a reduced ac input, or if it starts momentarily and then shuts down, you know for certain that your problem is shutdown related. Let's first discuss what to do if the set is shutting down with a 90V input.

In theory, the set should not be shutting down with the input voltage reduced because the output stages are not running with full power. The first thing to suspect is a problem in the shutdown circuits themselves. There may be as many as three sets of shutdown circuits, so your first step is to figure out which one is shutting the set down. The easiest way is to disconnect them one at a time to find which is responsible for the shutdown.

### WARNING

*Do not operate the receiver at voltages above 90Vac with a safety circuit disconnected. Every safety circuit must be reconnected and tested before you return the set.*

After finding which safety circuit is causing the shutdown, confirm whether it's activated because its sensor has too much signal or whether the sensor is too sensitive. Correct the problem, reconnect the safety circuit and confirm that the chassis works correctly at full line voltage. Check the safety

circuits using the procedures in the service literature.

Many sets will work normally at reduced voltage because the power of all the safety-monitored circuits is below normal. Next, you will slowly increase the ac voltage while watching the scope channel connected to the safety circuits. Pay close attention to the peak-to-peak level of the signal. You want to know the amplitude at the moment of shutdown.

If the pulse at shutdown is smaller than the normal level, the safety circuits are too sensitive; this confirms a nuisance shutdown. Suspect that a zener diode has changed value, that a resistor is shorted or off value, or that a diode or transistor has become leaky. If the pulse at shutdown is above its normal level, the safety circuits are doing their job and stopping some unsafe condition. The next step is determining which circuit is defective.

Test the regulator first. Return the voltage to 90V, turn off the set and wait for the voltage to bleed off. Reapply power and begin increasing the ac voltage while you monitor the dc voltage at the collector of the output transistor. You should see the voltage gradually increase from the 90Vac input level (about 100Vdc to 110Vdc) and then stop increasing when it reaches the normal operating voltage.

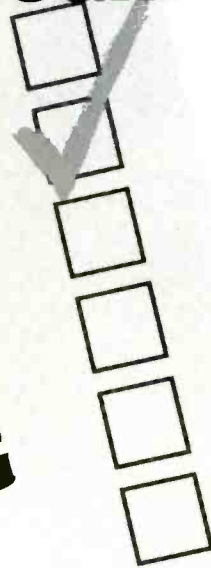
For example, if the output transistor normally operates at 118V, the dc level should increase from 110V to 118V but should then stay near 118V, no matter how much higher you adjust the ac power supply. If the voltage continues to increase as you turn up the ac voltage, the regulator is not working correctly. If the set shuts down before reaching the normal voltage (118V in this example), you know the problem is somewhere other than the regulator.

If the regulator is not the problem, you should confirm that the output stage is working correctly. The best way to do this is to check the waveform at the collector of the horizontal output transistor. Perform the following tests with the set operating at an ac line voltage low enough to prevent shutdown.



# DELIVERY IS THE MOST IMPORTANT FUNCTION OF A PARTS DISTRIBUTOR. BUT IT'S NOT ENOUGH.

AVAILABILITY  
DELIVERY  
RELIABILITY  
SUPPORT  
NETWORKING  
QUALITY



## MATSUSHITA AUTHORIZED PARTS-LINK™ DISTRIBUTORS. BECAUSE IT PAYS TO BE SURE.

Some distributors are quick to promise fast delivery of replacement electronic parts. But they may not always be the right parts. That's never a problem when you put your trust in a Matsushita Authorized PARTS-LINK™ Distributor—your best source for Panasonic, Technics and Quasar original replacement parts. For basic stocking, each distributor maintains over 1,000 of the most demanded part numbers for off-the-shelf delivery. Even if the part you need isn't so common, your Matsushita distributor is tied into our exclusive PARTS-LINK™ network, tracking over 385,000 part numbers, so that we can locate the part you need, lock in the order, and deliver it—if overnight delivery is requested to your doorstep within 24 hours. They can even cross-reference these original

replacement parts to other Matsushita built products so that you can retain the high quality and reliability of Matsushita's design.

### THE DIFFERENCE BETWEEN A PROMISE KEPT, AND A PROMISE BROKEN.

Your Matsushita Authorized PARTS-LINK™ Distributor isn't authorized by accident; each has met (and continues to meet) stringent requirements to ensure fast, courteous and responsive service backed by Matsushita's replacement parts warranty.

The right part at the right time from the right source. For the name and location of your Matsushita Authorized PARTS-LINK™ Distributor—contact us at the address below. **YOUR SOURCE OF CONFIDENCE.**



# MATSUSHITA SERVICES COMPANY

50 Meadowland Parkway, Secaucus, NJ 07094

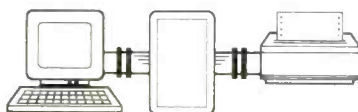
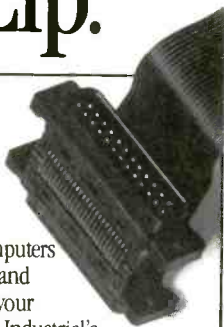
**Panasonic Technics Quasar**

Circle (23) on Reply Card

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# Test RS232C In A Zip.

Test RS232C data communications interfaces—like computers to printers, computers to modems, and computers to computers—fast and easy in the palm of your hand with Beckman Industrial's low-cost, easy-to-use line of testers. Each is self-contained in a Toughpak case, including five models in a durable zippered pouch, and a 10-year warranty on every model. Prices start as low as \$49.95.



See your nearest Beckman Industrial distributor today, or send for free brochure. We'll send it to you in a zip.

*Quick Cable Customizing*

*Fast RS232C Interfacing and Testing*

*LED Identification of Cable Configurations*

*Pocket and Hand-held Compactness*

*Speeds Up Trouble Shooting*

*10 Standard, Low-Cost Models*



EasyPATCH™ 704

Easy BOB™ 750

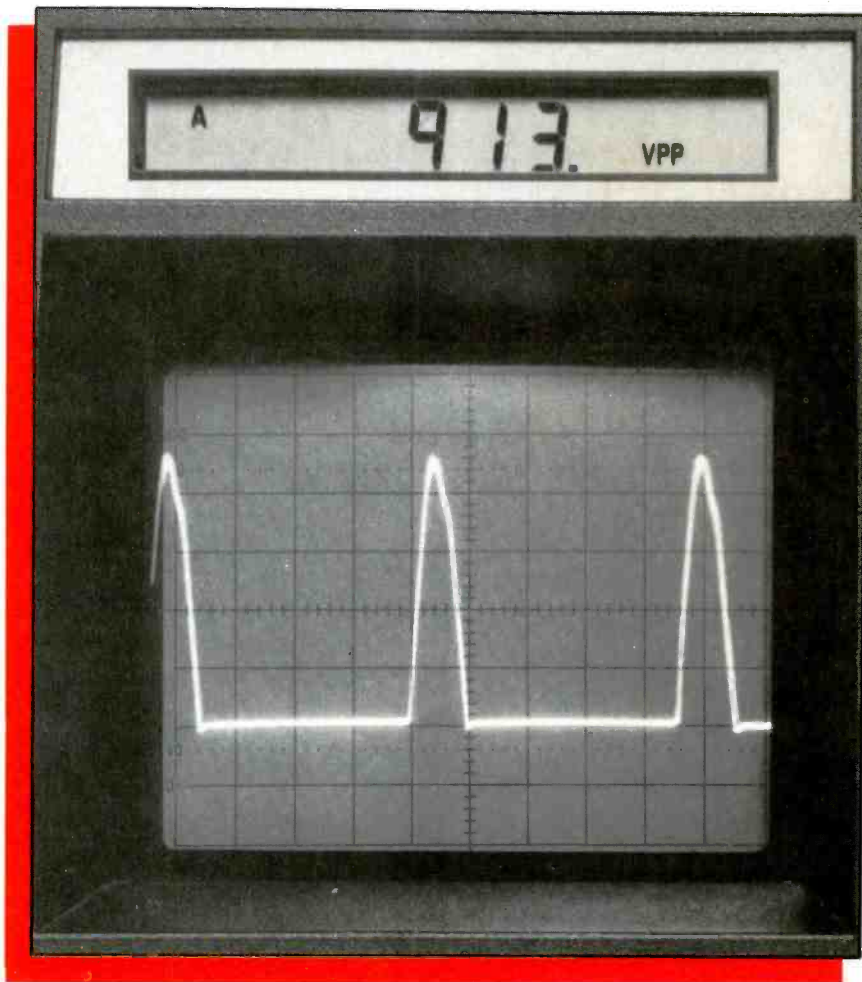
**In Service  
Instruments,  
We're The One.**

**Beckman Industrial™**

Beckman Industrial Corporation Instrumentation Products Division  
A Subsidiary of Emerson Electric Company  
3883 Ruffin Rd., San Diego, California 92123-1898  
(619) 565-4415 • FAX: (619) 268-0172 • TLX: 249031

© 1987 Beckman Industrial Corporation

Circle (24) on Reply Card



**Figure 10.** Many troubles can be isolated by observing the pulse at the collector of the horizontal output transistor if your scope has enough measuring range.

## WARNING

*Do not connect to the output transistor's collector unless your oscilloscope has adequate protection. Voltages as high as 1500V (dc plus peak ac) are possible when the output stages are not working correctly.*

The width and shape of the transistor's collector pulse tells a great deal about the operation of the output circuit. (See Figure 10.) First, confirm that there is no saddle or dip in the center of the pulse. If there is, the flyback is either shorted or has a shorted load. Second, look for ringing along the baseline. Ringing is a symptom of a cracked core. Third, measure the width of the pulse (remember that pulse time is defined as the time from the 10% point to the 90% point, not from the base to the base of the

pulse). The time should be near 12 $\mu$ s. If the pulse is too narrow, check the safety capacitors between the emitter and collector of the output transistor.

If the output pulse looks normal, suspect that one of the other flyback loads is open or shorted. Check the output of each scan-derived power supply for proper dc level. If you are operating with a 90Vac input, each voltage may be about 10% low, but none should be far above or below that variance.

It takes much less time to perform these tests than to read about them because you use each test to make a decision as to which way to go next. In actual troubleshooting, you should only use three or four of the steps covered. Remember that you are simply dividing your troubleshooting into an organized sequence of steps to identify which circuits work and which do not.

**ES&T**



## Books

**The Complete Compact Disc Player, by Martin Clifford; Prentice-Hall, 315 pages, \$29.95, hardbound.**

Although it is hard to say that any book about CD players is *complete*, this book, which covers both basic and advanced aspects of CD technology, covers the subject. The book starts with a lesson on binary arithmetic, which is important for understanding how the compact disc and its player work. Analog and digital recording are discussed, along with the pulse code modulator (the PCM, which converts analog to digital input) and the signal processing the PCM performs. The book examines CD player circuitry on basic and advanced levels, and provides a step-by-step operational analysis.

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

**Electronic Industry Telephone Directory (8th edition); Harris Publishing, 704 pages, \$44.50.**

This desk-top directory and purchasing guide to electronics companies and products provides current verified address/telephone/zip code information on 22,752 electronics companies (488 of them are new), including manufacturers, distributors and manufacturers' representatives. The Yellow Pages provide more than 4,000 individual product classifications of components, instruments, accessories and systems, including computers and peripherals.

Published by Harris Publishing Company, 2057 Aurora Road, Twinsburg, OH 44087; 800-321-9136 (in Ohio, 216-425-9000). Contact Joyce DeRemer.

**CD-I and Interactive Videodisc Technology, By Steve Lambert and Jane Sallis; Howard W. Sams, 224 pages, \$24.95.**

This source book for programmers and producers of interactive media provides a technical overview of the techniques and methods for using interactive videodisc (IVD) and compact disc-interactive (CD-I) technology. The book also covers types of laser videodiscs, videodisc formats and

levels of interaction.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5400.

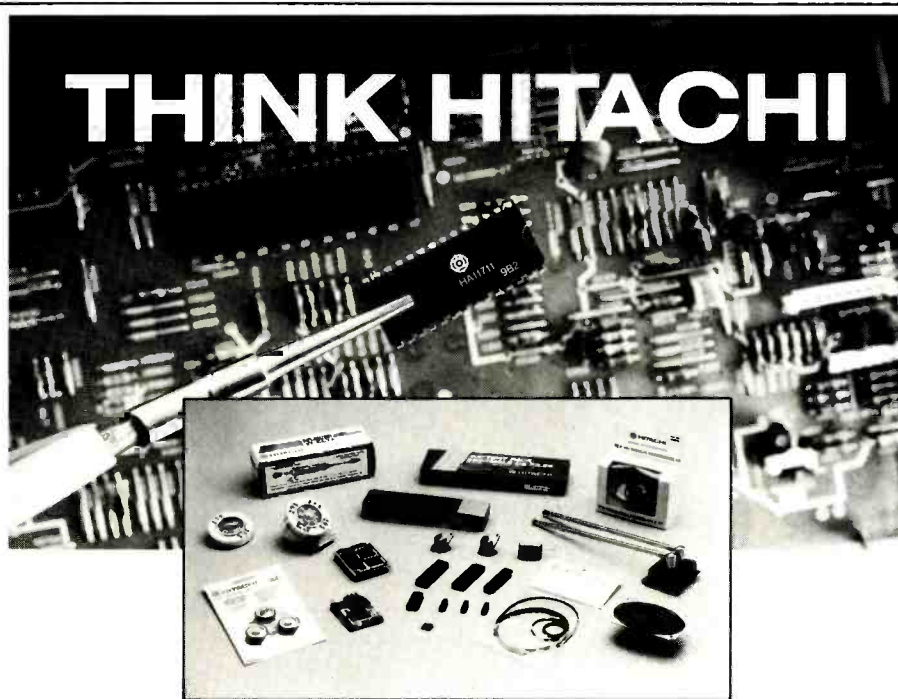
**IC Functional Equivalence Guide (8th edition); D.A.T.A., \$95.**

This guide provides alternate source and replacement information for more than 56,000 ICs from 164 manufacturers. Functionally equivalent devices (which are pin-

for-pin compatible based on technical data and physical lab testing) are listed for each IC in the book. This edition contains more than 5,500 new device types, with updated information on another 16,000. The user can start with either the device part number or the function.

Published by D.A.T.A., 9889 Willow Creek Road, P.O. Box 26875, San Diego, CA 92126; 800-854-7030 (in California, 800-421-0159).

**ES&T**



## Because Your Customers Deserve the Best



### Hitachi Original Replacement Parts

Quality, reliability, service...they're the touchstones of the Hitachi tradition, as recognizable as our trademark. And now those same standards that have earned us our reputation as a technological leader in consumer products, back up our new line of **Hitachi Original Replacement Parts**.

We know that for the service professional, time wasted is profit lost. Which is why Hitachi makes it easy for you. With our complete line of parts, we provide you with a single source for all your repair needs—and a profitable addition to your business. From VCR kits, IC chips and

diodes—to battery packs, video, audio accessories and technical publications.

What's more, our nationwide network of distribution centers means that you can get the parts and accessories you need, when you need them. And, of course, **Hitachi Original Replacement Parts** are included in our total service support program...because your customers deserve the best.

For more information, call toll-free **1-800-447-2882**.

**HSC SERVICE COMPANY**  
division of Hitachi Sales Corporation of America

401 W. Artesia Blvd.  
Compton, CA 90220  
(213) 537-8383

Circle (25) on Reply Card

September 1987 *Electronic Servicing & Technology* 57

# Test your electronics knowledge

By Sam Wilson, CET

In many ways, the second class FCC exam was a very good test. Here's a chance for you to see if you can answer some typical second class FCC license test questions. If you passed that test, this will be a good review. Expect to get a good grade. Some of these questions are also typical of those used in CET tests. However, FCC and CET test questions are multiple choice; in that sense these questions are not similar.

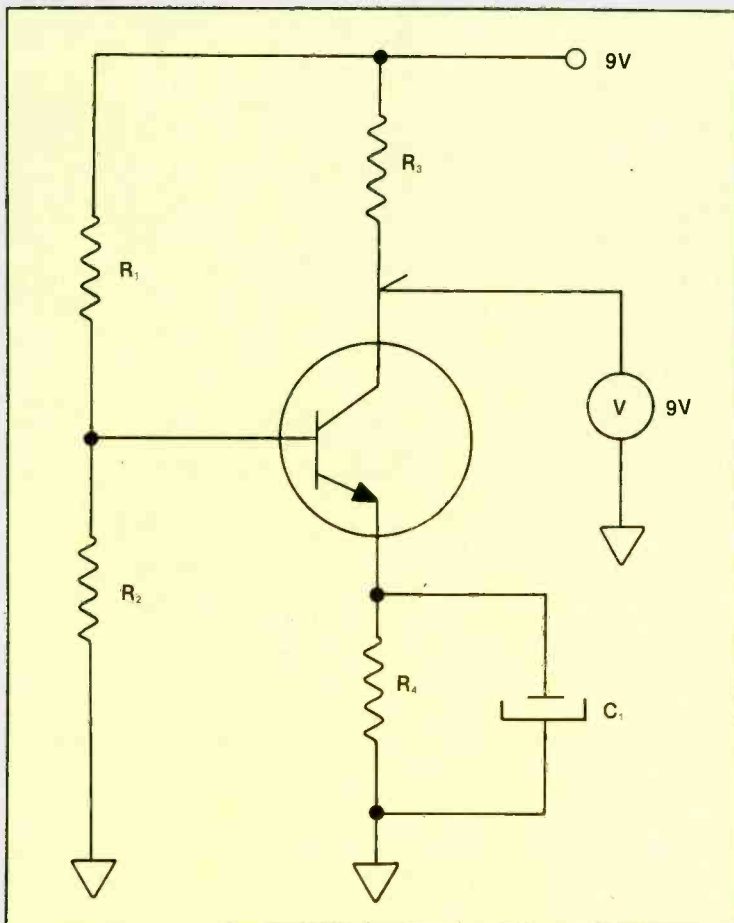


Figure 1.

1. In a certain power transformer the primary-to-secondary turns ratio ( $N_p:N_s$ ) is 3 to 1. If 5A of current flows in the primary circuit, how much current is available in the secondary? \_\_\_\_\_ amps

2. You cannot increase the capacity of a capacitor by  
 A.) increasing the area of the plates facing each other.  
 B.) increasing the distance between the capacitor plates.  
 C.) using a dielectric with a higher dielectric constant.  
 D.) None of these is correct.

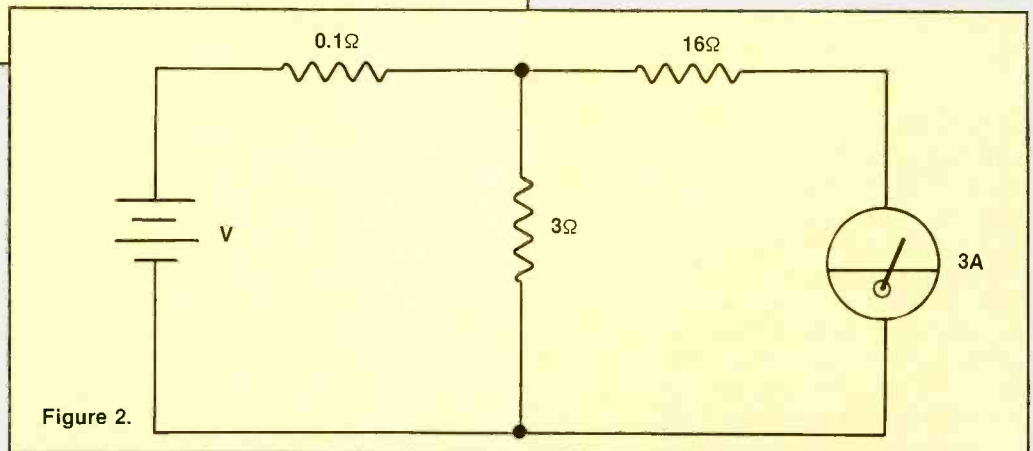


Figure 2.



**Discover How The World's Only  
100% Automatic, Dynamic, & Portable  
LC Analyzer Gives You Total Confidence  
In Your Cap/Coil Testing . . .  
Call 1-800-843-3338 Today!**

**New**



**LC77 AUTO-Z™  
Automatic Capacitor and Inductor Analyzer  
Double Patented \$1,895**

IEEE - 488

The first cap/coil analyzer guaranteed to reliably test anywhere, without calculations, look-up tables, or error — 100% automatically so you're confident of your accuracy.

Do you want to eliminate doubt from your cap/coil testing? The LC77 AUTO-Z tests all key parameters with results *anyone* can understand. Automatic good/bad results eliminate the guesswork for error-free analysis. Touch-sensitive keypad and one-two-three setup makes your AUTO-Z the easiest and fastest LC analyzer on the market.

Are you frustrated trying to test the new high-tech caps/coils used in modern electronics? Only the LC77 AUTO-Z allows you to test them all. Test capacitors from 1 pf to 20 farads, with leakage tests to 1000 V and ESR to 2000 ohms for locating failures other testers miss. Inductor value from 1 uh to 20 H and a patented ringing test for dependable, error-free coil testing every time.

Do you need the freedom of a battery-operated portable LC meter? The LC77 is 100% battery portable for use in the field or factory. The full power and potential of the LC77 AUTO-Z is packed into a light-weight, portable package. The AUTO-Z puts the complicated electronics on the inside for ease of operation on the outside.

Do you want maximum efficiency with a bus compatible LC testing system? Your LC77 AUTO-Z is IEEE 488 compatible for automated cap/coil analysis for data collection, incoming inspection, and quality assurance tests.

Be satisfied that you can meet all the challenges new technology brings. Call WATS Free 1-800-843-3338 today and tell your Area Sales Engineer you want to "try before you buy" with Sencore's exclusive 10 Day Self Demo.

AUTO-Z is a trademark of Sencore, Inc.

WATS Free 1-800-843-3338 In Canada WATS Free 1-800-851-8866



**SENCORE**

**Means Success In Electronic Servicing**

3200 Sencore Drive, Sioux Falls, South Dakota 57107  
Call Collect 605-339-0100 In SD & AK

Circle (26) on Reply Card

September 1987 *Electronic Servicing & Technology* 59

3. A kilowatt-hour is a unit of electric  
A.) real power.  
B.) apparent power.  
C.) reactive volt-amperes.  
D.) None of these is correct.

4. Which of the following is likely to be used in a relaxation oscillator circuit?  
A.) UJT  
B.) PUT  
C.) Both choices are correct.

5. What is the ripple frequency of a bridge rectifier operating from a line frequency of 400Hz? \_\_\_\_\_ Hz

6. For the circuit of Figure A, which of the following is true?  
A.) R<sub>1</sub> is probably open.  
B.) R<sub>2</sub> is probably open.  
C.) R<sub>3</sub> is probably open.  
D.) C<sub>1</sub> is connected upside down.  
E.) Nothing is wrong.

7. What is the battery voltage in the circuit of Figure B? \_\_\_\_\_ V

8. The vertical broadcast antennas at AM radio stations are  
A.) Zepp antennas.  
B.) Rhombic antennas.  
C.) Hertz antennas.  
D.) Marconi antennas.

9. What is the conductance of a component that draws 332mA when it is connected across a 3V battery? \_\_\_\_\_

10. Is the following statement correct? When you double the capacity, the capacitive reactance is halved.  
A.) The statement is correct.  
B.) The statement is not correct.

Answers are on page 65.

# What do you know about electronics?

# Do-it-yourself test equipment

By Sam Wilson, CET

The general procedure for troubleshooting—assuming that obvious faults have been eliminated—is:

Step 1: Make a measurement.

Step 2: Compare the measured value with the value you should get.

Step 3: If the values compare favorably, you are not at the location of the trouble. Go to the next point.

If the values do *not* compare favorably, you should investigate further to find the source of the trouble.

I realize this is really an oversimplification. It takes years of experience and training to be able to go through those steps at a reasonably fast pace. It looks simple on paper, but, after watching students struggle through the steps when they are learning to troubleshoot, it is obvious that a considerable amount of skill is involved.

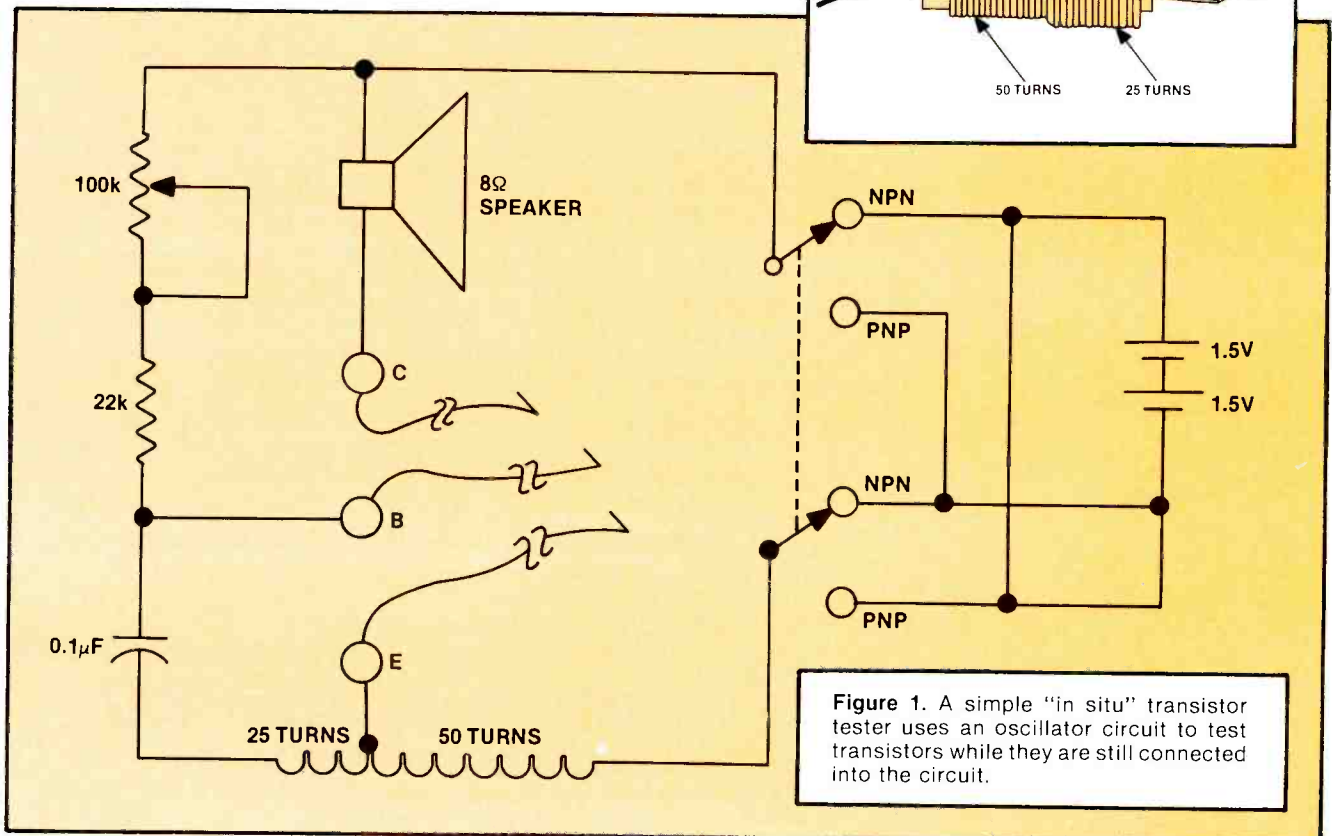


Figure 1. A simple "in situ" transistor tester uses an oscillator circuit to test transistors while they are still connected into the circuit.



# Analyze defective waveforms faster, more accurately, and more confidently — every time or your money back

The point I want to make is that an important part of troubleshooting is making measurements, and you need good test equipment for that step. There are many manufacturers with their versions of test instruments, but there is also some test equipment that you should consider making for yourself, because some valuable test equipment is not being manufactured.

One reason this equipment isn't being sold is that it is so inexpensive—there is simply no money to be made. When you consider the cost of manufacturing and distributing these testing devices, there is simply no room for a reasonable profit. However, you can make them on your bench in your spare time. It is an interesting and useful experience. *If you have a favorite example, please send it to us.* I'll pass it along.

Figure 1 shows a simple "in situ" transistor tester, submitted by Mike Olszewski of Palm Beach, FL. There have been many versions of this tester printed throughout the years.

The basic idea is that it tests transistors, while they are still connected into the circuit, by using the transistor in a simple oscillator circuit. The Hartly oscillator coil is wound as shown in Figure 1. A tone is produced if the transistor is OK. Defective transistors give no tone.

Olszewski used very small probes that clip onto the transistor leads; you don't have much room on most circuit boards. Two 1.5V cells are used for power.

I tried this device with both PNP and NPN transistors. Also, I tried it with both voltage and power amplifiers. It worked very well in all cases.

## Quick transistor checks

The tester just described is one of many ways to check a transistor while it is in the circuit. The tester is used when the transistor circuit is not energized. You can use a voltmeter to evaluate a transistor in an energized circuit. Two ways of doing this are reviewed here:

- For a Class A resistor-coupled amplifier, the collector voltage should be about half the power-



with the SC61 Waveform Analyzer  
Patented \$2,995

**If you value your precious time, you will really want to check out what the exclusively patented SC61 Waveform Analyzer can do for you. 10 times faster, 10 times more accurate, with zero chance of error.**

**End frustrating fiddling with confusing controls.** Exclusive ultra solid ECL balanced noise cancelling sync amplifiers, simplified controls, and bright blue dual trace CRT help you measure signals to 100 MHz easier than ever.

**Accurately and confidently measure waveforms from a tiny 5 mV all the way to a whopping 3,000 V without hesitation** with patented 3,000 VPP input protection — eliminates expensive "front end" repairs and costly equipment downtime.

**Make only one circuit connection and push one button for each circuit parameter test:** You can instantly read out DC volts, peak-to-peak volts and frequency 100% automatically with digital speed and accuracy. It's a real troubleshooting confidence builder.

**Confidently analyze complex waveforms fast and easily.** Exclusive Delta measurements let you intensify any waveform portion. Analyze glitches, interference signals, rise or fall times or voltage equivalents between levels; direct in frequency or microseconds.

**Speed your digital logic circuit testing.** Analyzing troublesome divide and multiply stages is quicker and error free — no time-consuming graticule counting or calculations. Simply connect one test lead to any test point, push a button, for test of your choice, for ERROR FREE results.

To see what the SC61 can do for your troubleshooting personal productivity and analyzing confidence, CALL TODAY, WATS FREE, 1-800-843-3338, for a FREE 15 day Self Demo.



Call Today Wats Free 1-800-843-3338

**SENCORE**

3200 Sencore Drive  
Sioux Falls, SD 57107  
605-339-0100 In SD Only

*innovatively designed  
with your time in mind.*

Circle (27) on Reply Card

September 1987 *Electronic Servicing & Technology* 61

supply voltage when there is no signal applied.

- To check a Class A amplifier for distortion, measure the dc collector voltage with no signal applied. With the voltmeter still connected to the collector, apply a pure sine wave to the base. There should be no difference in the dc collector voltage with and without the signal applied.

Another often-used voltmeter test is to measure the dc base voltage and dc emitter voltage. The difference between those voltages should be about 0.7V for silicon transistors. You may run across a germanium transistor now and then, especially in the power amplifier circuit. In that case, the difference should be about 0.3V.

Gallium arsenide (GaAs) transistors are now being pressed into service. They are especially good for high-frequency, low-noise work. The emitter-base voltage for those transistors should be about 1.5V.

Don't get married to those emitter-base voltage values. They are just rough guidelines. The most important use of emitter-base voltage measurements may be determining that the transistor is operating. The actual voltage for a silicon transistor can be as high as 1.2V!

Remember to keep your fingers out of unfamiliar systems until you have measured the power supply voltage. It is easy to get careless when working in solid-state systems because low operating voltages are common. But, there are 90V *bipolar* transistors and 400V *enhancement MOSFET* circuits in operation. If you stick your finger

into one of those you'll think you're getting an idea!

### If you teach electronics

I recently had the privilege of coordinating an Electronic Industries Association (EIA) digital and microprocessor course, taught at the New England Institute (in West Palm Beach, FL) by Dr. Elmer Poe. It was specifically aimed at people who teach electronics. More than 150 teachers in Florida, Georgia and Alabama were invited to attend this *free* course, and were told that, in addition to the course, they would be given \$100 in materials to take home.

The most frequent reaction was that anyone teaching digital and microprocessor courses doesn't need a course in those subjects. To be honest, I thought they could be right. During the week-long course I was able to sit in on most of the lectures and labs.

Let me tell you this. No matter how many years you've been teaching these subjects, you shouldn't miss the opportunity to take this course. Get in touch with EIA in Washington, DC, and find out if you, as a teacher, can get into a nearby course next year. Believe me, you won't regret it. It is *not* just a rehash of old material. You'll get new ideas for teaching these subjects.

### A letter from Art Hansen

Dear Sam:

In your article in the May issue of **ES&T**, you quote this unusual (strange) theory: "A battery cannot produce voltage at any time unless current is being drawn from the battery."

I think the question is not technical but metaphysical, like this one: "If a tree falls in the forest, and no one hears it, is there sound?"

My field is engineering, not metaphysics, so I can't handle that kind of question. However, we could turn it into an engineering question by changing it to this: "How can a battery's voltage be measured while drawing zero (not merely 'very little') current?"

Answer: With a potentiometric method. Consider the circuit enclosed (see Figure 2), which shows a black box containing a battery of unknown voltage, a voltmeter, a potentiometer and a second voltage source. To find the voltage inside the black box, do this:

1. Connect the voltmeter between the unknown and the wiper of the potentiometer.

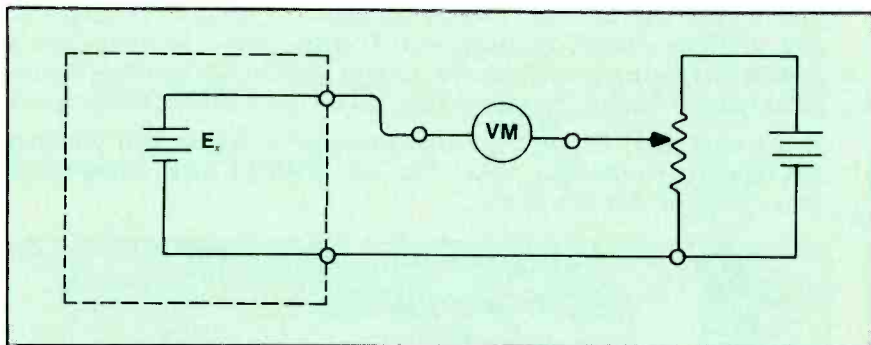
2. Adjust the potentiometer until the voltmeter reads zero. At this time, the meter, whatever its impedance, draws zero current.

3. Connect the voltmeter between the wiper of the potentiometer and common. The indicated voltage equals the battery voltage.

This method measures the voltage of the unknown battery without drawing current from it.

You may remember the Leeds and Northrup potentiometers for measuring thermocouple and other millivolt range voltages. This wonderful instrument had not one but *two* potentiometric measuring systems in it. The first was the millivolt measuring system itself. The system was mechanized using a servo and a motor-driven potentiometer. The servo ran on the difference between the input voltage and the voltage from the potentiometer, and ran the motor so as to reduce this voltage to zero. The motor shaft was coupled to the meter pointer, and the potentiometer was incredibly linear. As a result, when the error got to zero, the motor stopped and the pointer position indicated the voltage.

The second potentiometric system was in the calibration of the motor-driven indicating potentiometer. For the pointer position to accurately indicate the measured voltage, the excitation of the



**Figure 2.** To measure a battery's voltage without drawing current from it, use a potentiometric method, using a voltmeter, a potentiometer and a second voltage source.



potentiometer itself had to be extremely accurate. The only suitable source was a standard cell, which was only accurate when no current was drawn from it.

To get the few milliamperes needed to excite the potentiometer, the company used a disposable flashlight battery with a manually operated potentiometer across it. The voltage at the wiper of this second, manual potentiometer was the excitation of the main, measuring potentiometer. This wiper of this second pot was connected through a resistor, a momentary pushbutton and a sensitive galvanometer to the output of the standard cell.

To set up the unit, you just pushed the pushbutton and watched the galvanometer. You then adjusted the manual potentiometer until the galvanometer was in the center, zero position. At this point, you knew that the voltage exciting the measuring potentiometer was exactly equal to that of the standard cell. You then released the pushbutton and could operate accurately for many hours without recalibration.

I enjoy your articles. Let's have some more stuff from that "box of unusual letters."

### Is it a bram or a rambo?

As as general rule, read-only memory (ROM) is non-volatile. In other words, when the power supply goes off, the information in the memory is not lost. In a random-access memory (RAM), the information is lost when the power supply goes off, which is why RAM is called *volatile*.

However, there is a 40-pin RAM now being manufactured that has a built-in battery. The instant the applied power drops below a predetermined value, the battery takes over and saves the information in the memory. *The battery is guaranteed to hold the information in the memory for 99 years!*

No official name has been attached to this device. Here are two possibilities: BRAM (for battery-operated RAM), and RAMBO (for RAM-battery operated.)

Before I actually endorse this device, I'm going to get one and see if it actually *does* retain the information for 99 years.

**ES&T**

Call 1-800-843-3338 today  
to start thoroughly analyzing  
and pinpointing any trouble in any  
TV-RF distribution system,  
automatically to FCC specifications . . .

**New**



with the All New  
**FS74 CHANNELIZER SR.™ TV-RF Signal Analyzer**  
Patents Pending \$3495

IEEE - 488

Does your success in servicing RF distribution systems depend on locating problems quickly and accurately? If so, here's why your all new Sencore FS74 CHANNELIZER SR. will mean success for you . . .

Quickly tune in all TV/FM channels from 5 MHz to 890 MHz. Exclusive all channel, microprocessor-controlled digital tuner checks every standard and cable channel with better than FCC accuracy to fully analyze any system.

Exclusive 5 microvolt sensitivity to bring in even weak signals. Autoranged attenuator automatically selects the best sensitivity for simplifying your VHF, UHF, or FM signal measurements like never before possible.

Automatic hassle-free S/N ratio, A/V ratio, and hum level tests. Exclusive on-channel signal-to-noise ratio test eliminates time-consuming signal comparison and chart reading. Exclusive audio-to-video ratio test measures directly in dB for easy comparison to specifications.

Exclusive checks for ghosts, co-channel interference, line reflections, and other signal quality checks. Portable 4 MHz wideband battery-operated monitor lets you finally check the quality of your cable or MATV system and stop annoying callbacks.

Built-in autoranging AC/DC volt/ohmmeter makes troubleshooting a snap. Exclusive all-weather design holds tighter than FCC specifications from -4°F to +104°F. Truly portable, field-tested tough for dependable ease of use.

Begin successfully locating TV-RF signal problems more quickly and accurately than ever before possible, with the new FS74 CHANNELIZER SR. Call WATS Free 1-800-843-3338 today for a free Product Guide or an industry exclusive "Try before you buy" 15 Day Self Demo.

"CHANNELIZER SR." is a trademark of Sencore, Inc.

WATS Free 1-800-843-3338 In Canada WATS Free 1-800-851-8866



**SENCORE**

**Means Success In Electronic Servicing**

3200 Sencore Drive, Sioux Falls, South Dakota 57107

Call Collect 605-339-0100 In SD & AK

Circle (28) on Reply Card

September 1987 *Electronic Servicing & Technology* 63

## Tuning VCRs with PLL and AFT circuits

One method used to tune VCRs is the method used in the GE 1VCR 4016X, a frequency synthesis system that incorporates a phase-locked loop (PLL) and an automatic fine-tuning (AFT) circuit (see Figure 1).

The PLL circuit includes the phase comparator, programmable divider I, low-pass filter, local oscillator, pre-scaler, reference oscillator and programmable divider II.

The AFT circuit includes the video IF (VIF), AFT comparator, frequency control logic, frequency control, up/down counter, programmable divider II, phase comparator, LPF, local oscillator and mixer.

### How the PLL circuit works

The PLL circuit uses a 7.162109MHz oscillator as a frequency reference. The oscillator circuit is inside the IC, connected to pins 61 and 62, to which the frequency determining crystal and trimmer capacitors are connected. The output of the reference oscillator feeds programmable divider II, which in turn feeds one input of the phase comparator.

The local oscillator in the tuner produces a CW signal that is fed to the pre-scaler, which is also in the tuner. The pre-scaler output is fed to programmable divider I, which is programmed by the user according to the channel selected. The output of programmable divider I is fed to the second input of the phase comparator.

The phase comparator produces an error voltage pro-

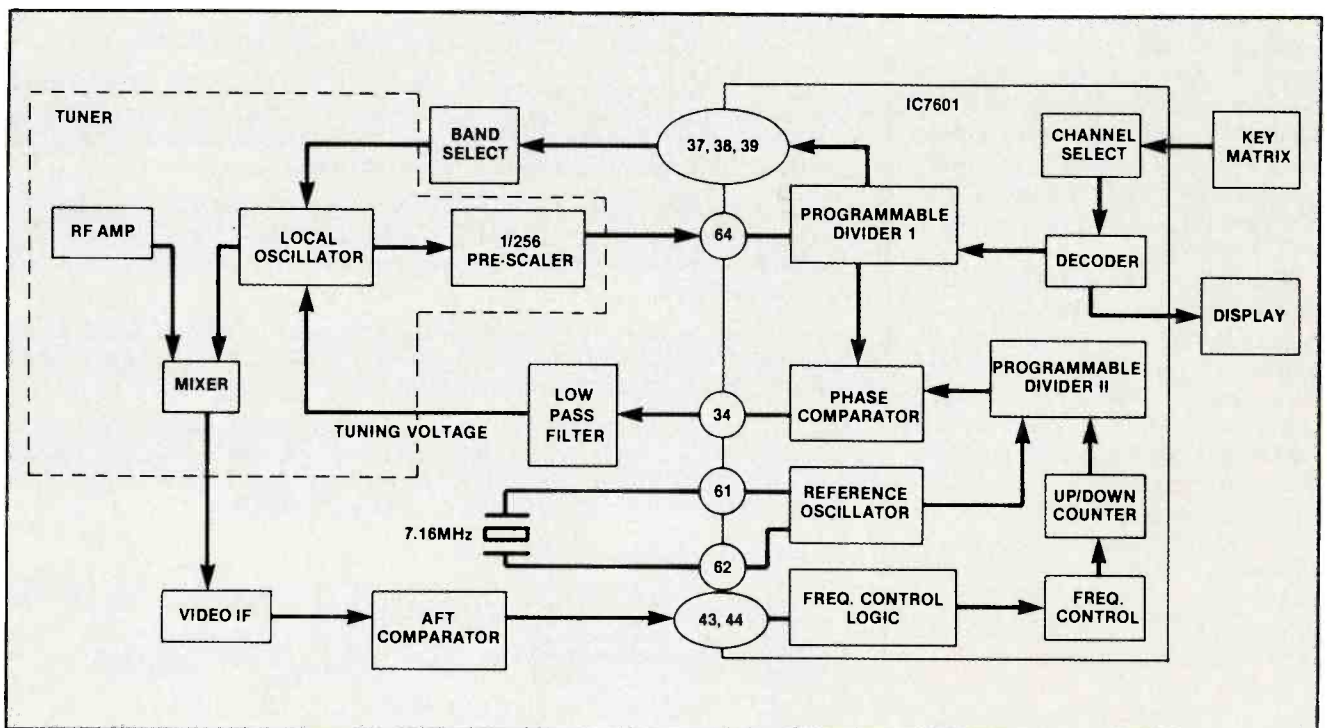
portional to the difference between the two inputs. If the input from programmable divider I is high, the phase comparator produces an output that will cause the local oscillator to tune to a lower frequency. The LPF integrates and amplifies the output and feeds it to the tuning (BT) terminal of the tuner.

### How the AFT circuit works

If all transmitting stations used standard frequencies, the division ratios built into programmable divider I would allow the PLL circuit to accurately tune them. However, because some stations transmit on frequencies that are offset from the standard, a circuit that detects what the transmitting frequency is and adjusts the tuning system is necessary. The AFT circuit supplies this need.

The AFT detection circuit is part of the video IF. This circuit works just like the AFT circuit in a TV set: It produces the familiar "S" curve, centered at 45.75MHz. At this frequency the voltage is 6.5V. The voltage rises at lower frequencies and becomes lower at higher frequencies. The AFT voltage is fed to the comparators in IC7603 to provide AFT direction and AFT window signals for IC7601. These are used to change the division in programmable divider II to *fine tune* the reference frequency sent to the phase detector.

*Adapted from GE VCR Service Bulletin No. 4016-1.*



**Figure 1.** This block diagram shows one method of fine-tuning a VCR. The PLL circuit uses an oscillator as a frequency reference. The AFT circuit detects the transmitting station's frequency and adjusts the tuning system.



## ANSWERS

Questions are on page 58.

1. 15A. Assuming a perfect transformer and a secondary circuit that will draw the maximum current, the secondary current will be 15A. The basic transformer equation is  $N_p:N_s = I_s:I_p$ .
2. B.) Increasing the distance between the plates will *reduce* the capacity of a capacitor.
3. D.) A kilowatt hour is a unit of electric *energy*.
4. C.) The unijunction transistor (UJT) and the programmable UJT are both breakover devices used in relaxation oscillators.
5. 800Hz. The bridge rectifier is an example of a full-wave rectifier, so the output ripple frequency is twice the input frequency.
6. A.) If  $R_3$  was open, the voltmeter would not display 9V. If  $R_2$  was open, the base voltage would be higher and the collector voltage would be lower. Capacitor  $C_1$  is an electrolytic type and is properly shown. An open  $R_1$  would remove base current, cut off the transistor and reduce the current through  $R_3$  to zero. With no drop across  $R_3$ , the collector voltage equals the supply voltage.
7. 49.9V. The voltage across the  $16\Omega$  resistor is 48V. That voltage is also across the  $3\Omega$  resistor, so the current through that resistor is 16A. That makes a total of 19A through the  $0.1\Omega$  resistor and a voltage across it of  $0.1 \times 19 = 1.9V$ . That voltage added to the drop across the  $16\Omega$  resistor (48V) makes a total voltage of 49.9V. (There are other ways to work the same problem.)
8. D.) They are  $1/4$ -wave vertical antennas. In other words, they are Marconi antennas.
9. 0.1107MHOS. The conductance is equal to the current (0.332A) divided by the voltage (3V).
10. A.) In the June '87 issue you were warned (in the table of contents) to "look out for the trick question." This must have been it, because the wrong answer was given. Write the equation for  $X_c$  as:

$$X_c = \left( \frac{0.159}{f} \right) \times \frac{1}{C}$$

If  $\left( \frac{0.159}{f} \right)$  is constant, then doubling  $C$  will halve  $X_c$ . **ES&T**

## Walk "Tough Dog" Troubles Out Of Any TV & VCR In Half The Time . . . Guaranteed!



with the exclusive, patented  
VA62 Universal Video Analyzer™ . . . \$3,495

Would you like to . . .

**Reduce your analyzing time?** Isolate any problem to one stage in any TV or VCR in minutes, without breaking a circuit connection, using the tried and proven signal substitution method of troubleshooting.

**Cut costly callbacks and increase customer referrals by completely performance testing TVs and VCRs before they leave your shop?** Own the only analyzer that equips you to check all standard and cable channels with digital accuracy. Check complete, RF, IF, video and chroma response of any chassis in minutes without taking the back off the receiver or removing chassis, plus set traps dynamically and easily right on the CRT.

**Reduce costly inventory from stocking yokes, flybacks, and other coils and transformers for substitution only, with the patented Ringing Test?** Run dynamic proof positive test on any yoke, flyback, and integrated high voltage transformer.

**Protect your future by servicing VCRs for your customers before they go to your competition?** Walk out "tough dog" troubles in any VCR chrominance or luminance circuit to isolate problems in minutes. Have proof positive tests of the video record/play heads before you replace the entire mechanism.

**Have one piece of test equipment that doesn't need replacing every time technology changes?** Be able to service Stereo TVs & VCRs profitably, and get in on the ground floor of this growing market with exclusive phase-locked accessories.

**Find out how the VA62 Universal Video analyzer will make servicing easier and more profitable in your shop?** Call WATS Free 1-800-843-3338 and ask your area Sales Engineer for a "Try before you buy" 10 Day Self Demo or a full color brochure and join the many servicers already on the road to more profitable servicing with the VA62.

Universal Video Analyzer is a trademark of Sencore, Inc.

WATS Free 1-800-843-3338 In Canada WATS Free 1-800-851-8866



# SENCORE

**Means Success In Electronic Servicing**

3200 Sencore Drive, Sioux Falls, South Dakota 57107

Call Collect 605-339-0100 In SD & AK

Circle (29) on Reply Card

## PLL tuned FM receivers

This month, we'll take a look at how phase-locked loop (PLL) FM receivers work and try to give some troubleshooting tips.

Figure 1 shows a generalized version of the PLL high-fidelity FM receiver. Of course, like almost everything else nowadays, it's a loop. A sample of the local oscillator (LO) is divided by an integer value chosen via the microcontroller. This frequency is then phase-compared to a stable crystal reference to produce a correction voltage that biases the varactor diodes to the proper capacitance for the LO frequency desired. Notice that the PLL both samples and alters the LO. That's what makes it a loop.

Contrary to what you'd expect, most newer receivers do not read the LO to display the tuned frequency. This was true of older devices, such as the Sansui G4700, which had a digital display but conventional mechanical tuning. However, today's units are more trusting. On command from the operator, they send out a digital code in serial form to the PLL IC and display the selected frequency. Then they assume that any right-thinking PLL will obey and tune to the correct station. If the quadrature detector is misaligned, it might look like the receiver is tuning to an "even" number, such as 98.2MHz, which, of course, isn't supposed to be allocated in the United States.

Without a computer and knowledge of the correct digital codes, there's not any practical way to be sure the micro is outputting the correct data to the PLL chip. In general, however, if the clock, data and latch lines have clean signals (square wave pulse trains) on them, we can assume the data is correct. Just remember later on that you made this assumption if nothing else seems to be bad in the circuit.

By the way, the latch or strobe pulse occurs after a complete data word has been transmitted, signalling the PLL controller to latch the data into storage and tune the front end. Therefore, the pulse repetition rate of this signal will be significantly lower than that of the clock or data lines.

In order to tune the front end, the PLL IC needs three input signals: the LO sample, the reference oscillator and

data from the micro. If any of these are missing, the usual symptom is no audio from the FM section, because the FM is generally muted between stations. A very simple way to determine whether you have tuning problems or a defective RF/IF section is to read the tuning voltage input to the tuner. It should change as you select different stations. To double-check, substitute a regulated, variable dc voltage (check the manual, but it's usually in the range of 2Vdc to 20Vdc) at the front end's tuning input. Slowly vary the voltage. If the RF/IF section is OK, you should be able to pick up stations, just as if you'd tuned in the conventional way.

If you've focused on the PLL controller as the culprit, first check the phase detector output. It's often some sort of cross between dc and pulse-width modulation (PWM), and is occasionally difficult to interpret, but it should change as different frequencies are selected. If not, test the reference oscillator. Use a scope and a low-capacitance probe to avoid loading. You should see a healthy sine wave at the correct frequency. If it's all right and you have a 100MHz scope at hand, see if there's an LO sample at the controller input. Don't assume that just because you can tune the FM with an external voltage, the LO sample must be present. There often are a buffer transistor and coupling capacitors in the front end to unload the local oscillator, and they can fail without upsetting the LO itself.

If all necessary inputs are present but the PLL phase detector has no output or change of output, the chip is probably bad.

If you feel that the phase detector output is normal, then the integrator stage may be bad. It should take the PWM and turn it into clean dc.

The latest receivers incorporate the PLL controller in the same chip as the microcontroller and display driver. The output to the tuner is pure digital, so there's no chance of troubleshooting by injecting an external control voltage. About all you can do is verify the presence of clock, data and latch pulses. If they're present, the tuner is probably defective.

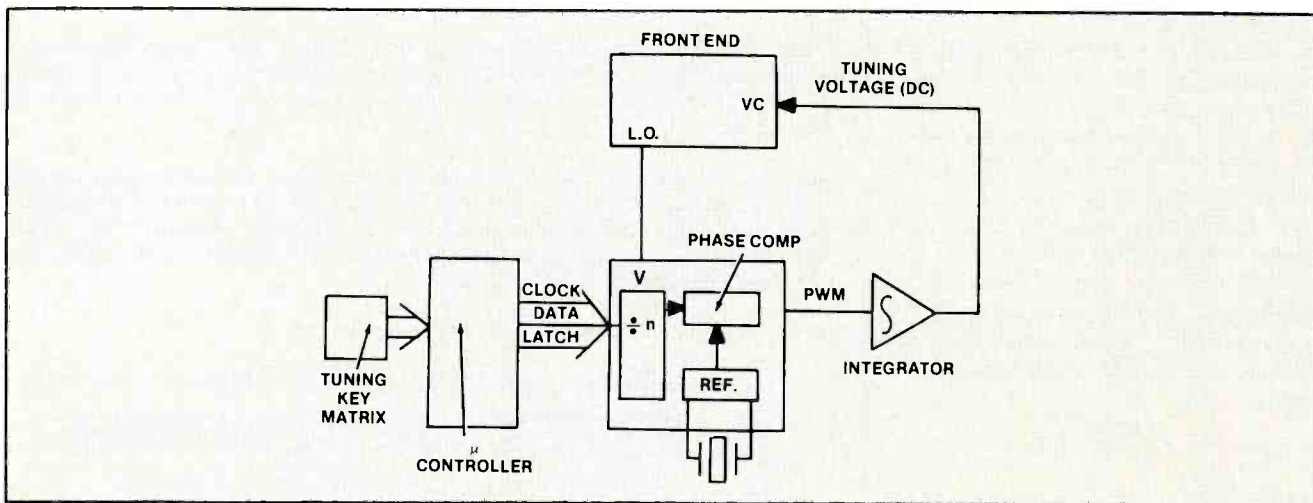


Figure 1. The PLL high-fidelity FM receiver employs a loop to both sample and alter the local oscillator, which is phase-compared to a stable crystal reference.



## Products

### Digital-storage oscilloscope

The HM205-2 scope from *Hameg Instruments* offers analog operating modes and digitized waveform processing for signals and events. A 5 million sample per second digitizing rate, dual-channel acquisition, an 8-bit vertical resolution and 1K record length per channel are included. A linear interpolator helps improve waveform recognition. The scope also offers an active TV sync separator, jitterless triggering up to 40MHz, hold-off control, X-Y mode, Y-output and a built-in component tester. A GPIB interface with DSO software for IBM-ATs or compatibles is optional.

Circle (75) on Reply Card

### Digital multimeter

The DM71 digital multimeter from *Beckman Industrial* is a hand-held, pen-type meter that features 3½-digit display with 0.7% accuracy (dc 2mV range) auto-ranging. The meter has a rotary dial and a data hold function that enables the user to manually freeze the display. Continuity and diode test functions are included. The unit has full auto-ranging capability on fifteen measurement ranges and measures voltages up to 450V and resistance up to 20mΩ.

Circle (76) on Reply Card

### Autoranging DMM

The DM-76 digital multimeter from *Philips ECG* is an autoranging model with a 20mΩ scale that is extendable to 30MΩ. It features a range indicator, 24 ranges and 10 functions, and it is equipped with a data hold that holds a displayed reading in any range. The DMM has a diode test (VF) to measure actual forward voltage drop, plus a transistor hFE test. The RF-shielded meter also has an audible continuity test, overload protection, an over-range indicator and a metal tilt stand.

Circle (77) on Reply Card

### Digital voltage calibrator

The DVC-350A from *Datel* is a microprocessor-based, hand-held digital voltage calibrator with true ±0.015% accuracy. The calibrator has a decimal entry mode with ±1.2V or ±12V output ranges, plus a hexadecimal entry mode that spans ±1.0V or ±10V. The fully bipolar output can source or sink up to 20mA at any voltage and is current-limited to 22mA. The calibrator has an operating range of 0°C to 50°C and a maximum calibration drift of ±10ppm/°C over 15°C to 35°C.

Circle (78) on Reply Card

**ES&T**

# What Strikes You?

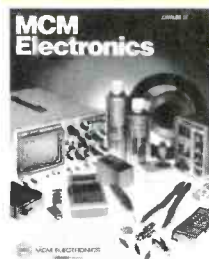
- Product Selection
- Fast, Dependable Service
- Convenient Ordering
- Low Prices



With the new MCM Catalog, lightning strikes in all four places — not just one! From products to prices, we have what you're looking for.

We also have the people who can help you weather any storm. Courteous sales reps on our TOLL-FREE phones, experienced technicians to answer your questions and warehouse experts who guarantee fast, efficient delivery.

Discover the difference our new catalog and our company can make for you. Call TODAY for your FREE copy!



## Call Toll Free 1-800-543-4330

In Ohio,  
1-800-762-4315  
In Alaska and Hawaii,  
1-800-858-1849



**MCM ELECTRONICS**  
858 E. CONGRESS PARK DR.  
CENTERVILLE, OH 45459

A PREMIER Company

Source No. ES-25

Circle (30) on Reply Card

## Knowing the parts of a personal computer

Before you can troubleshoot any kind of malfunctioning equipment, you have to understand the subsystems so that you can know what failure symptoms point to. For example, sound but no picture in a TV set might point to the horizontal deflection circuits, the luminance circuits or other circuits that affect the picture.

The same idea holds true with computers. Before you go jumping in and probing here and there in a malfunctioning computer, you have to understand the subsystems so that you can start at the most likely source of the problems, then work your way down to the least likely cause of the problem.

Figure 1 is a block diagram of the major subsystems in a typical microcomputer. When you encounter a problem with a computer, the first step in solving the problem is to examine the symptoms and ask yourself, "Given this symptom (or set of symptoms), what circuit is the most likely to be the cause?"

### Looking at the subsystems

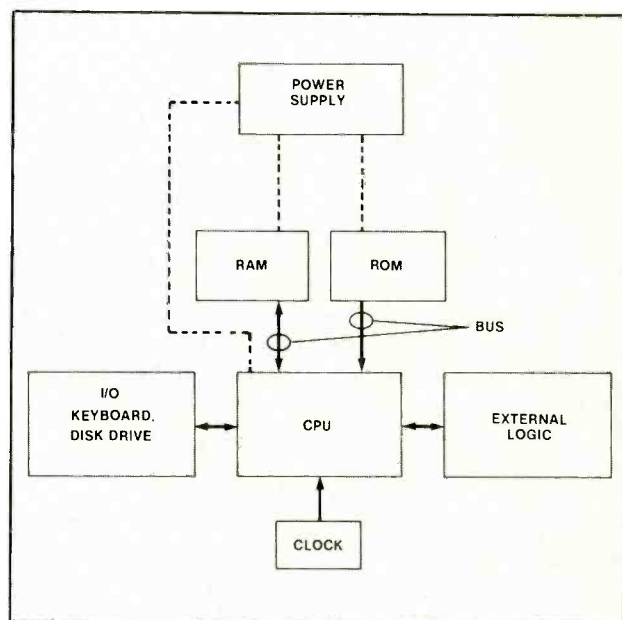
The concept of a *power supply* in a computer system should present no problems to someone who has had experience with TVs and other consumer electronics. Its purpose is to provide a dc voltage or voltages for the computer's electronic components; for example, the voltage might bias the transistors of ICs to their proper operating conditions.

The *clock* is a circuit that provides a continuous train of regular pulses (and frequently provides more than one such output) that is used to control the timing of events within the microprocessor. The clock circuitry in modern microcomputers is generally contained on the microprocessor chip. The clock input may be driven by a crystal, an LC circuit or an external clock source.

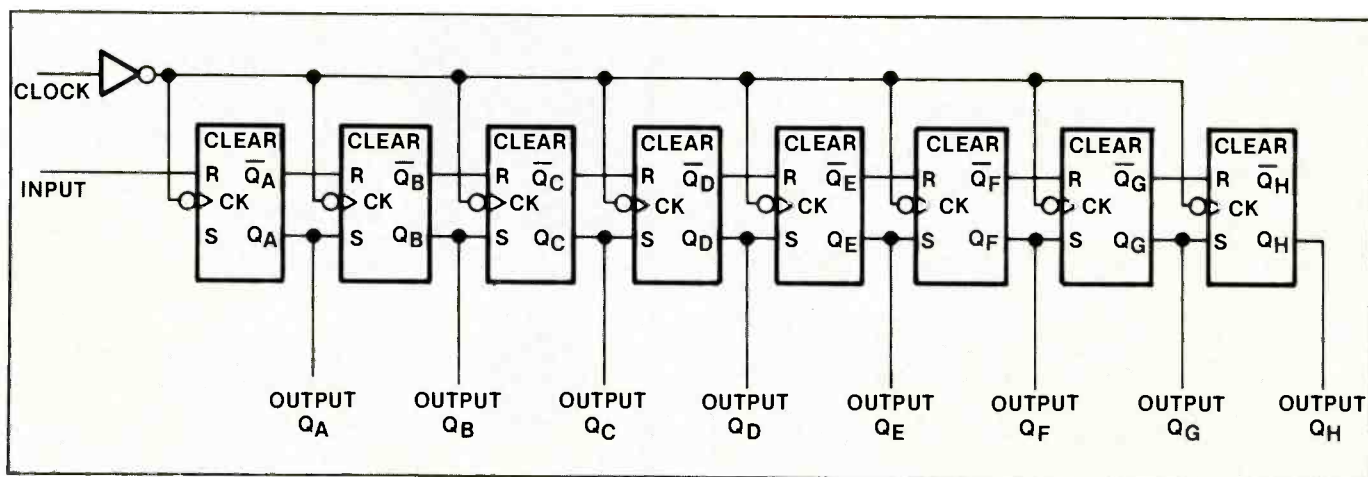
An example of the application of the clock circuit is in the operation of a shift register (see Figure 2), used to convert serial data to parallel data. (For more detail on shift registers see "What Do You Know About Electronics?" in the May 1987 issue of *ES&T*). The data (in the form of ones and zeros) to be stored in the shift register are presented to the shift register inputs a bit at a time.

Nothing happens until a clock pulse appears at the clock input to the shift register. Each time a clock pulse is applied, a successive bit is entered into the shift register's first flip-flop, and previously entered bits are shifted one bit to the right.

In the next installment of computer corner we'll continue breaking down the personal computer into its elements in order to better understand what's going on inside.



**Figure 1.** This block diagram of the major subsystems in a typical microcomputer gives you an idea of which circuits are most likely to be the problem behind a particular symptom.



**Figure 2.** The operation of a shift register shows an application of the clock circuit, which provides a continuous train of regular pulses to control the timing of events within the microprocessor.





## ELENCO PRODUCTS AT DISCOUNT PRICES!



**20 MHz Dual Trace Oscilloscope**  
**\$359.95** MO-1251

Two 1x, 10x 100 MHz probes, diagrams and manual included. Write for specs.

**35 MHz \$499.95** MO-1252

**GF-8016 Function Generator**  
with freq. counter



**\$239.95**

Sine, Square, Triangle  
Pulse, Ramp, .2 to 2 MHz  
Frequency .1 thru 10 MHz

**GF-8015 without freq. meter \$179**

**Triple Power Supply XP-660**

0-20V @ 1A  
0-20V @ 1A  
5V @ 5A



**\$159.95**

Fully regulated, short circuit protected  
with 2 limit cont. 3 separate supplies

**3 Amp Power Supply XP-650**



0-40V @ 1.5A  
0-20V @ 3A

**\$129.95**

Fully regulated, short circuit protected  
current limit control

**Color Convergence Generator**



**SG-200**  
**\$69.95**

Finest in the industry  
10 rock steady patterns

**Multimeter with Capacitance  
and Transistor Tester**

**Model CM-1500A**  
with case  
**\$64.95**

Reads volts, ohms, current,  
capacitors, transistors, diodes



**Digital LCR Meter**

**\$148.95**



Model LC-1800  
Measures: Inductors  
Capacitors, Resistors  
Inductors 1uH to 200H  
Capacitor .1Pf to 200uF  
Resistor .01 Ohms to 20M Ohms  
Ranges 6 Ind, 7 cap, 7 res

C + S Sales, Inc., 1245 Rosewood  
Dr., Deerfield, IL 60015. 800-  
292-7711, 312-459-9040. ASK  
FOR CATALOG. Add 5% P&H  
(\$10 max. per item) IL Res.,  
add 7% sales tax



Circle (33) on Reply Card

## Readers' Exchange

No ad requests will be accepted for Readers' Exchange without a full, verifiable name, address AND phone number. This information is necessary for ES&T files. Phone numbers will not be published, if so requested.

### Wanted

Sencore DVM 37 digital multimeter, \$125; B&K Analyst 1077B, \$225; Sencore LC53 Z-Meter. All equipment like new, with manuals and in original cartons. *Paul Cecil, Paul's TV, 260 Main Cross, Charlestown, IN 47111; 812-256-3119.*

Digital 11/34 computer with two RK056J drives and 22 discs, \$1,000. Simpson capachometer model 383-A, \$40. Beltron CRT tester, \$100. RCA oscilloscope, model W33A, \$50. B&K Dyna Sweep 1070, \$20. *Robert Blanchard, Pinehill Road, Warren, NH 03279.*

B&K Precision model 1248 digital I.C. color generator, excellent condition, \$250. *Michael Rowell, Gohmert Audio/Visual, Start Route Box 38A, Meyersville, TX 77974; 512-275-8951.*

TV sets for parts—Admiral 1M30, M25; Magnavox T809, T995, T979; Philco 22QT80, 3CR41; RCA CTC 40P, CTC 91, CTC 97, CTC 108; Quasar TS919; Zenith 19DC12, 25CC50. Also for sale, two excellent picture tubes—19V1NP22 and 25VFHP22; Knight 6/10 meter, model T-175 linear amp; two Litton oven parts: model 70/42 menu master and model 56-4888-10 11/78; Sony TC-580 reel-to-reel recorder. *D.J. Ajjala, 50 Fir Circle, Babbitt, MN 55706.*

DeVry Institute model 34 oscilloscope, \$75; EICO model 147 signal tracer, \$25; Sencore FE-20 hi-lo multimeter, \$75. Will consider trades. *B.L. Deck, 122 Fourth Ave. South, Algood, TN 38501.*

Heath IB-2A impedance bridge, \$45; Heath IT-3120 transistor tester, \$35. Both in good condition, with manuals. *Bob Kramer, 919 Grove St., Aurora, IL 60505; 312-898-8946.*

Service literature and repair manual for an Equiscan 4100 ultra sound system. Will pay for copies. *Carlson TV, 1209 12th St., Aurora, NE 68818.*

Knight 83YX137 AF generator with manual; 83Y135 signal tracer manual only; 83YX123 sweep generator manual only. *C.T. Huth, 229 Melmore St., Tiffin, OH 44883.*

New miniature tube boxes for type 12AX7, 6AV6, etc. Can use maximum quantity of 500. State price. *William A. Thoma, 762 Silverleaf Drive, Dayton, OH 45431.*

Cards for Cardmatic KS-15874-L2 tube checker by Hickok. *Mark Weber, Ed's TV Service, 4415 S. Kingshighway, St. Louis, MO 63109; 314-481-9106.*

Used satellite descrambler (Videocipher II). Must not have been tampered with. *J.R. Hinely, P.O. Box 119, Rincon, GA 31326; 912-826-5017.*

CRTs: 19VFAP22, 25VETP22, 510NFB22, used preferred; back cover for Sears 528.41881218; parts for Philco Predictas. *Dan Schafer, 4215 Buechner, Cleveland, OH 44109; 216-351-4555.*

Schematics and operating/maintenance/calibration instructions for model 80389-1 service monitor manufactured by the Alston division of Conrac Corporation. *Dave, P.O. Box 151, Poway, CA 92064.*

Hickok model 235A VHF/UHF field strength meter; Tequipment scope (Tektronix subsidiary). *James G. Shoemaker, 600 1st St., Leechburg, PA 15656; 412-842-8321.*

### For sale:

B&K 1077B TV analyst, \$300; B&K 1248 color bar generator, \$150; CIE Electronics Tech course, \$400; NRI television repair course, McGraw Hill, \$100. Will ship UPS COD only. *Mark Brown, P.O. Box 701, Grove Hill, AL 36451; 205-275-8951.*

Brand new 19JNP22 Zenith CRT in box, \$75, local preferred. *Hy Davidowitz, 911 E. 15th St., Brooklyn, NY 11230; 212-258-4877.*

B&K model 747 tube tester, \$50 plus shipping; Sam's CB books, one through 120, \$3.50 one or all. *William Blankinship, 1216 E. Main, Rusk, TX 75785; 214-683-5070.*

Tele-matic test jig; large CRT with all recent accessories; Heathkit power supply; Sams Photofacts; Sams CB, car radio manuals; many other items. Make offer. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

Harrison (HP) model 880A regulated power supply (0V to 100Vdc, 1A), \$125. Heathkit 1G-82 sine/square wave generator, \$50. Both with manual and schematic. Sencore FP201 and 39G89 probes, both for \$25; 42 each Sams between 600-800, \$31.50, all in good condition. *Lony's TV Service, 720 Goshen St., Salt Lake City, UT 84104; 801-595-8442.*

Sencore LC53 Z Meter, perfect condition, recently factory calibrated, \$585. *Nate Lilienthal, 29515 Quailwood Drive, Palos Verdes, CA 90274; 213-377-9913.*

Tubes, new and used, rare, old and current, \$25 and up. Send list for quote. *Ted Youngman, 2225 Vigo St., Lake Station, IN 46405.*

B&K model 162 transistor/FET tester, \$90, in mint condition, with batteries, test cables and instruction manual. Tests in circuit or out. Will ship UPS collect. *C.A. Caputo, 7 Donna St., Peabody, MA 01960; 617-535-1091.*

RCA picture tube tester and rejuvenator, model CR111 WT-333A, with sockets, manual and set-up charts, \$100; B&K model 747 tube tester, has had very little use, with manual and tube charts, \$200. All prices plus postage. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235; 412-242-4701.*

8-track players for parts: Dyn. Clarion, Bigelow, Concept, Mitsumi, Sears (send s.a.s.e. for list); and a Pioneer cassette stereo player. All are dash mounts. *D. J. Ajjala, 50 Fir Circle, Babbitt, MN 55706.*

Electronics books: classroom study type, some hardbound, some softbound. Current material—TVs, audio, digital, microprocessor, Sams Quickfacts Vol. 2, RCA, \$10; others, \$5 each. Send for list. *Calvin Logue Jr., 17J Washington Lane, Westminster, MD 21157.*

**ES&T**



# ElectroDYN is rebuilding the world of Electronics

## Tuner Rebuilding

- 24-hour Turnaround
- One-year Limited Warranty

## TVRO Equipment Repair

- 72-hour Turnaround
- 90-day Limited Warranty

## VCR Repair

- 72-hour Turnaround
- 90-day Limited Warranty

## Module Repair

- 72-hour Turnaround
- One-year Limited Warranty  
(see price list for exceptions)

## Most Makes & Models

\*Turnaround time is dependent upon parts availability

# ELECTRODYN, INC.

917 S. Rogers St.  
Bloomington, IN 47401  
(812) 334-1023

Circle (31) on Reply Card



### Power Supplies

3 amp 4 amp non-regulated with self reset circuit breaker and cigarette lighter attachment. Under \$25 and under \$28.00. Meets all Canadian and US standard specs

### DMR-45 4½ Digit Multitester

- Single 30 Position Rotary Switch with 5" High Contrast LCD
- Auto-Overrange and DC Auto Polarity
- Diode Test, Transistor HFE Test, Audible Continuity Test, Data Hold AC-DC Volts, AC-DC Current, Resistance
- Dual Slope Integration A-D Converter Systems



UNDER \$100.00

### DM 3520 CF

- Oversize 3½ digit display with 0.3% basic accuracy
- Audible continuity test, transistor HFE and diode test



UNDER \$85.00

- 35 ranges with professional carrying case and ruggedized cabinet
- 3 capacity ranges from 2000 PFD - 20 UFD
- 2 frequency ranges 20 KHz and 200 KHz
- 5 DC volt ranges from 200 MV - 1000 volts
- 5 AC volt ranges from 200 MV - 750 volts
- 6 DC current ranges from 200 UA - 20 amps
- 5 AC current ranges from 2 MA - 20 AMPS
- Resistance ranges from 20 ohm - 20 megohm

Available at your local distributor

- Single & Dual Trace Scopes
- Analog & Digital Multimeters
- Power Supplies
- High Voltage & Low Cap. Probes
- RF & Sine/Square Wave Generators
- Digital Capacity Meters

**EMCO ELECTRONICS**  
P.O. Box 327, Plainview, NY 11803

Send for your free catalog.

Circle (34) on Reply Card

# ATTENTION! ELECTRONICS TECHNICIANS

## EARN YOUR B.S.E.E. DEGREE



### THROUGH HOME STUDY

Our New and Highly Effective Advanced-Placement Program for experienced Electronic Technicians grants credit for previous Schooling and Professional Experience, and can greatly reduce the time required to complete Program and reach graduation. No residence schooling required for qualified Electronic Technicians. Through this Special Program you can pull all of the loose ends of your electronics background together and earn your B.S.E.E. Degree. Upgrade your status and pay to the Engineering Level. Advance Rapidly! Many finish in 12 months or less. Students and graduates in all 50 States and throughout the World. Established Over 40 Years! Write for free Descriptive Literature.

## COOK'S INSTITUTE OF ELECTRONICS ENGINEERING



347 RAYMOND ROAD  
P.O. BOX 20345  
JACKSON, MISSISSIPPI 39209

Circle (35) on Reply Card

# Classified

Advertising rates in the Classified Section are 85 cents per word, each insertion, and must be accompanied by payment to insure publications.

Each initial or abbreviation counts a full word.

Minimum classified charge is \$20.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of \$30.00 per insertion to cover department number, processing of replies, and mailing costs.

Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or distributor.

## FOR SALE

**AUTOMOBILE RADIO** and tape replacement parts. Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469. (212) 881-9600. National (800) 223-8314, NY State (800) 446-4430. 1-85-tfn

**PHOTOFACTS:** Individual folders #1 to #1400 \$3.00. Above #1400 \$5.00. Sent same day first-class postpaid. Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 4-87-61

**TV TROUBLESHOOTING.** Over 130 schematic ILLUSTRATED problems-solutions of difficult repairs. Also, 12 steps to easier TV repair, 25 pages \$12.00. Remarkable diagnostic tool. Determine operation of high voltage circuits every time, no mistakes. \$5.00. Jones, Box 702, Niceville, Fla. 32578 7-87-31

**VCR REPAIR SOLUTIONS FOR VHS MODELS.** Volume I—150 Symptoms and cures—\$11.95. Volume II—\$11.95. All 300, \$19.95. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 7-87-61

**THE WORKBENCH COMPANION**—Over 200 pages of Tough Dogs and troubleshooting notes from 20 years in the business. Partial contents: Sycmure Index 1970-1987, Radio Elect. Clinic 1969-1987, ETD Index ColorFax 1969-1982, Testing HV Diodes, Int. Flybacks, Zenors, etc. Important note on capacitors and much more. Price: \$29.95 + \$2.50 shipping and handling. Second Printing—Available Now! FARRELL ELECTRONICS, Hi-Teck, Larry Gribbin, Chief Engineer, 127 Providence Avenue, SOUTH PORTLAND, MAINE 04106. 8-87-31

**SERVICE MANUALS.** Large Shop has 18 yr. collection of duplicates. All original manufacturer. All new. Audio \$1.00, video \$5.00. Send SASE for list. Tape Recorder Clinic, 4850 E. Speedway, Tucson, Arizona 85712. 11-86-tfn

**TV/VCR "TUFF TIPS"** listed by mfg. and model. 1st edition—200 TV/VCR tips \$10.95; 2nd edition—200 TV/VCR tips \$10.95; both editions \$19.95. For TV tips only—1st or 2nd edition \$5.95, both editions \$10.95. For VCR tips only—1st or 2nd edition \$6.95, both editions \$12.95. TECH CURES, 4825 Fredericksburg Road, San Antonio, Texas 78229. 9-87-11

**TV/VCR FAILURE HISTORIES**—Multiple cures for most problem areas. Send \$6.95 with mfg. and model number to: Tech Cures, 4825 Fredericksburg Rd., San Antonio, Texas 78229. Money will be refunded with free sample, if model is not on database. 9-87-11

**ELECTRONIC SERVICE SHOP CONTENTS:** Sams Photofact Sets, 101 to 1250, \$2 each; Over 2500 New Boxed Tubes in stock 90% off List Price, non-listed tubes \$3 to \$6, some tubes excepted; Test Equipment & Parts send LSASE; OEM Service Data (TV) RCZ-NITH-QUASAR \$200.00 each. Plus UPS & HDLG. Wecco, 216 Broadway, Westville, NJ 08093. 609-456-4079. 9-87-11

**DIEHL MARK III SCANNER,** new, manual included, \$250, shipping paid. Jones, Box 702, Niceville, FL 32578. 7-87-31

**FOR SALE: B&K 1077TV** analyst. Bought 1979. Looks like new—with leads—Book—Repaired in 1984 by factory—\$135. 501-584-4002, Clarence. 9-87-11

**\$935 WORTH OF PRIMEFAX** hook-up time. B/O over \$200. T.T.V., 809 Amity St., Homestead, Pa. 15120, (412) 462-8720. 9-87-11

**B&K 530 in/out circuit transistor checker,** \$275. UNGAR 9100 soldering station. Variable 400-800 degrees, \$100. T.T.V., 809 Amity St., Homestead, Pa. 15120, (412) 462-8720. 9-87-11

## BUSINESS OPPORTUNITIES

**NORTH SHORE OF MASSACHUSETTS.** Established appliance, TV, and VCR repair service with new and used sales opportunity. Real estate package available. Call for details (617) 281-1006 days. 8-87-41

**ELECTRONIC REPAIR,** inventory & equipment. 11 years at same location. Small recreational town in Idaho. Owner wishes to retire. \$15,000. 208-756-2916, Box 488, Salmon, Id. 83467. 9-87-21

**FLORIDA WEST COAST:** TV service & sales, established 30 years. Valuable income producing real estate included. \$90,000 initial investment. Please call: Harold Nydick, V.P., Alario & Associates, Inc., Lic. R.E. Broker, 813-957-1414 or 813-371-3609. 9-87-11

## EDUCATION

**CABLE TV TRAINING**—Training in Cable Television Technology. Learn construction, installation, and maintenance. Cable Correspondence Courses, Inc., P.O. Box 1319, St. Charles, MO 63302. 7-87-tfn

## HELP WANTED

**VIDEO/AUDIO** technician needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer TV and audio equipment. Training by manufacturers such as: Sony, Hitachi, RCA, Panasonic, etc. are necessary for job experience. Write or call: Atlantic Electronics, Inc., 1232 NE 26th St., Ft. Lauderdale, FL 33305, 305-564-8274 (10 AM to 6:30 PM). Ask for Dave or Joe. 06-86-tfn

**CAMERA-VIDEO** Technicians needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer and/or industrial cameras and VCR's. Training by manufacturers such as Sony, Hitachi, Panasonic, etc. are necessary for job experience. Come to sunny Florida and enjoy your work & leisure time. Write or call ATLANTIC ELECTRONICS INC., 1232 NE 26th St., Ft. Lauderdale, FL 33305. (305) 564-8274 10 AM to 6:30 PM. Ask for Dave or Joe. 8-85-tfn

### PERSONALIZED 24-HOUR SERVICE ON OVER 10,000 ELECTRONIC COMPONENTS & PRODUCTS...

CALL TOLL FREE

IN  
1-800-558-9572 WIS 1-800-242-9553  
24 HOUR ORDERING: FAX: 414/473-4727



Circle (36) on Reply Card

### A MUST FOR THE TV TECHNICIAN

UNIVERSAL CRT ADAPTER- Don't buy another socket for your CRT Tester! Join 10,000 satisfied buyers & WIN the Socket War! GUARANTEED to fit your tester. Test/clean/restore ALL Color, B/W, Projection. \$63.95ppd w/Setup book, Visa, MC, COD.

1-800-331-9658

DANDY MFG. CO.

2323 Gibson, Muskogee, Oklahoma 74403

Circle (37) on Reply Card

**"Tech's Guide To Pricing"**  
updated new 5th edition... a framework for setting rates that apply to Hi-Tech products a formula that guarantees SUCCESS!  
Call Toll Free for details 8/5  
**1-800-228-4338 CST**

Circle (38) on Reply Card

**NEW 20-PAGE CATALOG FREE**  
**7 MILLION TUBES**  
Includes all current, obsolete, antique, hard-to-find receiving, transmitting, industrial, radio/TV types. **LOWEST PRICES.** Major brands in stock.  
Unity Electronics Dept. E  
P.O. Box 213, Elizabeth, N.J. 07206

Circle (39) on Reply Card

### ELECTRONIC TEST EQUIPMENT Reduced Prices - High Quality

Custom Reconditioned & New Products  
**FREE CATALOG AVAILABLE**  
**Accutest Instruments, Inc.**

CLARKSBURG, N. J. 08510  
(609) 259-0460 (NJ) or 1-800-524-0747

Circle (40) on Reply Card

# Advertisers' Index

	Page Number	Reader Service Number	Advertiser Hotline
Accutest Instruments, Inc.	72	40	609/259-0460
American Reliance	11	7	800/654-9838
Amprobe Instruments	69	32	516/593-5600
Atrix, Inc.	22	12	800/222-6154
Automated Production Equipment Corp.	29,30		516/654-1197
B&K Precision Dynascan Corp.	9	42	312/889-9087
Beckman Industrial Corp.	IFC,56	1,24	714/671-4800
C + S Sales	70	33	800/292-7711
Caig Laboratories, Inc.	24	14	619/743-7143
Clary Corp.	41-42		818/287-6111
Cleveland Institute of Electronics	31-32,54	22	800/321-2155
Computer Service Center	24	15	602/889-8888
Contact East	54	21	800/225-5370
Cooks Inst. Elec. Engrg.	71	35	601/371-1351
Dandy Mfg. Co.	72	37	800/331-9658
Digitron Electronic	8	20	800/526-4928
E-Z-Hook	23	13	818/446-6175
Electrodyn Corp.	71	31	812/334-1023
Emco Electronics	71	34	
Fluke, John Mfg. Co., Inc.	16	45	800/227-3800
Fordham Radio Supply Co.	5	8	800/645-9518
GE Consumer Electronics (RCA)	13	5	
GTE Electronic Supply	50	17	800/874-1765
Hameg Inc.	52	19	516/883-3837
Hitachi Sales Corp. of America	57	25	516/921-7200
Kenwood Test & Measuring Instruments	7	6	213/639-9000
Laguardia Enterprises	72	41	714/579-1276
Leader Instrument Corp.	3	4,43	514/337-9500
Matsushita Services Co. (Parts Div.)	55	23	
MCM Electronics	67	30	800/543-4330
Microwave Filter Co.	31-32		800/448-1666
National Technical Schools	29-30		800/BBE-TTER
NESDA	50		817/921-9061
NRI Schools - Electronics Division	27-28		202/244-1600
NTE Electronics, Inc.	27-28		800/631-1250
OK Industries, Inc.	15,29-30	9	800/523-0667
Philips ECG	21	18	800/225-8326
Prentice-Hall Inc.	41-42,43,44		
Projector Recorder Belt Corp.	72	36	800/558-9572
PTS Corp.	51	44	812/824-9331
RCA Distributor and Special Products	31-32		609/853-2441
Sencore, Inc.	59,61	26,27	800/843-3338
Sencore, Inc.	63,65	28,29	800/843-3338
Simpson Electric Co.	53	11	312/687-2265
Sperry AW Instruments Inc.	17	10	800/645-5398
Sperry Tech, Inc.	72	38	800/228-4338
Techni-Tool	41-42		
Tektronix, Inc.	IFCA-IFCB,1	3	800/433-2323
Tentel	43-44		800/538-6894
Triplett Corp.	IBC	2,46	800/TRI-PLET
U.S. Instrument Rentals	43,44,49	16	800/824-2873
Unity Electronics	72	39	201/351-4200
Zenith	27-28, BC		

**HAND REMOTE REPAIR**  
**LA GUARDIA ENT.**  
5882 Rich Hill Way  
Yorba Linda, CA 92686  
(714) 579-1276

90 Day Warranty  
New Battery included

- Call for pricing
- 24 hr. turnaround time
- Return freight pre-paid

Circle (41) on Reply Card

**ELECTRONIC SERVICING & TECHNOLOGY** Volume 7, No. 9 (USPS 462-050) is published monthly by Intertec Publishing Corp., 9221 Quivira Road, P.O. Box 12901, Overland Park, KS 66212. Second Class Postage paid at Shawnee Mission, KS, and additional mailing offices. POSTMASTER: Send address changes to ELECTRONIC SERVICING & TECHNOLOGY, P.O. Box 12952, Overland Park, KS 66212-9981.

## ADVERTISING SALES OFFICES

### ELECTRONIC

Service & Technology

**ALL U.S. TERRITORIES**  
Greg Garrison, Sales Manager  
P.O. Box 12901  
Overland Park, KS 66212  
Phone: (913) 888-4664  
Fax: (913) 888-7243  
Telex: 42-4156 INTERTEC OLPK

**NORWOOD, AUSTRALIA**  
Hastwell, Williamson, Rouse PTY. LTD.  
P.O. Box 419  
Norwood, S.A. 5067  
Phone: 332-3322  
Telex AA 87113

### LONDON, ENGLAND

Nicholas McGeachin  
Roseleigh House, New Street  
Deddington, Oxford OX5 4SP  
Phone: (0869) 38794  
Telefax: (0869) 38040  
Telex: 837469 BES G

### TOKYO, JAPAN

Haruki Hirayama,  
EMS, Inc.  
Sagami Bldg., 4-2-21, Shinjuku,  
Shinjuku-ku, Tokyo 160, Japan  
(03) 350-5666  
Telex: 2322520 EMSINCJ  
Cable: EMSINCPERIOD



# Reliability in Numbers



## Full Line DMM's Protected by Triplet's 3-Year Warranty. Dependable Digital Multimeters

Triplet announces the three-year warranty on its complete line of high-tech digital multimeters. These accurate, reliable digital testers, with their exclusive warranty, reinforce Triplet's position as the world leader in the design and manufacture of test equipment and panel instrumentation.

**Adaptable.** Triplet's complete line of digital testers offers the convenience of an easy-to-read liquid crystal display housed in an impact-resistant, ergonomically designed case. All models feature overload protection, auto polarity, solid-state electronics and low battery indicators. They come complete with batteries, test leads and instruction manuals.

**Cost-effective.** Model-for-model, feature-to-feature, Triplet's digital testers are competitively priced with any other testers in today's market.

**Quality.** State-of-the-art technology identifies the entire line of Triplet digital testers. Assurance of quality allows Triplet to offer this unique 3-year warranty.

\*Model 2030: 1-Year Warranty

When you are looking for the finest in high-tech digital multimeters, look to Triplet, the Company America has trusted for more than 80 years.

For more information, call 1-800-TRI-PLET ext. 100



TRIPLET CORPORATION  
A Perini Company

For Information Circle (2) on Reply Card

For Demonstration Circle (46) on Reply Card

# Zenith remanufactured and reconditioned replacement modules and sub-assemblies factory-fresh from Exchange Counters throughout the U.S.

## There's no sense risking an exchange anywhere else!

One of the easiest, fastest, and surest ways for you to preserve the pedigree of the Zenith products you service and maintain is with genuine Zenith replacement parts.

And at no time is this more critical than when you replace the more sophisticated components like modules, tuners, channel selectors and sub-assemblies.

Your participating Zenith parts distributor will supply you with a replacement remanufactured, reconditioned and serviced for reliability by Zenith people as dedicated and knowledgeable as those who made the original.

Equally important, the replacement module or sub-assembly you receive in exchange from your Zenith parts distributor will most likely incorporate Zenith factory modifications, if any, in effect at the time of remanufacture.

**And nowhere else but in a participating Zenith parts distributor's Exchange Program can you get assurance that a replacement incorporates a Zenith factory up-date if one exists!**



**ZENITH**  
®

The quality goes in before the name goes on.®

That's why you should start taking advantage of your Zenith parts distributor's R&R Exchange Program now.

We'll help you locate the Zenith R&R Exchange Counter in your area if you'll complete and send in the postage-free Reply Card inside this issue of *Electronic Servicing & Technology*.

Chances are there's an Exchange Counter for Zenith factory-fresh replacement modules and sub-assemblies closer than you realize.

Write, if you don't know, and we'll tell you where it is! There's no sense risking an exchange for a Zenith replacement anywhere else!