THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

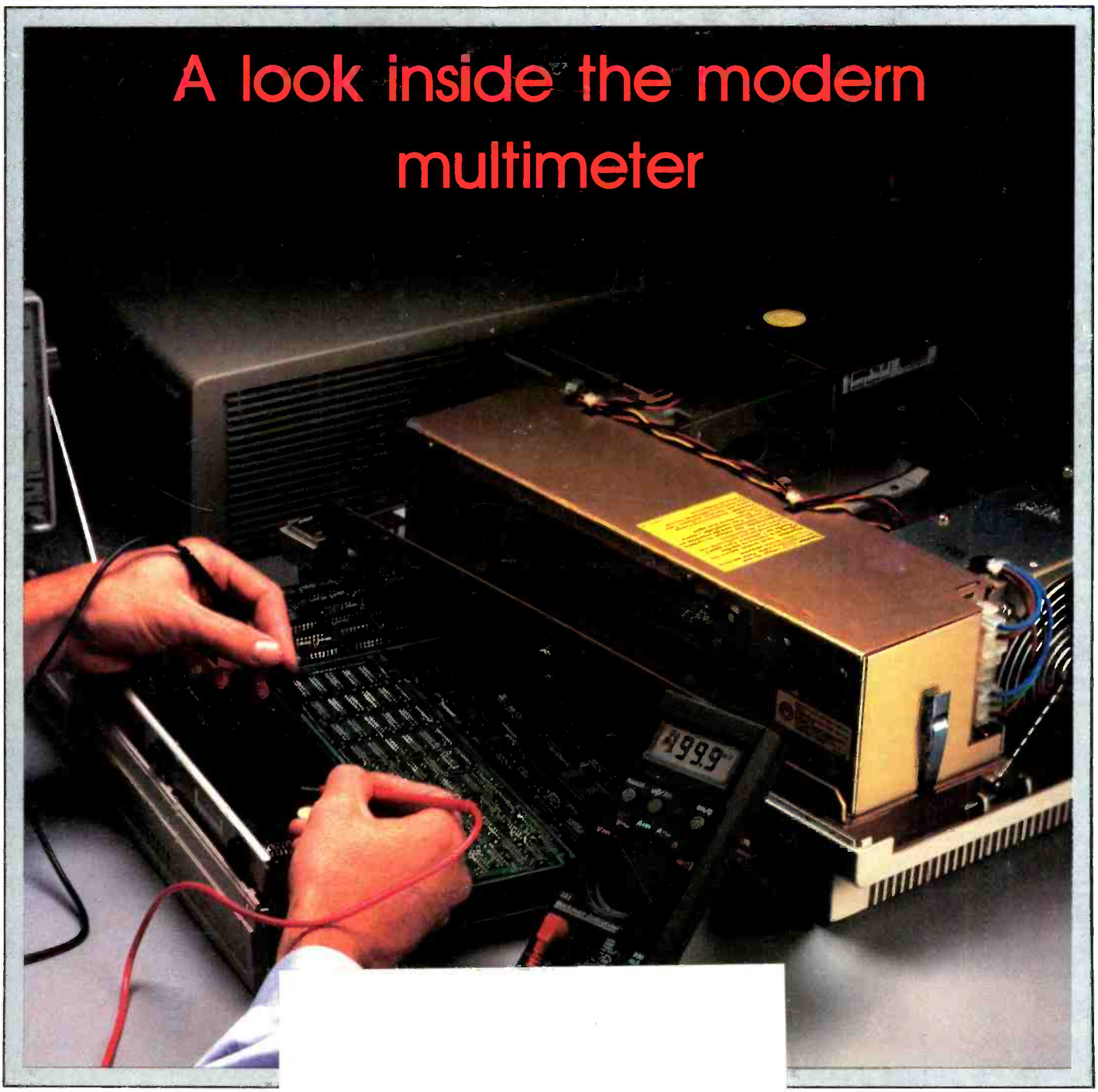
ELECTRONIC Servicing & Technology™

SEPTEMBER 1989/$3.00

Assuring an uninterrupted power supply

Servicing Zenith microcomputers, Part III

A look inside the modern multimeter



Cut Your Video Troubleshooting Time By 54%* With The VA62A Universal NTSC Video Analyzing System

New And Improved!

VA62A Universal Video Analyzer
Patented

- *Identify tuner problems with All-Channel, VHF, UHF, and Cable RF Generators.*
- *Pinpoint IF Problems with modulated troubleshooting signal and exclusive programmable IF/RF generators.*
- *Isolate any video problems with patented video and standard color-bar patterns.*
- *Find defective stages, without disconnecting parts, using exclusive phase-locked drive signals.*
- *Test yokes and flybacks, plus measure signal levels with autoranged digital meter.*

** Based on a nationwide survey of users who reported an average time savings of 54% compared to their previous test equipment.*

Update For New Technology With Exclusive Phase-Locked Accessories

VC63 VCR Test Accessory

Solve the VCR servicing challenge with substitute VCR signals, phase-locked to your VA62A.

ST65 Video Analyzer Stereo TV Adder

Easily test and troubleshoot today's new MTS Stereo TVs & VCRs.

NT64 NTSC Pattern Generator

Meet all Warranty Requirements by adding the NTSC full-field and split-field patterns to your VA62A Universal Video Analyzer.

RG67 NTSC Video Monitor Adaptor

Expand into analog and digital video monitor service with phase-locked R, G, B and I signals.

Call 1-800-SENCORE (736-2673)
In Canada 1-800-851-8866

SENCORE

Circle (1) on Reply Card

EXPAND YOUR CAREER HORIZONS...

The CIE Microprocessor Trainer helps you to learn how circuits with microprocessors function in computers.

START WITH CIE.

Microprocessor Technology. Satellite Communications. Robotics. Wherever you want to go in electronics... start first with CIE.

Why CIE? Because we're the leader in teaching electronics through independent study. Consider this. We teach over 25,000 students from all over the United States and in over 70 foreign countries. And we've been doing it for over 50 years, helping thousands of men and women get started in electronics careers.

We offer flexible training to meet your needs. You can start at the beginner level or, if you already know something about electronics, you may want to start at a higher level. But wherever you start, you can go as far as you like. You can even earn your Associate in Applied Science Degree in Electronics.

Let us get you started today. Just call toll-free **1-800-321-2155** (in Ohio, 1-800-362-2105) or mail in the handy reply coupon or card below to:
Cleveland Institute of Electronics,
1776 East 17th Street, Cleveland, Ohio 44114.

Circle (3) on Reply Card

CIE World Headquarters
Cleveland Institute of Electronics, Inc.
1776 East 17th Street • Cleveland, Ohio 44114

☐ Please send your independent study catalog.
For your convenience, CIE will try to have a representative contact you — there is no obligation.

Print Name _____

Address _____ Apt. _____

City _____ State _____ Zip _____

Age _____ Area Code/Phone No. _____

Check box for G.I. Bill bulletin on Educational Benefits
☐ Veteran ☐ Active Duty **MAIL TODAY!**

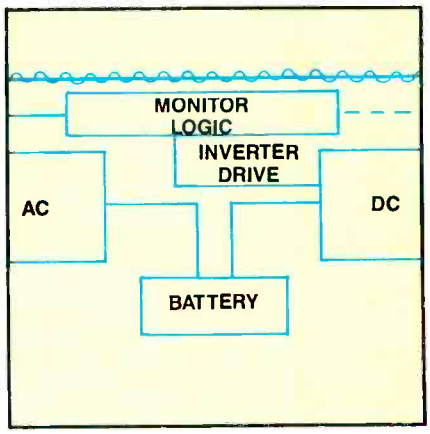
Just call toll-free **1-800-321-2155** (in Ohio, 1-800-362-2105)

AES-40

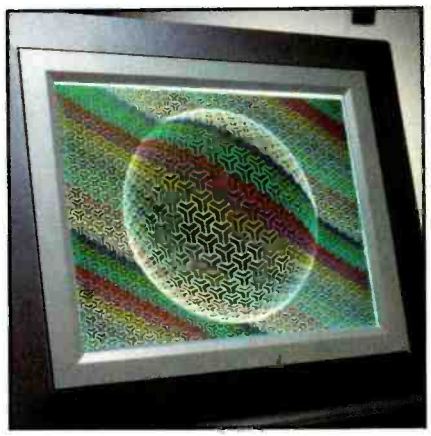
Contents

Volume 9, No. 9 September 1989

Page 10



Page 44



Page 54

FEATURES

DEPARTMENTS

ON THE COVER

New advances in technology have led to an explosion in the types of multimeters offered, and in the price range of a new multimeter. The type of multimeter chosen — not to mention the price the user should consider — will depend on the type of testing performed and the features the user just can't do without. (Photo courtesy of Beckman Industrial, a test equipment manufacturer based in San Diego.)

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC
Servicing & Technology

Portable Problem Solvers

Carry the performance today's technology requires. Not the bulk.

These are the hand-held, ultra-compact digital storage oscilloscope/digital multimeters that fit in small tool kits or attaches. And they're both battery and ac-powered.

Multi-function 3MS/s DSO.

Flip a switch to SCOPE. Capture and analyze single-shot and very slow phenomena. Store from three to six waveforms, plus auto-ranging time base setting, pre-trigger roll mode, and on-screen readout of setting conditions. Low power indicator on screen, plus *separate* memory back-up, built-in.

Full-function, 3½-digit DMM.

Flip back to DMM for precise ac/dc voltage, current and resistance measurements. Large, high-contrast easy to read display. Automatic range selection.

Leader gives you choices.

Single-Channel LCD-100 Unique combination of features and abilities provides ideal service anywhere. **Model 100P,** with built-in printer interface, comes with thermal printer. **Two-Channel Model 200** Even more features and memory range: X-Y capability, auto-ranging for vertical and horizontal, and up to 6 waveforms in memory with push-button throughout. Accepts optional **Model 710 Thermal Printer,** for hard-copy documentation.

For Information Circle (4) on Reply Card
For Demonstration Circle (5) on Reply Card

Call toll-free
1 800 645-5104
In NY State
516 231-6900

Leader Instruments Corporation
380 Oser Avenue, Hauppauge, New York 11788
Regional Offices:
Chicago, Dallas, Los Angeles, Boston, Atlanta
In Canada call Omnitronix Ltd. 416 828-6221

LEADER
FOR PROFESSIONALS WHO KNOW THE DIFFERENCE

Editorial

Repair or replace?

Today more than ever, business seems to be a tightrope act. With rapidly changing products, intense competition and more demanding customers, one slip can mean a serious fall.

Nowhere is this more true than in consumer electronics servicing. The pressures in the business are enormous. But you don't need me to tell you that. On the one hand, TVs, VCRs and computers are more reliable than ever. If the owner is lucky, they'll last for years without needing to be serviced. On the other end of the equation, when a malfunction occurs and the consumer is contemplating having a TV serviced, he should take into account the improvements and enhancements that are available in a new unit and the difference in cost between repairing and replacing the obsolete unit. If the consumer replaces the TV, he gets a brand new unit with much improved performance and neat new features. Somewhere in between there is a window of servicing opportunity in which a set that fails is a good candidate for being serviced.

However, at some point, a product may be considered to have reached the end of its useful life. At that point, any further repairs would be equivalent to throwing money away. Determining when this point occurs is further complicated by the increasing difficulty of finding servicing information and replacement parts for products that are reaching their twilight years.

There doesn't seem to be any hard and fast rule as to when a consumer electronics product has reached advanced age, but it seems to be somewhere between seven and 10 years. During that time, the manufacturer stops stocking the servicing manuals and the unique replacement parts. If a servicer or the customer insists on repairing a product beyond this point, it probably can be done, but it may not be economical.

A similar dilemma occurs when a technician encounters a brand of product with which he's not familiar. (There seem to be more and more such products for sale in department stores, specialty stores, discounters, and mail order.) If you take in a product like this, you may have to do hours of research and spend a lot of money in telephone calls trying to track down the servicing information and replacement parts — time and money you may not be willing or able to charge to a particular repair.

Still another variation on this theme occurs when a manufacturer either closes his doors entirely, sells to another company that will use the name but not manufacture the same products, or retrenches and stops doing business in this country. In some cases, replacement parts and servicing documentation remain available, but through a company with a name that bears no relationship to the name of the company for which he carries parts and manuals. For authorized servicers who are informed of the change, it may be business as usual. But pity the poor servicer who takes in a product like this to service and learns that he has no way of finding a contact to sell him parts and information.

Readers often write in asking for information on old or obscure sets, and sometimes we're able to help. However, keep in mind that if you're trying to service a set that is 10 or 15 years old or is so obscure you'll never see another one, you might be spending a lot of time researching information you'll never use again. It might seem like bad business to turn a customer away, but in those cases, your time might be better spent broadening your customer base.

So when does a servicing facility agree to diagnose and repair a product, and when does the facility turn the product away as being uneconomical to repair? A lot depends on the particular circumstances. And the answer probably lies in keeping good records. When a customer brings in any set, especially one you aren't familiar with, you should track the set from the time it came in to the time it went out. Include notations on how much time was spent actually working on the unit, how much was spent trying to track down information and parts — if that was a problem — and how much was charged for the repair. If you find that some specific brands cost more to research and repair than you can charge with a reasonable amount for profit, you might want to consider not servicing them and instead concentrate on those that provide you with a reasonable return.

One of the things we are instituting at **ES&T** in order to try to improve this situation is an information exchange. It debuts in this issue (see page 42). Since we mentioned it in the June issue editorial, we have already received a number of requests for information, as well as some information volunteered. As with any new venture, we're both excited and a little apprehensive. We're excited because the feedback we have received tells us that a lot of readers support the idea; we're a little apprehensive because it's new and it will be a while before it takes its final shape. That means we will have quite a bit of refining to do over the next few months.

On the other hand, that gives readers an opportunity to contribute to the shape of the final product. If you have suggestions for increasing the coverage, if you're looking for information or replacement parts for a certain manufacturer's products, or if you're still exultant about tracking down an elusive part or service manual and you want to share the information, please write. We'll be glad to hear from you.

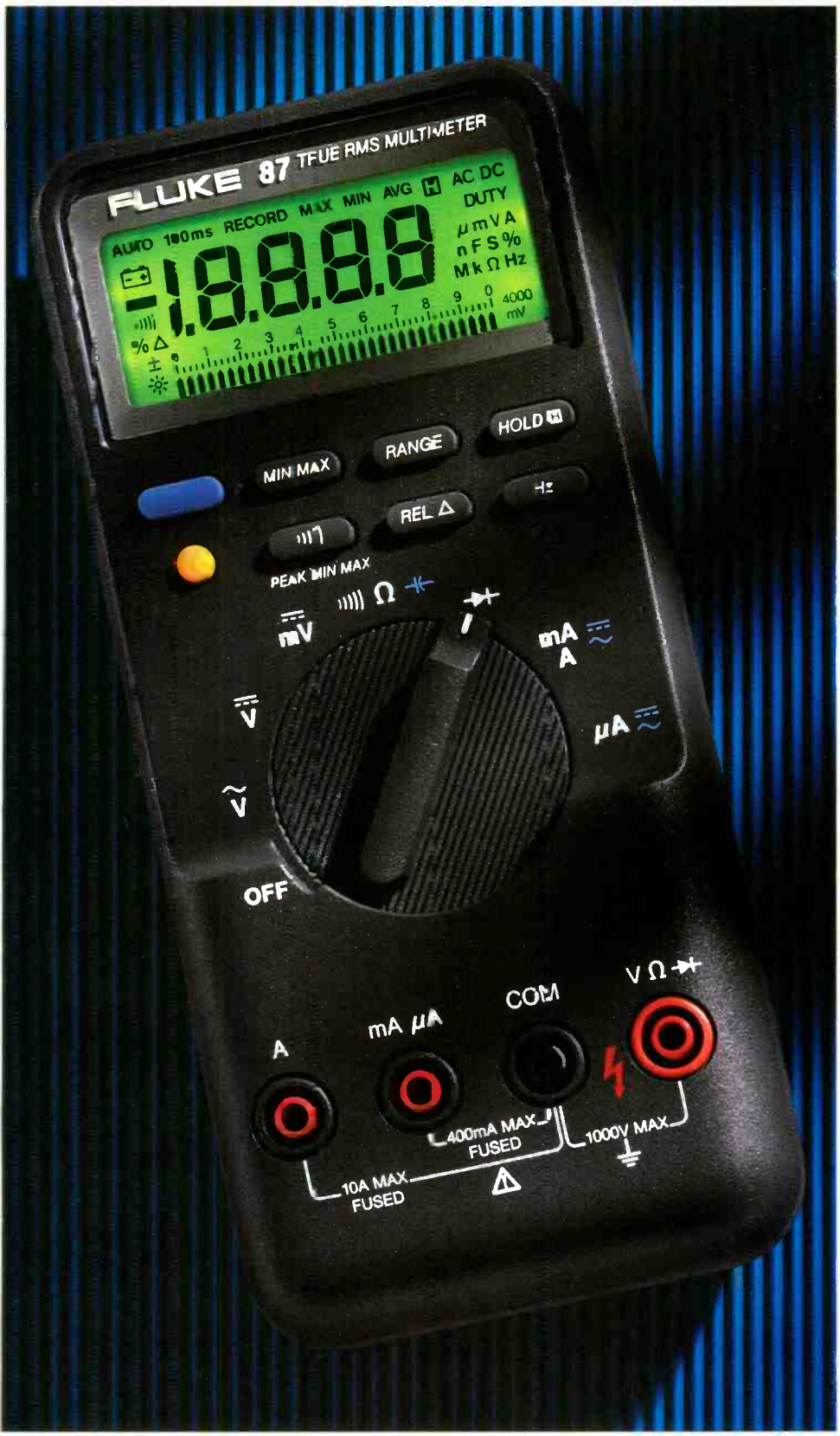
Nils Conrad Persson

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE

PHILIPS

PHILIPS



The new 80 Series is a digital meter, an analog meter, a frequency counter, a recorder, a capacitance tester, and a lot more.

It's the first multimeter that can truly be called "multi" . . . not only standard features, but special functions usually limited to dedicated instruments.

Plus, innovations only Fluke can bring you. Like duty cycle measurements. Or recording the minimum, maximum *and* average value of a signal. Or the audible MIN MAX Alert™ that beeps for new highs or lows.

There's even Fluke's exclusive Input Alert™, that warns you of incorrect input connections. And a unique Flex-Stand™ and protective holster, so you can use the 80 Series almost anywhere.

Make sure your next multimeter is truly multi. Call today at **1-800-44-FLUKE, ext 33.**

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 83	FLUKE 85	FLUKE 87
Volts, ohms, amps, diode test, audible continuity, frequency and duty cycle, capacitance, Touch Hold®, Relative, protective holster with Flex Stand™.		
$189*	$229*	$289*
0.3% basic dc accuracy	0.1% basic dc accuracy	0.1% basic dc accuracy
5 kHz acV	20 kHz acV	20 kHz acV
Analog bargraph & zoom	Analog bargraph & zoom	High resolution analog pointer
Three year warranty	Three year warranty	True rms ac
		1 ms PEAK MIN MAX
		4½ digit mode
		Back lit display
		Three year warranty

*Suggested U.S. list price

The new Fluke 80 Series shown actual size

John Fluke Mfg. Co., Inc., P.O. Box C9090 M/S 250C, Everett, WA 98206
U.S.: 206-356-5400 CANADA: 416-890-7600 OTHER COUNTRIES: 206-356-5500

FLUKE

Circle (6) on Reply Card

News

Reader wins multitester

Ronald Coultas, owner of an electronics servicing company in Pittsfield, IL, won the card-deck contest sponsored by ES&T in the May 1989 issue. The prize was a Fluke 85 multitester, a combination digital meter, analog counter, recorder, capacitance tester and more. The contest, which required contestants to answer two questions on the Contact East card, was entered by almost 2,000 readers. The Fluke 85 was donated by Contact East, North Andover, MA.

Consumers demand up-scale features

Consumers are showing a decided preference for up-scale consumer electronics products, according to a report from INTELECT, a service of the NPD Group. For the months of April and May, sales of 20-inch and 27-inch color TVs were up 27.1% and 76.1%, respectively, as compared to 1988. Sales of table and console models larger than 30-inch jumped 130.8%. The average price of color TVs was $403.20 in those months, down slightly from the $410.48 1988 price.

The rise in sales of larger screen TVs occurred at the same time total TV sales declined by 17.4%. VCR sales were also down (27.4%), although sales of 4-head models increased 19.1%. Play-only recorders accounted for 7.2% of VCR sales. The average price paid for a VCR was $301.55.

Camcorder sales increased 25.2%, with an average price of $1,061.52.

EIA supports HDTV report

The Electronic Industries Association (EIA) has testified before Congress in support of a government report that states too much emphasis has been placed upon HDTV's significance to the industry's and nation's overall competitiveness.

The report, prepared by the Congressional Budget Office (CBO), downplays the impact HDTV will have on U.S. competitiveness. Peter F. McCloskey, EIA president, testified that the impression that the competitiveness of the United States is solely dependent upon the country's ability to emerge as a winner in the HDTV race is wrong. According to McCloskey, treating HDTV as the only essential ingredient for U.S. competitiveness encourages line drawing between companies on the basis of ownership, which could discourage investing in American research, development and manufacturing. He emphasized that "a narrow focus on HDTV detracts from the need to find solutions for major, economy-wide problems of primary importance to national competitiveness."

The EIA called for Congress to enact several competitiveness measures, including the following:

- reduce the deficit, which would decrease the United State's dependence on foreign capital and increase the national savings rate.
- shift federal spending toward education, worker training, infrastructure and commercial science and technology.
- change tax laws to encourage investment, including reintroducing the investment tax credit and a graduated capital gains tax, which would provide strong investment incentives.
- make the research and development tax credit permanent, which, studies suggest, would increase private research and development.
- relax antitrust restrictions on joint production.

Industries agree on DAT

The Electronic Industries Association (EIA) has agreed to join the Recording Industry Association of American (RIAA) in supporting legislation for a new consumer digital audiotape (DAT) recorder system. The new system will allow first generation digital-to-digital copying of pre-recorded music, but it will not allow second generation copies.

EIA urges ATV standard

The Electronic Industries Association (EIA) has urged the FCC and the FCC Advisory Committee on Advanced Television Service to move quickly in selecting a broadcast NTSC-compatible advanced TV (ATV) standard.

According to the EIA letter, full U.S. participation in the world HDTV marketplace will depend on quick selection of the standard, which depends on accelerated system testing.

The EIA's ATV Committee has stated that "the timely adoption by the FCC of a compatible ATV standard is essential for the success of advanced television. A planned or de-facto marketplace solution as a result of FCC delay or inaction could result in consumer confusion about advanced TV standards, not unlike that which occurred with the AM stereo experience." ■

The magazine for consumer electronics servicing professionals

ELECTRONIC Servicing & Technology

Electronic Servicing & Technology is edited for servicing professionals 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.

EDITORIAL
Nils Conrad Persson, *Editor*
Tom Cook, *Senior Managing Editor*
Alisa Carter, *Associate Editor*
Andrew Naugher, *Editorial Assistant*

CONSULTING EDITORS
Carl Babcoke, *Consumer Servicing Consultant*
Homer L. Davidson, *TV Servicing Consultant*
Christopher H. Fenton, *Circuit Fabrication Consultant*
William J. Lynott, *Business Consultant*
Victor Meeldijk, *Components Consultant*
Kirk G. Vistain, *Audio Consultant*
Sam Wilson, *Electronics Theory Consultant*

ART
Barbara Miles, *Graphic Designer*

BUSINESS
Cameron Bishop, *Group Vice President*
Eric Jacobson, *Group Publisher*
Greg Garrison, *Sales Manager*
Kevin Callahan, *Creative Director*
Marcia Durrett, *Marketing Director*
Evelyn Hornaday, *Promotions Manager*
Darren Sextro, *Promotions Coordinator*
Dee Unger, *Advertising Business Manager*
Susan Edwards, *Advertising Coordinator*

ADVERTISING
Greg Garrison, **913-888-4664**

ADMINISTRATION
R.J. Hancock, *President*
Chuck Rash, *Corporate Circulation Director*
Sandra Stewart, *Circulation Director*
Donna Schlagle, *Circulation Manager*
Customer Service, **913-541-6628**

The Audit Bureau — **Member, Audit Bureau of Circulation**
ABP — **Member, American Business Press**
NESDA — **Member, Electronic Servicing Dealers Association**

CORRESPONDENCE
Editorial and advertising: P.O. Box 12901, Overland Park, KS 66212 (a suburb of Kansas City, MO); 913-888-4664. Circulation: P.O. Box 12960, Overland Park, KS 66212.
Home office fax: 913-541-6697.
Home office telex: 42-4156 INTERTEC OLPK

SUBSCRIPTION PRICES: one year, $19.49; two years, $32.98 in the USA and its possessions. Foreign countries: one year, $23.49; two years, $36.98. Single copy price: $3.00; back copies, $5.00. 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

Electronic Servicing & Technology (ISSN 0278-9922) is published monthly for $19.49 per year by Intertec Publishing Corp., 9221 Quivira Road, Overland Park, KS 66215. Second-class postage paid at Shawnee Mission, KS and additional mailing offices. POSTMASTER: Send address changes to ELECTRONIC SERVICING & TECHNOLOGY, P.O. Box 12960, Overland Park, KS 66212.

INTERTEC PUBLISHING CORPORATION

THINK OF IT AS AN ELECTRONIC SWISS ARMY KNIFE.

CAPACITANCE METER

FREQUENCY COUNTER

LOGIC PROBE

DIGITAL MULTIMETER

TRANSISTOR TESTER

What an idea the Swiss had... a hand-held device combining many different tools in one unit. The same inspiration is behind B&K-PRECISION's new Model 388HD Test Bench. It offers the capabilities of five popular instruments in one hand-held package.

This 41 range digital voltmeter, ammeter, ohmmeter, frequency counter, capacitance meter, logic probe, transistor and diode tester features an extra-large LCD display, rugged drop-resistant case and high-energy fusing.

While you won't flip-out forks or knives, you will flip for the versatility of this low-priced wonder. For immediate delivery, see your local B&K-PRECISION distributor.

MEASURE TO THE MAX WITH MAXTEC

B&K-PRECISION TEST BENCH

$139

B&K PRECISION

MAXTEC INTERNATIONAL CORP.

6470 W. Cortland St. • Chicago, IL • 312-889-1448

International Sales, 6470 W. Cortland St., Chicago, IL 60635

Canadian Sales, Atlas Electronics, Ontario.

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

Circle (7) on Reply Card

Learn Facsimile Service

There's never been a better time to enter the Facsimile service market.

MITSUBISHI SEMINARS 89

BECAUSE...

FACSIMILE products are emerging as one of the fastest growth products in the United States.

WHY...

FACSIMILE products have escaped the confines of the big business environment to reach the private sector...thousands of small to medium size businesses and even private homes are now relying upon FACSIMILE to satisfy their daily communications needs.

DID YOU KNOW...

the FACSIMILE SERVICE MARKET is virtually untapped? FACSIMILE maintenance is a clean, professional service performed by highly respected technicians in a professional environment.

Facsimile Service Training By Mitsubishi...

is the ideal way to take advantage of the ground floor FACSIMILE SERVICE opportunities with a minimum investment in time and money.

Who Should Attend?

YOU SHOULD
...if you are a SERVICE SHOP OWNER who seeks to diversify and CASH-IN on new service opportunities.

YOU SHOULD
...if you are a CONSUMER ELECTRONICS TECHNICIAN who is determined to enhance your marketable technical skills and increase your employment opportunities.

YOU SHOULD
...if you are a recent TECHNICAL SCHOOL GRADUATE who seeks the practical application of theory necessary to secure a well paying job in the growing field of office communications service.

YOU SHOULD
...if you are a BUSINESS MACHINE TECHNICIAN who wants and needs to remain current with the latest in business communications technology.

What Will The Course Do For You?

TEACH YOU the basics of FACSIMILE operation, transmission and reception.

TRAIN YOU in the latest FACSIMILE diagnostic tests and troubleshooting techniques with instructor-guided HANDS-ON laboratory sessions.

PREPARE YOU to service FACSIMILE products quickly and profitably.

Facsimile Seminar Outline

BASICS OF FACSIMILE

- Principles of Facsimile
- G2/G3 Facsimile Standards
- Telephone Systems
- Facsimile System

INSTALLATION

- Performing the Site Survey
- Communications Systems/Requirements
- Telephone Line Tests
- Compatibility Problems

PREVENTIVE MAINTENANCE

- Precautions
- Tools/Cleaning Materials
- Cleaning the Documents Handling System
- Lubrication

PROBLEM DETERMINATION

- Initial Diagnosis
  - Customer Difficulties
  - Transmission System Difficulties
  - Transmission Compensation
  - Facsimile Machine Difficulties
  - Facsimile Incompatibility
  - Ringer Equivalence Restrictions/Loads
  - Manual Transmission Compensation

TROUBLESHOOTING

- Tools & Equipment
- Functional Description of Assemblies
  - Electrical Diagnosis Procedure
  - Using Test Documents for Diagnosis
  - Contact Image Sensors
  - Thermal Head Assembly
  - Transmit/Receive Troubleshooting
- Mechanical Systems

The total cost* of $295 includes:

- **Two full days of HANDS-ON instruction**
- **Lunches**
- **Seminar workbooks**

- **TAKE YOUR SEMINAR HOME with a complimentary Video Tape packed with practical Facsimile service principles and valuable Troubleshooting tips...ideal for day to day reference.**

Individual class size is limited, so please register promptly!

Payment MUST accompany the registration form. Personal or company checks, money orders, VISA© or MASTERCARD© accepted.

Special price for Mitsubishi Authorized Service Centers - $250

*Participant's lodging and travel expenses are **NOT** included.

Seminar Schedule

LOCATION	DATES	ADDRESS
LOS ANGELES	October 3-4	**Mitsubishi Electric Sales America, Inc.** 5757 Plaza Drive, Cypress, CA 90630
NEWARK	October 17-18	**Mitsubishi Electric Sales America, Inc.** 800 Cotton Tail Lane, Somerset, NJ 08873
CHICAGO	October 31- November 1	**Mitsubishi Electric Sales America, Inc.** 800 Bierman Court, Mt. Prospect, IL 60052
DALLAS	November 14-15	**Holiday Inn - Irving** 4441 West Hwy #114, Irving, TX 75063
ATLANTA	November 28-29	**Mitsubishi Electric Sales America, Inc.** 6100 Atlantic Boulevard, Norcross, GA 30071
LOS ANGELES	December 5-6	**Mitsubishi Electric Sales America, Inc.** 5757 Plaza Drive, Cypress, CA 90630

For registration: Complete and mail the registration card to: **Mitsubishi Electric Sales America, Inc., Technical Services Department, P.O. Box 6007, Cypress, CA 90630-0007.** If registration card is missing, or to register by phone (credit card customers *ONLY*), call *TOLL-FREE* **1-800-888-6773,** and request **Fax Seminar Registration.**

Circle (13) on Reply Card

A look inside the modern multimeter

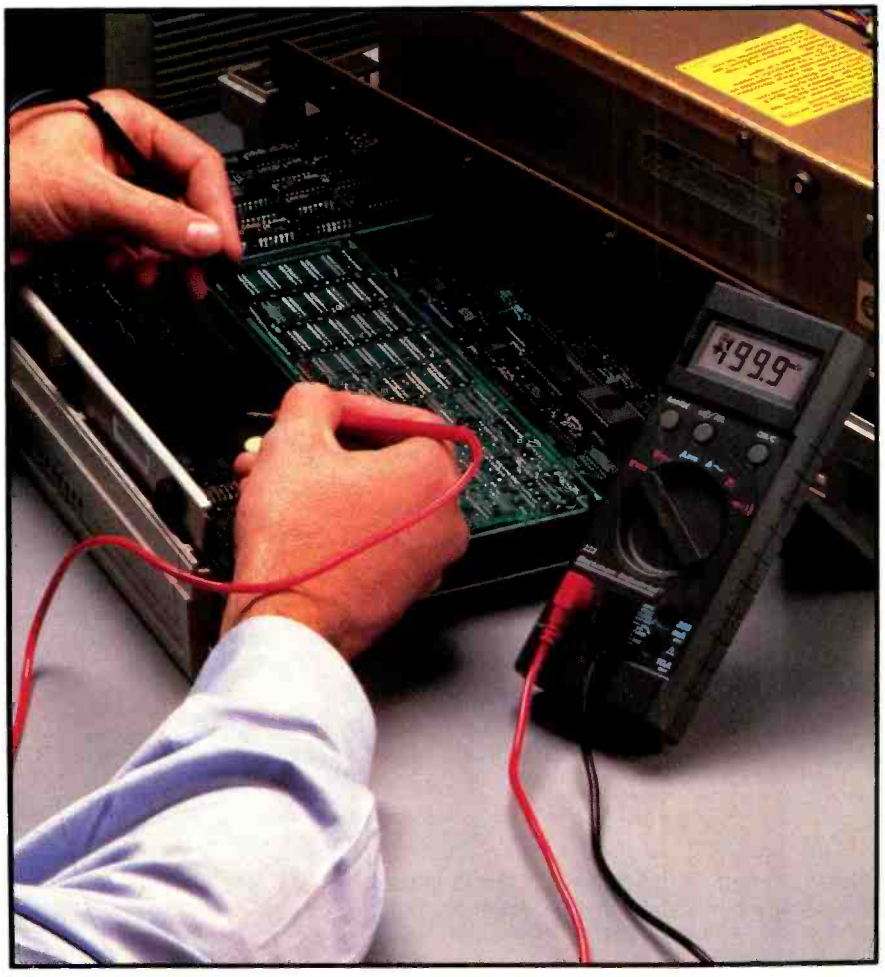
By Conrad Persson

One of the first things that happened when multimeters adopted solid-state circuitry is they became smaller. Down the road, when digital circuitry became reliable enough and inexpensive enough, meters incorporated this new circuitry and went from being multimeters to being digital multimeters (DMMs). As time has passed, meters become smaller — some versions can be put into a shirt pocket, and some are about the size of a pen.

Another direction manufacturers have gone in is to leave the size of the meter at the convenient hand-held size but take advantage of integrated circuitry to add new features to the old standby. Today it's not unusual to see meters that fit comfortably in the palm of the hand and yet can measure ac and dc volts, milliamperes and ohms, plus test semiconductor junctions, set their own range, count frequency and more.

This article will compare in a general way the circuitry between a typical analog meter and a digital meter. It will also give you an idea of how autoranging works. The better you know how your test equipment works, the better you'll be able to use it.

Persson is editor of **ES&T**.



The analog meter

The reading on an analog meter is accomplished by converting the current flowing into the meter into physical motion. This is ordinarily accomplished either by creating a magnetic field around a coil in the field of a permanent magnet (the most popular method), or by creating a heating effect. This produces motion in the moving coil proportional to the amount of current. Of course, when you make a voltage reading, the current in the meter is caused by and is proportional to the value of the voltage being measured. When you make a resistance measurement, an internal battery supplies the current.

Figure 1 is a simplified, generalized schematic diagram of an analog meter being used to measure current, voltage and resistance. Notice that when the meter measures current, it is in series with the source. All of the current supplied by the source flows through the meter, so the choice of shunt resistor R1, R2 or R3 determines how much current will flow through the meter movement. If you aren't sure about the amount of current, it's usually a good idea to start with the highest range (therefore, the lowest shunt resistance) and work to lower ranges. This way, the meter movement won't be subjected to excessive current, which could damage it.

When you measure voltage, resistors are placed in series with the meter movement. The meter's internal resistance, in series with the meter movement, is placed across the component being measured. The voltage causes a current to flow through the meter movement, limited by the resistance selected. The current that flows is proportional to the voltage and inversely proportional to the value of the series resistance. In this case, it's a good idea

to start with the highest voltage range and work down until you get a good deflection.

When the OHMS function is selected, the meter's internal battery is switched into the circuit. The current that flows is in proportion to the battery terminal voltage and inversely proportional to the series combination of the resistance being measured and the internal meter resistor selected.

The digital meter

A look at Figure 2 will reveal that the method of measurement employed by a digital meter is quite different from that used by an analog meter. In a digital meter, a front-end stage is used to convert ac current or voltage to a proportional dc voltage. In the case of resistance, the internal battery generates this voltage.

Next, this dc voltage is digitized and presented through other circuitry to the display circuitry.

One popular method of converting this analog dc voltage into its digital equivalent is the so-called *dual-slope conversion* method. We presented a detailed description of this method in the article, "The New Breed of Multimeters," in the September 1988 issue. A somewhat abbreviated description is presented here. (See the sidebar.)

Autoranging

Another desirable feature of some DMMs is the ability to autorange: It selects the correct range automatically, displays the result with the decimal point in the correct place, tells you what parameter (voltage, current or ohms) you're reading and what the multiplier is. Figure 3 illustrates some detail of the measurement circuit of a typical DMM. The input signal is buffered to protect the meter's circuits. A low-pass filter is placed in the measurement path to block audio and radio-frequency signals.

The autoranging function is provided by an adjustable attenuator. Take a look at the capacitor and diode just downstream of the attenuator. The purpose of that is to keep the display from varying constantly when you're measuring a signal that might be varying slightly.

The attenuator is controlled by a

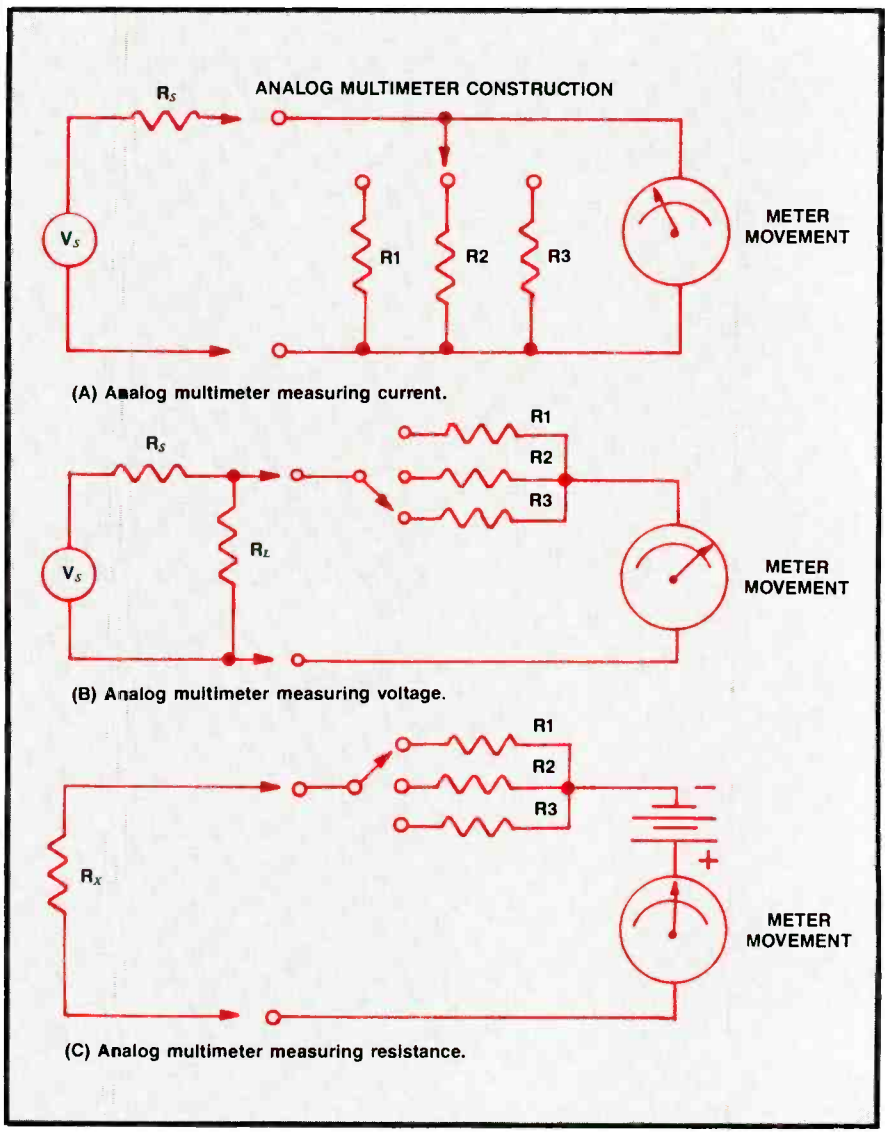


Figure 1. Analog meters generally employ a coil of wire, attached to the dial, in the field of a permanent magnet. The current through the coil causes it to move, thus moving the dial. The degree of motion and, therefore, the size of the reading are proportional to the amount of current through the coil. The current supplied to the coil is provided by the voltage or current measured or, in the case of resistance readings, by the meter's internal battery.

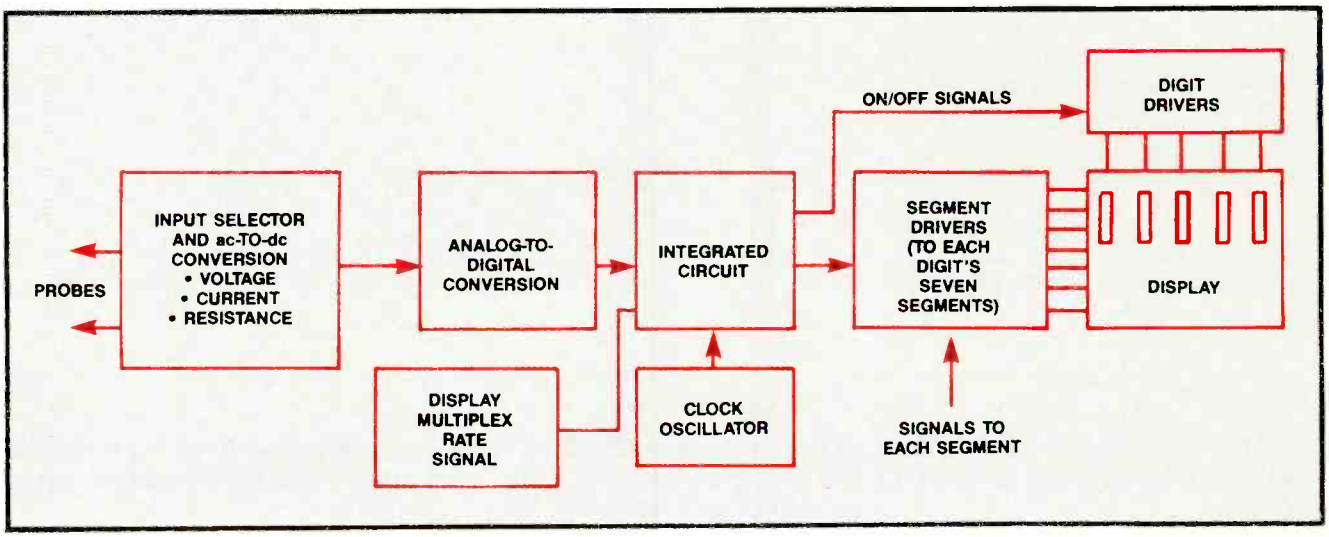


Figure 2. A DMM converts the analog value of the input parameter to a digital signal, then processes this information and displays it on the meter face.

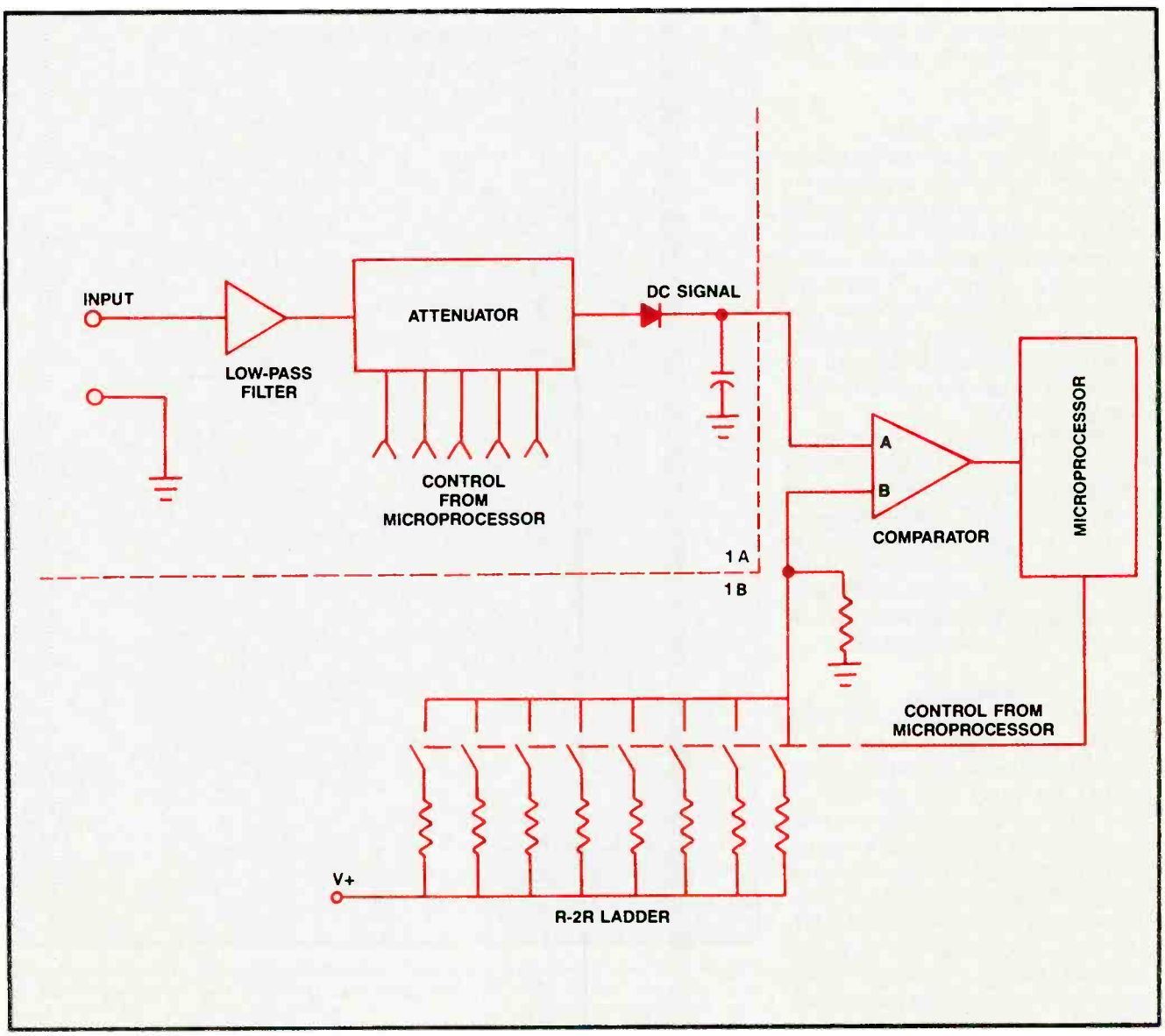
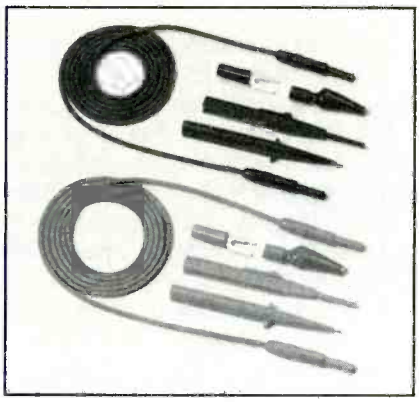


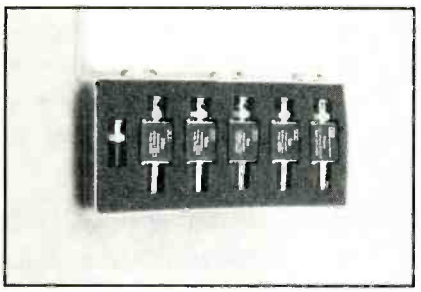
Figure 3. Autoranging by a DMM is achieved by employing a variable attenuator that is controlled by the meter's microprocessor.



DELUXE TEST LEAD KIT

Users call TPI test leads **The Absolute Best**. The TLS2000 features the highest quality cable in the industry — with spring-loaded safety-sleeved plugs. U.L. listed (file E79581). Kit: $29. Leads & probes only: $19. Satisfaction guaranteed.
TEST PROBES INC. Call toll-free for catalog: 1-800-368-5719.

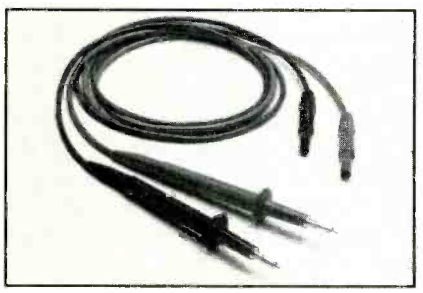
Circle (26) on Reply Card



BNC ATTENUATOR KIT

Contains 4 attenuators — 3dB, 6dB, 10dB, 20dB; 1 feedthrough and 1 termination. Thick-film circuitry for low reactances. Rugged design resists shock and lasts longer. Rectangular shape stays put on the bench. **Impedance:** 50Ω **Frequency:** 1GHz. **Maximum Power**: 1kW peak, 1W avg. **VSWR** 1.2:1. Attenuator Accuracy:±0.2dB. Terminations Resistance Tolerance: ±1%. $150.
TEST PROBES INC. Call toll-free for catalog: 1-800-368-5719.

Circle (27) on Reply Card



ECONOMICAL SILICON RUBBER TEST LEADS

Best value in moderately priced leads. High quality, soft, silicon rubber cable. Banana plug on measuring tip accepts push-on accessories. Plugs have spring-loaded safety sleeves. Model TL1000 $14.00. Satisfaction guaranteed.
TEST PROBES INC. Call toll-free for catalog: 1-800-368-5719.

Circle (28) on Reply Card

COAX ADAPTER KIT

- Create any adapter in seconds
- Make all combinations of BNC, TNC, SMA, N, UHF, Mini-UHF, F and RCA

The TPI 3000A kit contains male and female connectors of all 8 types, and 6 universal interfaces. Simply screw any combination of 24 connectors to one of the interfaces to create the desired adapter. $150.
TEST PROBES INC. 9178 Brown Deer, San Diego, California 92121. Call toll-free for catalog: 1-800-368-5719.

Circle (25) on Reply Card

New

No Better Probe Ever at This Price!

Shown here
Model SP150 Switchable 1x-10x $49

Risetime less than 1.5 nsec.

- **Universal** - works with all oscilloscopes
- **Removable Ground Lead**
- **Excludes External Interference** - even on scope's most sensitive range
- **Rugged** - withstands harsh environments including high temperature and humidity
- **Advanced Strain Relief** - cables last longer
- **Available in 10x, 1x and switchable 1x-10x**
- **10 day return policy** - performance and satisfaction guaranteed

TEST PROBES, INC. TPI

9178 Brown Deer Road
San Diego, CA 92121
Toll Free 1-800-368-5719
1-800-643-8382 in CA

Call for free catalog and Distributor in your area

Circle (29) on Reply Card

Converting voltage to a digital signal

One of the more popular methods of converting a voltage into a digital signal is called the *dual-slope conversion* method or the *double integration* method. See the accompanying figure for an idea of how it works.

V_{IN} is the input voltage: the voltage to be measured. V_{REF} is a reference voltage of polarity opposite that of the measured voltage, supplied by the meter. Capacitor C and op-amp A compose an integrator circuit. Switch S1 is an electronic switch initially in the position shown.

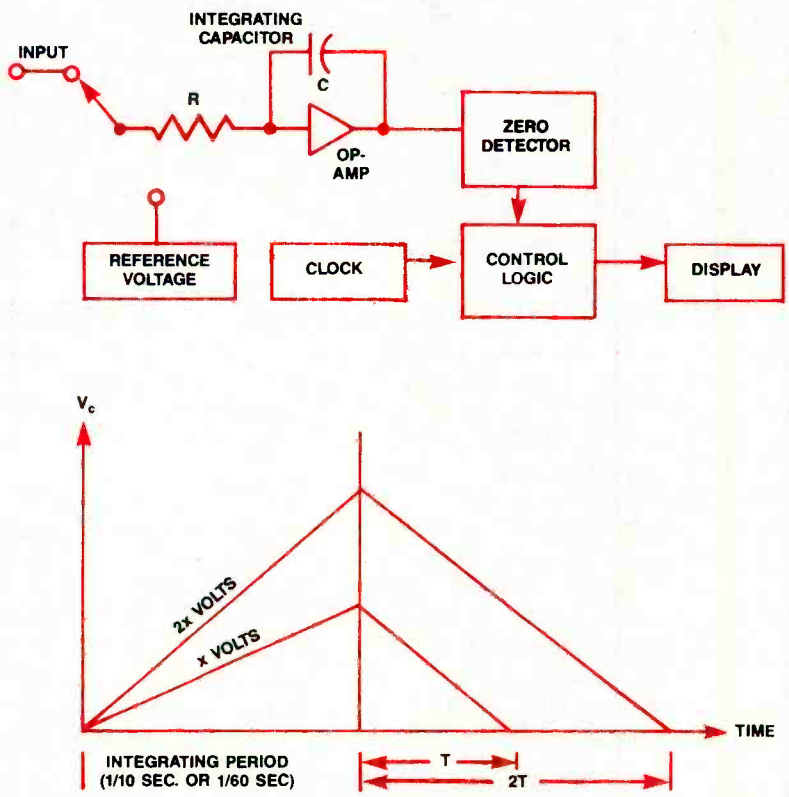
When the meter probes are first connected to the voltage of interest, that voltage is applied to the input of the integrator for a period of time (called the *integration period*) that was determined by the designers of the meter. (Integration periods are ordinarily selected to be related to the 60Hz line frequency, so integration periods of $^1/_{60}$th of a second and $^1/_{10}$th of a second are common.) The output of the integrator is a voltage that is determined by the RC time constant of R and C. Because of the nature of the integrator circuit, the maximum voltage (the voltage at the end of the integration period) is proportional to the voltage being measured.

At the end of the integration period, switch S_1 is moved to the other position and a voltage of polarity opposite to the polarity of the measured voltage is applied. In this configuration, the capacitor is discharged until its voltage reaches zero.

Take a look at the graph of voltage vs. time. Note that the discharge interval will be directly proportional to the maximum voltage, which is proportional to the applied voltage. As a specific case, if the input voltage is doubled, the discharge interval will double.

At the same time that the integration interval ends and the discharge interval begins, a counter that is part of the meter circuitry begins counting pulses generated by a clock circuit. When the voltage reaches zero, the counter stops counting. The number of pulses counted is therefore proportional to the discharge period, which is proportional to the input voltage. This count is converted to a digital number and displayed as the measured voltage.

Although this method works well, it is somewhat slow, so many microcomputer-based meters use a variation called multislope integration.



single-chip microprocessor, based on the readings taken from the analog measurement circuit. The analog measurement circuit consists of a comparator with two inputs. The parameter to be measured is fed through the attenuator to input A. The output of an R-2R ladder network is fed to input B. Whenever the voltage at A is greater than the voltage at B, the output of the comparator remains low.

If the attenuator is adjusted through its entire range and no match of input A and B is found, the overload or underrange indicator is displayed. If a match is found, the microprocessor processes the information to come up with the information displayed on the meter face.

At the beginning of a measurement, the attenuator is set by the microprocessor for minimum attenuation and the R-2R latter is set for minimum voltage output. If the voltage at comparator input A is less than the voltage at comparator input B, the microprocessor switches the outputs of the ladder according to a preprogrammed sequence. This switching causes the voltage at input B to increase in steps until it exceeds the voltage at A. When the voltage at input B exceeds the voltage at A, the output of the comparator goes high, signaling the microprocessor that the R-2R ladder output matches the output from the meter's front end.

If the microprocessor goes through the entire switching sequence of the R-2R ladder and the output of the comparator remains low, the microprocessor adjusts the attenuator to lower its output and the process is repeated. There are many variations of this scheme.

If the attenuator is adjusted through its entire range and no match of input A and B is found, the overload or underrange indicator is displayed.

In the case when a match is found, the microprocessor processes the information about the settings of the attenuator and the R-2R ladder to come up with the information displayed on the meter face. ■

Now Testing Is Seven Times Easier.

1. End Blown Fuses.

The new 200 Series multimeter is protected from excess voltage or surges with a self-resetting fuse.

2. Keep Your Eyes On Your Work.

Quickly probe a circuit board listening for audible tone changes that pinpoint the problem without glancing at the LCD.

3. Detect Intermittents.

Hear a distinctive crackling sound when an intermittent occurs.

4. Find Dead Capacitors.

Capacitor voltage build-up or bleed-off is heard loud and clear with the 200 Series' Audible Readout.

5. Find Logic Stuck-Ats.

Using standard leads, a fast Logic Pulse Detector lets you easily detect pulses down to 50ns.

6. Adjust Voltage Levels.

When adjusting audio or video response, an audible tone that changes pitch as measured signals increase or decrease permits faster and easier adjustments.

7. Stop Third Hand Problem.

Tilt stand and Skyhook,™ auto-ranging, and Audible Readout allow you to spend less time fiddling with your meter.

FEATURES	222	223
Audible Readout		•
Logic Pulse Detector		•
Fast Auto-Ranging	•	•
Self-Resetting Fuse	•	•
Auto-off Battery Saver	•	•
DC Voltage Accuracy	0.5%	0.25%
Warranty	2 years	2 years
Price	$129.00	$149.00

The 200 Series. Multimeters that take the work out of work. Call or write for complete information.
1-800-227-9781 Inside California.
1-800-854-2708 Outside California.

30 DAY MONEY BACK GUARANTEE

Circle (18) on Reply Card

Beckman Industrial™

An Affiliate of Emerson Electric Co.

Instrumentation Products Division
3883 Ruffin Road, San Diego, CA 92123-1898
(619) 495-3200 • FAX (619) 268-0172 • TLX 249031

Test your electronics knowledge

By Sam Wilson, CET

Every so often, we have to have a very easy test. Remember that there are beginners in our ranks.

If you are an experienced technician, you should get a grade of 80% to 100%.

1. What resistance value would you expect to measure across the component shown in Figure A?

2. What is the resistance of the surface-mount resistor in Figure B?

3. What is the applied voltage (V) in the circuit in Figure C?

Wilson is the electronics theory consultant for ES&T.

4. What do the following pin identifications mean on an integrated circuit?

A. $\overline{CE}$

B. $\overline{OE}$

5. What is the reason for using an overbar for $\overline{CE}$ and $\overline{OE}$?

6. A RAM is a random access memory. You can get information into a RAM, and you can take information out of a RAM as long as it is connected to a power supply. What do the letters DRAM stand for?

7. What is the capacitive reactance of the circuit in Figure D?

8. You have two lamps. They are rated at 6V, 0.5A and 6V, 0.25A. What value of resistance do you need (and where would you connect it) if you want them to glow at full brightness when they are connected across a 12V battery?

9. Which of the following PROMS is erased with an ultraviolet light?

A. EEPROM

B. EPROM

10. (I wish I had a dollar for every student who couldn't answer this question.) What is a third of a fourth of a fifth?

Answers are on page 37.

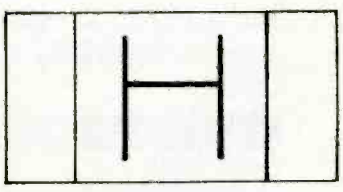


FIGURE A

FIGURE B

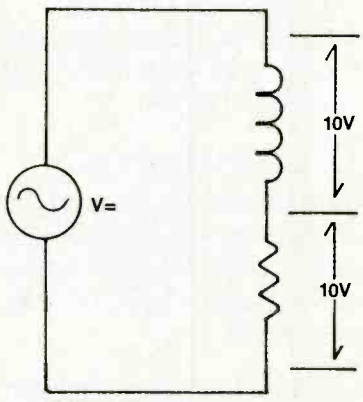


FIGURE C

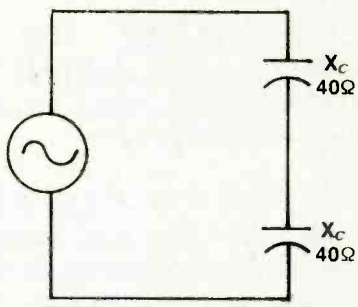


FIGURE D

Products

Gas production unit

The Spirflame, introduced by *Solder Absorbing Technology*, is a self-contained unit that produces gas from the electrolysis of water. It was developed for use in soft soldering, brazing and welding. Flame size can be controlled from small enough to thread through a needle to large enough to cut 2mm steel. Several workstations can be supplied from one unit.

Circle (72) on Reply Card

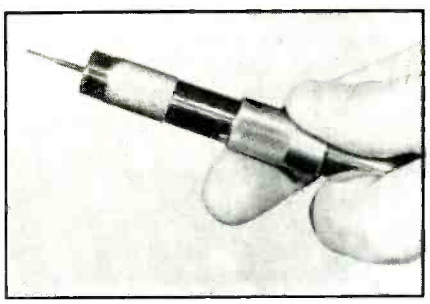
SMT home study course

Heathkit/Zenith Educational Systems has introduced a home study course developed for surface mount technology (SMT). The course, "Fundamentals of Surface Mount Technology," explains surface mount technology, a method of installing tiny electronic components on the same side of a circuit board, doubling or tripling the number of components on a board. The course uses practice boards to teach the basics of planning, designing, assembling and soldering surface-mount boards.

Circle (73) on Reply Card

Air turbine grinder

A miniature, high-speed air turbine grinder has been introduced by *Hunter Associates*. The grinder features speeds up to 340,000 rpm. It can be used for engraving, scribing, drilling, detailing, dies and molds, and general electronic

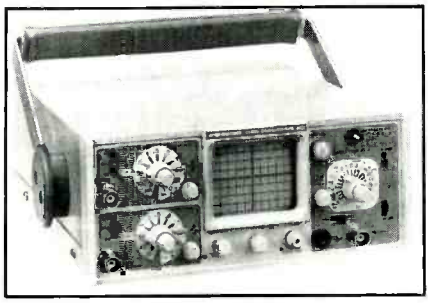


instrumentation applications. The tool can be used on hardened steel, glass, ceramics, carbides and more.

Circle (74) on Reply Card

Dual-trace oscilloscope

B&K-Precision has introduced a dual-trace oscilloscope that measures 4.5" H×8.5" W×12" D and has a battery that fits entirely within the scope. The model 1422 offers 20MHz response and can be powered from ac, an internal battery pack or an external 10Vdc to 16Vdc source. The scope features 10mV/division vertical sensitivity; a 8×10 division, high-brightness rectangular CRT; and front-panel X-Y operation. Eighteen



sweep ranges span from 1 μs/division to 0.5s/division. Sweep magnification is 10 times, extending the maximum sweep rate to 100ns per division.

Circle (75) on Rapid Facts Card

Diagnostic software

The HELPME diagnostic software, available from *Jensen Tools*, introduces an operator or technician to the complete configuration of an unfamiliar PC system. The system checks for hardware/software compatibility and reports processor type, clock speed, memory, drive sizes and types, and the presence of RAM and ROM boards. The software also locates hidden files, system files, drivers, libraries, windows, PIF files and selected applications. Throughout the operation, it documents and explains problems on screen and suggests corrective measures.

Circle (76) on Reply Card

Portable oscilloscope

The 2815 OPTO-Scope, available from *Tektronix*, integrates an 850nm optical input channel and an optical power meter into a portable, dual-channel, 50MHz oscilloscope. This scope allows for simultaneous viewing and measuring of electrical and optical system waveforms. An internal optical source for stimulating 850nm optical systems is included.

Circle (77) on Reply Card

Hand-held DMMs

The SOAR models 3255 and 3250 hand-held digital multimeters from *Carlo Gavazzi Instruments* feature industrial-rated cases; LSI design technology; and 3,200-count, full-scale analog bar graph displays. The DMMs incorporate such functions as auto or manual range selection, data hold, high-speed sampling for the 32-segment bar graph display, and high-speed autoranging. A temperature test function is included, along with an ADP mode, for use with the series 9300 optional adapters to extend measurement capabilities.

Circle (78) on Reply Card

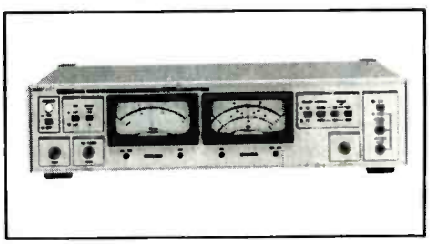
Disk drive exerciser

AVA Instrumentation has introduced the model 103E disk drive exerciser, which can exercise all sizes of floppy drives, including the high-density models and all Apple drives. It uses an LCD display for command prompts and offers track, head and step rate selection to accommodate all current and future production floppy and Winchester drives. The exerciser is user-programmable, with battery-backed memory and floppy alignment track information for the alignment diskettes stored in memory.

Circle (79) on Reply Card

CD jitter meter

Leader Instruments has introduced a compact disc (CD) jitter meter, the LJM-1851. The meter performs simultaneous measurements of jitter (3T) and HF levels (3T or 11T) for the 8-to-14 modulation (EFM) signals used in CD players. The sigma measuring mode computes the jitter within ±1 standard deviation to produce a near steady-state



reading of jitter. The EFM signal level is indicated as a peak-to-peak value for the 3T or 11T bit component and is selected by push-button.

Circle (80) on Reply Card

Precision tool set

Wiha Tools, distributed by Bondhus, has introduced a combination slotted and Phillips screwdriver set. The 7-piece set offers four slotted screwdrivers ($^1/_{16}$-, $^5/_{64}$-, $^3/_{32}$- and $^1/_8$-inch sizes) and three Phillips screwdrivers (no. 00, 0

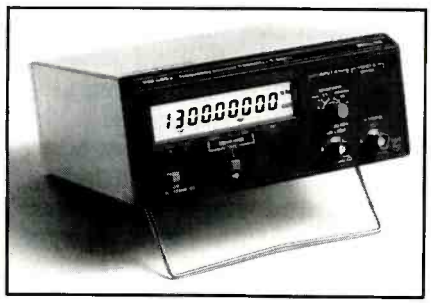
Continued on page 18.

Continued from page 17.
and 1 tip sizes).

Circle (81) on Reply Card

Frequency counter

The Philips PM 6662 120MHz frequency counter, available from *John Fluke Mfg.*, offers at least seven digits for a 1-second measuring time, from low-frequency signals up to 120MHz standard on channel A or up to 1.3GHz optional on channel B. Its input circuitry has a 15mV-to-5V noise immunity



range. Automated features include trigger level setting, selection of high-frequency or low-frequency input, detection of an external 10MHz reference signal, plus autoranging and automated calculation of the displayed resolution performed to match the measuring resolution.

Circle (82) on Reply Card

Analog voltmeter

KAPPA/VIZ has introduced an analog voltmeter, the model WV-595, VoltOhmyst III. This 50kΩ/V meter features a mirrored scale; 52 measurement ranges; a mid-scale switch; a separate dB measurement range; and a test function for 1.5V, 1.55V and 9V batteries. The meter also features a special measurement range for NPN and PNP transistor hFE gain, and a continuity testing range with buzzer.

Circle (83) on Reply Card

Digital multimeter

Beckman Industrial has introduced the Circuitmate DM27 digital multimeter, a 3½-digit, 0.8% accuracy multimeter with features such as a tilt bail, a single rotary switch for function and range selection, and ¾-inch input jack spacing. Functions include a diode tester, an audible continuity beeper and an LED tester. It also measures the frequency of transistor hFE and both square waves and sine waves. Its frequency counter has two switch-selectable sensitivity ranges to allow the measurement of both TTL and CMOS pulses as well as sine waves from 35mV to 450V.

Circle (84) on Reply Card

Digital multimeter

The DM-4000A, introduced by *A.W. Sperry Instruments*, is a 3½-digit, rotary-switch DMM that includes overload protection, current reading, a 0.5-inch-digit LCD display and 150-hour battery life. It incorporates six functions on 19 ranges, including dcV, acV, dcA, ohms, diode check and continuity buzzer.

Circle (85) on Reply Card

Permanent marker

The Sharpie permanent marker, with a 0.3mm tip, has been introduced by the *Sanford Corporation*. The Sharpie Ultra Fine has a water-resistant permanent ink and a precise tip for marking in very small areas.

Circle (86) on Reply Card

Prototype workstation

The Proto-Board model PB-204 from *Global Specialties* offers the designer a prototyping workstation in a metal cabinet. Design alterations can be achieved quickly by re-routing connections. The PB-204 offers a triple voltage power supply of +5V, +12V and −12V to handle op-amp, microprocessor, TTL and CMOS design applications. All three supplies are regulated and current-limited. The breadboarding area has 2,250 tie points, providing space for up to 24 14-pin DIPs.

Circle (87) on Reply Card

Desoldering station

ENDECO has introduced the model 7200 TC temperature-controlled desoldering station. A timed maximum vacuum followed by a rapid expulsion of contaminants into a spittoon keeps the internal components free from solder, resin, conformal coating and other contaminants. The iron has a 450°-to-950° temperature range. Any airborne contaminants will not affect the PVC parts inside the case.

Circle (88) on Reply Card

Analog multimeter series

Goldstar Precision has introduced its new line of analog multimeters. The model AM-2001 performs six functions and features continuity checking with audible alarm, fuse and diode protection, and a battery checker. Two other models in the series, the AM-1001 and the AM-201, execute five functions and feature a battery checker. The AM-201 features diode protection; the AM-1001 features diode and fuse protection.

Circle (89) on Reply Card

Multitester

The model 865 multitester, introduced by *Brunelle Instruments*, features high input impedance; a large, easy-to-read dial; overload protection; and a single range switch with 43 ranges. The unit tests ac and dc volts (0V to 1,200V ±2.5%), ac and dc current (1A to 12A ±2.5%), and has five resistance ranges.

Circle (90) on Reply Card

Vintage TV newsletter

Harry Poster is offering a quarterly, 16-page newsletter devoted to old TVs (from the 1920s and 1930s up to the unusual 1970s sets) and Catalin, mirror and novelty radios. The newsletter will offer articles, pictures and accurate pricing. The premier issue of "Sight Sound Style" includes more than 30 photos, plus information on RCA radios and TVs, Fada Catalin radios and TVs, and early TVs by Andrea.

Circle (91) on Reply Card

Cordless soldering iron

A butane gas-powered cordless soldering iron that is both self-starting and refillable has been introduced by *Blazer Products*. The portable model SI-

3000 is equivalent to a 100W electrical soldering iron. Torch, heat knife, heat shrink and polyfoam cutter tips, as well as soldering tips in four sizes, are also available.

Circle (92) on Reply Card ■

Readers' Exchange

After reading the notice placed in the Readers' Exchange section stating that a small fee will be charged per word, I felt that I must write. I commend your efforts to speed up the turnaround on the ads, but I am concerned with the amount being proposed per word. Fifty cents per word would cause the small, average-sized ad of 20 words to cost $10. Although this will not be a deterent for the For Sale section on items costing hundreds or thousands of dollars, it will totally devastate the exchange of information under the Wanted section. It also will wipe out the small, low-cost items in the For Sale section.

Although the content of the exchange section may not be of any consequence to you, I must say it is very relevant to me and many others, I'm sure. I have responded to several requests and have purchased used equipment from the exchange. Both of these transactions were provided by the existence of the exchange. To stifle the content within the exchange will be a big disservice to your readers.

Might I suggest that with some creative thinking we could solve both the administrative cost issues and yet still keep the free flow of information. You must realize the importance and scarcity of the exchange service within the arena of general circulation. I would rather pay a little extra for the content of the exchange than to stifle the content by an ad surcharge. I would be willing to pay extra for, say, a compendium of these ads or maybe have the cost of the ad be a function of the sale price on merchandise, or you could raise the subscription price or add one more page of commercial ads to cover the cost of the exchange.

As a recipient of the information contained within the exchange, I am willing to pay for that information. Please reconsider your present approach.

Michael Roberge
Milton, VT

Please rest assured that we, too, feel that the Readers' Exchange is an important part of ***ES&T****. We know it's a tough business, and being able to purchase or sell used equipment helps the small service company survive.*

However, as we stated in the August editorial (which I realize arrived after you sent your letter), there are many reasons we feel we must charge this small fee, from rising production costs to organizational streamlining. For one thing, not all of our readers use the exchange. If 50 readers get their Readers' Exchange items published in an issue, that leaves roughly 42,550 readers who ***didn't*** *send in items. For them, those pages might be more useful if they were devoted to articles, so it does seem that the 50 or so readers benefitting from those pages should defray the costs. That's why it seems unfair for all the subscribers to have an increase in their subscription rates. — Editor* ■

Servicing Zenith microcomputers

Part III: The central processing unit card

By John A. Ross

Part II of this series introduced the central processing unit (CPU). This part will continue the discussion of the CPU card with a detailed description of how U212, the 8088 microprocessor, communicates with and controls other portions of the microcomputer system.

The microprocessor: The brains of the system

Designated U212, the 16-bit 8088 microprocessor communicates with the remainder of the system via the 8-bit data signal bus found on the backplane. Figure 1 gives a complete picture of the pin-outs and waveforms for the microprocessor. IC pins 9 through 16 (which carry address lines AD0 through AD7), pins 2 through 7 (which carry address lines AD8 through AD14), and pins 35 through 39 (which carry address lines A15 through A19) handle the data bus signals, configured as multiplexed lines. AD0 through AD7 share the roles of low-order address and data lines.

At the beginning of a read or write cycle, the lines function as low-order address lines. As the cycle progresses, the lines serve as data transfer lines. Address lines A15 through A19 function as high address lines, and the system uses address lines A8 through A14 as middle address lines.

The system design dictates that lines A8 through A15 serve only as address lines. Even though lines A15 through A19 show multiplexed features the same way address lines AD0 through AD7 do, the system again only uses them as address lines. In a data transfer, the latch ICs process the data from lines A8 through A19 the same way they process any data from lines AD0 through AD7.

As the data latching or fetch portion of the operation cycle begins, the contents of the program counter internal register load onto these lines. With the presence of a stable address, the address latch-enable (ALE) signal found at pin 25 goes to an active high. Sensing the ALE signal at an active high, the 8-bit latch ICs found at locations U222, U241 and U242 grab or latch onto the address signal, placing the signal on the address lines.

U243, the bus controller found on the earlier versions of the CPU card, generates the latching and enabling signals for the buffer and latch ICs, plus the read and write pulses for both the system and the input/output sections of the system. In the later versions of the card, the gate array provides the bus control. Figure 2 illustrates the pin-outs and functions of the gate array.

Ross is a technical writer and a microcomputer consultant for Fort Hays State University, Hays, KS.

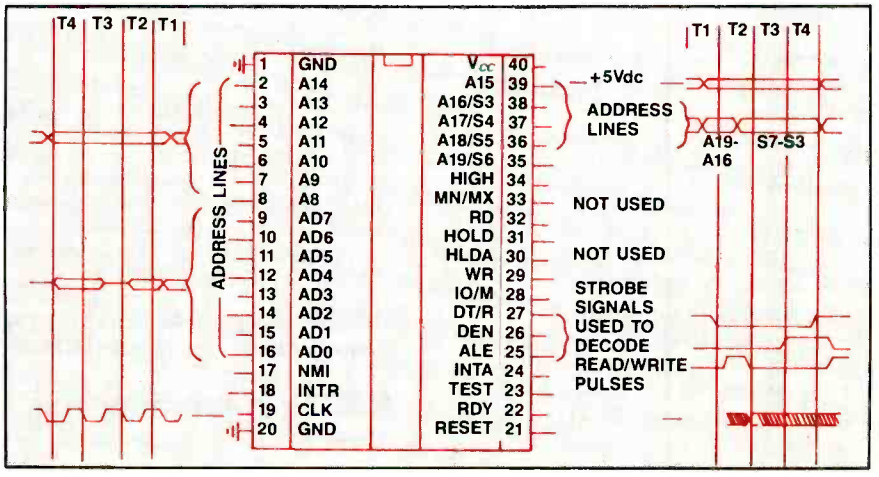


Figure 1. This diagram shows the pin-outs and waveforms for the 8088 microprocessor.

After the latching of the address occurs, the read signal goes to an active low (or zero logic state) as the result of the combined action of three strobe signals found at pins 26 through 28 of the microprocessor. The microprocessor can thus transfer and decode data through the address data pins to the system. If the CPU detects a 2-byte instruction instead of the sample 1-byte instruction, the cycle repeats and loads the remainder of the instruction.

The operation

After decoding the instruction, the CPU starts the second half of the instruction cycle, the operation. Again, the signals at pins 26 through 28 of the microprocessor come into play. Figures 3A and 3B show a breakdown of the signal action. Figure 3A depicts the early-run card operation; Figure 3B shows the later card signal decoding. An operation consists of either memory reads or writes or internal-only actions. Referring back to Figure 3, you'll notice that the strobe signals decode both memory and input/output read and write operations.

One difference becomes apparent in the two operations. If a memory operation happens, the memory input-output signal goes high to allow the addressing of the memory. Addressing an input/output operation sends the same signal to an active low. Using two separate registers for address storage, the microprocessor processes the memory in 16 64kbyte-long segments. One register, called the 4-bit register, stores the most significant bits, while the other register holds the remaining 16 bits of the address.

With the data transfer in progress, the data-enable signal at pin 26 of the 8088 goes to a low or logic zero state, which triggers the processing and interaction of the data signals sent from the microprocessor. U243 inverts the DEN* signal and enables the data transceiver IC, U223. If the data transmit/receive signal at pin 27 of the microprocessor swings to a low state, the micro-

processor readies itself to receive data. U223, the data transceiver, allows data to flow from the signal bus to the microprocessor. If the signal at pin 27 shifts to the opposite high state, data flows from the microprocessor through the data transceiver to the signal bus.

When the 8088 goes through the power-up sequence, it must also initialize the programmable interrupt controller. Beginning the sequence, the controller becomes enabled with pin 1 going to an active low state. Initializing U237, the microprocessor writes a control word into the semiconductor by placing the word on the data bus. Pin 2, carrying the write-receive pulse for the interrupt controller, also goes to an active low. Clearing the two internal registers, the control word sets priorities for the interrupt requests.

Interrupt requests

Pin 18 of the 8088 serves as the tie-point for the software-interrupt request input to the output seen at pin 17 of U237, the programmable interrupt controller. An active high INTR input signal tells the microprocessor that a maskable or ignorable interrupt of CPU operation has occurred. U237 assigns a priority to the request; primary processing by the microprocessor goes to the highest priority request. Because of the inherent flexibility of the design, the interrupt controller can rank up to eight different interrupt requests. Some instruction sets may tell the CPU to either ignore or change the priority of other maskable interrupt requests.

If the interrupt controller sees no interrupt request in progress, the interrupt signal at pin 17 goes to an active high state. If U237 senses an on-line interrupt request, the programmable interrupt controller waits for the current request to finish before starting a new interrupt-request process. The interrupt controller initially supplies the interrupt-request signal to the microprocessor. Then, U237 uses data lines AD0 through AD7 to send the address of the instruction that corresponds to the interrupt input. When a peripheral device needs to input data and sends an interrupt request to the CPU, the microprocessor acknowledges the request by sending the interrupt-acknowledge signal at pin 24 to an active low state. U237 receives this acknowledgement signal at pin 26 and responds by relaying the address of the instruction back to the microprocessor.

Using the low state of the interrupt-acknowledge signal at pin 24, the microprocessor responds to the interrupt controller and asks for a type number for the interrupt request. In short, the low state at pin 24 shows that

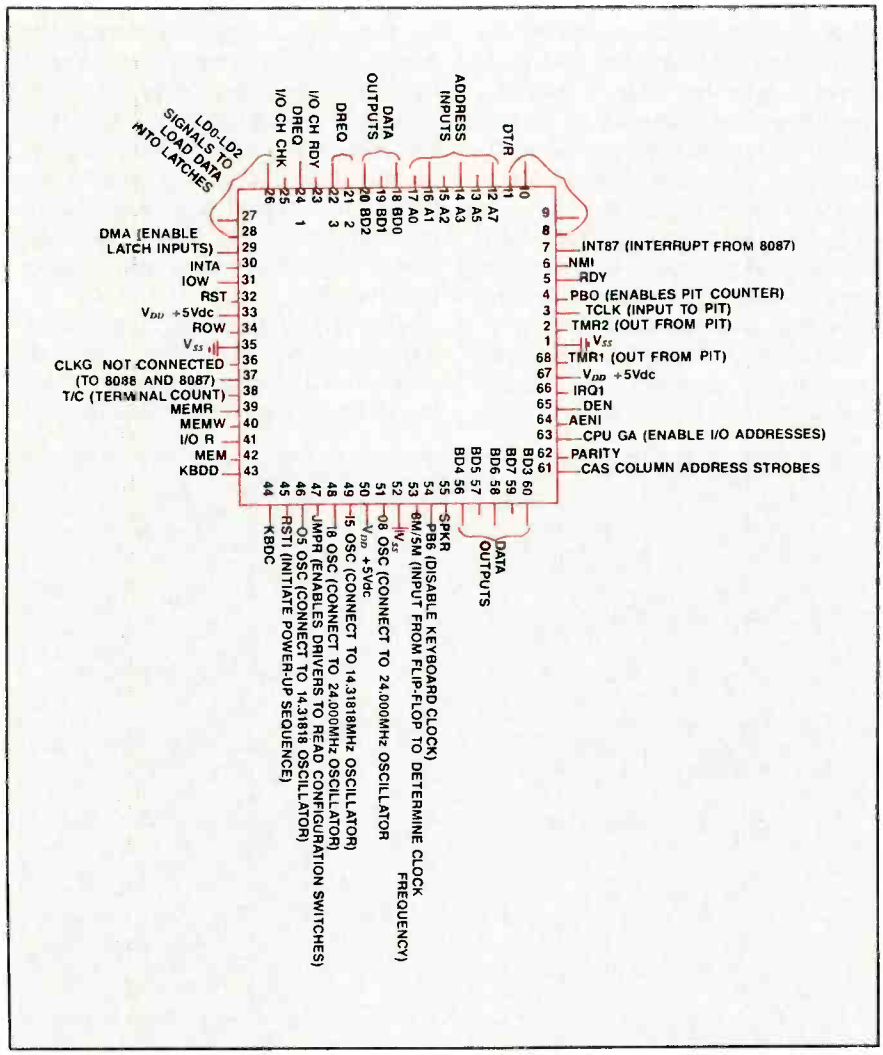


Figure 2. In the later versions of the CPU card, the gate array provides the bus control.

CPU strobe action

S0	S1	S2	Bus controller/gate array output
0	0	0	interrupt acknowledge
0	0	1	read I/O port
0	1	0	write I/O port
0	1	1	no output for bus controller — halt
1	0	0	no output for bus controller — code access
1	0	1	read memory
1	1	0	write memory
1	1	1	no output for bus controller — idle

Figure 3. After decoding the instruction, the CPU starts the operation, either memory reads or writes or internal-only actions. This list shows the combinations of logic states seen for strobe decoding.

the microprocessor has completed the instructions. Maskable interrupts receive a type-one address location; type-two address locations go to non-maskable interrupt requests. Normally running at an active high state, the request-granted signal at pin 34 goes to a high impedance state when the CPU acknowledges the request. This signal clears the interrupt register of the programmable interrupt controller.

Another type of interrupt request, the non-maskable interrupt, periodically comes to the CPU through pin 17 of the IC. Unlike the maskable interrupt, the microprocessor cannot ignore the non-maskable interrupt. Moreover, non-maskable interrupt requests take precedence over maskable interrupt requests. Memory-parity failures or voltage fluctuations may cause a non-maskable interrupt. Nearly identical processes occur for each type of interrupt request.

After receiving and executing the interrupt request instructions in both cases, the CPU looks for a return command. Given the return command, the CPU goes back to processing the original interrupted operation. When the signal at pin 17 goes to an active high state, the logic high forces the microprocessor to go to a specific location in the program instructions. Following in that sequence, the non-maskable interrupt request drives the central processing unit to a type-two interrupt address location.

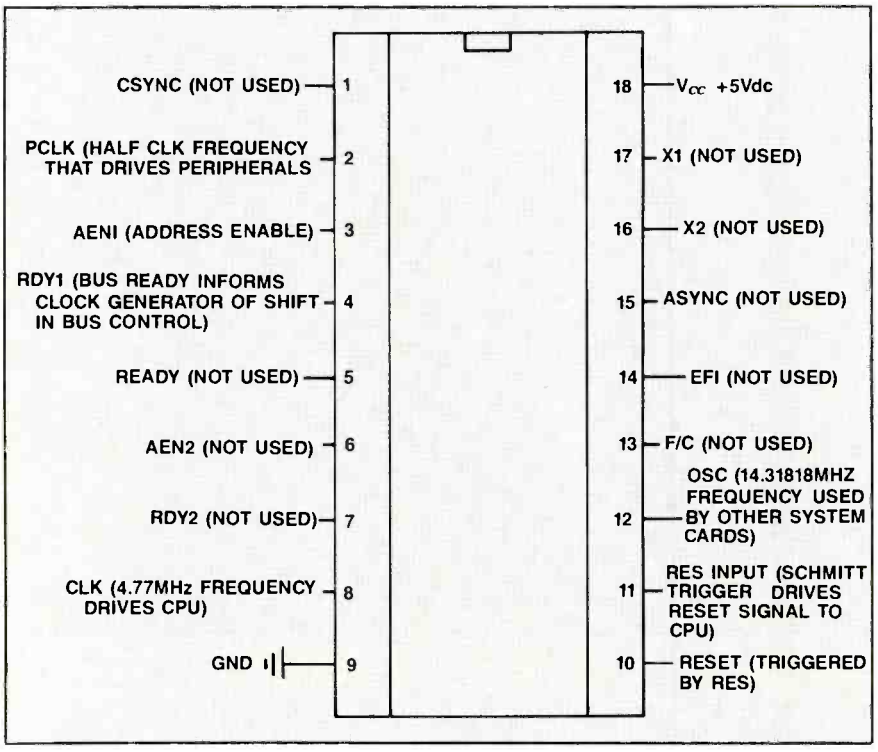


Figure 4. U211, the clock generator, provides a time base for the microprocessor operation and synchronization for the RDY signal of the older production CPU cards.

Common error messages

- Parity hardware failure or parity failure — Check system random-access memory ICs and settings of configuration switches.
- Drive not ready, Seek failure, Sector not found or Invalid address mark detected — Make sure you have operating system on the disk, and check for problems with the disk drive, the configuration switch settings or the drive designation jumper setting found on the disk drive.
- Invalid/no keyboard code received — Check for proper connection of the keyboard connector.
- CPU failure — check for any problem indications at backplane and CPU card diagnostic LEDs; check for +5Vdc at the microprocessor; remove the CPU card and clean the edge connector.

Figure 5. Because of the nature of the microprocessor and the firmware loaded on the system ROMs, automatic error messages will display on the monitor. The error messages are commonly seen at power-up.

Data transfer speeds

If slower memory devices require a data transfer, the ready signal at pin 22 of the microprocessor will go to a low state. When the slower device requires a longer period than one cycle for data transfer, the device requests the delay by placing the low on the RDY line. U211, the clock generator, will time the duration of the signal. Subsequently, when the memory device has reached its transfer state, it will start the transfer by returning the RDY signal to an active high. In the later versions of the central processor card, the gate array handles the requests for slower transfer.

Sometimes, peripheral and memory devices require a faster transfer of data. Examining the operation of the early cards, technicians will need to trace the interrelated functions of several ICs. Because U209, the programmable direct memory-access controller, uses stored instruction sets, it has an advantage over the microprocessor, which has to process differing sets of instructions. Transferring data, the DMA controller can move the data in blocks defined by the CPU, in blocks defined by a peripheral device or in single bytes. Receiving instructions on the data location and memory location from the 8088, the DMA outputs the data on its address lines found at pins 32 through 40. Pin 9 carries the active high address-enable signal that enables the associated address lines. Pins 1 through 4 of the DMA controller supply all the memory read and write signals.

When U209 needs to control the bus, it issues a hold-request signal through pin 10 to the microprocessor. A hold request may happen if a peripheral device requests service through the DREQ lines found at pins 16 through 19. Responding to the hold request, the 8088 sends a hold-acknowledge signal, which appears at pin 7 of the controller.

Clock signals

U211, the clock generator, provides a time base for the microprocessor opera-

Diagnostic tests

Keystrokes	Screen
Ctrl-Alt-Insert	MFM-150 Monitor, Version x.x Memory Size: xxxK bytes Enter "?" for help ->
"test"(Enter)	1. Disk read test — Checks for problems in the boot-up disk. 2. Keyboard test — Checks for proper function of any keyboard key. 3. Memory test — Thorough check of system random-access memory. 4. Power-up test — Continuously re-runs initialization test routine.

Figure 6. The monitor ROM contains several diagnostic tests. To start this diagnostic routine, press the Ctrl, Alt and Insert keys at the same time. Shown here are the keystrokes to use and the messages they bring up on the screen. Pressing numbers 1 through 4 and then Enter will initiate the specified self check.

tion and synchronization for the RDY signal of the older production CPU cards. Figure 4 gives a representation of the clock generator and its pin-outs. With a 14.31818MHz crystal controlling its oscillator, U211 sets the correct timing for the RDY signal through the bus-ready signal found at pin 5. With the bus-ready signal at an active high, the clock generator informs the microprocessor that it now has control over the bus. This control can shift from the microprocessor to other devices, such as the DMA controller. Other parts of the microcomputer system also use the buffered output of this 14.31818MHz signal, generated at pin 12 of the clock generator and sent to the system via the backplane, as a time base for their various operations. Dividing the output of the crystal by three, the clock generator supplies a 4.77MHz, 33.33% duty-cycle square-wave signal for the CPU clock. This signal, the clock output, flows from pin 8 of the clock generator to pin 19, the clock input, of the microprocessor.

Another signal, which is half the original 14.31818MHz crystal frequency and is called the peripheral clock signal, flows from pin 2 of the generator through buffers to any peripheral devices. This signal also connects to the programmable interval timer, U232. Containing three independently programmable clocks, the timer operates as three 16-bit counters. Responding to a software programmable control word sent by the microprocessor, U232 sets different modes of operation. With each clock loaded with a starting count, they count down until reaching zero and send out an active high on the respective out-

put line. Seeing this active high, the interrupt controller treats it as an interrupt request and triggers an operation. If not triggering an operation, the active high signal may drive some external peripheral device.

An address-enable signal appears at pin 3 of the clock generator in an active-low state and provides timing control over the buses during the switching operations. The clock generator also provides the RESET signal found at pin 10 of the clock generator and pin 21 of the microprocessor during initial system power-up. Located on the CPU card, capacitor C7 charges and keeps pin 11 of the clock generator at an active low state. As the system reaches the initial power-up stages and sees the full charging of capacitor C7, the clock generator inverts the low signal to an active high state. Using a Schmitt trigger input, the generator uses the reset input signal at pin 11 to drive the reset signal to the microprocessor. By pushing the CPU to a specific location in program instruction, the RESET signal forces the microprocessor to begin its power-up sequence.

The gate array

In the later versions, the single package of the gate array fulfills all the tasks once accomplished by the separate ICs of the older card design. Because of the circuit changes, some ICs have different placement designations. While U240 designates the programmable interval timer, the interrupt controller receives the designation of U241. All of the shared tasks generally have an identical structure. Looking back at the descriptions of the older design patterns will assist the technician in comprehending the gate array operation shown at Figure 2. However, the considerations of a newer technology cause a few differences to arise.

One major difference arises in the divide-by-three timing signals that the technician will find at pin 37 of the gate array. This CLKG signal provides either 4.77MHz or 8MHz timing for the 8088. Pin 53 carries an output from the dual flip-flop at U254 and, along with the external switch setting, determines the clock frequency for the system. If the user has set the frequency-select switch to the 8MHz position, the system will use the 8MHz clock signal derived from the 24MHz oscillator, Y201. Pins 48 and 51 connect the gate array to the 24MHz oscillator.

With the addition of the system random-access memory to the CPU card, other new signals appear at the gate array. An indication of memory operation in the form of the MEM signal shows at pin 42. Pin 61 carries the column address strobe or CAS signals to the RAM banks. Moving to pin 62, technicians will find a parity signal. This signal establishes the parity bit for RAM devices found at U201, U210 and U219. In the next article of this series, we'll take a close look at both these signals and the memory operation.

Aside from the memory-related signals, the gate array also furnishes signals for the keyboard and the speaker. With the addition of the gate array, the microprocessor does not need to constantly check any keyboard entries. Pressing a key on the keyboard causes the gate array to send a signal to the interrupt controller. While pin 43 carries the data signal from the keyboard, designated as the KBDD, pin 44 carries the clock signal for KBDD from the keyboard. A signal found at pin 54, called the PB6 signal, disables the keyboard clock. Pin 55 carries a signal to the system speaker through the P201 connector.

Troubleshooting

Troubleshooting problems with either card becomes an easier task for two reasons. By including diagnostic LEDs (light-emitting diodes) on the central processing card, Zenith lets the system point the technician toward the problem area. As the system powers up and initializes, the diagnostic LEDs — labeled CPU for checking the microprocessor operation, ROM for the read-only memory status check, RAM for checking the proper storage of data in the random-access memory, INT for the system clock check and interrupt at power-up, DSK for the checking of disk controller response, and RDY for the system boot indication — sequentially extinguish. If a problem occurs in a particular area, the designated LED and the LEDs following it will remain lit.

For example, if a problem happens in the system random-access memory, the four LEDs labeled RAM, INT, DSK and RDY will remain on. Many times, a quick glance at the diagnostic LEDs will save the technician a large amount of time in the troubleshooting process. As with any electronic device, the technician should remember to check the power-supply voltages that supply the components on the CPU card. If you examine the different pin-outs for the ICs, it becomes readily apparent that the technician should check for a +5Vdc at the designated locations.

Because of the nature of the microprocessor and the firmware loaded on the system ROMs, automatic error messages will display on the monitor and help the technician determine the nature of the problem. Many times the error messages describe the action needed to accomplish the repair. Messages such as "Error—ROM checksum failure," "Error—RAM failure," "Error—Bad disk controller" and "Error—sector not found" will often appear. Figure 5 shows some possible messages and service procedures.

Diagnostics

Zenith also provides a complete set of disks that contain diagnostic programs for use in the 150 series of microcomputers. By loading and running the more sophisticated diagnostic programs, the technician can obtain an excellent idea of system operation. With the floppy disk-based diagnostics, the technician may test a single section or the complete microcomputer. Moreover, the tests will lead the technician to the defective component.

Supplementing the internal and external diagnostics, the firmware found in the monitor ROM contains several diagnostic tests that may help the technician locate the source of a problem. To start the diagnostic, the technician needs to follow three steps. Simultaneously using the Ctrl, Alt and Insert keys on the keyboard will cause the monitor to display a message indicating entry into the firmware. Figure 6 shows this message and describes the functions of the section tests. By typing TEST and using the return key, the technician will display a menu of four section tests. Selecting the appropriate test will cause a system self-check.

In the next article of this series, we will probe the signal action of the memory devices. As the series progresses, technicians can sense the complexity of the interrelated functions found in the microcomputer. Each part of the system, although seemingly independent in function, depends on another part of the system to complete its task. By thoroughly understanding the interplay of the system components, technicians will find it much easier to troubleshoot the microcomputer. ■

Answers to the quiz

Questions are on page 16.

1. 0Ω. According to GE/RCA, it is a jumper used on surface-mount boards.

2. 12kΩ. That's a 12 with three zeros.

3. 14+ volts. Many good technicians answered 20V on a CET test. That's carelessness. The voltages must be added vectorially.

4. $\overline{CE}$ — NOT chip enable. $\overline{OE}$ — NOT output enable.

5. It means they are active low. In other words, you have to deliver a logic 0 to the pin to make it work.

6. Dynamic RAM. It is made with capacitors. Logic bits (binary digits) are stored by charging capacitors. The disadvantage is that a refresh signal is needed to keep the capacitors charged. Why go to all that trouble? Because they are fast. You can get information in and out quickly. More important, you can get more memory for a given area.

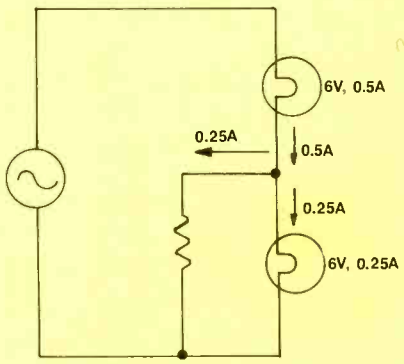


FIGURE E

7. 80Ω. You would be surprised at the number of technicians who have answered 20Ω.

8. 12Ω. The circuit is shown in Figure E. The voltage across the resistor is 6V and the current through it is 0.5A. (R = V/I = 6/0.5 = 12Ω.)

9. B. This is an erasable programmable read-only memory. The EEPROM is electrically erasable.

10. $^1/_{60}$. A third of a fourth is $\frac{1}{3} \times \frac{1}{4} = {}^1/_{12}$. A fifth of that is ${}^1/_{12} \times {}^1/_5 = {}^1/_{60}$.

What do you know about electronics?

Summarizing the differentiator

By Sam Wilson, CET

The major concepts of the R-C differentiator were reviewed in the July issue. It was shown that an R-C circuit can come very close to producing an output signal that is the derivative of the input signal. Close, but no cigar. Because of the trade-offs, it is not possible to get 100% accuracy.

The R-C circuit of the differentiator is also used for other applications. For example, it can be used as a low-pass filter. Figure 1B shows the characteristic curve for the R-C filter shown in Figure 1A. The graph looks like a time constant curve, but it is not. It is a graph of frequency vs. amplitude, not time vs. amplitude.

The pre-emphasis R-C muddle

The R-C differentiator circuit is in the same configuration as a basic pre-emphasis circuit used in FM transmitters. In that application, the circuit is used to partially overcome the problem of lower signal intensity at high audio modulating frequencies. The higher audio frequencies will normally receive less modulation, so the signal-to-noise (S/N) ratio does not come off so well. The pre-emphasis circuit gives the higher modulating frequencies greater emphasis at the transmitter.

You might expect the pre-emphasis circuit to be rated by its cutoff frequency. Not so. For some strange reason, the pre-emphasis circuit is rated by the time constant of the R-C circuit. In the United States, the required time constant is 75μs. In other countries, it is from 50μs down to 25μs. (In a similar way, the de-emphasis circuit required in the receiver is also rated by its time constant rather than by its effect on frequency.)

You might argue that the time constant and cutoff frequency are directly related. After all, a longer time constant will result in a rolloff at a lower frequency. However, strapping the pre-emphasis (and de-emphasis) to a time constant requires an R-C circuit design. Even if you found a better way to do it, you couldn't use it unless you could relate it to the time constant requirement.

The R-C integrator

Let's start by reviewing the idea behind differentiation. If you solve an algebra problem, you might be looking for the value of y if you know the value of x. So if $y = 4x$, you know that when x is equal to 4, y is equal to 16. (4x means 4 multiplied by x. The biggies in the algebra monopoly do not use a multiplication sign.) If you know one value, you also know the other in algebra.

In calculus, you are interested in how much y will *change* if x changes by a certain amount. If you relate that problem to time, you want to know how fast y is changing when you know the rate of change of x.

In the differentiator circuit, the rate of change of the output voltage is directly related to the rate of change of the input voltage.

So, what is integration?

Integration is sometimes said to be the opposite of differentiation. That explanation is not very descriptive except when you are talking about the circuits. Compare the differentiator with the integrator in Figure 2. You can see that they are, in a way, opposites.

The symbol for integration ($\int$) looks like the letter s. You can say that it stands for the sum. If you have a lot of little changes, and you want to know the total change after you add them all together, you have a problem in integral calculus.

As you might expect, integral calculus allows you to find the total of the little parts without taking 27 days to actually add them.

Knowing that, you can see that an integrator's output is the sum of a lot of little inputs. Figure 3 shows an example. In that circuit, the input to the integrator is a lot of little (short-time) pulses. The output is the sum of all of the short-time pulses. You have to give the circuit time to add those inputs. After it has added them, the output is the sum of the inputs. Three examples of R-C circuits used as integrators are:

- *The sync separator.* Integrators have

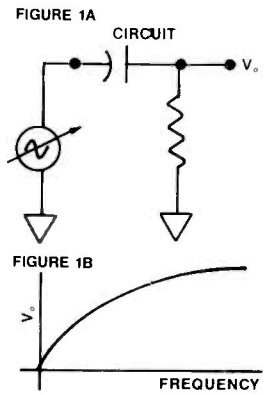


Figure 1. The R-C circuit of the differentiator can be used as a low-pass filter. Figure 1B, the characteristic curve for the R-C filter shown in Figure 1A, is a graph of frequency vs. amplitude.

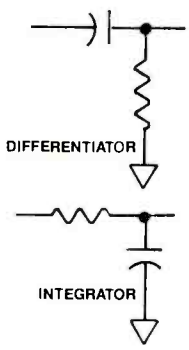


Figure 2. The integrator is, in a way, the opposite of the differentiator.

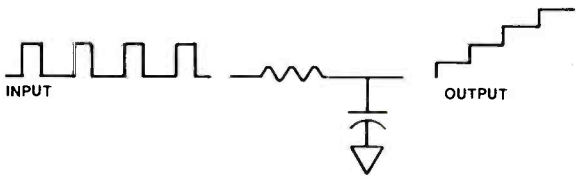


Figure 3. In this circuit, the input to the integrator is a lot of little (short-time) pulses. The output is the sum of all of the short-time pulses.

Wilson is the electronics theory consultant for ES&T.

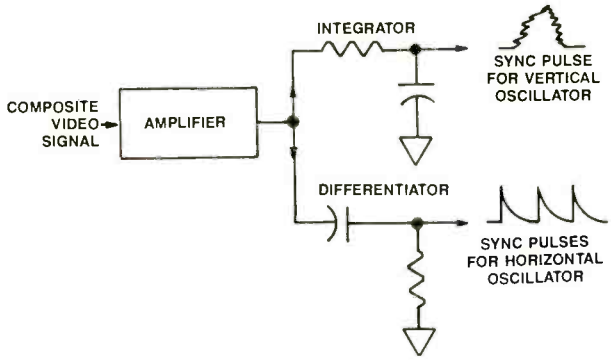


Figure 4. To separate vertical and horizontal sync signals, the integrator adds the pulses to get the vertical sync signal. The differentiator shapes the pulses to get the horizontal sync signal.

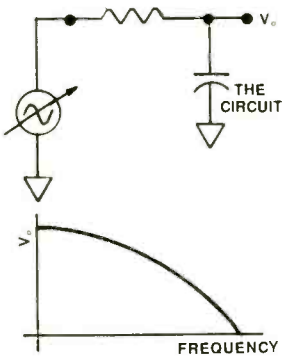


Figure 5. The R-C circuit used for an integrator also works as a low-pass filter. The high frequencies are shunted to common through the capacitor.

been used in analog television systems, along with differentiators, to separate vertical and horizontal sync signals. This concept is illustrated in Figure 4. The integrator adds the pulses to get the vertical sync signal. The differentiator shapes the pulses to get the horizontal sync signal.

• *The low-pass filter.* The R-C circuit used for an integrator also works as a low-pass filter. Figure 5 shows this idea. The high frequencies are shunted to common through the capacitor. Because the differentiator is a high-pass filter and the integrator is a low-pass filter, those concepts are sometimes used to describe the action of the sync separator in an analog TV system. This model of circuit behavior is illustrated in Figure 6.

• *The op-amp integrator.* Figure 7 shows an op-amp integrator. The op-amp will do whatever is necessary to maintain the virtual ground at 0V potential. Each time a pulse is delivered to the input terminal, that pulse tries to raise the virtual ground above 0V. The op-amp immediately responds by sending a pulse from its output to neutralize the effect of the input pulse. The op-amp pulses are fed back through the capacitor. The voltage across the capacitor increases with each pulse. The output of the op-amp is the sum of the pulses.

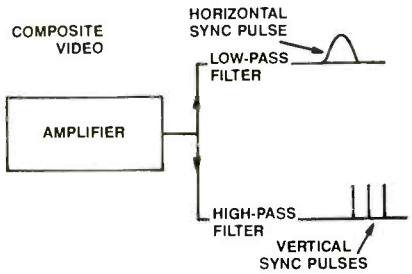


Figure 6. Because the differentiator is a high-pass filter and the integrator is a low-pass filter, those concepts are sometimes used to describe the action of the sync separator in an analog TV system.

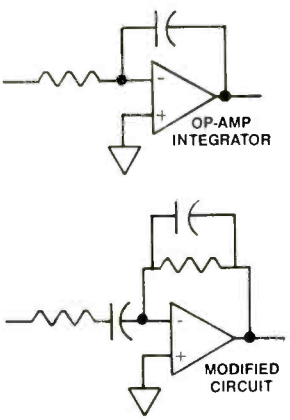


Figure 7. Another example of an R-C circuit is the op-amp integrator. If you compare the modified version with the modified version of the differentiator, you can see that the circuit configurations are identical.

As with the differentiator, the circuit is usually shown as the modified version in Figure 7. If you compare this circuit with the modified version of the differentiator, you can see that the circuit configurations are identical.

This is another example that shows why you can't learn electronics by memorizing circuit configurations. Although the configurations are identical, the circuits are different by their time constants. The integrator has a long time constant, and the differentiator has a short time constant. ■

Books/Photofact

Basic Electronics Theory, third edition, by Delton T. Horn; TAB Books; 608 pages; $21.60 paperback, $28.95 hardbound.

This guide is intended as a beginning text for the novice and as an easy-to-use reference for the experienced technician. This edition includes new chapters on Kirchhoff's laws, circuit diagrams, project construction techniques, photosensitive devices and other sensors, microprocessors and amplifiers. The book also includes more in-depth coverage of motors and superconductivity.

TAB Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138.

Surge Protection Test Handbook; KeyTek Instrument; 68 pages; $5 (free if requested on company letterhead).

This handbook contains a complete review of available surge protection components and the techniques for using them, as well as applicable standards and their real significance. It also shows how to surge-test equipment to ensure that it will survive in the end applications.

KeyTek Instrument, 260 Fordham Road, Wilmington, MA 01887; 617-658-0880.

One Evening Electronics Projects, second edition, by Calvin R. Graf and Richard S. Goss; Howard W. Sams; 150 pages; $8.95.

This introductory electronics text presents 16 easy-to-build projects, including five projects new in this edition. Each project includes step-by-step instructions, circuit diagrams and illustrations, a complete listing of the parts required, and theory of operation.

Howard W. Sams, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5604.

Power Electronics: Circuits, Devices and Applications; by Muhammad Harunur Rashid; Prentice Hall; 585 pages.

This book covers the fundamentals of conversion techniques and presents the characteristics of power semiconductors in reference to their applications to power circuit designs. Three main applications — dc drives, ac drives and power supplies — are explored in this text along with several power devices. Also reviewed are three-phase circuits, magnetic circuits, spectrum multiplication techniques, Fourier series, dc transient analysis, and computer programs lists. A disk that contains 51 programs for use with the book is included.

Prentice Hall, Route 9W, Englewood Cliffs, NJ 07632; 201-767-5937.

Introduction to Electronics Design; by F.H. Mitchell Jr. and F.H. Mitchell Sr.; Prentice Hall; 820 pages.

This book is a broad, systems-oriented introduction to electronics design that employs an evolutionary approach from building-block concepts to complex IC circuits and systems. The authors include in-depth coverage of semiconductor devices and computer-aided design, while making extensive use of learning aids throughout.

Prentice Hall, Route 9W, Englewood Cliffs, NJ 07632; 201-767-5937.

The Complete Electronics Career Guide, by Joe Risse; TAB Books; 192 pages; $19.95 hardbound, $12.60 paperback.

This book describes more than 30 different possible career paths in the electronics field and offers a useful overview of basic electronics to give readers an idea of whether electronics is the right career choice. The book provides a review of the career options in consumer electronics, industry, government, broadcasting, the military, communications and education. The author details the educational training required for each position and specifies each position's responsibilities, average pay scales and advancement potential.

TAB Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138.

Directory of Circuit Board and Disk Drive Repair Companies, fourth edition, published by Coordinated Service; $49.95.

This edition of the annual repair directory lists more than 250 depot and specialty repair companies that specialize in areas such as floppy disk drives, hard disk drives, Winchesters, board repair, mail-in, swap-out, component rebuilding and clean room service. Products covered are from all the major manufacturers plus many smaller, more obsolete products. Listings give the location, contact, a description of the equipment serviced, warranty periods and parts information.

Coordinated Service, 531 King St., P.O. Box 1260, Littleton, MA 01460; 617-486-0388.

Transformers and Motors: A Single-Source Reference for Electricians, by George P. Shultz; Howard W. Sams; 350 pages; $24.95.

Written for the National Joint Apprenticeship and Training Committee (NJATC), this new book provides information on installation, maintenance, troubleshooting, repair and replacement of transformers and motors. The book explores the existing technology of applications based upon electromagnetic theory, describes troubleshooting procedures, and ties electromagnetic theory to practical applications.

Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 800-428-7267.

The VCR Cleaning Guide, by Micheal Peterson, CET, and Fred Allen; IDC Electronics; 15 pages; $9.95.

This publication is intended to help VCR owners understand the basic principles of cleaning VCRs. It is geared toward the electronic novice or professionals who would like to take care of their own machines. The book comes with illustrations and offers tips on where to get quality cleaning supplies if they are not available in your local area.

IDC Electronics, 2745 Winnetka Ave. N., Suite 205 EST, New Hope, MN 55427; 612-476-1710.

Understanding Telecommunications, by Ronald R. Thomas; TAB Books; 288 pages; $24.95 hardbound, $17.60 paperback.

This book covers the recent changes in the telecommunications industry, including deregulation and the breakup of the Bell System. It offers an overview of the technology and the industry, covering basic electronics, computer communications, radio and TV broadcasting, and long-distance communications. The book also discusses the impact of the latest changes in the field and examines society's move toward an information- and service-dominated economy.

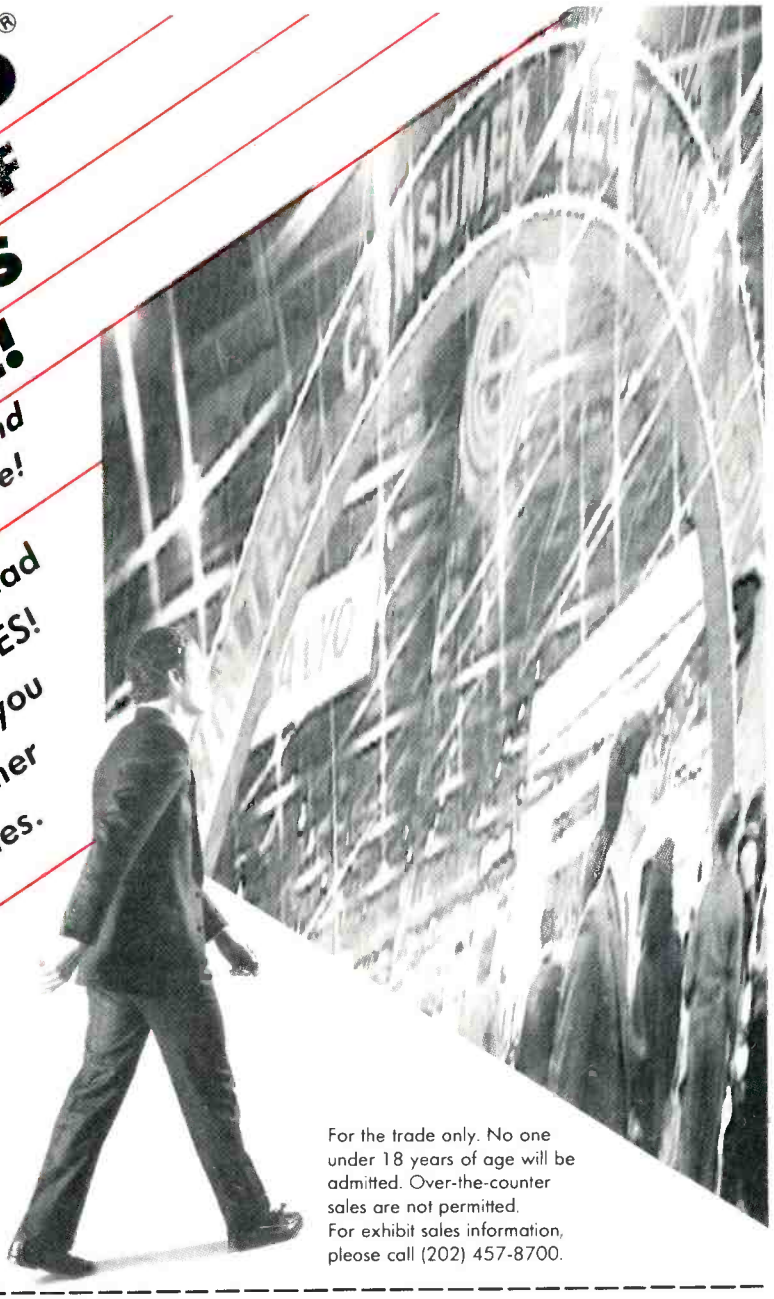
TAB Books, Blue Ridge Summit, PA 17294-0850; 800-822-8138. ■

WINTER CES®

PUT YOURSELF IN THIS WINNING PICTURE!

Pre-register Today and Save the $25 On-site Fee!

Get a clear view of what's ahead for the 90's at Winter CES! 1350 exhibitors will be there to show you what's new in over 95 consumer electronics product categories.



For the trade only. No one under 18 years of age will be admitted. Over-the-counter sales are not permitted. For exhibit sales information, please call (202) 457-8700.

1990 International Winter Consumer Electronics Show®

Las Vegas, Nevada, USA
Saturday, January 6 through
Tuesday, January 9, 1990

The Consumer Electronics Shows are sponsored and produced by the Electronic Industries Association/Consumer Electronics Group.

COMPLETE AND RETURN FOR A PICTURE PERFECT OPPORTUNITY!

Mail this completed form to Consumer Electronics Shows, c/o CompuSystems, Inc., P.O. Box 6579, Broadview, IL 60153-6579.

To obtain your badge by mail, we must receive this form no later than December 15, 1989. Attach your business card for proper verification and prompt processing. If we receive this form after December 15 and before December 28, you may pick up your badge at the "Advance Registration Pick-Up" Desk in the Main Registration Area of the Las Vegas Convention Center, West Hall, the Hilton Hotel and Sahara Hotel. Two forms of ID will be required. Registration Forms received after December 28 will not be processed. Please register on-site after paying $25.

To register more than one qualified individual, please duplicate this Advance Registration Form and attach business cards. Complete Show information, including housing form, will be sent separately. 126

Please check **only one** badge category:

1 ☐ Retailer
2 ☐ Distributor
3 ☐ Dept./Chain Store Buyer
4 ☐ Prem./Catalog Buyer
5 ☐ Manufacturer's Rep
6 ☐ Manufacturer
7 ☐ Institutional Buyer
11 ☐ Adv./Mktg./PR/Consultant
12 ☐ Financial/Market Analyst

*Name

Company

Street

City State Zip

Phone

Last four digits of your Social Security Number (for internal use only)

*Only 21 characters, including spaces, will appear on your badge.

Information Exchange

Editor's note: In the editorial in the June 1989 issue, I mentioned that we get many letters from readers asking where they can get servicing information on a certain consumer electronics product, or components for some other product. For a while, we tried to handle a few of these requests on an individual basis, but it was beyond our resources to look up this kind of information and reply individually. It also became apparent that many of these requests were repeated later by another reader, so if we published the information we dug up, a lot more people would benefit and we'd save some effort. Not only that, but it occurred to us that many of our readers had probably already dug up this information and would be willing to share it with others.

It occurred to us that it might be a good idea to initiate an information exchange where readers could write in with questions on where to find information or replacement parts and we could publish these questions in the hopes that another reader could answer them.

A lot of readers have since written in with either questions or answers, and generally with the comment that they think this is a heck of a good idea.

Here's the first round — mostly questions, but also a good supply of answers. If any of you can shed some light on any of these questions, we hope you'll take the time out to write. The staff of the magazine and the readers who will benefit from the answers thank you in advance.

Information wanted

• Source for a round capstan drive belt for a Dokorder model 7140 reel-to-reel tape recorder, manufactured by Denki Onkyo Co. Ltd., Japan. *Editor's note: I called Onkyo in Ramsey, NJ. They have no parts or information and couldn't help me.*

• Source for diagrams, a parts list, service information and possibly a source of parts for a Centronics model 739-1 DM printer, product model number 63739701-5518, serial number 05463. The manufacturer was the Centronics Division of Data Computer Corp., Hudson, NH.

• Address to order parts, etc., for Phonemate Answering Machines.

• Source for a service manual and replacement parts for the model V-3000 VCR manufactured by Vector Research.

• Source of servicing information and replacement parts for a model MVR-1000 VCR manufactured by Marta.

• Source of servicing information and replacement parts for a Lloyds model L838, series 821A VCR.

• Servicing information for a DynaTech model VR-71 VCR.

• Servicing information (circuit diagram) for a SuperMacy model 20MK.

• Service manual for a Video Concepts model HT 2000 VCR.

• Address for BSR (U.S.A.) Ltd., manufacturer of automatic record changers.

• Service manual for a Sony model STR-414S stereo system. The manual is out of print because the unit is a 1978 model.

• Service manual or schematic diagram for a Korean-made Supra VHS VCR, model SV-70.

• Replacement parts (flyback) for a Kawasho model 3713 TV. (Reader tried Kawasho International, New York.)

• Replacement part: IC #STK5486 voltage regulator chip for an Emerson model VCS966A VCR.

• Source for parts for an Akai model CS-703 tape recorder.

• Service manual or schematic for an Astro model LKS314B TV.

• Service manual for a General Sound model GS 230 5-inch TV.

• Service manual for an older model Sony radio (model TR4400).

• Service manual for an old tube-type scope pre-amp for the Philco model 8300.

• Service manual for Crowncorder model CSC 9350M, older-model AM/FM/cassette radio.

• Service manual for a Gemini AS20 radio.

• Service manual for an Enterprex International Ultronic Radio, model A-3971.

• Service manual for an Electro Brand radio, model 7984.

• Service manual or schematic for an Asian-made, 19-inch color TV, Sun Ray model SR 19.

• Schematic/service manual for a Samsung model VT-210TB VCR.

• Source for a 40-channel CB chip (PLL) #1302 0658 for a Browning-Mark IV transmitter, Browning Labs, Laconia, NH. Chip has the marking "Malaysia" on it.

• Schematic for a Vornado model VR-240 TV.

• Service literature, including schematic, for a Goldstar model TSR-581 AM/FM stereo recorder.

• Service manual, including schematic, for a Fisher model PC226W TV. Distributor only had it on microfiche.

• Address of distributor for parts and literature for a 4¾-inch portable color TV/AM/FM/cassette player combo. The unit is a Signal model DSC-500AG, made in Taiwan 1980.

• Service manual for an Ambassador model K1019 19-inch color TV set.

• Schematic for a Ball TD-3 B&W monitor.

Information found

MultiTech

Parts and servicing information for

MultiTech, DynaTech, Spectrum, HiTech:
Trans-World Electronics
15304 E. Valley Blvd.
City of Industry, CA 91748
800-822-1236

The MultiTech MV-089 is identical to the Symphonic model 5200, which is made by Symphonic:
Symphonic Corporation
100 North St.
Teterboro, NJ 07608
800-242-7158

Grundig stereo equipment

Servicing manuals and replacement parts for *some* Grundig units are available from:
Act Electronics
Parts Department
2345 E. Anaheim St.
Long Beach, CA 90804
214-433-0475

Akai

Servicing literature and replacement components for Akai products are available from:
Mitsubishi Electric Sales America
National Service Department
5757 Plaza Drive
P.O. Box 6007
Cypress, CA 90630-0007
800-553-7278
714-220-2500

Conic

Conic Model T-7711A: According to one reader, this set is exactly the same as the Radio Shack unit, catalog number 16-234. Anyone needing a schematic for this Conic set can use the Radio Shack documentation.

Hitachi

Editor's note: Two readers wrote that they were unable to obtain servicing information for Hitachi products because they were out of print. I contacted Hitachi. Their response was that after a product is 10 years old they no longer stock manuals. This seems to be standard procedure throughout the industry. They normally keep one copy, and if someone needs the information they will send a photocopy for a nominal fee. The address is:
Hitachi Service Company
401 W. Artesia Blvd.
Compton, CA 90220
213-357-8383 ■

To enter a question or answer in the information exchange, please fill out the following form and mail it to Information Exchange, Electronic Servicing & Technology, P. O. Box 12901, Overland Park, KS 66212.

REQUEST/SOURCE FOR INFORMATION

Name _____

Street _____

City _____ State _____ Zip _____

Telephone number _____

Information requested/provided: _____

_____

Model/part number _____

Manufacturer _____

Where have you checked? _____

Assuring an uninterrupted power supply

By Jim Keefer

Desktop computers have become central to the functioning of many offices, and the reliable functioning of those computers depends on a clean, uninterrupted supply of electric power.

In many cases, an uninterruptible power supply (UPS) can be justified with simple arithmetic. If several hours of work are lost to a momentary brownout — which would crash the machine before the work could be saved to disk — then the organization has suffered an expensive setback in terms of time and disruption. But if a UPS had been in place, that brownout would not even have been noticed. As little as a few hundred dollars spent on power protection can buy complete, permanent protection *and* peace of mind.

The need for power protection goes beyond the single-user desktop. The increasing use of local area networks (LANs) makes offices even more susceptible to power problems because most files on such networks are centralized on one high-speed file server. A brownout affecting that file server could disrupt 50 or 60 users. Because such systems are usually too small to have an operating staff, any power protection devices that are installed must be extremely simple and straightforward to use, if not entirely automated.

Also, today's office telephone systems are increasingly computerized, making them increasingly vulnerable to power problems. And if computer downtime is painful, downtime on the phone system can be disastrous — with the upsurge in telemarketing, many organizations now conduct literally all of their business over the phone.

The threats

Brownouts, surges and outages are the principal electric problems to which a computer is exposed.

Keefer is president of Para Systems, an international manufacturer of power protection equipment, located in Carrollton, TX.

Brownouts are momentary slumps in the ac power supply to a level under 100V. Brownouts are normally caused by the use of heavy electrical machinery in the vicinity — as motors and compressors are turned on, they cause a momentary drain on the grid. Within an office setting, air conditioners and laser printers are often the culprit.

Brownouts too brief to noticeably affect the room lights can still affect a computer. Even if they do not crash the computer, brownouts can cause stresses that may shorten the life of its components. It is common for line monitors to detect as many as four potentially damaging brownouts a day, and line monitors will always find more problems than the users expected.

Power surges often follow brownouts, as the power rebounds back to normal levels. High-voltage conditions, as opposed to momentary surges, are especially prevalent overseas in developing countries.

Actual outages are not as common as might be expected, especially in large cities where the power cables are safely buried under the streets. Outages are more common in suburban and rural areas where the power lines are hung on poles exposed to lightning and stray cars. Exposure to weather is especially acute along the Gulf Coast, where the power grid is exposed to tropical storms.

Protection methods

The classic UPS is a constantly recharging battery that stands between the computer and the power grid. The computer actually runs off the battery and is shielded from any variation in the power supply. This method has long been common in mainframe and industrial installations.

In the desktop computer field, a common, less-expensive, low-maintenance alternative is the stand-by power supply (SPS). With an SPS, the computer runs off the power grid, as it does normally, and the battery draws a trickle of power to keep itself charged while it monitors the power line. If a problem is detected, it transfers the computer to battery power.

Although it is simpler and cheaper, an SPS has a critical performance factor called *transfer time* — the amount of time it takes the unit to detect a disturbance in the power coming off the public grid, and switch to battery power. A quality unit will switch to battery power regardless of whether the disturbance is a brownout, a surge or an outage.

The amount of transfer time that is adequate varies with the machine. Most computers have a "ride-through" of 10 to 20 milliseconds (ms), provided by the capacitance within their power circuitry. In other words, they would not even notice a power failure of shorter duration. Although a 4ms transfer time should be short enough for even the most sensitive machines, the best SPS units achieve a transfer time of 1ms or less. Best results are obtained by using electronic (as opposed to mechanical) power disturbance sensors within the SPS.

Rectangular vs. sine waves

The nature of the backup power supplied by an SPS or UPS is a subject of popular interest. The utility grid will supply ac power in the form of ever-curving, 60Hz sine waves. A low-cost SPS will generally simulate this wave with a rectangular or square wave. More expensive systems will produce a true sine wave.

Actually, a rectangular wave is fine for a computer because its internal power circuits, which convert ac into various levels of dc, draw current in a non-linear fashion. If a rectangular wave is supplied, however, it must be done correctly, by modifying the square wave through pulse-width modulation (PWM). Instead of merely switching between positive and negative voltages, with PWM the wave spends a discrete

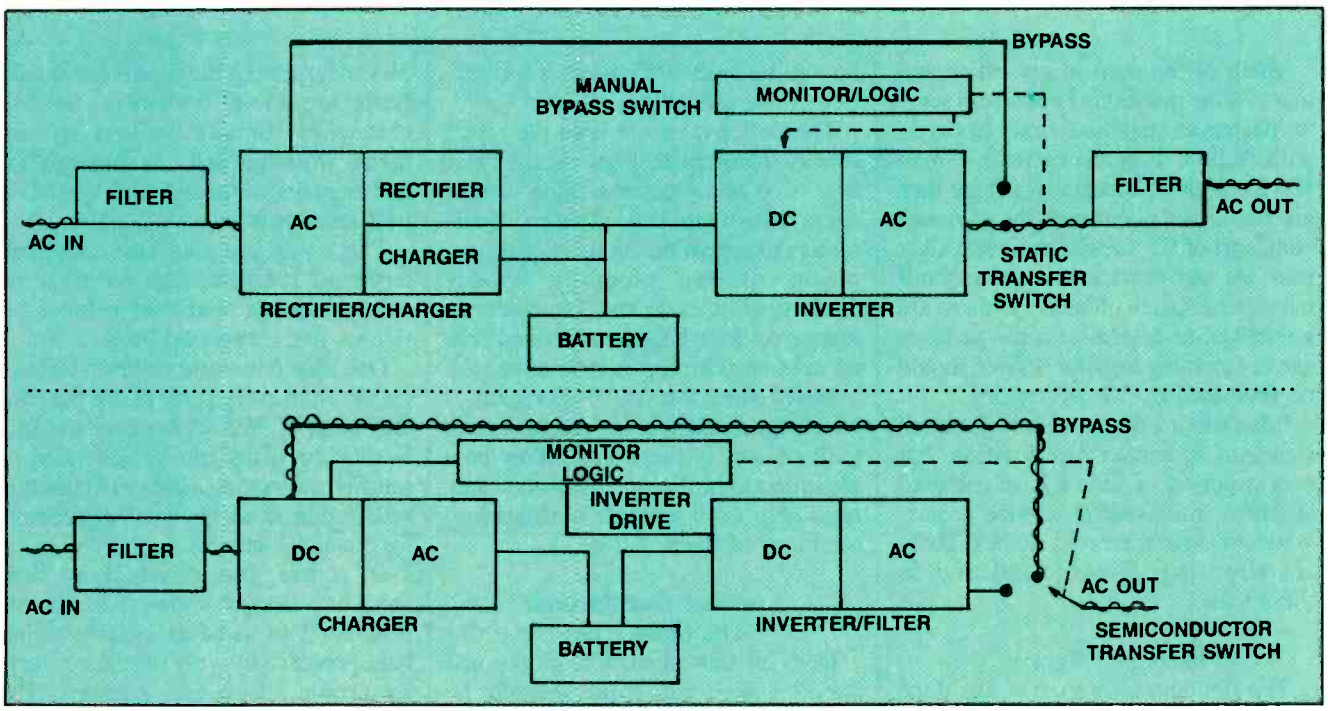


Figure 1. With the classic uninterruptible power supply (UPS), the computer actually runs off the battery and is shielded from any variation in the power supply. With a stand-by power supply (SPS), the computer runs off the power grid while the battery monitors the power line. If a problem is detected, it transfers the computer to battery power.

amount of time at the zero level while between the positive and negative states. This method better simulates the curve of a sine wave, where full voltage is achieved for the brief moments where the wave is at the top or bottom of the curve.

With PWM, as the power in the battery wanes, the amount of time spent at the zero level can be reduced, which ensures that enough voltage gets to the computer as long as enough power remains in the battery.

A quality SPS will also monitor the sine wave of the incoming ac power and will synchronize the sine wave or rectangular wave of its backup power to match it. The computer shouldn't notice the difference when backup power is switched in.

Meanwhile, power from the public grid is subject to electromagnetic interference (EMI) and radio frequency interference (RFI), either of which can cause problems with a computer's data integrity. Many UPS and SPS units will filter the incoming power to remove EMI and RFI.

Backup times

Few UPS or SPS units are intended to supply long-term power. Most vendors design their systems to supply backup power for about 10 minutes at full load (although many allow the addition of extra battery packs). This time limit is ample to bring the system down safely, ensuring that all data is saved. The grace period offered by the SPS also can be used to bring a backup diesel generator on-line.

But this grace period is of little benefit for an unattended unit or one with no operating staff. This is especially true for the file servers of LANs. Some vendors, therefore, supply a data connection between the SPS or UPS and the file server, alerting it to a power problem and triggering an orderly shutdown, performed automatically or by an operator. It is even possible for the SPS or UPS system to use modem connections to alert remote terminals of the impending shutdown.

Other possible options include readouts showing the current load the computer is drawing and the amount of battery life remaining. At the end of the backup period, automatic shut-offs are commonly used to prevent the battery from being drained to damagingly low levels.

Without power protection, a business is running the risk of losing hours worth of information input. With modern SPS and UPS technology, however, the company can buy its operators time to save documents — and a lot of valuable work time — before power is lost. ■

How effective is your advertising?

By William J. Lynott

Much of the mail in my office and many of the questions I hear from service dealers around the country has to do with Yellow Page advertising. Small service dealers, especially, tell me they are concerned about both the skyrocketing cost of YP ads and their effectiveness. At our service marketing seminars, participants often ask if there are guidelines to determine what percentage of incoming calls for service should be generated by YP advertising.

I don't know of any widely accepted standards to answer this question, but over a period of time I have gathered statistics from several service dealers who have done their own studies. There is a surprising degree of consistency in the results.

Facts and figures

The first study I ever saw was done by a small service dealer I met at a trade association meeting several years ago. His survey showed that only 12% of his incoming calls for service were the result of YP advertising. Repeat customers accounted for about 55% and referrals from customers or manufacturers accounted for another 23%. Together, repeat customers and referrals accounted for a whopping 78% of this service dealer's entire volume.

Those figures genuinely surprised me when I first saw them. Not any more. I have since seen several similar studies. They vary a bit, of course, but the results generally fall into a fairly narrow range.

What's it all mean?

There is an important message in these statistics that would be easy to overlook. With more than 75% of all business coming from satisfied customers and word-of-mouth referrals, the bottom-line value of customer satisfaction is dramatically confirmed.

The public does not hold the repair service industry in high regard these days. Too many disappointing experiences have caused huge numbers of customers to regard the industry with suspicion. Broken promises, shoddy workmanship, rude and inconsiderate employees have become the stated concerns of an alarming number of people.

Never mind that YOUR company is an exception, that it is seldom if ever guilty of any of these sins. Many people expect to be disappointed when they need help from a repair organization; too many of them will be.

Customer satisfaction: The bottom line

Does all this sound like gloom and doom? I hope not. It can actually be good news for the servicer who really is an exception. Service customers are hungry for the satisfaction they are paying for. When they get it, they reward the company by remaining loyal customers and by referring their friends and neighbors. All of this, I believe, is the underlying message in these studies.

If you decide to conduct your own survey of where your business is coming from (and I hope you do), there are pitfalls to keep in mind. Be wary if your figures vary substantially from the ones I've quoted. Remember, a service dealer who is doing a poor job of satisfying customers will have fewer repeats and referrals. When this happens, new customers generated through the Yellow Pages will represent a larger percentage of the total, all other things being equal. The servicer who is doing poorly on customer satisfaction may think his YP ads are more productive and effective than they really are — a dangerous and costly situation.

All statistical studies pose risks like that. When there are several variables, interpreting the results can be difficult. Are new YP customers a low percentage of the total because the ads aren't working well, or because the company has a strong foundation of repeat customers?

That's why you must take care in interpreting statistical data quoted in industry journals, and that includes the figures I've mentioned here.

One lesson, however, comes through clearly from every study of this type that I've seen: If 75% of the business in a healthy company can be generated by satisfied customers, a policy of customer satisfaction is an obvious requirement for financial success.

Of course, you already knew that. Everyone already knows that. Eternal dedication to satisfied customers has been preached at every meeting of service people I have ever attended. The problem is there are a lot more preachers on this issue than there is congregation. Satisfying customers in theory is easy. On the firing line, when money is at stake, the spirit often weakens along with the flesh.

In the real world, satisfying customers requires dedication and determination — and frequent biting of the tongue. To enjoy the bottom-line benefits, an up-front investment is often necessary. Too many service dealers I know are unable or unwilling to make that investment.

So, if you decide to study the effectiveness of your advertising, be sure to keep the influence of customer satisfaction in mind. It can and will have a significant effect on ratios and relative figures.

This doesn't mean that studies of this type are unreliable or unnecessary. Quite the contrary. Like all statistics, however, they must be examined carefully and viewed in context.

Next month we'll talk about how to jack up the effectiveness of those expensive YP ads. ■

Lynott is president of W.J. Lynott, Associates, a management consulting firm specializing in profitable service management and customer satisfaction research.

Troubleshooting Tips

Symptom: Picture pulsates when brightness increases
Set ID: Goldstar Model CMR 2030
Photofact: 2478-1

The raster on this Goldstar color TV would flash on and off any time the brightness in a scene increased. Decreasing the brightness would stabilize the raster but would result in a wide, black, vertical stripe on the right side of the screen. In my past experience with other brands of TVs, I have found that defects in the power supply frequently cause problems such as this.

My first thought was to check the 120V supply at test point TP81. I measured 102V, with a slight variation of plus or minus a volt or two.

Using the oscilloscope to test TP81, I found a very high ripple voltage. Desoldering pin 4 on IC801 had no effect, so I assumed IC801 was open. R803 was allowing enough unregulated voltage through to power up the set. Replacing IC801 restored the set to normal operation.

David M. Luckner
Corning, NY ■

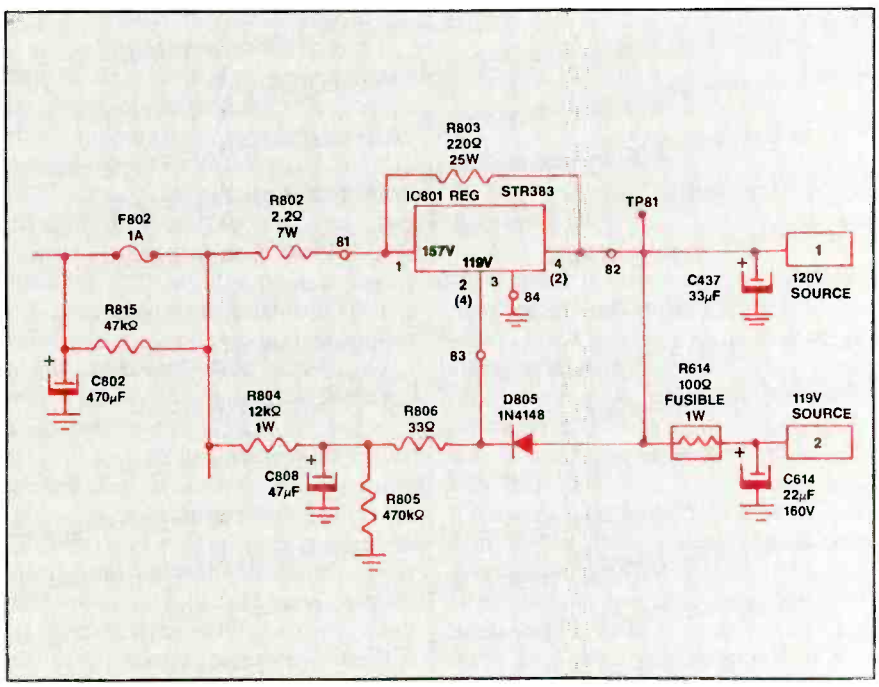
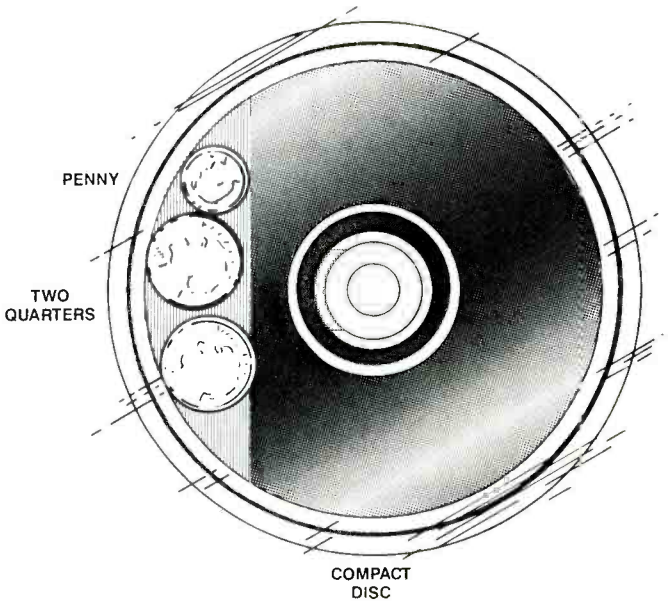


Figure 1. An open IC801 caused the raster on this Goldstar color TV to flash on and off any time the brightness in a scene increased.

A coarse test for CD malfunctions

By Paul Enlow



Did you ever have one of those days when things just don't seem to go right? The customer who just picked up that portable compact disc player brought it back and says it's not working right. You had checked it thoroughly and concluded that it was working fine. Now it seems to be all your fault that the skipping is still there.

You reluctantly agree to check it out again. You put the unit through its paces, using the best test disks available to you, and still you find nothing. The unit will even play disks that have been abused.

You try tapping the unit, but all you are able to conclude is if you tap it hard enough, it will skip. You then spend 30 minutes going through all of the recommended alignments. You convince yourself that you have taken care of the problem, but the ultimate test is yet to come. The customer is going to try the unit while jogging.

Depending on the customer's physical fitness regimen, it wouldn't be unusual for the unit to be returned yet again with the same problem, and unfortunately you will have to advise him to jog more softly.

Enlow, an electronics technician with 23 years of electronics servicing experience, has worked on CD players since their introduction. He was previously employed as a mechanical design engineer.

The right change

If this scenario seems familiar, or if it ever happens to you, you might want to try something that may seem crude, but might just work. Firmly attach some coins to the edge of a good (unscratched) disk as shown in Figure 1. The exact coinage is two quarters and one penny. This "51 cent disk" has enough weight at the edge to cause a fair amount of shaking when played in a portable CD player. The gyrations will be quite dramatic if you put the player on top of a piece of foam rubber about two inches thick. Once you have completed repair and adjustment of a portable CD player, if there are no lingering problems, it should be able to operate normally with this "calibrated paint shaker" inside. You may even be able to demonstrate to the owner that you have confirmed, with this vibration test, that the unit is OK.

This disk is not by any stretch of the imagination meant to be the ultimate test in any situation. It's a rough go/no-go test to give you an idea of whether you need to open up the unit for service. If the CD player doesn't skip with this disk in it, it is most likely playable under any reasonable amount of rough usage. If it skips when this disk is played, it may need adjustment.

What to do if the CD skips

If the CD skips when you play the weighted disk, it could be that something is wrong, and you probably should check it out. Start by disassembling the unit and then giving it a good, thorough, visual inspection to make sure everything is securely in position. If everything checks out OK during the visual inspection, the next step is to go through the recommended alignments.

There are three servos in the unit: a tracking servo to keep the optical pickup properly tracking the optically encoded digital music information on the disk; a focus servo to keep the laser beam that reads the information in focus; and a constant-linear-velocity (CLV) servo to vary the disc's rotation speed so that the linear velocity of the music information as it passes the optical pickup is always constant, regardless of whether the pickup is reading the inner tracks, where the rotational velocity of the disk is high, or the outer tracks, where the rotational velocity is relatively low. In other words, because the music on the disk begins near the center and ends near the outside edge, the CLV servo slows the disk as the playing progresses and the pickup moves from the center toward the edge, to keep the velocity of the disk beneath the pickup constant.

If a CD player is brought in with a complaint of skipping, and if it fails the 51 cent disk pass/fail test, check for such obvious mechanical problems as loose parts. If you don't find any, the place to begin is with an alignment of the tracking servo system. This is the most critical of the servo systems to the correct tracking of the music on the disk. If there's a tracking problem, such as skipping, this is the most likely cause.

If the tracking system has been ad-

justed and aligned according to the manufacturer's specifications, yet the problem persists, the next step is to adjust and align the other two servos.

If there is still no improvement in the skipping problem, replacement of the optical block may be indicated.

Checking a home unit is cheaper

CD players designed and built for use in the home are not designed for the rigors of being pounded by the running of avid joggers. Therefore, a disk with two quarters and a penny would probably cause any of them to skip, telling you exactly nothing. A somewhat less rigorous test for one of these units is to try playing a disk to which one quarter and one penny have been affixed. This will cause the player to shake, rattle and roll, but less vigorously. If a home CD player passes this test but the owner complains of skipping, you might check to see whether the player usually rests on top of a speaker and if the problem ordinarily occurs during passages with heavy percussion. If that's the case, the remedy may be simply to move it to a place where it will be subjected to less acoustic feedback.

A few other tests

Several other things you can do to a compact disc will provide a little challenge to the player's mechanisms. For example, placing a few layers of tape on the area of the disk that contacts the disc table will make the disc wobble as it plays, much the same as placing an object under an analog disc to see how well the tone arm tracks a record that is constantly moving up and down. This test of the CD makes both the tracking and focus servos work hard, constantly tracking the music tracks and keeping them in focus. Any CD player that can handle this test probably doesn't need any adjustment on those two systems. If it can't handle this test, it might need work.

Another challenge to the CD player's ability to operate properly is to place several layers of tape through the hole in the disc. The tape will cause it to operate eccentrically and possibly cause a malfunction. This is not a severe test, and most CD players pass it. If you experience one that does not pass this test, you probably should open it up and again lavish some attention on the tracking servo.

Let us know

These tests for CD playability are fairly new, although for a few technicians they have been a good test of whether a given CD player needs attention or is unintentionally being abused. Many of you no doubt have had similar ideas for quick and dirty tests of electronics products. The rest of us would appreciate being made aware of ideas similar to the ones presented here. By the same token, if any of the ideas in this column help you (or cause you problems), we'd be interested in hearing about it. Please send any ideas and comments to the editor of this magazine. ■

A servicing checklist

By Glenn R. Patsch

Several basic items are worth checking when you're servicing a personal computer (PC). It is easy to spend a lot of time tracking down a problem only to discover it was really something simple. Here's a list of things to check when you're faced with a computer that doesn't work, or doesn't work right.

Is the ac line cord plugged in?

It's not unusual to find that the line cord is not fully plugged into the PC or that the cord has pulled out of the wall. Also, check that the on/off switch on a multiple-outlet power strip is on and that the strip is plugged in. When you have on/off switches and power cords for a PC, printer, modem and video monitor, finding that one cord has become disconnected is not unusual.

Is the keyboard plugged in?

A 301 error message appears on the IBM PC monitor when it is turned on but the keyboard is unplugged. On many keyboards there is a connector at the keyboard end as well as where it connects to the computer. On the 1981 IBM PC, there are also two identical 5-pin DIN connectors. One is for a cassette tape; the other (closest to the ac power cable) is for the keyboard.

Are the boards plugged in tightly?

In the case of a portable computer, especially one that gets carried around a lot, the bus cards may work loose. Check this possibility before taking other diagnostic steps.

If the printer won't work (but it worked before).

- Check that the printer's ac line cord is plugged in and the printer is on.
- Check to see whether the printer cable is tightly plugged in at both ends.
- Make sure paper is in the printer. Most printers have an out-of-paper detector and will not print if there is no paper. Also, check for jammed paper. When you transport a printer, always put a single sheet of paper in it to avoid damage to the out-of-paper switch.
- Try another printer cable. The existing one may be defective.
- Check the ribbon. The ribbon may be hopelessly worn out or improperly installed. Adjust the form thickness or print density for best results. The ribbon installed may be the wrong ribbon for the printer. Check the printer manual for the correct ribbon number.

If the printer has never worked.

- Is it a serial or a parallel printer? Is it connected to the correct connector on the PC? A serial printer will not work if connected to a parallel port on the PC. The serial connector is a 9- or 25-pin male connector. The parallel connector is a 25-pin female connector. A parallel printer has a Centronics 36-pin connector. Some printers, such as the Hewlett-Packard Laser Jet, have both serial and parallel connectors. The control panel on the printer selects which one to use (parallel is the default).
- Is the cable the correct one, and is it good? Use a known-good cable to check the printer. Although most printers use a standard parallel or serial cable, some require custom cables. Check the printer manual.
- Serial printers usually require that the DOS MODE command be used to set up the parameters for the serial port. A typical set of MODE commands might be:

```
MODE COM1:9600,N8,1,P
MODE LPT1:=COM1
```

The first mode command sets the COM1 (first serial port) to 9,600 baud, no parity, eight databits, one stop bit. The P continuously retries time-out errors (printer off or not ready). The choices will vary with different printers. Consult the DOS manual for details on using the MODE command.

The second mode command allows application software (spreadsheets and word processors, for example) to use the usual first parallel printer LPT1. DOS redirects the output from LPT1 to COM1. This allows a serial printer to be treated as if it were a parallel printer.

The MODE commands must be typed in each time the PC is turned on, or it can be entered in the AUTOEXEC.BAT batch file.

Printer does not work — above checks did not help.

In this case, it's necessary to try to isolate the difficulty.

- Does the printer operate by itself? Turn off the printer power switch, unplug the cable from the printer and use the printer self-test (consult the printer manufacturer's instruction manual). To use the self-test feature on IBM Proprinters, press the Propark key and hold it down while you turn on the power switch. When printing starts, release the key. Turn off power to end the self-test. Most printers have a similar self-test feature.
- Is the computer correctly sending data to the printer? Enter the DOS command DIR to list the files in the current directory. The directory will be displayed on the screen. To print the same list on the printer, enter DIR LPT1. If the directory prints out the same thing you saw on the screen, the computer is properly sending data to the printer and the problem is most likely with the specific applications program. If your printer is connected to a different port, use LPT2 or LPT3. Sometimes a cable will be plugged into the incorrect port. Try DIR with LPT1, LPT2 or LPT3 to identify which printer is connected (if more than one is connected) to which port. Put a press-on label on the back of the computer to identify the connectors. If it is a serial connector, use the MODE commands to set it up properly, then do the test with DIR.
- Check for an internal modem. If one is present, it will be using one of the serial ports. Internal modems are usually set to use COM1 by default. The PC supports up to four serial ports: COM1, COM2, COM3 and COM4. The internal modem and the serial card plugged into the computer cannot both use the serial port. One of them must be changed.

The video screen is blank.

This problem indicates an absence of power to the monitor. Check to see

Patsch is a consultant specializing in the selection, evaluation and installation of IBM personal computer and compatible hardware and software.

whether the power switch is on and the power cable is plugged in. Many monitors also have an internal fuse. Check to see whether the one you're working on has one, and whether it's blown. If the screen is white, the problem most likely is that the monitor is on but the video cable is not connected. It is also possible to set the colors on a monitor so that the characters and screen are the same color, making the screen appear blank. You can check this possibility by booting the computer with a DOS disk in the a: drive that has no CONFIG.SYS or AUTOEXEC.BAT file and check the screen. There are many ways to set the screen colors, but they usually use the ANSI escape sequences. Rename the original AUTOEXEC.BAT file to AUTOEXEC.SAV until you can find the command that sets the colors.

The system can no longer use an application program that worked before.

This situation often occurs after a new application or an upgrade to an existing program is installed. Often what has happened is the AUTOEXEC.BAT and/or the CONFIG.SYS files have been altered or erased. The installation process of the new program can alter these files. The INSTALL software sometimes also changes the DOS PROMPT and PATH commands. PROMPT controls what is displayed at the DOS prompt. Enter PROMPT pg as a DOS command to set a prompt that shows the current directory and a > as a prompt. PATH specifies the directories to search for commands that are not in the current directory. To protect against this type of problem, copy the AUTOEXEC.BAT file to a new name, such as AUTOEXEC.SAV, and make a copy of the CONFIG.SYS file under a new name, such as CONFIG.SAV. You have to do this *before* the problem occurs. Sometimes you will find AUTOEXEC.BAK and CONFIG.BAK files, which are older versions of the files before the current changes were made. Use the .BAK files to reconstruct the .BAT files. Enter the DOS command SET to see the current path and prompt.

The computer doesn't boot up properly.

Check for a floppy disk in the a: drive. The computer will check for a disk in the a: drive and try to boot from this disk instead of the c: drive. Remove the floppy disk. This problem used to occur more often with copy-protected software that required the user to insert the key disk in the a: drive.

On a new PC, DOS may not have been installed on the hard disk, or the new hard disk may not have been formatted with the DOS FORMAT command. It's also possible that the hard disk might have been accidentally reformatted, erasing all the files on the hard disk.

Check to see that the file COMMAND.COM (in the root directory) has not accidentally been erased. Use the DOS ATTRIB command to change the file attribute to read-only to prevent the file from being erased. Enter ATTRIB +R COMMAND.COM.

On a PC with only floppy disk drives (no hard disk), the boot disk may be missing from the a: drive, or the disk drive lever may not have been pressed down. This boot disk must have DOS on it and must be in the a: drive when the PC is turned on.

If the problem persists, use the diagnostics disk to boot up the PC and run diagnostics to locate the problem.

A card newly installed in the PC bus doesn't work or is causing problems with existing cards.

There are a number of possible causes for this problem:

- The card may not be fully inserted into the bus.
- DIP switches on the card may not be properly set.
- The new card may conflict with an existing card or device. If this is the case, try removing the new card. If everything is restored to normal operation, check the new card's manual to resolve conflicts.
- There may be port conflict. If you install an internal modem and a serial port already exists, this will cause a conflict as both try to use COM1, the first serial port. Switch the modem to COM2, or change the existing serial port.
- The power supply may not be adequate to power all the existing circuitry and the new card as well. Check voltage levels.
- The ribbon cables interconnecting the cards may have been disturbed. Check all connections. ■

VCR test tapes

By Stephen J. Miller

In the April 1989 Video Corner, I detailed the two test shells I use to service VCRs. This month, I would like to take a look at the various videotapes necessary to repair VCRs. ***(Editor's note:*** *We had promised this Video Corner for the May issue. Our apologies for any inconvenience.)*

Alignment tapes, of course, top the list. These tapes, when used properly, will ensure that the VCRs you repair will play both their own tapes and those made on other machines. Unfortunately, alignment tapes are often used improperly, leaving the customer with an inaccurately aligned, poorly performing VCR.

Alignment tapes

I use three alignment tapes (two recorded in SP and one recorded in EP) to test and align VCRs. Two test tapes are necessary to properly troubleshoot and repair machines with four or more heads. Many technicians improperly use dubbed copies of a standard alignment tape as their test tape. I maintain that this practice is no better than doing your VCR alignment with a copy of the "Three Stooges"!

To understand my point, think of what qualities make an alignment tape a true standard. Is it the purity and accuracy of the test patterns and tones recorded on the tape? No, it is the uniformity and accurate placement of the signal tracks recorded on the tape that make test tapes special. Figure 1 shows the various tracks recorded in the SP mode of a typical VHS VCR. If a particular VCR is in standard alignment, each of its heads will accurately follow the tracks shown in the figure. Now, when we copy an alignment tape, are we really transferring the accurate track placement or just the audio and video? Of course, the answer is the latter. Therefore, you can see that an improperly dubbed alignment tape copy is no more a standard test tape than any other tape.

Because of the high cost of alignment tapes, we don't want to subject them to constant use. Yet as we have seen, alignment tape copies are really not a reliable standard. One answer to this dilemma is to produce your own:

1. Select a quality, high-end VCR that you have completed repairs on. Then insert your alignment tape.
2. Verify that the FM envelope is perfectly uniform, with no nulls even when the tracking control is rotated to either extreme. (Adjust the guide rollers to the correct position.)
3. Verify that the maximum FM envelope occurs at the center tracking position. (Adjust the conical nut on the audio/control head stack to the correct position.)
4. Verify proper audio/control headstack height by scoping the audio output line(s) while rocking the height adjust nut back and forth. (The height nut should be set for maximum peak-to-peak audio output.)
5. Verify that proper back tension exists. (Adjust or replace the tension band to the correct position.)
6. Verify both the head-switching point and the tracking preset adjustment as per the VCR's service manual.

Having adjusted this machine to be in agreement with a true standard alignment tape, you can now use it to record your own test tape. This test tape could be a copy of the alignment tape or video patterns of your choosing. I prefer to pick my own patterns and, by using a hi-fi VCR, I have a hi-fi audio test track recorded along with my video test patterns. If you choose to copy your alignment tape, remember that the VCR whose alignment you just verified must be the one used to record the copy, not to play back the original.

Select a 2- or 3-head machine to record version one of your SP test tape. Use a late-model, 4-head VCR to record your EP alignment tape and version two of your SP alignment tape. Figure 2 shows why. Many 4-head machines use SP heads that are so wide they eliminate one of the guard bands and reduce the other to a mere 8 microns. The widening of the SP heads allows these units to produce quality special effects in the SP mode. Machines with normal-width heads have no problems following these wide SP tracks. However, for

Miller is a senior bench technician for a Lancaster, PA, repair company.

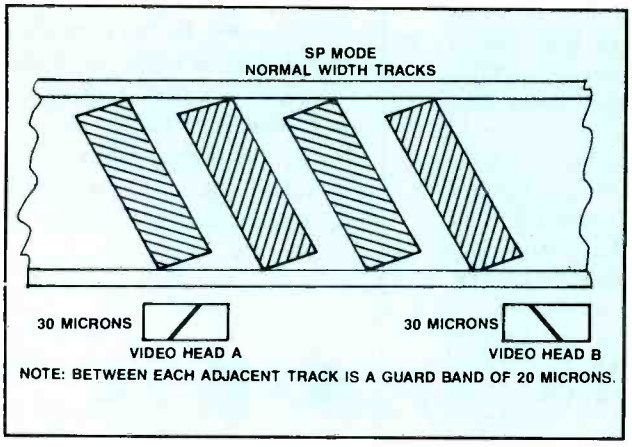


Figure 1. If a VCR is in standard alignment, each of its heads will accurately follow the tracks shown here, recorded in the SP mode of a typical VHS VCR.

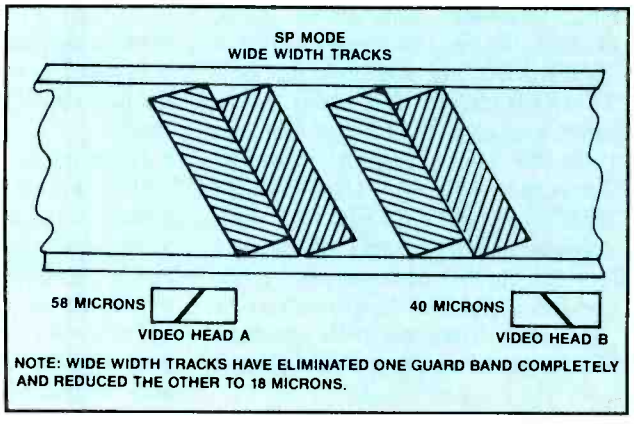


Figure 2. Many 4-head machines use SP heads that are so wide they eliminate one of the guard bands and reduce the other to a mere 8 microns. The widening of the SP heads allows these units to produce quality special effects in the SP mode.

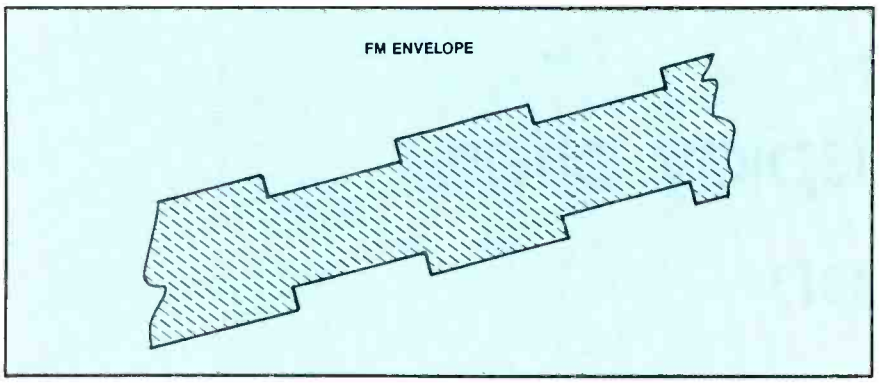


Figure 3. When a normal-width tape is played on many wide-width machines, the FM envelope might cause a technician to conclude that the VCR has one worn SP head or that a problem exists in the head amp circuitry.

alignment purposes, these wide tracks make envelope alignment imprecise. Because of the wide tracks, several guide-roller settings will appear to produce an adequate envelope. Therefore, use the version one SP tape to perform alignments on VCRs with normal head width (2-, 3- and some 4-head machines).

When doing the alignment on late-model, 4-head machines with the wide SP head width, use the version two SP tape. Figure 3 shows the FM envelope of the version one (normal-width) tape when played on many wide-width machines. Even though the playback picture is fine, many technicians looking at this envelope would conclude that the VCR has one worn SP head or that a problem exists in the head amp circuitry. However, this unequal envelope is actually caused by the wide heads playing back normal width tracks. If you encounter this type of envelope, try the other version SP test tape before troubleshooting further.

Double-check your alignment-tape copies by inserting the original alignment tape into the first four or five machines you align with the copy. Once you have verified on several machines that both the original and the copy produce the same alignment settings, this double check can be omitted.

The sacrificial tape

The sacrificial tape is another tape I use constantly. This tape is used to do the coarse or preliminary transport alignment, such as setting approximate guide-roller height and checking for tape creasing. Also, because cleaning solves many VCR problems, I usually give each VCR a thorough cleaning as a first troubleshooting step. Next, I install an empty shell (see the May Video Corner) to spin-dry the heads. Finally, I insert the sacrificial tape to check the VCR's operation. If the machine eats this tape, I haven't lost much.

The checkout tape

One last tape rounds out my collection. The checkout tape is used to verify both the play and record modes of every VCR that crosses my bench. Before being returned to the customer, each VCR is required to play back both its own recordings and those made by several other machines. In this way, I can be assured that the VCR is capable of playing back recordings made by a variety of machines, a sort of real-life interchangeability test. After all, none of my customers are interested in watching alignment tapes. However, they are interested in watching Aunt Edna's recording of "Gone With the Wind." Therefore, testing a machine's ability to play back recordings made by a variety of other VCRs is very important. After replacing video heads or doing other tape-transport work, I always play back several sections of the checkout tape to ensure that there are no interchangeability problems.

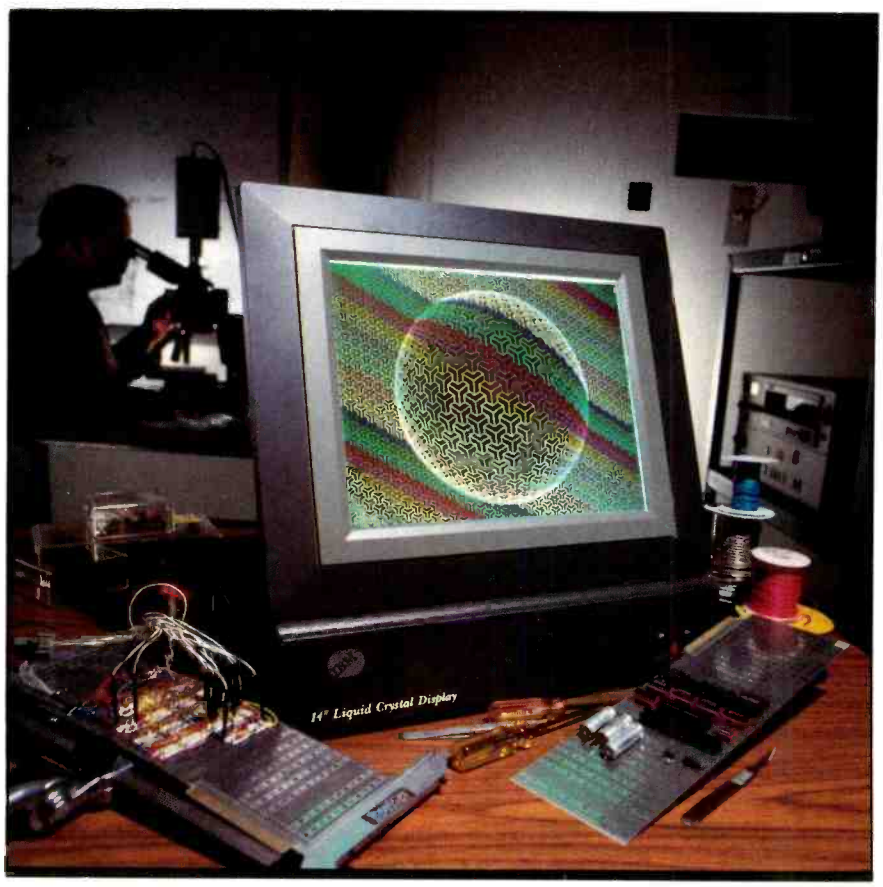
For those of you unfamiliar with the term *interchangeability*, it refers to a VCR's ability to play or interchange tapes with other units. Don't tell your customers you verified that their VCRs can play tapes recorded on other machines. Instead, tell them you performed a "tape interchangeability test" on their machines. Both phrases mean the same thing, but the latter sounds much more impressive. After all, salesmanship is a part of servicing! ■

Flat-panel display offers high resolution

IBM engineers and scientists are working on a prototype color, flat-panel computer display that is larger and clearer than any demonstrated so far.

With a screen density of more than 1.5 million color dots, the experimental 14-inch diagonal IBM panel has greater resolution than most current color computer displays, according to IBM. Images can change on the screen fast enough for animation, and the backlit screen is readable even in strong light.

At its present state of development, the 1.5-inch thick panel can display up to 16 colors. Images have high contrast (a contrast ratio between high and low of better than 20:1), and the screen remains visible and legible even from acute angles. This is an important consideration for laptop/portable and future computer applications where users may write on desktop panels rather than using a keyboard or mouse.



A 14-inch diagonal, 16-color flat-panel display being developed by IBM uses thin-film transistor technology to achieve a screen density of more than 1.5 million dots. The 1.5-inch thick panel displays 16 colors that can be viewed from acute angles and can change fast enough for animation.

The panel blends the semiconductor technology used to make million-bit computer chips with liquid crystal techniques to make a colorful and responsive display, until now only seen on the screens of high-quality, pocket-sized portable TVs.

Based on a 2-year joint program between Toshiba, IBM Yamoto Laboratory in Japan and the IBM Research Division in New York, the new display incorporates thin-film transistor (TFT) technology. The screen is actually an array of more than 1.5 million transistors that control the same number of individual color dots.

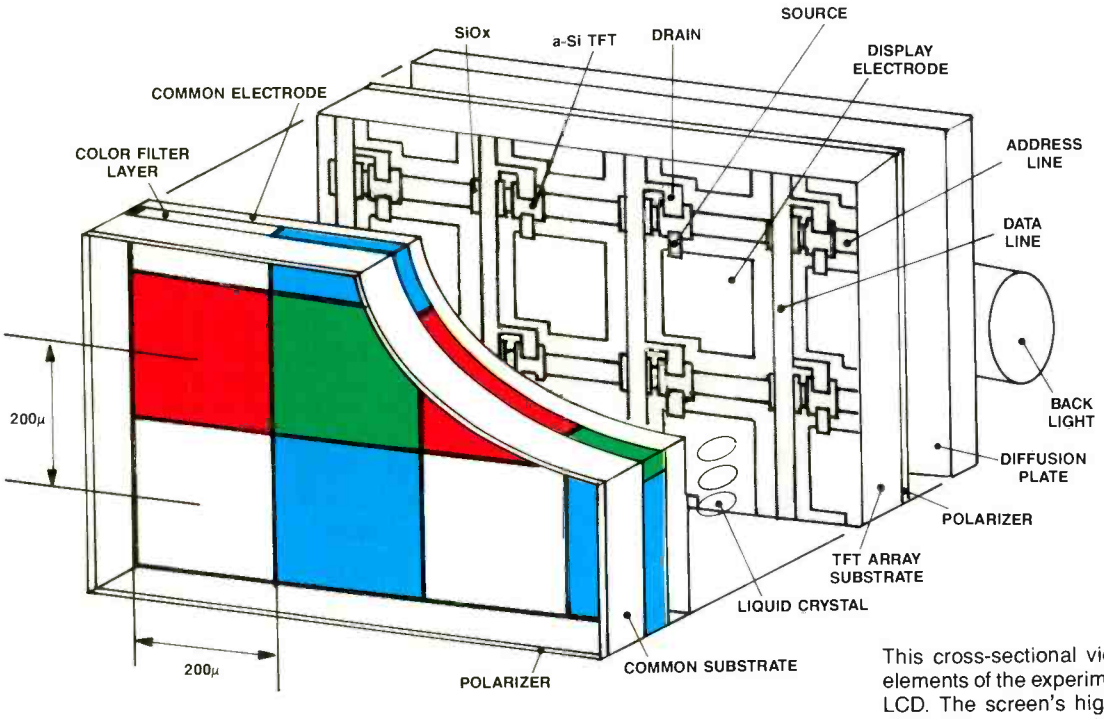
Just as a fine-grained photographic film delivers a superior snapshot, such high color-dot density contributes to the panel's high resolution and clarity.

Creating color

Each picture element (pixel) is made from four translucent dots: red, green, blue and white. Individual dots span only 200 microns (about two human hair widths). The transistor assigned to each dot turns the color on or off by electronically orienting liquid crystal molecules so they either block or transmit light shining through the pixel from behind the panel.

The result is that the pixel appears as one of 16 colors, depending on which combination of primary colors is expressed or repressed. The display is arranged as a matrix of these color pixels, 720 wide by 550 high. Each pixel is rewritten 60 times per second so the panel can track cursor motion and even display moving images.

IBM engineers and scientists are working to improve the screen's gray-scale rendition (to give it a full gamut of colors and tones) and to lower the fabrication cost.



This cross-sectional view shows the basic elements of the experimental high-resolution LCD. The screen's high brightness comes from a fluorescent back light behind the rear panel. ■

Symcure guidelines

ES&T is now paying $60 per page for accepted Symcure submissions.

The term *Symcure* is a contraction of two words: symptom/cure. Problems that are published in the Symcure department are those that have occurred more than once. This is the kind of problem you can solve without even a second thought because you've already seen so many of that particular brand and model of set with those symptoms. In almost every case, it will be the same component that fails or the same solder joint that opens. Submissions must follow these rules:

- Each submission must consist of *seven* individual symptom/cure units on a single brand of TV set.
- If there is no Sams Photofact on the unit, we cannot accept the submission.

Troubleshooting Tips guidelines

ES&T is also paying $25 per item for accepted Troubleshooting Tips.

A Troubleshooting Tip describes a procedure used to diagnose, isolate and correct an actual instance of a specific problem in a specific piece of equipment. Its value, however, lies in the general methods described.

A good Troubleshooting Tip has the following elements:

- It should be a relatively uncommon problem.
- The diagnosis and repair should present something of a challenge to a competent technician.
- It should include a detailed, step-by-step description of why you suspected the cause of the problem and how you confirmed your suspicions—anything that caused you to follow a false trail also should be included.
- It should describe how the repair was performed and any precautions about the possibility of damage to the set or injury to the servicer.

For Symcures and Troubleshooting Tips, please also include:

- the manufacturers name;
- the model and chassis number;
- the Sams Photofact number;
- a sketch of the schematic area where the fault was found. (Include a major component such as a transformer or transistor to provide a landmark.)

Literature

ESD prevention catalog

H&S Industries has published a 16-page catalog featuring the company's line of products for use in the electronics industry to prevent electrostatic discharge (ESD) damage. The catalog shows products from wrist grounding devices to flooring systems and test equipment. Highlights of the catalog include the company's wrist and ground cords, finger cots and gloves, ESD chairs, conductive clipboards, labels and posters and parts cups and bins.

Circle (140) on Reply Card

Audio/video catalog

Philips ECG is offering its updated Mechanical Parts Catalog and Cross Reference Guide, which contains more than 400 additional, cross-referenced listings. The catalog covers two new belt kits and nine idler wheels and assemblies for videocassette recorders. The product line also consists of audio and VCR test cassettes, a VCR tape repair kit, VCR opto sensing devices and VCR replacement heads.

Circle (141) on Reply Card

Kit guide

Heath is offering its Spring 1989 catalog, which features the company's picture-in-picture TV kit, a radio-controlled sailboat from Kyosho, Kyosho radio-controlled airplanes, and a selection of fish-finding and navigational equipment from Interphase.

Circle (142) on Reply Card

Microcomputer data acquisition glossary

A 25-page glossary of microcomputer data acquisition terms is being offered by *MetraByte Corporation*. The glossary contains nearly 300 terms and definitions that encompass data conversion, signal conditioning and microcomputer systems and software.

Circle (143) on Reply Card

Tool supplement

The 1989 supplement to the *Contact East* General Catalog is available, offering hundreds of products for testing, repairing and assembling electronic equipment. The 48-page "Tools of the Trade" catalog introduces new products such as analog/digital oscilloscopes, static protection products, soldering supplies and stations, test equipment and hand tools. All products are described with specifications, photos, prices and a guarantee.

Circle (144) on Reply Card

Surface-mount products catalog

Pace has introduced a catalog describing its new surface-mount products, including the CRAFT workstations, the HS-150 HotSpot auxiliary/preheating system and the SMR static-dissipative products. Another section in the catalog describes Pace's new surface-mount rework and repair training. This hands-on training course, taught by a Pace-certified instructor, covers all aspects of the SMT rework and repair process.

Circle (145) on Reply Card

Buying guide

The 1,100 pages of the *Newark* catalog provide complete dimensions, specifications and descriptions of more than 100,000 products from more than 240 manufacturers, including 7,900 new products and 13 new product lines.

Circle (146) on Reply Card

Cable care information

W.L. Gore is offering a guide to cable and connector use and maintenance that contains a VSWR/return loss conversion table and frequency band conversions. The guide is contained on a 2-sided, heavy-gauge, laminated plastic card. The information on the card includes common problems and solutions experienced in cable usage.

Circle (147) on Reply Card

ESD installation manual

A 4-page installation manual covering electrostatic discharge (ESD) control has been prepared by *Stanley-Vidmar*. It provides instructions for keeping technicians and equipment static-safe through effective grounding procedures that eliminate static charges and subsequent ESD damage to electronic equipment. The manual provides general installation instructions for workstations with and without electrical outlets, including the proper application of ground fault circuit interrupter devices.

Circle (148) on Reply Card

Crimping tool catalog

The *Rostra Tool Company* has released its Sargent crimping tool catalog. The new line of crimping tools is designed to prevent fatigue when the

tools are used. Featured in the catalog is the Pro Crimp series, plus special custom application tools, crimping system tool kits, and a full range of power crimping and industrial hand tools.

Circle (149) on Reply Card

Electronic tools catalog

A catalog of electronic assembly tools and accessories has been introduced by *Assembly Systems Group*. The 32-page catalog shows the company's line of controlled torque electronic screwdrivers and accessories for assembly and service. High-speed drivers and push-to-start tools are part of a line that includes tools for robotic applications, vacuum pickups and accessories, transformers and controls, torque testers, clean room assembly tools and special in-line tool attachments.

Circle (150) on Reply Card

Test instrument catalog

B&K-Precision has released the BK-89 Instrument Catalog covering the company's line of test instruments. The products are suited for applications in engineering, research and development, production line testing, field service and education. The catalog contains performance and mechanical specifications, along with photos of each product.

Circle (151) on Reply Card

Test instrument catalog

Three digital multimeters, two assembled oscilloscopes and a clamp meter and insulation tester are all featured in the *Heath Company's* Fall 1989 Heathkit catalog. The catalog features two multimeters, the models SM-2372 and SM-2311; the SM-2360, a benchtop DMM; the SO-4552 and SO-4554 oscilloscopes; and the model SM-2374 clamp-on meter.

Circle (152) on Reply Card

Tools and accessories catalog

Paladin's 152-page catalog, "Tools and Accessories," details the company's products. The catalog sections are assigned to each of the following applications: electronic production, electrical/industrial, telecommunications, cable preparation, screwdrivers and connectors. A new product section and a technical support section also have been added.

Circle (153) on Reply Card ■

Readers' Exchange

NOTICE: READERS' EXCHANGE SUBMISSIONS WILL BE CHARGED A SMALL FEE AS OF THE OCTOBER ISSUE.

This is the last month Readers' Exchange items will run free in this department. As of next month, Readers' Exchange items will cost 50 cents per word, per insertion, and must be accompanied by check or money order to ensure publication. Each initial or abbreviation counts as a full word.

WANTED

Service manuals for Garrard model 42M record changer and Pioneer model SX424 receiver. *M. Seligsohn, 1455 55th St., Brooklyn, NY 11219.*

NRI model 832 digital computer used in the digital electronics course. *Nick DeChristofano, Red Star TV, 6144 W. Belmont, Chicago, IL 60634; 312-736-3255.*

Sencore PR-57 Powerite AC power supply; Panasonic PV-6000 portable VCR or similar. *Ed Herbert, 410 N. Third St., Minersville, PA 17954; 717-544-3191.*

Zenith portable radios from the '50s, '60s and early '70s (single or multi-band), need not be in working order. *J. Philpot, 632 E. 160th Court, South Holland, IL 60473; 312-596-0580.*

Supreme service manuals for radio and TV, all volumes wanted. Please send price and condition. *McPherson Electronics, 107 S. Hennepin Ave., Dixon, IL 61021.*

Service manual for Panasonic model NV-8410 VCR. Will purchase. *Robert Forrester, Colonial Heights Radio & TV, 4200 Fort Henry Drive, Kingsport, TN 37663; 615-239-6221.*

Sam's sets 62, 69, 638; tuning eye EM-37/6CD7; last produced roll chart/roll chart book for Jackson 658A tube tester; clock crystal for 1966 Zenith X179G clock radio. *Jay De Lasse, 17 Seldin Ave., Richmond, NY 10314; 718-981-1218 or 718-761-6559.*

Mallory Radio Service Encyclopedia, 6th or later edition; auto radio vibrators and data; a vibrator tester. *Donald Harris, 3332 N. 57th Ave. Phoenix, AZ 85031; 602-247-7020.*

Anyone who has built and tested and has a working instrument of the November 1985 telephone tester that was in ES&T. *Murray Goldstein, 8842 Grange Hill Road, Sauquoit, NY 13456; 315-737-7192.*

H.H. Scott 310E tuner and 121 mono pre-amp; Wharfdale W70 midrange (8-inch); manual for Heath TS-4A generator. *Victor Staggs, 1361 Grand Ave. #9, San Diego, CA 92109; 619-272-1875.*

Service manual or schematic for RCA WO-505A solid-state oscilloscope. Will purchase or copy and return. *Phil Milner, 5072½ Cape May Ave., San Diego, CA 92107; 619-222-0953.*

Front loading assembly for Sony SL2500 VCR or Zenith VR9775 VCR. *Joe Sanfilippo, Northern Technical Services, Box 347, Woodruff, WI 54568; 715-356-6004.*

Starting new shop. Need add. of parts suppliers for flybacks, replacement knob kits, Walkman phone jacks and prefab headphone cables. *J. Kelling 204335, Riverfront State Prison, P.O. Box 9104, C-1, Camden, NJ 08101.*

Sparton "Nocturne," a 1936 floor model radio make with a 46-inch diameter blue or peach colored mirror in a chrome cradle. Will pay up to $3,000 for one in good condition or will pay $250 finder's fee. Also want a Zenith "Stratosphere," a 1936 model radio with three speakers and 25 tubes on two chromed chassis, has large, round, black dial behind sliding wood doors. Will pay $2,000 for one in good condition or will pay $200 finder's fee. *Doug Heimstead, 1349 Hillcrest Drive, Fridley, MN 55432; 612-571-1387.*

Regulator transformer (T402), part no. 62-25401 for Westinghouse model 26TKC51 TV; RCA equivalent spare part list. *C. Ferreira, 400 Waterloo Ave., Apt. 407, Guelph, ONT N1H 7J9, Canada; 519-763-7422.*

Third IF transformer (no. 116544) for RCA CTC-24A and CTC-27. *R.N. Baughman, 572 Strumbly Drive, Highland Heights, OH 44143; 216-461-6541.*

Schematic diagram and service literature for a Datsun-Hitachi automobile radio, model number A-1551. Will buy or copy and return. *Steve's Radio Service, P.O. Box 168, Wickes, AR 71973.*

Power transformer for a Telefunken radio "Gavotte" 5253 WK. Part no. BV41.5113.050-22. *Frank Nelson, CET, 2033 N.E. 52nd Ave., Portland, OR 97213; 503-287-6349.*

Control panel door for Zenith porthole TV (see Sams 98-17); last produced roll chart, roll book, for Jackson tube tester #658A; clock crystal for 1966 Zenith clock radio #X179G. *Jay DeLasse, 17 Seldin Ave., Richmond, NY 10314; 718-981-1218/761-6559.*

Looking for the book titled "Troubleshooting and Repairing Electronic Test Equipment," second edition, by Mannie Horowitz; also looking for used test equipment, non-working, as-is. *Greg Hingle, Rt. 2, Box 584, Port Sulphur, LA 70083; 504-564-2517.*

Schematic or photocopy for Sherwood S-9180 CP stereo receiver. Will buy copy or return. *S.U. Babbert, 5736 Bromley Ave., Worthington, OH 43085.*

Used NTSC color generator and microwave oven leakage tester. *Marion Organ Service, P.O. Box 92, Marion, MI 49665.*

Any flying spot test equipment such as B&K 1000, 1076, others; TEK 146 NTSC signal generator; Teletex decoder for TV. All reasonable. *D. Test, P.O. Box 9064, Newark, NJ 07104.*

National clock modules with 24-hour display format, need six in sets of two of any type (types MA 1002-C, 1010-C, 1012-C or 1013-C). *John Zuba, 23 Patton St., High Bridge, NJ 08829; 201-638-8370.*

Knight KG-688 audio generator; Knight KG-686 RF generator; instruction manual w/schematic for Knight KG-687 sweep generator. *Charles T. Huth, 229 Melmore St., Tiffin, OH 44883; 419-448-0007.*

A set of Sams Photofacts; also interested in parts inventory for VCR and TV repair shop. *Carrier, 760 Roanoke St., Christiansburg, VA 24073; 703-382-1040.*

Power transformer, Hallicrafters part no. 52A209 or Stancor PM8410. *RAM TV Service, San Vicente 4E, Mayaguez, Puerto Rico 00708.*

Copy of operators manual for (old) Wintronix model 820 dynamic sweep circuit analyzer, made by Winston Electronics of Philadelphia, PA. *Bob Collins, 4425 E. Sixth Ave., Anchorage, AL 99508; 907-333-9333.*

B&K 520B transistor checker, function or sweep generator; schematic for Sony ITA600-650 telephone recorder; information on digital transmitter garage door opener. *Mary Frances, Suite 100, 2542 Pioneer Parkway, Arlington, TX 76013.*

Diagram and/or service information for a Knight KG-600B tube tester. Will buy or copy and return. *David Thomas, Rt. 29, Pinehurst Lane, Knoxville, TN 37920; 615-577-8491.*

Schematic for Paco model G-30 signal generator; on/off switch for Precision model 920 tube tester. *Ralph Dorough, 117 Pecan St., Terrell, TX 75160; 214-563-7105.*

Digital readout MAN 8910 red high eff. CA; tube test data for Eico 666 tube tester (recurring) and the Eico 633 CRT tester. *Clarence England, RI Box 684, Rose Hill, VA 24281.*

Information, schematic, owner's manual or service manual on any of the following: HP model 400L VTVM, Cimron model 7630 DMM, Onion model V100M VTVM, HP model 412A dc VTVM, Bogen model MBT60 audio amp, HP model 2402A integrating DVM, Radio Spec. Mfg. model 1163-60-3 FM deviation meter. Will pay for copies or copy and return. *Donald H. Nash, 1444 Pulaski St., Port Charlotte, FL 33952.*

RF voltmeter, analog type. *Jerry's Radio Service, 409 S. Oklahoma St., Shamrock, TX 79079; 806-256-3405.*

Heathkits analog circuit design and TTL/CMOS course, any condition. *Ron Grega, 107 Ridgeview Drive, Dunmore, PA 18512; 717-347-6842.*

NRI microcomputer servicing and repair course with or without the Packard Bell computer. Very reasonably priced. *J. Wegner Jr., P.O. Box 262, Glendale, CA 91209.*

Apple III user's manual and service manual, will pay for copy if in readable condition; user's manual for Apple model A3M0004 disk drive and Apple model A9M0303 printer. *Aztec TV, 1339 Labrosse, Detroit, MI 48226, c/o R. Gomez.*

Sams TV Photofacts, #2411 through #2591. Will pay a reasonable price. *Jennings Hanson, 735 Clematis Road, Venice, FL 34293; 813-493-4159 or 813-497-0108.*

Commercial numbers of the following semiconductors used in a Wurlizer Electronic, model 200A: 142083-3, 142083-2, 142083-1, 137159-1, 203719, 203718, 507661-1, 507664-1, 142349. *Arthur Vickery, P.O. Box 742, Torrington, CT 06790.*

FOR SALE

6L6GA, asking $12. *C.M. Kelly, 3336 Chatham, Waukegan, IL 60087; 312-623-2597.*

Hickok 292X crystal-controlled microvolt generator, $75; B&K model 290 VTVM or RCA senior VTVM, $100; Measurements model 920 modulation dev. meter, solid state, ac/dc, $300. All negotiable. *Joseph Silver, 1883 E. Main St., Rochester, NY 14609; 716-288-1520 days, 716-654-8370 evenings.*

Commodore computer repair shop, selling entire repair business. Diagnostic cartridges/programs, service manuals, computer facts, repair manuals, chips, dual-trace scope, frequency counter, more, $1,800. *Bryan Ruppert, 318 Upperlanding Road, Balio, MD 21221; 301-682-6086, no collect calls.*

Oscilloscope, Tektronix C-12 instant camera w/hood; microfiche reader, Realist Co., 13"×9" screen for table-top, like new, $90 delivered within 50 miles; pocket tube tester, $7 each, postage paid; model 33KSR teletypewriter, have two, $50 each; videotape recorder, 1/2-inch helical, Concord #VTR-400, portable w/shoulder strap, $30. *D. Test, P.O. Box 9064, Newark, NJ 07104.*

Electronic tubes: 10,000 to 15,000, new and in original boxes, for TV, audio and other equipment, all for $2,500 plus shipping; Sams Photofacts for CB radio, volumes 1 through 289, $300 plus shipping. *Albert Carrier, 760 Roanoke St., Christiansburg, VA 24073; 703-382-1040.*

Diehl Mark V Super Tech, never used, priced for quick, reasonable offer. *Donofrio TV, 1523 Central Park Ave., Yonkers, NY 10710; 914-779-3057.*

Sams Photofacts, #20 through #450, all for $175 plus shipping or best offer. *Clarence Bialke, 3712 Main St. N.E., Minneapolis, MN 55421; 612-788-0586.*

Sencore SG165 stereo analyzer with probes and manual, $250. *Fred Cox, 3407 N. Douglas Ave., Loveland, CO 80538; 303-667-0025.*

Sencore VA62 video analyzer with NT64 and VC63, $2,000; Leader LFC-945 signal level meter, $400; Heathkit IM2402, 500MHz frequency counter, $95. All equipment excellent. *Randy Ulrich, 3320 13th St., Greeley, CO 80631; 303-356-8656.*

Test equipment — complete bench setup for shop, includes Fluke digital meters, Hitachi dual-trace scope, Weller solder station, B&H fiche reader, variable transformer, HV probes, Sencore VA48 analyzer, dc power supply, tuner sub, tool roll kit, vibrator, all with boxes and manuals, $2,000. *Moscow Radio & TV, c/o Max E. Bingman, Box 9088, Moscow, ID 83843; 208-882-2273.*

Retired — Test equipment, ICs, transistors, etc. Contact for list. *Henry Weymouth, P.O. Box 6292 Raritan Center, Edison, NJ 08837; 201-248-1176.*

Sencore test equipment: SC61 scope and PR57 ac power supply, in factory sealed boxes, like new, out of warranty, both for $2,200. *Dave, Future Video Services, 3490 N.W. 37th St., Lauderdale Lakes, FL 33309; 305-486-3175.*

Standard brand new tubes in manufacturers' cartons, at 90% off list price; AB Dick mimeograph machine with service manual, $25 plus shipping; text books, service manuals, magazines; radio and TV parts. Send large SASE for list. *M. Seligsohn, 1455 55th St., Brooklyn, NY 11219.*

Heathkit model IG-28 color bar generator, color bars, horiz/vert lines, cross hatch, dots, gray scale, modulated audio, RF/IF output, RF channels 2MHz to 6MHz, more, $150. *George Campbell, 44445 13th St. E., Lancaster, CA 93535; 805-948-4144.*

Model FC-7011 scope frequency counter, 100MHz, never used, $100; Tentelometer TZ-H7-UM tape tension gauge, used once, $250. *Gene McNaughton, 129 McDonald Blvd., Belleville, IL 62221; 618-235-5769.*

Parts, tubes, test equipment, tools and schematics from closed TV service business. For copy of inventory, send SASE. *H.E. Company, 1520 E. Frontier, Stillwater, OK 74075.*

TV equipment — Sencore VA-62 with VA-63, NT-64 and EX-231, $1,995; Sencore FC-71 1GHz frequency counter, $495; B&K model 2007 FM stereo signal generator, $85; Simpson model 465 autoranging multimeter, $50; Techronics model 465B 100MHz, dual-trace scope, $150; B&K 35MHz, dual-trace scope, $235. All with manuals. Add shipping. *Don Robbins, 5101 Springlake Parkway, #813, Fort Worth, TX 76117; 817-498-6759.*

Sencore model TF-46 super transistor checker, $275. *Angelo Alessi, 29 Cross St., New Windsor, NY 12550; 914-562-9152.*

Sams AR manuals, volumes 19-175, $3 each; 50+ new CRTs, $50 all; 100+ 1934-1974 car radios, $200 all; 100+ TV sets, $25 all; 400 BKB22 color CRT, $20; replacement TV antennas, $50 entire inventory; car radio vibrators, nos, $2 to $10 each. *Jim Farago, P.O. Box 6313, Minneapolis, MN 55406.*

Model 260 volt-ohmmeter, $35; model E-200C Precision signal generator, $25; model 350C Swan transceiver with ac and dc power supplies, $200. *Ralph Dorough, 117 Pecan St., Terrell, TX 75160; 214-563-7105.*

Sencore model YF33 ringer yoke and flyback tester with high-voltage probe set, good condition, $125; Heath model IM-36 transistor tester, good condition, $30; Eico model 633 CRT tester and rejuvenator, good condition, $25; Hickok model 660 dot/bar generator, working, $25; radio and TV tubes. Add shipping to all items. *Bob Garrett, 1259 Carl St., Alton, IL 62002; 618-465-8950.*

Older tune-up center with stand and five instruments, Pulsar 960 by Peerless Instrument Co., Chicago, best offer, include postage; old Allen B. Dumont cathode ray oscillograph, type 247, serial #262, all knobs present, make offer; used Little Litton microwave oven, model 945.101, needs display fixed, other oven parts also, includes Whirlpool, Kenmore, Litton. *Donald Aijala, 50 Fir Circle, Babbitt, MN 55706.*

Complete electronics and TV repair workshop — test equipment, tools, Sams Photofacts, etc. *Ellen*

Brantley, 342 W. Water St., Chillicothe, OH 45601; 614-774-3501 (home), 614-772-7008 (work).

Sams Photofacts, #900-#1400, $3; #1400-#1800, $4; #1800-#2000, $5; #2000-#2200, $6; #2200 and up, $7. Send check or money order with SASE. *J. Ohrnberger, 20 Narragansett Ave., Medford, NY 11763; 516-286-4185.*

Tubes, new, $1 each; Sams #1-#1384, 100 pieces, $40; Sams #39-#801, 105 pieces, $40; Sams #805-#1385, 106 pieces, $40. Add shipping to all. *Maurice E. Andrews Jr., 89 Ten Rod Road, P.O. Box 91, Exeter, RI 02822.*

B&K 415 sweep/marker, $125; Sencore tube tester, Mightly Mite V, $25; Heathkit 1015 ignition analyzer, $50. *Eddie Bryant, 9809 Hilgert Drive, Cleveland, OH 44104; 216-721-9435.*

Model 2120 B&K oscilloscope, 20MHz, brand new, with all accessories and manual, never used, $325; approximately 1,064 Sams Photofacts from #59 through #2375, with metal file cabinets, best offer (send SASE for list); complete TV shop, equipment and parts, mostly RCA and Zenith (owner deceased), send SASE for list. *Jerry's Radio Service, 409 S. Oklahoma St., Shamrock, TX 79079; 806-256-3405.*

B&K 1077B TV analyst with slides, manual and leads, $175. *Frank McCabe, P.O. Box 24714, Tampa, FL 33623; 813-874-5824.*

3-inch oscilloscope, Tenma 72-300, new, never used, $140; Solar model CF Exameter in-circuit capacitor checker, $40; B&K Precision model 2804 digital multitester, autorange to 20M and 10A, new, not used, $35; Heathkit RF signal generator, $25; Supreme model 600 tube and set tester, $25; two Viz (RCA) model WC528B, use with scope to check all in-circuit components, new, not used, $14 each. *Joe Oracki, 3502 E. Northern Parkway, Baltimore, MD 21206; 301-254-0284.*

Sencore MU150 tube tester with manual and setup book, in excellent condition, $110; Sencore UPS 164 universal power supply with manual and cables, used once only, $120. Items include shipping within the lower 48 states, USA. *Baros TV Service, 6113 Isleta Blvd. SW, Albuquerque, NM 87105; 505-877-5688.*

DSI 5600A 50Hz-512MHz frequency counter, $150; B&K 283 DMM, $175; B&K 1460 scope, $300; B&K 607 tube checker, $150; B&K 1243 color generator, $100; B&K 467 picture tube checker and rejuvenator, $250; RCA WV-98C Senior Voltohmyst, $125; RCA VW38A multimeter, $40; RCA WR508B color generator, $80; Castle tuner subber, $40; Knight ignition analyzer, $50; Finco TC-1 Dolly, $100; 20 popular TeleMatic yoke adapters for jig, $100. Send cashier's check for any or all — will ship UPS, COD. All in good condition, some have original cartons. All have manuals. *George W. Crouch, Ace TV, 4018 Lillian Drive, Concord, CA 94521; 415-682-8841.*

B&K 1822 universal counter, 175MHz capacity, $275; Heathkit 3100 analog trainer, $65; Heathkit "Concepts of Electronics" course, $40. *Ron Grega, 107 Ridgeview Drive, Dunmore, PA 18512; 717-347-6842.*

Sams #1200-#1400, $1.25 each; Sencore FC45 frequency counter, $125; IBM-compatible computer, $369; Fisher 1210X metal detector, $55; Eico audio signal tracer, $45; yokes, $3; flybacks, $5; ICs, transistors. Write or call for list. *B. Gillette, P.O. Box 637, W. Haverstraw, NY 10993; 914-942-2173.*

Video heads -- nine models for Betamax Sony, Zenith, Sanyo and Toshiba; other models for VHS. Call or write for list, prices and details. *Ray Coll, 8204 N.W. 14th St., Miami, FL 33126; 305-593-0650.*

New Sencore, B&K, Beckman, Eico and Triplett test equipment; used B&K, Triplett and Hickok test equipment. Send SASE for price list. *Electronic Service, Route 11, Box 540, Salisbury, NC 28144; 704-857-7104, no collect calls, please.*

Sound Technology 1000A FM alignment generator, $1,250; B&K 1500 100MHz oscilloscope, $1,150; Hewlett Packard 1600A logic analyzer with scope and cables, $750; Hewlett Packard 1607 logic analyzer, $350. *Rick Henly, Electronic Services, 5814 Industrial Road, Fort Wayne, IN 46825; 219-484-3326.* ■

Classified

Advertising rates in the Classified Section are $1.65 per word, per insertion, and must be accompanied by payment to insure publication.

Each initial or abbreviation counts as a full word.

Minimum classified charge $35.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $40.00 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

VHS-VCR Repair Solutions Volumes I, II, III, IV. Each contains 150 symptoms and cures, cross reference chart, free assistance. Each $11.95, any two $19.95, any three $29.95, all $39.95. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 01-89-TFN

TV TOUGH DOGS: 300 symptoms and cures. Send $8.95 to DAVIS TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 10-87-tfn

TV/VCR TUFF TIPS listed by mfg. & model. Over 400 tips. $21.95. TV Tips only $11.95, VCR Tips only $13.95. **VCR CROSS-REFERENCE** listing for electronically similar manufacturers, RCA, GE, Sylvania, Panasonic, Quasar, Magnavox, Philco, & J.C. Penney, $19.95. **TV/VCR FAILURE HISTORIES,** Multiple cures for most problem areas. Send $7.95 with mfg. and model number. Money will be refunded with free sample if model is not on database. Add $1.50 postage and handling. TECH CURES, 4825 Fredericksburg Road, San Antonio, Texas 78229.12-88-TFN

TV TROUBLESHOOTING: Over 300 problems/solutions. Nothing old listed. $12.00, add $1.50 shipping. Refund if not satisfied. Jones Enterprises, Box 702, Niceville, FL 32578. 6-89-tfn

REDUCED 75%, Diehl Mark V scanner $249, Diehl Mark III scanner $99. New. 2805 University Ave., Madison, Wis. 53705, 608-233-9741, 608-238-4629. 03-89-tfn

PHOTOFACTS. Folders under #1400, $4.00. Above #1400, $6.00. Sent same day first-class postpaid. Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 9-89-3t

TV/VCR REPAIR TIPS VOLUMES I AND II. Each with 1,000 up-to-date problems/cures listed by model and chassis for quick easy lookup. $29.95 per volume. Add $2.50 postage and handling. Computer Assistance, Box 232026, Anchorage, AK 99523. 8-89-3t

BUYING AND SELLING late model Electronic Test Equipment. Tektronix, HP, Fluke, Wavetek, etc. O'scopes, Signal Gen's., Pwr. Supplies, etc. Cal-Scope, 473-707 Macara Ave., Sunnyvale, CA 94086. (408) 730-4573. 8-89-3t

PARTS PRICING GUIDE: Proven method for increasing profits from parts sales. Send $10.00 to: Smart Management Publications, P.O. Box 315, Bryant, AR 72022. 9-89-1t

COMPUTER TV/VCR REPAIR TIPS DATABASE PROGRAM IBM Compatible w/hard drive). Scan symptoms and cures by model and chassis. Add, change,. delete, print out. Includes database with over 1,000 up-to-date repair tips. $69.95 plus $2.50 postage and handling. Computer Assistance, Box 232026, Anchorage, AK 99523. 8-89-3t

SENCORE VA62 with NT64/VC63 test accessories, microfiche reader, over 30 paper VCR (VHS) manuals, and assorted parts, $3,500.00 for all. (216) 628-0890 evenings. 9-89-1t

INTEGRATED CIRCUITS—Lowest prices on Admiral, GE, NAP, Philco, RCA, Sears, Sylvania and Zenith types. Write PEC, Box 894, Union, N.J. 07083. 8-89-4t

SERVICES

SPEAKER REPAIR. 4"-18" Speakers reconed. Cross-over parts. Orban Audio, 119 7th St. NW, North Canton, Ohio 44720, (216) 497-9932 6pm-9pm EST. 4-89-tfn

BUSINESS OPPORTUNITIES

VCR SERVICE COMPANY in beautiful Monterey, CA. $40,000-$50,000 yearly sales. $25,000 in parts, equipment, furniture and fixtures. Using only 400 square feet of 2,200 square feet. Busy drive-by corner building. Lease/rent—Only $675/mo. for entire facility. Lots of room to expand at no extra rent cost. Illness forces give away sale price of only $39,500. Hurry! Won't last. 408-649-6036. 7-89-3t

BE YOUR OWN BOSS—Audio/Video/TVRO sales and service. Perfect small business for 1-2 man operation. Profitable Colorado business. Low overhead, owner can finance, 303-867-3554. 9-89-2t

ROCHESTER, NEW YORK, ESTABLISHED 1955, owner retiring, will train, 2 way, auto sound, telephones, sales, service; building, 2 bays. (716) 654-8370. 9-89-2t

LARGE AUDIO/VIDEO SERVICE BUSINESS. In sunny S.W. city. Established 20 yrs. Well-equipped. Price & terms negotiable. (602) 298-8827. eves. 8-89-tfn

AUDIO SALES/SERVICE: Fully operational, profitable stereo business seeks new owner. Location: Fast-growing Research Triangle, NC. Great place to live. Tom 919-286-3891. 8-89-2t

MOVING?

If you're planning a move in the near future, don't risk missing an issue of Electronic Servicing & Technology. Please give us 6-8 weeks notice if you're planning on changing your address. Just write in your new address below and mail this coupon, WITH YOUR SUBSCRIPTION MAILING LABEL, to:

ELECTRONIC Servicing & Technology

Subscriber Services
P. O. Box 12901
Overland Park, KS 66212

Name _____

Address _____

City _____

State_____ Zip _____

Advertisers' Index

ADVERTISING SALES OFFICES

ELECTRONIC Servicing & Technology

KANSAS CITY, MISSOURI
Greg Garrison, Sales Manager
P.O. Box 12901
Overland Park, KS 66212
Phone: (913) 888-4664
Fax: (913) 541-6697
Telex: 42-4156 INTERTEC OLPK

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

TOKYO, JAPAN
Mashy Yoshikawa
Orient Echo, Inc.
1101 Grand Maison
Shimomiyabi-Cho, 2-18
Shinjuku-ku, Tokyo 162, Japan
Tel: 03-235-5961
Telex: J-33376 MYORIENT

FREWVILLE, SOUTH AUSTRALIA
John Williamson
Hastwell, Williamson, Rep. Pty. Ltd.
109 Conyngham Street
Frewville 5063
South Australia
Phone: (08) 79 9522
Fax: 08 79 9735
Telex: AA87113 HANDM

GO AHEAD... Make A Mistake

Fused to 600 Volts AC/DC to help protect instrument as well as user from mis-application

MODEL AM-12 ▶
- 20 Industrial Ranges
- .1Ω Resolution
- Pocket Size

Price: $44.85

MODEL AM-4B ▲
- .01Ω Resolution
- Sensitive 20μ A/20Ω Ranges
- Audible Continuity

Price: $104.85

NEW

◀ **MODEL AM-14**
- Direct Temperature Reading
- 200mV & 20MΩ Ranges
- Convenient Intermediate Range
- Audible Continuity

Price: $64.85

ALL MODELS INCLUDE
- Over Range Indication
- Low Battery Indication
- Auto Zeroes
- Reversed Polarity Indication
- Standard Banana Jacks
- PTC Protection to 500V AC/DC on all Ohms Ranges
- Fuse Protection to 600V AC/DC on all mA/μA Ranges

AMPROBE INSTRUMENT®
DIVISION OF CORE INDUSTRIES INC, LYNBROOK, NEW YORK 11563

630 MERRICK ROAD, P.O. BOX 329
Area Code 516-593-5600 • ITT TLX 4971416
FAX 516-593-5682

Circle (2) on Reply Card

INSIST ON GENUINE ZENITH FACTORY-FRESH REPLACEMENT PARTS NOW AVAILABLE AT AUTHORIZED EXCHANGE COUNTERS THROUGHOUT THE U.S.

Two of the most important reasons for exchanging Zenith replacement parts through your participating distributor's Exchange Program:

1) Your replacement part will most likely contain the latest Zenith engineering updates,

2) You will be assured of receiving a factory-fresh replacement part remanufactured and serviced for reliability by Zenith people as knowledgeable and dedicated as those who made the original.

Don't risk exchanging sophisticated Zenith modules, tuners channel selectors and subassemblies anywhere else.

Write today and we'll help you locate an authorized distributor Exchange Counter near you!

ZENITH®

The quality goes in before the name goes on.®

Zenith Service, Parts & Accessories/1000 Seymour Avenue/Franklin Park, IL 60131 • A Division of Zenith Electronics Corporation