THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

ELECTRONIC™ Servicing & Technology

NOVEMBER 1989/$3.00

Selecting a UPS ● A VCR Repair Case History — Update

Troubleshooting Varactor Tuners — Part I

Focus on soldering and desoldering

AN INTERTEC PUBLICATION

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.*

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

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.

SENCORE

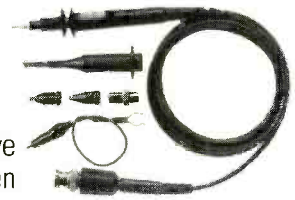
Circle (1) on Reply Card

PHILIPS

THERE IS NO SMARTER CHOICE THAN PHILIPS ECG.

ECG PR200A OR PR60: FOR THE RIGHT ANSWER TO YOUR SCOPE PROBE NEEDS.

ECG™ scope probes come packed with features and packed with value. Features on the PR200A include:



- ☐ 200 Mhz bandwidth capability
- ☐ X1, X10 attenuation and reference switch
- ☐ Low input capacitance
- ☐ Large thumb switch with positive detents, for easy switching between X1 and X10 and ground reference
- ☐ Comes with an IC tip, BNC adaptor, insulating tip and a retractable hook

The PR60 features:

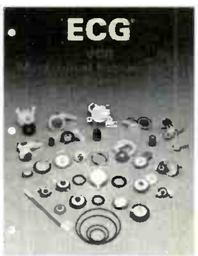
- ☐ 60 Mhz bandwidth capability
- ☐ X1, X10 attenuation and reference switch
- ☐ Retractable hook

ECG scope probes: the smart choice.

Circle (33) on Reply Card

ECG VCR MECHANICAL REPLACEMENT PARTS CATALOG: THE SMART PLACE TO LOOK FOR YOUR REPLACEMENT PARTS.

The ECG VCR mechanical replacement parts catalog has the industry's most comprehensive cross-references to make sure you get the correct part:



- ☐ Complete product line includes: 13 pinch rollers, 42 idler wheels and assemblies, 4 idler tires and 48 belt kits
- ☐ 55 individual belts also available

ECG VCR replacement parts: the smart choice.

Circle (34) on Reply Card

Contact one of more than 900 distributors or call 1-800-233-8767 for the name of the distributor nearest you. It just might be the smartest call you make all week.

ECG DM-26 AND DM-27 FULL FUNCTION GENERAL PURPOSE MULTIMETERS.

The ECG DM-26 and DM-27 multimeters are loaded with features and loaded with value. Just check out the array of capabilities:

- ☐ Diode test
- ☐ Rotary range switch
- ☐ Tilt stand
- ☐ 0.8% basic DC accuracy
- ☐ 3½" digit LCD display, 0.5" high
- ☐ 20 MΩ full scale
- ☐ 10 MΩ input resistance, DC
- ☐ Low power Ohms
- ☐ Overload protected
- ☐ The DM-27 also includes an audible continuity test

ECG multimeters: the smart choice.

Circle (35) on Reply Card

ECG TV-1100 CABLE CONVERTER: THE SMART WAY TO MAKE ANY TV CABLE-READY.

The ECG TV-1100 Cable Converter adapts any TV to receive cable channels. And the added features give added value:

- ☐ Remote control features on/off, channel selection, and picture fine tuning. Operates from up to 25 feet away
- ☐ Converts VHF and cable channels to a switch-selectable output, channel 2 or 3
- ☐ Remote control features last channel recall and memory to store up to 10 favorite channels
- ☐ Features a sleep timer that automatically turns TV off after pre-determined time (up to 90 minutes)

ECG cable converter: the smart choice.

Circle (36) on Reply Card

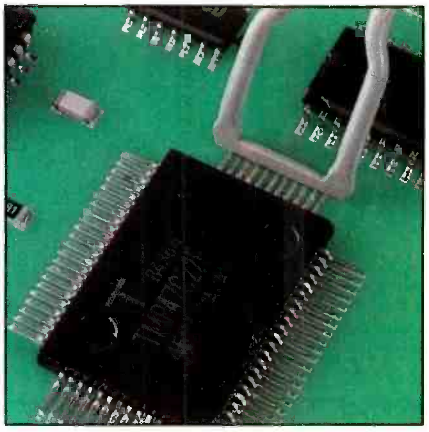
Philips ECG Company

A Division of North American Philips Corporation

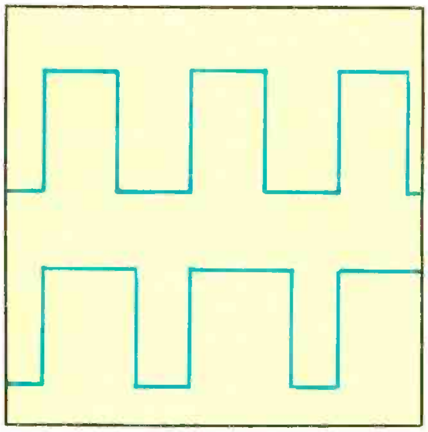
Contents

Volume 9, No. 11 November 1989

Page 8



Page 10

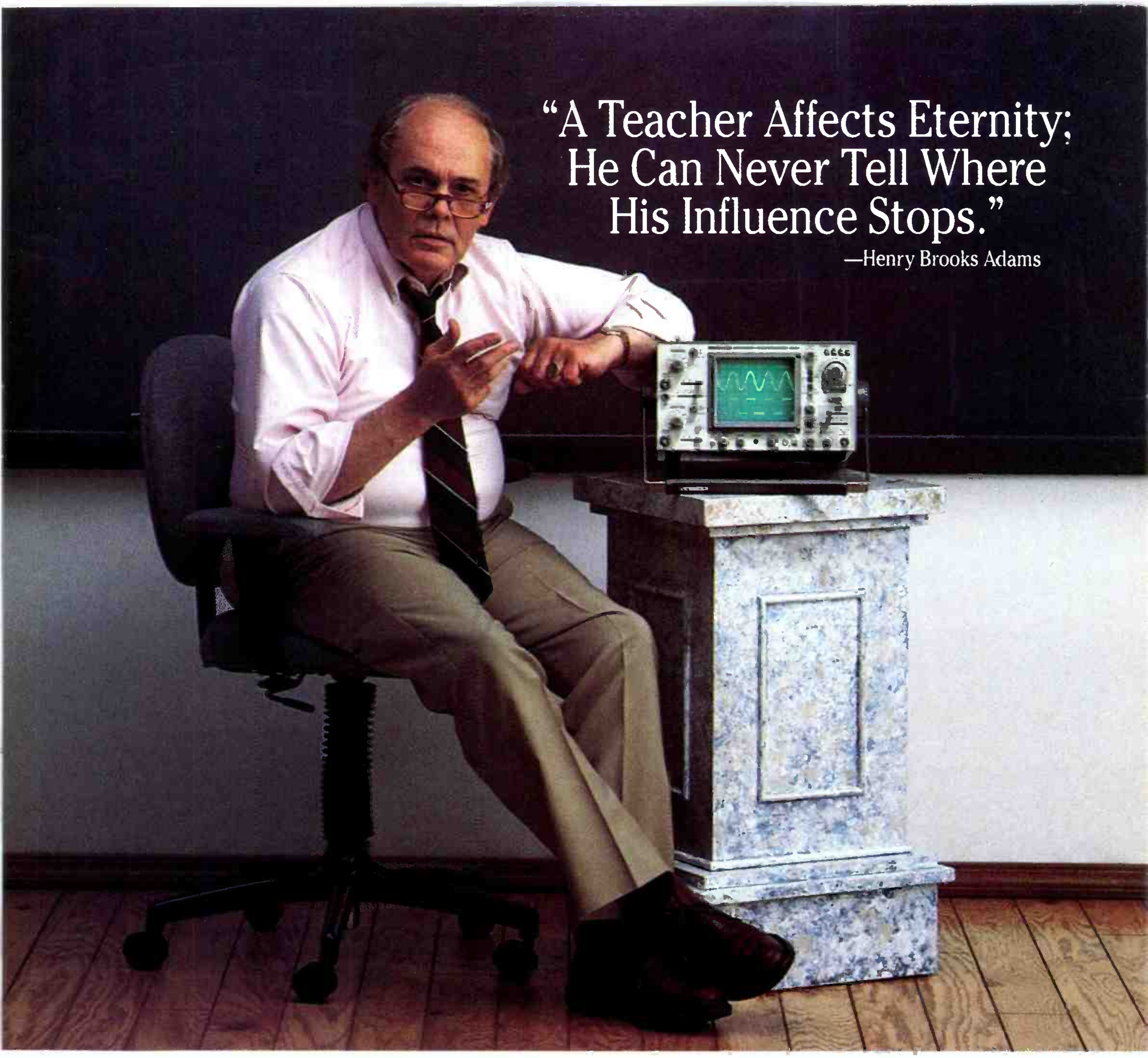


Page 40

ON THE COVER

Servicing modern consumer electronics products sometimes pushes basic skills into the high-tech arena. One skill that isn't necessarily basic anymore is soldering and desoldering. Faced with densely packed, multilayer boards and surface-mount technology, electronics servicers who work on the latest technology often must learn new techniques. (Photo courtesy of HMC, Canton, MA.)

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC Servicing & Technology



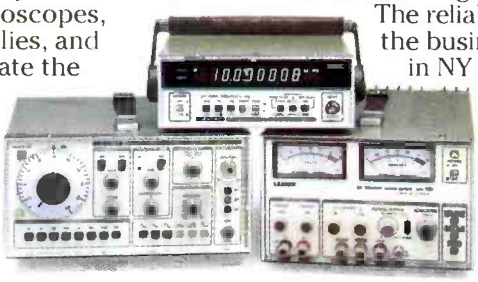
LET LEADER BE INSTRUMENTAL IN THE LEARNING PROCESS

Henry Adams' quote captures a wonderful sentiment. Of course, in Mr. Adams' time, a teacher needed to concern himself with little more than the three R's. Today, teachers of electronic theory and technology require the sophisticated instruments that will prepare their students for work in the next century.

We can help you meet this important obligation by offering a broad range of test equipment for classroom applications. This includes oscilloscopes, function generators, power supplies, and more. Your students will appreciate the valuable experience they gain from training on Leader equipment. They'll find Leader's leading-edge instruments used extensively in R&D, production, industrial, and service facilities.

For reliable performance and durability, Leader is unparalleled, maintaining a remarkable rate of *less than 1%* return during the 2-year warranty period. This high degree of dependability eliminates the inconvenience caused by equipment that spends more time in the repair shop than in your classroom.

For full-line coverage, absolute precision, and prices that won't tug at your purse strings, go with Leader.



The reliability of our products lets you get on with the business of education. For our full-line catalog, in NY call 516 231-6900. Or call toll-free:

1 800 645-5104

LEADER
FOR PROFESSIONALS WHO KNOW THE DIFFERENCE

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

For Information Circle (4) on Reply Card

For Demonstration Circle (5) on Reply Card

Know your associations

At the risk of being accused of being repetetive, this editorial will be about information — why it's more important now than ever before, why you need it, how and where to get it, and why we're trying so hard to bring more and better information to you.

There are many reasons consumer electronics servicers need information these days. Here are a few:

- There are so many kinds of consumer electronics products today that need servicing: TVs, VCRs, CDs, personal computers, fax machines, microwave ovens.
- There are so many different manufacturers of these products, and they frequently can't be identified by the brand name of the product.
- Many different brand names of products may be manufactured by the same manufacturer. In fact, several brands and models of a product (especially in the case of VCRs) may be identical.
- A new model of a product may contain not only a new design, but newly designed and manufactured IC chips that are different from the components in last year's model.

There are a number of sources from which an astute servicing technician can find the information he needs (well, most of it), including this magazine. Every modern servicing facility should have a library of this kind of information, and the shop should have as many connections as possible to feed information in and out.

One source of information that every servicing technician can and should be connected to is the Electronic Industries Association Consumer Electronics Group (EIA/CEG), specifically Product Services. This is the organization to which the manufacturers belong. Among other things, they are deeply interested in making sure there are enough servicing technicians to keep every consumer electronics product in good working condition. The Product Services division of the EIA/CEG offers books, pamphlets, videotaped instruction and even in-residence servicing seminars at which attendees get hands-on instruction in diagnosing and repairing products such as VCRs. These courses are FREE to working servicing technicians (not including travel, meals and lodging).

If you have never contacted the EIA before, do it now. Send them a self-addressed 6″×9″ envelope (73 cents postage, based on first-class postal rates of 25 cents per ounce) and ask for the "US Consumer Electronics Industry 1989 Annual Review." Starting on page 61, there's a list of pamphlets, catalogs, periodicals, films and videocassettes that are aimed at consumers, servicing organizations and manufacturers. Some of these are free (in single quantities if you send them a self-addressed envelope with the appropriate amount of postage affixed); others cost a nominal amount. One of the most helpful of the catalogs you can order from them will cost a buck for postage. The "Replacement Parts Source Book" lists replacement parts locations for parts, schematics and technical literature.

Another good source of information is membership in one of the consumer electronics servicing organizations. There are two of these: the Electronic Technicians Association (ETA) and the National Electronic Servicing Dealers Association (NESDA). Membership in one of these groups will give you the chance to associate with other technicians, to share information with them, to attend educational seminars, and to gain access to the publications and other information they publish.

One good source of information is published by a NESDA affiliate. It's a VCR cross-reference manual that tells you what brands and models of VCRs are made by what manufacturers. In some cases, you can use this manual to find which servicing manuals and replacement components made by one manufacturer may also be used on a completely different brand of VCR made by that manufacturer.

One other source of information you can use is the Electronic Industry Telephone Directory. It costs about $50, which may seem like a lot of money to pay for a phone book, but the address and phone number of just a few manufacturers might save you many times that amount in wasted time and frustration. Besides, if you do a lot of business with a given distributor or rep, they might just be interested in giving you a free copy.

And last, but we hope not least, is this magazine. Take a look at Information Exchange on page 19. More information appears this month than in the first edition of that department, thanks to some helpful readers.

Nils Conrad Persson

Electronics Associations

Electronic Technicians Association
604 North Jackson St.
Greencastle, IN 46135

National Electronic Sales & Service Dealers Association
2708 W. Berry St.
Ft. Worth, TX 76109

Publications

Electronic Industry Telephone Directory:
Harris Publishing Company
2057-2 Aurora Rd.
Twinsburg, OH 44087-1999

Replacement Parts Source Book:
Consumer Electronics Group,
Electronic Industries Association
PO Box 19100
Washington, DC 20036
Include $1.00 for postage and handling

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE

PHILIPS

Put a test lab in your tool pouch.

The Fluke 8060A 4½-digit handheld multimeter.

It's the best tool you could add to your tool pouch, because it lets you troubleshoot more ...with less.

This portable, powerful instrument has a unique combination of features not available in any other handheld DMM. It lets you reach beyond traditional DMM applications, tackling jobs that often require more equipment than you can carry.

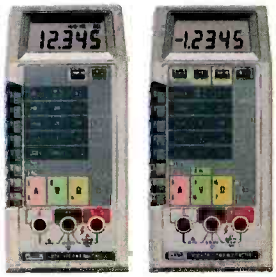
A simple push of a button on the Fluke 8060A lets you measure frequencies to 200 kHz, make relative offset measurements, convert voltages to direct reading decibels, or conduct audible continuity tests. Plus the 8060A offers wideband True RMS ac measurement capability to 100 kHz.

So say goodbye to your part-time counters, oscilloscopes, continuity testers, calculators and power supplies. And welcome a full-time professional that'll be there when you need it.

You'll find that for troubleshooting everything from motor controls to data communications equipment, the Fluke 8060A is the best multimeter value going.

Find out more by calling our toll-free hotline **1-800-44-FLUKE, ext. 33.**

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.



8062A	8060A
$329*	$389*
.05% basic accuracy	.04% basic dc accuracy
19999 count display	19999 count display
True-rms ac voltage and current	True-rms ac voltage and current
Continuity and diode test	Continuity and diode test
Relative reference	Frequency measurements
1-year calibration cycle and warranty	dBm, Relative dB
	Relative reference
	1-year calibration cycle and warranty

*Suggested U.S. list price, effective October 1, 1988.

Circle (3) on Reply Card

FLUKE

John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Sales: (206) 356-5400, Other: (206) 347-6100.
 Ad No. 1181-F8060

News

NESDA, ISCET make changes

Both the National Electronics Sales & Services Dealers Association (NESDA) and the International Society of Certified Electronics Technicians (ISCET) made several changes during their respective annual conventions. Both associations met as part of the week-long, annual National Professional Electronics Convention (NPEC) at the Loews Ventana Canyon Resort in Tucson, AZ, Aug. 6-12.

NESDA, which has been hampered by the rule that it must get approval for most actions from its House of Representatives (which meets twice a year), voted to give its Executive Committee (which meets at least quarterly) the power to act more promptly on association matters. It also discontinued its 5-year extended picture-tube warranty.

ISCET established longer-period memberships and updated technical education aids. It also is allowing ISCET-certified technicians to join ISCET for reduced-rate dues schedules for terms of five years or for a lifetime in addition to the regular 1-year membership term. ISCET will also be publishing a second edition of its "VCR Cross-Reference Guide" and a fourth edition of its "Associate CET Study Guide."

NPEC offers extensive seminar schedule

More than 570 people participated in the 1989 National Professional Electronics Convention (NPEC) and Trade Show. The annual week-long educational event was held Aug. 6-12 at the Loews Ventana Canyon Resort in Tucson, AZ.

A dozen technical seminars were offered, covering moderate and expert levels in such subjects as digital microprocessors and pulsating microwaves. The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) also conducted several hands-on schools on digital microprocessors. Major manufacturers produced seminars on VCR, LCD, microwave oven, camcorder and oscilloscope technology. Other sessions were offered for electronics instructors and business managers. More than 60 exhibitors were present.

EIA joins in HDTV testing

The Electronic Industries Association (EIA) has become a member of the Advanced Television Test Center (ATTC), which was established to test proposed high-definition TV (HDTV) transmission systems. The EIA will be working jointly with the broadcasting and cable industries toward a new advanced TV (ATV) transmission standard.

The ATTC was formed last year by a coalition of TV broadcasting companies and industry associations to evaluate the many proposed ATV systems under consideration as the terrestrial transmission standard for HDTV in North America. The center has also undertaken over-the-air propagation tests and consumer market research related to ATV. The center will conduct and support impartial tests of ATV systems in cooperation with the official Advisory Committee on Advanced Television Service of the FCC.

EIA/CEG updates pamphlet

The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) has updated one of its 22 consumer education pamphlets, "Consumers Should Know: All About Stereo Television and Second Audio Programs." The pamphlet is also now offered in Spanish. To obtain a copy, send a self-addressed No. 10 envelope with 25 cents postage to the EIA, Stereo TV, P.O. Box 19100, Washington, DC 20036. For the Spanish version, specify Stereo TV — Spanish. For a listing of all pamphlets available, write to Pamphlet Listing at the same address. For multiple copies, call 202-457-4977.

EIA/CEG and NAB promote AM standards

The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) and the National Association of Broadcasters (NAB) have entered a joint program to promote high-quality AM sound using the NRSC standards in AM receivers. The NRSC standards improve AM radio transmission and reception quality and reduce interference between stations.

The program goal is to establish a certification mark or logo that will be used on the faceplate of high-quality AM receivers. Under the EIA/NAB program, any receiver manufacturer could use this trademark in the promotion of receivers designed in accordance with the NRSC standards. ■

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

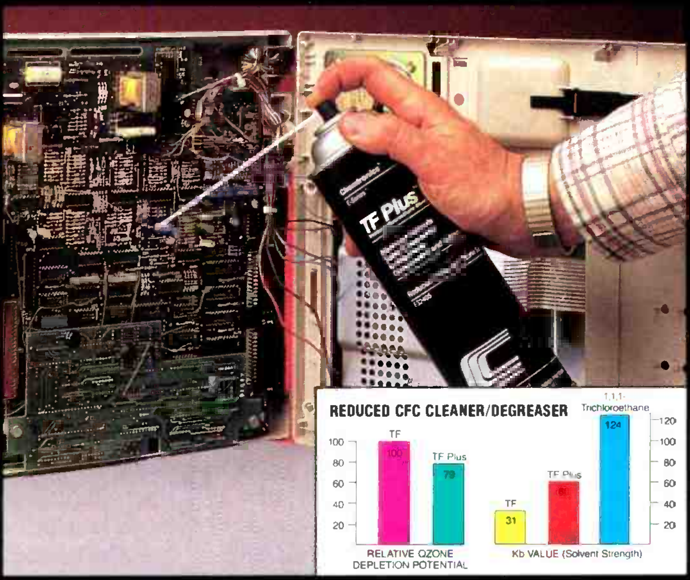
SUBSCRIPTION PRICES: one year, \$19.49; two years, \$32.98 in the USA and its possessions. Foreign countries: one year, \$23.49; two years, \$36.98. Single copy price: \$3.00; back copies, \$5.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks for new subscriptions.

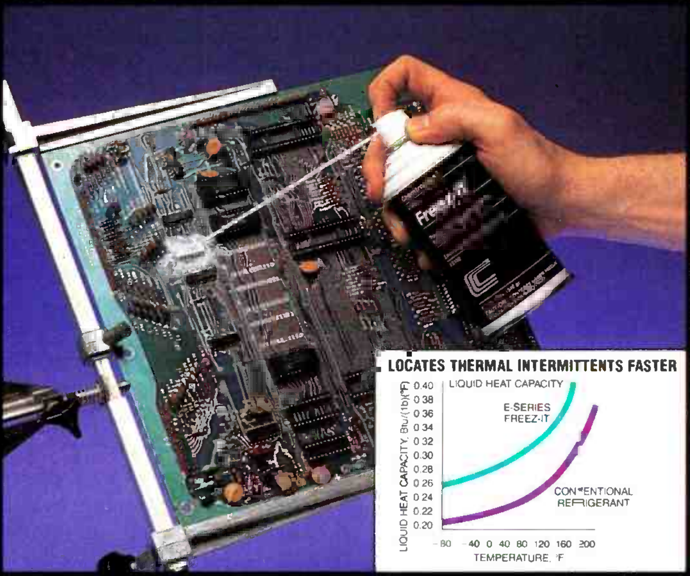
PHOTOCOPY RIGHTS: Permission to photocopy for internal or personal use is granted by Intertec Publishing Corp. for libraries and others registered with Copyright Clearance Center (CCC), provided the base fee of \$2 per copy of article is paid directly to CCC, 21 Congress St., Salem, MA 01970. Special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

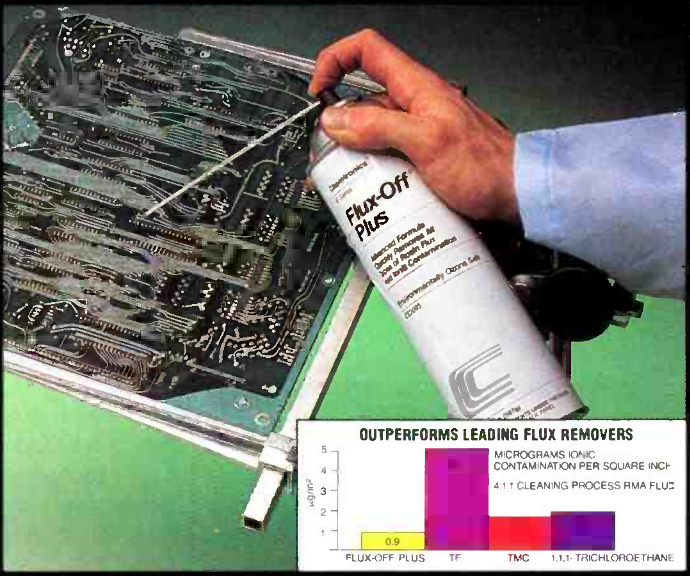
Electronic Servicing & Technology (ISSN 0278-9922) is published monthly for \$19.49 per year by Intertec Publishing Corp., 9221 Quivira Road, Overland Park, KS 66215. Second-class postage paid at Shawnee Mission, KS and additional mailing offices. POSTMASTER: Send address changes to ELECTRONIC SERVICING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

INTERTEC PUBLISHING CORPORATION


Ultrajet
HIGH POWERED PRECISION DUSTER
E-SERIES ULTRAJET
120 PSI
CONVENTIONAL DUST REMOVER
70 PSI
Pounds/Square Inch Initial Pressure


TF Plus
REDUCED CFC CLEANER/DEGREASER
TF
100
TF Plus
79
TF
31
TF Plus
1,1,1-Trichloroethane
124
RELATIVE OZONE DEPLETION POTENTIAL
Kb VALUE (Solvent Strength)


LOCATES THERMAL INTERMITTENTS FASTER
LIQUID HEAT CAPACITY
E-SERIES FREEZ-IT
CONVENTIONAL REFRIGERANT
LIQUID HEAT CAPACITY Btu/(lb)(°F)
TEMPERATURE, °F


Flux-Off Plus
OUTPERFORMS LEADING FLUX REMOVERS
MICROGRAMS IONIC CONTAMINATION PER SQUARE INCH
4:1:1 CLEANING PROCESS RMA FLUX
0.9
FLUX-OFF PLUS
TF
TMC
1,1,1-TRICHLOROETHANE

Focus on soldering and desoldering

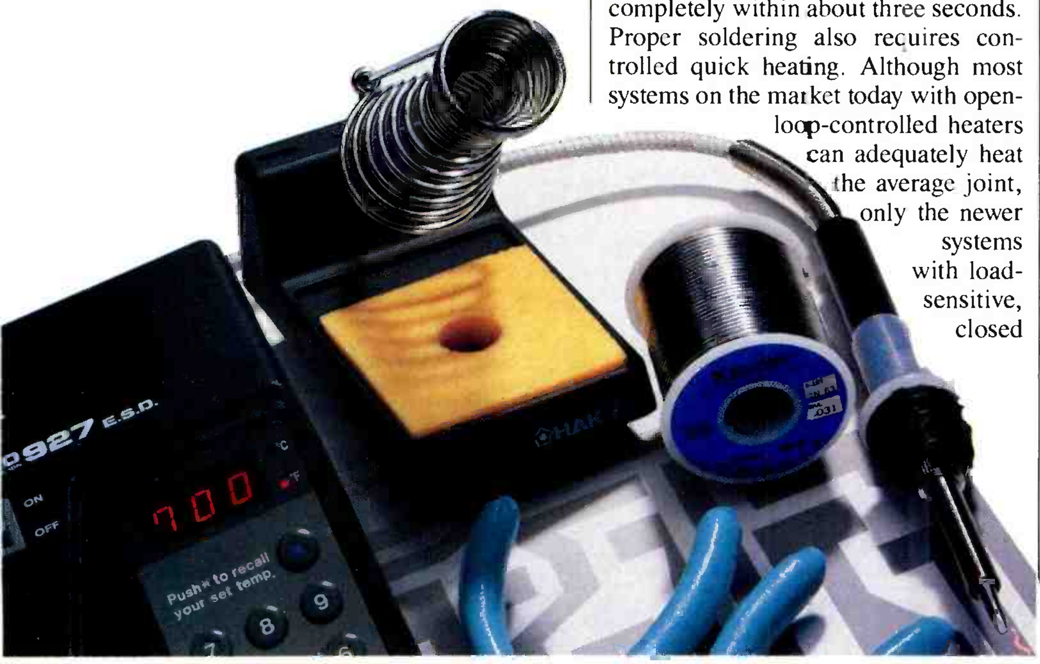
By James Bausell

With the advent of surface-mount technology and higher density and multilayer circuit boards, soldering, desoldering and board repair has become more complex. A technician who is called upon to repair one of today's sophisticated consumer electronics products may run into a number of situations that were unheard of just a few years ago, including surface-mount devices (SMDs), conformally coated circuits and damaged pc board traces. To cope with these and other situations that are unique to servicing modern electronics products, the technician may require a sophisticated soldering/desoldering rework center. Every service organization should take a fresh look at the latest equipment and techniques.

Component removal from thru-hole assemblies

The most frequently performed physical repair in most service operations is removal of faulty components. For the familiar thru-hole circuit board (one that has the components and circuit traces on opposite sides of the board, connected by holes through which the component leads protrude and are soldered to the circuit traces), continuous vacuum desoldering is the preferred method for removing components. A typical system has a handpiece with a hollow, heated tip. The heated tip melts the solder and a continuous vacuum, applied once the solder has melted, extracts the molten solder and deposits it in a solder collection chamber, where it solidifies. Such systems may come with their own vacuum pump, or they may be connected to the shop compressed air system through a Venturi vacuum system.

Bausell is corporate sales manager at PACE, Laurel, MD.



However, not all continuous vacuum desoldering systems are created equal, and there is some technique involved in achieving good results. The first task is to bring the heated tip into contact with the solder joint. This task is performed more easily with pencil-grip soldering handpieces, which are controlled with finger movement, than with pistol-grip desoldering handpieces, which are manipulated by wrist, elbow or shoulder movement.

The second objective in desoldering is to heat the joint quickly, yet under proper control, so that the solder melts completely within about three seconds. Proper soldering also requires controlled quick heating. Although most systems on the market today with open-loop-controlled heaters can adequately heat the average joint, only the newer systems with load-sensitive, closed loop-controlled heaters can properly handle heavy, thermally massive double-sided and multilayer boards. (Open-loop means the temperature of the soldering tip is adjustable, but there is no sensor at the tip to adjust the current to the tip to maintain the desired temperature when it's under a heavy load. A closed-loop system, on the other hand, has a sensor at the tip, like a thermostat, to maintain the tip temperature regardless of load.)

If desoldering or soldering operations are performed on such thermally massive boards in rapid succession, a high-quality, closed-loop controlled system is critical so that the proper operating tip temperature is sustained joint after joint.

Such systems also have digital readout of both the set and read temperatures in order for the operator to better control and monitor the temperature cycling of the desoldering (and soldering) process. On a few boards, even a high-quality system alone cannot heat the joint completely or rapidly enough. In these cases, *thermal-soaking* (preheating) and/or auxiliary heating is required.

Desoldering thru-hole components

To desolder thru-hole components, wiggle the lead with the desoldering tip as you heat the solder joint. When the lead moves freely, you know the solder has melted completely. Once the melting is complete, continue to wiggle the lead while you apply the vacuum and remove the molten solder. The air pulled through the hole cools the joint, thereby preventing the formation of a resweat joint.

For this desoldering action to work properly, the desoldering system must have a quick vacuum rise time. That is, a sufficient level of vacuum must be developed quickly enough for all of the molten solder to be withdrawn in one continuous slug, leaving the joint completely free of solder. Despite suggestions by some suppliers that the greater the level of vacuum, the better, recent tests have shown that systems which can

That's the name of the game

When you play for keeps, win the game with hand tool horsepower from Paladin.

Whether your game is production, installation or maintenance of connection systems for power and information, Paladin has your tool. Get the job done faster and better, and outshine the others with professional results every time.

After more than ten years serving the electronic, electrical, telecommunications and related industries, we understand your specialized needs, and have precision-engineered and patented solutions for almost any application you can imagine.

There's only one move to make...

You've checked the others. Now make your move to Paladin for cable preparation tools, strippers, crimpers and cutters, slitters, notchers, and screwdrivers, plus accessories like connectors, telecom hardware and other essential service and production aids. If we don't sell it yet, we can probably make it for you!

Paladin tools do more than fit your application. They also fit your hand, and your demands for ergonomic design, ease of use, and safety. With Paladin on your team, you'll win the time-and-money game, too... hands down.

Send for our free, 152-page full-color catalog, or call today for a demonstration at your workplace or your nearest Paladin distributor. You'll see for yourself that when you play the game with Paladin, you're a winner every time!

Send for our free, 152-page full-color catalog.

PALADIN

At work with professionals every day™

PALADIN CORPORATION
3543 Old Conejo Road, Suite 102
Newbury Park, CA 91320
(805) 499-0318 – FAX (805) 499-4006

A member of the Weidmüller group of companies

Circle (37) on Reply Card

A closed-loop, temperature-controlled soldering and desoldering station has a sensor at the tip, like a thermostat, to maintain the tip temperature regardless of load.

quickly achieve a modest level of vacuum (approximately 4.0 inches of mercury within about the first 40ms) perform the best.

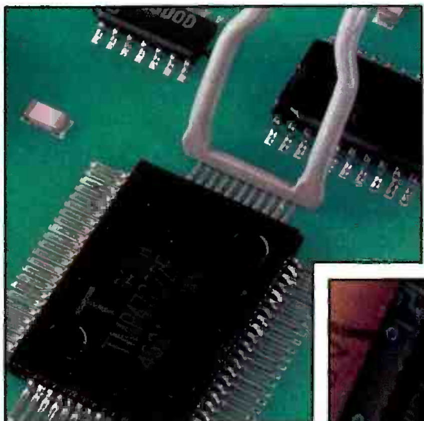
A good vacuum flow rate is also an important feature. Once all of the solder is removed, a flow rate of about 1 cfm is desirable to cool the joint rapidly and thereby prevent the formation of a resweat joint.

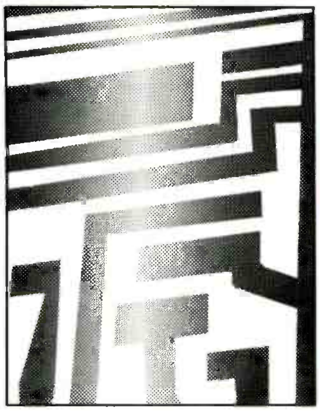
Avoiding damage to components

Recent military standards have become the benchmark to ensure that the soldering and desoldering equipment you use will not electrically or thermally damage good components on your board. These standards are

- leakage — no greater than 2mV rms at tip.
- idle tip temperature — within $\pm 11°F$ (6°C) of set point.
- transient control — all zero power (voltage) switching must be used.
- tool holders — must not create a heat sink, must protect the operator from burns and must exert no excess mechanical stress on the tool.

Be sure to verify that the soldering and desoldering stations you're using meet these stringent requirements. Equipment that doesn't can introduce problems, especially with sensitive components and circuitry.





Surface-mount technology

Densely packed SMDs can create problems when individual components are replaced. You have to heat the solder joints of the component to be removed while avoiding heating adjacent components. If adjacent component solder joint temperatures get too high, the solder in those joints may crystallize, creating brittle joints that are likely to fail.

A wide variety of tips can fit SMDs, from small chip resistors to SOICs, even PLCCs and QFPs (quad flat packs).

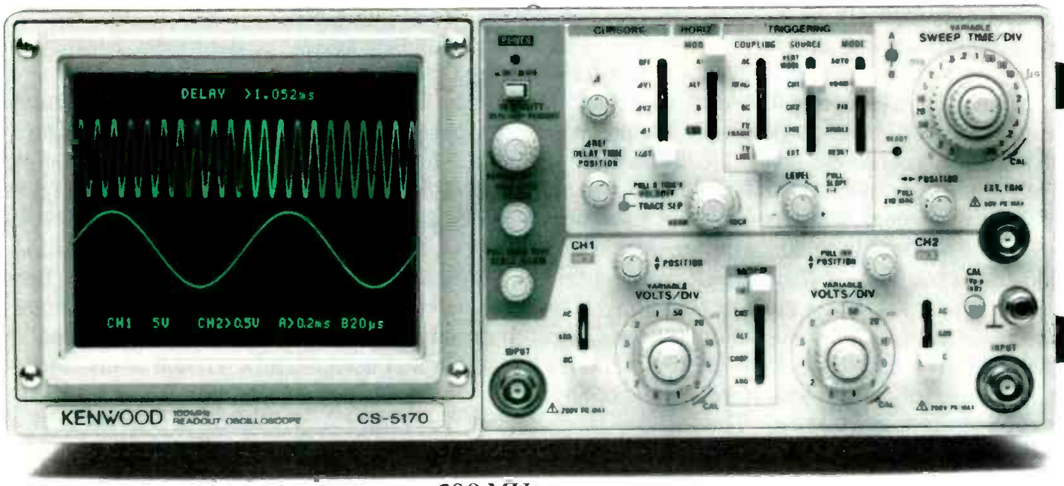
In one new method of soldering and desoldering SMDs, conductive handpieces are used. This new generation of pulse-heat SMD reflow systems can be used to install and remove a wide range of surface-mount components. Unlike continuously heated soldering irons, a pulse-heat solder system is not heated when it's idle. The operator applies the tip to the joint to be soldered, then presses a foot switch. The soldering system provides controlled temperature rise to the solder reflow point, then assures rapid cool-down.

A major problem when surface-mount components such as small-outline ICs (SOICs) and plastic, leaded chip carriers (PLCCs) are installed using a soldering iron is thermal shock and overheating, not only to the component itself, but also to adjacent components and their solder joints. Soldering iron stations typically rely on high temperature, continuous heat and bulky, massive tips for SMD installation. Because the tip is extremely hot when it is applied to the device leads, temperature rise is sudden and likely to cause damage. Pulse heat is the secret to installing SMDs without damage.

A variety of handpiece types and tips to fit a wide range of standard component types and lead configurations are available. More advanced SMD reflow systems permit rapid interchangeability of handpieces to a universal power cord in less than three seconds.

For soldering SMDs, there are small, low-mass tips that can fit into hard-to-reach places and grasp the component

If you want better measurements, check these figures out.



The Kenwood CS-5170. No other dual-channel 100MHz oscilloscope more economically combines performance and simplicity. And through December 31, 1989, its reasonable price has been reduced almost beyond reason.

You see, the CS-5170 forgoes unnecessary extras in favor of the practical features that make high-speed signal readings quick and easy. Like digital readout with cursor functions for voltage, time, frequency, ratio, phase, and delay measurements. The CS-5170's high-resolution 12kV CRT eliminates parallax error. Delayed sweep, high vertical-axis sensitivity from 1mV to 5V, automatic triggering and video signal capabilities all add to this scope's optimum functionality.

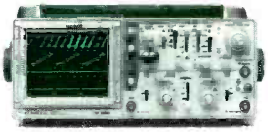
Prudent performers. For economical electronics, the 3-channel 60MHz CS-5165, 50MHz CS-5155 and 2-channel 40MHz CS-5135 models feature delayed sweep, bright CRTs, 1mV to 5V vertical-axis sensitivity and more.

Advanced 4-channel oscilloscopes. Kenwood's 6000 Series, the 150 MHz CS-6020 and 100MHz CS-6010, deliver added versatility for advanced applications. Cursor measurements include voltage, time, frequency, ratio, phase, and delay. Both models offer digital readout with a convenient calendar display and bright CRT. A trigger counter is useful for analysis of complex digital and video signals.

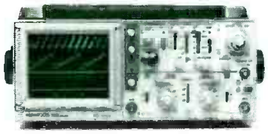
Irresistible prices. Consider all the features you get with sophisticated Kenwood Test and Measurement Equipment and the figures you see here look all the more attractive.

To get FREE information on any or all Kenwood oscilloscopes contact Kenwood USA Corp.–Communications & Test Equipment Group at 2201 E. Dominguez Street, Long Beach, CA 90810. Or call (213) 639-4200.

100 MHz $1595
CS-5170

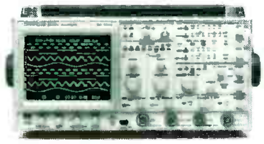


60 MHz $1095
CS-5165



50 MHz $995
CS-5155

40 MHz $895
CS-5135



100 MHZ $1995
CS-6010

150 MHz $2395
CS-6020

KENWOOD

Circle (6) on Reply Card

or clamp down the leads while the soldering tips are still cold. When the operator presses a foot-pedal switch, heat is immediately generated at the tip, which gradually increases in temperature at a rate selected on the power source. After the solder melts, the foot-pedal switch is released and the soldering tips, which are made of a material that the solder won't adhere to, continue to grasp the component or clamp down the leads until the solder cools down and solidifies. This method ensures good alignment of the component with its footprint and makes it possible to solder all of the leads at once, even if some of the leads don't want to lie flat on the circuit board.

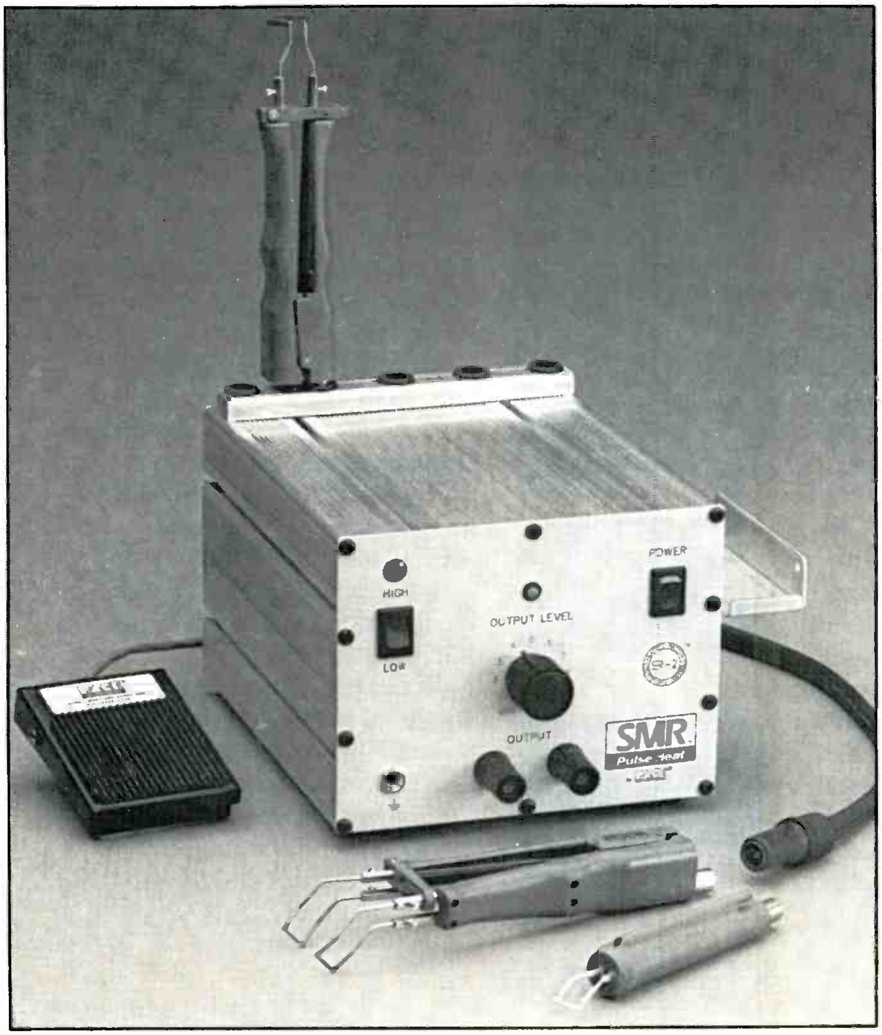
When solder paste is being used to do the soldering, the controlled temperature rise not only minimizes thermal shock to sensitive components but also drives off volatile materials in the solder paste before the solder melts. Eliminating these materials minimizes spattering and formation of solder balls.

Hot-air reflow workstations

The better hot-air reflow systems direct heated air onto the lead attachment area of the SMD being installed or removed. More advanced systems provide the operator with choices of vision systems to be used while aligning the new component to the substrate.

A fine-precision work-positioning table is necessary and critical for accurate alignment and placement of the component to its footprint. Also, closed-loop temperature control of the reflow air or gas is important for proper thermal processing of the workpiece. Precise air/gas temperatures between 500°F and 800°F should be selectable and easily read by the operator. High-capacity heater design increases the ability to maintain constant air/gas temperatures, even over long cycle times.

Service centers that will be performing removal and replacement of 4-sided SMDs (SMDs that have leads or component terminations on all four sides) should consider a hot-air workstation. Targeted hot air will provide uniform reflow of solder without overheating or degrading adjacent solder joints.



Pulse-heat SMD reflow systems are now available, with a wide range of interchangeable handpieces and conductive tips for removal and replacement of most common SMDs.

Removing conformal coatings

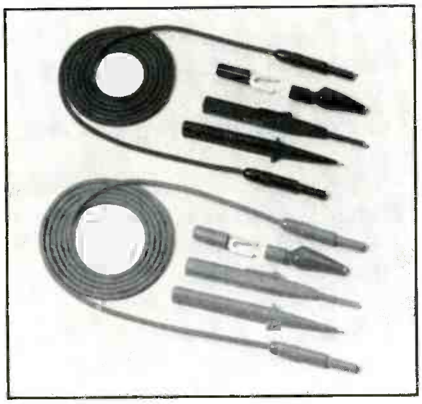
If part of a circuit is covered by a conformal coating, the conformal coating may have to be partially or completely removed from circuitry or solder joints that are to be soldered or desoldered. Coatings can create heat- and air-flow barriers that make it difficult to melt and remove solder joints. Before using vacuum desoldering to remove components from coated assemblies, the coating seal around each of the leads on the component side of the board must be broken to assure a positive air flow path through the solder joint. There are four recommended methods of coating removal: solvent, thermal parting, abrasion and hot-air jet.

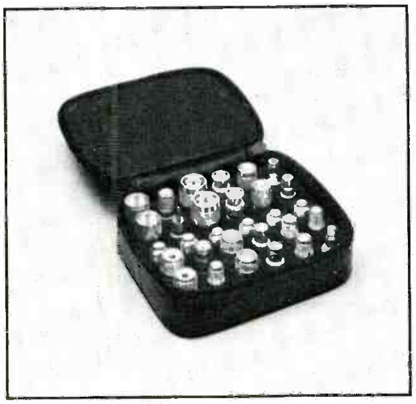
A central rework station should be able to provide the electrical controls and air pressure needed to operate the important tools the operator will use to remove conformal coatings.

The first removal method, called *thermal parting*, employs a controlled, low-temperature, localized heating probe to remove thick coatings with an overcuring or thermal degradation process. Various shapes of temperature-controlled tips, without sharp edges, should be available in a variety of configurations to allow easy access to the workpiece.

A second removal method is performed by using abrasion grinding. A powered machining system should be part of your rework system. It should permit fine fingertip control while providing low RPM at high torque to facilitate manipulation. For a greater degree of control, you should use a miniature machining unit that provides a constant RPM. Constant RPM allows the technician to be concerned with only one variable — the feed pressure applied to the work. Also, beware of rotary systems that offer variable speed. These systems often incorporate a brush motor, which may cause serious electrical overstress (EOS) damage to sensitive components on the board being reworked.

The final method for removing conformal coatings employs a hot-air jet. This method uses a temperature- and flow-controlled air jet to either soften or break down the adhesiveness of the





COAX ADAPTER KIT

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

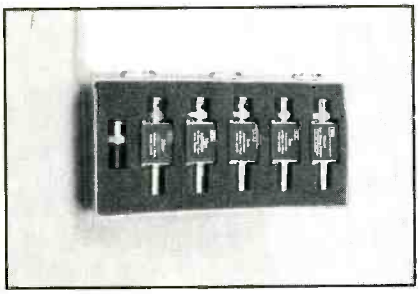
The TPI 3000A kit contains male and female connectors of all 8 types, and 6 universal interfaces. Simply screw any combination of 24 connectors to one of the interfaces to create the desired adapter. $150.
TEST PROBES INC. 9178 Brown Deer, San Diego, California 92121. Call toll-free for catalog: 1-800-368-5719.

Circle (10) on Reply Card

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.

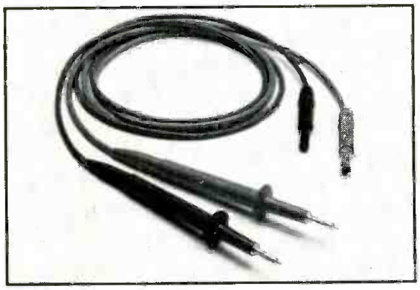
Circle (7) on Reply Card



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 (8) 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. Satisfaction guaranteed.
TEST PROBES INC. Call toll-free for catalog: 1-800-368-5719.

Circle (9) on Reply Card

Circle (11) on Reply Card

coating. With the end of a tool that has a soft, non-marring edge (Teflon, nylon or an orangewood stick), softened or overcured coating may be removed. A rework station should incorporate a hot-air-jet tool that can be attached to a power supply offering temperature control, air-flow regulation and preferably a self-contained air pump.

Repairing damaged pc boards

Damage to conductors on double-sided boards generally consists of a scratch or a complete break in the conductor, or a portion of the conductor might be lifted from the base material. The most reliable method of repair is to replace the damaged portion with new flat conductive material that has equal or greater current-carrying capacity. It should also have physical dimensions that are about the same as those of the original conductor.

A central rework system should contain the following elements to be able to perform this kind of repair:

- pre-tinned replacement conductors.
- a selection of different sizes of eyelets or funnelets for repairing, replacing or installing new plated-thru holes.
- a lap reflow soldering instrument.
- a hand-setting tool or fused eyeletting system for swaging or fusing new eyelets or funnelets to replacement conductor material.
- a miniature machining system, with selection of ball mills, for drilling holes and removing damaged material.

Problems the servicer should attend to but often overlooks are scratched edge connector fingers, or fingers that have been contaminated by solder-splash. To repair, first clean the work area with solvent. Then, using a miniature machining system attached to the rework center, abrade the surface down to the bare copper circuitry. If the connectors are damaged by solder splash, the excess solder must first be removed by the vacuum solder extractor attached to the rework center. The surface should then be abraded down to the bare copper.

When electroplating is required to effect a repair (for example, when circuit board edge connectors are damaged or worn), there are three solutions:

- Electro-Clean: used to remove any remaining oxides and to create a virgin copper surface.
- nickel: provides the underplating or lock-off between the copper circuit and the gold overplate, and prevents base metal migration.
- gold: pure 24 carat gold for high conductivity and lubricating qualities.

If you foresee the need for electroplating in your facility, the rework system you choose should contain a dc power supply for providing the proper plating voltages, the plating solutions, individual swabs, copper tape, plater's tape and color-coded cables to interconnect the power supply with the swabs.

As a final note, remember that any soldering, desoldering or repair system you choose is only as good as the human operator who will be using it. Excellent training programs are available to train any assembler to perform these rework tasks, typically with less than 40 hours of hands-on classroom time.

Although most rework systems that are capable of performing these tasks are reasonably priced, always request a complete demonstration of the soldering, desoldering or repair system you're interested in before you buy. ■

Choosing your desoldering equipment

By Paul Urban

When you need to remove leaded components from printed wiring boards, the most versatile desoldering tool is one designed to melt the solder around one lead at a time and then remove the molten solder with a vacuum. This tool easily desolders resistors, transistors and even multilead integrated circuits. Because technique is important, be sure to follow the manufacturer's recommended removal procedures. You should also choose a tool with the following features:

- power vacuum operation.
- selectable tiplet (nozzle) temperatures.
- closed-loop temperature control of tiplet temperature.
- a large selection of tiplet sizes.

The removal of surface-mount devices (SMDs) requires a different tool. There are two basic types available: contact and non-contact.

The contact tool works like a soldering iron: Heat is transferred from a tip (shaped to match the SMD) to the component's leads, the solder joining the lead to the printed wiring board is melted, and the component is removed. Some contact SMD tools have a vacuum suction cup that removes the component after the solder is melted. If not, tweezers can be used to remove the component. A good contact tool would have all the features recommended for leaded desoldering tools.

Non-contact SMD removal tools typically use hot air to heat the SMD's lead and then use a vacuum suction probe to remove the component. A few manufacturers produce hand-held hot-air tools, but this type of tool usually is part of an automated machine or system. With these tools, the air nozzles are shaped to match the different sizes of components. Some machines also have hot plates that preheat the board, facilitating component removal.

Meeting military specifications

Some companies must comply with military specifications when repairing printed wiring boards. Depending on the contract, the requirements for soldering and desoldering tools will vary. Common specifications are MIL-STD-2000, W-S-6536, W-S-570 and DOD-STD-1686.

The more stringent military specifications require idle-tip temperature controlled to within ±10°F, tip voltage (measured to ground) maintained to within ±2mV, and tip-to-earth resistance kept at less than 2.0Ω. The military also requires that you document periodic test measurements, and sometimes specifies that you protect your tools against electrostatic discharge (ESD) damage. Some soldering and desoldering tools are electrostatic dissipative. Others need antistatic coating to comply.

Trends in board design

There is little doubt that surface-mount technology will continue to replace the leaded through-hole technology. As more and more components become available in SMD packages, more boards will be designed using these components. We should see a steadily growing use of these components in the consumer, industrial and military areas, but leaded through-hole technology won't disappear.

Urban is the research and development manager at Weller, Raleigh, NC.

Rental instrument catalog

The 1989-90 rental catalog from *Genstar Rental Electronics* features equipment from major instrumentation manufacturers, including Hewlett Packard, Tektronix, Intel, Fluke and others. Product categories include analyzers, meters, generators, oscilloscopes, desktop computers, and telecommunications.

Circle (125) on Reply Card

Tool catalog

The *Jensen* 1989-90 catalog includes Jensen's tool kits and cases, plus test equipment from other manufacturers. The catalog features diagnostic software, field-service scopes and meters, hand tools and soldering equipment. The catalog also describes the company's custom kit design and free technical support services.

Circle (126) on Reply Card

Wire and cable catalog

Belden Wire and Cable is offering a 382-page catalog covering the company's product line. Product families include hook-up, multi-conductor, paired, coaxial, LAN, flat cable and connectors, fiber-optic, process control and special application wire and cable; power-supply cords; and molded cable assemblies. Also included is a cable finder chart, a part-number index, a standards reference guide, an NEC reference chart and a glossary of terms.

Circle (127) on Reply Card

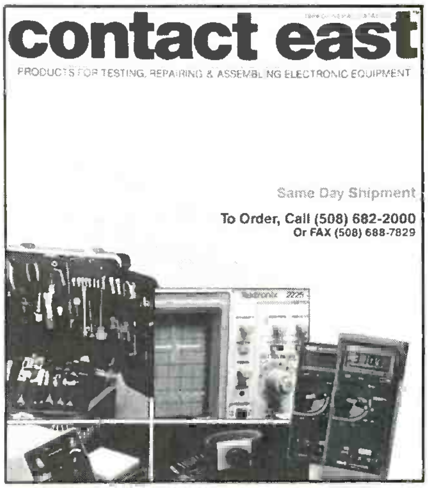
Test equipment catalog

Catalog number 21 from *Leader Instruments* is a 96-page catalog featuring the company's line of test equipment. Specifications are included for more than 100 products, including 13 new instruments. The catalog also contains "A Guide to Basic Needs," which describes the different stages of electronic testing and the instruments that are used.

Circle (128) on Reply Card

Electronics servicing catalog

Contact East is offering a 1989 supplement to its General Catalog, which features products for testing, repairing and assembling electronic equipment. The catalog features new products, including analog/digital oscilloscopes, static protection products, test equipment, precision hand tools, soldering supplies and stations, tele/datacommunications test instruments, tool kits, wire and cable aids, electronic adhesives and inspection equipment.



Circle (129) on Reply Card ■

Test your electronics knowledge

By Sam Wilson, CET

1. The gaps in the lissajous pattern in Figure A are produced by an input signal to ______________.

2. Connect a circuit across the battery output terminals in Figure B to get a positive and negative voltage.

3. To get the maximum output voltage from the transformer in Figure C, you should
A. connect terminal A to terminal C and take the output across terminals B and D.
B. connect terminal B to terminal C and take the output across terminals A and D.

4. Make the necessary connections in Figure D so that the lamp can be turned on or off by either switch.

Wilson is the electronics theory consultant for ES&T.

5. A certain type of resistor has a decreasing resistance as the voltage across it increases. Circle the letters that describe the resistor.
G B C E V O M D A R

6. Which of the following bridge circuits is used for measuring resistance?
A. Hay Bridge
B. Maxwell Bridge
C. Kelvin Bridge
D. Owen Bridge

7. If you must get involved in mixing the electrolyte of a lead acid battery, remember that you must NEVER
A. add acid to a container of cold water.
B. add water to a container of cold acid.

8. Which of the following could be used to increase the resonant frequency of a hertz antenna?
A. Add a loading coil at the base (in series with) the antenna.
B. Cut off some material from the top of the antenna.

9. A BFO might be used for
A. protection against transient voltages.
B. protection against inductive countervoltage.
C. terminating a transmission line.
D. detecting a CW signal.

10. Which of the following determines the pitch of a sound?
A. amplitude
B. frequency
C. waveshape
D. phase

Answers are on page 18.

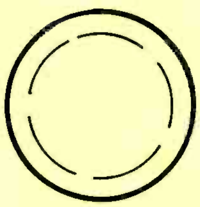


FIGURE A

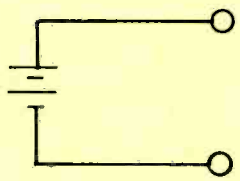


FIGURE B

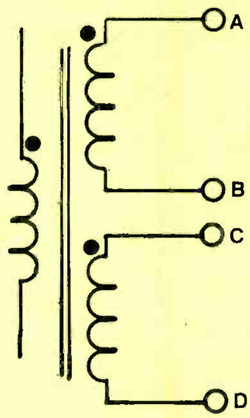


FIGURE C

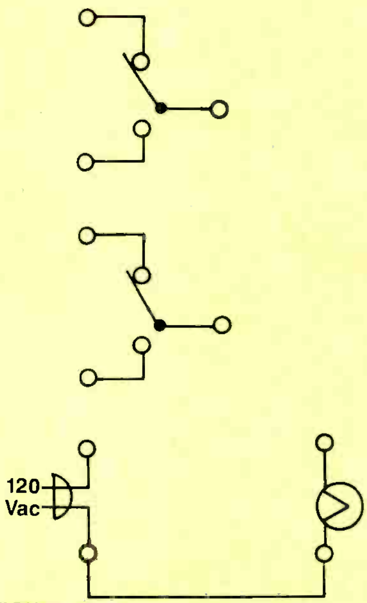


FIGURE D

Desoldering station

The OK Industries model SA-600115 voltage-regulated desoldering station, available from *Contact East*, has a 20V handpiece with a 65W ceramic heating element for fast thermal recovery, which allows it to be used for quick, continuous desoldering. It has a dial-adjustable temperature control with a range of 660° to 888°F. The built-in, diaphragm-type vacuum pump develops 21 inches of mercury and allows the unit to be used anywhere there is an electrical power source. The unit comes with felt and steelwool filters, anti-seize compound, a desoldering gun with tip, a sponge, and cleaning tools for the desoldering tip and barrel. The station operates on 115Vac (3-wire cord).

Circle (73) on Reply Card

Portable power conditioners

The portable PPC series Stabiline power conditioners from *The Superior Electric Company* maintain conditioned voltage to voltage-sensitive equipment. They maintain output voltage at 120V ±5%, 60Hz over an input range of 95V to 132V. They also provide 120dB typical common-mode noise rejection and 60dB typical transverse-mode noise attenuation.

Circle (74) on Reply Card

Remote control tester

Sunset Unlimited has introduced a remote control tester designed to reduce time on remote-related problems of audio and video equipment. Infrared signals from a suspect remote control are audibly detected from each control button, which isolates the problem to transmitter or receiver. The remote control tester can be connected to an oscilloscope or external amp and does not require a power source or amplifier.

Circle (75) on Reply Card

Aerosol chemical products

Philips ECG has developed a line of aerosol chemical products for electronic and electrical applications. There are a variety of cleaners, degreasers, lubricants, testing and shielding agents formulated to meet most industrial/MRO and equipment service requirements.

Circle (76) on Reply Card

Surge protectors

Stedi Watt's Diagnostic Power Refineries offer electronic surge protection with replaceable protection modules. The user now can detect power faults or hazards that are unsafe for computer-grade power. The devices have 3-mode, high-energy surge dissipation built into the replaceable protection modules. Other features include a resettable circuit breaker and triple-insulated cords.

Circle (77) on Reply Card

Continued on page 37.

Answers to the quiz

Questions are on page 16.

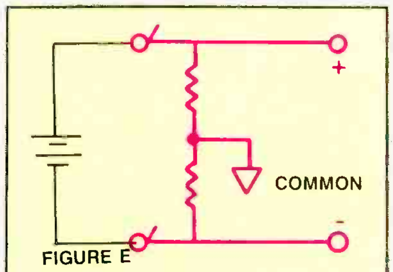


FIGURE E

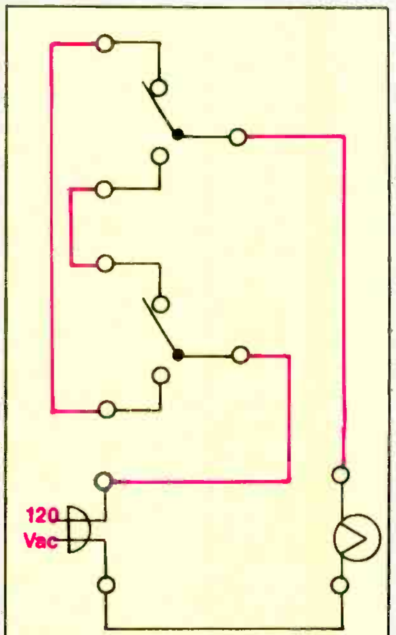


FIGURE F

1. Z axis. The Z axis is sometimes called intensity modulation. An input signal at the Z axis can be used to turn the electron beam on and off, producing the gaps in Figure A. For many oscilloscopes, an amplitude of the voltage needed to produce blanking is quite high. For example, in one scope the voltage applied to the Z axis must have an amplitude of at least 30V to affect the brightness of the trace.

2. Refer to Figure E. This circuit can be used with a floating power supply to get a positive and negative voltage for operating an operational amplifier.

3. B. To get the maximum output amplitude, connected the windings in series by connecting B and C together. Note that the dots on the symbol show points where the voltages are in phase.

4. Refer to Figure F. This arrangement is sometimes called a 3-wire installation.

5. The question describes a voltage-dependent resistor (VDR). Those are the letters you should have circled.

6. C. A Kelvin bridge is used for measuring very low resistance values. It accomplishes this by compensating for the resistance of the connections to the bridge. The other three bridges mentioned in question 6 are used for measuring inductance.

7. B. Adding water to acid can invite serious sputtering, which is a danger to your eyes. Also, if the container is closed, a minor explosion can take place. Take the time to read the instructions carefully before you attempt to combine acid and water. Choice A describes the correct procedure. Note that cold water is recommended.

8. B. If you want to increase the resonant frequency of an antenna, you can snip off some of its length. This procedure is not recommended for mobile antennas. The next time you look at the antenna on your car, observe the very small knob at the top. Its purpose is to reduce the possibility of electrostatic energy leaking into the air. The result of snipping off this knob is a greatly increased chance of undesired noise in the antenna system.

9. D — detecting a CW signal. Product detectors are also called synchronous detectors; they are sometimes called heterodyne detectors. A BFO in modern communications receivers can be used to detect single sideband signals and suppressed carrier signals as well as CW signals in an AM receiver.

10. B — frequency. The term *pitch* is used in sound-wave terminology.

Feedback

A 0Ω resistor?

I work as a repair technician for a computer company. We use a component we call a 0Ω resistor (even though it is a contradiction in terms). This might be a similar component to the one mentioned in "What Do You Know About Electronics? — Quiz Feedback" in the June 1989 issue.

The author is correct in assuming they are used as conductors that patch between two connectors. In my company they are used on some of our older printed circuit boards as jumpers or signal patch selectors. I've also seen them used on single-sided boards to provide means for circuit traces to cross over other traces.

The only logical solution I could think of is they are being used instead of wire jumpers so they can be inserted into boards using automatic insertion equipment. The composition of the component's casing wasn't mentioned, but if the material surrounding the conductor is ferrite, the component probably is a high-frequency choke working on the same principle as the ferrite beads placed on component leads in UHF and VHF tuners. If the casing is plastic, the first solution is still valid.

Peter M. Wisniewski
Cambridge, MA

Quiz error

In regard to the answer to question number eight in the September 1989 "Test Your Electronics Knowledge," I believe an error was made. The answer should be 24Ω. (The current is 0.25A, not 0.5A.)

Richard Balder
Onamia, MN

You are absolutely right. The answer to question eight was wrong. I'm sorry about the careless error. For those who sent letters, thank you.
Sam Wilson

*Have a comment, a correction, an opinion? Drop us a line. If the subject matter would be of general interest to the **ES&T** audience, we'll publish it here. Send your feedback to:*

Conrad Persson, editor
Electronic Servicing & Technology
P.O. Box 12901
Overland Park, KS 66212

If you are looking for a source for parts or servicing information, or if you have located a hard-to-find source, send that information to Information Exchange, Electronic Servicing & Technology, P.O. Box 12901, Overland Park, KS 66212, Attn. Conrad Persson, editor.

Information Wanted

Cassette deck assembly for a Wilco CRS-7000 stereo 4-band radio cassette tape recorder. (Electronic Warehouse, Panson, Audio and Video were unable to help.)

Replacement transistor (FSE 5025-051) for Alliance Genie AT203. Part is not in replacement manual.

Source for schematic for a Liberty Electronics model NOSN500A.

Information Found

Lloyds model L838 series 821A VCR parts and Magnasonic TV parts are available from M.L. Corporation, 1959 Leslie St., Donmills, Ont., Canada, M3B 2M3. Parts and schematics for Lloyds equipment can be ordered from Lloyds Electronics, 180 Raritan Center Parkway, Edison, NJ 08818, 210-225-2030.

Fisher TV parts — try Sanyo.

Video Concepts HT2000 — Mitsubishi will give its equivalent number.

Samsung VT-210 TB VCR — Samsung Electric America, 301 Mayhill St., Saddlebrook, NJ 07662.

Parts, schematics, etc., for Phonemate answering machines can be ordered from Audio Video Parts, P.O. Box 19670, 1071 S. LaBrea Ave., Los Angeles, CA 90019; 213-933-8141.

The STK5486 replacement IC voltage regulator chip for an Emerson model VCS966A VCR is listed in the MCM Electronics catalog. Contact MCM at 650 Congress Park Drive, Centerville OH 45459; 800-543-4330. (Original part number was #STK5486.)

REQUEST/SOURCE FOR INFORMATION

Name: ______________________

Street: ______________________

City: ______________________

State: ____ Zip: ______

Telephone number: ______________________

Information requested/provided: ______________________

Model/part number: ______________________

Manufacturer: ______________________

Where have you checked? ______________________

Selecting a UPS

By Stewart W. Nowak

When the lights go out or even blink momentarily and you hear your personal computer power down, it's obvious that such a power problem can be devastating to the computer — you may face erroneous transmissions, lost data, damaged hardware or wasted time. However, some of the power problems that occur all the time can't be seen or felt: transients, surges, spikes, voltage/frequency instability from facility generators, and sustained low voltage can have just as damaging a cumulative effect.

Surge and spike suppressors, isolation transformers, voltage regulators, line conditioners and uninterruptible power systems (UPSs) reduce the effects of these problems. Although each device combats specific power problems, only a UPS is designed to continue producing voltage-regulated, frequency-stable power during blackouts and sustained brownouts, thereby protecting valuable data and allowing an orderly shutdown. A well-designed UPS should incorporate the protective features of each of the other devices. Today's volatile RAM storage has made power protection a necessity in companies in which protecting computer data is critical.

Today's UPS designs come in three basic types: off-line, hybrid and on-line. Each type, in turn, can feature one or more technical variations, although the basic operation is nearly the same.

All UPS units use an internal battery that produces ac power via an inverter. How and when this inverter comes into play largely determines a UPS's effectiveness.

The off-line UPS

The off-line UPS (see Figure 1) is the simplest form of backup power system. The term *UPS* is really a misnomer because the inverter is normally off. For this reason, the off-line UPS is also known as a standby power source (SPS). During normal operation, an SPS routes raw utility ac power directly to the computer while trickle-charging the battery. When the incoming utility voltage drops below a certain value (typically 102Vac), a detection circuit switches onto battery power via a dc-to-ac inverter. This switchover causes a loss of power, or *glitch*, lasting typically 5ms to 10ms.

An SPS theoretically is designed to switch onto its battery before the microprocessor in your system senses a power loss. In many situations, an SPS can be an inexpensive solution to blackouts. However, during normal operation, these units provide no line conditioning, voltage or frequency regulation and little or no surge and spike protection.

During sustained low-voltage periods below 102Vac (brownouts) or while operating from a facility generator, an SPS can inaccurately sense a blackout and prematurely switch onto battery. If you experience a sustained brownout, take successive low-voltage hits, or run off generator power, an SPS can completely discharge its battery and crash your system, even though your building's lights might still be on. In addition, most SPS switching times increase as the utility voltage decreases. It is not uncommon for a unit with a 5ms transfer time at 120Vac to exceed 20ms at 100Vac. Because a brief period of low voltage precedes most blackouts, this may place a computer system at even greater risk.

The only significant advantage of an off-line UPS is its low cost. The unit can be less expensive because the inverter in these systems is normally off, so the charging and sense circuits are simple and inexpensive.

The inverter in these devices will almost never operate for more than a to-

Nowak is sales manager-power products at Clary, San Gabriel, CA.

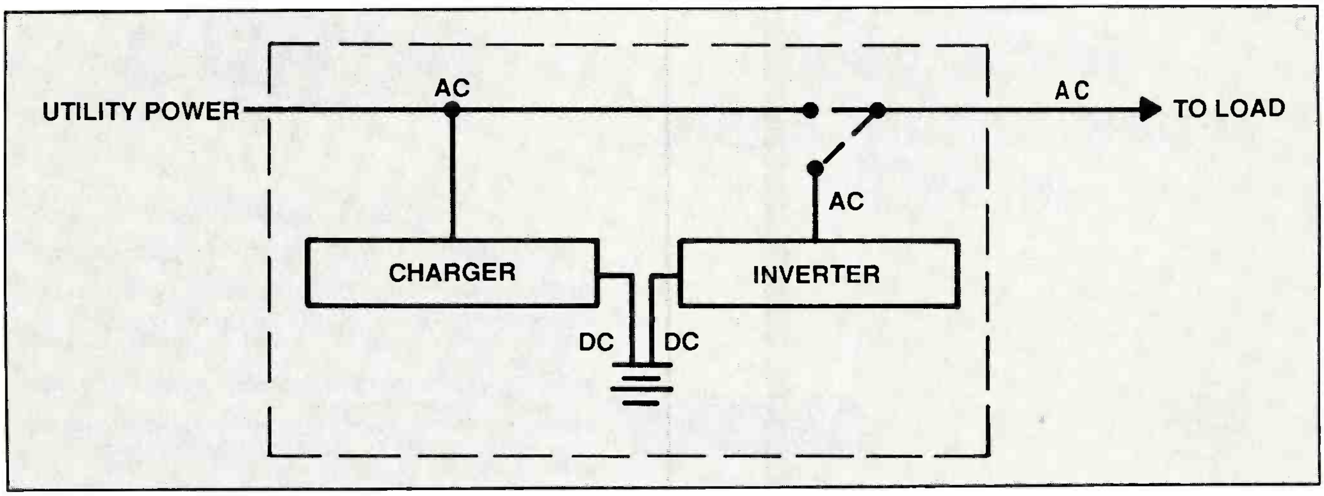
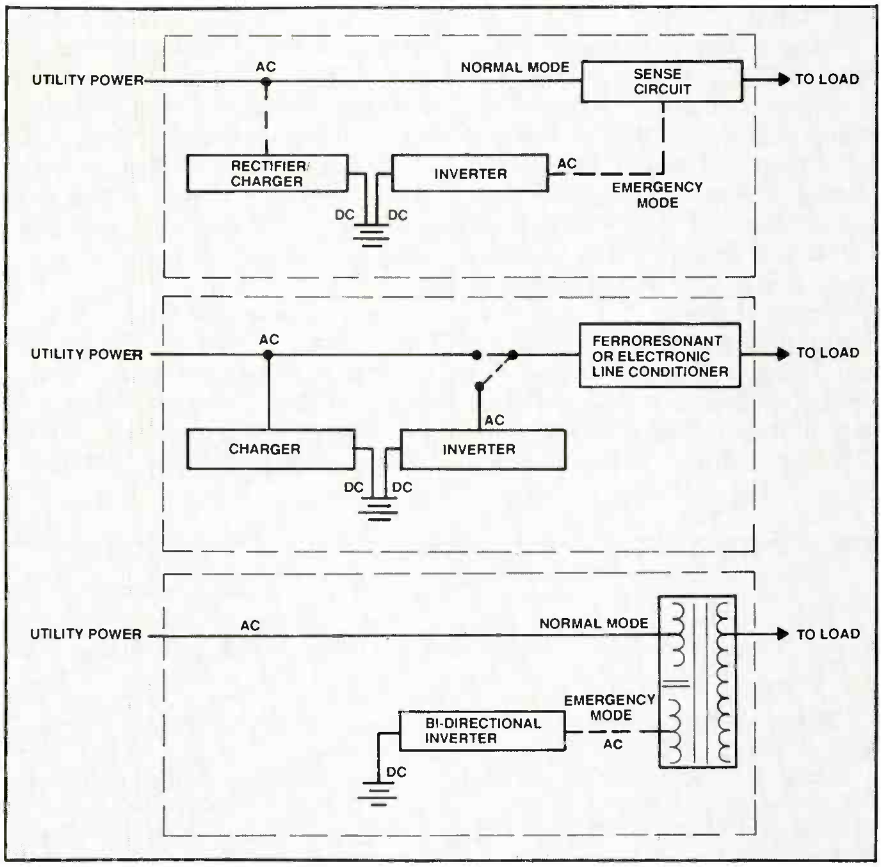


Figure 1. The off-line UPS is usually inexpensive and lightweight, but it does have some disadvantages: it causes a switching glitch of 5ms to 20ms; it has no line conditioning or regulation; it can be "fooled" by brownouts and frequency shifts; it usually doesn't have sine-wave output; and its switching time can triple during brownouts.

Figure 2. The hybrid UPS is sometimes less expensive and has fewer components, but it is inherently an off-line unit. Other disadvanges are its "ride-through" feature, which is often ineffective; it can be "fooled" by brownouts and frequency shifts; it has limited line conditioning and poor regulation; and it can be heavy and bulky.



tal of 72 hours over its lifetime. As a result, the inverters never pass the traditional infant mortality or *burn in* stage and are typically not suited for critical applications.

The hybrid UPS

Some off-line systems add surge and spike suppressors, ferroresonant or electronic line conditioners, or utility-interactive designs. The price goes up with each modification. A UPS with line conditioners or interactive designs is known as a *hybrid UPS*. (See Figure 2.) This type of device is called a confusing array of descriptive names, including triport, line interactive, electronic flywheel, hot standby, no break, load sharing, bi-directional and single conversion.

The addition of electronic or ferroresonant conditioners or an interactive design is intended to smooth out the load transition from utility-supplied to inverter-supplied power. A typical hybrid attempts to eliminate the switching glitch or resulting inverter output droop by using the capacitance of its electronic or ferroresonant conditioner to bleed onto the load line while the unit switches the entire load from the utility onto its inverter and battery.

In reality, this "ride-through" concept does not always work. During this switchover, the output voltage of some units can drop as much as 35V. Like the SPS, the hybrid can misinterpret brownouts as blackouts and prematurely switch to its batteries. Also like the SPS, hybrids' switchover times can more than triple during low-voltage conditions, often exceeding the ride-through of the conditioner as well as the hold-up capacity of a switching regulator load. Again, the load is left only partially protected and is at risk.

The on-line UPS

In contrast, the on-line UPS always operates on its inverter and no switching takes place. A well-designed on-line UPS (Figure 3) is a solid-state generator that continuously breaks down and filters utility ac power to dc. Then, via its inverter, it provides new, clean ac power in a perfect sine waveform for complete power protection. Regardless of the utility power's condition, the output of an on-line, sine-wave UPS remains rock steady at 120V, 60Hz (or any other established voltage/frequency). It protects against blackouts, surges, sags, spikes, transients, noise, frequency variations and brownouts.

Until recently, the one drawback with the on-line UPS has been a higher price. Recent advancements, however, have resulted in on-line, sine-wave units that are actually smaller and lighter than

Evaluating UPS performance

Evaluating and selecting a UPS from the numerous models available can be complex, but it need not be difficult. The following questions should help you discern the highest quality UPS for your application.

1. Is it off-line (fair), hybrid (better) or on-line (best)?

2. To know if a UPS is on-line, ask if the rectifier powers the inverter, which in turn powers 100% of the load continuously. If yes, it is on-line; if no, it is off-line or hybrid.

3. Is the inverter output square-wave (fair), quasi sine-wave (better) or sine-wave (best)? To know if a UPS provides a clean sine wave at all times, you can ask the manufacturer for photographs of its output waveform at full load, both on utility power and on battery. The two can be very different. They should both be a smooth, undistorted sine wave.

4. What is the lowest input voltage it can accept without discharging the battery? (The lower, the better.)

5. What is the crest factor ratio (repetitive peak current divided by rms current) at 100% non-linear load when total harmonic distortion is maintained at less than 5%? (The higher, the better. If the vendor cannot answer this, be careful.)

6. Can the backup time be extended? (The longer, the better.)

7. Does it maintain at least ±3% voltage regulation during battery operation all the way down to low-battery shutoff? (If not, you are not receiving adequate protection and may be exposing yourself to actual hardware damage.)

8. What range of input frequency can the unit accept without discharging its battery? (The wider, the better, especially for use with on-site generators.)

9. Is it UL-listed? Does it meet FCC 15J and pass IEEE 587 requirements? (The answers should all be yes.)

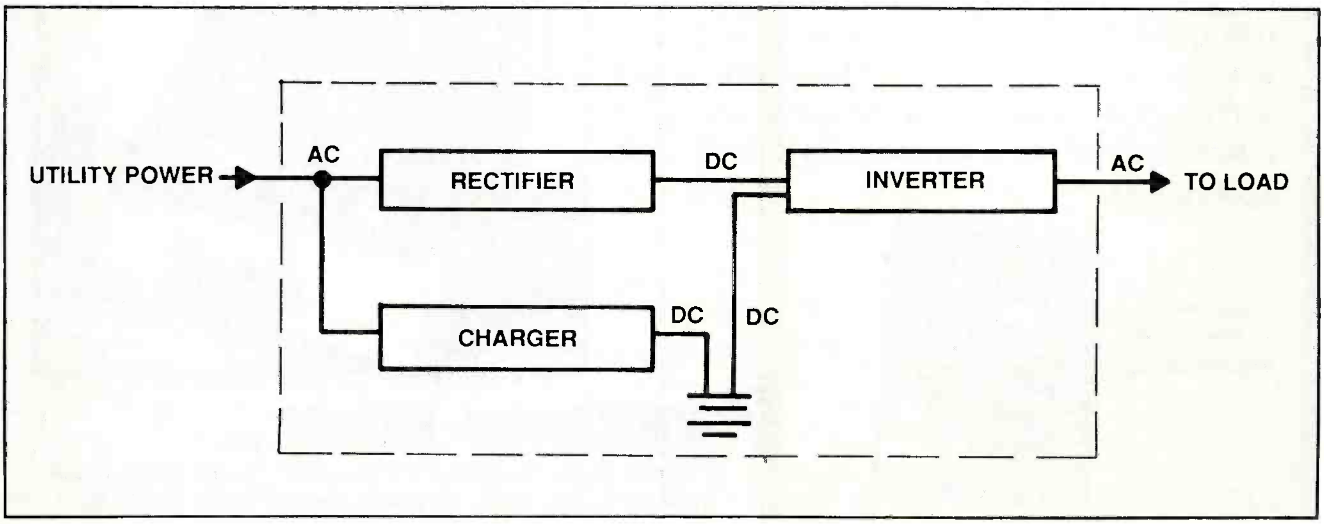


Figure 3. The on-line UPS offers no switching, 100% line condition and regulation, sustained brownout protection and sine-wave output. However, it is usually more expensive, larger and heavier. The unit's inverter powers 100% of the load at all times.

most off-line or hybrid units, yet are only marginally more expensive.

Sine wave vs. square wave

All three UPS types are available with sine-wave or square-wave outputs, or some modification thereof. (See Figure 4.) Sine wave power is best because it is the same as the waveform provided by the utility company. Most loads prefer a sine wave because they consist of linear or rms-sensitive elements and non-linear or peak-sensitive elements. A square-wave output only approximates the utility waveform and overstresses the rms-sensitive system elements while starving the peak-sensitive elements. The result can be overheating and premature component failure.

Today's computer systems employ switch-mode power supplies with charge-storage capacitors that draw power in the form of non-linear, repetitive, high-peak current. This current is typically more than double the linear rms current. The UPS must be able to support these non-linear elements whether the load is receiving its power from the utility or the battery/inverter

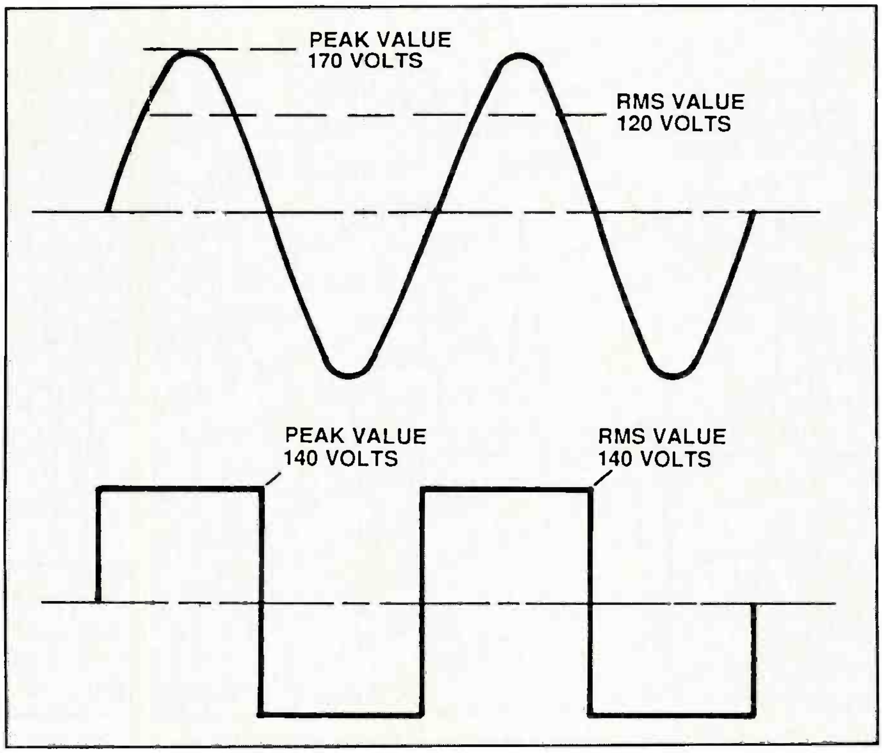


Figure 4. Computer systems contain a mixture of rms- and peak-sensitive loads that are meant to operate off of utility sine-wave power. A properly designed UPS has to produce this same true sine-wave output. A square-wave output can severely overstress some loads while starving others.

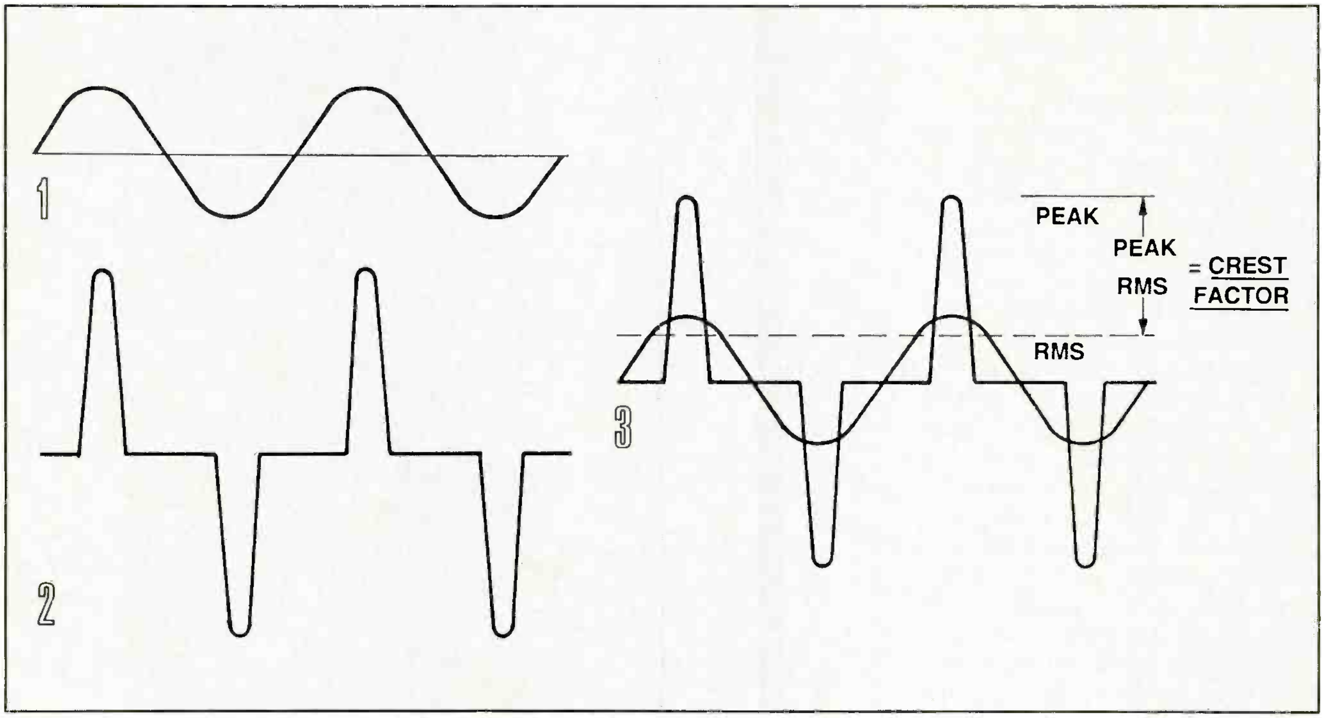


Figure 5. The traditional linear load is typical of light bulbs, motors and very old computers. Today's non-linear load is represented by computers, PBXs, LANs and instrumentation. A high ratio between the unit's non-linear (rms) and linear (repetitive peak) output current — the *crest factor ratio* — will give better performance with a non-linear load.

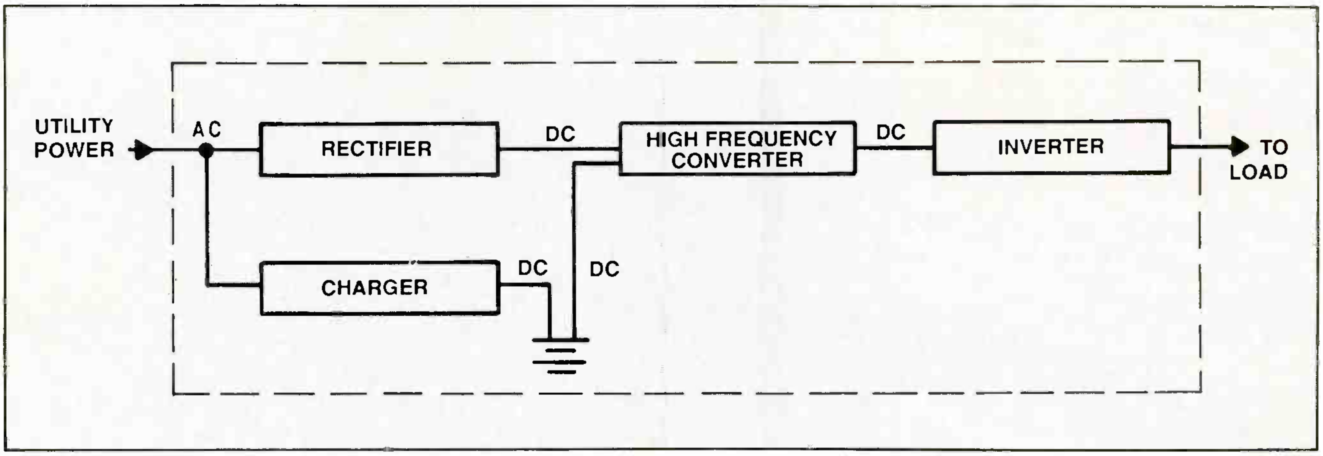


Figure 6. Newer generation UPS systems provide on-line topology with a sine-wave output generated by a high-frequency, PWM inverter. A low-impedance filter replaces the output transformer. These units can be smaller, lighter and nearly the same price as off-line and hybrid systems.

without distorting the output waveform.

Figure 5 compares the classic linear rms current waveform with the non-linear waveform of a switching power supply. The ratio between the non-linear (repetitive peak) current and the linear (rms) value is called the *crest factor ratio*. The higher a UPS's repetitive peak current capability in relation to its rms capability, the larger the crest factor ratio and the better the performance with a non-linear load.

These are relatively new specification items for most vendors and will not appear in all literature. Look for high crest factor or peak-current-to-rms values — the higher, the better, provided there is an accompanying value of less than 5% total harmonic distortion (THD) with a 100% non-linear load. Without this THD value, the crest factor ratio is meaningless. The absence of these can be a tip-off that the manufacturer has not addressed this critical issue.

THD is an important factor because most UPS systems become overloaded and distort the waveform when supporting non-linear loads that approach the UPS's rating. Don't be fooled by UPS nameplate ratings either. A UPS rated at 750VA with a high crest factor ratio (2.5 or higher) will typically support the same non-linear load as a 1,000VA unit with a low crest factor ratio (2.0 or less).

Today's state-of-the-art UPS provides on-line topology with a sine-wave output generated by a high-frequency, pulse-width-modulated (PWM) inverter. A newer generation UPS adds a dc-to-dc converter and removes the output transformer common to most UPS units, replacing it with a sophisticated low-impedance filter. (See Figure 6.) Without oversizing, this type of system provides clean, repetitive peak power at less than 5% THD. These new units can cost less and actually be smaller than some SPS systems. ■

Power conditioners

Shape Magnetronics has introduced 800VA, 1,000VA and 1,200VA power conditioners to its line of PC Line Tamers. Designed to protect PCs and peripherals from surges, brownouts and overvoltages, the units remove spikes, transients, common- and transverse-mode noise and provide line insolation. Output is 120Vac with wall-outlet input ranges from 95Vac to 132Vac with regulation of ±5%. Noise rejection is 120dB common mode, 60dB transverse-mode. Spike-attenuation mode is 250:1. All models meet ANSI standard C62-41 for surge repression.

Circle (78) on Reply Card

Surge suppressor

The model RTD410 communications surge suppressor from *Perma Power* is available to protect fax equipment and computers with modems against surges on both power and telephone lines. The outlet strip has four power line outlets, one telephone line output and one telephone line input. The suppressor circuit uses a 3-element gas tube and three metal oxide varistors. The unit disconnects equipment from the power line if the power-line surge suppressor element fails.

Circle (79) on Reply Card

Solder tool

Portasol has introduced a cordless, refillable butane-gas powered soldering tool for micro-precision applications. The tool features a flint-sparked ignition in the cap and also has an adjustable temperature-control range equivalent to 10W to 60W. Accessories available include a range of soldering tips, a blow torch, a hot blower and a hot knife.

Circle (80) on Reply Card

Video display restorer

Two video display restorer/analyzers designed for computer video terminals, video monitors and TV receivers have been introduced by *B&K-Precision*. The model 490 tests all three CRT gun colors simultaneously and analyzes cathode-to-cathode and G1-to-cathode leakage. Focus electrode continuity also is tested. Restorative functions include shorts removal, gun cleaning and balancing, and cathode rejuvenation. The model 480 features a single meter for testing and doesn't include line-voltage testing.

Circle (81) on Reply Card

Autoranging DMMs

ARI/American Reliance's models AR-3010 and AR-3100 3¾-digit, programmable, autoranging DMMs offer a fast-display mode that updates every 50ms. Other features include an audible continuity check, an AutoData-hold mode, a relative measurement mode, MIN-MAX memories, logic monitor modes with selectable variable thresholds, and range hold. Basic measurement ranges are dc voltage, ac and dBm, dc and ac current, diode junction and resistance. The DMMs offer 40-segment bar graphs and a safety alert, which produces an audible tone whenever 20V is exceeded.

Circle (82) on Reply Card ■

A VCR repair case history – an update to the sequel

By Victor Meeldijk

The second article in this series (See "A VCR Repair Case History — the Sequel" in the October 1988 issue) contained details on the removal and replacement of the clutch tire in a Fisher VCR. But what if the chassis doesn't have a cut-out for removal of the idler gear? Here is another repair method, plus a theory about why the idler tire wears out.

Removing the idler gear

In the October 1988 article, step number nine in the sidebar, "VCR Disassembly Steps," said to turn the assembly to the left to move the gear into an area where it can clear the chassis. (See Figure 1.) A reader has asked how to do the idler tire replacement on a chassis that doesn't have this cut-out area in the chassis. The service manual calls out for the removal, and later realignment, of timing gears, the capstan motor, reel assembly brackets and the loading motor.

If you want to remove the tire without removing the idler gear, all work has to be done through the top of the chassis (a little like microsurgery — doing all the work through a small incision). It is possible, although it does require some dexterity, as illustrated in the disassembly steps. The initial steps are the same as in the second article in this series. The bottom cover is still removed, but after the stopper washers are taken off the idler and idler gear assemblies, these parts are not taken out of the VCR. Stopper washer removal is done to allow some movement in these assemblies so that the idler tire can be pulled out through the top of the chassis. The whole procedure took me about an hour, but considering that this included devising the procedure and taking photo-

Meeldijk is the reliability/maintainability engineering manager at Diagnostic/Retrieval Systems, Oakland, NJ.

Figure 1. The notch in the VCR chassis may not be in all models to allow for easy removal of the idler gear assembly.

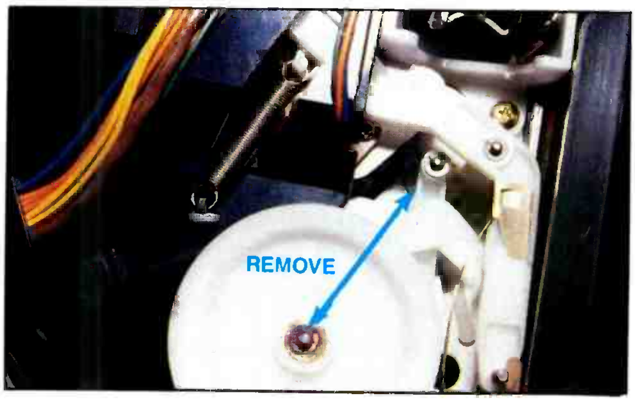


Figure 2. Remove the stopper washers from the gear idler and idler assemblies.

Figure 3. With the idler almost all the way to the right, gently press it through the chassis. Roll the tire free from the idler wheel, then grab it with a parts picker held in the right hand.

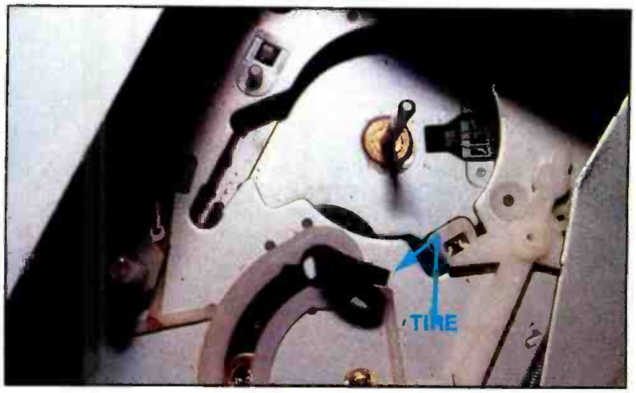


Figure 4. Free the tire completely from the idler so it is sitting on top of the idler wheel. Slip the idler tire through the top of the chassis.

graphs for this article, it should only take 20 to 30 minutes to complete.

1. Disconnect power from the VCR and remove the top cover. (Remove the two screws on each side of the unit, then lift the cover up from the rear.)

2. Remove the idler spring (Fisher P/N 143-2-6604-0540).

3. Lift off the stopper washer (143-2-6304-01800) that secures the take-up reel.

4. Holding only the take-up reel sub-brake take-up assembly, slowly lift the reel out of the VCR. Be careful not to lose the washer (143-2-6304-02900, 03000 or 03100, depending upon adjustments made to the reel height of the VCR — see the next section for more on this) just under the reel. Slowly release the brake assembly so the spring (143-2-6604-04300) doesn't fly loose. (Note: The VCR uses a Hall-effect sensor; magnets embedded in the reel send signals to the tape-footage counter.)

5. Put the cover back on but do not screw it in place. Turn the VCR over and remove the screws securing the bottom cover. Lift the cover off from the front of the VCR.

6. Remove the stopper washers from the gear idler and the idler (washer P/N 143-2-6304-01500), as shown in Figure 2, but do not remove these assemblies from the VCR. Remove the drive belt.

7. Replace the bottom cover, then temporarily secure it with one or two screws. Turn the VCR over and remove the top cover again.

8. With the idler moved almost all the way to the right, exposing part of the idler tire, gently press the idler down through the hole in the chassis. (See Figure 3.)

9. Roll the exposed edge of the tire down, or up, with the left index finger. When it separates from the idler, grab it with a parts picker.

10. Using the parts picker and your index fingers, free the tire completely from the idler so it is sitting over the idler wheel. (See Figure 4.)

11. Move the idler back and forth so the idler tire can be slipped out through the top of the chassis.

12. Slip a new tire through the slot. Use the parts picker to hold the right side of the tire; with a small slotted screwdriver (jeweler type 1.4mm, for example), pull the left side of the tire and slip it over the bottom (the edge toward the front of the VCR) of the idler wheel. Stretch and roll the tire with your free fingers until it snaps into the top part of the idler wheel. This method will be a bit tricky, but it can be done.

13. Pull the idler wheel back up through the chassis. (Use the parts picker.)

14. Reassemble the VCR, reversing steps 1 through 7.

Why do idler tires wear?

In a different reader's letter, a solution to the rapid wear of the idler tire was offered. A thin metal washer was added by this technician under the take-up reel to raise the reel and reduce the Hall-effect magnets' pull on the chassis. This pull, it was theorized, caused rapid tire wear because increased reel torque was needed to move the reels.

According to the Technical Service Department of Sanyo/Fisher (213-537-5830), some models, but not usually the FVH-839, do have reels that sit low on the chassis and, because of wear, will grab the chassis, causing a drag on the reels. The reel height should be checked and adjusted to prevent this, and a cassette housing positioning jig and washers are available. (For the FVH-839, the jig is SVJ-00010 and costs about $450, which even Sanyo/Fisher admitted was expensive if the servicer doesn't do much VCR servicing.)

Both reels need to be checked and adjusted because the supply reel as well as the take-up reel contain magnets for Hall-effect sensors. Idler tires in the older model Fisher units (such as the FVH-510 and 515) last about three times as long as the newer Fisher models (such as the FVH-839) because two tires were used, one for each reel. A ball bearing type assembly under the reels also reduces friction. The newer models only use one tire, have plain washers under the reels and have Hall-effect sensor magnets that will contribute to rapid tire wear. (Replacement time for the older models is five to six years; the newer models require replacement in about a year and a half to two years.) ■

ES&T STATEMENT OF OWNERSHIP

Statement of Ownership, Management and Circulation (Act of August 12, 1970; Section 3685, Title 39, United States Code).

1. Title of publication: Electronica Servicing & Technology

1A. 03610942.

2. Date of filing: Sept. 29, 1989.

3. Frequency of issue: Monthly.

3A. Number of issues published annually: 12.

3B. Annual subscriprion price: $19.49 U.S

4. Location of known office of publication (street, city, county, state, zip code): 9221 Quivira Road, Overland Park, Johnson County, Kansas 66215.

5. Location of the headquarters or general business offices of the publishers (not printers): 9221 Quivira Road, Overland Park, Johnson County, Kansas 66215.

6. Names and addresses of publisher, editor, and managing editor. Publisher (Name and Complete MAiling Address): Eric Jacobson, 9221 Quivira Road, Overland Park, Kansas 66215. Editor (Name and Complete Mailing Address): Nils Conrad Persson, 9221 Quivira Road, Overland Park, Kansas 66215. Managing Editor (Name and Complete Mailing Address): Tom Cook, 9221 Quivira Road, Overland Park, Kansas 66215.

7. Owner (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given. If the publication is published by a nonprofit organization, its name and address must be stated.) Intertec Group, Inc., 599 Lexington Ave., 36th Floor, New York, NY 10022.

8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities (if there are none, so state): None.

9. Paragraphs 7 and 8 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner. Names and addresses of individuals who are stockholders of a corporation which itself is a stockholder or holder of bonds, mortgages or other securities of paragraphs 7 and 8 when the interests of such individuals are equivalent to 1 percent or more of the total amount of the stock or securities of the publishing corporation.

10. This item must be completed for all publications except those that do not carry advertising other than the publisher's own and are named in sections 132,231, 132,232 and 132,233, postal manual (Sections 4355a, 4354b, and 4356 of Title 39, United States Code).

	Average No. Copies Each Issue During Preceding 12 Months	Single Issue Nearest To Filing Date
A. Total No. Copies Printed (Net Press Run)	42,133	38,900
B. Paid and/or Requested Circulation		
1. Sales through dealers and carriers, street vendors and counter sales	87	79
2. Mail subscriptions	39,515	37,568
C. Total Paid Circulation	39,602	37,647
D. Free Distribution (including samples) by mail, carrier delivery or other means	791	597
E. Total Distribution (Sum of C and D)	40,393	38,244
F. Office use, left over, unaccounted, spoiled after printing	1,740	656
G. Total (Sum of E and F should equal net press run shown in A)	42,133	38,900

I certify that the statements made by me above are correct. (Signature of editor, publisher, business manager, or owner.)

Sandra Stewart,
Circulation Director

Troubleshooting varactor tuners – Part I

By Stephen J. Miller

Varactor tuning systems are by far the most popular type of tuning systems in present use. TVs, VCRs and stereo equipment all make use of the varactor tuner. Unfortunately, troubleshooting these tuning systems, especially the phase-locked loop (PLL) varieties, can be difficult. In the past, tough tuning system problems were often solved by replacing the tuner/controller module. This approach doesn't work with newer models because most manufacturers are eliminating modules and instituting a one-piece motherboard design. However, with the proper troubleshooting procedures and a good understanding of the circuitry's function, accurate diagnoses can be fairly quick and easy.

The varactor diode

Varactor tuners derive their name from the special tuning device they incorporate: the varactor diode. These diodes have the ability to act as variable capacitors. The capacitance of a varactor diode is varied simply by changing the reverse bias applied to the diode. A varactor tuning system can be tuned by the reverse-bias voltage. This tuning voltage, often labeled VT, is commonly varied from 0V to 30V in order to tune all the necessary channels. ***(Editors note:** According to the Illustrated Encyclopedic Dictionary of Electronics, Second Edition, by John Douglas-Young, published by Prentice-Hall, Englewood Cliffs, NJ, varactor diodes are reverse-biased pn junctions with a specially graded impurity concentration at the junction. The width of the depletion or* barrier *region can then be altered by varying the bias. Because the barrier region is equivalent to the dielectric of a capacitor, with the p and n regions as the plates, a voltage-controlled capacitor results.)*

Varactor tuning systems are divided into two main types: voltage synthesis and frequency synthesis. Voltage synthesis tuning systems have a finite number of presets or channel slots. Lower priced equipment may have as few as 12 presets; higher priced equipment can have a channel capability of 80 or more. Older equipment usually adjusted the tuning voltage with a series of small tuning pots, one for each channel. Present technology uses an electrically alterable read-only memory chip (EAROM) to store the customer's favorite channels. When a customer selects a certain channel slot, or *preset*, the control circuitry adjusts the tuning voltage to the value previously stored at the preset's location.

Frequency synthesis tuning compares a divided-down sample of the tuner's local oscillator signal to a master reference frequency and adjusts the tuning voltage until the two frequencies are both frequency and phase-locked. Therefore, tuning can be accomplished by changing the division ratio of the local oscillator signal. Frequency synthesis tuning is also known as *phase-locked loop tuning* and will be covered in Part II of this series.

Troubleshooting the tuning system

Figure 1 shows a simplified block diagram of a TV receiver. Both the control circuitry and the tuner are included in the block labeled "tuning system" because both are necessary for proper tuning. For our purposes, the tuner will be treated as a black box. If the black box has all the correct inputs but fails to produce the correct output, it either must be sent out to be rebuilt or replaced with a new unit. (The vast majority of repair shops cannot afford the necessary alignment equipment needed to properly repair a varactor tuner.) What we will concentrate on is the control and support circuitry necessary for a varactor tuning system.

The tuning system has only one main output: the intermediate frequency (IF) signal. To verify that a suspected tuner problem is actually in the tuning system, the first step is to substitute a known-good IF signal, especially if the complaint is snowy raster and hissing sound. This signal can be obtained from a tuner subber device, a signal generator or an old tuner out of a junk set. (See the sidebar, "Building a Tuner Subber.") If the chassis fails to operate normally with the substitute IF signal, you must repair it first. Then, once the chassis is operating satisfactorily, tackle any problems that still show up in the tuning system.

If the chassis performs normally with the substitute IF signal, verify that the tuning system block has the proper inputs before you actually attempt to troubleshoot.

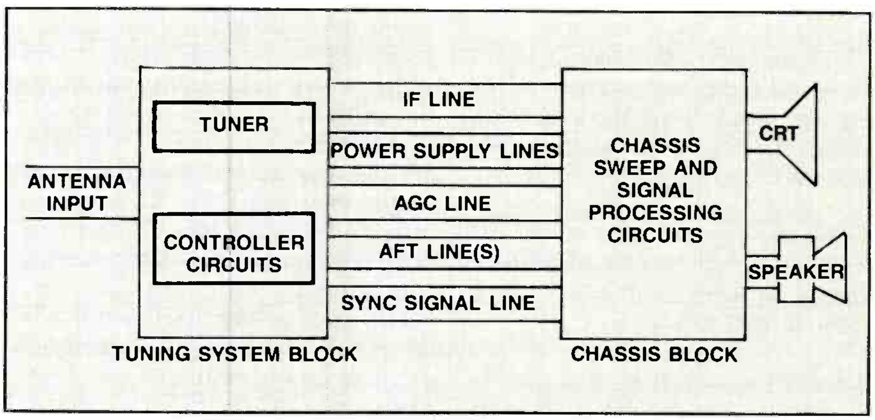


Figure 1. This simplified block diagram of a TV receiver shows that the tuning system has only one main output: the intermediate frequency (IF) signal. If the chassis performs normally with the substitute IF signal, verify that the tuning system block has the proper inputs before you actually attempt to troubleshoot.

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

Building a tuner subber

By Stephen J. Miller

Just about any salvaged mechanical tuner from a junked solid-state TV can be put to use as a tuner subber. Figure A shows the general hookup arrangement. Most of these tuners operate with a B+ of 15V to 22V. For portability, use two 9V transistor batteries in series. R2 allows you to adjust the gain of the tuner via the RF AGC terminal and should be mounted on the front panel. The equation to use when you are calculating R3 is $R3=(7.8V_g-V_{cc})\times 1{,}000/(V_{cc}-V_g)$.

In this equation V_{cc} is your B+ voltage and V_g is the average AGC voltage your tuner requires. This average AGC voltage value can be obtained from the service literature of the junked set. Many tuners use an average RF AGC voltage of +3V. With V_{cc} equal to +18V, this corresponds to a value of approximately 330Ω for R3.

If your tuner has one or more AFT terminals, they also must be terminated. (If your tuner has two AFT terminals, wire them together.) Figure A shows an AFT termination. The equation for calculating R4 is $R4=(V_{cc}-V_f)\times 1{,}000/V_f$.

V_f is the AFT voltage given in the service literature. A common tuner AFT voltage is 6V, in which case R4 is 24Ω.

Extension cables should be made out of low-capacitance coax, such as RG-62B/U, and limited to 18 inches in length. Finally, for safety sake, always use an isolation transformer on the chassis when operating a tuner subber.

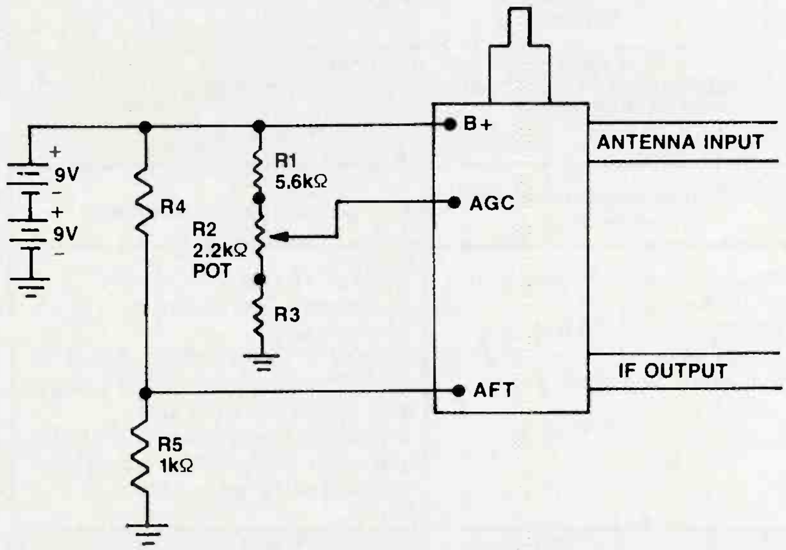


Figure A. To verify that a suspected tuner problem is actually in the tuning system, the first step is to substitute a known-good IF signal, especially if the complaint is a snowy raster and hissing sound. This signal can be obtained from a tuner subber device.

The first set of inputs to verify are the power supplies. At least three separate supplies commonly are present: a high voltage (30V to 50V) for generating the tuning voltage, a lower voltage (9V to 16V) for tuner B+, and 5V for the digital circuits. (See Case History #1.)

RF AGC is another input to the tuning system that should be checked. With the tuner subber in circuit, the AGC signal to the tuning system from the chassis should vary by several volts because the subber is tuned to channels of different strengths. (In general, most RF AGC signals decrease in voltage as the signal strength increases.)

If this AGC voltage shows little or no change, reconnect the receiver's IF line and substitute a variable dc voltage for the RF AGC voltage. Be sure to wick out or lift the connection on the chassis side of the RF AGC line to prevent the chassis AGC circuits from interfering with the dc voltage you are substituting. If proper reception is obtained with this substitute AGC signal, and if it is possible to both "snow up" and overload the picture by varying this substitute voltage, then a chassis AGC problem is indicated.

The servo diagnostic device (see the sidebar, "Building a Servo Diagnostic Device") is useful as a precisely variable substitute voltage source. Connect the positive lead of the device to the positive terminal of a low-voltage bias box, both negative leads to chassis ground, and the variable terminal to the circuit point you wish to control. Then use the coarse and fine adjustment controls, along with the range switch, to vary the substitution voltage.

Another input to the tuning system is the antenna input. Antenna input cables or baluns should be inspected or replaced with a temporary substitute. Static discharges from lightning strikes and power surges have been known to damage antenna blocks and baluns, causing poor or no reception.

Defects in the AFT input or the sync signal inputs usually cause fine-tuning or channel-scan problems. These will be detailed later. If all of the tests described here have verified the integrity of both the chassis signal and support circuits, you are now sure that an actual tuning system problem exists. Check the integrity of these circuits before attempting to troubleshoot the tuning system. You will avoid wasting time troubleshooting the wrong area.

Voltage synthesis tuning systems

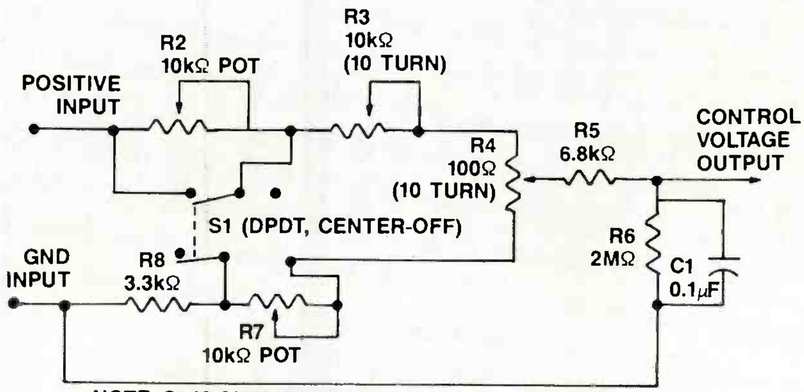
Voltage synthesis tuning systems tune stations by synthesizing the varactor tuning voltage stored in memory by the customer. When customers change channels, they are actually instructing the equipment to adjust the tuning voltage and bandswitching lines to the values they had previously programmed in that

Building a servo diagnostic device

By Stephen J. Miller

The servo diagnostic device was originally developed as a precisely variable voltage source. (See "Servicing VCR Servo Systems" in the October 1988 issue.) This precision substitution voltage is extremely useful in troubleshooting the servo loop circuits in VCRs. Its usefulness is not limited to VCRs, however. The diagnostic device can be put to use as a substitute voltage source in almost any piece of electronic equipment. Current-limiting resistors have been incorporated into the device to protect the equipment you are troubleshooting.

Figure B shows a revised schematic diagram of the diagnostic device. The only critical parts are the coarse and fine adjustment pots, which must be 10-turn devices. Construction can be point-to-point wiring in any suitable enclosure. Although the original version of the diagnostic device performed adequately for servo troubleshooting, a gap in the output voltage did exist between the Low and Run ranges. The new version of the diagnostic device retains all the features of the original design while eliminating the gap in output voltage. Also shown is a new alignment procedure for the new version diagnostic device.



Changes in new version diagnostic device	Calibration instructions
1. Remove R1 and replace with a jumper wire. 2. Change value of R8 to 3.3kΩ. 3. Change value of R5 to 6.8kΩ. 4. Recalibrate diagnostic device.	1. Input +5V to positive lead. 2. Connect dc meter to control voltage output. 3. Place S1 in low position. Adjust R3 and R4 for maximum output voltage, then adjust R2 for +2.0V. 4. Place S1 in run position. Adjust R3 and R4 for minimum output voltage, then adjust R7 for +1.8V.

Figure B. The servo diagnostic device provides a precisely variable substitute voltage source. Connect the positive lead of the diagnostic device to the positive terminal of a low-voltage bias box, both negative leads to chassis ground, and the variable terminal to the circuit point you wish to control. Then use the coarse and fine adjustment controls, along with the range switch, to vary the substitution voltage.

Case History #1: RCA CTC118A

The complaint on this set was a snowy raster, no sound and no LED channel display. Substituting a known-good IF signal brought back picture and sound. Power supplies into the control module were checked and no −60V horizontal pulses were present on pin 5 of J2. Tracing the circuit back, I found bad solder joints on L104. Repairing these connections brought the set back into operation.

This −60V pulse is easy to overlook as a power-supply line. It is coupled into the control module as an ac waveform, where the rectification and filtering take place. These horizontal pulses provide the run +8.7V, +5.1V and +28V lines. Defective solder joints on L104 are a common failure. In newer models, RCA has continued the design practice of coupling these horizontal ac pulses into the controller module for rectification and filtering. The recent CTC136 chassis derives both its run +5V source and its run +30V source this way.

Case History #2: NEC N925U VCR

This VCR arrived with the complaint that it would only record snow. Operating the VCR tuner, I found that none of the 20 presets contained an active channel. Trying to reprogram, I was able to tune channels while the VCR was in the preset mode. However, the memory function did not work. Upon returning to the normal mode, I found that I had been unable to alter any memory location. Because I was able to tune channels in the preset mode, I had verified that the tuner, bandswitching, IF circuitry and much of the controller were operating properly. This tuner problem seemed to really be a preset memory problem.

Figure C is a schematic drawing of the timer board that controls the tuner functions. IC801 is the control microprocessor. IC802 is an EAROM. Checking power-supply voltages into IC802, I found both the +4.6V supply on pin 1 and the −30V supply on pin 2 to be present. All input pins exhibited the correct dc level and correct ac activity except pin 4. This pin, CS, which stands for *active low chip select*, was clamped at −1.3V level. This pin is normally supposed to float to +4.6V via an internal pull-up resistor in the chip. When the microprocessor outputs a high on pin 14, TR803

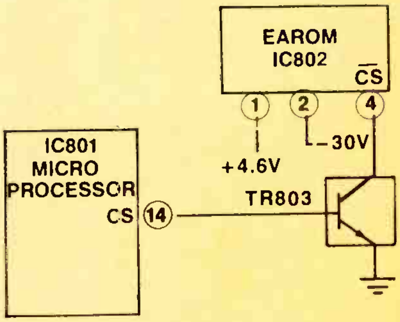


Figure C. This schematic drawing of the timer board that controls the tuner functions shows IC801, the control microprocessor, and IC802, an EAROM.

pulls pin 4 of IC802 to ground or low state, activating the chip select line. Checking pin 14 of IC801, I found it was low. Even after wicking out the collector of TR803, pin 4 of IC802 did not float high. Therefore, IC802 was definitely defective. After replacing IC802, the preset memory function worked properly. In retrospect, I realized that I gathered large amounts of valuable troubleshooting information by attempting to program the unit first. Before troubleshooting, it is often smart to "milk the controls" to determine what is functioning properly.

particular memory location. Voltage synthesis systems are "dumb" because they can only set these lines to data stored in the requested memory location. If that memory location's data is bad, corresponding to an inactive station or an unassigned frequency between stations, all the customer will receive is noise. A common customer complaint goes like this: "Little Billy played with all those little wheels in the door of my TV and now I can't receive any stations." The cure to this complaint is to reprogram the desired channels.

The digital ROM units may also need to be reprogrammed on occasion. I have encountered several MGA HS-318UR VCRs that could not be tuned. In these machines, reprogramming the channel memory often brings back all tuning functions. Nearby static discharges or power-line disturbances apparently can scramble the channel memory in these machines. Other models and brands can be similarly affected. If you can reset the channel memory, unplug the unit for a day or so to verify that memory is retained during power interruptions before returning it to the customer.

Digital ROM ICs often need a high negative voltage supply in order to store new data. In VCRs, this same negative voltage is used to run the display. If you lose the negative supply, its absence will be obvious because the initial complaint is usually "no display." However, in TVs and other equipment, you should always remember to check the negative supply voltage when you're troubleshooting situations that involve problems in writing new data to memory. Without the negative supply, many ROM ICs will permit memory reads but not memory writes. (See Case History #2.)

When troubleshooting voltage-synthesis tuning systems, first try reprogramming. If that is unproductive, follow the general steps outlined earlier to verify that the problem is indeed in the tuning system. (Figure 2 shows a general flowchart.) Once the chassis has been cleared, the inputs into the tuner itself need to be checked right at the tuner's connectors. Figure 3 shows the inputs to most voltage synthesis tuners. The power supply and AGC were cov-

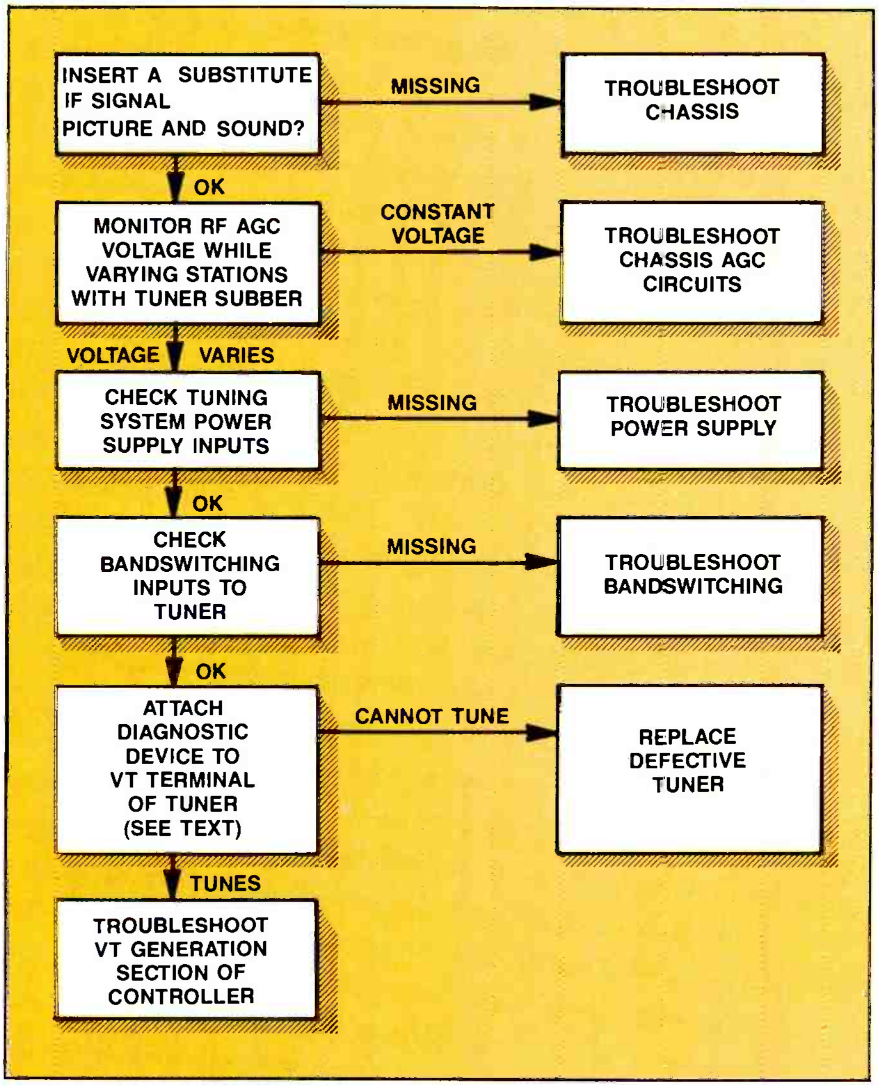


Figure 2. When troubleshooting voltage-synthesis tuning systems, first try reprogramming. If this is unproductive, follow the general steps outlined in this general flowchart to verify that the problem is indeed in the tuning system.

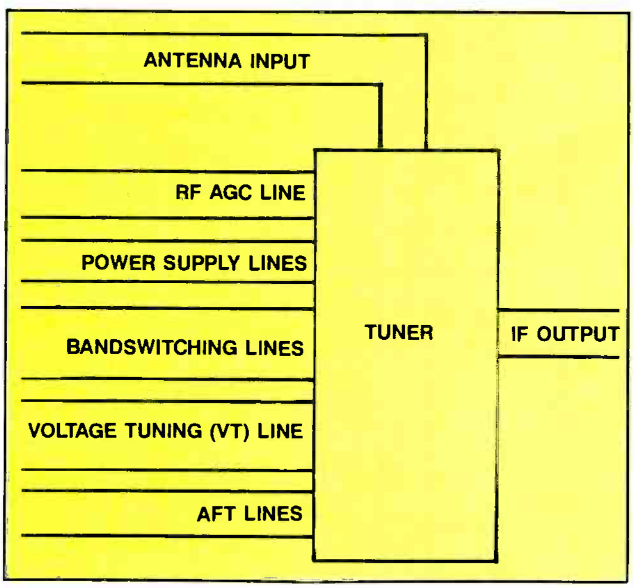


Figure 3. Once the chassis has been cleared, the inputs into the tuner need to be checked right at the tuner's connectors.

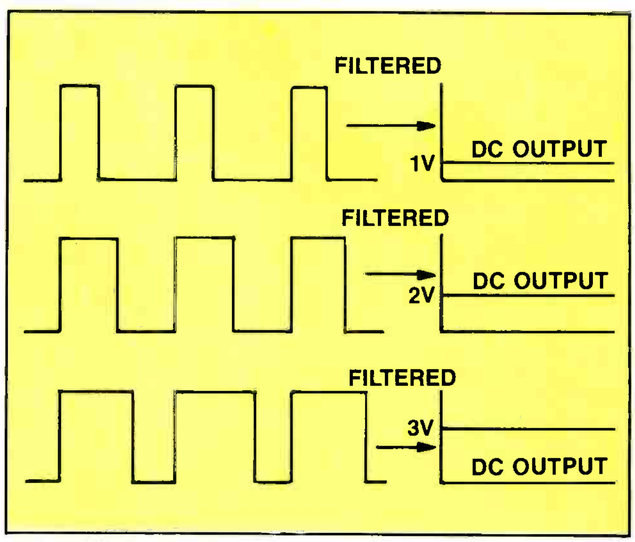


Figure 4. The digital circuit outputs a pulse train that, when filtered or averaged into a dc voltage, creates an analog dc voltage. The dc voltages are then amplified to the required magnitudes by dc voltage amplifiers.

ered in the "Troubleshooting" section.

Bandswitching inputs tell the tuner which frequency band is desired. Service literature usually contains a truth table with the voltages needed on these bandswitching lines to tune each band. If the band switching information is incorrect, follow the circuit back to discover the cause. A tuner bandswitch input occasionally will short internally to either ground or V_{CC}. Wick out any tuner pins that exhibit an incorrect voltage. If the voltage at the foil pad then exhibits the correct voltage, the tuner must be rebuilt or replaced.

The VT input

The voltage tuning (VT) input is the variable voltage used to change the tuner's frequency. If the other tuner inputs are correct but the VT line doesn't change, follow this procedure:

- Wick out the VT terminal of the tuner.
- Connect the positive lead of the diagnostic device to a bias box set to about 30V.
- Connect the diagnostic device and bias box grounds to circuit ground.
- Connect the diagnostic device's variable output lead to the isolated tuner VT terminal.

If you vary the coarse control and range switch of the diagnostic device, most channels of the band you are tuned to should be available. If no channels of the band in question are obtained, the tuner is defective. If proper channel reception is obtained with this substitution, the tuner has been verified as good and you should troubleshoot the VT generation circuit.

The VT output of the tuning microprocessor is usually a pulse-width-modulated signal. Pulse-width modulation is a simple method of digital-to-analog conversion. The digital circuit

Case History #3: Goldstar GHV-55FM

The customer's complaint was no channel reception on this VCR. Initial attempts to reprogram the thumbwheel presets were unsuccessful. Tuner substitution revealed that both the signal-processing and AGC sections were in working order. All power supplies into the tuning system were normal, and proper bandswitch voltages were present at the tuner pins. However, the tuning voltage line was low and didn't change. Inserting the diagnostic device into the VT line brought back channel reception. With the problem isolated to the VT generating system, further troubleshooting in that section revealed that ZD701 was shorted. (See Figure D.)

ZD701 is the regulator for the voltage generator amplifier Q710. Replacement of this device brought the tuning system back to operation. Do not replace these regulators with ordinary zeners. The thermal drift and tolerances of ordinary zeners are not acceptable in this application. Special tight-tolerance zeners, such as the ECG 637, are needed.

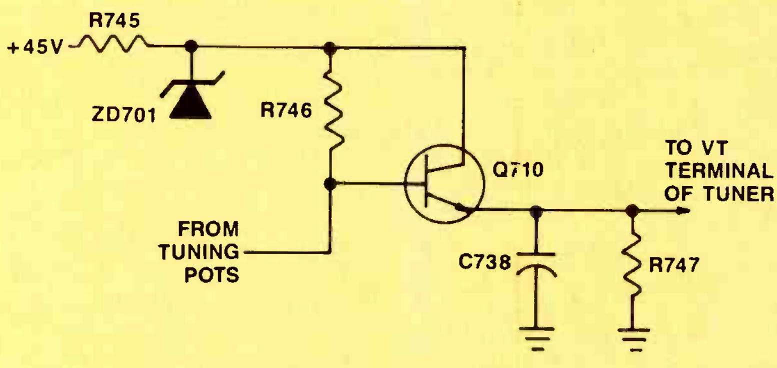


Figure D. If a VCR has no channel reception, first try to reprogram the thumbwheel presets. Then check the signal-processing and AGC sections, and make sure you have proper bandswitch voltages. If you find no problems, check the VT generating system.

Case History #4: Emerson ECR 138

Intermittent tuning problems and erratic channel changes were the complaints on this TV. The customer reported that the problems only appeared after he attempted to change channels and occurred most often when he switched from a strong to a weak station. Once the problem occurred, the customer could get the set to operate by repeatedly switching back and forth between channels.

On the test bench, I verified that the tuning system did occasionally "lock up" during channel changes. Resetting the thumbwheel tuning pots did not improve the set's operation. Yet, if I left AFT turned off via the AFT defeat switch, the intermittent problems disappeared. This clue indicated that the problem was in the AFT channel-change mute circuit.

When the user changes channels, pin 13 of IC101 goes low and turns on Q110 and Q109, which pulls pin 43 of IC201 low and defeats the AFT circuitry within IC201. Once the tuning system has stabilized, pin 13 of IC101 goes high and normal AFT control resumes. (See Figure E.)

The AFT defeat switch, SW106, is in parallel with Q109 and can also pull pin 43 low. Scoping pin 13 of IC101 revealed the proper negative-going pulse during channel change. Q110 and Q109 checked good in-circuit. However, D173 checked open in both directions. Replacing this diode cured the intermittent channel-change problems.

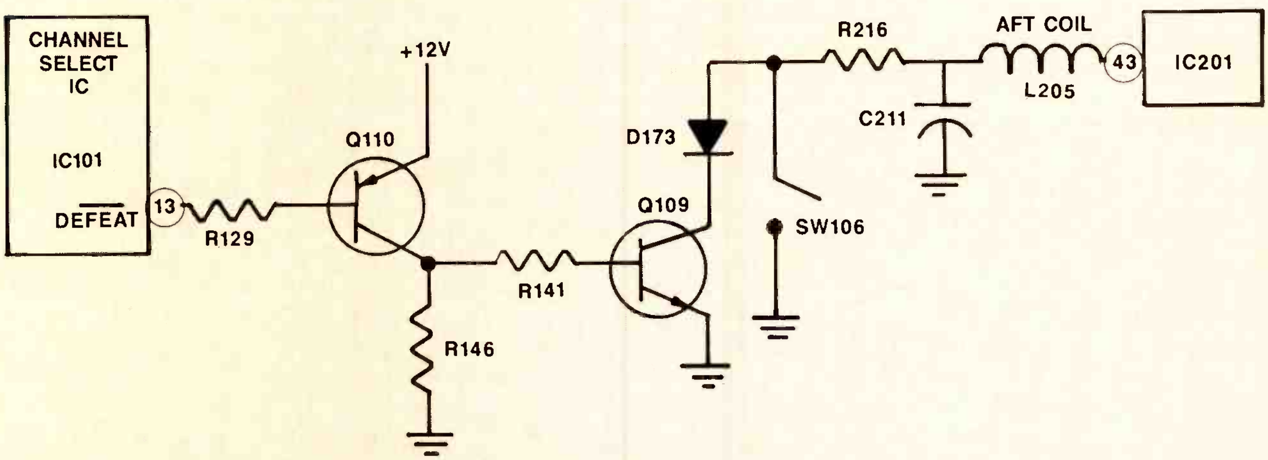


Figure E. When the user changes channels, pin 13 of IC101 goes low and turns on Q110 and Q109, which pulls pin 43 of IC201 low and defeats the AFT circuitry within IC201. Once the tuning system has stabilized, pin 13 of IC101 goes high and normal AFT control resumes.

outputs a pulse train with constant frequency, but the pulse width varies in direct proportion to the desired analog output. When this pulse train is filtered or averaged into a dc voltage, an analog dc voltage is derived from a digital source. See Figure 4 for some examples. These dc voltages are then amplified to the required magnitudes by dc voltage amplifiers. (See Case History #3.)

The final tuner input is the automatic fine tuning input (AFT). Problems with the AFT line generally cause the symptoms of distorted picture and sound, just the type of effect you would expect with misadjusted fine tuning. To troubleshoot this input, monitor the AFT input voltage while slowly varying the VT input with the fine control of the diagnostic device. At the correct tuning point (best picture and sound), the voltage should match the dc value specified in the service literature. As the diagnostic device is varied slightly, the dc AFT voltage should vary, with the voltage increasing as you tune off in one direction and decreasing as you tune off in the other. These AFT voltages usually are generated by the IF/video detector IC. If the AFT voltage is constant, wick out the tuner AFT terminal and monitor the foil pad. If the pad now responds properly, the tuner is loading the AFT line. If the pad voltage is still incorrect, a chassis AFT problem exists. An AFT defeat switch usually is provided to disable AFT during channel programming. Failure to defeat AFT during programming often leads to inaccurate channel programming and AFT drift as the equipment warms up.

During channel changes, AFT control must be muted. Otherwise, the AFT circuit will try to prevent the tuning system from changing channels. The result is erratic tuning during channel changes. Without an AFT channel change mute, the tuning system will occasionally lock up during channel change. Intermittent channel change problems or problems that occur only after a channel change are often caused by failure of the AFT mute circuit. When troubleshooting a receiver with this symptom, tune AFT off and then try changing channels. If the problem disappears with AFT turned off, a problem exists in the AFT or AFT mute circuits. (See Case History #4.) If the AFT control circuit is momentarily muted until the new bandswitching and tuning voltages have stabilized, trouble-free channel changes will occur.

A future article will provide an in-depth look into phase-locked loop tuning. ■

Troubleshooting Tips

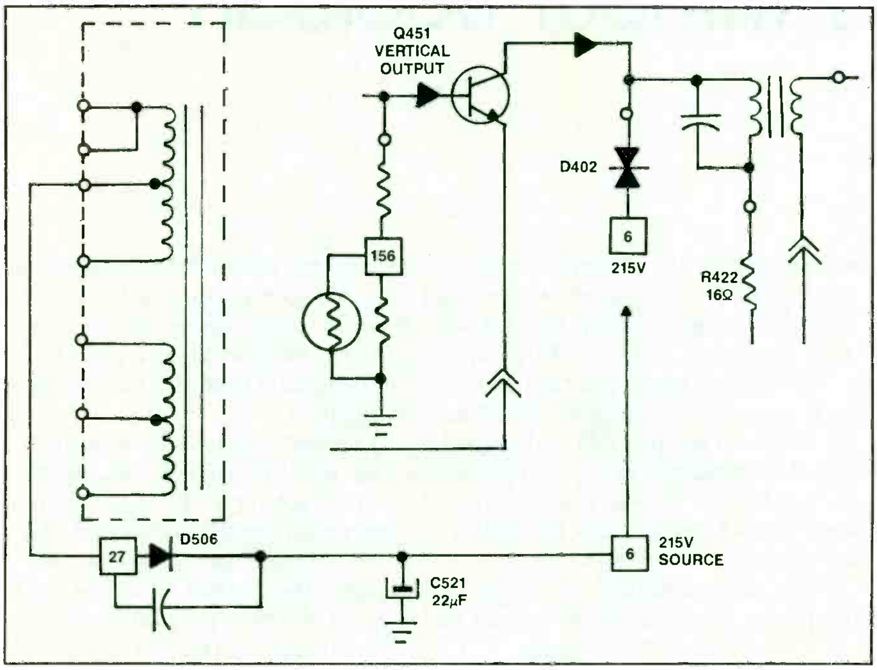


Figure 1. An open R422 suggested excessive current might have caused a vertical deflection problem. Although the vertical output transistor, Q451, checked out OK, replacement brought the TV back in operation.

Symptom: No vertical deflection, horizontal line across screen; sound OK.
Set ID: Quasar WU 9465PD TS-962
Photofact: 1743-1

Because there was no vertical deflection on this TV, the first place I checked was the vertical output transistor. (See Figure 1.) When I measured for B+ at the collector, I measured 0V. This measurement pointed to the power supply, so I traced back toward the supply. I found that R422 was open, so I replaced it with a new 16Ω, 1/2W resistor. Because I didn't have a flameproof resistor of this value on hand, I temporarily replaced this component with a standard device.

The open resistor suggested that excessive current might have caused the problem, so I removed the vertical output transistor, Q451, and checked for shorts. Everything checked out perfectly here, so I put it back into the circuit. To make sure everything was checked out before turning the power back on, I checked the driver and oscillator circuits. No problems there.

When I plugged the set back in and turned it on, I was shocked to see that R422 caught fire. I immediately turned the set back off again. I checked the set to see if the excessive current that had destroyed R422 had damaged any other components, but everything seemed to be normal.

I turned the set back on and started again by checking voltage at D402, which is connected to D506. The voltage here was 128V; the schematic specifies 215V.

This voltage led me to check filter capacitor C521, which I discovered to be open. I replaced the capacitor (the only component that seemed to be faulty) and turned the set back on to check that voltage at D402 again. No change. Whatever the effects of this faulty filter had been, apparently the customer hadn't noticed or just didn't mention it to me.

With no other course of action indicated, I decided that perhaps the vertical output transistor might be faulty even though it seemed to test good, so I replaced it and installed a new flameproof R422, which I had obtained in the meantime. When I turned the set on, everything was back to normal.

The obvious conclusion is that sometimes the only way to be absolutely certain of whether a transistor is good is to replace it with a new one and observe the effect.

Richard H. Burroughs
San Antonio, TX

What do you know about electronics?

Logic circuits without Boolean algebra

By Sam Wilson, CET

In previous issues I have been doing a series of articles on understanding network theorems and laws without using mathematics. A better way of saying that would be we're using a minimum amount of mathematics. This article is a continuation of that series.

When you were first learning to work with digital electronics, you were quite likely confronted with a sophisticated mathematics called Boolean algebra. That mathematics can be used to fully describe any static digital circuit. (Static circuits do not require a clock input signal.)

Using Boolean algebra, you can reduce a complex digital circuit to the minimum possible number of components (gates). Also, you can determine the output of a circuit if you know the values of the inputs. People who like their theory laced with mathematics are quick to point out that Boolean algebra is the fastest and easiest way to analyze a logic circuit.

Are there any non-math options? There are two very good methods. One is called Karnaugh mapping. It will not be discussed here. The other is the use of truth tables.

Before I unleash a rash of letters about this truth table method, let me explain that I know it is not the easiest way and that it takes longer than Boolean algebra. It is, however, an easy way if you're not going to use Boolean algebra.

We will start by using three basic gates — that is, circuits that are the foundation of logic systems. Then, using those three basic gates, we will build up to more complex systems.

It will seem too easy at first. Stick with it. It will stiffen up as we get into it in more depth. Some review is included so everyone can do it!

Review of basic ideas

All signals in logic circuits represent either 0 or 1. Logic 1 is frequently represented by 5V, although it may be some other positive voltage or even a negative voltage. Usually, but not always, logic 0 is represented by 0V.

The rows in a truth table run horizontally; columns run vertically. A truth table shows all the possible logic inputs and the corresponding logic output (in the L column). You can translate those logic levels to voltages for the particular system they represent.

To be sure you haven't left out any of the inputs, the columns are written as

The most complicated computer in the world can be made by using only AND, OR and NOT gates.

a binary count. If you are rusty in binary counting, refer to Table 1. It shows all of the first 16 counts.

Note that if you have a 2-input device, like the AND and OR gates shown in Figure 1, then only the two right-hand columns in Table 1 are needed. The zeros in the left two columns are not used.

You really need to know the information in Figure 1 before you can troubleshoot a logic circuit. You had a similar situation when you were learning linear electronics. For troubleshooting linear circuits, you need to know the polarities of voltages on the various amplifying devices. Then, when you troubleshoot, you can tell whether the device is working properly by making voltage measurements.

You can't afford the time to stop and look up every linear amplifying device to see what voltage relationship should exist. Of course, you may have learned those by simply using them a number of times. Maybe that is a good way to learn the truth tables for the logic gates in Figure 1.

A reminder about logic notation is in order. It's different from standard mathematical notation. The sign that in ordinary mathematics indicates multiplication (×) indicates the AND function in logic. The sign that in ordinary mathematics indicates the addition function (+) indicates the OR function in logic.

The most complicated computer in the world can be made by using only AND, OR and NOT (inverter) gates. It will be good practice in the use of truth tables to derive the characteristics of the remaining gates (NAND, NOR, EXOR, for example) using those three.

Here are some things that you must remember about the truth tables of the first three basic gates:

- For an inverter, the logic state at the output is the opposite of the logic state of the input. (If the input is a 1, the output is a 0, and vice versa.)
- For the AND gate, the only way to get a 1 output is if all of the inputs are at a logic 1. No other combination of inputs will give you a 1 at the output.
- For the OR gate, the only way to get a zero at the output is if both inputs are at 0. All other combinations of inputs result in a logic 1 output.

All of that information on inverters, AND and OR gates is shown in the truth tables. If you understand the truth table from what has just been said about the three basic gates, we are ready to roll.

The NAND gate

The NAND gate is usually considered to be one of the basic gates. It is obtained by inverting the output of an AND gate. The procedure for obtaining its truth table is shown in Figure 2.

First, you write the truth table for the AND gate. Then, the output of the AND gate is inverted to get NAND. So, ev-

Wilson is the electronics theory consultant for ES&T.

Table 1
Binary count

	0 0 0 0		1 0 0 0
End of count for 1 input →	0 0 0 1		1 0 0 1
	0 0 1 0		1 0 1 0
End of count for 2 inputs →	0 0 1 1		1 0 1 1
	0 1 0 0		1 1 0 0
	0 1 0 1		1 1 0 1
	0 1 1 0		1 1 1 0
End of count for 3 inputs →	0 1 1 1	End of count for 4 inputs →	1 1 1 1

ery place there is a 0 in the L column, you write a 1; every place there is a 1 you write a 0. Note that the output is now called NOT L ($\overline{L}$). The only way to get a 0 at output $\overline{L}$ is by making inputs (A and B) a logic 1.

The result can be written A AND B is equal to NOT L. In symbols: $AB=\overline{L}$. However, you can invert both sides of that expression and get $\overline{AB}=L$. It is always written that way in Boolean algebra.

I said you wouldn't need any algebra. You don't need to do anything with the equation. Just look at it and understand it.

The NOR gate

Let's do the same thing with the NOR gate. First, we write the truth table for OR. Use the first three columns in the first truth table of Figure 3. Then, you

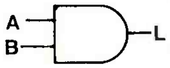
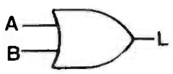
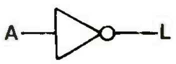
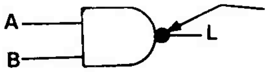
Name	Symbol	Boolean Notation	Truth Table
AND gate		$A\times B=L$	A B L: 0 0 0 / 0 1 0 / 1 0 0 / 1 1 1
OR gate		$A+B=L$	A B L: 0 0 0 / 0 1 1 / 1 0 1 / 1 1 1
inverter (NOT gate)		$L=\overline{A}$ overbar means NOT A	A L: 0 1 / 1 0

Figure 1. You should know the symbol, Boolean notation and truth table for these gates before you try to troubleshoot a logic circuit. The output of the AND gate is inverted to get the NAND. The output of the OR gate is inverted to get the NOR.

NAND gate

Symbol:



(Means output of the AND is inverted)

Boolean notation: $\overline{A\times B}=L$ (also written $\overline{AB}=L$ and $\overline{A\bullet B}=L$)

Truth table:
NAND output is the inversion of the output column for the AND truth table:

A	B	L	$\overline{L}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

($\overline{L}$ means NOT L)

AND output (invert to get the NAND output)

NAND output

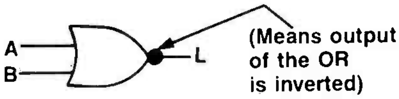
NAND truth table is made from the first two and last columns of the AND truth table:

A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

Figure 2. The NAND gate is obtained by inverting the output of an AND gate.

NOR gate

Symbol:



Boolean notation: $\overline{A+B}=L$

Truth table:

NOR output is the inversion of the output column for the OR truth table:

A	B	L	$\overline{L}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

A+B is inclusive OR

OR output (invert to get NOR output)

NOR output

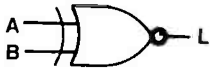
NOR truth table is made from the first two and last columns of the OR truth table:

A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Figure 3. The NOR gate is obtained by inverting the output of an OR gate. To get the truth table, write the truth table for OR, then invert the L column. Throw away the L column and you have the truth table for NOR, which is written in symbols as $A+B=\overline{L}$.

Logic comparator

Symbol:



Note: the logic comparator is also known as exclusive NOR

Boolean notation: $AB+\overline{A}\,\overline{B}=L$

Truth table:

To get $\overline{A}$ and $\overline{B}$ columns, invert input columns. AND as indicated to get A×B and $\overline{A}\times\overline{B}$ columns. To get last column, OR A×B and $\overline{A}\times\overline{B}$.

A	B	$\overline{A}$	$\overline{B}$	A×B	$\overline{A}\times\overline{B}$	$AB+\overline{A}\,\overline{B}$
0	0	1	1	0	1	1
0	1	1	0	0	0	0
1	0	0	1	0	0	0
1	1	0	0	1	0	1

Logic comparator truth table is made from the first two and last columns:

A	B	L
0	0	1
0	1	0
1	0	0
1	1	1

Figure 4. There is a logic 1 output from the logic comparator whenever the inputs are identical. For a 2-input comparator, both inputs must be either logic zeros or logic ones to get a logic 1 output. This relationship can be written as $AB+\overline{A}\,\overline{B}=L$.

invert the L column as shown in the illustration. You can throw away the L column and you have the truth table for NOR, which is written in symbols as $A+B=\overline{L}$. However, you can invert both sides of that relationship to get $\overline{A+B}=L$. That is the way the equation for the NOR gate is written.

Again, you don't have to do anything with this equation — just look at it and understand it. It means that NOT A OR B will give you L.

The truth table shows you the same thing.

The logic comparator

The logic comparator is another gate that is sometimes included with those considered basic. Like the NAND, NOR and EXCLUSIVE OR, it can be derived from the truth tables of AND, OR and NOT.

Figure 4 shows the important gates, characteristics and the truth-table proof for the logic comparator.

There is a logic 1 output from the logic comparator whenever the inputs are identical. For a 2-input comparator, both inputs must be either logic zeros or logic ones to get a logic 1 output. This relationship can be written as $AB+\overline{A}\,\overline{B}=L$. Read it as A AND B OR NOT A AND NOT B equals L.

I am going to get into more depth in next month's column. Before we leave this column, I want to make it clear that even though we don't need Boolean algebra, we do need a shorthand way of writing the rules of Boolean algebra. I have listed all of these rules in Table 2. If you are going to troubleshoot in logic circuits, you should know these rules.

In the "Test Your Electronics Knowl-

Table 2
Summary of the rules of Boolean algebra

Rule 1: A×1=A

Rule 2: A×0=0

Rule 3: A×A=A or AA=A

Rule 4: A+1=1

Rule 5: A+0=A

Rule 6: A+A=A

Rule 7: (A+B)(A+C)=A+BC

Rule 8: $A\overline{A}=0$

Rule 9: $A+\overline{A}=1$

Rule 10: $A+\overline{A}B=A+B$

Rule 11: Any time there is an odd number of overbars on a symbol, it can be represented by a single overbar.

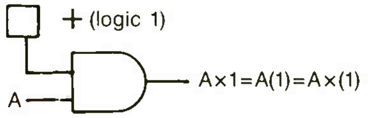
Rule 12: Any time there is an even number of overbars on a symbol, they can all be removed and the symbol can be represented without any overbars.

Rule 13: $\overline{AB}=\overline{A}+\overline{B}$

Rule 14: $\overline{A+B}=(\overline{A})(\overline{B})$

Proof that A×(1)=A

In symbol form:



Note that there are only two inputs: A and 1. To get last column, AND first two columns:

A	1	A(1)
0	1	0
1	1	1

(Note that the A×1 column is identical to the A column. Therefore, A×1=A.)

Figure 5. Circuits can be used for proving these rules. Use the truth-table method.

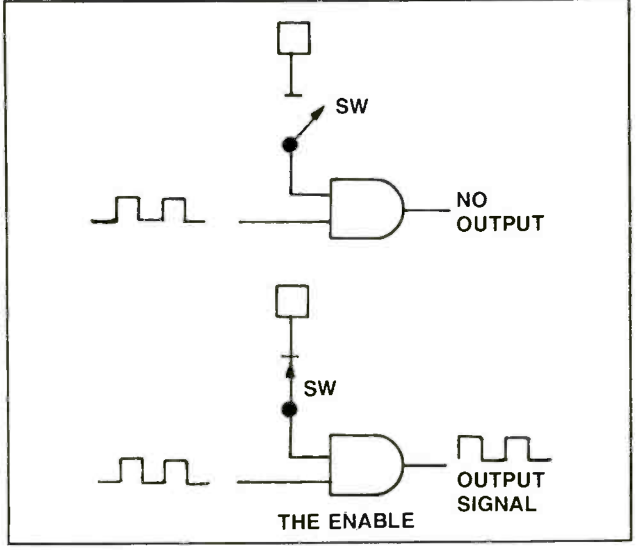


Figure 6. In Figure 5, if you put a switch in series with the lead to logic 1, the circuit becomes an ENABLE. When the switch is open, no signal passes through (A AND 0 = 0). With the switch closed, the output signal is the same as the input signal (A AND 1 = A).

edge" column this month, I have shown circuits that can be used for proving these rules. You should take the truth-table method just discussed and go through the "Test Your Electronics Knowledge" questions using the truth-table method. I have done the first one in Figure 5 so that you are sure to get off to a good start!

Refer again to the circuit in Figure 5. If you put a switch in series with the lead to logic 1, the circuit becomes an ENABLE. This circuit is shown in Figure 6. When the switch is open, no signal passes through (A AND 0 = 0). With the switch closed, the output signal is the same as the input signal (A AND 1 = A). ■

Correcting stereo separation problems

Today, in most cases, the term *audio* means *stereo*. Most audio systems, from the headphone units to the largest listening-room monsters, have stereo capability. There are two major reasons for this trend: Stereo provides more realism in the audio sound output and a more pleasing sound, and in many cases integrated circuit technology allows manufacturers to make a stereo system for not a lot more than a mono system.

Adjusting the controls

With stereo systems, one of the more frequent malfunctions is either loss of one channel or loss of stereo separation. When you're called upon to troubleshoot a system that has lost stereo separation, one of the first things to do is check the controls. Other than actual malfunctions in the audio circuitry, the most frequent cause of loss of the stereo effect is the accidental placement of the mode switch in the mono mode.

When a servicing technician is called in to troubleshoot a complaint that one of the speakers doesn't work, he'll frequently find that someone has rotated the balance control to either the extreme right or left position, turning off one of the speakers.

In the case when loss of stereo is confined to FM reception, the servicing technician often will find that the radio selector switch was inadvertently left in the FM position instead of in the FM-Stereo or FM-MPX position.

The phono section

In the case of loss of stereo in the phono section, phono cartridges may have been connected incorrectly so that only monophonic sound is produced even though the stereo cartridge is working properly. If the hot and return leads of one channel of a stereo cartridge are accidentally reversed while the terminals of the other channel are connected correctly, the only bad result will be phase reversal. However, if one of the sections of the cartridge is internally grounded, either to the frame of the tone arm or to the frame of the record changer or turntable, and this point is grounded to the amplifier chassis, a total short will have been placed across the incorrectly wired section of the cartridge and sound will come through only one channel.

Tape recorders

Many tape recorders also have mono switching arrangements that should be checked first before you check the circuitry for defects. Remember, in some complex systems, a tape deck may be

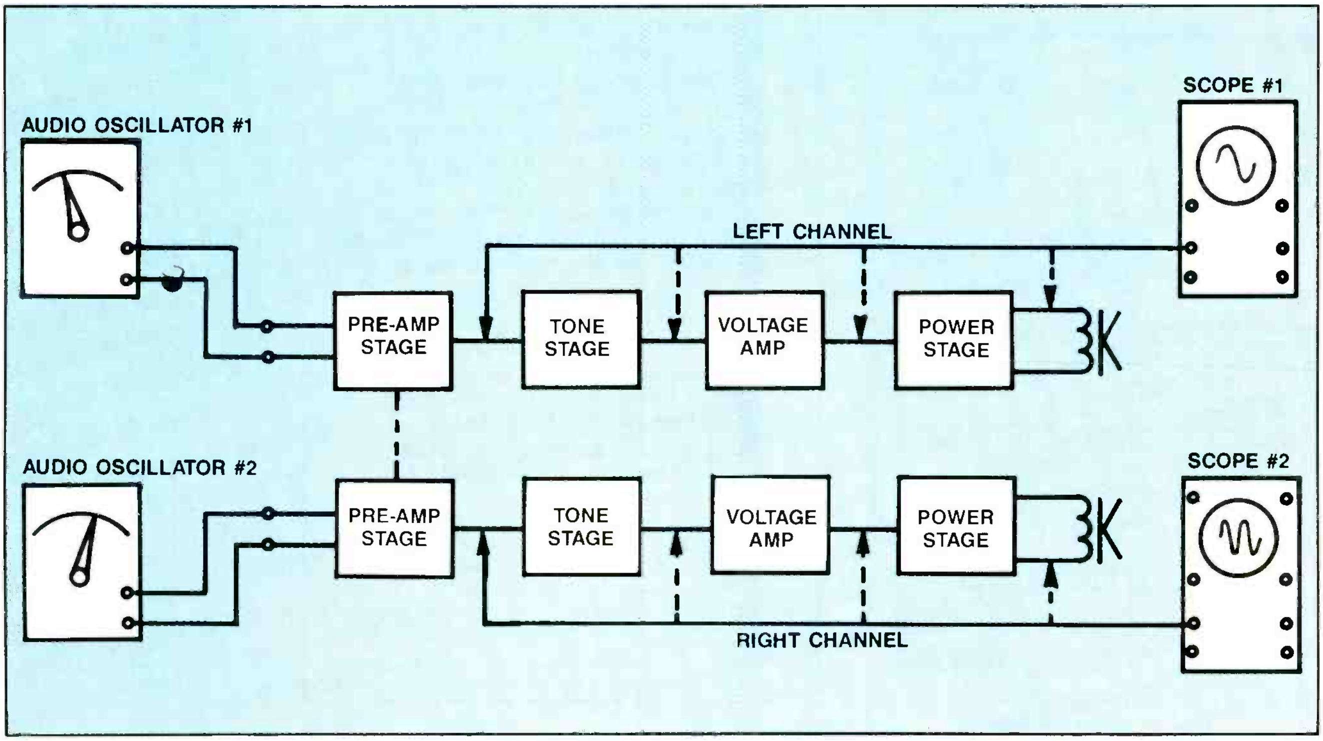


Figure 1. One way to trace stereo separation problems in amplifiers or pre-amps is by means of two audio oscillators, each set to a different frequency, each feeding one channel of the amplifier. Then, using a dual-trace oscilloscope, the technician can check for stereo isolation stage by stage.

connected to a pre-amplifier, which may be connected to an amplifier. All of these elements might have facilities for switching between mono and stereo operation. If any one of these switches is accidentally left in the mono mode, mono mixing of both channels will take place.

Locating circuit defects

One good way to trace stereo separation problems in amplifiers or pre-amps is by means of two audio oscillators, each set to a different frequency, each feeding one channel of the amplifier. (See Figure 1.) Then, using a dual-trace oscilloscope, the technician can check for stereo isolation stage by stage, as shown in the accompanying diagram. If the waveforms at the output of each stage are compared and if two adequately separated frequencies are used (for example, 400Hz for the left channel and 1,600Hz for the right), the presence of both frequencies in the channel where only one should be found will be obvious, even if the content of the undesired signal is only 10% or less of the desired signal (equivalent to separation of 20dB or more).

Stereo provides more realism in the audio sound output and a more pleasing sound.

The stage at which such crosstalk takes place can then be isolated and further investigated for the existence of such problems as shorts between channel components, shorts between hot conductors of audio cables from opposite channels, or unbypassed power-supply dropping resistors, any one of which could be responsible for the presence of an excessive amount of crosstalk. ■

Was that one beep or two?

By Glenn R. Patsch

When you turn on a personal computer, it first performs a power-on self-test, referred to as the POST. This is a hardware check to make sure everything is working correctly. On newer PCs, you will see the amount of memory tested in the upper left corner of the screen. If everything is OK, you hear one beep. If you hear two beeps or none at all, you have your first indication that something is wrong. If the video monitor is working, you usually see a message or an error code.

A 301 error code indicates a keyboard problem (keyboard unplugged or defective). A 165 error code indicates an adapter configuration error. This code will show up with IBM PS/2 systems that have had an option card added or removed (or a battery failure) and require the configuration program on the reference diskette to be run. A complete list of error codes for IBM PCs can be found in the "IBM Hardware Maintenance and Service" manuals. One of the most common error messages is "Non-system disk. Correct and press any key to reboot," which tells you the disk in the A: drive does not contain disk operating system (DOS). Most likely, a disk containing program files was left in the A: drive.

Diagnostics

When the PC has a problem, reach for your diagnostic software. IBM includes a diagnostics disk with the XT and AT and a reference diskette with the PS/2. The "Guide to Operations" manual has a section on testing your system. This section explains how to use the diagnostics disk and explains some of the more common problems. The "Quick Reference" booklet included with the PS/2 has a section on solving computer problems. This section explains some basic problems and how to use the reference diskette. IBM also offers advanced diagnostic software with the "Hardware Maintenance and Service" manuals.

Understanding how the PC works can often be your best diagnostic tool. Each PC contains one or more ROM (read-only memory) chips. When you turn on the PC, the power supply comes on and a program in ROM starts up. The ROM first runs the POST to assure that the hardware is functioning correctly. The equipment configuration is checked either by reading the DIP switches on the system board or from CMOS memory. (The equipment configuration includes information on the type of video mode, which serial ports are connected, the amount of memory, and whether a numeric coprocessor chip — 8087/80287/80387 — is present.)

The ROM first checks for a bootable disk in the A: drive. If no disk is in the A: drive, it checks the C: drive. If a disk is found in the A: drive, it attempts to boot from that disk.

Newer PCs use CMOS memory powered by a battery to store the configuration information. When you use the setup software you are storing the information in the CMOS memory. If the battery fails, the PC loses the configuration information and does not function properly. The wrong setup information also can cause problems. Check the configuration information if the PC is not working correctly. This often is the case when memory or additional cards are added or removed from the PC. It is a good idea to make a note of the DIP switches or the current configuration before any changes are made.

The IBM PS/2 also checks all the adapter (expansion) cards against the configuration stored in CMOS memory. If a card has been removed or added, it displays the adapter configuration error 165. The configuration software (on the reference diskette) uses the adapter description files (.ADF) and diagnostics files (.DGS) to set the configuration. Be sure to copy these files from any adapter cards to the reference diskette using the "copy an option diskette" choice from the reference diskette software. Then select the "run automatic configuration" to configure the system. The XT and AT use DIP switches on the system board and adapter cards to set the system configuration.

After the hardware self-test and equipment check, the ROM looks for a boot record on the disk. It first checks for a bootable disk in the A: drive. If no disk is in the A: drive, it checks the C: drive. If a disk is found in the A: drive, it attempts to boot from that disk.

Because the computer is designed to check the A: drive first, the PC may be booted up even in cases when the hard disk is damaged. The ROM in the original IBM PC, with only floppy disks, did not check for a C: drive because hard disks were not yet available. To install a hard disk and boot from it required the ROM chips to be replaced.

If the hard disk contains more than one logical drive, it checks the partition table created by FDISK to find which one is active. The active drive usually is the first drive or C: drive. The boot record looks for the IBMBIO.COM and IBMDOS.COM (IO.sys and MSDOS.sys for MS-DOS) as the first two files in the root directory. IBMBIO is loaded first, and it then loads IBMDOS. IBMBIO.COM and IBMDOS.COM are hidden system files that are created when DOS is loaded on the hard disk or floppy disk with the SYS command or FORMAT/S command. IBMDOS loads the CONFIG.SYS file if it exists. The CONFIG.SYS file is used to configure and customize DOS for the PC. It specifies the number of buffers to use for accessing a disk, how many files can be open at one time, a foreign language keyboard, stack space, and installable device drivers. Device

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

drivers are used for a hard disk cache, network support, scanners and the mouse.

The disk operating system

Next the DOS command processor, COMMAND.COM, loads. The automatic execute batch file AUTOEXEC.BAT is run if it exists, and the familiar DOS prompt appears. If no AUTOEXEC.BAT file is found, the date and time prompts appear. COMMAND.COM issues the DOS prompt and waits for a DOS command to be entered. The PROMPT prompt is probably PROMPT pg, which will display the current directory name followed by the > symbol. This prompt command would be placed in the AUTOEXEC.BAT file. The SET command will display the current prompt command. The COMMAND.COM program contains several DOS commands (CLS, VER, REM, IF, FOR, COPY, etc.) and checks to see whether one of these internal commands was specified. If not, it searches for the program specified, loads it and runs the program. It will search for a file with a .COM, .EXE or .BAT extension, in that order, in the current directory and the search path if one has been set with the PATH command. The familiar "bad command or file name" means that DOS can't find the program or command specified.

PCs most often use the DOS software. DOS is also referred to as MS-DOS for Microsoft DOS (Microsoft is the name of the software company that developed MS-DOS) and PC-DOS for IBM's Personal Computer DOS. Other operating systems, such as UNIX or OS/2, sometimes are used on a PC. Because DOS is the most popular operating system for the PC, the focus here is on DOS. The PC could have brought up UNIX or OS/2 instead of DOS by changing the boot record. Some programs, such as the Microsoft Flight Simulator, don't use DOS at all.

An operating system provides the basic services required to use the PC. With the IBM PC, DOS provides these basic services. The DIR command displays a list of files in the current directory. MD, CD and RD are used to make, change and remove directories. TYPE and PRINT display a file on the screen or printer. COPY and XCOPY copy files from one directory or disk to another. RENAME changes the name of a file. ERASE and DEL erase the file. DATE and TIME set or display the current date or time of day. CLS clears the screen. The CHKDSK command checks a disk for problems. There are many other DOS commands. A complete list of commands is in the DOS reference manual. Each new version of DOS has added some commands. The VER command will display which version of DOS the PC is using.

Powering up a PC is actually a complex process. The one beep lets you know it all went well. ■

Understanding the vacuum fluorescent display – Part II

By Stephen J. Miller

In the October 1989 issue, we began a discussion of fluorescent display systems. This month's Video Corner will discuss key scan and IC time-sharing. We'll finish this series next month with a discussion of troubleshooting procedures for vacuum fluorescent displays.

Key scan

Last month's column described how key scan operates. Figure 1 shows an example. If a logic high appears on input B when scan I is high, the microprocessor will deduce that switch two is closed. To eliminate the effects of random noise pulses, static and switch bounce, the microprocessor doesn't consider a key input to be valid unless the key remains closed for several consecutive key scans. The diodes in the key-scan matrix ensure that the input bus remains isolated from the scan lines if more than one key is closed simultaneously. To further reduce the number of IC terminals, the grid drive signals often serve dual functions: grid drive to the display tube and key-scan output signal to the key matrix. Because the grid drive signals are already in a sequentially scanned format, it is an ideal output signal for a key-scan matrix. The diodes in Figure 1 also provide isolation between the key-scan circuit and the display drive circuit. If one or more of the diodes develops leakage, you will have problems such as incorrect key entry or key closure affecting the display.

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

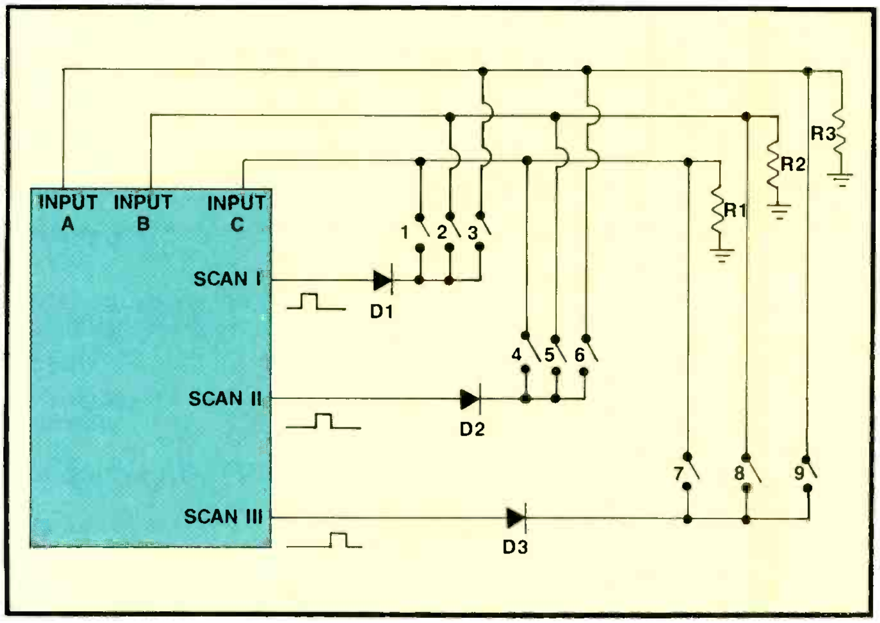


Figure 1. Because of the large number of front-panel keys, a key matrix is used to reduce the number of key-input terminals to the IC. Like the display matrix, the key matrix operates by outputting sequentially timed scan pulses. The key-input lines form a parallel bus. Each key-scan output line drives a bank or group of keys connected to the input bus.

Time-sharing the IC terminals

In some systems, the segment output lines are used as the key-scan output lines. In these systems, the display drive operation and key-scan operation use the same microprocessor terminals on a time-share basis. In other words, the microprocessor alternates between them. First a display section is serviced, and then a keyscan operation will occur. During key scan, all display grids are held low, which prevents the key-scan sequence from illuminating any display segments. Likewise, any data appearing on the key-input terminals is ignored during the display sequence.

Microprocessors perform nearly every function on a time-share basis because computers can only handle one operation at a time. However, a properly operating microprocessor is like a talented juggler. The juggler keeps a large number of objects aloft by regularly giving each one a thrust upward. The microprocessor appears to perform a large number of tasks simultaneously by regularly giving each task some attention.

Figure 2 shows the internal details of a typical display driver IC. Two different biasing schemes are in common use. The most popular type uses a high negative voltage supply. In Figure 2, the voltages without parentheses refer to this negative voltage supply system. To illuminate a segment of a character, both the fluorescent tube grid transistor and the segment driver transistor must be turned on. This pulls both elements to a +5V potential, biasing the tube into

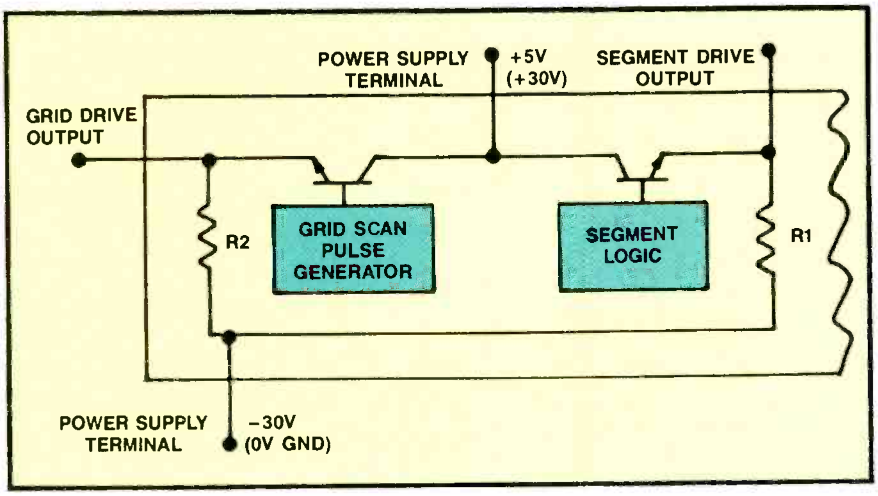


Figure 2. Two different biasing schemes for display driver ICs are in common use. The most popular type uses a high negative voltage supply. The other uses a high positive voltage supply.

conduction. When the segment driver transistor is turned off, the segment will be biased at −30V via R1, cutting off that segment of the tube. Turning off the grid driver transistor will bias the grid to −30V and cut off all the segments in that grid section.

The other biasing scheme uses a high positive voltage supply. In Figure 2, the terminal voltages with parentheses refer to this scheme. This type of display is becoming more popular. Modern varactor tuners require a high positive voltage for operation. If the manufacturer can operate the display from this same section of the power supply, a cost saving can be realized from the simplified power supply requirements of the VCR. In this scheme, if both the grid and segment driver transistors are turned on, the elements will be pulled to +30V, conduction will occur, and the segment will be illuminated. Turning off the segment driver transistor will allow the segment to be pulled down to ground via R1, turning off that segment. Likewise, turning off the grid driver will bias the grid to ground and turn off all segments associated with that grid. This operation is analogous to the negative bias scheme described earlier.

Next month, we'll finish this discussion of display tubes with a description of cathode bias schemes and troubleshooting. ■

Changing times, changing technology

By William J. Lynott

Diversification for the electronics servicer is no longer just good advice. It has gradually become the conventional wisdom of the industry. Almost without exception, service dealers who have been unwilling or unable to move into servicing the latest technology are either struggling or have already faded off into financial oblivion.

I've found that the reluctance of small service companies to diversify into new products sometimes reflects the owner's lack of confidence in his ability to deal with new technology. In other cases, it's just pressure from that age-old resistance to change that affects most of us at one time or another.

I remember a visit I made to a small shop in Boston several years ago. As I looked around the shop, the only products I saw were TV and audio equipment. When I asked him about diversification, he said, "I started out servicing TV and audio, and they're still good enough for me. There will always be enough of that kind of work to go around."

Sadly, when I tried to look him up on my last visit to Boston, I found that he was no longer in business. The result of a failure to diversify? Perhaps not, but I'm inclined to think it was.

Forging your way

Of course, it's easy enough to suggest diversification; accomplishing it effectively is something else. There are so many important questions: Diversify into what? How do I go about it? What investment will be necessary? Will my anticipated return be worth the investment?

The answers to some of those questions will be obvious to anyone who bothers to take a look at a few exceptionally successful electronics servicers. The assortment of products now being serviced by some companies that started out strictly as TV repair operations now includes such items as VCRs, CD players, computers, telephones, telephone answering machines, microwaves and, of course, facsimile (fax) machines.

I know of one servicer in Texas who is servicing those little computer modules found in virtually all new cars. The last time I spoke with him, he told me that he had a difficult time breaking into that field, that it took determination and patience. Now, he says, the work is very profitable and he has just about all he can handle. I tried to get him to explain how he went about it, but he won't reveal his methods except to say that it took a lot of persistence.

No doubt there are many other products suited to the expertise and equipment found in the typical electronics service shop. A few that come to mind are home and commercial security alarms, cellular phones and electronic equipment now being built into what are called "smart homes." And of course, there is always the urgency of keeping up with newly emerging technology, which presently includes high-definition TV (HDTV), CD players and digital audio tape recorders (DAT).

Choosing your field

The answers to the questions involving the amount of investment needed, training and anticipated return have all been answered by servicers who have successfully diversified. Many of those I have spoken with on this subject tell me that the biggest problem in diversification is making up your mind to go ahead and do it. Once you set your sights on a given product, I'm told, you must then deal with these problems one at a time until you're in business.

Readers of this column will include servicers who have already diversified successfully in all or most of the products I've mentioned, and probably some that I haven't mentioned. If you have successfully made the transition into servicing any products other than TV/audio equipment and you're willing to share your experiences with other readers, I'd like to hear from you. In addition to the products involved, I'd like to hear about the problems you faced and how you solved them, the approximate investment you had to make, and whether you feel your return on your investment, including training, is paying off.

If you are one of those servicers who has not yet diversified from TV/audio, I urge you to give serious thought to the consequences. Even servicers who have managed to develop enough conventional service work to keep the wolf away from the door should be concerned about the shrinking market for narrowly focused service dealers. Eventually, it will catch up to you.

Of course, there are practical limits to diversification. Ideally, any move you make into new territory will be designed to allow you to make use of — at least to some extent — expertise and equipment that you already have. I have known a number of servicers who have diversified into products far removed from their areas of expertise. Although some have managed to successfully pull off such a radical departure, most have found their moves to be ill-fated adventures.

Diversification is a major move, one that requires a great deal of thought and consideration. For most electronics servicers, however, there is no practical alternative. ■

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

Readers' Exchange

Readers' Exchange items cost 50 cents per word, per insertion, and must be accompanied by payment to ensure publication.

- Each initial or abbreviation counts as a full word (w/probes would be two words).
- Model numbers count as one word only. Company names also count (ACME model xyz would be three words).
- Specification ranges count as one word (1Hz-3MHz).
- Addresses should be included in the word count.
- Readers' Exchange items will continue to cover only Wanted and For Sale items. Specialized heads, such as job opportunities, business opportunities or help wanted, must continue to run in the Classifieds section.

Send your Readers' Exchange submissions, with check or money order, to:

READERS' EXCHANGE
c/o Susan Edwards
Electronic Servicing & Technology
P.O. Box 12901
Overland Park, KS 66212

FOR SALE

Gould K-25 General Purpose Logic Analyzer with cables and manual still in box new. $1850.00 *Raymond McLaughlin, URI 120 Crawford Hall, Kingston, R.I. 02881 401-792-2748* 10-89 2-T

Sencore CR70 Restorer/Analyzer. Excellent Condition, $650.00. *Bret Days; 607-432-1930 ext. 122, Nights; 607-432-2982. Route 7, Box 161, Colliersville, N.Y. 13747*11-89 1-T

CB Gen. - $125.00; SWR Pwr. - $25.00; C.B. SER Master - $75.00; 12V supply - $30.00; X-STR tester - $40.00; VOM - $40.00; Tube tester - $25.00; 10 MHz scope - $95.00; DVM - $42.00; Dot Gen. - $65.00; Capacitance tester - $125.00; I.C. tester - $250.00; Deviation meter - $250.00. *BOULEVARD RADIO & TV SERVICE, 1431 Robinson Avenue, HAVERTOWN, PA 19083, (215) 642-4429* 11-89 2-T

Sencore T.V. and VCR test equipment. Bought new in June '89, used very little. VA62, VC63. NT64, ST65. PR57, CR70, LC75. Also, Tektronix 2247A oscilloscope. *(707) 823-1103.* 11-89 2-T

Well established audio/video service shop in beautiful Sedona, located in the temperate, central part of Arizona. Live and work in Red Rock Country. Will sell with or without inventory/equipment. $35,000.00. *Sudden Service Electronics, 2035 Contractors Rd., Sedona, AZ 86336, 602-282-2350.* 11-89 1-T

WANTED

Non-working, good condition, Seagate and Miniscribe, half height, PC hard drives, all capacities. *Bill Thrasher, 422 E. Ferndale, Grand Prairie, Tx., 75051; 214-264-6842.* 11-89 1-T

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

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

LIKE NEW SENCORE TEST EQUIPMENT—VA62 Video Analyzer - VA63 VCR Accessory - NT64 Pattern Generator - LC53 Analyzer DVM37 VOM - PR57 Isolation Transformer. Also Kenwood CS2110 100 MHZ Dual Oscilloscope - B-K 470 Picture Tube Rejuvinator - Holiday 1501 Microwave Leak Detector. 918-534-3331 11-89-1t

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

ELECTRONIC SERVICE EQUPMENT For Sale. Sencore: UA62 with UC63, $3000. CB42 with CB41, $500. Leader: LBO-508A, $400. LTC-906, $50. Or all equip. for $3500. Call or write: Rogers Apple TV, 117 E. Main, Coldwater, KS 67029. 316-582-2803, ask for Leon. 11-89 -1t

REDUCED 75%, Diehl Mark V scanner $219, Diehl Mark III scanner $89. New. 2805 University Ave., Madison, Wis. 53705, 608-238-4629, 608-233-9741. 3-89-tfn

VHS-VCR Repair Solutions Sets I, II, III, IV, V. Each contains 150 symptoms and cures, cross reference chart, free assistance, $11.95 each, all five $49.95. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 10-89-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

PM SCHEDULES & REPAIR HISTORY: individualized for VCR, TV, 16mm, slide proj., and more. Hard copy package, $5.00; Lotus disk, $15.00. Mike Carter, 6 Rose Ave., Leominster, MA 01453. 11-89-1t

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

FAST CAMCORDER REPAIR Factory authorized, factory trained, free estimates. Paul's Electronics, Inc. 1120½ West Bristol St., Elkhart, IN 46514. Mon. thru Sat. 7:00 a.m. to 9:00 p.m., 219-262-8496 or 219-264-2147. 11-89-1t

BUSINESS OPPORTUNITIES

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

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

Circle (31) on Reply Card

Circle (28) on Reply Card

Circle (30) on Reply Card

Circle (29) on Reply Card

Advertisers' Index

Company	Pages Number	Reader Service Number	Advertiser Hotline
Automated Production Equipment Corp.	19	15	516/654-1197
Chemtronics, Inc.	7	14	800/645-5244
Chicago Case, Inc.	43	20	312/927-1600
Consolidated Electronics, Inc.	37	17	800/543-3568
Dandy Mfg. Co.	60	28	800/331-9658
ETA	57		800/359-6706
Fluke, John Mfg. Co., Inc.	5	3	800/227-3800
Fordham Radio Supply Co.	23	16	800/645-9518
Heath Co.	51	24	800/444-3284
HMC-Hub Materials, Co.	17	13	
Iscet	57		817/921-9101
Kenwood Test & Measuring Instruments	11	6	213/639-4200
Leader Instruments, Corp.	3	4,5	800/645-5104
Nesda	53,55		817/921-9061
Nutronix Inc.	55	26	313/939-4710
Pace, Inc.	15	12	301/490-9860
Paladin Corporation	9	37	805/499-0318
Parts Express Int'l. Inc.	41	19	513/222-0173
Philips ECG	1	33-36	800/225-8326
Prime Electronics	60	31	414/473-4727
PTS Corp	45,47	21,22	800/333-PTSI
Sencore, Inc.	IFC	1	800/843-3338
Sony (Service Data Software Div.)	37	18	
Sperry Tech, Inc.	60	29	800/228-4338
Techni-Tool	21	32	215/825-4990
Tentel	60	30	800/538-6894
Test Probes, Inc.	13	7-11	800/368-5719
Tool Kit Specialists, Inc.	53	25	800/621-0854
Viejo Publications	51,57	23,27	800/537-0589
Zenith	BAC		

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