

The how-to magazine of electronics...

ELECTRONICTM

Servicing & Technology

MARCH 1987/\$2.25

Product Directory • Services Directory • Company Addresses

Replacement Parts Directory • Association/Educational Sources



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ELECTRONIC

Servicing & Technology

Volume 7, No. 3 March 1987

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An advance in chip fabrication

This enhanced production process will produce, more rapidly, multilevel, very-large-scale ICs that are more densely packed. A Technology Department article.

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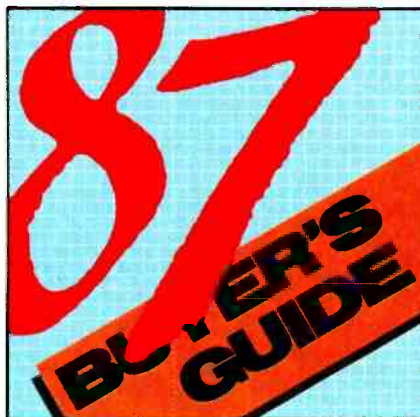
Product Directory

Listing everything from test equipment to miscellaneous tools, this directory provides the names of manufacturers who supply the products that technicians use every day in servicing consumer-electronic equipment. Just locate the name of the product you need and listed below, you'll find the name of the manufacturers who make it.

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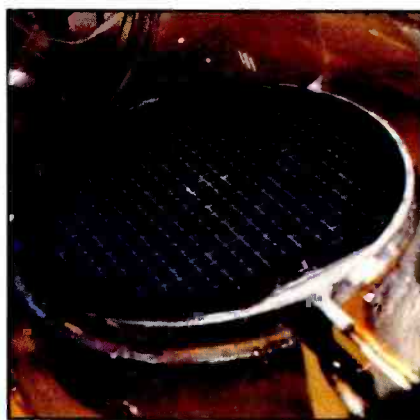
Replacement Parts Components Directory

Finding the right replacement part can be the hardest *part* of servicing. From A to Y, antennas to yokes, these pages will direct you to sources of those often elusive replacements.



Begins, page 13

For your convenience, ES&T coordinates Buyer's Guide lists of manufacturers, firms and organizations involved in the electronics industry.



Page 10

Here, a portion of the reactor where via holes, now with straight sides and regardless of depth, fill simultaneously.

(Photo courtesy General Electric.)

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Association/Educational Sources Directory

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Company Mailing Addresses

An alphabetical listing of all major firms involved with electronics. You'll want to keep it handy.

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Setting up a test bench

By Conrad Persson

Even with changes in consumer electronic products, certain test equipment remains basic; some new devices are requisite.

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We hope you like our Buyer's Guide issue

One of the most frequent requests we get from readers is for information about finding suppliers of specific kinds of test equipment, replacement parts, general servicing information, schematic diagrams. The *ES&T* staff spends quite a bit of time searching for answers to questions such as this, looking through catalogs, calling manufacturers, and either calling or writing back.

Here's one example: A representative of a utility company wrote that his company recently had begun selling a line of telephones. His problem was that some of them were beginning to need service and he needed a source of replacement parts. We were unable to provide him with a source of supply immediately.

One day at the Electronic Distribution Show, however, I stopped by a booth operated by a supplier of telephone replacement parts. When I asked a representative in the booth if that company supplied parts for that particular line of phones he said yes. When I returned to work after the show was over, I relayed the information to a very appreciative utility company.

On another occasion, I received a letter from a doctor specializing in hearing impairments who was looking for a supplier of telephones with volume control that would be useful to people who had difficulty hearing. Again, it was some time before I ran across the answer. I happened to stop by the AT&T booth at the Consumer Electronics Show, and found that this obvious source of supply had exactly what that doctor wanted.

Those are only two of the many such information requests we get. We have received requests for information on finding replacements for failed parts in older televisions and stereos. Readers have asked where they can find replacements for hard-to-find ICs in some of today's personal computers. We have even been asked where someone might have an old wire recording with sentimental attachments rerecorded onto cassette tape; we were able to fulfill that request.

In short, it has become amply clear to us that readers of *ES&T* could use some kind of unique guide that would help them find the suppliers of the kinds of goods and services that would suit their particular needs.

This is it! This issue of *Electronic*

Servicing & Technology is the first Buyers' Guide compiled exclusively for electronic servicing technicians and others who need a directory of suppliers that supply such things as test equipment, tools, replacement parts, and information required by people who are servicing consumer electronic products.

You will notice that in order to bring this guide to you that *for this month only* we had to drop a few of our useful and well liked regular features such as the Profax schematics, "What do you know about electronics?" and "Test your electronic knowledge" because of space limitations. But we're so sure that this buyers' guide will be a valuable reference all year long that it will more than make up for the absence of those features.

And there's some good news about our regular monthly features that will return next month. We have added Hitachi to our list of TV manufacturers that have graciously agreed to allow us to publish their schematics in the Profax section, and we are working to widen our coverage further.

And, of course, there's a lot of useful information packed into this issue besides the Buyers' Guide: Technology; Audio, Computer and Video Corners; and an article designed to help readers think about setting up or modernizing a test bench to facilitate servicing today's breed of consumer electronics equipment.

So go ahead, read the articles, let your fingers do the walking through the Buyers' Guide, and put this issue of *ES&T* on the shelf by the telephone where it'll be handy.

One more thing. If there's some particular kind of buying information that you need but you don't find here, by all means write to us and let us know. We won't promise anything, but if we evaluate it and the idea seems general enough to be applicable to a major segment of *ES&T* readers we'll try to include it in next year's guide. And if you possess some tidbit of information about some hard-to-find supplier and you'd like to share it with other *ES&T* readers, please let us know; we'll appreciate it, and other readers will appreciate it, too.

Nile Conrad Pearson

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Microprocessor seminars expanded

John Fluke Manufacturing announces an expanded schedule of training seminars on the testing and repair of microprocessor-based circuitry. Featured is a new intermediate level course titled "Troubleshooting." These seminars are scheduled throughout 1987 in various U.S. and Canadian cities.

The hands-on seminars will be of interest to technicians, engineers, and managers involved in the design, test, production and service of digital circuitry. Seminars are based on troubleshooting techniques using Fluke's 9000 series Micro-System Troubleshooter.

The new seminar, "Troubleshooting," provides service technicians with in-depth training on how to merge basic troubleshooting philosophies with the complexities of microprocessor circuit design. This course covers BUS,

RAM, ROM, and I/O testing; signature gathering using the 9010A's built-in tests, probe, and the asynchronous signature option for comprehensive hands-on component level troubleshooting. This 2-day course costs \$350.

Also available is the "Introductory" seminar that covers the basic

concept of microprocessor troubleshooting using the Fluke 9000 series, and demonstrates the total *design-to-service* capabilities of the system. This 1-day seminar is free.

The third seminar, "Programming," is offered to technicians who have completed either the "Introductory" or "Troubleshooting"

FLUKE 9000 SERIES TRAINING SEMINARS

INTRODUCTORY SEMINAR

Call nearest Fluke sales office for date and time.

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VANCOUVER Mar 31, Apr 1	OTTAWA Apr 7, 8	CHARLOTTE May 12, 13 Nov 17, 18	EDMONTON Sep 15, 16		

The how-to magazine of electronics

ELECTRONIC

Service & Technology

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

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seminars. This 2-day advanced seminar covers both the development and use of generic utility programs. It offers a review of troubleshooting procedures, hands-on experience, and an approach to testing and troubleshooting I/O through actual applications. Cost: \$395.

Also, Fluke is offering a new 9000 series evaluation program.

For more information on the 9000 series evaluation program and Fluke troubleshooting seminars, call toll-free 1-800-44-FLUKE, or write John Fluke Manufacturing, P.O. Box C9090, Everett, WA 98206.

Electronics information directory

The 1987 edition of *Sources*, a directory of electronics information agencies outside the United States, has been published. Prepared by the Electronic Industries Association's Marketing Service Department's Research Center, it is designed to offer an information sources guidebook to the electronic industries abroad. *Sources* lists approximately 700 individual entries in 78 different countries with addresses and telephone numbers. Where available, these alphabetical entries also include a contact person, statement of agency functions, as well as the titles of publication offerings.

Sources is the only publication of this type currently available.

Copies of *Sources* are available from the EIA's Marketing Services Department. The cost is \$25 for EIA members and \$50 for non-members. Contact Larry Himelfarb at 202-457-8757 for further information.



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An advance in chip fabrication

New technique will increase capabilities of multilevel semiconductors

A semiconductor processing advance that promises to provide improved yields and permit more dense packing of multilevel very-large-scale integrated circuits was reported in December by a team from the General Electric Research and Development Center.

The advance, an enhancement of GE's basic 1.2- μ CMOS process, is based on a special chemical vapor deposition (CVD) technique that permits the via holes that interconnect circuitry on different layers of multilevel chips to be rapidly filled with metal (tungsten). It solves the via-filling problems encountered with multilevel VLSI circuits having small vias at widely varying depths.

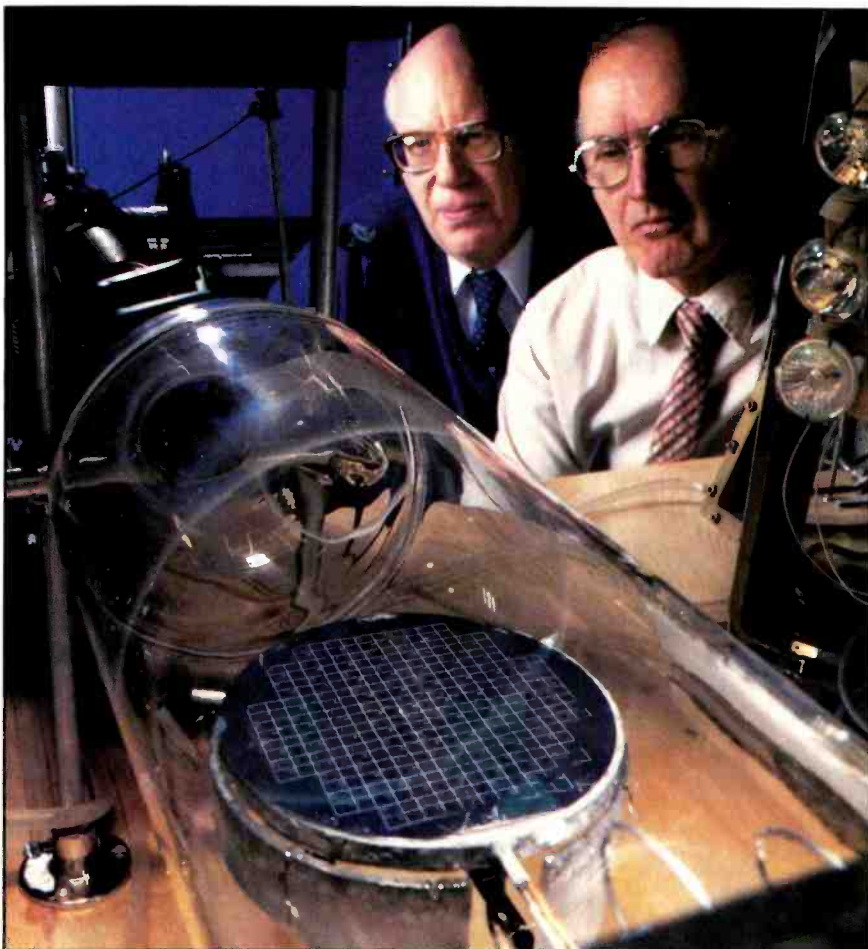
The CVD technique on which the process is based was discovered at the R&D Center. It represents an advance over previous selective tungsten processes in that the tungsten can be deposited selectively in the vias to thicknesses much greater and at rates much higher than previously attainable. With this approach, there is essentially no nucleation and growth of tungsten on the dielectric material in which the vias are etched.

A dual-metal process

In the GE selective CVD tungsten-based process, molybdenum is employed for the first-level metal circuitry (M1) and aluminum for the second-level metal (M2). A planarized interlevel dielectric separates M1 and M2.

Filling via holes in circuits containing both deep and shallow vias is accomplished in the new process by continuing the CVD tungsten deposition long enough to fill the deep holes. This results in the overfilling of the shallow vias and the formation of "nailheads" over them. A specially developed metal-planarization technique that can etch photoresist and refractory metals at the same rate is employed to remove these nailheads.

Among advantages realizable



Pictured is an experimental reactor built at the GE R&D Center for via-filling. The reactor consists basically of a gallon-size quartz vessel fitted with an electrical hot plate on which the wafer to be processed is heated. (For proprietary reasons, the actual hot plate is not shown.) Heat from the hot plate causes mixed gases to react as tungsten, which deposits selectively in the vias. Tungsten deposition rates of up to 8,000Å per minute have been achieved. Watching the process are Dr. Dale M. Brown and Dr. Ronald H. Wilson, two members of the R&D team.

from use of this enhanced process is the fact that it permits the use of straight via holes. In most present VLSI processes, by contrast, it's generally necessary to employ tapered vias that are wider at the top than at the bottom, in order to obtain suitable metal coverage within the holes. (The taper provides a bigger angle of entrance for sputtering in the via-filling metal.)

Straight vias advantageous

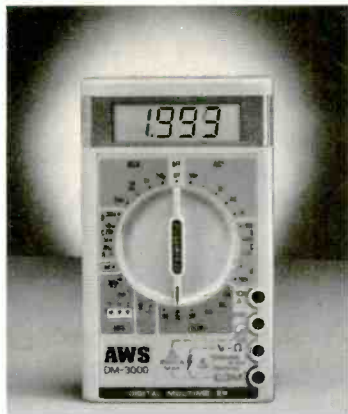
Straight vias are preferable for several reasons. First, they are much easier to make than are their

tapered counterparts. Tapering is accomplished by erosion of the photoresist during reactive ion etching, a process that is difficult to control, especially for small via sizes.

Another major advantage of straight vias is that they permit denser second-level metal patterning. Depending on depth, tapered vias can be two to five times wider at their tops than at their bottoms, taking up valuable "real estate" on the M2 level. By eliminating the taper, it is possible to reduce the M2 interconnection separation to two microns or less.

ES&T

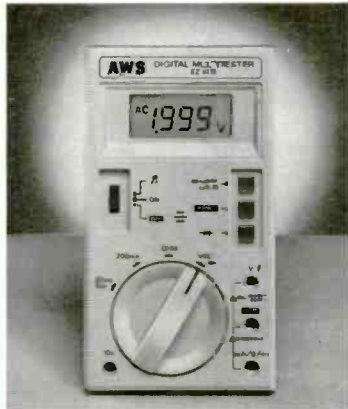
AWS MULTIMETERS



DM-3000 3 1/2 DIGIT ROTARY SWITCH DMM

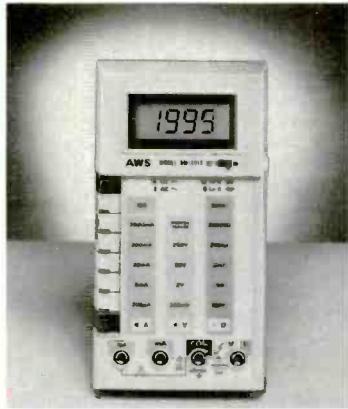
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DM-6500 3 1/2 DIGIT AUTORANGING DMM

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DM-7010 4 1/2 DIGIT ROTARY SWITCH DMM

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BUYER'S GUIDE

87

Welcome to *Electronic Servicing & Technology's* first Buyer's Guide. One of the most common problems mentioned by *ES&T* readers is "where to find it"; everything from test equipment, to replacement parts, to servicing information. For years, your questions have been suggesting to us that you need a guide to help you find what you need to service consumer products.

Here it is! During the past several months the *ES&T* staff has been working with industry authorities to establish a comprehensive list of product sources directed toward consumer electronics servicing.

How to use the guide

This Buyer's Guide is intended to be a useful reference throughout the year. It is divided into five main sections:

- a Product Directory;
- a Replacement Parts/Components Directory;
- a Services Directory;
- an Association/Educational Sources Directory;
- Company Address Directory.

The Product Directory is further broken down by types of products.

To find the product, service, or information source you need, just turn to the appropriate section and review the listings. You will note that some of the listings are printed in blue. These are the companies that have advertised in this issue. For more information about any of these companies, just turn to the page number opposite the entry to find the ad.

Once you have located the name of a company that supplies the product or service you're interested in, turn to the alphabetical listing of companies to find the address and phone number you need.

The *ES&T* staff has expended every effort to make this Buyer's Guide accurate and comprehensive and useful to you. However, because of the large number of sources and the continuous introduction of new companies and products, we may have inadvertently left out some information that's vital to you. If you need a product, part or information to fix a consumer electronic product but don't see it here, please take just a moment to bring it to our attention. Give us as many facts as you can in order for us to research and find the desired information. If we deem it appropriate for the majority of *ES&T* readers, we'll do our best to incorporate this material into the next Buyer's Guide.

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- Basic VCR Troubleshooting Techniques
- Troubleshooting Specific Problems
- VCR Preventive Maintenance
- Appendix and Glossary of VCR Terms

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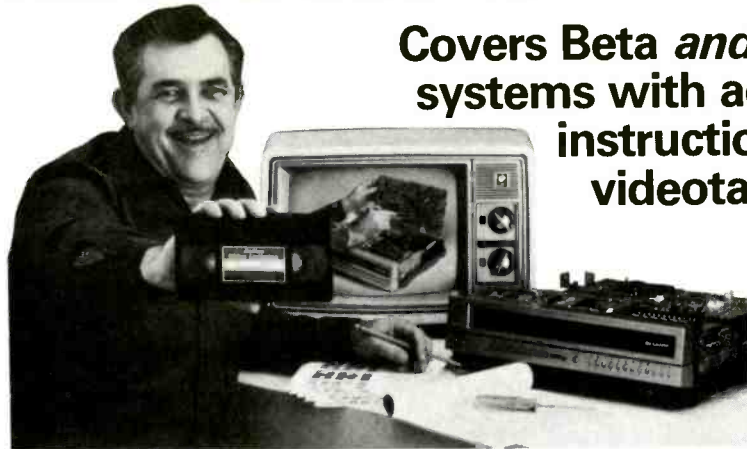
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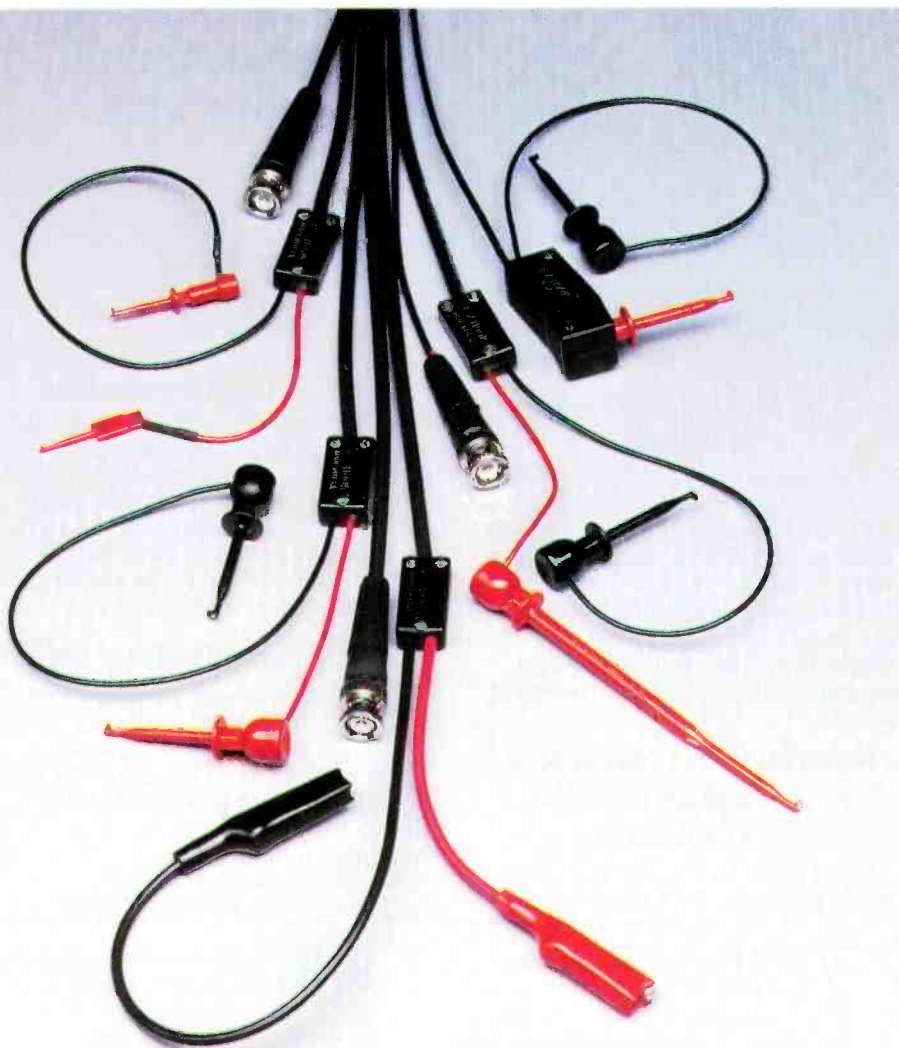
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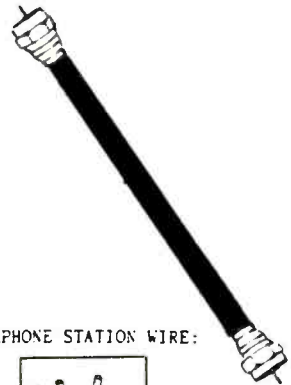
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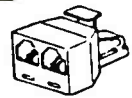


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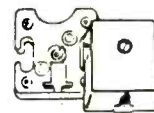
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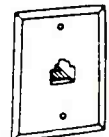
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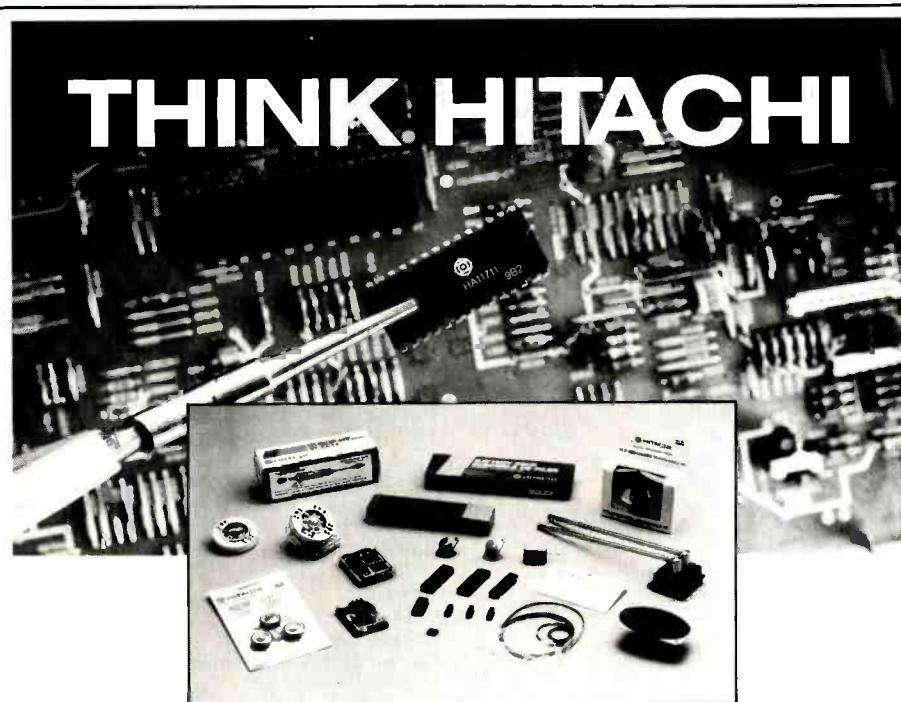
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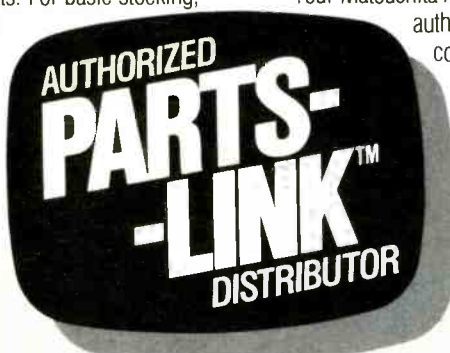
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Panasonic Technics Quasar

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CKC Chemicals	

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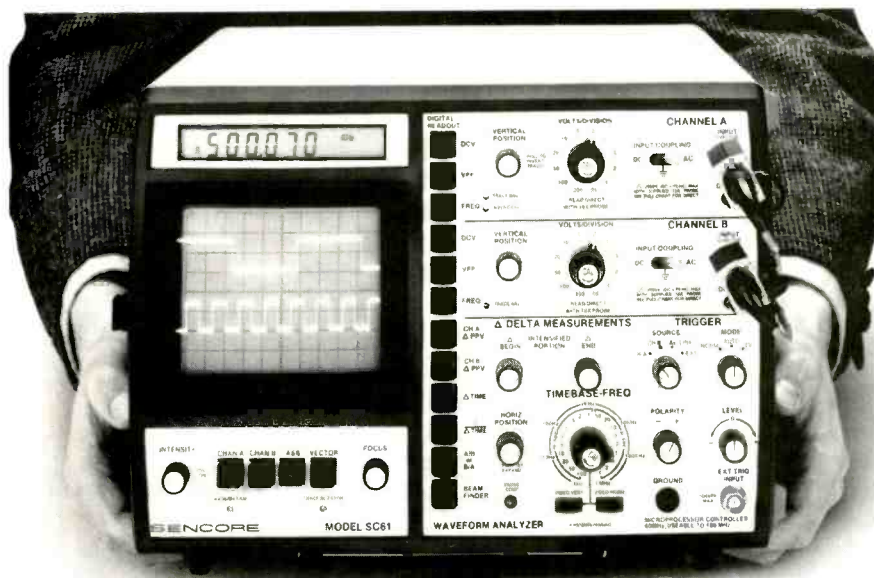
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312-541-9500
800-ACCO-INC

Accutest Instruments

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Clarksburg, NJ 08510
609-259-0460
800-524-0747

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Elk Grove Village, IL 60007
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800-STATIC-O

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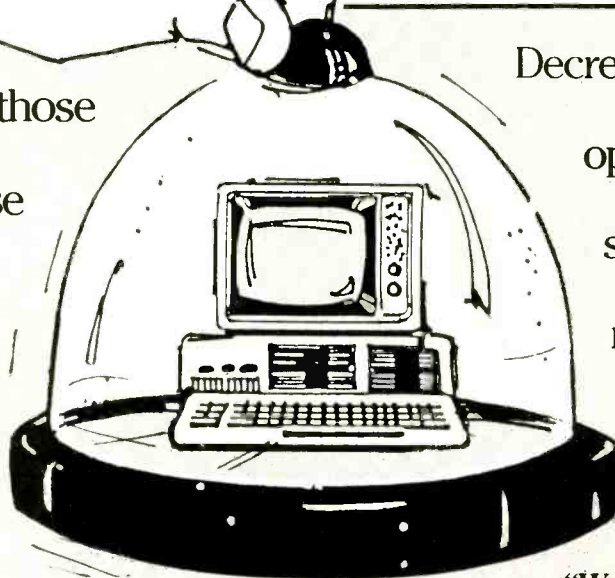
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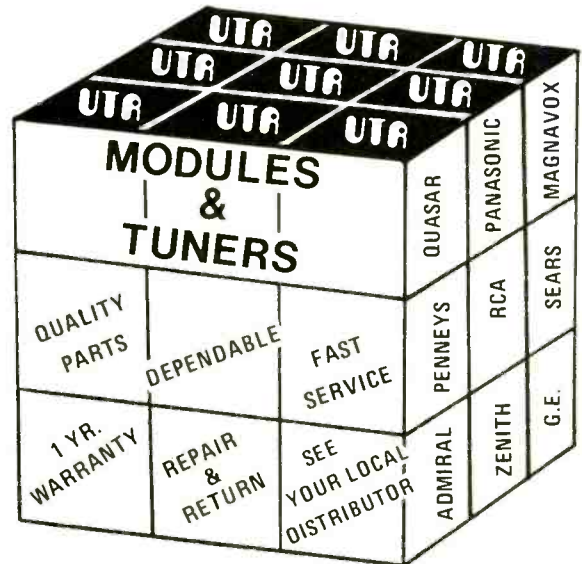
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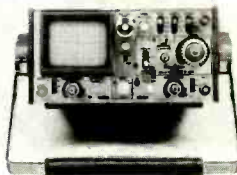
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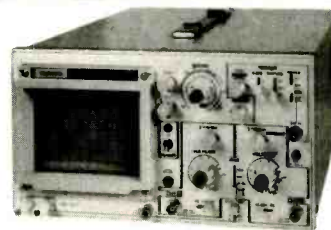
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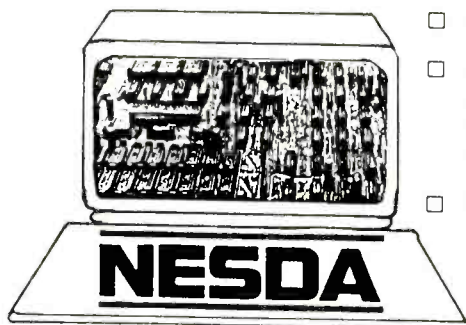


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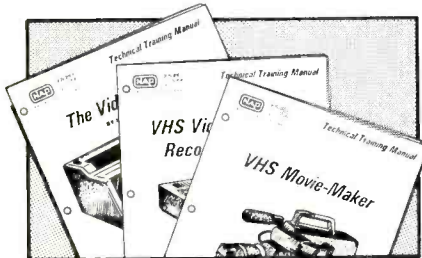
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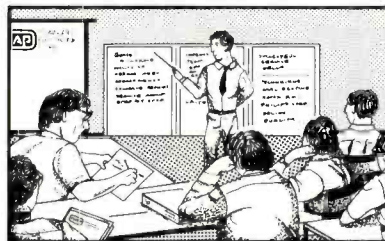
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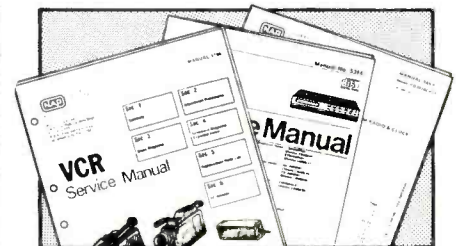
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Beginning with the January 1987 issue, ES&T is paying \$60.00 per page for Symcure submissions that are accepted.

Detailed Symcure and T. Tips guidelines are available upon request to ES&T

The term Symcure is a contraction of the two words: Symptom/Cure. Problems that are published in ES&T in the Symcure department are those that have occurred more than once.

This is the kind of problem that you can solve without even a second thought because you've already seen so many of that particular brand and model of set with those symptoms and in almost every case it was the same component that had failed, or the same solder joint that had opened.

Because of the manner in which we publish Symcure, TV submissions, if they are to be considered, must follow these rules:

1. It is preferred that each submission must consist of seven individual symptom/cure units on a single brand of television set. Seven are requested so we may chose the most appropriate for publication.
2. We must have the manufacturer's name, the model and chassis number, the Sams Photofact number (if you know it) and a sketch of the schematic area where the fault was found for each of the seven units. Each sketch should contain a major component such as a transformer, a tube or transistor to provide a landmark for the ES&T staff.
3. Because the very nature of Symcure is based on schematics, if for any reason there is no Sams Photofact on the unit, we cannot accept the submission.

We also will consider Symcure submissions on consumer electronics equipment other than television, such as VCRs, stereos, computers, microwave ovens. Depending upon the nature of the product and the symptom, it may not be necessary to refer to a schematic diagram in all of these cases.

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100	\$21.00	\$14.00	Not available	Not available	Not available	Not available
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*5,000-9,000	\$63.00/M	\$51.00/M	\$89.00/M	\$94.00/M	\$51.00/M	\$55.00/M
*10,000-19,000	\$61.00/M	\$46.00/M	\$84.00/M	\$89.00/M	\$50.00/M	\$51.00/M
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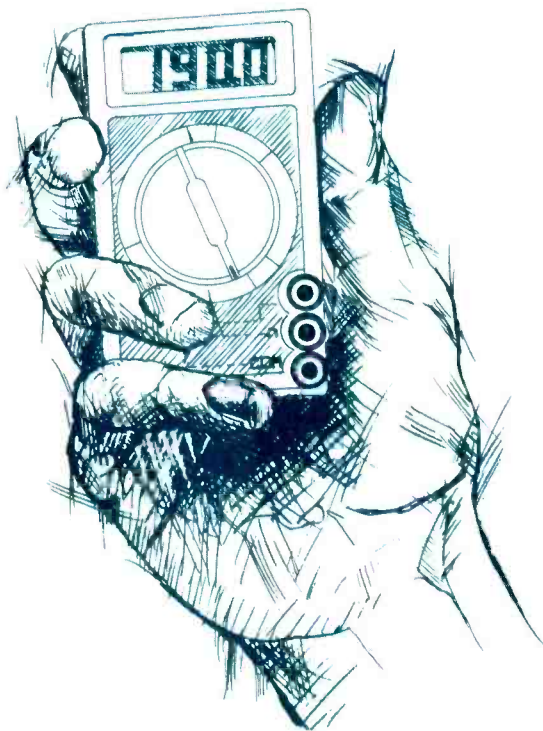
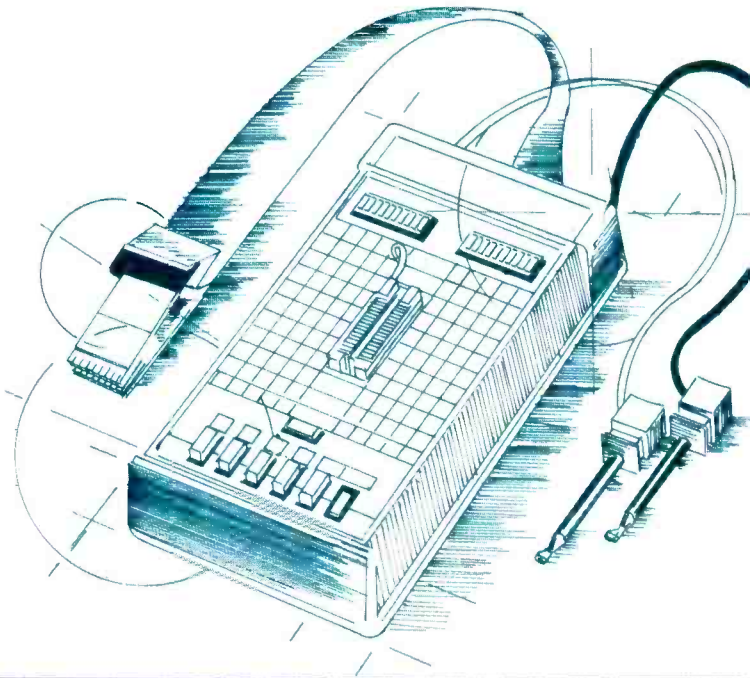
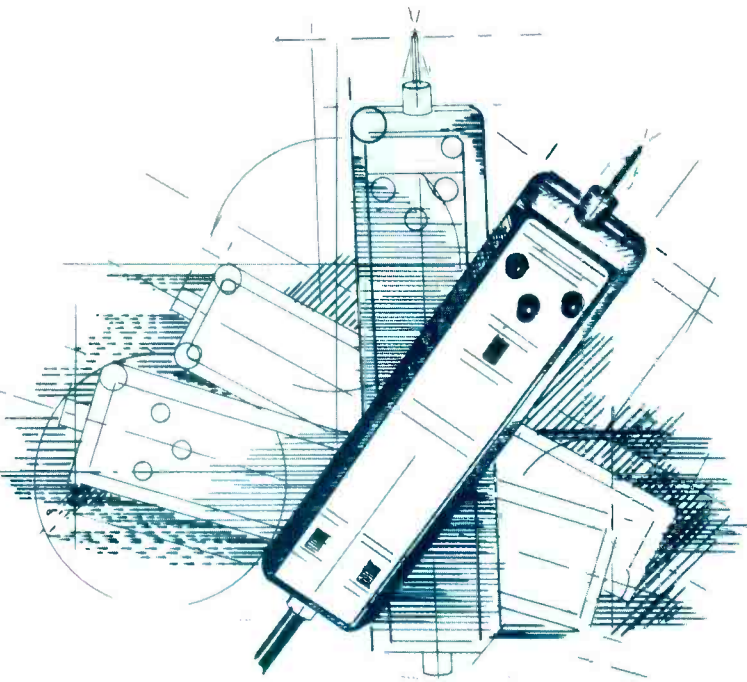


Table 1. General purpose test equipment

Oscilloscope

Multimeter

Frequency counter

Variable transformer

Bench power supply

Signal/pattern/function generator

Semiconductor tester

Tube tester

L/C tester

Field-strength meter

Signal-level meter

Curve tracer

R/C substitution box

Setting up a Test Bench

By Conrad Person

During the past several years, consumer electronics products have undergone immense changes. For starters, most products now contain many tiny integrated circuits. These ICs are great for the consumer because they allow the products to be more reliable, contain more features, feature greater stability, all at no increased cost. In fact, sometimes at reduced cost.

Unfortunately, for the servicer these tiny devices may not be a boon. For one thing, because you can't see what's inside, they tend to present something of a mystery. Besides that, they can be difficult to remove from the PC board (and in fact, not even one should be removed unless the technician is sure it's defective). What's more, they may be susceptible to damage from electrostatic discharge (ESD). Also, close lead spacing, especially of surface-mounted devices (SMD) may cause bridging problems when a replacement device is soldered in.

Changing the work area

If the foregoing causes you to think that the electronics workbench needs to change to accommodate these advances in technology, you're right. But basing electronic circuitry on integrated circuits is only one of dozens of changes in consumer electronics necessitating changes

in servicing facilities, techniques and procedures.

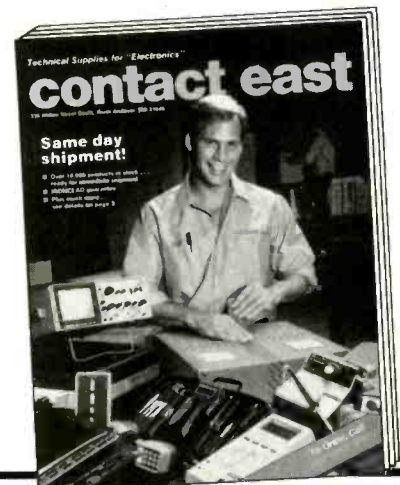
Another factor is the ever-expanding base of products that is called "consumer electronics." Not too many years ago, this class of products encompassed television, radio, stereo and not much else. In just the past few years, a host of new products has been added to the consumer electronics inventory: personal computers, video-cassette recorders and video cameras, microwave ovens, personally owned telephones, both corded and cordless.

And here's another factor: Changes and enhancements have been made in the traditional consumer electronics products. To the standard CRT type of television has been added projection television as well as tiny LCD televisions. In addition, stereo audio in the forms of MTS has been added.

To the typical home stereo system have been added such refinements as graphic equalizers and digital audio disc players.

Any technician who's still trying to service consumer electronics products with a 10MHz scope and a DMM is hopelessly out of date.

This article is intended to provide readers with some suggestions on test equipment and tools that will help a servicing technician determine what he will need in order to perform service on various kinds of consumer elec-



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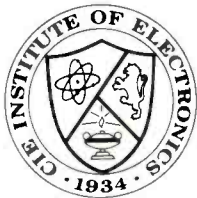
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Table 2. Multimeter considerations

A: Physical considerations

Size

Ease of use

Protection from physical damage

Protection from electrical damage

Accuracy/performance

B: Measurement characteristics

Volts Vac Vdc

Amperes Aac Adc

Ohms

Decibels

Diode test

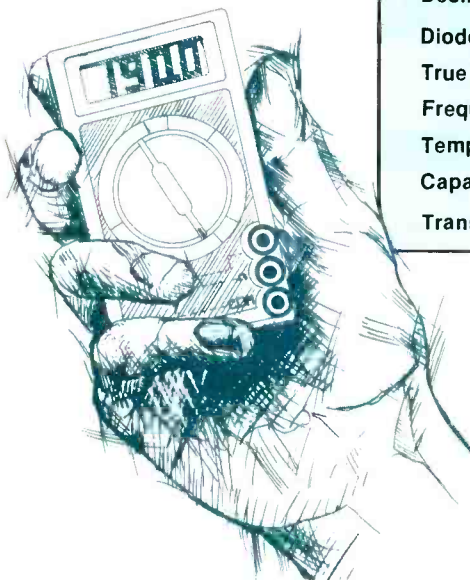
True RMS

Frequency

Temperature

Capacitance

Transistor gain (h_{FE})



tronics products. Unfortunately, an undertaking of this dimension would require the space of a textbook rather than the confines of a magazine article. For that reason, this article neither can be comprehensive or exhaustive in its coverage. If we have left out any equipment or other subjects that any readers feel should have been mentioned, we would welcome comments on the subject. Your input will be of great help the next time we undertake a project such as this.

Two of the most important pieces of equipment for a technician in servicing modern consumer electronics products are good lighting and a whopping big magnifier. OK, that's an exaggeration, but it does point up one of the important points about servicing today's products: There are many tiny components, and there are many components with close lead spacing, and if you're going to

service them, you have to be prepared to deal with minuteness.

In the February 1986 issue of *ES&T* there's an article entitled "Solder: the tin tie that binds." One of the things it points out about servicing today's products is that with extremely close lead spacing it's almost futile to try to solder each lead individually. The recommended technique is to apply the solder and the soldering pencil and run it across the leads from one end of the device to another. If you have judiciously applied soldering flux before applying the solder, you might not have any bridges, but Murphy's law says you probably will. This makes final inspection of any repair one of the most important steps in the process. And that's where the good lights and the magnifying lens come in.

Selecting a DMM

Troubleshooting an electronic product most often proceeds in three broad steps. First come the physical observations: Check to see what's operating and what's not; listen for normal sounds and abnormal sounds; check for signs of excessive temperature; check for signs of open circuits, etc.

Whether or not the physical examination reveals anything, the next step is almost invariably a series of probes with the multi-

Table 3. Oscilloscope characteristics

	BANDWIDTH	RISE TIME	OTHER KEY FEATURES
1. TV/video	12.5MHz	28ns	TV frame and line triggering
2. Digital	50MHz	7ns	Dual channels, alternate horiz. mag.
3. Audio	175kHz	...	500 μ V sensitivity
4. Electro-mechanical	5-10MHz	35ns	Single sweep, HF/LF reject trigger
5. Robotics	5-10MHz	35ns	Single sweep, HF/LF reject trigger, 500 μ V sensitivity
6. Power supplies	175kHz	...	500 μ V sensitivity

Notes:

1. Based on 0.14- μ S sync pulse rise time requirements. At least 50MHz needed for IF sections.
2. Covers most consumer digital systems (e.g. personal computers).
3. Does not cover digital recording; 500 μ V sensitivity for microphone, tape head measurements.
4. Based on rise time/switching requirements.
5. Same as 4; high sensitivity for low amplitude sensor waveforms.
6. Bandwidth determined by supply switching rates; 500 μ V sensitivity for low-level ripple measurements.

meter: perhaps a check for correct power supply output voltages, checks for continuity, checks for proper values of dc voltage at a few suspect test points.

If these preliminary steps fail to locate the source of the problem, the next step usually is to bring in the heavy artillery: the oscilloscope, the signal generator, etc.

The strategic position of the multimeter in the troubleshooting scheme points out the importance of selecting the right one. Determining which is the right one depends on what measurements you plan to perform with the meter, the conditions under which you plan to use it, and the condition of your pocketbook.

For example, if you plan on using the unit for taking ac measurements at higher frequencies, you'll need a meter that doesn't attenuate the signal appreciably in the frequency range you're interested in.

If you plan to use the meter to test semiconductor junctions, you'll want to have a diode test function available.

If most of your measurements will be performed at the bench, you probably won't need to worry too much about size, weight or ruggedness. But if you'll be toting it about in a toolbox full of other tools and test equipment, rugged-

ness will be of prime importance. Tables 1A and 1B list some of the important physical and measurement characteristics you should consider. For more detail on the considerations in choosing a multimeter, consult the September 1986 issue of *ES&T*.

Selecting an oscilloscope

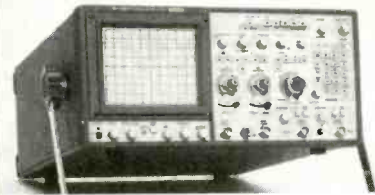
If choosing a multimeter is important because it's usually the first instrument that comes to hand for preliminary measurements, choosing an oscilloscope also is important because an oscilloscope is one of the most general-purpose of test instruments. It can be used to check voltage levels, examine waveshapes, examine phase relationships and more.

Another reason for choosing carefully is that, fortunately or unfortunately, depending on your point of view, there has been considerable change and improvement in oscilloscopes in the past few years. Now, in addition to such choices as bandwidth and risetime, single or multitrace and other choices, oscilloscopes come in digital as well as analog versions, some offer logic tracing functions, and one or two will even give you a printout.

Another important consideration is any special features you might need. For example, if you'll

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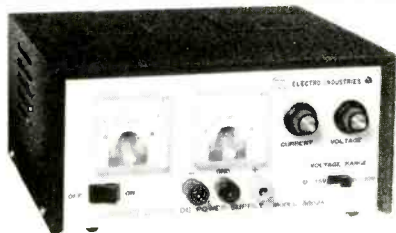
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be doing much TV/video servicing, you'll want to be sure that your scope has TV frame and line triggering capability. See Table 3 (taken from the January 1987 issue of *ES&T*) for a summary of applications vs. specifications.

Safety first

Because the multimeter and the oscilloscope are the most basic of the technician's arsenal of test devices they were discussed first, but there are several items of equipment that should be in place before you do any testing or disassembling, in order to ensure safety of the technician, the equipment and the owner of the equipment. Absolutely basic are an isolation transformer, an ac leakage tester and ESD protection.

Isolation transformer. Many of today's television sets have a hot chassis, that is, one with all, or part, of the chassis above ground potential. If this chassis is grounded while power is applied, damage or destruction of components may result. If the technician comes in contact with the chassis at the same time coming in contact with true ground, a nasty shock could be the result. Powering the set being tested from an isolation transformer isolates it from the power line ground and removes this source of shock hazard.

ESD protection. Integrated cir-

Table 4. Safety equipment
(Personal and equipment safety)

Isolation transformer
Leakage tester
Electrostatic discharge (ESD) protection
Bench mat
Wrist strap
Static detectors
Ionizers
ESD protective packaging

Table 5. Audio test equipment

Stereo signal generator
Wow and flutter meter
Distortion meter
AC voltmeter

Table 6. Video test equipment

Video signal/pattern generator
NTSC generator
Vectorscope
Waveform monitor
High-voltage probe
CRT tester/restorer
Tuner subber
TV test jig
VCR test jig kit
VCR head protrusion gauge

cuits are being used extensively in today's consumer electronic products. Many of these are susceptible to electrostatic discharge damage. The potential for ESD damage is obvious when the air is desert dry and you draw a loud, painful spark after walking across a carpet. But some of today's ICs are so sensitive to ESD that you can cause damage even if you can't feel or hear the static electricity.

ESD damage is not always obvious. If you're working on a piece of equipment and cause minor ESD damage, the product might operate just fine for a week or a year or more, but the stress to a component from the ESD might eventually cause premature failure of the product.

Table 7. Digital test equipment

Logic probe
Logic pulser
Logic monitor clip (IC clip on)
Break-out box
Logic comparator
Floppy-disk drive tester
Floppy-disk drive exerciser
Logic state analyzer
Logic timing analyzer

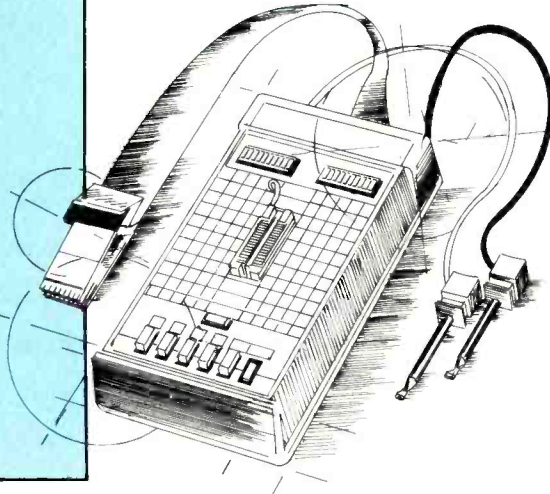


Table 8. Telephone test equipment

Telephone analyzer
Line analyzer
Cordless telephone tester

With modern, IC-based products, it's recommended practice always to use static protection equipment when servicing. This consists of a benchtop or mat that dissipates static electricity as it forms, a grounded wrist strap, and a grounded floormat. For safety to the technician, all of these grounding devices should be grounded through resistances in the megohm range to eliminate shock hazard.

It's also considered good practice to use antistatic containers or bags when storing, transporting or shipping static-sensitive devices to eliminate the potential for damage at all times.

Leakage tester. Any number of things can happen to cause potentially lethal voltages to be applied accidentally to the case of a consumer electronics product. Any time a product is serviced, the individual performing the service should perform an ac leakage test with the appropriate leakage tester before the unit is returned to operation.

Signal generators

Most problems in entertainment electronic equipment probably can

be located with little more than the test meter and the oscilloscope, given enough time and effort. And many problems will yield immediately with only this complement of test equipment. Many problems, however, will yield more quickly if you can inject a signal at various strategic points and check the result. For example, take an inoperative audio system. By injecting an audio signal at a point in the circuit that's about halfway between the input and the speakers, you can eliminate half of the circuit from suspicion of being faulty. By going through the same process repeatedly, you can, in relatively few steps, isolate the problem to a single stage.

The same is true of video circuits. Often, by injecting a known video signal at some point in a faulty television set and observing the result on the screen, it is possible to isolate the problem to a specific section of the TV circuitry.

Special test equipment

Thus far, this article has addressed primarily general-purpose test equipment: the basic items you'll find in almost any electronics servicing facility. But servicing of certain specific types of products frequently requires certain specific items of test equipment. In other cases, product-specific test equipment may not be an absolute necessity, but the right piece of test equipment will make diagnosis a lot faster and easier.

As an example, if you plan to service personal computer disk

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drives, you might get by with a fairly wide bandwidth oscilloscope and perhaps a logic probe. If you'll be testing and repairing very many units, though, you might be well advised to have a disk-drive tester or exerciser on hand to speed up the diagnostic process.

Because of space limitations in this article, it won't be possible to discuss all of the kinds of test equipment available for testing all of the modern consumer electronic products. Table 1 lists the basic items of test equipment common to most electronic servicing facilities and Tables 2 through 11 list the items of test equipment for servicing of specific kinds of consumer electronic products.

We have tried to be as comprehensive as possible in compiling these tables, but no doubt we have missed a few. If any sharp-eyed readers notice the absence in any category of some piece of test equipment that they consider essential, we hope they'll bring it to our attention. That will help us make the next article of this type even more complete.

Soldering and desoldering equipment

Whatever the consumer electronic product you're servicing, if the problem is in the electronic circuitry, most likely you're going to have to replace one or more components or ICs, and that means desoldering the bad part and soldering in the replacement.

When it comes to soldering and desoldering today's generation of products, the rules have changed and the tools have changed. You don't have to throw away that 100W soldering gun, but don't use it to solder in a 40-pin integrated circuit. Product manufacturers recommend using a 10W to a 50W soldering pencil that's temperature-controlled.

For desoldering ICs with their many leads, either you're going to need a soldering iron with a head that will heat up all the leads at one time, or you'll need some

Table 9. Soldering/ desoldering products

Solder

Soldering irons

Temperature-controlled soldering irons

Cordless soldering irons

Gas-fueled portable soldering irons

Solder/desolder stations

Solder suckers

Heat sinks

Soldering aids

Desoldering braid

IC insertion/extraction tools

PC board repair kits

PC board rework stations

method of removing the solder from each lead in turn. There are any number of products for removing the solder from component leads. One of the least expensive products for this purpose is desoldering braid: fine copper wire formed into a braided wire, impregnated with rosin flux and rolled up in a coil for easy handling. You simply place the braid against the joint to be desoldered and apply the soldering.

Other tools available for this job of removing solder from joints are suction devices that are applied to the joint while the solder is molten, and use either a squeeze bulb or spring-loaded plunger to suck the solder out.

Better yet (if you do enough soldering and desoldering to justify it) is the solder/desolder station. These can cost from a few hundred to a few thousand dollars, but they can do everything from soldering and desoldering surface-mount components to repairing the printed circuit board.

Some of the options on one of these stations include having two, or even more, heat producing units on the same unit so you can vacuum desolder with one unit and solder with the other without having to change tips. You can get one

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Table 10. Tools/Fixtures

Pliers	Crimping tools
Cutters	Wire wrap/unwrap tools
Screwdrivers	Tweezers
Nutdrivers	Files
Hex wrenches	Knives
Wrenches/nutdrivers	Vises
Wire strippers	Holding fixtures

with a self-contained air pump to give you both vacuum and air under pressure, or if you already have compressed air available, you can buy a unit that's designed to interface with your existing air system. You can opt for attachments that will let you strip wires thermally. You can have just about anything you could possibly need to rework a PC board in one of these units. Just bring money.

Tools, jigs and fixtures

The typical test-and-repair bench should be equipped with a selection of hand tools at least. You really can't do anything without a set of screwdrivers, standard and Phillips, so you have the right kind and size for the job. A set of nut drivers of most of the sizes used in electronic products is also very handy and probably essential.

Add to these a pair of long-nose pliers of two or more different sizes, and some side cutters.

An assortment of such things as wire strippers, wire crimpers and such speeds replacement of wire connections where that's necessary.

But those are just for starters. These days, with the proliferation of ICs and the introduction of more and more mechanical components like VCR and compact disc drive mechanisms, the required inventory of tools swells. For ICs you might need insertion and removal tools. Things that turn on shafts often have snap rings and suchlike that require special tools such as snap ring pliers to remove and reinstall them.

More than ever before, servicing today's consumer electronic products is made easier with the use of such things as vises, and other kinds of holding fixtures that will hold the workpiece in place while you use both hands to work on it.

Chemicals

Chemicals have for some time been valuable in performing service on consumer electronic products, but now more than ever the right chemical applied to the right point in the product will help restore it to operation. Here's an example: In replacing a surface mount IC, one recommended procedure is to use liquid flux applied to the solder lands to hold the device in place while you solder it in. That's one chemical. Then after you get the device soldered in place, chemically wash away the excess flux to avoid having the flux act as a dust magnet later.

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Table 11. Chemicals

Soldering flux

Flux remover

Heat-sink grease

Silicone lube

Freon cleaner spray

Glass/plastic cleaner

Anti-static spray

Compressed air

Adhesives

Conformal coating

Component coolant spray

VCR/audiocassette/disc drive head cleaner

TV tuner cleaner/restorer/lubricant

High-voltage insulator

Rubber belt/idler wheel restorer

Dirty heads cause many VCR problems. Solving these problems is the job of *cleaning* chemicals.

And don't forget that old stand-by coolant spray. Any time you have an intermittent fault, the alternate application to the suspect component of heat via a hair dryer and cold via freeze spray may be just the thing to isolate the source of the problem.

Updating the workbench

It's easy to get into a rut and conclude that the old ways, tried and true, are the best. In a lot of cases that's true, and change for the sake of change doesn't make sense. But the world has changed so much in the past 10 years that any operation that hasn't re-evaluated its tools and procedures

is in danger of being out of date.

Technology has changed the way almost everyone is doing almost anything. Manufacturers of every imaginable kind of product from semiconductors to something gargantuan are using computer-aided design and manufacturing. Information increasingly is being stored and retrieved in computers and on videotapes and discs. People whose jobs involve contact with other, distant people are more frequently spanning distances electronically instead of physically.

Technology also has increased the choice of consumer electronic products and changed the way they are designed and constructed. The electronic servicing bench also needs to change to keep up with this technology.

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Troubleshooting Tips rates and guidelines

Beginning with the January 1987 issue, ES&T is paying \$25.00 per item for Troubleshooting Tips that are accepted.

A Troubleshooting Tip is a description of the procedure used by a servicing technician to diagnose, isolate and correct an actual instance of a specific problem in a specific piece of electronic equipment. Its value to readers, however, lies in the general methods described rather than its applicability to the repair of the specific piece of electronic equipment.

A good, useful, Troubleshooting Tip has the following elements:

1. a brief but complete, accurate and concrete description of the problem symptoms;
2. a complete identification of the set, including manufacturer's name, model and chassis number and the Sams Photofact number, if applicable;
3. a hand drawn schematic sketch of the area where the trouble occurred, if applicable. Include some major component such as a transformer, tube or transistor to serve as a landmark to the *ES&T* staff;
4. a detailed, step-by-step description of the procedure used to track down the cause of the problem. This should include the thinking process used—for example, "the absence of B+ voltage led me to believe...etc.";
5. a mention of any symptoms that misled you and caused you to follow false trails;
6. a narrative telling why the defect was suspected and how it was determined to be the cause of the problem such as tested open, shorted, etc.;
7. a description of how the repair was performed, including any precautions about possibility of damage to the set or injury to the servicer, if applicable.

The characteristics of a good candidate for Troubleshooting Tips are as follows:

1. It should be a relatively uncommon problem.
2. The diagnosis and repair should not be obvious, and preferably should present something of a challenge to a competent service technician.



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Whatever happened to controllable intermittents?

It's been many years and several generations of electronic design, but, they haven't gone away; at least, not permanently. In fact, they come and go as they please. They cost you time and money. They increase the gray in your hair while decreasing the green in your bank account. Why do you tolerate them? Because you have no choice. They are the intermittents, and intermittents don't cooperate.

The scourge

How do we define "intermittent" failure? Sure, Webster has an entry for it, "stopping and starting at intervals." But what it really means is "fails for the customer, but works fine on the bench." It's almost as if intermittents were controlled by some yet to be discovered, malevolent life form, but, no, I don't suppose that's it.

Intermittent problems may be caused by any of these conditions:

1. Thermal extremes
2. Mechanical vibration
3. Supply voltage variations
4. Unknown

Whatever happened to controllable intermittents? You'd spray a little freeze here, tweak the board there, and your problem would come and go. It was easy to find the culprit. But lately, the old 62°-below treatment has been failing me. I had a CD player whose nasty habit was to start skipping, then eject the disc, and leave the drawer motor running. Even though I should know better, it seemed like microprocessor trouble, because the drawer limit switch was setting the appropriate input pin low, just as it should. I thermally cycled the suspected IC. The symptoms would come and go. Against my better judgement, I went with the test results and replaced the micro.

...thermally cycling the defective chip did not have an effect on the problem!

Guess what? That wasn't it. It turned out that the sled driver IC, which also controls the drawer motor and the eject LED, was at fault. This part is six inches away from the chip I was heating and cooling, and I took pains to localize my test to the microprocessor. Add to that *this* little piece of insanity – thermally cycling the defective chip did not have an effect on the problem! Sometimes you just want to take a hammer and . . .

So what's going on? Digital circuitry has added a new dimension of frustration to an already ulcer-promoting annoyance. Manufacturers have traded switches and pots, which we all enjoyed cleaning, for more reliable electronic switching and attenuation, leaving behind a new kind of intermittent. Thanks. A lot.

Methods of attack

All right, enough complaining, let's figure out how to deal with these gremlins. First, we eliminate things that don't work.

1. Just letting the unit run normally while you wait for it to quit.

2. Setting it up on a special cook bench halfway across the shop, while you go about your business and hope it'll fail as you walk by on the way to the parts department or coffee machine. (In case you haven't been in this business long, it usually happens when you're not looking.)

3. Telling the owner there's no problem because "I ran it all day and it never quit."

Know the enemy

What does work? Let's think about it. Intermittents can be classified by the types of things that cause them to occur.

1. Thermal extremes
 - A. Hot
 - B. Cold
2. Mechanical shock or vibration
3. Supply voltage variations
4. Cause unknown

Know your weapons

The key to ferreting out the cause of an intermittent is to control it. A controllable problem is a serviceable one. Some of the tools we can try are:

1. Heat gun
2. Freeze spray
3. Variac and variable dc supply
4. Non-conductive mechanical probe or "diddle stick"
5. Failure monitor (see *EST*, March 1984 for a description of the IM-1 monitor device).

The scientific method helped get us to the moon, maybe it'll work with balky stereos. Adapted to repair, it has five steps.

1. Observe symptoms.
2. Hypothesize the cause.
3. Design a test for your hypothesis.
4. Predict the results.
5. Make the test.

Many of us use this method subconsciously. For example, we observe that the receiver in front of us has no output, and that the STK2042 hybrid amplifier package is hot enough to blister skin. We hypothesize that the device is shorted. We decide to test our hypothesis by installing a new IC, and predict that the output will return and we'll be able to chalk up another success to the scientific method. Then we replace the part and test. If necessary, we keep repeating the procedure until the unit is fixed.

Know yourself

More fundamentally, the technician's attitude is a key element in successful repair of intermittents. Important factors are:

1. Assume the unit is, indeed, defective.
2. Aggressively try to get the unit to fail.
 - A. Open it up and flex boards.
 - B. Run it hard.
 - C. Throw a blanket over it.



- D. Hit it. (Not hard enough to break anything)
 - E. Try every function, in every combination you can think of.
3. Be patient.

Some of the procedures that may be used to stimulate an intermittent failure:

1. Heat gun
2. Freeze spray
3. Varying the supply voltage
4. Probe with a nonconductive probe
5. Connect to a failure monitor

Surveillance

Of course, if the problem is not controllable, patience is the most useful tool we have. Most shops can't afford a storage scope or event recorder. Something that might work, however, is to set up a camera and video recorder to monitor an oscilloscope connected at strategic points in the DUT (device under test). If the DUT is a television, the camera can be aimed to view the screen as well as the scope. If an audio device is being tested, its output should be recorded on the audio track of the VCR. Video decks can be tested similarly, using a monitor. After setting up this rig, you can go about your business, coming back to review the tape in fast scan at your convenience.

But what about my numbers?

I can hear some of you muttering a twelve letter word, "productivity." You don't have time to think and experiment, just repair. I know how you feel. All the same, if you don't figure out how to deal with intermittents, your productivity will suffer in the long run. Time spent working on an intermittent is not time lost. It's usually knowledge gained, which will help you the next time you see a similar problem.

Time spent working on an intermittent is not time lost... usually knowledge gained.

None of this is new, but it can't hurt to refresh the memory. Quite often, technicians, under pressure to produce, merely give an intermittent unit a cursory test, usually finding nothing wrong. Because failure to find intermittent problems is one of the most common complaints, it pays to take greater pains to service these units.

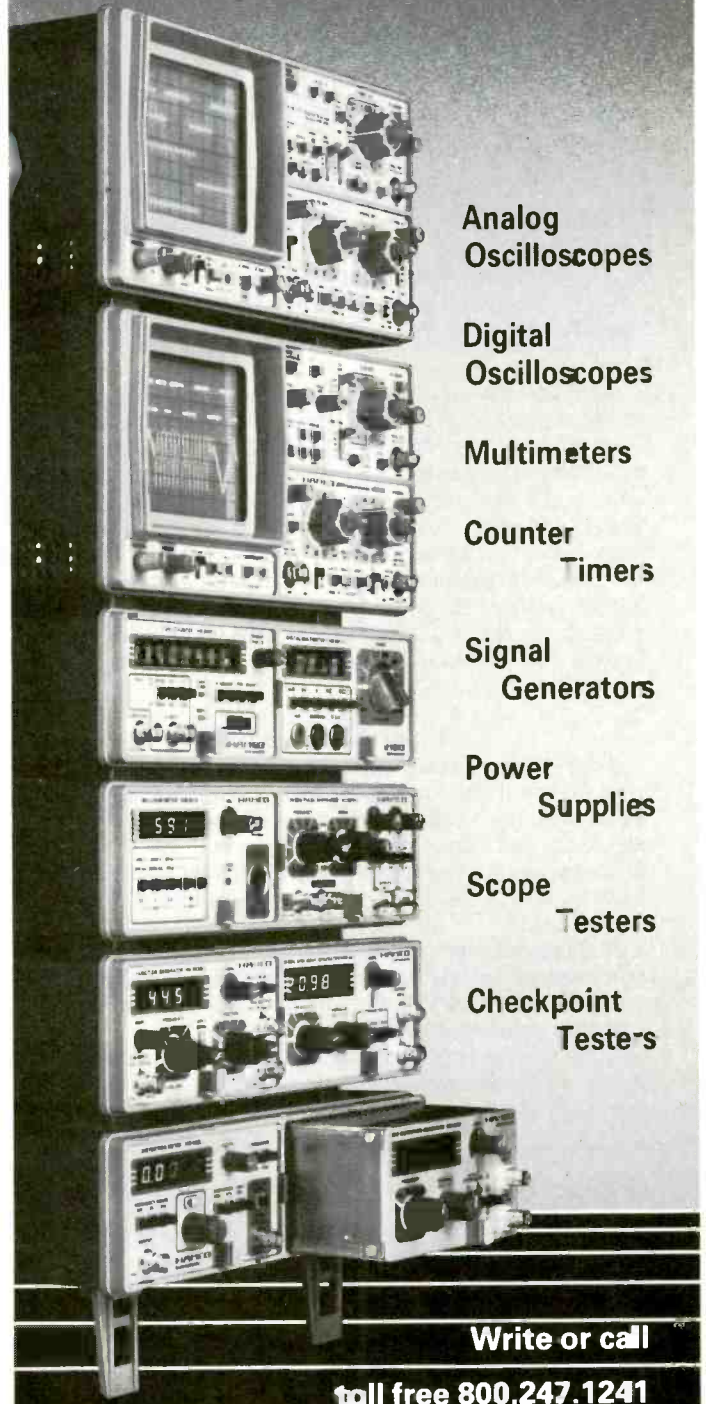
Maybe next time, we'll discuss two further avenues of approach, induced failure analysis, and computer aided testing. Until then, be productive, but take time to improve.



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If you're just starting to service computers...

Recommended personal computer test equipment (minimum)

Dual-trace scope (delayed sweep if possible)
Minimum bandwidth—35MHz (100MHz preferred)
Digital multimeter, high quality—3.5 digits minimum
Analog multimeter, medium quality

Other suggested equipment:

Known-good computer, same as you plan to test
Static protection equipment
Power conditioning equipment
Schematics and other documentation
Diagnostic software

As in the case of anything new, it's usually best to begin at the beginning. With microcomputer repair, this is not so easy because, for different technicians, the beginning is not always the same. So you'll know where *my* beginning will be, I'll tell you: I'm writing these articles from the standpoint of the consumer electronics technician with an audio/video background. That means you already know how to use a triggered sweep scope (and delayed sweep), a digital voltmeter, and have some journeyworker experience (perhaps at least two or three years), so you will understand the concepts of fundamental system troubleshooting.

Equipment required

Most of you already will have what you need to start working on micros and peripheral equipment. Peripheral equipment (also called "peripherals") includes everything not built into the main computer box itself such as printers, monitors and external disk drives. For test equipment, you will need the following pieces of major hardware:

dual-trace scope (delayed sweep if possible) with a minimum of 35MHz bandwidth (100MHz suggested).
digital multimeter, high quality, 3.5 digits minimum.
analog multimeter, medium quality.

After that, it becomes mainly a question of how serious you are towards making microcomputer repair a significant part of your overall business. For example, if you are

Most of you will already have what you need to start working on micros and peripheral equipment.

seriously going to work on Commodore 64s, an extremely popular home unit, you must have a fully functional unit on hand for test purposes. Otherwise you will, more often than not, find yourself in serious trouble.

First of all, if you are working on a disk drive that has a serious malfunction and won't load, if you can substitute disk drives, you quickly can localize the problem to either the disk drive or the main unit. Likewise, waveform analysis becomes very difficult without access to a known-good unit. Without an effective substitute unit, you are reduced to troubleshooting based on experience and "in-

stinct," two things that you will have in short supply when you are starting. Even if you have the latest version of the manufacturer's service literature or the equivalent from Sams, nothing, especially when you are beginning, will serve as a substitute for a fully functional working unit to be used for comparison.

Special test equipment and bench setup

On the bench where you do your micro repair, you want to make sure that the area is CMOS-safe. In other words, do all you can to make sure that no static electricity finds its way into the equipment you are repairing. There have been studies done on the long term adverse effect of static. Delco Electronics, for example, found that their call-back incidence was cut dramatically by installing anti-static

Do all you can to make sure that no static electricity finds its way into the equipment.

precautions on the bench itself in addition to the use of anti-static mats underfoot. Lots of us think that static damage is instantly apparent. This is not true. You could inject some static into, say, a modem card and have it work fine after installation, and then days, weeks, or even months later have it fail either partially or totally. If something like that happened to one of our customers, which of us would think to blame static as the culprit? The moral of the story is to buy an anti-static mat to put under your feet, another one on the bench itself, and then use an anti-static bracelet on your wrist. I do that whenever I take a unit apart with the intention of doing anything remotely connected with the main board, or whenever I change a plug-in card. By the way, installing all those mats and straps won't do much good unless you tie them all to a firm common ground. Usually the metal screw on your power strip or wall outlet nearest your bench will work just fine.

Next, give some thought to conditioning the power going to your workbench. There are some excellent power conditioners on the market. These units make sure you actually are feeding the computers a well-shaped 60Hz sine wave. You would be surprised at the waves some power companies have been known to produce from time to time. If you do not want to go that far, at minimum you should use a monitor and a variac (variable ac transformer) so that you can keep tabs on, as well as adjust, the power line voltage. By all means, run all computers and peripherals through a well-designed surge protector. Radio Shack puts out an excellent unit. At its current price of \$69.95, the unit offers fuse, circuit breaker and MOV protection, and has the additional benefit of automatically turning *on* peripheral units when the cpu switch is turned *on*. At the least, be sure to protect your equipment under test with that aforementioned, basic surge protector. The cheap and dirty method is to plug your test bench power into a single surge protector unit. These also can be obtained from Radio Shack for a bit under \$8.

Beyond that, you are left on your own to obtain what few specialized hand tools you may need.

Literature



Magazine: "Service Profit Profiles"

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March 1987 *Electronic Servicing & Technology* 71

Diagnosing VCR servo problems

In the February installment of *Video Corner* we presented part one of "Diagnostic procedures for system and servo control circuits," adapted from "Recommended Diagnostic Procedures for VCRs," a service booklet published by the General Electric Company. This installment is the second half of the 2-part article.

Servo control circuits

Servo circuitry could be thought of as the secondary operation that occurs within a VCR after the system control performs its function. Once the tape is loaded, the record and playback functions are taken over by the servo circuits. The *laying down* of both the video and audio tracks in the Record mode and, inversely, the tracking of this information in the Playback mode must be precisely controlled for playback to be normal. This is accomplished by two components, the cylinder motor and the capstan motor. Servo circuits can be troublesome to service because most of the circuitry is predicated on feedback loops. (Information is fed back to other related circuits where it is stripped and in some cases reformatted and sent out again to be compared.)

As was previously done in the system control circuitry, we will troubleshoot a hypothetical problem. Before starting, here is a good rule of thumb.

- If upon viewing the picture through a monitor you find that the picture tends to break up horizontally, suspect the cylinder motor speed as being incorrect.
- If the video pulsates in and out at a more or less steady rate, suspect the capstan motor speed as being erratic. (Most VCRs are designed to mute the audio when the servos are not locked.)

Although these rules are not foolproof, they may save you precious time and point you to the correct circuitry.

Here's an example: A noise band periodically runs up the picture when playing back a tape recorded on this

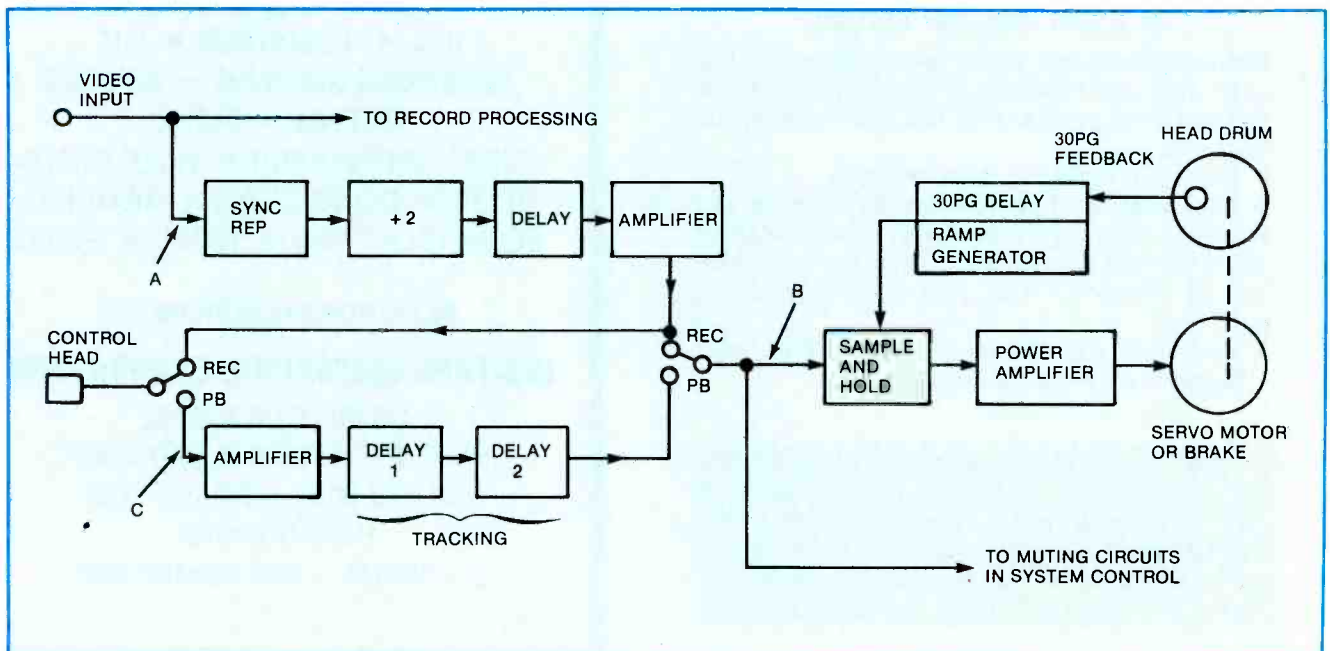
machine. It will play back all other tapes normally. A recorded tape made on this machine played in other VCRs will exhibit the same symptom.

You should suspect a servo problem in the Record mode. A quick way to confirm this would be to put a mark on the upper surface of the video head using a grease pencil. Place the machine under a fluorescent light and run the machine in the Record mode. Look down at the spinning video head assembly. You should see a blur but barely moving pattern of the mark you had placed. If you do not see this pattern, the servo is not locked. Seeing no pattern, you proceed.

You notice the following additional symptoms: the video head switching point appears to move vertically thru the picture. (The switching point from Head A to Head B is turned *on* and *off* by an electronic switch. This point is chosen to be 5 to 8 lines ahead of Vertical Sync. It is precisely controlled by a 30Hz square wave produced in the Servo System.)

Looking at the block diagram, between which two points do you suspect the problem exists?

If you said A and B you are right. The 60Hz vertical sync pulses from the composite video signal are separated and divided by 2. They are then amplified and sent to the control head to be used as a control for the servo circuit. Scoping these pulses will confirm their absence. On the other hand, if the servo locked in RECORD, but failed to lock in PLAYBACK, this would indicate that the timing reference is lost. This would point to a failure between points C and B. If the VCR fails to lock in both PLAYBACK and RECORD, the problem may lie with the 30PG feedback pulse generated by the video cylinder motor. Use a scope to confirm that the 30PG pulses are developed, that they have sufficient amplitude and that they are triggering the ramp that drives the sample-and-hold gate. Usually, most of this circuitry is inside one IC. You can however trace



Servo circuits can be troublesome to service because most of the circuitry is predicated on feedback loops.

both reference and feedback signals to points as close to the sample-and-hold gate as possible.

Two (2) important points to remember

1. The use of signal injection is certainly not a new tool. But in the age of high-tech, it is a viable one.
2. Forcing a change of state or put another way, making something happen, is a tool that should be considered when working with logic circuits.

Adjustment procedures

At right is a typical servo adjustment procedure as given in the GE service manual for one of GE's table model VCRs. TP indicates the point to which the test equipment is to be connected. The control to be adjusted is adjustable resistor R2021.

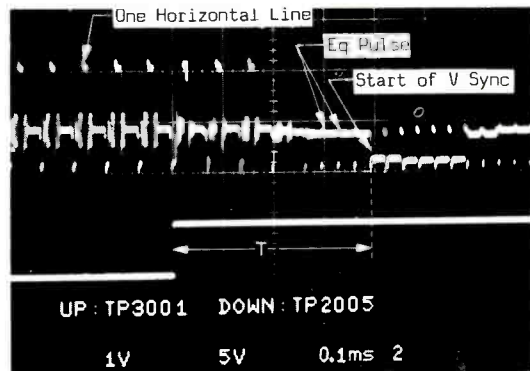
For this adjustment, a special alignment tape is to be played with the VCR in SP mode. The measuring device is an oscilloscope.

The scope-face pattern that will be displayed under these conditions is shown below right. The period T should be six times the horizontal line interval, plus or minus one line.

TP	ADJ.	MODE	INPUT
TP2005 TP3001	R2021	SP PLAY	
TAPE		M. EQ.	SPEC.
ALIGNMENT TAPE (VFMS0001H6) COLOR BARS		OSCILLOSCOPE	T = 6 ± 1 H (0.38±0.06msec)

Note :

TP2005, R2021 : Servo Section on the Main C.B.A.
TP3001 : Video Signal Process Section on the Main C.B.A.



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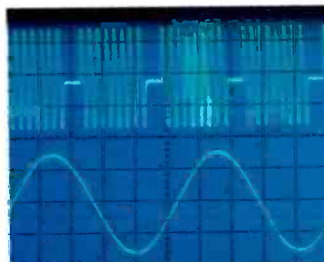
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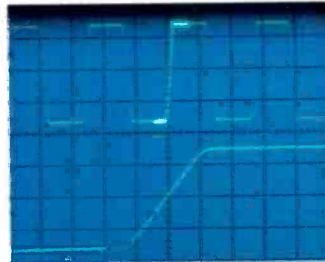
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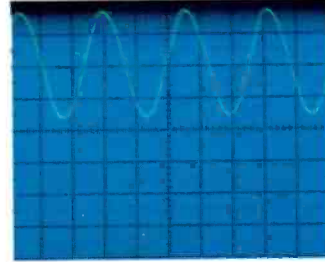
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Channel 1 dc volts measurement. The average dc component of a waveform is measured directly through channel 1 with direct digital fluorescent readout.

The Tek 2236 combines 100 MHz, dual timebase scope capability with counter/timer/DMM functions integrated into its vertical, horizontal and trigger systems. For the same effort it takes to display a waveform you can obtain digital readout of frequency, period, width, totalized events, delay time and Δ -time to accuracies of 0.001%.

The same probe is used to provide input for the CRT display and the digital measurement system, resulting in easy set-up, greater measurement confidence and reduced circuit loading. Probe tip volts can also be measured through the Ch 1 input.

Precision measurements at the touch of a button.

Auto-ranging frequency, period, width and gated measurements are push-button-simple. And the 2236 offers an independent floating 5000 count, auto-ranging multimeter with side inputs for DC voltage mea-



Bandwidth	100 MHz
No of Channels	2 + Trig. View
Max. Sweep Speed	5 ns/div
Digital Readout Features	Direct Ch 1 Voltage Meas. 0.5% DC; 2.0% AC RMS Resistance: .01 Ω to 200 Meg Ω Continuity/Temp: Audible/C $^{\circ}$ or F $^{\circ}$ Totalizing Counter: —1 counts to 8,000,000 Direct Freq. Meas: 100 MHz to 0.001% acc. Period, Width Meas: 10 ns with 10 ps max. resolution
Timing Meas. Accuracy	.001% (delay and Δ -time with readout)
Trigger Modes	P-P Auto, Norm, TV Field, TV Line, Single Sweep
Weight	7.3 kg (16.2 lb)
Price	\$2650
Warranty	3-year including CRT (plus optional service plans to 5 years)

surements to 0.1%.

A built-in, auto-ranging ohmmeter provides resistance measurements from 0.01 Ω to 2G Ω —as well as audible continuity. Automatic diode/junction detection and operator prompts serve to simplify set-up and enhance confidence in your measurements.

The 2236: scope, counter, timer, DMM plus a 3-year warranty —all for just \$2,650.

Contact your nearest distributor or call Tek toll-free. Technical personnel on our direct-line will answer your questions and expedite delivery. Orders include probes, 30-day free trial and service worldwide.

Call Tek direct:

1-800-433-2323 for video tape or literature,

1-800-426-2200 for application assistance or ordering information.

In Oregon, call collect:
1-627-2200

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Just as other retailers or service techs do, you can earn extra money from the relatively easy sale of accessories backed by Zenith, a name renowned for product performance and reliability.

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