THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

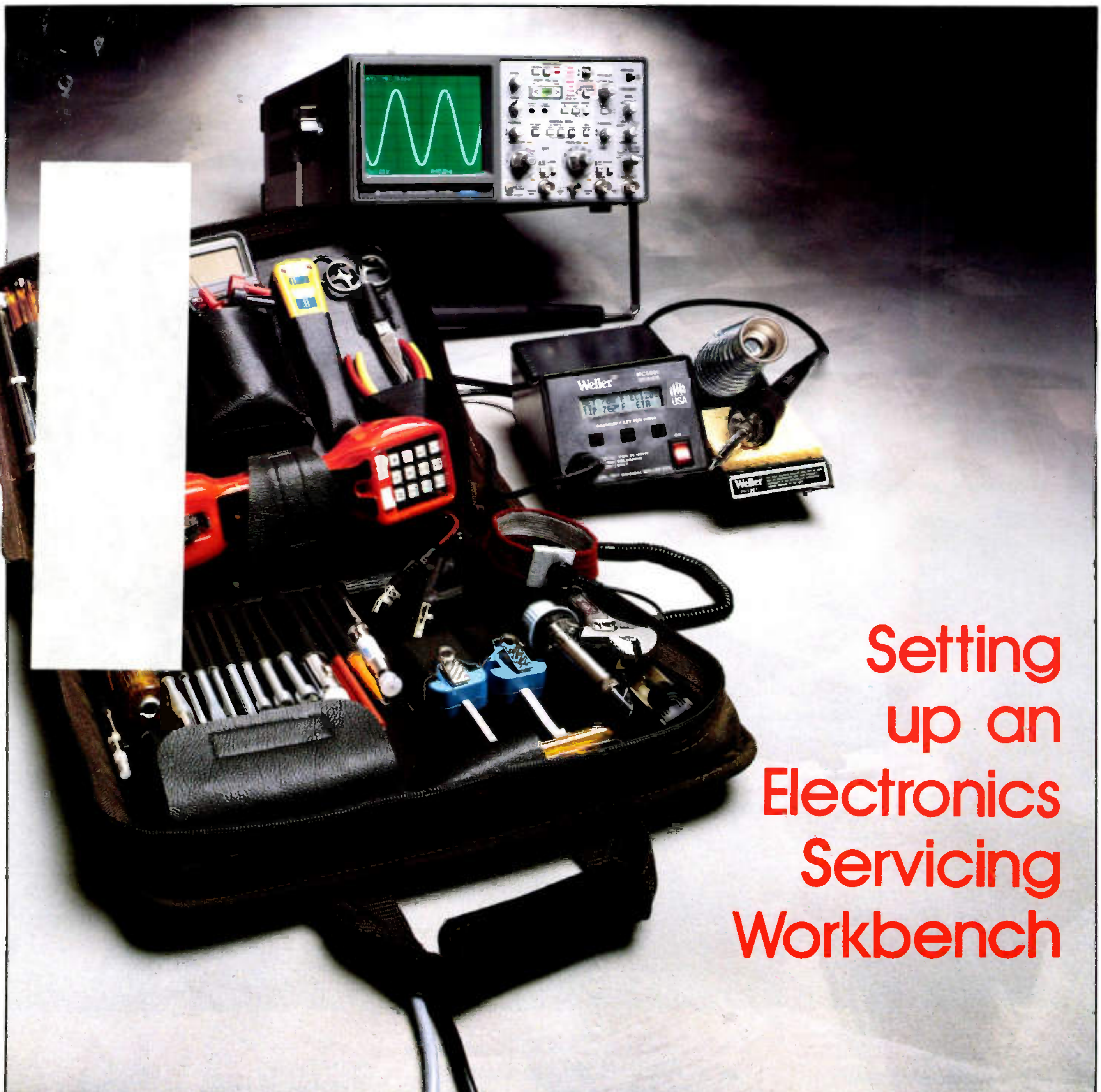
ELECTRONIC™

Servicing & Technology

MAY 1990/$3

The Leakage Test • Hand Soldering

The Portable Workbench • Anatomy of a Camcorder



Setting up an Electronics Servicing Workbench

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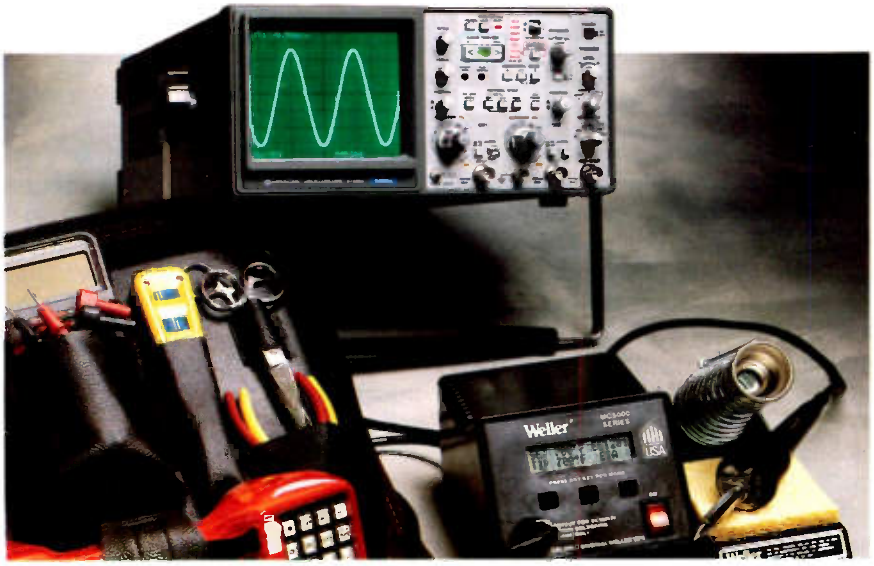

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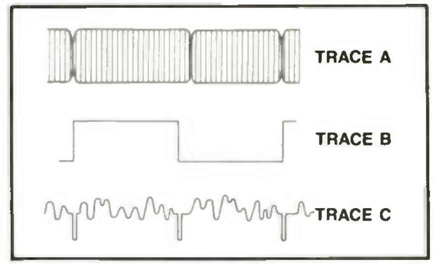

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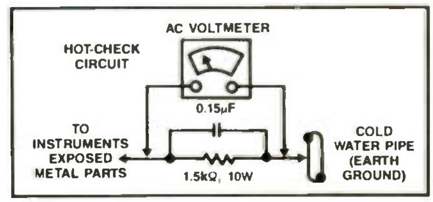

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FEATURES

DEPARTMENTS

ON THE COVER

Whether you are at the bench or in a customer's home, efficient servicing demands that you have the correct tools and test equipment readily available. This tool kit demonstrates that it is possible to pack a lot of tools into a small space. *(Photo courtesy of HMC, Canton, MA.)*

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC
Servicing & Technology

Editorial

A new beginning

Over the years, something that electronics servicing people have learned to accept has been the inevitability of change. We have discussed change many times on these pages. TV servicing had its heyday during the days of vacuum-tube sets. The gradual replacement of tubes with solid-state devices not only resulted in increased reliability, but it forced technicians to change their servicing methods as well.

Changes after changes brought us to today, a time that the circuitry of current consumer electronics items barely resembles that of early products, and the range of products is vastly greater than the range that was available in earlier days.

ES&T has changed to keep pace with technological and business trends, with the coverage of VCRs and camcorders, fax machines and personal computers. In addition, coverage has expanded to accommodate the introduction of new technology, including transistors, ICs, microcomputers and microcontrollers.

ES&T has recently experienced changes of a different kind. Some of you may have noticed that *ES&T* is now under new ownership. Intertec Publishing Corporation, the company that has published the magazine for more than 25 years, has sold it to CQ Communications, Inc. The sale was effective April 1, 1990. This issue has been published partly by the Intertec editorial staff and partly by CQ Communications. The June issue will be published entirely by CQ.

Lest any readers are concerned that the change of ownership may result in a change of direction for the magazine's editorial content, I assure you that that will not be the case. The magazine will continue to bring the nuts and bolts servicing articles that readers now expect from *ES&T*. There may be some cosmetic changes in the magazine and some minor adjustments in the type of articles published, as well as a possible expansion of coverage, but the electronic servicing technicians who make up the loyal readership of the magazine may continue to expect substantially the same publication.

By next month, the names on the masthead will have changed again to reflect a new editorial production staff. I am now employed by CQ Communications, Inc. and continue as editor of the magazine from a midwest office. Please look at the masthead on page 4 for new correspondence information.

Send editorial mail, such as Readers' Exchange, letters to the editor (feedback) and requests for information, to this address:

Conrad Persson, Editor
Electronic Servicing & Technology
P.O. Box 12487
Overland Park, KS 66212
Phone: 913-492-4857

CQ Communications, Inc., which also publishes CQ The Radio Amateur's Journal, Popular Communications, Modern Electronics, CQ Radio Amateur (Spanish CQ) and the CQ Amateur Radio Buyer's Guides has a history of publishing magazines that serve the interests of people for whom electronics is an important part of their lives. The purchase of *ES&T* by CQ is further evidence of the company's commitment to all people who service electronics equipment, whether as a profession or as a hobby.

We think that this change of ownership is a positive step to strengthen the magazine and make it even more valuable to the servicing technicians who read it. We look forward to continuing to bring you servicing articles about the consumer electronics products of yesterday and today, as well as those of tomorrow that have yet to be conceived.

Nils Conrad Persson

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These leaders specify Leader.

When servicing electronics, depend on Leader for your test equipment needs.

Leader meets the standards of so many, because we set such high standards in design.

Equip your bench with our standard test equipment as required by manufacturers. Leader continually consults manufacturers and their service facilities to determine what products and features you'll need. The unique features on Leader equipment help you work smarter and increase efficiency.

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See all there is to Leader's leadership, and benefit from our more than 34 years of experience. Phone now to discuss your equipment requirements, for a copy of our catalog, and for the name of your nearest "Select" Leader Distributor. All Leader equipment is backed by a TWO-YEAR WARRANTY, and factory service on both coasts.

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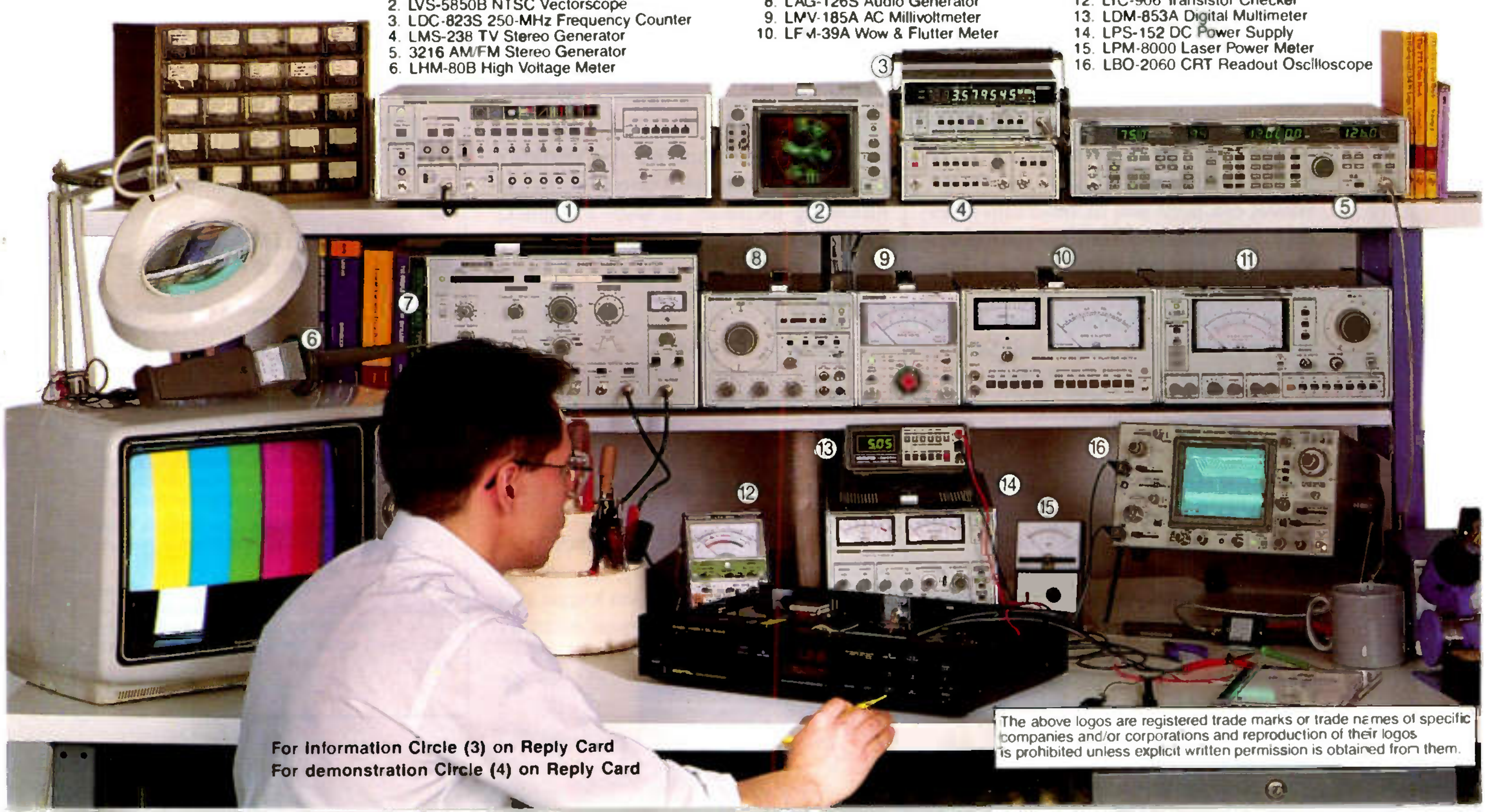
9. LMV-185A AC Millivoltmeter
10. LFM-39A Wow & Flutter Meter
11. LDM-171 Distortion Meter
12. LTC-906 Transistor Checker
13. LDM-853A Digital Multimeter
14. LPS-152 DC Power Supply
15. LPM-8000 Laser Power Meter
16. LBO-2060 CRT Readout Oscilloscope



For Information Circle (3) on Reply Card
For demonstration Circle (4) on Reply Card

Business management seminar at NPEC

At the 1990 National Professional Electronics Convention (NPEC '90) in Las Vegas, Connie Sitterly, M.A., will address "Quality and Customer Relations: The Competitive Edge" at the featured business management seminar. Sitterly, an author, trainer, consultant and speaker, heads Management Training Specialists.

At her Saturday, Aug. 11 seminar, Sitterly will show attendees how to commit their staffs to be error-free, on time, accountable and without excuses. The emphasis will be on teamwork to create an atmosphere that is committed to quality improvement and customer service. Participant sessions will be established in which groups will collectively resolve theoretical problem situations. Sitterly will also develop carry-home resource manuals for NPEC attendees. The cost for the seminar is included in the full registration fee for NPEC '90.

Other management-oriented sessions include "The Right Way to Hire and Fire Employees" by Don Erwin CSM of California; "Best Sales/Service Management Ideas" by Gerry McCann CET/CSM of Louisiana; a panel discussion on "How to Profit from Customer Complaints"; and "Electronic Filing of Warranty Claims" by the Electronic Industries Association's Consumer Electronics Group.

A week-long convention and show, NPEC includes daily technical seminars, a trade show, NESDA and ISCET annual elections and membership meetings, manufacturer/servicer dialog sessions, golf and tennis outings, and sponsored meal functions.

For more information, write to the National Electronics Sales and Service Dealers Association, 2708 West Berry St., Fort Worth, TX 76109-2356; 817-921-9061.

PC-Systems Workshops available

To provide engineers with insight into new instrumentation programming concepts, John Fluke Mfg. is offering a series of PC-based test and measurement workshops nationwide throughout 1990.

Among subjects discussed will be an introduction to PC-based instrument control fundamentals, building an instrument control program, signal processing and analysis, understanding the role of instrument drivers, and how to integrate all of these elements into a complete PC-based test system.

To enroll in a PC-Systems Workshop or to obtain schedule information, contact your local Fluke sales office. For additional information, write to John Fluke Mfg., P.O. Box 9090, Everett, WA 98026; 1-800-443-5853, ext. 701.

Eastern Region

Boston
May 1-3

Paramus, NJ
May 8-10

Philadelphia
May 15-17

Northern Virginia
May 22-24

Atlanta
June 5

Huntsville, AL
June 7

Orlando, FL
June 12-14

Western Region

Portland, OR
June 26-28

Fluke reserves the right to cancel or reschedule courses that do not reach minimum enrollment two weeks before the start of the class.

January sales high for video products

The first month of the new decade ended with excellent sales in all video product categories. Statistics released by the Electronic Industries Association's Consumer Electronics Group show the following increases in sales to dealers over the same period last year:

* VCRs — 42.1%
* Camcorders — 17.4%
* Projection TVs — 26.2%
* Color TVs — 3.6%

Stereo TV sales increased in 1989

Of all color televisions sold to dealers last year, 29% featured stereo sound. This constitutes an 18.7% sales increase over 1988.

According to the Electronic Industries Association's Consumer Electronics Group, more than 6 million stereo sets were sold in 1989. Average monthly growth for the category was 21.4%. ■

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

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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.

The Audit Bureau — **Member, Audit Bureau of Circulation**

NESDA — **Member, Electronic Servicing Dealers Association**

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Cultivating a business instinct

By William J. Lynott

"A feel for the dollar." That's how one service dealer described it to me years ago and that's still my favorite description. Others describe it as "having good marketing instincts" or being a "natural salesman."

Regardless of what you choose to call it, it's a vitally important part of the makeup of any person who chooses to go into business for himself.

Some people have it, some don't.

Almost everyone thinks he has "a feel for the dollar." Most people say they would like to make more money than they are making now. Who wouldn't like to eat in the finest restaurants without so much as a glance at the price column on the menu?

But that's not what I mean by a feel for the dollar.

An instinct for profit

As any electronics service dealer knows, running a service business requires a wide range of business skills. We must deal on a daily basis with people — customers and employees. We must set up and maintain orderly records. We must organize complex activities such as routing technicians and managing parts inventories. We must practice a high degree of self discipline. If the business is to prosper and grow, we must make a profit.

Almost everyone who starts out in business understands that last part: We must make a profit. But understanding it and knowing what to do about it are two different things.

I have worked with hundreds of service dealers throughout the years, and I recognize a pattern that is more common than you might suppose. I'm talking about the service executive who knows the nuts and bolts of his business to an extraordinary degree, is technically gifted, honest, hard-working and skilled in human relations, but he just doesn't have "a feel for the dollar."

It's the nature of the business, I suppose. The typical electronics service dealer has a technical, rather than a business, background. Most began their careers with a concern for fixing things rather than manipulating debits and credits. Many launched their businesses without even the barest knowledge of one of the most important of business dictums: *The life blood coursing through the veins of any successful business is INCOME.* Without a fresh supply every day, the business must eventually depart from this vale of tears.

Who is the person upon whom the business must depend for this life-sustaining transfusion? Why you, of course — the owner/manager.

Don't get comfortable

Some people come by this fiscal talent quite naturally. Others, if they are to develop any talent, must work very hard to get it. Some just never seem to get the hang of it.

If I had to come up with a sentence to explain the difference between the successful service dealer and the one who struggles to pay the rent each month, here is what I would say: The successful dealer understands the necessity of developing new sources of income, and he works at it, personally, every day.

The successful dealer understands the necessity of developing new sources of income.

Most of the day-to-day functions involved in running a service business can be delegated quite successfully. In fact, a business owner must learn not to take up his own valuable time with activities that can be more profitably handled by others. Once a service dealer learns how to delegate properly, he is free to attend to those responsibilities that employees are not likely to do as well, such as building an expanding base of income dollars.

For starters, consider the need for finding new customers. No matter how good your service, as much as 25% of your customers will be lost each year through normal attrition. People move, die, or are romanced away by competitors every year. According to government statistics, moving alone accounts for up to 20% of customer turnover annually. With this in mind, it isn't difficult to imagine the eventual fate of a business that doesn't have a program for bringing a constant supply of new customers into the fold.

Some ideas

Bear in mind that a planned program means exactly that. An ad in the Yellow Pages may be fine as far as it goes, but a complete marketing program for the development of new customers requires far more creativity than that.

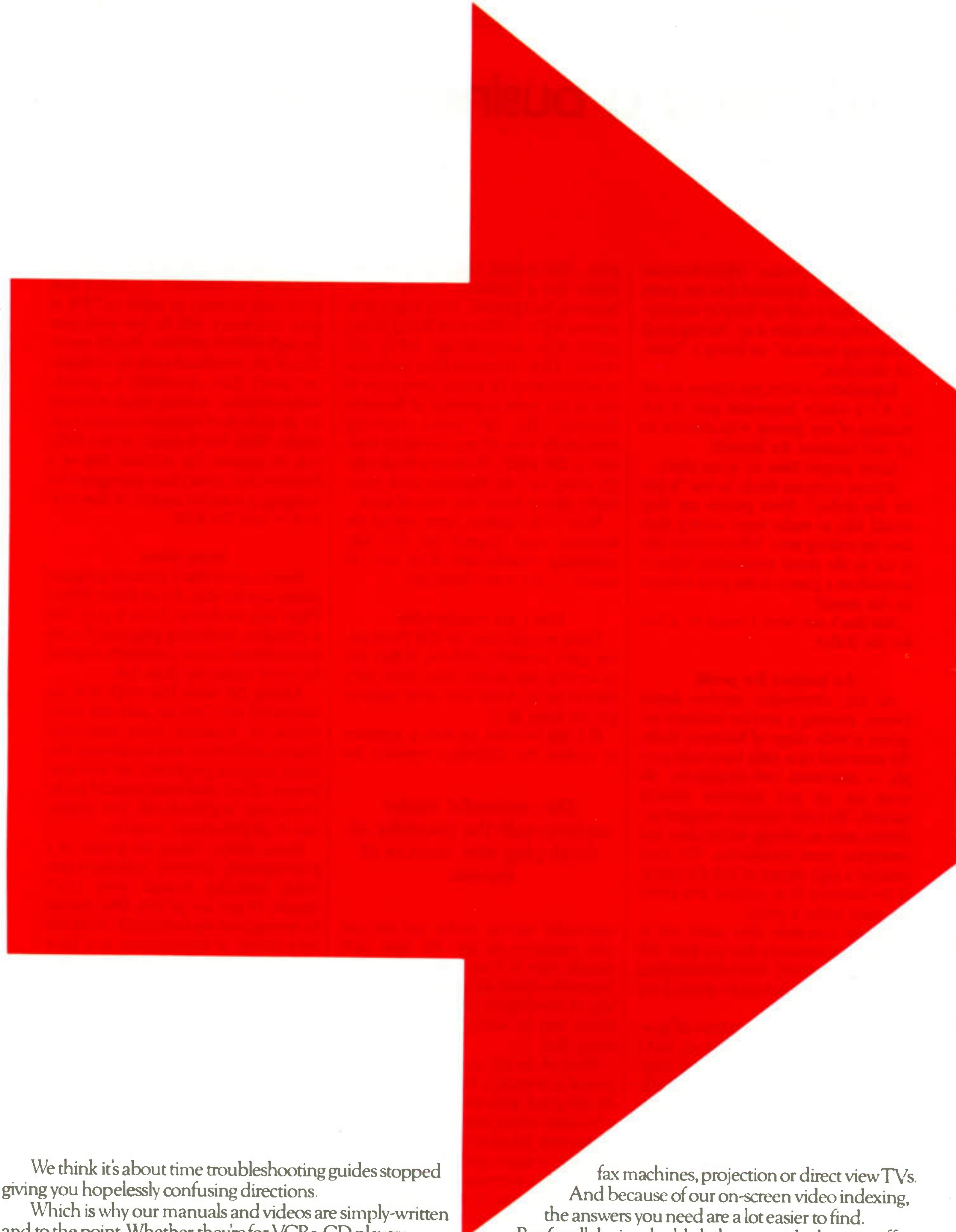
Among the ideas that work well for successful servicers are personal solicitation of business from apartment houses, institutions and businesses; discount coupons good only for new customers; direct mail concentrated in the immediate neighborhood; and display ads in neighborhood weeklies.

Don't underestimate the power of a professionally lettered, squeaky-clean truck traveling around your city's streets. If you use trucks, they should be among your best salesmen. To skimp on painting or maintenance is a poor business decision. I remember one service dealer in Boston many years ago who had his name and phone number painted in huge letters on the roofs of his trucks so that high-rise apartment dwellers could see them when they looked out their windows.

There are, of course, countless other techniques for developing new customers. I'll pass along the best of the ones I hear about from time-to-time in this column.

But don't forget, a "feel for the dollar" also calls for finding ways to increase sales from your present list of customers. We'll be talking more about that as well. ■

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



We think it's about time troubleshooting guides stopped giving you hopelessly confusing directions.

Which is why our manuals and videos are simply-written and to the point. Whether they're for VCRs, CD players, fax machines, projection or direct view TVs.

And because of our on-screen video indexing, the answers you need are a lot easier to find.

But for all the invaluable help our guides have to offer,

Setting up an electronics servicing workbench

By Conrad Persson

Because of the rapid changes in consumer electronics technology, electronics servicers must constantly remain aware of the current technologies and be certain that the equipment you have on hand is adequate to diagnose and service them. You should conduct inventories as often as once a year to determine whether the tools, test equipment and accessories on your workbench are outdated. Of course, many of the old tools and test equipment devices still perform the function they were designed to do, but because of current, sophisticated technology, you will need more ancillary equipment than before.

Persson is editor of ES&T

Lighting

With today's tiny circuits, effective technicians can not rely on merely decent general lighting. High-power task lighting and magnification are requirements for most demanding visual tasks.

ESD protection

A common cause of failure in current consumer electronics products is electrostatic discharge (ESD). You will find at least one IC in the schematic diagram of most sophisticated home electronics products, such as TVs, CD players, VCRs and microwave ovens.

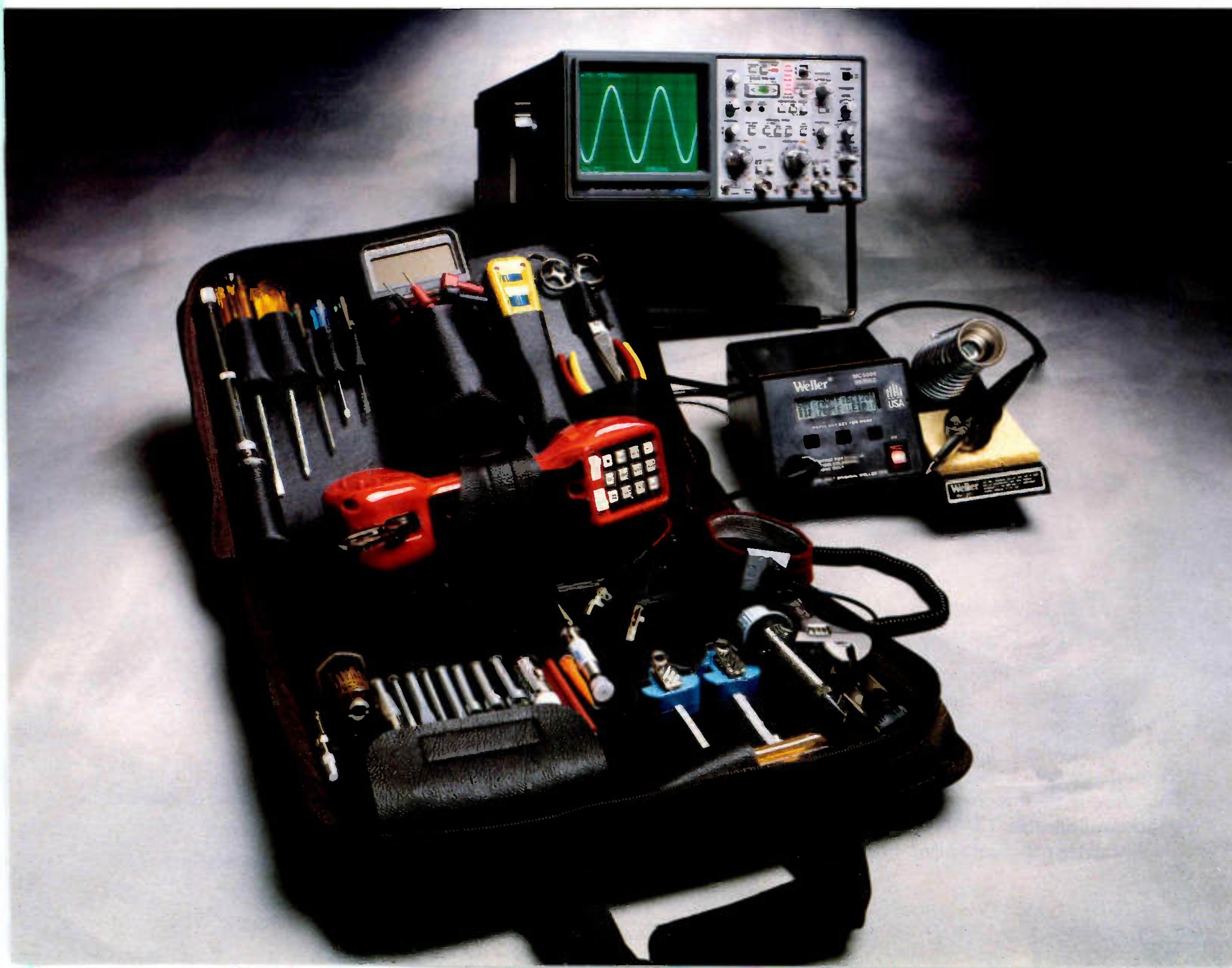


Table 1. EIA-recommended test equipment

Test Equipment	Specification	Camera camcorder	VCR/ hi-fi VCR	TV/monitor	Audio	CD player	Videodisc	Computer	Microwave oven
Dual-trace oscilloscope (triggered)	Bandwidth: 100MHz (dc) Sensitivity: 2mV, Time delay	•	•	•	•	•	•	•	
Frequency counter	Capability: 250MHz Sensitivity: 20mV to 5V 7-digit display, 10:1 attenuation	•	•	•	•	•	•	•	
NTSC pattern generator	$1V_{p-p}$ color bar with 75% saturation Color bars: 100% white Window: RGB $1V_{p-p}$	•	•	•			•		
Stereo generator	FM band separation greater than 50dB Pilot with adjustable level 19kHz (10%) Mode output: L, R, L+R, L−R				•				
MTS generator	Multichannel TV sound Base band (RFCH3/CH4) Out L−R, L+R, and SAP		•	•					
Audio oscillator	Frequency range: 0-100kHz Distortion: 0.003% Var. attenuation, 0 to 3V output		•		•	•			
Sweep generator	86MHz 108MHz		•	•	•				
Digital voltmeter	0.1Vdc to 1,000Vdc Sensitivity: 1mV, 0.5% accuracy	•	•	•	•	•	•	•	•
ac millivolt meter	0.10 to 100Vrms db range: −60db to +40db	•	•	•	•	•	•	•	
dc power supply	0 to 50V, 20A, well filtered	•	•	•	•	•	•	•	
Wow and flutter meter	Mode: jig/WRMS 0.003% to 3%				•				
Distortion analyzer	Sensitivity: 0.002% F.S. 10Hz to 110kHz, 0.1V to 130V				•				
ac leakage tester	500μA capability		•	•	•	•	•	•	•
NTSC vectorscope		•							
Solder station	Temp. controlled, grounded tip low wattage (25W to 35W)	•	•	•	•	•	•	•	•
Desolder station	Grounded tip	•	•	•	•	•	•	•	•
Color monitor or monitor receiver	With RGB input for computer	•	•					•	
Color monitor with under-scan		•							
Test speakers	0-100W				•	•	•		
Isolation transformer				•					
High-voltage probe				•					•
Hi-fi stereo amplifier	25W		•		•	•	•		
Laser power meter						•	•		
Light meter	1,000 Lux	•							
Light box with slides or halogen quartz lighting with NTSC color chart 11, step logarithmic grey scale, back-focus and autofocus charts, resolution and registration charts	3,200°	•							
VARIAC	Isolation type 0 to 140Vac variable with line monitor		•	•	•	•	•		
Degaussing coil				•					

NOTE: This is a recommended list. Some manufacturers may require different specifications than those listed here.

Table 2.
EIA-recommended tools and accessories

Accessory	Specification	Camera camcorder	VCR/ hi-fi VCR	TV/monitor	Audio	CD player	Videodisc	Computer	Microwave oven
Anode cap remover				•					
Eccentricity gauge			•						
Dummy loads	4Ω, 6Ω, 8Ω, 16Ω, (2 each), 250W				•				
Conventional hand tool		•	•	•	•	•	•	•	•
Hex wrench	Metric assortment	•	•	•	•	•	•	•	•
Hex nut drivers	Metric assortment	•	•	•	•	•	•	•	•
Test tapes	Stairsteps Color bars RF sweep 1kHz tone hi-fi audio	•	•						
Anti static mat, static control		•	•	•	•	•	•	•	
Back-tension meter		•	•						
Torque gauge		•	•						
Test tape	Crosstalk 1kHz, 10dB tape speed wow/flutter 3kHz-10dB head				•				
Cassette torque meter	0-169g/cm				•				
Mirror cassette					•				
Head cleaning kit	Non-abrasive type (chamois cloth)	•	•		•				
Molytone grease		•	•		•				
Teresso oil		•	•		•				
Hitazol grease		•	•		•				
Test disc					•	•	•		
Filters	Cloudy fine Fluorescent Red nd 0.1 nd 0.4 nd 1.0	•							
Leakage detector Survey detector	HEW approved								•
600cc beaker	Graduated scale								•
Volt/watt meter									•
Thermometer	100°C or 212°F 1 degree graduation								•
Thermocouple oven temp tester	For convection ovens								•

Specialized tools, adjustment fixtures and cables available from manufacturers.

Many of these ICs are sensitive to ESD. In many cases, it does not take much to damage or destroy these components.

Some sensitive components will be damaged by discharges in the range of 400V. The average human is not aware that a static discharge has taken place unless the voltage approaches 10 times that value. The presence or absence of crackling discharges is not a guide as to whether ESD protection is required.

In today's world, every consumer electronics product, every circuit board and every component should be treated as if it is susceptible to ESD damage. Every bench position and every tool kit for servicing electronics products should be equipped with antistatic wrist straps and antistatic mats. Every technician should be instructed in the use of antistatic products and in the importance of keeping static-generating products away from electronics that are opened up for servicing.

Test equipment

Although it may be possible to get by in electronics servicing with a simple DMM, a 20MHz scope and a few other basic pieces of test equipment, today's sophisticated consumer electronics products almost cry out for sophisticated tools and test equipment to service them. The Electronic Industries Association/Consumer Electronics Group (EIA/CEG) has compiled a list of test equipment considered essential or desirable for diagnosing and repairing current sophisticated consumer electronics products. Tables 1 and 2 list the test equipment and tools recommended for the electronics servicer. (For a pamphlet, write to the EIA/CEG, 2001 Eye St. NW, Washington, DC, 20006.)

Cleaning supplies and other chemicals

Many of today's consumer electronics products, such as VCRs and camcorders, are actually electromechanical devices. Computer floppy disk drives have moving parts that wear and break, and sensing heads and other mechanical components are subject to wear and travel of the magnetic medium. Servicing a consumer electronics product may require little more than thorough cleaning of the heads or other parts of the tape path.

This kind of service requires specific techniques and the correct supplies, which should be readily available at the bench or in the portable tool kit. If you service VCRs, for example, you will need the right cleaning aids and appropriate cleaning liquids, such as isopropyl alcohol or Freon TF. Never clean a VCR with cloth, cotton swabs or any other material that might leave lint or residue. The two materials generally recognized as appropriate for cleaning VCR heads and tape paths are chamois and plastic foam. Both of these materials are available in sticks or swabs. Spray the cleaning liquid on the material and carefully wipe the heads and transport parts clean.

You can also use cleaning tapes for VCRs and cleaning disks for computer disk drives. From the information available, it appears that most cleaning disks for computer disk drives are safe to use. In the past, we did not recommend VCR cleaning tapes. However, there are now one or two (and possibly more) that appear to be safe and effective. Choose among these products carefully. Some are thought to induce the problems they are supposed to eliminate. (See "Head Cleaning Tapes: Should You Recommend them?" in the February 1990 issue.)

Even the most knowledgable technicians cannot achieve their goals without the proper tools.

Soldering

If you closely examine current compact, lightweight, feature-packed consumer electronics products, you will find components that are smaller than a matchhead, printed-circuit board traces that are almost hair-thin, and packaging that leaves almost no room for finger movement. The manufacturing process employs fabrication technology that is exacting, including the temperature and other parameters of the soldering. When a component is desoldered and a replacement component is soldered in, the soldering irons used by the servicing technician must be able to provide sufficient heat at the right temperature if the new connection is to be made to the same specifications that prevailed during the manufacturing process.

The article "Hand Soldering: The Achilles' Heel in Electronics Reliability" is a detailed look at hand soldering, including metallurgical ramifications. It should give you a better understanding of what it takes to make a satisfactory solder joint.

Safety ac leakage testing

Some things, like the importance of safety, never change. Every TV, VCR and personal computer is connected to the ac line. Many things can go wrong within one of these products to cause the ac line to be accidentally connected to the exposed metal parts of the product. If someone comes in contact with the exposed parts and a good ground simultaneously, the result could be a fatal shock.

Every consumer electronics product that is serviced should be given a safety leakage test. The article "Safe Servicing: The Leakage Test" details some of the problems that turn consumer electronics products into potentially lethal traps. The leakage test allows you make sure they are safe.

The field service tool kit

The tool kit might be compared to a servicing bench that you can take out of the shop. Depending on the care with which you select the tools and test equipment for your tool kit, one of three things will happen: you are carrying the right equipment with you and are able to make field repairs in the customer's home; you seldom have the right tools to make field repairs in the field; you are able to complete most field-repairable projects, but many of the tools and test devices in the kit gather dust, and you are tired of carrying so much with you.

The tool kit is valuable, but its value is generally in proportion to the amount of thought that goes into assembling it and to the amount of review that goes into keeping its contents updated. "The Portable Workbench," in this issue, provides detailed suggestions on how to assemble a tool kit, and it offers a checklist on which to base your selections.

Putting it all together

Technicians are much more than tools and test equipment. The knowledge and skills they bring to the job are the most important part of troubleshooting and repairing products. However, even the most knowledgeable technicians cannot achieve their goals without the proper tools. Whether on the bench or out in the field, well-equipped servicers will be faster, more efficient and more accurate than their unorganized competition — and probably more profitable. ■

The Achilles' heel in electronics reliability

By Alan L. Royston and Joe Keller

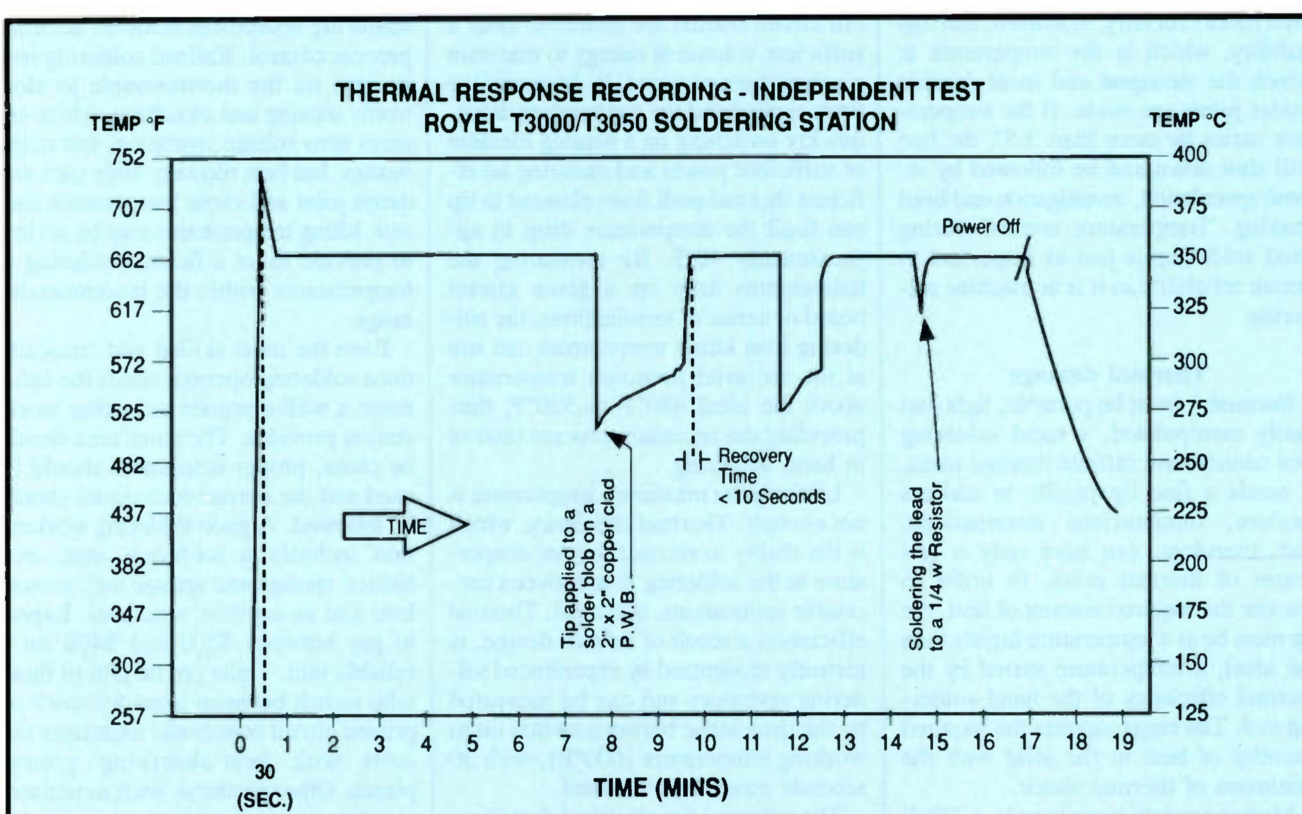
There was a time when manafacturers thought wave soldering would replace the humble soldering iron, but that time has never arrived. We still rely on hand soldering for interconnections, rework and component replacement. Manufacturers spend several thousand dollars selecting and testing soldering machines, component preparation and pick-and-place machines, and often overlook or fail to appreciate the necessity of checking and upgrading their soldering irons to handle the necessary process control for modern circuitry.

In 1982, an IBM study concluded that the best way to degrade a PCB connection is to touch it with a soldering iron. (Roger N. Wild, "Thermal characteristics of multilayer interconnection boards.") Since this study, the problem has become more critical because of the increasing miniaturization of electronic circuits. Manufacturers and electronics servicers should understand that the same laws of thermal dynamics and metallurgy relevant to machine soldering must also be applied in the use of the "simple" soldering iron.

Alan Royston is managing director of Royel Soldering Systems. Joe Keller is a soldering and cleaning consultant.

The soldering process

Soldering is a metallurgical process. It involves the *inter-alloying*, or melt-



A modern temperature-controlled soldering iron provides accurate tip temperature control and quick return to specified temperature after making a solder joint.

ing together, of carefully selected materials within an experimentally determined, narrow temperature range to achieve maximum strength and durability. It restricts *intermetallics*, which are alloy contents whose percentages of metals causes brittleness.

Solder is an alloy of tin and lead. The electronic grades give good wetting and high-reliability joints in the range of 480°F to 520°F. *Wetting*, which is the interaction between the liquid solder and the solid surface of the part being soldered, is possible only if the solder comes in direct contact with the solid surface of the part being soldered. Anything that sticks to the surface acts as a barrier to the solder and, therefore, prevents wetting. A drop of solder on a contaminated surface is like a drop of water on a greasy plate. If the surfaces are clean, wetting will take place and solder will flow freely across the surface. Basically, sufficient heat must be supplied to raise the joint to an ideal wetting temperature without damaging the workpiece.

Any respectable soldering machine contains a crucible of 400 to 800 pounds of solder. It must be this large for the mass to absorb board contaminants and, even more crucially, to achieve thermal stability, which is the temperature at which the strongest and most durable solder joints are made. If the temperature varies by more than ±5°, the line will shut down and be followed by intense speculation, investigation and head shaking. Temperature control during hand soldering is just as important to circuit reliability as it is in machine soldering.

Thermal damage

Because it must be portable, light and easily manipulated, a hand soldering tool cannot have infinite thermal mass. It needs a fine tip profile to address modern, miniaturized terminations, and, therefore, can have only a few grams of thermal mass. In order to transfer the required amount of heat, the tip must be at a temperature higher than the ideal, a temperature varied by the thermal efficiency of the hand soldering tool. The target supplies the required quantity of heat to the joint with the minimum of thermal shock.

Many operators happily poke a 700°F or 800°F tip at tiny, critical, soldered terminations. When a tool this hot is used, flux boils off, leaving non-wetting halide actuators on the pad. Track and pad adhesion is destroyed, bonds within the chip packages are degraded, silver is reflowed within capacitors, and glass-to-ceramic seals are thermally over-stressed. The operator may unknowingly sweep across the board, leaving a trail of degradation and intermetallics which eventually lead to system failure.

Thermal control

Why can't hand soldering be performed within the same temperature band as the very carefully calibrated and policed soldering machine? True, the slender soldering iron tips needed for the tiny soldered terminations of modern circuit boards are unable to store a sufficient volume of energy to maintain a constant temperature. If, however, the tip is applied and the temperature drops, quickly switching on a heating element of sufficient power and ensuring an efficient thermal path from element to tip can limit the temperature drop to approximately 40°F. By measuring the temperature drop on a given circuit board or series of terminations, the soldering iron idling temperature can run at the requisite premium temperature above the ideal 480°F to 520°F, thus providing the necessary process control in hand soldering.

A drop of solder on a contaminated surface is like a drop of water on a greasy plate. If the surfaces are clean, wetting will take place and solder will flow freely across the surface.

Limiting the maximum temperature is not enough. Thermal efficiency, which is the ability to recover the set temperature at the soldering face between successive applications, is critical. Thermal efficiency, a result of refined design, is instantly recognized by experienced soldering operators and can be measured by the time-lapse between switch on to working temperature (600°F), with 30 seconds considered as ideal.

The potential for electrical deterioration or catastrophic damage is recognized in current U.S. Department of Defense specifications. The requirements for soldering equipment in Defense Standard 2000-1B include a maximum soldering tip-to-ground resistance of 2Ω, a maximum tip-to-ground voltage potential of 2mV, and a maximum idling temperature range of ±10°F. Non-static generating soldering handles are also required.

To maintain government-qualified status, manufacturers must provide evidence that they regularly monitor soldering irons. This requirement has led to the introduction of specialized soldering iron test equipment and small, yet powerful and thermally efficient soldering stations, which are able to deliver the necessary repeatable performance. (See Table 1.)

Experience has shown that the most rapid heat flow is achieved with plug-type tips inserted in close-tolerance barrels. Split tips, with the copper core removed to accommodate sensors or loose fitting tips, limit heat flow and reduce the thermal efficiency of soldering tools.

Without adequate control, electronic circuit reliability may be degraded to an unacceptable level by hand soldering operations.

Regular monitoring of high-efficiency soldering equipment achieves accurate process control. Refined soldering iron designs tie the thermocouple to electronic sensing and switching, which ensures zero voltage switching, fast initial heatup, fast heat recovery after each soldered joint and close temperature control. Idling temperatures may be set low to provide more efficient soldering at temperatures within the recommended range.

Even the most skilled and conscientious soldering operator needs the assistence a well-designed soldering workstation provides. The work area should be clean, proper equipment should be used and the correct techniques should be followed. A good soldering workstation includes a soldering iron, iron holder, sponge and sponge tray, ground lead and an operator's manual. Expect to pay between $200 and $400 for a reliable unit. Units are helpful to those who switch between irons for work on printed circuit boards and multilayer circuits with heat-absorbing ground planes. Other products, such as replaceable tips and tip temperature testers, also add to the safety and efficiency of the soldering workstation. ■

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Circle (10) on Reply Card

JN189-11-0590

The portable workbench

By Conrad Persson

Many otherwise efficient technicians are hit-or-miss when deciding what to take with them on a service call. There are two extremes, and they both lead to inefficiency.

The lean extreme concerns technicians who get a call, throw a few tools into a tool case and head out the door. It is usually not until they are immersed in the middle of the repair that they discover they are missing a critical piece of equipment.

The heavy extreme concerns technicians who buy tool kits that are complete with every conceivable tool. Characteristics of these technicians are tool kits that are so full they can hardly be called portable, a difficulty in locating the right device, and, often, a bad back.

Planning a tool kit

The most important tool for stocking an efficient tool kit is planning. Just as you carefully plan your workspace and decide what products your shop will service, you must put time and thought into stocking a complete, but still portable, tool kit. Ask the technicians who actally do the on-site servicing for their opinion on tool selection. You do not have to include every tool they suggest, but their input will contribute to a more efficient tool kit.

Evaluate the work your shop does, what types of repairs you will make on-site, and what repairs you will only make in the shop. Here is a checklist to help you build an efficient tool kit.

- Determine what type of products you will service on-site.

- Many current components are subject to electrostatic discharge (ESD) damage. Be certain that your tool kit is equipped with a grounding wrist strap and anti-static mat. Also include anti-static bags to carry printed circuit boards you may replace.

- If you will service personal computers, a selection of diagnostic disks will help you pinpoint problems. Make sure that the disks are adequately protected from physical and magnetic damage.

- Do not forget the accessories. An angled mirror like the ones used by dentists may enable you to see into the dark recesses of a product. A hand magnifier may let you see details you cannot otherwise see, thus letting you complete a repair that would not have be possible. A flexible shaft or angled shaft may allow you to remove and replace screws that you might not be able to touch without extensive disassembly.

The most important tool for stocking an efficient tool kit is planning. You must put time and thought into stocking a complete, but still portable, tool kit.

- Inevitably, you will drop a fastener or other important part. According to Murphy's Law, it will land in the most inaccessible spot. To recover the missing part, you should have the two types of part retrievers: the magnetic and the spring loaded grabber. Both can turn desperate scrambling into routine servicing, but be careful to keep the magnetized retriever away from the diagnostic disks.

- There is never enough light. Carrying a flashlight and an ac- powered lamp in your tool kit will enable you to place enough light wherever you need it. In further deference to Mr. Murphy, you might want to carry spare lightbulbs and batteries.

- Another important ingredient in a well-stocked tool kit is a selection of cleaning supplies and lubricants, including paper towels and rags. Dust and dirt love to collect in the warm electrified atmosphere of consumer electronics products. Electromechanical components, such as magnetic heads in VCRs and disk drives, may become clogged with oxides and require cleaning.

  Other supplies to consider are a vacuum cleaner, a can of air under pressure, soft brushes, isopropyl alcohol, Freon, foam or chamois swabs and screen wipes.

- You should carry basic test and measurement equipment, such as a DMM, an oscilloscope and the appropriate gauges.

- The type of carrying case you select is also important. You can choose between an attache case, a soft-sided pouch or a formed aluminum case. Before purchasing a kit, you may want to ask your distributor's advice. Which one is best for you depends on the type of products you will be servicing, how many tools and test instruments you will carry, and how much abuse your kit will have to withstand. If you will equip several technicians, you may want to purchase each type of case, then determine which one lasts the longest and which one the technicians prefer.

The perfect tool kit

Is it possible to create the perfect tool kit? Probably not. You cannot predict every situation that will occur. No matter how hard you try, there will be times when you are not carrying the right tool to complete a repair. You may also discover that some of the tools that seemed necessary to include sit there during every service call, adding unnecessary weight to your already heavy load. Still, a well-planned, efficient tool kit will minimize return trips to the site. A little organization can save you (and your customers) a lot of frustration. ■

Persson is editor of ES&T.

Test and measurement catalog

John Fluke Mfg. is offering a new 1990 Fluke and Philips Test and Measurement catalog. The 536-page catalog features several new additions, including 20 new products, a new rack mount selection guide, a glossary of terms, and an abbreviations and symbols section to assist customers in selecting the equipment they need for their test and measurement requirements.

Circle (125) on Reply Card

Electronic test accessories catalog

ITT Pomona Electronics has introduced a 138-page catalog of electronic test accessories. Highlights of the catalog include five new product groups, such as IC test clips, low-cost coax assemblies and a new family of digital multimeter test-lead kits. Ten major product categories are presented via an easy-to-use index. The catalog also includes the company's most popular selection of jumpers and cables, boxes, plugs and jacks, connectors adapters, single-point test clips, and static control devices.

Circle (126) on Reply Card

Remote controls catalog

Thomson Consumer Electronics now has the January 1990 edition of the RCA and GE Remote Controls catalog. This catalog contains all available direct replacement, remote control hand units for RCA and GE TVs, video recorders, videodisc players, camcorders and audio components. The catalog is divided into three sections. One part contains more than 220 photographs of the remotes. The other sections contain cross-reference material, both in model number sequence and in remote type number sequence.

Circle (127) on Reply Card

Tool and test equipment catalog

Jensen tools offers a 96-page Winter Catalog, listing products for installation and maintenance of integrated voice and data communication systems. The catalog features the company's latest LAN service kits and introduces the JTK-46 Communications Maintenance Kit, designed for accessing all the equipment in a multi-system communications facility (modems, FAX, teletype equipment, switches and distribution systems).

Circle (128) on Reply Card

Test equipment catalog

B&B Electronics is offering its catalog #12-1990 — a 20-page, multi-colored publication that provides a reference and guide to the RS-232 interface and monitoring equipment manufactured by the company.

Circle (129) on Reply Card

Soldering information in newsletter

The Electroconnect Division of *Metcal* has introduced the latest issue of Hot Tips, a 4-page quarterly newsletter designed to share ideas on soldering technology, publish information on end-user applications, and update readers about the company and its product line. Featured in the Spring 1990 issue is the company's newest product, the STSS-004 STA-Temp desoldering system. An editorial questions the importance that the electronics industry places on tip idle temperature.

Circle (130) on Reply Card

Safe Servicing

The leakage test

By the ES&T staff

Every service manual for every electronics product strongly recommends that you perform a leakage test. Unfortunately, almost every servicer ignores that advice. The leakage test is complicated. It requires a good ground and a resistor/capacitor combination located among the shop parts. Setting up the test is time-consuming, and an abundance of time is something most technicians do not have.

Adapted with permission from Sencore's Tech Tip #146.

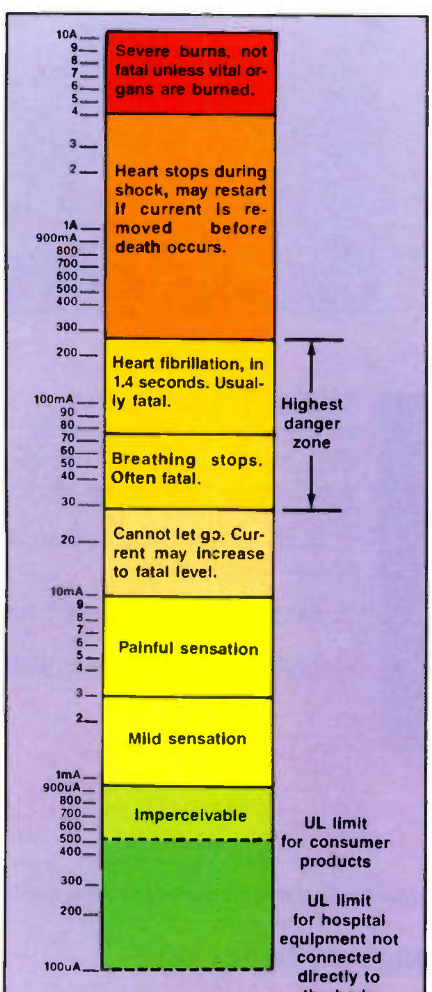


Figure 1. This chart shows the effect of electric shock on the human body.

The leakage test assures that the TV set or other consumer electronic device that is being returned to the customer does not have exposed metal parts that could give the customer an electric shock. That is why all service literature lists a safety leakage test similar to the one shown in the sidebar, "Performing the Leakage Test."

The safety check applies to all consumer units that are connected to the ac line, but it is most important when the device does not have an isolation transformer. The potential of a shock hazard increases dramatically when the set has a hot chassis.

Even if you find leakage on only one chassis out of a hundred, that one unit is the only reason you need to test every chassis that leaves your shop. It only takes one leaky chassis to put you out of commission, thus out of work. It only takes one to damage your expensive test instruments and put them out of service for a week or longer. Furthermore, it only takes one zapped customer to bring a lawsuit against you and your shop. One leaky chassis can cost you more than it costs to perform the leakage test on every chassis that leaves your shop.

Many technicians add an extra charge to the customer's bill for performing the leakage test. Most customers do not mind paying an extra $5 to ensure the safety of themselves and their families.

What causes leakage?

Any path that places the customer in direct or indirect contact with the ac line is dangerous. There are many different ways this can happen. The following is a list of the most common leakage causes:

Shorted antenna bypass capacitors are commonly seen after a thunderstorm. The capacitors are in series between the antenna terminals and the chassis to isolate the hot chassis from the antenna. When one of these capacitors is shorted, the customer notices no difference in the operation of the receiver. The RF signal passes through the shorted capacitor the same way it passes through a good capacitor. The problem, however, is that the antenna terminals are carrying raw ac.

Improperly installed tuners often cause leakage because when replacement tuners are not properly installed, the ac line may be tied to exposed metal parts. Also, do not use conductive shafts to replace insulated shafts on tuners. You could create a shock hazard on the tuning knob.

Conductive knobs cause leakage when they improperly replace insulated knobs. If the TV that is being serviced has control shafts connected directly to a hot chassis, the knobs on these shafts must be insulating, not metal- or chrome-plated knobs, which conduct current and result in a shock hazard.

Defective isolation transformers are often found on older TVs. These built-in transformers are supposed to isolate the metal chassis from the ac line, but they occasionally develop leakage between the primary and secondary windings and cause a hot chassis. The danger of this situation is compounded when the TVs have metal cases or metal pans covering the bottom of the chassis. All exposed metal becomes a shock hazard.

Ac bypass capacitors connect between the ac line and the chassis in most electronic devices that use isolation transformers. The capacitors bypass RF interference, picked up by the metal chassis, to the ac line for shielding purposes. Older capacitors are often the wax-coated, paper type, which develop leakage as the paper dielectric absorbs moisture. In some cases, a capacitor shorts completely, causing a direct connection between the ac line and the chassis. These capacitors, like antenna bypass capacitors, are commonly damaged during thunderstorms.

Bent rabbit ears are the rabbit-eared receiver antennas designed to slide down inside the back of the case. A plastic tube inside the case usually isolates the metal antenna rods from the chassis, but the rods often bend. When the bent rods are pushed down to the "nested" position, they touch the hot chassis. The exposed end is hot and the wire that comes out of the back of the chassis to connect to the antenna terminals also carries the full ac line voltage.

Improper installation of parts can cause leakage. When a servicer forgets to replace an insulating piece of "fish paper" under a component, the ac line current may be exposed to metal parts.

Foreign objects touching the ac line, such as pieces of wire or solder, result in a shock hazard.

A broken safety ground may allow a shaft or control to float.

Long metal screws often go through the plastic mounting tabs and touch the metal chassis, becoming live.

Adding an earphone to a set that lacks an isolation transformer constitutes a serious shock hazard because it is connected directly to the listener's head.

Foreign objects, such as coins, hairpins and other metal objects, can fall inside the set and cause connections that route ac to exposed metal parts.

Connecting an external speaker to a TV is dangerous when the set does not have an isolation transformer.

The list could go on and on. There is a shock hazard any time a piece of metal comes in contact with a hot chassis.

The leakage test

Leakage current cold check

1. Unplug the ac cord and connect a jumper between the two prongs on the plug.

2. Turn on the receiver's power switch.

3. Measure the resistance value (with an ohmmeter) between the jumpered ac plug and each exposed metallic cabinet part on the receiver, such as screwheads, connectors and control shafts. When the exposed metallic part has a return path to the chassis, the reading should be between 240kΩ and 5.2MΩ.

Leakage current hot check

1. Plug the ac cord directly into the ac outlet. Do not use an isolation transformer for this check.

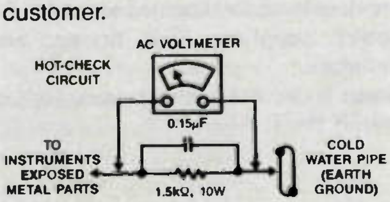
2. Connect a 1.5kΩ, 10W resistor in parallel with a 0.15μF capacitor between each exposed metallic part on the set and a good earth ground, such as a water pipe.

3. Measure the potential accross the resistor. Use an ac voltmeter with 1,000Ω/V sensitivity or greater.

4. Check each exposed metallic part and measure the voltage at each point.

5. Reverse the ac plug in the ac outlet and repeat each of the measurements.

6. The potential at any point should not exceed $0.75V_{rms}$. A leakage current tester may be used to make the hot checks. Leakage must not exceed 0.5mA. In case a measurement is outside of the limits specified, there is a possibility of a shock hazard, and the receiver should be repaired and rechecked before it is returned to the customer.



How much leakage is bad?

Figure 1 shows the effect of electric shock on the human body. The most likely range of fatal current is between 30mA and 250mA. It is in this area that the breathing and heart are most severely affected. The chart is based on a person weighing 150 pounds. Smaller people, especially children, are more susceptible to shock at lower current levels.

Ideally, no leakage should exist, but this standard is not realistic. Components such as RF decoupling capacitors and antenna matching transformers allow some current to flow. Underwriter Laboratories has established guidelines for safe leakage currents. The maximum UL allowable limit (since 1972) is 500mA. Consumer electronics devices manufactured before 1972 were allowed 750mA.

Testing for cord leakage

An increasingly common cause of electrical fires is leakage between the conductors of line cords and extension cords. This type of leakage may eventually short or cause sparks, which may ignite a fire.

To test for leakage in line cords or extension cords, use a Z-meter. Measure the leakage between the two conductors on a 2-wire cord or the leakage between the three conductors on a 3-wire cord. In either case, the leakage should be zero (with the cord unplugged from the wall or device to which it supplies power). If leakage is detected, the cord is defective and should be replaced.

Conducting the test

You may conduct the safety leakage test by following the directions outlined in the sidebar. As an alternative, you may use a piece of test equipment that offers the test as one of its functions. Ask a distributor or test equipment manufacturer which instruments offer the leakage test. ■

Books/Photofact

ES&T periodically publishes reviews on books that are particularly applicable to our readers. We do not have any information other that that supplied below each review. Contact the publishing company for further ordering or pricing details.

How To Make Printed Circuit Boards, With 17 Projects, by Calvin Graf; TAB Books; 224 pages; $23.95 hardbound, $15.60 paperback.

This book describes printed circuit board technology: how to design, lay out and etch the board and how to mount, solder, and desolder components, plus circuit-board testing. The book covers general workshop principles, such as basic electron theory, electronic components and schematic diagrams. A number of commercially available electronic assembly kits are covered, with details on how these kits can be ordered and assembled. Also included are 17 projects.

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

AC/DC Electricity and Electronics Made Easy — 2nd Edition, by Victor F. Veley; TAB Books; 368 pages; $17.95, paperback.

This book covers subjects that range from basic units of measurement to complex applications of waveform analysis. Using standard components, it demonstrates methods of problem-solving and provides choices of analytical techniques.

TAB Books, Blue Ridge Summit, PA 17294-0850; 1-800-822-8138.

Macintosh Repair and Upgrade Secrets, by Larry Pina; Hayden Books; 351 pages; $32.95.

This book provides repair and upgrade information for the power supply of all types of Macintosh machines. It includes part lists, instructions for disk drive, RAM and ROM upgrades and previously undocumented upgrades for power supplies, disk drives, and monitors.

Hayden Books, 11711 N. College, Suite 141, Carmel, IN 46032; 317-573-2676.

Understanding Digital Electronics — 2nd Edition, by R.H. Warring and Michael J. Sanflippo; TAB Books; 196 pages; $14.95, paperback.

This book stresses the importance of organization in thoroughly understanding the theory and practice of digital electronics. It introduces readers to digital circuit functions from three primary angels: mechanical equivalants of switches and symbols, truth tables displaying all possible digital device conditions, and solution-oriented binary arithmetic intruction.

TAB Books, Blue Ridge Summit, PA 17294-0850; 1-800-822-8138.

Computer Technician's Handbook — 3rd Edition, by Art Margolis; TAB Books; 580 pages; $36.95 hardbound, $24.95 paperback.

This computer troubleshooting and repair guide for professional electronics technicians and intermediate-to-advanced electronics and computer hobbyists explains simple adjustments and routine maintenance of personal computers. For more advanced readers, diagnostic and repair procedures are included. This book retains information on 8086-8088 systems and adds material on 16-bit 80286, 32-bit 80386, and 68000 processors. New developments covered include D/A conversions, dynamic 256K yo 1Mbyte memory chips, and surface-mount device testing and replacement.

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

600 Low-Cost Electronic Circuits, by David M. Gauthier; TAB Books; 350 pages; $18.60 paperback, $27.95 hardbound.

This book offers circuit designs assembled from a cross-section of manafacturers. Diagrams and specifications are included for all circuits, which can generally be constructed for less than $20. Audio, display, conversion, switching, automotive, computer, and control circuitry are included, as well as a collection of special-purpose devices.

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

Continued on page 43.

Test your electronics knowledge

By Sam Wilson, CET

This test deals with measurements and parameters. It has a high level of difficulty. A grade of 50% is considered to be good.

1. What is the unit of measurement for the reciprocal of the period of a sine wave?
2. What do you get when you divide the center frequency by the bandwidth? (It is more commonly called Q.)
3. In what unit is the time rate of doing work or expending energy measured?
4. Two components of the power triangle are of true power and apparent power. What is the third?
5. The number of amps per volt is called the conductance. In what units is it measured?
6. In the United States, it is called decibels and it is based on log10. In other countries, it is based on $\log^e$ or log. What is it called?
7. This 3-terminal thyristor will not conduct until its emitter is a certain decimal part of the power supply voltage. What is that decimal part called?
8. In what temperature scale does all motion of atoms stop at 0°?
9. What kind of interrupt is impossible to ignore when it is delivered to a microprocessor?
10. What is the reciprocal of reactance called?

Wilson is the electronics theory consultant for ES&T.

Answers are on page 37.

Measuring true rms

By Sam Wilson, CET

The letters *rms* stand for root mean square. That is actually a description of how the value is obtained mathematically.

One definition of rms voltage and rms current is that they are effective values. For example, you can replace the rms voltage across a resistor and the rms current through that resistor with an equal dc voltage and current. The result is the same amount of heat dissipated by that resistor.

Wilson is the electronics theory consultant for **ES&T**.

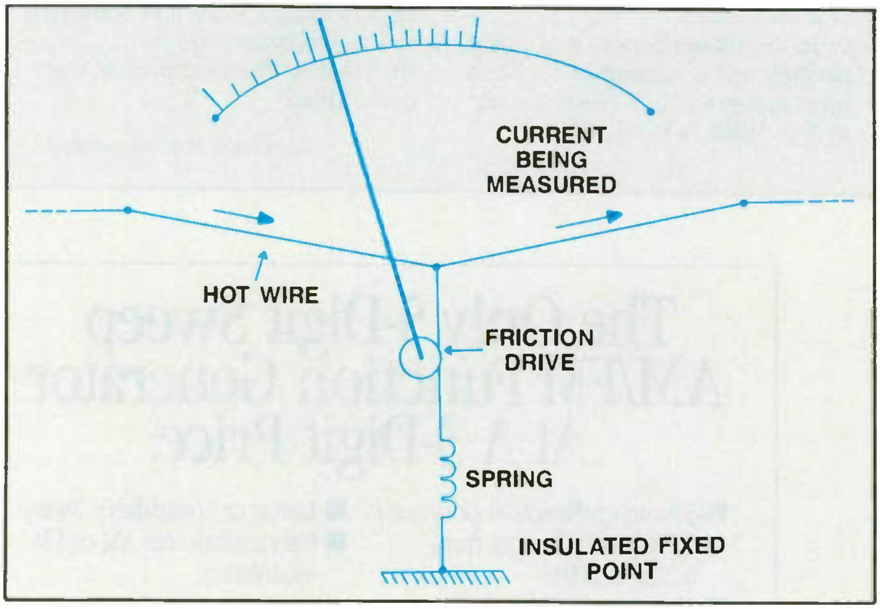


Figure 1. The hot wire ammeter measures rms current. When current flows through the resistence wire, the wire heats and expands. The expansion causes the wire to sag. A spring mechanism then moves the the pointer upscale.

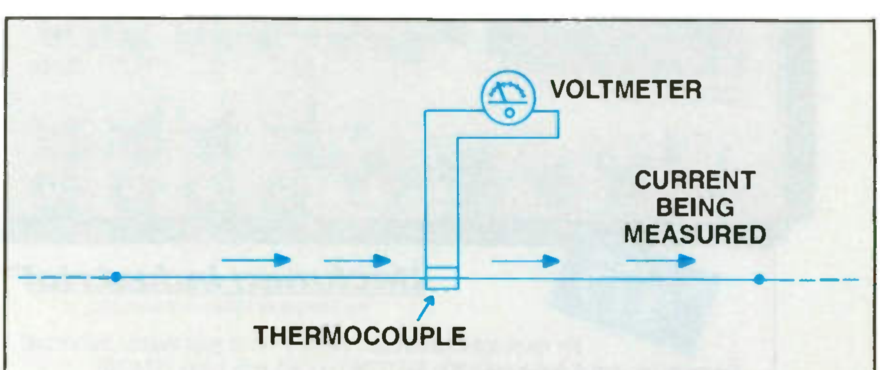


Figure 2. In the thermocouple meter, the current heats the wire and the thermocouple produces an output voltage that is directly related to the resulting heat. The voltage produces an upscale reading on the meter.

That explanation shows why rms values are also called *heating values*. The methods of measuring rms values are usually (but not always) based on measuring the heat produced by a current, or by a voltage across a known resistance value.

The hot-wire ammeter was an early instrument used for measuring rms current. Its principle of operation is shown in Figure 1. Current, flowing through a resistance wire, causes the wire to heat. The resulting expansion of the wire causes it to sag. A spring mechanism then moves the pointer upscale. Because the upscale motion of the pointer is directly dependent on the heat produced, the hot-wire ammeter can be used to measure true rms current.

The heat produced in the wire is the result of rms current. It does not depend on a specific waveform, such as a sine wave, for its operation. The same is true of all direct rms equipment, but it is not true of a typical VOM used in the everyday measurements by technicians.

It does not matter whether the meter is analog or digital. Many VOMs make measurements based on average values even though their scales are calibrated to display rms values.

The VOM scale is calibrated to read the rms value of a pure sine wave. Unless you know the trick (which will be explained later), you cannot use an average-responding, rms-reading instrument to measure non-sinusoidal voltages or currents.

Hot-wire ammeters are not famous for their accuracy. The measurement is dependent on spring tension. Springs get old and fatigued, so the ammeter has to be calibrated frequently. A wire can only be stretched and restretched so many times before it begins to show its age. Also, the surrounding (ambient) temperature greatly affects the accuracy of this instrument.

An improvement is the thermocouple meter. The principle of operation for this type of meter is shown in Figure 2. The current heats the wire and the thermocouple produces an output voltage that is directly related to the resulting heat. The voltage produces an upscale reading on the meter. Because the measurement depends on the heating effect of the current, the thermocouple meter responds to a true rms value.

Because the thermocouple meter uses a suitable series (multiplier) resistor, it can be used to display rms voltage. This type of meter is still being used.

Although it may seem clumsy, the calorimetric method is useful for measuring average power. Despite the ridiculous audio standard which declares that rms power is the product of rms voltage and rms current, that is not true in the real world. In this world, rms voltage multiplied by rms current is average power.

Figure 3 shows the calorimetric method's principle of measuring average power. Because the principle is based on the heating effect of current and of voltage across a known value of resistance, it is an indirect indication of true rms voltage and rms current.

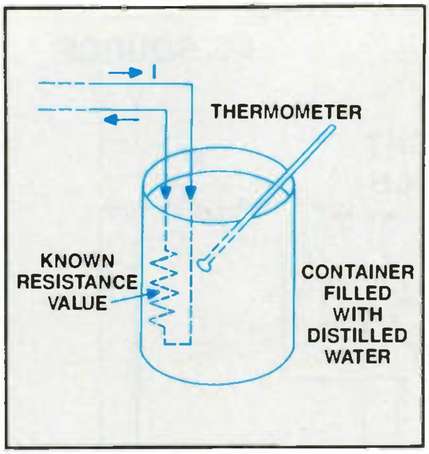


Figure 3. The calorimetric method measures average power. The principle is based on the heating effect of current and of voltage across a known value of resistance.

With the calorimetric method, voltage and current are applied to a resistor immersed in distilled water. The resulting heat dissipated by the resistor raises the water temperature. The water temperature is measured and converted to watts of power.

In a similar method, pulsed energy of a microwave radar system is directed into a terminating waveguide, sometimes filled with gold. The pulsed energy heats the material in the waveguide. The heat is sensed and converted to average power.

As a rule, however, the calorimetric method is most useful for measuring high values of power.

I once devised an experiment to demonstrate the meaning of rms voltage and rms current. I included this experiment in a book that I co-wrote with Milton Kaufman. The method is illustrated in Figure 4.

The ac current is used to heat the filament in a light bulb. A photographer's light meter is positioned to measure the amount of light. (This measurement may be the amount of deflection of the pointer on the light meter.) Without moving the lamp or meter, you replace the ac with a variable dc source. The dc current is adjusted to obtain the same reading on the light meter as the one obtained with the ac. The resulting dc voltage is equal to the rms value of the ac voltage.

The experiment works better in a darkened room. It sufficiently demonstrates that the rms value of a pure sine wave is 1.414 times the peak value.

As mentioned, an average-responding meter can be used to measure rms

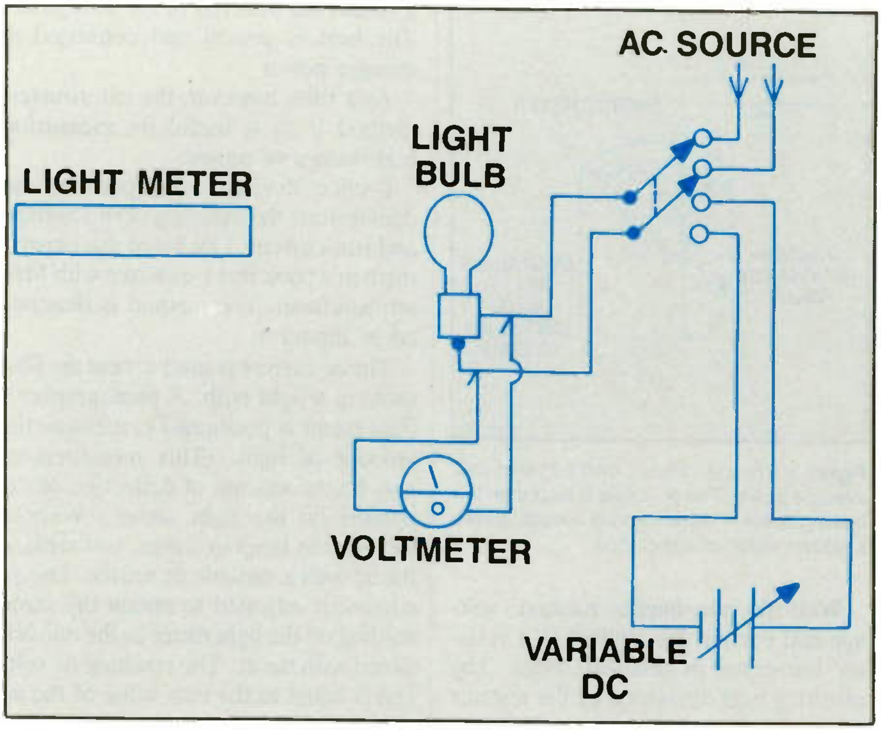


Figure 4. To demonstrate the meaning of rms voltage and rms current, replace the ac with a variable dc source and adjust the dc current to obtain the same reading as the ac current. Your result is a dc voltage equal to the rms value of the ac voltage.

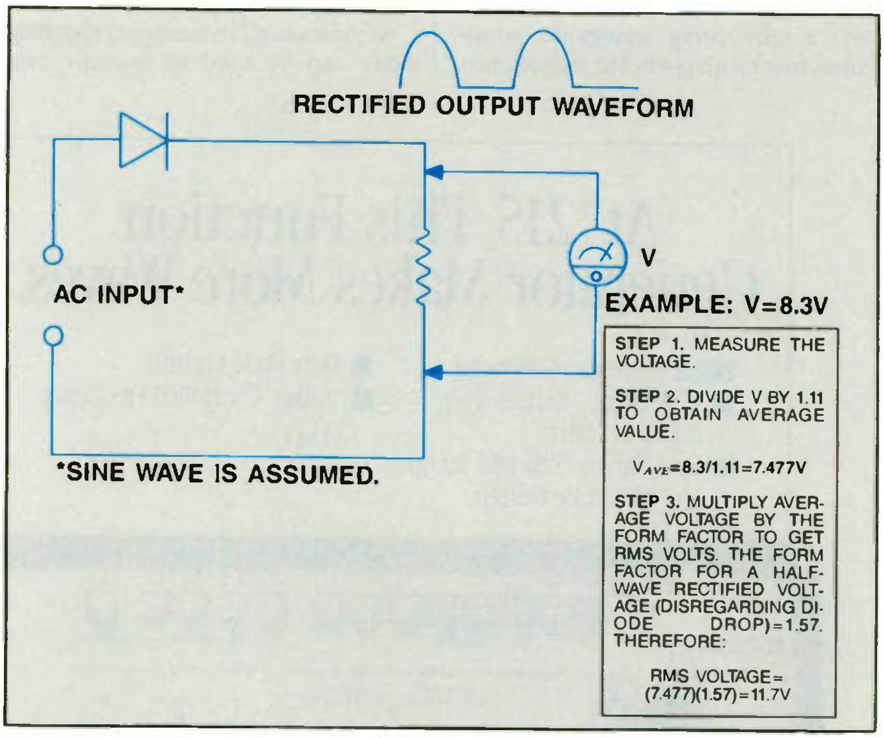


Figure 5. The rms voltage of a half-wave can be obtained with a VOM using this procedure.

values. To understand how it works, let's review the meaning of form factor. By definition, the form factor is equal to rms value/average value.

The average-responding meter has a deflection that is related to the average value of ac voltage current. The Simpson 260 and Triplett 630 analog meters and the Beckman model HD-100 digital meter are examples of average-responding analog meters. Many digital meters also respond to the average value.

The scale on the meter is calibrated to display rms values because the average value is multiplied by the form factor. To obtain the rms value, multiply average value by form factor.

One form factor of a pure sine wave is easily obtained. The procedure is to divide the rms value by the average value:

average value=(0.636)(peak value)
rms value=(0.707)(peak value)
form factor=(0.707)(peak value)/(0.636)(peak value)=1.11

(Note that the peak values cancel.)

The value is usually given as 1.11, which is obtained by rounding off the result of the calculation. This means that you can find the average value by dividing the scale reading by 1.11. Regardless of waveform, that will be the average value.

The rms value displayed is only correct for a sine wave because the average value of a sine wave is multiplied by the form factor of the sine wave. However, the average-responding meter will deflect to the average value regardless of the waveform. Therefore, you can measure the rms value of a non-sinusoidal waveform by converting the meter scale to average and then multiplying that average value by the form factor.

rms value=(displayed value/1.11)(form factor)

For example, the rms value of a pure sine wave (with a form factor of 1.11) equals:

rms value=(displayed value/1.11)(1.11)

The form factor of a full-wave rectified sine wave is 1.11, so you can measure it directly on an average-responding meter that is calibrated in rms values.

In a future issue, I will show you how to obtain form factors for popular waveshapes, then supply a table to summarize the results. By using the table and knowing the wave shape, you can use the VOM to measure the table of non-sinusoidal voltages and currents. For example, I will show that the form factor of a half-wave rectified voltage is 1.414+. Therefore, the rms voltage of a half-wave rectified sine wave can be obtained with a VOM using the procedure shown in Figure 5.

In case you have misunderstood me, I am not proposing that you do not need to buy a true rms meter. On the contrary, I think you should buy all of the test equipment you can use. (Build it if you cannot buy it.)

True rms meters require no calculations and you do not have to know the waveform or form factor. I have not needed the true rms value of a voltage (or current) since Hector was a pup. I plug along with the methods described in this series of articles. Perhaps if I had one, I would find uses for it. ■

3064

PROFAX Manufacturers schematics

MAY 1990

ZENITH
PV-140/DIGITAL(G)
REAR PROJ.
COLOR TV

PV-140/DIGITAL(G)
ZENITH REAR PROJ. COLOR DIGITAL TV RECEIVER
ZENITH SURROUND STEREO SYSTEM

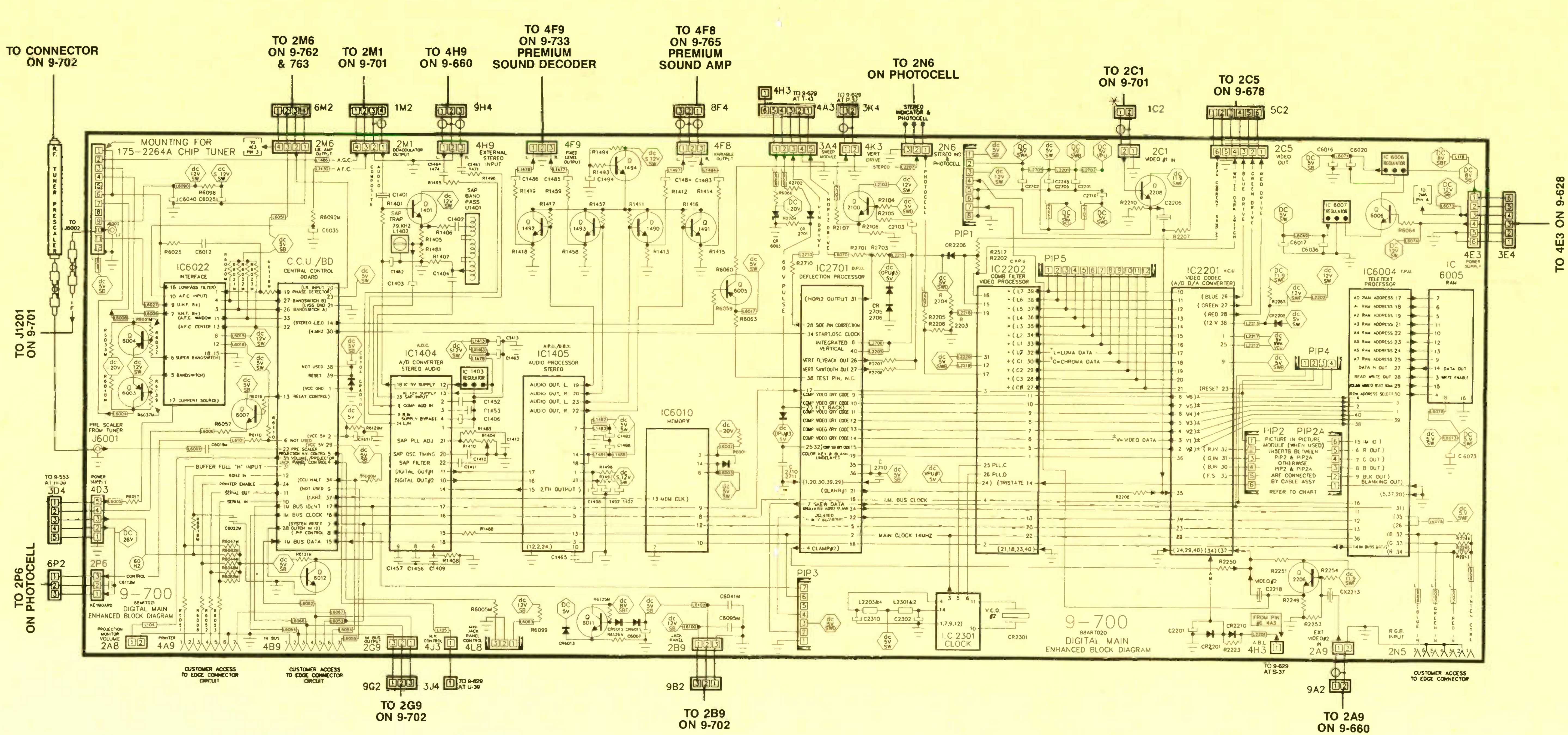
Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

Use of substitute replacement parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

The other portions of this schematic may be found on other Profax pages.

9-700 DIGITAL MAIN



PV-140/DIGITAL(G)
ZENITH REAR PROJ. COLOR DIGITAL TV RECEIVER

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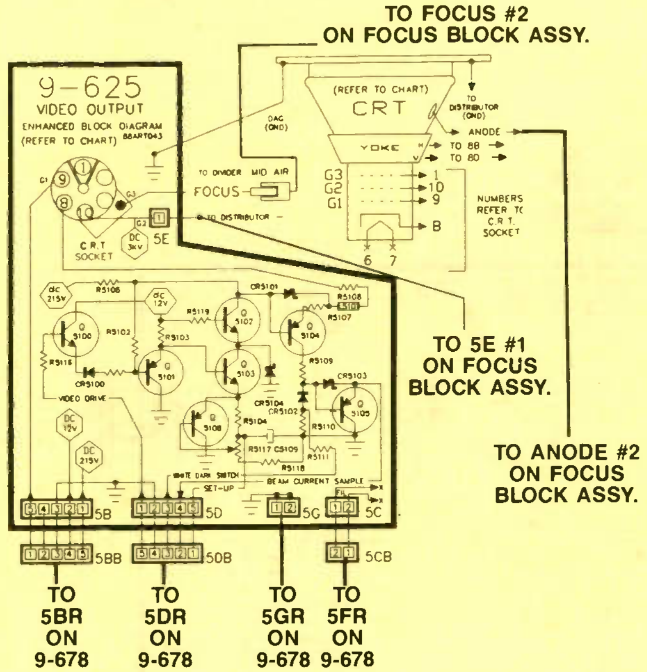
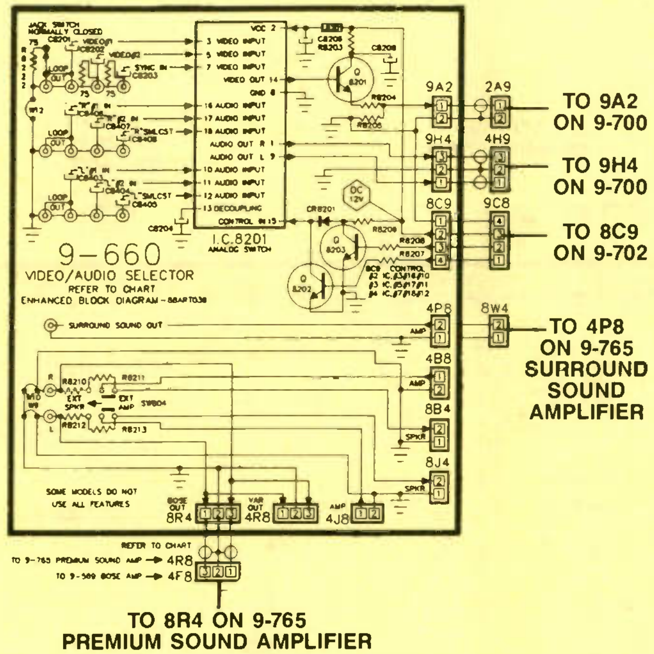
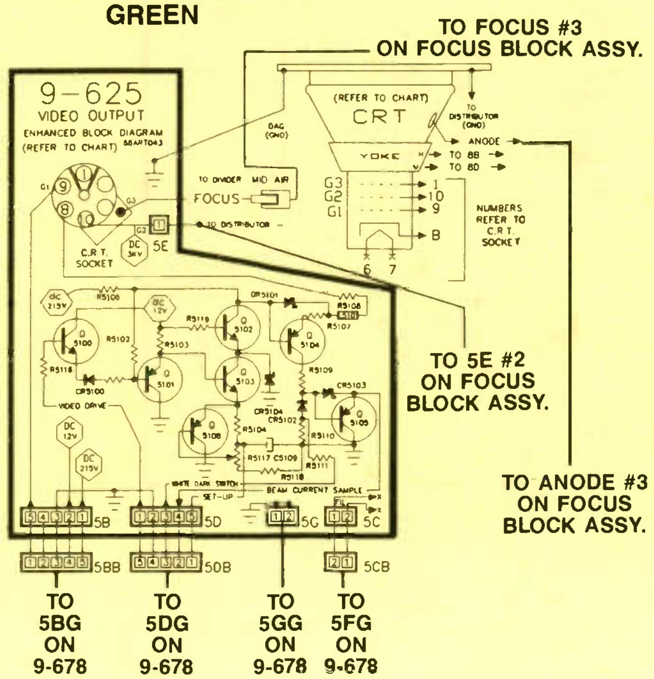
9-625 VIDEO OUTPUT RED



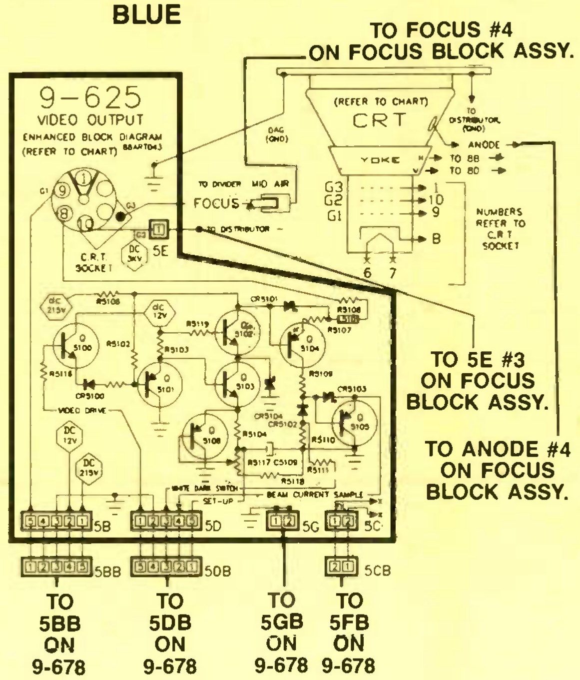
9-660 VIDEO/AUDIO SELECTOR



9-625 VIDEO OUTPUT GREEN



9-625 VIDEO OUTPUT BLUE



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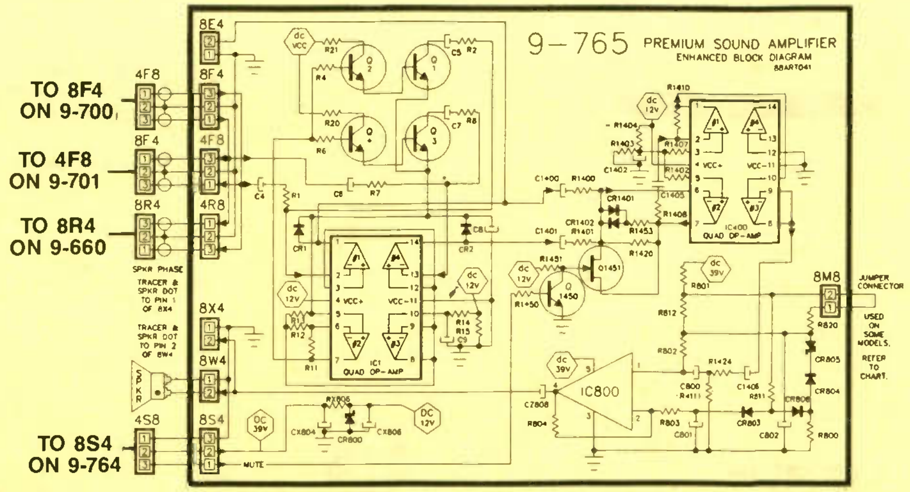
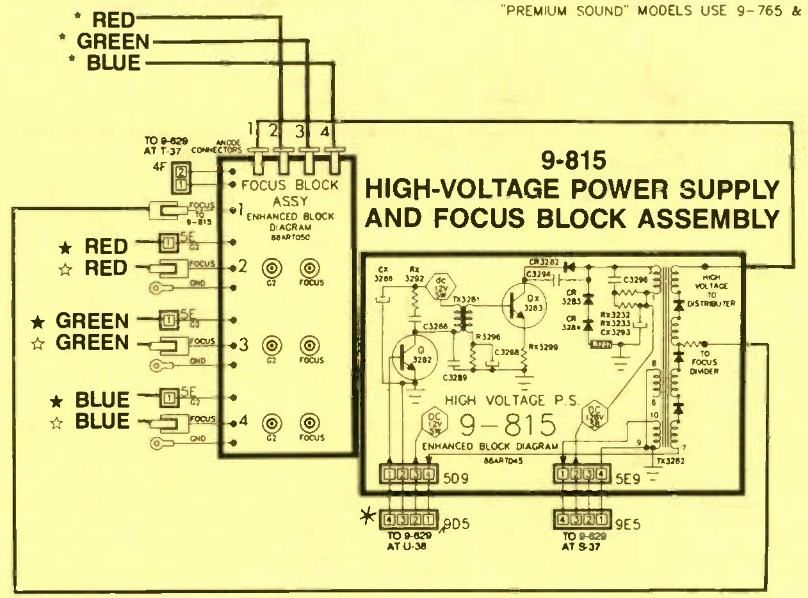
9-765 PREMIUM SOUND AMPLIFIER



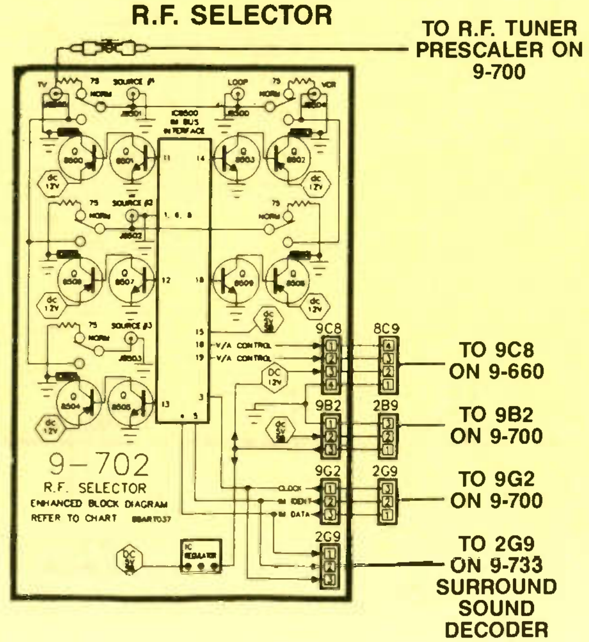
"PREMIUM SOUND" MODELS USE 9-765 & 9-764 MODULES. (REFER TO CHART)

9-815 HIGH-VOLTAGE POWER SUPPLY AND FOCUS BLOCK ASSEMBLY

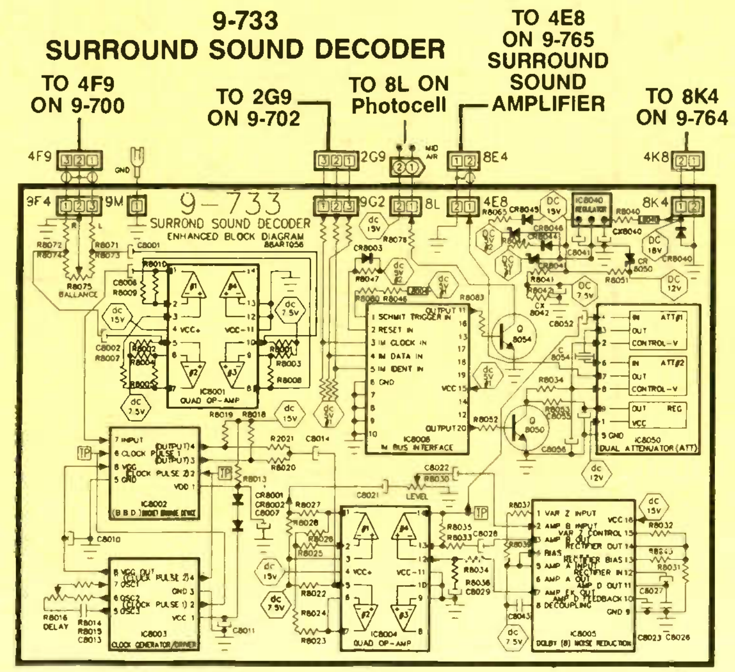


* TO CRT ANODES ON 9-625
★ TO 5E ON 9-625
☆ TO FOCUS ON 9-625

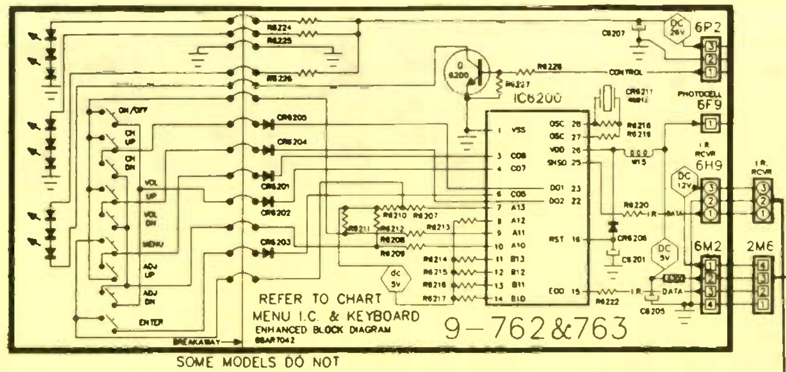
9-702 R.F. SELECTOR



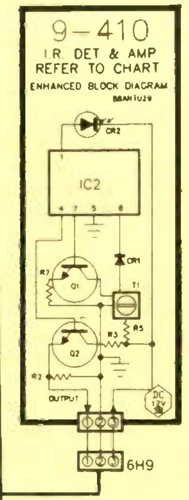
9-733 SURROUND SOUND DECODER



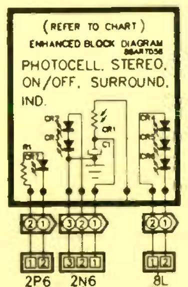
9-762 & 763 MENU IC AND KEYBOARD



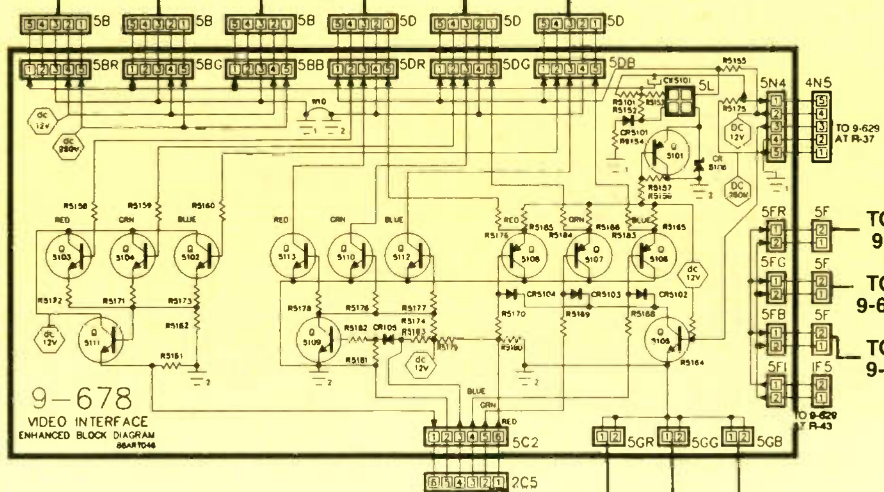
9-410 I.R. DET. AND AMP.



PHOTOCELL, STEREO, ON/OFF, SURROUND, IND.



9-678 VIDEO INTERFACE



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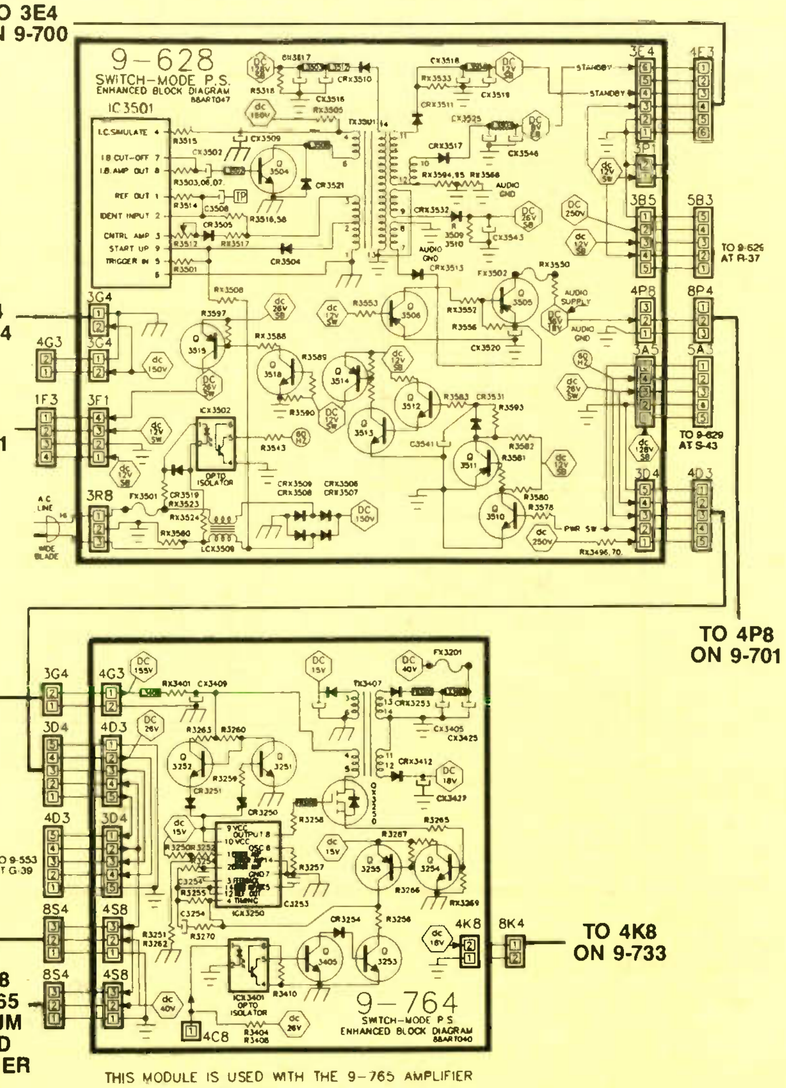
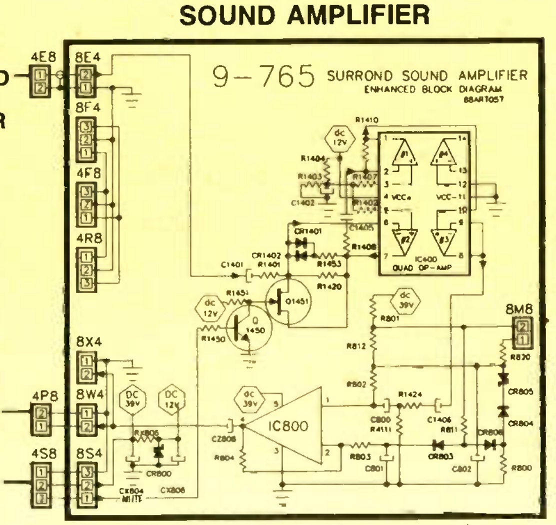
9-628 AND 9-764 MODULES

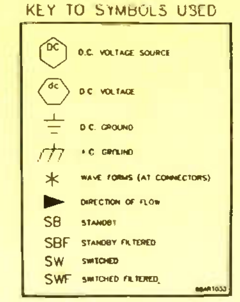


9-765 SURROUND SOUND AMPLIFIER

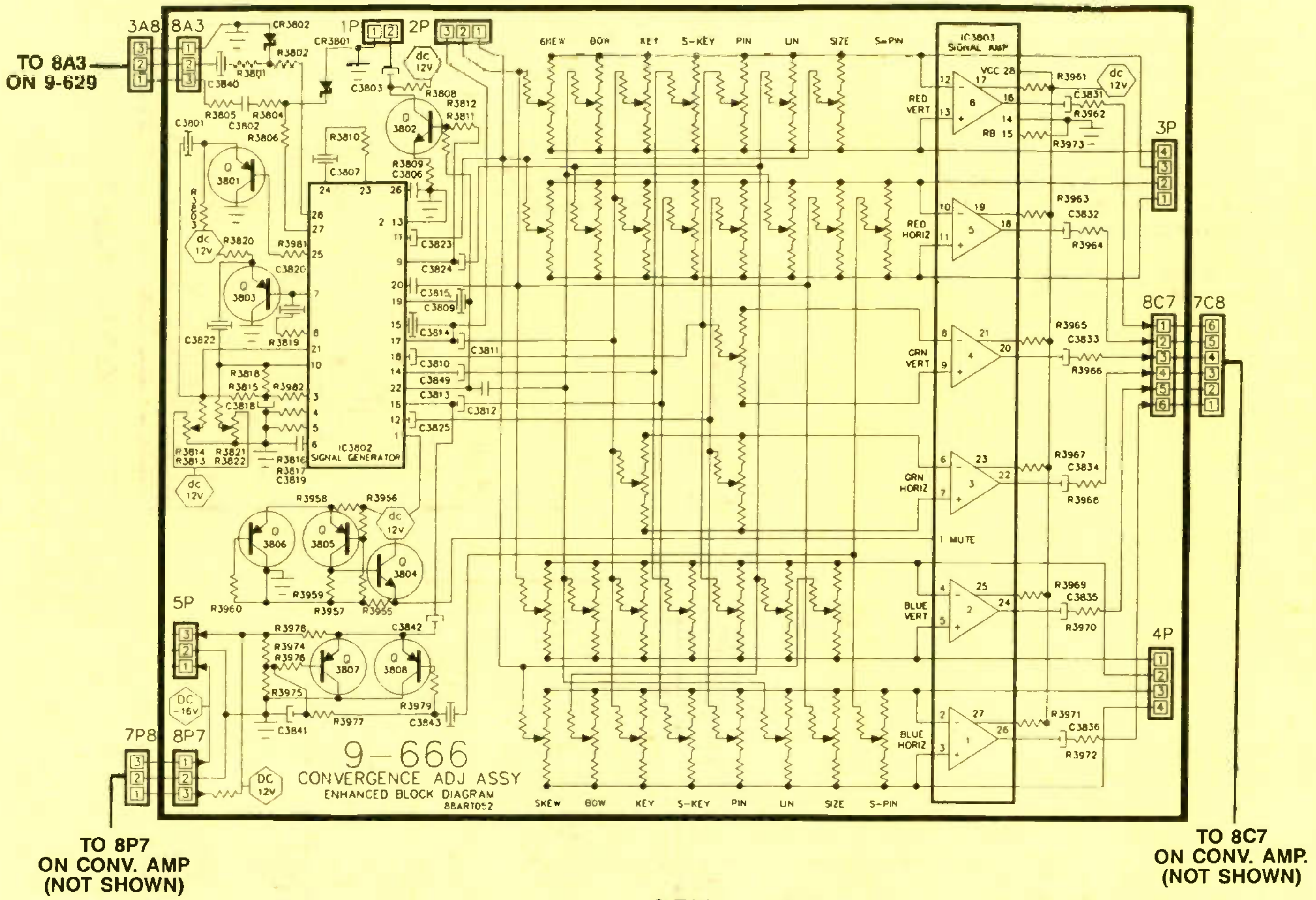


NOTE
9-700 CHASSIS USES SEVERAL INTEGRATED CIRCUITS WHICH ARE PLUG-IN (REFER TO CHART)

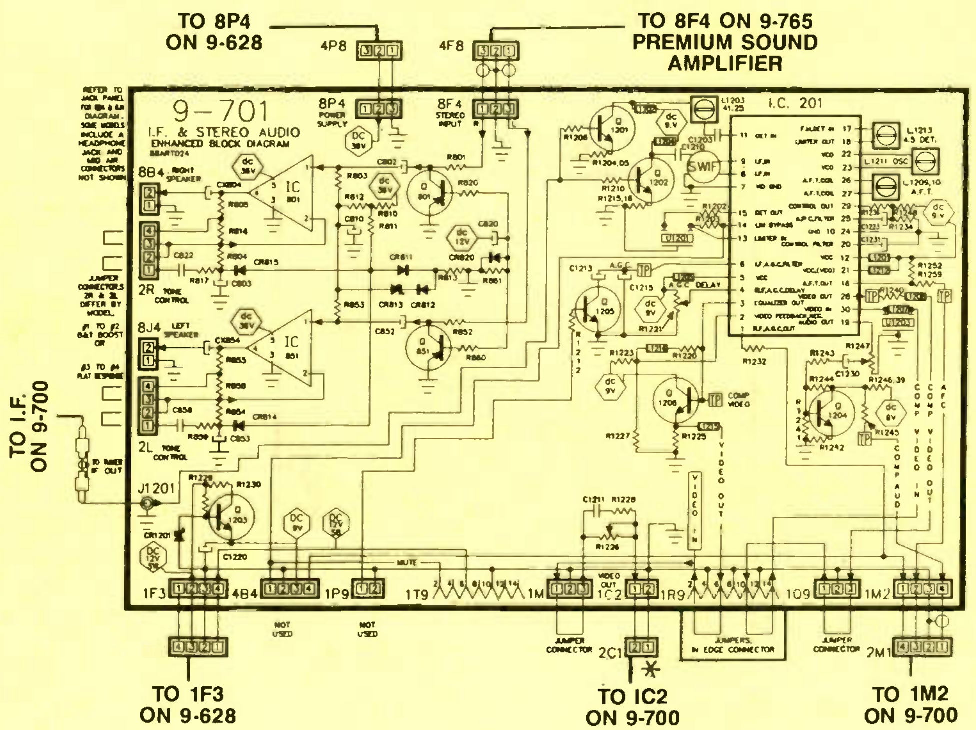
KEY TO SYMBOLS USED



9-666
CONVERGENCE ADJ. ASSY.



9-701
I.F. AND STEREO AUDIO



PV-140/DIGITAL(G) ZENITH REAR PROJ. COLOR DIGITAL TV RECEIVER

Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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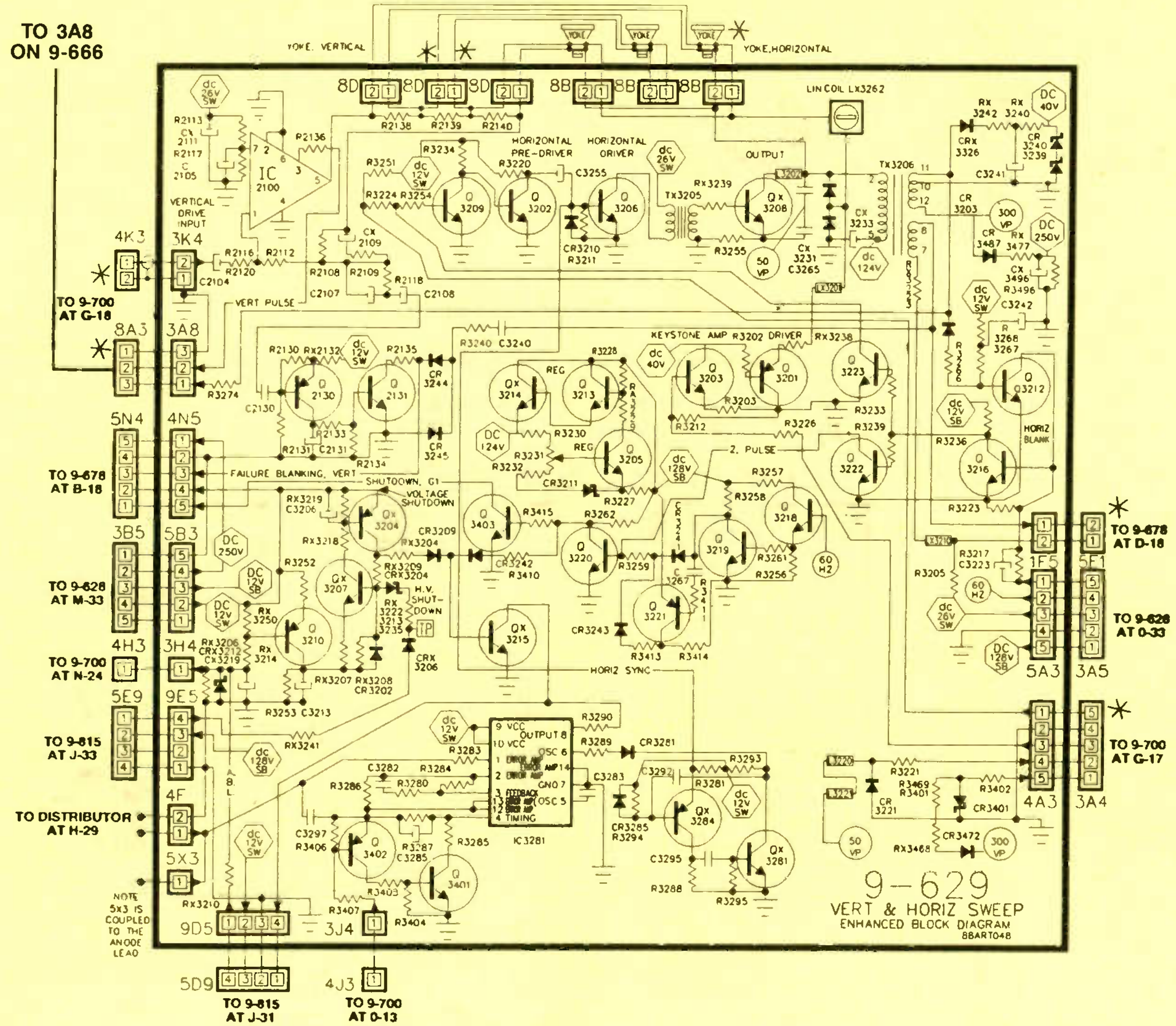
ES&T Manufacturers' schematics PROFAX

May 1990

Zenith	Profax number
PV-140/DIGITAL(G) rear proj. color digital TV receiver, Zenith surround stereo system	3064

9-629
VERT. & HORIZ. SWEEP



Answers to the quiz

Questions are on page 21.

1. Hertz — The period (T) is the time required for one cycle. The period is measured in seconds. Frequency (f) is the reciprocal of the period ($f = 1/T$), and it is measured in hertz.
2. Quality factor — At one time, the sharpest tuning was considered to be best for tuned circuits. Today, we know that is not always true, but the Q — quality factor — is still used as a measure of tuning sharpness.
3. Watts — The rate of doing work or expending energy is called power.
4. VARS — The letters mean *reactive volt amperes*. If the inductor or capacitor could dissipate power, that amount of power would be equal to the number of VARS.
5. Siemens — Conductance is the reciprocal of resistance (which is volts per ampere). Older books call the unit of measurement MHOS, which is ohm spelled backwards. I have always thought it was a better unit of measure than siemens. However, electronics is not a matter of opinion.
6. Nepers — It is the equivalent of our decibels, but nepers and decibels are not numerically equal.
7. ISR, or, intrinsic standoff ratio — It is defined by the question.
8. Kelvin — The temperature scale based on absolute zero is called the kelvin scale.
9. NMI, or non-maskable interrupt — This type of interrupt would result from an impending power failure.
10. Susceptance — The reciprocal of resistance is conductance. The reciprocal of impedance is admittance. The reciprocal of reactance is susceptance.

More about nepers...

Because "neper" is an unfamiliar term to many technicians, here is some additional information about the ratio.

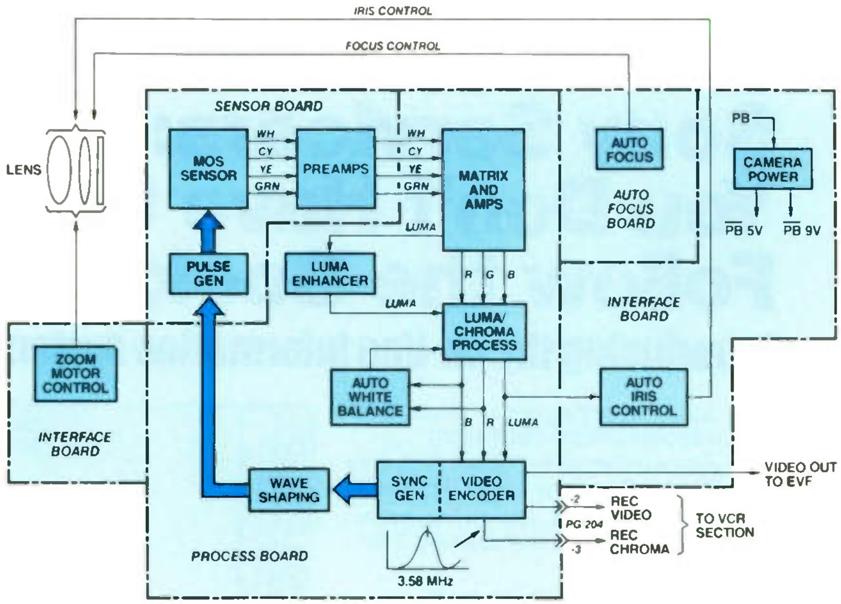
The neper is defined as the natural logarithm of the ratio of two currents or two voltages. The unit, neper, is named after Napier, the mathemetician who introduced the idea of natural logarithms. According to several sources, his name may have been spelled Neper, rather than Napier.

The decibel and the neper both represent ways of expressing ratios of quantities. In electronics, decibels and nepers are used to express the ratios of voltages, currents or powers. The equation for decibels is $db = 10 \log (P1/P2)$, or $db = 20 \log (I2/I1)$. The equation for nepers is $np = \ln(I2/I1) = \ln(V2/V1)$.

To convert from napiers to decibels, divide by 8.686. Thus, 1np = 8.686db, or 1db = db/8.686.

Anatomy of a camcorder

By the ES&T staff



CPR100 Camera Block Diagram

Figure 1. A block diagram of a typical camcorder shows its many features, such as auto white balance, a 6:1 power zoom, and autofocus, all contained within a limited space. The small size of camcorders creates a challenge for electronics servicers.

Camcorders represent a fast-growing segment of the consumer electronics market. These small, lightweight wonders of the home video scene also represent a significant opportunity for servicing technicians. Although they are highly reliable products, camcorders are subjected to a number of hostile environments: high temperature, dust, moisture, and clumsy humans. They require service.

Unfortunately, the small size of a camcorder, which is such a benefit to consumers, can be a nightmare for electronics servicers. Tiny components in a tiny compartment can cause gigantic problems. (See Figure 1.) Understanding how a camcorder functions is the first step in repairing one. We used the RCA CPR100 as a model to provide you with information on the anatomy of a typical camcorder.

Adapted with permission of Thomson Consumer Electronics from the RCA *CPR100 Small Wonder VHS-C Camcorder* training manual.

Camera specifications

The front end, or camera section, of the CPR100 Small Wonder camcorder contains circuitry based on that used in RCA's CLC020 Small Wonder video cameras. The camera features a 6:1 power zoom lens with a speed of f1.4 and macro focus capability. Autofocus is also provided, but the camera can be switched to the manual focus mode as well. Although this camera contains a constant automatic white-balance circuit, a manual iris control is provided to compensate for unusual lighting conditions.

The camera specifications include a low-light sensitivity of 10 lux with a 46mm lens diameter. The pickup device is the latest version of RCA's ⅔-inch, solid-state, metal-oxide semiconductor (MOS) sensor. This sensor has been designed to provide optimum picture quality over a wide variety of lighting conditions.

The white-balance circuit monitors the R-Y and B-Y signals from the camera luma/chroma processing circuits to optimize the overall picture color temperature. This automatic white-balance circuit compensates for a range of color temperatures. With an all red or all blue picture, you might expect the white-balance circuit to adjust video to all white. To prevent this, the gain of the circuit is controlled so that maximum compensation occurs at a color temperature of approximately 3,200°K.

Major camera circuitry

The camera section of this camcorder consists of three major circuit boards: process, interface and autofocus. The *process* circuit board, located on the bottom of the camera, contains most of the camera luminance and chrominance processing circuitry, as well as a number of adjustments located on the right side of the camera. You can make adjustments without removing the camera section from the camcorder, and you can remove the right side access panel by removing one screw. Most test points and adjustment controls are accessible once the access panel has been removed.

The *interface* circuit board is plugged into the process circuit board. The interface board contains several connectors, components and ICs that connect the camera section to the VCR deck and supply input/output (I/O) signals to the electronic viewfinder connector and the audio/video output connector.

Above the camera section is a small circuit board that contains the audio input for the camcorder. This board features the earphone and external microphone jacks. The interface wiring for supplying audio from the microphone to the VCR deck is also located in this board.

The *autofocus* circuit board is located on the left side of the camera. It contains two surface-mount dual in-line

ICs, as well as several chip components. A small circuit board containing two switches and a manual iris control is also located on the left side of the camera section, with the sensor board positioned at the rear. Mounted directly to the lens assembly, the sensor board contains the MOS sensor, the pre-amplifier and the sync generator.

The MOS sensor board

Because of the complexity of the sensor circuitry, the MOS sensor is often replaced as a module. Servicing the camera section separately from the VCR deck is not practical because the VCR section supplies power for the camera, and video processing of the camera composite video and the chrominace signal is provided in the VCR deck.

Most of the adjustments on the MOS camera section of the CPR100 are similar to those in previous RCA MOS cameras. However, the CPR100 uses more ICs, surface-mount devices or chip components, and better packaging techniques. Overall, servicers who are familiar with RCA's MOS cameras and camcorders should have little difficulty servicing the camera section of the CPR100. Servicers who require more information on the CPR100 camera section circuitry or adjustments should refer to RCA service data.

The camcorder uses a new generation of MOS image sensor (IC1001), which is mounted to the sensor board with the pulse generator and low noise pre-amps. Compared to early MOS cameras, the sensor has improved resolution, light sensitivity and color reproduction.

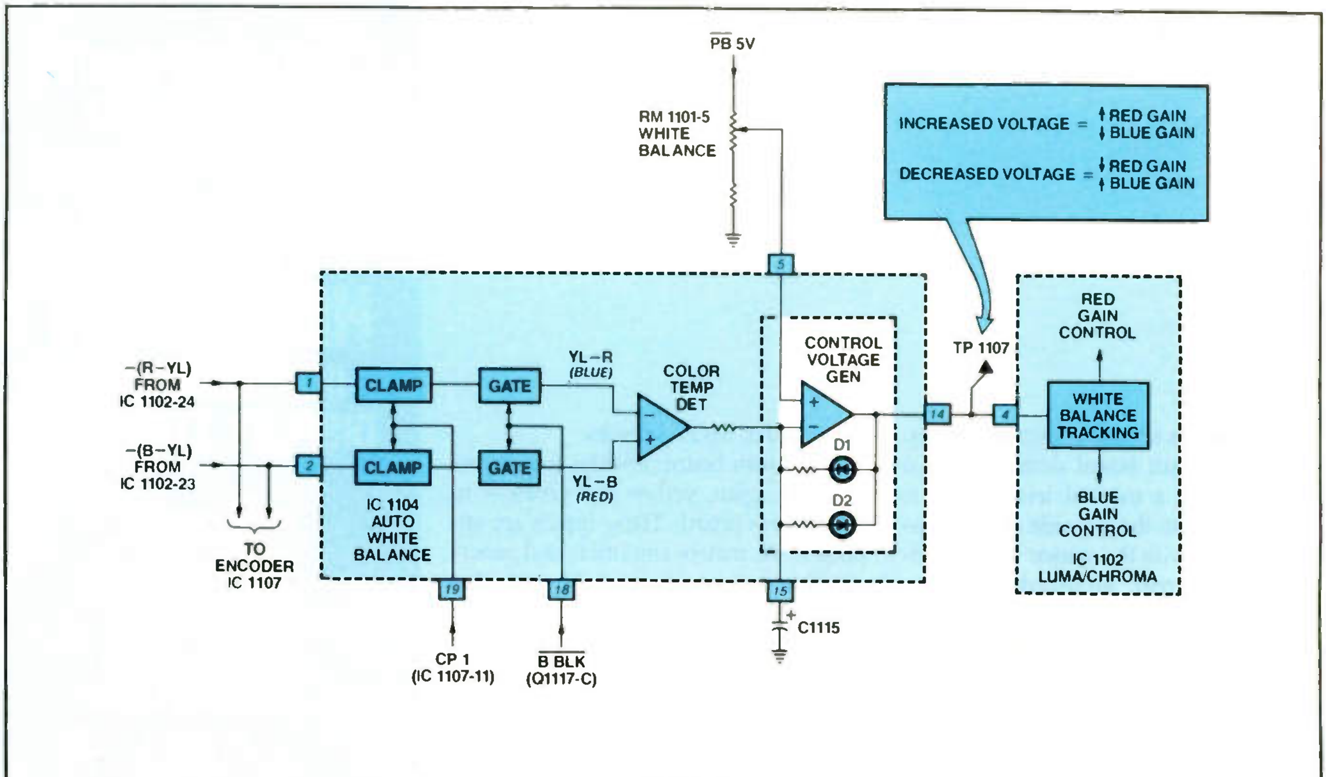
The number of light-sensing picture elements (pixels) has increased from 182,360 (376×485, H×V) to 279,360 (576×485, H×V), and the clock frequency has increased from 4.8MHz to 5.43MHz. Both of these result in an improved resolution. A new layer of semiconductor structure (3-layer, NPN) in the MOS sensor improves and balances the spectral sensitivity while eliminating the green vertical smear characteristic of older MOS sensors.

The sensor board provides four inputs — white, cyan, yellow and green — to the process board. These inputs are applied to the matrix amplifiers and generate four other signals. The Y (luminance) signal is applied to the luminance enhancer. The RGB signals are used to generate the NTSC R-Y, B-Y and luminance signals. A portion of the luminance signal is supplied to the automatic iris-control circuitry, and the R-Y and B-Y signals are sampled by the automatic white-balance circuit.

The NTSC color and luminance signals are applied to the video encoder on the process board, from the luma/chroma processing circuit. The encoder IC also incorporates a sync generator, which supplies drive pulses to the pulse generator on the sensor board. The video encoder generates video to the electronic viewfinder and the record video and chrominance signals. Separate video and chroma signals reduce crosstalk or beats.

Constant automatic white balance

The camcorder uses electronic circuitry (See Figure 2) to monitor the R-Y and B-Y signals from the luma/chroma processing circuit within the camera to adjust white balance. Earlier model camcorders used photosensitive diodes with filters to adjust white balance. The luminance and chrominance processing circuits within the CPR100 are the same as those used in RCA's CMR300, which incorporates photosensitive diodes. The main difference is that the automatic white balance in the CPR100 monitors the actual video, not photosensitive diodes, to determine lighting conditions. The output, or control voltage, from the white-balance circuit is applied to the luma/chroma processing white-balance tracking circuit and controls the gain of the R and B signals. The white color is reproduced correctly, even when the scene color temperature varies because of changes in the light source.



Constant Automatic White Balance

Figure 2. To adjust white balance, a typical camcorder uses electronic circuitry to monitor the R-Y and B-Y signals from the luma/chroma processing circuit. The automatic white balance monitors the actual video, instead of photosensitive diodes, to determine lighting conditions.

Auto white balance IC1104 is supplied samples of the red (R) and blue (B) signals from luma/chroma processing IC1102. The R and B sample signals are referred to as −(R−YL) and −(B−YL). Clamp circuits clamp the dc level of the input color-difference signals, and the clamp timing is controlled by clamp pulse 1 (CP 1), applied at pin 19 of IC1104.

Following processing in the clamp circuits, the R and B sample signals are supplied to gate circuits. The gates are controlled by the inverted blanking pulse (/B, B OK) applied at pin 18 of IC1104. The signals are gated to the color-temperature detector during the scanning period, when the blanking pulse is low. The outputs from the gate circuits are clipped to prevent the color-temperature detection circuit from attempting large adjustment.

The color-temperature detector is a differential amplifier that subtracts the sampled red signal from the blue signal to generate an output signal. When the correct white balance is obtained, the red signal equals the blue signal and the output voltage from the temperature detector is zero. If the color-temperature is low, or red, the output signal from the color-temperature detector is high. When the color temperature is high, or blue, the output signal is low. The color-temperature detection output signal is filtered by an internal resistor and C1115, connected at pin 15 of IC1104.

The averaged value, representing the average scene color temperature, is applied to the *control-voltage generator*, another differential amplifier. The control-voltage generator compares the color-temperature detector signal with a reference voltage supplied from pin 5 of white-balance control RM1101, a multiple control package. The white-balance control is the fifth element in the package. The control-voltage generator output, or control signal, follows the color temperature. In other words, the control voltage is lower when the scene color temperature is low, and the control voltage is higher when the scene color temperature is high.

The control voltage, which can be monitored at TP1107, exits IC1104 at pin 14 and is applied at pin 4 of IC1102 to the white-balance tracking circuit. The white-balance tracking circuit supplies outputs to the red and blue non-linear amplifiers within IC1102. When the control voltage goes high, the red control signal increases the gain of the red amplifier and the blue control signal decreases the gain of the blue amplifier. As the color temperature decreases, an opposite control occurs.

To service the white-balance circuit, you must use simple signal tracing. Confirm the existence of the correct red and blue sample signals at pins 1 and 2 of IC1104. If either is missing, suspect encoder IC1107. If both signals are present, vary the color temperature of the scene while monitoring TP1107 for a varying voltage that follows increases and decreases in color temperature. If the signal is missing or incorrect, suspect auto white balance IC1104. If the signal is correct, suspect luma/ chroma processing IC1102, or other camera processing circuits.

Camera power distribution

The camera section derives power from three sources in the VCR section. Circuitry within the camera section uses these three sources to generate two other sources. The power distribution diagram (See Figure 3) is provided as a service aid, but refer to the manufacturer's service data for exact information.

During playback, turn off the power to the camera section and apply the playback signal from the main board at PG901, pin 2, through the wiring board to inverter Q402. During the record mode, the playback signal goes low and Q1402 generates a high on its output.

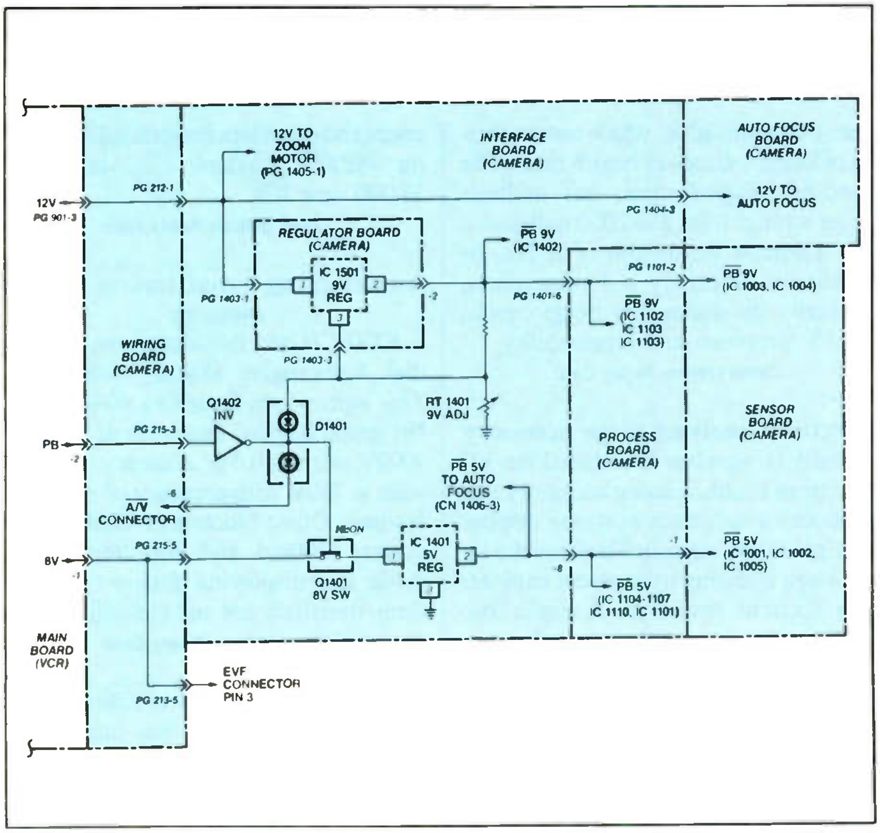


Figure 3. The camera section derives power from three sources — 12V, 9V and 5V — in the VCR section. Circuitry within the camera section uses these three sources to generate two other sources.

This high is applied to diode D1401, a dual-diode package, and reverse-biases both devices in D1401.

A high causes the 8V switch to turn on and supply 8V from the main board in the VCR section to 5V regulator IC1401 at pin 1. At the same time, D1401 allows pin 3 of 9V regulator IC1501 on the regulator board to be raised by the voltage developed across the 9V adjustment control, RT1401. A 12V source from the main circuit board is applied through PG605, pin 1, to the interface board and pin 1 of IC1501 on the regulator board. Pin 1 is raised by the voltage developed across the 9V adjustment control, RT1401. IC1501, a 3-pin adjustable regulator, generates the playback 9V signal source. The 5V regulator, IC1401, generates the playback 5V source, and the voltage from the main board on the VCR section is used as the 12V source in the camera.

Many boards contain circuits that are powered by the three camera voltage sources. The 12V source supplies power to the zoom motor and the autofocus circuitry. The 9V source supplies power to the luma/chroma process IC (IC1102), luminance enhancer IC (IC1103), and the luminance filter IC (IC1108) on the process board. This source also supplies power to pre-amps IC1003 and IC1004 on the sensor board. The 5V source supplies power to the chroma filter (IC1101), auto white balance IC (IC1104), pulse generator (IC1106), encoder/sync generator (IC1107) and the chroma amplifier (IC1110) on the process board. On the sensor board, the 5V source supplies power to MOS color image sensor (IC1001), MOS color image sensor drive pulse generator (IC1002) and pre-amp IC1005.

With the power distribution diagram, servicers can trace basic power distribution within the camera section. The manufacturer's service data for camcorders contains specific instructions on parts, safety and alignment procedures. All product safety requirements and testing must be complied with before the camcorder is returned to the consumer. Servicers who fail to perform safety checks or defeat safety features may be liable for resulting damages and may expose themselves and others to possible injury. ■

Microprocessor-controlled soldering station

Weller has introduced the MC5000-3 microprocessor-controlled soldering station, which features a compact, high-performance soldering tool designed for applications that require large heat output from a small tool. The 42W iron has high-mass tips, manufactured with a taper fit that matches the heater sheath. Suited for work with multilayer boards, this tool offers maximum heat transfer from the heater to any of the five tip shapes. The miniature profile of the tool assures easy access to difficult soldering applications.

Circle (75) on Reply Card

Electronic trade-in guides on disk

Orion Research announced that its seven guides will be published in magnetic disk form, making accurate pricing information for used equipment available to owners of MS-DOS computers. The company's Blue Books contain prices for buying and selling used cameras, computers, audio and video components, musical instruments and professional sound gear.

Circle (76) on Reply Card

Computerized claims processing system

KeyPrestige has introduced its KeyClub program for the electronics and appliance industries. The program offers a one-step data entry system for batch processing of claims. All claims are output onto a disk or tape from an IBM compatible computer and sent directly to KeyClub. Once the data is received, it is processed and payment cycles are completed.

Circle (77) on Reply Card

Instrument finds circuit board shorts

PAXR Test Systems has introduced Combitest, an instrument designed to pinpoint the exact component or track failure on printed circuit board assemblies. The unit is designed to locate the following faults: shorts and near shorts, multilayer PCB shorts, bus problems, fan-out problems, excessive Vcc loads and faulty decoupling capacitors.

Circle (78) on Reply Card

Magnetic field meter

Integrity Electronics & Research has introduced the Model IER-109 60Hz magnetic field meter. It monitors power lines, instruments, wiring and appliance magnetic fields, which are suspected of being sources of health risks. The hand-held digital meter has multiple range settings from 2 to 2000 milligauss, and a narrow bandwidth of 11 Hz. Its maximum sensitivity is 1 microgauss. Linearity throughout its range creates ±0.1% precision and repeatability.

Circle (79) on Reply Card

Spectrum analyzer scope accessory

Smith Design has introduced the 107 Spectrum Probe, a scope accessory that produces a spectrum analyzer display. A 10pF 3kVdc capacitor isolates the input stage allowing transparent exploration of circuit operation. A single connection is made to the normal scope vertical input. The scope bandwidth requirement is 500kHz. Frequency range of the probe is 1 through 100 MHz, with greater than 50dB dynamic range.

Circle (80) on Reply Card

Instrument for testing S-VHS products

John Fluke Mfg. has introduced an option that gives their PM 5514, PM 5515 and PM 5518 color-TV pattern generators the capability to test Super-VHS videocassette recorders. The PM 9553 Y/C option provides the separate luminance and chrominance (Y and C) signals used in super-VHS video recorders and monitors. The versatility of the unit is enhanced by its standard RGB output signals.

Circle (81) on Reply Card

Power vacuum desoldering system

Leads Metal Products has introduced the ENDECO power vacuum system, which is designed to eliminate clogging problems associated with some power vacuum desoldering systems. This system ejects the molten solder into a spittoon to save the operator from having to empty solder collection containers or change in-line filters. The system is capable of pulling solder through thick or multi-layer boards and boards with small lead-to-hole ratios.

Circle (82) on Reply Card

New IC data base

Hearst Business Communications has introduced the 1990 IC Master. The listing has been updated with all new sections and categories in each volume. It provides the design engineer and servicing technician with a comprehensive data base which references, cross references and organizes product information on 80,000 standard ICs, including 14,000 new ICs.

Circle (83) on Reply Card

Autoranging multimeter with memory

EXTECH had introduced the rotary-dial Autoranging Digital Multimeter. This unit, which features a 40-segment bar graph display, measures dc volts to 1000V with ±0.5% accuracy, and ac volts to 750V with accuracy of ±0.75 of reading. Other functions include dc/ac current (200mA and 10A), resistance, diode test displaying forward voltage drop, transistor test and continuity test.

Circle (84) on Reply Card

100-MHz 3-channel oscilloscope

Leader Instruments has introduced the Model 1100 oscilloscope, a 100MHz, 3-channel unit with dual time base, 6-trace capability, 500V maximum sensitivity and 5ns maximum sweep speed for analysis or low-level and high-speed signals. The scope has alternate triggering, alternate time base and variable holdoff.

Circle (85) on Reply Card

Repairable oscilloscope probe

Test Probes has offered thin-cable, 300MHz repairable oscilloscope probes that fit all makes of scopes having 1M input. A distinctive sawtooth-shaped center conductor eliminates microphonics. This design provides resistance to breakage from pulling and bending to assure long life. The modular probes screw together without soldering for on-site repairs, and offer greater integrity than snap-together probes. This type of construction also allows for inexpensive replacement of failed parts.

Circle (86) on Reply Card

DMM features true RMS, menu options

The Instrumentation Products Division of *Beckman Industrial* has introduced the RMS225 4-digit professional-grade DMM. The unit features 10,000 counts resolution, true RMS, 41-segment analog bar graph, auto max and min, probe hold, and a relative mode. The Auto Max Min, which is a trademarked capability, allows the user to record minimum and maximum readings while remaining in the auto-ranging mode.

Circle (87) on Reply Card

Continued from page 20.

Emerson
2716-1 .... TS4451D

JCPenney
2719-1 .... 685-2523-00 (CH. 855-9809)

Magnavox
2717-1 .... RK3955AL01/AL02 (SUF. A)/BK01/BK02

Panasonic
2723-1 .... CTK-1942R, PC-20S49R (CH. ADP163/GL7H, YADP163/GL7H)

Quasar
2718-1 .... TT9808CW, SP2530DE (CH. AEDC144/GL7S)
2722-1 .... WL9439BP-1/CP, WU9410BU-1, WU9411U, YWU9410BU-1, YWU9411U, YWU9420BK-1 (CH. 136/S1, LC136/S1, YC136/S1)

RCA
2721-1 .... E09395GMC01/GMF01, E09396SRF01, E09397ABF01, E09495FWF01 (CH. CTC134A)
2724-2 .... F26020WNF01, F26026MKF01, G26261TNC01/TNK01/TNL01, G26265TKK01, G26269HPK01/HPL01, G26271TNC01/TNL01, G26273TNK01, G26275CKK01/CKL01 (CH. CTC149A)

Samsung
2720-1 .... TC2050S (CH. 21K-50MS)

Sears
2716-2 .... 564.48703850, 564.48710850, 564.48710851
2717-2 .... 564.42453850, 564.42453851, 564.42454851
2718-2 .... 564.40654850
2720-2 .... 562.42082950
2721-2 .... 564.48130850, 564.48140850/51
2722-2 .... 564.40455950, 564.40555950
2723-2 .... 564.48128850, 564.48138850/51

Sylvania
2724-1 ..... CKF176WA01/2/3/4, RKF178WA01/2/3/4/5/6, RXF188WA01/2/3 (CH. 19C802, 20C802/804)
2725-1 .... 564.48704850

Zenith
2719-2 .... SD2035H6, SD2733H, SD2735P, SD2739N, SD2743G/H, SD2753H1, SD271W1/Y1
2725-2 .... D1314W, SD1315A/W/Y

AGC circuits in foreign-built TVs

By Homer Davidson

The old adage, "If you've seen one, you've seen them all," almost never applies to TV repairs. Foreign TVs differ from domestic TVs, brands differ, models differ. This variety can make servicing confusing.

Fortunately, if you've seen one automatic-gain-control (AGC) circuit, you may not have seen them all, but you've come close. AGC circuits in foreign-built TV receivers are similar to those used in comparable U.S. models. There are no basic electronic differences between AGC circuits for B&W receivers and those in color-TV receivers.

AGC circuitry is necessary in all TV receivers because TV signals are often received with varying or vastly different signal strengths from various channels. Unless corrected, these conditions make TV reception intolerable. Therefore, each receiver's AGC circuit must sense station signal levels (perhaps from the video detector) and automatically adjust the biases of RF and IF transistors. Adjusting the gain reduces the gain of stronger signals until the amplitudes of all station signals are approximately equal at the video detector.

Davidson is the TV servicing consultant for **ES&T**.

When the AGC works correctly, all stations show the same visible contrast and good stable picture without excessive snow, overload or distortion.

AGC basics

Signal gains of RF and IF transistors can be reduced if you decrease (toward cut-off) or increase (toward saturation) their forward biases from the dcV that produces maximum gain. Both methods provide the same maximum gains — at the same dc voltage.

Cut-off-bias gain variation is not used in foreign or domestic TV receivers. If increases in the input signal strength decreases the RF/IF transistor toward bias, an AGC circuit defect is indicated (the reading should have increased). Therefore, repairs are needed. This simple guide is also true for ICs, because they have transistor equivalents inside.

Keyed AGC is similar to simple AGC, except that it can operate only when a flyback pulse appears at the collector. Keyed AGC helps prevent instability from noise in the video signal because the AGC is dead until a horizontal pulse brings the circuit into operation for the duration of the pulse. The AGC operates during each pulse.

An out-of-lock horizontal sweep system can interfere with the keyed AGC operation because sync and horizontal pulses are not then synchronized. With these circuits, lock the horizontal (if possible) before testing the AGC or sync operation.

Minimum snow is obtained when the AGC voltage to the tuner is not applied until after maximum AGC action has been attained in the controlled IF stages. When the station signal strength in-

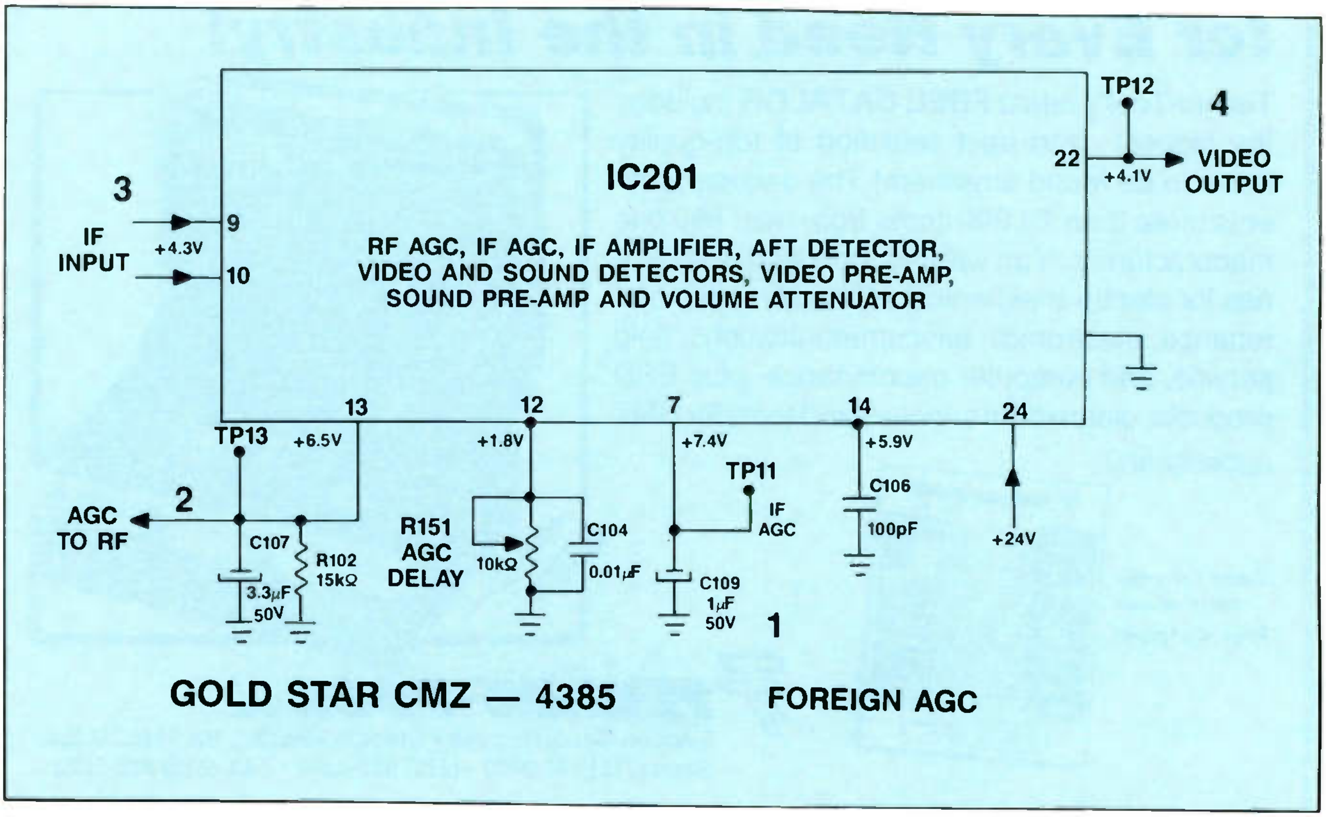


Figure 1. Large numbers on the schematic near certain IC201 pins show the sequence for testing dc voltages or ac signal readings.

creases beyond the ability of the IF-AGC system to control it, the AGC tuner begins to operate, applying a gradually increasing amount of RF-amplifier AGC voltage as needed to level the stronger signals. This RF-AGC control continues until both RF and IF stages have reached minimum gain. The RF and IF AGC voltages are at maximum.

In most foreign TVs, AGC voltage to the IFs can range from +3.5V to +11.76V, with an average of +4.5V to +8V. AGC to the tuner's RF stage ranges between +1.5V and +12.7V, with typical operation between +2.4V and +5.1V. Higher positive voltages indicate the gain is being further reduced, but beware of voltage extremes. If the gain is reduced by high positive voltages too much, it will cause a faint picture or a blank white screen. No voltage, or a voltage much lower than normal, produces the same white raster or faint-picture symptoms.

Symptoms of AGC failures

The first symptoms of AGC problems often come from CRT pictures. The TV screen might have a snowy picture or a white raster without picture. It could show typical signs of overload, such as excessive contrast or picture pulling. You may confuse these AGC symptoms with symptoms of sync, IF or video problems. Lines sometimes appear on the screen, or the picture becomes intermittent. The same component often causes symptoms that could indicate both sync and AGC defects.

Test equipment

Most defects in AGC can be found by using a good scope, for identifying waveforms, and an excellent digital multimeter (DMM), for accurate voltage and resistance measurements.

When the tuner is suspect, a tuner-substitute test is recommended. This test tells you whether the tuner is at fault. The external test tuner, however, does not use the TV's B+ voltages or AGC voltages, so these operating voltages should be tested with the original tuner connected. A test might require the use of an external voltage supply. If this happens, a variable-voltage source with good regulation should be chosen.

Multifunctional ICs

In some of the most recent foreign TV receivers, one large IC produces the functions of the RF AGC, IF amplifier, AFT detector, video and sound detectors, video pre-amplifier, sound pre-amplifier and volume attenuator.

As shown in Figure 1, the IF AGC voltage in the Gold Star model CMZ-4385 is developed inside IC201 by a non-keyed circuit. It controls the gain of three internal IF stages. This IF AGC voltage is used only within IC201, but it can be measured at pin 7 or test point TP11. In addition to controlling the gain of the three IF stages, the IF AGC voltage is used as a comparison against the AGC-delay control's dc voltage to determine the voltage for the RF AGC. The RF AGC voltage can be measured at TP13 or IC201 pin 13.

Another function of IC201 pin 7 (in addition to its obvious ones as a tie-point for C109 and as a test point) was discovered in the Gold Star service manual. When the pin-7 dc voltage drops below +0.3V, the video at pin 22 and the audio at pin 2 are muted. When or how this voltage can drop from the nominal +7.4V to less than +0.3V is unclear, but my guess is that it happens during station changes. A shorted 50μF C109 should stop all picture and sound by activating the muting circuits.

No control of AGC

When the AGC control is rotated from end to end without change of the overload symptoms, suspect a complete loss of AGC. If the AGC is functioning, you will observe some effect when you rotate the AGC control. Take voltage readings of the IF and IF-AGC dc voltages while you rotate the AGC control. If the readings are incorrect and do not vary as the control is rotated, a defective AGC circuit is certain.

With the receiver acV power off, test the resistance of the AGC control with the control turned counterclockwise, then watch the readings as you rotate the control clockwise. If the readings show an open or a short at one spot or at all positions, replace the AGC control.

Isolation of defective components

When the picture appears to have AGC or sync problems, disconnect the antenna and measure the dc AGC voltages applied to the tuner RF stage and to the IFs. Rotate the AGC control. If the metered voltages vary around the voltages shown on the schematic, the AGC system is functioning. You can obtain proof of the functioning by connecting an antenna and rotating the AGC control again. If the AGC control changes the picture contrast normally, it proves correct AGC operation. At this point, if tests give unwanted answers or you still have doubts, scope the flyback pulses (if the AGC is a keyed type). Notice the amplitude and waveform of the pulses. Also, scope the input and output video waveforms.

Check the circuit in the sequence shown by the large numbers on the Figure 1 schematic, and notice whether the correct waveforms and dc voltages are present at each testing number. Measure the tuner's AGC dc voltage. When the voltage is too high, the picture shows excessive snow or a white raster without TV picture. Next, connect a substitute test tuner to the chassis' input IF cable. If performance is improved, the receiver's tuner is defective or the B+ for the tuner is missing or incorrect. When the test tuner's operation produces the same unsatisfactory results, the TV's tuner is almost certainly normal. Connect a dc voltage varying between +2.5V and +7.5V to the RF AGC. Notice if a specific voltage results in a better picture. As a last resort, connect a dc voltage varying between +3.5V and +8.5V to the IF AGC testpoint. One of these tests should locate the general area of the tuner AGC problem.

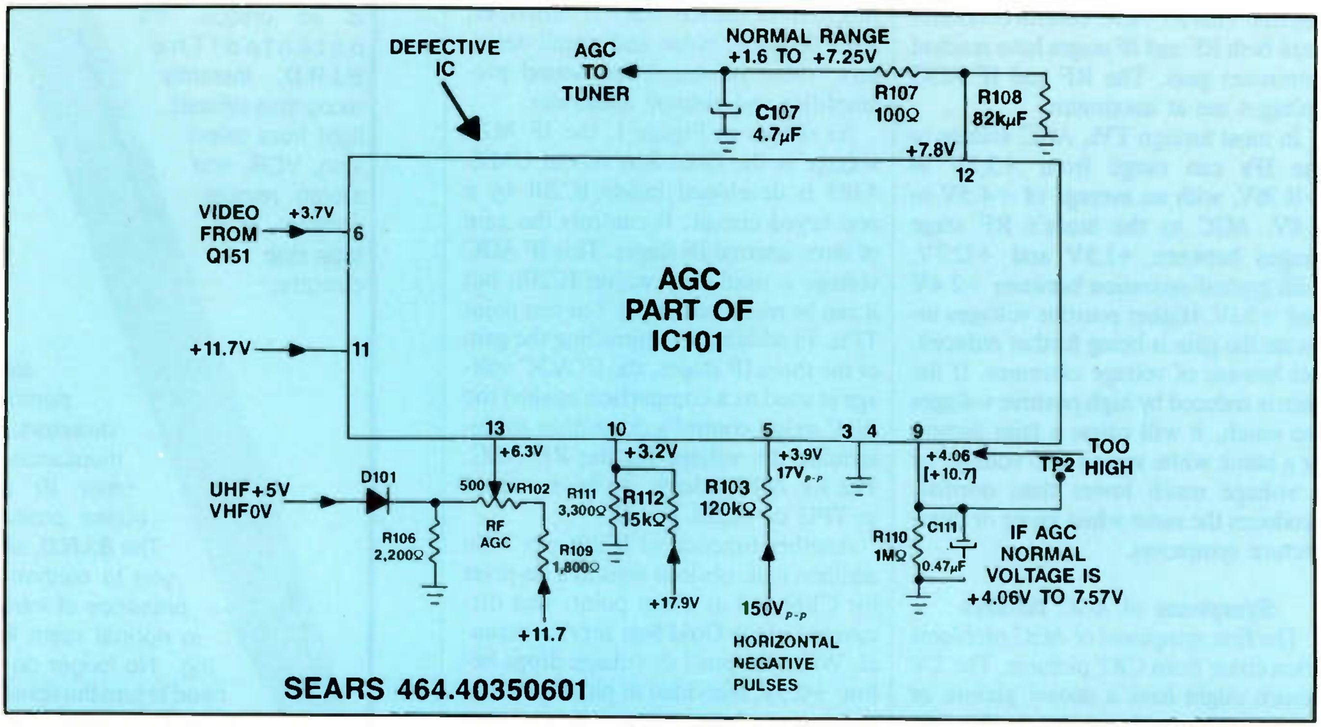


Figure 2. In this Sears portable color TV, a defect was producing a white raster with only a faint picture. The IF AGC voltage can be tested at pin 9 or TP2, but the AGC voltage is applied inside IC101 only. When IC101 was replaced with an SK3284, the AGC circuits operated normally.

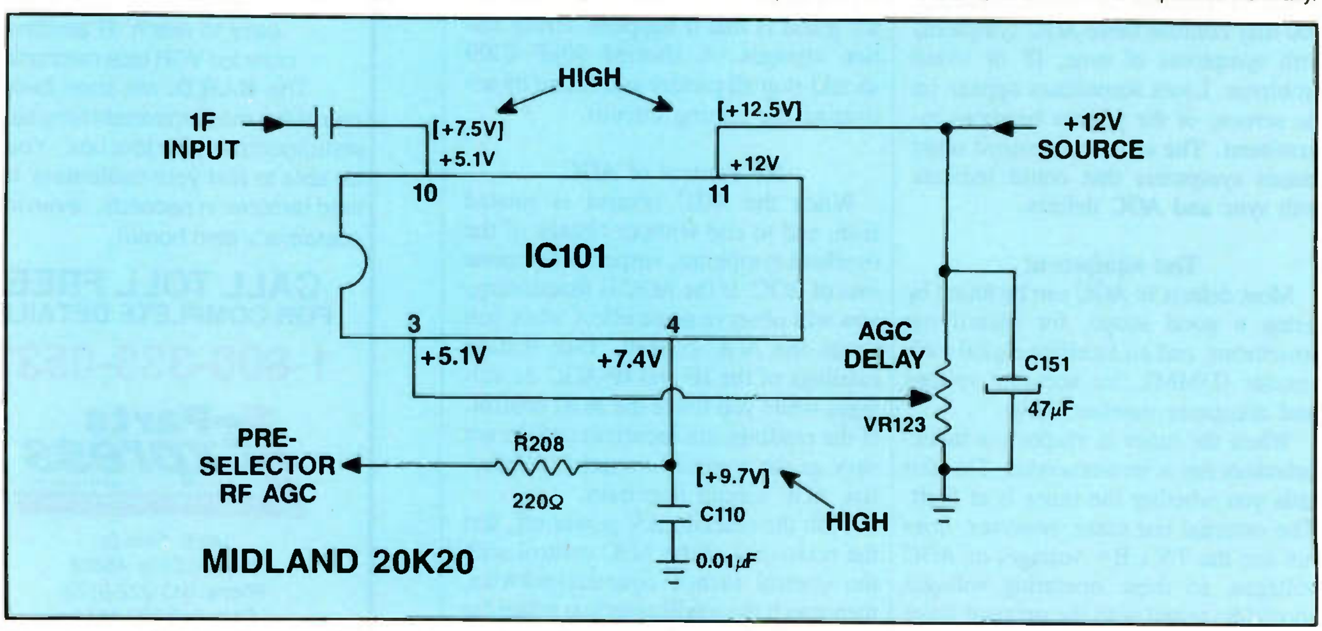


Figure 3. In this Midland model 2020, the picture showed overload, appeared snowy, then faded out. After the receiver was turned off, allowed to cool and switched on, rotation of the VR123 AGC-delay control did not improve the picture. Increased voltage indicated a defective IC101.

Excessive or insufficient AGC

Most AGC problems are caused by open or leaky transistors, ICs and capacitors. The defect is often heat-sensitive, thus spraying the components one at a time with canned coolant may restore a good picture for a few minutes. After a suspect has been tentatively identified, alternately use heat (perhaps from a small hair dryer) and cooling until the component is located. Check the electrolytic capacitors by using an in-circuit capacitance tester. All electrolytic capacitors of low-capacitance rating (1μF to 50μF) should be suspected of low capacitance or high ESR.

Lack of AGC action or a white raster with a dim picture can be caused by a defective AGC transistor or IC. Measure the RF AGC voltage at the tuner. If the voltage is greater than +7.5V, a defect in the AGC is certain. Then test for a leaky AGC-keying or AGC-amplifier transistor or IC. If rotation of the AGC control fails to change the picture, check for leakage in the capacitor between the AGC control's terminal and ground. The control may be internally shorted between terminals. Disconnect the capacitor; test both separately.

If the RF AGC voltage is extremely high (+7.5V to +15V), disconnect the AGC wire to the tuner. Test the voltage at the tuner end of the wire. If the reading is lower than the original RF-AGC voltage, the tuner is not leaking B+ voltage into the AGC. However, if the reading is as high or higher than the original RF-AGC dc voltage, something in the RF stage, such as the transistor, is leaking B+ into the AGC circuit. This leakage must be found and repaired.

An abnormally high IF-AGC voltage can often be tested in the same way. Disconnect the IF-AGC source wire to see if the AGC voltage at the IF transistor or IC is being increased by an AGC-source defect or by leakage in the AGC IC or transistor.

AGC or tuner problem?

To discover whether incorrect voltages at the tuner's AGC are caused by a defect in the tuner or by the tuner's AGC circuit, rotate the tuner control to a dead spot between stations or to an unused channel. Connect the DMM or VTVM to the RF-AGC voltage and notice the reading without a station. Rotate the AGC control while you note the maximum changes of tuner-AGC voltage. Low or no AGC-voltage change most likely indicates a defect in the AGC circuit.

Connect a substitute tuner to the antenna and the tuner end of the IF cable. If the tuner-sub provides normal TV reception, a defect is indicated in the RF-AGC circuit. Measure dc voltages at all pins of the multipurpose IC that control AGC operation. If the symptom is no picture/no sound caused by AGC or IF problems, suspect the IC itself. If the IC has abnormal dc voltages at several terminals, replace the IC. (Caution: Sometimes an IC will have fairly normal dc voltages, but it is still defective. Verify the faulty IC by other ways if possible. For example, you might find the same number IC defective in several other chassis of different brands. This is called "testing by suspicion," and should not be used until all else has failed.)

AGC or sync problem?

Picture stability problems are often difficult to track down. AGC defects can appear to be sync problems, or vice-versa. The same defective IC can produce AGC and sync symptoms. Sync defects can usually be disproved if correct waveforms and dc voltages are viewed and tested at all available points of the sync circuit. For AGC troubleshooting, scope the video waveform at the AGC input circuits, then measure the RF and IF AGC dc voltages. From these tests, you should be able to isolate the stage that is causing the trouble.

AGC or IF problem?

A snowy picture, or a white raster without a picture, often results from excessively high dc AGC. Therefore, the first step is to measure the IF-AGC dc voltage. If the voltage is too high, try to reduce it by adjusting the AGC control. If the control cannot reduce the voltage sufficiently, the AGC circuit has a defect.

For example, in a Sears model 564.40350601, abnormally high IF AGC voltage (+10.7V) was measured at TP2. (See Figure 2.) The normal range is between +4.06V and +7.57V. A few dc-voltage measurements were made at the IC101 pins, with most readings showing excessively high dc voltages. Higher voltages usually indicate a reduction of the normal B+ load. When there are no other symptoms, one strong possibility is a defective IC.

IC101 was replaced with a SK3284 universal replacement IC, solving the AGC problem. Normal adjustments and a heat run prepared the TV for delivery to the customer.

AGC or video problem?

An AGC or a video defect may produce a dark picture that fades to a white raster. If this symtom occurs, measure the IF-AGC dc voltage. If the AGC voltage is low (indicating a weak IF signal), check for a leaky IF transistor. If all IF stages are in it, suspect a defective IC. In some models, the first-video amplifier stages are also located in the same IC101, which strengthens suspicions about the IC's condition.

Similar symptoms appeared on the screen of a Midland model 2020. The picture showed overload, appeared snowy, then faded out. In this model (see Figure 3), the AGC circuits, AFT, IF amplifiers, video detector, video amplifier, inverter and audio limiter were inside IC101. When tests began, adjustment of VR123, the AGC-delay control, did not affect the picture or the symp-

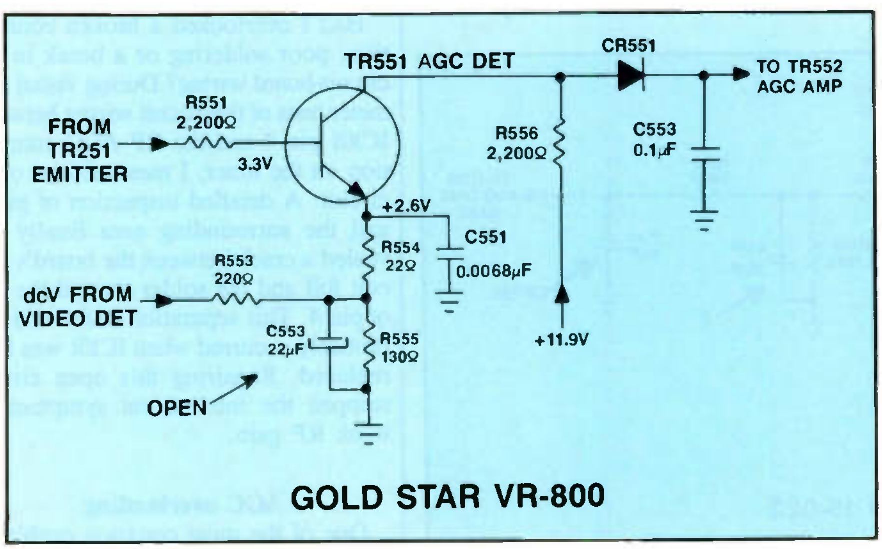


Figure 4. Horizontal pulling is often caused by open or high-ESR small-value electrolytic capacitors in the AGC circuits. C552, the major bypass for the emitter of AGC-detector TR551 transistor, was defective.

toms. Many IC dc voltages were high. The RF-AGC dc voltage at pin 4 was more than 2V higher than shown on the schematic. The IF input at pin 10 was more than 2V high. Even the +12V supply at pin 11 was +0.5V higher than normal.

All of these voltages and symptoms indicated a defective IC101. When it was replaced by a universal SK9379, the TV operated normally.

AGC or Horizontal pulling?

Horizontal pulling and other sync-like problems can occur when the AGC circuitry has an open filter or open decoupling capacitors. However, when the picture is dark with overload and cannot be lightened by adjustment of the AGC control, the trouble is most likely an ordinary AGC problem.

When the symptom is horizontal pulling, check for open or high-ESR electrolytic capacitors in the base, emitter or collector circuits of the keying or AGC-delay transistors. Check these small capacitors with a capacitance tester, or parallel a good capacitor of the same capacitance across the suspected one as you peruse the CRT screen for improvements.

In a Gold Star model VR-800 color receiver, the waveform was nearly normal at the base of AGC detector TR551, but it was unrecognizable at the collector. (See Figure 4.) Transistor TR551 was tested in-circuit and pronounced non-defective, but when a 25μF electrolytic capacitor was paralleled across C552, the picture returned to normal.

Intermittent AGC

Like all intermittent problems, intermittent AGC functions are difficult to identify. We often overlook the most obvious causes. Some receivers have intermittent picture, squeals or picture-overloading. These problems can be caused by intermittent transistors and ICs or by AGC controls with erratic contact. The IF amplifiers or almost any component in the tuner can become defective and erratically affect the reception.

When the chassis is operating normally, measure the RF and IF dc AGC voltages and write down the figures. After the intermittent problem occurs, measure the same RF and IF AGC voltages again, comparing them with the previous readings. By these and other voltage readings, attempt to isolate the problem to the AGC circuits or the video circuits.

In a Toshiba model CX2035 (see Figure 5), the RF AGC dc voltage decreased to only +1.9V when the chassis intermittently developed a faint, snowy picture. However, the limits of normal RF AGC voltage are between +2.8V and +7.5V. During intermittent operation, rotation of the AGC-delay control had no effect on the picture.

All voltages of IC101 were within tolerance except for the low voltage at pin 4 (RF AGC). IC101 had evidently been replaced before and there was a possibility that too much heat or handling of the various pins might have damaged the IC. I replaced IC101 with the exact TA7660P, being careful of soldering temperature, static sparks and potential pin damage. Unfortunately, the picture operated normally for only three hours before the weak signal reappeared.

When testing IC101, I again found that all IC101 dc voltages were within tolerance except for the abnormally low voltage at pin 4. Several capacitors and resistors (whose leakages and values were important) were tested at the IC101 pins, but no defectives were found.

Had I overlooked a broken connection, poor soldering or a break in the circuit-board wiring? During visual and meter tests of the circuit wiring between IC101 pin 4 and the RF AGC connection on the tuner, I measured an open circuit. A detailed inspection of pin 4 and the surrounding area finally revealed a crack between the board's circuit foil and the solder around the lug of pin 4. This separation of foil and lug probably occurred when IC101 was first replaced. Repairing this open circuit stopped the intermittent symptom of weak RF gain.

AGC overloading

One of the most common problems in foreign-built color TVs is AGC overloading, in which the picture pulls and tears horizontally on a dark raster. Some

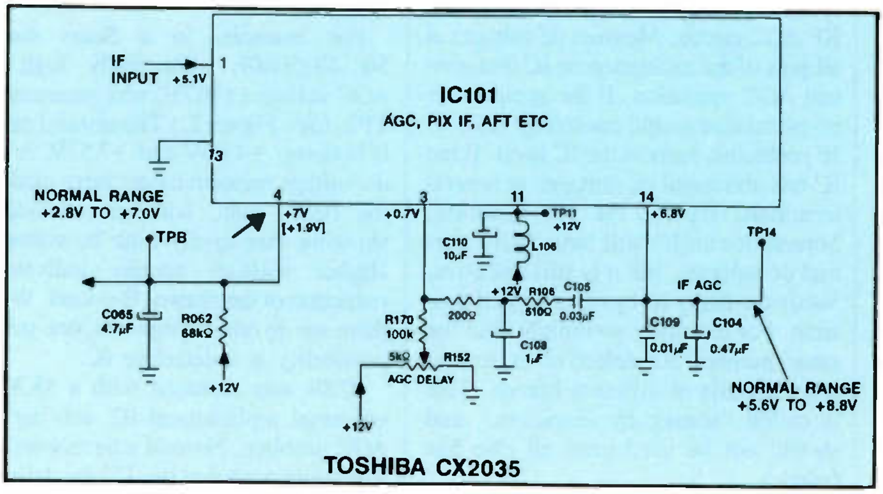


Figure 5. When a Toshiba model CX2035 developed an intermittently weak, snowy picture, the only clue was the IC101 pin 4 voltage, which decreased from a normal +7V to a low +1.9V. Visual and ohmmeter tests between the tuner's AGC and pin 4 of IC101 showed an intermittent open circuit.

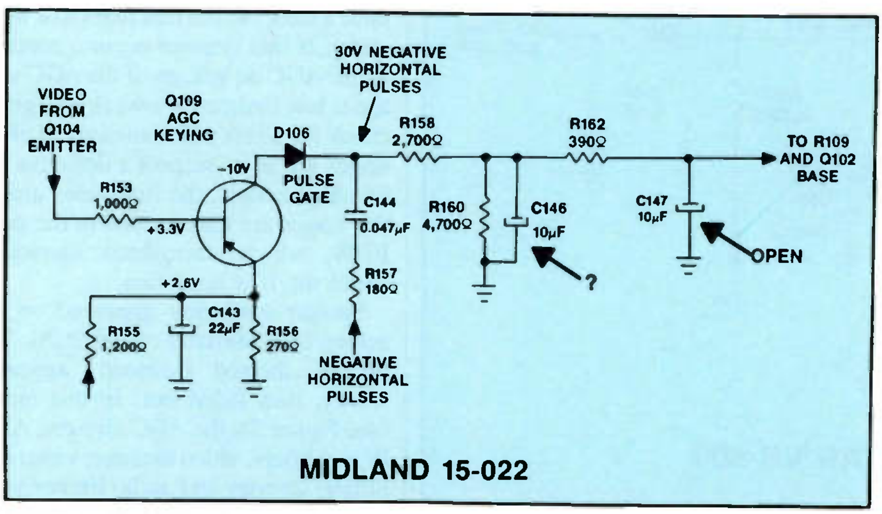


Figure 6. This Midland model 15-033 small-screen TV showed a progressively darker left side of the raster, which operated far from the correct 15.734Hz scanning rate. A common cause of this symptom is horizontal-sweep pulses leaking into the video or AGC circuits.

overloads also cause distorted sound or a buzz. In the worst cases, the picture loses all horizontal locking.

The problem usually originates in the AGC circuits. First, measure the RF and IF AGC dc voltages. Rotate the AGC or AGC-delay control, noticing whether these voltages change normally. If they do, the problem is in the circuits that supply signal voltages to the AGC stages. If the voltages do not change properly, remove the AGC wire from the tuner and connect an external variable-dcV source to the tuner. Vary the positive voltage smoothly from +2.5V to +7.5V. If picture conditions on the screen do not improve with the increase in voltage, restore the tuner's AGC wire and connect the variable voltage to the IF AGC. If varying the test voltage up to +8V eliminates the overload and produces a stable picture, the main defect is in the basic AGC system. Otherwise, look in the tuner or IF circuits for the problem. If the AGC is a keyed type, scope the flyback's horizontal-keying pulses for amplitude and waveshape.

Unusual AGC problems

When problems originate in the horizontal or video stages, symptoms of horizontal firing lines include several medium-width black vertical bars on the raster's left side, large back bars or a gradually shaded area with the blackest parts near the extreme left. These symptoms, however, can be caused by AGC defects, usually from open electrolytic capacitors in the base or emitter circuits (or IC equivalents). These defective capacitors will show a moderate loss of capacitance combined with excessive equivalent series resistance (ESR), or the capacitors will be open.

When I repaired a Midland model 15-022 small-screen TV, the horizontal sweep operated out of frequency and the raster's left side was darkened. These symptoms are typical when horizontal-sweep pulses leak into the AGC or video circuits. In the photofact 1536-1 schematic (see Figure 6), two small electrolytic capacitors were prime suspects. They were C160 (10μF) and C147 (10μF) in the circuit between the Q109 AGC-keying stage and the AGC for Q102, the second IF transistor. Paralleling a 10μF capacitor across C147 eliminated the dark area on the left side of the raster and brought the horizontal back to the correct frequency. Installation of a new capacitor finished the repair.

Solving AGC problems requires a method of troubleshooting. When you are faced with possible AGC defects, follow these steps:

- When you suspect trouble in the AGC system, accurately measure the RF and IF AGC dc voltages, with and without station signals.
- Inject variable dc voltages (from an external supply) into the RF and IF AGC connections to prove or disprove that those circuits can accept proper control voltages and provide normal operation. If they can, scope the input sources and all signals of the RF and IF AGC circuits.
- Connect an external tuner substitute to prove whether the receiver's tuner is normal.
- When the IC pin voltages (including the B+ source) are within tolerance but large changes of station-signal strength do not vary the RF and IF AGC dc voltages, consider replacing the multipurpose IC that contains all the AGC junctions.
- Before replacing the IC, make certain all other voltages and components connected to the suspected IC are normal.

Through the evolution of tubes to transistors, and now to integrated circuits, the basics of TV AGC have not changed.

The AGC circuits can often be found in one of the larger ICs, which also contains the IF amplifiers, video amplifiers, sound detector, audio pre-amps and other stages. This large amount of solid-state junctions increases the internal complexity and multiplies the chances of IC failures. It is not unusual to find the same IC defective in several different brands because the increased heat from the crowded internal layout causes extra failures.

All TV receivers described in this article are similar in many ways, although they were manufactured in Hong Kong, Japan, Korea and Singapore. Through the evolution of tubes to transistors, and now to integrated circuits, the basics of TV AGC have not changed. Practical AGC circuits have changed only enough to accommodate the different characteristics of tube, transistor or IC. You should be able to use the same methods to troubleshoot AGC circuits, regardless of the originating country. ■

Symtom: Intermittent no-start; when the set runs for a time, no functions work, neither remote nor local. When the set is unplugged, it will not re-start.

Set ID: RCA CTC-130-B model FMR-555-R

Photofact: 2574-2

This model, as with other RCAs of similar chassis with remote, effects the on/off function by controlling the start-up voltage to the horizontal oscillator circuit. This is accomplished by an effective open (high) or ground (low) at the cathode of CR-405 off of the deflection IC401. When the set is plugged in, raw B+ is always present. In sets with electronic tuning and remote control, the MTT001-A combined tuner and control module creates the high or low needed for the power function. The connection from the MTT module to the main chassis is made through P/J 303, pin 3. To turn on the chassis, unplug P-303 at the chassis. If HV is present, the problem is in the MTT001-A module or its controlling devices. The words "its controlling devices" are important: I had assumed the module was the culprit.

The microprocessor chip, pin 20 of U601, had a reading of +2.37V. Zero is normal for a set that is on; just under 4.8V is normal for a set that is off. Pressing the power button produced no change in this voltage.

Because I had a spare IC601 chip, I substituted it for the non-operating one. (A new MTT001-A module is very expensive.) This operation was unfruitful and caused further frustration.

I remembered an experience I had with an electronically tuned Magnavox, in which a stuck button on the # key pad caused a somewhat similar condition. Applying a similar principle to this model, I unplugged the RCA's front-panel keypad with the ch/up/dn, vol/up/dn, and power buttons. Using the remote hand unit to address the set, I pushed "TV (on)." Alas, nothing happened.

I went back to the schematic of the MTT001-A and its peripherals. The inputs come from remote pre-amp S-5-B (the aforementioned control buttons), and S-16-B, another row of auxiliary buttons associated with tuner functions, such as add, erase, clock set and auto program.

Checking all of the auxiliary buttons by pressing them failed to show the stuck ones. I then decided to unplug the two connectors on the auxiliary button board. (See Figure 1.) This was not an easy task, because the board is under the CRT on this compact table-model TV, and it is tricky to reach.

Eureka! Once the board was disconnected, I was able to control the set using the remote hand unit. This situation led to a question: What can go wrong with a board that contains only a bunch of pushbuttons? With difficulty, I removed the board, because I knew it would have to be replaced soon.

I examined the PC foil side, which is on the top and is exposed. Using a magnifying glass, I saw what looked like corrosion between two solder points at the location of the automatic programming button. (See Figure 2.) I set my digital VOM to a high-ohms scale and tried to read between the suspect pins. The meter indicated 42k, on a switch that normally reads open. With a small knife blade, I carefully scraped away the land area between the two leaky pins. That solved the problem — the meter read an infinite resistance between the two pins.

Yes, there is a lesson to be learned here about microprocessors: In addition to the supply voltage, always check the outputs, the clock oscillator and the momentary, rather than steady or leaky, inputs.

As a postscript, this trouble appeared because of a high-humidity condition at the time. This was a long-standing intermittent problem — presumably the set worked fine in cool, dry weather. The humid spell helped me pin down the problem.

W.J. Williams, CET
Brooklyn, NY ■

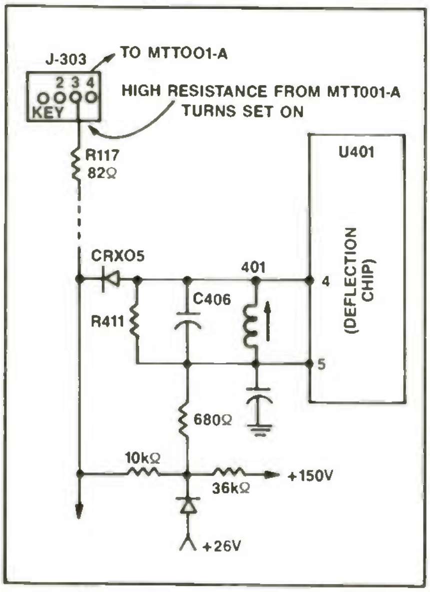


Figure 1. In order for the TV to be on, there must be a high resistance condition from the MTT001-A.

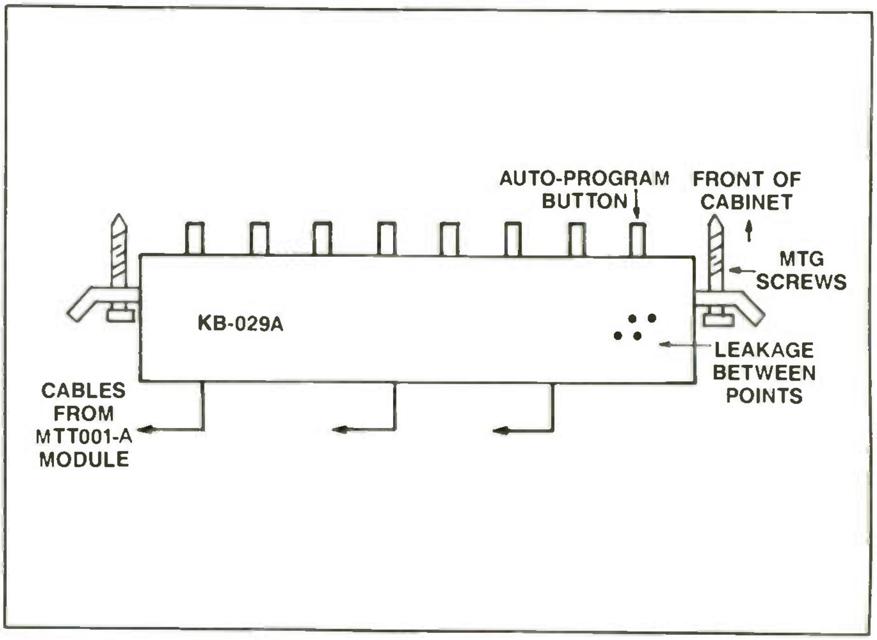


Figure 2. This top view of the S-16-B switch assembly shows where the leakage occured.

Dealing with software problems

By Conrad Persson

There is no definite way to know what percentage of personal-computer problems can be attributed to software. However, a well-intentioned operator can cause software problems that only a competent servicing technician, armed with a floppy disk complete with an operating system, will be able to combat.

If you encounter a computer that refuses to properly boot up, despite your efforts, turn it off. After waiting for a few seconds, put your system floppy disk in the floppy disk drive and turn on the computer again. If the system still refuses to properly boot up, there may be a problem in the computer's internal circuits. If, however, the computer boots up with the floppy disk in place, cross your fingers; it might only be overzealousness on the part of the operator.

The autoexec.bat file

When the computer fails to boot up from the hard disk but boots up normally from the floppy drive, the computer may have a problem in the hard drive. On the other hand, it is possible that an operator has experimented with batch files or other software and caused computer disarray.

For example, a company retrieved an 8088-based machine from a satellite office and gave it to one of its graphic designers. When he tried to boot up the computer, it emitted a strange error message.

The computer servicing technician turned on the computer and attained the same results. When he put his system floppy disk in the computer, it booted up correctly. After calling up the directory, he called the autoexec.bat file to the screen. The problem became immediately evident. The Path command read "PATH=D:DOS." Not bad, except that there was no D drive on the computer, nor was there a partition on the hard disk that created a D drive. The computer had a single hard disk and it was designated C. He changed the D to C and the computer booted as normal.

You may see a computer with an autoexec.bat file that has unfamiliar instructions. If you suspect that the file is causing the computer to misbehave, the safest way to proceed is to save the existing autoexec.bat file under a different name that will not execute, such as "autoexec.bak." This provides you with a backup copy of the original autoexec.bat file and enables you to experiment with the autoexec file. If you mess up the autoexec file you created, erase it, rename "autoexec.bak" to autoexec.bat, and you are back where you started.

A well-intentioned operator can cause software problems that only a competent servicing technician, armed with a floppy disk complete with an operating system, will be able to combat.

Memory-resident programs

There is a helpful class of programs for computer operators that, unfortunately, may cause trouble when technicians try to diagnose problems, especially when the technicians use diagnostic software. These memory-resident or terminate-and-stay-resident (TSR) programs are loaded into the computer and remain in memory until they are called up. The programs are usually called up to the screen by using the hot key, a key that is also used to escape the programs.

As an example of this type of program, my computer features an address-card program. When I hold down the ALT key and press the right shift key, a representation of a 3×5 card appears on the screen with the name, address and phone number of a contact I have entered into it. I can access other cards in the file by repeatedly pressing Enter, or I can search for a particular name, or a series of letters or numbers. I can add cards. I can even have the program dial the telephone by pressing the F6 key. Other programs allow the operator to use a calculator, a calendar and an appointment book on the screen, regardless of the program that is currently running.

As handy as TSR programs are, they can create problems. While the computer is running, the programs sit quietly in memory, even if you are running a diagnostic or other servicing program. Because of the nature of the diagnostics, TSR programs may cause them to give erroneous results.

Many computer users have the autoexec.bat file automatically call TSR programs into memory when they turn on the computer. This situation makes it impossible to run a diagnostic program without TSR programs resident if you boot the computer from the hard disk.

The solution to these problems is to always have a bootable floppy disk with the operating system on it. Preparing this disk is easy. When you format the disk you will be using for a clean bootup, type in format/s. The /s switch will write the operating system to the disk as it formats it. The next time you service a computer that you suspect has an autoexec.bat file loading peculiar things into memory, turn the computer on with this disk in the a: drive. After the computer boots up, you can type the autoexec.bat file to screen and see what it contains. ■

Persson is editor of ES&T.

Stereo phasing problems – Part I

By John Shepler

You are no longer considered an audiophile if you appreciate the wonders of stereo. As recently as 10 years ago, it was rare for a TV or PA service shop to be concerned about stereo problems. Only FM broadcasters and hi-fi shops worried about channel phasing and balance. Today, with the advent of MTS television, AM stereo, inexpensive mixing boards, satellite music distribution, and automotive systems with quad speakers and accessories, we are all in the stereo business.

Stereo sound brings with it many peculiar problems. However, by understanding a few simple principles, you will be able to isolate and solve most stereo problems with an oscilloscope. You will soon be converting audio system headaches into profitable service opportunities.

Shepler is an electronics engineering manager and broadcast consultant. He has more than 20 years of experience in all phases of electronics.

Unique characteristics

One channel of mono audio plus another channel of mono audio does not equal stereo. The best that monophonic audio can do is reproduce the amplitude and frequencies that the recording microphone hears. Stereophonic audio attempts to approach the sensitivity of the human hearing system. By using two microphones, the additional information of timing and phase are added to the system. Our ears use this information to locate sounds. When phase differences between the two microphone pickups are correctly reproduced, the stereo effect is said to sound "natural." When this information gets scrambled, the complaints range from a sound that "just isn't right, but hard to explain" to speakers that sound dead or damaged.

The most important new signal added to stereo is the phase difference between the channels. Figure 1 shows a 2-channel scope pattern for stereo signals. This pattern is obtained by connecting the left and right stereo signals to scope input channels 1 and 2. Adjust the time base to show one or more cycles.

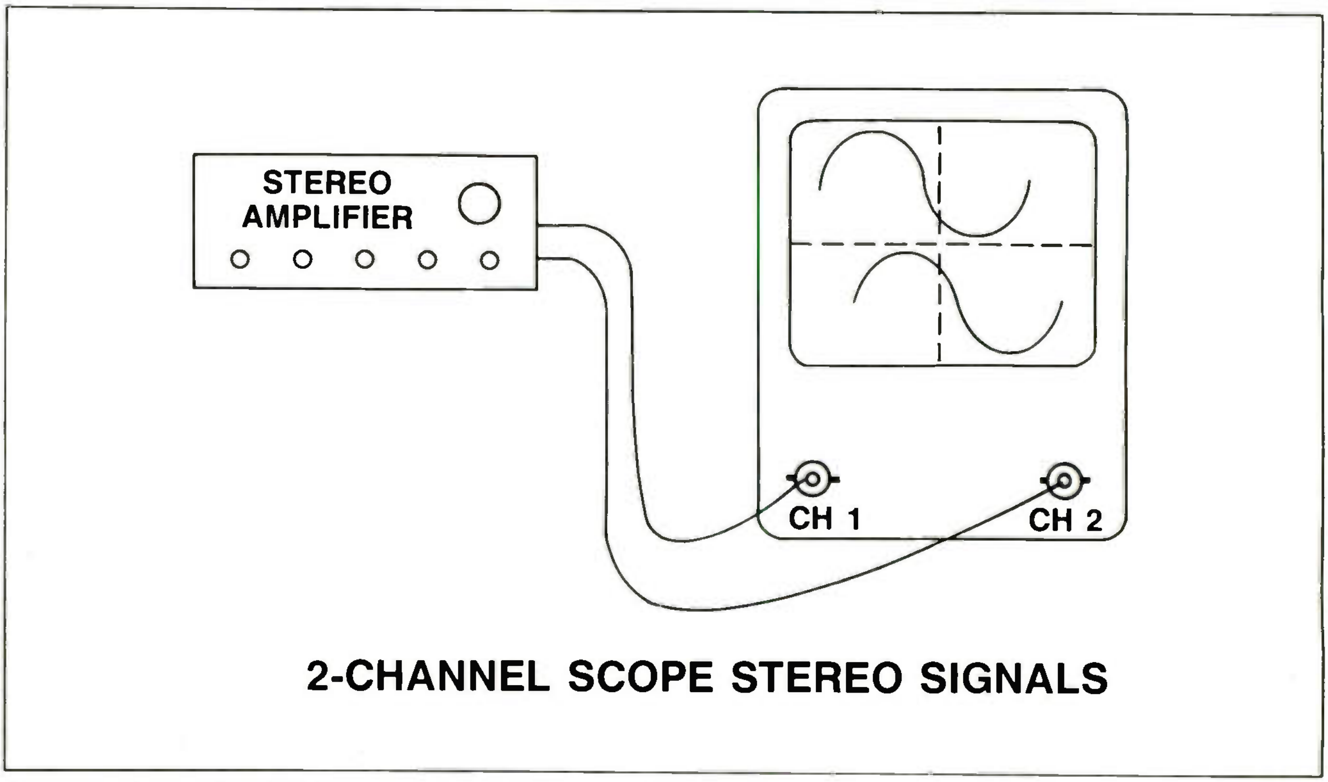


Figure 1. This 2-channel scope pattern for stereo signals is obtained by connecting the left and right stereo signals to scope input channels 1 and 2.

Notice that the peaks and valleys of the waveforms do not occur at the same time. The time difference between the peak of one cycle and the peak of the other represents the phase difference between the signals. This difference is usually expressed in degrees of a sine wave rather than milliseconds. When the peaks coincide, the phase difference is zero. When the peak of one cycle coincides with the valley of the other, they are 180° out of phase. Incorrect phase is the most common stereo problem.

The second important characteristic of stereo is the amplitude difference between the two signals. In normal stereo program material, most signals are stronger in one channel than the other. Each microphone most strongly picks up the sources closest to it, but it will also pick up sound from sources that are closer to the other microphone or microphones.

The combination of phase and amplitude differences produces a stereo effect called separation. Separation is that wide, full sound in which each instrument seems to be in its own unique location on a stage. Because separation is so delicate, it can be degraded easily by circuit problems or misadjustments.

Combined mono and stereo

Some of the most important signals in a stereo system are monophonic. Public address microphones are usually mono. The lead vocals on most records are recorded as mono. Mono signals have the exact amplitude and phase in both stereo channels. A mono source should sound as if it originates midway between the two speakers. When the speakers are widely separated, the source should sound loud and distinct in each speaker.

All broadcast signals, whether they are radio or TV, are expected to be mono compatible. No difference in amplitude, distortion, or tone quality should be noticed when switching the receiver from stereo to mono.

What can go wrong with mono signals? The most common problem is phase reversal. This mistake is especially easy with speaker cords or balanced audio pairs. If the signal lines are swapped on one channel only, the audio from the speakers will be out of phase. This will not affect the quality of audio in either speaker, but the stereo effect will be damaged.

For example, reverse the speaker leads to a car stereo and the sound will change. You will hear both of the speakers work, but the sound between them will be weak. This is called the *hole in the middle* effect, and it is most easily detected in headphones. To experience this effect, rig up a switch to flip the polarity of one side of a pair of headphones and notice the difference in sound when you change the system from in-phase to out of phase.

The most obvious problems with phase reversal occur when one mono source is reversed into a stereo system. For example, a broadcast station plays a recording using a phase reversed cartridge. The station is monitoring in stereo, so the sound engineers may not notice the problem. Anyone who is listening on a mono receiver, however, will notice that the audio suddenly becomes weak and distorted while that source is on. The problem can only be corrected at the station.

A more subtle problem occurs with reels and cassette tapes. It is easy for tape heads to get out of alignment. The azimuth adjustment is the most critical to stereo sound and is touchy at high frequencies. When the head is bumped or slightly moved out of alignment, the tape signal is packed up on one track of the head slightly before the other. This causes a phase difference, which can degrade stereo separation or cause a muddly sound in mono audio systems. This situation is common with broadcast signals or tape equipment in which a stereo signal is combined to feed a mono audio system. If you are losing high frequencies on some of your stereo sources, suspect phasing problems.

Next month, I will discuss how to use an oscilloscope to detect and correct stereo phasing problems. ■

The dreaded intermittent

By Stephen J. Miller

One electronic problem known to drive technicians crazy is the intermittent condition, especially when it occurs in random fashion and in varying degrees of severity. I recently worked on an Akai VCR, model VS-525U, that met these criteria.

The complaint was an intermittent snow bar in the picture. The position of this bar on the TV screen and its width varied. Often, no snow bar was present. At other times, a snow bar would cover a large portion of the screen. The VCR initially worked perfectly and was placed on the aging rack to await occurrence of the problem. For the next several days, the machine played a game with me. It occasionally failed on the aging rack, yet always played properly when moved to the test bench.

I finally recognized a pattern to the failures. If this VCR entered the play mode and produced a clear picture, it would continue working normally for the remainder of that tape. If the problem was observed when the VCR entered the play mode, the problem remained throughout the tape. These symptoms are most often caused by foreign objects inside the machine. After performing a thorough internal inspection, however, I found no foreign objects.

On the test bench, I repeatedly loaded and unloaded the tape, trying to get the problem to appear. Finally, success! A large snow bar covered the bottom third of the screen. Connecting an oscilloscope to the FM envelope test point, I observed a poor envelope (see Figure 1, trace A), yet a visual inspection of the tape path and tape wrap indicated no gross mechanical problems.

When troubleshooting video problems, I use the headswitching signal as a reference signal (see trace B) and observe the relationship of two other signals to this reference. These two signals are the FM envelope and the signal at the video output jack. Scoping the video output line, I was surprised to find the video waveform shown in trace C of Figure 1.

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

A lesson in headswitching

To understand what is wrong with the waveforms in Figure 1, refer to Figure 2, which displays the correct waveforms. In Figure 2, the FM envelope signal is continuous, with no large nulls or dropouts. Small notches in this envelope occur only at the headswitching points. Headswitching occurs at the rising and falling edges of the headswitching signal in trace B. Finally, if you compare the headswitching signal with the video output signal, you see that headswitching occurs just slightly before the vertical sync pulse.

The correct positioning of the headswitching points is critical to proper operation. During headswitching, extrane-

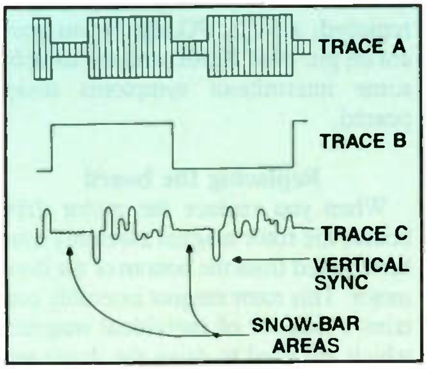


Figure 1. When a VCR intermittently causes a large snow bar on the bottom third of the screen, connect an oscilloscope to the FM envelope test point. In this case, the VCR displayed a poor envelope (see trace A) but no mechanical problems. The headswitching signal (trace B) can be used as a reference signal to show the relationship of the FM envelope and the signal at the video output jack. Trace C, the video waveform, shows snow-bar areas.

ous noise pulses are generated as the head amp switches between the two heads. If the headswitching points occur too early, these noise pulses form a visible line at the bottom of the TV screen. If the headswitching points occur too late, the noise pulses will be in the vertical sync interval and the playback picture will wither, shake or roll vertically. To prevent both of these conditions, set the headswitching points at approximately 6.5 horizontal lines before vertical sync. This allows the switching points to be hidden in the vertical overscan of the TV picture while keeping them out of the sensitive vertical sync interval.

Returning to the scope traces in Figure 1, we see that the poor FM envelope and playback snow bar are being caused by the headswitching signal arriving much too early. This headswitching signal is produced by IC501. When I scoped pin 14, the headswitching output of IC501, I found that it was occurring too early as well. IC501 uses the drum PG signal to produce the headswitching signal. However, upon scoping the drum PG input, pin 16, I found no signal. This obviously was not the standard headswitching signal with which I was familiar.

A block diagram of the standard circuit is shown in Figure 3. In this circuit, the drum PG signal is routed through two parallel paths. The positive-going pulse travels through the top path

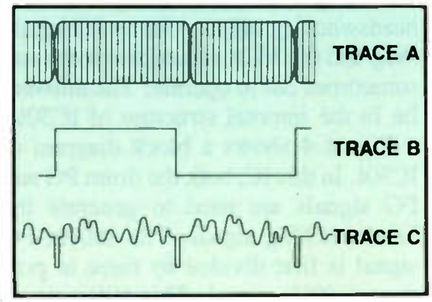


Figure 2. Notice the differences between a VCR with an intermittent condition (shown in Figure 1) and a VCR displaying correct waveforms, with a continuous FM envelope signal (see trace A). The video waveform (see trace C) does not show the snow-bar areas that would correspond with a poor envelope.

and triggers a monostable multivibrator. The negative-going pulse travels through the lower path and also triggers a monostable multivibrator. The output of these two multivibrators are summed to form the headswitching signal. If the drum PG input is missing in this standard circuit, no headswitching signal would be produced.

Back to the problem at hand

How did the Akai circuit produce a

headswitching output with no PG input? Why did the VCR sometimes work and sometimes fail to operate? The answers lie in the internal structure of IC501.

Figure 4 shows a block diagram of IC501. In this IC, both the drum PG and FG signals are used to generate the headswitching signal. The 180Hz FG signal is first divided by three to produce a 60Hz signal. This 60Hz signal is applied to a monostable multivibrator, whose duty cycle is adjusted by VR502, connected to pin 15. The output of the monostable multivibrator is then divided by two to produce the 30Hz headswitching signal. The FG signal is capable of producing the correct frequency and wave shape of the headswitching signal, but it will not always be at the correct phase relationship with respect to the video heads.

Phase correction is provided by the drum PG signal. The 30Hz, negative-going drum PG signal is used to reset the divide-by-3 and divide-by-2 counters. If a phase error exists at motor startup, the drum PG signal will reset the counters so that counting can begin at the proper time. If no phase error exists, the drum PG pulse will occur when the counters have already cycled to their reset positions. The drum PG signal is, therefore, only effective at motor turn-on. After the initial phase correction, the stable drum FG signal will maintain the headswitching signal at the correct frequency and phase. Thus, if the PG signal fails after motor startup, no effect will be seen until the motor is stopped and restarted.

The amount of initial phase error depends on the leftover data in the counters of IC501 and the motor's position at startup. These facts explain the Akai's apparently intermittent symptoms. Depending on the random nature of the leftover data and the motor's starting position, either a small, large or no initial phase error existed. Without the drum PG signal to reset the counters and remove the phase error, this same phase error existed until the motor was stopped.

Following the drum PG line back from pin 16 of IC501, I found no drum PG signal at the connector to the drum motor drive board. Because individual replacement parts are not available for these drive boards, it was replaced as an assembly. After the board was replaced, a $5V_{p-p}$ PG signal was present on pin 16 of IC501, and the troublesome intermittent symptoms disappeared.

Replacing the board

When you replace the motor drive board, the rotor magnet assembly must be removed from the bottom of the drum motor. This rotor magnet assembly contains a number of individual magnets, which are used to drive the drum motor and to produce the drum FG and PG signals.

To ensure proper reassembly, always place alignment marks on the rotor assembly and the motor shaft before disassembly. In many VCRs, including the Akai, the rotor assembly can be easily reinstalled ½-turn (180°) out of the correct position. With this misalignment, the headswitching signal will be 180° out of phase. A weak, snowy playback picture will result. The playback picture will be marginal even at the maximum rotation of the tracking control. Therefore, to prevent needless troubleshooting difficulties later, pay attention to the alignment of these parts.

Of the two signals, the drum FG sig-

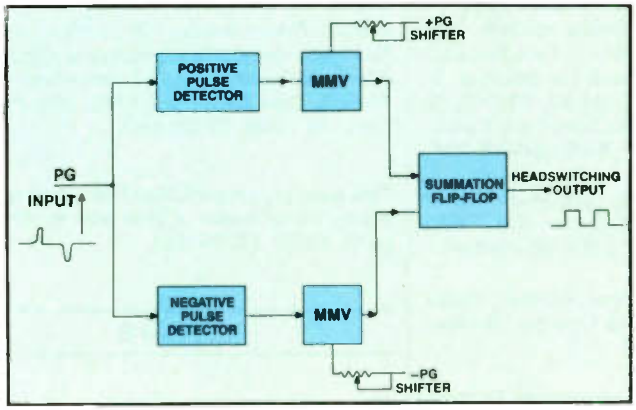


Figure 3. In this standard circuit, the drum PG signal is routed through two parallel paths. The positive pulse detector travels through the upper path and triggers a monostable multivibrator. The negative pulse detector travels through the lower path and also triggers a monostable multivibrator. The output of these two multivibrators are summed to form the headswitching signal.

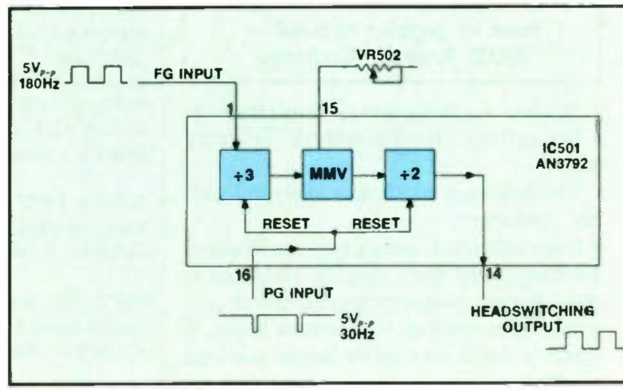
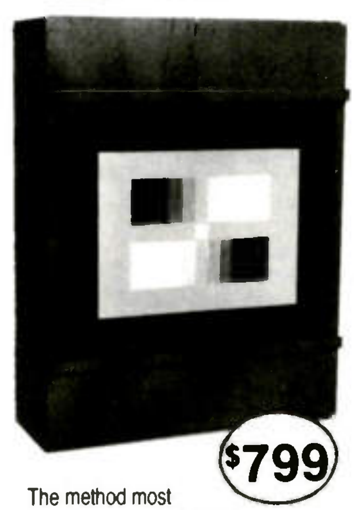


Figure 4. Although the drum PG and FG signals are used to generate the headswitching signal, the FG signal alone can produce the correct frequency and wave shape of the signal. In this IC, the 180Hz FG signal is first divided by three to produce a 60Hz signal, which is applied to a monostable multivibrator. The output of the monostable multivibrator is then divided by two to produce the 30Hz headswitching signal.

nal is the more important because no headswitching signal will be produced if this FG signal is missing. A missing FG signal will also cause the drum motor to rotate too fast. As we have seen, a missing drum PG signal will cause the headswitching signal to have a phase error. IC501 is an AN3792. This same IC has been used by several other manufacturers. Matsushita, for instance, used it in its 1986 line. Panasonic, Quasar, GE, Sylvania and Magnavox are a few of the brand names manufactured by Matsushita. Many other manufacturers have also adopted similar methods of developing the headswitching signal. Therefore, this same type of symptom can occur in many other brands and models.

The same intermittent snow bar symptoms were observed in an MGA HS-339UR. As in the case of the Akai, a headswitching phase error existed. The cause, again, was a missing FG signal from the drum motor drive board. Remember these symptoms — they are not unique to one make or model. ■



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• Readers' Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).

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WANTED

Vintage RCA TVs — pre-WWII models TRK-5 and TRK-9 consoles, TRK-12 mirror-in-lid console and TT-5 table-top model. *Doug Heimstead, 1349 Hillcrest Drive, Fridley, MN 55432; 512-571-1387.*

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

1930s or older radios, parts and tubes, new or used; books, magazines, service and advertising literature; 1956 or older color TV; 1940s B&W. *Mark, 203 Cactus St., Tallahassee, FL 32304; 904-575-7122 collect.*

40-pin IC MP2039 or TMS1370 for J.I.L. scanner model SX100; info about service address for same unit. *Sherman Stewart, 311 E 100 S #68, Kanab, UT 84741; 801-644-2945.*

Sencore VA62, SC61 and any other accessories; Sams folders, approximately #1500-2355; back issues of ES&T, years 1983, 1984, 1985. *Paul Carlson, 1120½ W. Bristol St., Elkhart, IN 46514; 219-264-2147.*

NRI VCR self-study course including VHS training tape and workbook. *Don Jordan, 1003 Oak Tree, Fort Worth, TX 76140; 817-483-5458.*

B&K model 375 VTVM, must be in good operating condition with manual. *Tri-City TV, R.R. #3, Box 186, Birch Tree, MO 65438; 314-292-3281.*

Owner's manual for Hickok model 288X universal crystal-controlled signal generator. Advise price of original manual or copy. *Jim Brugh, 1132 Sperling Drive, Pittsburgh, PA 15221; 412-371-6478.*

Schematic for VISTA XXX-V power supply — regulator board has following numbers: P/N 58005, Rev. C, TCI-AJS-94V-0. Uses four transistors (2N3771). Reg. board has following: 2-MPS-55, 1-PN-2222A, 1-LM-317, 1-TIP-32, 1-SCR #C-122F. *Jerry's Radio Service, 409 S. Oklahoma St., Shamrock, TX 79079; 806-256-3405.*

Sencore PR57 Powerrite, laser power meter; microwave tester. *A&B TV Service, 1158 Jericho Turnpike, Commack, NY 11725; 516-864-6644.*

5BP1 CRT, new or excellent condition. *Technical Electronics, 1245 Buena Vista Ave., Stockton, CA 95203; 209-948-5597.*

Schematic for Kloss video component TV tuner, model T-1. *S.A. Elosh, 4219 Westmont, Aust, OH 44515.*

Sams Quickfacts; used books on all model TVs; TV CRT tester, restorer. *William M. Jones, 8202 Chestnut Ave., Hampton, VA 23605.*

Heathkit technical manual for model EF-1 — "How to Understand and Use Your Vacuum Tube Voltmeter" with experimental chassis. *Sidney R. Creacey, 1358 Turquoise Ave., Mentone, CA 92359.*

Information on obtaining part number AA072 (IC) for Akai model X-2000 SD tape recorder pre-amp module. *Pat Wells, 449 S. Canyon Drive, Redmond, OR 97756.*

RT-4524 remote control for a Drake ESR 424 satellite receiver or APS 424 positioner; a hand unit for a 1980 Zenith color TV model SM1961W, or similar. Neither unit must work. *Joel D. Koivisto, Star Rt. 3, Box 92, Hibbing, MN 55746; 218-885-2175.*

VCR gauge, Sencore VA62; a frequency counter. *Sam F. Quon, Sam's TV, 929 Elliot St., Regina, SK, Canada, S4N3E5.*

Schematic and/or manual for Sharp SU-66PC B&W TV from the 1970's sold only in Japan. (Sams 1140-3 for SU-66p is not the same) with purchase or copy and return; general purpose scope, 5MHz or higher, with probe; infrared remote control for Panasonic VCR PV-1530. *C.L. Wallis, 365 Kenilworth, Memphis, TN 38112; 901-725-1971.*

Service manual (will copy and return with fee) for a Quasar model TL9980WW color console; a tuner/IF unit, P/N 4-1154-06171, for a Fisher model FVH 840 VCR. *Scott Cohen, 4640 N. Brittain Pl.,Tucsan, AZ 85705.*

SECO 107B tube tester; Knight KG-688 audio generator. *Charles T. Huth, 229 Melmore St., Tiffin, OH 44883; 419-448-0007.*

13VAHP22 (or equivalent) good, used picture tube. *C.A. Caputo, 7 Donna St., Peabody, MA 01960; 508-535-1091.*

Used, reasonably priced wow & flutter meter; MTS stereo generator, working or not. Need immediately. *503-267-0628.*

Parts list and schematic for Apple IIc monitor model G090S. *Jim Knutson, Box 373, Waterville, Quebec, Canada, J0B 3H0; 891-837-2785.*

Rider's *Perpetual Troubleshooting Manual*, Volume 23; *Troubleshooting with Oscilloscope*, by Middleton; operating instructions and schematic diagram for Feiler model TS-3 stethoscope. *Paul Williams, 2364 Beaver Valley Pike, New Providence, PA 17560; 717-786-3803.*

Tube tester in good condition. Please send information. *Daniel Seidler, 3721 W. 80th St., Chicago, IL 60652; 312-284-8221.*

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