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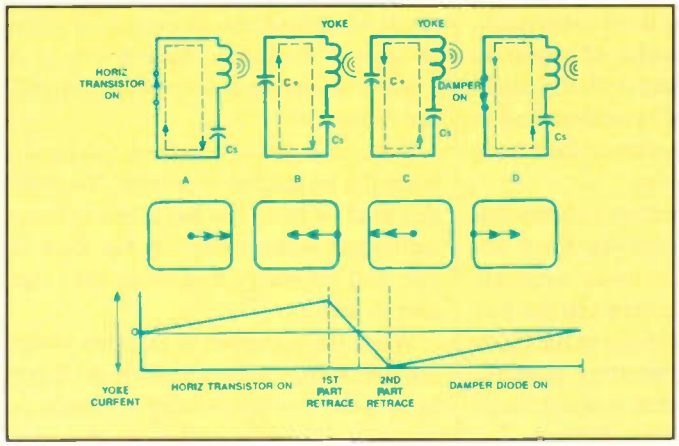

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ON THE COVER

Camcorders and VCRs contain a lot of moving parts that wear, get dirty, and require lubrication. Sometimes moving parts fail and require replacement. Proper routine maintenance, including periodic inspection, cleaning and lubrication, can extend the life of these products and keep them in peak operating condition.

(Photograph courtesy Tech Spray).

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING
ELECTRONIC
Servicing & Technology

Beware of servicing blindness

When it comes to servicing a TV set, VCR or stereo, nothing beats experience.

It's desirable and useful, of course, to possess the education and skills that allow you to observe a set of symptoms and to reason from there to a determination of the nature of the problem.

The proper test equipment is also essential. It allows you, once you have observed the symptom, to make measurements and observe waveforms so that you can determine what portions of the product being tested are operating properly and which are not, so that you can localize, isolate and correct the problem.

And, of course, it's useful to have the appropriate service literature at hand to help lead you through the product. Schematic diagrams give the service technician a "roadmap" of the circuitry of the product, showing how everything is connected together electrically. Waveforms show the technician what the signals he observes on his oscilloscope should look like. Troubleshooting diagrams show the technician how to proceed with troubleshooting. Photographs show what the product looks like physically.

But all the education, test equipment, and manufacturer's literature in the world aren't as valuable as having serviced the same product in the past and having corrected similar symptoms.

That's not to say that all of those other things aren't valuable. They are. They're indispensable. But the experience, when it exists, allows the service technician to quickly say to himself, "Aha. Had one of those in here last week. Exactly the same symptom. You'd turn it on, it would operate for five minutes, then give out a horrible squeal and stop working. No raster, no sound. Yup. Just replace the framsquatch resistor, R74963 and it'll be as good as new."

In fact, that kind of experience is so valuable it's a commodity. That's why there are packages of service tips available in so many forms. Manufacturers publish them for their authorized service centers. Local, state and national service organizations either sell them to raise money or share them among themselves. Some individual service technicians offer tips they have compiled for sale. Companies make a business of selling tips in looseleaf form, in book form, on floppy disk and on line.

And all of that experience saves thousands of technicians thousands of hours in wasted diagnostic time every year. There's no question about it, experience is a timesaver.

Once in a while, however, familiarity leads the technician into error. No doubt this kind of thing has happened to every technician at least once in his working life, and possibly more times than they care to admit.

When the symptom is one that you're familiar with, you immediately go directly to what you're absolutely certain is, based on all of your experience, the cause of the problem and fix it as you have many times before. In this case though, you find that the problem persists. So you go back to the same section of the circuitry, perhaps several times. After all, you know beyond any doubt what the cause of the problem is.

Only after you've let the problem sit for some time do you finally decide that in this case the problem must be something other than what you've experienced so many times before. So, you start again, and this time it's according to the rules of proper diagnosis.

This kind of blindness isn't confined to consumer electronic servicing. Any time a problem exists and a solution seems obvious, it's a natural tendency to grab on to it and stay with it, even when the solution doesn't eliminate the problem. This happens to engineers, medical doctors, mechanics; to anyone whose profession is to diagnose symptoms and cure them.

The only way to avoid this kind of blindness is to be aware of it, and to be on guard against it, especially when working on a familiar product. Whenever you encounter a situation in which the symptom you've observed over and over again isn't remedied by the corrective action you've taken many times, you should reason that perhaps in this case the cause is different. In this case you have to abandon the corrective approach based on experience and go back to your education, test equipment, and manufacturer's literature, and perform a systematic diagnosis as if you've never seen one of these products before in your life. ■

Nils Conrad Persen

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Literature

Expanded parts and service aids line

Philips ECG announces the fourth expansion to their ECG Audio/Video Parts and Service Aids line featuring replacements for over 3500 model/part numbers.

Additions to the line include a compression spring kit, felt washer kit, assorted parts kit, head pullers for VHS-C and 8-mm camcorders as well as for standard VHS units, a retaining ring puller and a spring hook. Also featured is a larger mechanical parts replacement line.

Among parts in the line are VCR modulators, pinch rollers, opto-sensing devices, idler wheels/assemblies and tires, springs, E-clip and washer kits, individual belts and belt kits, and VHS and Beta replacement heads, as well as service aids. ECG service aids are engineered to assist in performing repair and critical adjustments to tape equipment. They include precision VCR tools, VCR and audio test cassettes, alignment jigs, lubricants and cleaning materials.

The newly expanded line is described in the fourth edition of the ECG Audio and Video Catalog/Cross Reference. The catalog cross references 31 popular VCR and camcorder brands and over 3500 industry model/part numbers to the corresponding ECG replacement part.

Circle (1) on Reply Card

New version of parts catalog on disk

NTE Electronics, Inc. introduces the company's new components catalog on computer disk, "QUICKCROSS" Version 3.0. The semiconductor and relay cross-reference databases have been updated to include the newest U.S., Japanese and European device numbers. A resistor selector guide has been added for easy selection of the proper replacement from NTE's extensive line of over 1,350 resistors. Another new selector guide covers the company's extensive line of capacitors.

Other features include revised part number search capabilities, and a guide to available literature, such as its Semiconductor Cross Reference, Relay Technical Guide, and Resistor and Capacitor brochures.

The software runs in MS-DOS on any IBM PC or compatible with 640K of RAM, a small hard drive, and a 5 1/4"or 3 1/2" floppy drive. The database occupies only 2.8 Mbytes of hard drive space when loaded. It is a public domain release.

Circle (2) on Reply Card

"Power Quality Wellness Guide" demystifies power problems

EFI announces the "Power Quality Wellness Guide", which will help users to quickly identify the symptoms, probable causes and solutions of most commonly encountered power and data line problems affecting microprocessor-based equipment and other sensitive electronics. The technical content of the guide is based on years of real-world engineering expertise and laboratory experimentation by the company's principal consulting engineer.

The bulk of the guide is a chart that encourages users to "take EFI's 5-minute Power Quality Physical." As the brochure illustrates, several power problems have similar physical symptoms, yet require entirely different solutions. The guide goes on to describe various probable causes and cures, offering recommendations for specific types of engineering studies and systemic power quality solutions

Circle (3) on Reply Card

ESD workstation catalog

Kalamazoo Technical Furniture has just released a new catalog featuring their line of ESD (Electrostatic Discharge) controlled workstations. The 8-page, 4/color catalog showcases Teclab's static protective workbenches and complete furniture systems.

The catalog features the wide variety of ESD workstation components—hard-surface laminate worksurface material, wrist straps, constant ground fault monitors, dissipative pads, common point ground, grounded chairs and lighting, along with complete workstation systems.

For customers unsure as to what level of ESD protection their environment requires, the company offers their standard Free Planning and Design Service. With this service, an applications engineer will audit the product and work environment, then recommend an appropriate ESD workstation system to meet their individual needs. ■

Circle (4) on Reply Card

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

Electronic Servicing & Technology is edited for servicing professionals who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts who repair and maintain audio, video, computer and other consumer electronics equipment.

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Business Identity Council of America formed

Twelve national corporations have gathered to form the first user association dedicated to protecting and preserving the right of the American business community to identify their businesses by means of all forms of exterior and interior signs.

On October 15, 1992, the Articles of Incorporation of the Business Identity Council of America (BICA), filed by Ford Motor Company, were approved by the state of Michigan. BICA's mission is to educate architects, planners and regulators on the value of signs.

Once funded, BICA will hire colleges and universities to conduct comprehensive studies on the economic value of all forms of signage. Results of the studies will be disseminated to the planning community; architects, land use attorneys, all segments of the sign industry and, most importantly, the 80,000 communities in this country that regulate signs.

"If you've ever had to defend your needs for adequate signage against a restrictive sign code, maybe you can understand why you should lend your company's support," says Lynn Baxter, editor of Identity magazine. "By pooling the membership dues of numbers of companies, large and small, BICA may be able to accomplish what one company cannot undertake by itself.

BICA President Bill Delaney says signs stimulate commerce and make the economy run—giving people jobs, generating tax revenue and profit, and keeping the whole economic cycle turning.

Companies who use signs to identify, advertise or promote their business are invited to join BICA. For further information contact the Business Identity Council of America, 12729 Layhill Rd., Suite 102, Silver Spring, MD 20906; (301) 946-2022; (301) 946-2077 (FAX).

TIA testifies on emerging telecommunications technologies act

As spectrum demands continue to grow, legislative and regulatory actions to plan for the public interest are overdue, said Eric Schimmel, Vice President of the Telecommunications Industry Association (TIA). Appearing in February before the Subcommittee on Telecommunications and Finance, House Committee on Energy and Commerce, Schimmel, who is responsible for mobile radio, microwave and satellite telecommunications issues at TIA, addressed the Emerging Telecommunications Technologies Act of 1993 (H.R. 707). "A firm legislative directive will ensure that the critically needed reallocation of spectrum access will take place in an orderly and timely manner," Schimmel continued.

To support the public demand for spectrum dependent products and services, even during recessionary times, Schimmel cited the following statistics: cordless telephone sales have risen to an annual level of 17 million units from 12 million units one year ago. Cellular telephone subscribers grew to more than 10 million from approximately six million a year ago.

TIA, as an accredited standards developer, has been pressed to develop standards for new and improved services including an array of terrestrial and satellite Personal Communication Services (PCS), high-speed digital two-way radio communications for state and municipal law enforcement, and spectrally efficient next-generation cellular radio systems.

"The demand for more emerging technologies which will be spectrum dependent will continue," Schimmel said. One proposal on the horizon is the Intelligent Vehicle Highway System (IVHS). "It may be the telecommunications extravaganza of the late 1990s," he continued.

Definitive identification and allocation of a new spectrum implementation are crucial, Schimmel added. Service features, technology selection, regulatory considerations and scheduling are dependent on the amount and location of spectrum to be made available.

This issue, which was once solely a domestic one, has moved into the international arena. "Our major foreign competitors seem to have been able to accommodate their new generation of wireless services much better than we have," Schimmel said.

ETA-SDA participates in FCC commercial license program

The Federal Communications Commission in FO Docket No. 92-206 has proposed the privatization of examinations for applicants for the nine radio licenses, permits and endorsements it issues. In the same notice the Commission is asking the public to submit suggestions for input in the form of examination questions, which in conjunction with the use of private examination managers is intended to improve the availability, relevance, and validity of the current radio examinations. The program is also intending to reduce government expense.

The Electronic Technicians Association (ETA) is submitting a proposal to become a COLEM (Commercial Outside License Examination Manager). The FCC will continue to issue licenses, but the examination process will be turned over to entities that have experience in nationwide testing of technicians.

The nine classes of licenses (six of which require a written examination), permits or certificates presently are: 1) 1st Class Radiotelegraph Operator Certificate, 2) 2nd Class Radiotelegraph Operator Certificate, 3) 3rd Class Radiotelegraph Operator Certificate, 4) General Radiotelephone Operator License, 5) Marine Radio Operator Permit, 6) Restricted Radio Telegraph Operator Permit, 7) Restricted Radio Telegraph Operator Permit—limited use, 8) GMDSS Radio Operator License, 9) GMDSS Radio Maintainer's License (GMDSS stands for Global Maritime Distress Safety System).

In the past, there has been a limited opportunity to take the exams. Many technicians have felt the FCC exams were somewhat outdated. Because of the favorable experience the Commission has had during the past ten years of privatization of the Amateur license exams, the above change is being made by the FCC for the Commercial Licenses.

Licenses are required for virtually all marine, aircraft and broadcast station technicians. Familiarization with radio broadcasting rules, operation and regulations, as well as technical knowledge of receivers and transmitter circuits, operation and testing procedures is required.

ETA has administered the Certification Program for Electronics Technicians for 14 years, as well as the CSI, Certified Satellite Installer exams, since 1991. Included in the CET options is ETA's Radio Communications and Telecommunications Examinations. For more information, contact ETA at 317-653-8262, 602 N. Jackson St., Greencastle, IN 46135.■

Setting up a service bench

The service bench: Heart of the service center

By Conrad Persson

As often as not, little planning goes into equipping the service bench. A common method of planning a service bench is to install or build a bench with the most obvious equipment on it: oscilloscope, DMM, soldering station, etc., and have it evolve as its shortcomings become obvious.

The obvious drawback to the "let it happen" approach is that a great deal of time gets wasted. Every time the technician realizes he needs some piece of equipment he's lacking, he has to stop and request it. This may mean time consumed not only in the request process, but time wasted waiting for the requested piece of equipment, and possibly time wasted in rearranging existing equipment to make room for the new one.

Making a planning list

Service benches in the most efficient service centers, however, show evidence that someone did some planning and thinking before setting them up. The first step in planning a service bench is to write down the list of the work that will be done at that location. Different service centers service different products, and in somewhat different ways, so each service center will develop its own unique list.

Here's a list of some of the activities that take place at a typical service bench:

- Disassemble the product and temporarily store the fasteners, cabinet parts, components/assemblies removed.
- Visually inspect the product.
- Provide power to the product during diagnosis/checkout.
- Refer to service literature.
- Connect diagnostic equipment.
- Clean/lubricate the product.
- Adjust/align the product.
- Desolder defective components.

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

- Test removed components to confirm that they are faulty.
- Handle replacement components.
- Install/solder replacement parts.
- Burn in the repaired unit.
- Provide necessary signals to the product being serviced.
- Call manufacturers' help line.
- Record components needed, work performed, length of time worked.
- Refer to service "tips"; paper, fiche or computer disk based.
- Repair damaged PC boards/traces.
- Touch up cosmetic damage.
- Apply non-standard ac voltages.
- Inject externally generated voltages.
- Make temporary connections.
- See the front of the set while adjusting controls in the back.
- Work on "hot" chassis.
- Perform ac leakage tests.

What's needed to do the job

Given this list of tasks that may have to be performed, here are some of the things that should be at the bench.

- Good lighting. This includes both general overhead lighting and any pinpoint lighting needed to illuminate the product under service.
- Magnification.
- Good organization.
- Adequate tool selection.
- Holding fixtures: vises, jigs, PC board holders, etc.
- Telephone.
- Computer terminal.
- Variable power supply.
- Isolation transformer.
- Electrostatic discharge damage (ESD) protection.
- Vacuum pickup tool for handling ICs.
- Vacuum cleaner for cleaning out dusty products.
- Surge protection for products that are sensitive to ac-line anomalies.
- Solder/desolder station.
- Chemicals, cleaners, lubricants, dust off sprays, adhesives, fluxes.
- Consumables, solder, wire, wipes.
- Test equipment, probes, leads.

Making the service bench an efficient workplace

One of the things that any service manager has to consider when buying a service bench is what kind of bench to buy. There are the inexpensive benches that consist of nothing more than four legs and a top. This type of bench will have to be supplied with shelves or other provisions for stacking test equipment, outlet strips for power, lights, storage space, and whatever else a technician needs to perform his work.

An alternative is to buy a service bench that was designed with servicing in mind. Some manufacturers sell benches that come right from the factory with outlet strips anywhere you want them, storage drawers built in, shelves, lighting, even ESD protective tops.

While the first kind of stripped down bench seems like a bargain initially, if you add the cost of all of the accessories needed to truly make it into a servicing bench, especially if you include the time that will be spent by someone who could otherwise be servicing, a fully equipped bench might be a bargain.

Another thought along the same lines is that while many people, service managers included, look upon tools as just an expense, and a place to economize where possible, this is an area where false economy can be costly. Sometimes it might seem that it's more economical to buy a less expensive tool or piece of test equipment, but tools and test equipment are one-time, or at least infrequent expenses.

On the other hand, every minute wast-

ed by a technician, who could otherwise save time with a more efficient tool or test device even if it's a little more expensive, may occur day after day, week after week, year after year. All of those minutes are paid for at the technician's hourly rate.

In addition, if a service procedure performed with inadequate tools and test equipment results in a callback, the cost of a callback can easily be several times the saving realized in buying an inadequate tool.

Following are some specific areas that service centers in today's highly competitive, demanding, economy should give some serious thought to.

Lighting

General lighting should be bright enough to be adequate for most tasks. In addition, today's crowded product interiors, and crowded pc boards with their tiny components demand high-power task lighting and magnification.

ESD protection

Today, 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 must be equipped with antistatic wrist straps and antistatic mats. Every technician must be instructed in the use of antistatic products and in the importance of keeping static-generating products away from electronics products that are opened up for servicing.

Test equipment

Today, sophisticated consumer electronics products require sophisticated tools and test equipment to service them. As a matter of fact, there are some pieces of equipment that are all but essential.

Quite simply, good, easy-to-use, high quality test equipment is the foundation of a successful service operation. Just take a tour of any successful service center and see the concentration of test gear.

The Electronic Industries Association/ Consumer Electronics Group (EIA/CEG) has compiled a list of tools, test equipment and supplies considered essential or desirable for diagnosing and repairing current sophisticated consumer electronics products. (For a pamphlet, write to the EIA/CEG, 2001 Pennsylvania Ave, N.W., Washington, DC 20006-1813).

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 that are subject to wear and abrasion caused by travel of the magnetic medium. All such mechanisms are subject to accumulations of dirt. 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.

Environmental considerations

Many of the chemicals that were routinely used by service centers in the past are now known to cause harm to the environment. Chlorinated fluorocarbons (CFCs) used as propellants or cleaning agents, for example, are known to be detrimental to the ozone layer of the atmosphere, which blocks much of the sun's

harmful radiation. Every service manager should be aware of the chemical composition of the materials used in the service center for both environmental and legal reasons, and make every effort to buy and use safe chemicals.

Soldering

In today's consumer electronics products, 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 were followed during the manufacturing process.

Today, soldering and desoldering have almost been raised to a science. High quality solder/desolder stations can control not only temperature, but how quickly the tip reaches the desired temperature. Because so much of today's consumer electronics circuitry is sophisticated and extremely delicate, it only makes good sense for the service center to take a close look at the soldering tools they are currently using to make sure that they're adequate to do the job.

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 possibly fatal shock.

Every consumer electronics product that is serviced should be given a safety leakage test before it is returned to its owner. The leakage test, described in most service manuals, allows you to make sure they are safe.

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-organized, well-equipped service technicians will be faster, more efficient and more accurate than their unorganized competition—and more profitable.

Keeping the service center's heart beating

There are two ways to set up a service bench. One is to just let it happen: buy a bench, provide power, lighting, test equipment, etc., as it occurs to the service technician to request them. The other is to do some prior planning and preparation. This involves thinking through all of the products that will be serviced there, the operations that will be necessary to perform that service, the tools and test equipment that will be necessary to perform that service, etc.

While planning the workbench, it would make sense to do some cost comparison: for example, work out what it costs to buy a manufactured technician's bench, with the ultimate cost of putting one together in the service center.

The service bench is the heart of the service center. It's the place where all of the work that brings in the profits gets done. Make sure it's well planned. ■

Books

Making Sense of Sound: The Basics of Audio Theory and Technology, By Alvis J. Evans, Prompt Publications, 112 pages, $10.95, paper.

Through the easy-to-understand and clearly illustrated text of *Making Sense of Sound*, you will learn the basics of audio theory and their relationship to today's audio technology.

The contents include: stereo components—how they function separately and as a system, distortion and system noise, sound transducers, recording and playback, and combinations of video and audio technology. There is also a complete glossary and index.

Author Alvis J. Evans is an associate professor of electronics at Tarrant County Junior College in Ft. Worth, Texas. The author of many books on the subjects of electricity and electronics for both beginning hobbyists and advanced technicians, Mr. Evans is in demand to teach seminars and workshops nationwide to members of the trade.

Prompt Publications, Howard W. Sams & Company, Indianapolis, IN 46214

Tube Substitution Handbook, By William Smith and Barry Buchanan, Prompt Publications, 154 pages, $16.95, paper.

Tube Substitution Handbook is a reference tool for antique radio buffs, ham operators, collectors of vintage ham radio equipment, marine operators, microwave service technicians, TV and radio technicians, and any do-it-yourselfers with an interest in tubes and tube replacement.

With over 30,000 tubes and tube substitutions listed and over 800 basing diagrams provided for easy reference, the *Handbook,* is a valuable tool.

Prompt Publications, Howard W. Sams & Company, Indianapolis, IN 46214

1993 Directory of Parts Suppliers, Edited by Judith Sawyer, Coordinated Service, Inc., 60 pages, $75.00, paper.

Coordinated Service, Inc., a consulting and information service company for the service industry, has released its *1993 Directory of Parts Suppliers.* This second annual directory contains listings of over 300 vendors currently providing spare parts, components, whole units & systems, both new and refurbed, and accessories for computers, peripherals and other high tech equipment. There are 56 new vendors plus new parts listings for previous vendors in this new edition.

Each listing includes company name, address, contact, phone and fax, parts and services provided. Users can gain easy access to their particular requirements by using the manufacturers' index. Users who want IBM parts, for example, can go directly to that section and avoid the hassle of sifting through pages of listings. Specific information on each company is sorted alphabetically.

Coordinated Service, Inc., Littleton, MA 01460

Practical RF Power Design Techniques, By Irving M. Gottlieb, TAB Books, 304 pages, 219 illus., $19.95, paper, $32.95, hard.

Practical RF Power Design Techniques gives electronics technicians, hobbyists, and students hands-on instruction to understand radio-frequency electronic design techniques and translate RF theory into functioning hardware.

Packed with illustrated examples taken from real-world applications that help make the theory behind RF circuit design and operation clear, this book contains detailed coverage of the bipolar transistor and field-effect transistor in RF power applications, impedance-matching networks, and applications of transmission-line elements to RF power circuitry. Other topics examined include low-, medium-, and high-power applications and standing-wave ratio and related subjects.

TAB Books, McGraw-Hill, Blue Ridge Summit, PA 17294-0850

Professional Photocopier Troubleshooting and Repair, By Eric Kuaimoku, TAB/McGraw-Hill, 352 pages, 240 illus., $29.95, hard.

This book has complete, illustrated troubleshooting and repair procedures for practicing service technicians and technical students with coverage of today's most popular copier brands and models.

For technicians and apprentices who want to add photocopier repair expertise to their resumes, this hardback edition provides a comprehensive course in the tools and techniques employed by working professionals. Here, Eric Kuaimoku offers an expanded, more technically detailed examination of the general topics covered in *Photocopier Maintenance and Repair Made Easy*, with added emphasis on theory, operation, embedded systems, electromechanical processes, and troubleshooting.

Kuaimoku takes an in-depth look at each photocopier component and subsystem—including the optical system, coronas, developer section, drums, electronics and sensors, fusing mechanisms, and paper transport rollers and belts—pinpointing the sources and solutions to problems that typically arise through extended use. This book will give technicians and students all the background information and practical know-how they need to service and repair a full line of personal and business photocopiers.

TAB/McGraw-Hill, Blue Ridge Summit, PA 17294-0850

How to Test Almost Everything Electronic, 3rd Edition, By Delton T. Horn, TAB/McGraw-Hill, 304 pages, 213 illus., $14.95 paper, $24.95 hardcover.

With more than 25,000 copies sold of previous editions, *How to Test Almost Everything Electronic* is a beginner's guide to troubleshooting with electronic test equipment. This edition has been revised to include current testing techniques and new chapters on mechanical repairs and flowcharting.

As the world of electronics gets more complex, so do the meters, probes, and other testing devices used to troubleshoot electronic systems. This bestselling guide is designed for beginner-level hobbyists and students who want to understand and use today's electronic test equipment.

Light on theory and mathematical calculations, it's a practical handbook and reference that clearly explains how common testing devices such as the multimeter, frequency and logic probes, signal tracers, and oscilloscopes are used to pinpoint problems in everything from TV sets and computers to automotive electrical systems.

Delton T. Horn has written more than 30 hobby electronics books including *Low-Cost Test Equipment Projects You Can Build, Troubleshooting and Repairing Electronic Music synthesizers, and Designing and Buioding Electronic Filters.*

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Setting up a service bench

Build this variable isolation ac power source

By Homer Davidson

There are certain tools, test equipment and accessories that every consumer electronics servicing test bench should be equipped with if the technician is to work there safely and efficiently. A few of the absolute requirements are: an oscilloscope, a DMM, a solder/desolder station, a selection of hand tools, a power source that's isolated from the power line.

A few years ago, before the introduction of TVs with power supplies based on the bridge rectifier, it wasn't always necessary to provide isolation from the power line for the product being checked out.

Sets with bridge rectifiers, however, have made the availability of an isolated power source an absolute necessity. When a set is powered from a bridge rectifier, dangerous line voltages and current availability are present in the set.

Equally important, if the set is not isolated from the power line, when the technician plugs both the set and the oscilloscope into the same power line, and places the common lead between the oscilloscope and the chassis ground, it will, in effect, place a direct short across components in the set.

Such a connection will result in damage to at least one of the diodes in the power supply, and possibly other components in both the set and the oscilloscope.

Because of this situation, every bench in the service center should have isolated 120Vac available. Even better, however, is to make this isolated voltage variable. Availability of a variable supply voltage will allow the technician to decrease the supply voltage to products under test to determine their susceptibility to undervoltage.

A variable voltage will also enable the technician to supply power to recently repaired sets at reduced voltage and increase the power gradually. In this way the tech will be able to make sure that the service performed has in fact corrected the entire problem, and avoid destroying the replacement components just installed.

Buy or build

A number of manufacturers of test equipment and accessories offer variable isolated transformers. The large busy service center is probably best served by going out and buying one.

A small service center that has some slack periods, or technicians who are not busy all the time, might want to save some money by building one.

This article describes how to build a variable isolated ac power supply, for those for whom it makes sense to do so. At the same time, it provides some details about how such a power supply works, so that even if you're not interested in building one, after you read this you'll at least know a little more about what's going on in the one you bought.

The autotransformer

An autotransformer consists of a large single winding. AC voltage at 120V is applied across almost the full winding. Lower voltages are picked off by moving a wiper to various parts of the winding between the ac input connections.

Higher voltages than the 120V input are obtained by moving the wiper beyond the ungrounded input connection. Because this wiper can provide a range of

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

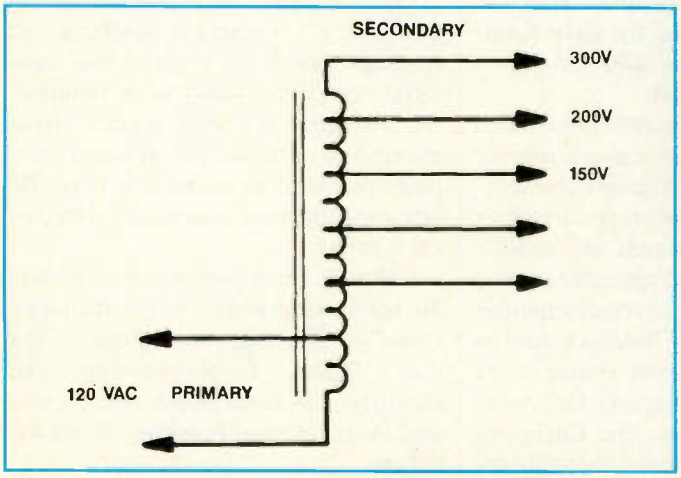

Figure 1. A variable step-up autotransformer with secondary voltage taps.

Figure 2. An isolation variable tapped primary and secondary voltage transformer.

output voltages both above and below the line voltage, it is a variable transformer. See Figure 1.

The term "auto" means "self." Because the input and output share the same winding, this is a "self transformer." This type of transformer was used in early test equipment and electrical applications. In earlier units, the autotransformer had several fixed taps to provide several different output voltages.

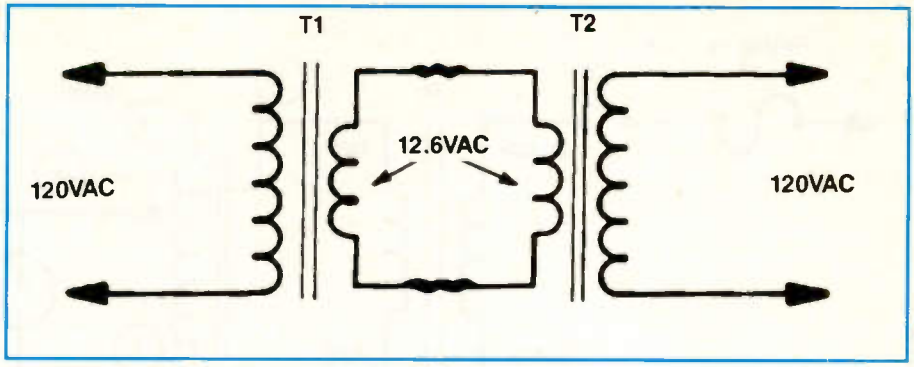

Figure 3. An isolation transformer can be made from two 12.6V transformers.

Isolation transformer

A straight isolation transformer has a 1 to 1 ratio between the input winding and the output winding. The primary and secondary windings are carefully arranged so that there is no electrical connection between them. This provides complete electrical isolation from the power line of the equipment connected to the isolation transformer.

One way to make an isolation transformer is to use two step down transformers. For instance, a transformer with 12.6V secondary connected to another 12.6V transformer connected backwards, provides a secondary of 120Vac.

This arrangement may provide a readily available isolation transformer at lower cost (Figure 3). If you choose to make this type of isolation transformer, choose a 2, 3, or 5A secondary for the required load.

This arrangement may not be suitable for current draw, however. It would also be prudent to measure the resistance from input to output to make sure that this arrangement does, in fact, provide sufficient isolation.

Variable power source

By connecting an isolation transformer and a variable transformer together, you can produce a very important test accessory that may help to solve intermittents in horizontal output and flyback circuits. Simply varying the ac voltage to an intermittent chassis may cause the chassis to act up.

Today virtually all TV chassis are operated directly from the power line. For reasons given earlier, the ac chassis is dangerous to service for the electronic technician, and you will almost certainly damage something if you don't use an isolation transformer to power a TV set being serviced. With this isolated power source the defective chassis can easily be serviced (Figure 4).

A variable isolation transformer may be helpful in at least two ways when you suspect that a TV malfunction may be caused by a faulty flyback transformer or horizontal output transistor (HOT).

First, you may be able to use the transformer as a diagnostic tool. By reducing the supply voltage to the set, you may be able to force the defective component to malfunction, and thus track down the source of the problem.

Then, once you've replaced the flyback or HOT, you can power the set at reduced line voltage then gradually increase the voltage to 120V. By doing so, if you have not entirely solved the problem, you may be able to find out without destroying the replacement components.

You can build an isolated variable transformer source for around $100.00. You might be able to save a few dollars by using salvaged components.

The circuit

Refer to Figure 5. The 5A fuse and toggle switch are placed in the primary lead of the isolation transformer (T1). Solder one conductor of a heavy duty power cord to one input lead of the transformer, and the other conductor to the other transformer input lead. T1 is a 1:1 isolation transformer with 120Vac on the primary winding and 120Vac on the secondary winding.

Connect a 120V pilot light across the two secondary red leads. In this project I used a large square lamp assembly. Solder one red lead of the isolation transformer to terminal 1 of the variable transformer (VRT). Likewise, connect the other red

Figure 4. The variable power source may be enclosed within the service bench, or in a separate cabinet.

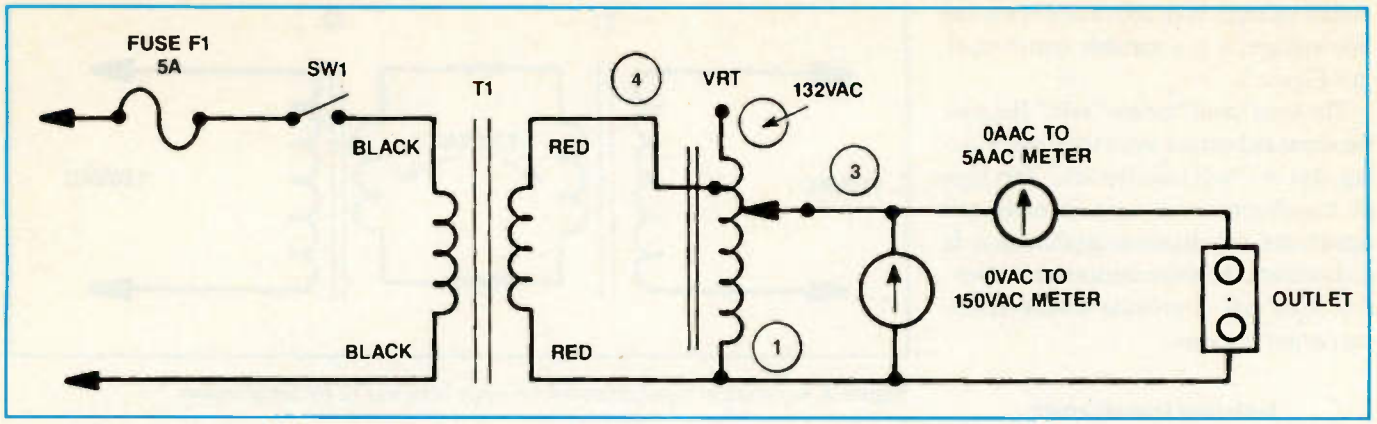

Figure 5. The power circuit of the variable power source project.

lead to pin 4 of the VRT. The secondary output voltage appears between terminals 1 and 3 of the variable transformer.

Wire the 5A ammeter in series with terminal 3 of the variable transformer and the ac receptacle. Connect the 0V to 150V ac meter across terminals 1 and 3 of the VRT. Together, the meters will measure the voltage to the TV set plugged into the receptacle, and the current drawn by it.

Obtaining parts

Most of the components for this project were ordered through a mail order firm. The isolation transformer was ordered through a local electronic wholesale dealer. All small standard parts can be ordered from a local electronics store.

For intermittent line voltage service, you can use a 35VA or 50VA isolation transformer with a 2A variable transformer. If the unit is to be used continuously, choose a 3A or 5A variable transformer with a 100VA or 150VA isolation transformer or higher. Remember, the higher the current rating, the larger the transformer. The larger transformers, which use more copper, are much higher in price. You can select the isolation transformer up to 10A, and the variable transformer from 0 to 140Vac.

A 35KVA isolation transformer and a 132V, 2A variable transformer were used in this project. T1 sometimes becomes a little warm after 3 or 4 hours of usage.

Cabinet or enclosure

The variable isolated transformer source may be mounted inside a metal cabinet, on the test bench, or between shelves. Select a big enough cabinet to hold all large parts without touching. It is best to ground all parts with a common ground wire.

This project was mounted on a piece of Masonite panel and placed between two bench shelves (Figure 6). If possible, mount the unit inside the test bench. Make sure all sides are enclosed to avoid shock hazard. Remember, you are working with high current and power line voltages.

Front panel layout

All components of the project are mounted on the front panel. The two meters are placed at the top and evenly spaced. Place the receptacle at the bottom area for easy use. The on/off switch and fuse holder may be mounted on the side.

Drill two large (two-inch) holes with a circular drill or cutter (Figure 7). If a hole saw is not available, drill out closely-spaced 5/32-inch holes within the circumference of the two inch circle. After all holes are drilled, break out the large center piece. Smooth sharp edges with a half-round file or rattail file. Remember, these meters are mounted with back-side angle clamps.

Drill two small 5/32-inch holes to hold the ac receptacle. Here the plastic outlet is mounted flush with the top panel area by drilling out the two larger holes. Lay the plastic cover down and mark out the holes to be drilled. Drill and break out holes as you did in making the meter holes. Also, drill a small 1/8-inch hole in the center for the screw to hold the receptacle plate. Smooth the holes with a file or a drill with a sander attachment.

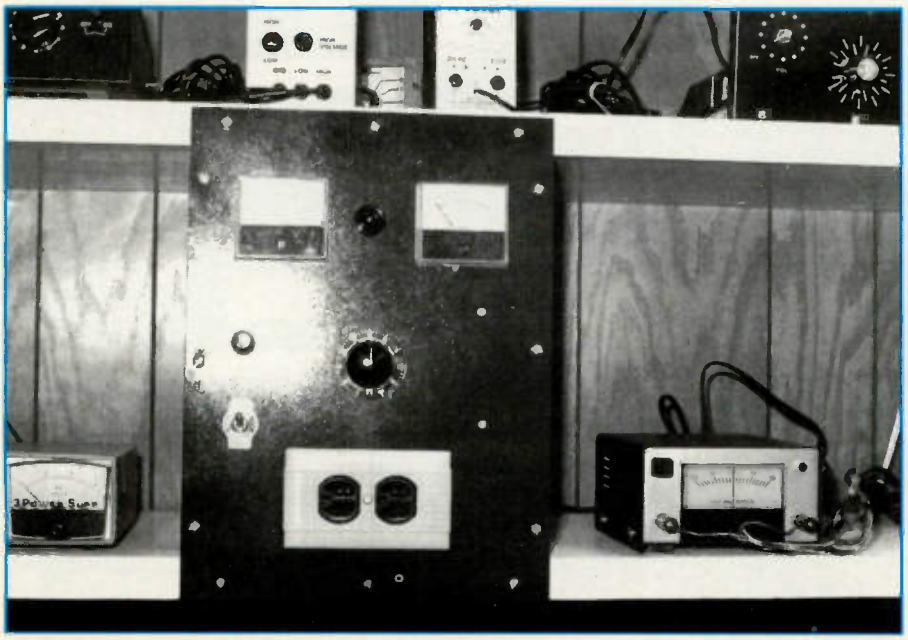

Figure 6. This project was mounted on a Masonite panel between two shelves.

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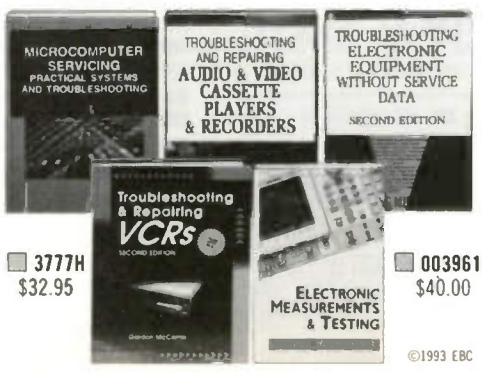

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Center the variable transformer assembly in the middle of the front panel. Drill out the center shaft hole with a 13/32-inch bit. Position a 7/32-inch hole at the bottom for the key lock. The transformer should be mounted with the contacts at the top. A panel drilling template is furnished with the variable transformer. Double check the holes with the VTR so they will fit. This variable transformer is held in position with a center shaft lock nut and star washer.

Drill two 6/32-inch holes to mount the isolation transformer. This transformer can be mounted on either side of the variable transformer. Just place the pilot light and switch on the opposite side.

After all holes are drilled, sand the sides and edges of the panel. Spray on two coats of auto enamel (I used black) over the front of the panel. Let the paint dry between coats. Do not mount parts until the panel has dried for 24 hours.

Mounting parts

After the front panel has been drilled and painted, start mounting the components. Mount the variable transformer last. Keep it in the packing box until other parts are mounted. Be careful when handling the variable transformer. Do not place or drop the unit on a sharp object as the windings can be damaged. Use extreme care when soldering the transformer and connecting other parts. Place a service cloth down to prevent damage to the transformer windings and meter faces.

First, mount the fuse block, SW1 and the 120V pilot light socket. Bolt the ac outlet to the front panel. Use either a toggle or push on/off switch to turn the unit on (Figure 8). Place each meter into the holes and fasten into position with metal brackets. Make sure the meters are level on the front side. Tighten mounting nuts to secure both meters.

Next mount the isolation transformer with 6/32-inch bolts and nuts. Place the secondary winding towards the center, since leads may be shorter in length.

After all other parts are mounted, place the variable transformer shaft into the 13/32-inch hole. Make sure the key is in the small 7/32-inch hole to lock the transformer in place and keep it from turning. Fasten the dial assembly and transformer into position with locknut and washer. Mount the furnished knob with the set screw. The knob, when mounted on the shaft, covers the nut and washer.

Wiring

Solder all component connections with regular ac wire or number 12 solid electric wire. Solid number 12 wire from a piece of 12-2 Romex will work fine if that's what you have available. Just slit the plastic jacket of the Romex down the center and extract each single wire. Keep all connecting wires as short as possible.

The wiring contacts of the variable transformer have slip-on type lugs. If slip-on or crimped lugs are not available, you can just solder the wires directly to each spade lug.

Remember, the input terminals of the variable isolation transformer are 1 and 4. The output terminals connect to 1 and 3 (Figure 9). With this method, the output voltage may be adjusted from 0V to 132Vac. If you connect the transformer in this manner, the voltage will increase as the knob is turned clockwise to match the dial voltage rotation.

After wiring is completed, tape parallel wires together for a neat appearance. Check the dial assembly for clockwise rotation. The voltage should increase as the knob is turned to the right.

Maintenance

Very little maintenance is required with this variable power source. The only servicing required of the variable autotrans-

Parts List

VRT - Variable ac transformer:
For intermittent line voltage service, this can be a 2A unit. For continuous operation, choose a 3A or 5A unit.

T1 - 1:1 Isolation transformer:
For intermittent service, choose a 35VA or 50VA isolation transformer. For continuous service, choose a 100VA or 150VA isolation transformer.

M1 - 0A to 5A ac ammeter

M2 - 0V to 150V ac voltmeter

P1 - 120V pilot light assembly

SW1 - Push-on or toggle switch 5A

F1 - 5A fuse holder and fuse

AC out - Regular heavy duty power outlet receptacle

Cabinet - large enough to hold all components. Or mount in bench.

Misc - AC plug, heavy duty ac cord, bolts and nuts, 12-gauge wire, solder, etc.

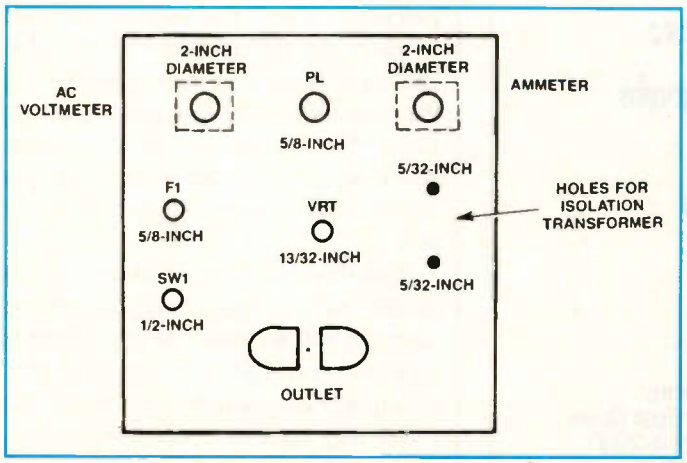


Figure 7. The front panel outline and mounting holes.

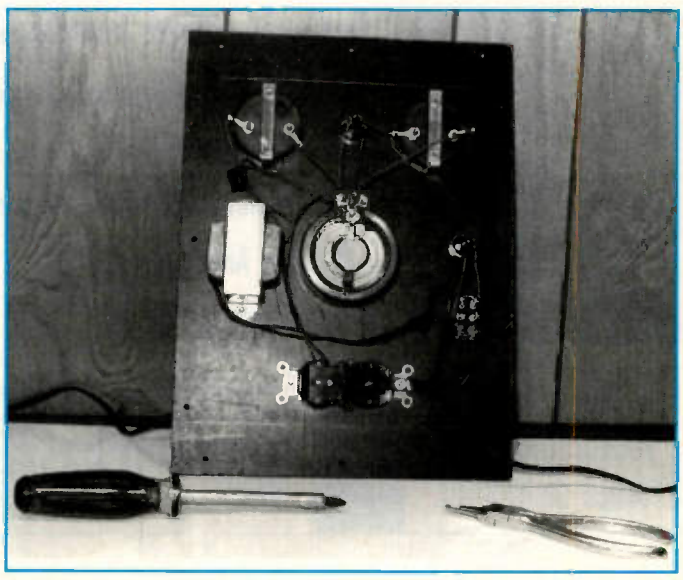


Figure 8. Back view of project with mounted components.

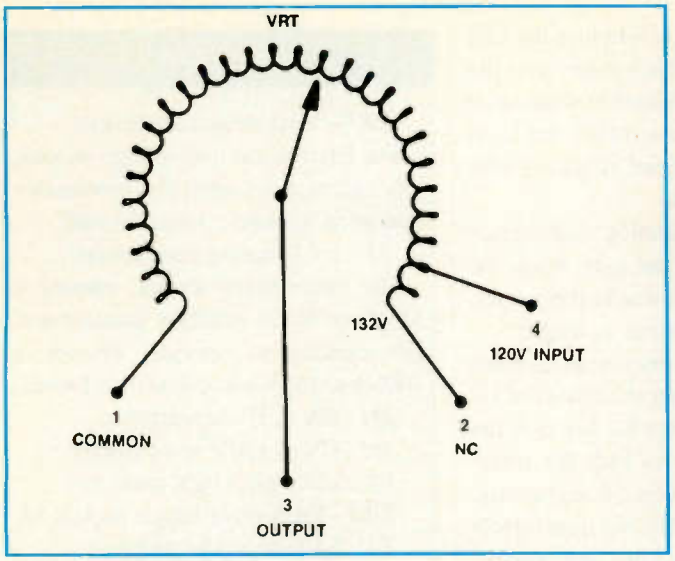


Figure 9. Input terminals 1 and 4 and output terminals 1 and 3 of the variable power transformer.

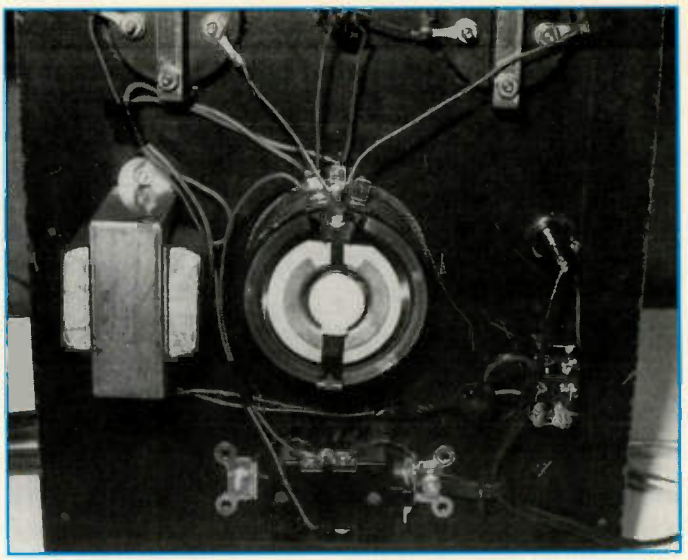


Figure 10. If the output voltage becomes erratic, check for excessive wear.

former is periodic inspection of the brushes. Badly worn or arcing brushes should be replaced. Of course it may be several years before replacement is needed. Use the exact replacement brush assembly which contains the special material required for normal brush operation (Figure 10).

Disconnect the power cord when replacing the brushes. Gently lift out the old brush assembly by lifting the spring and snap it out of position. Install the new brush assembly by lifting up the spring arm and snapping in a new brush.

Make sure the new brush is seated and riding correctly for proper operation of the transformer. Place a piece of garnet paper (non-metallic) between the brush and brush track, with the rough side towards the brush. A few rotations of the brush over the garnet paper will surface the contact face to the brush track. Remove paper and blow out any loose particles before again applying power.

Testing

Double check all wiring connections. Make sure all leads are properly soldered and nuts tightened. Check the unit out before a load is plugged into the outlet.

Slowly raise the ac voltage with the knob of the variable transformer. Notice if the ac voltage meter is tracking with the knob as rotated. The current meter will not move until a load is plugged into the receptacle. Push test leads from an ac voltmeter into the outlet and compare its voltage readings with that on the ac voltmeter which is part of the supply.

Next, plug in a TV chassis with the variable-isolation transformer turned off. Turn the TV set on and then slowly raise the transformer output voltage up to 120V. Check the TV chassis to see if it is operating normally. Notice how much current shows on the meter. Let the chassis operate for a full hour. Pull the ac plug on the power source and feel the transformers for overheating.

When the TV set plugged into the variable isolated transformer is a monochrome or small color set, very little current is indicated on the current meter. Larger portables and console models will pull more current. You may want to make a note of the current drawn by each size chassis and mark it on the ac ammeter. Do the same for the 120V setting of the voltmeter. Simply remove the front meter plastic dial face and then mark the various numbers in red, with a felt tip or ballpoint pen.

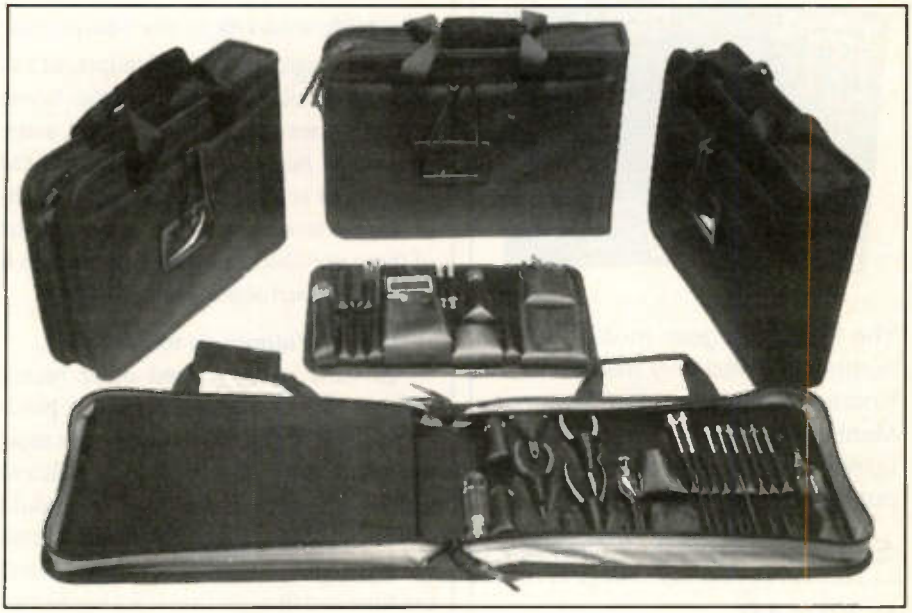
With these markings in place, when a defective chassis pulls heavy current, the ammeter will increase and the voltmeter may decrease. In addition to providing the actual operating current and voltage, the meter may indicate a defective chassis with overloading conditions. Always remove the ac power plug when working on the variable power source.

Planning the technician's toolkit

By Conrad Persson

When a technician travels to a site, whether it's someone's home, an office, or other location, he takes a miniature workbench with him: the toolkit. How efficiently and how effectively he'll be able to get the job done will depend on how much thought and planning went into designing and stocking the toolkit in the first place.

Of course no one expects the toolkit to contain as complete a selection of tools, test equipment and supplies as exists at the service bench. Nevertheless, careful selection of what goes into the toolkit will make it possible for the technician to get a lot more accomplished on site.



The toolkit is a portable version of the workbench. (Photo courtesy of C.H. Ellis Company, Inc.)

Keeping up with the changes

On-site electronics servicing has undergone substantial changes over the years. In the early days, TV sets were vacuum-tube based, and most service calls involved replacing one, or a few, tubes without removing the unit from its permanent location.

As tubes gave way to transistors and then ICs, servicing of the set became substantially more involved, and in most cases on-site servicing consisted of a few checks. If the set could not be quickly restored to operation, the technician would take the chassis back to the service center for service at the bench.

Today, servicing when the technician makes an on-site call has swung back, at least to some extent, to service on site where possible. Projection TV sets, for example, are large and heavy, and just to move a large-screen set from the home to the service center and back can cost in the neighborhood of $100.00 or more. In addition, these units are fragile, and it's easy to scratch the screen or dent the cabinet. If the problem appears to be relatively simple to correct, the technician may make every effort to service the set on site.

The modular construction of some of today's sets makes it more feasible in many cases to service on site. The ability to isolate the cause of a problem to a functional circuit board and then replace the board, rather than to diagnose the cause of the problem all the way down to a component, on site, makes it much easier to service these units.

Companies that service computers and/or office equipment do considerable service on site. Many computer users either can't or won't be without their computers for long, so the servicing technician is under pressure to complete the work immediately.

And computers can often be restored to service quickly. Diagnostic software often makes it possible to pinpoint the cause of the problem quickly. Once the offending circuits have been detected, modular construction often makes it possible to replace the problem board quickly. The problem board may then be returned to the service center for service to the component level, or sent to a depot or the manufacturer for rework.

The portable workbench

Many technological advancements in tools and test equipment have made the toolkit of more value in helping the technician get the job done. Test equipment has become smaller and lighter even as it has become more accurate, more rugged, more reliable and easier to use.

Take the DMM, for example. Before the introduction of semiconductors, the typical portable meter was battery operated, large, heavy, measured only volts, amps and ohms, and loaded the circuit under test. Today, you can quite literally slip some DMMs into a pocket, and with them measure not only current, voltage and resistance, but semiconductor junctions, capacitance, continuity, and more, while loading down the circuit being tested almost not at all.

Oscilloscopes, too, have evolved to the point that some are small enough to put into a toolkit. They're also more rugged and lighter, and much easier to use than older models.

ESD protection kits

There is really no excuse to work on any ESD sensitive product anywhere without precautions. Many manufacturers now offer a kit that consists of a mat that dissipates static electric charge as it

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

builds up. The mat features a snap to which the technician can snap his ESD wrist strap, and the whole thing features a cable that can be connected to the nearest ground. These kits are flexible, and the whole thing can be rolled into a tidy little package and slipped into the tool kit.

Portable solder/desolder equipment

Soldering/desoldering equipment has been made completely portable. Some portable irons are battery operated, some operate on butane gas. Now, even if the service call is somewhere where the technician has no access to 120Vac power, one of these portable soldering irons makes it possible to perform service on site.

Planning a toolkit

In view of these and other recent changes in consumer electronics products and the needs of consumers, the most important tool for stocking an efficient toolkit is planning. Just as you should carefully plan your workspace and decide what products you will service, you must put time and thought into stocking a complete, but still portable, toolkit.

Ask the technicians who actually do the on-site servicing for their opinion on tool selection. You don't have to include every tool they suggest, but their input will contribute to a more efficient toolkit. Evaluate the work your company does, what types of repairs you will make on-site, and what repairs you will only make in the service center.

It might help this effort if every technician made a note when they are unable to complete a service call on site, why they were unable to complete the call. If the reason was lack of a certain tool or test instrument, the service manager might put it on a list of items to be considered for inclusion in the toolkit.

A toolkit planning checklist

Create a checklist to help plan what will go into a toolkit. This might include questions such as what products will be serviced on site, what kinds of tools and test equipment that should be stocked in the toolkit to service that list of products, what kinds of accessories should be added to the toolkit.

The products to be serviced

The first question to be asked in determining toolkit stocking is what types of products will be serviced. It might be a good idea to create a list of potential products, then determine which of these it would make sense to service in the home. The list might be something like this:

- TV (projection and large screen) - Yes. Too cumbersome to move.
- TV (portable and table model) - No. Can be carried in.
- Microwave oven - No. Can be carried in.
- VCR - No. Can be carried in.
- Camcorder - No. Can be carried in.
- Computer - Depends on nature of computer and user.

The tools

Every toolkit needs a basic complement of hand tools and other specialized tools, no matter what types of products will be serviced on site. A list of these is pretty straightforward:

- Screwdrivers/nut drivers
- Wrenches
- Pliers
- Wire cutters/strippers
- Crimping tool
- Knife
- Retaining ring pliers
- Computer keycap removal tool
- Soldering iron

The test equipment

The test equipment that should go into a toolkit will of course depend on how committed a particular service center will be to servicing on site, the skills possessed by the technician who does on-site service, and other factors best determined by the service manager. Following is a general list of test equipment from which the toolkit items may be chosen:

- Oscilloscope (battery-operated, if this is to be used without isolation
- DMM
- Leakage tester
- Microwave oven test meters
- Computer diagnostic discs

Accessories

Certain accessories, such as ESD preventive equipment should be a mandatory item in every toolkit. Other accessories can help a technician see, or gain access to an otherwise inaccessible area, or otherwise make the job of servicing a product easier. Here's a list of accessories:

- A grounding wrist strap and antistat-

ic mat. Also include antistatic bags to carry static-sensitive printed circuit boards.

• An angled mirror like the ones used by dentists may enable the technician to see into the dark recesses of a product.

• A hand magnifier will allow the technician to see details that otherwise would not be visible.

• A flexible shaft or angled shaft may allow removal and replacement of screws that might otherwise be inaccessible without extensive disassembly.

• A power screwdriver will make it easier and faster to remove screws and screw them back in again.

• Small parts retrievers, one magnetic and one spring loaded grabber, can turn desperate scrambling into routine servicing, but the technician must be careful to keep the magnetized retriever away from the diagnostic disks.

• A flashlight and an ac-powered lamp. This will allow the technician to place enough light wherever it is needed, regardless of the lighting in the environment he's working in. Spare light bulbs and batteries would also be a good idea.

• 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 accessories and 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.

Communications equipment

Two-way communication, either via a two-way radio system or a cellular telephone, or both, might more than pay for itself. Some larger consumer electronics service centers now equip their field technicians with wireless communications.

In many cases, if a field technician is faced with a problem he just can't quite solve, consultation with a more experienced technician back at the service center might turn a "I'll have to take it into the service center" situation into a "you're back in business" situation.

Another way in which service centers use two-way communication between the field technician and home base is to arrange express delivery of parts from the service center or a distributor to the work site to avoid interrupting a repair or taking a set into the service center.

Choose the tool case carefully, too

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.

Talk to the experts

Another approach to putting a toolkit together is to buy one already designed and stocked. Companies that sell tools and toolkits are in constant touch with customers, study their needs and design and stock toolkits of all kinds. It's entirely possible that a tool manufacturer has already studied the needs of service centers like yours and has available a kit with not only every tool and test device you might need, but a pouch, flap, or pocket designed just to fit it. You might even find that they seem to know as much about your servicing needs as you do. You might also find that if they don't have exactly what you need, they might be willing to work with you to design and stock what you do need.

Learn from experience

When you're planning a toolkit, until you've thought it through, then made alterations based on the experience of the technicians who use the toolkit to get the job done, you'll find that there will be times when the toolkit doesn't have the right tool in it to complete a repair.

The converse will also be true. The technicians may find out after a while that they are lugging around some heavy tools that they never use. Still, a well-planned, efficient toolkit will minimize such problems, and reduce the number of return trips to the site.

When experience determines that a needed tool isn't available, it can be added. When a particular tool or other item is determined to be unnecessary, it can be removed from the toolkit.

A little planning and organization, and experience, in putting together the toolkit can save you (and your customers) from a lot of frustration. ■

Understanding TV horizontal output/deflection circuits

By Glen Kropuenske

To many technicians, the operation of the horizontal output stage and flyback transformer of a TV set is mysterious. Few technical books provide a clear explanation of how the stage operates. Therefore, when the stage develops problems, as it often does, technicians have difficulty interpreting the waveform in this circuit and relating symptoms to possible causes.

This article describes the operation of a horizontal output circuit and examines the currents and voltages within the stage. In a later issue we'll examine what measurements you can make in the horizontal output stage and how to use those measurements to isolate defects.

Key horizontal output stage components

The horizontal output circuit consists of six key components:

- horizontal output transistor (Q1),
- flyback transformer (flyback),
- retrace timing capacitor or "safety cap" (Ct),
- damper diode (D1),
- horizontal yoke,
- yoke series capacitor (Cs).

Figure 1 shows a simplified horizontal output stage with these six components.

Although there are many different TV and monitor chassis, the horizontal output stages operate virtually the same in all of them. The stage is energized by current from a B+ power supply flowing through the primary winding of the flyback transformer. The path for current is provided by the conduction of the horizontal output transistor (HOT).

Once energized, the horizontal output stage switches between two resonant LC circuit conditions. The resonant LC circuits are formed by the flyback, yoke and capacitors in the horizontal output stage. Currents alternating in the stage produce sawtooth currents in the yoke and primary winding of the flyback transformer. The sawtooth current in the yoke provides the magnetic field that deflects the electron beam across the CRT screen, thus painting the TV picture. Lets look at the role that each component plays in the operation of the horizontal output stage, then put them together and analyze the circuit.

Horizontal output transistor (HOT)

The horizontal output transistor serves as a switch. It switches on and off at the horizontal scan frequency of the TV or monitor. When switched on it provides a low resistance path for the flyback primary and yoke currents. When switched off it serves as an open circuit.

Like a class C amplifier, the horizontal output transistor has no dc bias applied to its base. The transistor is switched on by the drive signal applied to the base/ emitter junction. Because the horizontal output transistor is a power transistor, it is base current, resulting from the drive, that actually controls the transistor switch.

One of the biggest misconceptions about the horizontal output stage is when the horizontal output transistor is on. Many mistakenly believe that the horizontal output transistor is conducting when the flyback pulse is produced at the collector (retrace or sync time). This is

Kropuenske is an applications engineer for Sencore.

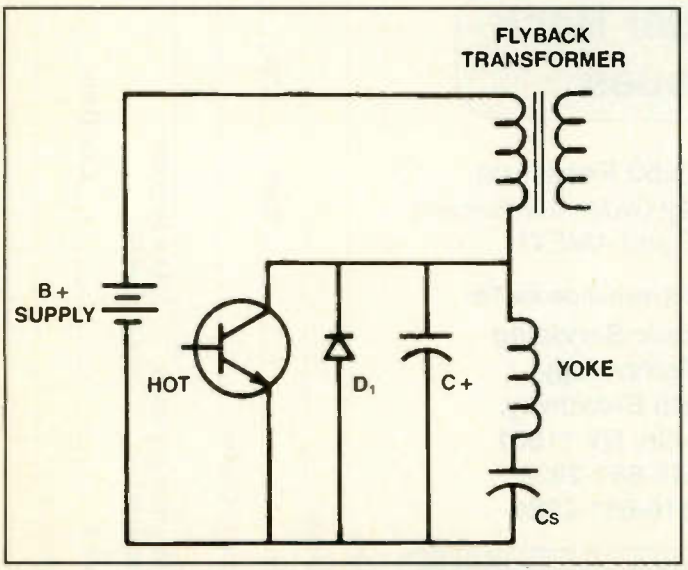


Figure 1. The horizontal output circuit consists of six key components.

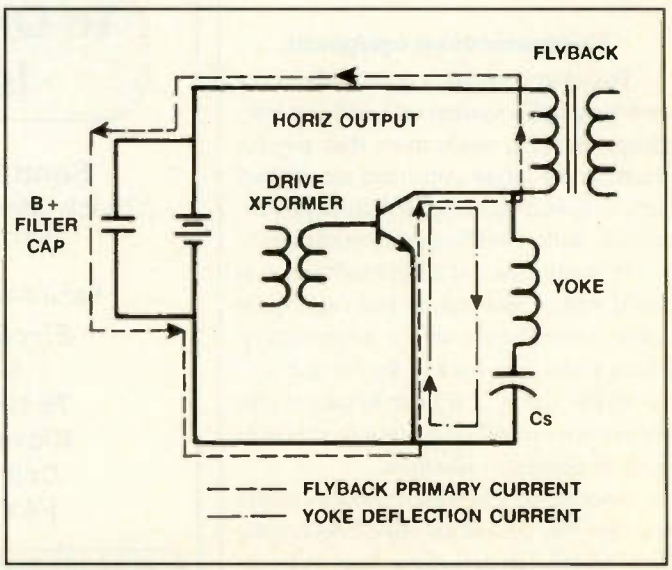


Figure 2. Horizontal output transistor conduction current paths.

not the case. The horizontal oscillator and driver stage are synchronized to turn the horizontal output transistor on prior to horizontal sync or retrace. In a TV receiver, the transistor turns on 30µS to 35µS before horizontal sync or retrace. The transistor is switched off at the start of horizontal sync. See Figure 2.

Because a power transistor is not an ideal switch, several factors can influence the operation of the horizontal output stage. First, for proper operation, the base drive current must bias the transistor into a completely "on" state, meaning low collector-to-emitter resistance. Insufficient drive leaves resistance between the emitter and the collector, which resists current flow and generates high transistor heat.

Equally critical is the time it takes to switch the horizontal output transistor between on and off states. As the transistor switches, the emitter to collector resistance changes from less than 5Ω (on) to greater than 10MΩ (off). Current flowing through the transistor during the transitions produce heat. Longer transitions result in higher transistor heating. Switching irregularities can cause the horizontal output transistor to develop excessive heat and fail.

Second, transistor theory dictates that the amount of collector current that will flow through the transistor is determined by multiplying the base current by the current gain (beta) of the transistor. Unlike other switching transistors, the base current may be considerable (100mA to 300mA) to deliver the needed collector current peaks.

The transistor must have proper gain (beta) and the horizontal driver stage and driver transformer must produce adequate base current. Reduced beta or insufficient base drive current limits collector current, starving the flyback and yoke of current needed to produce full deflection and high voltage.

Flyback transformer

The horizontal output transformer is called the flyback or integrated high voltage transformer (IHVT). An IHVT is a flyback transformer that includes the high voltage multiplier. The flyback is primarily responsible for developing high voltage. It is constructed with a powdered-iron or ceramic core to work efficiently at high frequencies.

The flyback transformer includes one primary winding and many secondary windings. The main secondary winding supplies voltage pulses to a voltage multiplier. Other secondary windings supply CRT filament power, keying pulses and scan-derived power supplies.

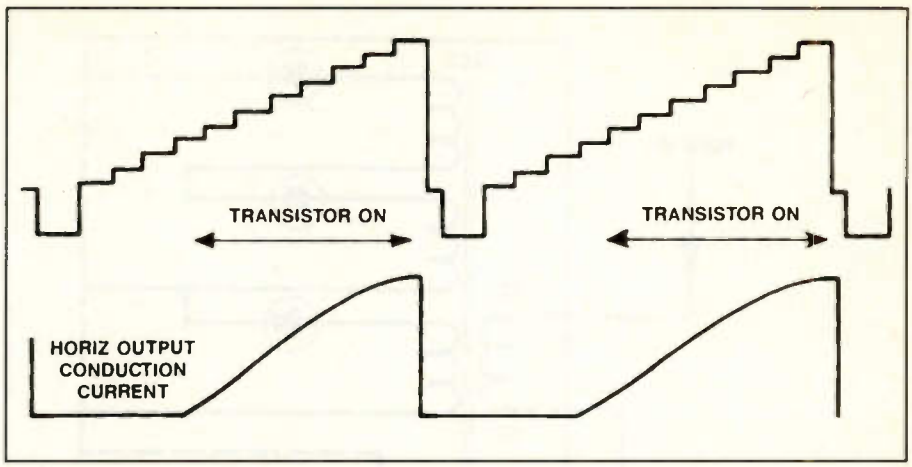


Figure 3. Conduction time of the horizontal output transistor relative to one horizontal line of video.

The horizontal output stage develops high voltage pulses to the individual windings of the flyback transformer. This is accomplished as a result of the inductive nature of the flyback transformer primary, along with timing capacitors and the horizontal output transistor. To understand how these pulses are produced you need to recall some inductor theory.

Inductor theory tells us that the voltage induced across any inductance is always proportional to the rate of change of current with time. This means that a fast current change in an inductor can produce a large induced voltage. This large induced voltage is known as an inductive "kick."

The mathematical formula that gives the relationship between the voltage across and inductor and the current through it is:

$$V_L = L(di/dt)$$

where L is the inductance and di/dt is the expression for the rate of change of current through the conductor with time at any instant.

During the conduction time of the horizontal output transistor, there is an inductive or linear rise in current in the flyback primary. This increase in current produces a constant induced voltage across the flyback windings. When the horizontal output transistor is abruptly turned off current flow in the flyback primary abruptly ends. The magnetic field within the flyback core collapses rapidly, producing a high induced voltage into the flyback primary and secondary windings.

In the horizontal output stage, the rate of change of current, and thus the rate of collapse of the magnetic field in the flyback primary, is slowed and controlled with timing components (Ct). If the rate of the collapsing field was not slowed it would produce an induced voltage spike of several thousand volts across the flyback primary. The spikes would exceed the breakdown rating of the horizontal output transistor and produce excessive high voltages to all flyback windings.

Despite the inductive "kick" action to produce high voltage pulses, the flyback transformer works similar to other transformers in transferring energy to its secondary windings. If the secondary circuits were opened, the inductive flyback transformer would return the energy stored in the magnetic field back to the primary circuit. When secondary circuits draw power (volts x current), the transformer action transfers power from the resonant primary circuit to the transformer secondaries. Some problems, such as a shorted flyback secondary circuit or flyback transformer (shorted turn) cancause excessive circuit power losses.

Retrace timing capacitor (Ct)

The retrace timing capacitor plays an important role in the operation of the horizontal output stage. The capacitor is sometimes referred to as a "safety" capacitor because it acts to hold down the high voltage. It does this by slowing the change in current through the flyback, and thus the collapse of the flyback's magnetic

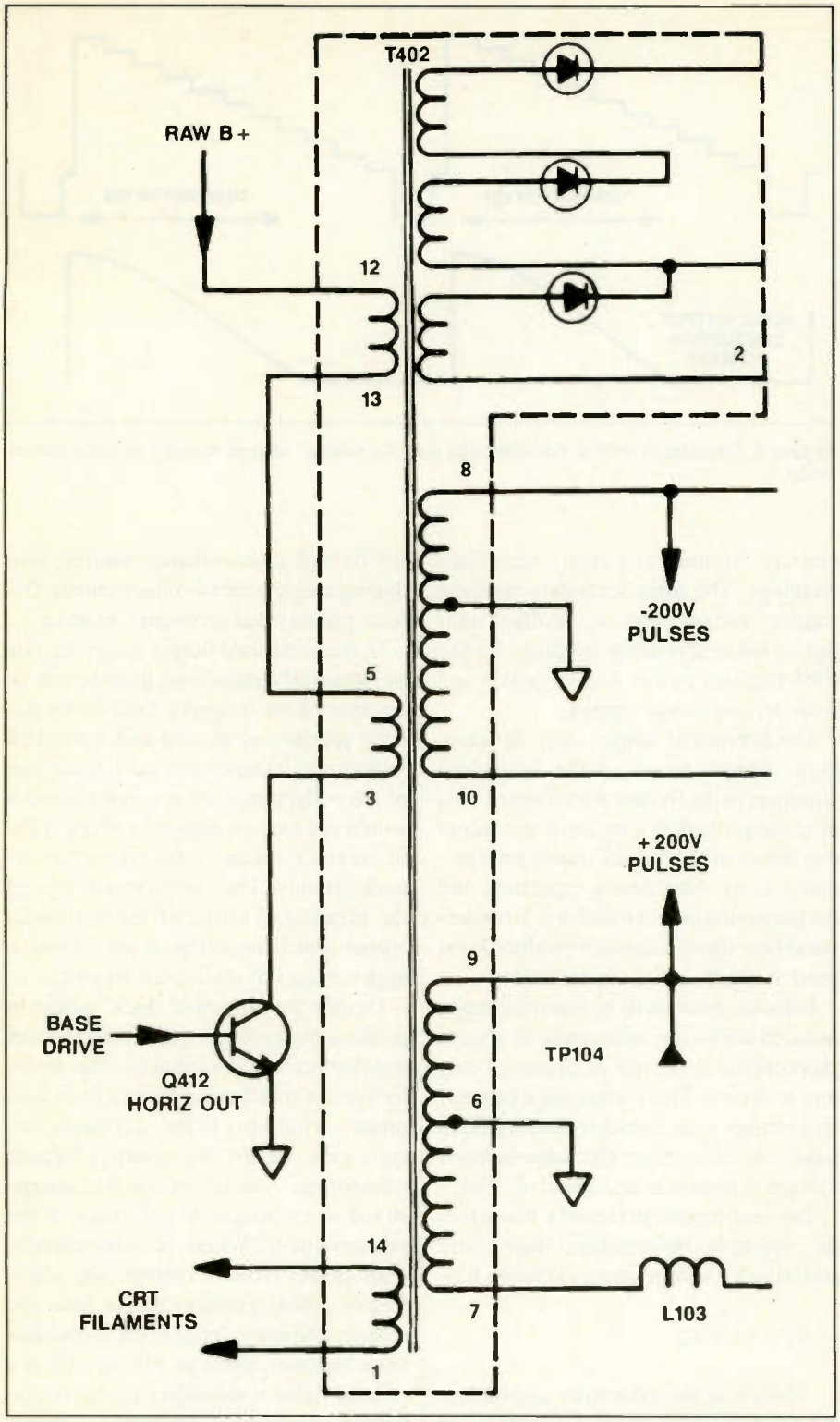


Figure 4. The flyback transformer includes one primary winding and many secondary windings.

field which determines the amplitude of the flyback pulse. If the capacitor reduces in value or opens, the flyback voltage pulses would rise several thousand volts. To minimize the danger, smaller capacitors are sometimes connected in parallel. Manufacturers have added safety shutdown circuits to disable drive or B+ to the horizontal output stage in the event of excessive high voltages.

Damper diode (D1)

Like the horizontal output transistor, the damper diode serves as a switch. The damper diode completes the circuit path for the flyback primary and yoke currents during a portion of the resonant cycle in the horizontal output stage. Therefore, the damper diode must pass several amperes of current and switch at high horizontal frequencies. If the damper diode opens, the horizontal output transistor is forced to operate in reverse breakdown. This causes the horizontal output circuit to be inefficient and causes the horizontal output transistor to heat and eventually fail.

Horizontal yoke and yoke series capacitor

The horizontal yoke is responsible for deflecting the CRT's electron beam. A sawtooth current in the horizontal yoke moves the CRT electron beam continually from left to right across the face of the CRT. Capacitor Cs is placed in series with the yoke to develop the resonant timing and prevent dc current from flowing. DC current to the yoke would cause improper picture centering. Capacitor Cs further shapes the sawtooth rise in current to match the slight curvature of the CRT. Because the yoke and its series capacitor are part of the horizontal output stage, they influence the resonant timing of the horizontal output stage.

Understanding the horizontal output stage operation

Now lets put the components together and see how the whole circuit operates. We will analyze the output stage in two parts according to the major functions it performs:

- flyback primary current and retrace,
- horizontal deflection.

The first function, flyback primary current and retrace time, is responsible for producing CRT high voltage, focus and scan derived supplies. The second function, as its name implies, deals with deflecting the electron beam. Although these functions interact and are part of the same circuit, discussing them separately will help you to better understand the operation of the output stage.

Flyback primary current and retrace time

Understanding the alternating sawtooth current paths of the flyback transformer primary help explain how the horizontal output circuit functions, and how the retrace timing capacitor affects the operation of the circuit. Figure 6 breaks down the flyback action and current paths into four separate periods beginning with

the conduction time of the horizontal output transistor.

When the horizontal output transistor is on (6A), primary current rises in the flyback primary. Current is sourced from the B+ power supply. It is during this period that all the power needed by the stage and flyback secondaries is delivered to the circuit. The inductive current build-up continues until the transistor is turned off.

During the next three periods the magnetic energy stored in the flyback is exchanged with the retrace timing capacitor. The resulting current alternates through the flyback primary transferring power to the secondary load circuits.

Immediately after the horizontal output transistor turns off, the magnetic field of the flyback begins collapsing. This is the beginning of the retrace time which corresponds to the start of horizontal sync. When the horizontal output transistor is switched off, the retrace timing capacitor is effectively placed in parallel with the flyback primary forming a resonant circuit as shown in figure 6B & C. The resonant circuit timing is determined by the retrace capacitor and equivalent flyback inductance. Timing is also slightly influenced by the yoke components in parallel with Ct.

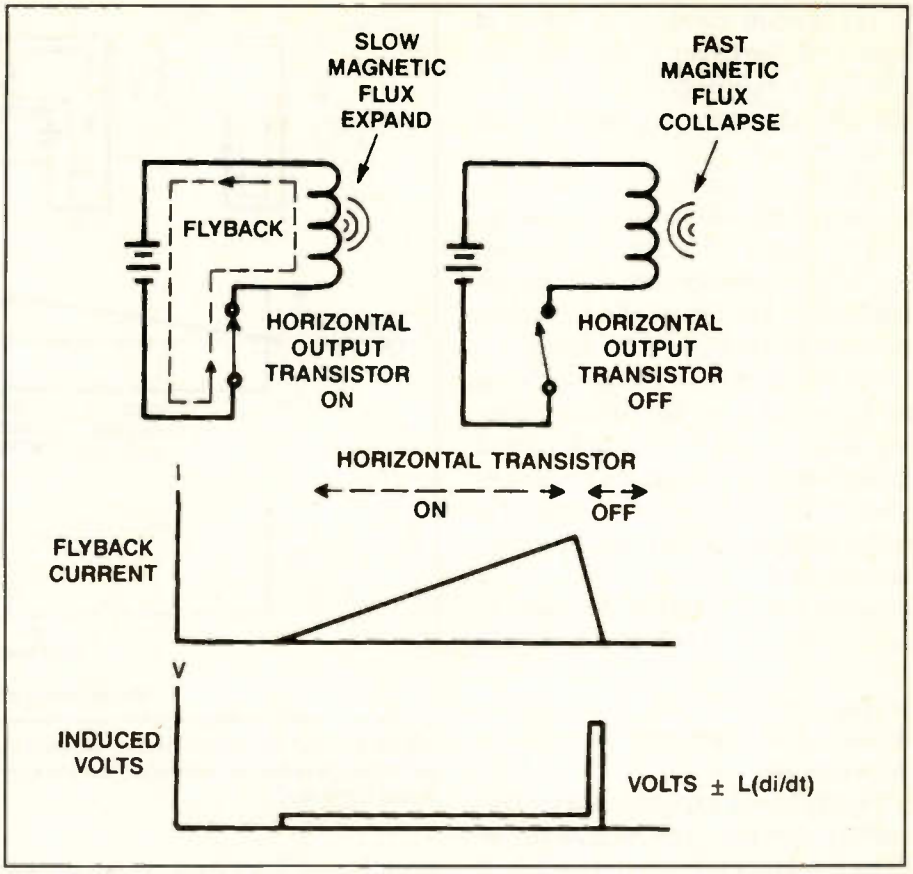


Figure 5. The rapidly collapsing magnetic field of the flyback transformer when the horizontal output transistor is switched off produces a high voltage pulse.

With the horizontal output transistor off, the collapsing magnetic field of the flyback produces current flow through the low impedance of the B+ supply filter capacitors, charging Ct. The rise in voltage across Ct is the flyback pulse formed at the collector of the horizontal output transistor. This is the only voltage waveform available to help analyze operation of the horizontal output stage.

When the flyback's magnetic field is collapsed, Ct begins to discharge, reversing the direction of current through the flyback primary. This completes the second part of retrace time and is the falling portion of the flyback voltage pulse viewed at the collector of the horizontal output transistor. Properly operating horizontal output stages of television receivers produce a total retrace period (flyback pulse duration) lasting anywhere from 11.3µS to 15.9µS. Computer monitors may have much shorter retrace times under normal operation depending on their horizontal scan rates.

When Ct has completely discharged, the magnetic field begins to collapse inducing a voltage with a polarity that forward biases the damper diode D1 (6D). The damper diode serves as a switch to allow magnetic energy in the flyback and yoke to decay at the same rate as when the horizontal output transistor was on. When the damper diode turns on, the circuit becomes highly inductive once again producing a slowly changing current in the flyback primary. Before the current fully decays, approximately 18µS later in a television receiver, the horizontal output transistor is once again turned on and the cycle repeats.

Understanding horizontal yoke deflection

The second major function of the horizontal output stage is to provide deflection current. Most horizontal output stages now use a direct method of providing yoke current. With this arrangement the horizontal output transistor's collector current splits two ways between the flyback and yoke. The flyback and yoke currents utilize a common damper diode and retrace timing capacitor.

Figure 7 breaks down the yoke deflection current into four separate events to gain a better understanding of how deflection current and timing is achieved. When the horizontal output transistor is switched on (7A), the bottom of the yoke series capacitor Cs is connected to the top of the yoke. Capacitor Cs is fully charged at this time and begins to discharge current through the horizontal output transistor. The resulting current produces an expanding magnetic field in the yoke which moves the electron beam from the center of the CRT to the right.

When the horizontal output transistor opens, the retrace timing capacitor is added to the circuit (Figure 7B and 7C). This increases the resonant frequency producing a rapid collapse of the yoke's magnetic field. This is the beginning of retrace time and the CRT beam is snapped from the right side back to the center. The induced voltage causes current to flow, returning the energy stored in the yoke to capacitors Ct and Cs. It is at this time that the retrace timing capacitor is replenished with charging current from the flyback transformer. It then serves as the current source for the yoke current.

During the second part of retrace, Ct

and Cs discharge and force current flow in the opposite direction as shown in Figure 7C. The timing is identical to the first part of retrace and the CRT beam is moved quickly from center to the left side of the screen.

When capacitors Ct and Cs are fully discharged, the yoke's magnetic field begins to collapse (7D). The induced voltage forward biases the damper diode into conduction. The timing of the circuit is now determined by the yoke and capacitor Cs and agrees with the timing during the right trace time. The yoke's collapsing magnetic field produces current through the damper diode, returning energy to the circuit charging Cs. The point at which the damper diode conduction stops is determined by the decay of the yoke's magnetic field. In order to avoid non-linearities in the center of the raster, the timing must coincide with the point at which the horizontal output transistor yoke conduction begins.

To simplify our explanation of the horizontal output stage we have analyzed the flyback and yoke operations separately. It should be noted that these circuits are not independent of each other. The flyback current is transferred to the yoke by the retrace timing capacitor Ct. The yoke and flyback currents share the conduction time of the horizontal output transistor and damper diode. They further share the retrace timing capacitor. Because of this interaction, most problems in the horizontal output circuits alter both the flyback and yoke currents.

In the next article we'll look at measurements you can make to analyze the horizontal output stage and how these measurements can help you isolate the problem. ■

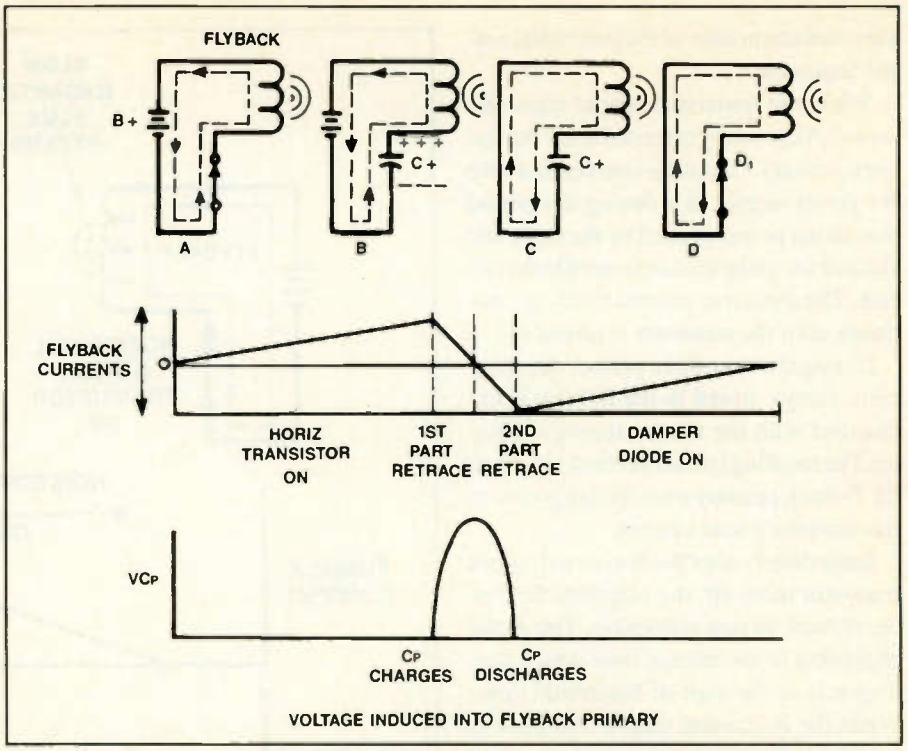


Figure 6. Four equivalent circuits showing the alternating flyback current wave form and flyback voltage pulse for one horizontal line interval beginning with the "on" time of the horizontal output transistor.

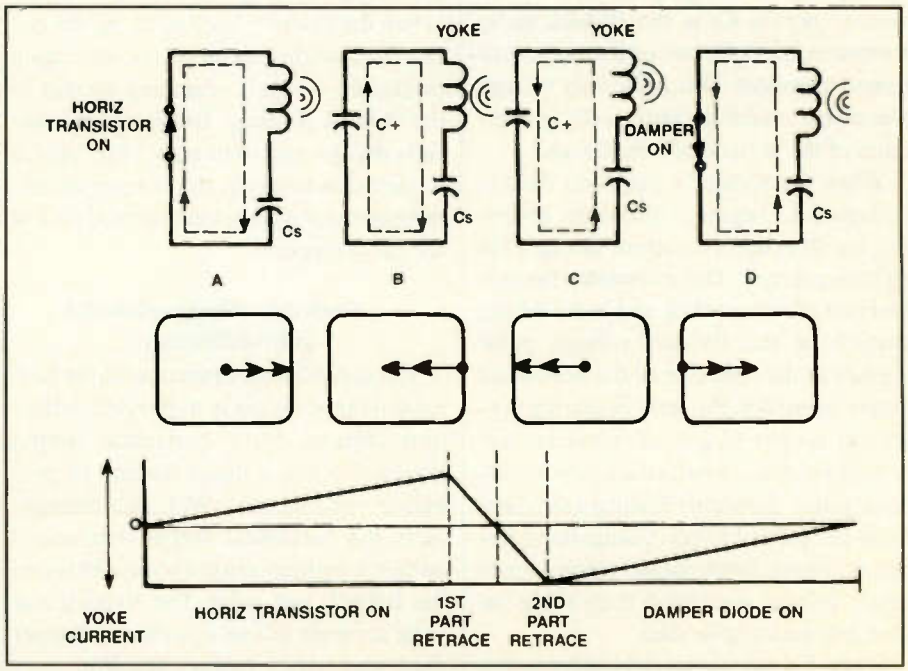
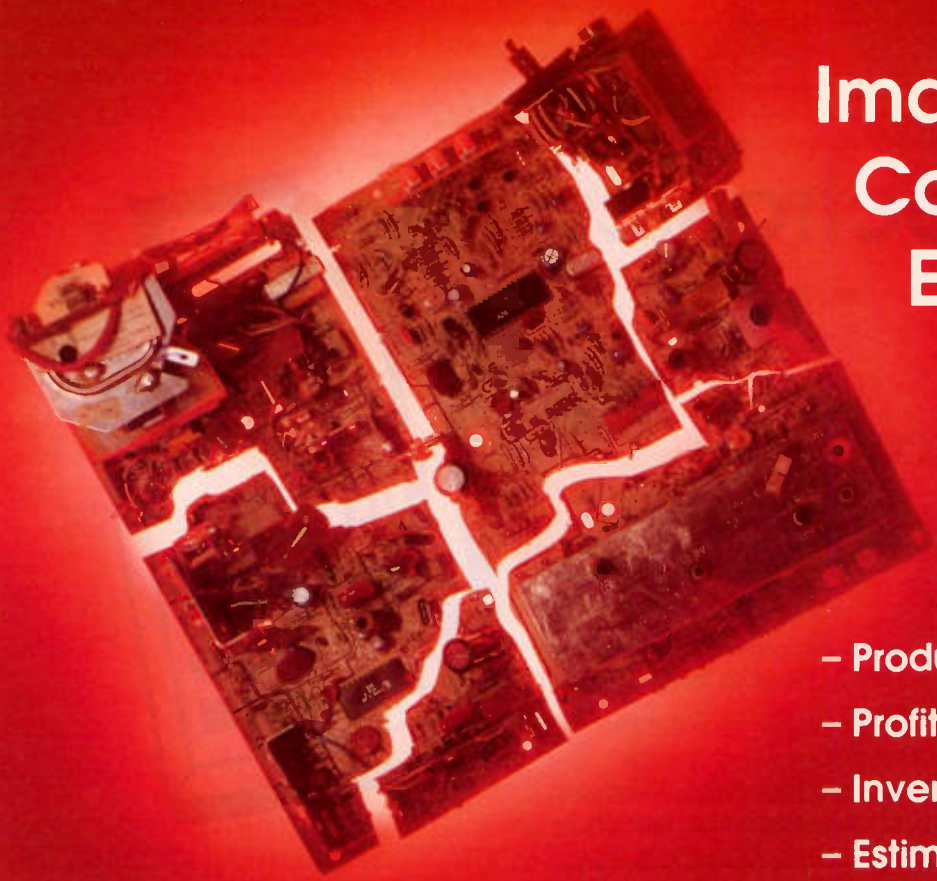


Figure 7. Four equivalent circuits showing the alternating flyback and yoke currents and relative position of the electron beam on the face of the CRT.



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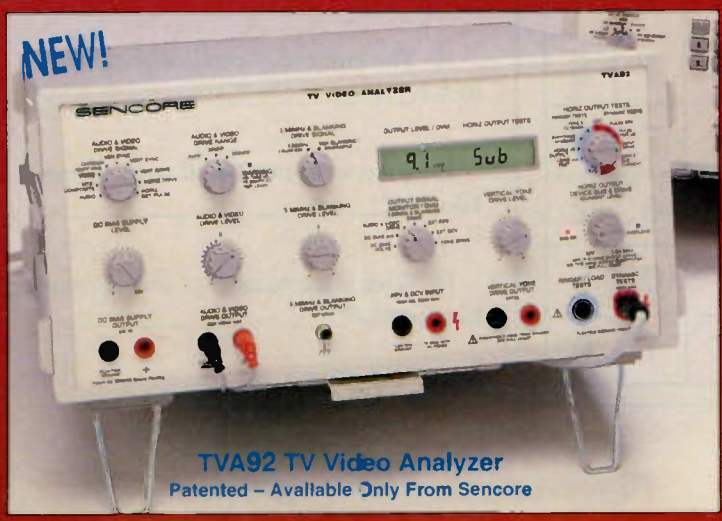

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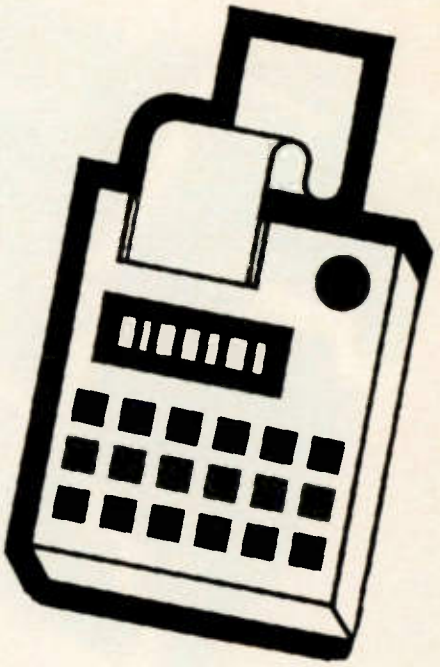

Circle the *complete* answer in the matrix including the zero before a decimal (for example: 0.15, not .15). Numbers can go any direction *except* backwards (for example: from right to left). Any number in the matrix can be used as part of more than one answer.

If you don't feel up to a hunt right now, just check your answers with those given on another page.

1. What is the numerical value of epsilon? _____

Wilson is the electronics theory consultant for ES&T.

2. To accurately convert the RMS value of a sinewave voltage to the peak value, multiply by _____.

3. To accurately convert peak sinewave voltage to the average value, multiply by _____.

4. What is the power factor when the phase angle between the voltage and current is 27.5 degrees? _____.

5. In the equation for resonant frequency, $fr=x/\sqrt{LC}$, the value of x is _____.

6. The number of radians in 180 degrees is _____.

7. To convert feet to meters, multiply by _____.

8. To accurately convert peak sinewave current to the RMS value, multiply by _____.

9. The decimal equivalent of 5/32 is _____.

10. There are _____cubic inches in a cubic foot.

11. What is the cube root of 1157625? _____.

12. The number of centimeters in one inch is _____.

13. What is the number of watts in one kilowatt?_____.

14. What is the number of watts in one horsepower?_____.

1	3	4	3	7	2	7	2	8	8	2	1
0	1	5	9	1	5	4	9	2	6	5	0
8	1	6	0	9	4	7	8	6	5	5	0
8	0	6	3	6	6	1	9	7	7	2	0
7	1	3	0	2	8	3	5	6	4	7	1
0	4	9	4	2	6	7	5	9	3	1	5
1	7	2	8	7	3	9	9	9	2	7	6
5	1	1	4	1	4	2	1	3	5	6	2
0	7	0	7	1	0	6	7	8	1	0	5
2	6	6	3	5	1	0	1	3	7	1	0

(Answers on page 63)

ES&T Manufacturers' schematics **PROFAX**

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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.

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

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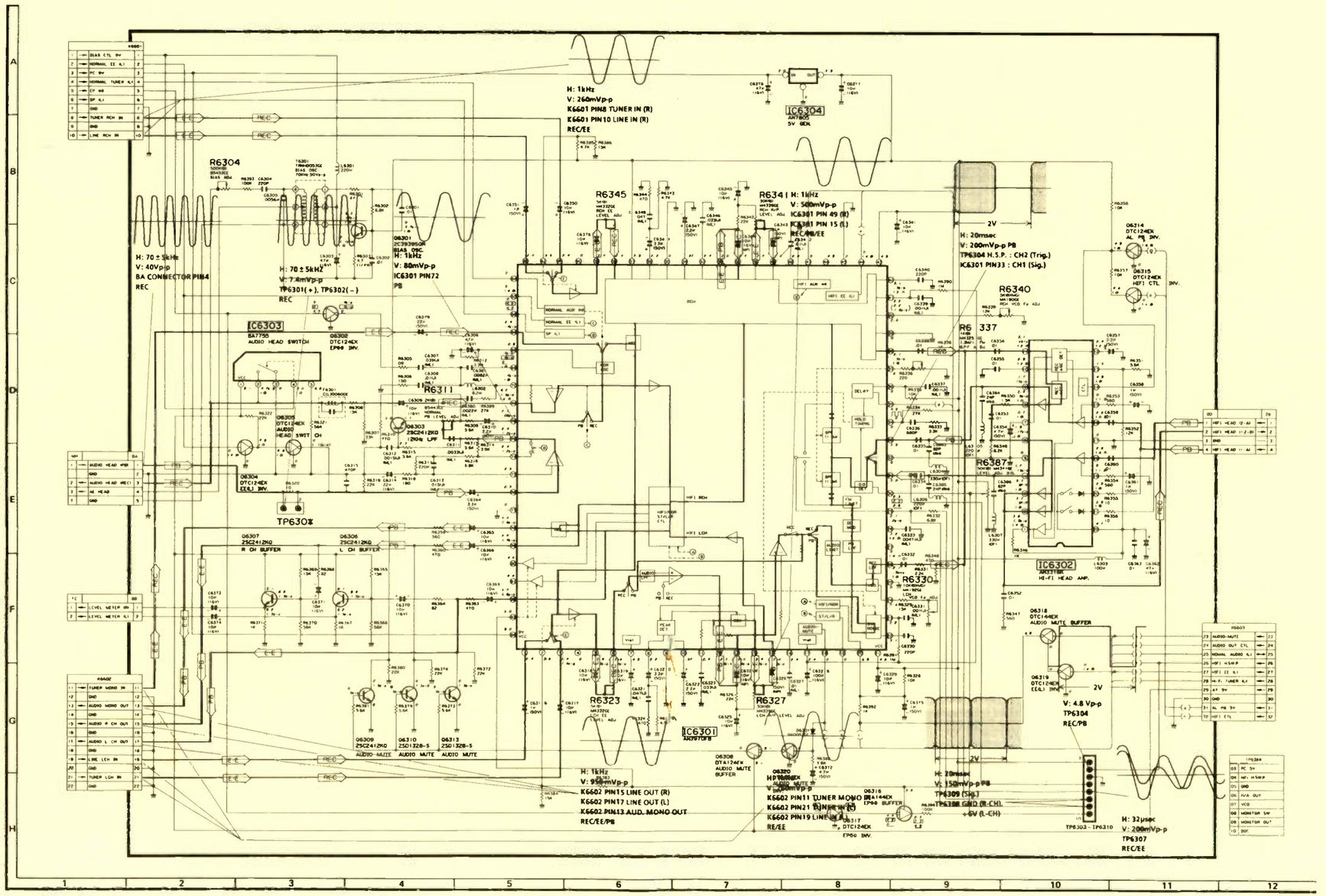

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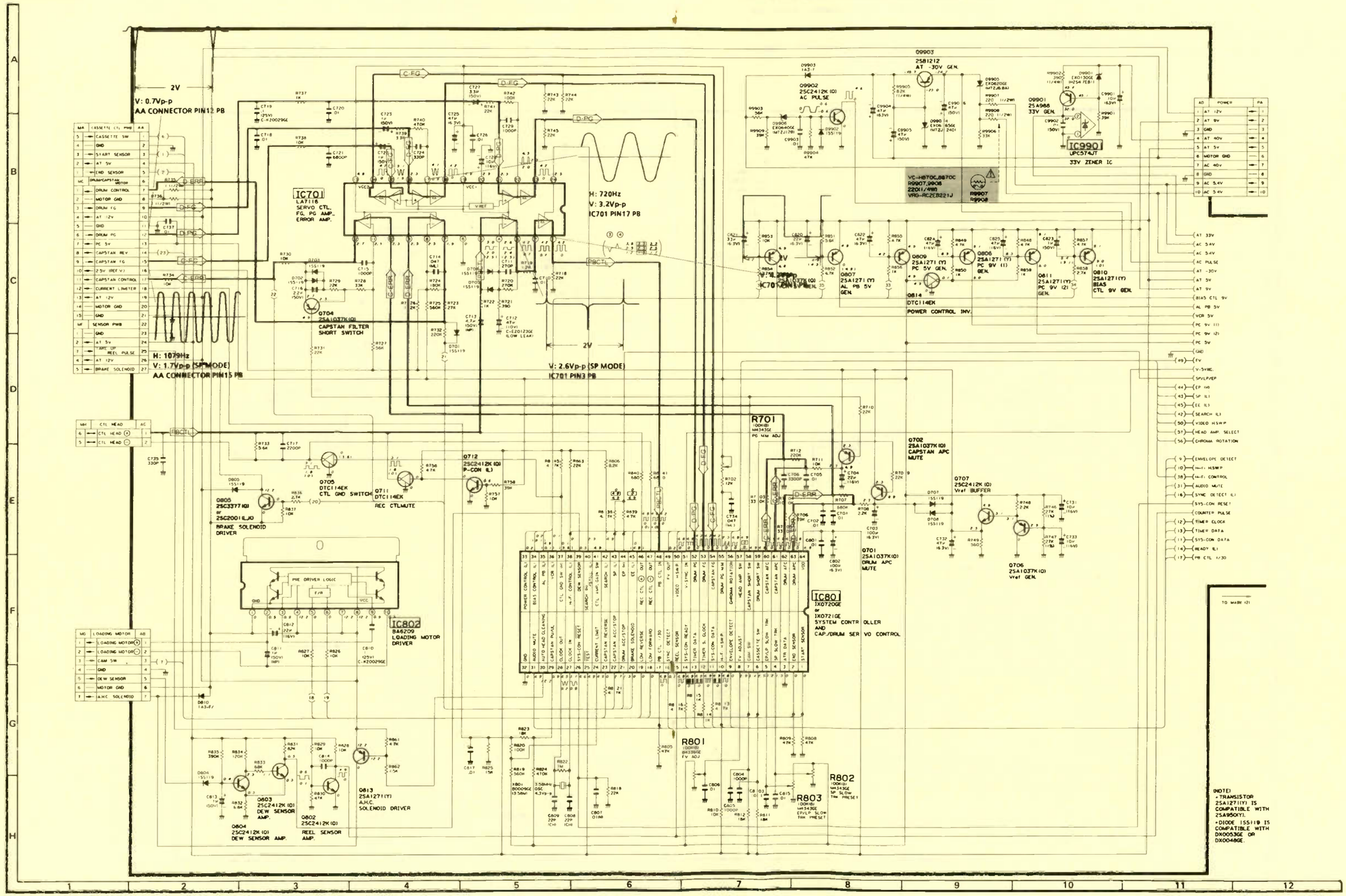

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Product safety should be considered when component replacement is made in any area of an electronics product. A star next to a component symbol number designates components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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.

All integrated circuits and many other semiconductors are electrostatically sensitive and require special handling techniques.

Manufacturers' schematics PROFAX 3102

MAIN-2 CIRCUIT

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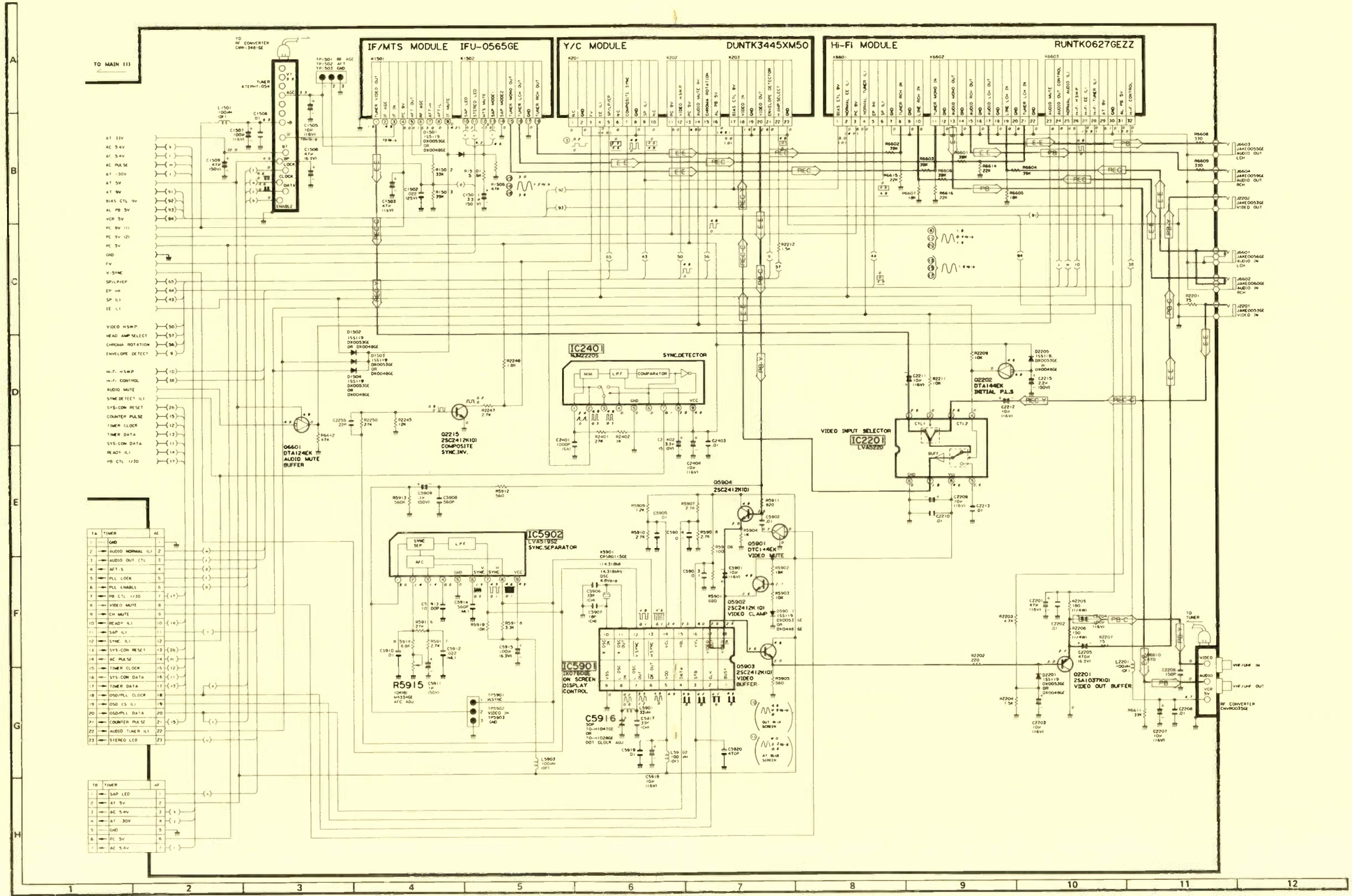

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3102

Sharp
Video Cassette
Recorder
Models VC-H870U/C,
VC-8870U/C

PROFAX Manufacturers' schematics

MAY 1993

Y/C CIRCUIT

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Y/C CIRCUIT

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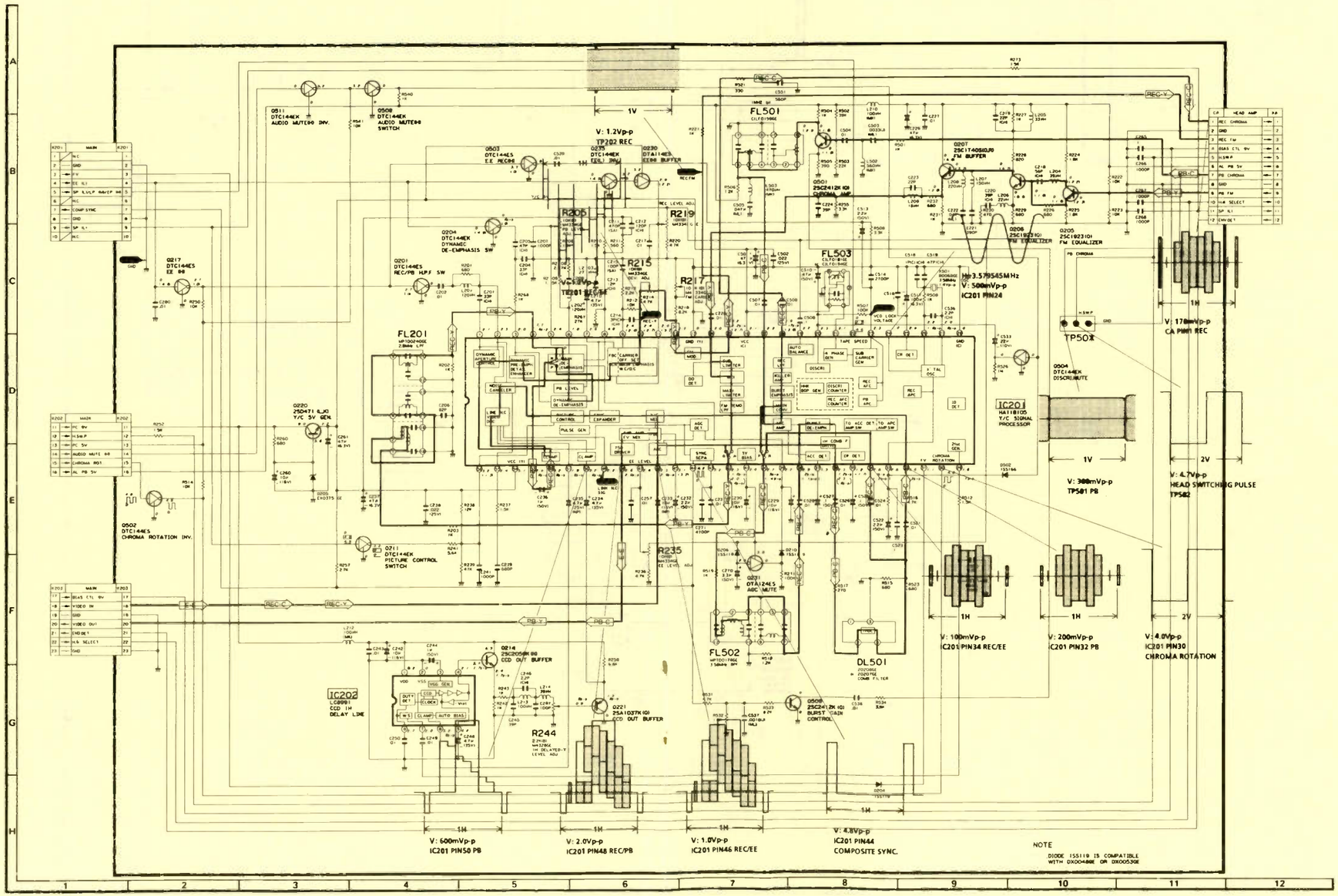
Manufacturers' schematics PROFAX 3102



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ES&T Manufacturers' schematics PROFAX

MAY 1993

Profax Number

SHARP
Color TV Chassis No. 20R1, Model 20SB65 3103

SCHEMATIC DIAGRAM: SIGNAL MODULE

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ES&T Manufacturers' schematics PROFAX 3103

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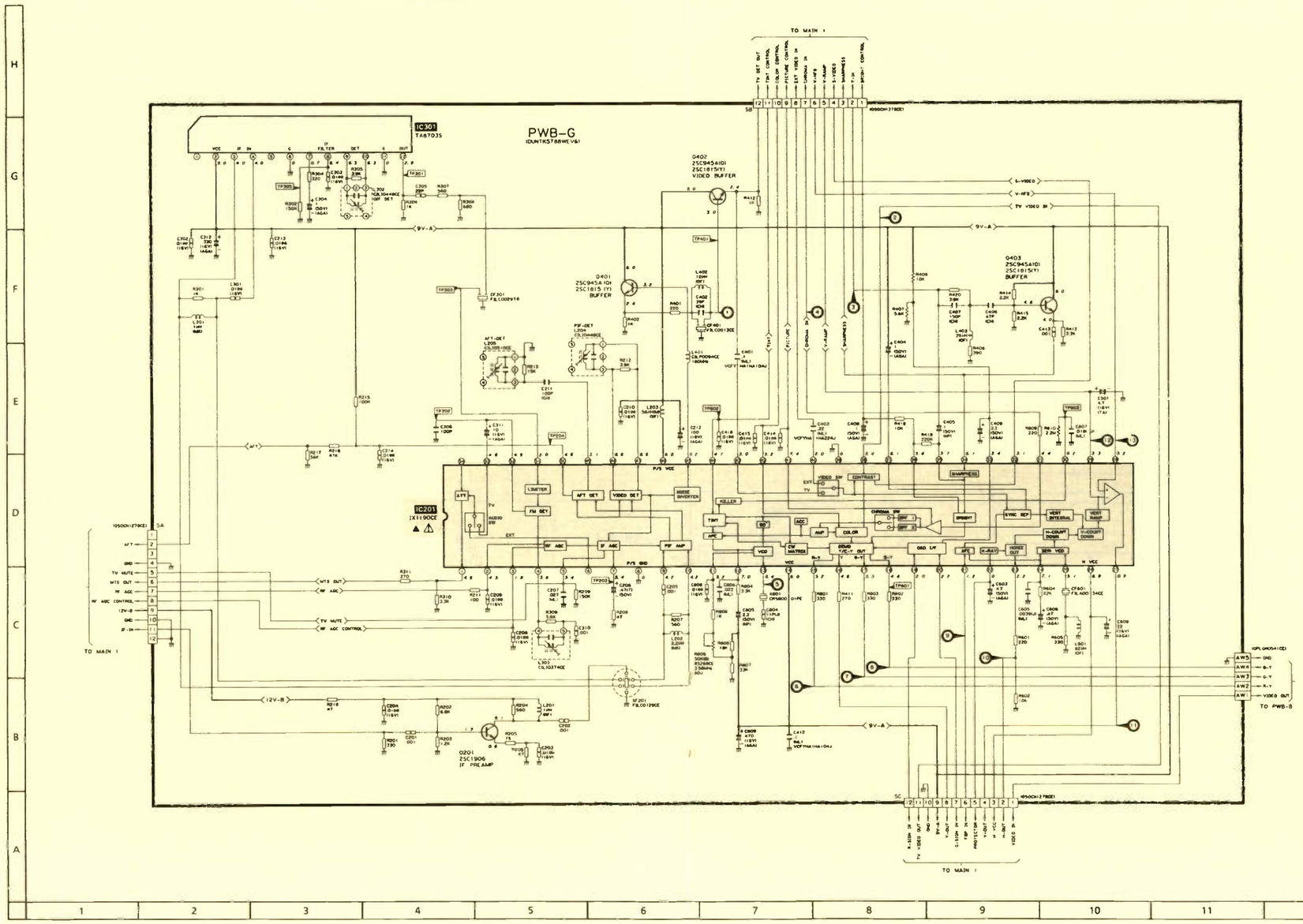

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SCHEMATIC DIAGRAM: MAIN-1

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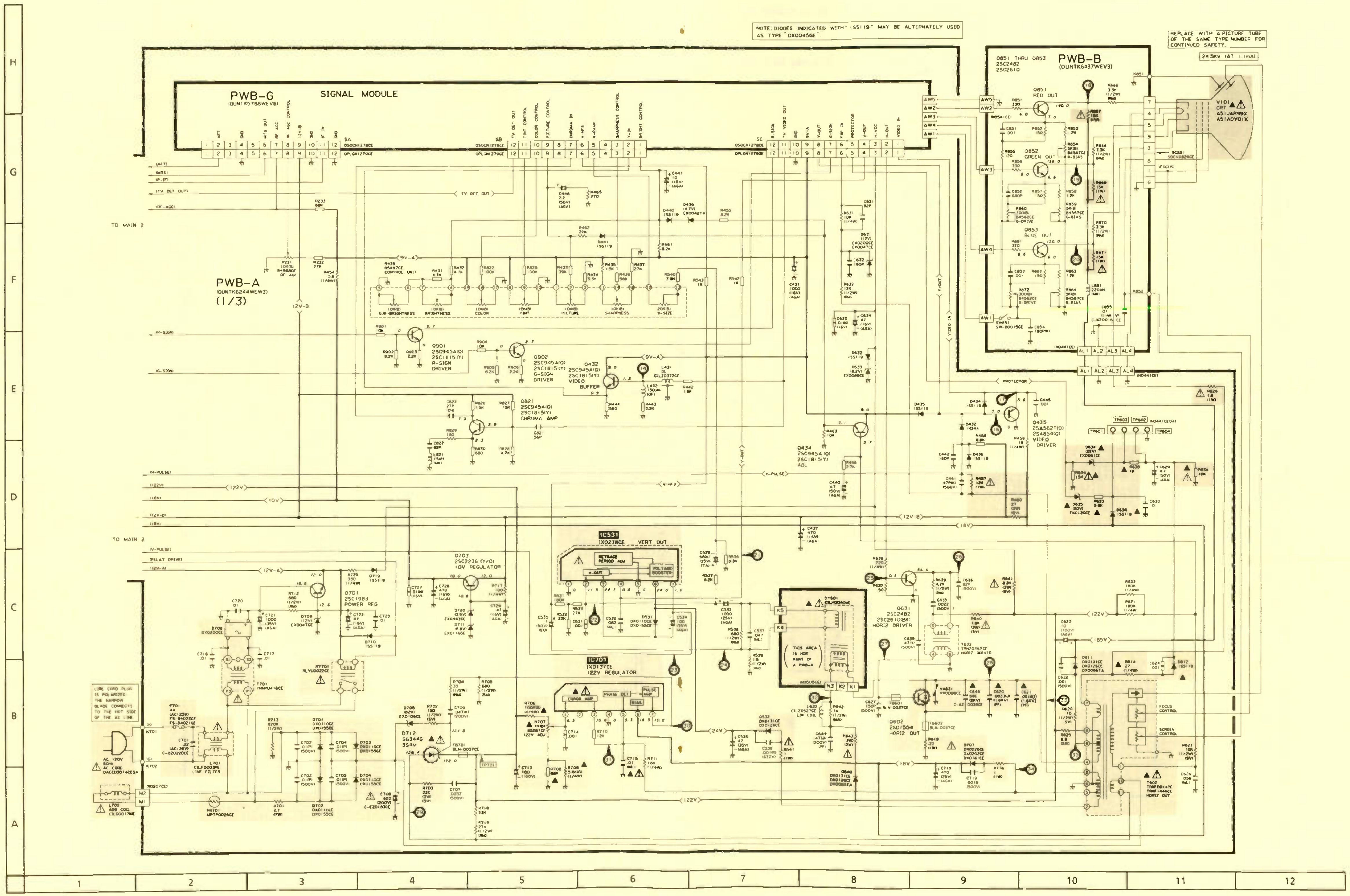

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SCHEMATIC DIAGRAM: MULTIPLEX TELEVISION SOUND (MTS) MODULE

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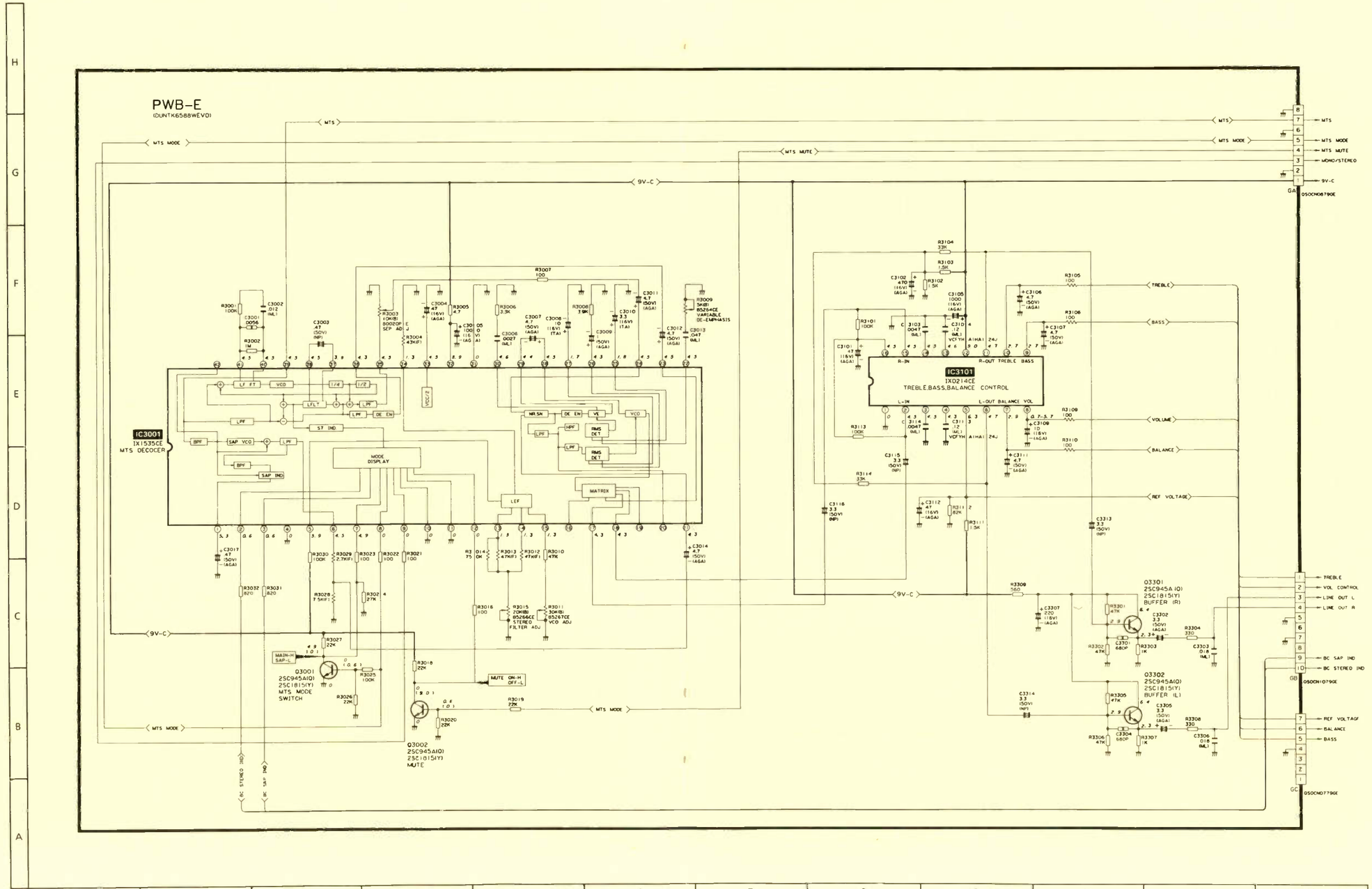

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SHARP
Color Television
Chassis No. 20R1
Model 20SB65

SCHEMATIC DIAGRAM: MAIN-2

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SCHEMATIC DIAGRAM: MAIN-2

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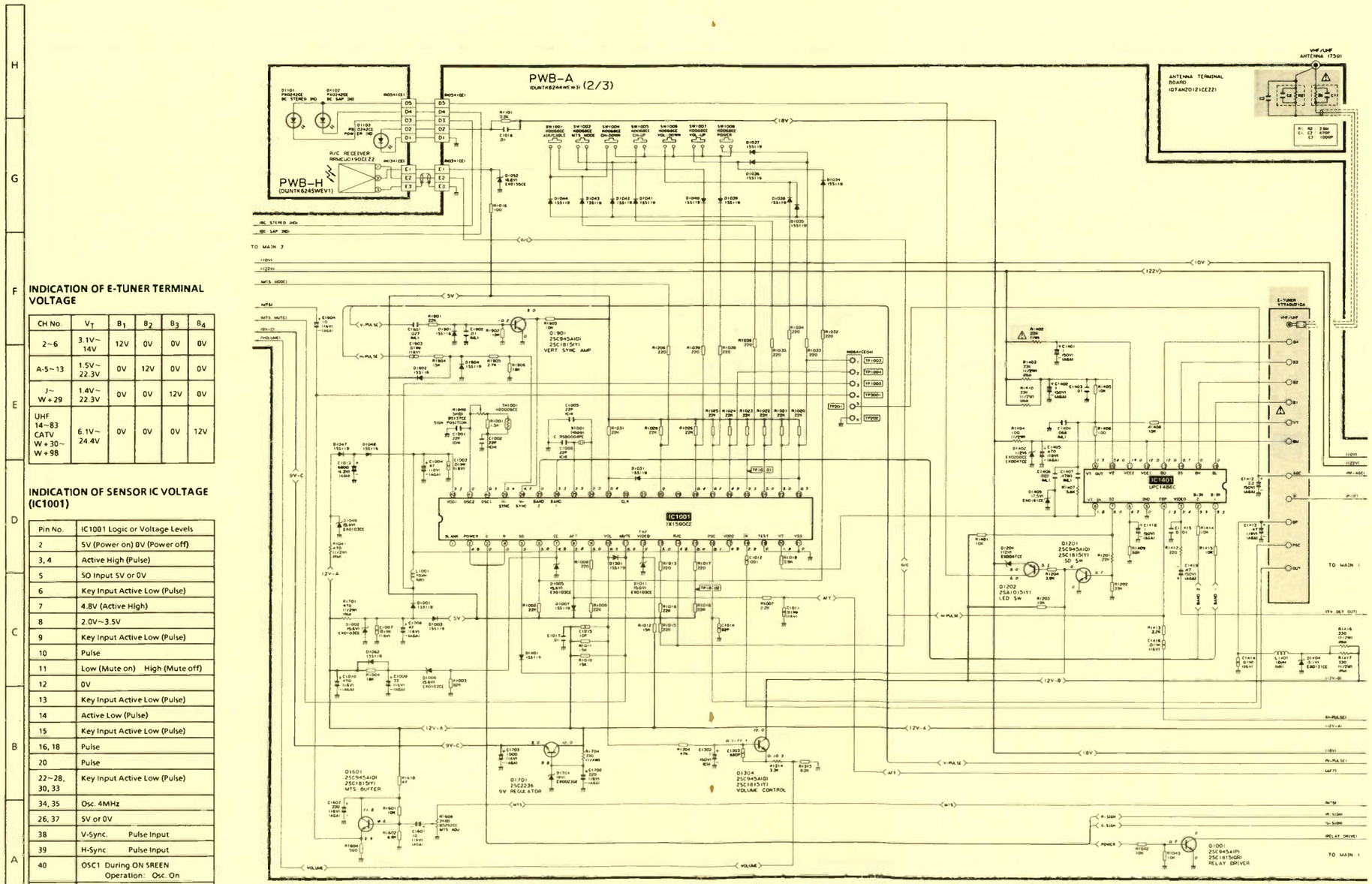
Manufacturers' schematics PROFAX 3103



INDICATION OF E-TUNER TERMINAL VOLTAGE

CH No.	V_T	B_1	B_2	B_3	B_4
2~6	3.1V~14V	12V	0V	0V	0V
A-5~13	1.5V~22.3V	0V	12V	0V	0V
J~W+29	1.4V~22.3V	0V	0V	12V	0V
UHF 14~83 CATV W+30~W+98	6.1V~24.4V	0V	0V	0V	12V

INDICATION OF SENSOR IC VOLTAGE (IC1001)

Pin No.	IC1001 Logic or Voltage Levels
2	5V (Power on) 0V (Power off)
3, 4	Active High (Pulse)
5	SO Input 5V or 0V
6	Key Input Active Low (Pulse)
7	4.8V (Active High)
8	2.0V~3.5V
9	Key Input Active Low (Pulse)
10	Pulse
11	Low (Mute on) High (Mute off)
12	0V
13	Key Input Active Low (Pulse)
14	Active Low (Pulse)
15	Key Input Active Low (Pulse)
16, 18	Pulse
20	Pulse
22~28, 30, 33	Key Input Active Low (Pulse)
34, 35	Osc. 4MHz
26, 37	5V or 0V
38	V-Sync. Pulse Input
39	H-Sync. Pulse Input
40	OSC1 During ON SREEN Operation: Osc. On
41	OSC2 During ON SREEN Operation: Osc. On

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Inspection, cleaning and lubrication of camcorders

By The ES&T staff

This article is adapted from the service manual for the Hitachi VM-E35A/A(PX) 8mm video camera/recorder.

Camcorders go where no self-respecting piece of delicate consumer apparatus should go. People take them out when the temperature is well below zero. They put them in the trunk of the car when the temperature outside is above 100 degrees, and the temperature in the trunk would be hot enough to barbecue a slab of ribs.

All those videos of people at the beach mean that the videographer has exposed the camcorder to sun, sea and sand. I even saw one camcorder waiting on the shelf of a service center that had been taken to a monster truck rally. The videographer got some great footage, but the outside of his camcorder had been caked with flying muck. The service manager suggested to the owner that next time he might want to put his camcorder in a transparent plastic bag, but for this time he had on his hands a camcorder that needed some serious cleaning.

Given the abuse that camcorders are exposed to, it's no wonder that they need maintenance, cleaning and lubrication, and a thorough once over every so often.

Required maintenance

Here is a recommended maintenance schedule and procedure for camcorders that are used routinely. Naturally, you should recommend to your customers that if they abuse their camcorders that they should have them checked more often. The cleaning/lubrication discussed here is based on an 8mm video camcorder, but is applicable to all camcorders.

The tape transport system in an 8mm camcorder uses very precise components. If any of these components is worn or dirty, the symptoms will be the same as if the component is defective.

To ensure a good picture, the tape transport system must be cleaned and lubricated periodically, and worn-out components must be replaced.

Scheduled maintenance

Schedules for maintenance and inspection are not fixed because they vary greatly according to the way in which the customer uses the camcorder, and the environment in which it is used. In general home use, a good picture will be maintained if inspections are done every 1,000 hours or so. Table 1 shows an inspection schedule based on the number of hours the camera is used each day.

Check before starting repairs

The faults shown in Table 2, which appear during playback, may be remedied in many cases with just a cleaning and lubrication of the tape transport mechanism. When a camcorder is brought in to you with one or more of these problems, we suggest that you perform the indicated maintenance procedures and check the results before you begin any other service procedure.

Tools and materials needed for camcorder inspection and maintenance

If you plan to perform camcorder and/or VCR service on a regular basis, you should have all of the following mate-

Average hours used per day	When inspection is necessary
	About 1 year / About 18 months / About 3 years
One hour	
Two hours	
Three hours	

Table 1. Recommended maintenance intervals for camcorders depend on the amount of usage the product gets. Of course, if a camcorder is abused by being exposed to dust, moisture or excessive heat, maintenance intervals should be shorter.

Symptom	Inspection location
Poor picture S/N, No color	Dirt on video head or worn video head
Tape does not run or tape is slack	Dirt on pressure roller, in tape transport system or/and on cylinder
Vertical jitter	Dirt on video head or in tape transport system
Low volume or distorted sound	Dirt on video head or worn video head

Table 2. A dirty tape transport system can cause problems in a camcorder. If the owner of a camcorder complains of symptoms, try cleaning and lubing the unit before you perform any diagnostic procedures.

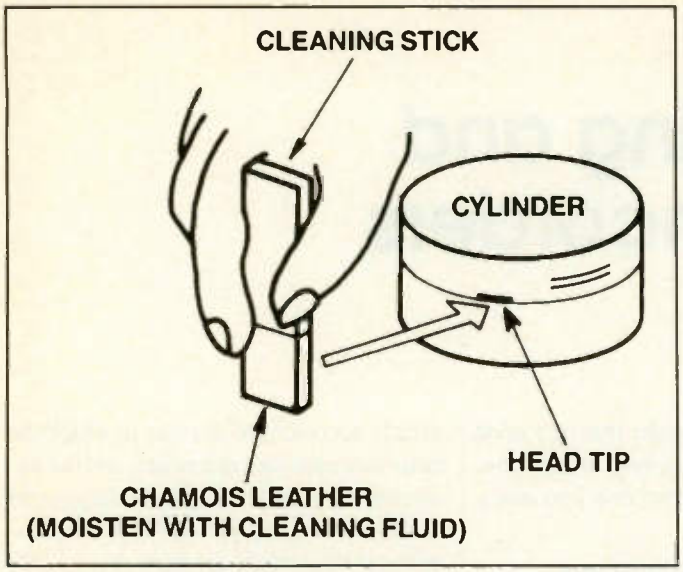


Figure 1. If the head cleaning tape doesn't completely clean the head and the head drum, use a chamois-tipped swab moistened with cleaning fluid, as shown here and as described in the text. Never move the swab vertically against the head, and never touch the head with any part of the swab except the chamois tip, as this could cause damage to the head.

Name	Using locations
Sonic Slidas Oil (#1600)	Lubricate low-speed rotating sections
Froil (G31-SAY)	Grease metal components or molded sections subject to light load
Lock paint	Fix adjustment screws and nuts

Table 3. Use this information to determine what lubricant to use for the various portions of the camcorder tape transport.

rials on hand (see Table 3 for the applications):

- Head cleaning kit
- VCR oil kit
- Ethyl alcohol (ethanol)
- Lint-free gauze
- Cleaning tape (available from many suppliers, including 3M and Maxell).

Cleaning the video heads

The first step in cleaning the video heads is to run a cleaning tape through the transport. Consult manufacturer's literature, information from the manufacturer of the tape, and your distributor to determine the applicability of any particular tape. Before using it, carefully read the instructions that come with it.

If the cleaning tape doesn't remove all of the oxide and other contaminants on the heads and head drum, use the head cleaning kit. Follow this procedure (see Figure 1):

- Moisten the chamois leather on the cleaning stick with cleaning fluid.
- Touch the moistened chamois leather of the cleaning stick against the head tip, and gently turn the upper cylinder back and forth against the leather.

Caution: Do not move the cleaning stick vertically against the head. This could damage the head. Also, make sure that only the chamois leather portion of the stick touches the head. If any other part of the stick touches the head, the head could be damaged.

Cleaning the tape transport components

To clean the tape transport components, moisten some gauze or VCR cleaning foam swabs, or other manufacturer-recommended materials with ethyl alcohol, and use it to wipe the surfaces of transport system components that come into contact with the tape. Use extreme care to make sure that the tape transport components are not damaged or deformed by cleaning.

Oiling

• Use only manufacturer-recommended lubricants in the camcorder.

• Use an oiler to apply one or two drops of Sonic Slidas oil to the specified components. Refer to the manufacturer's service manual for lubricating locations.

Caution: Do not use any more oil than recommended. Any excess oil may spill over or leak and come into contact with rotating parts. This could cause slippage or other defects. If you accidentally apply too much oil, wipe it clean with gauze slightly moistened with ethyl alcohol.

Oiling should be done about every 1,000 hours of use.

Greasing

• Use only manufacturer-recommended greases in the camcorder.

• Apply Froil with a stick or brush to the locations specified in the manufacturer's service literature.

Caution: Use grease sparingly. Excessive grease may come into contact with tape transport components and cause defects. Wipe off any excess using gauze moistened slightly with ethyl alcohol.

Greasing is normally recommended every 5,000 hours.

Keeping 'em rolling

As the current evidence shows, people are using and abusing their camcorders. As an example of the fascination with camcorders, there are now several TV shows dedicated to showing viewers funny or dramatic events captured on home video tape.

People are using and being conditioned to use their camcorders everywhere. All of those camcorders will require periodic cleaning and lubrication. If you're prepared to perform these procedures, it can mean additional business.■

Sources of technical information on parts

By Victor Meeldijk

(NOTE: The author and publisher disclaim any responsibility for any problems relating to transactions with any companies, agencies or individuals referenced herein. These names and addresses are provided strictly for informational purposes. Caveat emptor—let the buyer beware.)

You've just finished diagnosing a problem in a consumer electronics product, and you've isolated the problem to a specific transistor or IC. Unfortunately, the manufacturer no longer sells products in this country, or has gone out of business altogether, and you can't find any kind of cross reference that will allow you to locate an equivalent component.

It's likely that you'll have to give the bad news to your customer that the unit will have to be replaced. There is a remote possibility, however, that you might be able to locate a replacement for the faulty component.

This article lists a number of sources of information from which a competent and diligent service technician might be able to glean enough information to find a replacement for a component that otherwise can't be replaced.

In the interest of completeness, in addition to information on consumer electronics components we've included information for commercial and military devices as well.

Component source books

The following books contain component specifications.

D.A.T.A. Business Publishing
PO Box 6510,
Englewood, CO 80155-9832,
303-799-0381
800-447-4666

D.A.T.A. publishes reference books on digital, interface, linear, memory and microprocessor integrated circuits and transistors. The books summarize device parameters and provide listings of identical/equivalent parts from different manufacturers.

EEM - Electronic Engineers Master Catalog
Hearst Business Communications
645 Stewart Avenue,
Garden City, N.Y. 11530,
516-227-1300.

EEM is a multi-volume set of books that contains product information from leading electronics manufacturers (including catalog pages), and distributor listings.

Edward's Publishing Company, Inc.,
14129 Chadron Avenue
PO Box 1668
Hawthorne, CA 90251-1668
310-644-5643 Fax: 310-675-9850

This company publishes books on many kinds of military connectors.

Genium Publishing Company
1145 Catalyn Street
Schenectady, N.Y. 12303-1836
518-377-8854
Fax: 518-377-1891

This company publishes the Component Technology and Standardization Manual, a 3 volume set of books produced by GE's Aerospace Electronics Division on electrical/electronic components. The manual, which contains similar information to that found in this book, includes sections on blowers, fans, capacitors, connectors, crystals, delay lines, diodes, tubes, filters, illuminated panels, lamps, meters, microcircuits, motors, optoelectronic devices, protective devices, optical reflectors, relays, resistors, servomechanisms, switches, transformers, inductors and transistors.

IC Master
Hearst Business Communications
645 Stewart Ave.
Garden City, N.Y. 11539
516-227-1300
Fax: 516-227-1901

The IC Master lists over 80,000 IC's by function. Alternate sources, IC manufacturers, distributors and local sales offices are listed. Specification sheets for some of the IC's are also included in this set of 3 books. The Alternate Source Directory (ASD) is also available on computer disk (called the IC Master ASD).

Modern IC Databook
WEKA Publishing Inc.,
97 Indian Field Road,
Greenwich, CT 06830.
203-622-4177

This databook contains information on various types of IC's including: linear, digital, consumer, microcontroller, microprocessor, coprocessor, digital signal processor, data communication, interface, A/D, D/A, synchro-resolver, VCR, optoelectronic, and transducer IC's. Periodic supplements expand the information contained in the book, which includes a functional index, detailed component data sheets and manufacturer address and alternate source list.

Sav-Soft Products
Education Division
PO Box 360974
Milpitas, CA 95036
408-263-9150

This organization conducts seminars on a variety of subjects including one on Component Technology and Reliability. This seminar includes information on construction, qualification, application and reliability of various components, including resistors, capacitors, semiconductors, contacts/connectors, inductors/transformers and motors. The course includes a manual with derating guide-

Meeldijk is Reliability/Maintainability Engineering Manager, Diagnostic/ Retrieval Systems, Inc. Oakland, NJ 07436

lines and reliability design rules, which is also available separately.

Computer aided component selection systems

The following computer programs allow the user to search for a particular part based upon system prompts. Using companion CD ROM disks or tapes, the user can look up the manufacturer data sheets. While the systems generally concentrate on IC's, there are plans to include other passive devices in the database.

Readers should be aware that some of these systems can cost in the thousands of dollars, so while they are useful, they are expensive.

Cahners Technical Information System
275 Washington St.
Newton, MA 02158-1630
617-558-4960
800-245-6696

This system, named "CAPS" or Computer-Aided Product Selection, is a variety of PC based and UNIX programs that use CD-ROMs or magnetic tapes. Information is updated monthly.

IHS - Information Handling Services
15 Inverness Way E
Englewood, CO
303-790-0600
800-525-7052

IC/Discrete Plus 1 and 2 is a data base of IC and discrete semiconductor information, vendor master directory and vendor catalog information on over 1.3 million active and discontinued parts. The master directory includes data on passive components such as resistors, capacitors, and attenuators. Military and commercial parts are in the database.

There is also a Taiwan Industrial Products Services catalog that allows searches by product, subject, brand name, trade name or vendor name.

The company also has a database called "Haystack" (Hotline phone number is 800-821-4636) which includes all parts that have a NSN (National Stock Number). This database can be used to find alternate sources for parts.

NSA - National Standards Association
1200 Quince Orchard Blvd.
Gaithersburg, MD 20878
800-638-8094
In Maryland 301-590-2300

NSA publishes directories, in hard copy, microfiche or on CD ROM that provides Military Specifications, Federal Specifications, Military Standards, NAS and SAE standards. QPL (Qualified Products List) suppliers are identified along with the manufacturers location, test qualification references and military designation numbers. Tradenamed "Partsmaster" and "Specmaster", the suppliers directory is called "The Identified Sources of Supply".

USA Information Systems, Inc.
PO Box 2927
Virginia Beach, VA 23450-4902
1092 Laskin Road, Suite 208
Virginia Beach, VA 23451
800-872-8830
Fax: 804-491-7811

This CD ROM system, called CD Fiche, is an automated Logistics Procurement system with federal logistics data, Army, Navy, Air Force, DLA (Defense Logistics Agency), and defense contractor information. This automated parts research system has information on more than 12 million parts and assemblies within the Federal Supply Catalog System.

ViewPoint Information Systems, Inc.
An affiliate of R.R. Donnelley and Sons
100 Fifth Avenue
Waltham, MA 02154
617-890-0505
Fax: 617-466-9121

The ViewPoint component library is an on-line interactive system that provides easy access to current component data for ICs and other parts. ViewPoint provides data transfer interfaces, and can automatically generate symbols and library files to all major CAE (computer aided engineering) platforms (such as Mentor Graphics, which also sells this product).

Sources of specifications and standards

If the component you need is defined by a military or technical specification the following organizations can be contacted to obtain a copy of the specification. We'll start with the U.S. Government.

Department of Defense Single Stock Point (DODSSP)
Standardization Document Order desk
BLDG 4D
700 Robbins Avenue
Philadelphia, PA 19111-5094
Fax: 215-697-2978 (use for "Ad Hoc" requests, see text.)

(To order from this organization use form DD Form 1425 if available, or company letterhead, request each document slash sheet separately.)

TeleSpecs (see text)
8AM to 8PM Monday through Friday, Eastern Time
215-697-1187

Subscription Requests for Documents
DODSSP
Subscription Services Desk
700 Robbins Avenue, Building 4D
Philadelphia, PA 19111-5094
215-697-2569

Special Assistance Desk (not for ordering documents)
DODSSP Special Assistance Desk
same address as above
215-697-2667/2179
Monday Through Friday 7:30AM to 4:30PM Eastern Time

Canceled & Superseded Document Assistance
215-697-2975

Orders for government specifications and standards are available from the government office (this replaces the previous address which was the Commanding Officer, Naval Publications and Forms Center, ATTN: NPODS, 5801 Tabor Avenue, Philadelphia PA 19120-5094 as of November 1989).

A pamphlet entitled "A Guide for Private Industry" is available to assist government contractors in obtaining specifications and standards. Note: Non-Government standards adopted by the Department of Defense are only issued to Department of Defense Activities (non-government standards can be ordered from the preparing technical societies).

Defense Electronic Supply Center
Attn: DESC-EAA
1507 Wilmington Pike
Dayton, Ohio 45444-5272
513-296-6095
Autovon 513-986-6095

The DESC personnel are military experts on electrical and electronic components. This organization is also the

source of military "SMD" (Standard Military Drawings, formerly known as DESC drawings). The military document that lists SMD drawings is MIL-BUL-103 (a Military Bulletin). Further information of DESC is provided below. There is a Remote Computer Bulletin Board for downloading SMD's and Military Specifications and Standards. Full document updates on MIL-BUL-103 are provided on a monthly basis. The document may be downloaded from the bulletin board, which is available 24 hours daily, at 513-296-6046 for up to 2400 Baud or 513-296-8875 for 9600 Baud (V.32/V.42 BIS protocol). Information on this can be obtained from DESC-ECS, Chief of the Microelectronics Branch, at 513-296-5377, (AV)986-5377.

DESC Standard Military Drawings (SMD) may also be obtained from the library at 513-296-6095. Printed copies of MIL-BUL-103 are mailed to people on the mailing list every three months.

If you need to locate a specification/standard for a particular application, consult the following reference books.

* AMSDL—Acquisition Management Systems and Data Requirements Control List, by the Department of Defense, Number DOD 5010.12-L. This document is available from the Standardization Documents Order Desk, listed above.

*Department of Defense List of Approved Recurring Information Requirements, Number 5000.19-L, also available from the Standardization Documents Order Desk.

*Defense Standardization and Specification Program Policies, Procedures and Instructions, DOD 4120.3-M, also available from the Standardization Documents Order Desk.

Defense Logistics Agency
Defense Logistics Services Center
Federal Center
74 N. Washington
Battle Creek, MI 49017-3084
FTS (Federal Telephone System): 552-7409
AV: 932-7409
Tel: 616-961-7409

The DLA has a Logistics Remote Users Network (LOGRUN) which provides online access to supply support information contained in the Defense Logistics Information System (DLIS), the Military Engineering Data Asset Locator System (MEDALS) and the Automated Mailing Labels System (AMLS). LOGRUN is accessible via the Defense Communications Network (DCN, formerly DLANET), the Defense Data Network (DDN) and the Navy Logistics Network (NLN). In the Logistics On-Line Access (LOLA) query system the user can query the system on parts by a number of parameters, such as National Item Identification Number (NIIN) or part number.

The ALMS system provides mailing labels for product distribution.

LOGRUN is a free service (except for costs associated for hooking up the system and the cost of the calls). The user however must have a government sponsor, who will forward the necessary paperwork to the DLA.

DTIC - FDRB, Defense Technical Information Center
Defense Logistics Agency
Cameron Station, Building 5
Alexandria, VA 22304-6145
703-487-4660 (Customer Service)

This organization has various technical reports and studies that were done by various contractor and government agencies. Reports can be ordered with either a credit card, by check, or billed (with an added processing fee).

MIL-HDBK-331

This military handbook is a directory of the DOD (Department of Defense) data repositories. Data is categorized by such listings as Submarine Antennas, Test Equipment for Electronic and Proximity Fuses, Automotive Electrical Components, etc.

Documents from other international organizations

ANSI/ISO - American National Standards Institute, Inc.
11 W 42nd Street
New York, N.Y. 10036
(212) 642-4900

ANSI/ISO is a private organization that creates standards. Over 8000 standards are used by commerce and industry. ANSI is also responsible for U.S. representation at the IEC (International Electrotechnical Commission. NATO (North Atlantic Treaty Organization) Standards, nomenclature AQAP X (Allied Quality Assurance Publication), are also available from ANSI.

BSI - British Standards Institution
Information Department
Linford Wood,
Milton Keynes MK14 16LE
England
Tel: 0908 320033
Telex: 825777

T.H.E. - Technical Help To Exporters
British Standards Institution
Linford Wood
Milton Keynes MK14 6LE
England

This agency of the British Government publishes a wide range of English translations of international standards, along with a newsletter.

IEC - International Electrotechnical Commission
3 Rue de Varembe
CH-1211
Geneva 20,
Switzerland
Tel: 41 22 734 01 50
Fax: 41 22 733 38 43
Telex: 28872 CEIEC CH

I.E.E.E. - Institute of Electrical and Electronics Engineers
Standards are available from:
I.E.E.E Standards Department
445 Hoes Lane
PO Box 1331
Piscataway, N.J. 08855-1331
908-562-3800

A quarterly newsletter, the Standards Bearer, provides information on standards developments and issues.

VDE - Verband Deutscher Electrotechniker
VDE-Prufstelle
Merianstrasse 28,
D-6050 OFFENBACH am Main
Germany
Tel: (49) 69 8306 1
Fax: (49) 69 8306 555
Telex: 4152796 VDEP D

Translations of DIN and VDE standards are available.

Documents available from private companies and organizations

Documents and specifications that may

help in identifying component characteristics and specifications are available from a number of private companies and organizations.

ASQC - American Society for Quality Control
611 East Wisconsin Avenue
Milwaukee, WI 53202
414-272-8575
FAX: 414-272-1734

This society also sells specifications from various agencies including those from NATO (AQAP X specifications, Allied Quality Assurance Publication).

Compliance Engineering
629 Massachusetts Avenue
Boxborough, MA 01719
508-264-4208

Compliance Engineering is a magazine (by Dash, Straus and Goodhue, Inc., free to qualified subscribers) on international regulatory compliance. Specific areas that are covered include EMI, EMC, Telecommunications, ESD and safety requirements.

Document Center
1504 Industrial Way
Unit 9
Belmont, CA 94002
415-591-7600
FAX 415-591-7617

The document center is a source of DOD (Department of Defense) specifications and standards; Industry Standards (ANSI, ASTM, IPC, IEEE, EIA, etc.); International Standards (IEC, ECMA, VDE, etc); Government Publications (NASA, FAA, FCC, GPO etc.).

Document Engineering Company
15210 Stagg St.
Van Nuys, CA 91405
818-782-1010
213-873-5566
800-645-7732
Fax 818-782-2374

The Document Engineering Company is a source for military and federal specifications and standards. They also have MS standards, and industry standards such as ASTM and the SAE. This company also has available "Standards Infodisk" a CD ROM based system containing a specifications and standards bibliographic database. This database, published by ILI in England, has information on over 175,000 national, international and military standards from the U.S., Britain, Canada, Japan, Germany, France, Australia, Sweden, Norway and such international standards organizations as the ISO, IEC, CEN/CENELEC.

EMACO Consultants
7562 Trade Street
San Diego, CA 92121
619-578-1480
Fax: 619-578-1467.

Translations of DIN and VDE specifications are available from this company.

Global Engineering Documents
PO Box 19539
Irvine, CA 92713
800-854-7179
FAX: 714-261-7892
1990 M. Street
Suite 400
Washington, D.C. 20036
202-429-2860
Fax: 202-331-0960

Global Engineering is a source of military and international specifications and standards, including English translations of DIN and VDE specifications. This is a sister company of Information Handling Services, Inc. that has a specification service on microfilm, fiche and CD ROM. Their address is:

Information Handling Services, Inc.
PO Box 2220
Englewood, CO 80150
1-800-525-7052
Fax: 303-790-0686

Infonorme London Information
Index House
Ascot Berks SL5 7EU
England
Tel: 0344 874343
TLX:849426 LONINF G
FAX: 0344 291194

This company developed "Standards Infodisk", represented in the U.S. by Document Engineering Company, Inc. (see above).

IDA Institute for Defense Analyses
Science and Technology Division
1801 North Beauregard Street
Alexandria, VA 22311
703-845-2238

This organization issues various reports on a variety of technical subjects including Power Supply studies, Cabling and Connector Technology Working Group Analyses, Reliability and Maintainability Parameter Analysis, etc.

Standards Sales Group
9420 Reseda Blvd.
Suite 800
Northridge, CA 91324
818-368-2786
FAX: 818-360-3804

This company is a source for international regulatory standards, product safety test equipment and accessories, reference books on quality, reliability and safety and translations of foreign language books and documents.

UMI - University Microfilms Intl.
300 North Zeeb Road
Ann Arbor, MI 48106
800-521-0600
313-761-4700
Fax: 313-761-1204

This organization has I.E.E.E. and I.E.E. publications on CD-ROM disks. The database includes periodicals, journals, conference proceedings, standards and magazines.

Books that List Manufacturer Representatives and Distributors

Ameritech Industrial Purch. Guides
35 West Huron - Suite 700
Pontiac, MI 48342
313-334-4100
800-331-1385

Part of Amertech Industrial Yellow Pages, this group publishes 14 regional editions that cover various industries including: manufacturing (including electrical and electronic), wholesale trade, construction, transportation, utilities, mining, government, professional services/institutions, business services and agriculture.

EITD - Electronic Industries Telephone Directory
Harris Publishing Co.
2057 Aurora Road
Twinsburg, OH 44087
216-425-9000
800-888-5900
FAX: 216-425-7150

A directory by manufacturer name or type of product manufactured. Distributors and representatives are also listed.

Electronic Source Book
Professional Decision Making, Inc. and Paramount Publishing, Inc.

125 Wolf Road
Albany, N.Y. 12205
518-458-2300
In the Western U.S.:
So. California 714-897-9576
No. California 408-727-0157
Texas 214-466-2499

A regional directory (that includes New England, Mid-Atlantic, South-Atlantic, Midwest, Northern CA, Southern CA, Southwest and Mountain States editions) that lists distributors, value added servicers, manufacturers and representatives.

ERD Electronics Representatives Dir.
Harris Publishing Co.
2057 Aurora Road
Twinsburg, OH 44087
216-425-9000
800-888-5900
FAX: 216-425-7150

This directory lists over 5,300 electronics representatives. Harris Publishing Company also publishes the EITD, Electronic Industry Telephone Directory (see above), U.S. Electronics Industry Directory, and Who's Who in Electronic Sources (separate issues for different regions of the U.S.). They also publish industrial directories for the various states including: Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, Ohio, Pennsylvania, and West Virginia.

IICIT, International Institute of Connector and Interconnection Technology, Inc.
(Connectors and Interconnection Handbooks)
PO Box 25625
Anaheim, CA 92825-5625,
213-941-9990
Fax: 213-941-0451.

Regional Industrial Buying Guide
Thomas Regional Directory Company
(a subsidiary of Thomas Publishing Company)
Five Penn Plaza
New York, N.Y. 10117-0266
212-629-2100

The Regional Industrial is a guide for regions of the United States that lists industrial suppliers, manufacturers representatives, distributors and service companies. The product section contains over 3,500 different product headings.

The Thames Group LTD.
20 Clipper Drive
PO Box 353
Mystic CT 06335
800-443-2640
Fax: 203-536-0890

This publisher has a guidebook called the Walton's Cable Comparator. This cross reference has over 1000 cable constructions (which includes such construction listings as multipair foil/braid shield, unshielded, foil shielded, and individual shield with listing for each gage wire size), with up to 24 manufacturers for each construction.

Thomas Register of American Mfg.
One Penn Plaza
New York, N.Y. 10117-0138
800-222-7900 ext 200
212-290-7277
Fax: 212-290-7365
Telex: 12-6266

Thomas Register is a multi-volume set of books that lists over 153,000 American and Canadian manufacturers and suppliers. The books contain over 52,000 product and service headings and over 111,000 trade and brand names, including manufacturer logos. In the catalog volumes there are over 1800 manufacturer catalogs that contain engineering drawings, specifications and performance tables.

U.S. Industrial Buyer's Guide
U.S. Industrial Directory
A Reed Int'l, Cahners Publication
8 Stamford Forum
PO Box 10277
Stamford, CT 06913-0168
203-328-2500
FAX: 203-357-7864

Circulation Office:
44 Cook Street
Denver, CO 80206
303-388-4511
800-637-6086

These books, of which the U.S. Industrial Buyer's Guide was introduced in 1991, contain manufacturer sources of various products including adhesives, crane parts, electronic components, electronic hardware, electronic enclosures, maintenance products, tubes, varistors, X-Ray equipment, etc. The books contain data on almost 60,000 companies which are sources of over 20,000 products from abrasive belts to zirconium oxide. ■

Familiarity breeds carelessness

By Dale C. Shackelford

When working with familiar products, an electronics service technician will often diagnose a problem based not on voltage measurements, waveform observations or the application of mathematical formulas to schematic diagrams, but upon past experience. This can lead the technician to omit some key diagnostic steps and come to an incorrect diagnosis. Here's what happened to me while working on one particular television receiver with which I was intimately familiar.

Upon initial observation, I found that the 13" KTV color TV set (Model 13 MAE) on my bench was completely dead, with no raster and no sound. Additionally, none of the channel indicator LEDs would light when the set was turned on and a channel had been selected. This combination of symptoms suggested that either the power cord was faulty, or at least one of the two fuses within the set had opened.

Shackelford is an independent electronic servicing technician.

After removing the back from the set, I found that fuses F801 (ac line) and F802 (B+) were open (Figure 1). Having worked with a number of similar chassis configurations (including Emerson, Goldstar and others), I automatically removed the horizontal output transistor (HOT), Q404, and tested it. Q404 was shorted all the way around. When replacing Q404 (original part number 2SD1426), I made sure to apply a liberal amount of heat sink compound to the back of the replacement transistor (ECG 2302) as well as to the heat sink plate.

Because this particular model does not contain the low-value (one ohm or less) fusible resistors often found in similar chassis in the horizontal output section (Figure 2), the ac line fuse (F801) is a 3A, 125V slow blow fuse. I replaced the blown fuse with the correct replacement as called for in the parts list of the schematic package. In order to limit the current during further diagnosis, I connected a 100W incandescent bulb across the F802 fuse clip in place of the fuse.

Even though my DMM is battery powered, I made sure that the set was plugged into an isolation transformer (actually, a variable isolation transformer) and that the degaussing coil was disconnected from the main circuit board (P802) before the set was powered up.

Even though the lamp bulb was in the

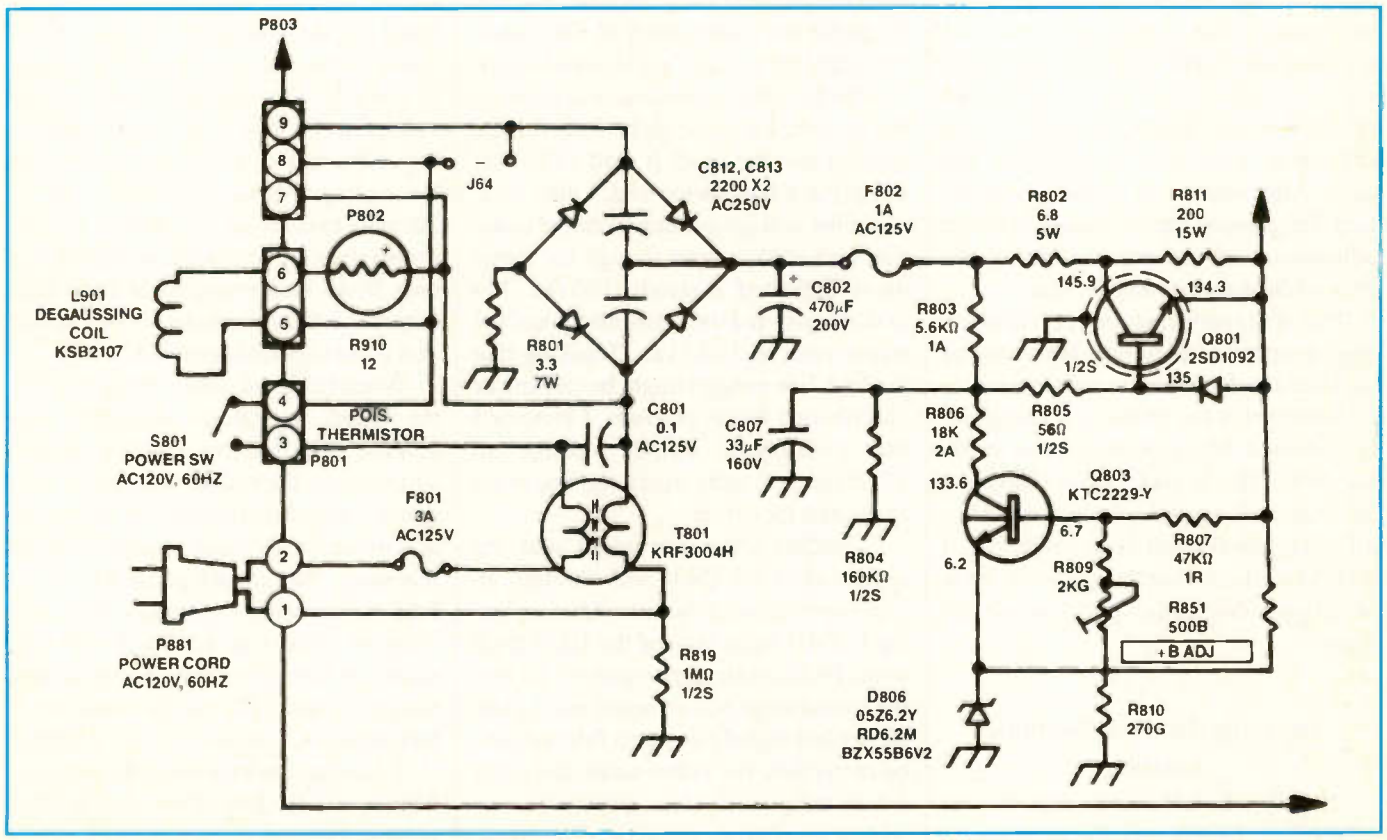


Figure 1

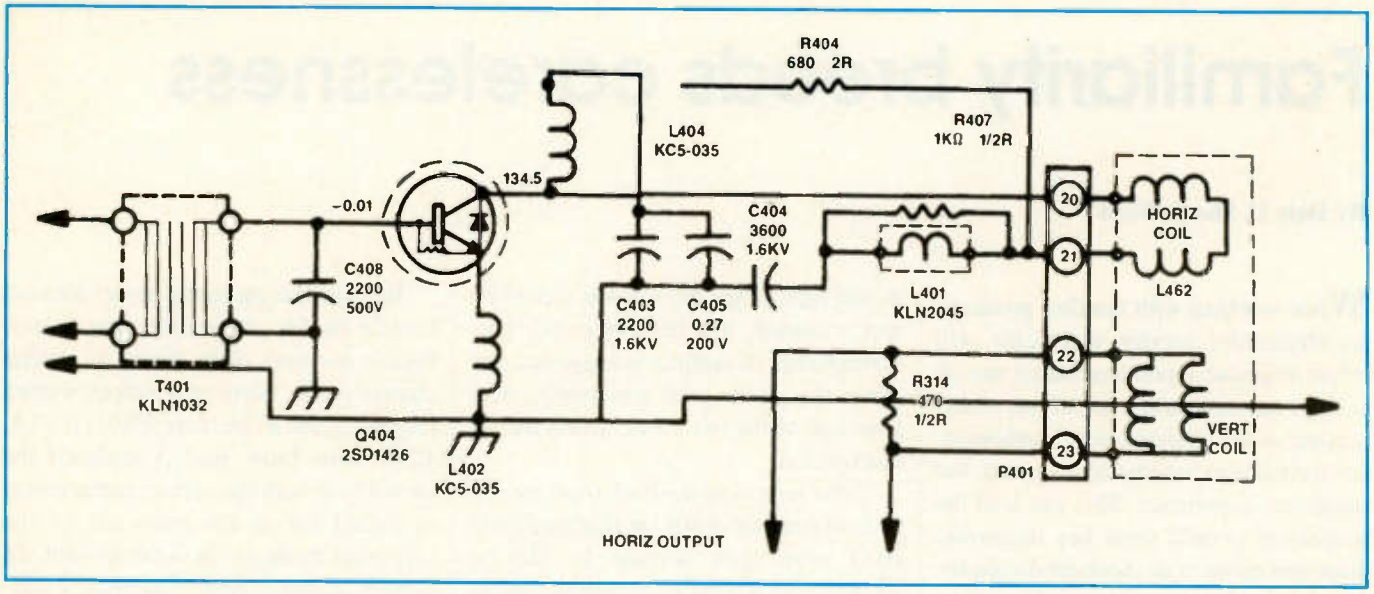


Figure 2

B+ line in place of the fuse, the set came on, and raster, though somewhat pulled in at the sides, was present, along with sound. I connected the antenna terminals to the cable TV system and selected and tuned in a channel. The set worked fine.

I let the set play for approximately 10 minutes with the bulb across the F802 fuse clip, and observed no change in the deflection or the quality of operation. I replaced the 100W bulb with the specified 1A, 125V slow blow fuse, which resulted in full horizontal and vertical deflection, with good audio, video and color. After another 30 minutes of operation, I degaussed the set and made minor adjustments of convergence, purity and gray scale as a customer service.

Part of my servicing routine is to allow a set to operate for another two hours or so after the back has been replaced to make sure that the problem is completely corrected. Many other technicians do the same. This is preferable to having a set come back a couple of days later. After all safety checks had been performed, I went to work on something else while the set played. No further problems developed.

Powering the set without line isolation

Needing the isolation transformer for another set, I unplugged the set from the transformer and plugged it into a standard non-isolated ac receptacle. The minute I turned on the power switch I heard a small "pop," and the set was once again dead: no raster, no sound, no channel indicators. Back to square one.

Upon removing the back of the set once again, it was obvious that F802 was open, as the burning filament had blackened the inside of the glass tube. A quick in-circuit resistance check of F801 indicated that the ac line fuse was still intact.

Thinking that something was amiss in the ac line, I measured the line voltage coming into the shop. It read 123.5Vac; not perfect, but not too bad. I then measured the voltage coming from the isolation transformer, even though the meter on it indicated a steady 120Vac. My DMM registered the voltage output of the transformer at 120.3Vac. Thinking that the high line voltage might be causing or contributing to the problem, I increased the transformer output voltage to 123.5Vac to exactly match the line input to the service center.

Further checks revealed that the replacement for Q404 was shorted; an expensive lesson, to be sure. After replacing Q404, I again hooked the 100W bulb to the F802 contacts, plugged the set into the transformer and turned it on. Again, the set had slightly less than full horizontal deflection, but video, audio and color information were clear, presenting me with a perplexing situation. The transformer output was exactly the same voltage as that from the ac line, and the set played properly when plugged into the transformer, but blew F802 when hooked directly to the unisolated ac line. Still puzzling over this strange situation, I replaced the bulb with F802, which returned the raster to full deflection.

With the set still plugged into the transformer and operating normally, I measured the B+ voltage at the collector of Q404 and found it to be high: in excess of 154Vdc. The schematic specifies this voltage to be 134.5Vdc. I attempted to lower this voltage by adjusting R851, the B+ voltage variable resistor, but all attempts to decrease the voltage to within specification resulted in a reduction of only 2Vdc. Measurements of the voltage output at R851 revealed a B+ of 158Vdc, as did the measurements at F802.

When I measured the voltage at Q801, the voltage regulator, I found the same 158Vdc at the base, the collector, and, not surprisingly, the emitter. Because it's not unusual to find that measured voltages are at variance with those specified on the schematic diagram of a particular circuit, I did not immediately suspect that something as critical as a voltage regulator might be defective when the set seemed to operate normally on the transformer. Nevertheless, I decided to check Q801.

I disconnected the set from the transformer, and discharged not only the high voltage (second anode) socket on the CRT, but the ac filter capacitor as well.

These precautions are also part of my routine. I unsoldered the pins of Q801 from the circuit path traces, but left it, as well as the heat sink, mounted to the circuit board.

Noticing that this transistor used an insulator, I measured the resistance between the collector and the heat sink. The insulator was still performing its job. Resistance measurements between the base, collector and emitter of Q801, however, revealed that this component was completely shorted, all the way around. This allowed the source 158Vdc access to all otherwise unregulated circuits and stages.

Once I replaced Q801 (Part Number 11114113) with an ECG 1092, I again plugged the set into the transformer with the output set at 123.5Vac, and a 100W bulb across F802.

There were no obvious defects in raster/video, sound/audio or color, and voltages were well within tolerance, so I replaced the light bulb with the fuse and again applied power to the set, still through the transformer. Voltages at the various test points were a little below normal, but a slight adjustment of R851 cleared that up nicely.

I again checked the set for convergence, purity and gray scale, and then connected it directly to the ac line and let it play for more than five hours.

Jumping to conclusions

Because of my familiarity with this, and similar models, when I found the HOT to be defective I jumped to the conclusion that the HOT had simply failed from the stress of working at high voltages and currents, as had many HOTs in similar sets that I had serviced. It didn't occur to me that perhaps some other problem in the set had contributed to the failure.

I simply failed to take the necessary precautions that any experienced technician should have taken. A couple of voltage measurements at easy to access test points would have revealed that I had overlooked something critical.

Without the benefit of the voltage regulator's protection, small spikes on the ac line voltage were enough to blow the HOT. These spikes did not appear at the output of the transformer. Had the transformer's output been up to about 125Vac, it is likely that Q404 would have been destroyed even when the transformer was used.

Had this been an unfamiliar set, I would have probably paid more attention to protocol. This lapse of judgment resulted in the unnecessary destruction of a (costly) transistor, and a loss of time. It has also resulted in this article, which, if it instills in one technician the importance of following correct, step-by-step procedure, even when working with familiar products, will have been well worth writing. ■

What do you know about electronics?

The tunnel diode

By J.A. Sam Wilson, CET

If you took the quiz in "Test Your Electronics Knowledge" in this issue, you may wonder about the number of significant figures in some of the answers. For example, we usually multiply the peak value of sinewave voltage or current by 0.707 to get the RMS value. The multiplier given in "TYEK" is 0.707106781.

Accuracy

The number of significant figures in a calculation depends upon the minimum number of significant figures used. For example, if the peak value is given as 7.86A (or V) you cannot use a conversion factor with more than three significant figures. The proper answer in that example would be rounded off to three significant figures, or, 5.56A (or V).

This subject came up before when I gave answers in some problems to more significant figures than would be expected in a computation. That was a different situation. In that case I worked a problem two different ways. My objective was to prove that both methods gave *exactly* the same results.

I got some very terse letters on that one. The gist of the letters was that you could not buy a component with guaranteed accuracy to ten digits. Of course, that is true. However, I wasn't writing a purchase order. I was working a problem two different ways to show the answers to be identical—at least, to ten digits.

Can you program a VCR?

In the last month I have heard several complaints about how hard it is to understand the instructions for programming a VCR. I read the instruction book for my VCR and could not come up with a better way to explain it. It is easy to criticize a piece of writing but the critic should be sure to give a better way to say it.

Wilson is the electronics theory consultant for ES&T.

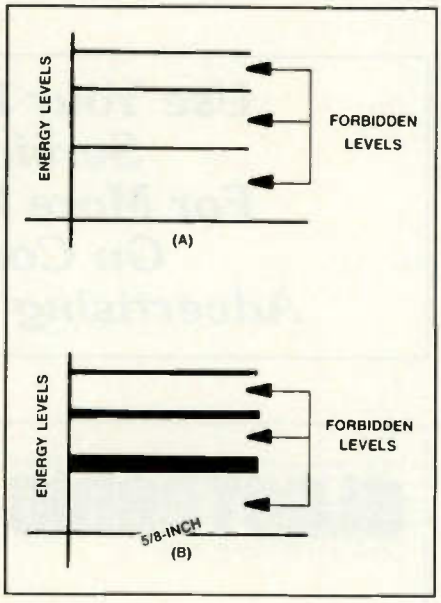


Figure 1

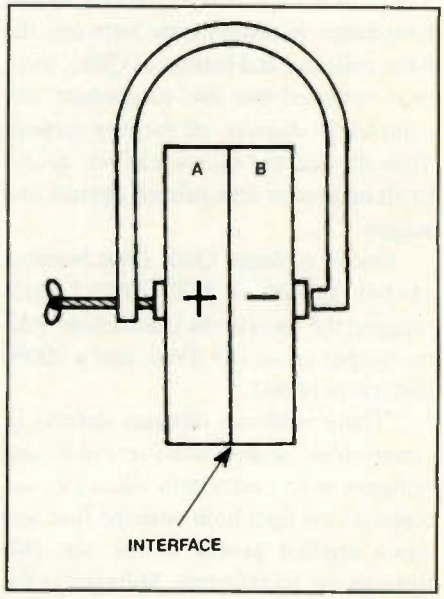


Figure 2

Now, if you really want to see confusion on instructions, read one of your prescription bottles (if you have one). Recently I went to a doctor because of a slight infection in my epizookis. I got my prescription and the instructions were to "take one pill twice a day." To me, that is impossible.

I decided the closest I could come to doing that was to cut the pills in half and take one-half in the morning and one-half in the evening. Norma said, "not so. It means to take a pill in the morning and a different one twelve hours later." I know she is wrong. If they wanted me to do that the instructions would have read, "take a pill every twelve hours."

Now, if you don't program your VCR correctly you might miss a program on TV. However, if you don't get the instructions right on your pills your epizookis could turn green.

The tunnel diode

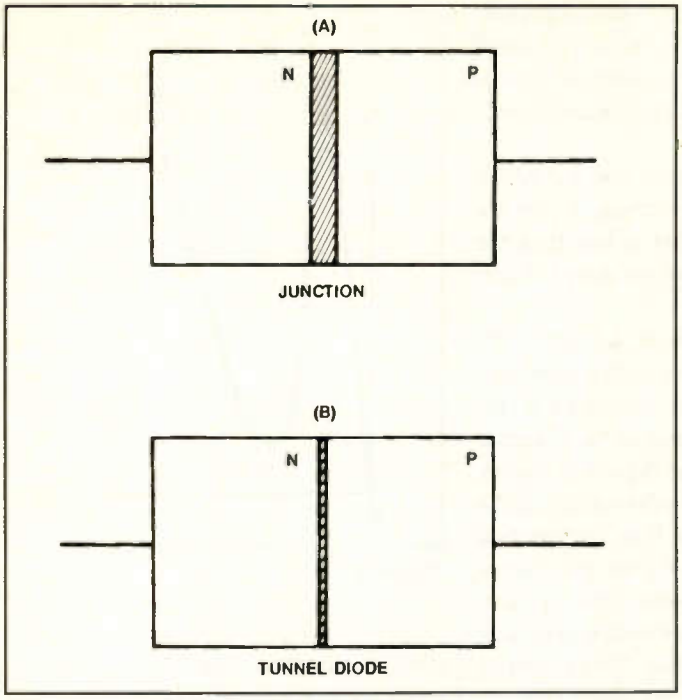
Once again I have decided to attack, or explain, the impossible. In this issue I am going to explain how a tunnel diode works and in the next issue I am going to give a simple circuit for a tunnel diode (see Editor's Note). Naturally, I looked it up first to see if anyone else had already explained it, and I am not happy with anything I have found.

Two authors adroitly sidestepped the whole issue and went directly to the tunnel diode curve. Another said that it is simply a matter of "quantum tunneling."

My first thought was to just go ahead and explain how they work. That is easy to say but darn near impossible to do unless you go into quantum mechanics and very rigorous advanced mathematics. So, in my explanation I have resorted to models. I have always said that there is nothing wrong with models as long as you explain that they are models.

Electron energy levels

We will start with the energy levels of electrons. Energy is defined as the capacity to do work. Kinetic energy is the energy a body has by virtue of its motion. Potential energy is the energy a body has by virtue of its position. An electron has both kinetic and potential energy.



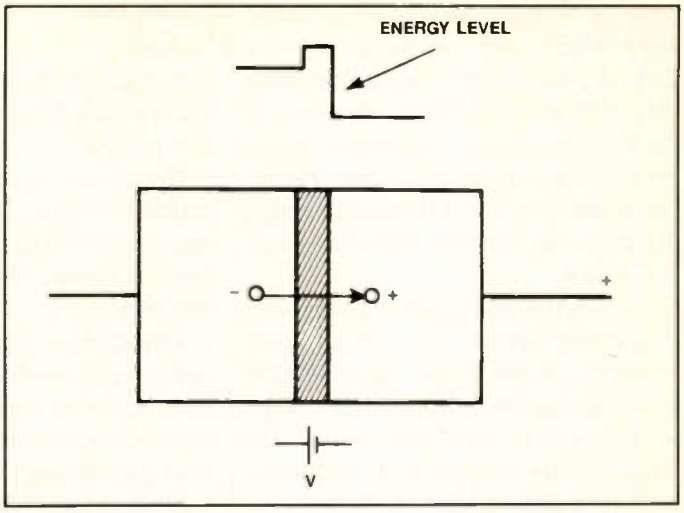


Figure 4

Figure 3

An electron can exist at only one discrete energy level at a time. This concept is illustrated in Figure 1. The horizontal lines in Figure 1(a) represent allowable energy levels. The energy level at any particular time depends upon the temperature of the body where the electron is located and some other factors such as light, and the presence of an electric field.

The energy levels are separated by forbidden levels. If an electron is to be raised to a higher level it must go across one of these forbidden levels where it cannot exist and go to a higher level.

Energy quanta

Physicists are fond of saying that the electron must receive exactly one quantum of energy, or give up one quantum of energy, to go to a higher or lower level.

If you are talking about a material that is made up of two or more elements the forbidden regions still exist. However, the energy levels are broader. That is shown in Figure 1(b).

To understand what I am going to say about tunnel diodes you have to understand that in a material at room temperature an electron can gain enough energy to reach a higher energy level. This is a random thing. They don't all go to a higher level at once, but, here and there throughout the material an electron will gain enough energy to go to a higher level. If it is at its highest level it can gain enough energy to escape its atom momentarily.

If you could look at a cross section of a material like carbon and observe the electrons, you would see that throughout the carbon at any given time there are electrons that have escaped from their atoms. These are sometimes referred to as free electrons and their motion inside the material is called an instrinsic current.

The physics of junctions

Take a look at Figure 2. Here we have two blocks of material, A and B, pressed tightly together. In a short time some electrons in one of the materials, like A, will find enough energy to cross the interface between the blocks of material. This will cause block B to become negative and block A to become positive. After a few moments the electron drift across the interface stops because B has become negative.

Figure 3 shows a situation very similar to the one in Figure 2. There are two materials—a P material and an N material—that are connected at a junction in the manufacturing process. There is a depletion region between the materials. It is illustrated with a shaded area. It acts like the natural barrier between the materials in Figure 2.

In Figure 3(a) the materials are separated as in a junction diode. Compared to the depletion region shown in Figure 3(b), the one in Figure 3(a) is much wider. The illustrations represent a junction diode 3(a) and a tunel diode 3(b).

To get the narrow depletion region in the tunnel diode the N- and P-type materials are very heavily doped.

When both the diodes are manufactured there is an initial drift of electrons

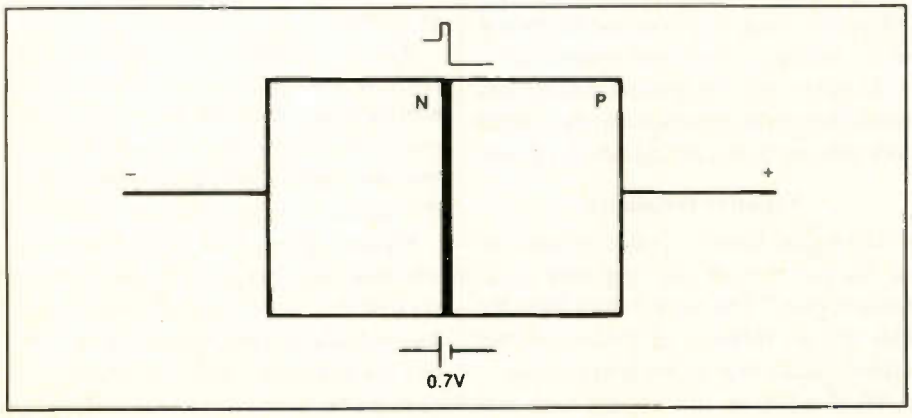


Figure 5

from the N region into the P region and that produces a negative charge very near to the depletion region. At the same time holes drift across the depletion region to the N region, so, there is a positive charge in the N region near the junction. The result is that there is a difference in potential across the depletion region as shown in Figure 4.

The positive and negative charge carriers at the junction result in a voltage across the junction as illustrated in Figure 4. As a technician, you know that voltage to be about 0.3V for a germanium diode, about 0.6V for a silicon diode, and, about 1.5V for a gallium arsenide diode.

Refer again to the tunnel diode in Figure 3(b). It has a very narrow depletion region so it is possible for some electrons to achieve enough energy to pass through the depletion regions rather easily. In this way it is like the two blocks of metal pressed together.

The tunnel phenomenon

Suppose you apply a very low positive voltage on the lead at the P end, and a very low negative voltage on the lead for the N end. The electrons and holes that wandered across the junction will flow to the source. In this discussion they represent the tunnel electrons. So, there is a current flow due to the tunnel electrons. The voltage you apply must be lower than the junction voltage.

This is very important. You would not expect current to flow because you are applying a voltage that is less than the junction voltage. However, there *is* a current flow.

Turn again to Figure 4. A junction diode is represented here with a relatively wide depletion region. In order for current to flow, the electron in the N region must pass through the depletion region. For that current to flow the voltage on the leads must be greater than the junction voltage marked with a V in the illustration. This is usually represented by a plot of the energy level of the electron necessary to get across the junction. This is shown above the junction in the illustration.

Moving electrons across the junction

Note that it is necessary to apply energy to the electron in order to get it to rise above the point needed to get it across the junction. The energy needed is supplied by the electric field at the positive lead. Once the electron has crossed the junction it gives up its extra energy. As shown in the illustration its energy level drops to a lower value.

For the tunnel diode shown in Figure 5 the same energy level is needed to move the electrons from the N material to the P material. When this occurs the current through the tunnel diode is no longer dependent upon the tunnel electrons that wandered across the depletion region.

The characteristic curve of Figure 6 shows the tunnel electron current as a current between the zero-volt mark and point "a" on the curve. After point "a" is reached the tunneling electrons become depleted. Therefore, there is a decrease in current as the voltage is increased beyond "a".

At point "B" the applied voltage exceeds the junction voltage and the normal forward current in a junction diode occurs.

Negative resistance

The region between points "a" and "b" on the curve mark the "negative resistance region." The name comes from the fact that an increase in voltage in that region results in a decrease in current.

We don't have any devices with real negative resistance but we do have some devices, like the tunnel diode and the tetrode vacuum tube, that behave like they have negative resistance. It will be shown in the applications section of this discussion—a future issue—that the negative resistance region gives the tunnel diode its usefulness.

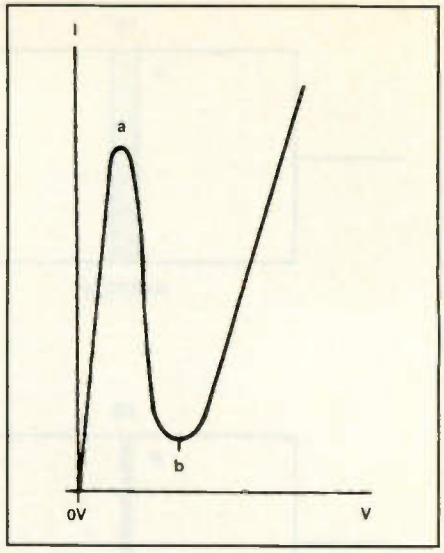


Figure 6

Editor's note

To head off any misconceptions, or possible confusion about the word "tunnel" as it is used in the term "tunnel diode," a few words are in order. The word "tunnel" does not refer to physical tunneling; the electrons in a tunnel diode do not physically tunnel through the diode in any sense of the word.

In diodes, the semiconductor junction causes a difference in potential between the P and the N material sections of the diode. In order to cause current to flow, the voltage applied to the diode must be sufficient to overcome this potential difference. This potential difference at the junction is often referred to as an "energy barrier."

When the potential gradient across the diode is drawn as a graph, this energy barrier looks like a hill. In order for current to flow through the diode, the electrons have to be given enough energy from the voltage source to get over this hill.

Because of the physics of the tunnel diode, however, it is possible for electrons to cross the junction with less energy that it would take to climb over the energy barrier, the potential "hill." In essence, the electrons that do this have tunneled through the potential hill, hence the term "tunnel."

Test your electronics knowledge

Answers to the quiz *(from page26)*

1. $\ln^{-1}1$, or $1/\ln 1$, or $e^x = 2.718281828$ (note: x = 1).

2. $\sqrt{2} = 1.414213562$.

3. $2/\pi$, or 0.636619772.

4. Cos 27.5° = 0.88701.

5. $1/2\pi = 0.1591549$.

6. π, or, 3.14159265.

7. 12 inches/39.37 inches = 0.3048.

8. $1/\sqrt{2} = 0.707106781$.

9. 0.15625.

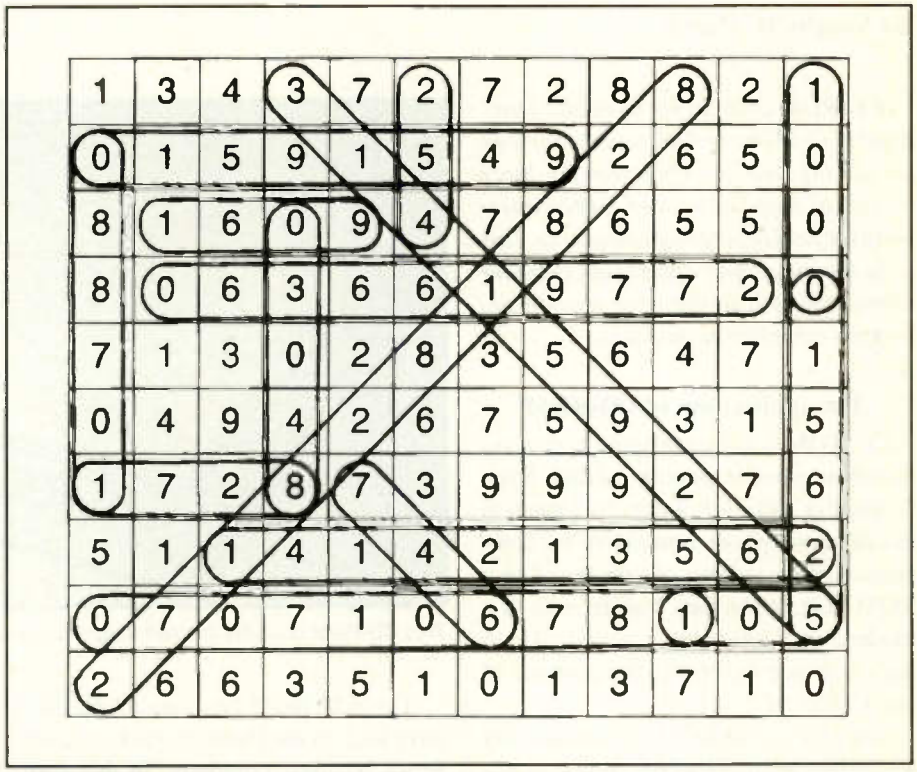
10. 12^3=1728.

11. 105.

12. 2.54.

13. 1000.

14. 746.



The CD-ROM Primer - Part 2

By Vaughn D. Martin

CD-ROM is short for Compact Disc-Read Only Memory. This new technology for storing and quickly retrieving large masses of data has created a keen interest in the field of personal computers. This is the second of three articles in Computer Corner that will describe this recently developed computer technology.

This CD-ROM drive fits in a half height floppy disc drive space.

The applications of CD-ROM

CD-ROM is so far the best way to mass distribute massive amounts of data. Even "paperless" transfer of data by a modem usually costs phone time. Here's a comparison of the volume of data stored on a ROM disk, to the data transfer rate of a modem: at 1,200 baud, it would take 46 days non-stop to transfer the contents of one CD-ROM.

The uses of CD-ROM are limited only by the human imagination. As one example of commercially available CD-ROMs containing vast amounts of information, consider the "Microsoft Bookshelf." This CD-ROM product was reviewed in an issue of Lotus magazine. The reviewer admitted what many others have honestly said; that he was lost once he got into it.

The reviewer was lost not because of a lack of direction, but because he was awestruck at the sheer volume of the data. Moreover, each subject he encountered led to other areas of inquiry until he was several levels deep and suddenly lost. This was in no way the fault of the CD-ROM's sorting algorithm.

The following is a list of what comes with the Microsoft Bookshelf package:

- The American Heritage Dictionary.
- Roget's II: Electronic Thesaurus
- The 1992 World Almanac and Book of Facts
- The Chicago Manual of Style
- Bartlett's Familiar Quotations
- Houghton Mifflin Spelling Verifier and Corrector
- Forms and Letters
- U. S. Zip Code Directory
- Houghton Mifflin Usage Alert
- Business Information Sources

This CD-ROM fits into a CD-ROM drive such as the Hewlett- Packard 3,000 Series business computer. In this computer, the drive fits below the floppy drive. Also available are stand alone drives that do not take up a drive space within the computer. There are some small units that take up a space normally reserved for a half-height floppy disc unit, such as the one shown in Figure 1. As previously stated, because these CD-ROM drives use the same type of discs as audio CD-ROMs, you can listen to music on this drive when you aren't doing research.

The CD-ROM and audio CD player compared

Audio CDs contain musical information in digital form, which must be converted into analog music, because this type of CD's information is specifically made to make sense musically. The conversion from digital information into an analog signal that is a representation of music takes place in a digital to analog (D/A) converter.

Conversely, a CD-ROM player requires some means by which to interface it with a computer. The interface board within the computer and the interface for the CD-ROM itself provide this interface. CD-ROM drive manufacturers have standardized on the SCSI (small computer system interface) system. When you buy a CD-ROM it includes a built in port and interface card for the computer built right within the CD-ROM itself.

The final ingredient required is the software driver allowing this CD-ROM and your computer to communicate. Microsoft has developed a set of CD-ROM extensions. These consist of a TSR (terminate and stay resident) program called MSCDEX.EXE, which the user installs, along with a device driver developed by the manufacturer. This is loaded by the CONFIG.SYS file.

A TSR program is one that is loaded into the computer's RAM and remains there doing nothing while the computer operator uses other software applications. When the computer user wants to use the features of the TSR program, he presses a key, or combination of keys, such as CTRL + S, (this is called a "hotkey") to cause the TSR program to "pop up" on the monitor screen.

One of the best known of the TSR programs is "Sidekick" by Borland Software, which allows a computer user to gain access to an on-screen calculator, calendar, and several other useful desktop programs.

Pressing another key, usually indicat-

ed on the TSR program screen, returns the user to the program he had been using, exactly where he was when he invoked the TSR program.

MSCDEX.EXE provides the interface to DOS itself; it takes the unique character of the CD-ROM drive by making it appear to DOS as a very large hard drive.

Because it costs little to add audio output to a CD-ROM drive, in order to allow it to be used to play audio CDs, the manufacturers of these drives are now starting to use inexpensive DACs in them with left and right channels accessed via audio output jacks. Another alternative is to use headphones with some sort of emulation software. This is definitely not very good quality audio.

If you are thinking about trying to convert your audio CD player into a CD-ROM player, you will encounter two problems. First, remember the less extensive error checking algorithms associated with this less demanding technology, and secondly, keep in mind that Microsoft only sells these CD-ROM extensions to drive manufacturers.

Security

If security is a concern, a CD-ROM can be locked into a drawer. This foils even the most enterprising hacker's attempts at gaining access to data through data communications links. As an added safeguard, you can encrypt (encode) data.

Never growing old

Many applications of CD-ROMs involve data which is updated on a regular basis. This might include parts lists and prices. This can be done by sending out a new CD, which keeps all data current.

Disadvantages

The CD-ROM's advantages are also its disadvantages. More specifically, the sheer volume of data on a disc means that a user can drown in a sea of data while searching for pertinent information.

However, it is easy to access data. This ease of locating data also has the potential effect of fragmenting information and pulling it out of context, while context may be very important.

Some applications programs allow you to make electronic Post-it notes, since you obviously can't underline, highlight, use bookmarks or write in the margin of the page. These notes are stored separately on a hard disc and linked automatically to the information on the CD-ROM by the applications program.

Finding the proverbial needle in the haystack

Automated indexing describes software which searches and displays information from the disc. This software is also called the "search engine" and may be found on the CD-ROM.

Although requirements vary, you will typically require a hard disc and from 512 to 640 kilobytes of RAM. A mouse or pointing device is helpful in quickly selecting choices from a menu.

CD-ROMs can serve multiple users through a LAN (Local Area Network); however, this sharing can slow down the CD-ROM to the point of possibly canceling the benefits of its speedy data searches.

Retrieving information

Retrieving information from a CD-ROM consists of browsing and searching. This refers to generalized versus specific searches. In a typical browse, you would be given a list of publications containing your general subject of interest.

To refine and make the search more specific, you'd use keyword searching. This type of a search typically produces all of the documents with that keyword. It also often has a short description beside the documents. In certain software application packages you can even restrict the search to a specified period of time before and after a certain date.

Indexes

Keyword searches are powerful. They use indexes which include virtually every word on the disc.

In the case ofprinted documents, the author decides which words to include in the index. In comparison to the overall document, this typically small tightly controlled vocabulary is but a fraction of the total. On a CD-ROM, the indexes are created by special indexing programs using a process called full inversion. This creates an inverted index, which contains essentially every word of every document, minus stopwords or words so common that they are purposely left out. Examples of these common words are "a", "an", "the", "but", "that", "my" etc.

The indexing process occurs before data is placed on the disc. It may also take up over half of the space on the disc. However, there are separate indexes for many fields, which is why retrieval is so fast.

Hewlett-Packard also makes CD-ROMs which they call LaserROM. The LaserROM was designed to perform searches in a further variety of ways. It accepts Boolean search strings. Therefore, keywords can be logically combined with AND, OR and NOT operators. HP LaserROM can search for exact words, strings, or specific fields, or itcan use wildcard characters. It also searches for key words that are close to each other.

Next time

The third article in this series of three on the subject of CD- ROM will describe how the CD-ROM-generated document may be viewed or manipulated, how CD-ROM discs are developed, and touch on several other related technologies. ■

Why radio sometimes sounds inferior to CD or tape

By John Shepler

One disappointment common to many who buy expensive stereo systems is that the radio section often doesn't sound nearly as good as the tapes or CDs. You might be tempted to write this off to limitations in tuner design or radio wave propagation. For AM signals that is often true. For FM, however, the major limitation in sound quality occurs within the radio station's equipment.

For FM, the major limitation in sound quality occurs within the radio station's equipment.

You probably know that the FCC has reasonably strict standards for FM stereo audio. Frequency response from 50Hz to 15,000Hz and separation to 30dB may not sound state-of-the-art, but if these were the only limitations, most listeners would be hard pressed to find a problem.

Surprisingly, technology is not the culprit. The major limitations to radio audio quality have to do with business decisions.

Extreme business pressure to reduce expenses encourages some stations to skimp as much as possible on maintenance, testing, and equipment upgrades. While solid state control boards and newer transmitters can be ignored for years with little negative impact, cartridge and reel tape equipment, the mainstay of many stations for commercials and music, need more frequent attention.

Tape recorders and players are notorious for drifting out of alignment. Without regular tweaking to NAB (National Association of Broadcasters) standards, this equipment will gradually sound duller and duller until repairs are finally made.

You can reassure customers that their receivers are functioning correctly and then help them find the higher quality broadcasts.

CDs, on the other hand, either sound great or don't play at all. Compact disc is helping radio stations to sound consistently better, but is only starting to be practical for local recording. Digital tape is certainly an improvement over analog, but the recorders and tapes are still somewhat expensive.

The other major influence on station sound quality is the competitive pressure to stand out on the dial. The general public may be under the impression that a radio station is simply a wireless link from a CD player to their home systems. Nothing could be further from the truth. Most stations use extensive audio processing prior to transmissions. This processing is in the form of gain riding, equalization, compression, limiting, and

The major limitations to radio station audio quality have to do with business decisions.

even clipping. The purpose of the processing is to make the station sound loud and distinctive, so that listeners will tune no further.

Audio processing can be made to sound nearly transparent or very irritating, depending on how much is applied and how clean the audio is to begin with. The minimal amount is just enough peak limiting to prevent overmodulation of the transmitter. Most stations go well beyond this. If they didn't, their signals would sound weaker and presumably attract fewer listeners. Unfortunately, it is easy to adjust the audio processors incorrectly and overdo the desired effects.

If you listen carefully to each station in a given area, they all sound a bit different. Some have wide stereo separation. Others have little stereo effect. Some sound very clear and distinct. On others, it is hard to pick out the instruments in a song. Some announcers sound clear. Others sound like the microphone is distorting. The audio processing is probably what is causing many of these problems.

Compact disc is helping radio stations to sound consistently better, but is only starting to be practical for local recording.

Knowing what is happening on the radio dial is useful to servicing technicians in a couple of ways. You can reassure customers that their receivers are functioning correctly and then help them find the higher quality broadcasts. Then, once you have educated your customers, maybe they will be motivated to voice their complaints to some of the offending radio stations. Perhaps when the stations become aware of how important the audio quality is to their listeners, they will make the necessary changes to improve it. ■

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

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SMD rework kit

ESP Inc. has introduced a new SMD Rework Kit that allows a PCB rework operator to perform quality board repairs without using flux core wire and liquid flux. The new kit provides solder cream and paste flux in pre-packaged 5cc barrels for precise application. Finished work looks similar to new with no bridging between leads and no harm to the circuit board or component. The new kit contains the following: reusable ergonomic HP hand dispenser for easy application; two pre-filled barrels of surface mount grade Sn62 solder cream and two pre-filled barrels of paste flux; eight no-scratch dispensing tips for controlled dispensing of dots or beads of solder cream or paste flux; VacTweezer, with a variety of straight and bent tips and clear pads for easy, accurate placement of components. The solder cream provides consistent wetting and proper tack to hold components in position for reflow. The paste flux stays where it is applied and allows for fast, clean component removal. The kit is available in rosin, no-clean, or water soluble flux systems.

Circle (5) on Reply Card

Parts reference on disk

Philips Consumer Electronics Company (PCEC) has introduced the Philips Part Number Cross Reference Program to aid consumer electronics ser- vicers in looking up, stocking and ordering replacement parts quickly and efficiently. This simple program makes it possible for a user to cross reference almost any Philips part number with Philips and other manufacturers' model and parts numbers. The program is contained on just two computer disks and the only system requirements are DOS 2.0 or higher and a hard disk with at least 10MB of storage space available.The Philips Part Number Cross Reference program has been designed with user-friendly, pull-down windows for easy use by non-computer-literate technicians. The program also comes with simple instructions and a number to call if the user has any questions on operations or installation.

Circle (6) on Reply Card

Advanced formula deoxidizing solution

DeoxIT, a one step treatment, by *Caig Laboratories Inc.*, is a fast-acting deoxidizing solution that cleans, preserves, lubricates and improves conductivity on all metal connector and contact surfaces. This new formula contains improved deoxidizers, preservatives, conductivity enhancers, anti-tarnishing compounds, arcing and RFI inhibitors and it provides extended temperature range

(-34C to 200C). DeoxIT also prevents dissolved oxides and contaminants from re-attaching to metal surfaces, providing longer lasting protection. Available in spray, liquid, wipes and pen applicators. Use on switches, potentiometers, relays, PCB edge connectors, batteries, faders, interconnecting cables, plugs, jacks, etc.

Circle (7) on Reply Card

Programmable power supplies

American Reliance announces a new line of standard linear power supplies. The line includes 21 models so users can select the model that most precisely fits their needs. All of the units in the PPS series feature a built-in GPIB interface for remote operation. The supplies adhere to

IEEE 488 standards and all functions are available through the GPIB interface, including calibration. Local operation is easily performed through a convenient front-panel keypad, and output voltage and current can be constantly monitored via the built-in LCD panel. In addition, a step-up/step-down programming function is available through the keypad and all single output PPS units can also be programmed with an external voltage source. Each unit offers line/load regulation of 1mV/1mA, load PARD (periodic and random deviation), and quick transient recovery time. An optocoupler circuit is used to isolate the digital control circuits from the analog power system. To ensure that the proper voltage and current is deivered to the load, a remote sense function is built into all units to compensate for any loss in the lead wires.

Circle (8) on Reply Card

Air ionizer tester/field meter

The new *3M* Model 713 air Ionizer Tester and Field Meter is used for locating and measuring static charge voltages. Used in combination with the isolated plate test fixture and Model 713CH Charger, the unit tests the function and balance of ionized air blowers and guns. The plate test fixture attaches to the meter to make ionizer discharge rate and balance measurements. For discharge rate measurements, the tester can be charged by using the small, battery powered Model 713CH Charger. The meter can also be used to find static charged areas

so they can be corrected or avoided. The meter is battery powered and it features a 3 1/2 inch LCD display for easy reading. It has a range of 0V to ±1999V when used at a distance of 1 inch or when used as an ionizer tester. The pocket-sized case is conductive and features a ground snap to facilitate accurate measurement. The circuitry is designed to make accurate measurements even in ionized air environments. The unit features SAMPLE and HOLD modes that allow measurements to be made in difficult to reach places.

Circle (9) on Reply Card

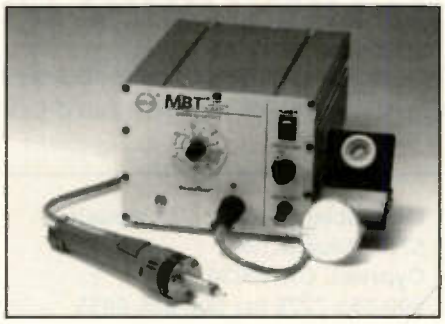
Hot air SMT rework with vacuum pick-up

The FCR-2200 series from *OK Industries* is a forced convection SMT rework system with vacuum pick-up. Employing a self-contained air source, the unit regulates air flow and temperature to rework a wide range of components including discretes, SOIC, PLCC, and QFP. Because the system uses forced convection heating, damage to pads, boards or component leads is virtually eliminated when compared to direct contact heating methods. Equally important, once the component leads are desoldered the vacuum pick-up lifts and removes the component. Its three-mode operation provides manual or semi-automatic control for component removal or replacement. The handpiece has a spring loaded vacuum tube which virtually eliminates mechanical stress when contacting the component. Additionally, the vacuum tube length is adjustable: the operator may extend it for better viewing during placement or retract it to allow the nozzle to "encapsulate" the component during reflow. Over 25 standard nozzles are available, mechanically matched to each component. The nozzles are designed to encapsulate the component in effect creating a localized reflow chamber while protecting adjacent components from heating. Temperature within the chamber is precisely regulated with a closed-loop thermocouple control.

Circle (10) on Reply Card

Self-contained desoldering system

The new MBT 101 has been introduced by *Pace, Inc.* as a low cost, self-contained desoldering station which can be easily upgraded to perform virtually any SMT-Thru-hole component installation or removal. The unit features a high-performance Snap-Vac desoldering pump which provides safe, effective thru-hole component removal-even on heavy multilayer boards, and the new SX-70 high capacity Sodr-X-Tractor for enhanced thermal performance in a variety of thru-hole desoldering applications. With the purchase of optional SensaTemp handpieces, the product can be instantly upgraded to handle virtually any surface mount component installation and removal requirement. The IR-70 SMT/Thru-hole Iron provides unsurpassed performance on multilayer assemblies as well as convenient removal of SOICs and other SMDs. The ThermoTweez handpiece provides safe, one-handed reflow and removal of PLCCs, LCCCs and other components in seconds. The ThermoPik handpiece incorporates a self-adjusting integral vacuum pick, for safe, one-handed removal of PQFPs and flatpacks.



Circle (11) on Reply Card

Analog scopes based on digital scope interface

A new family of analog real-time scopes by *Tektronix, Inc.* incorporates the highly successful user interface recently pioneered on the TDS (Tektronix Digital Scope) Series. Combining exceptional reliability with modern measurement capabilities, the new TAS (Tektronix Analog Scopes) 400 family streamlines scope operation for the service, education and broad-based electronic design markets. The initial two scopes in the family include the two-channel 60MHz TAS 455 and the two-channel 100MHz TAS 465. These scopes make operation virtually intuitive with an innovative user interface. Based on the highly successful TDS platform design, but tailored to the analog scope user, the user-friendly interface exhibits a balanced combination of buttons, knobs and simple menus. Features such as Autoset, save/recall setups, cursors and Set to 50% triggering help the user to quickly trigger on, display and measure signals. These products are backed with a *free scope* replacement if the TAS breaks in a three year period. A proprietary hybrid circuit houses the entire acquisition system including the vertical, horizontal and trigger functions for each input channel. Virtually a "scope on a chip," these hybrids enable the scopes to increase the MTBF hours. This is accomplished through a 75 percent reduction in part count, a 50 percent improvement in mean-time-to calibrate, and less than 12 manual adjustments. Reliable, cleanly designed and lightweight (17 lbs), these scopes are suitable for basic troubleshooting and repair at the customer site.

Circle (12) on Reply Card

Readers Exchange

Reader's Exchange has been reinstated as a free service.
The following restrictions apply to Reader's Exchange:
•Only individual readers may use Reader's Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropiate place for your message is in paid advertisement, not Reader's Exchage.
•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 colum lines in length (about 20 words).
Send your Reader's Exchange submissions to:
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WANTED

Volume control for a Bradford model 89193 stereo player. *Paul Capito, 637 West 21 St., Erie, PA 16502.*

Sanyo RD 8400A Plastic front panel and/ or cassette door. VCR service manuals. Tech tips on VCRs. *B&R Electronics 10 Mt. Pleasant View Ave., Cumberland, RI 02864. 401-658-1856.*

Service manual for Multitech CD player model MD-140, service manual for Kenwood DP-840 CD player. *John Phipps, 1412 Navaho Trail, St. Charles, MO 63304.*

Schematic for Kenwood receiver model KR-7200. *J. Schmidt, Box 12397, Jones, MI 49061.*

Actual horiz./verti. osc./countdown IC chip (not the SPS cap) P/N 145803 for CTC 99/101, new or used, but good. *D.H. Eadie, 4627 Wilson-Burt Rd., Wilson, NY 14172. 716-751-9799.*

Panasonic VSZS0040 display tube, used in a Panasonic PV-1740 VCR. Also, service data, manufacturer's address, etc. . . ., for a Nippon Electric Model P415E turntable. This has an "NEC" logo, but is NOT supported by NEC Technologies in Wood Dale, Illinois. *Conrad Enterprises, Larry Sheingorn, 9715 Medical Center Drive-#502, Rockville, MD 20850.*

Service manual/instruction book/schematic for Paradyne Challenger 16000, model 2599-01. Will pay for copying or buy. *George Kieffer, 5437 W. 140 St., Hawthorne, CA 90250-6401.*

Source for all VCR RF modulators by VCR model number; B&K 470 CRT checker adapter socket CR-42. *Ed Herbert, 410 N. 3rd St., Minersville, PA 17954.*

Motor Block assy., part number 160035 for RCA VKT 275 VCR. Send Price. *#17 Eastlawn, Kearney, NE 68847.*

Microfiche Reader and 'fiche. *Neil, 209-795-5655 or P.O. Box 2011, Arnold, CA 95223.*

Schematic or copy of for a Zenith TV Model EO930S. Send charge and schematic to *Robert J. Nathman, 240 N.E. Cambridge Circle, Corvallis, OR 97330.*

FOR SALE

Knight R/C Tester & Eico 324 Signal Generator—$10.00 for both, plus shipping. PF Reporter, 58-59-60-61-62-63—$10.00, plus shipping. *M. E. Andrews, P.O. Box 91, Exeter, RI 02822.*

Sencore VA-48 Video Analyzer, excellent condition. Cables and manuals included. $495.00. *Call Mike at 608-223-0077, 10 a.m. to 1 p.m.—CST.*

Used electronic equipment for sale—schematics back to 1972. Sencore PS29—Minute Man. Make offer. *314-838-3358.*

New metal 200W computer power supply boxes. Power supply removed. Switch, fan, AC line cord included. $10.00 each, includes shipping. Money order only. *Brad Doody, Rt. 2, Box 199, Chester, VT 05143.*

Quitting business sale! The latest test equipment and service literature library. Vectorscope, monitor scope, lightbox, etc. Leader, Hitachi & Sencore. *Call Ed, 209-686-5938.*

Manufacturers Parts and Literature Directory

This monthly section is sponsored by manufacturers to help you find the parts and technical literature needed to service their equipment. Call them for replacement parts or for the name of their nearest distibutor.

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Panasonic 50 Meadowlands Parkway Secaucus, NJ 07094 800 545-2672	**Philips ECG** 1025 Westminister Drive Williamsport, PA 17701 800-526-9354 fax 800-346-6621	**Quasar** 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672
Technics 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672	**Thomson Consumer Electronics** 2000 Clements Bridge Road Deptford, NJ 08096 800-257-7946 fax 800-524-1498	**Zenith Electronics Corp.** 1900 N. Austin Avenue Chicago, IL 60634 312-745-2000

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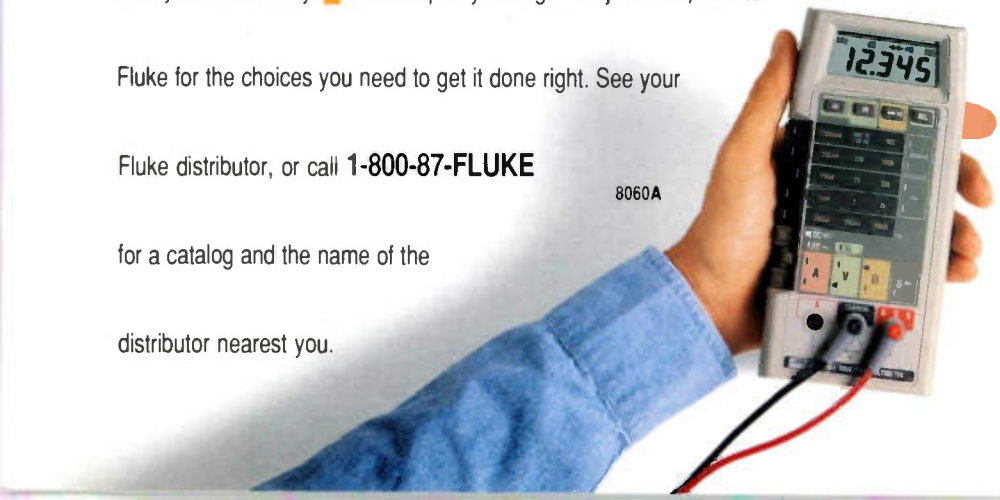

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