

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

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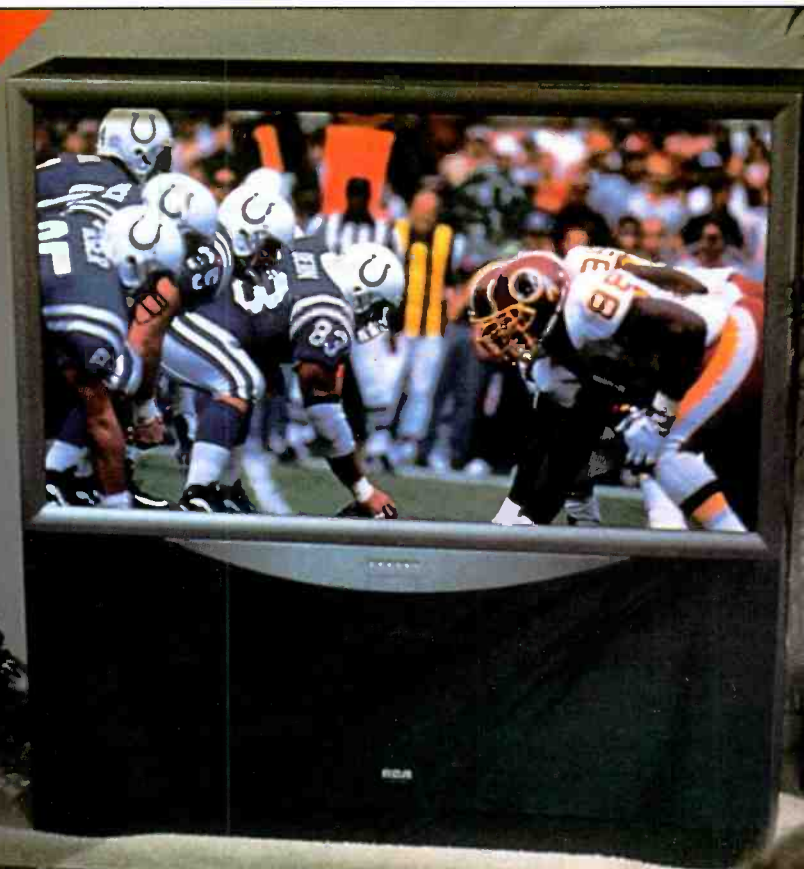
Servicing & Technology

August 1999

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in the year 2000**

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contents

FEATURES

- 6 Laser diodes** by James Van Laarhoven
Here are some do's and don'ts for technicians who encounter problems with laser diodes while servicing.
- 9 Successful servicing: Doing business in the year 2000** by Bob Rose
Successful service centers have coped with many changes. Here are some thoughts on remaining successful in the next century.
- 15 To repair or to throw away?** by Bob Rose
Inexpensive products can be repaired economically. The author provides some thoughts on determining when that's the case.
- 20 Service aids** by the ES&T Staff
This article discusses some of the aids that are available to help a service technician perform some of the difficult tasks he may face.
- 48 The Magnavox signal processor — Part II** by Stephen Babbert
Here are some tips for troubleshooting video problems caused by the Magnavox signal processor.
- 52 Diagnosing screen interference** by Michael L. Hiles
The cure for jitter or distortion may simply be to eliminate a spurious magnetic field.

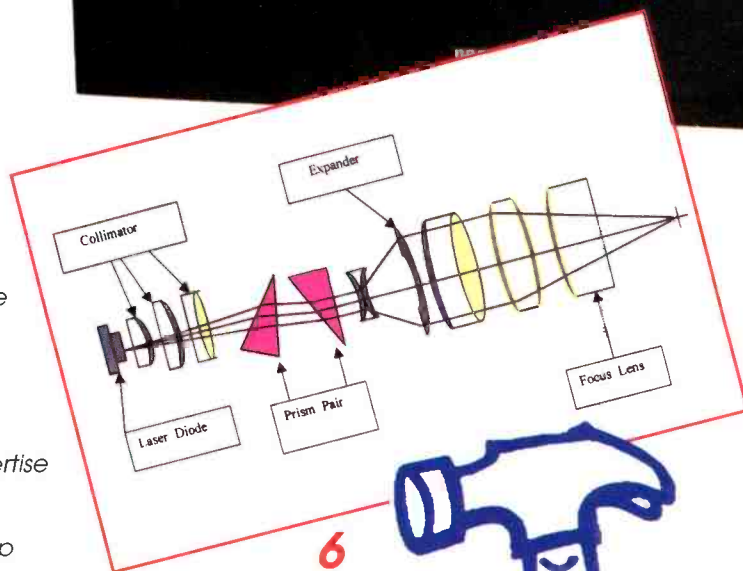
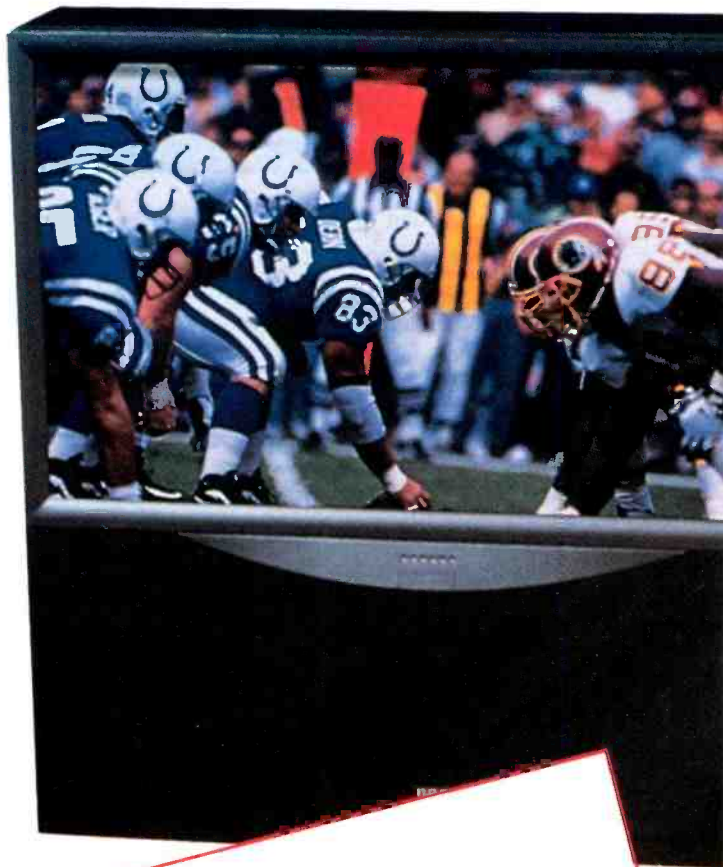
ADVERTISING SUPPLEMENT

- 22 Replacement Parts Showcase**
In this showcase, replacement parts suppliers who advertise a half page or more are given an equivalent amount of space to tell you a little bit about their companies. The information in those company descriptions may help you locate the supplier you're looking for to help you locate that elusive part.

DEPARTMENTS

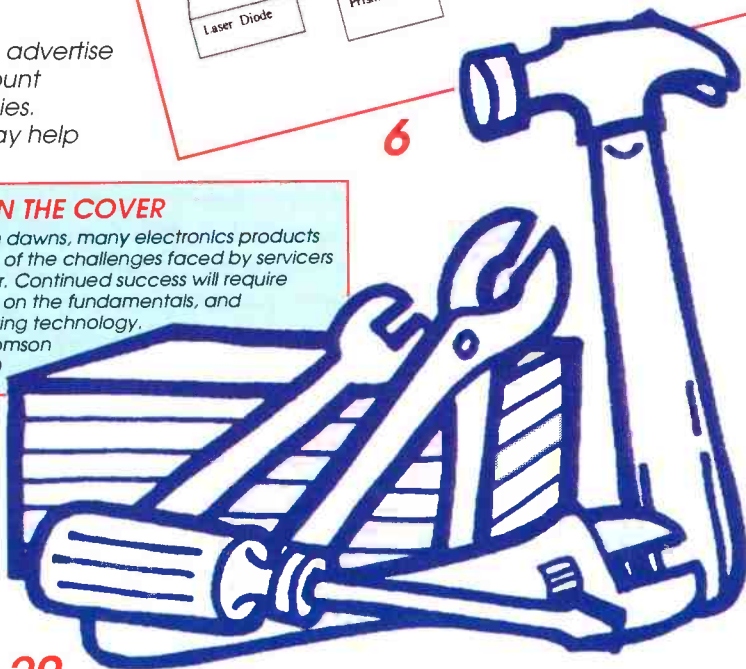
- 2 Editorial
3 News
4 Products
18 Test Your Electronics Knowledge
27 Profax
47 Literature
56 What Do You Know About Electronics?
58 Classified
59 Reader's Exchange
60 Advertisers' Index

9



ON THE COVER

As the new millennium dawns, many electronics products will be new, but many of the challenges faced by servicers will be old and familiar. Continued success will require acquiring a firm grasp on the fundamentals, and keeping up with evolving technology.
(Photo courtesy of Thomson Consumer Electronics)



20

Editorial

by Nils Conrad Persson

As the second millennium draws to a close (take your pick as to whether the next millennium starts on January 1, 2000, or January 1, 2001), a consumer electronics service center requires a powerful combination of skills and talents to continue in business, and to remain successful. Bob Rose does a very nice job of describing some of these skills in his article in this issue "Doing business in the year 2000."

More than just technical skills required

The demands of the service business today are such that the staff must possess many skills other than the technical skills required to fix the product, or the business simply cannot remain successful. First of all, the service center will not be servicing any products if the people in the local community don't bring in their faulty products to be serviced. Another factor that is of vital importance today is the requirement of the service center's technical staff to remain current on new products and the new technologies being introduced into both existing products and the newer products.

Many service centers do considerable business by performing service for stores that sell consumer electronics products. It can make a great deal of difference to the profitability, as well as the headaches that may be involved, however, which store or stores a service center chooses to work with, and how the contract is negotiated.

An important question for any service center is whether or not to do warranty work for manufacturers. For some service centers, the answer is yes. For others the answer is no. Whichever answer the service center decides on will affect them for years to come. Neither answer is "correct." Whether or not doing warranty service makes sense for a particular service center depends entirely on the individual service center owner and/or manager.

There are so many other factors that help to determine whether or not a service center will remain successful. If the potential clients don't know you're there, they won't come. Advertising, promotion, good, professional-looking signs help get out the word to the public that your service center is in business, and helps to bring the customers in.

Sharing information is one key to success

There are several organizations to which service center owners and technicians belong. One of the hallmarks of these organizations is that the members of those organizations tend to be more successful than their counterparts, who are not members of a professional organization.

Service centers and technicians who belong to organizations/associations have an important advantage. They are asso-

ciating with other people who are doing the same kind of work. Sometimes, they are associating with other people who are far more successful, and just in conversation, they can learn things that they can apply to their own businesses to improve their success and profitability.

What keeps your service center successful?

The article by Bob Rose that appears in this issue, "Doing business in the year 2000," mentioned earlier, provides some valuable insights into the inner workings of his very successful business. We hope that many of our readers can use directly, or adapt, some of his ideas expressed in that article to help make their own businesses more successful.

We have published similar articles in the past, that have contained descriptions of the management and operation of successful service centers.

We're sure that other successful businesses have a lot of useful ideas to share with other service centers. We'd like to publish profiles on some of these companies to help other readers become more successful. The stronger the consumer electronics service industry is as a whole, the stronger will be each service center that constitutes a part of that whole.

If you are a successful service center owner, or service manager, or know of another service center that you feel is successful and deserves recognition and can contribute useful ideas to other service centers, we'd like to hear from you, with a view toward developing a "Successful Servicing" article.

For anyone who can write such an article, we'd welcome a manuscript, outline, or just an idea that we could develop with you. For anyone who either can't, or chooses not to, write such an article, but would be interested in talking about what makes them a success, we would be interested in interviewing you with a view to developing a staff-written article about the service center you propose for treatment in "Successful Servicing."

In any event, we would like to hear from anyone who has a candidate for "Successful Servicing." There is no obligation involved. If you propose your own service center, or some other service center for this department, and then for some reason decide that you don't really want to go through with the process, that's ok. We won't push it. But we'd like to hear from any readers who have a proposal for "Successful Servicing." It's a great way to share the ideas that have brought success to service centers, and a great way to be recognized by your peers.

For those of you who want to contact me, my address is P.O. Box 12487, Overland Park, KS 66282-2487. My E-mail address is cpersedit@aol.com. My phone and fax number is 913-492-4857. Let me hear from you.

CEMA takes leading role in educating public on V-Chip technology

Anticipating the need for a greater understanding of V-Chip technology among parents and the general public, the Consumer Electronics Manufacturers Association (CEMA) announced a nationwide consumer education campaign in support of the V-Chip. The campaign is being launched as the July 1st deadline set by the Federal Communications Commission (FCC) approaches mandating that manufacturers have 50 percent of their television models (13 inches and larger) with V-Chip circuitry ready for market.

"We are proud to take a leading role in educating consumers about this new technology," said CEMA President Gary Shapiro. "With this campaign, we hope to compliment the tremendous efforts of the FCC and, specifically, Commissioner Gloria Tristani in giving parents tools and resources to help them shape the lives of children."

According to FCC guidelines, all television sets 13-inches and larger must incorporate V-Chip circuitry by January 1, 2000. CEMA reports that television set manufacturers are on schedule to meet both the July 1 and January 1 deadlines.

"We are pleased to report that television manufacturers are stepping forward to meet and exceed their obligations under the law," said Shapiro. "Each of the major set manufacturers are on target to deliver V-Chip equipped sets to consumers."

CEMA's campaign includes an aggressive media outreach program to reach the public and a complementary program for retail outlets. As part of the program, CEMA is creating a logo and sticker retailers can use to identify the V-Chip equipped sets in their stores. The materials will be made available on a fulfillment basis. CEMA will release more information soon for retailers interested in obtaining the stickers. The campaign is aimed at educating consumers in three key areas: the availability and affordability of V-Chip devices; the functions and features of V-Chip products; and the "how to's" for buying and using V-Chip products.

Shapiro warned that the V-Chip should not be viewed as a "cure-all." "While we are pleased to offer and promote this technology, industry efforts and government mandates on the consumer electronics industry, are not a substitute for good parenting," Shapiro added. "Parenting experts agree that the V-Chip is just one tool to help parents monitor their children's television viewing habits."

Audio/video distribution specialty added to ETA's technician certifications

AVD, Audio Video Distribution, is the Electronics Technicians Association International's (ETA-I) newest examination program for electronics technicians. AVD competencies list the skills and knowledge needed by workers who plan, install, and service audio and video signal distribution equipment and wiring. This includes home theater, satellite, consumer

electronics products, and multiple room/multiple dwelling (MDU) signal distribution practices. It also includes requirements for knowledge of rooftop TV antenna systems.

Dick Glass, CETsr, President of ETA (and the National Satellite Dealers Association), stated that the AVD testing and registration program is the latest in ETA's worldwide credentialing services, which now administers 19 C.E.T. (Certified Electronics Technician) categories. In addition to the ASSOCIATE (core) C.E.T. exam, which covers basic electronics knowledge, ETA's testing includes separate programs for Fiber Optics Installer certification; Computer Network Systems Technician; Consumer Electronics; Customer Service Specialist; Wireless Communications, and others, including another new category being beta tested currently at a number of locations: PCS-C, a specialty for technicians working in the Personal Communications Service and Cellular telephone industry.

The Audio Video Distribution specialty evolved from combining ETA's Certified Satellite Installer; Registered Small Dish Installer (RSDA), and Video Distribution specialty exams into a single program. The reason for this, explains Mr. Glass, is that the small DBS dish systems have become "just another component" in home entertainment sound, video, and data communications systems for many families and businesses. Rooftop antenna solutions also have become a part of the "system," rather than a specialty service.

Certification of consumer electronics technicians began through NEA, the National Electronic Associations, Inc. (an early TV dealer association) in 1966. Dick Glass, ETA's executive officer today, was NEA's President and manager at the time the C.E.T. program was initiated. There are over 50,000 certified electronics technicians today. Companies (and the public) are looking for qualified high-tech workers and certification has become a preferred way to determine who is qualified to work in high-tech industries and who isn't.

ETA administers written examinations through over 500 certified administrators at technical schools and colleges in the U.S. and elsewhere. Successful examinees receive identification wallet cards and wall certificates and permanent inclusion in ETA's Certified Technician data base, plus listing in the *High Tech News* publication. ETA also is one of seven commercial radiotelephone license testing managers for the Federal Communications Commission.

ETA has initiated additional help to educators wishing to set up courses leading to certification of technicians. This is accomplished by providing competencies, equipment listings, course outlines, and recommended study materials for training in any of the specialty areas of certification for electronics technicians and computer professionals.

For more information regarding the Audio/Video Distribution Certifications, or any of ETA's other testing and recognition programs for electronic technicians, call 800-288-3824 or look at ETA's site on the web at www.eta-sda.com. ■

Products

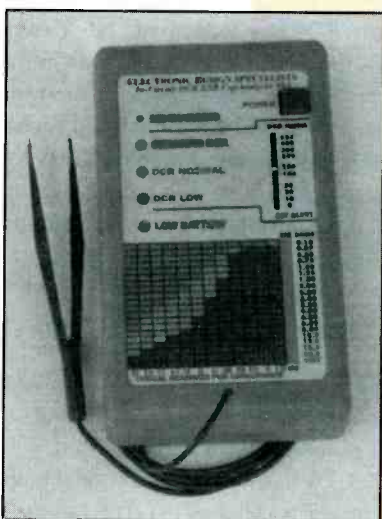
Contact cleaner

CAIG announces their new R5 contact cleaner line, again offered with a nonflammable, fast evaporating solvent that is safe on plastics. Like the previous product, which contained Freon TF, the new contact cleaner improves conductivity, deoxidizes, cleans, and preserves metal surfaces, according to the manufacturer. It will reduce intermittents, arcing, RFI, wear, and abrasion and also prevent fretting corrosion. The product is offered in a choice of applicators: pump spray, aerosol spray, precision dispenser, and bulk containers. It is useful on: switches, batteries, probes, connectors, plugs and sockets, edge connectors, terminal strips, interconnecting cables, and anywhere else metal conducts electricity.

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Capacitor analyzer

The CapAnalyzer 88 from Electronic Design Specialists has been improved and updated. The 88A has improved test probes with just one hand. A higher DCR range set-alert now adjustable up to 500Ω allows checking both electrolytic and now tantalum caps. A QuickESR test has been added for super-fast ESR-only testing, with the original discharge/DCR test/ESR test mode still available for super-accurate good-fair-bad testing. Also new is a one-to-five-beep multi-tone that allows a technician to know the approximate ESR reading without having to read the 20-segment LED display. Battery life is also improved. All of the original tester's desirable features remain, such as the three-color chart on the front panel that allows comparison of ESR to capacity, the expanded scale display, and the portability of battery operation to repair big screens in the field in minutes. An optional AC adapter is also available for all-day power at the bench.

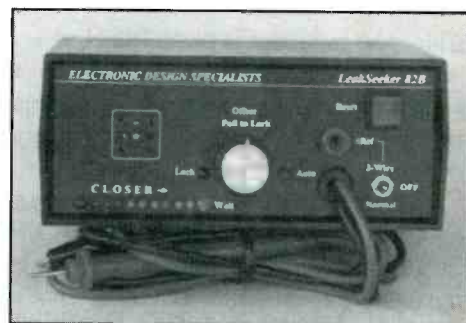


Check out <http://www.eds-inc.com/> for user comments and an animated display of the product in action.

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Component leakage tester

Technicians looking for a better way to find that elusive shorted or leaky component now have a new improved LeakerSeeker 82B from Electronic Design Specialists. The old method of unsoldering every suspected component from the printed circuit and measuring resistance, hoping to find the defective component by chance, is gone forever. Simply touch the unit's probe to pads along the trace that you suspect a short or leaky component is: the pad where the beep is highest is the lowest resistance and therefore is the bad component.



Touch pads in one direction then the other, and the tester will beep higher or lower, and light the LED scale, to show you if you are getting closer or further from the leaky part. LeakSeeker 82B will automatically recalibrate itself as you make progress, or switch to manual and probe a small dense area, where a bad part only a quarter of an inch away from a good part can be found. The unit will locate not only shorted components, but even leaky components that can be as high as 150Ω. It can even find active shorts that only show up when the unit is turned on.

There is also a three-wire test mode, to locate high-resistance shorts and thermally defective components. The product comes with a very complete manual and gold-plated test leads.

Check out <http://www.eds-inc.com/> for user comments and an animated display of the product in action.

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Computer workbench

The TechBench Pro, available from Jensen Tools, is a fully functioning computer workbench. It provides an ESD-safe work area for computer repair, assembly, and testing of any type of computer or workstation from the motherboard up. It provides a bench that allows easy access to all components being tested and comes fully configured with an anti-static base, a Senstron 250W ATX power supply, including AT converter cable, a custom fit non-conductive motherboard pad, integrated sliding keyboard tray, PC speaker, computer reset button, eight drive bay dividers, and one fixture mount.

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Servicing & Technology

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

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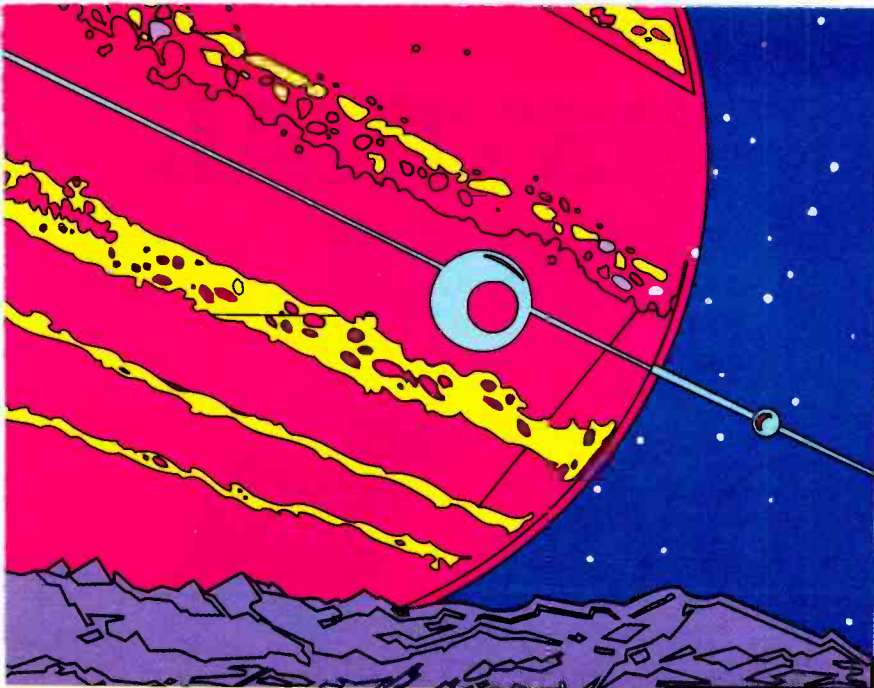
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Laser diodes

by Jim Van Laarhoven

In 1958, the first laser (light amplification through the stimulated emission of radiation) was created in Bell Labs by two brilliant men: Arthur L. Schawlow, a researcher, and a consultant named Charles H. Townes. This first laser was a simple, but effective array: a small ruby rod surrounded by a coiled flash tube (much like that of a camera). Since then, lasers have been used for so many applications that it is impossible to keep track of them all. There is even a mirror placed on the moon by Apollo 11 that bounces a laser beam back to earth for distance measuring. While many of these applications are interesting, this article will concentrate on diode lasers and their applications to compact discs, digital video discs, and other data storage media.

Injection diodes

Laser diodes used for compact and video disc players belong to a variety known as injection diodes. The construction of this type of diode starts with a top and bottom area made of metal (Figure 1). In between this metal sandwich is a p-n junction that is forward biased during operation. Forward biasing causes holes and electrons to be injected into the active layer. The energy is then confined in the active layer by the barrier of the adjacent layers. The recombination of this energy produces photons that stimulate other photons until the current in the active region reaches a point at which light

Jim Van Laarhoven is an independent technician and consultant for computer based lighting.

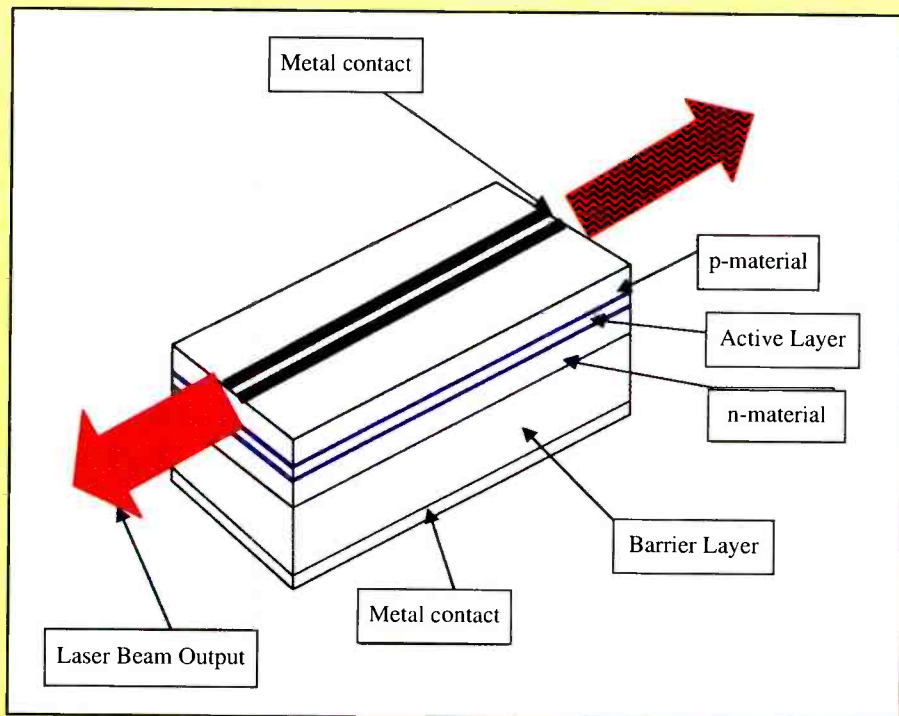


Figure 1. The construction of a laser injection diode consists of a top and bottom area made of metal, with a p-n junction between them that is forward biased during operation.

escapes or *lases*. Optics are then needed at each end of the diode to accelerate the beam to make it a true laser.

Diode lasers are usually packaged ready to use. This means the laser and all of the optics are hermetically sealed in one complete module. As to the module; although it does not appear to be complicated, it is a device of complexity and exactness. A typical module will have a collimator (to focus the diverging beam), then a prism

pair (to change the beam from elliptical to circular), and finally an expander and a focus lens (Figure 2). Interestingly enough, the laser diode is the smallest component inside the module. Each diode module will have different optical assembly configurations that will be established by the manufacturer. One of the main reasons for these differences is to adjust the beam's focal point with reference to the final optical component. Without this

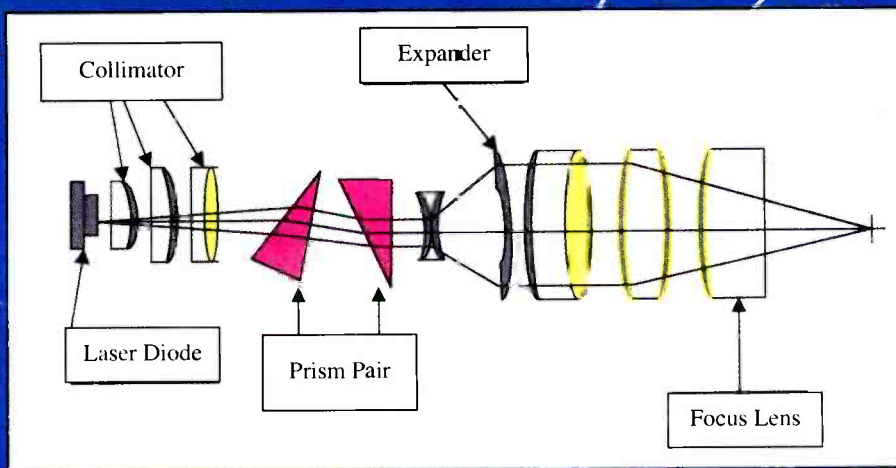


Figure 2. A typical laser diode module will have a collimator (to focus the diverging beam), then a prism pair (to change the beam from elliptical to circular), and finally an expander and a focus lens.

accuracy, for instance, a CD player could not read a disc.

Principles of operation of pumped and gas lasers

Since flash tube pumped and gas lasers preceded the diode laser, it might be helpful to cover some of the principles of each of these. The very first laser used a ruby rod. Manufacturers and researchers still use ruby as a laser medium, but the rubies are now man-made from a boule of mostly aluminum oxide. Many solid state lasers, such as the Neodymium-Yag (Nd.Yag), commonly use a laser diode instead of a flash tube to excite the medium. This cuts down on the heat that is produced from these high-wattage lasers. Nd.Yag lasers are similar in operation and construction to the original ruby types.

Gas lasers are still very popular and are manufactured in a variety of wavelengths (colors/frequency), depending on the gas used. Almost all of the elemental gases are used in these types of lasers, either separately or in mixture with other gases to produce visible, infrared, or ultraviolet lasers (see Figure 3).

Precautions when working with lasers

These lasers typically have very high-voltage requirements, sometimes in the tens of thousands of volts. Though current tends to be low in most gas lasers, the power supply voltage could easily cause sudden heart-stoppage if inadvertent contact is made with an exposed area. Care

should be observed whenever working with these or any lasers, not only because of the high-voltage risks, but also because of the damage even a low-powered beam can cause to the eye. More information about these risks will be included in the area on safety later in this article.

Laser diodes generally are low-powered. Some laser diodes, however, are rated rather high and can now do the jobs that many of the gas and solid-state lasers use to handle. It should be mentioned that technically laser diodes are a solid-state

device, but the industry is usually referring to the more complex lasers, such as the Nd.Yag, when they use that term.

Lasers are used in bar-code scanners

One of the areas that laser diodes have captured from the gas laser market is the bar-code scanner. Helium-neon lasers were used exclusively until laser diode technology came of age. The diode lasers we will talk about next are of the low-power classification. These are the lasers you will most likely find in consumer

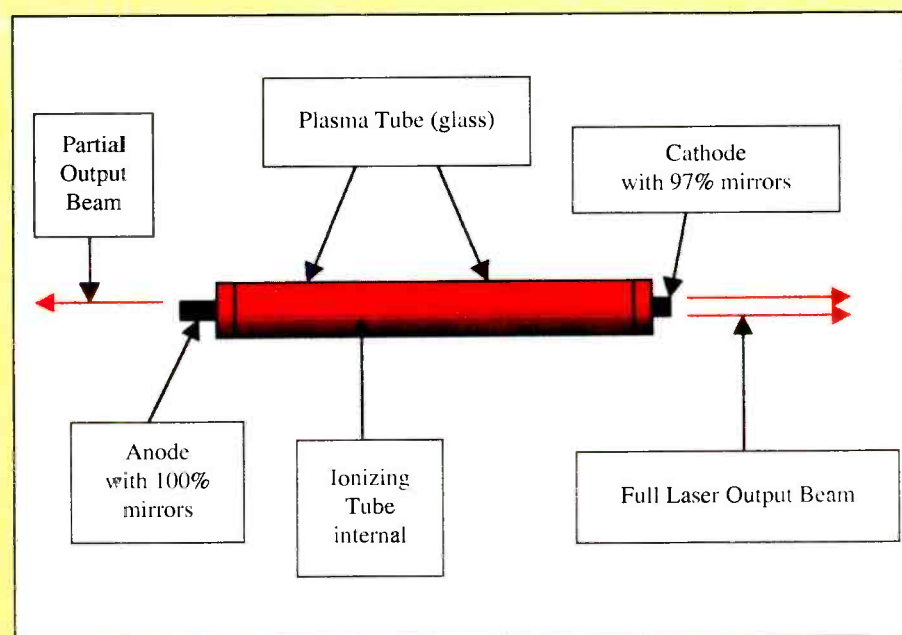


Figure 3. Gas lasers are still very popular and are manufactured in a variety of wavelengths (colors/frequency) depending on the gas used. Almost all of the elemental gases are used in these types of lasers, either separately or in mixture with other gases to produce visible, infrared, or ultraviolet lasers.

Laser Safety Classifications

Class I Laser Systems—	completely enclosed or have insufficient power. Classified as safe.
Class II Laser Systems—	Less than One milliwatt. Can do damage to eye if stared at continuously.
Class IIIA Laser Systems—	2 to 5 milliwatts. Focused beam can injure eye.
Class IIIB Laser Systems—	5 to 500 milliwatts. Brief viewing can injure eye.
Class IV Laser Systems—	Highly intense beam. Even diffuse viewing causes serious eye damage. Also fire hazard.

Figure 4. Lasers are classified as to their beam output strength and wavelength.

electronics products such as CD-ROMs, and Digital Video Discs.

Servicing laser diodes

Servicing laser diodes is a tricky job. It's easy to damage or destroy a laser diode, even if proper care is taken. Laser diodes are static and voltage sensitive, not to mention the delicate nature of the complete module assembly. The first thing you'll notice as you look at a laser module assembly is a small window about a quarter-of-an inch in diameter. In most diode assemblies, this is the final focusing or objective lens (on some it may be a combination lens incorporating a diffraction grating or some other optical feature).

Sometimes, this window can become dirty from dust or an accumulation deposited from CD discs. The best way to clean this window is by blowing it off with compressed air. You may want to use a pressurized can of clean air of the type that is available to blow off circuit boards and other electronics assemblies. Some technicians use alcohol and a cotton-tipped swab, but this puts some stress on the floating tracking module and that may damage it. In addition, you have to make sure that the window is streak-free, otherwise you will distort the output beam and cause further reading errors. Having clean optics in any laser application is essential.

Laser diode output

The output from this type of laser diode is about 5mW before it transmits through the optical components. By the time the beam exits the window to the CD surface, its power can be as low as 1mW. You will

most likely notice a very dim red beam. Don't mistake this for a weak diode. Most diodes used in CDs operate near the infrared spectrum, at about 780nm (wavelength). It really depends on the individual's eyesight as to how much red they actually see.

Never look directly at the beam; the infrared can be just as harmful as the visible beam. Worse, really, because you cannot see it. Use an infrared card to detect the beam and watch it from an oblique angle if you can. You can also use a white card to reflect the red emission of the laser diode. And always wear eye protection when working with lasers.

Laser beam control elements

Looking at the outer area of the module, you will probably notice some coils. These coils are used for servo control of the focus and tracking systems. This servo system positions the diode window extremely close to the CD using the return beam as a reference. The laser diode module can sometimes house a photo diode sensor that helps regulate the power of the beam. This regulation is needed since the laser diode heats up while in operation and tends to draw more current.

When testing the electronics of the module, use extreme care. An ohmmeter output can easily introduce enough current to destroy the diode. If you have the specifications for that particular laser diode module, you can check voltage drops to it. Otherwise, it is hard to guess which leads go to the photo diode sensor, and which go to the laser diode. If you test the assembly without the spec sheet, keep

in mind that the photo diode will have a lower voltage drop (less than 1V), as compared to about a 2V drop to the laser diode. Be careful not to reverse the test leads as this may damage the laser diode.

Laser diodes in DVDs

Digital video disc (DVD) diodes differ slightly from CD laser diodes in that they tend to emit light in the visible range. This makes it easier to see if the diode is in fact operating and may save some disassembly time during repairs.

Safety plays an important role when working with any laser. The human eye will actually re-focus a laser beam to a small pinpoint on the retina, causing irreparable damage. Always wear protective eyewear. There are companies that manufacture protective eyewear when dealing with all laser wavelengths and power levels. Intra-beam viewing (straight-on) is always discouraged, even with eyewear protection.

Infrared and ultraviolet lasers are very common and you could be at risk without knowing you are. An inert looking laser diode may be fully energized and sending a beam right at your eye, so it pays to be attentive to eye safety. Lasers are classified as to their beam output strength and wavelength (see Figure 4).

Another area of caution is dealing with the power supply and the connections to the laser. The high voltages incurred in some types of lasers can make normally non-conductive material act unusually conductive. Nearly all standard wire insulations will leak at 12kV.

Diode wavelengths

Diode lasers come in a variety of wavelengths. The most recent list compiled indexes from 635nm to 1550nm. This is an approximate list since researchers and laser developers are making new advancements all of the time.

The future of laser diodes is hard to predict, however, researchers seem to be making progress in the area of data storage. Their goal is to pack more information into a smaller area on disc. This means shorter wavelengths will be needed to retrieve and write to these higher density discs. Since shorter wavelengths are generally in the visible part of the light spectrum, we should be seeing some powerful and colorful laser diodes in the future. ■



Successful servicing: Doing business in the year 2000

by Bob Rose

If you are a consumer electronics technician, you have undoubtedly noticed a change in the quantity, quality, and types of equipment you repair. If you haven't, you've been sleeping through your workdays. If you own your business, you certainly have noticed a change in the nature and mix of the products you take in for repair.

The demand for service on some products has decreased

For example, I have reflected on the changes in the business my partner and I own and operate. As recently as three years ago, we were servicing approximately fifty VCRs a week. We are now lucky if we see twenty-five. As early as five years ago, we repaired several dozen remote controls a month. Now, a month can go by without our being asked to repair a single one. We have never really been enthusiastic about camcorders, but we have always serviced them. A week often goes by without our being asked to service even one. The same obtains for other products we routinely repair like stereos and microwave ovens. These products are so cheap consumers throw them away and buy new units.

The demand for service on other products has increased

Other aspects of our business have increased. We service more televisions than we once did, especially VLS (very large screen) TVs. As a matter of fact, service of the larger TVs has mushroomed. We used to service just a few a month. We now see in a day or two what we used to

see in a month. I stopped by the service center today (I don't work on Fridays) and noted that a projection set was setting on the floor waiting for a module, two were on the van waiting to be unloaded, and the techs who share our in-home service had three "boxes" to deliver.

This is just one-half of the picture. The other half is made up of what's on the horizon — VLS televisions much larger than we now have, DVD players, recordable CD units (which Philips will introduce next year), digital cameras, the much-touted "high definition" television sets, more sophisticated computers, and on-and-on the list goes.

Servicing newer products requires an investment in time, money

The new products provide service opportunities, but they also demand extensive training and significant investments

in literature, parts, and equipment. For instance, the field service engineer for one of the brands we service dropped by for his annual visit not long ago. He showed me the inner workings of their new digital camcorder and told me that a service center would have to spend about \$12,000.00 just to equip a bench to work on the product. The screwdriver needed to assemble the new camcorder will cost in the neighborhood of \$135.00. You read the figure correctly: \$135.00 for a screwdriver. Of course, it's a "special" one because all of the screws, even the screws in the case, have to be torqued. The rep was not happy about the turn of events, but he's a player in a larger game, just as we are.

DVD players will require equipment like a computer and special programs to service. The high-definition televisions may even require a spectrum analyzer to service. Do you know how much one of



Rose is an independent consumer electronics business owner and technician.



those costs? The on-the-horizon products tantalize us with new service opportunities. However, the opportunities may be offset by increased servicing expenses.

Collaboration works for us

I don't want you to assume that I participate in a large-scale operation, because I don't. I am the sole full-time technician in our service center. Neal, who retired from a job in a related field, works part-time. Two techs who own their own businesses, Donald and Thomas, work with us doing projection work. They like to do in-house service, whereas I don't. The arrangement works nicely, and all of us profit by the collaboration. Robert, my partner, is the business manager and general hustler. He wrangles with the warranty companies, locates used merchandise to repair for resale or to salvage for parts, handles the sale of used merchandise, and deals with our walk-in customers and the dealers whom we service, leaving me free to

operate the service center. My wife, Vicki, does the bookkeeping. Bryan, the man who drives our van and does pickup and delivery at the dealers we service, rounds out the team.

We service an average of about seventy-five pieces a week. If you are in a one-person service center, you may think seventy-five pieces a week is a lot, but it isn't. Chances are our business is like yours. At times, it's an "in-one-hand-and-out-the-other" operation, usually facing a cash flow crunch, and always looking for ways to increase our revenue because the present way seems "not quite sufficient" for the needs at hand.

Our customer base

Our service base may be a little different. We don't depend on walk-in customers, though we certainly encourage them. We are located almost in the center of West Tennessee, most of which is more-or-less rural. Oh, we have several towns in the area, but with an exception

or two, the towns are small (fewer than 10,000 population and most far smaller than that). We depend on dealers, like furniture store owners, for the bulk of our repair work, and we have a marvelous collection of them scattered all over our geographical area. Let me be clear about one thing. Robert and I decided that we would stay away from the larger merchants and work to get the smaller ones. Neither of us wanted the headache of dealing with the larger ones, and you wouldn't believe the headache in attempting to provide service for some of the larger ones. However, we do service one large retailer in our area on a COD basis for out-of-warranty repair. No "fix it now and we'll pay you in thirty days-maybe."

How we chose the dealers we work for, and how we keep them satisfied

How did we accumulate our roster of dealers? We did a survey of the brands and products sold in our area and secured warranty status for those brands and prod-

ucts. We promised regular pick up and delivery at their places of business, gave them special rates on non-warranty repair so they could make money, and promised them quick, reliable service. Then we followed through on our promises. We believe that if the customer has a problem, we have a problem, and we work toward resolving it.

Most of our dealers have been with us for ten years. Our reputation (of which we are quite proud) often leads a dealer to call us asking for service. While I was in the service center this morning, Robert told me about a call he had taken from an RCA dealer about sixty miles from us who wants us to do his service work.

You may be wondering why I have described my business in some detail. Conrad Persson, the editor of this magazine, asked me to share with you my ideas about operating a successful repair business. I can't do it unless I first give you an idea about the business that I help to operate. Hence, the description of "Electronic Service Center," the name of our repair service. I am going to proceed with the editor's suggestion by asking a series of questions Robert and I face almost every day and then sharing the answers we have discovered, in the hope that our answers will stimulate you to find your own. I am under no illusion that the solution to our business problems will be your solution. I do hope that our solutions will stimulate you to find your own.

How can I set up for service?

My partner and I decided what we would service by finding out what was needed in our area. We service Philips, Magnavox, Sylvania, Philco, Zenith, RCA, GE, Funai, Symphonic, White-Westinghouse, JVC, Goldstar, Quasar, Panasonic, Hitachi, Toshiba, Crosley, Sharp, Samsung, Sanyo-Fisher, Welton-Techwood, and few others. As I have indicated, we also service VCRs, most microwave ovens, some camcorders, some audio equipment, and other products that sort of fall into a miscellaneous category. In other words, if it's broken, we usually attempt to fix it.

If we lived and worked in a different environment, we would extend our service to Sony and Mitsubishi (which we are considering), Pioneer (which Thomas is considering), and possibly automotive audio. If I were just starting out, I would defi-

nately move into automotive audio because of the amount of stuff on the market, but it is not an option now. Besides, we don't have the time or space for it. I would even consider servicing vacuum cleaners if the demand was there, but it isn't. In short, we service what we do because market research pointed us in this direction. What you service will be different because your market will be different.

Doing the research

How can you determine what products are being sold in your area? Quite simply. Read the advertisements in your newspaper. Browse the shelves of Wal-Mart, Lowe's, K-Mart, Sears, and the local furniture stores. Pay attention to the brands you find in your customer's houses and the brands your friends use. There is no secret. Just pay attention to what you see.

To do, or not to do, warranty work

The question of service brings up doing warranty work. We do it because it is necessary to attract business, but it is a hassle even in the best of times. I am fortunate to have Robert who is "a thorn in the flesh" of the companies for whom we do warranty work. He spends hours a week

on the phone making certain that our claims have been received and are being paid in a timely fashion. If you do warranty work, you will have to do the same, or you will lose money.

As an example, we once had a claim for almost \$1,000.00 sit on a desk in a corporate office for over six weeks because, according to the manufacturer, it didn't have the customer's zip code on it. But it did. After a hassle, someone located the "missing" claim and admitted that the zip code "had just been overlooked." In the meantime, we had to pay a distributor for a 31" picture tube.

But that's not the whole story. Warranty status attracts customers in several ways. First, it gives you an "in" with the electronics dealers in your area. If you get them, you will probably also pick up their non-warranty work. Second, you are put on a referral list by the manufacturer who gives your phone number to customers seeking help. Third, you can advertise as "a factory authorized service center" and maybe even pick up some co-op advertising money. Fourth, you are privy to information that non-authorized service centers never see. Fifth, you get access to techni-



Are You Servicing Computers?

Do you know that major computer hardware and software vendors, distributors, resellers and publications, back the A+ Certification program as a means to verify the competencies of computer service technicians.

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cal help lines and technical training that sharpens your skills as a service provider. Even though it is a hassle, warranty status and warranty work is worth the effort.

Test equipment, and service literature

Now, forgive me because I'm going to get on my soapbox for a few lines. If you are going to stay in the service business, you must have the equipment and literature necessary to do the work. I know of service centers that try to get by using just a Simpson 260 multimeter. You could do it years ago. You can't now.

Some service center owners think they can't afford literature subscriptions. Most of them have stuff stacked everywhere because they can't fix it. If you are going to stay in business, resign yourself to the fact that you must have certain basic pieces of equipment (a DMM, scope, signal generator, computer, etc.) and good literature. If you don't purchase factory manuals, then subscribe to Sams Photofact, but for goodness sake have reliable service data at hand.

Keep learning every way you can

I have one more point to make about gearing up for service. Learn everything you can about the products you service. Go to service schools. Watch service videos and CD ROMs. Read technical service bulletins. Participate in seminars. Read magazines, books, and service manuals. Talk to other technicians wherever you can. Do what you have to do, but keep up.

Nowadays, a computer and modem can put you in touch with more data than you can imagine. Check out, for example, on-line help sites like www.repairworld.com or www.anatekcorp.com. You have to pay for their services, but I feel that they are worth the expense. Other sites offer free access. Need information about a particular IC? Check out www.hotyellow98.com/gnacet/techforum.html. Click on "IC Master," and see what's available just for the asking. Do the same at www.pacificsemi.com/contact/contact.html, and see what turns up. These are just a few of the myriad of sites from which you can glean valuable information.

What kinds of products should I be servicing?

We made a conscious decision to concentrate on the repair of consumer elec-

tronics, culling service on certain items, which might be quite profitable for you. We are located quite near a major metropolitan center that has several businesses offering sales, service, and support for computers and monitors. Since we got (and get) few requests to service computers, we decided forego servicing them. Oh, we can and often do evaluate a unit for a customer. If the computer needs extensive work, we will refer the customer to a qualified computer service center. Our referral often brings us new customers.

The owner of the computer might bring us another product to fix because we were so helpful with computer, or the computer servicer might bring us a TV or VCR to fix. We have never had much of a demand for camcorder service, but we do fix a few. We ship the smaller camcorders to the factory or a repair depot because they do it quicker and cheaper than we can, leaving a little room for us to make some money too. Either way, we get the customer into our service center and provide him or her with the needed service.

We concentrate on what we do best, fixing televisions, VCRs, microwave ovens, audio equipment, and the like. I will also repair irons, vacuum cleaners, toasters, hair dryers, and so forth, for the people who live in our town and for our good customers. Hey, why not? I don't make much money, but I build good will.

Do, then, what you do best, but don't overlook opportunities to expand.

What about advertising?

Ah yes, advertising. We tried advertising in the local newspapers, of which there are three. Since the ads didn't pay for themselves, we canceled them. However, I am glad we explored the newspaper because it taught us something about our area. Don't ignore the possibility of newspaper advertising, because it might work for you. We even tried sending an occasional mailer to everybody in our town and on the rural routes, and that didn't work. We are so small that we didn't even consider television advertising because it's terribly expensive. We did consider radio spots but dismissed the idea because most of the local radio stations didn't reach the audience we wanted to reach. But let me hasten to add that if our location were different, we would seriously explore this option.

Promotional products to spread the word

Certain strategies have worked to bring us more business. For example, if the repair comes from a walk-in or local customer, I put a white sticker on the back of the unit giving our name, address, and telephone number and tell the customer, "Here are our name and phone number. Call us when you need us." We have a box of ballpoint pens and a stack of scratch pads on the front counter for our customers. The pens and pads have our name, address, and phone numbers on them. We have a brochure on the counter that contains "chatty" information about our business — who we are, what we repair, what our rates are, how we can be reached, what services we provide, our warranty, etc. We also have a few leaflets we include with certain repairs. The leaflets explain how to care for a CD, how to care for a VCR, how to check for a defective speaker, and other useful bits of information. Of course, the leaflets have the appropriate name and phone numbers on them.

Yellow pages work for us

We also have a business-card-size ad in the yellow pages. The ad gives our name, address, and phone numbers (We have an 800 number) and lists the brands for which we offer factory authorized service. The ad pays for itself many times over.

Signs proclaim what your service center does

If you concentrate on a certain brand, say RCA, Zenith, or Magnavox, the company might co-op some advertising with you. We have a four-foot by six-foot lighted sign outside the building that Zenith helped to pay for. I have a philosophy that goes something like this: if it calls attention to what you do and is tasteful, try it. The Zenith sign works. If RCA or Magnavox or JVC or whoever had one, I'd put it up too. By the way, I do have decals from these companies on two of the front windows. They look nice.

Which brings up another issue. We have a large, very well-done sign on the front of our building identifying us. It can be seen and read from quite a distance because we wanted people to notice us. I deplore poorly lettered and unattractive signs because I believe they are a "turn

off." Spend a little money and get an attractive, professionally-done sign to advertise your business. Remember, the sign is a reflection of you and attitude toward your work. We also have professionally-lettered signs on our two vans. The vans may be old and a bit weary, but they are neat, well-cared for, and highly-visible advertisements for our business.

Keep your service center well-maintained and neat

Finally, keep your place of business in good repair. Keep the parking area free of clutter, the windows washed, the building painted, and the service center area neat and clean. I have been in service centers that were like walking through a maze, and I never felt comfortable leaving something for repair in those places. Who knows? My possession might get lost or mishandled, either of which I wouldn't like. I know some techs who say, "If my service center is neat, people will think I'm not busy!" My reply is, "Bunk!" A neat and tidy service center is an invitation to leave an article for repair in the hands of someone who will take care of it. Your service center's appearance is a potent advertisement for your business because it either attracts or repels customers. Appearance may not be everything, but it certainly counts.

How can I cut expenses?

Keeping expenses down is a constant struggle, and I don't believe it's getting easier. Some expenses are given: mortgage or rent, utilities, vehicle payment and upkeep, salary (or salaries), and things of this nature. Some expenses can be controlled. My wife did a bit of shopping and found a way to save almost \$100.00 a month on our phone bill. Remember, we have an 800 number as well as regular phone service, but we have just one phone line. We also have a fax machine, a computer, and an answering machine. A switching modem interfaces the phone line with the equipment. No sense in paying for two or more phone lines when one will do the job, is there?

My partner routinely calls the dealers we service for a little chat. Then he asks, "Got anything for us?" Making a phone call is cheaper than putting a van on the road and driving forty miles unnecessarily.

ly. Using necessary lighting and turning everything else off saves electricity. Buying good, used test equipment instead of new stuff also makes sense. By the way, the same obtains for vehicles. We have never bought a new van and don't plan to.

Other ways to save money

Shop around for reliable parts suppliers. When you find one or several who are reliable, consolidate your buying to save money on shipping charges. One manufacturer charges \$4.95 per package. Another manufacturer charges as much as \$5.75. However, one of our distributors charges much less. If we can get a part from that distributor, we do it and sometimes save as much as \$5.00 an order. You can't avoid shipping charges, but you can minimize them. For example, we order parts three days a week at a maximum and have cut our shipping expenses by at least \$500.00 a year.

Buy certain parts in bulk. I order a few parts, like optocouplers that go in VCR power supplies, a dozen at a time. I save a dollar here and another there by order-

ing in bulk and another dollar or two by shopping around. The dollars saved add up.

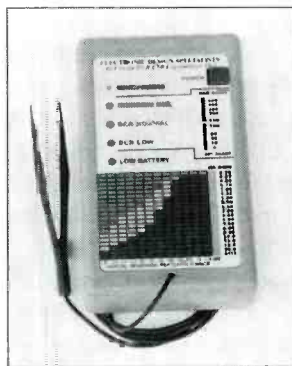
There is, however, one thing I do not do: I never sacrifice quality. Put an inferior part in a TV and have it come back with the same problem in a week, and you will understand why I insist on quality and am willing to pay a little more for it.

While I am on the subject of parts, don't overlook your salvage (See my article in **ES&T**, "Your Salvage Can Make You Money"). Why spend \$30.00 for a new cassette up unit for a VCR when you can sell your customer a good, used one for less? Tell your customer what you are doing, and warranty the part. The customer will appreciate the savings, and you will make more money on the repair. Besides, a good salvage bin will permit you to pick up jobs you otherwise will have lost.

What is tomorrow calling for?

What do we need to do that we are not doing, and what are we doing that we perhaps shouldn't be doing? We have to ask

Don't be stupid.



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August 1999 **Electronic Servicing & Technology** 13

these questions just about every day. When our VCR service business fell off, Robert and I scratched our heads and wondered how to make up for the lost revenue. We decided to try to secure a source for used consumer electronics products that we could fix up and resell. We have been quite successful at this venture, and the revenue we realized has more than offset our losses in other areas. We have been lucky because the demand is still greater than the supply.

Those two questions have led us to discontinue doing warranty work for two companies that you might consider major players in the field of consumer electronics. We had a lot of trouble getting parts, information, and payment from one. It held up payment on some claims for more than six months. After we got payment, we decided to tell them to take a flying leap. You know something? We haven't missed their work or the hassle. The other company was okay to work for, but we weren't getting enough work to justify the cost of literature. We saved money by discontinuing our warranty status for that company's products.

When the market for in-home service developed beyond our capabilities, we were fortunate to find Donald and Thomas who like in-home service and who are easy to work with. Expansion into that area has been pleasant and profitable for the four of us, and it just keeps getting bigger and bigger. You go where you need to go and do what you need to do (within reason, that is) to make an honest living.

We are also gearing up to service the new DVDs, all VLS televisions sold in our area, the high-definition products when they become generally available, and the new generation of microwave ovens (no more transformers), VCRs, combi units, and so forth. Current plans also include continuing our used electronics sales. Where we turn and what we do will be determined by the market that develops in West Tennessee.

We never forget, though, what is going on now. VCRs are cheap, but we still service them economically and reliably in part because of our enormous stockpile of used parts. We turn down some "oldies but goodies," especially televisions, because we can't get parts or don't believe the oldies will stay fixed. "There is no need,"

as my grandfather used to say, "to throw good money after bad." So, we refuse the job if we think it won't be profitable.

Speaking of what's happening now, ever hear, "If I can't get it fixed cheap, I'll just throw it away?" Cheap electronics, the downfall of the service industry? Not necessarily. A customer gave me a microwave oven because it quit working, and he had bought a new one. I fixed it and put it on my counter and attached a sign to it: "Someone threw this away. We fixed it for \$25.00," to make our customers aware that service is frequently less expensive than purchasing a new product. Think about doing something similar with a microwave, TV, or VCR. Would you rather buy, in this instance, a microwave for about \$100.00, or get the old one fixed for \$25.00?

Should I charge a technical evaluation fee up front?

Do I charge an estimate (or technical evaluation) fee? Some service centers advertise "free estimates," holding that it brings in business. Yes, it does, but it can create problems. Others charge an estimate fee and collect it up front when the merchandise is presented for repair.

Robert and I decided to do things a bit differently. We collect a non-refundable charge for camcorders and certain other pieces of equipment that we ship to repair depots because we sometimes lost money dealing with them. We do not, as a rule, do estimates for other products, but we do have an "approval rate" that we use when a customer asks us for an estimate.

If the product is, let us say, a 19" TV, we require approval up to \$75.00. We tell the customer that the repair might not cost that much, but we need a commitment up to \$75.00. If the repair exceeds the limit, we call the customer and discuss the issue with him/her. If the customer declines the repair, we charge a technical evaluation fee. If we do insurance estimates, we most certainly charge. Nobody has the right to ask you to work without compensation. If you do, don't moan and complain about lack of revenue in your business.

Calculating labor charges

The other question that crops up is, "How do I determine how much to charge for my labor?" You have to get adequate

compensation for what you do, or you will go out of business. What your charges are will depend on your cost of doing business. Cost of doing business in West Tennessee will not be the same as in New York City or Memphis or Nashville. Moreover, what you charge has to be balanced against the value of what you are asked to repair. So, we decided to charge a specific amount to repair a 19" TV, and increase the rate as screen size and complexity of the unit increase. Again, your labor rates will be determined by your geographic location.

We do a couple of things to bring in a few extra dollars. We include a "shop material charge" on every bill to cover the cost of supplies like solder, desoldering braid, chemicals, cotton tipped swabs, and the like. The charge never exceeds 10% of the labor charge, and is more than adequate to cover the cost of supplies. We also do "a safety leakage test" on all televisions and some VCRs we service, and we put the results on the invoice. The results reads like this: safety leakage, +150 microamps. That little test clears us of fault in case the equipment malfunctions in the future, and brings in a little extra revenue because we charge \$3.00 per test.

Building on what I have just suggested, let's do a little math based on the assumption that you fix ten televisions a week. Let us also assume that your labor rate for the ten averaged \$50.00 per unit for a total of \$500.00. If you charged just \$3.00 per unit for shop material and \$3.00 per unit for a safety leakage check, you increased your revenue by \$60.00. Multiply that by fifty weeks, and you will get an idea of what I'm talking about. You could buy a variable/isolation transformer with the necessary probe to do safety leakage checks, and it would pay for itself in less than year.

One final thought about charges. You really should take a look at what you charge once a year and make whatever adjustments your situation calls for. If you do warranty work, you should also ask for an adjustment of your warranty rates annually because, believe me, those fellows won't be calling you.

Doing business in the year 2000 will be quite a challenge. But, then, we are accustomed to challenges because we are in the service business. ■

Troubleshooting techniques: To repair or to throw away?

by Bob Rose



Consumer electronics are “dirt-cheap.” That’s a West Tennessee expression that means the prices are about as low as they can get. For example, I read the advertisements in our Sunday paper and noted that one major retailer recently advertised a national brand four-head VCR for \$99.99. Wal-Mart has been advertising two-head VCRs for as low as \$69.95. I wish the situation in West Tennessee was regional, but it isn’t. I belong to a group of techs who use the facilities of Repairworld.com (www.repairworld.com) to communicate. It’s a way to get help for those troublesome repairs, secure information about parts or literature or manufacturers, share your expertise, and occasionally get on a soap-box and talk about what’s on your mind.

That consumer electronics are dirt-cheap is a constant topic of conversation. Who hasn’t fussed about the customer who brings a unit in for service and tells you, “If it’s going to cost much to fix, I’ll just get a new one?” You, I am sure, have heard the same line, and if you are like me, just hearing it causes your stomach to growl.

That the price of TVs, VCRs, and other consumer-oriented gadgets is low means we face the dilemma of deciding between lowering our repair rates or losing a repair job. But if we lower our rates, given the cost of doing business, how are we going to stay in business? On the other hand, if we keep on losing jobs, how are we going

to stay in business? Those questions are difficult to answer.

Different answers for different people

Different service centers have different answers. Some techs are branching out. One told me he was focusing on computers and monitors. Another said he was gearing up to repair the new DVD products. The advent of “high definition” has the possibility of putting new life into the consumer electronics service industry. A lot, though, will depend on how the manufacturers deal with training and compensation. One has already said, “Don’t attempt repair of our units unless you contact us first.” I confess I am somewhat skeptical about how it will go and have adopted a wait-and-see attitude.

My partner and I have begun to repair and sell good, used televisions, VCRs, and stereo equipment, having given up selling new products several years ago (we couldn’t compete with Wal-Mart and others. They sold the same products cheaper than we could buy them wholesale.) The recent issue of Proservice magazine carried an article about a service center that has become a “fix-it” center. They will tackle anything a customer brings in and have been quite successful at it. In the meantime, there are niches here and there that provide at least a modest opportunity to add to diminishing revenue.

Don’t dismiss service work out of hand

There are many cases in which it just doesn’t make economic sense to service a low-cost product. But there are other

cases in which it does make sense. It might be bad for the economic health of your service if you judge a job not worth your time before you think it through. Let me illustrate my point with this story. I recently inherited three Magnavox VCRs from another service center. The owner of the service center has never been interested in VCR service, especially if the problem unit has more than a simple mechanical problem. He knows we salvage discarded units for parts and sent them to me to add to my “bone yard.”

Lightning had damaged all of these VCRs, and from the looks of the circuit boards, the power supplies had been hit relatively hard. My friend had concluded the units were not worth repairing; a conclusion that in these cases is easy to reach.

Was he correct? Were they “beyond economical repair?”

A preliminary evaluation

I proceeded to disassemble the units by removing the front panels, the screws that held the decks in place, the decks, the screws that held the circuit boards in place, and the circuit boards. Then I inspected the bottoms of boards for damage and found none. If a circuit board had been damaged, I would have condemned the VCR (and collected a technical evaluation fee if a customer had brought it in for repair or evaluation).

Next, I located the literature for these VCRs: Philips manual number 5537 for model numbers VRU222AT21/ VRU2-42AT21. If you don’t have the exact manual in your service center, you might have one that will work because these VCRs

Rose is an independent consumer electronics business owner and technician.

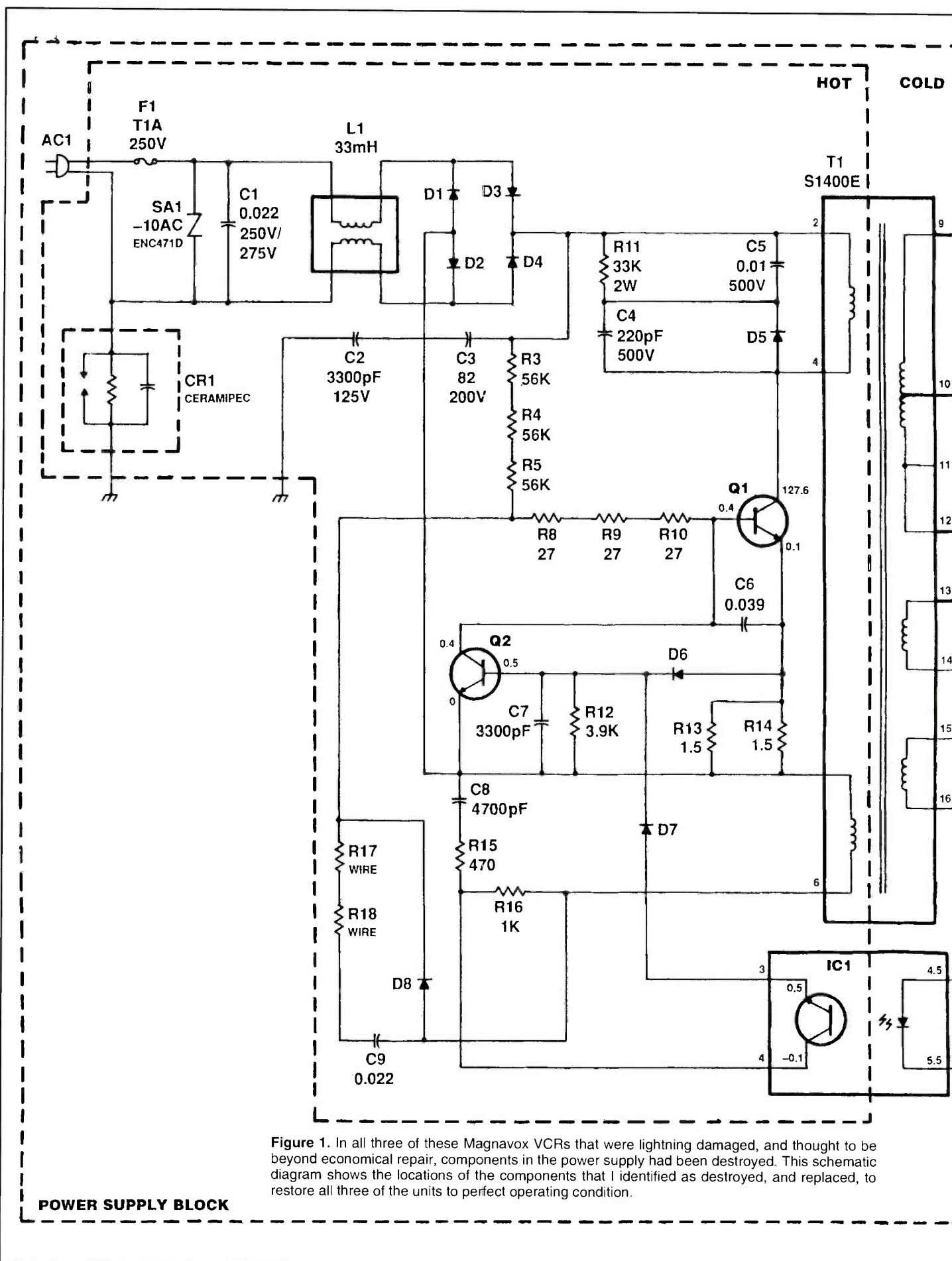
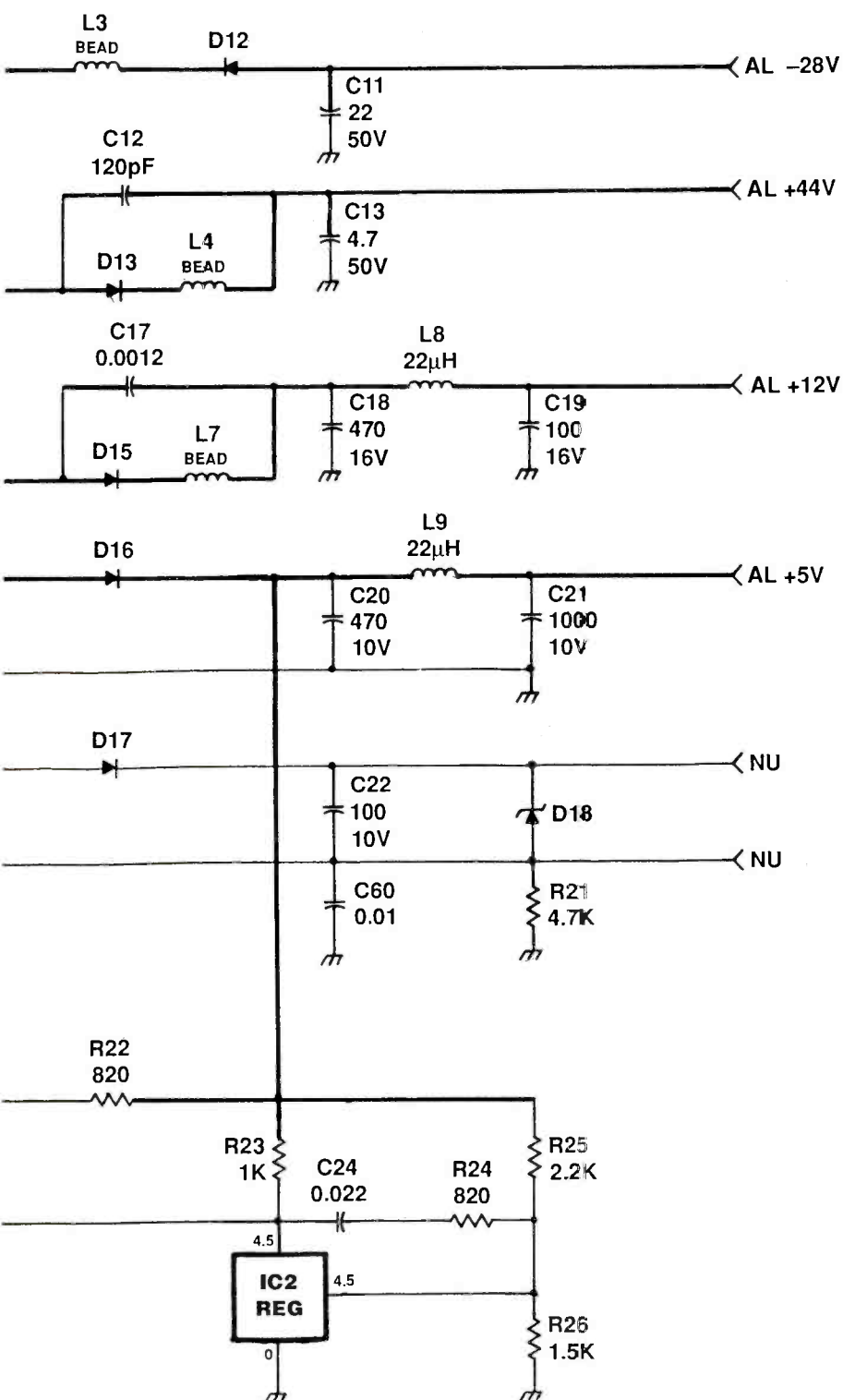


Figure 1. In all three of these Magnavox VCRs that were lightning damaged, and thought to be beyond economical repair, components in the power supply had been destroyed. This schematic diagram shows the locations of the components that I identified as destroyed, and replaced, to restore all three of the units to perfect operating condition.



have been marketed as Funai, Symphonic, Hitachi, Sylvania White-Westinghouse, Magnavox, and a few others. It is possible to repair them without service literature, but the job goes smoother if you have the appropriate schematic diagrams, block diagrams, parts lists, and so forth.

Replacing shorted components

My wife says I insist on taking a short cut even when it costs me time and money. She is correct. I have a habit of checking for shorted components as quickly as I can, replacing them, and checking to see if the power supply works. Most of the time, I have to disconnect the unit from the power line, discharge the filter capacitor, and check the remaining components. Some shortcut, huh?

A systematic approach

I decided to repair these three VCRs in a systematic way. So, I laid out the service literature and went to work. The procedure worked so well for me that I am recommending it to you.

Since the damage to all three units was similar, I'll use one of them to illustrate how the jobs went. See Figure 1.

First, I removed the obviously defec-



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Circle (83) on Reply Card

tive parts. In this instance, components that showed signs of damage were F01, C03, Q01, and Q02. With these three components out of the way, I checked all of the resistors in the primary of the circuit and found R03, R08, R09, R13, R14, and R16 defective. I removed them. Then I checked the diodes, finding D06 and D07 leaky and removed them. Lightning invariably damages the optoisolator, IC01, and the precision voltage regulator, IC02. I also removed them.

Second, I replaced the defective resistors. The schematic calls for 1/8W resistors, but I often use 1/4W resistors as replacements simply because they are easier to work with. However, 1/8W resistors may fit onto the circuit board better. I suggest you use whichever you have. Note that 1/4W resistors will upgrade the power supply.

Third, replace the defective diodes using generic replacements, unless the documentation calls for diodes with specific characteristics.

Fourth, replace IC01 using a PC817 and IC02 using one of the following: KIA43i, KA431Z, L543i, or AN1431T.

Fifth, replace C03 with an 82 μ F, 200V capacitor. As I have said, you won't need to replace it all of the time because the surge that destroys the power supply will not always be large enough to blow it apart.

Sixth, replace F01 with a 1A GMA fuse. Somewhere in the repair process, I suggest that you take a minute (It won't take more than a minute) and check the diodes in the secondary: D12, D13, D15, D16, D17, and D18. If any of these diodes are shorted, you will of course need to replace them. Most of the time, the lightning damage will be confined to the primary circuit, but it's better to be safe than sorry. Happily, I found no trouble in any of the secondary circuits.

Checking the results of your work

The time had come to check the results of the repair. I connected a scope between the negative terminal of C03 and the collector of Q01 and a DC voltmeter between cold ground and the AL +5V line at the cathode of D16. I turned the variable/isolation transformer to 0V, plugged the unit's line cord into it, and slowly began to increase the ac while watching the scope and the voltmeter. I saw an ac waveform pop up when the ac voltage reached about 10V and increase in amplitude as the ac increased. The waveform stabilized

when the ac input reached 35V to 40V, and the dc voltmeter stabilized at slightly more than 5Vdc.

I slowly increased the ac input to 120V while I monitored the scope and voltmeter and listened for squealing from the power supply that would indicate additional shorted components. The waveform at the collector of Q01 held stable. The output of the 5V line was also stable. It looked as if the power supply had been restored.

Buttoning the unit back up

The next task was to reassemble the VCR and check for other problems. I set the deck on the circuit board and hooked up an antenna and a television. The VCR worked like a brand-new one. I had installed about \$6.00 worth of parts and invested about 35 minutes of my time.

With one exception, the remaining VCRs were just as easy to repair. The exception needed a tuner. Since I salvage units, I had about half-a-dozen used tuners in stock. I refuse to miss a repair job if I have the needed, relatively expensive part in stock, particularly if the part didn't cost me anything. So, I popped in a used tuner and reassembled the VCR.

Servicing lightning-damaged units may be more difficult

I would be wrong if I said all lightning repair jobs were as easy as these repairs were because they aren't. The transformer (T01) and almost any of the components in the secondary can be damaged. Moreover, the damage may extend to the microprocessor, the video processing IC, the servo IC, and/or the tuner-demodulator. You can't check these circuits until the power supply is up and running. Which is to say you gamble a little when you begin the repair.

However, I believe it's a gamble worth taking. If the damage is too extensive, you can remove the more expensive parts and back out of the repair with a minimum investment of time. You have to decide if the project is worth your time.

Reaping the rewards

I believe the effort is worth my time. Here's why. I completed the three repairs on a Thursday. Since I take Fridays off, I came to work the following Monday and found that my partner had sold the three VCRs for \$60.00 apiece! Not bad for less than two hours' work and about a \$15.00 investment in parts. It's money that would

not have gone into our bank account if I hadn't attempted the fixes.

Repair parts, and repair kits

You can get parts for these power supplies in one of two ways. You can purchase a kit of parts from a distributor that sells that type of kit. The kits are relatively inexpensive and might be the way to go if you repair just a few units a year. If, however, you service several over the course of a year, you might want to make up the kits yourself. I make up my kits by ordering the parts in lots of a dozen and the resistors in bags of twenty, saving a little here and there by ordering in quantity.

If you make up your own kits, you will need the following: a 1A GMA fuse, possibly an 82 μ F/ 200V capacitor, a 2SC4418 (an upgrade from the original 2SC4953) transistor, a 2SC4204 transistor, a PC817 optoisolator, a KIA43i precision regulator, and a few resistors.

As you can see by studying Figure 1, the power supply uses several values of resistors in the primary. Some are more likely to fail than others. I suggest you keep a healthy supply of the following values in stock: 1.5 Ω , 27 Ω , 1k Ω , and 56k Ω .

The total investment in parts per VCR will usually be between \$4.00 and \$7.00, which means you can salvage more of these jobs than you think. You have at least one thing working for you. When your customer gets accustomed to using a particular model, he or she is likely to spend a little money getting it repaired than, say, double the cost of repair to get a new one with which they are not familiar.

Thinking through each service opportunity

If we can add a little extra revenue by rethinking how we handle VCR repair, couldn't the same be claimed for certain televisions that we consistently refuse to repair? Or audio equipment? Or micro-waves? Or the occasional small appliance a regular customer asks us to take a look at? We techs have a tendency to become opinionated, don't we? In the best of times, we can afford to choose our work: this model over that one, this newer set versus one that is ten years old, that TV because it's easier to fix than this one, etc. I admit that working on some units invites problems, and we need the wisdom of Solomon to decide which to fix and which to cull. But I still believe we are letting some revenue walk out the door because we have become just a little too opinionated. ■

Test Your Electronics Knowledge

by J.A. Sam Wilson

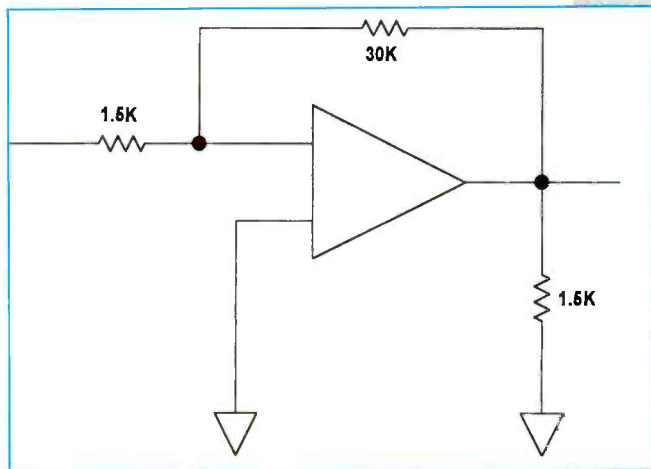


Figure 1. What is the gain of this op amp?

- Mathematical operation priorities are as follows:
A. Multiplication and division before addition and subtraction.
B. Addition and subtraction before multiplication and division.
- What is the gain of the op amp in Figure 1?
A. $1500/30k$
B. $30k/1500$
C. $R_L/1500$
D. $1500/R_L$
- Which of the following LEDs is sensitive to static electricity?
A. Red
B. Blue
C. Green
D. Yellow
- What is the rms value of a sine wave that has an average value of 7.11V?
- A certain manufacturer makes all of its gates with CMOS circuits. Their product is called a _____ of gates.
- Given the following binary number, 00111, what is the next binary count?
- A bubble displayed on bubble memory is actually a _____.
- How do you get a logic 1 output from a NAND gate?
A. Two logic 0 inputs
B. Two logic 1 inputs

9. Which of the following power supply voltages will give a CMOS gate a shorter propagation delay?

- 6V
- 12V

10. Is the following statement correct? "The current gain of an emitter follower is less than 1.0?"

can be quite high, but voltage gain is less than 1.0.

1. A.
2. B.
3. B.
4. 7.89V (7.11×1.11)
5. Family
6. 01000
7. Cylinder
8. A.
9. B.
10. Not correct. The current gain of an emitter follower

Answers to TVEK



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Service aids

by the ES&T Staff

Did you ever get involved in a service procedure and sat there wishing you had an extra pair of hands? Or, did you ever try to pick up one of those tiny surface-mount components and wish your hands were smaller? And did you ever wish that your eyes were a lot better than they are, so you can see those tiny components, fine wiring traces, and tiny lands on that printed circuit board?

Of course, you can't grow an extra pair of hands, or shrink your hands, and you're pretty much stuck with the eyesight you have, short of laser surgery. But there are lots of service aids, many of them available at the local distributor, that can make the job of picking, placing, moving, soldering, desoldering, seeing, storing, and on and on, a little easier.

In doing research for this article, the staff visited several distributors' websites. There are a number of distributors listed in the **ES&T** March Annual Buyers' Guide issue. If you're interested in learning more about what kinds of aids are available to service technicians, we suggest having a look at a few of these sites, or ordering their catalogs. Figure 1 is a list of products made for making service work easier, faster, and more efficient. A glance at the list might make a technician or a service manager aware of the wealth of products that are available that can make service go faster. We found this list at the website of one manufacturer that offers such products, as well as repair and rework services.

Of course, many of these products, such as very expensive repair/rework centers and vision systems, are really out of reach of the average consumer electronics service center. But many of the products are useful to technicians at every kind of service center and are affordable.

Some useful service aids

Of course, any of these products costs money, and in that regard, reduce the size of the bottom line. And if they don't perform a useful function, they're a waste. On the other hand, if a service aid saves several minutes of a technician's time on a number of occasions, or makes it pos-

sible for a service center to complete a repair that it otherwise would have had to pass up, then a few bucks spent on that item was well worth the expense. Only a given service center has the knowledge to decide if any service aid is worth the money, and only then by giving the idea of purchasing such products some serious thought. So we're not going to offer any advice along those lines here, merely mention some of the service aids we've run across that look like they might be useful for some service centers.

Screwdriver/light

This product is a screwdriver with a space for two AAA cells in the handle, and two small bulbs in the handle that aim toward the screwdriver tip. There are so many dark areas in a TV, or VCR, or other consumer electronics product, that many times it's difficult to see to screw in a screw. And use of a flashlight might require that the technician have three hands. And there might not be enough room for both the screwdriver and a flashlight. With this gadget, the light is contained in the screwdriver, and aimed exactly where it's needed.

Multipurpose pocket tool

This might be more useful in the toolbox than at the bench. It includes, all in one unit, a pair of pliers, a serrated blade, a large jackknife-type blade, wire cutters, file, wire strippers, needle nose pliers, and screwdriver blades. These all-purpose tools tend to be a little awkward, but sometimes if it contains just the tool needed by a technician trying to get the job done and out of the way, just once, it might be paid for in that single instance.

And when the technician is ready for lunch, the tool includes a bottle opener to use for opening his bottle of soft drink.

Retrieval tools

How many times have you dropped a screw or

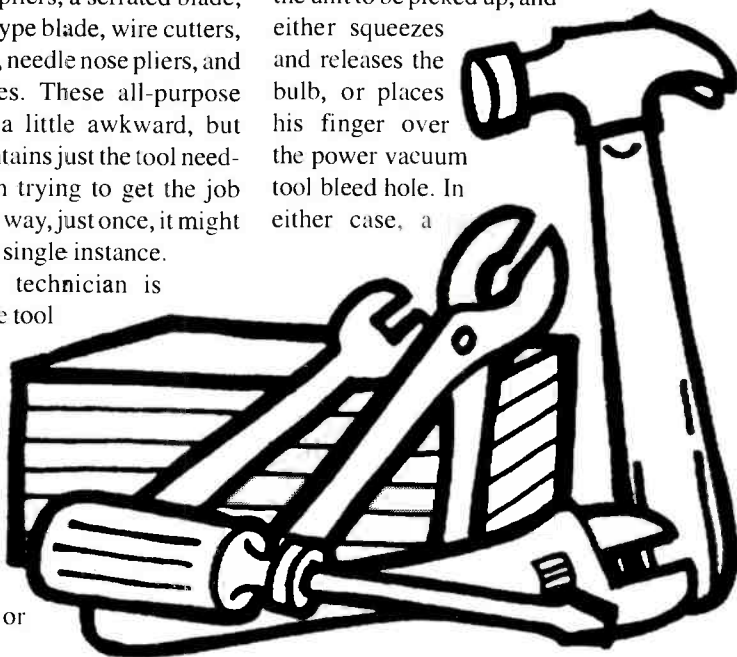
nut into the guts of a product you're servicing, and had to disassemble a part of the product just to get to it? After all, you can't leave it in there to interfere with the mechanism, or to short something out. These products have a long telescoping handle, and either a magnet, or a spring-loaded claw at the business end that's operated by a pushbutton at the operator's end. The technician uses a good light to locate the dropped fastener and reaches in with the retrieval tool and plucks it out. End of story. One of these can pay for itself in a single use.

Vacuum pick and place tools

When a technician has removed a tiny surface mount resistor, transistor, diode, or some other component, he now must place the replacement on the board in the correct position and orientation. Anyone who has ever tried to pick up one of those tiny components knows what a pain it can be. And then trying to place it in the right position for soldering is even worse.

The answer is a vacuum pick and place tool. Some of these units use a power vacuum, and some use a vacuum bulb that the technician squeezes and releases. The business end of the device is like a miniature suction cup. These come in different sizes for different size components.

The technician places the suction cup on the unit to be picked up, and either squeezes and releases the bulb, or places his finger over the power vacuum tool bleed hole. In either case, a



vacuum is formed and the technician can move the component to the exact spot, in the exact orientation that is necessary. He then either releases the bulb, or removes his finger from the bleed hole and the component drops into place.

Personal magnifier

If the technician is having a hard time seeing those tiny components, perhaps a personal magnifier is what he needs. This item consists of a headband that fits over the technician's head, to which is connected a magnifier. When the technician needs magnification, he pulls the magnifying lens in place and looks through it. When he no longer needs magnification, he simply pushes it up out of the way. It can even be used with eyeglasses, contacts, or safety glasses.

Hand power tools

On some occasions, a technician needs to grind, sharpen, drill, polish, or sand something while involved with servicing. A hand power tool is just the thing for this type of project. You know, one of those hand-held, high speed tools into which you can chuck a drill bit, a small grinding wheel, a cut-off wheel.

Orange sticks and spudgers

Sometimes, the need is for something decidedly low-tech. Sometimes, a technician simply needs to hold a lead in place to be soldered (using a non-conductive stick of some kind that doesn't have resins in it), or bend a component lead, or turn a screw with a non-conductive tool.

In these cases, the tool of choice might be an orange stick, or a fiberglass spudger.

Conductive ink/overcoat fluid

Another frequent requirement when servicing is to lay down a conductor where one has become broken. Some chemical manufacturers offer pens that contain conductive ink. All the technician has to do is use the pen to draw the trace in the desired location and the conductor is restored.

Of course, if it's in an area where it needs to be insulated, the same chemical manufacturer probably makes another pen that contains a nonconductive overcoat fluid that can be painted over any conductive surface to insulate it.

The right tool/aid at the right time

The nature of consumer electronics servicing is a lot like any other craft. It

A Aerosol Cleaners Adhesives Adhesive Dispensers Adhesive Removers Alcohol Antistatic Spray Anti-Wicking Tools	F Fans Floor Care/Wax Flux Flux Bottles Foot Grounders Form Tools Fume Removers	R Repair Kits/Systems Repair Services Retrieval Tools Rework Systems Rulers
B Ball Mills BGA Rework Systems BGA Reballing Kits Benches Bins Board Holders Books Braid Brushes	G Gauges Gloves Ground Straps/Cords	S Saws Scissors Screwdrivers Seating Shelving Signs Smoke Removers Snips Socket Sets Solder Soldering Aids Soldering Baths Soldering Irons Soldering Iron Tips Solvents Spring Hooks Spudgers Squares Surge Protectors Swabs
C Cabinets Carts Chairs Chisels Circuit Repair Kits Circuit Replacements Clamps Cleaners Coating Pens Coating Removers Coating Repair Kits Color Agents Containers Conductive Foam Conductive Ink Conductive Mats Continuity Testers Crimping Tools Cutters Cutting Mats	H Hammers Hand Lotions Heat Guns Heel/Toe Grounders Hex Drivers Hot Air Tools	T Tapes/Dispensers Tape Measures Temperature Meters Thermal Tweezers Tinning System Tool Boxes/Chests Tool Stands Tote Boxes/Bins Torque Tools Torx Drivers Training Tweezers
D Desoldering Pumps Desoldering Stations Dispensers Demagnetizers Drills Dusting Gas	I Ionizers Inspection Arrows Inspection Mirrors	V Vacuum Pick-Up Tools Video Cameras Vises Vision Systems
E End Mills Engravers Epoxy Kits ESD Bags ESD Coats ESD Field Service Kits ESD Labels ESD Monitors ESD Testers Eye Glasses Eyelets/Presses	K Wipes Knives/Blades	W Wick Wipes Wire Carts/Shelves Wire Strippers Wood Sticks Workstations Wrenches Wrist Straps
L Label Removers Levels Lights Loupes Lubricants	M Magnetic Tools Magnifiers Mats MicroBlasting Microscopes Multi-Purpose Tools Multimeters	
N Needles Nutdrivers	O Orange Sticks Outlet Strips	
P Pick-Up Tools Plating Systems Pliers Polarity Testers Power Supplies Probes Punches		

Figure 1. This list of products offered by one repair/rework company that also functions as a distributor for repair/rework products gives an idea of all of the tools and service aids (and a whole lot more) available to the informed technician.

requires the proper tools and aids to get the work done efficiently. Oh, it may be possible to get it done without using that tool or aid, but it might take more time, and it might not get done quite right.

Any time you're repairing a product,

and you say to yourself "I wish I had a . . ." or "If only someone made a . . .," someone probably sells just what it is that you need. Flipping through a catalog or two, or a brief surf of the internet might lead you to just the device you need. ■

Replacement parts showcase

If you take a look at the list of the components that goes into a typical consumer electronics product today, and then you consider the number of different products, and models of product that are manufactured by that manufacturer, and then the number of manufacturers producing consumer electronics products throughout the world today, and then think of the number of years that is considered to be the useful life of a consumer electronics product (seven to ten years), the number of individually identified part numbers becomes astronomical. When you think of it that way, the fact that most of the time when you call your distributor he has the part, and can find it on his shelves and get it to you quickly, becomes pretty amazing.

On the other hand, that's what distributors are supposed to do. Their job is to stock, keep track of, and be able to identify the part needed by the consumer electronics service technician, so they can pack and send that part to the technician so that he can finish repairing the customer's product and return it to the customer in a reasonable length of time.

Identifying the needed component

If the technician has the complete service literature for the product he's servicing, identifying a faulty component should not be a big problem. After all, the service literature should have a list of all the parts and components in the unit. Except, of course, that the component will have the manufacturer's part number on it, and will not necessarily bear a generic equivalent part number.

If the service center has some kind of cross reference, such as the ECG, NTE, SK, and/or Sams cross reference guide(s), the technician might be able to find an equivalent generic part for a failed part in a particular manufacturer's product. Then, if the technician wants to go to his general line distributor to buy all the parts, all he has to do is provide a list of part numbers.

Of course, if the part is not listed in any of those guides, which isn't unlike-

ly in the case of a brand new product, the technician will have to depend on the distributor to have the research capability to do the cross reference. If the distributor is organized and efficient, performing the cross reference should be no problem for him.

Parts stocking

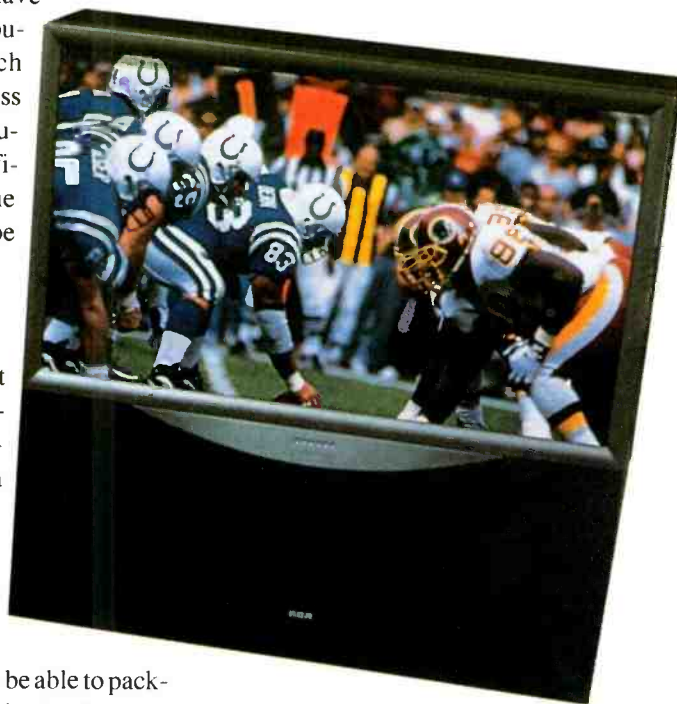
Another important consideration for the service center when thinking about ordering a component from a distributor is "Will he have it in stock?" And that's an important question. If the needed part is in stock, the distributor will be able to package and ship it the same day (well, some distributors). That means that the service center will be able to install the part, check out the quality of the repair, and be able to get the product fixed and back into the hands of the owner quickly.

If the distributor doesn't have the part on hand, he will have to order it and then turn around and send it to the service center. That slows the process considerably. Especially if the part is somewhere on a boat crossing the Pacific ocean.

Evaluating a distributor

Here's a list of questions you might ask yourself when you're evaluating the performance of distributor.

- How many locations do they have?
- How often are they able to fill orders from stock?
- What payment options do they offer—open order account, credit card, etc.?
- How soon after receipt of an order to they ship?
- Do they add a shipping surcharge?
- Do they have a toll-free number?
- What ordering options do they offer?
- What is their return policy?
- Do they offer a warranty?
- Is there a minimum order amount?



- What shipping options do they offer?
- What special services do they offer?
- Do they have a research department to help technicians find a specific part?

Food for thought

Keep some of these questions in mind when you're looking for a supplier of replacement components. You want to find someone you can count on for reliability, convenience, and service. Merely locating someone who stocks the part isn't the only consideration. For example, if you have to wait until you fill a large minimum order amount before you can order, or if you have to wait weeks for the part to arrive, you'll have that defective product sitting around the service center for a long time without earning you any profit, and the customer will not be pleased with the long wait before getting it back.

It might be tempting to order from the first distributor that comes to mind, but if you will take the time to ask a few questions, it might save time, money, and aggravation. The following section will give you a head start in answering some of those questions. ■

Thomson Consumer Electronics

Thomson Consumer Electronics believes that you should have a choice. We realize that you rely on our genuine replacement parts not only during the required warranty period, but also when you want the highest level of quality and performance available. We also realize that not every estimate you give can be converted to a repair using original parts. That's our difference. We give you a choice!

Original Parts

RCA and GE genuine replacement parts provide today's service professional with the reliability they need when completing in-warranty repairs. And they are delivered to you by parts distributors who provide an outstanding level of service. In fact, our most recent survey of the service industry continues to show that three out of four servicers believe that no other manufacturer provided a consistently better parts fulfillment system than the Thomson Consumer Electronics' parts distributors.

Thomson Premier Distributors can fill your warranty parts orders either off their shelves on all in-stock products, or by placing a Direct Drop Shipment (DDS) order via computer directly into the TCE national parts depot. Either way, you receive the part you need to complete the repair quickly and you get the highest possible fill rate for warranty parts to service RCA, GE, and ProScan products. This computer link also allows the Premier Distributor access to all the information needed to provide you with the high level of service you require in today's fast paced business.

SK Series Universal Parts

You know that lower estimates

equal more repairs and more business for you. To help you turn more of those COD estimates into repairs, Thomson continues to broaden its line of SK Series Universal Products. These quality parts let you reduce the repair estimate by lowering your replacement parts cost, and that's good news for you!

SK Series Universal Products cover a wide range of high wear, high usage parts. Whether you need video heads, flyback transformers, video replacement parts, belts, tires, pinch rollers, laser pickups, RF modulators, exact semiconductors, servicer aids, repair kits, capacitors, resistors, and more, you can look to SK Series first.

TCE Literature

Thomson also provides a number of publications which makes finding the right part for the repair even easier. Our latest SK Series Product Guide (Catalog #301) is a quick reference tool to the SK Series Universal Product line. Photographs, text, and graphic illustrations all help guide you to the right stock number very quickly and easily.

In addition to TCE service data, the "Television Components Quick Reference Guide" contains key part numbers for recent RCA, GE, and ProScan chassis. It's ideal for the technician on the road. It folds to fit in your pocket. The Quick Reference Guide also contains a section dedicated to the EPROM's associated with chassis CTC168 through CTC187.

And there is of course, our well-known and widely accepted OEM Remote Control book. This book is

printed once a year and no one that repairs TCE products should be without one!

These publications are available from your Authorized Thomson Parts Distributor. For the SK Series Product Guide order publication 1J1226, for the Quick Reference Guide order publication 1J9548 and for the Remote Control Book order 1F5790.

Accessories and Components Business

The Thomson Consumer Electronics, Accessories and Components Business provides service from a 358,000 square foot facility located in Deptford, New Jersey. All business functions — customer service, sales and marketing, quality assurance, product analysis, administrative departments and warehousing — operate under one roof. Some parts are stocked in satellite warehouse facilities in El Paso, TX and Indianapolis, IN.

A full line of RCA brand Consumer Electronics Accessories is marketed from this facility as well. The business is managed by Jack Nick, Vice President. Thomson Consumer Electronics corporate headquarters is in Indianapolis.

One Call Is All You Need To Make

Whether you need original RCA and GE parts or SK Series products, your Thomson distributor is your one stop source. A single call to a Thomson Distributor gives you the choice you deserve, making your business more profitable. To locate a nearby Thomson Authorized Distributor simply call (800) 336-1900 today. ■

Herman Electronics

7350 Herman Way
Miami, FL 33122
Phone: 800-938-4376
Fax: 800-938-4377

Herman Electronics is a diverse and multi-faceted full-line distributor of everything in electronics, committed to offering only the best in original replacement parts and everything in service accessories including tools, test equipment, cable, connectors, semiconductors, chemicals, and most importantly, customer service to their customers. In business for over 40 years, Herman Electronics has clearly established itself as one of the leaders in the industry by providing only quality products and outstanding customer service to all facets of the electronics industry. The heartbeat of the company lies in the OEM parts department. While serving the industry for over 3 decades, Herman has many of the major OEM parts lines enabling them to provide efficient and cost effective service to you, their valued customer. The company prides itself on being a SINGLE source to the service industry.

Herman Electronics is one of the largest

original replacements parts and accessory distributors in the country and is factory authorized for most of the major brands. In addition, Herman Electronics is the source for everything in service accessories. Their new catalog, published three times a year, includes everything in technicians' aids, tools, solder & de-soldering equipment, test equipment, audio/video accessories, chemicals and much more from the industry's leading manufacturers. Stocking one of the largest and most comprehensive inventories in the country enables the company to fill over 80% of their orders from inventory and guarantees SAME DAY shipment of all in-stock orders placed before 5:30 P.M. (EST).

Herman Electronics is proud to announce the introduction of the HERMAN CYBER-WAREHOUSE! Now you can shop on-line at their electronics superstore. This completely interactive site contains over 4000 items including photos & detailed descriptions on everything in service accessories. Simply

point, click, and your order is on the way. Also take advantage of their constantly changing specials for great value and savings. All this and more available NOW at the new Herman Web Site (www.Hermanelectronics.com). And coming soon... THE PROS. The Herman Electronics Parts Remote On-Line Service. Herman Electronics is proud to be the leader in providing the first true internet based on-line parts service. Now you can order your parts on-line, get real time prices & availability information, ETA information, Order Status Information, On-Line Research and more! The company prides itself on providing more efficient and effective ways to provide a higher level of customer service and the internet is certainly going to provide a significant benefit. "We realize there are many good distributors throughout the country," says Jeffery A. Wolf, President and son of one of the company's founders. "It is our job to EXCEED customers' expectations by taking that extra step in providing the highest level of professional, personalized service. This industry has quickly become service driven and therefore it is our focus and dedication to maintain a standard of excellence in customer service. As the year 2000 rapidly approaches, we must continue to develop innovative ideas and fresh approaches to meet and exceed the demands that lie ahead." And the company is doing just that. Get on-line today and see how Herman Electronics is leading the way!

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Courteous and knowledgeable phone representatives are available Monday through Friday 8:00 a.m. - 8:00 p.m. EST and Saturdays from 8:00 a.m. to 5:00 p.m. EST and are ready to take your order or assist you with on-line pricing and availability information. A toll free fax is also available 24-hours a day, 7 days a week for customers to fax their orders. A confirmation of your order can be returned upon request indicating the order number and item availability.

Accessories: Added-Value Electronics

Philips offers a full line of added-value electronics in the form of Magnavox and SouthWestern Bell branded accessories. We have something to enhance everyone's enjoyment of their electronic products. Shop us for all your needs in Surge Protection, Audio/Video Tapes, Audio/ Video Cables, Universal Remotes, Observation Systems, Telephone Accessories, Audio/Video Cleaning Products, Camcorder Batteries/ Chargers, VCR/Camcorder accessories and much, much more. Also, ask about our FREE personalized accessory display.

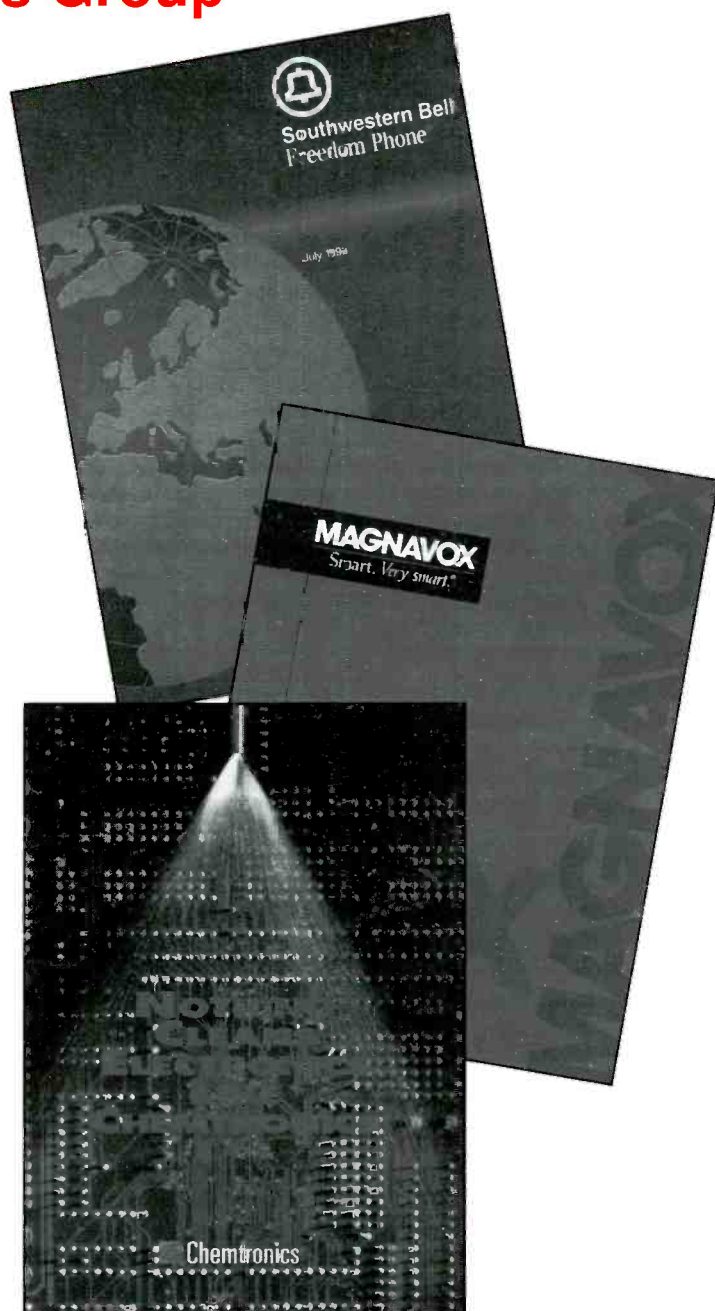
Customer Service Department

Servicers are encouraged to contact our Customer Service Department if they experience any problems with their orders, parts returns, or account. Associates are trained to resolve most problems while you are on the phone. The Customer Service Department can be reached through the Parts and Accessories ordering number 1-800-851-8885.

Making Things Better

Reduced Pricing

In our effort to continually make things better, Philips Service Solutions Group reduced its parts pricing in late



1996 representing a reduction in price from 2%-23% for many of our most popular items such as tuners, remotes, and transformers. There has been only a 2.7% increase since that time and we continue to review to ensure we remain competitive in our pricing. We believe in offering the highest quality products at the best possible price.



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Panasonic Services Company

**20421 84th Avenue South
Kent, Washington 98032
Phone: 800-833-9626
Fax: 800-237-9080**

For over 35 years, the Panasonic, Quasar, and Technics brand names have appeared throughout American homes and industries. In that time, our company's commitment to total customer satisfaction has manifested itself in many ways. Our approach to post sales support has evolved to include programs that encompass qualitative human resource training, as well as ones that stress the development of automated processes that allow us to offer timely, accurate solutions to our users' service needs.

The engine behind PACS's ability to ensure timely repairs is our ability to deliver parts, accessories, and service literature to our network of factory service centers, independent servicers, and dealers in a timely manner. We are now seeing the results of over a decade of continued investment in the modernization of our facilities. The primary point of support for all replacement parts and service literature is the National Parts Center in Kent, Washington. From here and with further support from sales & marketing staff and field staff throughout our U.S. regions, we handle a wide variety of inquiries and fill just about any request made of us.

Customer Contact

Generally, the first line of customer support is provided by our Customer Service Department located in Kent, WA. This office handles a wide variety of customer calls ranging from simple parts orders to research requests on unique model numbers. Currently, the Customer Service Department handles over 3,200 calls per day taking orders, supplying estimated shipping time, return authorizations, processing credits and special orders. Also, the Customer Service Department receives over 1,000 faxes daily. In addition, we offer retail customers toll-free phone and fax numbers and on-line ordering through the Internet. Our customers can order literature, parts, or any of our comprehensive line of accessories.

In order to further improve our level of customer service, we have made significant investments in phone management

systems in order to improve our efficiency. Data gathered from these systems graphically depict work load volume, peak times, and average call length on a daily basis, and give management a true picture of where additional improvements are needed.

Our staff includes representative that reach out to the field as well. Regional Parts & Accessory Representatives call on distributors, independent servicers, dealers and even to customers to assess their needs. With a comprehensive portfolio of sales programs and promotional items, they are able to offer profitable opportunities to small and large businesses alike. Along the way they are able to keep in touch with ever changing needs of all, and make the necessary recommendations to our market developments personnel.

Our commitment does not stop with our internal efforts. We also maintain a network of over 40 authorized independent parts and accessory distributors who are well positioned to support our wide range of customers in various markets throughout the country.

Parts and Service Literature Distribution

Once we've established what our customer needs, we have to get it to them. That's the job of over 125 employees that staff our parts and service literature warehouse in Kent. The building is a quarter mile long, and encompasses 228,000 square feet, which houses over 110,000 line items and 2.8 million pieces.

The warehouse day begins at 6:00 a.m. There are over 2,000 parts orders being processed at any given time. In order to manage such an overwhelming task, procedures have been created that allow us to meet our goal of having all orders shipped within 24 hours. By the end of the day, the facility will have shipped approximately 2,700 parts and literature orders, which consist of over 7,000 line items, and over 35,000 pieces!

Through the use of bar coding, and a RF (radio frequency) based receiving sys-

tem, we are able to reduce the turn around time for receiving and stocking, making goods available to the customer even sooner.

We have recently completed our investment in the modernization of our warehouse operations. This includes the expanded use of RF and bar codes throughout the facility, conveyors, carousels, and a new software system. Designed to create a paperless environment, this comprehensive, state-of-the-art installation enables us to provide faster, error free service to our customers as well as positioning Matsushita for the next decade.

Finally, in our effort to be earth friendly, the warehouse has been a leader in the effort to recycle. It all started four years ago when we began to use biodegradable packing material. Today, we have a comprehensive program to recycle all paper, cardboard, aluminum cans and pallets. We make an effort to purchase recycled products when it is available. In recognition of our efforts, we were designated a "Distinguished Business in the Green" by King Country.

The Future

We have recently expanded our customers ability to have on-line access with Panasonic Services in the form of an Internet parts inquiry and ordering system. Our new order system is easy to use and provides up to the minute detail on parts availability, orders, credits, returns, and order history.

Internally, with systems that our customers don't directly see, we move further into the information age. Not only do our purchasing agents continue to employ CD-ROM information systems, we are now on-line with factories in Japan for inquiry purposes, a capability we plan to expand to selected aspects of our market. The use of bar coding will continue to expand.

Our goal for the future is customer satisfaction, not just for our direct customer, but anyone who comes in contact with Panasonic, Technics, or Quasar. ■

Matsushita Original Replacement Parts and Accessories

A Guarantee of Quality

Nothing less than total satisfaction is expected by today's customers. The only way to live up to this standard is by using Matsushita Original Replacement Parts and Accessories. The source of this quality is Panasonic Services Company and your Authorized Replacement Parts Distributor. Consult the list below, or call **1-800-545-2672** for the location nearest you.

CALIFORNIA

Andrews Electronics (C/V/M/A) * 25158 Avenue Stanford, Santa Clarita 91355 * 800-289-0300 * FAX 800-289-0301
AVAC Corp. (V) * 3746 Bradview Dr., Sacramento 95827 * 916-361-7491 * FAX 916-361-5480
Blakeman Wholesale (V) * 1800 E. Walnut St., Fullerton, 92631 * 714-680-6800 * FAX 714-680-8700
Cass Electronics (C/V/M/A) * 801 Seventh Ave., Oakland 94606 * 510-839-2493 or 800-974-5775 (outside 510) * FAX 510-465-5927
E and K Parts, Inc. (C/V/M/A) * 2115 Westwood Blvd., Los Angeles 90025 * 800-331-8263 or 310-475-6848 * FAX 800-826-0890 or 310-474-0846
Pacific Coast Parts (C/V/M/A) * 15024 Staff Court, Gardena 90248 * 800-421-5080 * FAX 800-782-5747
Star For Paris (V) * 10727 Commerce Way, Suite B, Fontana, 92335 * 909-428-1404 * FAX 909-428-3213

COLORADO

Star For Paris (V) * 2350 Arapahoe St., Denver 80205 * 303-296-2117 * FAX 303-296-2120

CONNECTICUT

Signal Electronics Supply, Inc. (C/M/A) * 589 New Park Ave., West Hartford 06110 * 860-233-8551 * FAX 860-233-8554

FLORIDA

Herman Electronics (C/V/M/A) * 7350 N.W. 35th Terrace, Miami 33122 * 800-938-4376 * FAX 800-938-4377
Layco, Inc. (C/V/M/A) * 501 S. Main St., Crestview 32536 * 850-682-0321 * FAX 850-682-8820
Vance Baldwin (C/M/A) * 2701 W. McNab Road, Pompano Beach, 33069 * 800-432-8542 * 954-969-1811 * FAX 954-969-0226 * 800-552-1431
Vance Baldwin (C/M/A) * 1801 N.E. 2nd Ave., Miami 33132 * 305-379-4794 * FAX 305-373-8855
Vance Baldwin (C/V/M/A) * 1007 N. Himes Ave., Tampa 33607 * 800-299-1007 * FAX 813-870-1088

GEORGIA

Buckeye Vacuum Cleaner (V) * 2870 Plant Atkinson Rd., Smyrna 30080 * 404-351-7300 * FAX 404-351-7307
Wholesale Industrial (C/M/A) * 5925 Peachtree Corners East, Norcross 30071 * 770-447 8436 * FAX 770-447-1078

ILLINOIS

B-B & W, Inc. (C/V/M) * 2137 S. Euclid Ave., Berwyn 60402 * 708-749-1710 * FAX 708-749-0325
Hesco, Inc. (V) * 6633 N. Milwaukee Ave., Niles 60714 * 847-647-6700 * FAX 847-647-0534
Joseph Electronics, Inc. (C/M/A) * 8830 N. Milwaukee Ave., Niles 60714 * 847-297-4208 * FAX 847-297-6923
Union Electronic Dist. (C/V/M/A) * 311 E. Coming Rd., Beecher, IL 60401 * 800-618-6657 or 708-946-9500 * FAX 800-43-UNION or 708-946-9200

INDIANA

Electronic Service Parts (C/V/M) * 2901 E. Washington St., Indianapolis 46201 * 317-269-4527 * FAX 800-899-1220

MARYLAND

Tritronics, Inc. (C/V/M/A) * 1306 Continental Dr., Abingdon 21009-2334 * 800-638-4328 * FAX 800-88-FAXD

MASSACHUSETTS

Tee Vee Supply Co. (C/V/M/A) * 407 R Mystic Ave., Unit 14, Medford 02155 * 781-395-9440 * FAX 781-391-8020

MICHIGAN

Allied National (V) * 13270 Capital Avenue, Oak Park 48237 * 800-999-8099 * FAX 800-730-5696
G. M. Popkey Co. (C/V/M/A) * 5000 W. Greenbrooke Dr. S.E., Grand Rapids 49512 * 800-444-3920 or 616-698-2390 * FAX 616-698-0794
Remcor Electronics (C/V/M/A) * 10670 W. Nine Mile Rd., Oak Park 48237 * 248-541-5666 * FAX 248-398-1016

MINNESOTA

Almo Distributing (V) * 8600 109th Ave. N., Champlin 55316 * 800-252-2566 * FAX 612-421-8640
AVAC Corp. (V) * 666 University Ave., St. Paul 55104 * 612-222-0763 * FAX 612-224-2674
Ness Electronics, Inc. (C/V/M/A) * 441 Stinson Blvd. N.E., Minneapolis 55413 * 612-623-9505 * FAX 612-623-9540

MISSOURI

Tacony Corp. (V) * 1760 Gilsinn Lane, Fenton 63026 * 314-349-3000 * FAX 314-349-2333

NEW JERSEY

Panson Electronics, (C/V/M/A) * 1-80 and New Maple Ave., PO Box 2003, Pine Brook 07058 * 800-846-2484 or 973-244-2400 * FAX 800-332-3922

NEW YORK

Dale Electronics (C/V/M/A) * 7 E. 20th St., New York City 10003 * 212-475-1124 * FAX 212-475-1963
Jayso Electronics Corp., (C/V/M/A) * 3210 White Plains Road, Bronx 10467 * In NY 718-798-1050 - Outside NY 800-426-4422 * FAX 718-655-1196
Radio Equipment Corp. (C/A) * 196 Vulcan St., Buffalo 14207 * 716-874-2690 * FAX 716-874-2698
Standard Electronics (C/V/M/A) * 215 John Glenn Dr., Amherst 14228 * 800-333-1519 OR 716-691-3371 * FAX 800-338-1241
Star For Paris (V) * 250 Rabro Drive E., Hauppauge 11788-0255 * 800-525-6046 * FAX 516-348-7160

OHIO

Electric Sweeper Co./ESSCO (V) * 7800 Hub Parkway, Valley View 44125-5711 * 800-321-2664 * FAX 216-524-4142
Fox International, Inc. (C/V/M/A) * 23600 Aurora Rd., Bedford Heights 44146 * 440-439-8500 * FAX 800-445-7991
MCM Electronics (C/V/M/A) * 650 Congress Park Dr., Centerville 45459-4072 * 800-543-4330 or 937-434-0031 * FAX 937-434-6959

OKLAHOMA

Hueyis, (V) * 6005 N.W. 2nd, Oklahoma City 73127 * 800-654-6622 * FAX 405-495-3812

OREGON

Diversified Parts (C/V/M/A) * 2114 S.E. 9th Ave., Portland 97214-4615 * 800-338-6342 * FAX 800-962-0602
Northwest Wholesale (V) * 426 N.E. Davis St., Portland 97232 * 800-234-8227 or 503-232-7114 * FAX 503-232-7115

PENNSYLVANIA

Steel City Vacuum Co., Inc. (V) * 919 Penn Ave., Pittsburgh 15221 * 800-822-1199 or 412-731-0300 * FAX 412-731-3205

TENNESSEE

Electrotex, Inc. (C/V/M/A) * 6122 Macon Rd., * Memphis 38134 * 901-383-9300 * FAX 901-388-0258
Shields Electronics Supply, Inc. (C/V/M/A) * 4722 Middlebrook Pike, Knoxville 37921 * 423-588-2421 * FAX 423-588-3431

TEXAS

Electrotex, Inc. (C/V/M/A) * 2300 Richmond Ave., Houston 77098-3299 * 713-526-3456 * FAX 713-639-6400
Electrotex, Inc. (C/V/M/A) * 1200 W. Hildebrand, San Antonio 78201 * 210-735-9271 * FAX 210-737-2642
Fox International (C/V/M) * 752 S. Sherman, Richardson 75081 * 800-321-6993 or 214-439-8500 * FAX 800-445-7991
Genvac (V) 1560 A Industrial Drive, Missouri City 77489 * 800-229-8227 * FAX 281-261-6383
VCP International, Inc. (V) * 2285 Merriitt Dr., Garland 75040 * 972-271-7474 * FAX 972-278-5981

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Panasonic Services Company

20421 84th Avenue South, Kent, Washington 98032

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Andrews Electronics

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Santa Clarita, CA 91355

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Fax: 800-289-0301

Website: www.andrewselectronics.com

Andrews Electronics is housed in 50,000 square feet of warehousing and office space. Miles of shelving are arranged for immediate identification and easy accessibility for over 250,000 different parts that we carry.

Maintaining an inventory of this size has been the cornerstone of our success as the O.E.M. parts distribution industry leader. It provides us with an average first pass fill rate of above 90% and makes us the largest supplier in America for the manufacturers we represent. Our fill rate is calculated on not only everything that is ordered but also on every call or fax we receive for availability, even if it isn't ordered! Our dealer order desk has 32 available sales representatives to handle all of our ordering needs.

We've built our reputation on a very simple philosophy. . . service. Not very fancy, but very effective. Our constant growth attests to it. You see, all of our policies that have been developed over the years have been based on that one simple thought: "How may we better serve the industry?" How about:

- 14 major brands to save you time, frustration, and money with "one-stop shopping."
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- A fast, highly-efficient research department, second to none.
- A program that converts make/model descriptions to part numbers instantly for the majority of research requests.
- 24-hour toll-free phone and fax order lines.
- Over 100 full-time employees waiting to serve your needs.

Our already outstanding freight program has been drastically improved! The minimum qualifying amount has been cut in half and the 2 day air discount has been almost doubled! With this type of shipping program, we're a lot closer than you might think.

In case you've heard this elsewhere before, now's the time to let us prove it to you. By investing a mere two minutes of your time, you can discover what thousands of others have: that there is a difference. When you place your next order with your local supplier, check the availability of all the items. Then call or fax Andrews and check out our stock levels. We believe you'll be pleasantly surprised! Wouldn't getting those extra units repaired a week or two sooner be good for your reputation? Sure it would! And we can help! After all is said and done, it is performance that counts. We know that your ability to perform your job depends on how well we perform ours. Our regular office hours are from 8:15 to 4:45 PST and we're closed for lunch between 12:00 and 12:30. When you think of electronic parts . . . think of Andrews.



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B&D Enterprises is your Semiconductor specialist. Filling your semiconductor requirement is our #1 priority. Our objective is to meet the consumer and industrial repair market's demand for a price competitive, well-stocked, highly knowledgeable, factory authorized distributor.

JAPANESE SEMICONDUCTORS

B&D Enterprises stocks more than 15,000 line items. Specializing in Japanese semiconductors, we can help you solve your component problems.

Since 1976, B&D Enterprises and their parent company have been entrusted by the manufacturers to be the authorized distributor in the United States. Companies such as Sanyo Semiconductor, Sanken Electric, Shindengen America, and NEC Electronics trust us to handle the ever-growing need for a dependable, customer service oriented stocking distributor. At B&D, you'll find 23+ years of accumulated product knowledge and factory direct supported sales.

We also carry an extensive inventory of hard-to-find and discontinued products, as well as

many components made by non-Japanese manufacturers.

PRODUCT KNOWLEDGE

Our sales staff is technically trained. To service the OEM customers, we have to be. We have the largest library of semiconductor manuals in the market available to support our sales. Hundreds of part cross references are in our database. We back what we say. When we offer a cross, we know it's right and can send you the specifications to prove it. Feel free to talk to our Engineering/Technical Support office at 814-757-8300.

PRODUCT RELIABILITY

As a factory authorized distributor, we only sell original quality manufactured parts. NO "rebrands," NO "off-brand" imitation manufactures, just original

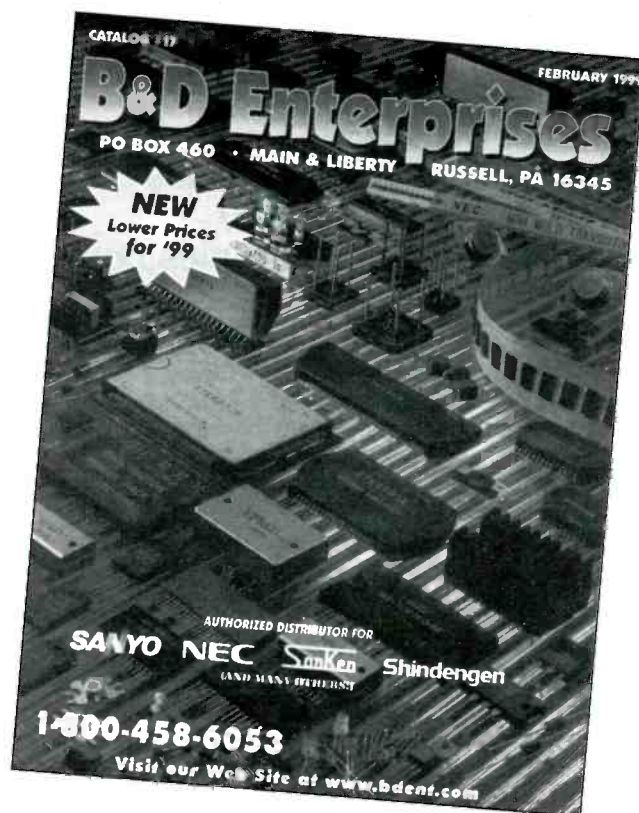
components. We feel that our customers deserve a part that works, not one that's close.

CONVENIENCE

To better serve our customers we offer them the WEBSITE — at www.bdent.com you will find our ENTIRE INVENTORY for you to view. 24 hrs a day, 7 days a week, you can check prices, request quotes, and place orders on a secure server. We update our site DAILY with new parts and prices.

Go factory direct with B&D and get the price you need with the factory authorized service you deserve!

Call today for our FREE 1999 CATALOG and see what a difference we can make! Selling a lot of things doesn't make us better, just diversified. At B&D, we do one thing, and we do it right! ■



MCM Electronics

650 Congress Park Drive
Centerville, OH 45459

Toll Free Phone: 800-543-4330

Toll Free Fax: 800-765-6960

Website: www.mcmelectronics.com

MCM Electronics is THE SOURCE for Service Parts and Accessories.

During their 20 plus years, MCM's superlative service has made them the supplier of choice for the electronics servicing industry. Services include IN-STOCK original OEM parts used for the consumer electronics repair from such names as RCA/GE, Panasonic, Technics, Quasar, ECG, Philips and Magnavox — replacement part you need is always available when you need it!

For the bench, MCM stocks a broad selection of tools, technician aids, and chemicals from trusted names such as Chemtronics, Tech Spray, Caig, Xcelite, Crescent, Weller, Ungar, and Hakko.

Test equipment from Fluke, B&K, Precision, Hitachi, Sencore, Leaders, Triplett, Simpson, Tektronix and Tenma — MCM's value priced signature series — is available at competitive prices.

Free Literature

MCM sends out flyers regularly featuring popular, new and specially priced products. Some products featured are one time buys at outstanding prices. Also for additional HOT DEALS, check out our website at www.mcmelectronics.com

Superior Customer Service

MCM's knowledgeable staff is trained to answer your calls in a fast, friendly

manner. The sales lines are staffed Monday through Friday from 7:00 am to 9:00 pm and Saturday from 9:00 am to 6:00 pm EST. If you have any questions about any products you've purchased from MCM, call their toll free technical support at 800-824-TECH (8324) — they'll be glad to help solve your problem!

Fast Delivery from the East and West

With distribution centers in Ohio and Nevada, MCM can offer economical ground service delivery throughout the continental United States. So, no matter where you're located, MCM can deliver your package quickly and economically.

MCM Electronics boasts one of the fastest order fill rates in the industry, with 99% of all orders shipping within 24 hours! In fact, all orders received before 5:00 pm YOUR TIME are shipped the SAME day.

For more information or FREE LITERATURE, call 800-543-4330.

In Dayton, Ohio, call 434-0031.

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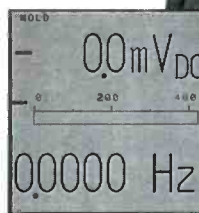


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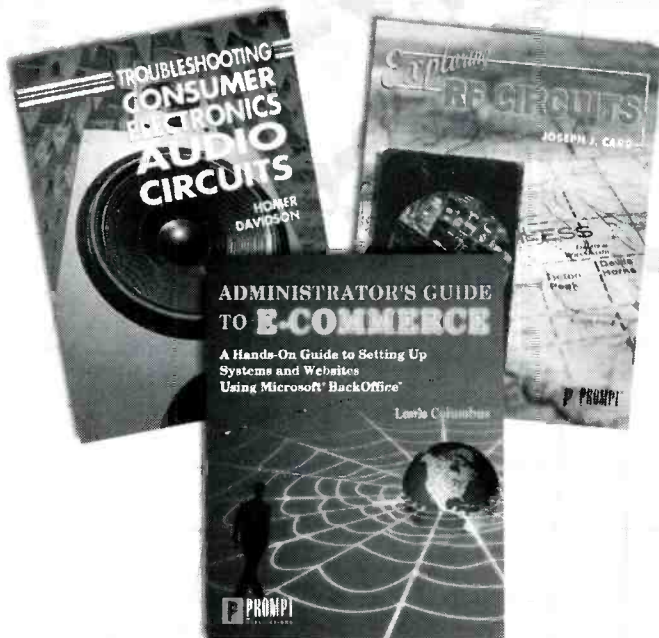
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LCR measurement primer

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The LCR primer is divided into several sections: a discussion of complex impedance terms and series/parallel measurements, connection methods and associated errors, functions and features employed in today's LCR meters, unique considerations to be taken into account when measuring capacitance, inductance, or resistive components, and finally a discussion of the electrical characteristics of solid and liquid materials used to manufacture these components. An appendix is also included which lists typical measurement parameters (frequency, voltage, and equivalent circuit) for a variety of components and materials.

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Components catalog and internet features

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Magnavox processor — Part II

by Steven J. Babbert

This installment of the state-of-the-art TV series will continue to look at the main video processor used in the Magnavox 25P506-OOAA. IC270, a Phillips TDA8369, contains all chroma demodulation blocks necessary to recover the red, blue, and green signals required by the CRT. IC270 also coordinates the OSD (on screen display) and picture preference adjustments (brightness, color, tint, etc.). Before we proceed with the article, let's review chroma basics.

The NTSC chroma system

The designers of the NTSC system found that they could superimpose chroma information on a standard luminance signal if the information could be confined to two components. It was found that through the right combination of

red, blue, green, and Y signals (the Y signal is derived by adding red, blue, and green in the proper amounts), it would be possible to describe the colors in a video scene using only two such components.

These two components are then amplitude modulated separately onto 3.58-MHz carriers that differ in phase by 90 degrees. The two resulting signals are known as I (in phase), and Q (quadrature). These signals are then combined to form a resultant carrier. Hue is represented by the phase of the resultant, and saturation, by the amplitude. Once this signal is mixed with the video carrier, it is considered to be a subcarrier.

Suppressed carrier

When a carrier is amplitude modulated, sidebands are created that contain the modulating information. For this reason, it is unnecessary to transmit the carrier

itself as long as the sidebands are sent. In fact, in the NTSC system the subcarrier is suppressed for a number of reasons, which are beyond the scope of this discussion. Suffice it to say that advantages are gained by suppressing the subcarrier before transmission.

Color burst

A sample of the 3.58-MHz subcarrier, however, known as the color burst, is sent with the composite signal on the back porch of the horizontal blanking pedestal. At the receiver, the color burst is used to phase lock a 3.58-MHz oscillator. This CW (continuous wave) signal is then recombined with the sidebands in order to recover the original information.

Typically, the video signal, complete with chroma sidebands, is taken from the first video amp following the video detector. The signal then passes through a color IF or BPA (bandpass amplifier), which

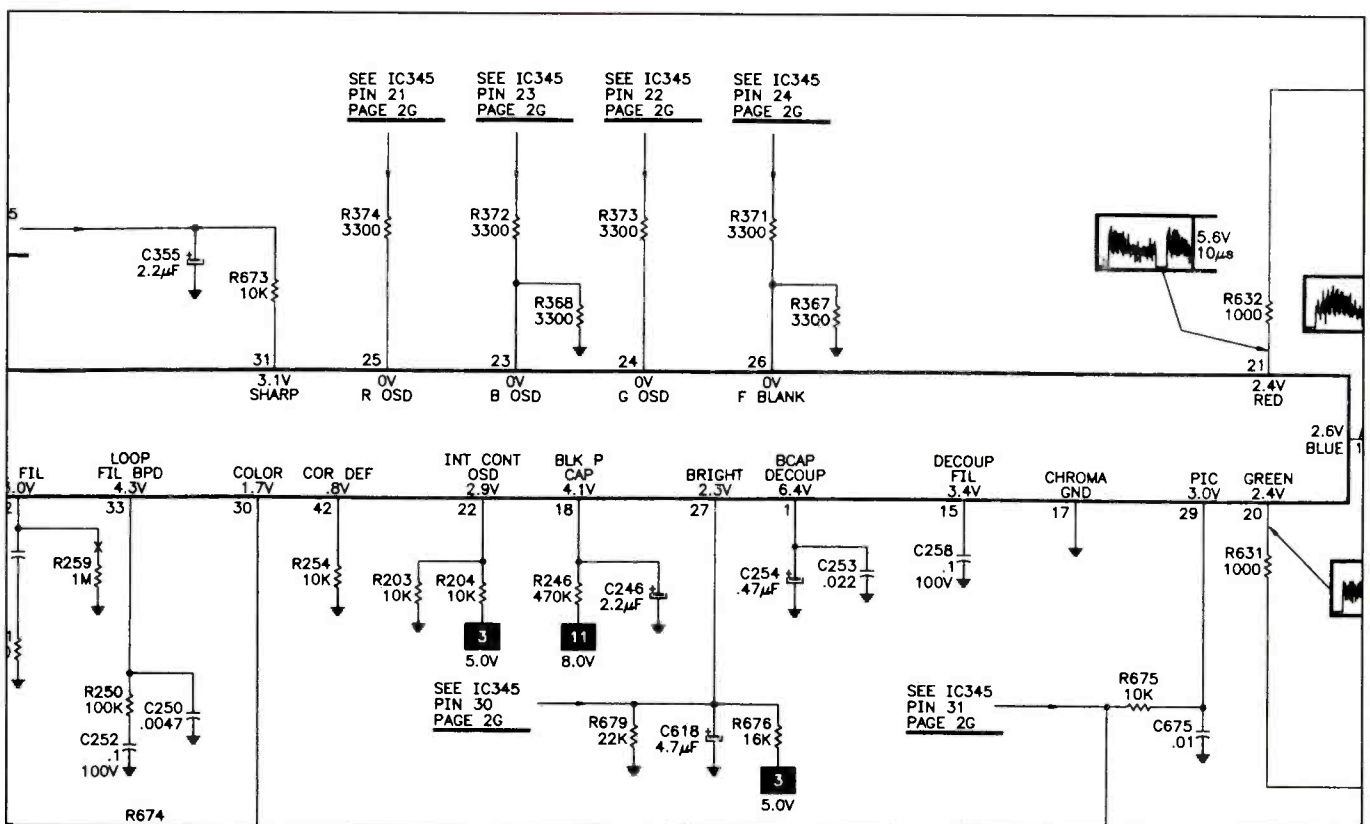


Figure 1. The system control (syscon) circuits in the Magnavox 25P506-OOAA. The main processor, IC270, is a Phillips TDA8369.

nal used for modulation and that of the reinserted signal will result in improper hue. Tint control acts to fine-adjust the phase relationship to compensate for any error in the APC circuit.

Some demodulation systems output so-called difference signals (R-Y, B-Y, and G-Y), which are then matrixed with the Y signal to recover the original R, B, and G. This matrixing may take place in the final video output stages or in the CRT itself. In the latter case, the Y signal is applied to the cathodes, while the difference signals are applied to their respective grids. In most newer chassis, the video processor IC outputs only R, B, and G signals. In these cases, the CRT requires no Y signal.

Electronic picture control

In the early days of television, potentiometers were used to adjust parameters such as brightness, picture (contrast), sharpness, color level, and tint. A separate bank of internal presets allowed the user to override the external controls in the event that proper adjustment was found to be too troublesome. In virtually all modern TVs, all adjustable picture parameters are electronically-controlled.

In this chassis, adjustments of the various picture parameters are performed in IC270 via pins 27, 29, 30, 31, and 32 (Figure 1). Note that, unlike the stereo processor and tuner, which were discussed in previous installments, IC270 is not bus controlled. The above mentioned pins are connected directly to the syscon, IC345.

Each of the syscon's control pins outputs a PWM (pulse width modulation) waveform. The duty cycle of this waveform changes in response to adjustment commands. The waveform is integrated or low-pass filtered by an RC network in the control line. The resultant dc voltage is applied to the appropriate analog input pin on IC270. The changing duty cycle can be observed on a scope while an adjustment is being made.

On-screen display

All characters and icons needed for on-screen display (OSD) and closed captioning are stored in the syscon's character generator ROM. Getting the characters onto the screen is simply a matter of blanking the normal video information in selected parts of the raster and

replacing it with information from the syscon. The syscon receives vertical and horizontal sync pulses so that it knows exactly what point of the raster is being scanned at any given time.

IC270 contains the OSD switch block (Figure 2.). The OSD switch has R, B, and G inputs and outputs. When there are no characters being displayed, the switch is "transparent." In other words, the R, B, and G video signals pass through the switch block without being modified in any way under these conditions.

The OSD switch also has several lines coming from the syscon. These are R, B, G, and "Fast Blanking," which enter IC270 at pins 23 through 26. These lines are only active when characters are being displayed. Essentially, the OSD switch selects either normal video from the demodulator or data from the syscon. The fast blanking data controls the state of the switches. The R, B, and G data is nothing more than a series of logic highs and lows that bias the video output amps on or off, as the beam scans portions of each character in the on-screen display.

Color output amps

Once the R, B, and G, signals pass through the on-screen display switch-block, they exit IC270 at pins 19 through 21. Outside of IC270, the signals are amplified and then applied to the CRT. Since all three color channels are basically the same, the discussion will be confined to the blue signal path.

The blue signal is routed to the base of the common emitter driver amplifier, transistor Q630, where it is amplified and inverted. The gain of this amplifier, and hence the amplitude of the drive waveform, is set by drive control R642. The signal then passes to the cutoff control, R648. This control actually sets the average dc value of the drive waveform so that beam cutoff will occur at the proper point on the blanking pedestal.

Common-base output amplifier Q23 is the final stage in the blue signal path. The signal then goes to one cathode of the CRT. Since there is no Y signal applied to the CRT, the grids are grounded.

Troubleshooting

Since all chroma processing is done internally in IC270, troubleshooting will be limited to checking external signals. In

earlier receivers, failure of the 3.58-MHz oscillator would cause a loss of color resulting in a monochrome picture. In IC270, the horizontal and vertical dividers are locked to the oscillator. Failure of the oscillator will cause a loss of horizontal and vertical synchronization.

Oscillator failure will also cause the raster to have vertical black bands about two inches wide at both sides. When no active channel is tuned, snow and OSD will appear normal. When a channel is tuned, however, the picture will consist of rolling black and white horizontal lines, possibly mixed with color. OSD will be jittery and have a gear-tooth appearance at the edges. Check crystal Y620 if you have this problem.

If there is no color, but the monochrome picture is okay, check for proper voltage on pin 30. You may inject a dc bias as a test if you think that the syscon is not supplying the correct voltage. Use this method also for any problem related to the tint, brightness, picture, or sharpness. Note: On-screen display will always be in color even if there is no demodulation because the control signals are added after the demodulator. If there is no color demodulation with bias on pin 30, then IC270 is probably defective.

If one color is missing, the most likely cause is the associated output transistor since it is a power handling device. If the transistor is okay, work your way back through the driver circuit to the color output at IC270. If taking voltage measurements doesn't reveal the problem, scope the waveform. If there is no output at a given pin, then IC270 must be bad.

In a case where all three colors are missing (no raster), check all power supply lines that are common to the three output circuits. Don't overlook pins 27 and 29 of IC270, which control brightness and picture. This also applies to low-brightness problems. If you find abnormal measurements at pin 29, check beam limiter Q661 and associated circuitry.

A logic high on pin 26 (fast blanking) will blank normal video while allowing OSD to function normally. If this pin is stuck on high, lift one leg of R371 to isolate it from the syscon. If normal video returns, then the syscon must be at fault.

A future installment will look at how IC270 processes the horizontal and vertical drive waveforms. ■



Diagnosing screen interference

by Michael L. Hiles, Field Management Services

When mysterious image jitter or color distortion appear on CRTs, in many cases, the technician is called upon to correct the problem. Frequently, the first step in correcting the problem is to swap out the monitor, but the problem persists. Apparently, the problem is not the monitor or even the video card. The technicians next try surge protectors and UPS units, in the belief that the source might be the quality of the power, but without success. Next, the electrical contractor checks the circuits and finds nothing wrong. The local power company is called in and does a power quality analysis. Everything is within specification and they conclude the problem is not the power. It must be somewhere else.

The problem may be magnetic fields

Somewhere along this process, someone with some experience voices the theory that the problem is not inside the monitor, but outside. You can't see it, but the problem may be magnetic fields, either ac fields from a power source or dc fields from a magnetic source. It can be as simple as having speakers too close to the monitor, or having an electrical distribution panel on the other side of the wall from the computer.

These interference issues are relatively rare, but as the proliferation of computers continues apace and people and equipment are forced into places that had not supported these activities before, they are rapidly becoming more frequent. They often appear during building remodels, upgrades, or expansion. If you haven't encountered the problem before, the process of discovery can take weeks. We have seen instances where it took years. And fighting the problem can be very expensive, to say nothing about the disruption it can cause.

The physics of monitor interference

Most computer monitors are based on cathode ray tube (CRT) technology, in which an image is created on the face of a monitor by a stream of electrons emitted from an electron gun located at the back end of a glass vacuum tube. The location, direction, and focus of this beam is controlled by internal magnetic fields, which are generated by a set of horizontal and vertical deflection coils, located in the yolk of the tube.

The rate at which the beam is directed back and forth is its horizontal rate and the up and down control fields operate at the monitor's vertical rate. All of this assumes that the environment in which the computer operates is free from any environmen-

When a computer monitor exhibits jitter or image distortion, the problem may be magnetic fields, either ac fields from a power source or dc fields from a magnetic source. It can be as simple as having speakers too close to the monitor, or having an electrical distribution panel on the other side of the wall.

tal, or ambient, background magnetic fields, which would interfere with this electron beam scanning process.

Early computer monitors had their vertical scan rates derived directly from the power line frequency (60Hz), thus, any background magnetic field caused by power systems in the area would be at the same frequency as the computer vertical scan rate. Although this interaction between fields would distort the image slightly, the distortion would be constant and relatively small, for all but the most energetic background fields.

Monitors become more sophisticated

As monitors became more sophisticated display devices, they were increasing in color, larger in size, and higher resolution devices. Each of these desirable characteristics increases the sensitivity of a monitor to an external background field. Both color and higher resolution require a more precise alignment and focus of the beam, and manufacturers began to increase the vertical scan rate to allow for these higher resolutions.

Larger monitors are more sensitive since the distance the electron beam must travel is longer and less controlled by the internal monitor control fields. Energy efficient monitors are configured to operate at lower anode voltages, which causes the electron beam to travel more slowly, thus making it more sensitive to the external fields. Ironically, "low-radiation" monitors reduce the CRT's internal control field strength and make them less able to resist an external magnetic force.

In other words, all of the trends in CRT monitor technology tend to increase the frequency and severity of the magnetic interference problem. Note that this particular aspect of the broad area of the subject called electromagnetic interference (EMI) is limited to CRTs. Since an LCD display has no control fields, it is not subject to the problem.

Building sources of magnetic fields

Electric and magnetic fields (popularly referred to as EMF) are a natural consequence of the use and distribution of electricity. At extremely low frequency (ELF), the electric and mag-

netic fields operate independently of each other and it is possible to shield or eliminate one but not materially affect the other. The commercial power frequency, in the U.S. generally 60Hz, is within the area of the frequency spectrum known as ELF. At radio frequency (RF) and higher level frequencies, on the other hand, a fixed relationship exists between the electric and magnetic fields. To affect one of these fields is to affect the other.

Electric fields are caused by voltage and are measured in volts/meter (V/m). Magnetic fields are caused by current and are measured in milliGauss (mG). At ELF frequencies, the electric field is relatively easy to shield: most common building materials will substantially reduce the strength of an electric field. However, exactly the opposite is true of an ELF magnetic field. At these frequencies, magnetic fields will pass undiminished through virtually all common building materials. Materials even as dense as lead have essentially no effect on them.

With this in mind, magnetic fields will normally be found in areas adjacent to high current-carrying conductors. Examples are electrical closets and switchgear, building feeders, conduit and bus bars, transformer vaults, and even the power distribution and transmission lines outside the building. Other common sources of magnetic fields are fluorescent lights and adjacent monitors. Two monitors side-by-side can create EMI distortion on one or both of the monitors, as they each have internal magnetic fields that can interfere with the horizontal and vertical scanning fields that control the adjacent monitor.

Sometimes, the source may not be obvious. It is quite possible that, if the building has wiring errors in it, even relatively low current distribution circuits will cause substantial magnetic fields to exist over large areas of a building. Wiring errors in an office or manufacturing building, or even in wired partitions, can create "net-current" conditions, in which not all of the return current from a circuit is returning on the same path.

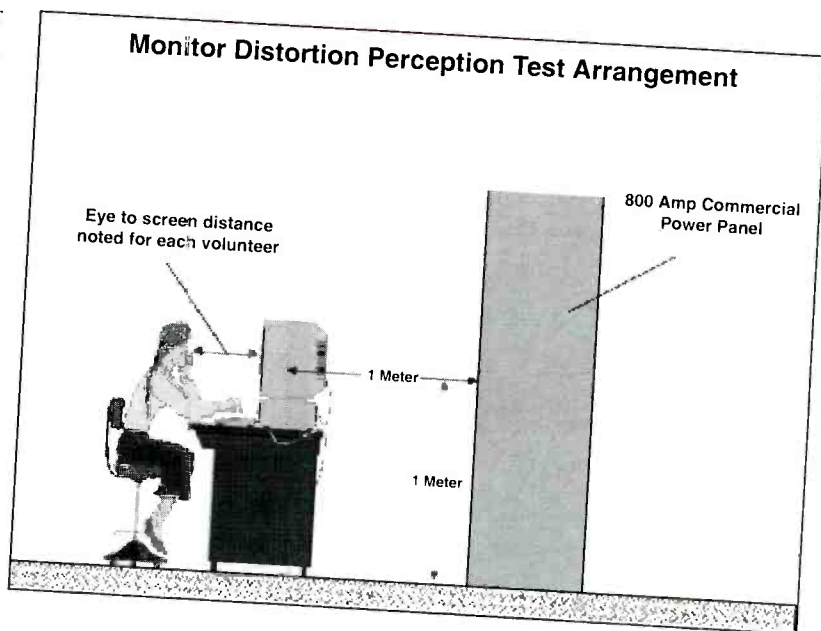
Further, since the strength of a magnetic field is directly proportional to the amount of current flowing in the circuit, fluctuations in the use of power throughout the year or even over the course of a day can cause periodic interference problem. For this reason, it is common to receive complaints from a computer user who only experiences jitter during the summer months when the air conditioning is being used.

Alternating current or direct current

Screen interference caused by magnetic fields generally falls into two categories. Alternating current (ac) fields, typically cause the image to "jitter," while direct current (dc) fields usually cause a steady distortion or loss of color integrity. Sometimes, however, you may observe other signs of instability or a combination of above symptoms.

Dc fields are typically generated by magnets, building steel, batteries, and speakers, or by direct current sources, including subway or train rails. The earth produces its own magnetic field, but monitor designs already compensate for this field.

Common sources of dc fields are powerful magnets associated with medical diagnostic and research instruments, like MRI



(magnetic resonance imaging) and NMR (nuclear magnetic resonance) devices. By the way, the "nuclear" in NMR has nothing to do with atomic energy. The term "nuclear" refers to the nucleus of the cells in animal tissue.

These tend to be obvious sources. Less obvious sources are fields that are the result of building structural and reinforcement steel that has become magnetized. These extraneous fields can occur as a result of the existence of a prior tenant with an MRI or, it is possible for building steel to become magnetized as part of the welding process during construction.

CRTs are much more sensitive to ac fields than to dc fields. Many CRTs will exhibit signs of interference in ac fields of 8 milliGauss (mG) and most will be unstable in fields of 15mG. By comparison, most monitors will begin to exhibit interference when they get subjected to dc field strengths of 1,500mG (the earth has a dc field of approximately 500mG).

Importantly, some computer systems/monitors are more sensitive than others. For example, Macintosh and Sun Workstations tend to be much more sensitive, and interference will often be seen at thresholds as low as 3mG to 5mG. Since the normal ambient field in a building can vary from between 1mG and 4mG, the chances for monitor screen interference with these devices is considerable.

Factors that affect the appearance and sensitivity of electromagnetic interference (EMI) include the type of system and monitor being used, the monitor's refresh rate, the strength, direction and source of the external fields, and the user's personal sensitivity. The last one needs comment. (Extensive research has shown that there are substantial differences among people in their ability to perceive interference on a monitor.)

Confirming the cause of the problem

Unfortunately, there are few easy and inexpensive solutions to these problems and the building owner or systems administrator may have to choose between solving the problem and reducing the seriousness of the symptoms.

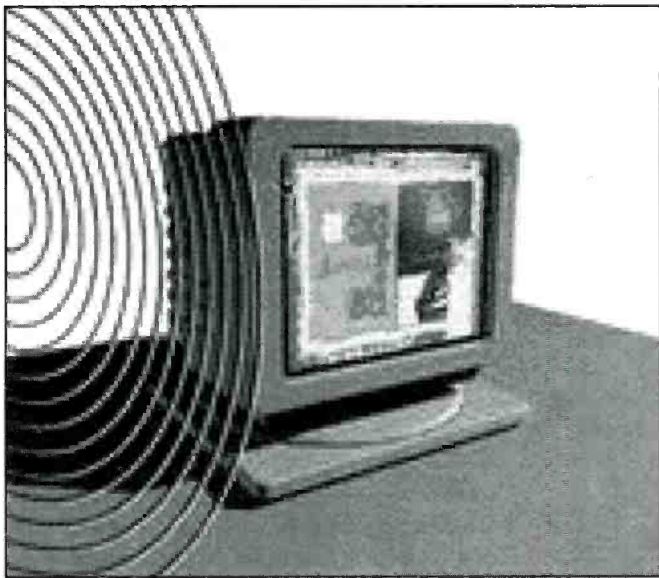


Figure 1. A magnetic field in the vicinity of a monitor may cause distortion or jitter.

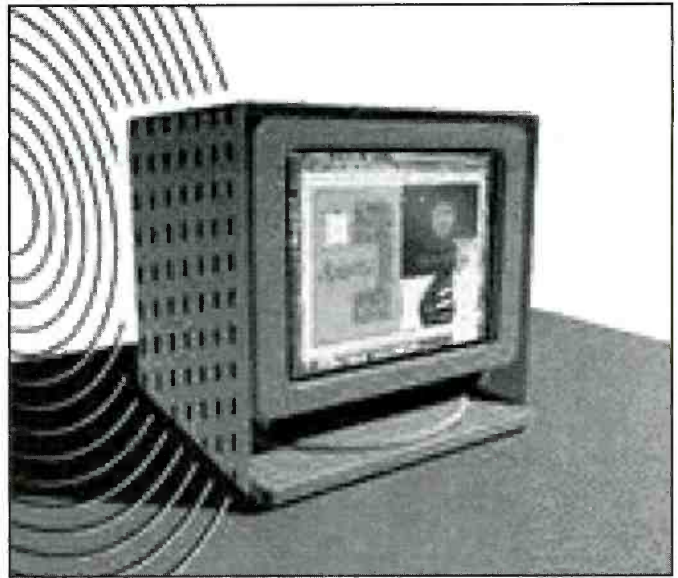


Figure 2. One solution to magnetic interference in monitors is to use a magnetic shield.

If an EMI problem is suspected, it can be useful to measure the ambient magnetic fields in the area in which the problem is occurring. Frequently, the local utility company will perform this service, either free of charge or for a small fee, for their commercial customers, and they will have competent people to advise their customers. Independent, professional surveys, are advisable if a sizeable problem is discovered. Care should be taken, however, that the report that issues from these surveys, which can be relatively inexpensive, must include a range of mitigation plans, with performance guarantees and fixed prices.

If you're servicing someone's computer system, and you suspect that the problem is magnetic interference, you may prefer to purchase a meter to take your own readings. Meters to measure ac fields are relatively inexpensive (about \$200) and can be useful in identifying hidden sources. Gauss meters for dc fields are more expensive, running into the thousand dollar range. If you perform your own magnetic field survey, make sure that nearby CRTs are shut off, so that the field they generate is not measured as well as the background fields.

Eliminating or reducing the problem

If the source of the interference is an ac magnetic field, there are several mitigation options available, depending on the magnitude of the problem. Generally, there are five solutions to the interference problem, listed here, in order of increasing cost:

- modify the refresh frequency of the monitor,
- increase the monitor-to-source distance,
- shield the monitor,
- buy LCD displays,
- shield the source.

On some systems, it is possible to reset the refresh rate of the monitor to line frequency (60Hz) without serious side effects. More often, though, this will result in a sacrifice of resolution, and in almost all cases, the jitter will have been traded for flick-

er (the refresh rate has been increased by the monitor manufacturer to avoid flicker: the eye can detect a refresh of the image at 60Hz). Further, if the background magnetic fields are strong enough, even setting the refresh rate of the computer monitor to 60Hz will not remove all of the jitter.

Another theory suggested by a leading monitor manufacturer, is to set the refresh rate to 120Hz. Doing this would rid the monitor of both the jitter and the flicker. Unfortunately, few applications at present are compatible with the 120-Hz setting.

The second solution is to increase the distance between the monitor and the source of magnetic field interference. Often a relatively small change in distance or orientation may be enough to eliminate the interference. This solution is effective in cases where the monitor is near a transformer or switch panel, but is ineffective if the source is transmission and distribution lines running outside the building.

If the source is power lines, or if it is not feasible to move the monitor and/or workstation, the third solution to consider is shielding the monitor or the affected device. External shields made of permeable materials will attract the magnetic fields and give them an alternate path around the monitor. A well-designed shield will fit snugly around the monitor and should allow for adequate ventilation to prevent overheating.

External monitor shields are commercially available and come in a range of options, from adjustable to custom-made, mu-metal boxes. The material used to make the monitor shields is expensive, especially if you require mu-metal to shield the monitor from exceptionally high fields.

In some circumstances, it may be acceptable to purchase LCD monitors. Cost, quality, and system compatibility are issues which must be resolved prior to purchase, but withstanding that, an LCD will not be affected by an external field.

In cases where the source of the problem is a dc magnetic field, you can usually degauss the monitor by pressing the degauss button or restarting the monitor, depending on the

Table I - Perception of Computer Monitor Distortion

	CTX VU700 17"		MAG DX17F 17"		MAG MXP17F 17"		MAG DX1595 15"		CTX VU700 17"		Apple M0401 14"	
Person	Noticed		Noticed		Noticed		Noticed		Noticed		Noticed	
	Objective	Subjective	Objective	Subjective	Objective	Subjective	Objective	Subjective	Objective	Subjective	Objective	Subjective
A	4.9	15.6 mG	4.9	9.6 mG	15.6	15.6 mG	9.6	15.6 mG	15.6	26.4 mG	4.9	4.9 mG
B	9.6	15.6 mG	4.9	9.6 mG	4.9	9.6 mG	4.9	15.6 mG	26.4	31.2 mG	4.9	9.6 mG
C	9.6	15.6 mG	4.9	9.6 mG	9.6	9.6 mG	9.6	15.6 mG	21.2	21.2 mG	4.9	4.9 mG
D	9.6	15.6 mG	2.3	9.6 mG	4.9	9.6 mG	4.9	9.6 mG	4.9	9.6 mG	2.3	9.6 mG
E	9.6	15.6 mG	4.9	9.6 mG	9.6	15.6 mG	9.6	15.6 mG	15.6	31.2 mG	2.3	4.9 mG
F	9.6	9.6 mG	4.9	9.6 mG	9.6	9.6 mG	9.6	9.6 mG	21.2	31.2 mG	4.9	4.9 mG
G	4.9	9.6 mG	4.9	15.6 mG	4.9	21.2 mG	4.9	21.2 mG	15.6	31.2 mG	4.9	9.6 mG
H	9.6	21.2 mG	9.6	9.6 mG	9.6	15.6 mG	4.9	15.6 mG	15.6	21.2 mG	4.9	9.6 mG
I	9.6	21.2 mG	9.6	9.6 mG	9.6	15.6 mG	9.6	15.6 mG	15.6	15.6 mG	4.9	4.9 mG
J	4.9	21.2 mG	4.9	4.9 mG	9.6	9.6 mG	9.6	9.6 mG	26.4	26.4 mG	4.9	4.9 mG
High	9.6	21.2 mG	9.6	15.6 mG	15.6	21.2 mG	9.6	21.2 mG	26.4	31.2 mG	4.9	9.6 mG
Low	4.9	9.6 mG	2.3	4.9 mG	4.9	9.6 mG	4.9	9.6 mG	4.9	9.6 mG	2.3	4.9 mG
Average	8.2	16.1 mG	5.6	9.7 mG	8.8	13.2 mG	7.7	14.4 mG	17.8	24.5 mG	4.4	6.8 mG

Measurements are Resultant values, in milligauss (mG)
All test monitors located at + 1 meter from floor and 1 meter from service panel

Table I — Perception of Computer Monitor Distortion, "ELF Magnetic Field Interference with Computer Monitors: Field Characteristics, Choices and Costs of Remediation" presented at 1997 Annual Review of Bioeffects Research at San Diego, CA.

model. It may be tempting to simply degauss the monitor and consider the problem fixed, but if you leave the monitor exposed to the ambient dc field source, over time, the computer monitor will again become distorted, so you will want to shield or move the monitor in addition to the degaussing.

Finally, if the magnetic fields are affecting a fairly large area, other mitigation options are available. If the source is a transformer vault or an electrical closet, the building owner or managers may want to consider shielding the vault or sections of the affected area. If the magnetic fields are due to wiring errors, it is often effective to have a specialist locate the errors and work with an electrician to correct them. This solution to the interference problem can be inexpensive and complete.

A final word: there are always multiple choices available to solve an EMF problem. The least cost option is seldom obvious and care should be taken in reviewing those options before selection. The cost of errors can be considerable.

Study Case 1

Problem: Elevated ac fields over a wide area of the facility

Cause: Wiring errors in the building

Solution: Isolate and correct wiring errors as necessary

A software development company purchased an old building and had it converted to office space. As part of the renovation, they upgraded the electric service. As soon as they moved in, they discovered that many of their monitors were experiencing "jitter" and instability. After a survey, it was discovered that there were elevated fields spread out over a large area which is a key characteristic of net-current problems. Wiring errors were causing an imbalance on the electrical distribution system.

After isolating and correcting the wiring problem that caused the net-current condition, the majority of the interference disappeared, leaving the normal, high field areas next to the trans-

former vault, which were eliminated with shielding. Employees were also counseled to relocate certain pieces of equipment, including stereos, farther from their sensitive workstations.

Study Case 2

Problem: High performance computers will not boot up

Cause: AC magnetic fields from an electrical closet

Solution: Shield the area

A high tech research company needed more lab space. The building owner built out new space on the first floor. Upon moving into the new lab, the company found that their engineering workstations would not boot up inside the new lab. They would function flawlessly in other rooms in the building but not in the new space. As a test, the customer attached a long power cable to one of the machines, and slowly moved it outside the new lab, attempting to boot as it moved. When it got sufficiently far away from the lab, it would operate normally.

The problem was very high magnetic fields throughout the lab, coming from the main electrical room for the building, which shared a common wall with the lab. The computer became a surrogate for a magnetic field meter. Since tests showed that it would not operate above 3mG, the specification for shielding (the least cost solution) was established. The shielding met the specification: 1.3mG average throughout the room and the computers could be operated anywhere in the lab.

Study Case 3

Problem: Elevator causes computer monitor interference

Cause: Building steel is magnetized and perturbed by passing elevator

Solution: Shield the monitor

Every time the elevator car went past the floor, the monitors nearby would experience interference. The computer operators were concerned that the elevator car carried harmful magnetic fields that, in addition to affecting the monitors or adversely affecting their bodies as well, were affecting them.

Although the field levels changed as the car passed the floor, careful analysis of the waveforms revealed that the source of the field was not based on building power. Further analysis revealed an elevated dc field, caused by building steel that had become magnetized, was being perturbed by the passing car, causing the effect of an ac field. The anxieties of the operators were relieved and the monitors were shielded with JitterBoxes.

About the author

Michael L. Hiles is the president of Field Management Services, a New York and Los Angeles based company that manufactures the JitterBox and provides magnetic field mitigation and survey services. He can be reached at: FMS@FMS-Corp.com (323) 937-1562.

What Do You Know About Electronics?

by J.A. "Sam" Wilson

Finding the resistance of a bridge circuit using Maxwell's equations

In the February issue, I made a poor attempt to find the resistance of the bridge circuit in Figure 1 as seen by the battery. I promised (later) that I would rework the solution to that problem using Maxwell's loop equations. This is it.

The June 1999 issue showed the solution to that problem by using a delta/wye transform. The resistance from B to E was determined to be 25.4Ω. I said to remember that value so we can compare it to the solution by Maxwell's loop equations that follows in this article.

As shown in Figure 1, there are three loops marked I_1 , I_2 , and I_3 . So, our solution will have three equations and three unknowns. The loop currents are assumed electron currents without regard to their actual direction. For example, electron current is shown leaving the positive terminal of the battery. That is obviously a wrong assumption. However, our solution for I_1 will give the correct numerical value, but that value will be negative. So, when you draw the assumed currents, don't waste time trying to draw the current arrows correctly.

I always draw the assumed electron current arrows clockwise. That way, when there are two currents flowing through a resistor, they will always have opposite voltage polarities. For example, in Figure 1, note the opposite two voltage polarities across the three resistors, R_1 , R_3 , and R_4 .

So, the next step (after marking assumed electron current directions) is to mark the voltage polarities of voltages across each resistor based upon the assumed current directions.

When writing the loop equations, when you enter a negative polarity, the value of that voltage is negative. Entering a positive polarity results in the value of voltage being positive.

It is important to note that when there are two polarities, both must be considered when writing an equation. As an example, when I flows through R_1 , the voltages are written as $-I_1R_1 + I_2R_2$, or, substituting the value of 10A for the current, the loop equation becomes $-10R_1 + 10R_2$.

Remember that the sum of the voltages around any closed loop is zero. That's Kirchhoff's voltage law.

Having given the rules for a Maxwell solution, here are the equations for the circuit in Figure 1.

Loop ABCEFA:

$$-10I_1 - 30I_1 + 10I_2 + 30I_3 - 12 = 0$$

Loop BDCB:

$$-20I_2 - 40I_2 - 10I_2 + 10I_1 + 40I_3 = 0$$

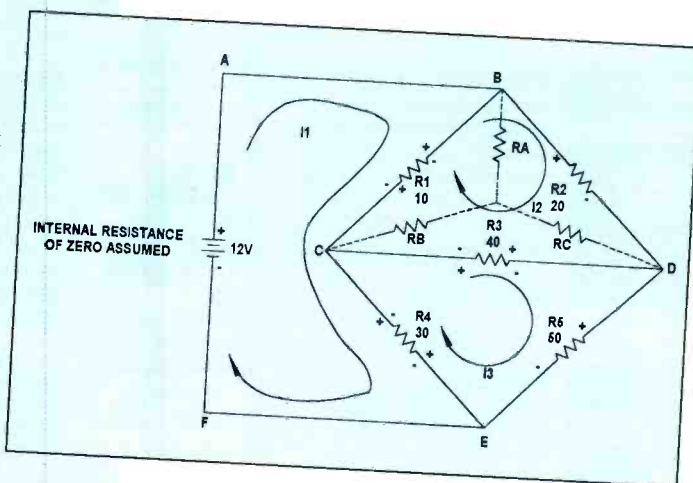


Figure 1. Find the resistance of this bridge circuit as seen by the battery using Maxwell's loop equations.

Loop CDEC:

$$-40I_3 - 50I_3 - 30I_3 + 40I_2 + 30I_1 = 0$$

Rearranging the equations into columns having identical subscripts. Remember: columns are vertical and rows are horizontal. Here are the three equations as they now appear.

$$-40I_1 + 10I_2 + 30I_3 = 12$$

$$+10I_1 - 70I_2 + 40I_3 = 0$$

$$+30I_1 + 40I_2 - 120I_3 = 0$$

Now make a matrix of the coefficients. Include the plus and minus signs.

$$\Delta = \begin{vmatrix} -40 & -10 & +30 & +40 & +10 \\ +10 & -70 & +40 & +10 & -70 \\ +30 & +40 & -120 & +30 & +40 \end{vmatrix}$$

Observe that the first two columns are repeated. When we get a value for I_1 , it will be in the form of a fraction with Delta (Δ) in the denominator. So, $I_1 = N/\Delta$. Above we are presently solving for Δ . We will solve for N later in this exercise.

Lightly draw the down arrows and up arrows on the matrix in the manner shown.

The next step is the step in which the mistakes are usually made. The sum of the products (multiplications) of the downs minus the sum of the products of the ups equals the value of the matrix. If you can't say it, you can't do it.

Here is the sum of the products of the down arrows:

$$\begin{aligned} & [(-40 \times -70 \times -120) + (10 \times 40 \times 30) + (30 \times 10 \times 40)] \\ & = [(-336000) + (12000) + (12000)] \\ & = -312000 \end{aligned}$$

Here is the sum of the products of the up arrows:

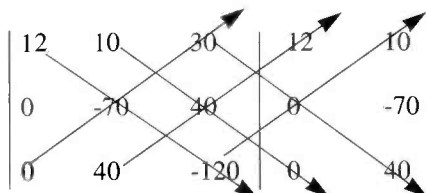
$$\begin{aligned} & -[(30 \times -70 \times 30) + (40 \times 40 \times -40) + (-120 \times 10 \times 10)] \\ & = -[(-63000) + (-64000) + (-12000)] \\ & = -[-139000] \\ & = +1390000 \end{aligned}$$

Here is the sum of the products of the down arrows minus the sum of the products of the up arrows:

$$-312000 + 139000 = -173000 = \Delta$$

$$\text{So, } I_1 = N / -173000$$

To solve for N, substitute the knowns column for the I_1 column and solve the resulting matrix.



Here is the sum of the products of the down arrows minus the sum of the products of the up arrows:

$$\begin{aligned} & [(12 \times (-70) \times (-120) + (0) + (0))] - \\ & [(0) + (40 \times 40 \times 12) + (0) \times (0)] \\ & = [100800] - [19200] = 81600 \end{aligned}$$

$$\begin{aligned} \text{So: } N &= 81600 / \Delta \\ &= 81600 / -173000 = 0.472 = I_1 \end{aligned}$$

The resistance that the battery is looking into is $V/I_1 = 12 / 0.472 = 25.4\Omega$. That is the resistance of the bridge from junctions B to E that we arrived at. Compare this to the solution of 25.4Ω that we arrived at by the delta/wye transform method in the earlier issue. (Note: the negative sign for the resistance has been dropped).

Wisdom on the "Rockford Files"

Remember that show? In one segment, Rockford's brother (a swindler) offers this great piece of advice about advancing in the business: "The hardest thing about getting to the top is getting through the crowd at the bottom."

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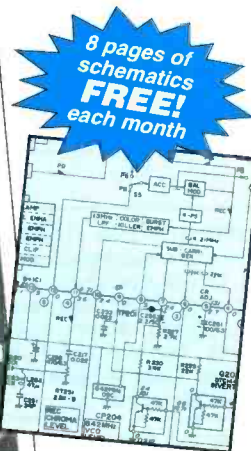
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Listing of the tubes used in a Model 466 Simpson handiscope. *Contact: David Splinter, 608-568-7222.*

Toshiba TV Model CF2026 CRT board PN 23158256, Part NLA. *Contact: Helwig Electronics, 803 First St., Melrose, NM 88124, 505-253-4732.*

TV chips, used o.k. NAP 612426-3/-4, IC-1000 (Philco) 25C537, NAP 612498-1 (Sylvania) 13C505 and 192743 (GE), U-3100V from CTC-148A. Not over \$12.00 each. *Contact: W. Worley, 305 Hickory Bend Rd., Enterprise, AL 36330, Phone: 334-347-5281, E-mail worley@snowhill.com.*

RCA '88 Colortrak 2000 TVs, model G27149TK floor wood console, Hickok tube testers and audio tubes. *Contact: 612-869-4963.*

Sams Photofact #2544 to 3761. *Contact: Patrick Willie, 520-871-2139.*

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