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This guide is a comprehensive, yet easy-to-use training course designed to help you become more efficient at computer monitor servicing. The course provides you with in-depth troubleshooting information on all of the complex monitor circuits, such as switched mode power supplies, horizontal outputs, and CRT circuits. The Self Study Guide is great for everyone from technicians to instructors.

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THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

Volume 19, No. 2 February, 1999

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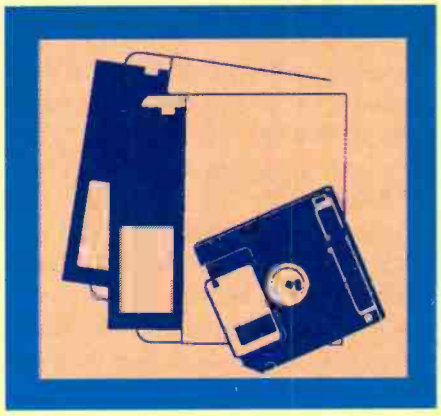

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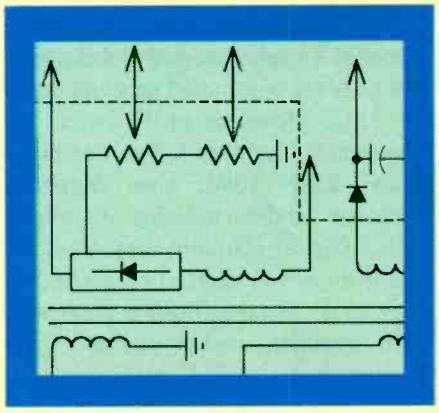

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ON THE COVER

The technological history of the development of the VCR was relatively short, but fraught with the problems and intrigues that have been known to accompany the introduction of a new technology. An awareness of this history helps the technician appreciate the efforts that went into bringing this product to the mass market. (Photograph courtesy of MCM)

What a show

The new technology that was introduced at this year's show was pretty amazing, and has some implications for consumer electronics service centers.

Another Consumer Electronics Show has come and gone in Las Vegas. ES&T was at the 1999 show with a booth and an editor who walked around the show as wide-eyed as a kid in a candy store. The new technology that was introduced at this year's show was pretty amazing, and has some implications for consumer electronics service centers, although only time will tell just how far reaching the effects might be.

Of course, the most spectacular of the new technologies was HDTV, and more generally, digital TV. A number of booths operated by the big names in consumer electronics featured multiple screens of the new digital products. Not only were there sets with standard CRTs, but there were also many rear projection models, as well as LCD, plasma screens, and something that Sharp had, called PALC, plasma addressed liquid crystal.

The pictures were, as touted, incredibly clear. Many of the pictures looked better than a film image would look. Of course, the program material that the companies had generated to display the new products was especially designed to show off the qualities of the screens. Still, the pictures were impressive.

And attendees even got to watch a live football game broadcast in high-definition. The picture was, as advertised, clear, bright, and completely free from ghosting and interference.

But there was a great deal of other cutting-edge technology being displayed, as well. One new technology that will require some study on the part of consumer electronics service technicians is based on a new standard promulgated by the IEEE (Institute of Electrical and Electronics Engineers). The standard is called IEEE 1394, also known as "firewire," and it's amazing. A company called Digital Harmony has developed and licenses to manufacturers a "family of protocols and specifications, that, when used together, enable interoperability between home entertainment products," based on the IEEE 1394 standard.

According to an engineer from Digital Harmony, to whom I spoke at CES, using the standard, all of the components of a home audio/video system would be interconnected by a bus; cables that consist of two twisted pair, or two twisted pair and a pair of power wires. All of the digital information of which the program consists would be available everywhere on the bus. Each portion of the program carries a code, so that it can be identified. Every component connected to the bus would have its own controller chip that would give it "intelligence." The component would only use the portions of the program information that was earmarked for it.

Here's an example. The installer or owner would run the "bus" wires to every component of the system. Then he would program the system so that each component would access only the information intended for it. As the program was playing, all of the digital information of which the program consisted would be available on the bus: left front channel audio, right front channel audio, center channel audio, left rear channel audio, right rear channel audio. But each of the components would have been programmed to accept only the portions of the entire program that it was intended to reproduce. Imagine trying to troubleshoot a system like this, not knowing how it was designed.

Another technology that seems to be going great guns is digital photography. One company was demonstrating a digital camera and photo printer at the show. The simple digital camera had a list price of around $500. The single-lens reflex digital camera was pegged at about $800. The printer had a price tag of around $500.

With this system, the photographer could shoot a number of photographs, which would be recorded on a memory chip that's not much larger than a postage stamp. Whenever the photographer wanted to develop the photos, he would remove the memory chip from the camera and slip it into the printer. The printer would display the image on a monitor. The photographer could view each of the photographs and decide if he wanted to print it.

The dye-sublimation printer is designed to work on a cartridge that comes packaged with a number of sheets of special printer paper. When the paper has been used up, the cartridge is also expended, and the user simply opens a new package and slips in a new cartridge. The quality of the photographs was acceptable for snapshot type photos.

Home networking is another technology whose time seems to have come. Several companies at CES, including IBM, were showing home networking products. One such network consists of a lot of audio, video, and telephone cable strung throughout the home, with nodes wherever the information on the cables is to be used, and one central node where control is to be exercised from.

Using a system such as this, any kind of audio or video program, telephone connection, or computer information can be routed to anywhere in the home.

Then there was wireless networking for computers. At least two companies were offering systems that consisted of cards that could be installed into computers that would allow them to be networked without wires. The user would install the cards, and the software provided, on the home's main personal computer, as well as, say, a laptop computer. Now, the user could go anywhere in the home, or even out on the patio, with the laptop, and access files from the main computer.

There was so much fascinating new technology at CES that there has not yet been time to sort it all out. But the editors brought home a lot of literature and other information, and over the course of the next year, we will be presenting articles in more depth on all of the hot new consumer electronics technologies that were presented at the show.

Nils Conrad Persson

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NEWS

New FCC rules ensure that consumers have access to new broadcast technologies

Consumers can install antennas and dishes in rental properties to receive HDTV, DBS

Commenting on the recent Federal Communications Commission (FCC) decision that allows rental property owners to install dishes and antennas in any area under their exclusive control, Consumer Electronics Manufacturers Association President Gary Shapiro said: "This is a big victory for the American consumer. With this decision, the FCC has taken a significant step toward ensuring that all Americans, including residents of apartments and condominiums, will have access to the benefits of digital broadcast satellite (DBS), digital and high-definition television broadcasts, and other new technologies.

"CEMA advocated strongly for a rule that allowed consumers flexibility with regard to antenna and dish installation. The recent decision allows consumers to place dishes and antennas outside rental units on balconies, balcony railings, patios, yards, and gardens. The new rules also permit the installation of these devices inside rental units. All existing restrictions prohibiting such actions are invalidated by the FCC's action."

"This decision is particularly critical in light of the recent launch of digital broadcasts. Now consumers with digital television sets can have access to local digital broadcasts in the top markets and satellite digital television programming on a national basis."

CEMA launches antenna selector map program

The Consumer Electronics Manufacturers Association (CEMA) announced in December 1998 the launch of the TV Antenna Selector Map Program, a new campaign aimed at making antenna sales easy and rewarding to consumers. Using color-coded maps that match antenna performance, CEMA's new program will help consumers select the appropriate type of antenna for their television reception location, taking the guesswork out of antenna purchases.

"This program provides essential help to consumers and retailers at a critical juncture," said CEMA President Gary Shapiro. "Millions of consumers use antennas to receive free over-the-air television signals, and the need for antennas is greatly increasing. As consumers continue to embrace digital satellite TV systems, such as the Digital Broadcast System (DBS), they are turning to antennas to receive local off-air signals. Additionally, antennas may be the only way for consumers to receive the sensational picture quality and digital surround sound of a high definition television (HDTV) signal until their local cable system passes through HDTV signals. And as new technologies for broadcasting and receiving information and entertainment content emerge, antennas will provide a cost-effective, space-saving solution for receiving these signals. In this dynamic time, CEMA's new program will provide retailers with the tools they need to increase antenna sales and consumers with the tools they need to make the right purchasing decisions."

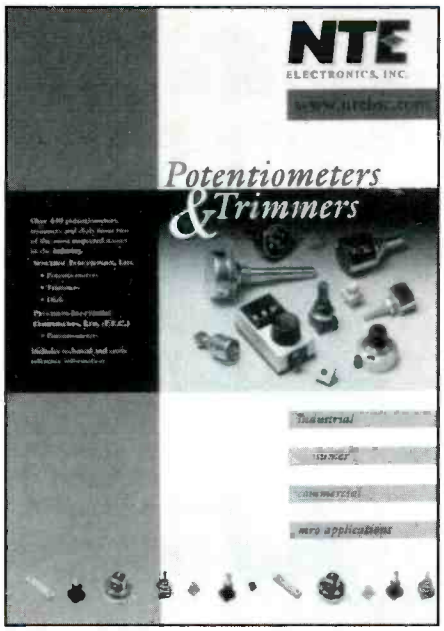
Companies participating in the mapping program include Channel Master, Gemini Industries, Helios Antenna Systems/HDTV Group, Jasco Products Company, Lance Industries, Leviton Mfg. Company, RDI Electronics, Recoton Corporation, Sony Electronics, Tandy Corporation, Terk Technologies Corporation, Thomson Consumer Electronics, Winegard Company, and Zenith Electronics Corporation. The National Association of Broadcasters (NAB) and the Satellite Broadcasting Communications Association (SBCA) have provided technical assistance.

At the core of the new program are antenna selector maps which have been developed for all 211 designated market areas (DMAs). The maps calculate reception from all full-powered TV stations in a city, including terrain and building obstruction and likely interference. A consumer can work with the retailer to identify the location of their home on the map. Once they have identified in which "color" they reside, they consult the antenna selector guide that explains which types of antennas are most useful. The guide also lists the models available for the reception area. Following voluntary antenna performance specification standards, antenna manufacturers participating in the program will include a stylized CEMA logo with color labels on product packaging that accurately match the guide and the maps, making proper product selection for consumers a snap.

"Never before has the general public had such carefully detailed maps that relate to TV reception," said Neil Terk, president of Terk Technologies Corp. "The map system was based on extensive lab and field testing, correlating antenna performance with reception environments and numerous conservative assumptions about home set-up. The program all but assures that when a consumer uses one of the recommended antennas they will get off-air reception better than ever before. Additionally, the antenna selector project includes the DTV 'planning' factors in its technical assumptions, ensuring that consumers can receive digital television broadcasts through their new antenna."

Retailers can obtain information about the program from their preferred antenna manufacturer or by logging onto <www.CEMAcity.org>. Complete map kits may be ordered from: The Shipyard, 2710 NE Summer Street, Minneapolis, MN 55413; Fax: (612) 676-0080, E-mail: mail@theshipyard.com. Retailers can order the kit for $25 which includes an antenna map book for the specified DMA, an informational brochure that explains the program, a technical sheet that reviews more advanced technical issues, five pocket reference guides for salespeople, and a five-minute training video. Consumers can order map kits from The Shipyard at a cost of $49.95 per kit. The Shipyard accepts credit cards (Visa and MasterCard only), a check made out to CEMA or a money order made out to CEMA. Materials for the Top 30 DMAs are expected to be completed and available by mid-December 1998. Materials for all 211 DMAs will be available first quarter 1999. Kits will be shipped UPS Ground within 3–4 weeks after the DMA is made available. The kits will be clearly labeled "CEMA TV Antenna Selector Program." ■

LITERATURE



Potentiometer and trimmer catalog

NTE Electronics has released a new catalog featuring their new line of potentiometers and trimmers. The company has teamed up with Spectrol from the UK and Precision Electronics from Canada to offer over 440 potentiometers, trimmers, and dials in bulk and blister pack. The line features military type potentiometers, single and multi-turn Cermet trimmers, multi-turn wirewound potentiometers, single-turn Carbon and Cermet potentiometers, 10 and 100 turn digital dials, and 15 turn vernier dials.

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Fall '98 full line catalog

Specialized Products has released its new comprehensive Fall '98 Catalog. The new 392-page publication features a wide assortment of products for virtually every service application in Telecom, LAN, Fiber Optic, Wireless, Medical Electronic, and Computer industries.

Technicians, field service managers, and engineers can choose from a complete assortment of electronic test equipment featuring component testers, digital multimeters, frequency counters, function generators, oscilloscopes, power supplies, and the largest selection of cases in the industry. The computer testing selection includes benchtop test equipment, EPROM testers, and SIMM testers. LAN test equipment choices include analyzers, Category 5 testers, continuity testers, and fiber optic test equipment. The telecom selection features bit error rate testers, digit grabbers, digital butt sets, and transmission test sets. For fiber optic test equipment, choose from cleavers, light sources, optical time domain reflectometers, power meters, strippers, and more. Any standard tool kit may be modified to suit a customer's specific application or budget. For more unique requirements, custom tool kits can be built from scratch to exacting specifications.

Circle (91) on Reply Card

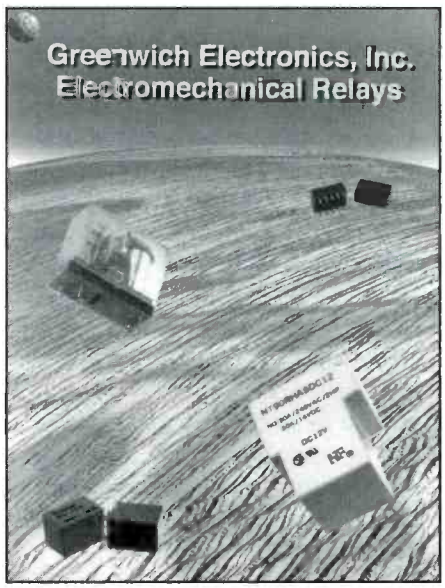
Wall transformer and power supply catalog

Surplus Traders offers their new catalog of wall transformers and power supplies. The company specializes in the buying and selling of factory excess inventories of wall transformers and power supplies. In addition to the inventory on hand, the company maintains a database listing thousands of units available in factory warehouses across North America.

Circle (92) on Reply Card

Mechanical relays catalog

A new 36-page catalog featuring a full line of electromechanical relays for automotive, appliance, industrial, motor control, instrumentation, telecommunications, security, and other applications is being offered by Greenwich Electronics. The catalog features 14 different types of electromechanical relays in a variety of configurations with ratings from 2A to 70A. Providing general application guidelines, this catalog helps users select the best relay for their requirements with respect to performance, contact shapes and materials, life, and loads.



To assist designers, the 36-page Greenwich Electromechanical Relays Catalog includes complete specifications for each relay, dimensions, schematics, approvals, and ordering information. A cross-reference guide to other manufacturers and a relay specification guide sheet are also provided.

Circle (93) on Reply Card

Technical magazine

Sencore announces Sencore News #183; a technical newsletter designed to support the electronics servicing industry with troubleshooting procedures, tips, and current trend information. This issue contains articles on several subjects, including in-circuit component testing, new products, computer monitor analyzing, CRT analyzing, and more. The newsletter also contains the company's Technical Training schedule.

The newsletter is published 6 times per year and sent free of charge to electronic service technicians and owners of the company's test equipment.

Circle (94) on Reply Card

Measurement products catalog

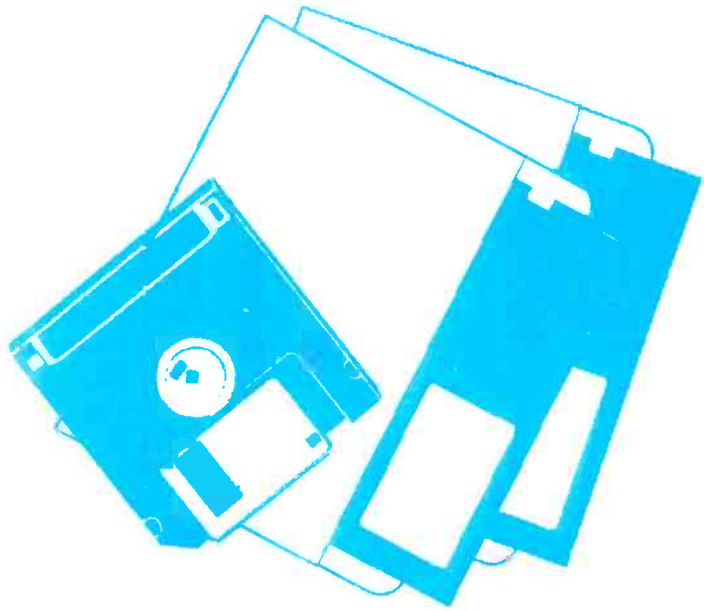
Tektronix announces its new 1998-99 Measurement Products Catalog. The catalog includes a broad offering of test equipment including innovative products such as the Digital Phosphor Oscilloscope (DPO), for design engineering, manufacturing, service, communications, and television test applications. The 700-page, soft cover catalog includes a full-color, new product section that features over 70 new products and measurement solutions.

In addition to the paper catalog, measurement product information is also available on a CD-ROM that uses web-technology-based viewing and searching software that allows users to navigate the CD-ROM, as if it were a website.

Circle (95) on Reply Card

Using software to increase profitability

by John A. Ross



Whether we want to admit it or not, the profitability of servicing electronics products has decreased during the past several years. Pressure from discount houses has driven retail prices for televisions and VCRs lower and, as a result, has caused consumers to view many of those products as throw-away devices. However, a quick tour of most service centers will show that the demand for service continues to exist. Indeed, as the prices for lower-echelon devices have shifted downward, many consumers have purchased products that offer advanced features or greater entertainment value.

Still, the challenge of obtaining profitability continues to exist for most service centers. When the demand for service grows, timelines and knowledge become key factors for profitability. Within those factors, service center managers must consider customer needs and the capabilities of their staff. In addition, managers must also remain aware of the availability of components, diagnostic tools, and manufacturer's service literature.

Part of this challenge also involves taking advantage of the diversity of the electronics industry. At any one time, a service center may have a wide range of defective products either on the test bench or in a waiting area; a different manufacturer may have produced each. Of those products, some may have just arrived for diagnosis; others may wait for a parts order; and still others may require additional service information.

Regardless of the concern about profitability, efficiency, or effectiveness, the service center needs some method for managing service calls, matching technician skills with the task, and performing traditional office accounting chores. In the end, the concerns about profitability, efficiency, and effectiveness boil down to one essential goal: providing great customer service. Good management practices lead towards profitability, efficiency, and effectiveness, while creating an environment for great customer service.

Ross is a technicial writer and microcomputer consultant for Ft. Hays State University, Hays, KS.

Using personal computers as a service tool

The same price decreases that have changed the face of the service industry can also assist the service center with the profitability challenge. Here, as in all cases, the main reason for utilizing a tool or a management technique is the increasing of the efficiency and effectiveness of the service center. Given the correct software — and the knowledge about how to apply the software to the task, a service center can use a personal computer to increase its efficiency and effectiveness.

As an example, we can use the standard word processing, spreadsheet, and database software to generate invoices, check daily accounts, and manage customer records. When using a word processing package to generate invoices or customer mailings, several functions become particularly valuable. The *template* function defines the formatting of a document in a specific style and allows the application of that format to any portion of the document. The format can include special headings, font types, spacing, and other standard formatting options.

While applying the template function, we can also utilize the *insert* function to place images or different file types within the document. As a result, we can build an invoice template that has a customized header and then insert information from a spreadsheet or database into the invoice. If the service center plans to send a general mailing to its customer base, it can also use the same functions along with the insert field function to simplify the process of addressing the letters and envelopes along with personalizing the message.

Spreadsheet packages provide the structure needed for income statements, balance sheets, accounts payable ledgers, and accounts receivable ledgers. In each case, the functionality given by the spreadsheet package simplifies the task of keeping daily records and tracking profits and losses. Because every spreadsheet has a formula function, we can establish formulas within the totals of each row or column of a spreadsheet and simplify any calculations. Along with those basic functions, every spreadsheet application also offers the capability for "what if" calculations. With this, we can base the business plan for next year on a percentage increase of volume, assume that a specific inflation will occur, and adjust calculations for those percentages.

By definition, database packages allow the storage and manipulation of informa-

Chart One — Available General Purpose Software

Word Processing	Spreadsheet	Database	Available as a Suite?
Microsoft Word	Microsoft Excel	Microsoft Access	Microsoft Office*
Lotus Word Pro 97	Lotus 1-2-3 97	Lotus Approach 97	Lotus Smart Suite
ClarisWorks Word Processor	ClarisWorks Spreadsheet	ClarisWorks Filemaker Pro	ClarisWorks Office 5.0
Corel Wordperfect	Corel Quattro Pro	Paradox 8	Corel WordPerfect Suite 8

*Microsoft Access is offered as part of the Microsoft Office 97 Suite but not in later editions.

tion. Rather than fumbling through an endless stack of notes when attempting to find a vendor telephone number, we can establish a simple database that contains all vendor information and then use the search function to quickly locate the needed phone number. Going back to the use of a word processor for general mailings, the database software works as the storehouse for all customer names and addresses. In addition, we can use a relational database to link those names and addresses with other key information such as product types, warranty information, past work, and case histories.

The following chart lists a number of available word processing, spreadsheet, and database software applications. In most cases, we can purchase the applications as part of larger suites. Since the same manufacturer produces each application, the user gains through the capability to move files from one application to another. Most also contain translation routines which allow the user to accept documents or files produced through other software packages.

Tracking service requests

Some repair services implement a scheduling system, customer contact tracking, and troubleshooting checklists. Whether customer contacts to a repair center occur through phone messages, electronic mail, or face-to-face meetings, an office staff-member translates the customer's contact into a written, numbered work order which becomes the first stage of the process. With the work order in hand, the office manager places the task into the office work schedule and assigns it to a particular service technician. After scheduling the task, the manager informs the customer about the scheduled day and time, the assignment of the task to the staff member, and that all times are tentative. The last, qualifying statement accounts for unforeseen delays that are a part of the service business. All this accomplishes several things. Translating the customer's call into a written work order creates a paper trail for the manager and the staff member. After completing the task, staff members ask the customer to sign the work order. For the manager, staff member, and most importantly, the customer, this signifies the completion of the work order. Placing the task into the office work schedule allows the manager and staff to see the progress for the day. If the daily schedule is disrupted by jobs that take longer than anticipated, the service manager has the opportunity to call the customers and re-schedule the repair.

Using management and scheduling software

Several companies produce service center management software packages that automate almost every part of a business. With the software in place, one can enter any information provided by a customer and link that information to a manufacturer and model number. The resulting data files can then become part of a larger troubleshooting tips file and can provide an instant reference to information regarding a particular customer.

In addition to data entry and address control, the software management packages may also offer a method for tracking and scheduling tasks. Within the tracking information, the system will show job information, the current status of the job, a listing of parts ordered for the particular job, and a schedule of service performed

Chart Two — Service Center Management Software

Manufacturer	Product Name	Company Address
Sencore	SM2001 Service Center Manager	Sencore Electronics Sioux Falls, South Dakota http://www.sencore.com/ Toll Free: 1-800-SENCORE (736-2673)
Sencore	SA32 Service Assistant Business Management Software	
Foresight Software, Inc.	Front Office Service Management System	Foresight Software, Inc. Six Concourse Parkway Suite 2200 Atlanta, Georgia 30328
Metrix, Inc.	Modular Service Package	Metrix, Inc Management Software 20975 Swenson Drive Waukesha, WI 53186 Toll Free: (800) 543-2130 Phone: (414) 798-8560 Fax: (414) 798-8573

by all technicians. An inventory management program shows which in-stock parts sell and whether prices and quantities have changed. The data accumulated through the tracking and inventory modules then becomes part of the information written to the customer invoice.

Most service management software packages also generate invoices and progress reports. Combined with operating statements, and accounts payable and receivable statements, those reports can provide an instant method for observing daily business operations. From a business perspective, the use of the service management software also frees the technician's time because of the automatic generation of forms and invoices. Chart 2 lists a few of the many available service management software packages.

Purchasing service call management software

When purchasing management and scheduling software, always check for several necessary features. The software should have easy-to-understand entry screens. With this, the software should provide the ability to enter or access customer information including phone number, address, and job information. In addition, the entry screens should provide information about the current status of a specific task or detailed information about all equipment under repair in the center. Here, the software should link the task with a customer phone or ID number and should show whether the task is completed, in-progress, whether parts are ordered or on back-order, or if the job cost estimate is waiting for customer approval. Most software packages will also offer the capability to track equipment serial numbers, service maintenance schedules, the number of calls to a specific location, and the time needed for each service call.

Many companies look for service call management software designed specifically for their needs. However, finding the best features for the best price may involve purchasing software that will answer both small and large business needs. Generally, the software should automate repetitive tasks and make comprehensive service information available throughout the organization. Of particular note, some software packages automatically assign order numbers, add new solutions to existing solutions databases, and calculate the number of times that specific problems occur. More expensive packages link the application with a paging service and feature automatic technician paging.

Integrated management and scheduling solutions provide a method for customer support, field service, contract management, logistics, inventory, dispatch, and repair center operations within one package. For example, an integrated solution may cover repair center/depot challenges by providing repair histories for an item by serial number. Along with the repair histories, those applications offer the capability to display service orders in a customized format, itemize and calculate parts, labor, and service charges, and generate management reports.

Contract and warranty administration

Many manufacturing and service organizations offer service contracts for sale to customers who have purchased an electronic product. When a customer purchases a service contract, the service company guarantees to perform any periodic service that falls within the limits of the contract for no charge. Most professional service contracts include all parts and service labor charges needed to return a product to its original operating condition following a normal failure and have separate clauses to compensate for the aging of components.

Some software manufacturers offer contract and warranty management software that answers many of the contract administration challenges. Some of those challenges involve tailoring service contracts to specific customer needs. Having the capability to write a customer-specific contract not only provides a valuable service and relationship-building tool but also sets apart one service institution from another. Contract and warranty administration software ensures that contract renewal occurs on a timely basis and that the customer receives the level of service defined by the contract. As a result, the satisfaction of the customer remains in place while revenue continues to flow.

The warranty administration portion of the software package stores information about warranty service requirements. With this, a technician can check about manufacturer warranty policies and can verify whether a product remains in warranty. Information of this type includes warranty exclusions, warranty lengths, labor rates, and address and telephone information for the manufacturer. The

Chart Three — Web Site Addresses

Title	Type of Equipment Covered	Address
The Electronic Technician's Forum	Televisions, VCRs, Computers Monitors, Audio Equipment	http://www.anatekcorp.com/techforum.htm
Electronic Repair Tip	All	http://www.elmswood.guernsey.net/
RepairWorld	Television, VCRs, Computer Monitors, Camcorders	http://www.repairworld.com/
Jughead's Information Station Electronics Page	Theory, Vendors, Manufacturers, Use of Test Equipment	http://www.teleport.com/~jughead/electronics.htm
Electronic Technician's Association	Organization for Technicians	http://www.eta-sda.com/eta/
Consumer Electronics	Organization for Technicians Policy-making Organization	http://www.cemacity.org/
sci.electronics.faq	Troubleshooting Tips/Theory	http://www.repairfaq.org/
Electronics Manufacturers on the Net	List of All Electronics Manufacturers Web Site	http://www.electronics-oems.com/homepage.html
The Ref	Personal Computer Hardware Information	http://theref.c3d.rl.af.mil/theref.html
Electronix Express	Troubleshooting Tips	http://www.elexp.com/tips.htm
International Society of Certified Electronics Technicians	Organization for Technicians Certification Information	www.iscet.org

warranty service database also contains information about special warranty extensions or safety related product callbacks.

Diagnostic and simulation software

With many service centers also entering the personal computer repair business, diagnostic software has become an often-used item. Although we can still rely on a multimeter, a logic probe, and an oscilloscope for part of the diagnosis, the complexity and speed of most computer operations requires different problem-solving tools. Most diagnostic packages include a hundred or more tests that provide a clear picture of the computer operation.

Diagnostic software for the personal computer tests the random-access memory, all types of hard disk drives, floppy drives, the I/O ports, and the main board for problems. Along with basic tests, the software will benchmark the processor during normal operation, test memory addressing, check the video memory, measure the accuracy of the real-time clock, and check the hard disk drive seek time.

A POST reader card supplements the diagnostic software by monitoring the system as it boots. By watching all the computer functions during the boot sequence, a technician can isolate problems even if the system BIOS does not send the POST codes. Since the POST reader card displays fail or pass codes on the system display, a technician can compare those codes with listings contained within the card manual. Each code signifies a specific test and lists the integrated circuit or device that could cause the failure.

Circuit simulation software has become a necessity for most electronic training programs. With the software in place on the computer, a technician can design a virtual circuit and apply "power" without the risk of damaging any components. Software such as the *ELSA Spice Simulation*__and the Interactive Image Technologies *Electronics Workbench* packages provide a method for designing analog, digital, or a mix of analog and digital circuits. In both cases, the software contains more than 10,000 components and is available in a demonstration format.

Using the World Wide Web as a service tool

During the past two years, the World Wide Web has become an increasingly valuable service tool for technicians. Several independent websites list common problems and solutions for many different types of electronics products including televisions, VCRs, projection televisions, and satellite equipment. As well as listing repair information, some manufacturers have also begun displaying schematic information — in a downloadable format — on the Web. Moreover, most integrated circuit manufacturers provide downloadable white papers and data sheets that cover almost all semiconductor products. Chart 3 provides a listing of website addresses.

Conclusion

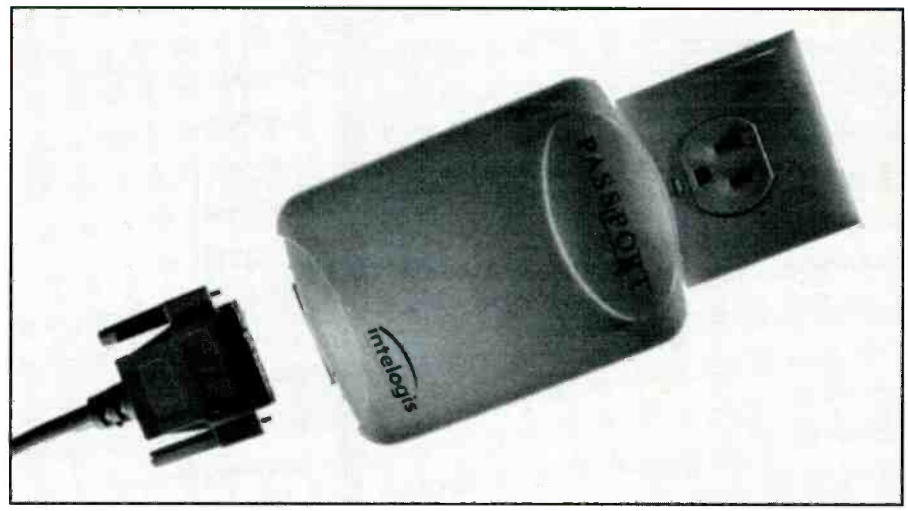
By now, most of us have become accustomed to using a computer, different types of software, and many of the resources presented through the World Wide Web. Yet, using a computer and those resources to solve management problems could be a new method for extending profits and for satisfying customers. In some cases, the image of efficiency and effectiveness can work as the first move for establishing customer confidence. While this article provides a general overview of available resources, future articles in this series will compare various software packages and introduce more techniques.

New consumer electronics technology

by the ES&T Staff

The world seems to be increasingly driven by technology and automation. The rapidly increasing abilities of computers and the rapid continuing microminiturazation of the circuits is leading manufacturers to include computers everywhere, in many cases, computers that we're not even aware are there.

This article highlights some new technological developments that service centers should be aware of. The information presented here is for the most part a verbatim transcript of the story as provided by the companies themselves. The information has not been verified.



A new system from Intelogis, called PLUG-IN, provides a lower priced way to connect computers and peripherals via the power line.

Personal television

Today, if you're watching a TV program and the phone rings, or if you have to go out, most likely you will miss the rest of the program. Or if you had planned to tape a program to watch later, but forget to do so, you've missed it. That is now changing. A company called Replay Networks is introducing a system that makes television programs available when you want to watch them, and will even search for the programs that you have told it that you want to watch.

The story of the genesis of Replay Networks and Personal Television began in 1991 when the company's CEO, Anthony Wood, an avid fan of *Star Trek: The Next Generation*, began thinking about how difficult it was to make regular recordings of his favorite television show.

Being an engineer by education and training, Wood had easily mastered the complexities of programming his VCR. But still, there always seemed to be a few problems: the tape was full, the wrong tape was in the VCR, he didn't know he was going to be late, the timer wasn't setup correctly, the power was in the wrong state, etc. And once the show was recorded, the problems kept coming. How do you find the show on an unlabeled tape? Which tape is the show on? There had to be a better way.

A few years earlier, Wood had designed and built what would turn out to be one of the most popular audio digitizers for personal computers, and understood the power of digitizing media, then storing and playing it back from hard drives. It seemed obvious that the right combination of storage and compression technology, coupled with some software to tie it all together, could result in a huge breakthrough in the way people watch television. With this combination, people would be able to personalize their television viewing experience. They could watch the shows they wanted to watch whenever they wanted. It would be television-on-demand that actually worked! This could change everything.

Of course, in 1991 hard drives were far too expensive to be used in consumer video products. As was the compression technology needed to squeeze large video files down to a size that could be managed by a consumer electronics device. But over time, prices spiraled downward, storage capacities dramatically increased, and video compression technologies made significant advancements. In August of 1997, when Wood felt that the prices of storage and compression technology had crossed into the consumer price range, he formed Replay Networks to make personal television a reality.

A vision of personal television

Television hasn't changed much in 50 years. Broadcast networks create and transmit shows on specific schedules. Thursday night seems to be popular. There have been some advances. Color was a pretty good idea. Then cable came along and offered more channels. Satellite dishes, large and small, offered even more television programming. Now there are lots and lots of channels. But shows are still only available to watch at certain times. And even with all the channels, it still seems there's never anything good on when you want to watch TV. A viewer could have hundreds or even thousands of hours of programming coming into their home on a 24-hour basis, but the odds that something "good" would be on during the few hours that they actually sit down to watch were slim indeed.

What if you could watch TV when you wanted? After all, if you want to rent and watch a movie, you can do that when you

want. If you want to visit a website, you can do that whenever you want. In a world becoming increasingly more personalized, you do more and more things on your schedule. Why not TV?

The first attempt to solve this problem was called "video-on-demand." Industry leaders thought it would be simple: All they would need, they thought, were huge video servers in every town in the country. These massive and expensive computers would serve up high-speed video data streams to expensive receivers in houses miles away (across phone or cable networks that were not originally designed for high-speed, two way data transfer). The industry and executives at large companies spent billions to discover the obvious: traditional video-on-demand is too expensive and too complicated. Even though there have been many attempts, there has yet to be a single example of this "server side video-on-demand" concept that has been successfully deployed anywhere in the world.

Replay Networks turns this model upside-down by installing the server (ReplayTV) locally; in the home. This local "client side" system offers the features dreamed of by video-on-demand supporters in a much simpler and practical way. It's called Personal Television. It's personal, because it's a device you buy, own, and personalize. There are no expensive high-speed networks required. There is no huge array of servers required. There are no monthly service fees. In fact, there's is no new infrastructure required at all. It works with whatever television signals viewers have available.

You own your ReplayTV, and you personalize it. You tell the unit what kind of shows you like, and it automatically creates channels for you and lets you view those shows on-demand. The product does this by accessing the Replay Network Service. Among other things, this service enables the device to know what shows are on, what time they are on, and what actors, directors, and descriptions are associated with those shows. The device then automatically captures those shows, using its local, high-capacity hard disk to digitally store them for viewing at your convenience. Now, whenever you sit down to watch TV, the shows you like are on now. Like *ER, Friends, Babylon 5,* or the news? Create a personalized "Replay Channel" and you can watch them when you want. Like Harrison Ford? Create the Harrison Ford channel, with Harrison Ford movies available on-demand. Plus, ReplayTV gives you unprecedented control of your viewing experience by letting you pause, rewind, and fast forward live TV.

The future of personal television

The personalization of television means big changes for everyone. As computers become more powerful and hard drives become larger, the power to personalize television will grow exponentially. Imagine 10 years from now, when a low cost hard disk will have enough space to hold 500 movies. Imagine a "video juke box" with all your favorite TV shows, sports, and movies available at your convenience.

TV on demand

In a perfect world (according to this manufacturer), you could turn on your television any time you wanted and be guaranteed that there would be something great to watch. In a perfect world, you would never miss your favorite TV shows. In a perfect world, you would have your own custom channels filled with only the great TV programs that you love. In a perfect world, you would never have to fumble around with videotapes. You'd never have to make sure that the tape was in the machine, or wonder if it was rewound, or worry that you were recording over something important. In a perfect world, it wouldn't matter if the telephone rang right in the middle of your favorite show because you could pause live TV just like you pause videotape. In a perfect world, you would have an "instant replay" button on your remote control. In a perfect world, you would be in complete control of your television viewing experience. One company has created what they say makes this a "perfect world."

ReplayTV from Replay Networks, Inc., according to that company, allows the user to:

- Easily create and configure personalized channels
- Guaranteed recording of your favorite TV shows
- VCR-type controls while watching live TV (Pause, Rewind, Fast Forward)
- Rewind to the beginning of a live broadcast while it is still being recorded
- Instant replay
- User definable video-quality levels
- Fast IEEE-1394 (FireWire connection) for future attachments and storage expansion
- Upgradable storage capacity
- On-screen easy-to-use program guide
- Automatic clock set
- Compatible with all over-the-air, cable, and direct broadcast satellite systems
- Easy one-button recording of television programming
- ReplayTV does not use videotape
- Models that store 6 to 28 hours of video

The network service

The Replay Network Service (RNS) provides the data that the ReplayTV device uses to allow you to personalize your television viewing experience. Without the RNS, the device would be nothing more than a fancy digital recorder. The RNS provides regularly updated television programming information and combines it with software to create the television control device.

With the network, the unit creates a customized channel guide and makes it easy to search for shows you want to watch or select future TV shows that you would like to record. The RNS makes it possible for the viewer to easily create customized channels filled with favorite TV shows or custom channels that contain movies by your favorite actors or directors.

Every night, the device dials a free local number and automatically logs on to the Internet. Once connected, the unit contacts the company's server and downloads the latest programming information customized for the owner's specific over-the-air, cable, or DBS system (or whatever combination of these sources the owner has). The server always has at least one week's worth of programming information available for navigation, future recording, or searching. In addition to updating the channel guide information, the RNS also checks to make sure that the device's clock is set accurately and resets it if necessary. Finally, the device is easily upgradeable because the RNS can also download regular software updates that increase the functionality of the system.

In the very near future, the company plans to add features to the network service that will extend the user's control of

television. These new services will work with existing devices. Planned Replay Services include:

Replay Zones: special areas that help the user navigate the hundreds or thousands of hours of TV shows that come into the home on a daily basis to find exactly the programs that they want to watch. For instance, the network will provide a special Christmas zone that makes it easy to create a Christmas channel that contains all the Christmas specials that are available during the Christmas season. Or, the user can make selections from the Kid's Replay Zone that highlights all the children's programming available on a daily basis. And networks can sponsor zones.

Replay Indexes: will allow the user to use the device to create customized news, sports, business, and weather channels.

Replay Previews: will provide on-demand video previews of upcoming television movies, sports, and more.

Frequently asked questions about ReplayTV

1. What is it?

ReplayTV is a VCR-sized box that sits on or near a television and automatically records and stores favorite television shows, sporting events, and other TV programs, making them available for viewing on the user's schedule. The device lets users watch their favorite programs when they want, not when some anonymous television programming executive has decided to broadcast. It's TV-on-demand that actually works.

2. How is the unit different from a VCR?

The product is different from a VCR in many ways, but one big difference is that it does not use videotape. The unit's digital storage technology provides many advantages over the limited tape format. For instance, there's no need to scramble to find a blank tape before recording, and users never have to fast forward or rewind the tape to locate a safe record space. Since storage is random-access, it can record and play two different sections of a show at the same time. So now, viewers can start watching the beginning of a recorded show while it is still being broadcast. This also allows for pause, rewind, and fast-forward of live TV shows.

3. How else does it differ from a VCR?

The product is different from the standard VCR in many other significant ways. For example, it is easy to use. Unlike the relative complexity required to set up future recordings on a VCR, the device records events and can be set-up by pushing one button on a remote control. It also has a built-in channel guide that includes personalized Replay Channels.

4. What's a Replay Channel?

The device can search its built-in channel guide and record shows based on the user's search criteria. When it does this, it creates a Replay Channel. For instance, someone could tell the device to get Clint Eastwood movies, and it would create a Clint Eastwood channel and record a new Clint Eastwood movie every time one is broadcast. The user would simply select the Clint Eastwood channel from the channel guide and begin watching the movie.

That's an example of an actor-based channel, but the product can also create theme-based channels like the cooking channel, or the home improvement channel, as well as show-based channels like the *Babylon 5* channel, the *ER* channel, or the *Frasier* channel. Replay Channels automatically manage space using sophisticated software that prevents running out of storage space.

5. So you could tell it to record Frasier *once and it would do it every week?*

Exactly. Guaranteed recording of favorite TV shows for on-demand availability is one of the product's main features. And it's easy to set up. When watching a favorite show, the user needs only press the "Record This Show" button on the remote control. A graphic requester pops up on the TV screen asking, "Record Just This Episode or Record All Episodes?" The user simply selects "Record All Episodes" (the default setting) for guaranteed recording of the favorite show. Each week, the viewer would simply tune to the *Frasier* channel and the latest episode would be waiting there. That's all there is to it. Clearly, this is much less hassle than programming a VCR to perform a weekly record session.

6. How does the product do all that?

Every ReplayTV contains the latest and most accurate information about all the TV shows that are being broadcast over the air, or on cable or satellite service. Using sophisticated search software, the unit intelligently searches this database of programming information to locate the shows it has been asked to identify. For example, let's say a viewer asked the device to create a Humphrey Bogart channel. The device would constantly scan the continuously updated channel guide information, searching for references to Humphrey Bogart. Once it identified this information in the database, the unit would automatically configure itself to record the Humphrey Bogart movie and make it available for on-demand viewing

7. How does the unit update the channel guide information?

Every unit has a built-in telephone jack that allows it to be connected to a telephone line. Every night, the unit dials into a secure server and downloads the latest channel guide information. It even resets the clock so users never have to worry about the perennial flashing 12:00.

8. How much does this cost?

The network service is free of monthly fees for the basic service.

9. What else can it do?

VCR-type controls while watching live television give the unit some useful features. If a user is watching *Frasier* at its regularly scheduled time and right in the middle of the show the telephone rings, this is not a problem. The viewer simply hits the "pause" button on the remote control and takes the call. A few minutes later, he or she can hit "play" and pick up right at the pause point. The device can play the show while it continues to record the real-time video feed, making it possible to fast-forward if the viewer wants to catch up to real-time.

10. How many shows can it store in its digital storage space?

The base unit comes with about six hours of storage space, but additional storage of up to 28 hours or more may be purchased by the owner.

11. Six hours doesn't seem like a lot... won't most people need more?

Well, more is always better, but remember, the product was not designed to be a long-term archival device. It is constantly recycling storage space as recorded shows

are watched. If the unit captures something that users would like to save permanently, they can easily off load it to a VCR.

12. *Does the company offer models with more than six hours of storage?*

Yes. Six hours is the amount of storage in the base model, but the company also offers models with higher storage capacity. Initially, the practical maximum capacity is just over 20 hours of program storage, but that will increase over time as hard drives continue to get bigger. Also, in the future, the product will offer an expansion module that connects to via the FireWire (IEEE-1394) port that will allow users to increase dramatically the number of hours of TV programming that the device can store.

Technical FAQ

1. *How does the device interface with DSS and cable boxes?*

The product interfaces with DSS and cable boxes through the use of an IR blaster. In the case of some DBS receivers, we also support direct serial data interface.

2. *What sort of hard drive does it use?*

The device uses computer hard drives that have been qualified to meet the thermal, acoustical, and mechanical requirements of a consumer electronics product. The file system is optimized for the particular application.

3. *What are the limits on repeating events?*

The device supports an unlimited number of scheduled record events, limited only by the available record space.

4. *Does the product have a skip forward 30 or 60 seconds?*

Yes. The "Quick Skip" button on the remote control that will allow you to instantly skip over unwanted material.

5. *Can the device automatically edit out commercials?*

The product records entire programs, including any commercials. During playback, the "Quick Skip" button can be used to skip the commercials. If you're archiving the show to a VCR, the commercials can be edited out manually in this way.

6. *If you stop watching a recorded program before it's over, what are the options for watching the rest of the program?*

When you stop a play back prior to the end of a show, upon restart you will be asked where you would like to resume viewing. You can choose the beginning of the show or the point where you left off.

7. *Can the device delete selected portions of shows, as well as entire shows?*

This feature won't be available in the initial product release, but is being considered for a future software release. New features can be automatically downloaded through the free network service.

8. *Can the unit manually record programs like a VCR?*

In "manual" mode, you can configure recording similar to a VCR.

9. *Does the network service include complete program listings for every geographic area?*

The service has complete listings for over 12,000 cable, DBS, and terrestrial systems in North America.

10. *Does the device keep past listings?*

This feature won't be available in the initial product release, but is being considered for a future software release.

11. *How many days of future program listings does the unit contain?*

The network service provides 7 days of future program schedule information.

12. *Can I manually program the device to record a show beyond the range of the listings?*

You can easily create a channel that will automatically find a specific program whenever it appears in the channel guide database. The device will continually search for and locate shows until you tell it to stop searching.

13. *How does it handle conflicting events?*

The device will warn you whenever you try to record a show that conflicts with a previously scheduled event, and allows you to resolve the conflict.

14. *Will the product support HDTV and AC3/Dolby Digital?*

Initially, the product will not directly support HDTV or AC3. As the broadcast media adapts these formats, the product will respond with compatible products.

15. *How good is video quality?*

The device uses the MPEG 2 compression system which allows a range of video quality settings. Compression rates are user adjustable from the default setting of 2Mbps (megabits per second) to 6Mbps. All storage times are calculated based on the default setting of 2 Mbps. At 2 Mbps, the picture quality is better than VHS tape. At 4Mbps, the quality is better than SVHS tape. Above 4Mbps, the quality approaches the level of DVD. The default rate can be easily changed by controlling on-screen menus.

Using existing electrical wiring to network computers

A new product has made it possible to network PCs and printers using existing electrical wiring. By plugging the product into ordinary electrical outlets, users can create an instant network to share an internet account, a printer, files, or multi-user games between PCs. Absolutely no additional wiring is required. The user simply connects the parallel cables from a PC or printer to the PassPort Plug-In adapter, plug into any electrical outlet in your home or office, load the software, and it's ready to operate.

Plug-in overview

Power line communication technology, which is the ability to transfer data over the power line, has existed for many years. However, the technology has not been widely adopted for data networking in homes and small businesses due to high cost, low speed, low functionality, and other existing barriers.

A new system from Intelogis, called PLUG-IN™, provides a lower priced way to connect computers and peripherals via the power line. This segment of this article discusses how this product uses the power line in comparison to other power line communication technologies.

Power line communications industry overview

In the many years that power line communication technology has existed, several technologies have gained a certain degree of success in specific markets.

This section provides a broad, descriptive backdrop of the power line communication industry. It includes a description of traditional power line technologies, followed by a discussion of the barriers that keep the existing technologies from achieving expected levels of success in applicable markets.

Traditional power line technologies

Traditional power line technologies include X-10, Intellon CEBus, Echelon LonWorks, and Adaptive Networks. Following is a brief description and a summary of the advantages and disadvantages of each technology.

X-10

Basic X-10 power line technology is almost 20 years old and was initially developed to integrate with low cost lighting and appliance control devices. X-10 originally started out as uni-directional only, however, capability has recently been added for bi-directional communication if needed. Nevertheless, the vast majority of X-10 communication remains uni-directional only.

X-10 controllers send signals over existing ac wiring to receiver modules. The X-10 modules are adapters that connect to outlets and control simple devices. X-10 power line technology transmits binary data using an Amplitude Modulation (AM) technique. To differentiate the symbols, the carrier uses the zero-voltage crossing point of the 60Hz ac sine wave on the cycle's positive or negative transition. The zero-crossing point usually has the least noise and interference from other devices on the power line. Synchronized receivers accept the carrier at each zero-crossing point.

To reduce errors, X-10 requires two zero crossings to transmit either a zero or a one. Therefore, every bit requires a full 60Hz cycle and thus the X-10 transmission rate is limited to only 60 bits per second (bps). A complete X-10 command consists of two packets with a 3 cycle gap between each packet. Each packet contains two identical messages of 11 bits (or 11 cycles) each. Therefore, a complete X-10 command consumes 47 cycles that yields a transmission time of about .8 seconds.

Cost for X-10 nodes range from about $8 for simple receiver units to $50 for a master transceiver unit, depending on the application. Although recent price reductions have made X-10 technology more affordable, the limited bandwidth and functionality of X-10 limits the technology to simple lighting, security, and appliance control applications.

The main disadvantage for legacy X-10 technology is the fact that it has very limited capability in terms of both speed and intelligence. It is a technology relegated to control applications only, due to its low data rate and rudimentary functionality.

Intellon CEBus

Intellon is a private company that produces products that conform to the CEBus standard. The CEBus standard is an open standard that provides separate physical layer specification documents for communication on power lines and other media. The technology is oriented toward providing control capabilities to home networks and consists of two fundamental components — a transceiver implementing spread spectrum technology and a micro controller to run the protocol.

Data packets are transmitted by the transceiver at about 10 Kilobits per second (Kbps), employing spread spectrum technology. Each packet contains the necessary sender and receiver addresses. The CEBus protocol uses a peer-to-peer communications model so that any node on the network has access to the media at any time. To avoid data collisions, it uses a Carrier Sense Multiple Access/Collision

Detection and Resolution (CSMA/CDCR) protocol. This Media Access Control (MAC) protocol requires a network node to wait until the line is clear, which means that no other packet is being transmitted before it can send a packet.

CEBus includes a common application language (CAL) that allows devices to communicate commands and status requests between each other using a common command syntax and vocabulary.

CAL defines various electronic device functional sub-units called contexts. For example, the audio control of a TV, a stereo, a CD Player, or VCR is a CAL context. Each context is further broken down into objects, which represent various control functions of the context, for example, volume, bass, treble, or mute functions.

Finally, objects are defined by a set of instance variables that specify the operation of the function of the object, such as the default or current setting of the volume object. By utilizing the CAL specification, Intellon ensures their chips can communicate with other CAL compliant devices.

Intellon offers products ranging from chip sets to board solutions, depending on the level of integration the manufacturer wants to perform on their own. Although Intellon chips offer more functionality than X-10, the cost of the Intellon technology has prevented it from being widely used in home consumer markets.

Echelon LonWorks

Echelon, like Intellon, provides a peer-to-peer communication protocol, implementing Carrier Sense Multiple Access (CSMA) techniques. Echelon offers a 10 Kbps power line chip based on spread spectrum technology. Echelon also offers a sophisticated proprietary MAC protocol embedded in their Neuron chip, providing the peer-to-peer networking layer.

Two versions of the Neuron chip are currently available. Both versions contain three eight-bit processors, with up to 10 Kbytes of RAM and up to 10 Kbytes of ROM. Echelon's proprietary protocol strategy changed recently when they opened up their Neuron protocol, allowing it to interface with third-party power line transceivers.

Because of the Echelon chip's extensive hardware design and the MAC layer capabilities, they are somewhat expensive for home consumer solutions. Hence, Echelon technology applications are limited to industrial/commercial solutions, rather than home applications. In fact, 30 percent of Echelon revenues come from commercial building automation systems alone, and another 30 percent is derived from industrial-oriented controls.

Adaptive networks

Like Intellon and Echelon, Adaptive offers power line chip sets based on spread spectrum technology. However, Adaptive offers both low- and high-speed chip sets, with data rates of 19.2 Kbps and 100 Kbps respectively.

Adaptive utilizes a hybrid token passing media access scheme as opposed to the peer-to-peer CSMA/CDCR schemes used by Intellon and Echelon. The hybrid token passing scheme allows network nodes to minimize unnecessary token passing in light load environments, while preserving the reliability of token passing in heavy load situations.

While the Adaptive technology offers better data rates than Echelon and Intellon, it is still less than adequate for certain high bandwidth applications, such as file sharing, print sharing, digital voice, and video transmission.

Furthermore, the Adaptive chip sets, like those previously discussed, are still too expensive to be incorporated into products targeted at the home and small office consumer.

Industry barriers to success

Even though power line technologies have been available for many years, product solutions based upon power line technologies have not been as successful in the market as originally forecast. The main reasons for the slower than anticipated growth into consumer markets is summarized as follows:

High cost: The high cost of power line components is mostly represented by the newer entries into the industry, Intellon and Echelon being the most representative of this group. These companies rely on expensive spread spectrum transmission technologies that require significant

engineering and component costs. Furthermore, their peer-to-peer networking architectures require sophisticated intelligence to reside in each network device in order to resolve network traffic contention and to manage interaction between all nodes in which each device must communicate. This forces unnecessary intelligence and cost to exist in all network nodes. Even simple nodes, such as light switches, must contain fairly complex and robust components to turn a light on and off.

Low data rates: Due the low 60 bps data rate of X-10, integration of this technology into products other than simple control applications is unlikely. In fact, 60 bps is inadequate for many control applications that require real-time response times. Even though CEBus and Echelon technologies offer data rates of 10 Kbps (over 150 times faster than X-10), they remain viable for control applications only. Data networking between computers and printers and transmitting streaming voice or video data is still out of reach for these technologies.

Low functionality: X-10 was designed with a command set oriented toward simple control functions. Unless significant redesign occurs, X-10 is not capable of more intelligent operations that will characterize future home networks. Home networks will become more sophisticated, taking on additional functional responsibilities over simple control applications. Intellon and Echelon begin to address network functionality with their MAC layer protocols, but fall short of supporting file, print, and streaming data services.

Home data networking

Traditional power line solutions are too slow to satisfy data networking needs of home or small office networks. PLUG-IN provides high speeds, together with high reliability to enable the growth market of office solutions within the home.

With PLUG-IN, data networking solutions can be developed that eliminate the need to install dedicated wiring for a small office or home office network. Instead, the building's electrical wiring serves as the network wiring and provides more than adequate bandwidth with minimal setup and configuration demands. PLUG-IN will allow any data networking device with a parallel or serial interface to connect to one another. For example, users will be able to access, manage, and share devices such as removable media drives, computers, printers, modems, cameras, etc. over the power line. With these devices connected to each other, users will be able to send files to one another, play multi-player network games, and distribute the cost of expensive modems and printers among all users on the network.

Distribution of high band width internet access

In conjunction with the solutions detailed in the home data networking category, PLUG-IN can provide distribution of high bandwidth access to the Internet or to dial-in corporate networks. As high speed cable and xDSL modems become available to consumers, they will want to access these modems from any room in the house. With a system like PLUG-IN, consumers can buy one modem and access the modem from any electrical outlet in the home.

Messages combine graphics, voice, text, and markup

Have you ever tried to explain something over the phone or with e-mail and the other person just didn't "get it?" Now imagine being able to use your voice with pictures, text, and drawings to get your point across. That's what a new software product, eTEAM, does — it lets the user quickly capture and share information in a clear, powerful, and personal message via networks, e-mail, and groupware systems.

"For engineers working in project teams spread across the country, eTEAM provides a viable technology to aid us in our communication about complex design problems," said Kim Kelley, director of Customer Support Operations for Mentor Graphics, a leading worldwide provider of electronic design software. "Imagine trying to describe to a customer over the phone which component is failing in a 100M transistor design; it's time consuming and our customers don't have time to spare. In electronic design, markets are won or lost in days. The capability of capturing design images and annotating where the exact problem occurs represents huge time savings."

This software is not just a tool for the high-tech industry, says the manufacturer. It can be used in any situation where professional collaboration takes place. The software is intuitive and natural to use — the fundamentals can be mastered in less than ten minutes. To create a communication file with this software, all a user needs is a Windows-based PC and a copy of the software.

The product works like this: If a doctor in San Francisco wants to send comments about a patient to a colleague in New York, she can display the patient's chart on her PC. Using eTEAM, she captures the image of the chart and begins recording her voice. Then, she adds a sequence of X-rays and medical diagrams, marking up the relevant parts of the images as she speaks. The result: a personalized message with synchronized images, markups, and voice that can be sent to the doctor in New York and played at his convenience. The software can store the entire conversation between the two doctors — the second doctor can reply to the original message with his own images, markups, and voice.

Need more information?

For readers who may need more information on any of the technologies described here, we provide the addresses and telephone numbers of the companies mentioned:

Replay Networks, Inc.
1003 Elwell Court
Palo Alto, CA 94303
650-968-9942
Fax: 650-969-6098
http://www.replaytv.com

Intelogis, Inc.
12257 South Business Park Drive,
Suite 108
Draper, UT 84020
801-571-4000
Fax: 801-501-7630
http://www.intelogis.com

Infocast LLC
1600 NW Compton Drive, Suite 100
Beaverton, OR 97006
503-531-2880
Fax: 503-690-1525
http://www.i-cast.net

Test Your Electronics Knowledge

By J.A. Sam Wilson

1. DSP means _____.
(Example: Conversion of analog signals into direct signals.)

2. Rise time means the time required for a step voltage to go from _____% to _____% of its final value.

3. The dc voltage that must be applied between input terminals of an amplifier to force the quiescent dc output voltage to the specified value is called _____.

4. The gain of the amplifier in Figure 1 is:
A. one (unity)
B. -1
C. zero

5. When comparing the bandwidth of two operational amplifiers, the widest bandwidth goes with the amplifier having a gain of:
A. 10^3
B. 10^2

6. Another term for stochastic is _____.

7. What is the meaning of the following: "Double the C figure and add 30?"

8. Is the following true? Cryogenics is the study of the behavior of materials or gases at a temperature of absolute zero.
A. True
B. False

9. The length of the daytime and nighttime are equal at the _____.

10. Phrone Smedge has decided to take his $200.00 inheritance to Las Vegas and parley it into a very substantial retirement fund. He decides to do that by playing the slot machines! Phrone's idea is to watch for slot machines that have not "paid off" for a long time. To him, that means they are "ready" to pay off! Eventually, using his idea, he will:
A. go broke.
B. realize a high return for his money.

(Answers on page 60)

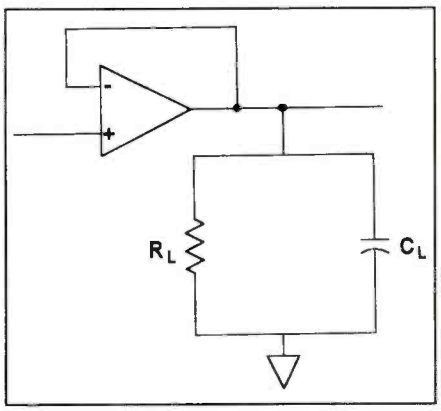


Figure 1. What is the gain of this amplifier?

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

ES&T Calendar

Western States Conference
(Regional Associations Conference)
Feb. 18–20, 1999
Queen Mary
Long Beach, CA
Bob Lunn (AZ)
Phone/Fax: 602-943-0596
E-mail: Lunncet@aol.com

1999 All Service Convention
March 10–14
Radisson Resort Parkway Hotel
Orlando, FL
Sponsoring Associations:
Professional Service
Association — PSA
Electronics Technicians
Association — ETA
Florida Electronic Service
Association — FESA
Satellite Dealers
Association — SDA ETA
604 N. Jackson, Greencastle, IN 46135
765-653-8262 • Fax: 765-653-4287
E-mail: eta@indy.tdsnet.com
Website: http://www.eta-sda.com

Tri-States Annual State Convention '99
March 11–14, 1999
Hood River Inn
Hood River, OR
Mike McCray (OR)
503-288-5356 • Fax 503.288.0359
E-mail: mmccray@cowboyz.com

Electronic Distribution Show: EDS '99
May 18–20, 1999
Educational Programs May 17th
Las Vegas Hilton Hotel
Las Vegas, NV

Electronic Distribution Show
Corporation
222 South Riverside Plaza, Suite 2160
Chicago, IL 60606
312-648-1140 • Fax: 312-648-4282
Website: http://www.edsc.org
E-mail: eds@edsc.org

National Professional Service
Convention
August 2–7, 1999
(Trade Show August 4 and 5)
Hotel Intercontinental
Dallas, TX

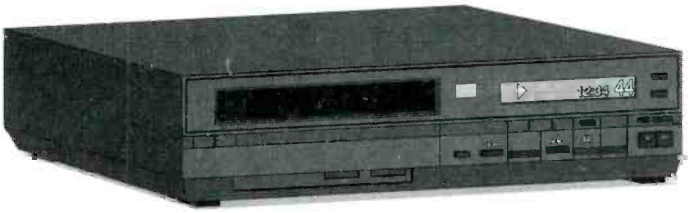
NESDA
2708 W. Berry
Fort Worth, TX 76109-2356
817-921-9061 • Fax: 817-921-3741
Website: http://www.nesda.com

PCS '99
September 22–24, 1999
New Orleans, LA
703-739-0300

Consumer Electronics Manufacturers
Association (CEMA)
2500 Wilson Blvd.
Arlington, VA 22201-3834
703-907-7600
Website: http://www.cemacity.org

VCR servicing: The history and technology of the VCR

by the ES&T Staff



This article was adapted from material on the CEMA website.

When you're servicing technologically advanced products, it frequently makes the task more interesting to be aware of how that product was introduced and how it evolved. This article recounts some of the events that took place to develop not only VCRs, but laserdisc as well.

From magnetic disc to today's hi-fi/stereo VCR, the video recording industry has come a long way. Today, millions of home theater owners have the convenience of choosing what they want to watch and deciding when they want to watch it with a hi-fi/stereo VCR or a laserdisc player.

Videodisc/videotape technology goes back to 1927 when John Logie Baird demonstrated what he called "phonovision" using waxed phonograph discs to record TV images.

The next major advance was in 1951 when the first magnetic videotape recorder was demonstrated by Bing Crosby Enterprises. Although it performed poorly, it was predicted that such a recorder would eventually allow full color, stereoscopic pictures, and sound to be recorded on one strip of tape. RCA demonstrated a color videotape recorder the following year.

While in the 1950s there may have been dreams of eventually coming up with a videotape system for the home, the market for these first machines was limited to television stations and production houses.

Development in magnetic disc recorders and home video players

Magnetic video recording was responsible for the next innovation in the broadcast market — the creation of "Instant Replay." Its use was largely limited to sports broadcasting because of its expense and the small disc capacity.

In the mid-'60s, a number of manufacturers went after the home videotape industry with no success. Among these were Sony, Ampex, Matsushita (through Panasonic), Philips, General Electric, 3M, and Bell & Howell. Prices of over $1,000 were the major obstacle, with the units consisting of a combination camera-recorder monitor.

One of the first companies to enter the home video player arena was CBS. In the late 1960s, CBS Laboratories' Dr. Peter Goldmark was responsible for perfecting a device that played film cartridges on the home television set. The system was called electronic video recorder (EVR).

While it was not widely reported, there were difficulties with EVR, including picture weave, vertical and horizontal jitter, and scratched film. In 1971, CBS decided to give up its interest in EVR.

EVR did spark a competitive reaction from CBS's rival RCA. In 1969, RCA demonstrated its holographic color television tape players. RCA was counting on low cost to sell the players, that used inexpensive film for its recordings. However, the picture quality of the device was limited. Nonetheless, consumer appetite for home video recording and viewing had been aroused, and the consumer electronics industry soon responded with new technologies and products.

Beta vs VHS

Sony introduced its first Betamax machine for the home market in 1975 for an initial price of $1,300. With this introduction, consumers had the opportunity to record their own programming and move into the world of home movies.

In 1977, Sony's monopoly ended when Japan Victor Company (JVC) introduced the VHS format video cassette recorder (VCR), that permitted consumers to record up to six hours on a single tape. RCA introduced VHS machines and were shortly joined by Panasonic (Matsushita). These machines offered a cassette format that was technically incompatible with Sony's Beta machines.

Gradually, the new VHS machines became dominant in the home VCR market. Longer recording times and increased availability of prerecorded films to consumers stimulated sales, bringing prices down from an average of more than $1,000 in the late 1970s to about a third of that amount a decade later.

By 1978, Magnetic Video was taking steps to license movies on videotape, notably an experimental deal with Fox for some 50 pictures. Today, there are more than 25,000 movies on videotape, according to the Video Software Dealers Association based in Los Angeles, California. In the mid 1980s, VHS VCRs were available with hi-fi/stereo capabilities that offered Surround Sound encoded audio tracks for use in the home setting.

Introduction of the videodisc

Magnavox introduced the videodisc in 1978. Although the videodisc player could be used for playback only, not for home recording, it cost about half of what a VCR then cost and offered a superior picture. Several incompatible formats, using either laser or nonlaser electronic technology, soon came on the market.

RCA bet on the latter approach, introducing its Selectavision in 1981. But mass marketing brought down the prices of VCRs faster than expected, wiping out the cost advantage of videodiscs. Coupled with the inability to record and price competition from VCRs, the videodisc proved fatal in the home market. However, they continued to play a role in training education and business. In 1984, RCA pulled Selectavision out of the home videodisc market.

Laserdisc players

While the VCR has achieved commodity status and near saturation, the laserdisc (LD) has had much more modest reach and penetration. Developed by Pioneer in 1978, the first widescale use of the LD was by General Motors for product training of Cadillac salespersons in showrooms. Two years later, Pioneer released the first LD player for home use in the U.S. LD players, which are largely self-contained, include discs that are more durable than videotape. Laserdiscs deliver a 60-percent better picture than conventional VHS VCRs and digital/CD quality sound.

Unlike a CD, a laserdisc holds information on both sides, either half an hour or an hour on each side, depending on how the disc was recorded. Most movies are on one disc divided into two sides. The difference between film on laserdisc and on videotape is more than the physical medium: a laserdisc is capable of 425 lines of resolution, the highest resolution offered in any National Television Standards Committee format, better than broadcast TV and almost twice as good as the VHS videotape.

Another difference between movies as presented on laserdisc versus videotape is the availability of special editions, such as discs that have extras including original movie trailers, documentaries, and other behind-the-scene information. Many directors re-edit their films, add footage, and produce versions available only as director's editions on laserdiscs. Many discs have separate audio tracks that include commentary by a film scholar or by the director while the movie plays.

There are nearly 10,000 movies available on laserdisc and almost every major Hollywood film is released on laserdisc as soon as it is released on videotape, according to Laserdisc Newsletter, published by Douglas Pratt Publishing, headquartered in Long Island, New York.

Enjoy great picture and sound on home theater

The benefits of stereo soundtrack that today's hi-fi/stereo VCRs and laserdisc players offer are best enjoyed in a home theater. Sales gains in hi-fi/stereo VCR show home theater to be one of the hottest consumer electronic product introductions of recent years. ■

Sources of replacement parts

by the ES&T Staff

There was a time in consumer electronics when the range of products was limited to TV and radio/phonograph. The circuitry in these products was relatively straightforward, and contained a relatively small number of components. Moreover, most of these products were designed and constructed using commonly available parts.

How times have changed. Now consumers can buy not only TVs and radios, but VCRs, CD players, personal computers, DVDs, and much more. And the circuits in these products are extremely complex. Many of the parts are proprietary, designed specifically for that manufacturer's products and not readily available on the general market.

Finding the right replacement part

Given the broad array of consumer electronics parts that exists today, locating the correct replacement for a faulty part, especially for a product that is either brand new, or very old, is occasionally a lot like looking for the proverbial needle in a haystack. We present the accompanying list of parts distributors with the hope that it will be of use to service centers in locating those hard-to-find parts that will help them complete those critical repairs.

Consumer electronics parts distributors

Alfa Electronics
P.O. Box 8089
Princeton, NJ 08543
609-520-2002
800-526-2532
609-520-2007

Amcom Corporation
6205 Bury Drive
Eden Prairie, MN 55346
612-949-9400
800-328-7723
612-949-9400

Ames Supply Co.
2537 Curtiss Street
Downers Grove, IL 60515
800-323-3856

Andrews Electronics
P.O. Box 914
Santa Clarita, CA 91380-9014
805-257-7700
800-289-0300
800-289-0301

Antique Automobile Radio
700 Tampa Road
Palm Harbor, FL 34683-5454
813-785-8733
800-933-4926
813-789-0283

Antique Electronic Supply
6221 South Maple Avenue
Tempe, AZ 85283-2856
602-820-5411
602-706-6789

Antique Radio Classified
P.O. Box 802-C12
Carlisle, MA 01741
508-371-0512
508-371-7129

Audio Parts Co.
1070 South Orange Drive
Los Angeles, CA 90019
213-933-2141

AudioVisual Inc. dba AVI Systems
6253 Bury Drive
Eden Prairie, MN 55346
612-949-3700
612-949-6000

Vance Baldwin Inc.
2701 W. McNab Road
Pompano Beach, FL 33069-4802
954-969-1811
800-432-8542
954-969-0226

B-B&W Electronics
2137 S. Euclid Avenue
Berwin, IL 60402
708-749-1710
800-722-9684
708-749-0325

Bi-Tronics Inc.
76 Main Street
PB Box 125
Tuckahoe, NY 10707-2904
914-961-2004
800-666-0996
800-569-4244
E-mail: Info@bi-tronics.com
<http://www.bi-tronics.com>

Blue Fin Technologies Inc.
55 Green Street
Portsmouth, NH 03801-3735
603-433-2223
603-433-6437

Bullfrog
87 Quail Street
Mahtomedi, MN 55115
612-426-0971
800-362-3192

Burks, P.I.
842 S. Seventh Avenue
Louisville, KY 40203
502-589-3960
800-274-2875
800-723-8383

Bursma Electronic Distrib.
2851 Buchanan S.W.
Grand Rapids, MI 49548
616-831-0080
800-777-2604
616-831-9400
E-mail: Vanran@iserv.net

C&S Sales
150 W. Carpenter Avenue
Wheeling, IL 60090
847-541-0710
800-292-7711
847-541-9904
E-mail: Cs_sales@elenco.com
<http://www.elenco.com/cs_sales>

Calrad Electronics
819 N. Highland Avenue
Los Angeles, CA 90038
213-465-2131
213-465-3504

Cititronix/Panson
1260 Karl Court
Wauconda, IL 60084-1094
847-487-5170
800-726-0146
800-726-0142

Computer Component Source
135 Eileen Way
Syosset, NY 11791
516-496-8727
800-356-1227
800-926-2062

Computer Parts Unlimited
5069 Maureen Lane
Moorpark, CA 93021
805-532-2500
805-532-2599

Computer Svcs of America
1050 Perimeter Road
Manchester, NH 03103
603-644-5005
800-255-7815
603-644-4645

Consolidated Electronics, Inc.
705 Watervliet Avenue
P.O. Box 20070
Dayton,OH 45420-0070
937-252-5662
800-543-3568
937-252-4066
E-mail: Scoy@dmapub.dma.org

Contact East, Inc.
335 Willow Street
North Andover, MA 01845-5995
508-682-2000
800-225-5334
508-688-7829
E-mail: Sales@contact-east.com
<http://www.contact-east.com>

CRC Components
186 University Parkway
Pomona, CA 91768
800-822-1272
800-858-4880
909-594-4761

The Current Source
5159 Glenwood
Boise, ID 83714
208-323-9692
208-323-9691

Dak Tech
4900 Ritter Road
Mechanicsburg, PA 17055
717-795-9544
800-325-3238
717-795-9420

Dak Tech
4025 9th Avenue SW
Fargo, ND 58103
701-282-6686

Dalbani Corporation
4225 NW 72nd Avenue
Miami, FL 33166-6841
305-716-1016
800-325-2264
305-594-6588

Dalco Electronics
275 South Pioneer Blvd.
Springboro, OH 45066-1180
513-743-8042
800-445-5342
513-743-9251
<http://www.dalco.com>

Datacomm Distribution
2490 Black Rock Turnpike #403
Fairfield, CT 06432
203-367-7767
203-367-7040

Digi-Key D*
701 Brooks Avenue South
P.O. Box 677
Thief River Falls, MN 56701
218-681-6674
800-344-4539
218-681-3380
E-mail: Sales@digikey.com
<http://www.digikey.com>

Diversified Parts
2114 S.E. 9th Avenue
Portland, OR 97214-4615
503-236-6140
800-379-7737
800-373-2987

East Coast Transistor
2 Marlborough Road
West Hempstead, NY 11552-1712
516-483-5742
800-645-3516
800-733-5904
E-mail: Ectd@aol.com

Echelon Industries
20681 E. Truss Court
Walnut, CA 91789
714-594-1891
714-598-3810

Eiger Electronics
70A E. Jefryn Blvd.
Deer Park, NY 11729
516-242-2583/84
516-242-2586

Electro Dynamics, Inc.
7 Oser Avenue
Hauppauge, NY 11788
516-496-4400
800-426-6423
800-873-2948
E-mail: Sales@edi-sales.com

Electronic Prod. Specialties
W140 N5084 Lilly Road
Menomonee Falls, WI 53051
414-783-6300
800-783-3337
414-783-6707

Electronic Parts Supply
4071 Emery Street
Emeryville, CA 94608
510-420-1040
800-227-0104
510-420-0812
E-mail: Mlmld@aol.com
<http://www.gen.com/wondarl>

Electronics Warehouse Corp.
1910 Coney Island Avenue
Brooklyn, NY 11230-6590
718-375-2700
800-221-0424
718-375-2796

Electronix Corp.
1 Herald Square
Fairborn, OH 45324-5155
513-878-1828
800-223-3205
513-878-1972
E-mail: Sales@electronix.com
<http://www.electronix.com>

Electronix Express
365 Blair Road
Avenel, NJ 07001-2201
908-381-8020
800-972-2225
908-381-1572

E.M.T. Parts, Inc.
2031 East Via Burton Street Suite J
Anaheim, CA 92806
714-758-8769
800-448-7892
714-758-8768

Excel Distributing
1819 Mentor Avenue
Cincinnati, OH 45212
513-531-3989
800-733-3329
800-735-8007

Fairway Electronics
4210 Howard Avenue
Kensington, MD 20895
301-564-1440

Fedco Electronics, Inc.
P.O. Box 1403
Fond Du Lac, WI 54936
414-922-6490
800-542-9761 • 414-922-6750
E-mail: Fedco@attmail

Fotronic Corporation
P.O. Box 708
Medford, MA 02155-0006
617-665-1400
800-996-3837
617-665-0780

Fox International
23600 Aurora Road
Bedford Heights, OH 44146-1712
216-439-8500
800-321-6993 • 800-445-7991
E-mail: Foxintl@aol.com
<http://www.fox-international.com>

Fox International
241A Central Avenue
Farmingdale, NY 11735
516-694-0596
800-874-1765
800-635-0595

Franks Electronics
P.O. Box 357
Glen, MS 38846
601-287-1594

R. Frazier Inc.
1300 Intervale Drive
Salem, VA 24153
703-387-3799
703-387-1180

Future Active
41 Main Street
Bolton, MA 01740
800-655-0006
800-645-2953

Galco Industrial Electronics
26010 Pinehurst Drive
Madison Heights, MI 48071-4189
810-542-9090
800-827-8902
810-542-8031

GC Electronics
A Division of GC Thorsen Co.
1801 Morgan Street
Rockford, IL 61105-1209
815-968-9661
800-443-0852
800-527-3436

GE Remarketing Services
2912 Pacific Drive
Norcross, GA 30071
404-263-5984
800-431-7671
404-263-5780

Global Micro-Parts Depot
11151 Denton Drive
Dallas, TX 75229-4707
214-241-9470
800-325-8488
800-433-2060

Harco Electronics
Rte 22 Carsins Run
Aberdeen, MD 21001
410-838-7990
800-638-7616
410-734-7288

Herman Electronics
7350 N.W. 35th Terrace
Miami, FL 33122-1241
305-477-0063
800-938-4376
800-938-4377
E-mail: Info@hermanelectronics.com
<http://hermanelectronics.com>

HMC — Hub Material Co.
33 Springdale Avenue
Canton, MA 02021-3200
617-821-1870
617-821-4133

Hosfelt Electronics, Inc.
2700 Sunset Boulevard
Steubenville, OH 43952-1158
614-264-6464
800-524-6464
614-264-5414

ICM Components
1545 Sawtelle Boulevard, Suite 21
Los Angeles, CA 90025
310-268-1005
800-748-6232 • 310-445-5003
E-mail: Icmsteve@worldnet.att.net

Industrial Elctric Supplies
2101 N. Fairview Street
Santa Ana, CA 92706
714-971-2292
800-4-HURLEY
714-971-5033

Instek Corp.
1205 John Reed Court
City of Industry, CA 91745
818-336-6537
818-369-1748
E-mail: Instek@earthlink.net

International Components Corp.
107 Maxess Road
Melville, NY 11747-3836
516-293-1500
800-645-9154
516-293-4983

Jameco Electronic Components
& Computer Products
1355 Shoreway Road
Belmont, CA 94002
415-592-8097
800-831-4242
415-592-2503

Jayso Electronics
3210 White Plains Road
Bronx, NY 10467
718-798-1050
718-655-1196

JDR Micro
1850 S. Tenth Avenue
San Jose, CA 95112
408-494-1400

W.S. Jenks & Son
1933 Montana Avenue N.E.
Washington, DC 20002
202-529-6020
202-832-3411

Jim-Pak
1355 Shoreway Road
Belmont, CA 94002
415-595-5936
415-592-2503
E-mail: Info@jameco.com

Joseph Electronics
8830 N. Milwaukee Avenue
Niles, IL 60714-1794
847-297-4200
800-323-5925 • 800-446-8366
E-mail: Joseph@shoga.wwa.com

Kelvin Electronics
10 Hub Drive
Melville, NY 11747
516-756-1750
800-535-8469
516-756-1763

Laser Products Company
1821 Macon Street
Kansas City, MO 64116
816-421-7830
800-786-8897
816-421-8053

L.J. Enterprises
11 McMillan Way
Delaware Industrial Park
Newark, DE 19713
302-369-1590
800-627-8755
302-369-1594
E-mail: Lee@ljent.com
<http://www.ljent.com/>

Marshall Industries
9320 Telstar Avenue
El Monte, CA 91731
818-307-6000

M.A.T. Electronics
400 Pike Road
Huntingdon, PA 19061
215-364-7667
800-628-1118
800-628-1005
E-mail: 7471.645@compuserve.com

MCM Electronics
650 Congress Park Drive
Dayton, OH 45459-4072
513-434-0031
800-543-4330
513-434-6959
<http://www.mcmelectronics.com>

Mendelson Electronics
340 East First Street
Dayton, OH 45402
513-461-3525
800-344-6324

Metric Supply
21029 Itasca Street, Unit C
Chatsworth, CA 91311-4924
818-701-9911
800-289-8953
818-701-6011

Micro Dimensions, Inc.
89K Washington Avenue
Natick, MA 01760
508-650-9008
508-650-9207

Montgomery Ward
National Parts Center
5750 McDermott Avenue
Berkeley, IL 60163
800-323-1965
800-215-3767

Mouser Electronics
958 N. Main Street
Mansfield, TX 76063
817-483-4422
800-346-6873
817-483-0931
E-mail: Catalog@mouser.com
<http://www.mouser.com>

National Parts Depot
31 Elkay Drive
Chester, NY 10918
914-469-4800
914-469-4855

Nationwide Electronics
1242 E. Lexington Avenue
Pomona, CA 91766-5561
909-591-5885
909-627-3391

NCS
P.O. Box 1200
Newfields, NH 03856-1200
603-773-5500
800-767-2554
603-773-9789

NEC Technologies, Inc.
1255 Michael Drive
Wood Dale, IL 60191
708-860-9500
800-366-3632

Neptune Electronics
P.O. Box 245495
Brooklyn, NY 11224-5495
800-242-5556
800-239-6349

P.K. Neuses
1401 Rohlwing Road
Rolling Meadows, IL 60008
708-253-6555
708-253-6652

Northeast Electronics Inc.
6 Wilkins Drive #207
Plainville, MA 02762
508-699-6935
508-695-9694

NTE Electronics, Inc.
44 Farrand Street
Bloomfield, NJ 07003
201-748-5089
800-631-1250 • 201-748-6224
E-mail: Maillist@nteinc.com
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Successful servicing: How to successfully market your repair business

by Anthony Morganti, Sr.

Quick, state what makes your service center stand out from all of the other service centers in your area. If you had difficulty answering that question, your service center may be headed for trouble. I speak from first hand experience. A number of years ago, a partner and I started our own repair business. I was a successful service technician and manager for a number of years and my partner was a successful entrepreneur having run a number of his own businesses for most of his adult life. We opened up in a prime location with a five-year budget and business plan, only to lose quite a bit of money and close within three years. What went wrong?

Well, many factors were involved but I believe the primary reason was that we did not have a firm marketing plan entrenched. We assumed that we would open up, do some advertising in the Yellow Pages and in the local weekly coupon newspaper, and would have all of the work that we could handle. Wrong! What we failed to do was think like a potential customer. We failed to ask ourselves why a person should bring us their faulty electronics equipment instead of to our more established competition. If we had asked ourselves this very important question, we would have seen the main flaw in our business plan.

Learn from successful businesses

Learn from the successful service businesses in your area. I'm not one to accept failure so it didn't take long for me to start thinking about opening up another service center. Obviously, part of my thought process was trying to figure out what mistakes I made in the past in order to avoid them in the future. I realized that my failed business attempt was missing a key ingredient but initially, I really did not know what it was. I decided to closely examine other service centers in my area that were successful to see if there was a common element between them that I was missing.

I quickly came to realize that the service centers in my area that were doing well were all offering something unique. One company is advertising that they specialized in the repair of Big-Screen Projection TVs. A statement to that effect is on their business cards, their Yellow Page ad, and even on the sign on their building. Another service center's specialty is fax machines. A number of years ago, the owner of this shop saw the potential of fax machine service and trained himself accordingly. He purchased any schematics he could and attended all of the manufacturer training offered. He then advertised his "specialty." Today, he is *the* shop for fax machine repair and has expanded his services to include printers, scanners, and copy machines.

Exploit what you do best

I began to think of what I could offer that would set me apart from my peers. I

Morganti is owner of an independent consumer electronics service center.

knew that I was one of a few servicers in my area that repaired car audio equipment, so I immediately knew that I would exploit that. Unfortunately, I also knew that in this area of the northeast United States, car audio repairs are a bit seasonal so I wanted to think of a second item that I could specialize in. In the past, I enjoyed working on computer monitors, found it to be highly profitable, and knew the monitor repair market was strong, so this became my second choice.

Draw up a plan and implement it

Now I had to come up with a marketing plan that exploited the fact that I was a car audio repair expert and a monitor repair expert. The first thing I did was design a business card; actually, two business cards. I had one card with my company name, address, and phone number with the statement that my company was the car audio repair experts. To dress up the card, I had a picture of a high tech looking car audio amplifier on the card. Similarly, I did another card for computer monitor repairs: Name, address, phone number, plus the statement that my company was the monitor repair experts. And of course, the card sports a colorful computer monitor logo.

OK, I had the cards, what next? Well, I had recently seen a brochure extolling the virtues of a local travel agency. I didn't think any of my competition used this advertising method so I decided that a company brochure was my next step. What I did was come up with two three-fold brochures. One for car audio repair and the other for computer monitor repair. Each respective brochure extolled my expertise in car audio repairs and computer monitor repairs. I also gave mention to my huge parts inventory and computerized tracking system that directly contribute to my shop's fast turn-around time. Additionally, I mentioned that I offer free pick up and delivery because I knew that this was something that my competition did not offer.

Now I had to sell. I used the Yellow Pages and looked up all of the stores in my area that sold car audio equipment. I either mailed them the brochures with a business card or I visited them directly. Similarly, I did the same thing with my computer monitor brochures and business cards, mailing and dropping off brochures to the computer stores and consultants in my area.

The response was overwhelming. I quickly garnered new accounts, which after time I used as references to get more accounts. My shop was still a full service electronic service center, but it had two specialties; car audio and computer monitor. Eventually, I called these "divisions." My shop had a car audio repair division and a computer monitor repair division.

The snowball rolling downhill effect

Eventually, I did not have to go out and try to attract business. It was coming to me! I had car stereo stores in other parts of the state call me because they heard that I was the car stereo repair expert. I had a large local steel plant call me to repair their monitors because I was the expert. They liked the service they received on their monitors, so they asked me to start repairing their trolley phones, two-way radios, and the circuit boards that are in the machinery throughout the plant. This became my first foray into industrial electronics and it will soon be another "division" in my repair shop.

Think of what can set you apart

The falling prices of electronic equipment and the difficulty in servicing it create an enormous challenge for today's service center. Think of what can set you apart from your competition and exploit it. Look on the horizon for emerging technologies and be the first service center in your area to service this product. A service center that stands apart from the others has a far greater chance to succeed. ■

The complete TV power supply for the novice

By Steven Jay Babbert

Many readers of this magazine possess the basic understanding of electronics and the troubleshooting skills required to repair a TV. This is especially true when the problem is in the power supply, which uses simple components that are easy to test without specialized equipment in most cases. In fact, a large percentage of TV problems can be traced to the power supply. What prevents many people from diving in is their lack of understanding of how these somewhat unconventional power supplies operate as a whole. This document will explain the basics of the modern TV power supply and outline some troubleshooting procedures. Armed with this information, readers will be able to tackle a variety of problems on their own without resorting to the "hit-and-miss" or "shotgun" method.

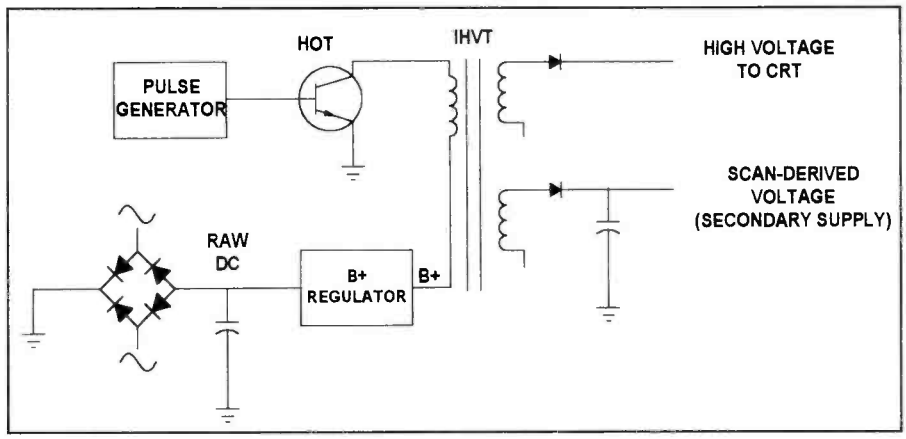


Figure 1. The typical TV power supply can be divided into two main sections: the low-voltage supply associated with the primary side of the horizontal output transformer; and the high-voltage supply associated with the secondary side. There is also a secondary low-voltage supply, which is referred to as the "scan-derived" supply.

A typical TV power supply

The typical TV power supply comprises two main sections: the low-voltage (LV) supply and the high-voltage (HV) supply (Figure 1). The LV supply is straightforward except for the fact that it does not use a transformer. In this supply, a full-wave bridge rectifies the ac line voltage directly which, after filtering, results in a raw dc voltage of around 153V. This is then regulated to between 110V and 130V, depending on the particular design. This regulated "B+" supplies the horizontal output section which, in turn, provides the HV required by the CRT, as well as the so-called "scan-derived" voltages, which supply most of the remaining sections of the TV.

There are a variety of LV regulator circuits currently being used in TV design. They range from the most basic "linear" type to the more complex switching or "chopper" types that typically use SCRs. Many of these circuits are adjustable. Some high-end TVs use a complete switching power supply instead of a simple regulator. These dc-to-dc converters typically use MOSFETs to drive a switching transformer with multiple secondary windings. In addition to the regulated B+, these supplies can provide some of the voltages that are normally scan-derived. The most common regulator in use today, however, is the five-terminal linear regulator IC, which will be used to simplify this discussion.

Babbert is an independent consumer electronics servicing technician.

Elements of the five terminal regulator

The main blocks of the five-terminal regulator are the error detector, the error amp, and the series-pass transistor (Figure 2). This IC requires a few passive components, mostly power resistors and electrolytic capacitors, to complete the circuit. The IC itself resembles a large power transistor and is mounted on a heat sink. In most cases, the value of the output voltage can be found as part of the device number. For example, an STR30125 is a fixed 125V regulator. STR is the most common prefix on these ICs.

Circuit overview

As stated earlier, the main purpose of the regulated B+ is to power the horizontal output section. The collector of the horizontal output transistor, or HOT, gets its B+ via the primary winding of the integrated high-voltage transformer, or IHVT (Figure 3). The IHVT unit contains the horizontal output or "flyback" transformer and the HV rectifier(s), as well as the focus and screen divider block. These were separate components on earlier TVs. The HOT base is driven by a pulse signal that causes it to switch on and off at a frequency of approximately 15,734kHz. This results in the generation of the so-called HOT pulse waveform in the primary that is inductively coupled to various secondary windings, where it is stepped up or down as needed.

The HOT collector load consists of the combined inductive reactance of the IHVT and the horizontal deflection yoke, as well as the capacitive reactance of the timing capacitor, Ct. These components form a tuned circuit that shapes the waveform to provide a linear scan and rapid retrace or "flyback" of the beam in the CRT. The nature of beam deflection or "scanning" will not be dealt with here; the related components are only brought up because they are part of the horizontal output section.

The IHVT

The main purpose of the IHVT is to supply the 2nd anode, focus, and screen voltages required by the CRT. These volt-

ages are derived by stepping up and rectifying the HOT pulse. The 2nd anode or "high" voltage is typically around 25kV. The focus and screen voltages are tapped from the main HV winding and can be adjusted by controls on the IHVT. They are typically around 5kV and 500V respectively. These voltages are rectified by diodes within the IHVT.

Other sections of the TV that derive power from the IHVT are the video output amplifiers (typically around 180V); the vertical output amplifier (typically around 27V); and the various signal-processing circuits and ICs (typically 12V). These "scan-derived" supplies are rectified and filtered by components external to the IHVT (in some cases voltage regulators are used as well). Finally, the IHVT supplies an ac voltage for the CRT filament. The ABL (automatic beam limiter) connection enables the video circuits to compensate for excessive brightness, which can cause defocusing due to loading of the HV.

Tuner voltages

The TV tuner requires three separate voltages in most cases. 5V and 12V sources power the components in the tuner (e.g., RF amps, mixer, oscillator, etc.) A source of around 33V is needed for the voltage synthesizer, which adjusts the voltage on the various varactor diodes for tuning. This source is often derived from the regulated B+ through the use of a zener shunt regulator. In some cases, this voltage will be scan-derived.

Horizontal drive

The horizontal drive pulses originate in the main signal processor IC where they are divided down from a master oscillator. These ICs are sometimes referred to as a "TV-chip" because they contain most of the basic TV sections (e.g., audio, video, chroma, horizontal, vertical, etc.). In most cases, the output amplifiers for each of these sections are external to the chip.

You may encounter an older model that uses a separate "countdown" IC that contains the horizontal and vertical blocks, but the function is the same. The drive pulses are applied to the base of the horizontal driver transistor where they are amplified before being coupled to the base of the HOT via the driver transformer. These pulses must be present for the horizontal output circuit to run.

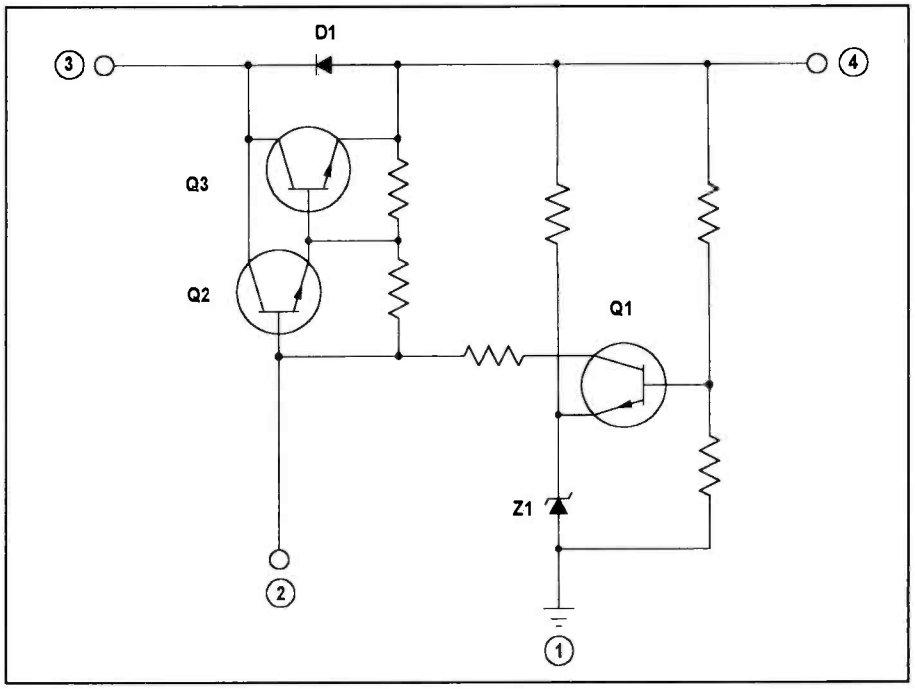


Figure 2. The five-terminal linear regulator comprises the error detector Q1, the error amp Q2, and the series-pass transistor Q3. Raw DC is applied to pin 3 and regulated B+ is available at pin 4. Z1 sets the reference for Q1 and D1 and allows any reverse current to bypass Q3. Pin 5 is unused. In actual practice, a high-wattage resistor is connected between pins 3 and 4 to take some of the load from the regulator. An external RC network at pin 2 sets the bias for Q2 and helps to provide ripple rejection.

Since the drive pulses must be present for the horizontal output section and the scan-derived power supply to run, the pulse generator must be powered from the LV supply at least until the chassis is running. The main processor has a separate supply pin for the horizontal section. In the most common "trickle start" system, this pin is connected to the regulated B+ supply through a dropping resistor.

In some chassis, a commuting diode allows the scan-derived supply to take over once the chassis has started, while providing isolation between the two supplies. The horizontal driver transistor also needs collector voltage for the chassis to start. Connection is made to the LV power supply via the primary winding of the driver transformer.

The standby supply

The system control microprocessor or "syscon" must be kept running even when the TV is off in order to accept a "power-on" command. When the set is off, the power relay contacts are open, hence there is no B+ at the output of the bridge. A standby supply consisting of a half-wave rectifier ahead of the relay provides power for the syscon (via a 5V regulator) and the relay driver circuit. Some models use a small transformer and a full-wave bridge rectifier instead of the single diode used in Figure 3.

When the syscon receives a "power-on" command, the "power" pin goes high, pulling up the base of the relay-driver transistor. This energizes the relay which, in turn, applies the ac line voltage to the bridge. *Note*: Older televisions use a conventional on-off switch in place of the relay, which will simplify the troubleshooting process.

In some models, if the chassis does not start about a second after the relay is energized, the relay drive will be lost, causing it to drop out. This is because the standby supply is not designed to power the relay continuously.

In some designs, the syscon will then attempt to start the chassis by energizing the relay again. If it does not start, the process will repeat, resulting in a "tic-tic" noise that will continue until the set is turned off. In other chassis, the relay will not drop out if the horizontal output section fails to start. Problems in these chassis are easier to pin down; with the relay energized, B+ will be present in the horizontal output section. This will be helpful when trying to locate defective components by making voltage measurements.

X-ray protection

Excessive HV can cause unsafe levels of x-ray emission from the CRT, which poses a health threat. For this reason, all modern televisions employ a fail-safe circuit that causes shut-down in the event that the HV rises above a predetermined level. These circuits function by monitoring one of the IHVT secondary voltages which track the HV; if the HV increases, all of the IHVT secondary voltages will increase. In one common design, a half-wave rectified sample of the CRT filament voltage is applied to a zener diode that is rated so that it will block current if the voltage is within tolerance.

If the voltage goes too high due to a fault, the diode will break over and conduct, triggering a block labeled shut-down, hold-down, or x-ray protect which is part of the main processor. This block will then disable the horizontal drive by shutting down the pulse generator; immediate shut-down will follow. *Note*: Shut-down is a latching function. Once it occurs, the TV will have to be turned off before the circuit will reset. The set will not automatically restart once the high voltage drops to a safe level.

A less-common fail-safe circuit

There is a less common fail-safe circuit that does not shut the chassis down in an over-voltage condition. Instead, the system is designed to force the horizontal pulse generator to run at a reduced frequency. This reduces the HV to a safe level. The frequency change will cause a loss of synchronization in the horizontal deflection circuit. This results in tearing of the picture, which resembles a horizontal hold problem. The service literature will indicate what type of fail-safe system is being used in a given model.

The "loop" nature of TV power supplies

One of the factors that complicates TV power supplies and can make them difficult to troubleshoot is their loop nature. The horizontal output section needs drive from the main processor, but in some cases the main processor needs voltage from the scan-derived supply; the relay must be energized for the chassis to start, but in some cases the relay will not stay energized unless the chassis is running properly. A problem in any part of such a loop may disable the entire system. Sometimes a signal or voltage can be substituted, or a component can be bypassed in order to get the system running. This can be helpful during troubleshooting, as will be shown below.

Common troubles

Now that we have a general idea of how the TV power supply works, let's look at a few common problems and test procedures. A symptom of no sound and no visible raster usually indicates that the horizontal output section is not running. Any sound or any raster at all indicates that HV is present; the CRT cannot produce any illumination without HV and most of the sound section will not function without the scan-derived supply. Once it is established that the power supply is down, the fault must be isolated to either the HV or LV supply.

Check the B+

A good first testpoint is the output of the B+ regulator. Assuming that the fuse is intact and the set is turned on, you should be able to measure over 100Vdc. If the B+ voltage is not over 100Vdc, then something must be open ahead of the regulator. Of course, if the relay will not energize or will not stay energized, then the driver circuit, which includes the syscon, and the relay itself will need to be examined. Do not overlook the possibility of a standby supply problem. If B+ is present at the regulator's output, then proceed to horizontal output section.

If you find higher-than-normal voltages at the output of the B+ regulator when the horizontal output section is not running, do not automatically suspect the regulator. In most cases, the regulator will not regulate unless the horizontal output section is running and drawing a substantial current. The voltage at the regulator's output and the collector of the HOT may be about the same as the raw dc at the regulator's input. This condition may lead you to suspect a shorted pass-transistor in the regulator. If the regulator is suspect, look for a low-resistance reading between the input and output pins indicating a shorted pass-transistor.

If B+ is 0V

If there is no B+ at the collectors of either the horizontal driver transistor or the HOT, check the components in their respective B+ paths. These paths can usually be traced without a schematic because the individual components are easy to spot and the connections will be as shown in Figure 3. The HOT is the largest transistor in the chassis and is mounted on a heat sink near the IHVT. A medium-sized driver transistor and a small driver transformer will be found near the HOT. Look for open resistors and transformer windings. Occasionally an open circuit trace or cold solder joint may be found. A fusible resistor is often placed ahead of the IHVT in the HOT supply line. If this resistor is open or charred, suspect a short or leakage in the HOT, the IHVT, or one of the scan-derived supply loads.

Each of the scan-derived supplies usually has a low value (typically between Ω and 5Ω) fusible resistor just after the rectifier to protect the IHVT and associated circuitry. If one of these is open, it is likely that an overload exists. These resistors may open without showing any sign of burning. In most cases, the chassis will still run if one of these supplies fails, but there will be an obvious symptom. If the vertical output supply fails, for example, there will be no vertical drive. This will be evidenced by a single horizontal line across the middle of the raster. If the 12V supply fails, however, the chassis may stall immediately after start-up. Do not confuse this with an active shut-down mode.

Faulty electrolytics

If an electrolytic filter capacitor becomes open or dried up, in most cases, there will be a visible symptom. An open capacitor in the LV supply may result in reduced B+, evidenced by a shrunken raster that is pulled in at the top, bottom, and sides. Excessive 120Hz ripple may cause a pair of horizontal "hum bars." There may also be an audio hum if the audio output amp is powered by the LV supply as they often are.

Open electrolytics in the scan-derived supply also cause visible symptoms but they will be different because of the higher frequency of the ripple (15.734kHz). These caps are easy to identify because they are located near the IHVT and typically have lower values because of the high frequencies involved. Common symptoms are low brightness or excessive brightness at one side of the raster,

or vertical "jailbars" resulting from multiple changes in brightness as the beam scans each successive line. In this case, ripple or ringing in the video amp supply line is modulating the video output amps. Observing the supply lines on the oscilloscope screen while watching the symptoms will show how the two correlate.

A dried up capacitor in the 12V power supply can cause a variety of problems due to the resulting drop in voltage or increased ripple. Since this power supply feeds a number of stages, the symptoms of the fault can be mixed. Unusual noise in the picture, halo effects, and pulling of the raster to one side are some examples. This may also apply to other low-voltage secondary supplies. Check these capacitors anytime you encounter a visible symptom that seems puzzling.

The drive waveform

If B+ is found at the collectors of the HOT and driver transistor but the set is not running, check for a drive waveform at the base of the driver. With the oscilloscope's timebase set for 10usec, look for a rectangular pulse with a frequency of approximately 15.734kHz (this will not be locked to the exact frequency when the chassis is not running). If this is present but the chassis is not running, troubleshoot the driver circuit. *Note*: If you scope or measure the collector of the HOT while the chassis is running, be sure that any equipment is rated to handle $1000V_{p-p}$; the HOT pulse amplitude can be this high.

The shape of the horizontal waveform becomes more complex as it passes through the driver circuit; this is normal and does not indicate a problem. An open bias resistor, driver transistor, or transformer winding can disable the driver circuit. A shorted turn or turns in the driver transformer will not change the resistance appreciably but can still disable the circuit. This type of fault is not common, but if you suspect that one exists, you will need to "ring" test the transformer. This also applies to IHVTs. Ring testers work by shock exciting an inductor and counting the number of ring pulses. If any turns are shorted, the number of ring pulses will be fewer than if there are no shorted turns.

If drive pulses are not present at the base of the driver transistor, check the output of the main processor IC. If no pulses are present, check the IC's horizontal

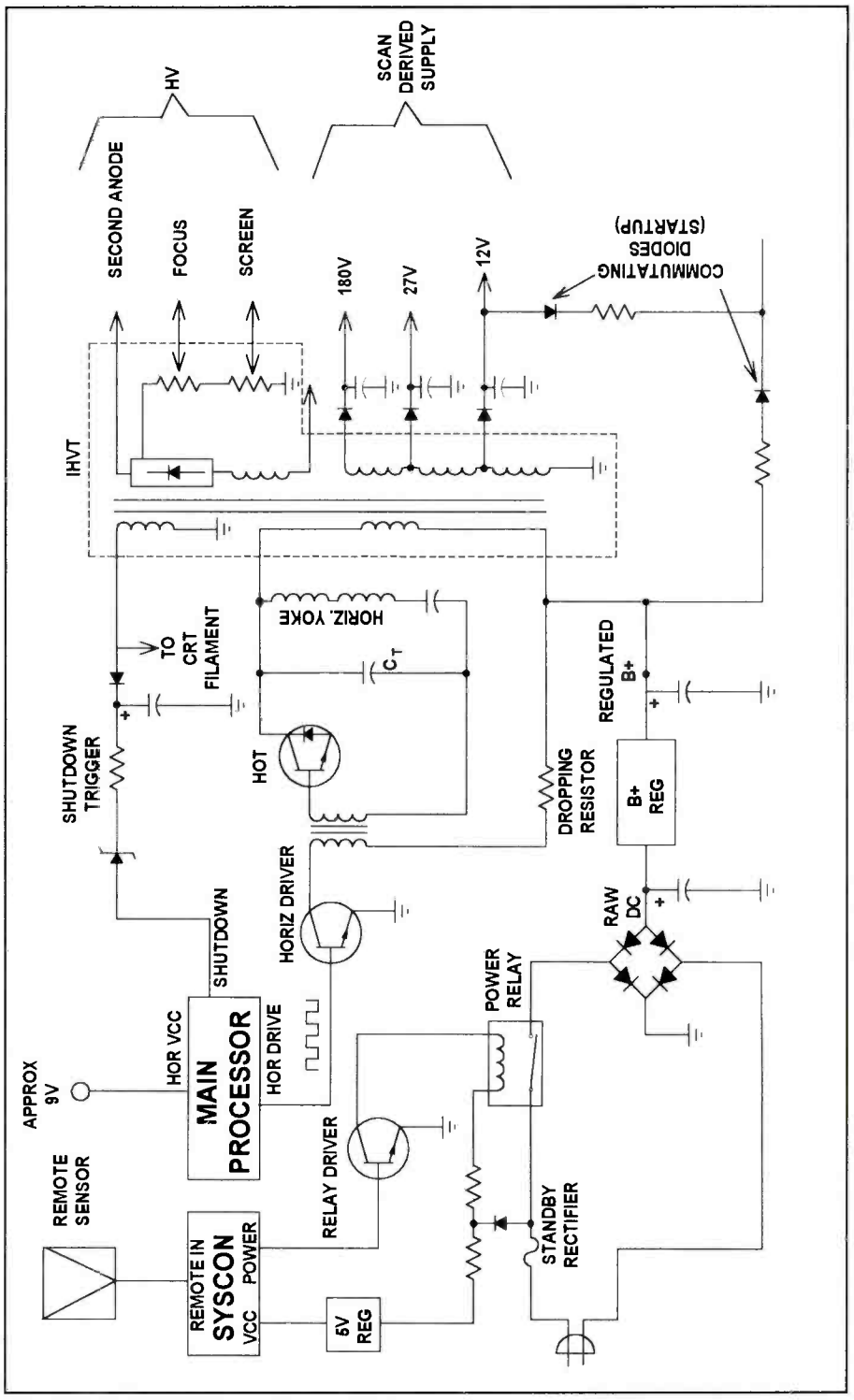


Figure 3. This figure shows an enhanced block diagram of the typical TV power supply. If a chassis uses something other than the five-terminal regulator, its connection within the rest of the system will essentially be the same. This also holds true for switching power supplies.

supply pin. This is often labeled HOR V_{CC} on the schematic. Normally, this pin will measure around 9V when the LV supply is operational. If you do not have a schematic, check for this voltage on any pin. If you find a voltage within this range, it is likely that you have located the supply pin (voltages on most other pins will not be present until the scan-derived supply is running).

If V_{CC} is present but no drive pulses are being generated, suspect the IC itself. If V_{CC} is not present, check for open components in the supply path. It may be nec-

essary to obtain a schematic diagram for the unit in this case. *Note:* Sometimes the pinout of an IC can be found in a semiconductor replacement guide.

The "kick-start" system

Some chassis employ a "kick-start" system that only applies HOR V_{CC} to the chip for a brief period during start-up. In this case, the start voltage will only be present for a fraction of a second when the set is turned on. If you suspect that you are dealing with such a system, you can use voltage substitution to test the IC. With the TV off, connect a 9V battery or an external power supply to the IC with positive to HOR V_{CC} and negative to ground. If the chassis has more than one ground, be sure to use the one associated with the IC. Pulses will be present at the horizontal drive output pin if the IC is good. In this case, the start-up circuit should be looked at.

Specialized test equipment is available that will allow a technician to inject, for example, a horizontal drive signal directly into any point of the horizontal driver section. This can be helpful in localizing a problem by noting what stages seem to be operational. Signal substitution, though, is not essential by any means. The better you understand the system as a whole, the less you will have to rely on exotic test equipment.

Fuse blowing

A blown fuse does not necessarily indicate a problem in the chassis; fuses sometimes open due to transients on the power line or from thermal fatigue due to repeated cycling. A repeated fuse-blowing symptom, however, indicates a short or leakage to ground. The most likely cause of such an overload is a defective HOT. Look for a low-resistance reading from collector to emitter. This can usually be checked while the transistor is in the circuit. If a short or leakage is found, remove the HOT and test it again to be sure that a parallel component is not actually at fault.

The emitter-base junction of the HOT will normally appear shorted when tested in-circuit for a front-to-back resistance ratio. This is because of the low resistance of the driver transformer secondary that is connected across the junction. In most cases, this winding will not affect tests performed with a transistor tester.

Note that the HOT contains an internal damper diode in nearly all TVs made within the last ten years. Its purpose is to shunt reverse currents around the transistor during a portion of the horizontal cycle. This diode can be tested like any standard diode using the diode test function of a DMM or by measuring the resistance ratio. In addition to the damper diode, the HOT often contains a resistor between the base and emitter. This may appear as a short, even when the transistor is out of the circuit. If you measure between 40Ω and 50Ω in both directions, then it is safe to assume that you are measuring the value of this resistor and not a short or leakage. Replacement guides will give the internal breakdown of any transistor in question.

If the HOT is shorted

Once you determine that the HOT is shorted, you will have to find the cause. While these transistors do occasionally fail for no apparent reason, in most cases they fail as a result of a short or leakage in the IHVT.

If the IHVT shows signs of burning or arcing, then it will have to be replaced. If not, then resistance measurements will need to be made to look for shorts between windings or between a winding and ground. In this case, a schematic may be needed. Bear in mind that some windings have a connection to ground and will normally show a short to ground.

The primary winding that connects the B+ regulator to the HOT will never show a short to ground in a good IHVT. If you suspect a primary-to-ground short, be sure to eliminate any possibility that the short is actually in another parallel component or circuit path.

IHVT problems

If after replacing the HOT it runs too warm or fails, it is possible that the IHVT has one or more shorted turns or is being excessively loaded by one of the secondary (scan-derived) supply loads. Testing for shorted turns will require a ring tester. As for the secondary loads, look for any low-resistance paths to ground at each pin of the IHVT that is associated with a secondary supply. Lifting component legs and jumpers will be helpful in isolating these kinds of problems. A shorted diode or leaky filter capacitor can load the IHVT, or loading can be caused by a defective component or IC in any of the sections powered by the scan supply. In most cases, this type of loading will blow a fuse or open a resistor before it will destroy the HOT, the IHVT, or B+ regulator.

When replacing a shorted HOT and/or IHVT, be sure to check any components in the LV supply that might have been stressed before the fuse blew. It is not uncommon to find a shorted regulator or diode in the bridge rectifier in a chassis with a shorted HOT. A shorted regulator generally results in excessive (unregulated) B+ which, in turn, causes excessive HV. This usually leads to an HV shutdown condition. Always be sure to replace any insulators and reapply heat sink compound if used.

Focus and screen voltage problems

Focus and screen voltage troubles can result from an IHVT problem, such as an open control or voltage divider. Poor focus will result if the focus voltage is too high or too low. This problem can also be caused by a detached focus element in the CRT. Screen voltage problems range from a dark screen (voltage too low) to an excessively bright screen (voltage too high) with visible "retrace" lines. These lines, which are normally blanked, will be evenly spaced from the top to the bottom of the raster. This type of symptom can also be caused by problems in the blanker circuit, which is beyond the scope of this discussion. Always check the setting of the adjustments first if you encounter either of these problems.

There are HV probes available for directly measuring the CRT's 2nd anode voltage. There are also adapters that will extend the range of a DMM for HV measurement. However, it is rarely necessary to measure the HV on newer TVs that employ fail-safe circuitry. By placing your hand on the face of the CRT, you should be able to feel a static charge as the HV comes up when the set is turned on. You may also be able to hear a "crackle" as the CRT charges.

Sound but no raster

If a set has sound but no raster, look at the CRT filament. If it is not lit, check for an open resistor, an open IHVT winding, or an open condition in the filament itself.

If the filament is lit, you might suspect a loss of HV. In fact, it is possible to lose HV even though the secondary supply is operational. A bad HV diode, for example, could cause this problem, but it is rare. If the filament is lit, then HV is probably present and you should consider some of the possible causes outlined above.

Most connections to the IHVT are made through the mounting pins. The HV, focus, and screen connections are made through wires that are part of the IHVT. The HV lead connects to the bell of the CRT. This is where any HV measurement is made. The focus lead connects directly to the CRT socket, which is mounted on the CRT driver board. The screen lead is soldered directly to the driver board (the driver board holds the video output amps).

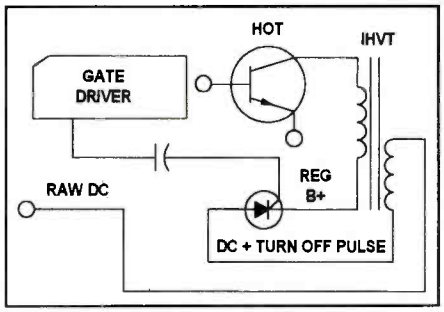


Figure 4. The B+ path is different in any chassis using an SCR "chopper" regulator. In these designs, the raw dc is passed through a separate winding on the IHVT before being applied to the regulator's input. An inverted HOT pulse is impressed on the dc to turn the SCR off at the appropriate point during each horizontal cycle. The SCR is driven by a gate-driver IC and regulation is achieved through pulse-width modulation. The regulator's output is applied to the IHVT primary as always.

Shutdown

When a TV powers up for about a second and then immediately shuts down, there is a good chance that it is in an HV shutdown mode. In nearly all cases, this is the result of a shorted or misadjusted regulator. Component aging can cause changes in value, which can sometimes be compensated for by readjustment. There can be situations in which the HV increases due to a problem in the HOT's collector load circuit. This is a tuned circuit and changes in component values can alter the "Q" of the circuit. C_t, for example, can lose value, which will raise the Q increasing the amplitude of the HV pulse. In most cases, however, excessive HV results from a shorted regulator.

Excessive HV

If you suspect such a fault, use a variable transformer (sometimes referred to as a "Variac") to lower the line voltage to around 80V. This input voltage will reduce the B+ to the point where the set should run without shutting down, even with a shorted regulator. If it runs, then replacement of the regulator should solve the problem. If the chassis still shuts down even with reduced line voltage, it is likely that some other problem exists (a shutdown-like condition may result from a serious overload in any circuit).

Most service literature will outline a procedure for defeating the shutdown circuit in order to help isolate a problem. With a design as shown in Figure 3, the circuit can be defeated simply by lifting one leg of the zener diode. It is advisable to do this with reduced line voltage. Be sure to restore the circuit to its original condition after troubleshooting.

The relay can also cause symptoms ranging from a "dead" set to intermittent operation. An open coil will disable the relay completely. This type of fault can be easily found with a continuity test. Pitted or oxidized contacts can cause a chassis to run seemingly with a will of its own. Once the TV is turned on, it might turn itself off and then back on again with no apparent pattern. The "click" when the relay drops in will only be heard when the power is first applied. The making and breaking of a solid connection between the contacts is the problem in this case. The contacts of a suspect relay can be temporarily bypassed in order to see if the chassis will run. If it does, then the problem must be in the relay-driver circuit, the syscon, or the relay itself.

Safety precautions

Because TV chassis contain a high-voltage section, it is important that you take all of the necessary precautions during servicing. Since most TVs are not isolated from ground, additional precautions must be taken. A non-isolated or "hot" ground will typically measure about 60Vac with respect to earth ground. Always power the TV from an isolation transformer before connecting any grounded test equipment to avoid a ground fault which can cause serious damage to the TV and/or test equipment. Note that variable transformers typically use an autotransformer type winding (i.e., the primary and secondary are part of the same winding) and do not provide isolation.

It is always a good idea to power the set being tested through an isolation transformer. In any event, it is a good idea to keep one hand in your pocket while the other is in the TV. This will keep you from forming a complete circuit with your body by accidentally touching two points in the set that are at different voltages. Always discharge the CRT before you begin troubleshooting. First, ground a thin-blade screwdriver to the chassis ground with a clip lead then insert the blade under the insulating boot on the second anode connection on the bell of the CRT. Make sure that the blade actually makes contact with the metal of the connector.

Obtaining parts and service literature

Howard W. Sams publishes "Sams Photofact" folders for most TVs. These contain the complete schematic diagram, as well as other useful troubleshooting information. Individual Photofact numbers can be found in the Sams Annual Index by looking up the make and model number, or by calling a toll-free number.

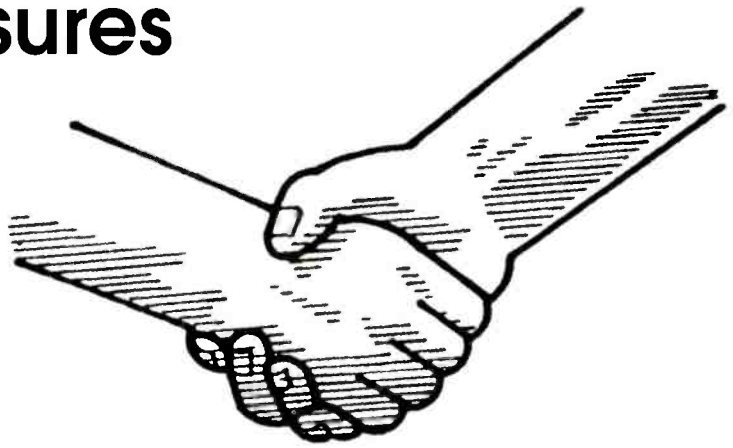
Most common TV parts, including discreet components, ICs, and IHVTs, can be found in mail-order catalogs from the manufacturer or distributors. If you need a part with an unlisted number, you may be able to find a cross-reference equivalent in a semiconductor replacement guide (see ECG, SK, NTE, etc.) or consult the service literature for a manufacturer's exact replacement number.

Summary

There are many variations of the basic TV power supply design presented here; relay drivers may use a darlington configuration instead of a single transistor; different types of start-up and fail-safe circuits may be employed; scan supplies may have other voltages besides the most common ones shown in Figure 3. This is especially true for high-end TVs that have a larger number of sections to power. However, virtually all modern TV chassis conform to this basic design to a large degree. Once it is comprehended, you should be able understand any variations when you encounter them. ■

Counter measures

by Bill Weiss, CET



"Where's my remote?" your customer asks, eyeing their completed VCR on your counter. Your best entrepreneurial smile melts as your invoice's Accessories field appears empty.

Even experienced servicers sometimes lose accessories, miss preexisting cabinet damage, forget to list symptoms or collected diagnostic fees. Unfortunately, lax attention during product log-in carves deeply into profits. Worse, it's harmful to customer confidence.

Four reasons for good customer care

A recent study by international consultants Bain & Co. spotlights four reasons for good customer care:

- Acquiring customers costs five to ten times as much as servicing existing ones.
- Repeat customers almost always increase their average purchases.
- Loyal customers are more willing to pay a premium for products and services.
- Repeat customers are more inclined to refer other people to a business.

Consider also the Better Business Bureau's caution that dissatisfied customers typically tell seven to nine people about negative experiences.

Let's see — You spend ten times more attracting new clients; mishandled clients tell nine others. Ten times nine . . . A mishandled customer costs you 90 times (in lost opportunities) what proper handling would have cost. Ouch!

Here are some front counter procedures you can institute that will make customer satisfaction as simple as ABC.

Assess

A keen eye during log-in helps eliminate problems, such as lost accessories and other profit eaters.

- *Logging accessories:* Itemize all accessories. If there's a remote, list whether it has batteries. List chargers, dc adapters, ac cords, cables, tapes, everything. Also note the physical condition of damaged or worn accessories.

In cases where accessories are not presented but will be needed for test, politely explain that although you carry an extensive inventory, there's no way to have each of the thousands of accessories available at all times. Recommend the easiest way(s) to get it to you — night drop slot, early or late business hours, courier.

Place your job number on each accessory. Inexpensive one-up computer labels, whether printed or hand-written, work great. And make sure accessories appear on client's claim check or on their copy of the repair order given at carry in. Go over the accessories list with the client and have them sign it.

Attach accessories to logged product with packing tape or store everything together in a box.

- *Physical damage:* Examine every exterior surface of every repair. One way to insure that it's done right every time is to have simple check sheets available at the counter. This can be part of your form or computer file, or it can be a separate sheet. Examine all six surfaces: top, left, right, front, back, even the bottom. Check each category, noting any mars or other damage. The "bottom" category lets you note missing foot pads, screws, bottom plates, or any dents. Point out damage to the customer as you find it. Provide a copy of your damage report to your client and technician. Your technician can use the report during initial evaluation.

When repairs arrive via courier, examine all cartons for damage. Have courier sign-off on any damaged cartons, or refuse to accept them. Time permitting, ask the courier to wait while you open and inspect package contents.

- *Targeting symptoms:* Always ask, "What problems are you having?" Note the plural "problems." This opens the door for anything and everything they've noticed. Note each problem in as much detail as possible. If your computer or paper forms don't allow you to enter detailed failure modes, jot notes and attach them to the product to help technicians target problems.

Follow up with "Have you experienced any other problems?" You'll be surprised how many forgotten failures will spring to mind. Additional problems spell additional service dollars.

- *Pinpoint the cause:* Always ask how the product failed. "When did the problem start?" "Under what circumstances?" "How frequently?" This is where you discover it was dropped off a moving van or doused with champagne. For intermittents problems, ask how often and in what modes the problems occur?
- *Urgency:* Ask when the product is needed. This helps determine priority.

Build

Whether you call it building customer trust or profits, the two should be inextricably bound at your front counter. Here are a few simple business building tools.

- *Additional needs:* Always ask whether clients have additional needs. Perhaps there's another set that needs home service, or they're interested in accessories.
- *Loaner:* For higher ticket repairs, make loaners available (for fee or deposit). When loaners are not needed, at least you've shown you care. And offering to apply deposits or loaner fees to repairs can yield substantially lower (more acceptable) repair balances.
- *Delivery:* Ask whether clients would like completed repairs delivered. Have a list of delivery rates available. This is especially appreciated with larger products or during severe weather.
- *Training:* Offer for-fee training to

Weiss is owner of an independent consumer electronics service center.

your customers on complex products, such as computers and camcorders.

• *Priority service:* If fast turn-around is essential, offer priority or next-day service for an additional fee.

Communicate

Proper communication during log-in can save loads of wasted phone time.

• *Rates:* Post a sign that provides detail of all standard rates and diagnostic fees. Explain these rates as you log each repair. Do it *every* time.

• *Dates:* Clarify approximately how long repairs will take. Note log-in and estimated completion dates on claim checks or service invoices. A front counter calendar aids explanation.

• *Hours:* Post hours on your door and behind your counter. Recite your hours as you close your log-in process.

• *Contact information:* Get the name(s) and phone number(s) of people to contact for approvals and completions. For work phones, note full name and extensions. And don't forget to ask about E-mail addresses. E-mail can help you expedite approvals and pickups.

• *Claim checks:* Informative claim checks can save hours of wasted phone time. Two-sided claim checks work best. Well designed claim checks should include the following:

• Your name, address, phone, fax, E-mail and hours (to eliminate nuisance information calls)

• Job number (for quick reference and easy identification)

• Date in and expected completion (to provide at-a-glance time frame)

• Client's name (added identification and to allow you to call client by name during pickup)

• Product make, model, and serial number (lets client know that the correct unit has been returned to them)

• Symptom (lets client know the right problem is addressed)

• Collected front fees (establishes what was paid and when)

• Accessories (reminds staff and client about what was left with unit)

Demonstrate

A little time spent in customer education can sharply decrease reservice and build customer confidence.

• *Operator error:* When operator error is likely, check operation during log-in. Remember, telling clients about operator error after the fact leads to embarrassment and mistrust. Better to prove yourself trustworthy and build future business. And if your demonstration proves customer error, remember to ask whether they'd like a cleaning.

• *Install and demo accessories:* Install purchased accessories (batteries, antennas, etc.) and show that they work.

• *Hook-up instruction:* Provide and explain hook-up instructions. Have printed diagrams available.

• *Handouts:* Hand out brochures with helpful hints on product use. Include news about services you offer.

• *Preventive how-tos:* When VCRs or disc-based products suffer a media jam, have a tape of disc on hand to show clients proper insertion and handling to minimize future problems.

Entertain

Popular TV food critic James Ward calls restaurant atmosphere circuses. These intangibles enhance the dining experience and justify fatter tabs. They can do the same for your service center.

• *Greeting:* Greet everyone who walks in your door with a smile and kind word. Mail carriers, UPS and FedEx drivers, folks looking for directions — everyone may be a future client.

• *Anecdotes and humor:* Use anecdotes to diffuse complaints. Here's one I use to short circuit complaints on the cost of adjustment or cleaning only repairs: Years ago, a plumber came to repair my weak shower head. A sharp rap on a pipe restored a healthy spray, after which the plumber presented his $45 bill. When I asked "What? Forty-five dollars for tapping on a pipe?" He replied, "No, $45 for knowing where to tap."

This story (every bit of it true) serves two purposes: its humor disarms anger; its truth paves the way to explain that constant education, which is costly in terms of both time and money, lets you maintain your technological edge — education that teaches you where to tap.

• *Compliments:* Compliment your client's product choice, and how well it is taken care of. This minimizes doubts about whether repair or replacement is best. Let them know their decision to seek preventive maintenance is the *right* choice.

• *Visual aids:* Keep sample PC boards, motors, and other components at your counter to help demonstrate work done. For years, one servicer I know kept a melted TV (damaged in a fire) in the lobby area of his store. On top sat a sign that read: "Do it yourself and save!" This little eye catcher not only led to some lively (friend-building) conversation, but highlighted a big reason to leave service to professionals.

• *Freebies:* Offer free tapes with VCR repairs. Give away pens, key fobs, or refrigerator magnets that keep your name in front of the client. Dollar off coupons toward future repairs or cleanings assure future business.

Whether your front counter is a simple shop cart or a sprawling colossus swarming with POP displays, it's the most valuable bit of real estate in your store. Defend it well. Minimize casualties. ■

Voltage, the difference

by Al Schamel

Whether aware of it or not, a person using an oscilloscope to make any voltage measurement is actually making a differential voltage measurement. By definition, voltage is the measure of the difference of electric potential between two points. The concept of voltage being the difference of potential between two points is easily understood by a person using a voltmeter. One cannot measure a voltage using only one voltmeter lead. The other lead needs to be connected in order to provide a reference point. When using a scope, we sometimes forget that the signal displayed on the scope is not simply the "signal at that point." It is actually the signal voltage at that point as it differs from some other point.

"Ground" referenced measurements

This other point is usually the circuit's ground, which is assumed to be 0V. For an example, let's assume we wish to use a scope to measure the voltage (referenced to ground) at the emitter of the transistor in Figure 1. This may appear to be a simple circuit, but by referring to Figure 2 we can see how complex the actual signal measurement environment can become when we include the scope probe and the ground connections between the scope and the circuit. V_{A-B} represents the transistor emitter voltage waveform that we wish to display on the scope. $Z_{CIRCUIT}$ is the resistance of the emitter-connected resistor R_1 in parallel with the emitter impedance of the transistor. We will assign a point as an *ideal earth ground* in the circuit so we have a solid point of reference. $Z_{SCOPE\ GND}$ is the impedance of the scope's power cord ground lead. Z_{COMMON} is the impedance between the circuit common and the ideal earth ground point. The value i_{COMMON} represents currents (ground loop) flowing through Z_{COMMON} from other sources, such as other instruments connected to the circuit under test and results in V_{COMMON}.

Schamel is employed by LeCroy Corporation.

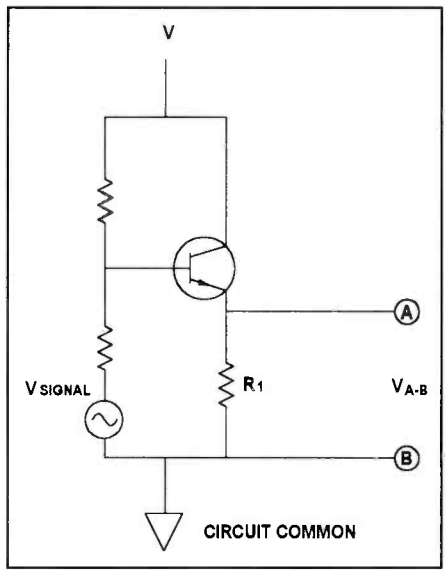


Figure 1. Observing the waveform at the output of this transistor circuit seems to be a simple proposition. But is it?

What the scope actually displays on screen is a voltage waveform that appears as the difference between the voltage at the center conductor of its input connector and the connector's ground or V_{C-G}. In most cases, the displayed waveform, V_{C-G}, is fairly representative of the signal at the probe tip, V_{A-B}. By examining the various elements of the circuit in Figure 2, we can understand how and why V_{C-G} may differ from V_{A-B}.

To begin with, if the values of i_{COMMON}, Z_{COMMON}, and $Z_{SCOPE\ GND}$ were zero, we would not need to use the probe's ground lead, since there could be no voltage difference between the circuit common and the scope's ground. They are not zero, so we must try to shunt their effects by adding a ground connection at the probe. While the probe's ground lead shunts the effects of i_{COMMON}, Z_{COMMON}, and $Z_{SCOPE\ GND}$, it does have some resistance and inductance of its own. This impedance, which we will call $Z_{GND\ LEAD}$, depends on the ground lead's length.

Current flow changes things

Some current must flow out of the circuit under test and into the scope's input in order to develop a voltage waveform within the scope for it to measure. The signal current flowing through the impedance of the probe ground lead, $Z_{GND\ LEAD}$, causes a voltage drop that makes V_{C-G} differ from V_{A-B}. To illustrate this effect, Figure 3 shows a square wave measured with a scope and a compensated standard scope probe. The first waveform measurement is taken using a probe tip adapter that minimizes the length of the ground connection. The second and third waveforms are taken with the same equipment, but using 15cm (6-inch) and 45cm (18-inch) ground leads on the probe. In many measurements, the signal corruption caused by the ground lead impedance may be acceptable, but it is important to know that it is present.

Again referring to Figure 2, as I_{COMMON} flows through Z_{COMMON}, it develops a voltage we have chosen to call V_{COMMON}. If the scope probe is not connected, V_{COMMON} will appear as a voltage that is common to both points A and B. The voltage waveform at either of these points with respect to the ideal earth ground will include V_{COMMON}. Point B will equal V_{COMMON}, and point A will be $V_{A-B} + V_{COMMON}$. By applying the scope probe ground lead to point B, we can reduce, but not eliminate, V_{COMMON} from the measurement. The reason we cannot eliminate V_{COMMON} is because of the finite value of $Z_{GNDLEAD}$.

$Z_{GNDLEAD}$, Z_{COMMON}, and $Z_{SCOPE\ GND}$ form a loop through which i_{COMMON} flows. The voltages caused by i_{COMMON} flowing in the loop will further corrupt the waveform V_{C-G}.

Non-ground-referenced measurements

The effect of i_{COMMON} can usually be reduced by opening the safety ground on the scope. Depending on the magnitude of V_{COMMON}, this can be very hazardous, and under no circumstances is it recommended. Opening the safety ground lead

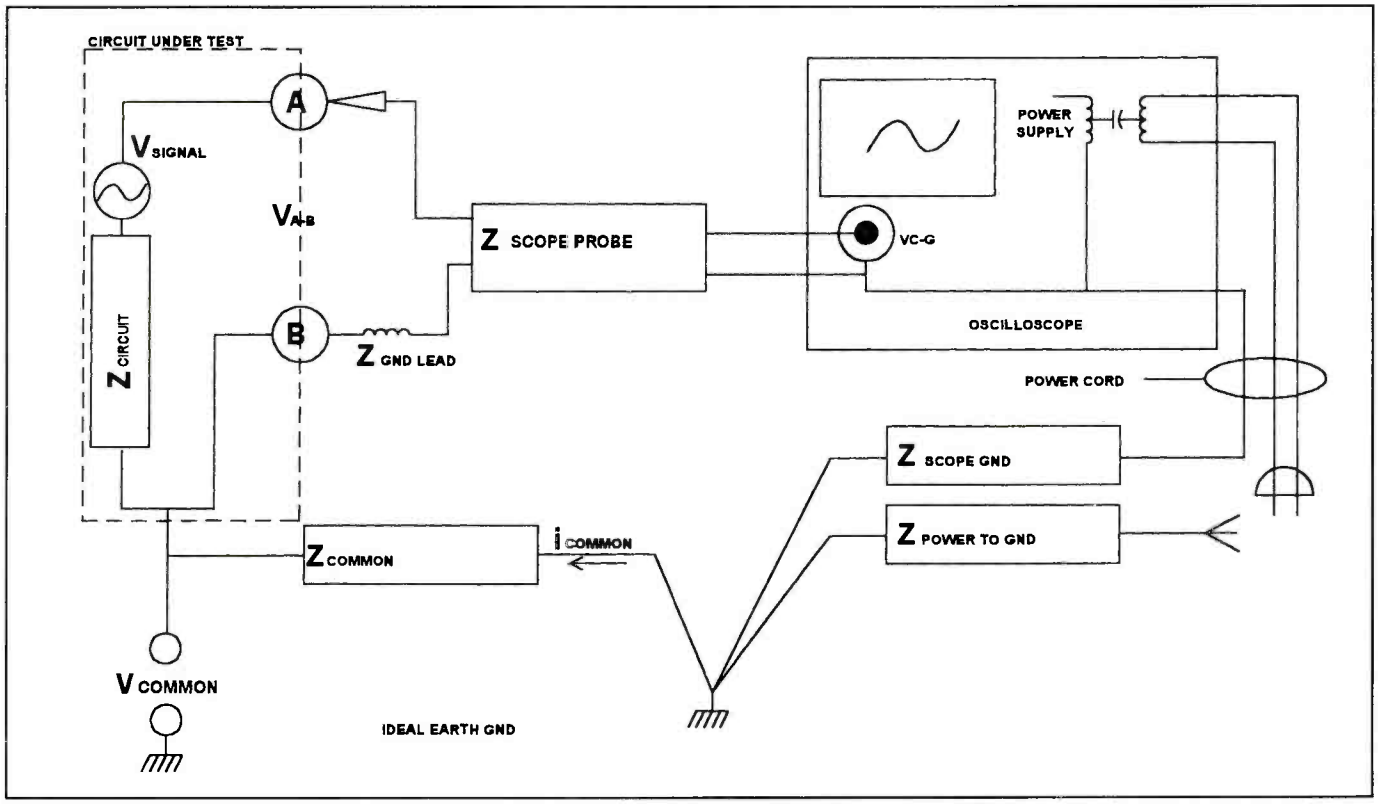


Figure 2. The actual complexity of the signal measurement environment of the circuit of Figure 1 becomes apparent when the effects of the scope probe and ground connections are added to the circuit diagram.

of the scope does not fully eliminate the flow of i_{COMMON} through $Z_{GND\ LEAD}$, since $Z_{SCOPE\ GND}$ is in parallel with a complex impedance formed by the scope's power transformer inter-winding capacitance in series with the impedance of the power system, $Z_{POWER\ TO\ GND}$.

The model of V_{COMMON} we have used can also explain measurement constraints that we usually think of when we are making "floating" measurements. Let's assume that V_{COMMON} is the output of a low impedance voltage source, such as the power line, rather than a small voltage resulting from ground loop current. We can see that connecting the probe ground lead to point B could cause a destructive level of i_{COMMON} to flow. This is the case when trying to measure voltages in a "floating" power supply control circuit, where V_{COMMON} is the power line voltage.

Even if the practice of floating the scope by opening the safety ground lead weren't hazardous, the measurement is still corrupted by the effects of the flow of i_{COMMON} through the scope's power transformer inter-winding capacitance and the power line impedance. Also, the flow of signal current through $Z_{GND\text{-}LEAD}$ will contribute the same signal corruption as it did in our earlier ground referenced measurement example.

Another, somewhat unrelated, point: the practice of floating the chassis of a scope to line level voltages may place more voltage between the scope's power transformer primary and secondary windings than it was designed to handle and could possibly damage the scope.

Differential voltage measurements

One can greatly reduce these corruptive measurement effects by using a scope or a preamplifier that has differential measurement capability. Figure 4 shows our equivalent circuit with the same ground referenced scope and a differential preamplifier.

An ideal differential amplifier will only amplify the difference it sees at its + and - inputs. In this respect, it is very similar to the voltmeter, where we probe two points to find the voltage difference between them. As the differential amplifier amplifies the difference between the two points, it rejects any voltage that is common to both points. Since V_{COMMON} appears at both points A and B in our circuit, the differential amplifier rejects it and presents the scope with the difference between points A and B, which is $V_{A\text{-}B}$.

$$(V_{A\text{-}B} + V_{COMMON}) - (V_{COMMON}) = V_{A\text{-}B}$$

The loop current effects of V_{COMMON} are also greatly reduced because the high impedance of the probes prevents V_{COMMON} from generating an appreciable amount of current into the scope ground. Since the probe ground clip is not connected to Point B, the effects of $Z_{GND\ LEAD}$ are eliminated. For all of these reasons, $V_{C\text{-}G}$ is much more representative of $V_{A\text{-}B}$ than was possible when the scope probe ground lead was used to provide the minus reference.

Since a differential amplifier equipped with properly designed probes can reject common voltages of relatively high magnitude, there is no need to float the scope to an unsafe level in order to make good quality measurements.

Common mode rejection ratio or CMRR

We have been discussing the benefits of using an ideal differential amplifier to make voltage waveform measurements.

PHOTOFACTS

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G3S-55310 4097
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PC-25R80 4099
PC-5531 4097
PC-5531U 4097

FUNAI
F4813T 4094

HITACHI
M3LXU 4101
27CX25B 4101

JVC
AV-20920 4098
AV-20921 4098
AV-32920 4092
C-20910 4098

MAGNAVOX
VRT342AT21 ..... VCR-306
VRT344AT21 ..... VCR-306
VRT642AT01 ..... VCR-306

PANASONIC
AEDP305 4103
AEDP323 4091
AMEDP305 4103
CT-27SF25W 4091
CT-27XF25CW 4091
CT-32G3UW 4103
CT-32G3W 4103
CT-32G13CW 4103
CT-32G13UW 4103
CT-32G13W 4103

PHILIPS/MAGNAVOX
TP3669C1 4095

SANYO
AVM-1308C 4093
AVM-1308G 4093
AVM-1308S 4093
AVM-1338C 4093
DS13380 4093
DS25730 4100
G6F-1308C0 4093
G6F-1308G0 4093
G6F-1308S0 4093
G6F-1338C0 4093
13380-00 4093
25730-00 4100
25730-01 4100

SONY
KV-20S40 4096
KV-20S41 4096
KV-21SB40C 4096
KV-21SB40M 4096
KV-21SB40P 4096
KV-21SE40 4096
KV-21SE40A 4096
KV-21SE40C 4096
SCC-S01B-A 4096
SCC-S01C-A 4096
SCC-S02A-A 4096
SCC-S03A-A 4096
SCC-S03L-A 4096
SCC-S04A-A 4096
SCC-S04C-A 4096
SCC-S04D-A 4096
SCC-S04H-A 4096
SCC-S04J-A 4096

ZENITH
A19A11D 4102
LGA20A11DM 4102

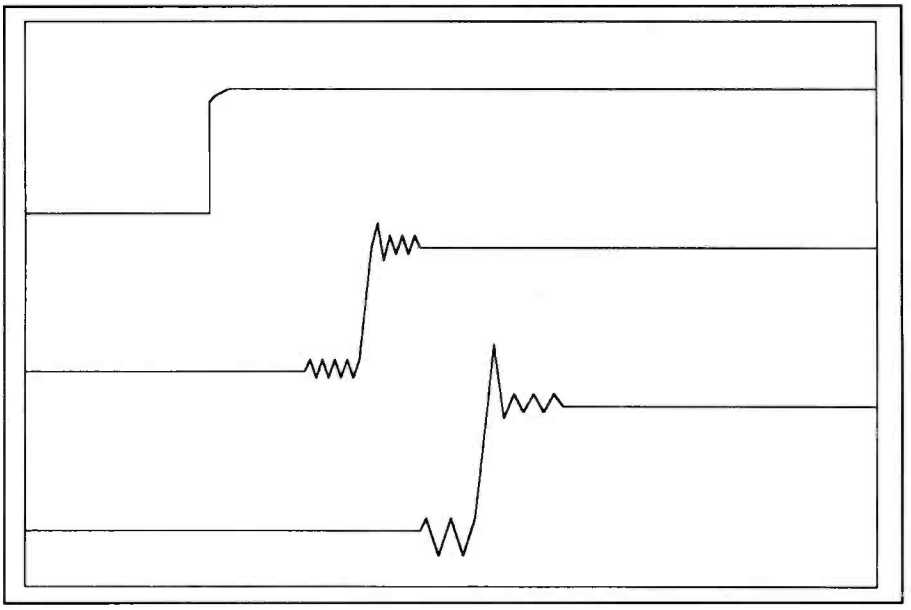


Figure 3. Here are three different views of a square wave measured with a scope and a compensated standard scope probe. The top waveform was taken using a probe tip adaptor that minimizes the length of the ground connection. The second waveform was taken with the same equipment, but using 15cm (six inch) leads on the probe. The third waveform was taken with the same equipment, but using 45cm (18 inch) leads on the probe.

Unfortunately, the ideal differential amplifier does not exist, so we need to understand some of its characteristics and limitations. By again referring to Figure 4, we can see that the differential amplifier deals with two voltage waveforms; one we want to see and one we don't. We can call these differential mode (the difference between point A and point B), and common mode (that which is common to both point A and B) waveforms. The waveform we want to see is the differential mode signal, V_{A-B}. All of the characteristics of a single-ended amplifier, such as gain and bandwidth, apply to the differential mode of the differential amplifier. So if you need a scope with a bandwidth of 50MHz and enough gain to adequately measure a ground referenced signal, such as V_{A-B}, then you would need a differential amplifier with the same capability in its differential mode.

As we have seen earlier, dealing with the common mode signal, V_{COMMON}, with a single-ended scope input is either done by applying a low impedance shunt ($Z_{GND-LEAD}$), or by placing a higher impedance in series with the common mode signal (floating the scope). The differential amplifier deals with the common mode signal by algebraically subtracting it from the measured differential signal. The measure of how well the differential amplifier can remove or reject the common mode signal is specified similarly to the differential bandwidth and gain, except now we want to evaluate attenuation instead of gain.

Common mode bandwidth is measured by simultaneously applying exactly the same signal (frequency, amplitude, and phase) to both inputs of the differential amplifier. With these input signals, an ideal differential amplifier would have no signal at its output. Since real world limitations apply to real amplifiers, there will be an output that is a function of amplitude and frequency of the input signal. If we put a 1V, 10MHz, signal into both inputs (same phase) and we measure a 1mV signal at the output, the differential amplifier can reject 1MHz signals by a factor of 1,000.

How well the differential amplifier can reject a common mode signal is usually stated as a ratio of the output signal's magnitude divided by the differential input signal's magnitude, or Common Mode Rejection Ratio (CMRR). In this case, the CMRR is 1,000 to 1 at 10Mhz. It is also commonly given in, but it is always the ratio of the output magnitude over input magnitude. It should be specified as a function of attenuation ratio versus frequency, since it is a function of frequency. CMRR is highest at dc and declines as the frequency increases.

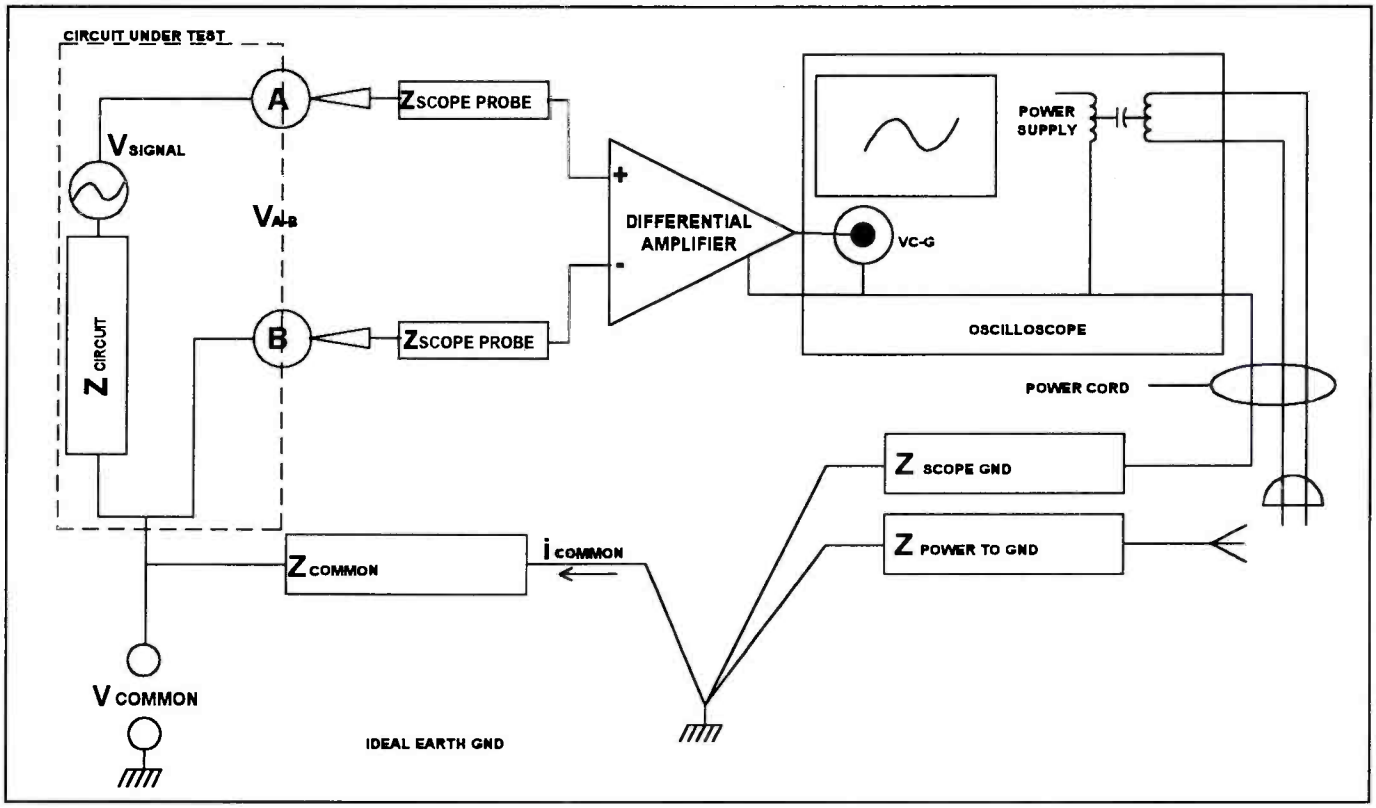


Figure 4. The distortion caused by the length of the oscilloscope probes can be reduced by using a scope or a preamplifier that has differential measurement capability. This is the same equivalent circuit with the same ground referenced scope and a differential preamplifier. As the differential amplifier amplifies the difference between the two points, it rejects any voltage that is common to both points and presents the scope with the difference between points A and B, which is V_{A-B}.

Common mode range

The next most important characteristic of the differential amplifier that we need to know about is its common mode range. This lets us know how large the amplitude of V_{COMMON} can become before the amplifier can no longer tolerate it. This value is usually at least several times larger than the differential input range and is specified as a dc value, but it applies to the peak magnitude of an ac signal as well. How much common mode range a differential amplifier should have depends on the measurement requirements. If the common mode voltage is a small signal caused by ground loop currents, then a volt or two of range will be sufficient. However, if the differential signal we are trying to measure is riding on top of a large common mode voltage, the range will have to be large.

As an example, let's assume that V_{A-B} is the voltage waveform across a current monitoring resistor in the primary of a switching power supply. In this example, V_{COMMON} is 400V (dc+peakac) and the V_{A-B} waveform is a voltage ramp with a 1V peak. By using probes and attenuators that have a combined divide by 100 attenuation factor, the value of V_{COMMON} will be attenuated to 4V and V_{A-B} will be attenuated to a 10mV signal. The differential amplifier must have at least 4V of common mode range.

If the amplifier's CMRR is 10,000 to 1, then the differential amplifier will attenuate the 4V V_{COMMON} down to a 400μV level at its output. In this case, when the CMRR of the amplifier is combined with the attenuation of the probes and the amplifier's internal attenuator, the common mode signal is attenuated by a factor of 1,000,000 to 1, while the differential signal is attenuated by a factor of 100. This output can be easily and safely displayed on a standard ground referenced scope.

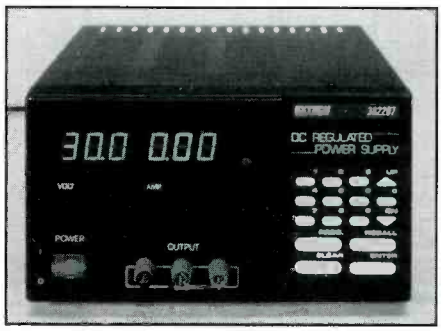
Obtaining good CMRR

Good common mode rejection performance is obtained by carefully matching all attributes of the paths for the + and - signals into and through the differential amplifier. This matching is as important for the probes as it is for the amplifier.

Some scopes provide methods of algebraically subtracting one input from another (commonly referred to as A-B). In analog scopes, this is accomplished by inverting one channel and adding it to another in the scope's input section.

Digital scopes (DSO's) provide math functions that allow one acquired waveform to be subtracted from another. CMRR is not normally specified for this type of operation, but a figure for dc can be derived by taking into account the accuracy specifications of each channel. If the dc gain accuracy of each channel is ±1%, then the CMRR could be as low as 50 to 1 and is seldom better than 100 to 1. When ac signals are taken into account, the CMRR deteriorates even further. In our earlier example of the 1V signal riding on a 400V common mode signal, the output would be 10mV of differential signal and 40mV of common mode signal. It is also unlikely that the inputs could tolerate the 4V offset level.

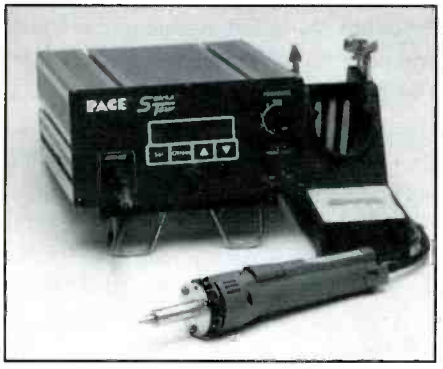
To obtain optimum CMRR, the probes used with the differential amplifier should be designed to maximize CMRR. The user needs to make sure that the probes are optimally compensated. ■



Digital dc power supply with RS-232 interface

Extech's new digital dc power supply, Model 382207, supplies constant 0 to 30V and 0 to 3A dc outputs with high load/line regulation and low noise/ripple. A 9-step memory is available for programmed (manual or timed) outputs and test routines. Digital keyboard operation allows for easy programming and setup. There is instant recall of output presets at the touch of a key. Two large digit LEDs display voltage and current. A built-in RS-232 bi-directional interface permits remote PC control. The power supply comes in a galvanized steel case with binding post connectors. Complete with power cable, Windows software, and RS-232 interface cable.

Circle (97) on Reply Card



Self contained, digital desoldering system

PACE introduces the new ST 105, a self-contained digital desoldering system. Features include a quiet vacuum pump, new backlit illuminated LCD, and kickstand for easier programming and viewing. The Auto Snap-Vac feature provides a minimum vacuum on-time for improved desoldering performance, reduced maintenance, and extended tip life.

This system comes standard with the SensaTemp SX-70 Sodr-X-Tractor handpiece. The ST 105 System can be easily converted into a full-range SMT and thru-hole system with the addition of any optional SensaTemp handpiece.

Circle (98) on Reply Card

Oscilloscope/multimeter combination

Extech's hand-held oscilloscope/multimeter, the MultiScope, features a dc to 100kHz oscilloscope with a sample rate of one million samples/second. The single channel oscilloscope range is 100mV to 800V/division and 1 second to 10msecond/division, 500ns glitch capture, and pre post trigger (-4 div./+10 div.). The display is a 128 x 64 pixel graphic LCD with a view area of 2.8 inches x 1.5 inches. HELP screens explain test operations.

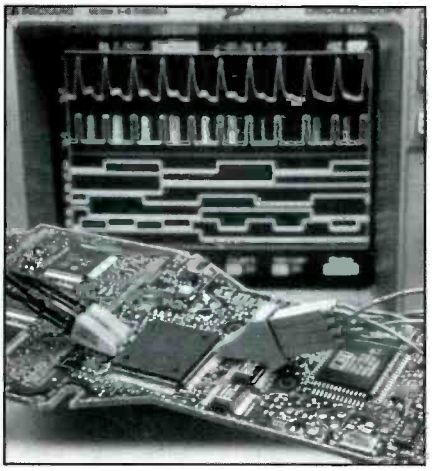
MultiMeter functions include true RMS ac voltage and current, dc voltage and current, resistance, capacitance, frequency, dB, temperature (using adaptor), duty cycle, pulse width, period, TTL signal generator, diode, and continuity tests.

Circle (99) on Reply Card

Surface mount rework on CD-ROM

PACE introduces a new CD-ROM on surface mount technology with over 50 step-by-step procedures to help with the installation and non-destructive removal of virtually all surface mount components applicable to assembly and rework operations. The removal and replacement of misaligned, poorly soldered, damaged, or faulty components are also illustrated, and the procedures are ideal for meeting internal ISO 9000 guidelines. Over 25 video clips are included to show live techniques used within the step-by-step procedures to provide greater visual assistance when needed. In addition, this CD-ROM includes component, tip, and handpiece identification information, as well as the company's full line catalog.

Circle (100) on Reply Card



IC package connector

Hewlett-Packard introduces the HP Wedge Probe Adapter, developed to ease the task of connecting probes to fine-pitch integrated circuits (IC), a frequent source of technician frustration. The adapter is designed to facilitate reliable, non-destructive, "hands-free" connections of probes to thin quad flatpack (TQFP) and plastic quad flatpack (PQFP) ICs.

Circle (101) on Reply Card

Precision voltage current source

IET Labs has introduced the VI-700, a versatile precision dialable or remotely programmable voltage and current source. It features 0.5 LSD accuracy. Its three ranges provide up to 200V full scale down to 100µV resolution, and 200mA full scale down to 0.1µA resolution. Both voltage and current outputs are available simultaneously. The output is set by a range selector and thumbwheel switches in the local mode or by a digital input at the rear panel. This control is available as an IEEE-488 or a BCD parallel interface.

Circle (102) on Reply Card

Test meters

Philips ECG introduces seven new test meters to suit every need. From the economical meter for the do-it-yourselfer, to a lab quality multimeter.

Meters to suit every need: general purpose, temperature measuring, home-office pocket digitals, heavy duty, workshop-school, plant and industrial, analog, and digital. The list continues: battery testers, capacitance meters, hand-held digital thermometers, and logic probes.

Also offered are accessories: test leads, protective holsters, stands and soft carrying cases, oscilloscope probes, temperature probes, and thermocouples.

Circle (103) on Reply Card

Component placement system

PACE USA introduces the TF 700 ThermoFlo Advanced Placement System; a solution for virtually all surface mount removal and installation applications. This system includes the main unit, the Heat Wave preheating system, and a platform with a fine adjustment table.

Process controlled hot-air reflow of BGAs and SMD components is provided by the programmable unit. Up to 80 user-defined thermal profiles can be preset for consistent repeatable results. Over 30 standard nozzles are available and can be easily interchanged to meet any application needs. The integrated heat wave preheating system allows bottom-side preheating with board supports. Workpiece alignment for fine-pitch SMD components and standard BGAs is simple using the fine adjustment table, which holds circuit boards up to 18 inches square.

Circle (104) on Reply Card

100 MHz scope features exclusive digital multimeter

Test Products International, Inc. (TPI) has introduced a new hand-held digital multimeter, Model number 153. The TPI 153 is an autoranging DMM with easy to read, 4000 count LCD display.

The meter can measure ac and dc line and control voltages, current draw of electrical circuits, continuity in circuits and wires, resistance of components, and test diodes for shorts and opens. The unit will record minimum and maximum readings for all ranges and functions, and maintain the readings on the display with its data hold function.

Circle (105) on Reply Card

ALT/sweep mode

The latest dual trace, dual time base 100 MHz oscilloscope from *HC Protek* simultaneously displays 4 traces in an exclusive ALT-sweep mode, as well as providing CRT displays of two unrelated signals through vertical mode triggering. The Model 6510 analog oscilloscope offers five vertical display modes, a trigger hold-off circuit for synchronizing complex waveforms, and provides TV sync for either line or field. It provides sweep speeds down to 2nS/Div.; 12 KV acceleration potential; bright 6-inch square CRT with an internal graticule; Z-axis input; and 20MHz bandwidth limit switch for viewing signals in a noisy environment.

Circle (106) on Reply Card

What Do You Know About Electronics?

By J.A. Sam Wilson

In the previous issue, we reviewed the method of writing Maxwell's voltage (RxI) loop equations, and the determinant setup for the resulting two equations and two unknowns. By using Cramer's rule, we found the value of the two currents and proved our answer by using the reciprocal current method.

Once the methods in that issue have been reviewed and understood, it has been shown to be a fast and easy way to solve a basic problem of an unknown current. In fact, the reciprocal method of finding a parallel current used in that issue can be used to estimate the value of that current in your head without using formal math.

In this issue, we will show how a bridge circuit can be analyzed for a specific current (Figure 1). The unknown current is I_5. Cramer's rule will be used again to solve the resulting three equations and three unknowns, and your understanding of basic circuitry will identify other features of the Wheatstone Bridge-type of circuit involved.

Question: How much current is flowing through R_5 in Figure 1?
Solution: I am going to use conventional current for this solution.

Observe that in the following equations, I have assumed that the current through R_5 is I_5. That permits me to keep track of which current I want for the answer.

As a first step, mark the polarities of the voltages based upon your assumed direction of conventional current.

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

When I solve for unknown currents using Maxwell's method, I always assume a clockwise direction of assumed current. A wrong assumption gives a correct numerical value, but the answer will be negative — go back and correct your assumed direction. In other words, if you get a negative value for a current, go back and correct the assumed direction and take the negative sign off your answer.

Remember — in my solution this time, I am using conventional current. So, if I am moving in a loop and I encounter a negative sign for a voltage (due to the assumed current), I call it positive; but, if I encounter a positive sign for voltage, I call it a negative voltage. You can verify that when you check the equation I wrote for loop ABCEFA.

Here are the three equations and three unknowns for Figure 1:

Loop ABCEFA

$-(10 + 30)\, I_1 + 12 + 10I_2 + 30\, I_5 = 0$

Loop BDCA

$-(20 + 40 + 10)\, I_2 + 40\, I_5 + 10\, I_5 = 0$

Loop DECD

$-(40 + 50 + 30)\, I_5 + 30\, I_1 + 40\, I_2 = 0$

For an easy determinant solution, align the unknown currents having the same subscripts.

$-40I_1 + 10I_2 + 30\, I_5 = -12$

$+ 10I_1 - 70I_2 + 40I_5 = 0$

$+ 30I_1 + 40I_2 - 120I_5 = 0$

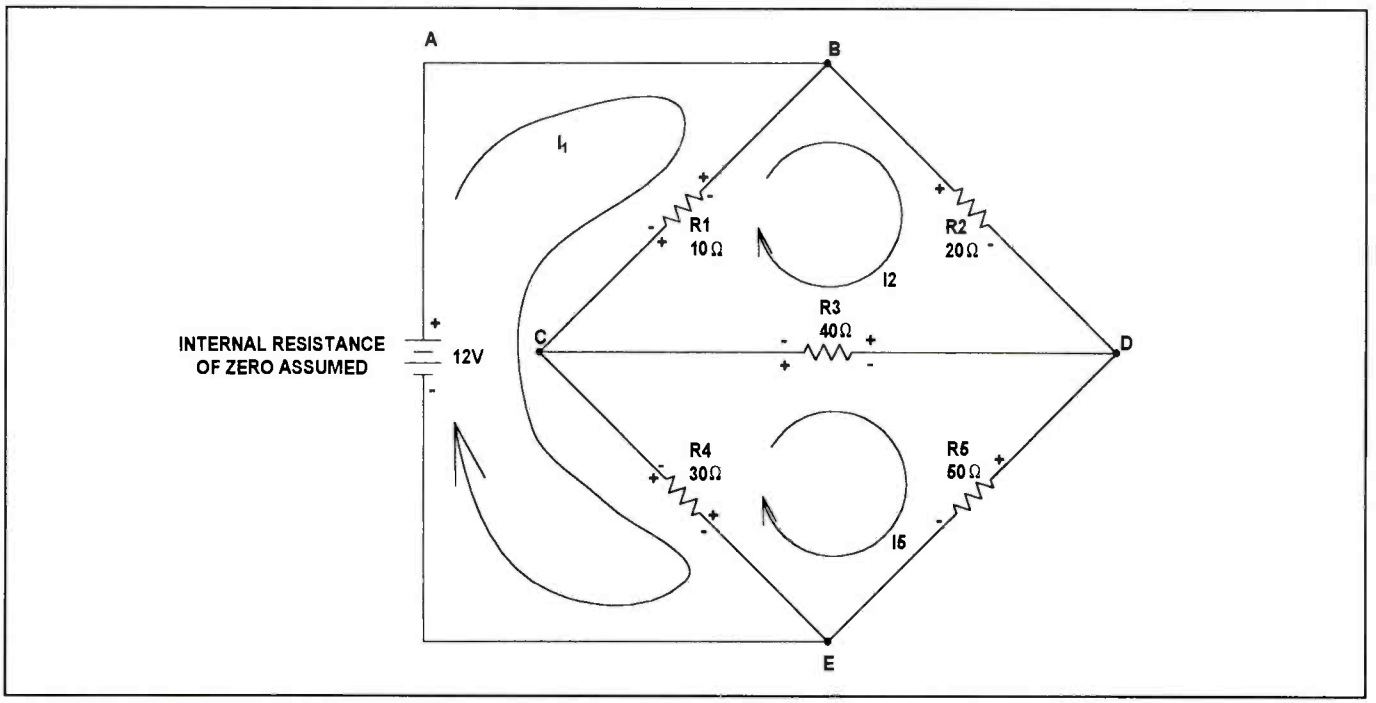
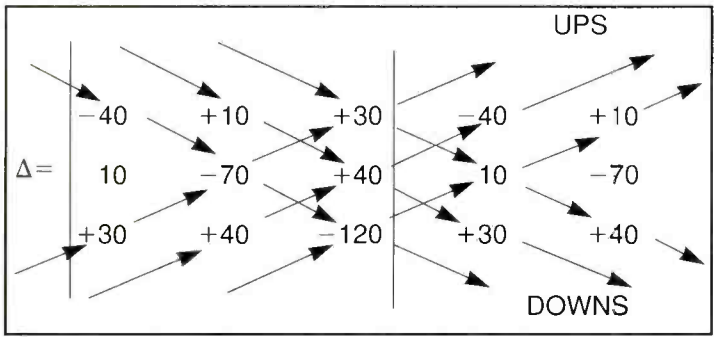


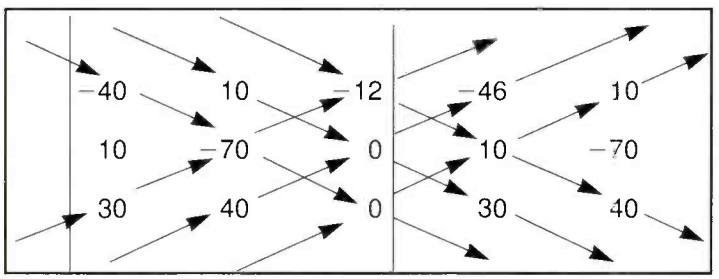
Figure 1.

Write the determinant for the delta (Δ). That is the denominator for the final equations. Use only the coefficients of the unknowns. Note that the first two columns are written a second time to make it easy to identify the downs and ups. Remember — the value of the determinant is equal to the sum of the products of the downs minus the sum of the products of the ups. If you can't say it, you can't do it!



$\Delta = [-40 \times -70 \times -120] + [10 \times 40 \times 30] + [30 \times +10 \times 40]$
$-[30 \times -70 \times 30] + [40 \times 40 \times -40] + [-120 \times 10 \times 10]$
$\Delta = -173{,}000$

The numerator of I_5 is a determinant obtained by plugging the right-hand column (-12, 0, 0) in place of the I_5 column. The value of I_5 then becomes



$I_5 = \Delta$

$$I_5 = \frac{[0 + 0 - 4800] - [(+25200) + 0 + 0]}{\Delta}$$

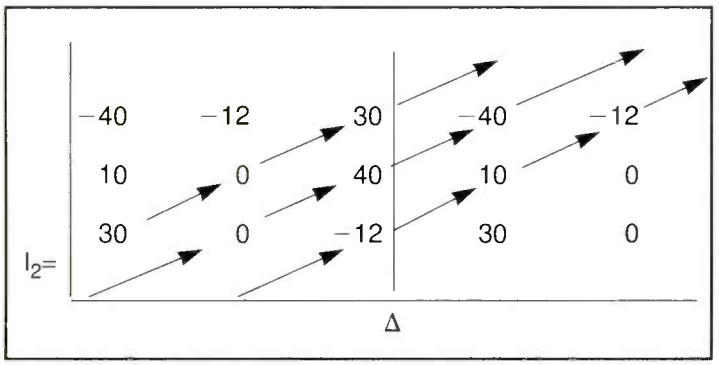
$$I_5 = \frac{-4800 - 25200}{-173000} = \frac{-30000}{-173000}$$

$I_5 = 0.1734$

(The assumed direction for I_5 is correct because the answer is positive.)

Now, how do we check that answer?

You can see from Figure A that the voltage across R_5 added to the voltage across R_2 must add to 12 volts. We already know the value of delta, so, the voltage across R_2 will be easy to find. We plug in the knowns column (12, 0, 0) in place of the I_2 column and solve for I_2.



$$I_2 = \frac{[(0) + (-12 \times 40 \times 30) + 0] - [(0) + (0) + (-120) \times (10) \times (-12)]}{\Delta}$$

$$= \frac{-14400 - 14400}{-173000}$$

$$I_2 = \frac{-28800}{-173000} = 0.1665$$

Again, the answer is positive so the assumed direction of current is correct. The voltage across R_2 is V_2.

$V_2 = I_2R_2 = 0.1665 \times 20 = 3.33V$

The voltage across $R_5 = I_5R_5 = 0.1734 \times 50 = 8.67V$

$V_2 + V_3 = 3.33 + 8.67 = 12$ volts (applied)

Since we know I_2 and I_5, and the two currents are flowing in opposite directions through R_5, we can subtract the smaller current from the larger current and find I_3.

$I_3 = I_5 - I_2 = 0.1734 - 0.1665 = 0.0069A.$

Some interesting blurbs from an advertisement on the Internet

I am told that there is such a glut of information on the Internet that no one person can hope to read every bit of it. So, you may not have seen some of this HDTV stuff.

Every Internet tidbit I get comes from my wife Norma, who is supposed to be working. Some questions have been sent to the Editor of **ES&T**, and, they have been passed on to me.

"Does Sam surf the Internet?" No, My C drive has crashed, so, I don't even have a computer at this time.

"Does Sam have an e-mail address?" No, all of the letters I get are sent by snail mail via the **ES&T** address.

"What is J.A. Sam Wilson's real name?" J.A. Sam Wilson (to distinguish it from a dog named Sam on TV).

Aliasing from computer boards in Massachusetts

Advertising literature often provides a variety of valuable technical information. The following comes from PC Measurement News — a newsletter from Computer Boards, Inc. of Middleboro, Massachusetts. It is a newsletter mailed to certain magazine subscribers.

We're frequently asked by customers about aliasing, and whether or not anti-aliasing filters are recommended.

First, let's describe the phenomenon of aliasing. Anyone who has ever been to the movies has probably seen a perfect example of aliasing. It's what makes the helicopter blades or airplane propeller appear to rotate slowly backwards. Aliasing occurs when your sample rate is not at least twice the maximum frequency contained in the input signal.

Though a crude representation, you can see that sampling the waveform shown too slowly portrays a dramatically different waveform than actually exists. In the movie example, the 24 frames per second of an average movie (or 30 fps for video) is not fast enough to capture the propeller blade without aliasing. (Assume a propeller at 2000 rpm or 33.3 rps.)

An anti-aliasing filter is typically a very sharp-edged filter set that allows through only frequencies less than one half the sample rate. In practice, since the filters aren't perfect, it's common to set the roll-off frequency at 25% to 30% of the sample rate.

More Internet goodies

"What does the FCC mean by ATV?"

Advanced Television refers to any television technology that provides improved audio and video quality or enhances the current NTSC television system. As first used, ATV meant an HDTV program compressed to fit the size of a current NTSC broadcast channel. Now, the definition is being broadened to include the concept of multiple video programs and other data simultaneously carried within one channel.

"If we can't afford an ATV transmitter during the transition period, will the FCC let us use our existing UHF channel, antenna, line, and transmitter when NTSC is shut down?"

The FCC has requested comment on what special assistance should be provided to public broadcasters in order to facilitate the transition.

"What problems might viewers experience with ATV reception?"

Some viewers may be annoyed by the longer time needed for the receiver to display a new picture when changing channels. People who view poor quality NTSC reception due to low signal strength, severe multi-path, or noise may not be able to receive ATV at all. It may be possible for some viewers to overcome this barrier with a better antenna system. This is a complex phenomenon with many varying situations. ■

Test Your Electronics Knowledge

Answers to test *(from page 19)*

1. Digital Signal Processing

2. 10% to 90% (by definition)

3. Offset voltage (by definition)

4. A — Based upon Op Amp theory

5. B — Based upon Op Amp theory, identical amplifier designs with a lower gain *always* have a wider bandwidth.

6. Random (by definition)

7. It is a rough estimate of the conversion of Celsius temperature to Fahrenheit temperature.

8. B — An absolute temperature of zero has never been reached. Cryogenics deals with materials at *near* absolute zero.

9. Equinox (meaning "equal night")

10. A — Phrone's idea is known as the "gambler's fallacy." The slot machines (as of now) have no memory. So, each pull of the lever has the same chance as all the other pulls. Since slot machines pay back only a percentage of the money received, Phrone will surely go broke!

BOOKS

***Communication Electronics for Technicians* by Joseph Carr, PROMPT Publications, 311 pages, paperback, $39.95**

Communication Electronics for Technicians is an invaluable study guide for readers who are seeking to improve their status as electronics technicians by obtaining CET Certification.

As long as you're licensed as an electronics technician and you have a job, you don't need to waste your time procuring other credentials and certifications, right? In *Communication Electronics for Technicians,* noted and respected author Joseph Carr explains why the CET is an important and valuable addition to your professional resume. The comprehensive text is divided into three sections: the associate level, journeyman level, and a body of knowledge. If you take pride in your work, and want to elevate yourself above the other run-of-the-mill electronics techs, then completing the CET exam is a major step. Your peers will respect you, and your customers will have more confidence in your abilities.

Joseph J. Carr has published more than 80 books and 600 magazine articles since 1968. He writes monthly columns in several electronics magazines. Joe has also authored the four-part Electronic Circuit Guidebook series available from PROMPT Publications. With more than 25 years experience, he is one of the best known writers on electronics technology and has an international reputation.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

***The Management Survival Manual for Engineers,* by Ronald H. Hermone, CRC Press, 143 pages, hardcover, $39.95**

Although engineers receive an outstanding technical education, their success in today's organization demands knowledge of how to put that education to work. *The Management Survival Manual for Engineers* provides this information, creating the bridge between the world of science and the working organization. The text discusses the management of technology within the organization, the management of the engineering department, and the management of engineering projects through technical approaches and personnel aspects. *The Management Survival Manual for Engineers* introduces the engineer to basic management of engineering, encouraging essential leadership and managerial philosophies. The book acts as a primary resource for engineers moving into managerial areas, as opposed to technological ones. It addresses a multitude of topics, enabling the reader to grasp general concepts before addressing more specific concepts.

Topics include:

- Examining the inter-organizational behavior, procedures, and policies required to work in formal organizations
- Identifying required knowledge of leadership
- Outlining the principles for effective communications skills
- Determining the responsibilities of the organization and engineering manager for preparing the new engineer entering the organization
- Introducing how engineering functions in the organization
- Forming a basic understanding for project management
- Describing the transition from new engineer to supervisor

The Management Survival Manual for Engineers emphasizes an understanding of people, the organization, and management as opposed to technology — serving engineers entering the engineering field, as well as those engineers moving into project management for the first time.

CRC Press LLC, 200 Corporate Blvd., N.W., Boca Raton, FL 334431-9868

***Power Supply Troubleshooting & Repair* by Lanny L. Logan, PROMPT Publications, 195 pages, paperback, $24.95.**

Power Supply Troubleshooting & Repair provides information that will give technicians a better understanding of switched-mode power supply operation, and also provides practical, useful procedures to follow when troubleshooting switched-mode power supplies.

This book covers switched-mode power supplies that you may encounter in modern consumer electronic products, and focuses on the most common supplies found throughout the industry. Using a block diagram and a full-circuit schematic, this book presents various circuits throughout its chapters to show you how switched-mode power supplies work. A brief troubleshooting procedure for servicing each supply is also included. After reading through this book, you will have a complete understanding of switched-mode power supplies and will be able to troubleshoot and repair them yourself within your own shop or home. A variety of topics are covered, including switched-mode power supply basics, and free-running supplies.

Lanny L. Logan is a member of ISCET and is currently working as a lead training specialist at the Philips Service Company. His background includes working as an instructor for a two-year technology course and as a chief electronics technician.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

***Electrical Engineering Dictionary*, CRC netBASE 1999, CRC Press, $129.00**

Features of this dictionary include:

- All the topics and attractions of tile printed version
- Complete text/word search
- Extensive searching using Boolean and proximity algorithms
- Screen cam that quickly reviews the use of this CD-ROM
- Illustrations and photos containing zoom features and hotlinks
- Hotlinked key terms
- 6.462 hyperlinks — finding essential information even easier
- High resolution printing of text, graphs, and illustrations.

An annual subscription option is available through which the reader receives continual updates at a nominal price of $95.00 per renewal. The publisher will send reminder notices to subscribers three months in advance before the update is ready to be forwarded.

System requirements: IBM-compatible computer; 486 microprocessor or higher operating software; Windows 3.1 or higher; 8MB RAM, CD-ROM drive.

CRC Press LLC, 200 Corporate Blvd., N.W., Boca Raton, FL 334431-9868

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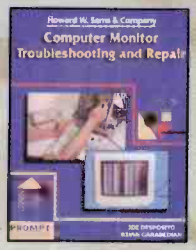

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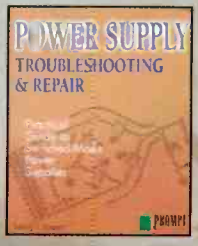

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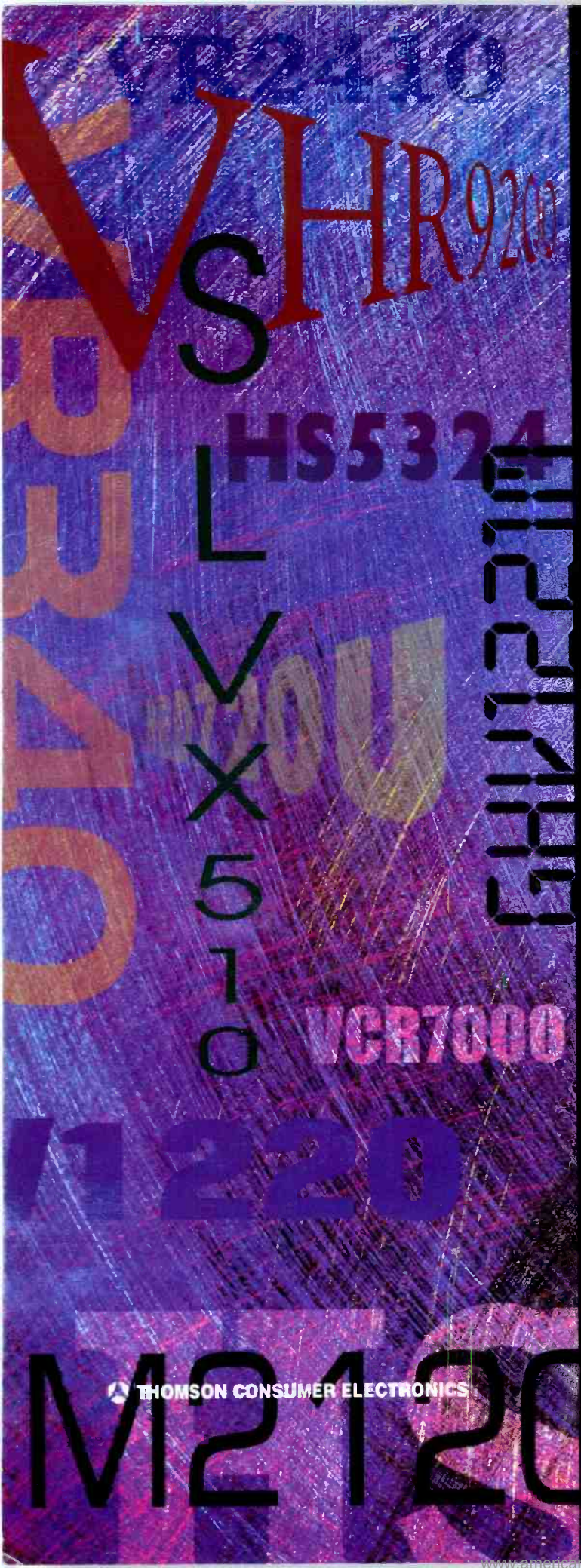

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