THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

T.M.

January 1999

How antennas work

Understanding SCSI

Managing a service center

Don't gamble: Some ideas to make success a sure thing

Hitachi Color Television CT2550/CT2551 CT2552/CT2555 CT2556

U.S. $3.50

01>

7 25274 86667 0

Y2K and Beyond...

Philips SmartParts and Magnavox Smart Accessories

BOOTH # 928 at CES

Your reliable partners for the next millennium.

Philips Service Solutions Group is ready to help you to and through the new millennium. We have Y2K compliant systems to see that your orders are processed with the reliable same-day service they receive now. Our 97% same day ship rate and 98% order-fill rates can only increase in the future. Philips has always been about quality and reliability, and we can give you the peace of mind and security that we will continue supporting your needs regardless of the new millennium. Philips plans only to continue to "make things better" both now and in the future.

For all your service support needs call 800-851-8885 or fax 800-535-3715.

Circle (120) on Reply Card

PHILIPS

Let's make things better.

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

Volume 19, No. 1 January, 1999

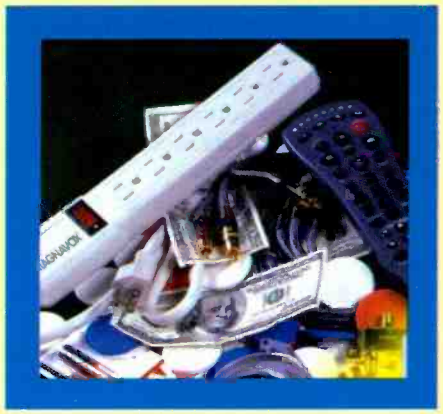
Contents

FEATURES

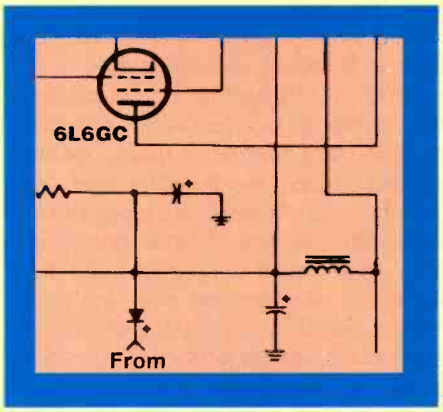
DEPARTMENTS

EDITORIAL INDEX

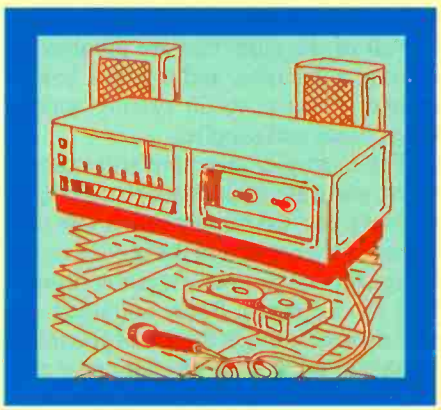
ES&T presents its annual article, department, and Profax 1998 indexes.



page 8



page 11



page 14

ON THE COVER

Successful service centers don't gamble. They make success a sure thing by adhering to accepted management principles and sharing their ideas for success with other service centers. (Cover photo courtesy Philips Consumer Electronics Company)

Managing a service center

The technical side of the consumer electronics service center is, without a doubt, of paramount importance. If the service center can't take in a customer's faulty product and return it to like-new (or almost like-new) condition, it doesn't matter what else the service center does, it will fail. However, proper management is also important, especially in these times of inexpensive products and thin profit margins.

For example, it's important for a service center to know how much to charge for servicing a given type of product. And the only way to know that, is to know what it costs the service center to provide such a service, and to charge that much, plus something more for profit. And it's important to know what actually goes into the cost of that service. It's not just the hourly wage of the technician for the amount of time it took to service the product. The cost of the technician also includes benefits, his unproductive time, such as vacations and sick time.

Other factors have to be included in the cost of that service procedure: overhead, such as rent for the building, utilities needed to keep the business operating, maintenance of the facility, tools, and test equipment, salaries of the support people who are essential to operating and managing the business, but who don't contribute directly to output of the company, such as the counter personnel, receptionist, owner, and service manager.

The point is that in order to manage a business properly, a "manager" should have at least some kind of rudimentary education in managing. Without that kind of training, it's difficult to be able to identify all of the costs that are involved in running a business, and to know how to recover those costs in pricing service labor, parts, and supplies.

For example, there are still components, parts, etc., that may go into a repair that may cost the service center less than a buck. So what should the service center charge for that part when it gets consumed in a service repair. Some untrained service managers might think that you might be able to get away with charging a couple of bucks for such an item, and others feel uncomfortable because they think that the charge may be excessive.

But think again. What has it cost the service center to buy that item, stock it, inventory it, pay interest on the money used to buy it (or conversely, forfeit interest on the money that could have been set aside into some kind of investment). The actual cost to the service center to own that item may be several times the amount of cash paid for it. And how about the time it took the technician or parts person to cross reference that part, locate it in inventory, and retrieve it.

If the service center manager doesn't know what those costs are, or that he even should be considering them in pricing, the service center could be slowly going out of business and not even know it.

But being a manager is so much more than just directing the day-to-day activities of the service center. It also involves a lot of creative activities; or should. For example, if the income of the business seems to be dropping off, how does the manager determine what the cause is. And how does he find ways to correct the problem. Actually, a better question might be, how does he know that problems may be coming before they actually occur. In these days of products that are priced so that they are practically throwaways, the service center has to do one of two things: find a way to service products more economically, so that customers are still inclined to have their products serviced, or look for other products to service that are less likely to be abandoned by the owner when they fail.

The degree of future success of the business depends to at least some extent on how the management of the business handles that type of problem. Presumably all of the readers of this magazine are still in the business, so that means that they, or someone in the company where they work, did something right.

We're all familiar with the sad stories of the service centers that were successful during the good times in the business, but that fell by the wayside when things got tough. But proper management techniques might have kept that from happening. Because while some companies were going out of business, other companies weathered the storm, sometimes somewhat a little worse for wear, but sometimes coming out of the crisis in better shape than ever.

Many of these companies expanded the line of products that they service to include products that are not traditional consumer products: things like computers, and video games, even childrens' electric cars. Some got involved in servicing even farther out items: someone has to service those drive-through communications systems at McDonald's, Burger King, Wendy's, Hardy's, etc.

In other words, service managers and owners in today's service centers need to think "outside the box." That is, it's important to always be on the lookout for trends that may be coming along in consumer electronics that may be going to affect business for the better, or adversely, and take advantage of the one and defend against the other.

In this issue, we have included two articles that include ideas brainstormed by a group of service center owners and managers who have come up with ideas for improving business, or their operations, or attracting customers.

For example, one idea suggests a way in which a service center can recover some of the service time invested in a product that is abandoned by the owner: rent them to clients who have to leave their products to be serviced. Another idea is to contact schools to solicit service business from their A/V equipment. Another individual suggests that service centers advise clients, in writing, in a preprinted form that some procedures may not be covered by warranties. Still another individual suggested that technical procedures such as ac leakage check, and supplies and chemicals be invoiced separately and charged for.

Many of these ideas have helped the companies that suggested them stay in business and remain successful. We invite you to read them, in the hopes that they strike a creative spark that will help some of you not only stay in business, but positively thrive. And we thank NESDA and its members for being gracious enough for allowing us to publish them.

Nils Conrad Persen

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC
Servicing & Technology

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

EDITORIAL
Nils Conrad Persson, *Editor*
(Internet e-mail: cpersedit@aol.com)
Alycia Nicholsen, *Associate Editor*
(Internet e-mail: kirstieest@aol.com)
Richard S. Moseson, NW2L, *On-Line Coordinator*

CONSULTING EDITORS
Homer L.Davidson, *TV Servicing Consultant*
Victor Meeldijk, *Components Consultant*
John E. Shepler, *Audio Consultant*
Sam Wilson, *Electronics Theory Consultant*

PRODUCTION
Elizabeth Ryan, *Art Director*
Barbara McGowan, *Associate Art Director*
Edmond Pesonen, *Electronic Composition Mgr.*
Dorothy Kehrwieder, *Production Manager*
Emily Leary, *Assistant Production Manager*
Pat Le Blanc, *Phototypographer*

BUSINESS
Richard A. Ross, *Publisher*
Sal Del Grosso, *Accounting Manager*
Ann Marie DeMeo, *Accounting Department*
Judith Erickson, *Office Manager*
Catherine Ross, *Circulation Manager*
Melissa Gilligan, *Operations Manager*
Jean Sawchuk, *Data Processing*
Denise Kells, *Customer Service*

ADVERTISING SALES OFFICE
Electronic Servicing & Technology
21704 SE 35th Street, Issaquah, WA 98029
Tel.: 425-557-9611 Fax: 425-557-9612

Evelyn Garrison, *Director of Advertising*
Emily Leary, *Sales Assistant*

EDITORIAL CORRESPONDENCE:
P.O. Box 12487
Overland Park, KS 66212
913-492-4857

NCA Member Networking For Excellence · ETA Electronics Technicians Association · National Electronics Service NESDA Dealers Association, Inc. Member, Electronic Servicing Dealers Association

Electronic Servicing & Technology (ISSN 0278-9922) is published 12 times a year by CQ Communications, Inc. 25 Newbridge Road, Hicksville, NY 11801. Telephone (516) 681-2922. Periodical class postage paid at Hicksville, NY and additional offices. Subscription prices (payable in US dollars only): Domestic—one year $26.95, two years $49.95. Canadian—one year $36.95, two years $69.95. Foreign Air Post—one year $44.95, two years $85.95. Entire contents copyright 1999 by CQ Communications, Inc. Electronic Servicing & Technology or CQ Communications, Inc. assumes no responsibility for unsolicited manuscripts. Allow six weeks for delivery of first issue and for change of address.
Printed in the United States of America.

Postmaster: Please send change of address notice to Electronic Servicing & Technology, 25 Newbridge Road, Hicksville, NY 11801.

CQ Communications, Inc. is publisher of CQ The Radio Amateur's Journal, Popular Communications, CQ Radio Amateur (Spanish CQ), CQ VHF, CQ Contest, and Electronic Servicing & Technology.

Understanding SCSI: the small computer systems interface

by Philip M. Zorian

A computer can be connected to, and made to communicate with, its peripherals, such as the hard drive, the printer, or the scanner, in a number of ways. Depending on the method chosen, the connection will be more or less reliable, faster or slower in transfer of data, more or less flexible, and more or less expensive. One very flexible, very fast scheme currently available for connecting computers with peripherals is the small computer system interface, abbreviated SCSI. The abbreviation for this interface scheme is usually pronounced "scuzzy." SCSI is less used, and therefore less well known, than many other interface schemes because it is more expensive, and somewhat more complicated to install.

The decision to upgrade to a SCSI Hard Drive, or a SCSI Scanner, is usually based on one important factor: the need for greater performance. With the ability to transfer data at a rate of 80 MB/sec., it is the interface of choice in applications where speed, time and quality make all the difference. It is important, however, to have a basic understanding of the "scuzzy" Interface before you make use of it. Although it may seem daunting, understanding this interface is not difficult. This article introduces the reader to the use of SCSI devices by describing both the advantages, and the drawbacks, of using them.

The host adapter card

SCSI devices require the installation of a Host Adapter Card onto the computer's motherboard. It is the card that provides the computer with a SCSI port. Once this card is installed into an empty PCI (Peripheral Component Interconnect) slot, you are then able to connect a SCSI cable from the computer to the SCSI device. It is the card, the connecting cable, and the peripheral device that make up the SCSI bus (Figure 1).

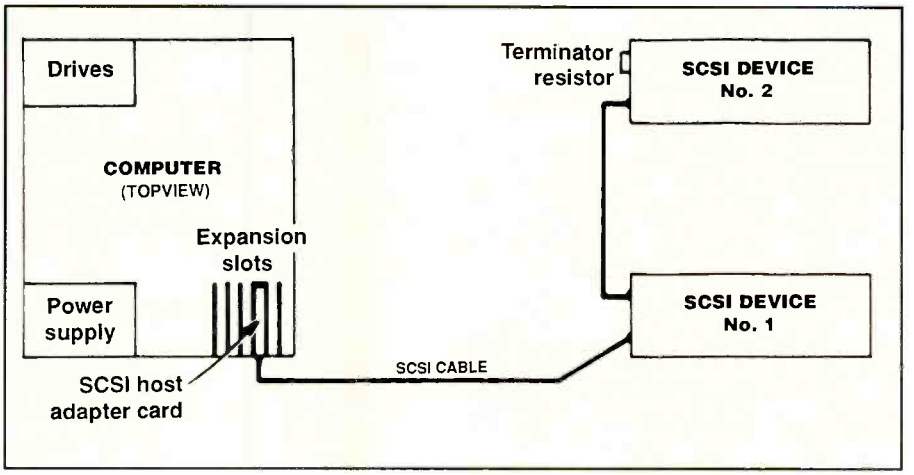


Figure 1. The host adapter card, the connecting cable, and the peripheral device make up the SCSI bus.

The host adapter card, designed with its own dedicated processor, is the brain of the SCSI interface. It is the card that actually controls the SCSI device. This "onboard" intelligence gives the SCSI Interface the following advantages:

- It transfers data at a very high rate - up to 80Mb/sec.
- It allows the user to connect numerous SCSI devices, up to 15, to the same port.
- It enables two peripherals to work simultaneously; commonly referred to as multitasking.

Nevertheless, the host adapter card presents the user with two obstacles. First: there are several versions of host adapter card: SCSI-I, SCSI-2, SCSI-3, FAST & WIDE (Figure 2). Choosing the correct card can be difficult since each version is designed for a different purpose, and some of the specifications are difficult to understand. Second: installing the card

SCSI SPECIFICATIONS

SCSI Version	Data Transfer Rate (MB/Sec)	Bus Width (bits)	Cable Connector (no # pins)
SCSI-1	8	8	25
SCSI-2	5	8	50
FAST SCSI-2	10	8	50
FAST WIDE SCSI-2	10-20	16	68
8 Bit Ultra SCSI-3	20	8	50
16 Bit Ultra SCSI-3	20-40	16	68
8 Bit Ultra2 SCSI-3	40	8	50
16 Bit Ultra2 SCSI-3	40-80	16	68

Figure 2. There are several versions of host adapter card: SCSI-I, SCSI-2, SCSI-3, FAST & WIDE.

Zorian is the director of the video/audio department at the school for international training in Brattleboro, VT and is the owner of Phil's VCR Repair.

can be difficult, especially if problems arise with hardware/software conflicts, or driver installation. Both of these obstacles, however, are easily overcome.

Choosing the correct card is a process of matching the SCSI device with the computer (386, 486, Pentium, etc) and the Operating System (Windows 3x, Windows 95, etc). One of the leading makers of SCSI devices, Adaptec Inc., offers an excellent Website for making this choice. At <http://www.adaptec.com/tools/selectors/index.html>, simply choose the above parameters and the web site automatically provides you with two host adapter cards for your system — a recommended solution and a premium solution.

To overcome the difficulty of installing the adapter card, consider using the AdvanSys model ABP925 SCSI Card; it's a good choice for a Pentium class PC using Windows 95/98. Not only does their Website at <www.advansys.com>, walk you through the installation of a host adapter card, but the card also comes bundled with a powerful utility called SuperSCSI, SuperInstall version 2.2. This software utility renders the installation process painless, using graphics to walk through the driver installation. It automatically configures the direct memory access (DMA), input/output (I/O) address, and interrupt request (IRQ) lines; and it finishes by confirming that the drivers and the card were installed successfully, with no hardware or software conflicts.

Guide to connecting SCSI peripherals

Connecting a SCSI device to a computer requires the following steps:

1. Choose the peripheral device based on price, availability and technical requirements.
2. Choose a SCSI Host Adapter Card.
3. Obtain the correct connector cable. There are a four different SCSI connectors, (Figure 3). Most host adapter cards come bundled with a cable. If you are purchasing both the device and the card from the same dealer, there should be no problem obtaining the correct cable. The above web site can also help with this.
4. Install the card. This requires shutting down the computer, opening the case, locating an empty PCI slot (typically short and white), on the computer's motherboard and carefully inserting the host adapter card into the slot. Close the case.

Terminology

Some of the terms in this article will, no doubt, be unfamiliar to many readers. This glossary is included to provide definitions of some of those terms.

Address: The ID number of a device on the SCSI Bus. No two devices can have the same ID number.

Byte: A group of eight bits. This is the standard size unit for computer information. A byte holds the equivalent of a single character, such as the letter A.

MB/s MegaBytes per Second: One million bytes per second.

Data-Transfer Rate: The rate that a drive or other device can transfer bytes of information. Transfer rates are measured in bits or bytes per second.

DMA (Direct Memory Access): Circuitry that transfers data from memory to memory without using the CPU. Data is transferred much faster than using the CPU for every byte of transfer. On PCs, there are eight DMA channels.

Driver: Also called a device driver, a program routine that links a peripheral device to the operating system. When a new host adapter card is installed, its driver must also be installed. The operating system calls the driver, and the driver "drives" the device.

ID Numbers: Each device on the SCSI Bus must be set to a unique ID number. A subset of Plug and Play, called SCAM (SCSI Configured automatically), allows IDs to be set via software.

Interface: The connection and interaction between hardware, software and the user.

Hardware interfaces are the plugs, sockets, and cables. Software interfaces are the languages, and codes programs use to communicate with each other and to the hardware. User interfaces are the keyboards, mice, commands and menus used for communication.

I/O (Input/Output): Transferring data between the CPU and a peripheral device. Every transfer is an output from one device and an input into another

IRQ (Interrupt ReQuest): A hardware interrupt on a PC. 16 lines accept interrupts from devices such as a scanner or network adapter. Unless specifically programmed to interact together, two devices cannot use the same line. If a new expansion board is preset to the IRQ used by an existing board, one of them must be changed.

Peripheral: Any device attached to a computer system — printer, scanner, etc.

PCI (Peripheral Component Interconnect): A peripheral bus commonly used in PCs, Macintoshes and workstations. PCI provides a high-speed data path between the CPU and peripheral devices. There are typically three or four PCI slots on the motherboard.

Plug & Play: A feature of the Windows 95/98 operating system. It provides the computer with the ability to add a new component without the user having to perform any technical analysis.

SCSI Controller: An expansion board that adds SCSI capability to a computer.

Terminator: The device at either end of a SCSI chain must be terminated by setting a switch or plugging a resistor module into the open port.

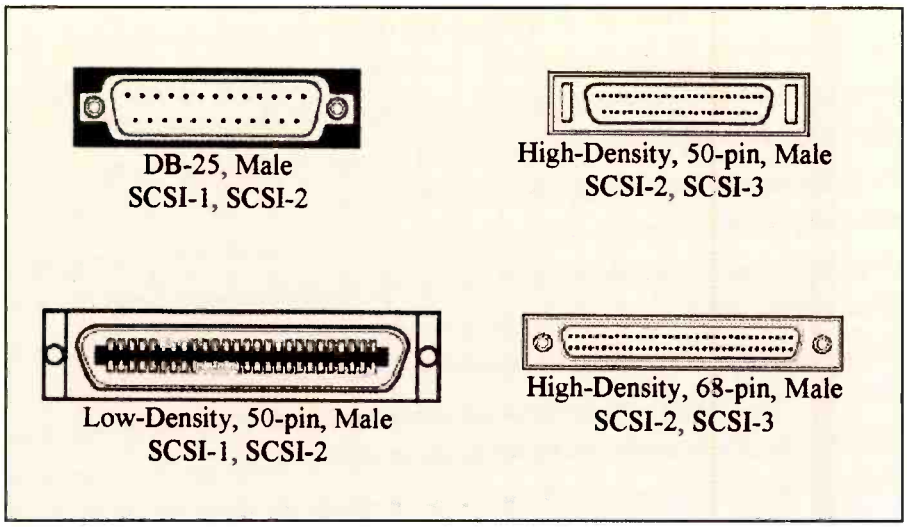


Figure 3. There are a four different SCSI connectors. Most host adapter cards come bundled with a cable. If you are purchasing both the device and the card from the same dealer, there should be no problem obtaining the correct cable.

5. Attach the SCSI cable from the peripheral device to the SCSI port on the back of the computer.

6. Install the Termination Resistor. There is a basic rule that is unique to the SCSI interface: The last connected device at either end of the SCSI bus must be terminated with a terminating resistor.

7. Reboot the computer. Since the arrival of Windows 95 with its Plug & Play feature, configuring the host adapter card and SCSI peripheral device is easier than with Win3.X.

Under Plug & Play, each time you boot up, the entire system is checked to see if any new devices are installed. If a new device is detected, the computer will try to identify it, for example, the host adapter card, and assign the necessary resources to it.

8. *If necessary*, install the software drivers that came bundled with the device

Conclusion

Before the arrival of the SCSI interface, each peripheral device required its own specific interface circuit in order to communicate with the computer. Connecting a printer or tape drive to a computer was difficult. The original purpose behind the SCSI interface was to make all peripheral devices look the same to the computer. Thus, a standard interface was created, requiring only a single adapter.

Although the SCSI interface offers many benefits, it can be difficult to troubleshoot when a peripheral is misbehaving. A follow-up article will describe problems that arise with the SCSI interface, and explain the methods used to analyze the Bus in a logical manner. The article will also introduce an important piece of test equipment: The SCSI Active Diagnostic Terminator from Granite Digital. This inexpensive tester provides critical information on the status of the Bus, especially when the system "hangs up." ■

TECH TIPS

Following are several tips on servicing of computer monitors, provided by M.I. Technologies

Manufacturer: Apple
Model Number: M2943

Symptom:
Vertical shrinkage. Picture has about two inches of vertical sweep.

Corrective action:
Replace C312, 2200uF/35V. This capacitor is located about 1/2 inch to the left front of the yoke plug.

Manufacturer: Apple
Model Number: M2943

Symptom:
Power LED flashing. Unit makes a ticking sound.

Corrective action:
Replace Q403, 2SC3886A; Q405, 2SB 1375 (On a small heat sink in the center of the main PCB).

Note: Also check C413, 5.6NF/1.6KV. If this capacitor starts to break down, it can also cause damage to Q403, 2SC2886A.

Manufacturer: Apple
Model Number: M2943

Symptom:
Pincushion, Horizontal oversize, Horizontal size controls not working

Corrective action:
Replace Q405, 2SB1375 (On a small heat sink in the center of the main PCB).

Manufacturer: Apple
Model Number: M2943

Symptom:
No control of the width. Too wide, and pin cushion bad.

Corrective action:
Replace Q405, SB 1375 (Shorted)

Manufacturer: Apple
Model Number: M2943

Symptom:
Missing colors, or intermittent or abnormal video.

Corrective action:
Resolder solder joints on the CRT board, including videoprocessor LM1203, Q961 for the blue, or one of the other two corresponding transistors for red or green. Also, check and resolder the three small (square) chunky transistors next to Q961 and Q901. Check the two or three black coax wires that are bowed like vertical arcs on the left side of the component side of the board.

Manufacturer: Apple
Model number: M2943

Symptom:
Intermittent heater voltage

Corrective action:
Replace IC002, MC 14551BCP. IC 002 turns on the base of Q003 to provide 6.13V to the filament.

Note: The switches of the multiplexer IC002 are controlled by pin 9, logic low for normal operation, Logic high for power saving mode.

Manufacturer: Apple
Model number: M2943

Symptom:
HV is functional. Blank screen. No voltage to the heater.

Corrective action:
Replace Q003, 2SD667 on the power saving board. Test voltages are as follows: base 7.02V, emitter 6.13V, collector 6.37V.

Note: 6.4V comes from P501A in the middle at the very rear of the main PC board on a blue wire to the collector of Q003, 2SD667. The base of Q003 is driven by pin 6 of IC002, MC14551BCP.

Robert Yount, M. I. Technologies, Inc., 3310 E. Peterson Rd.,Troy, OH 45373, 937-335-4560

LITERATURE

New components catalog and internet features

Jameco Electronics has just released a new catalog and updated website. The free 148-page catalog features thousands of ICs, components, tools, test equipment, and computer products for OEMs, engineers, educators and service/repair technicians. More than 350 new products have been added including test/measuring equipment and accessories, USB products, robotic parts, and more potentiometers, capacitors, and LEDs.

The company also has an on-line Catalog at <www.jameco.com>.

Circle (90) on Reply Card

Cross referencing software

NTE Electronics has released Version 7.0 of their electronic cross reference software, QUICKCross. This new easy to use version contains all the updated semiconductor, relay, and flyback transformer cross reference databases, plus the new Aluminum Clad Power Wirewound resistors. A new selector guide for potentiometers and trimmers has been added, which includes a cross reference for Spectrol and Precision Electronics device numbers to competitors' device numbers.

The software can also be downloaded at the company's website at <http://www.nteinc.com>.

Circle (91) on Reply Card

Floor safety catalog

New Pig Corporation has introduced a new catalog to help customers develop a floor safety program to prevent slip and fall accidents. To help keep clean, safe floors, the complete product guide contains 67 new products, as well as existing products; seven easy practices; a free inspection checklist; easy to use selection charts; money-saving offers; and 11 technical sidebars.

Circle (92) on Reply Card

Managing a service center: Some ideas for improving operations

by Gerry McCann and members of NESDA

The ideas published here were generated by members of the National Electronics Service Dealers Association (NESDA) during a "Best Ideas Contest." We publish them in the hope that they may help other service centers, and perhaps inspire them to come up with their own ideas to improve their businesses.

1. For a quicker method of wiring during a drop ceiling installation, carefully use a slingshot mounted to a fishing reel with a small weight. After removing a few tiles, shoot the weight with fishing line and use the line to pull the cable without removing as many ceiling panels. (*Editor's note: I have also seen this done with a toy bow and arrow*).

2. As a front office conversation piece and humorous mascot, one inventive servicer showed off a three foot high "technician" doll. The impressive talisman is fully dressed in company uniform work clothes along with tool box, hat, name tag, company logos, and a smile. "He" is described as the "perfect tech," always ready to work and never complains.

3. When a television repair estimate is turned down and the unit is to be disposed of, salvage the tuner section. Collect the tuners and sell them to rebuilders. Also, watch for modules and other subassemblies of value. The reporting servicer finds a nice extra amount of income from these items salvaged during slower times. Some of the modules being found are reported to have dud value.

4. Sometimes it's in the wording: always sell "experienced equipment" not "used equipment."

5. Avoid accidents working on camcorders. Instead of using small alligator clips, which may slip off, to connect the power source to camcorders under service, buy a collection of inexpensive dc car adapters. These connect to battery connectors on camcorders much more solidly and can be purchased very inexpensively from accessory vendors.

6. Here's a tip for recovering the service time invested in a product that has already been repaired and is abandoned by the owner. These units can be placed in your rental pool. Rent out to clients for the length of time their units are in for repair. You might establish a flat rate on commodity products and rent by the day or week on higher end or specialty items. It was suggested that the value of the rental product offered be kept comparable to the value of the client's unit because no damage deposit is commonly taken.

7. Contact community colleges. as possible new business for A/V, camcorder, TV, computer, monitor, and printer repairs. Don't forget video tape sales. Approach school librarians because they normally coordinate the institution's A/V products for classroom use. A new source of business: the school transportation buses of many areas have now become extensive electronics surveillance users. Because of the harsh environment they operate in, they are in constant need of video recorder and camera repairs.

8. Use a formal preprinted form to advise clients with warranty or service contract coverage, in advance, that some adjustment, cleaning, software, or other services may not be covered by warranty. You then have that document as a means to negotiate and collect the minimum technical charge when no hardware problem is found.

9. Several technical procedures that can be added to invoices were introduced such as AC leakage check charge, service supply charge, and chemical use fee. Prices ranged from $2.50 to $6.00 per completed service item.

10. Retailers always seem to be out of note paper around their telephones.

Create an advertising pad as a giveaway for your retail dealers. On one side of the sheet, list your company name, address, telephone number, etc. and the brands you are authorized for. If appropriate, put a map to your location(s) on the back. These preprinted pads of note paper become an "always available" handout from dealers to their customers. This advertising method is of reasonable cost if ordered in large quantities.

11. Instead of expensive chamois leather cloths, use a good quality coffee filter to clean video heads. This money saver has been used successfully for head cleaning by many service centers. The material does a good job, is lint free, and has never damaged a video head.

12. Develop an "owner responsibility" letter. This letter is worded so as to make the owner responsible for repair charges in the event that a third-party warranty company refuses to pay for the work, or becomes bankrupt. It was mentioned that some of this "disclaimer" verbiage can be found on the NESDA form.

13. In storage areas using large shelving and a mixture of outgoing and incoming television products, face the "completes" in one direction and the "incompletes" in the other direction for quicker and easier status identification.

14. One servicer reports finding an inexpensive large quantity source of surge suppressors and using these as "lagniappe," giving one to each customer when they return the repaired set. This company receives continuing praise and recommendations after completing PTV repairs.

15. Color codes of many kinds speed up work flow. Try color paper clips used on hard copy paperwork to identify status. Green: "incoming," Blue: "parts on order," Red: "no repair," etc.

16. Teach listening techniques to field technicians. Technicians should carefully listen to the client's complaint with the unit when first arriving on a site call. The complaint may be different from the one given over the phone when the service call was scheduled. This will often change or shorten the approach to the specific troubleshooting.

17. One servicer lowers repair counter stress by keeping a puppy dog up front. This was mentioned as a stress reliever and distraction for both clients and employees. A small friendly dog was described as working best. It was reported that when the dog had a day off, clients asked about him and missed him. Clients were reported to even have left dog treats hanging on the door. (Really)

18. Another front counter stress reliever was introduced: a nice fish aquarium, positioned close by and well kept, gives off an aura of peace and tranquillity. (But don't give the fish a day off)

19. A basket of various toys is kept near the front counter in the front office of a reporting servicer. This little extra keeps children busy and quietly distracted while their parents conduct business.

20. Interoffice e-mail addresses for all employees was suggested by one participant. Use as a modern system for internal company communications. With the use of many computers in most companies, this intranet concept achieves a level of "no more lost notes."

21. Local technician associations often act as industry watchdog groups. Be alert to contact local TV stations when they advertise they will run an "expo report" on electronics repair in your area. As a member of a local association, they will call or interview the local professional group for advice. For one association, this turned into a long time running local radio show manned on a rotating basis by association members. This can be a great way to promote your own business and your local association at a minimal cost with maximum effectiveness.

22. The front counter of the service center has been found to be the best place to promote your additional services. Create a promotional packet to attach to each client's invoice. Include a list of products and brands you are authorized for, and include a coupon for the next trip charge or future repairs and accessories.

23. In a poorly ventilated work area where solder station fumes are a concern, an inexpensive vacuum cleaner can be mounted in the ceiling venting outside with a series of PVC tubing run to each solder station to evacuate the fumes from each area. (*Editor's note: Check federal state and local ordinances first to see what kinds of venting are legal or illegal*).

24. If you must relocate your business, began promoting the new location with a full previous-customer mailing at least one month before the move. Create a "preferred client discount card." One reported success was offering to pay sales tax on all repairs for one year when the "preferred client card" is used.

25. If you have prospective clients phoning in regularly asking the price of cleaning on various products, quote your posted price then offer a discount. Put a short time limit on the discount. Tell the caller that they must mention the "phone special" to receive the discount.

26. For computer servicers: create a Year 2000 compliance sticker to attach to all computer repairs which informs the client if their product complies to hardware specifications or if they should contact their software vendor for Y2K compatibility upgrades.

27. Computer servicing opens a new and important issue involving sometimes expensive software. Have a system and a predetermined format for assigning the responsibility of backing up software before problems occur to the owner. Disciplined paperwork systems avoid misunderstandings, lessen friction, and clarify owner software responsibilities. A well thought out sample of a modified NESDA form was passed around.

28. Regarding workmen's compensation insurance: The reporting servicer switched to an insurance broker away from a direct insurance agent. He found his employees could be rated in multiple categories instead of just a few. This helped save serious money. This suggestion to annually shop insurance and investigate using a broker instead of a dedicated company agent was echoed by the group.

29. An inexpensive regular 8 1/2 x 11 sheet of paper can be cleverly folded into

an interesting company brochure and envelope pocket for the repair invoice. This brochure might include such information as company name, address, products repaired, etc., and made available for clients at the front counter.

30. Collect a $25.00 refundable disposal fee in addition to the minimum technical charge on older products left for repair. This fee helps to defray the cost of disposing of the older set when the need develops. Usually the owner returns for the set and their $25.00.

31. Strip the chassis out of old console TVs, use them as inexpensive work tables and cooking benches.

32. One sales and service dealer reports the effectiveness of having a popular One-Hour Film Lab set up in the very rear of his business. Each customer must walk through the entire sales floor to get to the film lab — twice.

33. One service center sent out a direct mail piece, advertising of the remodeling of his service center. This worked very well as an incentive for almost every client to pick up their products.

34. Consistently mail out "Thank You" cards to each client from the previous week's work. This small gesture builds recognition, good memories, and results in return clients for the business.

35. A "priority service" multiple copy form was passed around. It explained that for a predetermined (filled in) price, the service company would expedite the repair in the following ways: 1) Unit would go immediately to the appropriate technician without waiting in line. 2) The service manager would closely monitor the process of this repair. 3) Parts will be ordered the fastest way. with extra shipping charges added to billing. If repairs are not completed by the promised time, regular charges will apply, along with any extra shipping incurred. The form is then dated, timed, and signed.

35 A problem that frequently occurs on some later model televisions is an arcing — notable by the loud snapping noise. To cure this problems, clean up the anode wiring and the transformer area carefully. Apply three fully drying coats of GE Acrylic. This is available from GC Electronics and reportedly is known by the "White can with the Pink label."

36 Set your minimum diagnostic charge two dollars below the amount collected at the counter. This two bucks will often bring the owner of a turned down repair back in to pick up the unit.

37. When feeding coax through narrow spaces inside a low roof or between floor joists, use a small diameter PVC pipe to lead the way. This avoids the "pushing a wet noodle" dance. Then, feed the wire inside the PVC and out to an accessible area. Use angle bends to get around minor obstacles during tight cable feeds. Position the PVC pipe end towards the destination, push the cable through, and don't forget you will need a free end to slip the pipe off the now positioned cable.

38. Wiring installers: To orient yourself when drilling upwards from below in a crowded area, carry with you some long nails painted with a loud or fluorescent paint. Hammer one down from a sensible spot above. Measure above and below from the bright nail(s) for more accurate spotting during tight runs.

These ideas were generated by members of NESDA, the National Electronic Service Dealers Association, during a session called the NPSC '98 Best Idea Contest. This session took place during the NESDA National Professional Service Conference on August 13, 1998 in Orlando, Florida. We thank NESDA for giving permission to reprint them here. For more information about NESDA, call or write: NESDA, 2708 W Berry, Fort Worth, TX 76109-2356, 817-921-9061. ■

PHOTOFACTS

DAEWOO
CN2001 4086
DTQ-26S1FC 4086

FISHER
G6B-19R800 4085
PC-19R80 4085

GE
CTC185AA2 4082
25GT511TX 14082

JVC
AV27920 4080

QUASAR
ANEDC303 4078
ANEDC305 4089
SP2721UW 4078
SP2721W 4078
SP3221UW 4089
SP3221W 4089

RCA
CTC187CN3 4083
G32643SKLX1 4083

SANYO
AVM-1908C 4079
AVM-1908G 4079
AVM-1908S 4079
AVM-2508C 4088
AVM-2508G 4088
AVM-2508S 4088
AVM-2538C 4088
G5C-2508C0 4088
G5C-2508G0 4088
G5C-2508S0 4088
G5C-2538C0 4088
G6B-1908C0 4079
G6B-1908G0 4079
G6B-1908S0 4079

SHARP
VA-A373UVCR-305
VC-A572UVCR-305
VC-A572U(A)VCR-305
VC-A574UVCR-305
VC-A574U(A)VCR-305

SYMPHONIC
ST4813 4087

TOSHIBA
CE27H15 4084
CE27H50 4084
TAC9807 4084
TAC9815 4084

ZENITH
A25A74R 4081
A25A76R 4081
A27A23W 4090
LGA29A23WM 4090

Vacuum tube matched pairs and bias

by Alvin G. Sydnor

Editor's note: *Many current readers of this magazine have had little or no experience with vacuum tubes. And for the most part, except for the high voltages present in TV picture tube circuits, these technicians are used to dealing with solid-state circuitry that operates at 12V or less. Vacuum-tube circuits operate at voltages on the order of several hundred volts. If you decide to experiment with vacuum-tube work, exercise appropriate care while working around voltages that may be lethal.*

Moreover, those glowing filaments in vacuum tubes generate a great deal of heat. Be careful when touching any part of a tube circuit. Some parts may be hot enough to burn.

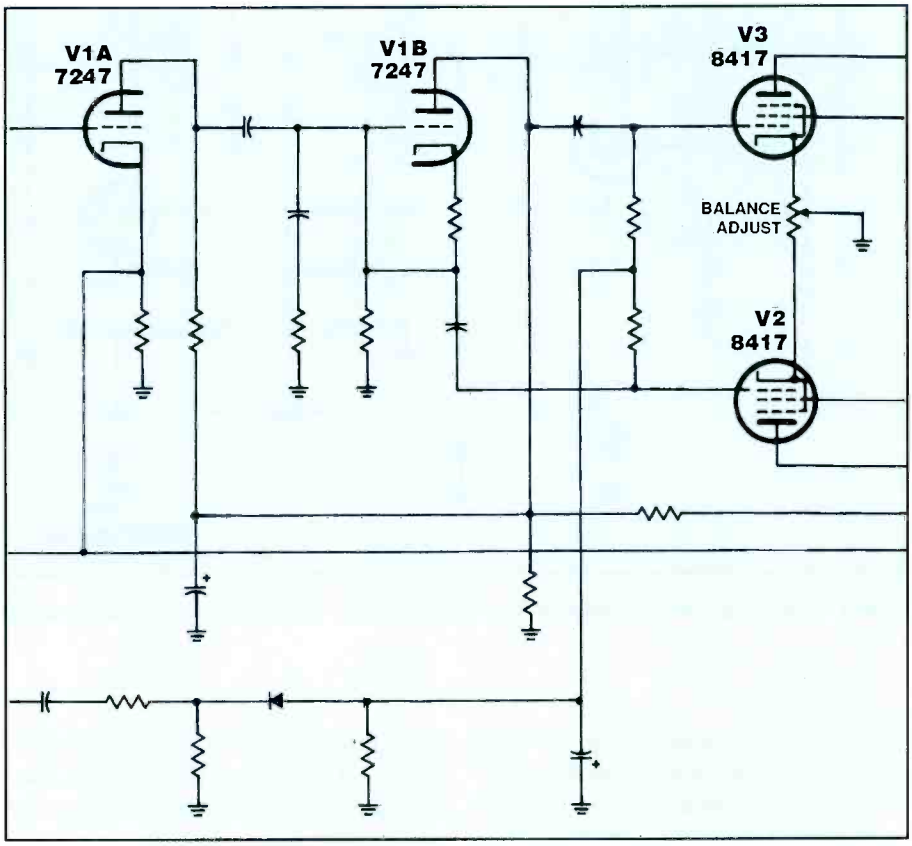


Figure 1. Many high power tube amplifiers such as this one, have adjustable bias potentiomters, normally screwdriver-adjust types, that are for the service technician only.

For many years electronic technicians, design engineers, and electronic manufacturers have pondered the question of why tubes fail and there are numerous opinions and much controversy over matched pairs of power output tubes. Last month, we covered the importance of tube ratings and why they must not be exceeded.

If any one rating, or more than one of a tube's ratings, are exceeded for any appreciable period of time, tube damage can occur. Line voltage variations exceeding + 10 percent can also damage tubes.

There are many forms of bias and various ways to obtain bias, all of which are decisions that the circuit design engineer must make to meet the desired specifications. Insufficient bias, particularly in the case of power amplifier output tubes, can cause excessive plate dissipation, distortion, and damage to the tubes. Many of the high power tube amplifiers such as that shown in Figure 1 have adjustable bias potentiometers that are normally screwdriver-adjust types for the service technician only. Please note that there are many high-power audio amplifiers that have fixed bias and on which there is no means of adjusting the bias. See Figure 2.

The function of the bias-adjust potentiometer is to set the optimum operating point of a tube that will allow the tube, or tubes, to function on the most efficient portion of its characteristic curve. Proper bias will also assure low distortion and extended tube life. The optimum bias point, once set, will be for the tubes that are in the circuit at the time of adjustment. If either tube is replaced, or if both tubes are replaced, the bias voltage must be set again, since the bias requirements vary from tube to tube.

It is also important to know that the function of bias on plate current and input signal is different depending on the class of operation. As an example, in a class A amplifier the grid bias and the input signal voltage on the grid are such that the plate current of the output tubes flows all the time. In a class AB amplifier, the grid bias and input signal voltage on the grid are such that the plate current in any specific tube flows a little more than half of the entire cycle.

Matching and the effects of mismatching

When dealing with push-pull output power amplifiers you will often be asked to replace the output with matched pairs, or you may find the owner has replaced the output tubes with matched pairs, with the assumption that the bias need not be checked or adjusted.

Matching pairs is a process of selecting tubes for satisfactory push-pull operation. Most tube suppliers will supply, for an additional cost, tubes that have been stabilized and matched for the application required. It is important to specify the

Syndor is a retired consumer electronics servicing technician.

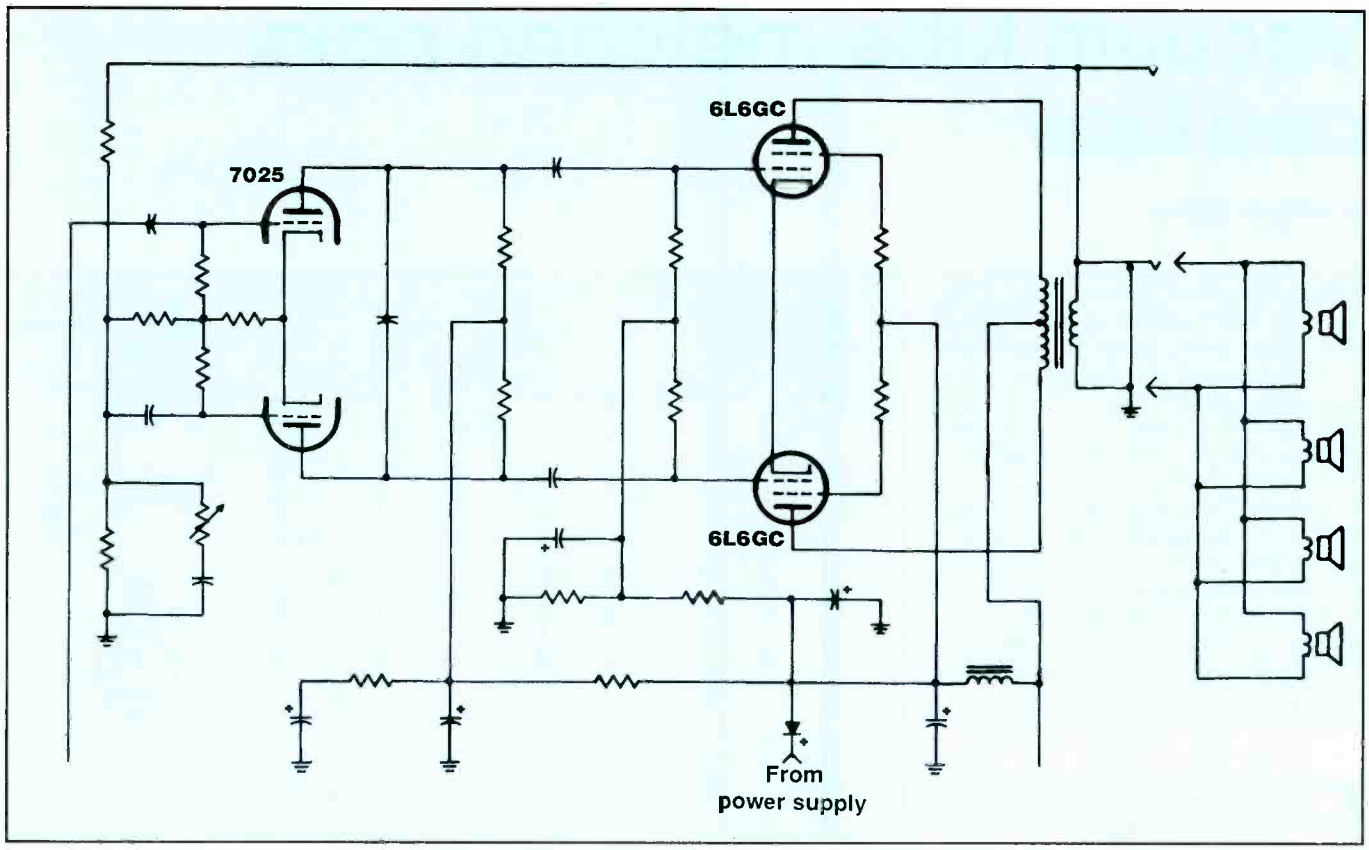


Figure 2. Many high-power audio amplifiers have fixed bias, on which there is no means of adjusting the bias, such as the one shown here.

conditions and circuit that they will be operated in when ordering matched pairs. Unless they are stabilized and matched under similar operating conditions, they will drift apart and may even be mismatched initially.

The procedure used in matching tubes should be based on the class of operation in which the tubes will be operated. For example, when the tubes are operating in class A1, the matching is not as critical as when they are to be operated in class AB1 AB2 or class B.

Triodes that are to be operated in class AB1, AB2, or class B should be tested at a number of points on the tubes plate current grid bias curve. These points should be taken at zero signal input, and the bias set to correspond to the maximum permissible plate dissipation. The measured plate currents should agree at all points within 2 percent. Triodes that are to be operated in class AB2 or class B should be matched for amplification factor as well.

Even if there is a perfect match between tubes in a matched pair when they are initially installed, they will drift apart, so I believe that regardless of whether you are using matched pairs or not, the bias must be set for proper operation of the pair. Pentodes and tetrodes can be balanced by adjusting the screen voltages.

Whenever you see the output tubes running hot, and in some cases the plates are cherry red, you are seeing the effect of under-biased tubes, which can contribute to hum and distortion. When the tubes are over-biased, they will be running cool and the output will be distorted at any volume level. An amplifier that has its bias adjusted properly will sound clean and its tone will be much improved over one that needs its bias to be adjusted.

Before you start dealing with adjusting the bias, it is important that a series of tests be performed such as checking coupling capacitors, B-plus power supply, the bias supply, and its associated components. Also be aware that a short between electrodes of any tube within the amplifier can drive the power supply current beyond its limits and cause damage.

The importance of setting the bias is to make sure that the output tubes are not exceeding their plate current ratings for the applied plate voltage and control grid drive. The following procedure can be followed in adjusting the bias or what is sometimes called "balancing the output tubes" in a push-pull output circuit.

1. Connect a dummy load that matches the output impedance of the amplifier and is capable of handling the maximum output power of the amplifier.
2. Set the bias potentiometer at about 50 percent (midway).
3. Connect an oscilloscope across the dummy load.
4. Set the amplifier gain control at about 40 percent or 50 percent
5. Feed a 1,000 cycle signal into the amplifier's HI Z input
6. Adjust the signal level (to point where clipping occurs) to provide slightly over full rated output.
7. Adjust the bias potentiometer for equal clipping on the oscilloscope.

NOTE: If a distortion analyzer is available, it should be used in preference to an oscilloscope. When using the distortion analyzer, adjust the bias potentiometer for approximately 1 percent or 2 percent dis-

tortion which should be measured at full output, providing all else within the amplifier is operating within its specifications.

When operating Al push-pull triodes, a considerable degree of mismatch between the tubes is permissible without serious effects, provided that the tubes are being operated under single tube conditions with regard to grid bias. Under these conditions, there will be a slight effect on the maximum output power and odd harmonic distortion. Also, there will be some second harmonic distortion and some out-of-balance producing current in the output transformer.

The fact that matched pairs are not absolutely necessary when operating in the Al push-pull circuits indicates that there is a wide latitude permissible. This is provided that the bias is retained at the value for a single tube, and also that the load resistance is not much less than the sum of the single tube load, or 4 times the average plate resistance.

Tube testers vs replacement test

Today tubes are available as "New," "New-Old-Stock," (NOS) and "Used-Tested-Good"(UTG). In most cases, you will have to take what you can get. If purchasing NOS or UTG tubes, you will very likely be getting a tube that has been sitting around for a considerable amount of time and there is no telling what the remaining life of the UTG tubes are.

In many instances, tubes that have not been used for a long time may show signs of sputtering or arcing, or they may even blow fuses when first put into use. This does not necessarily indicate that the tube is definitely no-good, because in many cases this defect can be overcome by performing a simple seasoning of the tube (s).

Such a tube should be operated at normal filament voltage, but with no plate or grid voltage being applied for at least 15 minutes. Next, apply about half of its normal plate voltage and operate about one-half hour, then operate the tube under its normal operating conditions for an hour, while monitoring its operating voltages. Some times you win, some times you lose.

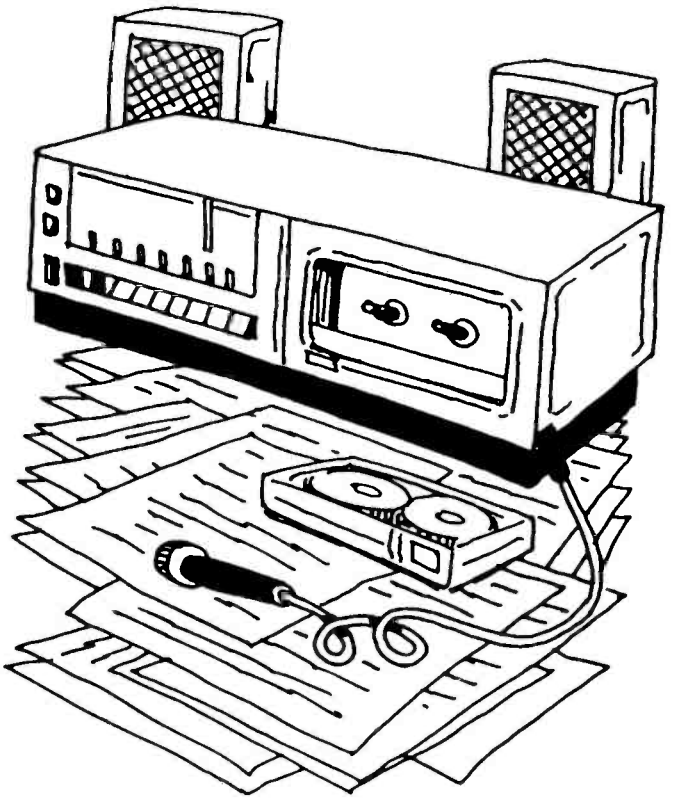
There is much controversy over tube testers verses tube replacement testing. By controversial, I mean that at least two sides that can be taken, and this is also true when we discuss tube testers versus replacement testing.

The necessity for comparing tubes of the same type under standardized conditions cannot be overstated. There are many who maintain that the best test for a tube is to simply replace the defective tube with the same type in the circuit. Those who subscribe to this say that this test is simple, and has the distinct advantage that the tube is being "tested" under actual operating conditions.

As far back as 1934, every RCA Receiving Tube Manual including the latest issue contains the following statement: "The tube tester cannot be looked upon as an authority in determining whether or not a tube is satisfactory. Actual operating test in the equipment in which the tube is to be used will give the best possible indication of a tube's worth." I will leave this controversy up to your good judgment and experience. ■

Magnavox stereo sound section

by Steven J. Babbert



A previous article in the state-of-the-art-TV series dealt with the new-generation syscon used in a Magnavox chassis #25P506-00AA. The series will continue here with a look at the sound section. Before we begin, a brief description of the MTS (Multichannel Television Sound) system will be given. For an in-depth treatment of this system, see Sencore Tech Tip #213.

MTS system

The MTS system used for TV is similar in some ways to the conventional FM stereo multiplex system. The main components of the MTS signal are the mono channel, the stereo subchannel, and the SAP (Second Audio Program) channel. The mono channel consists of the L+R signal included to maintain compatibility with mono receivers. The stereo subchannel or "difference" channel consists of the L-R signal needed to recover the individual L and R signals at the receiver.

The L-R signal is combined with a 31.468kHz (twice the horizontal rate or 2H) carrier in a balanced mixer before transmission. This results in a DSBSC (Double Sideband Suppressed Carrier) signal. Carrier suppression reduces interference and allows a reduction in transmitter power. A pilot signal is included to be used by the receiver to phase lock a reference oscillator. The oscillator generates a subcarrier that is reinserted into the DSBSC signal to recover the L-R. Signal. The L-R and L+R signals are then matrixed resulting in the original L and R.

The SAP channel is frequency modulated onto a subchannel at a frequency of 78.671 kHz (5H). The L+R signal, the L-R sidebands, the pilot carrier, and the SAP FM subchannel are combined to form a composite audio signal by frequency modulating them onto the audio carrier of the TV channel.

Stereo decoder

The heart of the sound section in this chassis is IC200, an I2C-bus controlled BTSC (Broadcast Television System Committee) SAP/stereo decoder, and audio processor made by Phillips (Figure 1). Note that with the exception of the input/output interface devices, IC200 requires few external components and no alignment or adjustment controls. All adjustments are made electronically by the syscon via the I2C bus connected to pins 21 and 22. Ceramic resonator, Y209, sets the frequency of the reference oscillator at 503kHz (32H).

The TV audio carrier is demodulated in the main signal processor IC. The resultant composite signal comprising all of the above mentioned components is applied to pin 24 of IC200. The L-R and SAP signals will not be recovered until they are processed within IC200. The L+R signal, however, was recovered in the first FM demodulator in the main processor. This means that the L+R (mono) audio signal can be scoped at pin 24.

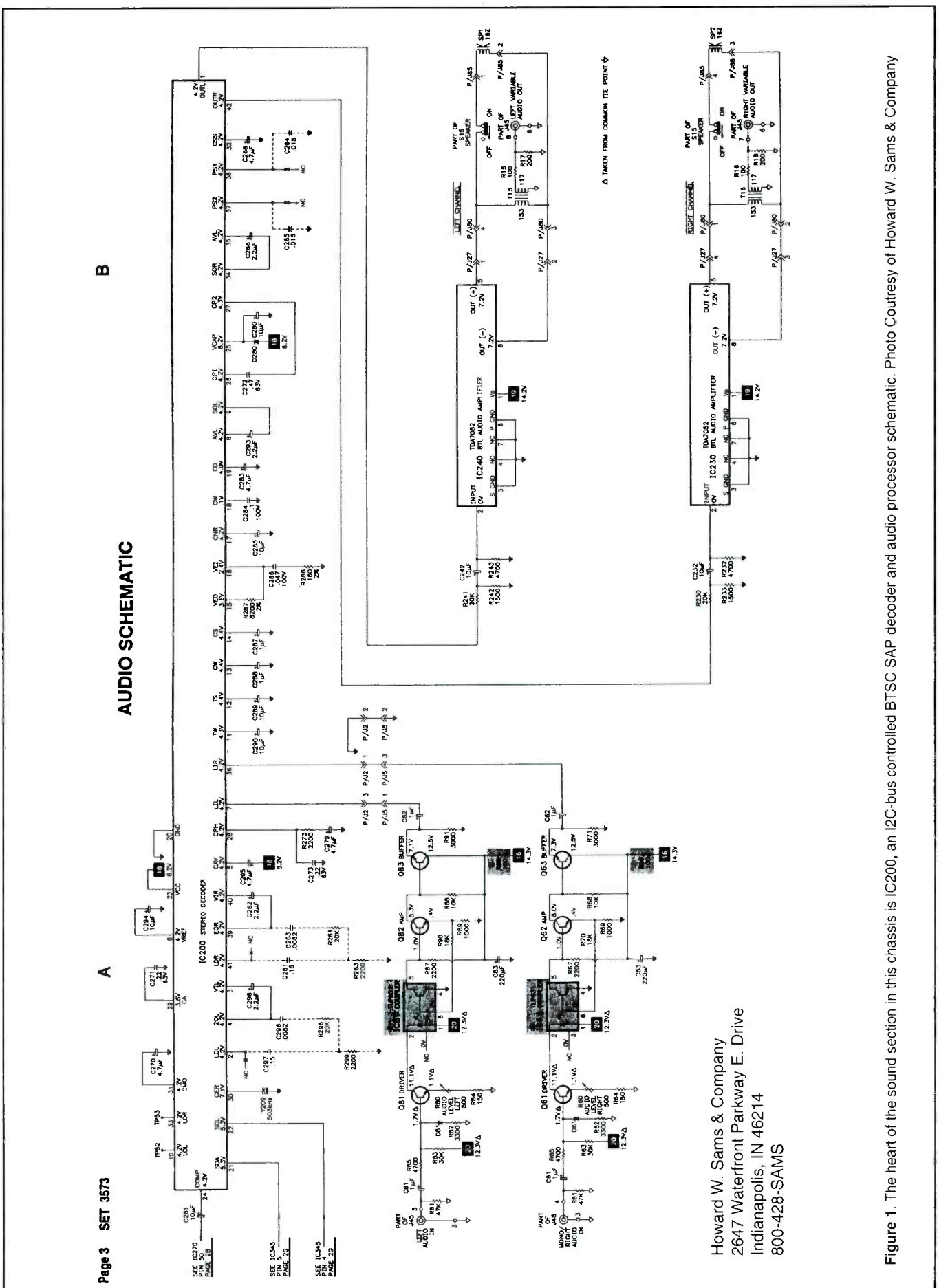
The amplitude of the signal at pin 24 is nearly line-level ($1V_{PP}$) and can be tested at this point using simple audio signal tracing methods. This will be helpful when troubleshooting no-sound or distorted-sound symptoms.

The signal amplitude is independent of the volume setting and should be present whenever any program is being received. If the L+R signal is normal at this point, then it is safe to assume that the other signal components are okay too; it is unlikely that a problem ahead of this point would only effect, for example, the L-R signal or pilot carrier. Note that the undemodulated audio components mixed with the audio signal at pin 24 will appear as noise during any signal tracing test. This is normal and does not indicate a problem. In other words, expect to hear some noise mixed with the audio signal at pin 24.

Auxiliary inputs

Left and right/mono aux. input signals are passed through optocouplers IC81 and IC61 to maintain isolation between the hot chassis and the user and/or external equipment. The left channel signal level is dependent on the gain of driver transistor Q81. The gain is adjustable via R80 in the emitter circuit. Note that components on the input side of the optocoupler use a floating ground.

The output signal from the optocoupler is applied to common-emitter stage Q82. Negative feedback from the emitter of Q82 is applied to the base of the transistor in IC81 via R90. This acts to stabilize the amplifier. The signal at the collector



Howard W. Sams & Company
2647 Waterfront Parkway E. Drive
Indianapolis, IN 46214
800-428-SAMS

Figure 1. The heart of the sound section in this chassis is IC200, an I2C-bus controlled BTSC SAP decoder and audio processor schematic. Photo Coutresy of Howard W. Sams & Company

of Q82 is passed through common-emitter buffer stage Q83 and routed to pin 7 of the stereo decoder IC. Operation of the right/mono channel is the same. The signal is routed to pin 36. Signal source selection is controlled by the syscon via the 12C bus.

Audio output

The audio output section used in this chassis could not be any simpler. Left and right output signals from pins 1 and 42 of IC200 are routed to IC240 and IC230. The TDA7052 is a BTL (Bridge-Tied Load) audio amplifier (Figure 2).

Note that these ICs require no external components other than the RC network used for input coupling. The speaker is connected directly to pins 5 and 8. Isolation transformers are used for right and left variable audio outputs.

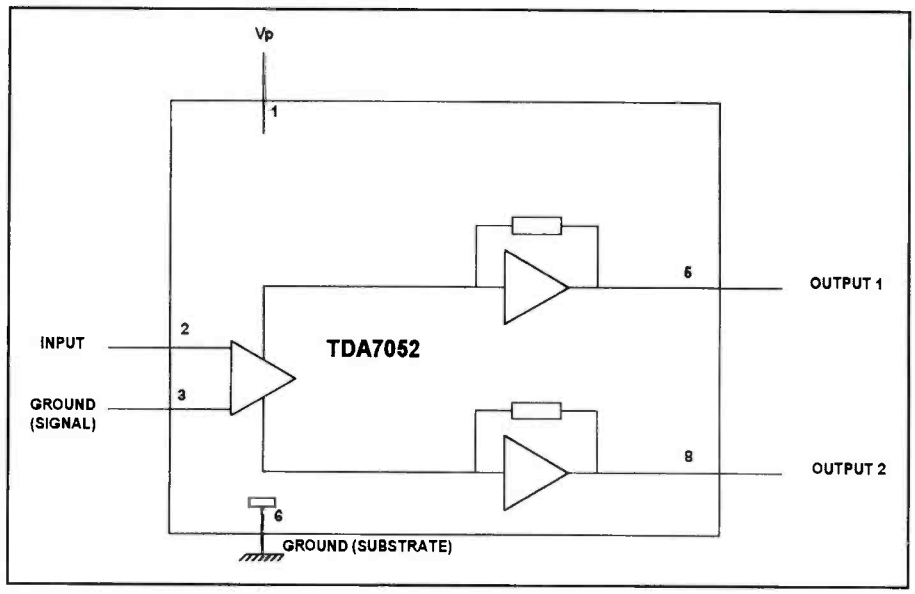


Figure 2. The TDA7052 is a BTL (Bridge-Tied Load) audio amplifier. Note that these ICs require no external components other than the RC network used for input coupling. The speaker is connected directly to pins 5 and 8.

Troubleshooting

Problems in the sound section of these sets should be relatively easy to isolate. The output amplifiers can be tested individually by signal injection if they are suspect in a dead-channel situation. Signal injection and tracing can also be used to test the right and left auxiliary input circuits. Don't overlook the possibility of power source problems when any of these circuits are not passing signals.

In a case where one or both channels are dead and you have verified that the output amplifiers and the signal at pin 24 are okay, it is likely that IC200 is faulty. This integrated circuit is also likely to be faulty if auxiliary input signals reach pins 7 and 36 but do not pass through IC200 in the auxiliary mode. IC200 may also be suspect if a single function, such as SAP or stereo does not work.

If IC200 is not functioning there is, of course, a possibility that it is not receiving the appropriate data from the syscon via the 12C bus. However, if the other bus-controlled functions are working, such as the tuner and picture control circuits, then it is likely that the data is okay. If any of the above mentioned problem conditions exist and the supply voltage is normal, IC200 is probably defective and should be replaced.

It is almost certain that at least one of the output amplifiers will be working no matter what type of sound problem you have as long as voltage source # 19 is up. It is very unlikely that both amps will fail simultaneously. A working amp can be used for signal tracing, saving the time needed to set up additional test equipment.

Connect any non-polarized capacitor of 1μF or larger to one end of a clip lead as shown in Figure 3. The capacitor will block dc while passing the audio signal allowing you to bypass suspect stages. By connecting the lead between pin 24 and the input of the amp, you will be able to determine whether the L+R signal is present. If the L+R signal is not present, then the trouble is probably in the main signal processor section. This method can also be used to trace signals through the auxiliary input circuits, provided they are connected to an audio source. The L+R signal can be injected into the auxiliary input using a second lead and capacitor if necessary.

With a general understanding of the state-of-the-art television sound section, you should be able to tackle most problems without difficulty. In fact, with the information presented here, you might find this chassis easier to service than many older monophonic chassis. ■

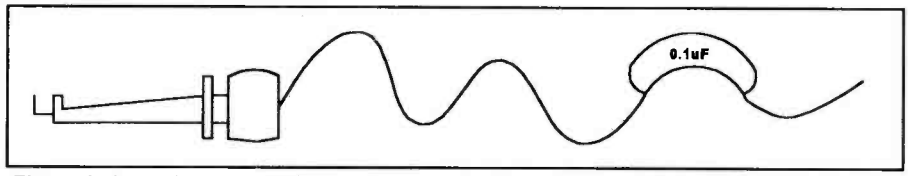


Figure 3. A working amp can be used for signal tracing, saving the time needed to set up additional test equipment. Connect any non-polarized capacitor of 1μF or larger to one end of a clip lead. The capacitor will block dc while passing the audio signal allowing you to bypass suspect stages.

ES&T Calendar

Int'l. Cons.Electronics Show (CEMA)
January 7–10, 1999
Las Vegas Convention Center and Hotels
Las Vegas, NV
CEMA (VA): 703-907-7600
www.cemacity.org

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

How antennas work

by Dick Glass

Editor's note: High definition TV (HDTV) is beginning to be available in the United States. For the time being, until some issues in the cable industry are resolved, broadcast TV will be the only way HDTV is available to many people. That means that antennas will be of increasing interest. With that in mind, and considering that for many years antennas have been de-emphasized in favor of cable delivery, this magazine will be publishing articles on the subject of antennas to try to help readers get up to speed on antennas and their installation and application.

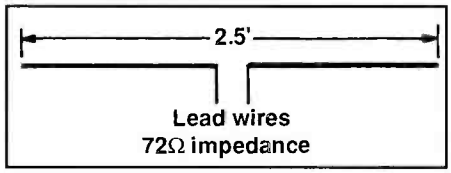


Figure 1. The half-wave dipole is the most common type of antenna used for radio/TV communications.

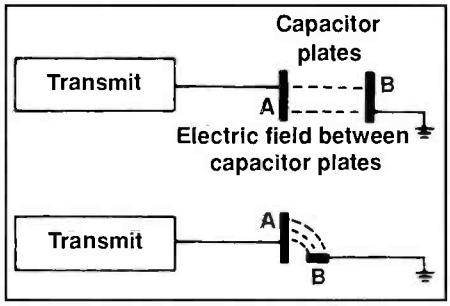


Figure 2. The signal voltage from the transmitter is impressed on the antenna in a manner similar to connecting a signal to a capacitor.

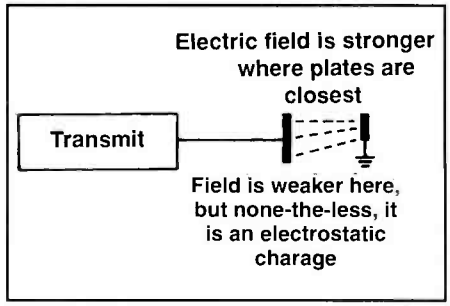


Figure 3. Where the elements of an antenna are closer together, the electric field is stronger.

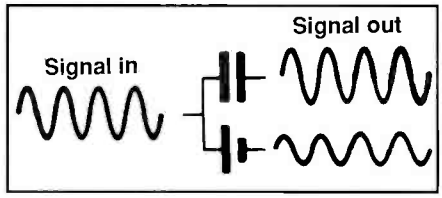


Figure 4. The antenna generates an electric field as a result of the signal coming from the transmitter.

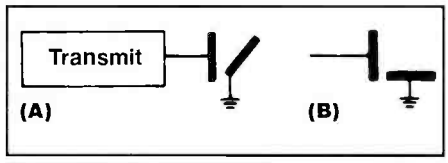


Figure 5. Setting the elements of the antenna at an angle to each other, rather than parallel, allows the field generated to be propagated.

The half-wave dipole antenna is the most common type of antenna for radio-TV communications. Mechanically, it is made of two pieces of wire.

The length of the half wavelength dipole antenna in Figure 1 is about 2.5 feet. This is the right size to be resonant (or receptive) to TV channel 11 (channel 11 frequency is 199MHz). We will find out how to determine antenna length later. For now, understand that this dipole antenna is correct to receive a horizontally polarized RF (radio frequency) signal of 199MHz.

When the RF 199MHz signal voltage is properly transferred from the final power amplifier in a transmitter, through the air, to this half wavelength dipole, the antenna element charges and discharges in much the same manner as a capacitor charges and discharges.

A signal voltage applied to plate A in a circuit produces a charge on plate A, which sets up an electrostatic field between the plates. This field causes the input signal voltage to be impressed across the plates of the capacitor (Figure 2). If one plate of a capacitor is much smaller than the other, (Figure 2 lower, or Figure 3) maximum voltage will not be impressed across it because the larger plate would not be able to set up, or react, with the metal plate opposite it, except for the areas of metal opposite each other. Actually, all of the area of the larger plate will still have an electrostatic field reacting with the small plate, but since the capacitance of a capacitor is inversely related to the distance between the plates, you can see that the top edge of the large plate A will have much less influence on the small side B (in Figure 2) than that portion directly across from it (Larger in Figure 2 lower, smaller in Figure 3).

Notice the capacitor with a small sized plate would not pass the signal as well as one with proper sized plates, but it would pass some of the signal. An antenna can be considered to act like two plates of a capacitor, having an electrostatic field between the two rods that make up a dipole. Notice that the electric field may not be as concentrated as it is in a capacitor (that has two equal size plates that are barely separated). While the field may not be as intense, still, there is an electrostatic field which (as it varies in strength and frequency) will cause an electromagnetic field. This field will travel away, or propagate from the antenna at the speed of light. (186,000MPS).

An antenna works in the same manner as a charging and discharging capacitor, creating a varying electrostatic field that, like ripples on the water, travels away from the antenna rods, perhaps forever. (We know that we can receive radio waves from Jupiter and Mars — millions of miles from Earth).

Spread the field

A capacitor usually has plates of equal size, separated by air, or by an insulator such as glass, mica, wax paper, or even an electrolyte. Usually, the metal capacitor's plates are very close to each other, and parallel.

But what happens if the plates are not parallel? We have seen what happens when one plate is much smaller than the other. Now, if the plates are not parallel, then at one point the plates are close to each other, but get farther and farther apart. The electrostatic field will be of greater magnitude where the plates are close together, and much less where the plates are farther apart. The important thing here is to realize that the entire plate

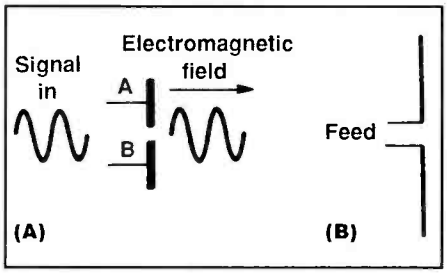


Figure 6. If the elements of the antenna are placed at an angle of 180 degrees with respect to each other, the field created will be propagated to the maximum extent.

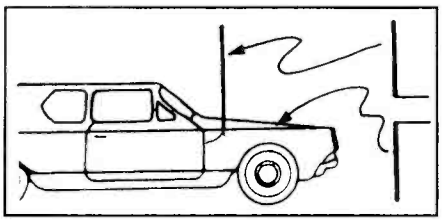


Figure 7. An auto antenna uses the fender as the other half of the dipole.

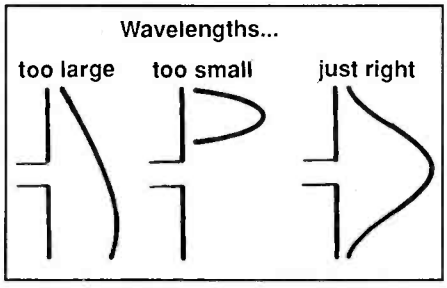


Figure 8. If the length of the antenna is one-half of one wavelength of the broadcast radio wave, the signal impressed on the antenna will be a maximum value.

still has an electrostatic field, even though the field will not be as intense where the plates are farther apart (Figure 2, 3, or 4.)

Should you then turn one plate at right angles, as in Figure 5b, the field will be distorted even more from that of two parallel, close-together plates, such as a capacitor has. But still, there is a field created as one plate becomes either positive or negative in relation to the other.

In Figure 6a, you see the plates of the capacitor at 180 degrees. This is the worst placement possible, but, still, an electrostatic field will be created as shown. While this electrostatic field may be much weaker than that created between the plates of a real capacitor (Figure 3), it is actually better for the purpose of transmitting a signal because the field is allowed to propagate outward without the restriction of the confining metal plates of the capacitor.

Next, instead of attaching the wires that connect the antenna to the middle of the elements, connect them between the rods as shown in Figure 1. The two plates, or two elements of our capacitor, still can be charged through the feed wires, but now, the charging and discharging may leave a high voltage at the feed point, while the opposite end of that piece of the antenna rod is still at a minimum at some instant. As the charging signal varies, the current and the voltage fed into the antenna elements change along the length of the rods, thus creating a pulsating electrostatic field, which, in turn, emanates outward as an electromagnetic field.

The explanation of this is that the capacitor must absorb some electrons in order to become positive or negative. These electrons must travel from the feed point to the other end of the element (or plate, if a real capacitor). Since the current leads the voltage in a capacitor, the antenna current will be maximum where the voltage is minimum and vice-versa. As long as the signal is varying, and near the proper wavelength for the antenna

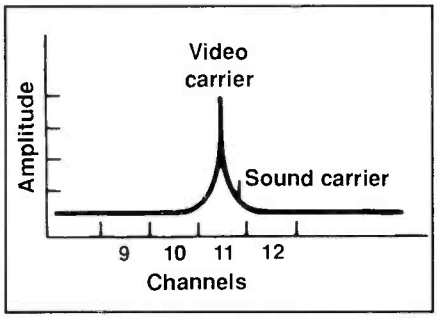


Figure 9. This signal for channel 11 shows that the signal contains most of its energy at the center of the band.

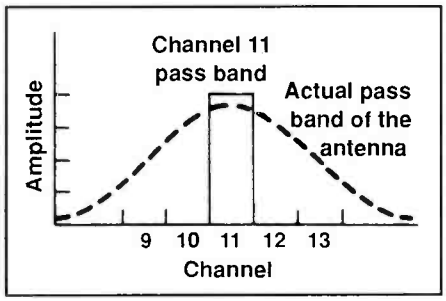


Figure 10. This diagram shows the broadcast channel bandpass allotment by the FCC versus the actual passband.

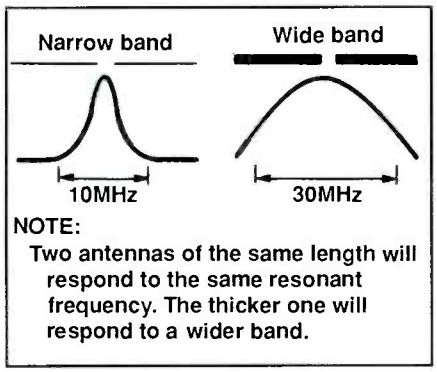


Figure 11. Two antennas of the same length will respond to the same resonant frequency.

elements, this action will continue to happen and the varying electrostatic field will produce radio signals.

While we are familiar with the very small signals used in radio communications, Nicola Tesla demonstrated that not only can you transmit voltage variations across hundreds of miles of the earth's surface, but it is actually possible to transmit power without using wires also.

Antenna resonance

If you connect a set of rabbit ears to your TV set, it will receive enough variations in the electromagnetic TV signal, (which originated at the broadcast antenna), to produce picture and sound. However, if the length of the rabbit ears antenna's V-shaped dipoles are only about 1 inch long, you will receive very little or no TV signal. Your chances of receiving enough signal to show even a faint picture are small. However, the chances are better that you can receive an ultra high frequency UHF channel (like channel 69) than of receiving a low channel, like channel 2.

Maximum transmitted signal occurs when the length of the antenna elements are nearly as long as the half-wave length of the frequency being input into it. We say "Nearly" because electric signals travel slightly slower in metal than in air, or in a vacuum (electrical signals do not need air to propagate; they do just fine in a vacuum and travel just as far and fast). In metal conductors, the speed of electrical impulses is 95% or less than in space.

We could use a full wavelength size element for our antenna but since a half-wave will radiate the maximum voltage peaks as well as the full-wave will, why waste metal?

We can even use a quarter-wave antenna. Auto radios use quarter-wave antennas to reduce physical size (Figure 7). The antenna (a Marconi) works as if it were a half-wave antenna, but one half of the physical length of the antenna is reflected by the auto body metal. The metal used for the reflected portion of an antenna is called a ground plane.

Transmitting antennas — receiving antennas — same length

If you are attempting to receive a signal with an antenna that is not the proper size (the proper size for TV channel 11 is 2.5 feet) the electromagnetic waves will not be received as well as they would be with the exactly correct-sized elements (Figure 8). If you could get the ripples on a rope you are undulating to be exactly the right size, you could "Crack the whip." If you can get a child's swing pushed with just the right amount of force, at just the right time in its arc, it will swing high. If you get the ripples in a tub of water to build by reinforcing each wave with your hand or a paddle, the wave will be big enough to splash something or somebody. There is a natural frequency of resonance with just about everything.

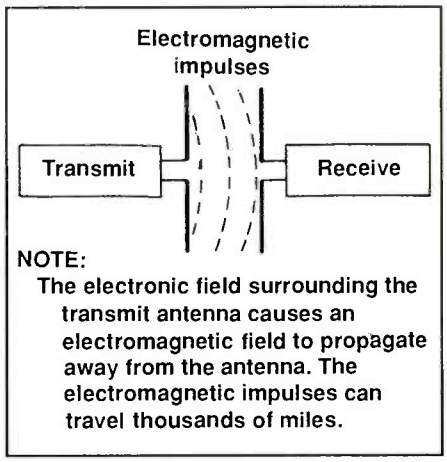


Figure 12. The signal from the broadcast antenna travels through space for perhaps many thousands of miles.

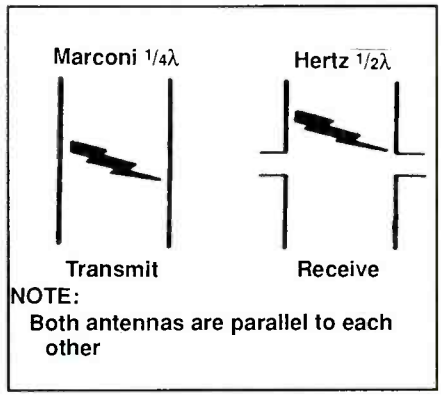


Figure 13. When the broadcast antenna and receiving antennas are aligned in the same direction, the signal received by the receiver will be the strongest it can be.

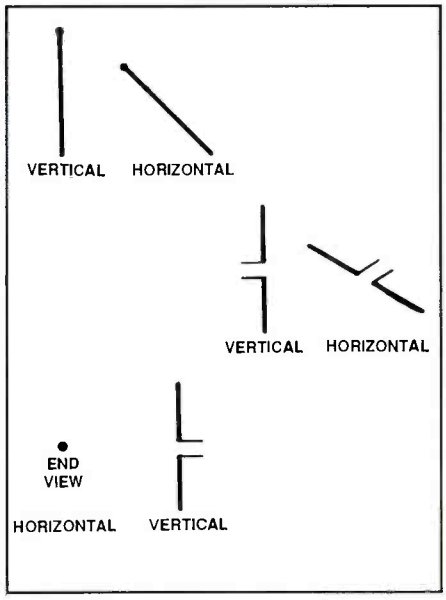


Figure 14. If the transmitting and receiving are polarized in opposite directions, the received signal will be weaker.

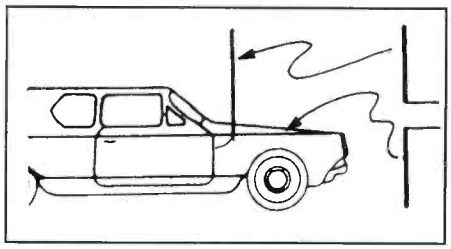


Figure 15. A fender-mounted auto antenna is vertically polarized.

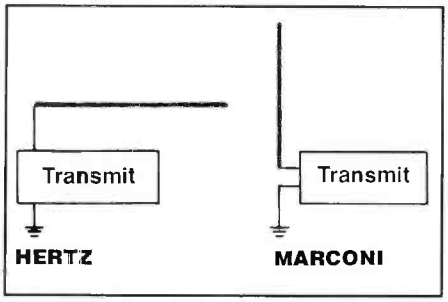


Figure 17. The radio pioneers Hertz and Marconi developed different types of antennas.

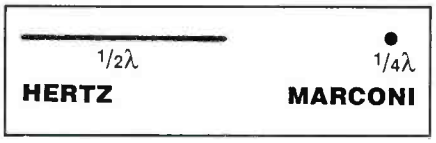


Figure 18. This drawing shows the Hertz and Marconi antennas from above.

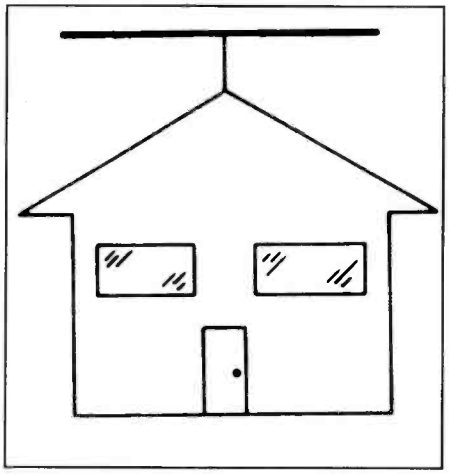


Figure 16. A standard roof-mounted TV antenna is horizontlally polarized.

If the half-wavelength size of the broadcast radio wave is the same as the 1/2 wavelength size of the receiving antenna, maximum voltage can be impressed across the two "plates" of the "capacitor," which are the two elements of the receiving antenna.

Think of the wind blowing past an antenna element at 40 to 50 mph. The elements will hum as they resonate mechanically against the blowing wind. This resonance has nothing to do with RF frequency resonance except to show that the antenna is sympathetic, or receptive, to the incoming force. In each case, the antenna reacts or responds. If the antenna responds to the tiny radio signal's magnetic variations, it can develop the voltage variations across a coil of wire, or a resistor, and begin the process of amplifying and detecting.

Frequency bandpass

An antenna will respond, or resonate, to frequencies that they aren't exactly "cut" for. They won't collect quite as much of the signal, but they may collect a usable, even satisfactory, amount. Because one antenna may, for practical purposes, need to cover an entire band of frequencies, rather than only a single narrow channel, this phenomenon is important.

Note in Figure 9 that TV channel 11 contains most of its energy near the center of the band. Both ends of the band taper off sharply, thus the signal does not normally mix, or interfere with, an adja-

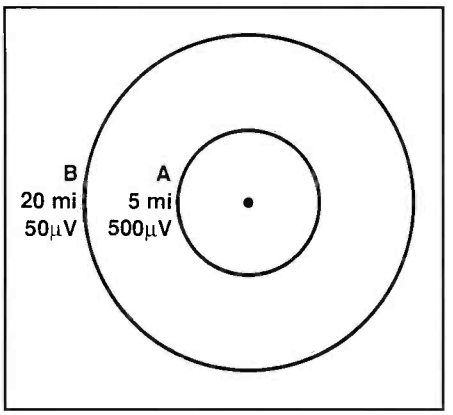


Figure 19. As the signal radiates out from the antenna in all directions, the signal is reduced in amplitude proportional to the distance it has traveled from the antenna.

cent channel. Most of the energy on the station is contained near the video and sound carrier frequencies.

The antenna for TV channel 11 would be perfect if it had a bandpass like the broadcast channel allotment specified by the FCC (Figure 10).

With such a perfect antenna frequency response, no signals above 204MHz or lower than 198 MHz could be received. No interference from channel 10 or channel 12 would occur.

The real world of antennas

So, you can see that while the typical channel 11 antenna does receive channel 11 frequencies best, it can also pick up channels 10 and 12, nearly as well (Figure 11). Can that be why some rooftop antennas need only 3 or 4 elements, yet they still seem to receive channels 2 through 13 well enough to be satisfactory?

The importance of this article is to show you that antennas really do work. We have shown that a transmitting antenna is charged with an excess or deficiency of electrons in proportion to the ripples of the signal voltage. These RF variations travel away from the transmitting antenna at the speed of light. They can be received by an identical-length antenna at your house. It is a little like transformer action (Figure 12).

Polarity

Another important concept about antennas and signal propagation is polarity. If the receiving antenna elements are parallel to the transmitting antenna elements, they can receive the electromagnetic impulses or signal voltage variations sent by the broadcast station. If both are not parallel, little or no signal can be received. Try aiming a rooftop antenna towards the station, then twist it so that the flat elements are perpendicular to the earth, rather than parallel to it. The signal developed by the antenna will measure much less on a field strength meter when it is perpendicular, as the TV transmitter antenna (in most cases) is parallel to the earth, even though it may be far up a vertical antenna tower. Take a look at the following Figures 13 through 16 to see what is meant by polarity:

Hertz and Marconi

Heinrich Hertz, of Hamburg, Germany, and Guglielmo Marconi, of Bologna, Italy, made early discoveries about radio, antennas, and electromagnetic waves, and developed antennas that still bear their names. The early antennas used for radio transmissions were the first of two types: Hertz, and Marconi (Figure 17).

Think of the Hertz antenna as a half-wave long wire antenna, parallel to the earth (although it can also be used vertically). Think of the Marconi as an auto fender-mounted antenna, one-quarter-wavelength, using the auto body as the reflected quarter-wave portion.

A bird's-eye view of the Hertz and Marconi antennas are as shown in Figure 18. The Hertz antenna, in the early days of radio, was often strung between poles, as the dimensions were much longer than for TV antennas. In the early part of the 20th century, VHF and UHF frequencies were thought to be too high to be used for any practical purposes. Meanwhile, the broadcast AM radio frequencies started out at 500kHz. This frequency has a wavelength of near 2000 feet. As higher frequencies were achieved, and thus antenna elements became shorter, vertical polarity became just as popular as horizontal.

The radiation pattern for each antenna type will show why one might use a Hertz rather than a Marconi. Note in Figure 19, that a vertically polarized monopole antenna distributes the electromagnetic waves in a 360-degree pattern. The radiation pattern for a Marconi dipole antenna is shown in Figure 20.The Hertz long-wire antenna will distribute the waves in two directions — both parallel to it. Actually, the Hertz distribution pattern is

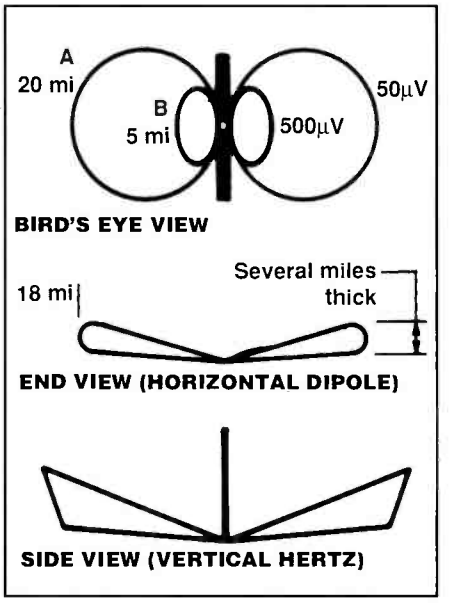


Figure 20. The pattern of the propagation of a signal from a Marconi or dipole antenna.

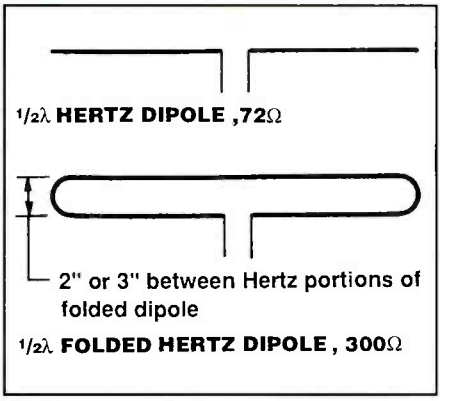


Figure 21. To take advantage of the ability of an antenna to be "broadband," some TV antennas are constructed using a "folded" dipole as shown in this illustration.

more the shape of a dome, or better yet, a Quonset hut, as it also radiates up, in addition to radiating in both parallel directions across the land.

The Marconi radiation pattern will have a null directly above it and the 360-degree outward propagation will look something like a teardrop if you could see it in a side view. It is really less like a teardrop than like the front wings of a butterfly. This propagation shape occurs because of obstacles such as trees, metal buildings, hills, and so forth that will absorb some of the ground wave as it travels across the land. Note the leading, or higher up portion of the transmitted signals, not affected by hills and ground junk, will be

stronger than those closer to the ground. Knowing this, you can see why getting your antenna up above the clutter usually will produce a stronger signal.

Thickness of the elements

A key understanding of antenna resonance and frequency response concerns the actual thickness of the metal used in the elements. If your antenna is constructed using a fine wire, it will respond to only one frequency; that is its resonant frequency. Frequencies higher or lower will be received less easily or not at all. You may recall optimizing the length of your Marconi CB (Citizen's Band) fender-mounted antenna.

Changing the length of that skinny-rod antenna only a fraction of an inch made a considerable difference in the power you were able to transmit, and also in the reception ability. The frequency desired for the CB band is 27 MHz. You do not want 26 MHz or 29 MHz signals cluttering up your radio front end.

TV antennas are commonly made with one set of elements expected to receive 2 or 3 channels about equally as well. The metal rods are thicker than most CB antenna whips. The thick TV antenna metal element allows signals adjacent to the resonant frequency to also be received, nearly as well as the resonant frequency. Thus, one element may receive channels 11, 12, and 13 about equally as well.

To take advantage of the ability of an antenna element to be "broad band," some TV antennas are constructed using a "folded dipole" as shown in Figure 21. The folded dipole looks (to the received signal) to be, not 3/8-inch or less thick, like the metal rods, but rather, about 2 or 3 inches thick (the distance between the parallel portions of the folded element.) This confuses RF signals so that they don't seem to know exactly what the resonant frequency is. They go ahead and resonate for frequencies well above and well below the actual folded dipole maximum length end-to-end.

Take the associated quiz to see that you have a grasp of antenna concepts and how antennas work. ■

Glass is President of ETA and SDA. He is owner of Glass Antenna Systems, Inc., which sells and services satellite systems and off-air antennas and operates two small cable systems and a master antenna system. This article is exerpted from "The Antenna Book," a publication that is available from The Electronics Technicians Association, 602 N. Jackson St., Greencastle, IN 46135, Tel: 765-653-8262.

How antennas work Quiz

1. If 6.24 x 10^{18} electrons were forced into one plate of a capacitor (or one of the halves of a dipole antenna) the number of electrons would be equivalent to:

a. one volt
b. one Ω (ohm)
c. one watt
d. one coulomb

2. If 6.24 x 10^{18} (6, 240,000,000,000, 000,000) electrons are forced into one plate of a capacitor (or one half of the dipole antenna) that plate, or half-antenna, will be:

a. positive
b. negative
c. neutral
d. burned up

3. If much less or much more, than a coulomb of electrons is placed onto the antenna element, then between the two sections of the antenna dipole there will be a (an):

a. electrostatic field
b. electromagnetic field
c. Marconi field
d. Hertz field

4. The resistance between one element of an ordinary half-wavelength dipole and the other portion of the dipole is _____Ω (ohms).

a. 0
b. low ohms reading, depending on frequency
c. high ohms reading, depending on frequency
d. infinite

5. The impedance between one section of a half-wave dipole antenna and the other is _____Ω (ohms).

a. 0
b. 72
c. 300
d. infinite

7. The impedance between the terminals on a folded dipole antenna, at resonance, is _____ Ω (ohms).

a. 0
b. 72
c. 300
d. infinite

8. A folded dipole, as compared to an ordinary dipole, has _____bandwidth.

a. narrower
b. wider
c. the same
d. wider bandwidth at resonance — narrower at all other frequencies

9. A Marconi antenna is usually mounted _____ to the ground.

a. parallel
b. vertical
c. isotropically
d. with coulombs isolating the main element from ground

10. The wavelength in feet of an RF (Radio Frequency) signal is calculated using the formula:

a. I= E/R
b. Wavelength = 984/f kHz
c. Wavelength = 984/f MHz
d. Wavelength = 984,000/f

11. The polar pattern of a Marconi, vertically-mounted antenna is:

a. A Figure 8
b. an exclamation mark
c. a question mark
d. a circle

Answers

1—d, 2—b, 3—a, 4—d, 5—b, 6—a, 7—c, 8—b, 9—b, 10—c, 11—d

BOOKS

***Audio Systems Technology, Level II: Handbook for Installers and Engineers* by NSCA, PROMPT Publications, 336 pages, paperback, $39.95**

Audio Systems Technology, Level II: Handbook for Installers and Engineers is designed to correspond with Level II work elements on the NICET tests. Intermediate level content is presented on audio installation as it is practiced in the industry today.

Some of the topics covered in *Audio Systems Technology, Level II. Handbook for Installers and Engineers* include basic audio calculations, acoustical measurements, trigonometry and geometry, wiring and cable, effective business communication, and bench test equipment. Additional information about getting certified by NICET is included, with tips and strategies to help the test-taker improve their chances of success on the NICET exams. This book is for you if: You want to be NICET-certified in audio systems, you are a developing audio installer or engineer, you want to enhance your knowledge of audio systems design and installation, or you are experienced but want to brush upon intermediate-level audio. Also look for the Level I book in the Audio Systems Technology series!

Authors James S. Brawley, Jr.; Bob Bushnell; Karen B. Hunt; Matt Marth; Ted Uzzle; Bill Whitock; Melvin J. Wierenga; and Ian R. Wolfe contributed chapters that draw from their specialized fields of technical expertise.

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

***Tube Substitution Handbook, Revised Edition* by Barry Buchanan and William Smith, PROMPT Publications, 160 pages, paperback, $19.95**

Tube Substitution Handbook, Revised Edition is an accurate, up-to-date guide to determine direct substitutes for receiving tubes and picture tubes.

Tube Substitution Handbook, Revised Edition will be useful to antique radio buffs, Classic car enthusiasts, ham operators, and collectors of vintage ham radio equipment. In addition, marine operators, microwave repair technicians, and TV and radio technicians will find the handbook to be an invaluable reference tool. *Tube Substitution Handbook, Revised Edition* is divided into three sections, each preceded by specific instructions. Those sections are as follows: Section 1: Vacuum Tubes, Section 2: Picture Tubes, Section 3:Tube Basing Diagrams. The diagrams provide handy reference to pin numbers for the tubes listed in the above sections of the book.

Barry Buchanan and William Smith are engineers with Howard W. Sams & Company. They amassed the information for this book while designing Photofact service documentation.

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

***Audio Systems Technology: Handbook for Installers and Engineers, Level I* by Larry W. Garter, CET, PROMPT Publications, 336 pages, paperback $34.95**

Audio Systems Technology: Handbook for Installers and Engineers, Level I is an excellent guide for the beginner or experienced audio installer who desires to learn the "entry level" basics of audio installation, and information, tips, and strategies for taking the NICET exam.

NSCA's *Audio Systems Technology: Handbook for Installers and Engineers, Level I* is a one-stop information source for today's audio technician. It can be used as a study guide to prepare for NICET audio technician certification exams, as well as a comprehensive reference for the installer of audio systems - both out in the field and at the bench. Designed to correspond with Level I work elements on the NICET tests, this book presents the basics of audio system installation as it is practiced in the industry today.

Here are just a few of the topics: Basic electronic circuits, basic math basics of microphones and loudspeakers, basic wiring switches and connectors codes, standards and safety reading plans and specifications. This book is for you if: you want to be NICET-certified in audio systems, you are a new or inexperienced audio installer, you want to learn about the basics of audio systems design and installation, and if you are experienced, but want to brush up on audio basics. Also look for Level II book in the Audio Systems Technology series.

Larry Garter is the owner and senior consultant at Techplex, a technology infrastructure designer, and he is also contracted by the NSCA as an instructor for the Certified Audio Technician Training Program. He is a member of the Audio Engineers Society, BICSI and NSCA, and is NICET certified at Level 2 in Audio Systems

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

***Understanding Neural Networks* by John Iovine, PROMPT Publications, 256 pages, paperback, $29.95**

Understanding Neural Networks explores the world of artificial intelligence by uncovering current subjects in neural network research and forecasting potential advancements in neural network technology that are simply science fiction to us now.

In *Understanding Neural Networks,* author John Iovine explains the differences between traditional rule-based (symbolic) computer processors and the mind-boggling possibilities of neural networks (artificial intelligence). Following an introductory explanation of the science and history of development, Iovine delves deeper into the subject, covering subjects such as: Biological and mathematical neurons, artificial neuron software project training, a neural network speech recognition circuit, neural paradigms, back propagation, teaching computers to speak, computers that smell, fuzzy logic, artificial life and more. Just as space flight in Buck Rogers movies proved to be a window to the future, so may the concept of the "HAL 9000" computer. If these subjects intrigue you, *Understanding Neural Networks* will help you understand the nuts-and-bolts of neural networks, along with the whys, hows, and, for the dreamers, the what-ifs.

John Iovine is an avid electronics hobbyist and author of many electronics books. His articles frequently appear in electronic magazines.

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

Test Your Electronics Knowledge

by Sam Wilson

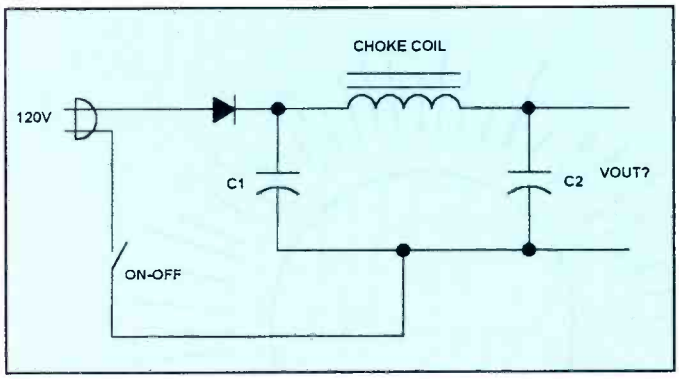


Figure 1. When the switch in this circuit is closed, what will be the dc output voltage of the half-wave rectifier?

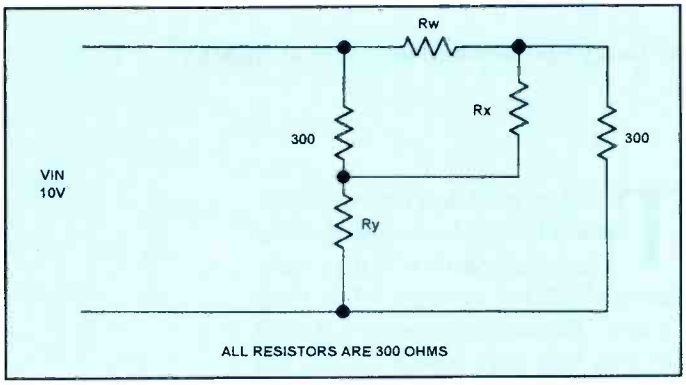


Figure 2. What voltage would you expect to find across Rx?

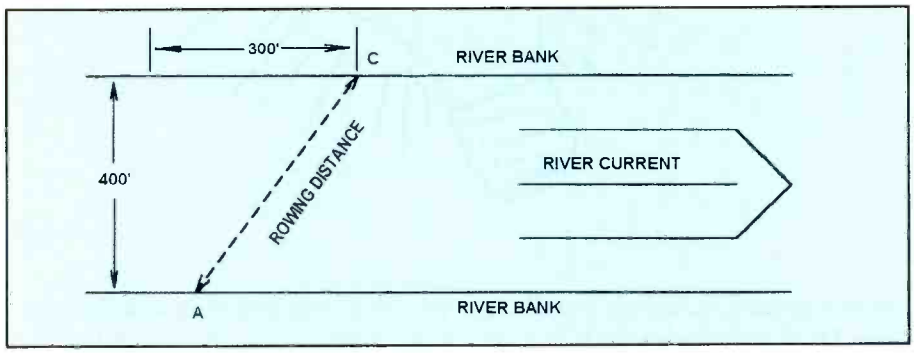


Figure 3. What total distance will the boat have traveled when it reaches the other bank?

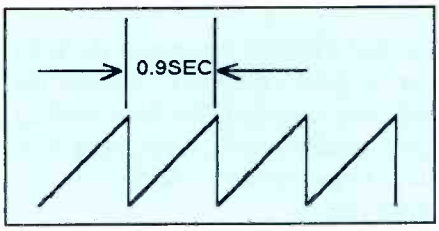


Figure 4. What is the frequency of this waveform?

1. What is the name of the number that expresses the likelihood of an occurrence of a specific event?

2. When the switch is closed, the dc output voltage of the half-wave rectifier in Figure 1 should be about _____.

3. What is the value of 1/3 divided by 3/4?

4. What do the initials DTV stand for?

5. What is the voltage across Rx in Figure 2?

6. If you are given two carbon-composition resistors, you can tell which has the highest power rating by its color code. That statement is:
   A. correct.
   B. not correct

7. A man is rowing a boat across a river that is 400 feet wide. He starts in a direction straight across at point A and the river carries him down stream 300 feet to get all of the way across. How many feet does he actually travel to get all the way across the river? See Figure 3.

8. Is the following statement correct? Digital modulation is always the most efficient method of radio transmission.
   A. correct
   B. not correct

9. Three resistors having identical resistance values are connected in series across a 120V dc source. The voltage across the center resistor is:
   A. Cannot determine unless the value of the resistors is known.
   B. 40V

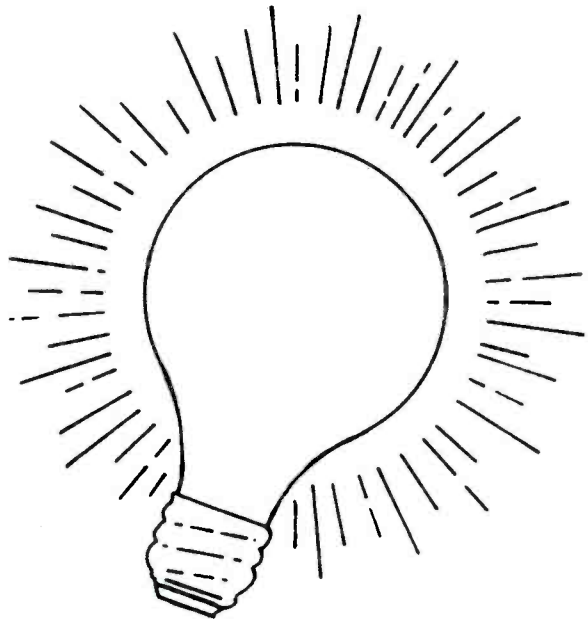
10. What is the frequency of the waveform in Figure 4?

(Answers on page 53)

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

Some ideas for improving operations

by Gerry McCann and members of NESDA



The ideas published here were generated by members of the National Electronics Service Dealers Association (NESDA) during a "Best Ideas Contest." We publish them in the hope that they may help other service centers, and perhaps inspire them to come up with their own ideas to improve their businesses.

1. Use a motion detector at the front door to greet customers. "Freddy the Frog" was suggested. The floor standing figure "ribbets" when a client enters. This often brings a smile to the lips of even cranky clients.

2. The accountant of one business owner suggested he buy his company trucks, then lease them to the business. This study of financing has helped him save taxes.

3. Keep outside technicians supplied with brochures and info on the latest technology and when it is expected to come on the market. Have copies of current articles that mention the approximate cost of new technology. This program of information encourages clients to approve repairs of existing units instead of waiting for newer technology. Current HDTV articles were passed around as an example.

4. One service center owner placed an exotic fish tank in the front lobby of his business. Watching the fish had a calming effect on front counter clients. Comments were made that the nature of our service business brings unhappy folks to our counters and we must be prepared to repair both the product and the buyer's disappointment.

5. A 25% increase in billable labor was realized by one service manager by clocking time on each repair closely and billing for it. The Sperry Tech system of time averaging was an alternative mentioned.

6. One attendee extends labor and parts warranty to 6 months on C.O.D. jobs. This was found to increase client satisfaction at a minimal cost.

7. Create a full Service Resource manual. This can become a major addition to a company policy and procedure manual. The fine sample shown contained forms for manufacturers consumer relations contacts, plus information on how and when to contact each division. A full list of each manufacturer, current service reps, steps to processing warranty, etc. This resource is used to train new employees, as well as a quick information referral for all employees.

8. Use an HTML Browser and an Intranet system. This system uses the technology for instant information. For example, when a client calls in with product or accessory questions, the employee has a menu to select category for info requested. Pictures of products, forms, etc. can be imported from manufacturers home pages for instant accessibility.

9. When selling a universal remote control, put the code for client's set on the invoice. Since remote controls are such an important element of home electronics, these will be readily available to the owner if the manual is lost or misplaced.

10. A variation of the above was offered. Write the codes onto a paper sticker place it under the battery cover when selling universal remote hand units.

11. An Intranet Concept was further mentioned. Using a company Intranet for communications internally in the service center is emerging as a modern platform for more than E-mail: sharing schematics, warranty information, parts and accessory descriptions, and scheduling were noted.

12. In order to protect units from being damaged in transport, constructing a stretcher was suggested. A 24 x 30 sheet of plywood was used. The top was carpeted, 4 pieces of appliance blanket was

attached to the sides, which covers the product envelope style. Straps were used to hold the product on. Galvanized pipes were added underneath and extended outward to make carrying easier.

13. Create a pick up and delivery route on certain days of the week at local shopping centers and elderly complexes. This idea was successfully promoted through the local Chamber of Commerce. Use an ice cream truck bell to attract attention. have portable receipts available for clients. A U-haul type truck with a rear lift works best. This servicer caters to many elderly communities in their area.

14. Make up numbered information binders for each manufacturer you represent. Different colored transparent folders for product classifications works well: TV, VCR, Camcorders, etc., with corresponding color pages. Technicians can easily put schematics in folders with large numbers and apparent location now obvious.

15. As service units come in, use a large folder to place schematic, invoice, time card, etc. This envelope follows the service unit through completion.

16. Include a question on your (QOS) Customer Satisfaction Survey asking the name of an employee who was particularly helpful. Reward the employee named on the returned form with an extra $5. Employees have a special challenge to take a personal interest in each client and this becomes positively noticeable. This policy will also create a need for an ample inventory of personalized business cards.

17. Advertise any special talents your staff can provide. Multilingual capability was mentioned. Don't miss the small but important human components of the service business.

18. Change your phone system to one chime instead of several ringing thru out the building. This lowers noise levels and reduces stress.

19. Create a dealer information package. Include hook-up diagrams, care tips on products, customer service phone numbers, info on TPW's represented, etc. When thought out well, placed in a nice binder and kept current, this book can become a constant reference and source of service referral and can be in the control area of each retail floor of your dealers.

20. Use post cards with stamps for customer satisfaction surveys.

21. Large removable Red Dot stickers can be used on the front of products coming in to the service center to denote when priority service is requested or additional service is required. The placing of the large Red Dot sticker in view of the set owner introduces a physical evidence of urgency.

22. In place of music on hold, use nature tapes mixed with info about your service center. This makes waiting more relaxing and pleasant for the client. We must go out of our way to understand the proper attention being paid to the temperament of service transactions.

23. Instead of written QOS surveys, use the phone to check with repair clients two weeks after each repair to make sure they are satisfied and don't have any questions or problems. Always remember to ask: 'What else needs fixing?"

24. If your service counter is semi-technical, try to solve clients complaint at the front counter by asking about complaints. If the problem can be solved by simple cleaning, degaussing, etc., do these instantly. The word of mouth advertising this promotes is well worth the time.

25. In today's servicing, we are moving more large-screen products. If your building doesn't have a loading dock, construct your own free-standing trucking ramp. Build a loading dock platform, with a long smooth deck plate so one man can dolly load and unload a truck.

These ideas were generated by members of NESDA, the National Electronic Service Dealers Association, during a session called the NPSC '97 Best Idea Contest. This session took place during the NESDA National Professional Service Conference, on August 8, 1997 in Las Vegas, NV. We thank NESDA for giving permission to reprint them here. For more information about NESDA, call or write: NESDA, 2708 W Berry, Fort Worth, TX 76109-2356, 817-921-9061.

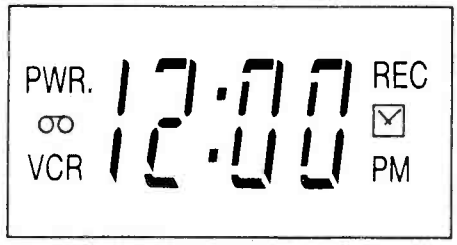
The Magnavox VRX video cassette recorder

by Bob Rose

The Magnavox VRX VCR has been in consumer hands for about a year now. It includes the following models: VRX 222AT21, VRX 242AT21, and VRX 262AT21.The service literature for these models is Manual 5847, available from Philips Consumer Electronics Company. The manual is in three parts consisting of sections 1a and 1b, which detail the VCRs specifications, operating instructions, adjustment procedures, schematics, and cabinet and electrical parts. Section 2 covers every aspect of the deck mechanism, including a parts list.

Since the VRX models are similar to products with the Funai brand name on them, this manual will allow you to service a variety of brands. I checked through my Funai literature, and I believe their manuals for model numbers LV 227G and/or LV446G will work for these

Rose is an independent consumwe electronics business owner and technician.



" H "= LED Light on, " L "= LED Light off

LED MODE	INDICATOR ACTIVE	
CASSETTE "IN" CASSETTE "OUT"	" ⊙⊙ " " ⊙⊙ "	ON OFF
VCR/TV VCR MODE VCR/TV TV MODE	" VCR " " VCR "	ON OFF
CLOCK	" 88:88 " " PM "	ON ON
POWER ON	" PWR "	ON
REC	" REC "	ON
REC PAUSE	" REC "	Blinks at 0.8Hz interval
T-REC, OTR	" ☑ "	ON (T-REC OFF, T-REC incomplete Blinks at 0.8Hz interval)
When reel and capstan mechanism is not functioning correctly	" ⊙⊙ "	Blinks at 0.8Hz interval
When tape loading mechanism is not functioning correctly	" ⊙⊙ "	Blinks at 1.6Hz interval
When cassette loading mechanism is not functioning correctly	" ⊙⊙ "	Blinks at 3.2Hz interval
When the drum is not working properly	" ⊙⊙ "	Blinks at 6.4Hz interval
S-INH Condition	All modes	Blinks at 0.8Hz interval

Figure 1: The above symbols will appear on the indicator panel to indicate the current mode or operation of the VCR. On-Screen modes will also be monmentarily displayed on the TV screen when you press the operation buttons.

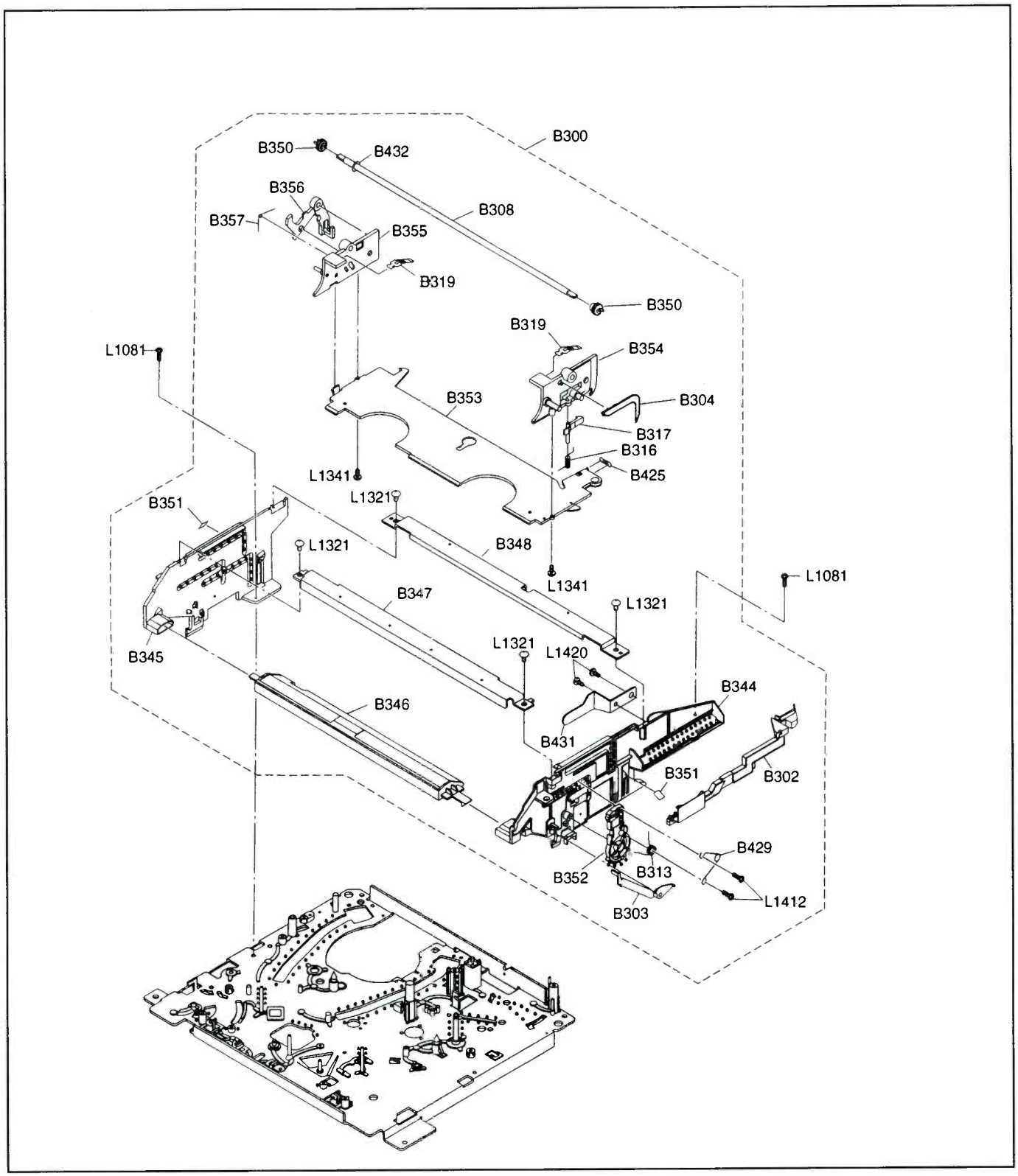


Figure 2. Deck mechanism of the VRX video cassette recorder.

units, for the most part. However, do keep in mind that there may be critical differences, and different part numbers, so if you use the Funai manual, do so only as a general guide, not as gospel. The "LV" designation identifies these VCRs as those sold under the Sylvania brand. Remember that "Sylvania" no longer refers to a Philips brand.

How can I describe these units?

Electrically, these VCRs offer a variety of options that we consumers have grown accustomed to and do not markedly differ in this respect from the more expensive brands. The power supply, which is a high failure circuit in any device, appears to be relatively trouble free. The exception will

be capacitors that have a close voltage tolerance. Funai has had modest problems with certain microprocessors in previous units. The "jury is still out" with respect to the VRX units, but it appears that these new units will function quite well (and reliably) electrically.

Mechanically, the VRX VCR's offer a lighter, compact deck than previously manufactured. The manufacturer has found a way to use fewer parts, which means that the manufacturing and selling costs have decreased. The VCR is surprisingly light. I can hold one between my thumb and fingers without fear of dropping it. I have to confess that this bothers me. I am from "the old school" which means that the heavier a unit is, the more metal it has in it rather than plastic and it will tend to be a little bit more reliable. Only time and use will tell us how mechanically reliable the new units will be.

Even though they have been out only for about a year, the VRX units have a repair history. Some of the problems are unique as you will see (if you haven't already experienced them!). I will attempt to group the problems with which I am familiar around common themes.

Problems with the front panel display

You may be called on to service one of these VCRs because all or part of the segments of the display don't come on. The display has a black mask surrounding it. Would you believe the mask can shift and block the display! The cure is to disassemble the unit and reposition the mask.

The problem can also be caused by cold or broken solder joints around the pins that anchor the display to the PCB. There have also been reports of broken copper runs to the pins of the display.

LED problems

The photodiode continues to be a problem. In some instances, the diode itself is defective and must be replaced. How does the problem show up? A friend of mine bought a new combi unit. He was pleased with its performance, especially the picture quality. However, after he had it for two months, he said it woke him up about two o'clock one morning turning itself on and off! He wanted to know if he needed an exorcist or a repair person! The problem was a defective photodiode.

The part designation for the VRX photodiode units is D511. Under normal circumstances, the LED "lights up like a Christmas tree" when ac is applied. It turns on the tape end sensors which send lows to the CPU. The CPU interprets the low as "no cassette present" and keeps the mechanism in an off state. If the light path is interrupted, the CPU will receive a high. It interprets the interruption in the light path as a command to turn the unit on and begin the play sequence. If no tape is present in the basket, the CPU will turn the VCR on and off several times before it powers down. If you examine the display, you will see that the "cassette in" symbol is blinking at a 3.2Hz rate, which means the cassette loading mechanism is not functioning correctly.

The literature explains the problem like this: D511 deteriorates to the point where its emission is insufficient to turn the end sensors on. The microprocessor does not receive the "low" it expects and interprets this as a command to turn the VCR on. The manufacturer cautions us not to replace D511 with a part from an older unit because the older parts cannot supply the necessary output. I can confirm that they are correct! The Philips part number is 4835 130 87139.

Incidentally, these new units will tell you what is bothering them if you know how to interpret the data. Figure 1 lists "the trouble indicators" and how to interpret them. If you use these indicators, you can often know what the trouble is before you take the top off the VCR.

Now, suppose you load a tape and the unit goes into shutdown three to nine seconds after the tape starts to play. You wonder if the capstan is working, but you know it has to be because the counter is working. The first thing to check is the alignment and physical integrity of the prism. Reports indicate prism alignment problems are common, especially if you have taken the deck out of the unit. I have not seen this particular problem, but I have seen a host of broken prisms.

The prism is of a different configuration than the type of prism we are accustomed to. It is so configured because the VRX mechanism uses D511 to sense the end-of-tape and reel rotation. Its part number is 4835 402 97727.

Suppose you load a tape and put the VCR into play or record mode and it shuts down in about fifteen seconds. The problem could be a defective D511. Before you replace it, check to see that the black barrier between the take up reel and start sensor is in place. If the glue that holds it has come loose and/or the barrier has moved, it will block light from the prism to the take up reel and create this very symptom.

Picture problems

I have seen a unit or two that had a snowy picture during playback. If you jarred the VCR, the picture might clean up for a moment or two. The VCR is so constructed that the B13 lever can strike C301 and break it loose causing the picture problem. The cure is to reposition the capacitor and resolder it.

Mechanical problems

There are two mechanical problems I want to deal with. First, you may notice excessive noise when the unit is in FF or RW mode. The cause is the capstan belt rubbing against components on the main PCB. The cure is to reposition the components. Second, the carriage (cassette basket) does not seem to be as substantial as it has been. If you have serviced any VRX units, you will understand. The parts breakdown for the cassette basket is displayed in the "deck mechanism view 3" diagram (see Figure 2 for a view of a portion of this mechanism).

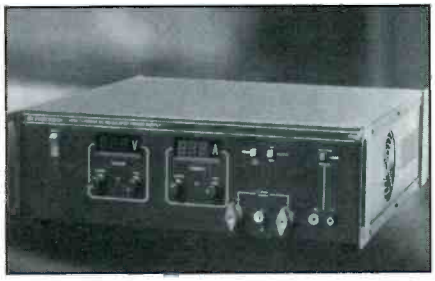
I have had problems with the teeth of items B350 breaking off and getting stuck in the grease in the tracks of B351 and B344. If this happens, the mechanism will jam when tapes are inserted or ejected. The cure is to remove the debris, replace the grease, and perhaps replace one or both B350 parts (4835 522 37347). Item B302, the rack, also breaks. I have no Philips part number for this piece. If you don't want to put the basket together piece by piece, order the whole assembly, 4835 103 97092. It is inexpensive and may in fact save you time.

If you have encountered problems I haven't seen and/or haven't discussed, let me know. I am interested in collecting and passing on information, and I always enjoy talking with people who are in our line of work. ■

Programmable high-power regulated dc power supply

BK Precision introduced the Model 1790 high-power, 20A regulated dc power supply. According to the manufacturer, the supply's excellent constant voltage/current operation, ability to preset current limit without load, high stability, and close regulation (+/-0.01%), make it a viable choice for use in high current, variable voltage lab, and production applications.

This analog, remotely programmable power supply also features remote voltage sensing, overvoltage protection (optional), and phase controlled pre-regulation and linear post regulation. Two large 3-digit LED voltage and current displays, constant voltage/current indicator, stand-by DC Output ON/OFF switch, and a momentary contact switch for setting constant-current are front panel mounted.



Circle (100) on Reply Card

Capacitor tester

The Capacitor Wizard is an instrument that is specially designed to check capacitors of 1µF and larger "in circuit," eliminating the need to remove the capacitor for accurate tests. The unit measures ESR (equivalent series resistance). High ESR is an indicator of a bad cap.

The meter is easy to use, says the manufacturer. Connect the meter to the capacitor and look at the display: red for bad caps and green for good.

Circle (101) on Reply Card

Epoxy kits for PCB repair

Repairing cosmetic damage to printed circuit boards is possible with Epoxy Kits from Circuit Repair Corporation. To use, simply mix, add the right coloring to match your board's hue, and apply. The epoxy cures to a strong and durable finish, restoring the integrity and appearance of your repaired PCB.

Epoxy Kits include EP-01 Epoxy, a clear, low viscosity, superior strength epoxy, precisely measured out in two compartment plastic pack-ages, so that

Circle (69) on Reply Card

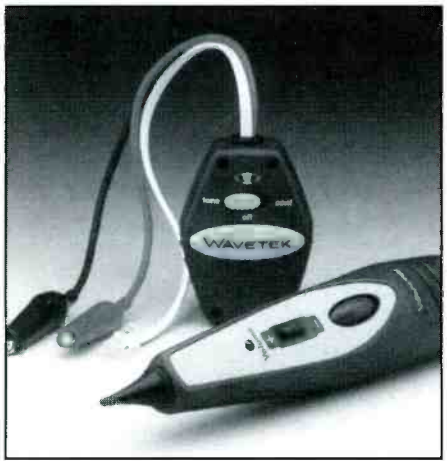
Circle (74) on Reply Card

the user doesn't have to measure. The EK-10 Epoxy Kit includes 10 packages of EP-01 Epoxy, 10 mixing sticks, mixing cups and foam swabs. The EM-10 Epoxy/Mask Kit also includes 3 different coloring agents for proper color matching. A wide selection of additional coloring agents is available.

Circle (102) on Reply Card

Inductive speaker probe and tone generator

Wavetek introduces the new 540 Series, the 5425P Inductive/Sensing Speaker Probe and the 541TG Tone Generator/Sender. These products are compatible with each other, as well as with other similar devices sending or sensing tones. Designed for moves, adds and changes to telephones, LANs, security systems, audio/visual systems, etc.



The Model 5425P probe detects tones and provides an audible signal to inform the user of the correct wire carrying the tone signal. Extra features include an LED lamp and sensitivity adjustment knob. The LED light provides visual indication and glows with the correct wire. The sensitivity adjustment knob allows for quieter operation in crowded areas or louder operation in noisy settings.

The Model 541TG tone generator sends an alternating frequency "warble" signal for detection by the speaker probe. An RJ11 connector for quick plug-in to standard telephone jacks, datacom RJ45 jacks 3, and a pair of alligator clips for quick attachment to any wire pair are all included. Its 3-position switch selects warble tone, off or continuous output. An LED indicates continuity and warns users of an active circuit.

Circle (103) on Reply Card

Projection television repair and maintenance video

This instructional video from Electronix starts by explaining the similarities and differences between projection sets and standard televisions, including basic theory. Next, different types of troubleshooting are covered, along with tube replacement and alignment. Convergence adjustment, a too often challenging problem, is reviewed in detail. The last segment of the program addresses common failures and their likely solutions. This video assumes that the viewer has had some basic experience with television repair.

Circle (106) on Reply Card

Training package for digital multimeters

Fluke has teamed up with the professional educators at American Technical Publishers, Inc. (ATP) to develop a comprehensive instructional program on the proper use of digital multimeters (DMMs). The new training package, *Digital Multimeter Principles*, is designed for use in company training programs, schools, and by educators to teach DMM fundamentals.

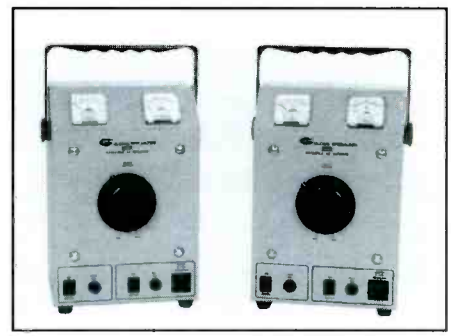
The training package includes the *Digital Multimeter Principles* textbook; the instructor's *Resource Guide* with hands-on exercises, a step-by-step outline, and 42 color transparencies; *Electrical Principles and Practices* and *Electrical/Electronic Systems* textbooks; two videotapes covering DMM operation and safety procedures; and a Components Kit for use with the hands-on exercises. The package also includes a Competency Skill Checklist and Certificate of Completion for the instructor's signature.

While the training package is intended for use in a seminar or classroom setting with a qualified instructor, there are individual items offered for self-study. The *Digital Multimeter Principles* textbook, the *Digital Multimeter Principles Resource Guide*, the Digital Multimeter Principles videotape, and the ABCs of DMM Safety videotape are all separately priced and comprehensive.

Circle (107) on Reply Card

High current variable voltage ac supplies

Global Specialties introduces two high-current variable line ac sources, featuring continuously variable outputs from 0Vac to 130Vac at 0A to 10A (Model 1510, p/n 105-1510), and 0Vac to 130Vac @ 0A to 15A (Model 1515, p/n 105-1515)



Both models have a wide operating frequency range from 47Hz to 450Hz, making them especially suitable for testing and repairing products that have stable but changeable frequencies, such as in avionics and repair.

Both models have built-in analog voltmeters and ammeters with 2% full scale accuracy, power ON/OFF, and special ON/OFF voltage load switches.

Both models also feature separate input and output fuses for double protection and a rugged design, portable with unique adjustable handles.

Circle (108) on Reply Card

Soldering iron

The new PS-80 Soldering Iron from PACE allows for reliable soldering at lower temperatures. SensaTemp control and a platinum temperature sensor provide accuracy for repeatable performance with no calibration required. Its innovative handle design is lightweight, comfortable, and stays cool during use, says the manufacturer. With over 75 thru-hole and surface mount tip choices, this iron is designed to meet a variety of production and rework requirements.

Circle (109) on Reply Card

What Do You Know About Electronics?
The Determinant

by Sam Wilson

In a previous issue in a TYEK question, you were asked to evaluate a determinant like the one shown in Figure 1. The noble editor of ES&T reminded me it is probable that many of our readers haven't looked at that math for a long time, so, they may not remember Cramer's Rule. I'll take care of that now.

The two-by-two determinant in Figure 1 is part of a solution of the two simultaneous equations in Figure 2. They are simultaneous equations because there is a value of X and a value of Y that can be used in both equations and the equations will be correct. I'll show you that case in the determinant problem that follows.

As shown in Figure 2, the unknown values are X and Y. The question is: What value of X and of Y can be substituted into both of these equations to make them true? The first step is to make sure that the equations with X and Y, and the known values, are aligned vertically as shown in Figure 2.

Now the coefficients of X and Y are written in the same alignment to make the determinant (D) - sometimes called Delta (Δ). Cramer's rule says that the value of D can be obtained by subtracting the product of the ups from the product of the downs. See Figures 3 and 4. The rule, as stated, applies only to a 2 by 2 matrix.

The determinant is (D) the denominator of the final solution. The numerator for the solution of X and Y is obtained as follows: substitute the knowns column (10 and 3) for the coefficients of X. The solution now looks like Figure 5. Find the value of X by using Cramer's rule on the numerator as shown in Figure 5. Then substitute the knowns column for the coefficients of Y. See Figure 6. Find the value of Y.

You now have the values of X and Y for the simultaneous equations. You can prove that your values of X and of Y are correct by substituting each value into the original equations:

$$D = \begin{vmatrix} 5 & 2 \\ 3 & 6 \end{vmatrix}$$

Figure 1. This two-by-two determinant is part of a solution of the two simultaneous equations in Figure 2.

$$5X + 2Y = 10 \quad \textbf{Equation 1}$$
$$3X + 6Y = 3 \quad \textbf{Equation 2}$$

Figure 2. A "determinant" provides one method of solving a system of two equations with two unknowns.

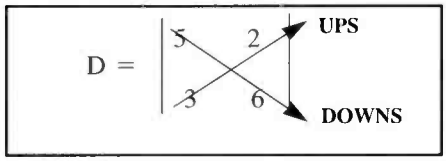


Figure 3. To evaluate the determinant of Figure 1, cross multiply as shown here.

$$D = (5 \times 6) - (3 \times 2) = 24$$

Figure 4. This is the result of the cross multiplication of Figure 3.

$5(2.25) + 2(-0.625) =$

$11.25 - 1.25 = 10$ (See Equation 1 in Figure 2)

and $3X + 6Y = 3$

$3(2.25) + 6(-0.625) =$

$6.75 - 3.75 = 3$ (See Eq. 2 in Figure 2.)

The next question is: Where will you find a situation where you can use two simultaneous equations? Usually a circuit with two power supplies is used for an example. However, I'm going to use a circuit with one power supply and two loops — often called "meshes." My reason for doing that is that the problem can be easily solved as a basic series-parallel problem and that will check the answer given by determinants. Refer to Figure 7. The problem is to find the value of current through R_2.

As I said before, we can solve that problem easily as a series-parallel problem. When I write $R_2//R_3$, I mean the value of R_2 and R_3 connected in parallel.

The total resistance (R_T) as "seen" by the battery is:

$$R_T = R_1 + R_2//R_3 = 8 + 2 = 10\Omega$$

The total current (I_T) is $V/R_T = 10/10 = 1A$

The current through R_2 can be found by the reciprocal method.

$$I_2 = I_T \times (R_3/R_2 + R_3) = 1 \times (6/9) = 2/3A$$

Observe that 2/3 of the 1A total current flows through R_2, so 1/3 of the current flows through R_3.

Now, we will use determinants in the solution for the current through R_3. See Figure 7. We have already determined that the current through R_3 is 1/3A, so, the following solution should be a proof of that solution. I'm going to romp through a couple of basic network theorems and laws before I start the solution.

Kirchhoff's Voltage Laws — The algebraic sum of the voltage drops and voltage rises for any closed loop is zero; and the algebraic sum of the currents at any junction is zero.

I'm going to give a solution that is totally out of sync with my training. In fact, it may totally destroy my epizookus. I'm going to assume electron current flow. So, when assumed current enters the negative side of a voltage, I'll call it a voltage drop (-), and when an assumed current enters the positive side of a voltage, I'll call it a voltage rise (+).

I'm going to use Maxwell's loop equations to solve the problem. That is a generalization of a Kirchoff law. For the Kirchhoff's solution, you use as many

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

$$X = \frac{\begin{vmatrix} 10 & 2 \\ 3 & 6 \end{vmatrix}}{24} = \frac{(10 \times 6) - (3 \times 2) = 54}{24} = \frac{2.25}{24}$$

Figure 5. To solve for X in the simultaneous equations, in the numerator, substitute the knowns column (10 and 3) for the coefficients of X. The determinant (D) is the denominator of the final solution.

$$Y = \frac{\begin{vmatrix} 5 & 10 \\ 3 & 3 \end{vmatrix}}{24} = \frac{(5 \times 3) - (3 \times 10) =}{24} \quad \frac{-15}{24} = -0.625$$

Figure 6. To solve for Y in the simultaneous equations, in the numerator, substitute the knowns column (10 and 3) for the coefficients of Y. The determinant (D) is the denominator of the final solution.

junction current equations as needed to include all of the currents in the circuit, and as many voltage loop equations as needed to include every voltage.

With our problem, as drawn in Figure 7, that would require three equations and three unknowns (one current equation and two voltage loop equations) if you use Kirchhoff's method. With Maxwell's solution (sometimes called the Maxwell-Helmholz solutions), we can solve the problem with only two voltage loops, and, therefore, two equations with two unknowns.

Note: Maxwell's method is sometimes (erroneously) called a solution by Kirchhoff's laws.

I have systematized the Maxwell's method by always assuming clockwise currents as shown by I_1 and I_2 in Figure 8. Put down your pen and listen to me . You don' t need to write and tell me I have assumed the wrong direction for I_1, and I_2. As I said, I always assume a clockwise direction for assumed currents. If my assumption is wrong, my answer for I_2 will be the correct numerical value, but it will have the wrong polarity.

For voltage loop ABEFA (starting and ending at A)

$$-8I_1 - 3I_1 + 3I_2 - 10 = 0$$

Observe that there are two polarities of voltages across R_2. Both polarities must be counted for each voltage loop.

For loop BCDEB

$$-6I_2 - 3I_2 + 3I_1 = 0$$

First we combine the I_1's and I_2's, then align the unknowns and knowns.

$$-11I_1 + 3I_2 = 10$$
$$+3I_1 - 9I_2 = 0$$

Figure 8. Writing the voltage equations for the two loops in the circuit of Figure 7 results in these two equations with two unknowns.

The value of D is shown in Figure 8. The determinant and solution for I_2 is shown in Figure 9.

The current I_3 through R_3 has been shown to be 1/3A. Describing a solution by determinants is much like describing how to tie shoe laces without illustrations. I assigned that problem once in a technical writing class. (Don't try that at home).

Observe that the sum of the currents through R_2 and R_3 is 1A.

$$Y = \begin{vmatrix} -11 & 3 \\ 3 & -9 \end{vmatrix} = 99 - 9 = 90$$

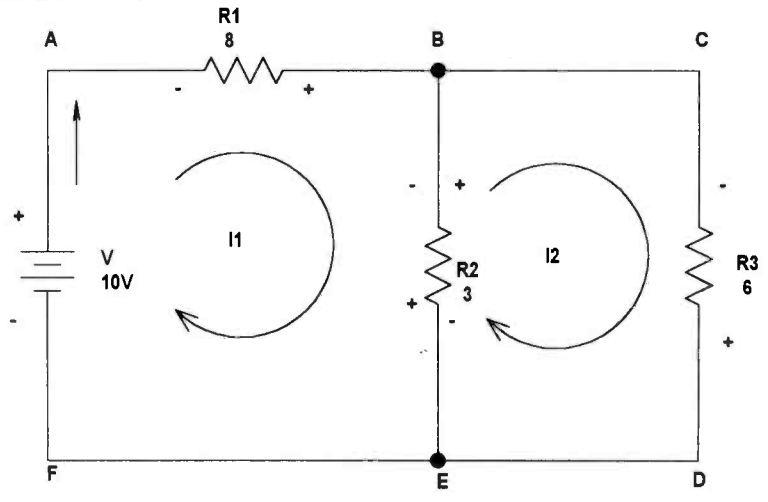
$$I_2 = \frac{\begin{vmatrix} -11 & 10 \\ 3 & 0 \end{vmatrix}}{90} = \frac{0 - 30}{90} = -1/3A$$

$$I_1 = \frac{\begin{matrix} 10 & 3 \\ 0 & -9 \end{matrix}}{90} = \frac{-90 - 10}{90} = -1A$$

For R_2 the actual current through it is:

$$I_1 = I_2 = -I_1 - (-I_2)$$
$$= -I_1 + I_2$$
$$= -1A + 1/3A$$
$$= 2/3A$$

Figure 9. To solve Figure 8 for the values of I1 and I2, use determinants, as shown here.



(POLARITIES ACROSS RESISTORS ARE BASED UPON ASSUMED CURRENTS I_1 AND I_2)

LOOP ABEFA: $-8I_1 - 3I_1 + 3I_2 - 10 = 0$

$-11I_1 + 3I_2 = 10$

LOOP BCDEB $6I_2 - 3I_2 + 3I_1 = 0$

$3I_1 - 9I_2 = 0$

Figure 7. When using electronics mathematics to find values of voltage or current results in systems of two equations with two unknowns, you can use determinants to arrive at the solution.

1998 Article Index

ES&T 1998 Department Index

Test Your Electronics Knowledge

Answers to test *(from page 39)*

1. Probability
2. Greater than 160V
3. 1/3 divided by 3/4 = 1/3 x 4/3 = 4/9
4. Digital TV
5. 0V — The circuit is a Wheatstone Bridge.
6. B — You can tell which has the higher power rating by its larger physical size.
7. 500 feet — Note from Figure 3 that a 3, 4, 5 right triangle is involved.
8. B — "Analog amplitude modulation is the most efficient method of transmission in an analog channel." (Quoted from *IEEE Spectrum* — April 1991).
9. B — If the resistors have equal resistance values, one-third of the voltage drops across each resistor.
10. F = 1/T = 1/0.9sec = 1.11Hz

Profax Ten-Year Directory

(January 1988-December 1998)

	Profax #
January 1988	
Zenith PV800 color monitor	3017
Hitachi color TV, CT 1358 chassis	3018
February 1988	
GE VCR, 2018W Model	3019
March 1988	
GE 8-4500 projection TV	3020
April 1988	
NAP projection TV, E54-10 chassis	3021
Zenith color TV, C2020H chassis	3022
May 1988	
RCA PVM050 color TV	3023
Hitachi CT2652, CT2653 color TVs	3024
June 1988	
Hitachi color TVs CT2647/CT2648/CT2649 chassis	3025
NAP projection TV, E54-15 chassis	3026
July 1988	
GE Model 1VCR2006W VCR	3027
Zenith color TV, CM-139/B-0 (B) chassis	3028
August 1988	
Hitachi color TV, CT1344 chassis	3029
NAP color TV, E51-56 chassis	3030
September 1988	
RCA color TV, PVM035 chassis	3031
GE color TV, NC-05X3/06X1 chassis	3032
October 1988	
Hitachi CT3020W/CT3020B color TV	3033
Zenith CM-139/B-3 (I) SD2511G/ SD2581H color TV	3034
November 1988	
Hitachi VHS VCR, Model VT-63A	3035
NAP RD4502SL/RLC312SL color TV monitors	3036
December 1988	
GE proj. TV, PW chassis Model 40PW3000KA01	3037
January 1989	
Hitachi color TV, CT1955, NP85XA chassis	3038
NAP color TV, series 19C2 chassis (Magnavox)	3039
February 1989	
RCA/GE color TV, CTC145/146 chassis	3040
Zenith col. TV, CM-140/b-2 (G) chassis (Models SE2503G/SE2505P, SE2507N/SE2509H)	3041
March 1989	
NAP color TV, chassis E34-11	
Hitachi color TV, chassis CT1941/CT19A2, NP83X chassis	3042 3043
April 1989	
GE VHS VCR, Model 1VCR2002X	3044
Hitachi CT1955 color TV	3045
May 1989	
Zenith CM-14-0/B-3(1) color TV (Models SE2721H/SE2725R/SE272H)	3046
GE color TV, 1987 CTC 136	3047
June 1989	
RCA P42000-S1 projection TV (additional Models: RVM46700, 46GW700, P46000)	3048
NAP color TV, chassis E54-15 (Magnavox RD8518 and RD8520; Philco Model P8190S; Sylvania PSC410 and PSC420)	3049
July 1989	
Hitachi CT2066 color TV	3050
RCA CTC135 color TV	3051
August 1989	
GE CTC135-S1 color TV	3052
Zenith CM-140/B-2(I) color TV	3053
September 1989	
RCA CSM055 col. TV/AM/FM/clock radio	3054
October 1989	
Hitachi CT2086 B/W chassis G7NU3 color TV	3055
Zenith PV4661H rear-projector col. TV	3056
November 1989	
GE 1987 8-4500 projection color TV	3057
RCA/GE CTC 145/146 color TV	3058
December 1989	
Zenith CM-140/Digital (C) chassis color TV (ModelsSE3135P/SE3191H/SE3535H/ZB2771H/ ZB2771H2/ZB2777H/ZB2777H2/ZB2797P/ ZB2797P2/ZB2797Y/ZB2797Y2/ZB3193H/ZB3193Y/ ZB3539T/ZB3539Y)	3059
January 1990	
Hitachi CT 1395W G7NSU2 color TV	3060
February 1990	
Zenith CM-139/B1 (Y) and (K) color TV receivers Models SD2097S (Y) and SD 1327W3, SD1327Y, SD1327Y3 (K)	3061
March 1990	
RCA/GE CTC 148/149-S2 chassis color TV	3062
April 1990	
Hitachi G7XU2/3 chassis color TV G7XU2—Models CT2087B/W, A087 (MT2870 through MT2878) G7XU3—Models CT2088B/W, A088 (MT2880, MT2886, MT2887)	3063
May 1990	
Zenith PV-140/Digital (G) Rear Proj. digital TV receiver, Zenith surround stereo system	3064

	Profax #
June 1990	
Hitachi CT4580K, VP7X2 chassis projection TV	3065
July 1990	
Zenith PV454-1P chassis color TV	3066
August 1990	
RCA/GE TX81 chassis color TV	3067
Septemeber 1990	
RCA/GE CTC156 chassis color TV	3068
October 1990	
Hitachi VP9X1 chassis color TV	3069
November 1990	
RCA/GE CTC169 (PV) chassis color TV	3070
December 1990	
RCA CTC91 chassis color TV	3071
January 1991	
RCA CTC99 chassis color TV	3072
February 1991	
RCA CTC107 chassis color TV	3073
March 1991	
RCA/GE CTC168 chassis color TV	3074
April 1991	
RCA/GE CTC86 chassis color TV	3075
May 1991	
RCA/GE KCS203 chassis B&W TV	3076
June 1991	
RCA CTC96 chassis color TV	3077
July 1991	
RCA CTC107 chassis color TV	3078
August 1991	
Hitachi CT1947/CT19A7 chassis color TV	3079
September 1991	
Hitachi CT2541/2542 chassis color TV	3080
October 1991	
RCA/GE CTC167 chassis color TV	3081
November 1991	
RCA/GE CTC166 chassis color TV	3082
December 1991	
RCA/GE CTC 169 chassis color TV	3083
January 1992	
RCA/GE CTC168 chassis color TV	3084
Feburary 1992	
Hitachi AP13 color TV	3085
March 1992	
Hitachi VT-M40A color TV	3086
April 1992	
Hitachi 3267E VCR	3087
May 1992	
RCA/GE CTC 168-53 color TV	3088
June 1992	
Hitachi VT-M231A VCR	3089
July 1992	
Hitachi VT-F551A VCR	3090
August 1992	
RCA/GE color TV No 7-7800A	3091
September 1992	
RCA/GE TX82 color TV	3092
October 1992	
Sharp Model 13C-M100 color TV	3093
November 1992	
Sharp Model 27C-5200 color TV	3094
December 1992	
Hitachi VT M150A VCR	3095
1992/1993 Profax Schematics Special Issue:	
Curtis Mathes Projection TV: Models SMP 4100, 4600, 5210	
Hitachi Camcorder Model UM-E2A	
Memorex Pocketvision 26, Catalog Number 16-163	
Mitsubishi VCR Model HS-U55	
Panasonic color TV Model SR400EK	
RCA/GE VCR Model VG4202	
Sharp color TV Model 27SV65	
Toshiba color TV Model CF2077A: CX21772	
Zenith color TV: Models SD5515/SD5535/SD555G	
January 1993	
Sharp Model 20C-5300 color TV	3096
February 1993	
Sharp chassis No. 25S1 color TV	3097
Sharp VCR Model VCA45U	3098
March 1993	
Sharp Model 20C-S200	3099
Sharp VCR Model VC-H86U/C	3100
April 1993	
Sharp Model 27SV70	3101
May 1993	
Sharp VCR Model VC-H870U/C, VC-8870U/C	3102
Sharp Model 20SB65 color TV	3103
June 1993	
Sharp VCR Model VC-A503U, VC-A504U/C	3104
July 1993	
Sharp VCR Model VC-H903U/C, VC-H904U/C	3105
August 1993	
Sharp VCR Model VC-H87U/C	3106
September 1993	
Sharp Models 19E-M40R, 19-EM50R color TV	3107
October 1993	
RCA color TV Model CTC176	3108
November 1993	
Hitachi Proj. color TV Models 55EX7K, 50EX6K, 46EX3B/4K, 50ES1B/K, 46EX3BS/4KS	3109
December 1993	
Sharp color TV Model 19E-M50	3110
1993/1994 Profax Schematics Special Issues:	
Curtis Mathes VCR/Model GV730/740	
Hitachi TV/Model NP 83LX	
IBM Monochrome Display/Model 8503	
Magnavox TV/Model RD0945C101, RD0946T101	
Memorex Portable Compact Disc Player/Model CD-3360	
Memorex VCR/Model 29	
Mitsubishi TV/Model CS-3535R/CK-3536R, CS3135R/CK-3136R	

	Profax #
Panasonic CTM1353R	
JC Penney TV/Model 2003	
Sharp color TV/Sigma 9700 chassis	
Thomson Consumer Electronics color TV/RCA CTC175	
Toshiba VCR/Model M222, M222C, M227C, M227L	
January 1994	
Memorex Portavision 9-inch color VHF/UHF TV monitor	3111
Feburary 1994	
Hitachi VHS VCR Models VT-F350A, VT-F351A, AW	3112
March 1994	
Sharp color TV Model 20SB55m chassis No 20R1	3113
April 1994	
GE VCR Models 9-7100, 9-7115, 9-7120, 9-7215	3114
May 1994	
Hitachi VCR Model VM-2400A (U,PX), AW	3115
June 1994	
Thomson Consumer Electronics color TV: TX825	3116
July 1994	
Sharp CTV Models 13F-M40, 13F-M50, 13F-M100, 13F-M150	3117
August 1994	
Hitachi Video camera/recorder Models VM-2700A, VM-3700A (U,C)	3118
September 1994	
Sharp CTV Models 25F-M40/50/100/120, chassis No SN 41	3119
October 1994	
Hitachi VCR Model VM-1700A (U,C)	3120
November 1994	
Hitachi VCR Models VT-F380Z/ F381A, VT-F382A/F385A	3121
December 1994	
Thomson Consumer Electronics color TV: TX825	3122
1994/1995 Profax Schematics Special Issue:	
Hitachi VCR Model VM-1600A	
Memorex VCR catalog no. 16-620	
Panasonic VCR Models PV-4962, PV4941-K, PV-4960-K	
JC Penney TV/VCR Model 2163	
Quasar Model CTM-1355R & TP-1330EE	
RCA color TV Model CTC168-S4	
Sharp color TV models 20C-S100 & 20C-S120	
Tatung color monitor	
Toshiba VCR Model SV-F990	
Zenith color TV receiver CM-139/B-1	
Zenith CM-143/Digital (A)	
January 1995	
Sharp video cassette recorder Models VC-A502U, VC-A506U, VC-A507U	3123
February 1995	
Sharp color TV Model 19TF30, chassis SN40A	3124
March 1995	
Hitachi video cassette recorder Model VT-F482A	3125
April 1995	
RCA video cassette recorder Model VR530	3126
May 1995	
RCA video cassette recorder Model VR530 (cont'd)	3126
June 1995	
Hitachi projection television Models 50UX 18B/19K, 46UX 16B/17K	3127
July 1995	
JC Penney combination Model 2163	3128
August 1995	
Sharp video cassette recorder Model VC-H925U/H927U	3129
September 1995	
Thomson Consumer Electronics color TV Model CTC187	3130
October 1995	
Sharp TV/VCR combo Model 13VT-F40/13VT-F100	3131
November 1995	
Thomson Consumer Electronics VCR Model VG2030	3132
December 1995	
JC Penney color television Model 1048/1049	3133
1995/1996 Profax Schematics Special Issue:	
Panasonic TV Model CTM-2092S Chassis ALEDP203	
JC Penney TV Model 2157	
JC Penney TV Model 2294	
Sharp TV/VCR Combination Models 20VT-G60, 20VT-G100, 20VT-G200	
Sharp VCR Model VC-H946U, VC-H948U	
Thomson VCR Model VR516	
Thomson color video camcorder Models CC525, CPS014, CPS015	
Thomson TV, AM radio cassette combination Model 7-7800A	
Toshiba TV Model CF2771A	
Zenith projection TV L-Line C-8 Chassis	
Zenith color TV receiver Models SD2501W, SD2509H	
January 1996	
Zenith wall projector Model PV-144	3134
February 1996	
Hitachi VCR Model VT-Ux605A	3135
March 1996	
Zenith digital direct view Model CM-142	3136
April 1996	
Thomson Consumer Electronics VCR Model VR321	3137
May 1996	
Sharp color television Models 25E-M100 & 25E-M120	3138
June 1996	
Sharp TV/VCR combination Model 27VS-G300	3139

	Profax #
July 1996	
JC Penney color TV receiver Model 2307	3140
August 1996	
Zenith color TV receiver Model CM-142/C-1	3141
September 1996	
Sharp VCR Models VC-A555, 556 VC-H955, 956, 958U	3142
October 1996	
Thomson Consumer Electronics Color TV Model CTC177	3143
November 1996	
RCA/GE VCR Model VR520/523	3144
December 1996	
Memorex moviecorder Model 127	3145
1996/1997 Profax Schematics Special Issue:	
Hitachi video camera Model VM-E25A (U,C)	
Panasonic VCR Model PV-4066	
JC Penney color TV receiver Model 2158	
JC Penney color TV receiver Model 2509	
Sharp TV/VCR combination Model 20C-V300	
Thomson Consumer Electronics projection TV Model PTK 171	
Toshiba color TV Models 6F35661, CX37662	
Zenith digital color TV Receiver J-Line Model PV-143	
Zenith color TV Model S1322S, SMS 1324SS/X, SMS1325S	
January 1997	
Hitachi Color TV Models 35UX80B/CZ58, 35UX70B/CZ57	3146
February 1997	
Thomson video cassette recorder Model PTK171	3147
March 1997	
Thomson video cassette recorder Model PTK171 (cont'd)	3147
April 1997	
Sharp color TV Models 27H-S200, CH27S20	3148
May 1997	
Hitachi video cassette recorder Model VT-F390A/F391A	3149
June 1997	
Sharp color television Model 25H-M100	3150
July 1997	
Thomson Consumer Electronics video cassette recorder Model VR71HF	3151
August 1997	
Sharp TV/VCR combination Model 20VT-H60, 20VT-H200, 20VT-CH6	3152
September 1997	
Thomson Consumer Electronics color video camcorder Model CC710	3153
October 1997	
Toshiba video cassette recorder Model M-651/651C	3154
November 1997	
Thomson Consumer Electronics color TV Model CTC170	3155
December 1997	
Sharp video cassette recorder Model VC-A25U, C A55U, C	3156
January 1998	
Thomson Consumer Electronics video cassette recorder Model VR800HF	3157
Feburary 1998	
Zenith rear projections color TV receiver Model PV-145/c8 (A)	3158
March 1998	
Thomson Consumer Electronics color video camcorder Model CC390	3159
April 1998	
Sharp video cassette recorder Model VC-A70U, VC-H100U	3160
May 1998	
Sharp color TV Model 13H-M60/100/150, CH13M6/10/15	3161
June 1998	
Sharp color TV Model 19H-M60/100/150, CH16M6	3162
July 1998	
Sharp video cassette recorder VC-A575U, A578U, H973U, H974U, H975U, H976U, H978U	3163
August 1998	
Sharp TV/VCR combination 25VT-H200, 25VS-H300	3164
September 1998	
Sharp video cassette recorder Model VC-A523U	3165
October 1998	
RCA color TV Model CTC172	3166
November 1998	
Thomson RCA/GE Color video camcorder Model CC415	3167
December 1998	
Sharp video cassette recorder Models VC-H902U, VC-H906U, VC-H907U	3168

Company Index — 1988–1998

	Profax #	Month/Year
CURTIS MATHES		
Models SMP 4100, 4600, 5210 Projection TV Set	Special	1992/93
Model GV 730/740 VCR	Special	1993/94
GENERAL ELECTRIC		
1VCR2006W Model, VCR	3027	Jul 88
1VCR2018WModel,VCR	3019	Feb88
NC-05X3/06X1 chassis, color TV	3032	Sep 88
8-4500 Projection TV	3020	Mar 88
PW chass., Model 40PW3000KA01 proj. TV	3037	Dec 88
Model 1VCR2002X VHS VCR	3044	Apr 89
1987 CTC136 color TV	3047	May 89
CTCI35-S1 color TV	3052	Aug 89
1987 8-4500 projection color TV	3057	Nov 89

	Profax #	Month/Year
Models 9-7100, 9-7115, 9-7120, 9-7215VCR	3114	Apr 94
HITACHI		
CT1344 chassis color TV	3029	Aug 88
CTl358 chassis colorTV	3018	Jan 88
CT2647/CT2648/CT2649 chassis color TVs	3025	Jun 88
CT2652, CT2653 color TVs	3024	May 88
CT3020W/CT3020B	3033	Oct 88
VHS VCR, Model VT-63A	3035	Nov 88
CT1955 color TV, NP85XA chassis	3038	Jan 89
CT1941/CT19A2, NP83X chassis color TV	3043	Mar 89
CT1955 colorTV	3045	Apr 89
CT2066 color TV	3050	Jul 89
CT2086 B/W chassis G7NU3 clr. TV	3055	Oct 89
CTl39SW G7NSU2 color TV	3060	Jan 90
G7XU2/3 chassis color TV	3063	Apr 90
G7XU2 - Models CT2087B/W, A087 (MT2870 through MT2878)		
G7XU3 - Models CT2088B/W, A088 (MT2880, MT2886, MT2887)		
CT4580K, VP7X2 chassis proj. TV	3065	Jun 90
VP9X1 chassis color TV	3069	Oct 90
CT1947/CT19A7 chassis color TV	3079	Aug 91
CT2541/2542 chassis color TV	3080	Sep 91
chassis AP13 color TV	3085	Feb 92
Model 3267B VCR	3087	Apr 92
Model VT-F551A VCR	3090	Jul 92
Model VT-M40A VCR	3086	Mar 92
Model VT-150A VCR	3095	Dec 92
Model VT-M231A VCR		
Model UM-E2A Camcorder	Special	1992/93
Models 55EX7K, 50EX6K, Projection color TV	3109	Nov 93
46EX3B/4K, 50ES lB/K, 46EX3B5/4KS		
NP 83LX color TV	Special	1993/94
VCR Model VT-F350A, VT-F351A, AW	3112	Feb 94
Model 35UX80B/CZS8 35UX70B/CZ57 color TV	3146	Jan 97
Model VT-F390A/F391A VCR	3149	May 97
Model VM-2400A (U,PX), AW VCR	3115	May 94
Model VM-1700A (U,C) VCR	3120	Oct 94
Models VT-F380Z/F381A,VT-F382A/ F385A VCR	3121	Nov 94
Mods. VM-2700A, VM-3700A (U,C) Vid. cam/rec.	3118	Aug 94
Model VM- 1600A VCR	Special	1994/95
Model VT-F482A VCR	3125	Mar 95
Models 50UX 18B/19K projection television	3127	Jun 95
46UX 16B/17K		
Model VT-UX605A VCR	3135	Feb 96
Model VM-E25A video camera	Special	1996/97

	Profax #	Month/Year
IBM		
Model 8503 Monochrome Display	Special	1993/94
MAGNAVOX		
Model RD094SC10l, RD0946T101 color TV	Special	1993/94
MEMOREX		
Catalog Number 16-163 Pocketvision 26 TV	Special	1992/93
Model CD-3360 Portable CD Player	Special	1992/93
Model 29 VCR	Special	1992/93
Portavision 9-inch color VHF/UHF TVMonitor	3111	Jan 94
catalog no.16-620 VCR	Special	1994/95
Model 127 Moviecorder	3145	Dec 96
MITSUBISHI		
Model CS-3535R/CK-3535R CS3 135R/CK3136R color TV	Special	1992/93
Model HS-U55 VCR	Special	1992/93
NAP		
E51-56 chassis color TV	3030	Aug 88
E54-10 chassis, projection TV	3021	Apr 88
E54-15 chassis, projection TV	3026	Jun 88
RD4502SL/RLC312SL color TV monitors series 19C2 chassis	3036	Nov 88
(Magnavox) color TV	3039	Jan 89
chassis E34- 11 color TV	3042	Mar 89
chassis E54-15 color TV	3049	Jun 89
(Magnavox RD8518 and RD8520; Philco Model P8190S;Sylvania PSC410 and PSC420)		
PANASONIC		
Model SR400EK color TV	Special	1992/93
Model CTM1353R color TV	Special	1993/94
Models PV-4962, PV4941 -K PV4960-K VCR	Special	1994/95
Model CTM-2092S Chassis ALEDP203	Special	1995/96
VCR Model PV-4066	Special	1996/97
JC PENNEY		
Model 2003 color TV	Special	1993/94
Model 2163 TV/VCR	Special	1994/95
Model 2163 combination	3128	Jul 95
Model 1048/1049 color TV	3133	Dec 95
Model 2157 TV	Special	1995/96
Model 2294 TV	Special	1995/96
Model 2307 color TV	3140	Jul 96
Model 2158 color TV	Special	1996/97
Model 2509 color TV	Special	1996/97
RCA		
PVM035 chassis color TV	3031	Sep 88
PVM050 color TV	3023	May 88

	Profax #	Month/Year
P42000-S1 projection TV (additional Models: RVM46700, 46GW700, P46000) CTC 135clr. TV	3048	Jun 89
CSM055 color TV/AM/FM/ clock radio	3051	Jul 89
CTC9 1 chassis color TV	3054	Sep 89
CTC99 chassis color TV	3071	Dec 90
CTC107 chassis color TV	3072	Jan 91
CTC96 chassis color TV	3073	Feb 91
CTC107 chassis color TV	3077	Jun 91
CTC176 chassis color TV	3078	Jul 91
CTC175 chassis color TV	3108	Oct 93
Model CTC 168-S4 color TV	Special	1993/94
Model VR530 VCR	Special	1994/95
	3126	Ap/May 95
RCA/GE (Thomson Consumer Electronics)		
CTC145/146 chassis color TV	3040	Feb 89
CTC145/146 color TV	3058	Nov 89
CTC148/149-S2 chassis color TV	3062	Mar 90
TX81 chassis color TV	3067	Aug 90
CTC156 chassis color TV	3068	Sep 90
CTC169 (PV) chassis color TV	3070	Nov 90
CTC168 chassis color TV	3074	Mar 91
CTC86 chassis color TV	3075	Apr 91
KCS203 chassis B&W TV	3076	May 91
CTC167 chassis color TV	3081	Oct 91
CTC166 chassis color TV	3082	Nov 91
CTC169 chassis color TV	3083	Dec 91
CTC168 chassis color TV	3084	Jan 92
CTC168-53 chassis color TV	3088	May 92
Model 7-7800A color TV	3091	Aug 92
TX82 chassis color TV	3092	Sep 92
Model VG4202 VCR	Special	1992/93
TX825colorTV	3116	Jun 94
TX825 color TV	3122	Dec 94
Model VR516 VCR	Special	1995/96
Models CC525, CPS014, CPS015 color camcorder	Special	1995/96
TV AM radio cassette combination Model 7-7800A	Special	1995/96
Model CTC187 colorTV	3130	Sep 95
Model VG2030 VCR	3132	Nov 95
Model VR321 VCR	3137	Apr 96
CTC 177 colorTV	3143	Oct 96
Model VR520/523 VCR	3144	Nov 96
Model PTK171 projection TV	Special	1996/97
Model PTK171VCR	3147	Feb/Mar 97
Model VR71HF VCR	3150	Jul 97
Model CC710 color camcorder	3153	Sep 97
Model CTC170 color TV	3155	Nov 97
Model VR800HF VCR	3157	Jan 98
Model CC390 color video camcorder	3159	Mar 98
Model CTC172	3166	Oct 98
Model CC415 color video camcorder	3167	Nov 98
SHARP		
Model 13C-M100 color TV	3093	Oct 92

	Profax #	Month/Year
Model 27C-5200 color TV	3094	Nov 92
Model 27SV65 color TV	Special	1992/93
Model 19E-M50	3110	Dec 93
Model 19E-M40R, 19E-M50R color TV	3107	Sep 93
Model 20C-5300 color TV	3096	Jan 93
Model 20C-5200 color TV	3099	Mar 93
Model 20SB65 color TV	3103	May 93
25S1 chassis color TV	3097	Feb 93
Model 27SV70	3101	Apr 93
Sigma 9700 chassis color TV	Special	1993/94
Model VC-A45U VCR	3098	Feb 93
Model VC-A504U/C VCR	3104	Jun 93
Model VC-H86U/C VCR	3100	Mar 93
Model VC-H87U/C VCR	3106	Aug 93
Model VC-H870U/C, VC-8870U/C VCR	3102	May 93
Model VC-H903U/C, VC-H904U/C VCR	3105	Jul 93
Model 20SB55, chassis No. 20R1 VCR	3113	Mar 94
Models 13F-M40, 13F-M150, 13F-M100,13F-M150	3117	Jul 94
Models 25F-M40/50/l00/120, chassis No SN 4l	3119	Sep 94
Models 20C-Sl00, 20C-S120 color TV	Special	1994/95
Models VC-A502U, VC-A506U, VC-A507U VCR	3123	Jan 95
Model 19TF30, Chassis SN40a color TV	3124	Feb 95
Model VC-H925U/H927U VCR	3129	Aug 95
Model 13VT-F40/13VT-F100 Models 20VT-G60, 20VT-G100 TV/VCR combination	3131	Sep 95
20VT-G200, Chassis VN-51 TV/VCR combination	Special	1995/96
Model VC-H946U, VC-H948U VCR	Special	1995/96
Model 25E-M100, 25E-M120 color TV	3138	May 96
Model 27VS-G300 TV/VCR combination	3139	Jun 96
Models VC-A555, 556, VC-H955, 956, 958UVCR	3142	Sep 96
Model 20C-V300 TV/VCR combination	Special	1996/97
Models 27H-S200 CH27520 colorTV	3148	Apr 97
Model 25H-M100 color TV	3149	Jun 97
Models 20VT-H60, 20VT-H200 20VT-CR6 TV/VCR combination	3151	Aug 97
Models VC-A25U,C A55U, C VCR	3156	Dec 97
Model VC-A70U, VCH100U VCR	3160	Apr 98
Model 13H-M60/100/150, CH13M6/ 10/15 color TV	3161	May 98
Model 19H-M60/100/150, CH19M6 color TV	3162	Jun 98
Model VC-A575U, A578U, H973U H974U, H975U, H976U, H978U VCR	3163	Jul 98
Model 25VT-H200, 25VS-H300 TV/VCR combination	3164	Aug 98
Model VC-A523U VCR	3165	Sep 98
Model VC-H902U, VC-H906U, VC-H907U VCR	3168	Dec 98
TATUNG		
color monitor	Special	1994/95
TOSHIBA		
Model CF2077A: CX21772 color TV	Special	1992/93
Model M222, M222C, M227C, M227L VCR	Special	1993/94
Model SV-F990 VCR	Special	1994/95
Model CF2771A TV	Special	1995/96
Models 6F35661, CX37662 color TV	Special	1996/97
Model M-651/651C VCR	3154	Oct 97
ZENITH		
CM-139/B-0 (B) chassis color TV	3028	Jul 88
CM-139/B-3 (I) SD2511G/ SD2581H	3034	Oct 88
C2020H chassis color TV	3022	Apr 88
PV800 color monitor	3017	Jan 88
CM-140/b-2(G) chassis color TV	3041	Feb 89
CM-14-0/B-3(1) color TV (Models SE2721H/SE2725R/SE2727H)	3046	May 89
CM-140/B-2(I) color TV	3053	Aug 89
PV4661H rear-projector color TV	3056	Oct 89
CM-140/DIGITAL(C) chassis color TV (Models SE3135P/SE3191H/SE3535H/ ZB2771H/ZB2771H2/ZB2777H/ ZB2777H2/ZB2797P/ZB2797P2/ ZB2797Y/ZB2797Y2/ZB3193H/ ZB3I93Y/ZB3539T/ZB3539Y)	3059	Dec 89
CM-I 39/B2 Models SD5515, SD5535, SD5556	Special	1992/93
Model CM-139/B-l color TV	Special	1994/95
CM143/digital (A)	Special	1994/95
L-line C-8 Chassis TV	Special	1995/96
Model SD2501W, SD2509H color TV	Special	1995/96
Model PV-l44 wall projector	3134	Jan 96
Model CM-142 digital direct view	3136	Mar 96
Model CM142/C-1 color TV	3141	Aug 96
J-Line Model PV- 143 digital color TV	Special	1996/97
Models S1322S, SMS13245/X, SMS 1325S color TV	Special	1996/97
Model PV-145/c8(A) rear projection color TV receiver	3158	Feb 98

ES&T Book Shop

ES&T Presents Computer Troubleshooting & Repair
Features information on repairing Macintosh computers, a CD-ROM primer, and a color monitor. Also included are hard drive repair tips and computer diagnostic software.
61087 . . . . . .$24.95

Computer Monitor Troubleshooting & Repair
Learn the basics of computer monitors with chapters on tools and test equipment, monitor types, special procedures, how to find a problem, and how to repair faults in the CRT.
61100 . . . . . .$34.95

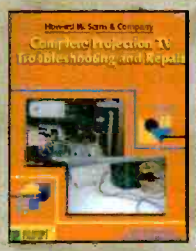
1998 Computer Monitor Tips
Includes over 2,000 troubleshooting and repair tips listed by manufacturer name and model number featuring such major names as Apple, Gateway, Compaq, IBM, and Dell.
61160 . . . . . .$49.95

ES&T Presents the Test Equipment Guide
Includes the latest information on how to choose the best equipment, how to build test equipment and accessories, how to set up the ideal service bench, and how to put together a practical tool kit.
61089 . . . . . .$24.95

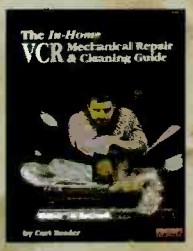
Complete VCR Troubleshooting & Repair
In addition to troubleshooting procedures, this book contains nine detailed VCR case studies, each focusing on a particular model of VCR with a very specific and common problem.
61102 . . . . . .$34.95

Electronic Troubleshooting & Servicing Techniques
The premiere guide for hobbyists, technicians, and engineers to a variety of troubleshooting tests, measurement procedures, and servicing techniques.
61107 . . . . . .$29.95

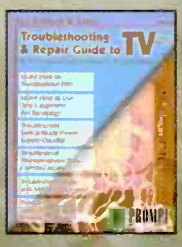
ES&T Presents TV Troubleshooting & Repair
Presents important and new information that will make it possible for technicians, students, and electronics hobbyists to service TVs faster, more efficiently, and more economically.
61086 . . . . . .$24.95



Complete Projection TV Troubleshooting & Repair
Covers everything from the basics of projection circuits, tools and test equipment, TV types, safety procedures and measurements, to the finely detailed repair techniques.
61134 . . . . . .$34.95

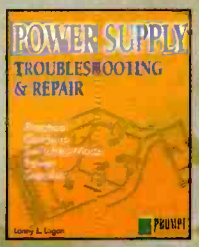


In-Home VCR Mechanical Repair & Cleaning Guide
Regular VCR maintenance is critical to prolonging the life of your equipment, and this book shows readers the tricks and secrets of the trade using just a few small hand tools.
61076 . . . . . .$24.95



Troubleshooting & Repair Guide to TV, Second Edition
The most comprehensive, complete, and up-to-date television repair book available, with tips on how to troubleshoot the newest circuits in today's TVs.
61146 . . . . . .$34.95

Complete Camcorder Troubleshooting & Repair
Contains sound troubleshooting procedures beginning with the external parts of the camcorder, then narrowing the view to gears, springs, pulleys, lenses, and other mechanical parts.
61105 . . . . . .$34.95



Power Supply Troubleshooting & Repair
Designed to provide technicians with a better understanding of how switched-mode power supplies operate. It also provides practical, useful procedures to follow when troubleshooting power supplies.
61138 . . . . . .$24.95

YES! I want to learn from the experts. Rush me my book(s) right away!

Please add $4 shipping & handling. **FREE shipping & handling for orders $50 and over.**

Please make your check or money order payable to: Electronic Servicing & Technology

U.S. and possessions - add $4 shipping/handling. FREE S/H on orders $50 and over. Foreign - shipping/handling charges are calculated by order weight & destination. A $4 credit will be applied for Foreign orders over $50.

To Order Call 516-681-2922

Qty	Order#	Description	Price	Total Price
			Shipping/Handling	
			New York Residents add applicable sales tax Total	

Name _____

Address _____

City _____ State _____ Zip _____

MC/VISA/AMEX/Discover # _____ Expires _____

Form of payment: ☐ MC ☐ VISA ☐ AMEX ☐ Discover ☐ Check ☐ Money Order

Please mail your orders to: Electronic Servicing & Technology, 25 Newbridge Rd, Hicksville, NY 11801-9962 FAX- 516-681-2926

CLASSIFIED

Classified advertising is available by the word or per column inch.
By-the word. $1.65 per word, per insertion, pre-paid Minimum charge is $35 per insertion. Initials and abbreviations count as full words. Indicate free category heading (For Sale, Business Opportunities, Miscellaneous, Wanted). Blind ads (replies sent to ES&T for forwarding) are $40 additional. No agency discounts are allowed for classified advertising by the word. Contact Alycia Nicholsen at 516-681-2922 to place your classified ad (by-the-word). Mastercard, VISA, American Express and Discover are accepted for FAX or mail orders.
Per column Inch (classified Display): $235 per column inch, per insertion, with frequency discounts available, 1" minimum, billed at 1/4" increments after that 10" maximum per ad. Blind ads are $40 addition. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.) For more information regarding classified display advertising please call 516-681-2922. Optional color (determined by magazine) $150 additional per insertion.

Send your order, materials and payments to:
Electronic Servicing & Technology, 25 Newbridge Road, Hicksville, NY 11801
Attn: Classified Department Ph: 516-681-2922 FAX: 516-681-2926

FOR SALE

SERVICE TIPS for **FREE!!!** ******** That's right it's **FREE!! PROFESSIONAL BOARD LEVEL & COMPONENT LEVEL REPAIRS for TV's, VCR's, Projection TV's, CAMCORDER's, CD Players, Audio** and other repairs on computer disk. **ADD** your own repair tips. **PRINT** out repair tips. **BACKUP** & save **Your** repairs. Want to share your own repair tips? If you do, we will send you **FREE** Updates!!! Ask about our **TIP EXCHANGE** policy. For IBM compatible computers with a hard drive and some Apple Macs. **Get your FREE Stage 1 SERVICE TIPS PROGRAM Now!!! ***** FREE CALL — CALL NOW!!! CALL 1-800-215-5081. *****

SERVICE TIPS ***45,000* technical **SERVICE TIPS** with **MULTIPLE SOLUTIONS FOR EACH SYMPTOM** IN 1 CONCISE FORMAT has features no other tips program has. **SERVICE TIPS THE ONLY NESDA APPROVED TECHNICAL TIPS PROGRAM available for $199.95** (plus s&h) Electronic Software Developers Inc. 826 S. Main St., S. Farmingdale, NY 11735 or e-mail us at esd@bccom.com or visit our Web site at www.servicetips.com. TO ORDER SERVICE TIPS CALL **1-800-621-8477.**
****COMING SOON NEW COMPUTER MONITOR TIPS PROGRAM****

TEST EQUIPMENT FOR SALE: REASONABLE PRICES SENCORE, TEKTRONIX, HP and MUCH MORE. View complete list at: http:// www.astglobal.com or contact: **AST GLOBAL ELECTRONICS**. Voice: 888-216-7159; Fax 814-398-1176; e-mail: ales@astglobal.com

NAP Tuner 340309. RCA Tuner TCHRIA or TCCRIA and more. Snowy picture? Will rebuild for $25.00, Free Shipping. **Tip Top TV & VCR**, 18441 Sherman Way, Reseda, CA 91335, 818-345-1974.

WinSTIPS! — over **80,000** current Service tips from **KD T-V**, NESDA,& over 600 contributors! 380 brands (TV, VCR, Computer Monitor, Microwave, Camcorder, Audio, Misc.) Deluxe. Print tips search. Group add multiple records Symptom/Info/Cure Search. VCR CROSS. Sams similar-model cross. Finest ORIGINAL data. One-button update Tips from web. Advanced Multiple Search, One-button e-mail in your tips for credit! Windows 95/98 **$149.95**.(CD or Web download). FREE Registerable Demo: http://www.kdtviwe.com . **KD T-V 514 3rd St. Aurora, IN 47001. TOLL FREE 1-888-KD-STIPS.** DOS version $89.95. All c/cards. Ken Hull C.E.T.

FURTHER PRICE REDUCTION. Diehl Mark III $49, Diehl Mark V Horizontal circuit tester $169. New. Conductive coating for remote control keypads $9.99 ppd. **WEEC**, 2411 Nob Hill Road, Madison, WI 53713. 608-238-4629, 608-273-8585.

FOR SALE

((36,000 REPAIR TECH-TIPS)) STEP-UP OPPORTUNITY. You may purchase our Windows **95/98** CD data-base only, 1987 thru Nov 98 for **$99.00** or Paper Format in (5) manuals for **$175.00**. If you are satisfied with our product, you may have your purchase applied to our full membership of **$350.00** with Telephone Tech Support — FCCID Cross-Reference Manual — Tip informer magazine, 6-month updates of 2,000 repairs at reduced cost.**"GET TO THE BOTTOM LINE PROFITABLY."** CALL TODAY and speak to service center owner and technician **ED Erickson, NESDA MEMBER** and past president of the (Professional Electronics Assn. of South Florida) **800-474-3855** or 954-328-2443.

SENCORE, TEKTRONIX, HEWLETT PACKARD (all models). We **BUY, SELL, & TRADE**. Please call **"CHOICE ELECTRONICS"** for all of your test equipment needs. Complete financing options available. Call 1-800-609-0677, 605-361-6386 ask for Lance Tople.

TV CASE HISTORIES: Volume 7 with 3,045+ histories. Satisfaction assured. Only $59 (plus $3.25 shipping). Over 8,100 books and supplements sold with only 1 returned for a refund! **Mike's Repair Service**, P.O. Box 217, Aberdeen Proving Ground, MD 21005. Same mailing address 34+ years. Send SASE for samples. 410-272-4984,1-800-2-FIX- TVS 11am-9pm. (http://www.netgsi.com/~mikesrs).

Factory service data, used-Sams, books, vintage parts. AG Tannenbaum, Box 386, Ambler, PA 19002. 215- 540-8055, fax 215-540-8327, **On-line catalog: www.agtannenbaum.com.**

TEST EQUIPMENT BOUGHT & SOLD: OSCILLOSCOPES, ETC. 925-706-0177. FAX: 925-706-0156.

HORIZONTAL OUTPUT STAGE ANALYZER- Repair to component level in 10 minutes or less, or verify proper operation before replacing H.O. Transistor; must be used in conjunction with the oscilloscope and Meter, is the best Horizontal Analyzer you can have. Send $10.00 for demo-training video or for free information. H.O.S.A. is $175.00 (satisfaction guaranteed) Luis Zubieta, 2380 S.W. 2nd Street, Miami, FL 33135. Telephone: 305-642-6438. 30 Years in Electronics, same address and phone.

NEVER USED SENCORE CM2125 Computer Analyzer, Cover, Complete Course and all the adaptors. $2000.00. 281-835-3431.

SENCORE TEST EQUIPMENT: VG91 Video Generator. TV92 TV Analyzer. Brand new, 1 year warranty-Owner. $2000.00. Odom TV Sales and Service, 843-479-3631.

CLASSIFIED

BUSINESS OPPORTUNITIES

SERVICE CENTER FOR SALE: Great opportunity in the corner of Tri-state area. Offers outstanding growth potential for the right person. High growth area, low rent. High traffic volume, audio-video-camcorder-office products repairs. Proven business, yearly revenue increases. Phone: 864-882-6580. Ask for Ian.

TV/VCR Repair business in Oregon. Est. 50 years, warranty referrals, excellent employees, owner training and terms. VR Business Brokers, 800-917-1707.

CENTRAL FLORIDA TV/ELECTRONICS Business/Building. Heart of the retirement area. 36 years (75K). Owner retiring. **941-385-0359.**

FOR SALE

ELECTRONIC SERVICE BUSINESS FOR SALE in Spearfish, Black Hills of South Dakota. Business, truck and real estate (195K) or buy business (50K) and lease property. 23 years, owner retiring. Call 605-642-7943 M-F or 605-642-8496. E-Mail jmservicato.com

WANTED

WANTED:USED TEST EQUIPMENT. TURN IDLE OR EXCESS EQUIPMENT INTO CASH. AST GLOBAL ELECTRONICS. Voice: 888-216-7159; Fax 814-398-1176; e-mail: sales@astglobal.com.

READERS' EXCHANGE

Readers' Exchange is a free service.

The following restrictions apply to Readers' Exchange:

- Only individual readers may use Readers' Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropriate place for your message is in a paid advertisement, not Readers' Exchange.
- Readers' Exchange items must be restricted to no more than three items each for wanted and for sale.
- All submissions must be typed or printed clearly!

Send your Readers' Exchange submissions to:
Readers' Exchange, Electronic Servicing & Technology, 25 Newbridge Road, Hicksville, NY 11801

FOR SALE

Three Heath electronic courses with parts for experiments. Never used, all for $150.00. *Contact: Daniel Seidler, 3721 West 80th St., Chicago IL 60652-2415 or 773-284-8221.*

Sencore TVA92, VG91, like new with leads, manuals, schematics, in original boxes, $1800.00. *Contact: Frank, 318-628-6802.*

Sencore SCR250 and LC102 component analyzer with 12V battery, probes and manuals, $1100.00. *Contact: Brian, 706-687-0910.*

Sencore video repair equipment, schematics, service tools, etc. *Contact: 907-747-6944 or send SASE to Equipment, 101 American Way, Sitka, AL 99835.*

Lectrotech scope T060 excellent condition with manuals and probes, $150.00. Variac 0-140VAC 2.4A general radio, $30.00. Clamp-on ampmeters, calibrated, $30.00. Digital Vom, Sears Model 82386, like new, $20.00. Model TO 60 Lectrotech dual trace scope with manual and probes, $200.00. BC 221E frequency meter, war dept. with power supply, original manuals and set-up charts, $50.00. Shipping not included. *Contact: Kermit Shetley: 573-334-2055.*

B&K 820 digital capacitance meter, like new, $75.00. *Contact: 718-779-7874 or e-mail amerat @prodigy.net.*

Sencore dual trace oscilloscope waveform analyzer, like new, original box, all leads and manuals, $700.00 plus shipping. B&K sweep/marker generator, all leads and manuals, $200.00. *Contact: George McBroom, 281-470-9288.*

Sony 7200 beta VCR w/factory service manuals. Magnecord audio broadcast recorder w/schematics. *Contact: Richard Gilman, P.O. Box 633, King City, CA 93930, 831-385-9248.*

Sencore VC93 analyzer, like new, $1700.00. *Contact: John, 787-895-8357.*

Sencore LC-102 cap analyzer, $850.00. General radio 1396B tone burst generator, $150.00. *Contact: Kim, 612-869-4963.*

Sencore VC93 VCR analyzer, like new, all cables and manuals in original box. $950.00. Circuit make program, never used, $150.00. *Contact: Gary, 978-441-1983.*

Panasonic 8-track stereo cartridge deck, RS-803L15 recorder and Sams Photofact, old speakers. Setchell Carlson TV units, new. Hickok signal generator. Hickok color bar gen. 246, Hickok TV gen 615. *Contact: Ann Bichanich, 15 West Lake St., Chisholm, MN 55719.*

B&K 2009 MTS stereo generator, $100.00. B&K 3020 sweep/function generator, $100.00. Blondertongue FSM-4 UHF/VHF field strength meter, $50.00, all in excellent condition with cables and manuals. Shipping not included. *Contact: Jesse Baros, 505-877-5688.*

Sencore VA62 w/VC63 plus HP200, $900.00. All probes, manuals, schematics. Excellent condition, original boxes. *Contact: Frank: 727-392-0230.*

Sencore LC-102 Auto-Z, excellent condition, $1000.00 *Contact: Bruce, 212-285-7857, 12-8 p.m. EST.*

WANTED

RCA CTC 108A horizontal output transformer, part 1455854-501. *Contact: George Fogelman, 915-778-0997, 1201 Idelwilde, El Paso, TX 79925.*

Microfiche readers for 4 x 6 plastic slides, portable or table model. *Contact: John Mathews, 610-356-1249.*

Flyback transformer FD 0054A for Sanyo model AVM-270. New or used. Will pay $25.00 and postage. *Contact: Al Berntsen, 619-669-2881.*

Eight track demo or test alignment tape. *Contact: Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Old radios, parts, dealer signs, tubes, literature, etc. pre WWII. Radios wanted are 1935-1938 consoles or table sets by Detrola, Midwest, Scott, Mc Murdo, Zenith, RCA, Stromberg. Will buy large lots or trunkfuls. *Contact: Mark Oppat, 253 Blanche St., Plymouth, MI 48170, 734-455-4169.*

Technics SP-15. SP-10MK3, SL-100.3, EPA tonearms, Quadraphonic encoders, decoders, tapes, Pioneer SD-1100/JVC MM-4 scope analyzer. Nakamichi T-100 and other audio analyzers. *Contact: 612-869-4963*

Hitachi Model VT-62A tuner/if PCB Part No. 5586322. Service manual for JVC R-X400 stereo receiver and Sansui SV-R9000 VCR. *Contact: Don Hicke, 619-994-3406.*

Sony used lower video drum and motor assy SLV-720HF VCR part A-6709-721-A. *Contact: Bruce, 212-285-7857, 12-8 p.m. EST.*

ADVERTISERS' INDEX

We'd like to see your company listed here too. Call Evelyn Garrison at 425-557-9611 or Fax her at 425-557-9612 to work out an advertising program tailored to suit your needs.

Stop Unsoldering — Analyze In-Circuit!

Now, reduce the number of capacitors and inductors you unsolder for good/bad testing or replacement by 50% or more with the new LC103 ReZolver™.

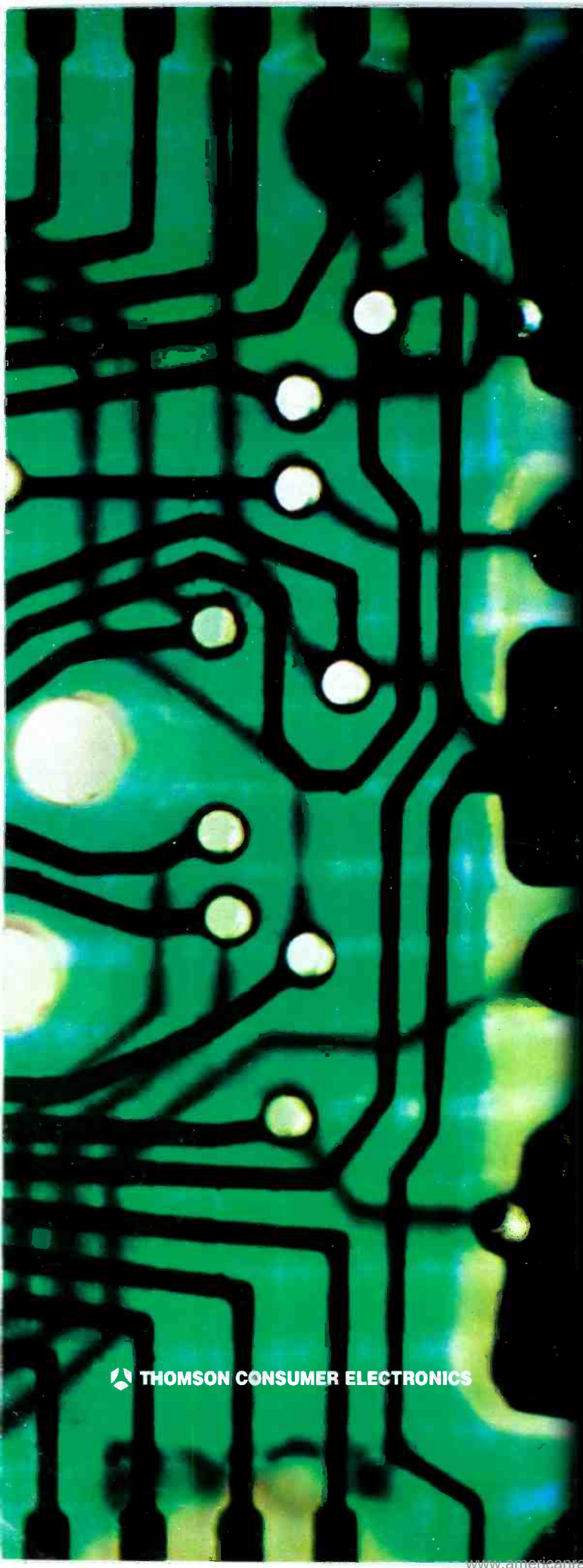
How often do you unsolder capacitors and inductors only to find they test good or a replacement doesn't solve the problem? The Sencore ReZolver™ offers exclusive in-circuit analyzing tests guaranteed to reduce unsoldering time and avoid costly surface mount component replacement.

The ReZolver™ features in-circuit value and ESR tests on capacitors from 0.02 to 20,000 µF. Innovative tests sense parallel components for error free results. An Adjustable In-Circuit Test Probe provides reliable connections, push-button test ease, and frozen display measurements.

Give us a call at 1-800-SENCORE or email sales@sencore.com for a FREE 10-Day Trial and Tech Tip showing how the LC103's exclusive in-circuit tests will catch more defects than any other tester on the market.

Circle (1) on Reply Card

SENCORE
www.sencore.com



Exact Semiconductors

The Right Parts For The Job

"Trust Me!"

How many times have you heard that!

You built your reputation on hard work and quality repairs. Why change now?

Put your reputation on the line with two names you *can* trust.

SK *Series* and Thomson Consumer Electronics.

With over 1,700 exacts in stock, you won't have to look anywhere else. And when you're in need of any video heads, belts, tires, flyback transformers or video replacement parts, we have them too.

But we don't stop there.

Our continuing quality assurance and accuracy goes into every SK *Series* product.

For more information on SK *Series* products, contact your nearest Thomson Distributor.

SK *Series*...The parts you need to do the job. "Trust me!"

THOMSON CONSUMER ELECTRONICS

SK *Series*

Circle (113) on Reply Card