The how-to magazine of electronics...

AN INTERTEC PUBLICATION

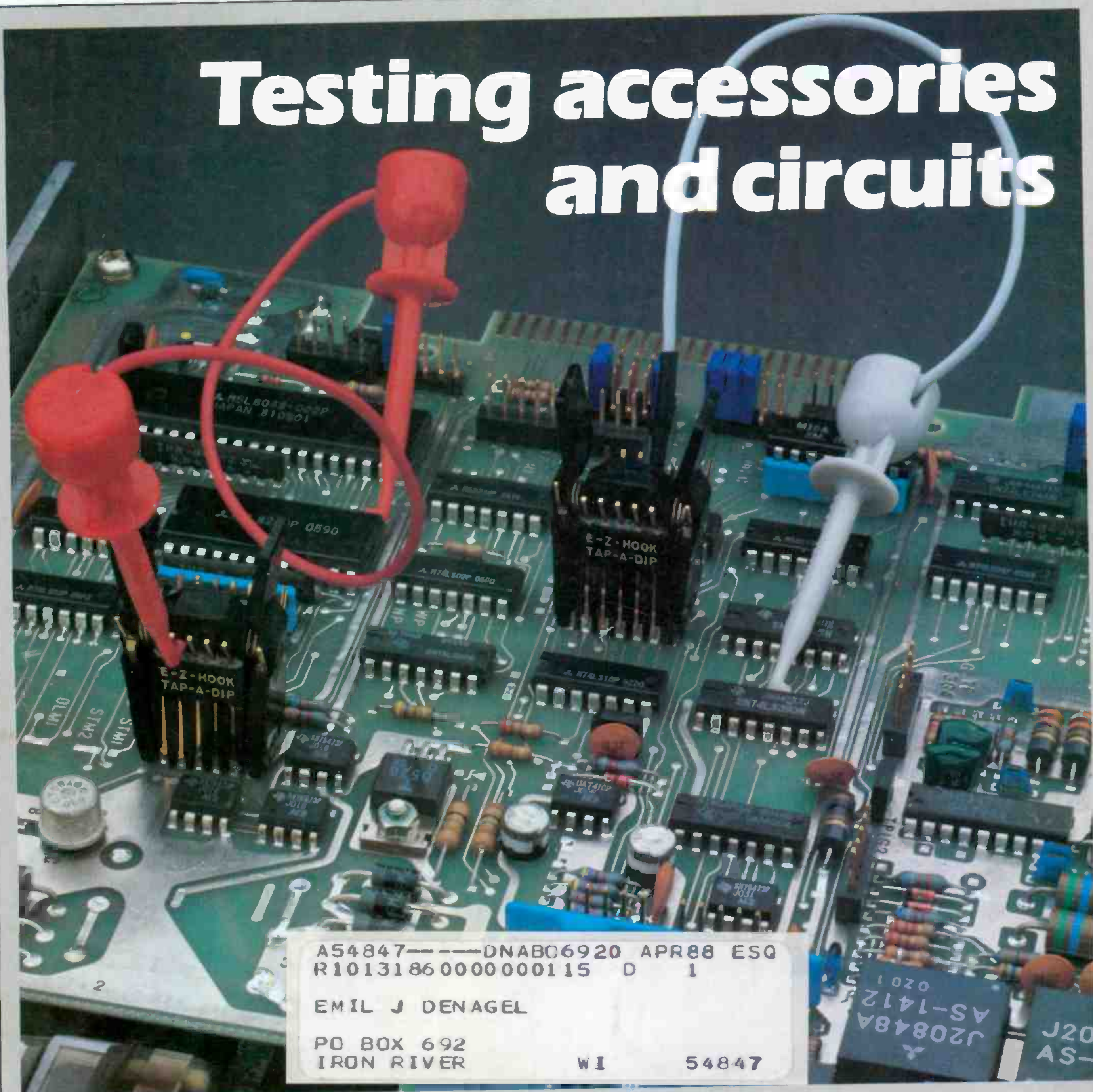
ELECTRONIC Servicing & Technology

AUGUST 1987/$2.25

Technical training, literature update • We all know how to solder

Using your scope to troubleshoot LV/dc power supply

Testing accessories and circuits



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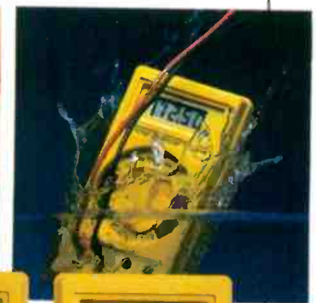

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Circle (2) on Reply Card

Feedback

A Technology error

In reference to ***Electronic Servicing & Technology's*** article from June 1987, "Digital Technology Double Scanning Clearer TV Pictures," the information given is not completely correct. The line memories are just that – line memories that store one line or one horizontal scan of information.

The reading speed of each memory is doubled from that of the writing speed, so each field broadcast, 262.5 lines, is converted to 525 lines for display. This also gives 1050 lines of display information for each field. Two different fields of information are not mixed or overlapped....

Dennis Flubacher
National Training Instructor
Toshiba America, Inc.

*The information for the article to which Mr. Flubacher refers was taken from the monthly Toshiba Newsletter of February 1987. Somehow between the production of the original information and its publication in **ES&T** a slight error crept in. We hope it has not caused any inconvenience to any of our readers. Please see page 10 in this issue for a further explanation of this correction.*

Editor

Regarding electronic organs

Electronic organs have become very popular, and there are many technicians who would like to service them but don't know how. Your *ES* magazine had a series of articles on electronic organs in 1976. Wouldn't it be a good idea to write a new series of articles on this important instrument?

What is needed is an in-depth discussion of fundamentals and servicing techniques. The articles should cover both the simpler $150 electronic organs and the more complex Wurlitzer organs that sell for $2,000.

A review of books on this subject should be given in your magazine so that a technician can select a good book on this subject inasmuch as your articles would take some time to be written up.

O. D'Alessandro
Bloomfield, NJ

We are sure that by "organs," the above correspondent also includes the new electronic keyboards.

If you service electronic organs and keyboards and feel that a series of articles as described above would be of value to you, please drop us a line. We will judge from your response how widespread is the need for this type of information.

Editor

Do you have a comment, a gripe, or some other valuable information that you'd like to share with the editors and/or readers of *ES&T*? Please address your comments to *ES&T*, care of the "Feedback" department. If they're of general enough interest and we have the room, your comments might be published here in the "Feedback" column.

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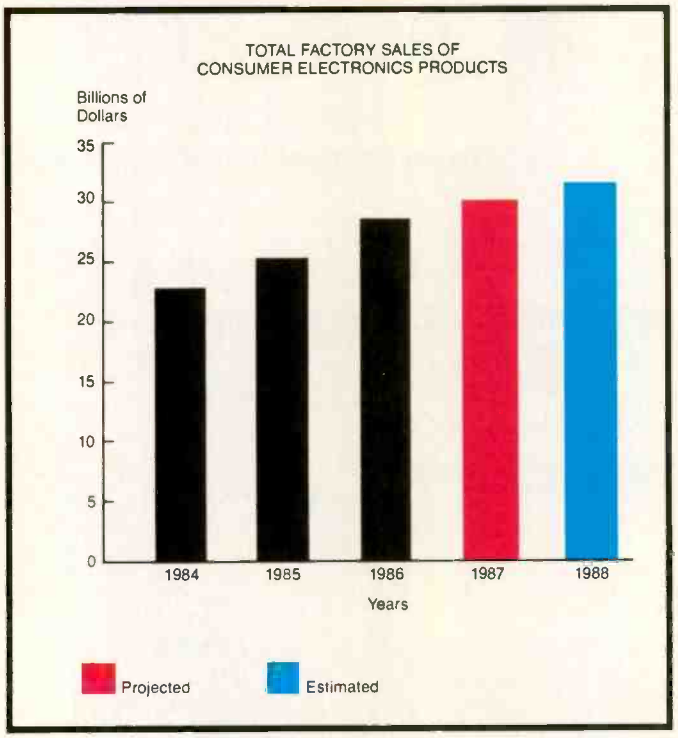
For Information Circle (5) on Reply Card
For Demonstration Circle (6) on Reply Card

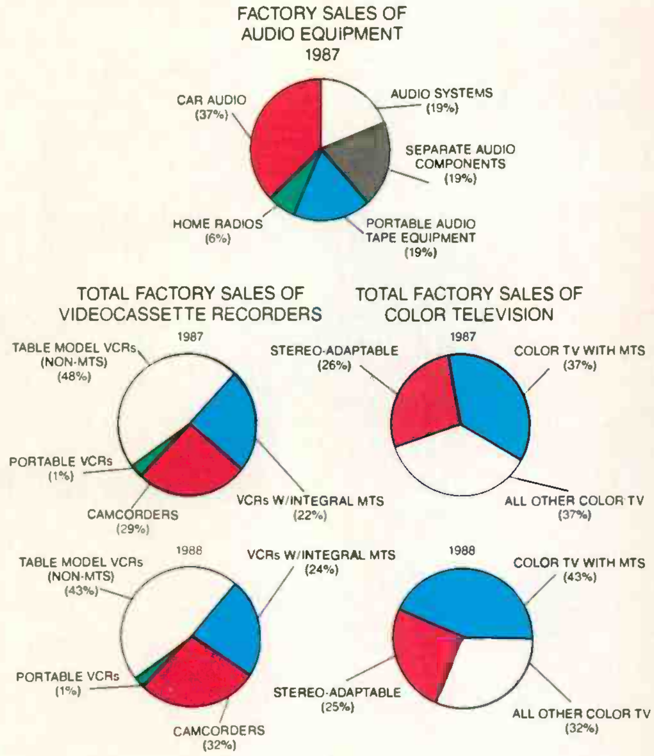
News

Consumer electronics: U.S. sales as of June 1987

These graphs and charts were developed by the Marketing Services department of the Electronics Industries Association, an authoritative source of information for the electronic industry.



SOURCE: Electronic Industries Association



Sales figures through 1986 were drawn from actual market activity reports. Projected sales for 1987 are based on market activity reports published to date and adjusted for seasonality, and on data submitted by individual manufacturers. Estimated sales for 1988 are based on a consensus of various industry sources.

The how-to magazine of electronics

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Servicing & Technology

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ELECTRONIC SERVICING & TECHNOLOGY is the "how-to" magazine for technicians who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts, who repair and maintain audio, video, computer and other consumer electronics equipment.

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NASM '88 will be in New Orleans

The 32nd Annual Conference and Exhibition of the National Association of Service Managers (NASM) will be held Oct. 11-14, 1987 at the Fairmont Hotel, New Orleans, and will feature the theme of "Service Quality: The Marketing Difference."

"This conference will be an important forum and educational resource for service professionals and their organizations," said Conference Chairman Robert Snopko, manager, Agricultural Product Support, J.I. Case Company. "We will be looking at concrete ways to improve service management, operations and profitability."

The conference will feature a product and service exhibition designed to bring together purchasers and vendors of service-information systems, tools, and equipment, including the latest service-management software.

As with previous NASM conferences, an extensive educational program will present the latest information and techniques on various topics related to the conference theme of Service Quality. The topics will include: Conducting a Service Audit; Customer Perceptions of Service Quality; Measuring and Preserving Quality Service; and more. The conference also will present a spouse's program that will include a special presentation on starting a home-based business.

For more information, contact Caryn Worcester, NASM, 60 Revere Drive, Suite 500, Northbrook, IL 60062; 312-480-9575.

The National Association of Service Managers is the oldest professional non-profit association of product service executives in the United States.

Luxor to end U.S. marketing

Luxor North America Corporation has announced that it will discontinue its North American distribution and marketing of satellite TV products. Luxor will maintain an organization for customer service, technical support, spare parts supply, and in-warranty and out-of-warranty servicing of installed products.

The company's current distribution structure will be kept intact for a limited period of time for the marketing of its existing inventory of North American satellite TV products.

Company President Hans Giner said it is generally perceived that 1987 will be another year of insufficient sales and profits in the satellite TV industry. Given the industry's grim sales results in 1986 and the present outlook for 1987, he said, Luxor has decided to halt U.S. satellite system marketing and concentrate its resources in Europe, where an orderly and booming direct broadcast satellite market is developing. ES&T

High perform multiple-speaker

A new dimension in speech recognition technology brings day-to-day living closer to those old-time *Amazing Stories* pulp magazines that seemed impossibly imaginative. An advanced prototype Japanese-speech LSI was announced by Toshiba at the Solid-State Circuits Conference held in New York. These new LSIs recognize a vocabulary of up to 50 words delivered in any voice, by any speaker. Accuracy is astonishing – 95%, with a key 13-word vocabulary. The system will adapt to any language.

To date, high-precision, selected-task LSIs have been available that responded to specific *voices*, requiring that the system be "trained" by words spoken by a single spokesperson. The new LSIs recognize *words*, words that may be spoken by anyone.

Picture this scenario: With both hands on the wheel, a driver utters the word "home" into his mobile phone, which dials the number automatically. After being connected to his telephone answering system, he commands it to turn up the heat (or turn down the air conditioning) and light the entrance hall. He arrives to a comfortable and bright home environment. Once there, he dictates a letter to his trusty secretary, the word processor, and his missive is soon ready for mailing. Sound like science fiction?

These LSIs, palm-size and probably costing about $67 for the set, are the first affordable speech-recognition devices capable of distinguishing the commands of random speakers with such precision. Prior to their development, only minicomputers with pricetags of $27 thousand to $67 thousand were capable of recognizing the speech of unspecified individuals with a comparable level of accuracy. With those devices requiring *specified* voices, confusion resulted when the specified speaker was not available.

In the new LSIs, Toshiba's multiple similarity (MS) method is used to recognize the pronounced words. MS technology was previously used in applications apart from speech recognition at the minicomputer level, including optical character readers, mailsorting machines with zip code readers and telephonic bank balance inquiry systems.

In the conventional MS method used in minicomputers, the elements of each word pronounced by several hundred persons are plotted in a 256-dimensional space to form specific nebula-like clusters pecular to each word. Spoken words are recognized by ascertaining to which *nebula* the pronounced word belongs.

To utilize this method at the LSI

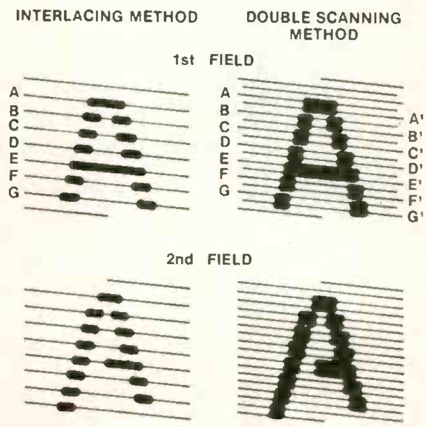
Amplification of Feedback item

A letter from Mr. Dennis Flubacher, National Training Instructor at Toshiba America Inc., Consumer Products Business Sector in Wayne, NJ, pointed out an error in the explanation of the operation of a television that uses the double scanning method.

The operation of these television sets is correctly described here.

A conventional television composes its picture from two fields, an even field and an uneven field, with an interlace ratio of 2:1. Each picture, one frame, is composed of 525 scanning lines, but only one field, 262.5 lines, is displayed every 1/60 of a second. When the subject moves up and down, the picture becomes rough because each field is only composed of 262.5 scanning lines.

However, the double scanning television's picture is composed of 525 scanning lines per field and 1,050 scanning lines per frame. Through doubling of the scanning lines, we produce a high quality picture with almost invisible scanning lines and very little line flicker. The double scan process is made possible by doubling the horizontal frequency of a conventional television, 15.734kHz, to 31.47kHz for the non-interlace television. Although the horizontal frequency has been doubled, the horizontal deflection circuit



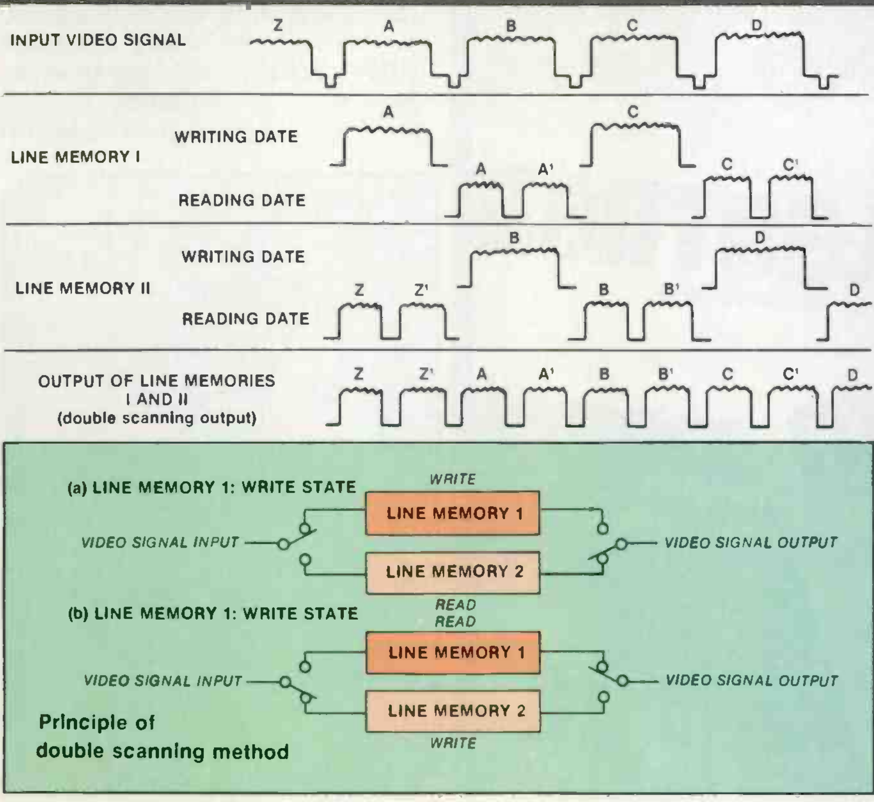
ance LSIs capable of speech recognition

Technology

level, dimensions must be reached to the limits of reasonable integrative capacity. Company researchers found. that dimensional numbers could be reduced to 60 in order to recognize at least 13 words with an accuracy of more than 95%. In this new development, the MS algorithm has thus been integrated into three LSIs.

Although the MS method can be applied to all other languages besides Japanese, some languages have certain aspects that will present challenges to the system. English, for example, has more consonants and uncertain endings – such as "-er" and "-or" – as well as homonyms such as "two, too and to." With artificial intelligence, however, these problems probably will be solved. Already a reality, state of the art speech recognition will continue to move ahead rapidly.

Trying out the speech recognition prototype LSIs installed in a Toshiba personal computer.



Principle of double scanning method

is the same as that for a conventional television with the exception of the operating frequency.

Video Operation

Doubling the horizontal frequency makes it possible to move the electron beam across the screen at twice the rate of a conventional television. In order to increase the video information from 262.5 lines per field to 525 lines, we utilize 2-line memories placed between the CVPU and VCU. Two memories are necessary for alternate operations of reading and writing of data: while one memory is writing data *in*, the other is reading data *out*. The doubling of video information is accomplished by doubling the frequency of the reading clock from the writing clock; for every 262.5 line field written in, we have a 525 line field read out.

Test your electronics knowledge

By Sam Wilson

This quiz is based upon material that was presented in the issues between September 1986 and now. Are you keeping up with the technology of today? Of course you are – you're reading ***ES&T*** magazine. So, this should be a cinch!

1. Assume there is a 1,000 μV RF signal with about 75% modulation delivered to the RF input of a typical small TV receiver. Also assume that this RF frequency is set equal to the middle of a VHF channel. The receiver will deliver about
A.) 50Vp-p at the video amplifier output.
B.) 5Vp-p at the video amplifier output.

2. Which of the following statements is correct?
A.) You should operate every receiver that comes through your shop at its upper limit of line voltage as rated by the manufacturer. This will show if any weak components are about to go bad and cause expensive callbacks.
B.) Never test receivers for their ability to operate at their upper limit of line voltage.

3. When using a lissajous pattern to compare the input and output signals of a Class A amplifier, the CRT should display
A.) a straight line.
B.) an elipse.
C.) a circle.

4. A perfect capacitor would have an equivalent series resistance of
A.) infinity (infinite resistance).
B.) zero ohms.

5. Which of the symbols in Figure 1 represents a tunnel diode?

6. When a logic analyzer is used to sample input lines, the period of the sampler should be
A.) long.
B.) short.

7. To minimize noise and stray pickup, a coaxial cable shield should be grounded at
A.) both ends.
B.) one end only.

8. Which of the following means "to boot the disk"?
A.) Turning the computer *on* with a DOS/BASIC disk in the disk drive. A small program in the computer ROM operates the disk and reads the disk contents into the memory so the computer can operate the disk drive.
B.) Using the built-in program so that it is not necessary to start operating by installing the DOS into the computer.

9. NASA scientists spent eight years trying to eradicate carbon dioxide from space shuttles, then solved the problem in four weeks when they turned to ___________.

10. Toshiba researchers have developed a transistor that they call the fastest in the world. It is called a heterojunction bipolar transistor (HBT). It has a switching time per gate of ____ picoseconds.

Answers are on page 54

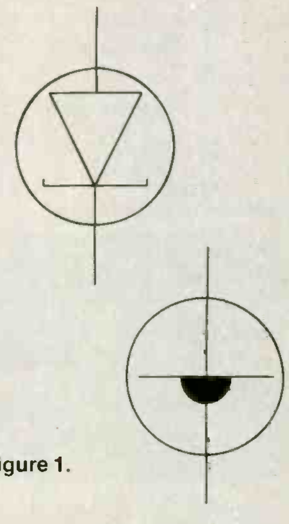


Figure 1.

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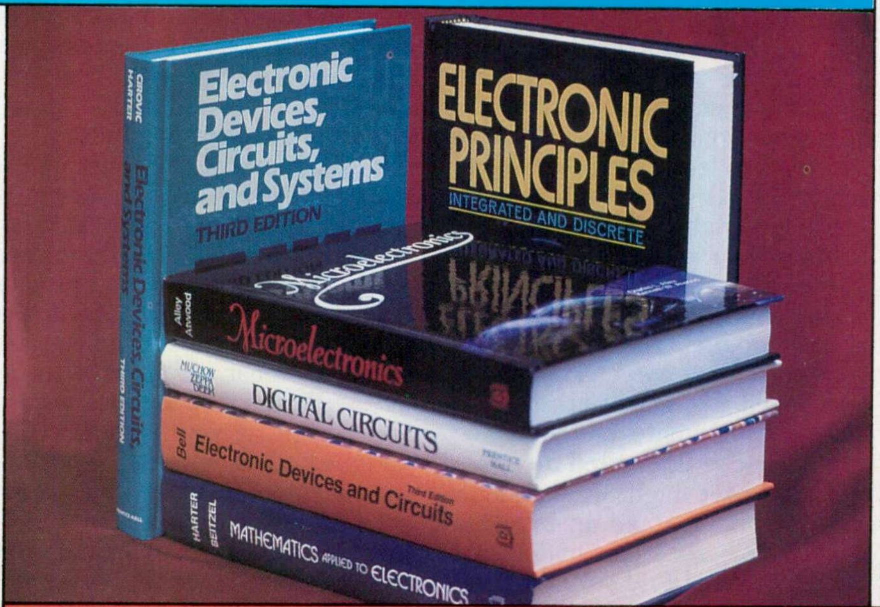

ES&T staff photo

By Conrad Persson

One of the sad facts of choosing a technical career such as servicing consumer electronic products is that no matter how hard you try, you will always be behind, trying to learn the new technology. Even while a technician is completing his formal education, he's probably studying a great deal of information that's already out of date or soon will be. While he studied, the electronics research and development organizations and manufacturers will have been churning out today's technologies as well as tomorrow's, which the fledgling technician will have to cope with after his formal education is finished.

Here's an example: When I was studying electrical engineering in the early '60s, I spent several semesters dealing with piecewise linear models of vacuum tubes. I had one full-year course on transistors, on which every consumer electronics device then being manufactured was based. I once heard the term *integrated circuit* mentioned but had no idea what it meant.

That was the state of my formal education in electronics when I graduated. I have been trying to catch up ever since. It's futile, but try we must.

It's just like the Queen said to Alice in Wonderland: "You have to do all the running you can just to stay in the same place. To get anywhere you have to run even faster than that."

To carry that analogy a little further, the problem then becomes one of choosing which road to run on. In this case they're not very well marked. Some are straight and wide and level, while some are rutted and filled with potholes and obstacles. Some are dead ends.

This article is intended to show you where some of the roads begin. Unfortunately, we don't have any road maps so we can't advise you as to which of these options are best and which are worst. You'll have to trust to your own judgement and luck.

Several avenues

There are two pivotal decisions to make when you're deciding how to further your education. What do you need to learn and how will you learn it? It's important to do a thorough analysis of exactly what it is that you want to learn. A typical statement is "I want to learn about computers" or something equally vague. The question that you need to answer is "What do you need to learn about computers?", or whatever the subject is that you're interested in.

The answer might be something like "I want to take an introductory course so I can understand the jargon and find out how hardware and software work together so I can find out what *more* I need to learn." That doesn't pin it down completely, but it does state some specific goals.

Once the specific goals are set, you need to determine how to get to them.

Self-study

One inexpensive method of continuing your education is to buy a book on the subject and study it yourself. This has a lot of pitfalls. Some books are excellent and deliver what they promise in terms of knowledge to impart, and are written in such a manner that you come away enlightened. Unfortunately, for every book like that, there are books that don't deliver what they promise or that are couched in language that's difficult or impossible to fathom.

Another problem with this approach is that even if the book is excellent, it won't do you a lot of good if you don't read it. Self-study from books in this manner requires an iron self-discipline.

Self-study through a home study course is another way to learn by yourself at home. Home study courses offer a major improvement over studying from books. The material is broken down into study units, you learn what is expected of you and you get feedback through regular tests.

This approach also requires self-discipline as it's easy to let things slide and to ignore notices sent in the mail. If you're *motivated*, you can learn a lot this way.

Schools and seminars

If time and money permit, a more effective way to learn is through structured class and lab courses. Here again, there are many avenues. Public and private technical schools throughout the country offer a selection of courses from the most elementary introductory courses to detailed theory and design. If you have the time and the budget to travel, manufacturers of consumer electronic products offer seminars to servicing technicians on the operation and servicing of specific items.

A letter to the product servicing department of any of the manufacturers of these products will get you information on what education they have available and what their policy is on providing this training.

Other training available

All manufacturers of test equipment and tools for electronic servicing want you to buy their products. Naturally, the more you know about the type of product they offer in general and their product in particular, the more likely that if you need such a product you'll buy theirs.

For that reason, many manufacturers of test equipment and tools offer information on using that equipment. Some of this information is rudimentary and some is all you'll ever need to know about that particular product or process. Some of this information is free and some is quite expensive.

Here are examples of education materials offered by tool and test equipment manufacturers.

Catalogs and engineering notes – most manufacturers spend huge amounts of time and money putting together catalogs that present their products in the best light. Some of these are not as useful as they could be, but others not only list the kinds of tools the manufacturer offers, but provides tips on where and how to use them. The best of these are educational, and, in many cases, they're free.

Many manufacturers offer mini courses of many kinds. Tektronix, for example, now offers a training lab, for a fee, that guides the user in the use of the oscilloscope. According to the book that comes with it, "The Tektronix Training Lab family of circuit boards provides a source of typical problem signals that demonstrate the troubleshooting, timing and voltage measurement capabilities of a modern oscilloscope. The signals may be used to develop measurement and analysis skills needed for the design and troubleshooting of modern electronic devices."

Sencore puts out a newspaper with articles designed to teach servicing methods periodically, and sponsors training seminars. These are free. Of course, the content of both the newspaper and the seminars is heavily slanted toward the company's own products.

If you're interested in learning more about the use of certain test equipment, tools, supplies, etc., write to the manufacturer, tell them what you need in terms of information and ask what's available. It could be an education in itself.

Trade associations

It is in the best interest of product manufacturers as well as technicians to make sure that all technicians who service electronics equipment are well trained. A well-trained, efficient, professional technician will enhance the image of the manufacturer of the product he services and the image of all technicians everywhere.

For this reason, the manufacturers through the Electronic Industries Association (EIA) and the technicians through technician associations have training programs available to technicians. EIA, for example, has available a broad range of educational services for technicians: everything from free pamphlets that address such subjects as servicing methods and consumer and technician safety to training seminars on specific items of equipment, such as VCRs. These seminars are available to working technicians at a variety of locations in the United States at no cost. Expenses are, of course, up to the individual or the individual's employer.

The Electronic Technician's Association likewise has frequent seminars at nominal charges. For example, in association with its annual convention, usually in June, ETA hosts satellite and master antenna TV (SMATV) schools, as well as a selection of other seminars ranging from servicing VCRs

Trade Associations

Electronic Industries Association/Consumer Electronics Group (EIA/CEG)
2001 Eye St., NW
Washington, DC 20006
202-457-4919

Electronic Representatives Association (ERA)
20 East Huron St.
Chicago, IL 60611
312-649-1333

Electronic Technicians Association (ETA)
RR 3, Box 564
Greencastle, IN 46135

National Association of Retail Dealers of America (NARDA)
2 North Riverside Plaza
Chicago, IL 60606
312-454-0944

National Association of Recording Merchandisers (NARM)
1060 Kings Highway North
Suite 200
Cherry Hill, NJ 08034
609-795-5555

National Electronic Distributors Association (NEDA)
1420 Renaissance Drive
Park Ridge, IL 60068
312-298-9747

National Electronic Service Dealers Association (NESDA)
2708 West Berry St.
Ft. Worth, TX 76109
817-291-9061

Recording Industry of America, Inc. (RIAA)
888 Seventh Ave.
New York, NY 10106
212-765-4330

Technical Book Publishers

Hayden Book Company
Rochelle Park, NJ 07662

McGraw-Hill Book Company
1221 Avenue of the Americas
New York, NY 10020

Prentice-Hall
Englewood Cliffs, NJ 07632

Howard W. Sams & Company, Inc.
4300 West 62nd St.
P.O. Box 558
Indianapolis, IN 46206

Tab Books
Blue Ridge Summit, PA 17214

Cleveland Institute of Electronics
1776 E. 17th St.
Cleveland, OH 44114

Cook's Inst. of Electronics Eng.
Desk 15; P.O. Box 20345
Jackson, MS 39209

Electronic Institute of Brooklyn
4823 Avenue N
Brooklyn, NY 11234

Grantham College of Engineering
2500 S. La Cienega Blvd.
Los Angeles, CA 90034

National Institute of Technology
1701 W. Euless Blvd.
Euless, TX 76039

National Technical Schools
456 W. Santa Barbara Ave.
Los Angeles, CA 90037

NRI Training for Professionals
McGraw-Hill Continuing Ed. Center
3939 Wisconsin Ave.
Washington, DC 20006

National Association of Trade and Technical Schools
2021 K St., NW
Washington, DC 20006

to avoiding electrostatic discharge damage.

That organization hosts other seminars throughout the year.

The National Electronic Sales and Servicing Dealers Association (NESDA) and its affiliate, the International Society of Certified Electronic Technicians (ISCET), also hosts seminars. Many seminars are held, for example, at that organization's annual convention, usually in August. In addition, many of that organization's state and local affiliates also hold educational seminars.

Identifying the resources

A local school may have just the course you need listed in its catalog. One of the book publishers might have just the book or series of books to fill in the gaps in your knowledge. One of the associations related to home electronics equipment manufacturing, sales or service may have just the item of information you need, or may be able to point you in the right direction.

Microwave Filter Company (East Syracuse, NY) offers catalog MTV/87. It teaches terrestrial interference (TI) symptoms and helps select filters to cure TI in more than 500 different receivers.

The catalog features diagrams for standard and block downconversion receivers, showing where interference can affect the system and the choice of filters to solve the problem. From literature that's been published in several past issues, this company appears to offer a number of other books and pamphlets that address multifacets of the TI problem.

Omega Press, an Omega Group Company (Stamford, CT), offers a publication called The Complete Handbook of Science and Technology Books. Known as the Book of Books, it is a one-stop source for ordering English language texts from the 14 leading science and technology publishers.

More than 10,000 books are listed in the Book of Books, along with scientific software and complete descriptions and prices.

The Electronics Industries Association/Consumer Electronics Group, Washington, DC, publishes, among other things, a quarterly magazine, available free to owners and managers of businesses that service consumer electronics products. Its purpose is to keep you up to date on industry-management matters, educational opportunities, service meetings and conventions.

A catalog from Pace (Laurel, MD) describes that company's motion picture/video training courses: "Basic Soldering" (now available in 11 languages) and "Rework and Repair for Electronics." The company also provides a repair support program including documented solutions to specific repair problems with customized repair instructions and instructor courses.

A videotape program available from the 3M Static Control Systems Division (Austin, TX) discusses ways to minimize electrostatic discharge (ESD) damage to sensitive electronic components during field service operations. Titled "How to Avoid Static from All Sides," the 20-minute videotape is designed to increase static awareness among management and field personnel, specifically in electronics field service.

Anyone contemplating a technical career might wish to check the National Association of Trade and Technical Schools' (NATTS) "Trade and Technical Careers and Training" handbook. Accredited private schools throughout the country that offer skill training are listed alphabetically both by career and by state. See the address for NATTS in the listing in this article.

Hewlett-Packard Company (Colorado Springs, CO) offers a booklet "Feeling Comfortable with Logic Analyzers," which describes how logic analyzers operate and how they may be used in diagnosing digital equipment. ***Electronic Servicing & Technology*** reproduced this booklet in the October 1986 issue as the article "Seeing digital circuit operation with a logic analyzer."

The supply was limited when we first published this literature item in September 1986, and they might be gone by now, but the "Diskette

Guide Book" from BASF Corporation (Bedford, MA) provides answers to hundreds of questions about how diskettes are made and how they work.

Here's a reminder about the seminars offered by John Fluke Manufacturing of Everett, WA, at its training centers throughout the country on the application of its products and their maintenance. For example, a partial listing of their offerings in September includes "Metrology for Technicians" in Detroit, Phoenix and Paramus, NJ; "DMM Maintenance" in Chicago, and "9010 Board Tester Troubleshooting and Programming" (two separate courses) in cities across the country. Similar courses are offered in October. See pages 8 and 9, ***ES&T*** Buyer's Guide, March 1987.

Tektronix, Inc. (Beaverton, OR) has just released a library of support material for its lowest cost portable scope, the 2225 50MHz oscilloscope. The material includes a demonstration videotape, a full-color brochure, a 36-page primer ("The XYZs of using a scope") and five technical briefs on oscilloscope measurements. This is free of charge.

An operator's videotape also is available at a charge of $60. This tape provides full details on usage of this scope, and can be used as a supplement for the manual provided with the unit, or as a classroom instruction aid.

Again, this listing of literature and other forms of technical training is not meant to be exhaustive or comprehensive, but to serve as an idea starter. If you're wondering how to learn more about how to service a VCR or operate an oscilloscope or whatever, write the manufacturer, the schools, etc., and ask what kind of training or educational materials they have available.

If any readers have any information on specific training courses or material or any suggestions on how ***ES&T*** can make readers more aware of what training is available, please let us know.

In order to round out the coverage of the kinds of training and literature available for technicians interested in rounding out their education, here is a sampling of books brought to our attention recently by publishers of technical books.

Troubleshooting and Repairing Electronic Test Equipment—2nd Edition, by Mannie Horowitz; Tab Books, 448 pages, $17.45 paperback, $24.95 hardbound.

Troubleshoot and repair test equipment, ending the hassles and delays of taking gear to a repair shop or sending it back to the factory.

The author, a professional engineer and test equipment designer, covers everything needed to fully understand and apply the principles of electronic test equipment troubleshooting and repair.

Revised and expanded, this guide brings the reader up to date on the newest digital equipment and state-of-the-art troubleshooting and repair techniques.

Published by Tab Books Inc., Blue Ridge Summit, PA 17214; 717-794-2191.

68000, 68010, 68020 Primer, by Stan Kelly-Bottle and Bob Fowler; Howard W. Sams, 368 pages, $21.95 paperback.

This primer begins with an introduction to the 68000 chips and why they are one of the most powerful microprocessors currently on the market. The book progresses to the architecture of the chips, how to program in Assembly language, how to utilize the 68000 to its fullest, what makes files lock and how to minimize the problem, how code mapping works, how to use various instructions and registers, and how the chips are used in multi-user systems.

It is written in the Waite Group's authoritative primer style, with everything you need to know about the 68000 family and its important programming features. Actual programming examples are presented throughout the book and a tear-out card lets you keep instructions close for easy reference.

Published by Howard W. Sams & Company, 4300 W. 62nd Street, Indianapolis, IN 46268; 317-298-5400.

FM Atlas and Station Directory; Bruce F. Elving, Publisher, 164 pages, $8.95 plus .55 postage.

This revised 10th edition of the FM Atlas and Station Directory is designed to make it easier for FM radio-equipped travelers, or those who dial around from home, to tune in their favorite sounds.

The book features 77 pages of maps showing exact station locations, call letters and frequencies, as well as directories arranged by frequency and geography. The directories give full technical and programming data on some 5,000 FM radio stations of the United States, Canada and Mexico. Listed, too, are stations having an SCA subcarrier, and what they use this closed-circuit service for. Low-power FM translators are shown, giving their frequency and call letters of the full-service station they rebroadcast. Educational, public and religious stations are shown, as are commercial stations.

Published by Bruce F. Elving, P.O. Box 24, Adolph, MN 55701; 218-879-7676.

ST Disk Drives—Inside and Out; Abacus Software, 403 pages, $24.95.

This book includes chapters on files, files structures and data management. It thoroughly discusses the floppy disk, the hard and the RAM disk both from a programming and a technical perspective. In addition, the reader will find several full-length utilities and programming tools that enable him to further explore the ST disk drives.

Published by Abacus Software, 2201 Kalamazoo S.E., Box 7211, Grand Rapids, MI 49510; 616-241-5510.

Electronic Devices, Circuits and Systems—3rd Edition by Michael M. Cirovic and James H. Harter, Prentice-Hall, 444 pages, $37.95 hardbound.

The purpose of this book is threefold: first to introduce a variety of semiconductor devices (integrated circuits and discrete devices), their basic operation, and their characteristics; second, to illustrate how these devices are used in simple electronic circuits, as well as how these circuits are analyzed and designed; third, to present complex electronic systems as simple extensions and examples of the use of devices and simple circuits. The prerequisites for understanding the material are basic college mathematics (algebra) and a basic course in electronic circuits.

Part I presents the basic physics and physical principles that make understanding the operation of electronic devices possible. This is a brief description, not a mathematical discussion, leading to the terminal characteristics of devices. The terminal characteristics directly lead to and suggest biasing schemes that follow. With the devices properly biased, terminal characteristics under signal conditions are presented, leading to the use of models and equivalent circuits in the systematic analysis of circuits containing devices.

Part II deals with applying the devices introduced in Part I in simple circuits. Methods of analysis stressing approximations and practical considerations are used, and some design problems also are illustrated.

In Part III more complex electronic circuits and systems are described. In some cases, actual circuits are examined; in other cases block diagrams are used.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 800-223-2336.

Troubleshooting & Repair of Audio Equipment, by John D. Lenk; Howard W. Sams, 181 pages, $21.95 paperback.

A simplified, practical system of troubleshooting for the many types of audio equipment now available. This 8½"x11" book concentrates on modern audio equipment found in home-entertainment systems, including integrated amplifiers, linear-tracking turntables, cassette decks with noise-reduction, AM/FM-stereo tuners with PLL frequency synthesis and compact disc players. It is assumed that the reader is familiar with the basics of electronics, including audio.

Instead of trying to provide details on specific products, this book concentrates on troubleshooting/repair approaches that can be applied to any audio component (both those now in use and those to be designed and manufactured in the future).

The approach here is to break each audio component down into its various circuits or sections. All modern audio components have certain circuits and/or sections in common (such as microprocessor system control, front-panel operating controls and indicators, amplifiers, and so on) as well as special circuits unique to a particular type of component (such as the oscillators that provide bias and erase currents for cassette decks).

A separate chapter is devoted to

each audio component. Individual chapters are divided into sections with a consistent format. Using this chapter/section approach, the reader can quickly locate information needed to troubleshoot a malfunctioning component.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5400.

Electronics Math, by R. Jesse Phagan, Tab Books, 256 pages, $15.45 paperback, $22.95 hardbound.

This book treats mathematics as a practical electronics tool. The mathematics covered is basic and useful to the technician. It contains sample problems that illustrate how each procedure is performed when working out an electronic design problem. Because math is so basic to our industry, ***ES&T*** is bringing this book to your attention for the second time; it first was reviewed, briefly, in the April 1987 issue.

The text leads the reader from the basics of scientific notation through the principles of ac and dc circuit math and on to transformers, and inductive and capacitive reactance. In the process, these other concepts are introduced: use of the oscilloscope for measuring phase shift, the theory and applications of time constants used in R-L circuits, and a short course in understanding power supplies and how to measure them and make modifications when necessary.

Some of the highlights of the book include a chapter covering the use of the j-operator for solving complex circuits, and coverage of R-C waveshaping and how-tos for calculating resonance frequency and more.

Published by Tab Books, Blue Ridge Summit, PA 17214; 717-794-2191.

Digital Circuits, by Kenneth Muchow, Anthony Zeppa and Bill Deem; Prentice-Hall, 390 pages, $34.95 hardbound.

Within the last decade there have been rapid technological advances in the computer field. The need for clear, comprehensive and practical information on currently available digital devices has grown just as rapidly. The book tries to close the gap between academic instruction and current industrial practices in digital electronics.

A thorough introduction to digital circuit concepts related to minicomputer and microcomputer applications is presented. Real off-the-shelf circuits are used in problems and examples.

This text is written for students in technical schools, community colleges and universities, and for electronics technicians currently employed in the field of digital computers.

Subject matter covered includes computer number systems and math, description of logic gates, logic circuits, MSI and LSI circuits.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632; 800-223-2336.

Op-Amp Handbook – 2nd Edition, by Fredrick W. Hughes; Prentice-Hall, 308 pages, $31.95 hardbound.

This revised and updated edition provides a direct, easy-to-read approach for developing basic understanding and practical skills in working with op-amps. The book is designed for the electronics student, technician, and engineer, but does not require background knowledge beyond fundamental algebra and basic ac/dc circuit theory.

Beginning with an explanation of what an op-amp is, how it works, and its important characteristics and parameters, the text then describes the basic op-amp circuit configurations. Basic signal-processing circuits and op-amp oscillators in the form of various waveform generations are fully described.

Necessary formulas are included to aid in the understanding of the function of the op-amp in waveform generating circuits.

The book includes a discussion of basic op-amp testing and troubleshooting techniques.

Published by Prentice-Hall Inc., Englewood Cliffs, NJ 07632; 800-223-2336.

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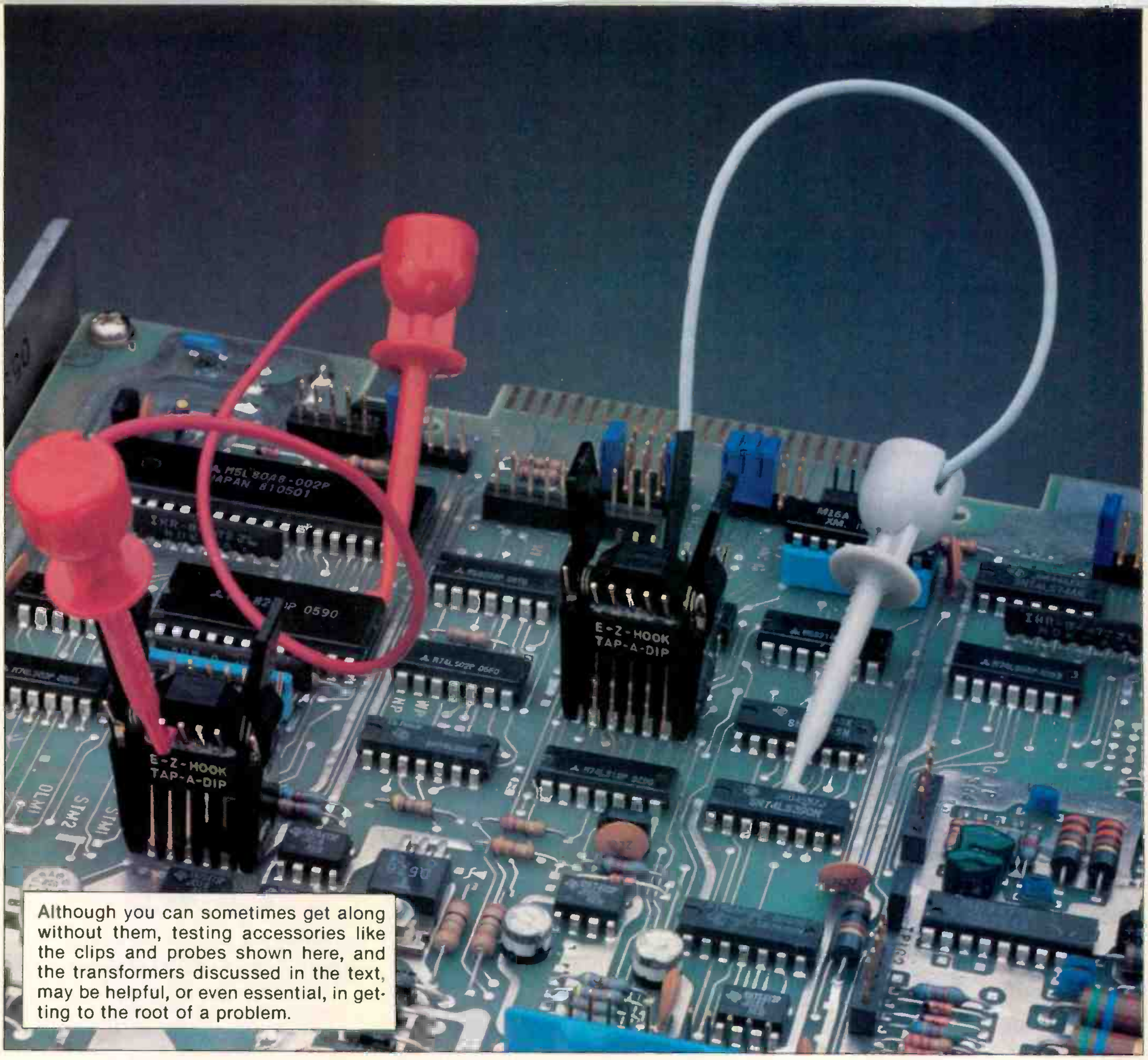

Although you can sometimes get along without them, testing accessories like the clips and probes shown here, and the transformers discussed in the text, may be helpful, or even essential, in getting to the root of a problem.

Circuits for electronic measurements

The circuits described here, which can be used to help in taking measurements during troubleshooting, are reproduced with permission of the publisher, Howard W. Sams & Company, from "Electronic Test Instruments: A User's Sourcebook," by Robert Witte, Copyright 1987, reviewed in May 1987 ***ES&T.***

The information shown here constitutes part of Chapter 7 of the book titled "Circuits for Electronic Measurement."

Electronic circuits are usually the devices that are to be characterized or measured. The voltages or currents of some circuit that already has been designed and built often are measured in order to evaluate or repair the circuit. In other cases, it may be necessary or convenient to design and construct a simple circuit in order to perform the measurement. These circuits to aid electronic measurement generally fall into two categories: circuits that produce the measurement parameter (voltage or current) and circuits which condition a voltage or current that already exists.

Resistance measurement — indirect method

Modern ohmmeters (or multimeters) provide a convenient and accurate means of measuring resistance values. For most applications, this is the fastest and easiest way to make resistance measurements. There are other situations, however, where the ohmmeter is not capable of making the desired resistance measurement. Remember that the ohmmeter requires that all power sources be removed from the circuit under test. For measuring devices such as the input and output resistance of an amplifier, this is not possible. In fact, there is no single resistor to be measured because the input and output resistance of an

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Test accessories and circuits

By Conrad Persson

In performing any kind of product service, there are certain essentials: You must have enough information to understand, at least in general, how the product works, and what the observed failure symptoms indicate. If the product is at all complex and its operation obscure, you probably will require some kind of test equipment.

In most cases of product service, you also will need some kind of tools to disassemble the unit to get to the failed section in order to remove failed parts and to install replacement parts. You also need the replacement parts, of course.

In addition, there are servicing accessories that you may wish to have, or in some cases some accessories that you absolutely *must* have in order to test and repair the unit you're working on. You may also find that there are instances where circuitry that you can construct will make possible valuable tests that you couldn't otherwise perform.

Testing accessories may be as simple as the test clips and test leads shown on the cover, or they may be as complex as signal generators and pattern generators. This article will concentrate on the benefits that the use of transformers can bring to the test bench: isolation from the line and voltage variation.

Keeping your cool with a hot chassis

Most, if not all, TV sets manufactured in the past 10 years for use in the United States have a *hot* chassis; that is, one that is directly connected to the ac power line without the benefit of transformer line isolation. Because of this fact, if you hook up a test equipment probe that is tied back to earth ground to some of these sets, you will damage the television, and possibly the test device. The following paragraphs will explain why televisions are so designed, what happens when you hook up a piece of grounded test equipment, and how to avoid this source of damage.

Back in the '70s, when the OPEC countries had a stranglehold on the petroleum supply, when people were waiting in line for gas, and everyone was being exhorted to extinguish unnecessary lights (and maybe suffer a little discomfort by keeping the thermostat set at an energy-saving level), TV manufacturers were being urged to increase the efficiency of televisions. The TV manufacturers responded by pledging to produce televisions that consumed less than 100W, in contrast to existing TVs that might use 150W to 200W or more. That might not seem like a big deal, but if you multiply that savings by the average number of hours a set is watched, times the millions of TV sets in use in this country, the savings add up. This resulted in today's hot chassis televisions, and increased problems for servicers.

In many older televisions, the ac power line came into a transformer. This provided isolation from the ac line: The only connection between the primary and sec-

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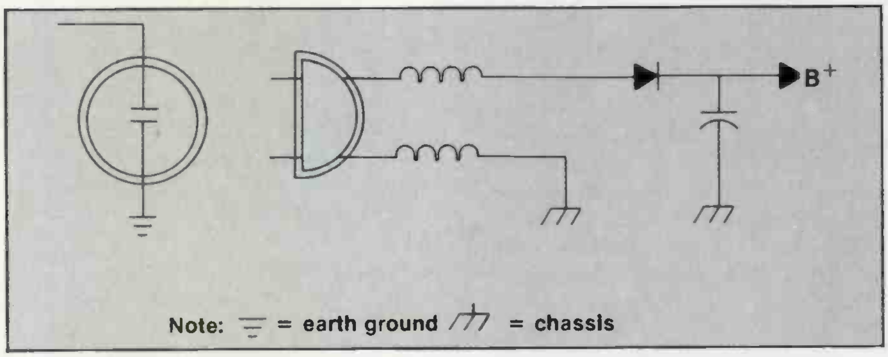

Figure 1. In a ½-wave rectifier hot-ground television, one side of the ac line is connected directly to the chassis.

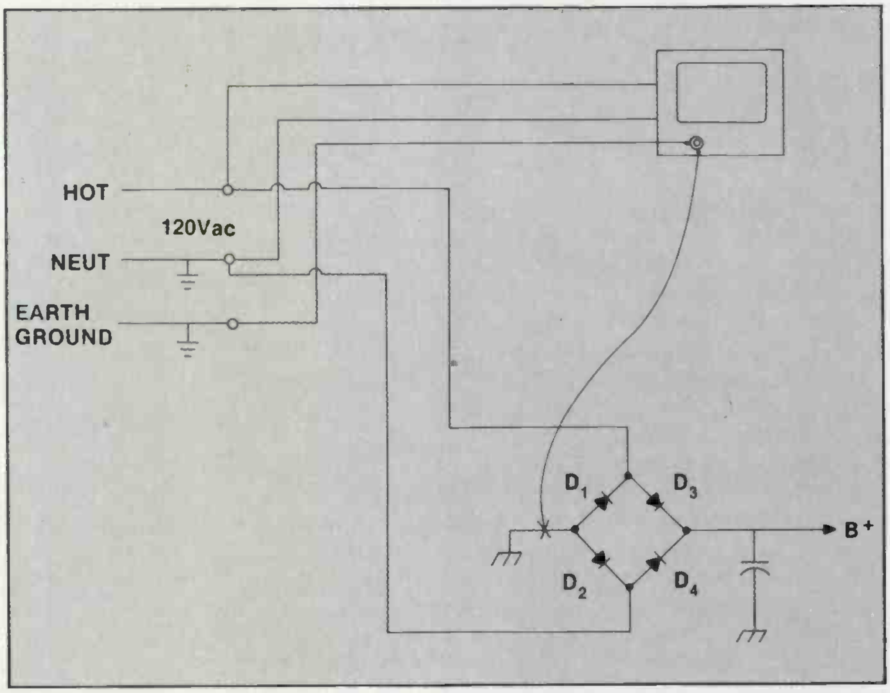

Figure 2. Connecting an oscilloscope or other grounded test instrument to the chassis of a bridge-rectifier television creates a short-circuit path to earth ground, usually damages components in the TV power supply, and may damage the test instrument.

amplifier is the equivalent resistance looking into the input or output of the amplifier. This equivalent resistance depends on the active components (usually transistors) and bias circuits inside the amplifier. The circuit must have power applied to measure the input or output resistance accurately.

Voltage divider

One way to measure a resistor is to use an indirect method, which measures circuit parameters other than the unknown resistance and then uses them to compute the unknown value. Consider our old friend the voltage divider, shown in Figure 1. The voltage divider equation for this circuit is:

$$V_L = \frac{V_S R_L}{(R_S + R_L)}$$

Rearranging, R_L and R_S can be found in terms of the other values:

$$R_L = \frac{V_L R_S}{(V_S - V_L)}$$

$$R_S = R_L \left(\frac{V_S}{V_L} - 1\right)$$

So, for instance, if V_L, V_S and R_S are known, the value of R_L can be determined.

Output impedance

Suppose the output resistance of a signal source (or amplifier) is to be measured. An ohmmeter cannot be used because the source must be powered up during the measurement. The source's output can be modeled as the circuit shown in Figure 2A, which is a voltage source with a series resistance representing the output resistance. The value of V_S can be determined by measuring the output voltage of the source under open-circuit conditions. (Of course, the level of the source depends on its control settings, but for a given instrument state, V_S will be constant.) A known load resistor can then be connected to the output of the source and V_L can be measured. V_L should always be less than or equal to V_S, due to the loading effect.

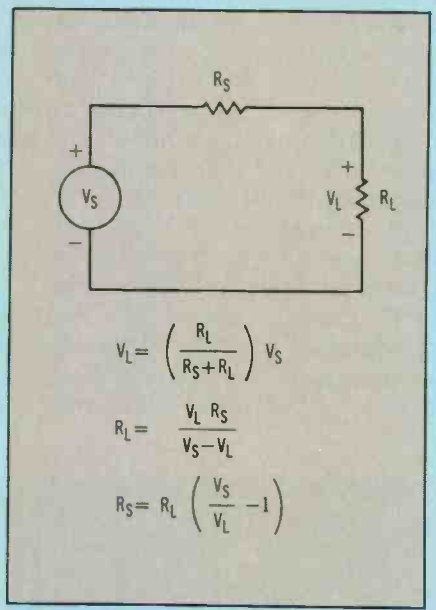

Figure 1. The voltage divider circuit can be used for measuring the value of an unknown resistance.

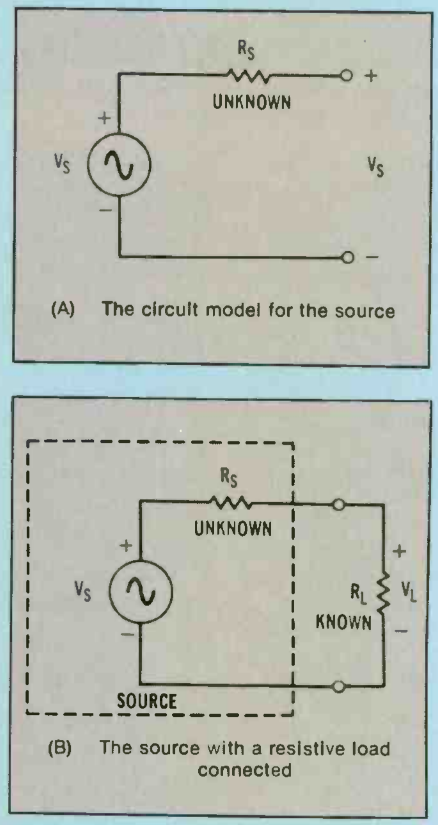

Figure 2. Using the indirect method to measure the output resistance of a signal source.

Some experimentation may be required to determine a suitable value for the load resistor. If R_L is too large, indicated by V_L being very close to or the same as V_S, then the circuit is not being loaded enough. If R_L is too small, indicated by V_L being only a small fraction of V_S, the source may become too heavily loaded and may no longer operate within specification. In general, with a suitable value for R_L, V_L should be no more than 90% of V_S and no less than 50% of V_S. Loading the source such that V_L is 50% of V_S eliminates the need for any further calculation because, under this condition, R_S equals R_L.

This technique works on a variety of devices that can be modeled as a voltage source with an internal series resistance. Examples are signal sources, batteries and (the output of) amplifiers. The same concepts apply whether the voltages involved are dc or ac. In the ac case, it is important to note that the output impedance must be resistive. Fortunately, this is true for many of the output impedances that are measured. Some devices (batteries, for example) will not tolerate heavy loading; measure them with as little loading as possible.

Example 1—The output resistance of an amplifier is to be determined, using the indirect method. A sine wave source was connected to the input, causing a 2V rms ac voltage at the output with no load (Figure 3). A 500Ω load resistor connected to the output caused the output voltage to drop to 1.5V rms. What is the output resistance of the amplifier?

V_S is equal to the open circuit (no load) voltage, so V_S = 2V rms. V_L was measured at 1.5V rms, and R_L is 500Ω. (Note that rms values are used for V_S and V_L. Zero-to-peak or peak-to-peak also could be used as long as they are used consistently.)

$$R_S = 500\left(\frac{2}{1.5} - 1\right) = 167\Omega$$

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ondary was through magnetic induction. But transformers are around 60% efficient, which means that they waste energy, so they had to go.

Besides isolation, however, the transformer, if it had a center tap, afforded full-wave rectification with just two diodes.

Today's more efficient televisions, minus the isolation transformer, have "hot" chassis: They are connected to the power line with no isolation.

Some of these units, ordinarily the smaller screen units that inherently consume small amounts of power, use ½-wave rectification. That is, a single diode passes the positive-going portion of the ac sine wave and discards the negative-going portion (see Figure 1). Here, one side of the ac line is connected to the metal chassis.

With this scheme there is no problem connecting grounded test equipment as long as the TV chassis is at ground potential through the common side of the ac line. Most TV sets manufactured like this have a polarized plug that assures that the television will be connected this way. If the plug is not polarized, it's a simple matter to use an ac voltmeter to take a reading from the chassis to the ac ground. A high ac voltage reading indicates that you need to turn the plug around before you begin testing.

Sometimes you must use an isolation transformer

Elimination of the transformer greatly improved efficiency, but in many cases throwing away half of the ac power by using a ½-wave rectifier is unacceptably inefficient. In these cases, the solution is to use a full-wave bridge rectifier. This is a great solution to the problem of inefficiency. Unfortunately, because of the way the bridge rectifier works, the chassis of whatever has a bridge rectifier in its power supply is at half the line potential, no matter which way the plug is turned.

That's a serious problem for the technician. If you connect a piece of test equipment, say an oscilloscope, that has a grounded test probe, to chassis ground, you will, in effect bypass one of the diodes in the rectifier.

The effect of connecting this grounded test probe can be seen in Figure 2. On the first negative ½-cycle of the line ac, the diode will be forward biased by 120V with nothing to limit the current. The diode will try hard to do what it is asked to do in this case: pass infinite current. It will not be able to do this, and will fail catastrophically. If the TV set you're testing did not have a problem when you started, it does now.

In addition, the high current passing through the common test lead may be higher than the rating of the ground-return circuit in the test equipment, causing it to be damaged as well.

One way to overcome this problem would be to defeat the third-wire ground to the test equipment by, for example, cutting the third-wire ground connector. DON'T. For one thing, now you have a shock hazard between the case of the test device and anything connected to earth ground. For

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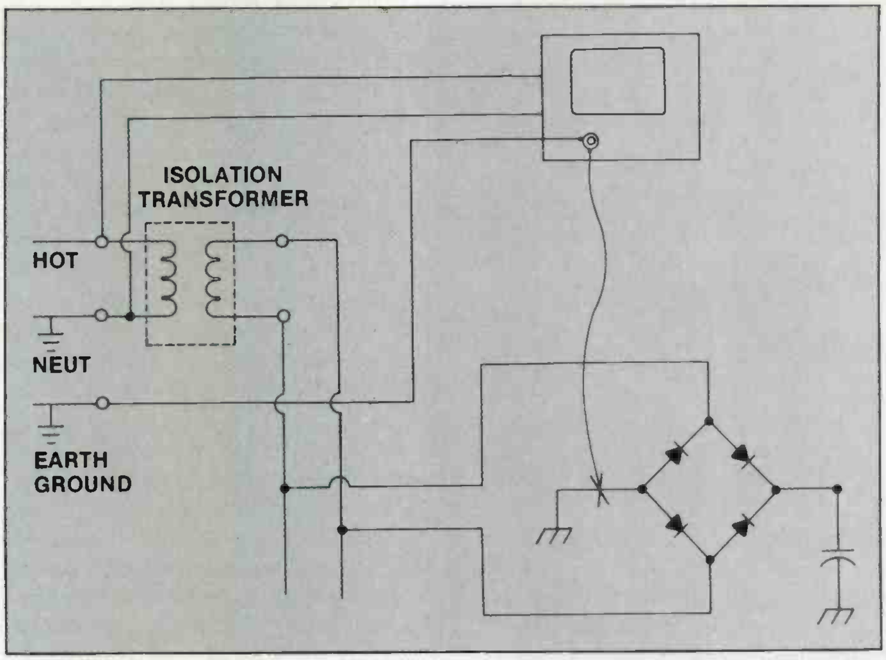


Figure 3. The correct way to connect a test instrument to a unit that uses a bridge rectifier is to connect the unit under test to the ac line through an isolation transformer.

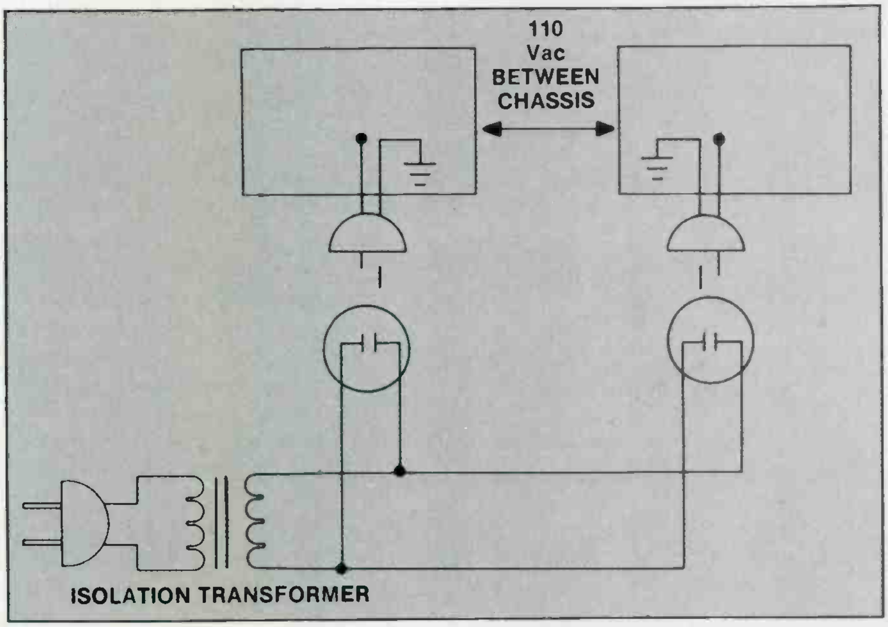


Figure 4. The benefit of using an isolation transformer may be negated if you connect more than one TV set to the transformer.

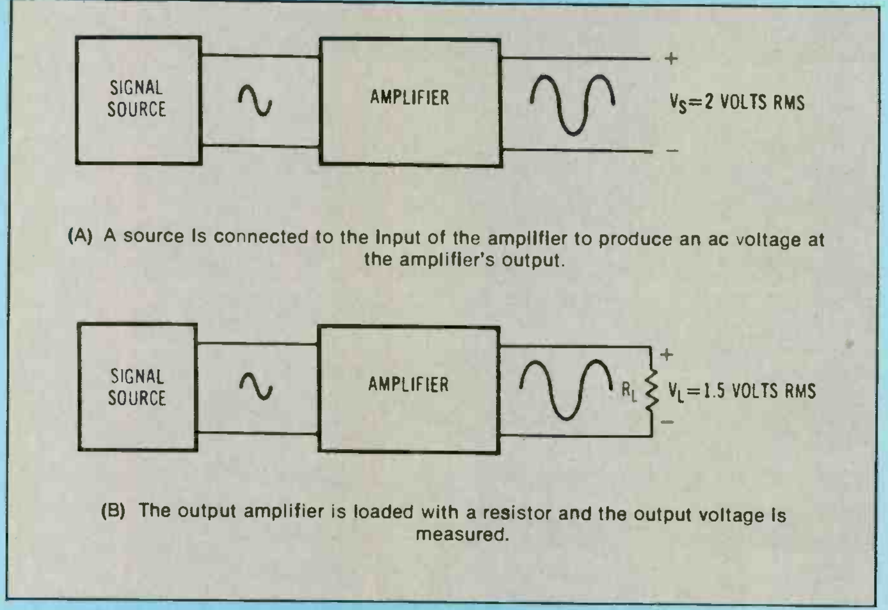


Figure 3. The output resistance of an amplifier is to be measured.

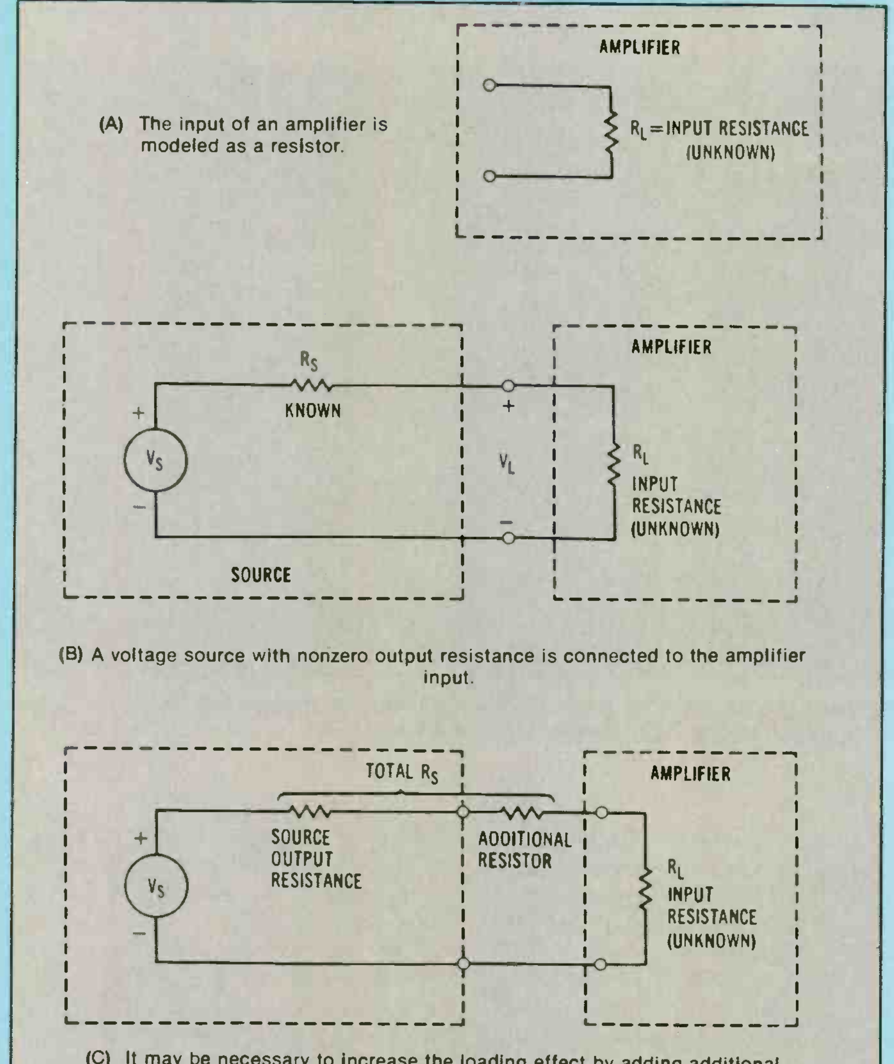


Figure 4. the indirect method can be used to determine the input resistance of a device.

Input resistance

Another problem is measuring the input resistance of devices, such as amplifiers and filters. The input of an amplifier can be modeled as a single resistor, as shown in Figure 4A. If a source is connected to such an input, a voltage divider results, with the input resistance of the amplifier acting as the load resistor (Figure 4B). With such a connection, neither R_S nor R_L can be varied. This is acceptable if a suitable amount of loading occurs (V_L being 50% to 90% of V_S). More often, an additional resistance is inserted in series with the output resistance of the source (Figure 4C). This resistor can be chosen (with some experimentation) to provide a reasonable amount of loading. For calculation purposes, the new R_S is the source's output resistance plus the added resistor. The open circuit voltage of the source (V_S) and the loaded voltage (V_L) are measured, and R_L is computed. When using an additional series resistor, it is important to measure V_L across R_L (and not across the output of the source). Another measurement limitation is input capacitance, especially in circuits with high input impedance. Generally, this method is practical for input impedances up to 100kΩ, and for frequencies less than 20kHz.

Example 2—The input resistance of an amplifier is to be measured using the indirect method. A sine wave source with open circuit voltage of 0.2V zero-to-peak and an output resistance of 600Ω is connected to the amplifier using a 10kΩ resistor. The voltage at the input of the amplifier is 0.12V zero-to-peak. Determine the input resistance of the amplifier.

R_S, for our calculation, is the sum of the source's output resistance and the additional 10kΩ resistor. R_S = 10.6kΩ, V_S = 0.2V and V_L = 0.12V.

$$R_L = \frac{V_L R_S}{V_S - V_L} = \frac{0.12(10.6k\Omega)}{0.2 - 0.12} = 15.9k\Omega$$

another, a return to earth ground for the test unit may be necessary to insure the integrity of the shielding.

The isolation transformer

The correct way to connect a test instrument to a unit that uses a bridge rectifier in the power supply is to connect the unit under test to the ac line through an isolation transformer (see Figure 3). The isolation transformer isolates the chassis from the ac line and essentially breaks that ground-return path so that diode D2 is no longer bypassed, and the bridge rectifier operates as it should.

One at a time please

An isolation transformer made expressly for servicing will have only one outlet. The reason for this is that if you plug more than one hot chassis television into the same transformer, you're bringing back the same problem you were trying to eliminate by using the isolation transformer in the first place. You will damage equipment (see Figure 4). So, if you happen to be using an isolation transformer with more than one outlet, use only one of the outlets at a time.

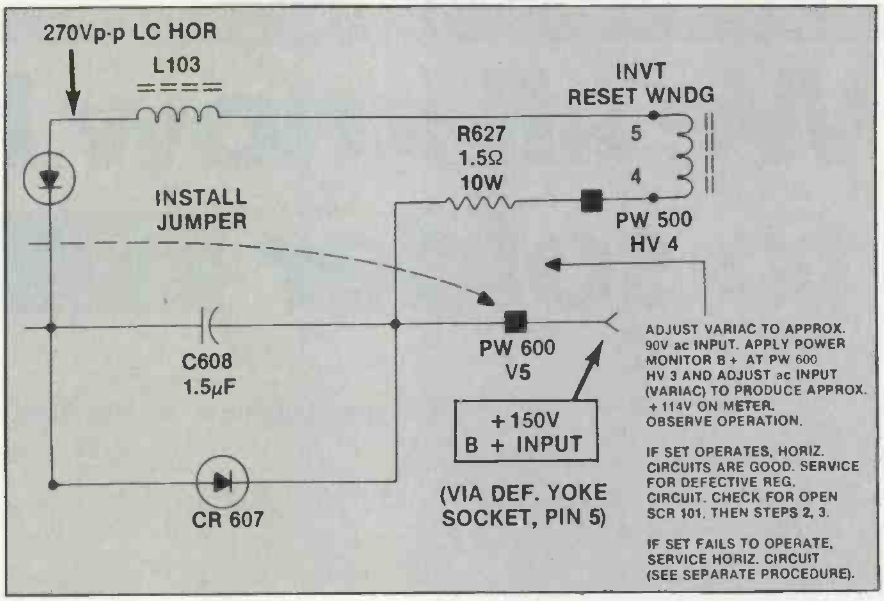


Figure 5. A variable transformer may help in troubleshooting regulator and shutdown circuits, as evidenced by this service literature.

Variable transformers

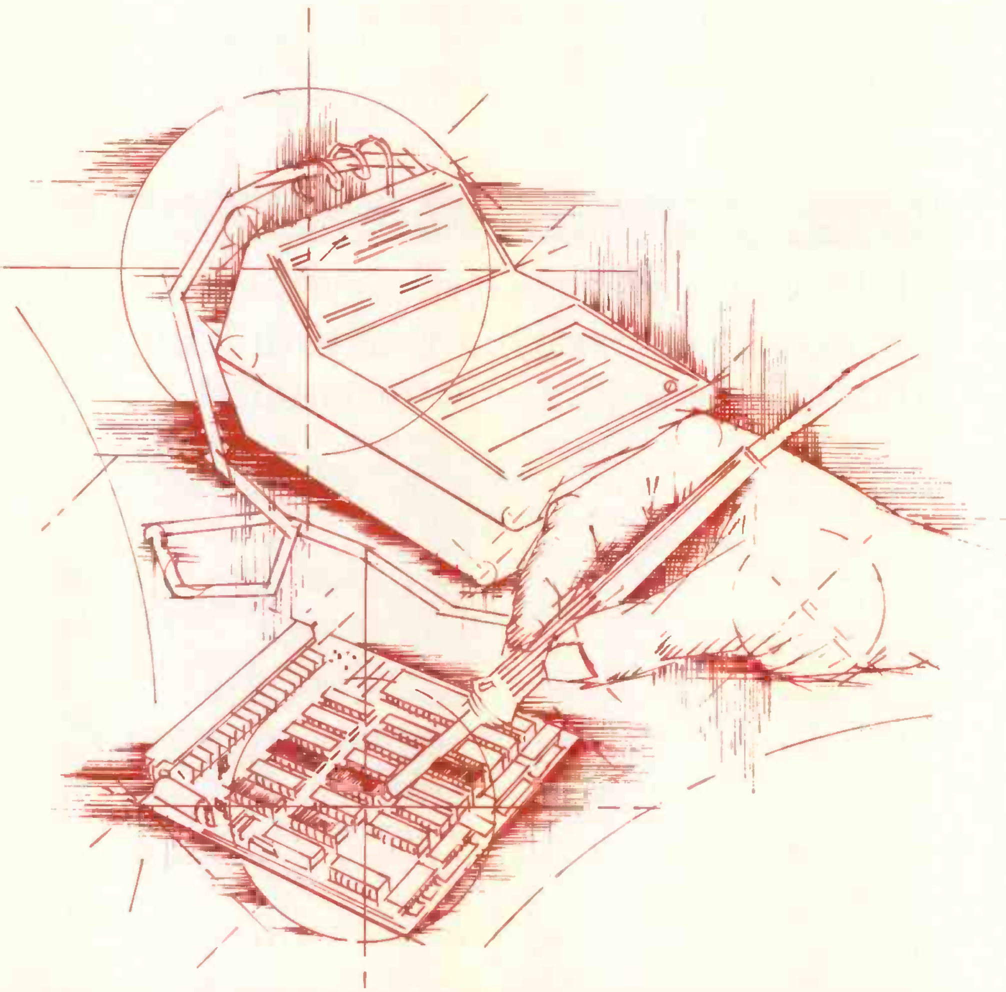
There are times when you would like to apply a lower-than-normal voltage to a consumer electronics product; for example, to determine the set's reaction to brownout conditions. Or you might want to start with a low voltage during servicing in order to avoid damage to the unit under test.

KEEP THIS IN MIND: An autotransformer (Variac is the best

Continued on page 47

We all know how to solder

By Larry Critchlow, the Old Timer



Electronics servicing technicians rely daily on an ability to make a good solder joint. Whether you learned in school or at the bench, you know the rules. Items to be soldered must be pre-tinned or cleaned and fluxed, and the appropriate heat must be applied. Enough heat must be applied to raise the temperature of all parts involved above the melting point of the solder. You know when you have made a good solder joint; it's nice and shiny and flowing on all surfaces. Getting sufficient heat in the proper place is not always easy, especially if the part to be soldered has a large bulk and acts as a heat sink. Transformer lugs mounted on printed circuits are a good example. They're a good example because you resoldered a thousand of them last year. Half the work in today's TV shop involves tracking down and resoldering improperly made solder joints. Good solder joints don't go bad. Rest assured, the joint you're resoldering today was no good the day it was made. Look inside an antique radio from the '20s. You will see soldering, done by hand 60 years ago, good as new. They knew how to solder.

The advent of the printed circuit in the '50s and their almost exclusive use today in no way changed the rules of soldering. But some of the rules have been ignored along the way. We were told a new level of *reliability* had been reached. Substitute standardization, precision, and many other adjectives. In reality, what was accomplished was a huge cost saving for the manufacturer. All of the leads of all of the components are now machine soldered in the wink of an eye. A common method, aptly called wave soldering, involves a tray of molten solder being agitated so that ripples appear on the surface. A wave of hot solder washes across the underside of the printed circuit, neatly catching every lead and foil. It's a marvelous system. It's quick. It saves labor. It doesn't cook the board. It doesn't overheat the components. Oh yes, one more thing it doesn't do: It doesn't give the extra time and heat required for a good joint on the heavier parts. Bulky items like transformers, iron core chokes, electrolytic cans, heat sinks, even power transistor pins do not solder properly. Some makers add these parts last and solder by hand, but the trend toward complete automation and single board TV sets assures that poor solder joints are here to stay.

By way of illustration, here are some classic cases to watch for:

1. All Zenith 9-160 modules: The horizontal output transistor and heat sink don't get soldered well, developing open or intermittent connections.
2. Sylvania D14-D16 chassis: filter cans on the printed circuits.
3. GE "Griplets": a unique connection between top and bottom foils on a printed circuit. They hardly ever get soldered well on the component side.
4. Color and B&W imports: flyback transformer pins.
5. Magnavox T-952: filters and tube sockets.
6. All convergence boards: Check shell connections on small pots.

Here's a familiar case: Someone is describing a problem with his XL-100. "Something's loose in my television. When I walk across the floor, the picture collapses into a line." You immediately think vertical trouble, but his gesturing indicates loss of horizontal sweep.

Your iron should be already heating as you probe the sweep mother board. You know what to look for. You don't waste time tweaking resistors and capacitors. You go right for the big stuff. This chassis has four heavy transformers, mounted only by their solder lugs, on an upright panel (this set doesn't even have gravity going for it).

We all know what the trouble is, but limited access to the wiring side of the board makes this a difficult repair. Worse still, too much probing will polish up the corroded joint and you may lose the symptom when you need it most. Get out the schematic with the phantom view of the mother board and, staying on the component side, use a clip lead to work around the suspected area. Most terminals are readily available on this side. Frequently you can make a fix by adding a jumper, bypassing the defective solder joint.

Sloppy workmanship, you say? We fix one thing and already have the back cover half on. Doesn't our keen knowledge of the situation demand more? We described 50 bad solder joints in detail and only fixed one. The rest are there, we all know it.

If you want this television to run into the next century, you feel, you must do more: complete disassembly and inspection. At least solder the connections that look funny. At least resolder the terminals on the heavy components. Hold on! The next connection to act up is the one that looks okay today. We recognize good soldering when we are doing it, but second guessing 10-year-old joints is chancy. Many of the joints will fail completely when heated, and not resolder at all without scraping and refluxing, and some added jumper wires will surely be needed. Lifted and broken foils and all, this could turn out to be a half-day's work.

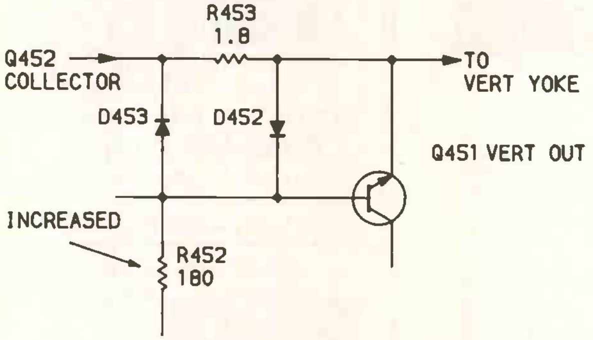
There's another rule about soldering and resoldering. You have to know when to stop.

ES&T

Symcure

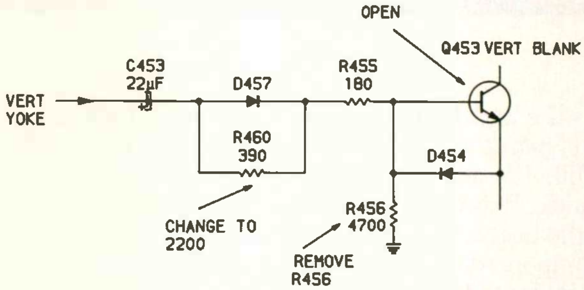
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Quasar ADTS-980 1
PHOTOFACT—2115-1



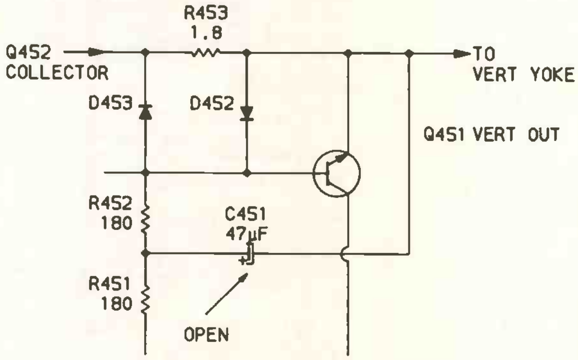
Symptom—Very little height
Cure—Check critical resistors. Replace R452 if the value has increased.

Chassis—Quasar ADTS-980 2
PHOTOFACT—2115-1



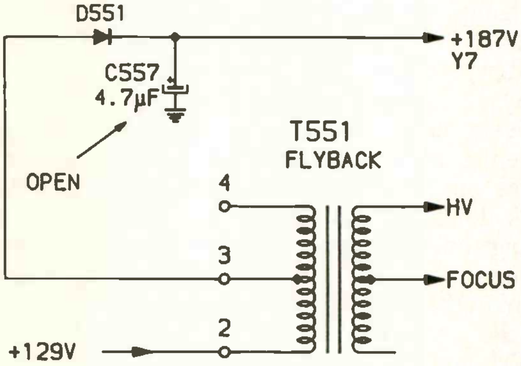
Symptom—The picture has vertical-retrace lines.
Cure—Check Q453 and replace, change R460 from 390Ω to 2,200Ω and remove R456.

Chassis—Quasar ADTS-980 3
PHOTOFACT—2115-1



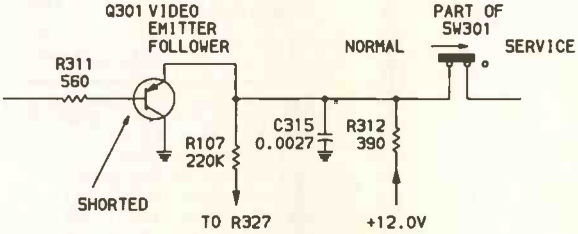
Symptom—Top 1" to 2" of picture is missing; vertical linearity is very poor.
Cure—Check all vertical-circuit capacitors. Replace C451, if open.

Chassis—Quasar ADTS-980 4
PHOTOFACT—2115-1



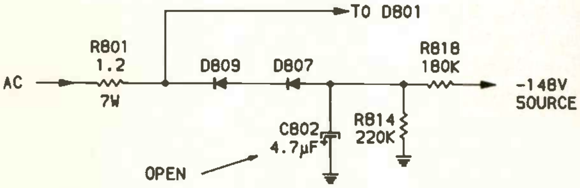
Symptom—Bright, smeared picture; sometimes "jail bars" on left side of screen.
Cure—Check all video B+ capacitors. Replace C557, if open.

Chassis—Quasar ADTS-976 5
PHOTOFACT—2036-2



Symptom—Extremely bright picture with retrace lines.
Cure—Check SW301, resistors and Q301. Replace Q301, if shorted.

Chassis—Quasar LDTS-989 6
PHOTOFACT—2045-1



Symptom—60Hz noise band in picture on VHF low-band channels.
Cure—Check power-supply electrolytics; replace C802, if open.

3009

Zenith D2500W chassis Color TV

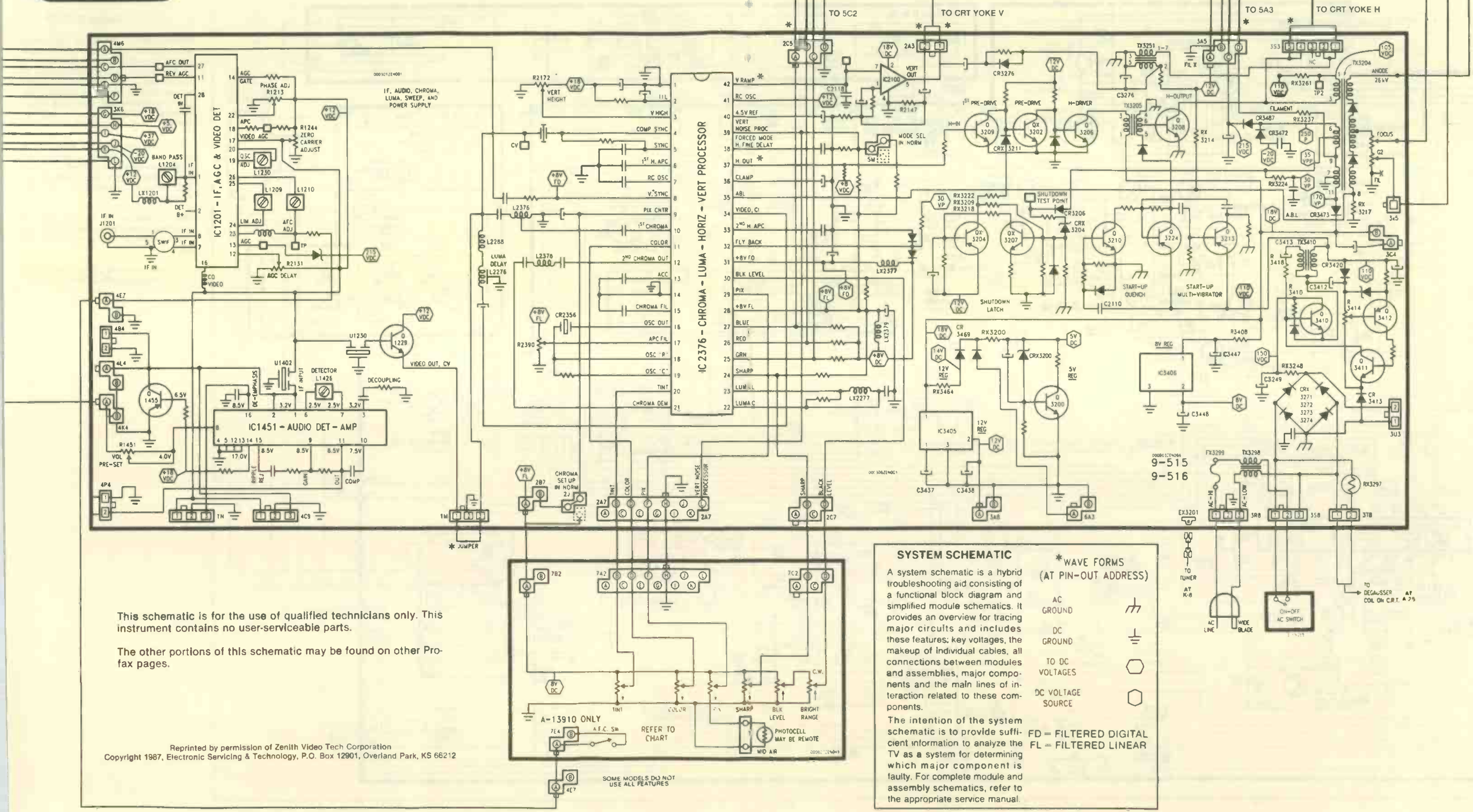
PROFAX

ES&T Manufacturers' Schematics

August 1987

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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



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

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

SYSTEM SCHEMATIC

A system schematic is a hybrid troubleshooting aid consisting of a functional block diagram and simplified module schematics. It provides an overview for tracing major circuits and includes these features: key voltages, the makeup of individual cables, all connections between modules and assemblies, major components and the main lines of interaction related to these components.

The intention of the system schematic is to provide sufficient information to analyze the TV as a system for determining which major component is faulty. For complete module and assembly schematics, refer to the appropriate service manual.

*WAVE FORMS (AT PIN-OUT ADDRESS)

AC GROUND

DC GROUND

TO DC VOLTAGES

DC VOLTAGE SOURCE

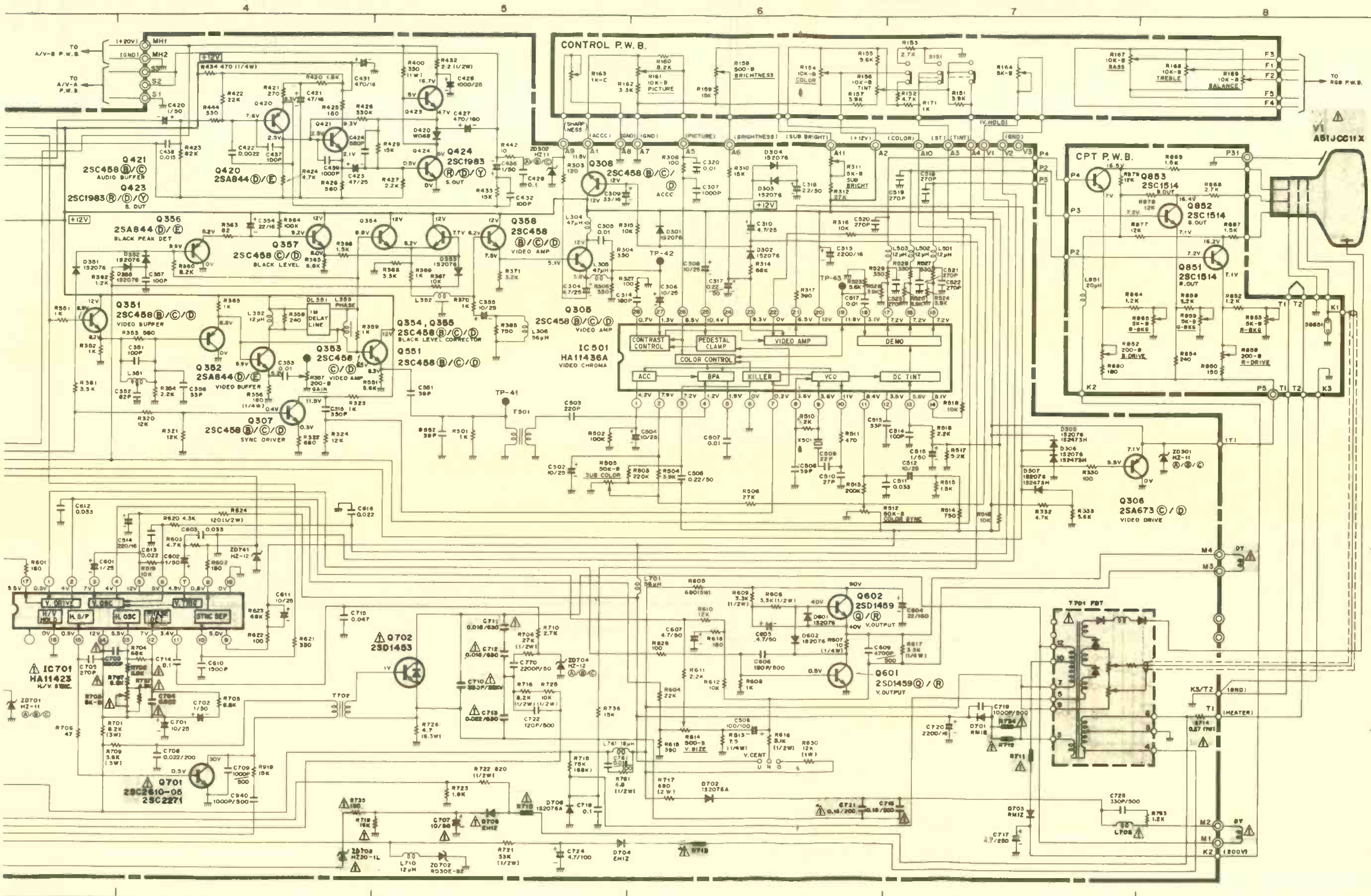
FD = FILTERED DIGITAL
FL = FILTERED LINEAR

Because this is a basic circuit diagram, the value of the parts is subject to be altered for improvement.
All dc voltage to be measured with a tester (100kΩ/V).
Voltage taken on a complex color bar signal including a standard color bar signal.

3010

Hitachi
CT2020W
CT2020B
chassis
Color TV

August 1987



Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ⚠ and shaded areas of the schematic diagram designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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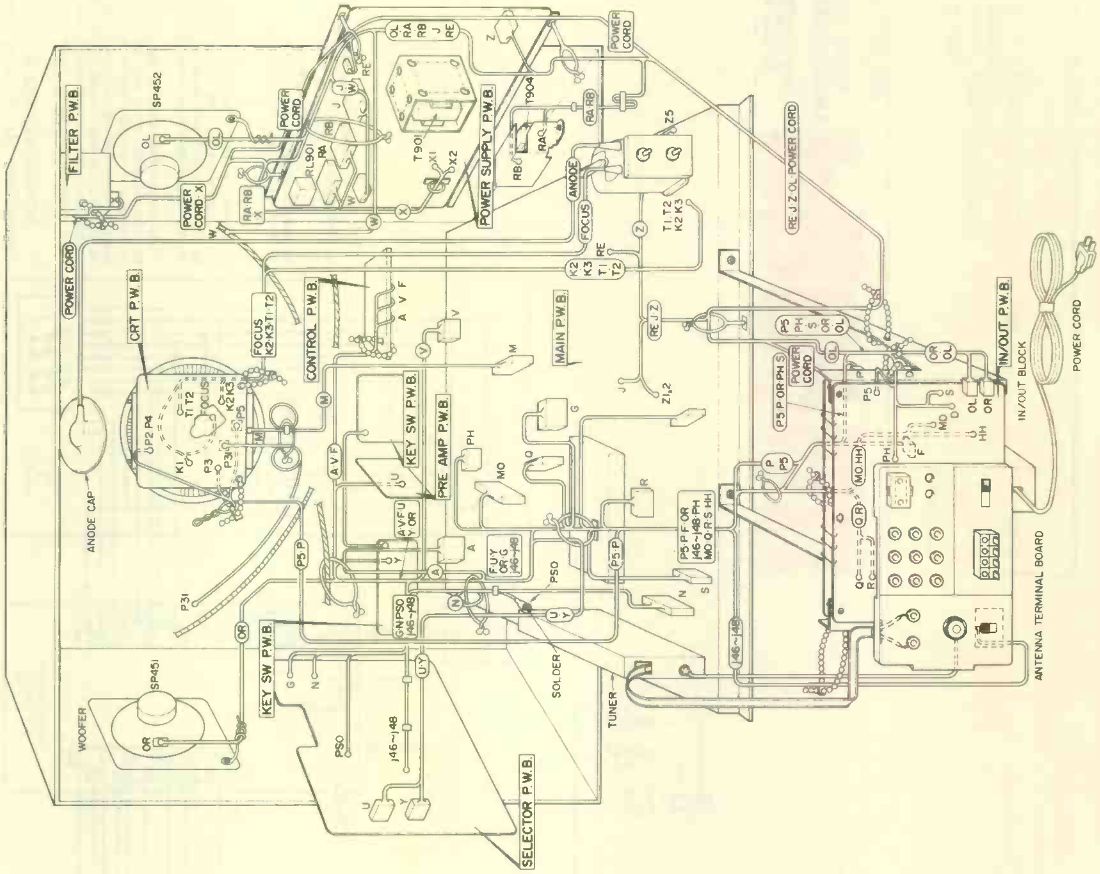
The other portions of this schematic may be found on other Profax pages.

WIRING DIAGRAM
Hitachi CT2020W, CT2020B chassis



MAIN SCHEMATIC DIAGRAM, Zenith D2500W chassis

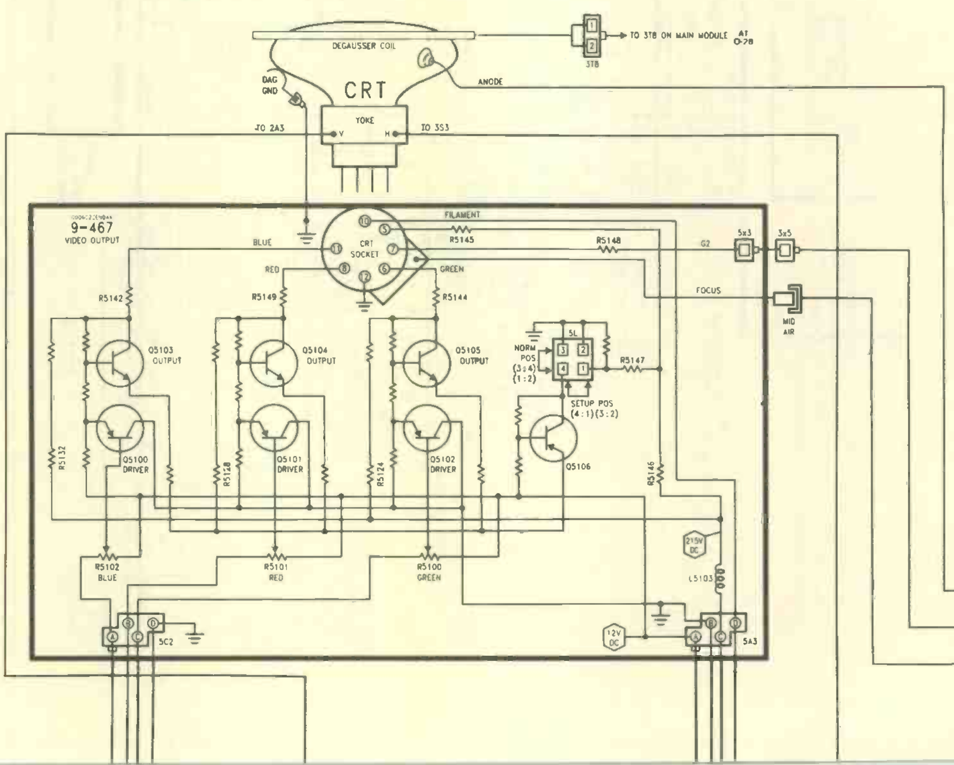
Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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

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

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

This portion of the main schematic, Zenith chassis D2500W, has been turned at right angle to fit the alloted space.



MAIN SCHEMATIC DIAGRAM, Zenith D2500W chassis

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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

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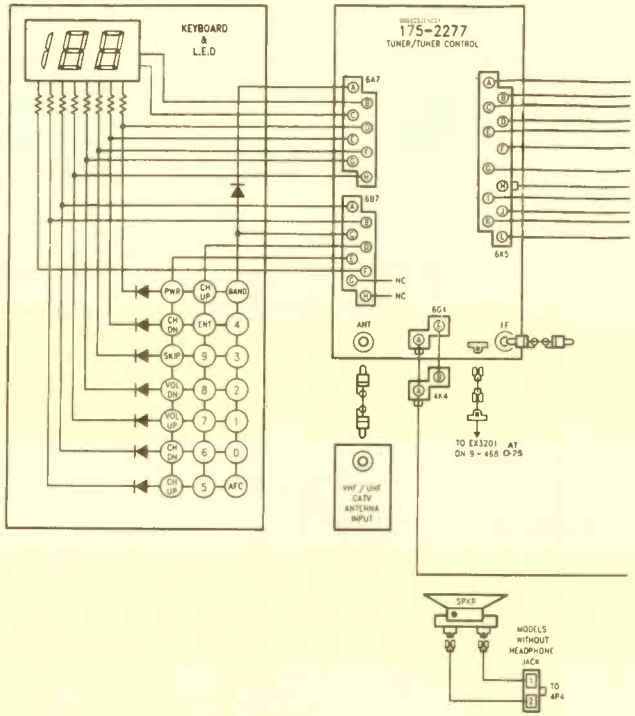

ES&T Manufacturers' schematics PROFAX

August 1987

	Schematic
Zenith	
Color TV, chassis D2500W	3009
Hitachi	
Color TV, chassis CT2020W, CT2020B	3010

Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ⚠ and shaded areas of the schematic diagram designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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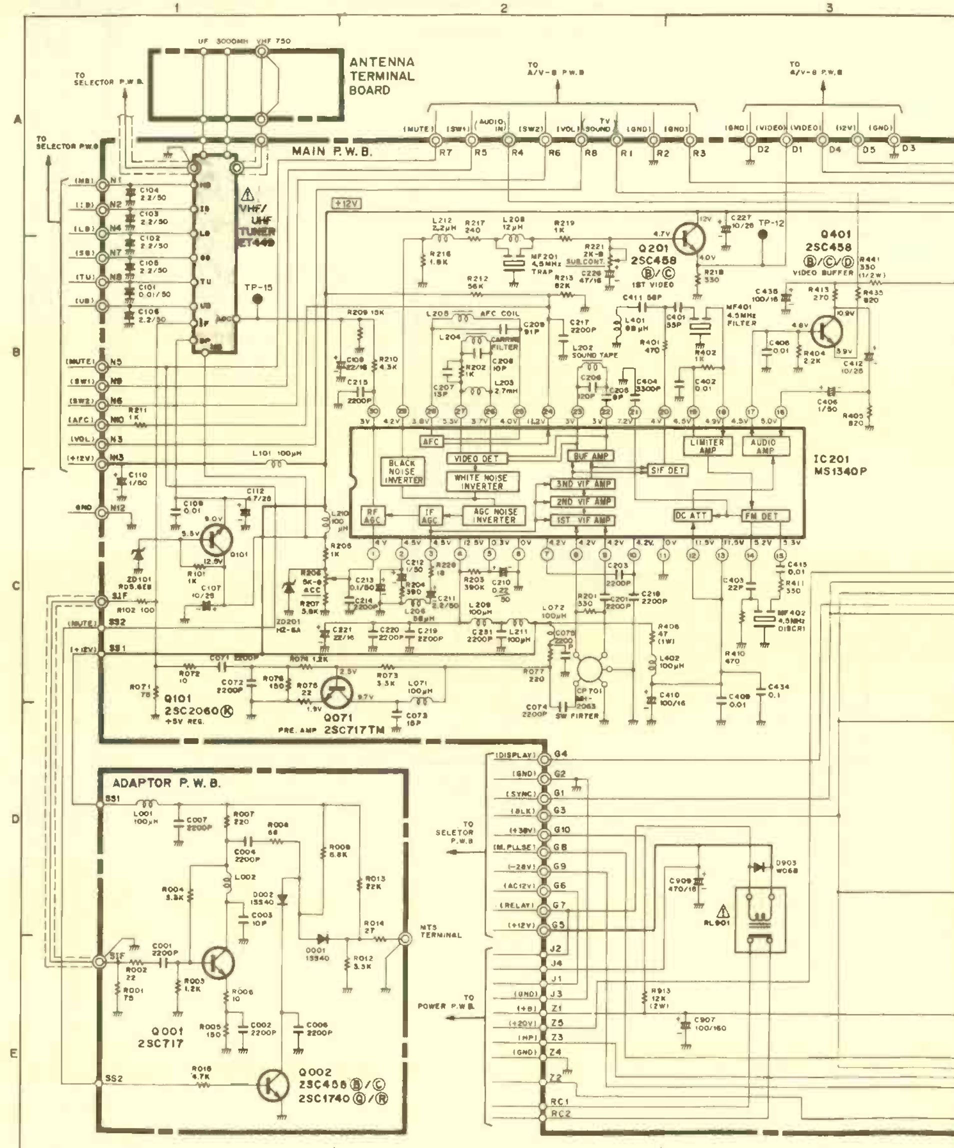


Using the scope to troubleshoot the low-voltage dc power supply

By Joseph J. Carr, CET, MSEE

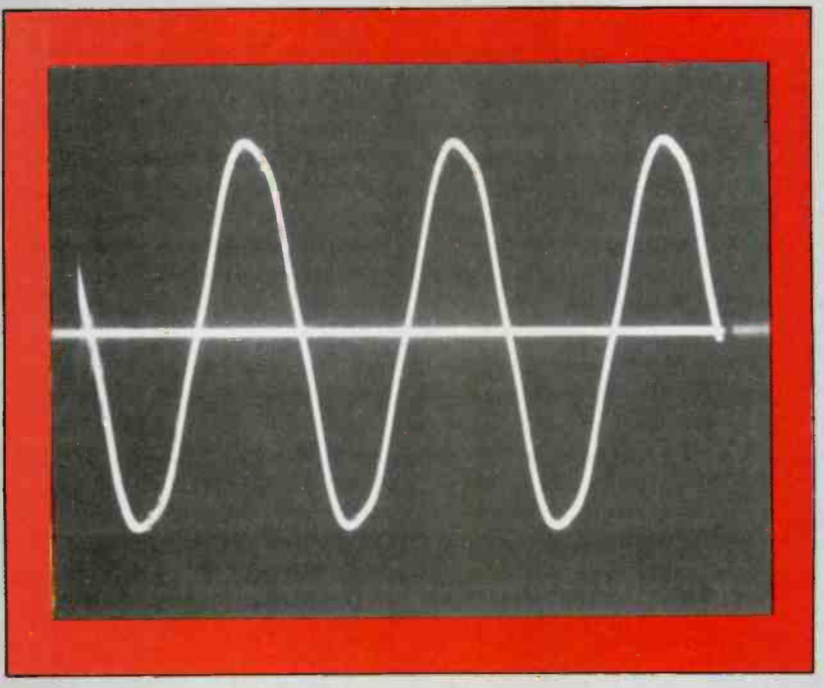


Figure 1A.

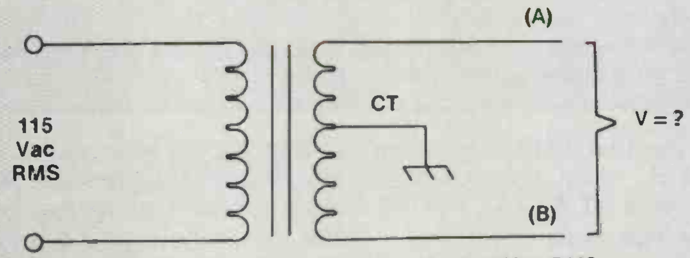


Figure 1B.

V = 12.6 Vac *RMS*
V = 17.82 Vac *PEAK*
V = 35.64 Vac *PEAK-TO-PEAK*

Figure 1. The output of the power transformer (1A) will be a sine wave or nearly so. If the transformer is center tapped (1B), carefully determine if the output voltage specification is across the entire secondary from one end of the transformer to the tap.

Most professional servicers know that the first place to look for faults in malfunctioning electronic equipment is the dc power supply. Every servicing organization that keeps records of equipment failure over time will report that a large percentage of actual repair actions (as opposed to "no fault found" actions) involve the low-voltage dc power supply.

This problem is so commonplace, and is such a logistics headache, that the U.S. Navy now has a power supply standard that limits the maximum junction temperature of semiconductor devices to 110°C, and also limits the power per unit of volume (W/in^3).

Both of these points should tell servicers that *heat* is the great killer of power supplies – and either reducing the load, or otherwise getting rid of the heat, will pay your customers rich dividends.

Why not the scope?

Most services probably think first of the bench multimeter for troubleshooting the supply. Yet the same professionals will tell you that the oscilloscope is their most useful piece of test equipment. The question is: Why can't the scope also be used to troubleshoot the dc power supply? The answer: It can be used for this work, and in fact is superior to the multimeter for this purpose. After all, when dc-coupled, it will measure the dc output voltage to as good a resolution as is needed for the job at hand (the difference between 26.2V and 26.234Vdc is *not* usually important for determining the health of the power supply).

Complications from the transformer

The typical low-voltage dc power supply will have a transformer to step-down the 120Vac line voltage to some lower voltage. The exact value of the transformer secondary voltage, of course, depends

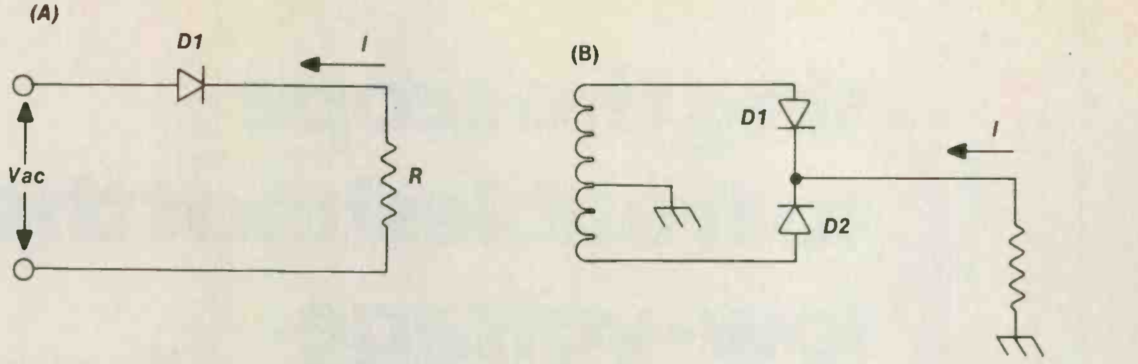


Figure 2. A dc power supply may use one of these forms of rectifier: (A) ½-wave, (B) full-wave, using a center-tapped transformer, or (C) full-wave bridge rectifier.

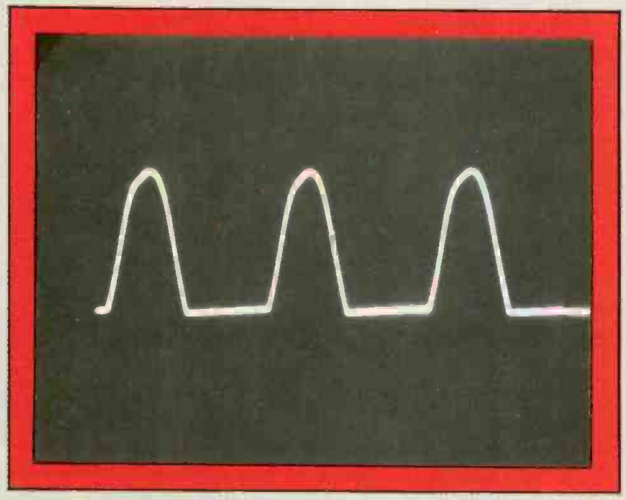


Figure 3. A ½-wave rectifier produces an output waveform that looks like that shown in (A). Where the input waveform goes negative, that half cycle is just discarded. A full-wave rectifier produces a positive pulse on every half cycle (B).

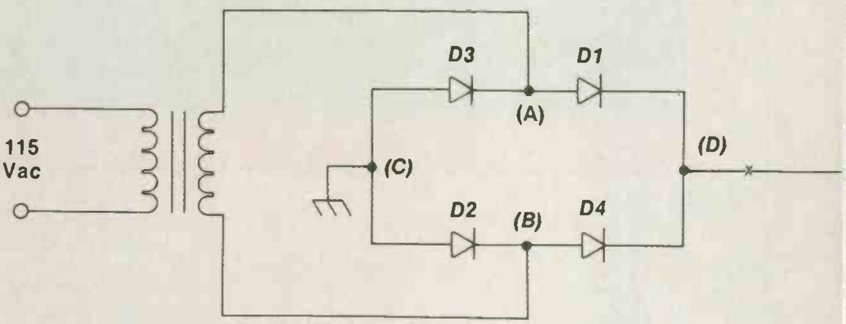


Figure 4. This is the power supply that was used to make the measurements and generate the waveforms used in this article.

upon the dc output potential of the supply. The output of the transformer will be a sine wave or near-sine wave (See Figure 1A). The transformer voltage ratings sometimes yield some confusing results for the troubleshooter. For example, consider the standard 12.6Vac transformer (Figure 1B). The rated voltage of a transformer is the rms potential across the entire secondary, unless otherwise specified.

If you use a reasonably good quality ac voltmeter, then the reading will be 12.6Vac across points A-B, right? *Not necessarily*. First, it should go without saying that the input voltage will vary somewhat, and that in turn reflects variation in the secondary voltage. Measurements made to prepare this article showed a line voltage of 123Vac rms at my home, while at other times it has been as low as 102Vac rms.

Second, the rated voltage of a transformer assumes a *minimum load current* being drawn. If you measure a transformer with no load, then expect a higher voltage than the rated potential. Some transformers are worse than others in this respect, but all will demonstrate the phenomenon to some extent.

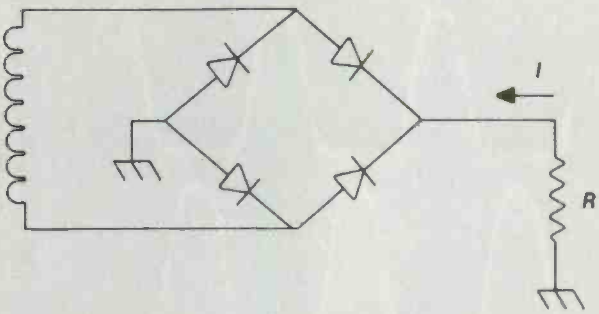
The problem is the internal resistance of the secondary windings. It's possible for a 12.6Vac, 20A transformer to show 22Vac "rms" on a digital ac voltmeter of good quality, until a 500mA load is placed across the secondary. The load reduces the secondary potential to 12.6Vac rms, plus or minus line fluctuation.

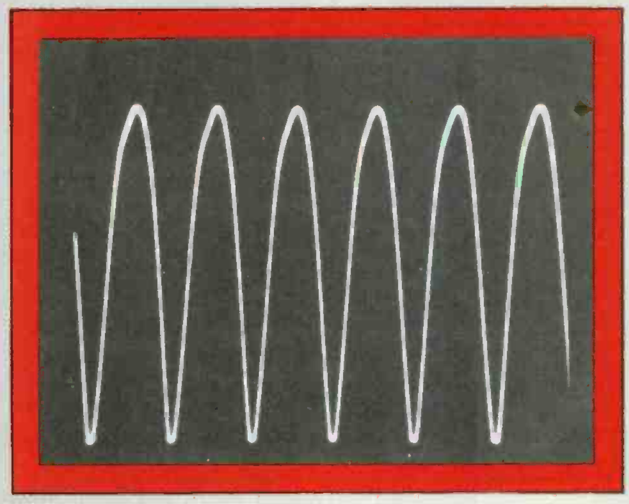
If the transformer is center-tapped, as in Figure 1B, then the rating of the secondary must be scrutinized to determine the actual voltage. For example, "12.6Vac C.T." means that 12.6Vac appears across A-B, while the potential readings from CT-A and CT-B will be 6.3Vac rms each.

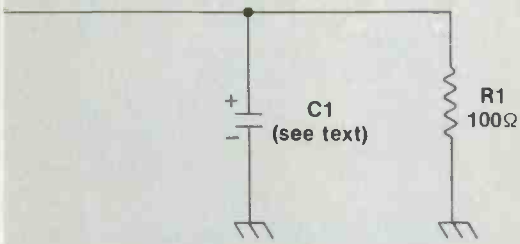
The scope—a peak-to-peak reading instrument

Another point of confusion is found when measuring the voltage across the transformer secondary with an oscilloscope. Most ac meters are rms-reading devices (or nearly so) for sine waves, unless specifically designed for peak-to-peak or peak-reading applications. But the oscilloscope is inherently a peak-to-peak reading instrument. In Figure 1A, the horizontal line denotes the 0V baseline, while the positive excursions are above the line and negative excursions are below the line (following the standard convention). The peak voltage is the potential between the

(C)







zero baseline and either peak, while the peak-to-peak voltage is the reading between a negative peak and the adjacent positive peak. The peak voltage is 1.414 multiplied by the rms voltage, while the p-p voltage is 2.83 times the rms voltage. On the scope, it is easier to measure the p-p voltage, so to correllate between scope and meter readings you need to divide the p-p reading obtained on the scope by 2.83. Similarly, multiplying the rms reading on the meter by 2.83 gives you the approximate p-p voltage to expect on the scope screen.

Rectifying ac to dc

The ac voltage provided by the transformer is useless for most electronic circuits, so you need to provide a rectifier to convert bipolar ac to unipolar pulsating dc. (Figure 2 shows the various forms of rectifier, while Figure 3 shows the waveforms that the scope will show when connected across load resistor R.) The rectifier in Figure 2A is the ½-wave rectifier, and it produces the waveform shown in Figure 3A. Note that only the positive half of the applied ac sine wave is applied, which causes a certain amount of inefficiency in this form of power supply.

The other two rectifiers are both full-wave types, and they produce the waveform shown in Figure 3B. The rectifier shown in Figure 2B is a conventional full-wave rectifier, and depends upon the center-tap of the transformer secondary winding to provide a ground reference.

The rectifier in Figure 2C is a full-wave bridge. It does not require a center-tapped transformer, but instead uses a node of the bridge to provide the ground reference. The bridge rectifier is by far the most commonly used in modern electronic equipment in which full-wave rectification is used (there is still plenty of cheap ½-wave rectified equipment out there, however). It is the bridge rectifier that formed the basis of this article; Figure 4 shows the circuit of a dc power supply that was used in making the measurements and waveform photographs. The transformer was an 8.5Vac, 1A transformer, while the rectifiers (CR1-CR4) were 1N400x-series devices.

Figure 5 shows the normal waveforms expected when the scope probe is applied to points A and B in Figure 4. Each waveform is ½-wave rectified, but they are 180° out of phase with each other. This phasing reflects the fact that the bridge rectifier is full-wave, and therefore uses the entire 360° of the input ac waveform.

A

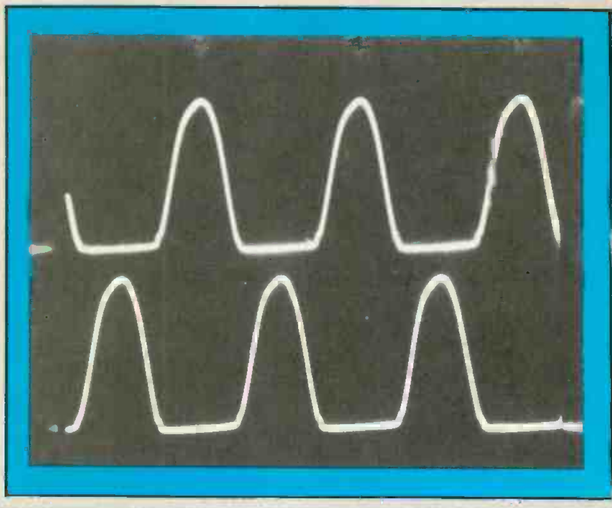


Figure 5. The photograph in (A) shows the normal waveforms expected when you apply the scope probe to point A and point B of the circuit of Figure 4. If for some reason the load becomes disconnected, the waveforms will look like the ones shown in (B).

A

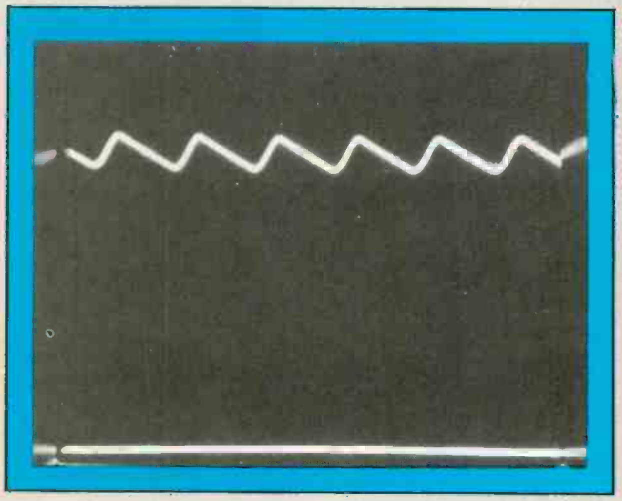


Figure 6. The ac ripple component of the output of the power supply will depend on the value of the filter capacitor. In (A), 500μF of filter capacitance was used, whereas 2,700μF produced the waveform shown in (B).

A

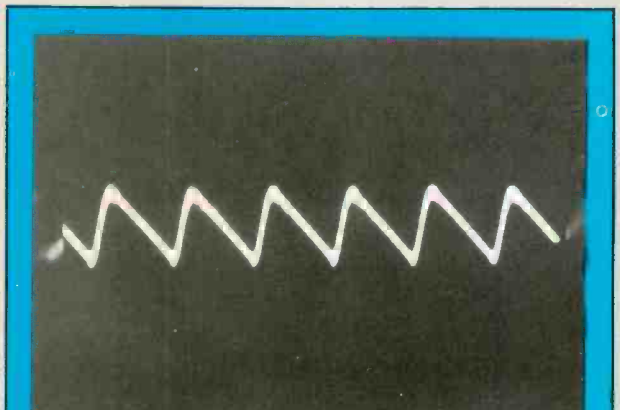


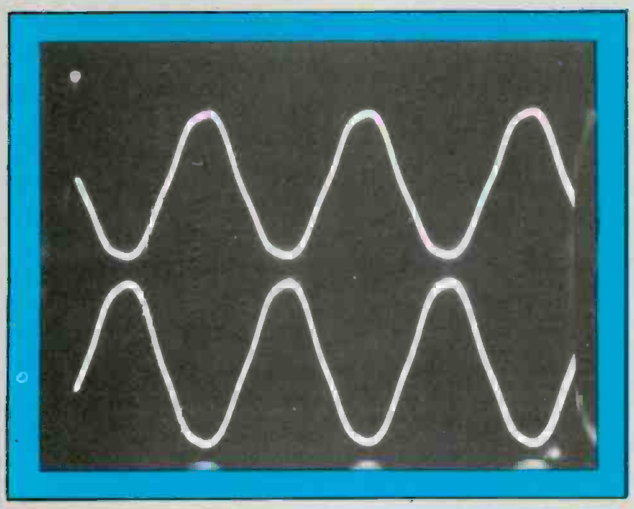
Figure 7. A filtered pulsating dc waveform in a normally operating waveform is shown in (A). If one leg of the bridge (CR4 of Figure 4) is open circuited, the ripple amplitude will increase and ripple frequency will be half of the frequency in the normally operating circuit.

Even with a single-trace oscilloscope you can tell that the circuit is working correctly by the ½-wave trace. Figure 5B, on the other hand, shows an anomaly. This waveform showed up in a 50W rms stereo receiver in which the printed circuit trace from the positive terminal of the bridge rectifier on the power supply PC board was cracked and peeled back because of heat, and that fault effectively removed the load from the rectifier. If you see a sine wave or near-sine wave at the ac nodes of the bridge (points A and B in Figure 4), then suspect that the load is somehow disconnected.

Filtering pulsating dc

The full-wave, pulsating dc waveform shown in Figure 3B is almost as useless for electronic

B



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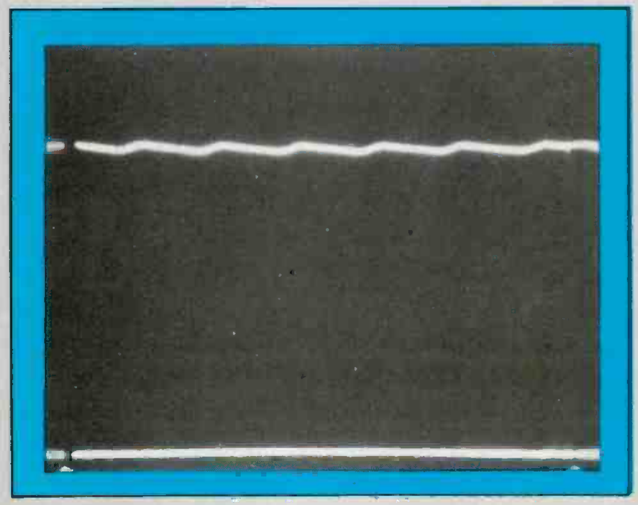

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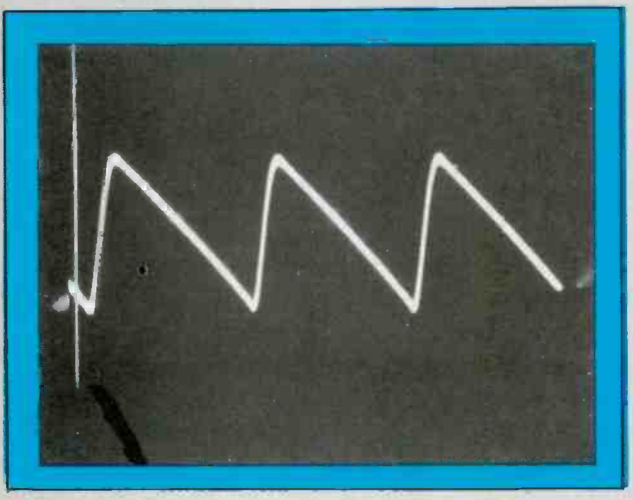

equipment as ac is, so circuit designers supply a filter capacitor, such as C1 in Figure 4. Figure 6 shows two cases of a filtered pulsating dc output from the low-voltage power supply of Figure 4.

In both Figures 6A and 6B, the horizontal white line was placed at the 0V line to provide a frame of reference. The line was created artificially by adjusting the position control for channel-2 of the scope, and keeping the input selector in the grounded position. The waveform, Figure 6A, represents the case where 500μF of filter capacitance was used. In this case, the digital voltmeter read 12.03Vdc, while the measurements on the scope screen showed 10.8V between the 0V baseline and the bottom of the ripple waveform, and 12.4V to the peak of the ripple waveform (resulting in a ripple

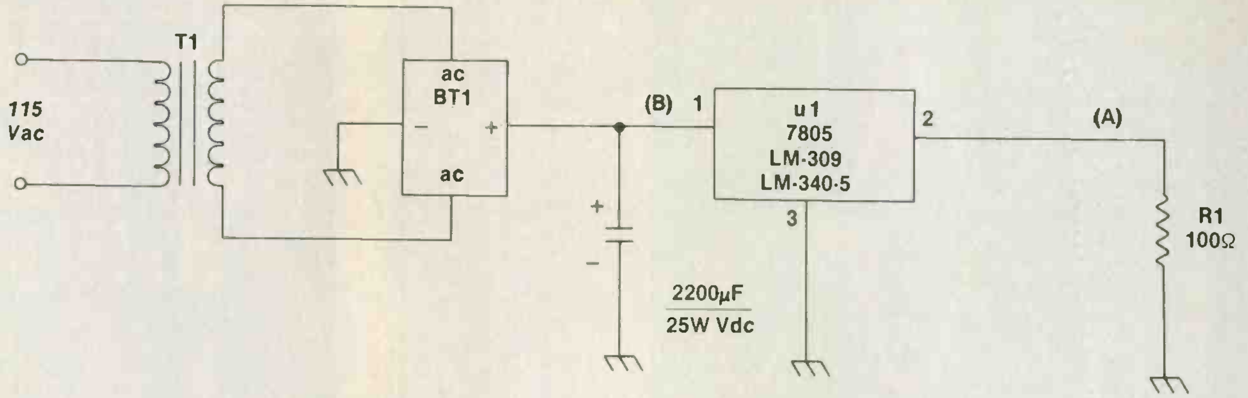

Figure 8. A basic IC voltage regulator circuit that is based on the three terminal IC regulator devices.

amplitude of 1.6V).

In Figure 6B, the filter capacitor is increased to 2,700μF. The DVM read 12.01Vdc, while the scope showed 12V between zero and the bottom of the ripple waveform. The ripple amplitude in Figure 6B is 0.25V, or 15.6% of the ripple amplitude generated when 500μF was used for the filter. Obviously, the greater the capacitance, the less the ripple.

The general rule of thumb for the value of capacitance needed in a full wave supply is:

$$C\mu F = \frac{1{,}000{,}000}{416\ R_L\ (RF)}$$

Where:
CμF is the capacitance in microfarads;
R_L is the load resistance (V_o/I_o); and
RF is the required ripple factor.

If the filter capacitor is open, a fault that happens often, then you should expect to see the pulsating dc waveform shown in Figure 3B across the load resistor, instead of the distinctive waveforms of Figure 6. Where a certain amount of judgement and experience is needed, however, is in the case where the filter capacitance is reduced significantly. This fault occurs sometimes in aluminum electrolytics, especially in equipment that has been sitting unused for awhile.

Some professional service literature (e.g., Sams Photofact) shows the peak-to-peak readings to expect across the filters, while in other cases only experience or *hunches* are available to aid the troubleshooter.

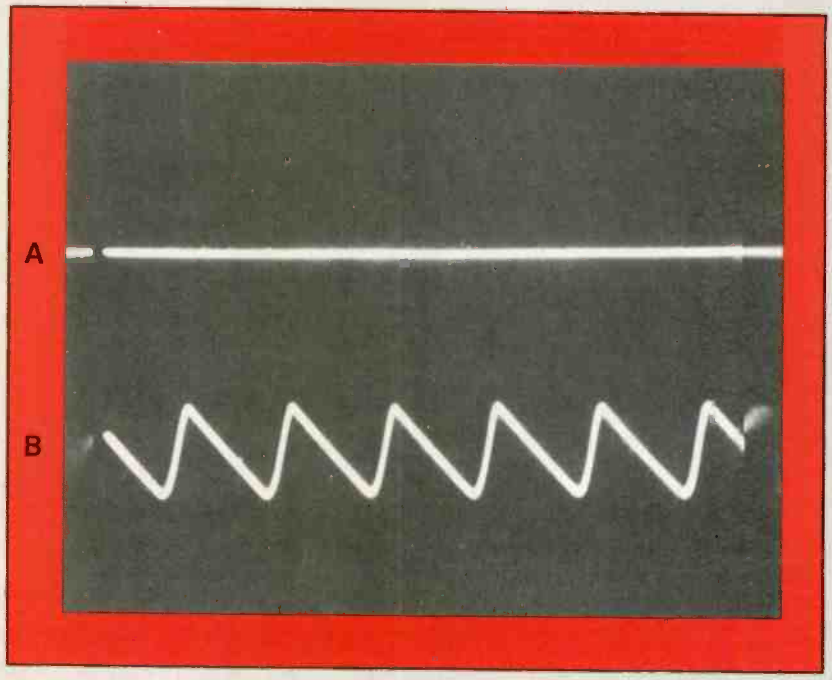

Figure 9. IC voltage regulators can provide the equivalent of having an impossibly large filter capacitor in the circuit. (A) is the waveform at point A in Figure 8, while the waveform of (B) is that seen at point B in the circuit, before the IC regulator.

Figure 7 shows a pair of ripple waveforms that is found in another situation. Both waveforms were made with the scope vertical input ac-coupled: We are specifically looking at ripple, rather than the *ripple plus dc component*. The top waveform shows a filtered pulsating dc waveform in a normally operating dc power supply.

In a full-wave rectified supply the ripple frequency is twice the line frequency, or 120Hz in the United States. Figure 7B, however, shows the same power supply with one leg of the bridge (CR4 of Figure 4) open-circuited.

The ripple amplitude is up, a fact that also could be attributed to a weak filter capacitor, but the ripple frequency is one-half the expected frequency. On the scope timebase (horizontal) line, you will find that the ripple waveform on a full-wave circuit will have a period of 1/120Hz, or about 8.3mS. The ½-wave rectified ripple waveform resulting when a diode is opened produced a period of 16.7mS on the scope.

A lesson to be learned from this example is to examine not just the *amplitude* of the waveform, but also its *period/frequency*. Also, if its *shape* is wrong, then suspect a fault (again, examine the difference between Figures 5A and 5B).

Voltage regulated dc power supplies

Many types of currently made consumer electronic equipment use voltage regulated dc power supplies. This is due, in part, to the nature of modern solid-state circuits–they tend to work better when the power supply is voltage regulated. Today, availability of IC voltage regulators also must be credited. It once was expensive to regulate a supply, so many manufacturers made do with unregulated supplies.

Figure 8 shows a basic IC voltage regulator circuit based on the 3-terminal IC regulator devices. The measurements for this article were taken with a 7805 device, which, for the purpose of this article, is the same as the LM-309 and LM-340T-05 devices, all of which produce 5V output for TTL digital circuits. Similar devices are available in output voltages to 24Vdc, both positive and negative.

One effect of the voltage regulator is to reduce greatly the ripple of the power supply. In fact, in 1964 a test equipment maker was marketing a new regulated bench supply (then a rarity) and bragged that it had the "equivalent of one farad of filtering." The voltage regulator produced a reduction in ripple equivalent to what would be obtained with 1,000,000 μF of filter capacitance.

This effect is shown in Figure 9. The upper trace, A, is taken at point A in Figure 8, and represents the output waveform from the regulator. The bottom trace is the filtered pulsating dc at the input of the regulator device (point B in Figure 8). Both trace photos were taken with the scope vertical attenuator set to 0.1V/cm.

The bottom trace shows 160mV of ripple, while the upper trace shows no discernible ripple. In fact, the scope showed no discernible ripple on all settings of the attenuator except the 5mV/cm setting, the most sensitive position. A defective regulator will show a high ripple on the output as well as an incorrect voltage.

WARNING: Defective regulators can produce a higher than normal voltage at the output of the supply. That potential can damage electronic circuits, so IMMEDIATELY turn *off* the equipment if this result is found. If the regulator is a simple IC type, then it can be replaced and the circuit inspected for damage.

Trobleshooting regulated equipment

A current-limited, bench-power supply is simple to use for troubleshooting voltage regulated equipment. Disconnect the regulator, set the bench output voltage to the same potential the regulator is supposed to produce, set the current limiting control to the rated value produced by the regulator, and then connect the bench supply across the equipment circuits. If the circuits are undamaged, then they will function correctly. Next, place a load resistor across the output of the regulator (the equipment circuits are still disconnected). It should draw a current of 25% to 100% of the normal load for that particular supply. Measure the output voltage and examine the waveform across the load resistor. If the regulator is operating correctly, then you may reconnect the circuits to the replaced or repaired regulator.

The oscilloscope is the professional servicer's instrument of choice for most electronics troubleshooting jobs. It should also be the instrument of choice for dc power supply jobs. Use it in any power supply where the actual voltage (plus transients) does not exceed the input voltage rating of the scope vertical amplifiers. It will work well on almost all low-voltage dc power supplies, and yields faster and more useful information than the dc meter in all but a few cases. It can measure dc voltage, ripple and waveforms, and can tell you whether or not the circuit is working as specified. So, next time you reach for your DMM on a power-supply job, consider the scope instead. You may find another use for that versatile piece of equipment.

ES&T

Literature

Oscilloscope literature

Tektronix has released a library of support material for the 2225 50MHz portable oscilloscope. The free material includes a demonstration videotape, a brochure, a study guide titled "The XYZ's of Using A Scope," and five technical briefs on scope measurements.

Also available for a charge is an operator's videotape that provides details on scope usage and can be used as a supplement for the manual or for classroom instruction.

Circle (125) on Reply Card

Electronic chemicals catalog

Now available from *Chemtronics* is the 1987 full-line catalog of chemicals and related materials used in electronics production, rework and maintenance. The catalog describes the company's existing products, including cleaning agents, flux removers, circuit refrigerants, lubricants, desoldering braids, conformal coatings and solder masks, and introduces new lines, including clean-room wipers, precision dusters, premoistened pads/swabs and instant adhesives.

Circle (126) on Reply Card

Test instrument catalog

Iwatsu Instruments has issued a short-form catalog covering its line of test and measuring instruments. This 16-page catalog presents features and specifications on oscilloscopes, scope calibrators and wagons, function generators and trace recording camera systems. Selection charts for oscilloscope accessories, passive probes and active probes are also included.

Circle (127) on Reply Card

Backup power planning guide

A booklet that explains how computer users can evaluate their needs for backup power is now available from *SAFE Power Systems*, a subsidiary of Acme Electric Corp. The booklet, titled "To Keep Your Data, SAFE: The Inside Story," is written for non-technical users of PCs and minicomputers. The information will help determine if a backup power system is needed and indicate how to select the right wattage and features.

Circle (128) on Reply Card

Catalog of UL standards

Underwriters Laboratories has released the July 1987 Catalog of Standards for Safety. Fifty-three standards have been revised since the previous catalog was issued. A larger typeface for the catalog makes it easy to find the dates of these revisions, as well as the current edition and revision page dates for all of UL's 530 published standards.

Circle (129) on Reply Card

Tool and test item catalog

A catalog of tools and test equipment is offered by *Jensen Tools.* The 128-page catalog contains more than 1,000 items, including an expanded line of circuit board equipment containing breadboard kits, cutter and drill sets, anti-static carrying cases, test cables and insertion/extraction tools.

Circle (130) on Reply Card

Soldering brochure

A brochure featuring a line of soldering irons, tips, a temperature-controlled soldering station and accessories is offered by *M.M. Newman.*

The "Antex Soldering Irons and Accessories" brochure describes precision miniature soldering irons for electronics manufacturing, larger soldering irons for general purpose work, and features a chart with more than 40 different styles of interchangeable slide-on tips.

Circle (131) on Reply Card

Technical supply catalog

A new general catalog from *Contact East* contains 108 pages of products for service specialists, engineers and technicians. More than 140 new products are introduced. Established lines covered are tool kits, test instruments, precision hand tools and soldering supplies.

Circle (132) on Reply Card

ES&T

Testing accessories...

Continued from page 27

known brand name of these devices) is not an isolation transformer. To be safe if you're working on a set with a hot chassis, you'll need to plug the variable transformer into the isolation transformer.

According to research done by Sencore, TV problems resulting from sensitivity to voltage variations are common. One technician told them that he found one in five sets, both tube and solid-state, to be voltage sensitive.

The same source reports that according to TV manufacturers, problems in the regulator or shutdown safety circuits are ranked as number one or two as far as field problems are concerned. For that reason, much of the service literature recommends a continuously variable transformer as an important servicing tool. The RCA service notes in Figure 5, showing the procedure for testing the regulator circuits, is an example of this.

As most readers of ***ES&T*** know, and many have reported, shutdown circuits are a particular problem. These circuits are designed to turn *off* the horizontal oscillator if any condition occurs that may cause excessive X-ray radiation. The television stops operating because the B+ voltages for operating the low voltage circuits are derived from the horizontal output transformer.

Using a variable transformer simplifies this problem: Lower the input voltage until the shutdown circuit no longer kills the operation, then locate the defect with dc voltage measurements of the regulator and shutdown circuits.

The right tool

There are many cases where you can improvise something if you don't have the right tool. This is not one of them. If you're going to be working on hot-chassis televisions, you will need an isolation transformer *before you hook up any piece of test equipment with a grounded probe*. Following the TV manufacturer's recommendations in this regard will save you a lot of grief. **ES&T**

What do you know about electronics?

The open emitter resistor

By Sam Wilson

There are inquiries about certain CET test questions that seem to make the rounds every two or three years. Many of these questions concern the open emitter resistor.

Two symptoms, one cause

One example is shown in Figure 1. This circuit is a Class A transistor amplifier with a simple base bias configuration. The emitter resistor is used to stabilize the circuit.

The actual circuit may be in some other configuration, and the circuit may be made with a tube or field effect transistor. In any event, the question is the same: *What happens when the resistor marked R_E is open?*

When the switch is closed, the voltmeter should read a positive voltage if the transistor and the other parts of the circuit are working properly.

When the switch is open (simulating an open R_E), the voltmeter should show a definite increase in voltage reading. As a matter of fact, the voltage should be very close to V_{cc}.

For some reason, people who send queries on this test question seem to feel that the voltage should be zero. Look at it this way – when the emitter resistor is open there is no current through the transistor and there is no current through the collector resistor. The base circuit is also open. (Current through the high-impedance voltmeter is so low that it can be disregarded.) Because there is no voltage drop across the transistor and R_c, it follows that the emitter must be the same voltage as the power supply voltage. (It doesn't much matter which kind of a voltmeter you use for making this measurement, but a very high-impedance voltmeter is preferred.)

I built the circuit in the lab and used a meter with a 32MΩ input impedance. I measured 11.56V with the switch in the open position (to simulate the open emitter-resistor). The components for the circuit that I used are shown in Figure 1. (If there are readers who don't believe my results, they are invited to build the circuit and determine for themselves that the emitter voltage is very high when the emitter resistor is open.)

The illustration in Figure 2 shows a similar condition with an open emitter resistor. Because of the change in the type of bias for this circuit, the symptom for the open resistor is entirely different. You can think of R_2 in the voltage divider network as being a pull-down resistor. It keeps the base voltage at a fixed value with reference to the power supply.

When the emitter resistor opens, the emitter lead will float to approximately the same value as the voltage at the junction of R_1 and R_2. That voltage is usually about one-half the power supply voltage, so you can expect the voltmeter reading as illustrated to be about 6V.

The fact that you get two different symptoms for the same cause

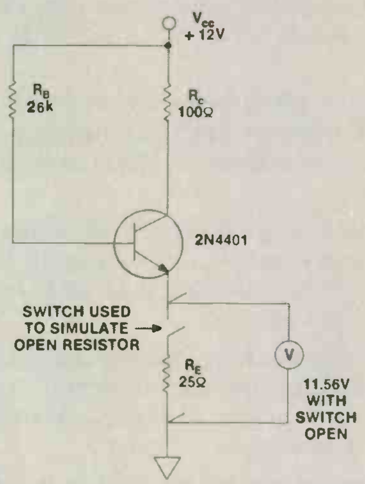

Figure 1. In this Class A transistor amplifier with simple base bias configuration, if the emitter resistor opens, the voltage from emitter to ground will be very close to V_{cc}.

might be the reason why this question is missed on the associate-level CET test.

A 2N2222 with Justice

I'm not sure I understand all I know about this next condition. The circuit in Figure 3 was constructed by student John Justice as part of a laboratory experience teaching the fundamentals of differential amplifiers. It illustrates another question: *What happens if you connect a transistor into a circuit backwards?*

There is nothing especially unique about the circuit except that it was made with two 2N2222 transistors. For that reason, it may not work with all transistors in the same situation.

The student who constructed the circuit inadvertently connected the negative side of the power supply to the collector of the NPN transistor and the positive side to the emitter. As you can see from the illustration, this circuit uses a combination of fixed and long-tail bias. What happened was, the circuit worked—*except that all the voltages were reversed.*

The circuit was using the collector-base junction as an emitter-base junction; the base-emitter junction was being used as a base-collector junction.

In other words, the transistor was being used upside down and the circuit still worked! (I am giving all of the details of the circuit so that you can construct it yourself if you don't believe it. I don't

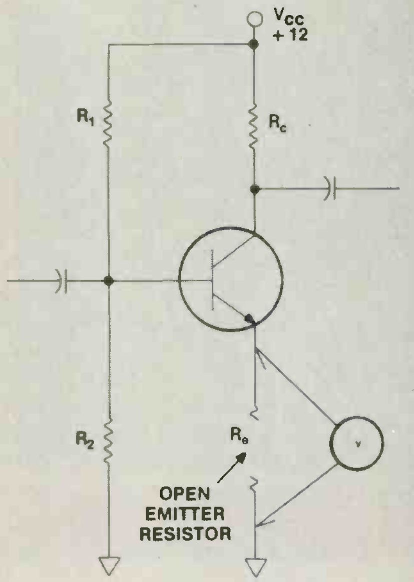

Figure 2. In this transistor circuit using a voltage-divider biasing arrangement, if the emitter resistor opens, the emitter lead will float to approximately the same value as that at the junction of R_1 and R_2.

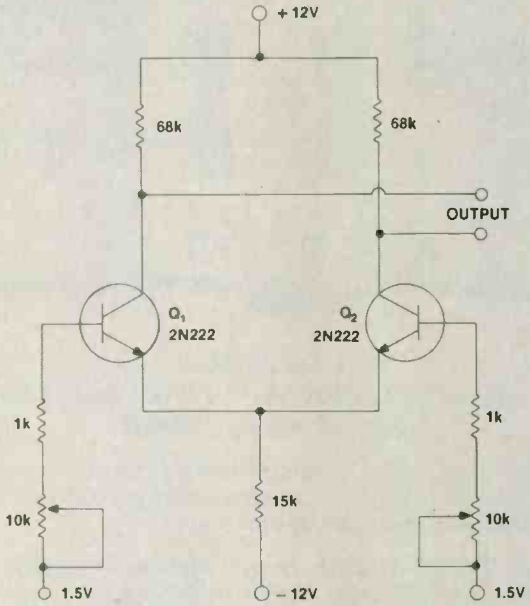

Figure 3. When the supply voltage to this circuit was reversed, the circuit still worked—but all the voltages were reversed.

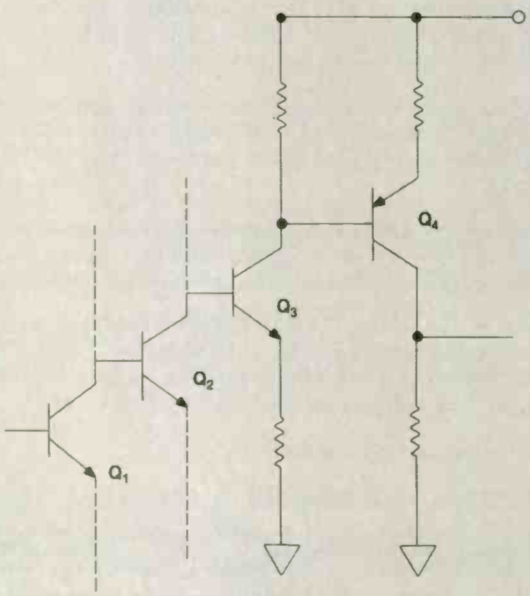

Figure 4. This type of circuit is used extensively as the last amplifier in a chain of direct-coupled amplifiers in order to reduce the problem of level shifting.

know if this has any practical application in troubleshooting, but it certainly does tell you a little bit about transistors.)

When the student pursued the matter, he found something equally confusing. When he used a Beta tester on a group of 2N2222 transistors, he got beta values ranging from 100 to 200. *When he connected those transistors into the Beta checker backwards, he got beta values ranging from 5 to 9.*

If you just happen to connect one of these dandy transistors into a circuit backwards, the only indication you might get is a very low gain.

We can't find anything in any literature that discusses the upside-down connection of a transistor.

Any comments?

Upside-down transistor amplifier

One of the circuits that seems to be troublesome to technicians taking the associate-level CET test is the upside-down configuration of the transistor amplifier Q4 shown in Figure 4. The emitter of the PNP transistor is connected toward the positive side of the supply and the collector is connected toward the negative side of the supply.

This type of circuit is used extensively as the last amplifier in a chain of direct-coupled amplifiers. Its purpose is to reduce the problem of *level shifting*.

As shown with the direct coupled amplifiers, the collector of each amplifier must be more positive than its base, so the collector of the next amplifier must be more positive than the collector of the previous amplifier. Therefore, in each subsequent amplifier there is a build-up of the dc voltage level.

The upside-down PNP amplifier converts the relatively high dc voltage level of the signal back to a lower dc level. This could also be accomplished by using an emitter follower. However, that results in a stage that has no voltage gain.

The configuration of the amplifier shown in Figure 4 is *common emitter*. That is one of the questions concerning the circuit that seems to cause a lot of trouble. Common emitter circuits have the input signal at the base and the output signal at the collector. It doesn't matter that the emitter is connected to the positive side of the power supply. Positive or negative connection has no meaning in terms of the configuration.

Because this is a common emitter amplifier, there is a voltage gain. Incidentally, there is also a 180° phase shift.

A second question related to this upside-down amplifier concerns the emitter-base short test. When the emitter is shorted to the base, the transistor stops conducting. That means that the collector voltage goes to zero volts. In a conventional amplifier, shorting the emitter to the base causes the collector voltage to be equal to the power supply voltage.

Remember, the emitter-base short test should not be used in direct-coupled bipolar amplifiers. Also, it should not be used in Class B bipolar amplifier circuits.

Diode characteristic curves

When a diode is connected into a relatively low-impedance circuit, as shown in Figure 5, it is not possible to predict diode current by assuming that the voltage across the diode is 0.7V (for silicon). I discussed this in a previous article and it has always been my contention that a load line solution is the simplest for that type of problem.

I received several queries ask-

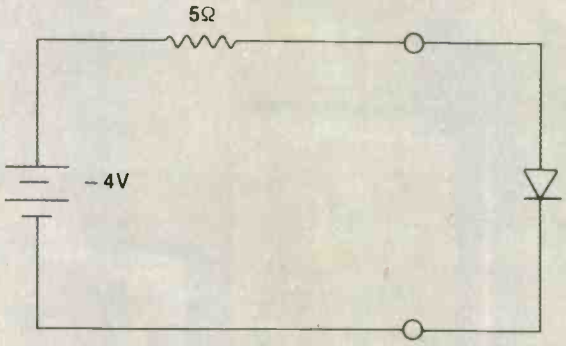

Figure 5. When a diode is connected into a relatively low-impedance circuit, it is not possible to predict diode current by assuming that the voltage across the diode is 0.7V (for silicon).

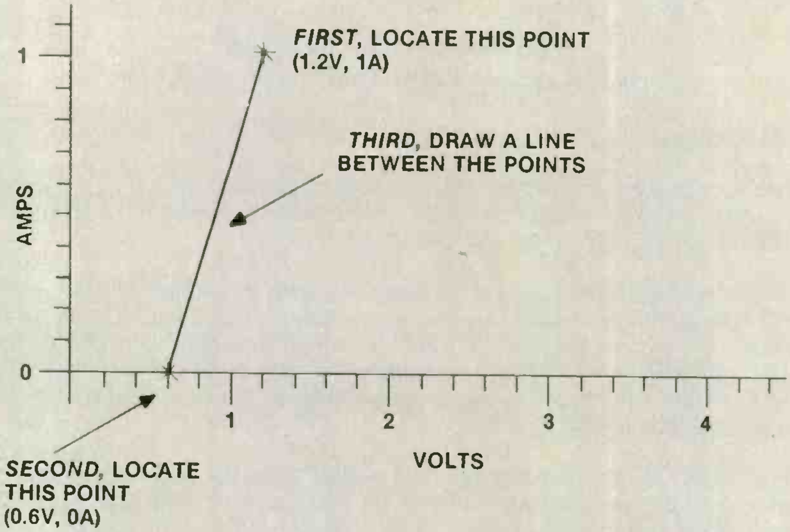

Figure 6. You can use a piecewise linear approximation to draw a diode characteristic curve, as described in the text.

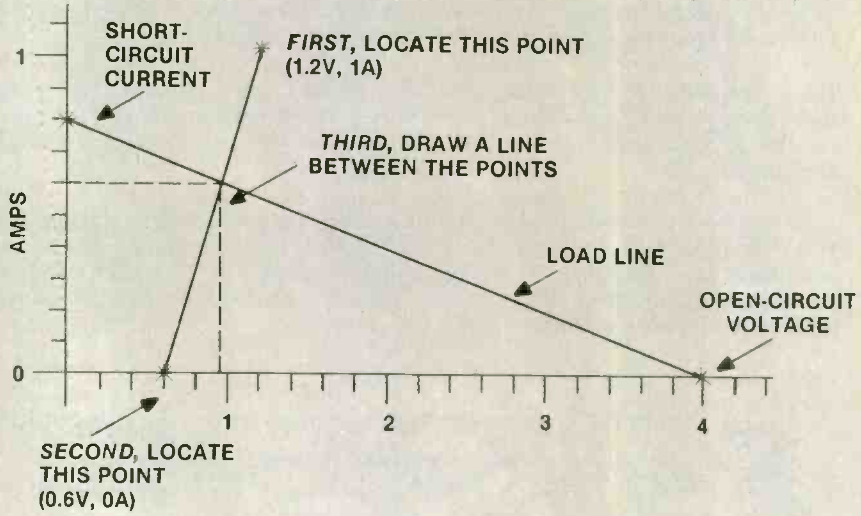

Figure 7. Draw a load line by calculating the open circuit voltage and the short circuit current. The diode operating conditions are (approximately) where the characteristic curve and the load line meet.

ing, "Where do you get the characteristic curve of the diode in order to draw the load line?"

There are several ways to do this. One is to use a simple diode curve tracer and mark the load line with a grease pencil on the face of the oscilloscope CRT. This procedure gives limited accuracy, and it may be difficult to calibrate the diode curve using a typical curve tracer.

A better method is to use a piecewise approximation method for drawing the characteristic curve. For example, the manufacturer's literature for the 1N4001 diode says that this diode has a maximum forward current of 1A. When that current is flowing, the maximum voltage across the diode junction is 1.2V. (So much for the idea that there is always 0.7V across a silicon diode when it is conducting in the forward direction.)

The procedure is to mark these two points on the graph as shown in Figure 6. Then, draw a line to the 0.6V mark on the X axis. The current on the graph from 0.6V to 0V is presumed to be zero in the forward direction.

Of course, there is actually a very small amount of current in the forward direction when the voltage is less than 0.6V. This will not make any serious difference in the graphical solution.

Once the curve is drawn, the procedure for drawing the load line is simple. The load line for the circuit shown in Figure 5 is drawn in Figure 7. The piecewise graph of Figure 6 is used for this purpose.

Two points are needed:

- The open-circuit (no-load) voltage equals 5V
- The short-circuit current

$$\frac{4V}{5\Omega} = 0.8A$$

The load line is drawn between these points. Then, the diode current and voltage across this diode are determined graphically. The broken lines show the method. Using this method, you would determine that the current through the diode in Figure 5 is 0.6A and the voltage across the diode is 0.95⁺V.

ES&T

Photofact

These Photofact folders for TV receivers have been released by Howard W. Sams since ES&T's last report.

AOC
Chassis M3C3-7K2, M3C3-8K2 2515-1

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EMERSON
M195R (suffix A) 2513-1

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MAGNAVOX
CG4045WA01/47WA01, Chassis 13A201 2510-1

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Chassis CTC117C 2511-2

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Chassis CTC133B 2513-2

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Chassis SCC-648Y-A, SCC-552U-A 2514-1

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TOSHIBA
CF2636, CX2836C 2510-2

TOSHIBA
CX1466, CX1466C 2512-2

TOSHIBA
CX2060C, CX2066/C, CX2076 2514-2

Answers: to the Quiz

Questions are on page 12

1. A. The question describes a quick way to check receiver sensitivity. A 50Ω or 75Ω output impedance must be matched to the receiver to avoid getting an erroneous, low-sensitivity indication. See "TV Tests and Measurements" in the September 1986 issue. This test also is described in Robert G. Middleton's book, titled "101 Ways to Use Your VOM, TVM, and DVM."

2. B. The test described in (A) is a destructive test and should not be performed! (Again, see "TV Tests and Measurements" in the September 1986 issue.) The upper rating of line voltage should be accepted without testing.

3. A. The input/output phase should be either 0° or 180°. In either case, the lissajous pattern will be a straight line. See "What Do You Know About Electronics" in the September 1986 issue.

4. A. See Figure 2. Equivalent series resistance is undesirable in capacitors. The charging and discharging current of the capacitor must pass through the ESR. That means power wasted in the form of heat and an undesired voltage drop across the resistor. See "Reports from the Test Lab" in the October 1986 issue of ***ES&T***.

5. Both symbols in Figure 1 are used to represent a tunnel diode. In "Test Your Electronic Knowledge," October 1986, the tabs on the upper symbol were accidentally omitted.

6. B. See page 43, October 1986 issue. As an analyzer samples the input lines, the sample points are developed by an internal clock. The period of the sampler can be selected by the user. Because the analyzer is sampling asynchronously to the system under test from direction of this internal clock, a long sample period results in an inaccurate picture. That is because the sampled lines may change many times in between sample points, as you can see in Figure 3. If you need more resolution, the sample period should be kept short.

7. B. Grounding both ends can result in a shield current that introduces undesired noise and stray pickup. See "What Do You Know About Electronics" in the October 1986 issue. Refer to Blocks 1 and 8.

8. A. The procedure described in (A) is used for Apple computers. It is called "booting." The procedure described in (B) is used with Commodore computers. "Computer Corner" in the October 1986 issue warns that when servicing computers you must keep the two systems in mind or you are liable to lose data or even damage the disk and/or disk drive.

9. AI applications. Artificial Intelligence will, no doubt, be the next great electronic frontier. An AI system can mimic human behavior in many ways, but it could be oversold. Read about it in the article, "Artificial Intelligence – Debunking the Myths," by Joseph J. Kroger in the December 1986 issue.

10. 35. That's a trillionth of a second! The transistor is made with aluminum gallium arsenide and gallium arsenide. The key to the short switching time is in the new method of fabrication that permits very small transistors. See "The World's Fastest Transistor" in the December 1986 issue.

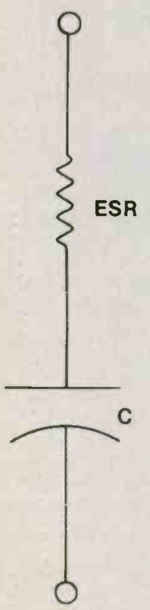

Figure 2.

Figure 3.

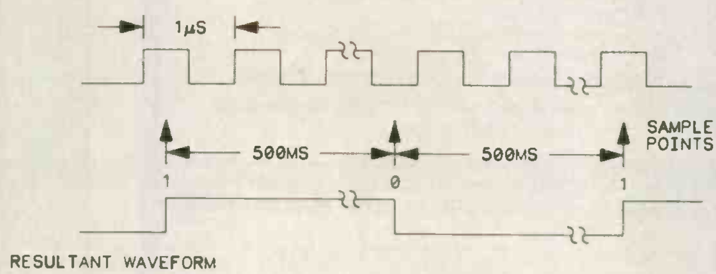

Figure 3. If the sample period is long compared to the period of the waveform being sampled, inaccuracy may result because the sampled lines may change many times in between sample points.

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Products

Micro-clean

Automated Production Equipment has introduced a line of ultrasonic cleaners for the electronic industry.

A.P.E.'s Micro-Clean are available in 2-quart to 11-quart sizes and feature optional custom-fitted covers, baskets and trays.

Circle (75) on Reply Card

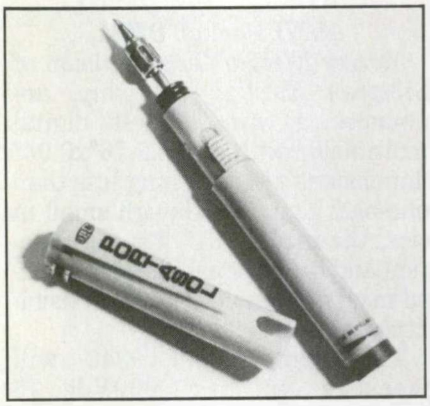
Flux remover

CRC Chemicals has introduced an electronic-grade flux remover that degreases metal parts and assemblies. It leaves no residue to affect circuit integrity or performance. The cleaner removes rosin, flux, mounting wax, molding compounds and miscellaneous organic compounds. It has no flash or fire point.

Circle (76) on Reply Card

Butane soldering iron

Eaglestone's butane energized Portasol soldering iron eliminates battery recharging and heats in seconds, offering adjustable heat output, equivalent to 10W to 60W. The 7-inch long, 3-ounce iron has a protective cap with a built-in igniter that energizes the catalytic



tip, which glows orange red, does not flame, and is operational in less than 30 seconds. Nonelectric, the unit is static free and provides about 60 minutes of cordless soldering. It is equipped with a 2.4mm tip; 1.2mm, 3.2mm and 4.8mm tips are available.

Circle (77) on Reply Card

All-purpose lubricant

Philips ECG has added an all-purpose lubricant to its aerosol chemical line. The PH1000-11 lubricant is a heavy-duty, anti-corrosion agent that coats and protects indoor and outdoor metal equipment. The non-staining lubricant displaces water, restores dielectric properties and facilitates removal of frozen parts. The product can withstand temperature extremes from −40°F to +500°F and resists bacterial action, salt, moisture and acids.

Circle (78) on Reply Card

CRT set-up book

The 1987 CRT set-up book for the *Sencore* CRT analyzer and restorers is now available. The set-up book, which is designed for the models CR70 Beam Builder and CR31A CRT analyzer and restorer, contains more than 600 new CRT listings plus more than 1,500 original CRT listings from the 1986 edition. The book contains listings for a variety of cathode-ray tubes, including video, camera pickup, scope and projection tubes.

Circle (79) on Reply Card

Circle (33) on Reply Card

Vector SMT training kit

The Vector SMT training kit, available from Jensen Tools, is designed to give electronic engineers and technicians a working knowledge of the materials and methods to use with surface mount (SMT) semiconductor assembly technology.

The kit contains SMT devices, prototyping boards, component attachment and interconnection materials and a comprehensive 50-page instruction manual. Included are 270 capacitors, 300 resistors, 10 diodes, 10 transistors, five different ready-to-use double-sided circuit boards with layout/planning sheets, a single-sided board with six PLCC patterns, 2-part conductive adhesive that cures at room temperature, solder paste with dispenser needles, solder wire, solder removal braid, one plastic and one stainless steel tweezers, and pins for piggy-back mounting of finished PC boards on larger circuit boards.

The illustrated "Guide to SMT" manual contains detailed instructions on attaching and removing SMT devices. All components are furnished in a sturdy, foam padded, snap-close ABS plastic case with handle. Replacement parts are also available.

Circle (80) on Reply Card

MINI Pocket DMM

Mercer Electronics, a division of *Simpson Electric Company*, announces a *mini* pocket digital multimeter with 4.96"x2.76"x0.94" dimensions and weighing less than one-half pound. Although small in size, the model 9340 has full function and range capabilities, is housed in a high-impact and high-visibility yellow case.

The mini model 9340 will measure up to 1,000Vdc (5 ranges), 750Vac (2 ranges). 20MΩ (6 ranges) and 2Adc (5 ranges). The basic dcV accuracy is 0.5%, and dc input resistance is 10MΩ. An audible continuity buzzer and diode test are provided.

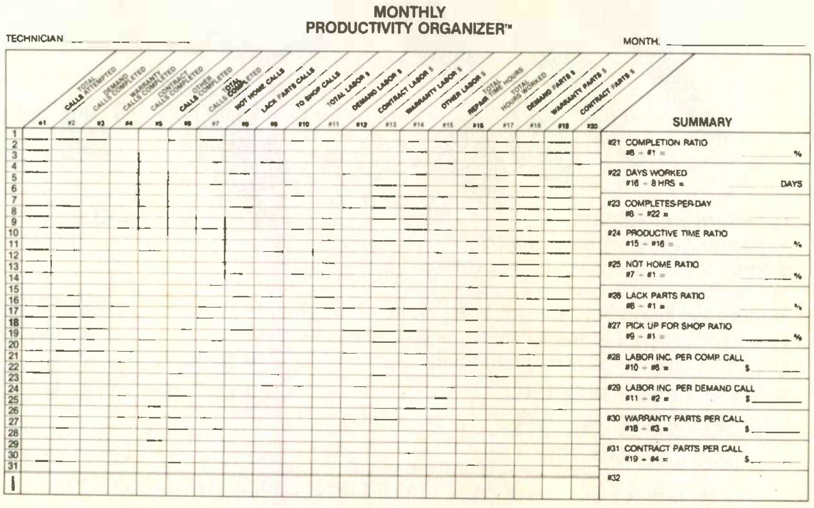
Circle (81) on Reply Card

Productivity organizer

The publishers of *Service Dealer's Newsletter* announce the latest version of the Productivity Organizer, an 8½"x14" manual for recording and analyzing service technician productivity statistics. There are provisions for recording statistical categories covering all types of service businesses. Users may elect to record information in all categories or only in those applicable to their specific needs. Summary pages at the end of the manual allow you to summarize and compare technician performance in the four categories most important to you. Formulas used to compute monthly and yearly productivity averages are simple and the instructions are complete in every copy.

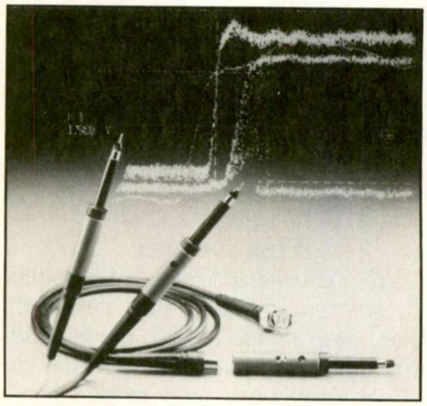
Each copy has enough pages to record performance of up to four technicians for a full year.

Circle (82) on Reply Card



Oscilloscope probes

O.K. Industries' electronics division has introduced a range of modular oscilloscope probes. Ranging in bandwidth from 10MHz to 100MHz, these probes adapt to all oscilloscopes. Their modular design features replaceable tips, probe cables, probe heads and ground leads. Each probe is equipped with its own ac-



cessory kit with two insulating tips, a quick-connect BNC adapter, a sprung hook and a trimmer tool The silicone-insulated probe cable is offered in 1m, 2m and 3m lengths. A read-out actuator option for all x10 probe cables is also available. The SP300 series probes are available with x1, x10 or x1/x10 attenuation.

Circle (83) on Reply Card

Analog scope converts to digital storage scope

Sibex has released model 610 Scope Memory, an addition to the line of instruments that converts an analog oscilloscope into a digital storage scope.

The model 610 features a 10MHz maximum sampling rate and is capable of storing sine wave signals up to 1MHz frequency in its 2K x 8 static RAM. The input sensitivity is 10mv/div.

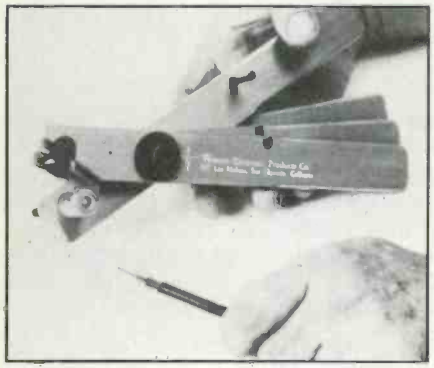
The unit features pre- and post-triggering capabilities or the selection of a ½ pre-, ½ post-data combination. In this mode, the trigger point always is displayed midway across the oscilloscope screen for convenience.

A sweep function has been incorporated. This feature allows the operator to sweep through the entire memory, then expand any portion of the waveform for detailed analysis.

Circle (84) on Reply Card

Coaxial cable stripper

This stripper from *Western Electronic Products* prepares most cables in a range of 0.075 diameter to 0.485 diameter in a single operation with any desired stripped configuration. The CX-1 coaxial cable



stripper makes a step-wise strip to fit any coaxial cable connector. Precision screws adjust the depth of each cut. Built-in length adjustment allows any desired center conductor length to be stripped, and variable spacers permit needed stripping configurations.

Circle (85) on Reply Card

Electronically controlled

A desoldering station, featuring electronically controlled temperature settings from 350°F to 850°F, has been introduced by the *Weller* division of the *Cooper Group*.

The unit, DS1000, uses an internal vacuum pump and keeps temperature accurate to within ±10°F. This conforms to military specifications. Electrical spikes are eliminated throughout the unit because of the zero crossing switches that are used.

The DS1000 has an air flow electronic control with light indicator as well as a three digit LED readout for digital temperature setting and reading. The desoldering station is noise and static free. Tool interchangeability is another feature.

Circle (86) on Reply Card

Teflon/silicon lubricant

LOR-DEE Ltd. has introduced the LDL 3000 Teflon/silicon lubricant. The lubricant is odorless, non-flammable, water repellent and heat stable. Applications that require a non-greasy, non-staining lubricant that is dry to the touch are appropriate. The lubricant is non-polluting, uses no chlorinated hydrocarbons, and is safe to use with a TLV 1,000 ppm.

Circle (87) on Reply Card

PC monitor tester

Network Technologies announces the Montest-15k portable video generator for testing the IBM color display. The hand-held unit is suited for service technicians or others involved in the testing, maintenance or adjustment of IBM or IBM-compatible color graphics displays. With the Montest-15k, a monitor can be aligned in the field in a matter of minutes, according to the manufacturer.

This battery powered test unit generates four different patterns (color bars, cross hatch, window and full raster) with up to 16 different color/intensity options as well as reverse video. The user can learn to operate the unit in minutes. With its 9-pin, D-Series connector, the unit directly drives the display monitor for easy operation.

Circle (88) on Reply Card ES&T

Video Corner — By Conrad Persson

Coming soon: Super VHS

Just when you finally started to understand what VHS video was all about, some wise guy announces S-VHS. The "S" in S-VHS stands for "super," and from all reports it does provide a picture that's considerably superior to standard VHS.

Here's a summary of the picture improvements you can expect to see with S-VHS compared to VHS:

- 430 horizontal lines of resolution for S-VHS compared to 230 lines to 240 lines for VHS.
- Reduction in color noise, particularly magenta and red noise.
- Reduction of noise and jitter, resulting in clear, fine-grained color images.
- Considerable reduction in cross color (color flickers when fine stripe patterns are on the screen) as well as in cross luminance (dot disturbance), in which consecutive dots appear in the boundary of color patterns.

How it's done

Conventional VHS systems use a frequency band of approximately 2.8MHz. This translates into horizontal resolution of approximately 250 lines. S-VHS boasts a wider frequency band of 5MHz (see Figure 1). This wider frequency band makes possible a horizontal resolution of more than 400 lines. Higher resolution means finer detail. S-VHS also offers a wider frequency deviation. By expanding frequency deviation from 1MHz, offered by conventional VHS systems, to 1.6MHz, S-VHS systems feature reduced screen noise and thus better overall picture quality.

One of the features of S-VHS (refer to Figure 1) is that overlapping in color and FM luminance signal bands is reduced. It is this feature that greatly reduces the incidence of cross-modulation interference between color and luminance and provides the noticeably higher picture quality. In addition, during playback, S-VHS systems provide separate color and luminance signal output for clear, rich color gradation that is virtually free of cross-color noise and cross luminance.

Compatibility

With all of the new formats constantly being introduced, one of the big questions regarding S-VHS is, "Is it compatible with existing formats?" Happily, for the most part the answer is yes. Take a look at Figure 2. Switch-selectable recording formats give S-VHS VCRs the flexibility to record with either S-VHS or conventional VHS tapes. During playback, S-VHS VCRs automatically determine the tape type using an ID hole, and play back in the correct format.

Here are the words of one of the manufacturers on how they, the manufacturers, see the future of S-VHS: "The higher resolution provided by S-VHS systems opens the door to camcorder production of home videos with superb quality. S-VHS camcorders take full advantage of the CCD image sensor to provide clearer video reproduction. This technology will usher in an era of home video production with unprecedented quality.

"Current TV broadcasts are transmitted at a horizontal resolution of approximately 330 lines–well beyond the recording capabilities of conventional VHS systems. The higher resolution of S-VHS allows it to take full advantage

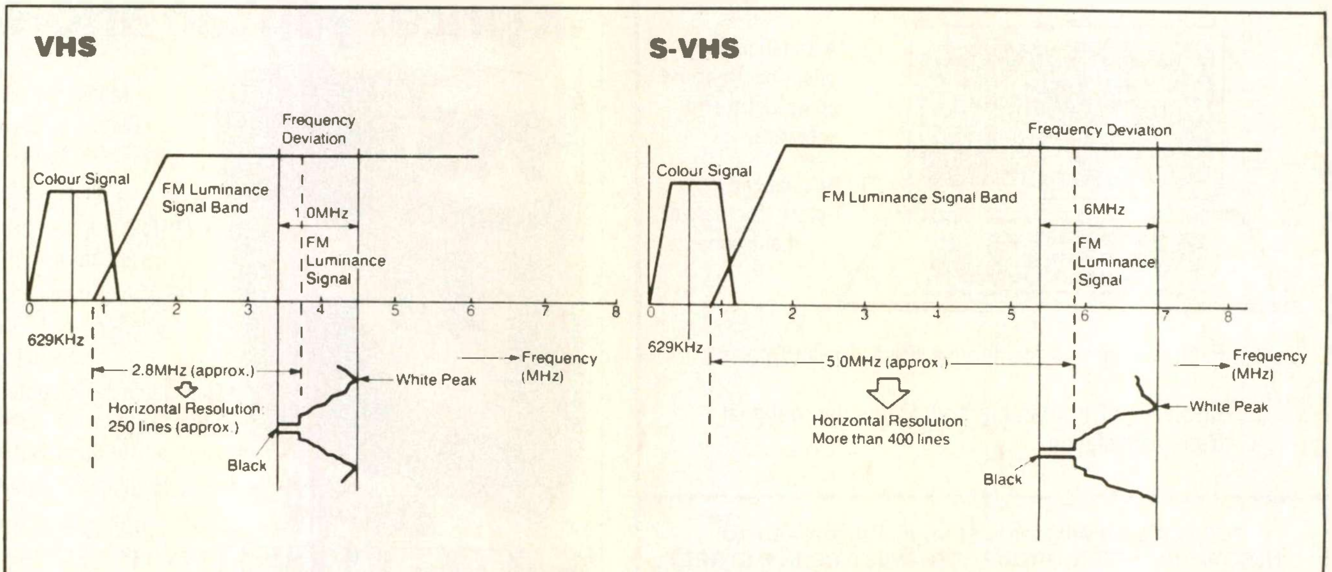


Figure 1. The S-VHS system uses a frequency band of about 5MHz, compared to the 2.8MHz frequency band of conventional VHS systems. The wider frequency band results in a horizontal resolution of more than 400 lines; conventional VHS has a resolution of about 250 lines.

of today's TV broadcasting signals. In the near future, when the high definition TV broadcasting technology now under development is implemented, S-VHS will be the system of choice for optimizing the quality of TV broadcast recordings."

We'll keep you updated on the progress of S-VHS.

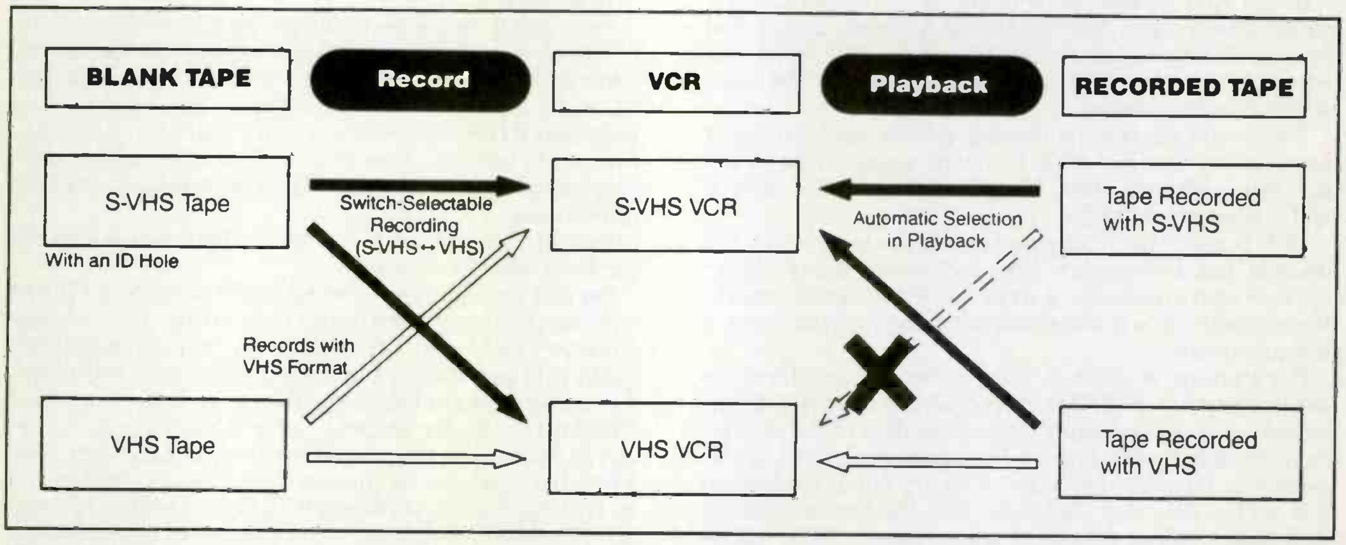


Figure 2. S-VHS systems have switch-selectable recording formats that allow the VCR the flexibility of recording with either S-VHS or conventional VHS tapes.

Understanding binary coded decimal (BCD)

In the past several installments of Computer Corner, we've talked about the numbering systems, binary and hex, used by computer-oriented people, and we've discussed how they relate to each other and to the more familiar decimal system.

There's yet another numbering system that you might want to be familiar with if you're going to be doing anything with computers. It's called binary-coded decimal and is abbreviated BCD.

BCD is not a true number system as are binary, hex and decimal, but a convenient system that's used in an intermediate step in converting from the binary system used in the computer to a decimal readout to be interpreted by a human operator.

For starters, here's how BCD works. Say you have the decimal number 4975. The BCD equivalent of this number would be formed by simply taking each digit of the number by itself and representing it by its binary equivalent. If you remember from the discussion of binary numbers, decimal 5 is simply 101. Note, however, that the highest decimal digit that it will be necessary to represent in BCD will be the digit 9, which requires four binary digits. In order to be consistent then, let's represent the decimal digit 5 with four binary digits: 0101.

The number 7 is represented by 0111, 9 is 1001 and the digit 4 is represented by 0100.

Putting this all together, then, the BCD equivalent of the decimal number 4975 is 0100 1001 0111 0101. Again, note that what we have is not the binary equivalent 4975, but the binary equivalent of each of the digits, one at a time.

By contrast, the binary equivalent of 4975 is 1001101101111. Not even close.

What good is BCD?

Each binary coded decimal digit must have the capacity for four binary digits in order to accommodate the decimal numbers 8 and 9. However, this represents excess capacity, so to speak, as once the 4 digits have been used to represent 8 (1000) and then 9 (1001), that's as high as you can go. In essence those two middle digits remain zero. Because of that, BCD cannot be used directly to perform calculations.

Instead, BCD is used as an intermediate step in converting from binary to decimal.

Say, for example, you have entered the numbers 475 and 348 into your computer in order to add them. The interface circuitry converted 475 into its binary equivalent 111011011 and 348 into its binary equivalent 101011100. The adder circuitry then adds them to give the binary sum 1100110111. So far so good, but you want the sum read out in decimal, so the computer has to do something else. First, the computer has to convert the binary number into its BCD equivalent; then each BCD digit is converted using a BCD-to-decimal decoder or, in the case of a calculator, a BCD-to-seven-segment decoder.

Although it is simple enough to say "binary to BCD" and "BCD to decimal," describing the operation would take more space than is available in this corner. Briefly, the binary-to-BCD converter places the binary number in a binary down counter, which is connected to a BCD up counter. Then, as the binary number is counted down to zero, the BCD counter is counted up to the BCD equivalent of the binary number. Then the output of each digit's counter is applied to a converter that converts the BCD number to its decimal or 7-segment equivalent.

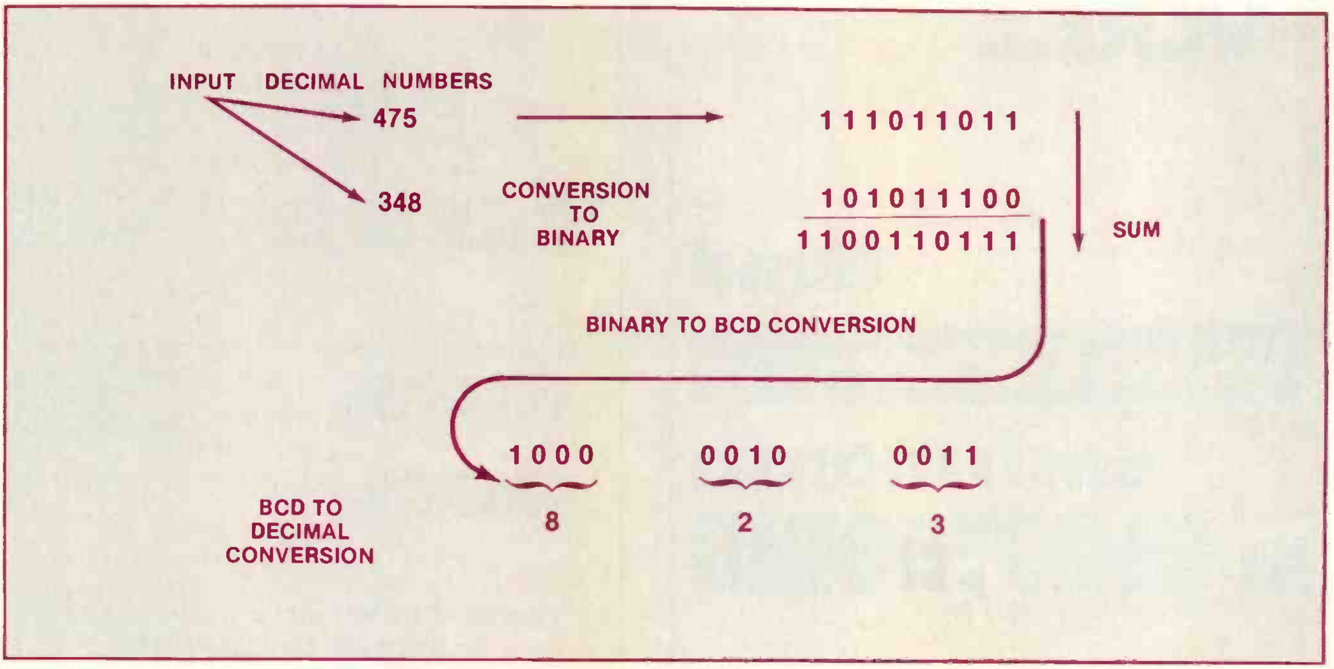


Figure 1. When two numbers are added in a computer, they are entered in decimal, converted to binary and added. Before the resulting sum is read out it is converted to BCD then back to decimal.

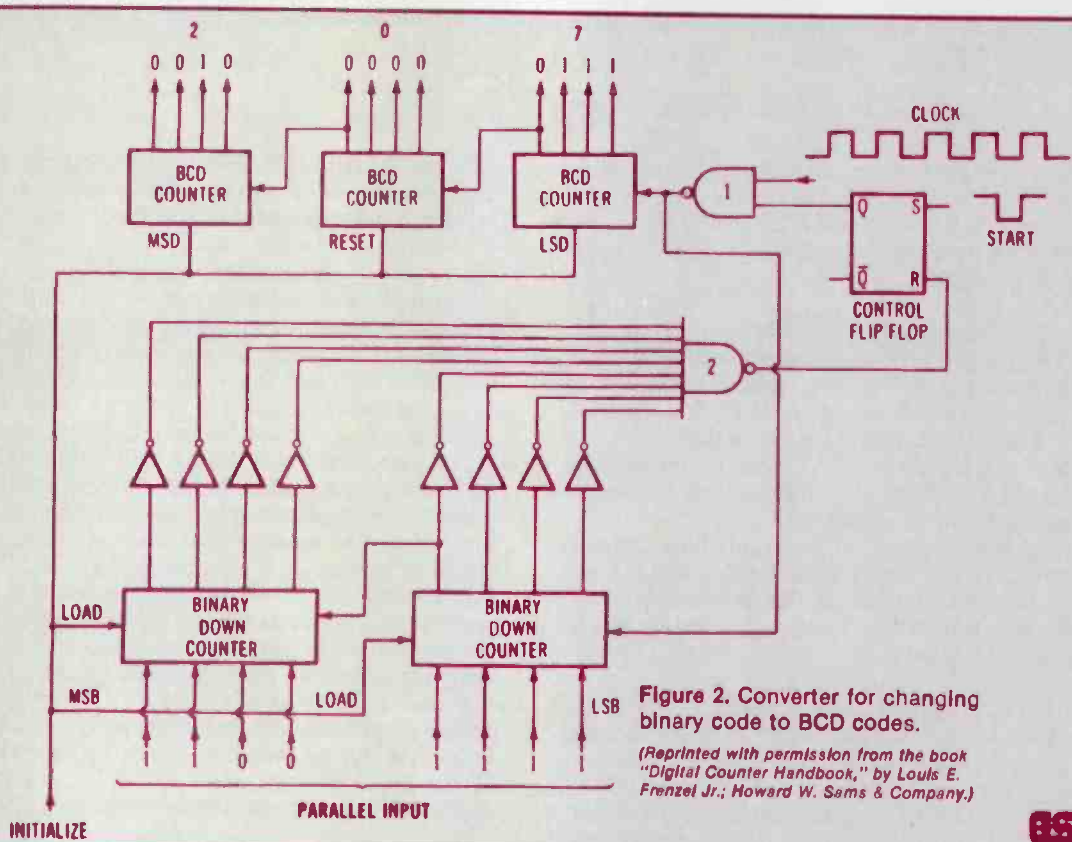


Figure 2. Converter for changing binary code to BCD codes.

(Reprinted with permission from the book "Digital Counter Handbook," by Louis E. Frenzel Jr.; Howard W. Sams & Company.)

Audio Corner

By Kirk Vistain

CD sled and RF PLL testing

Last month, you read about techniques for breaking various servo loops inside a CD player. This time around, I'll show you a quick test for the RF PLL, and talk about ways to distinguish between mechanical and electrical causes of poor tracking.

Testing the RF PLL

The RF PLL (phase-locked loop) is responsible for creating the write frame clock (WFCK), which is phase-locked to the CD's data stream. By comparing WFCK to the read, or reference, frame clock (RFCK), which is derived from a crystal-controlled oscillator, the CLV circuitry generates a correction signal to control the disc motor, ultimately keeping it locked to the recorded data.

If speed control is OK, but there is something amiss in the phase servo, the audio output is usually muted. Some machines disable muting when in the adjustment mode, however, allowing you to hear the gritty-sounding distortion typical of this failure.

Testing without an eye pattern

You can quick-test the PLL's ability to track a signal even if the laser is dead and you have no RF (eye-pattern). Assume you're servicing a unit using the CX20109 RF amp along with the CX23035 CLV/digital signal processor chip. With the unit in PLL adjustment mode, use an RF generator to feed approximately a 2.16MHz, 400mV signal into CX20109, pin 2 (RF1) and monitor the phase-lock clock (PLCK). Varying the input frequency slightly should cause PLCK to track. If not, check the EFM signal path, and perhaps the varactor control circuitry.

I feed the signal in at the RF amp so that it is squared up and looks like EFM to the CLV/signal processor. Maybe you're wondering why I don't use 4.3218MHz, the nominal operating frequency of the PLL. So am I. I tried it, and it doesn't work. Anyone with an explanation, feel free to write.

If the VCO section of the loop is dead, you can test the inverter inside the CX23035 by toggling pin 9 with a logic high and low, while watching for inversion at pin 8. No inversion usually indicates a bad chip.

Mechanical or electronic?

The most common symptom of CD tracking problems probably is skipping or mistracking. It sounds pretty much the same as on an analog phonograph record. On my first encounter with it, I found it amusing that a new technology, supposedly designed to eliminate the shortcomings of its predecessor, should fail with the same symptoms.

The technician must determine whether the problem is mechanical or electrical in nature. A thorough check and touch-up of all tracking-related adjustments is usually a good idea. The most critical ones, in my experience, are tracking balance (E-F balance) and RF PLL. It is important that the output of the tracking detector amplifiers is symmetrical about 0Vdc (i.e., positive and negative peaks are equidistant from the 0V baseline), so that the output is truly zero when there is no tracking error.

Proper adjustment of the RF PLL assures that the disc motor cooperates with the optical block, and is especially important during dropouts caused by defects on the disc. If the free-run frequency of the PLL is too far from 4.3218MHz, it will take longer to recover after a dropout.

Jamming the sled

As often as not, all the adjustments look good, the eye pattern is OK, and the player still skips randomly. So is it the optical block or the sled drive mechanics? Scope the tracking error test point (TE), with a 5ms timebase. You will usually see what looks like random noise. But, if mechanical binding occurs in the sled drive, the gradual build-up of a *fundamental* frequency in the range of 250Hz will be apparent. To demonstrate for yourself, get a CD player and try jamming the sled during play, while monitoring the TE.

Another way is to check the actual drive going to the sled

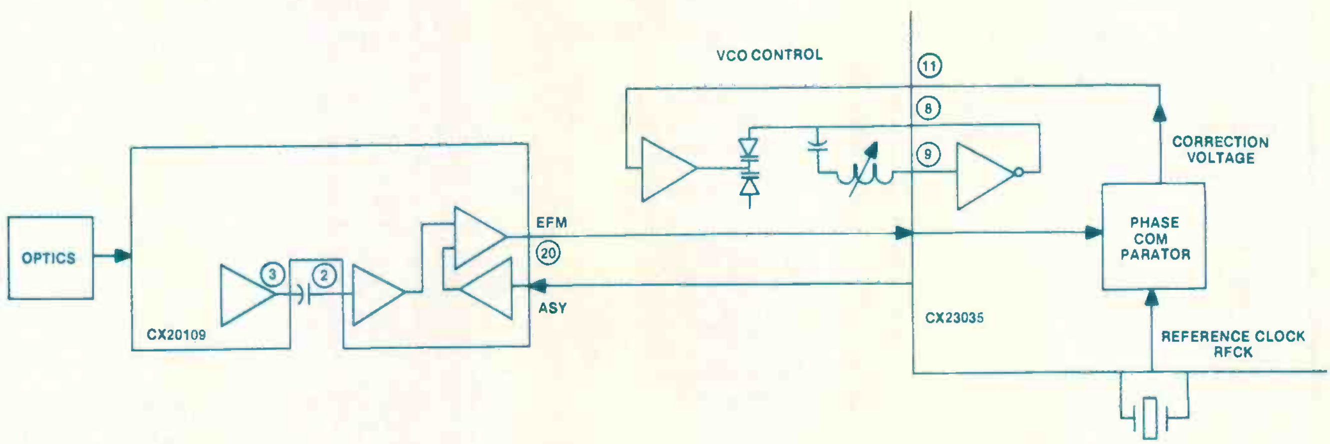


Figure 1. This simplified circuit, using a CX20109 RF amp and a CX23035 CLV/signal processor chip, shows how to check the RF PLL. With the unit in PLL adjustment mode, use an RF generator to feed a 2.16MHz, 400mV signal into CX20109, pin 2 (RF1) and monitor the phase-lock clock (PLCK). Varying the input frequency slightly should cause the PLCK to track.

motor. If it uses pulse-width modulation (PWM) drive, it is particularly easy to detect mechanical binding. For example, the sled drive pulsewidth on a Sony D7 typically varies between 2μs and 7μs. When there is too much friction in the drive system, the pulsewidth slowly increases, then jumps back to nothing right after a skip. This happens as the drive circuitry tries to pump ever more power into the motor. Then, either the sled assembly breaks loose and jumps forward, or the objective lens reaches the end of its range and jumps backwards. In either case, for a moment there is zero tracking error, and thus no correction. This is a sure sign of mechanical trouble.

Knowledge is power

Usually, signal substitution and analysis techniques such as these are tailored to a specific unit or model line. It is necessary to know what types of signals should appear where in a properly operating device. The only way I know of doing this is to check a known-good unit and take notes. Relying on the manufacturer's service information is risky because it is too often incorrect and misleading, even if you can get it translated into understandable English. Waveforms and dc voltage callouts are always suspect. I'm sure we could all write a book chronicling the times faulty service information has sent us on a wild electron chase.

If this makes it sound like you are on your own, you are. More than ever, being a productive technician means spending a good deal of non-productive time researching the new technologies. With the strong yen destroying Japanese profit margins, major players in the home entertainment electronics business are more reluctant than ever to provide the kind of quality service data needed to quickly repair equipment. This comes at a time when the most complex home electronics in history comes limping into your shop on a daily basis.

Symcure rates and guidelines

Beginning with the January 1987 issue ***ES&T*** is paying $60.00 per page for Symcure submissions that are accepted.

Detailed Symcure and T. Tips guidelines are available upon request to **ES&T**

The term Symcure is a contraction of the two words: Symptom/Cure. Problems that are published in ***ES&T*** in the Symcure department are those that have occurred more than once.

This is the kind of problem that you can solve without even a second thought because you've already seen so many of that particular brand and model of set with those symptoms and in almost every case it was the same component that had failed, or the same solder joint that had opened.

We also will consider Symcure submissions on consumer electronics equipment other than televisions such as VCRs, stereos, computers, microwave ovens. Depending upon the nature of the product and the symptom, it may not be necessary to refer to a schematic diagram in all of these cases.

Readers' Exchange

No ad requests will be accepted for Readers' Exchange without a *full, verifiable name, address AND phone number*. This information is necessary for ***EST*** files. Phone numbers will not be published, if so requested.

Wanted:

CRT-10VAHP22, RCA modules–MCY001A, MDF001A, MCZ001B. Will pay cash or possible trade for Heathkit vector monitor. *Jim Lokken, 18402 Avolinda, Yorba Linda, CA 92686.*

Will trade new Diehl Mark III Scanner for serviceable Sencore PR57 Powerite. *Fred Jones, 407 Morningbird Court, Niceville, FL 32578; 904-678-1803.*

Usable 7-inch B&W CRT to fit Sony model TV-700u. Or could someone rebuild *my* CRT? *Dan Elliott, Route 1, Box 117, Cabool, MO 65689.*

RF signal generator (100MHz) WOW flutter meter; sweep/marker generator; FM stereo signal generator; color-bar generator. Must be in good-fair condition with manual if possible. Good used audio-video test equipment, must be reasonably priced in good working order, with manuals if possible. *Squarewave Audio-Video, 866 Cy Ave., Casper, WY 82601; 307-266-1509.*

Handset cradle switch for Code-A-Phone model 2570 telephone answering machine. *MacKenzie TV, 1800 N. Scottsdale Road, Scottsdale, AZ 85257.*

Service literature and schematics for Kenwood KR-6600 stereo receiver; Guild Radio & TV "New Englander," model numbers 921ML, 630, MX622. Will buy or copy and return. *R.J. Shafer, 8119 South Sandy Hook Terrace, Clinton, WA 98236; 206-321-5178.*

Schematics and/or servicing information for Sanyo television, model CTP 6281-01. Also need Sams 1100-1 schematic for GE television (WMZ66CWD-10). Will buy or copy and return. *Thomas Carey. 211 S. Lee Drive, Goldsboro, NC 27530' 919-734-7656.*

Used B&K Precision model 1801 6-digit autoranging frequency counter. Quote price and condition. *R.N. McEntire, 323 Tram Road, Columbia, SC 29210.*

Schematic and dial cord-stringing diagram for GE console stereo, model C-966g. Will pay for photocopy. *Don Setcliff Radio, Rt. 1 Box 237A, Apple Grove, WV 25502.*

Sams Photofact TR-82; Tekfax 100, 102, 117; and Knight 83YX137 AF generator. *C.T. Huth, 229 Melmore, Tiffin, OH 44883.*

RCA high-voltage transformer No. 79642 for RCA color television, model 21-CT-55, chassis CTC2B; would consider complete chassis. *George Mayne, 307 Moxon Drive, Rochester, NY 14612; 716-865-5227.*

Current tube data for precision tube tester, model 10-12. Will copy and return if necessary. *Larry Cook, 362 E. South St., Richland Center, WI 53581; 608-647-4678.*

B&K solid-state RF signal generator (100kHz to 50MHz), model E200D with cables and manuals. State condition and price. *Harv Dowdle, Rt. 1 Box 71, Glenhazel Road, Wilcox, PA 15870; 814-929-5591.*

Owner's manual/service data for D-Tex Electronics model Rebel 1 metal detector. Will buy or copy and return. *B.L. Deck, 122 Fourth Ave. South, Algood, TN 38501.*

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For sale:

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Picture tubes of all kinds; triplers, flybacks and modules. Guaranteed and reasonably priced. *G. Barzily, 84-39 120th St., Jamaica, NY 11415; 718-847-7965.*

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Xerox copies of Zenith "Interference Handbook," 40 pages, $14 postage-paid; Motorola service manuals for 1968 Chrysler, American motors, and 1969 Chrysler, American Motors, Ford, Volkswagen, 50 pages, $17.50 postage-paid. *Kenneth L. Mixon, 401 East San Pedro Ave., Perry FL 32347; 904-584-2116.*

Collectors items: Rider perpetual service manuals, abridged volumes I through V; volumes VI through XX. Best offer F.O.B. Springdale, AR. *James W. Carpenter, 124 Rogers Circle Drive, Springdale, AR 72764; 501-751-5455.*

Service manuals, text books; radio and TV parts; 700 new standard brand tubes (85% off list price); Pilot model AA905 audio amplifier, push-pull 6L6 output, $35. Send large s.a.s.e. *Max Seligsohn, 1455 55th St., Brooklyn, NY 11219.*

Precision EV10A center-source voltmeter, $80; 90° LNA, $40; CM 8-track auto stereo-tape player, $35; two 25W speakers with cabinets, $65 for the pair; obsolete tubes, $6 each. *Kaz Glista, 274 Newington Road, Elmwood, CT 06110; 203-232-8793.*

Tek 453 portable 50MHz dual-trace scope with calibrated delay. Good condition, operator and repair manual included, $500. *James Kasperski, 40 Altamore St., Melville, NY 11747; 516-271-2494 after 6 p.m.*

Sams Photofacts auto radio books, AR-40 through AR-224. Make offer for one or all. Send s.a.s.e. for list. *Blankinship TV, 1216 N. Main, Rusk, TX 75785.*

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