THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

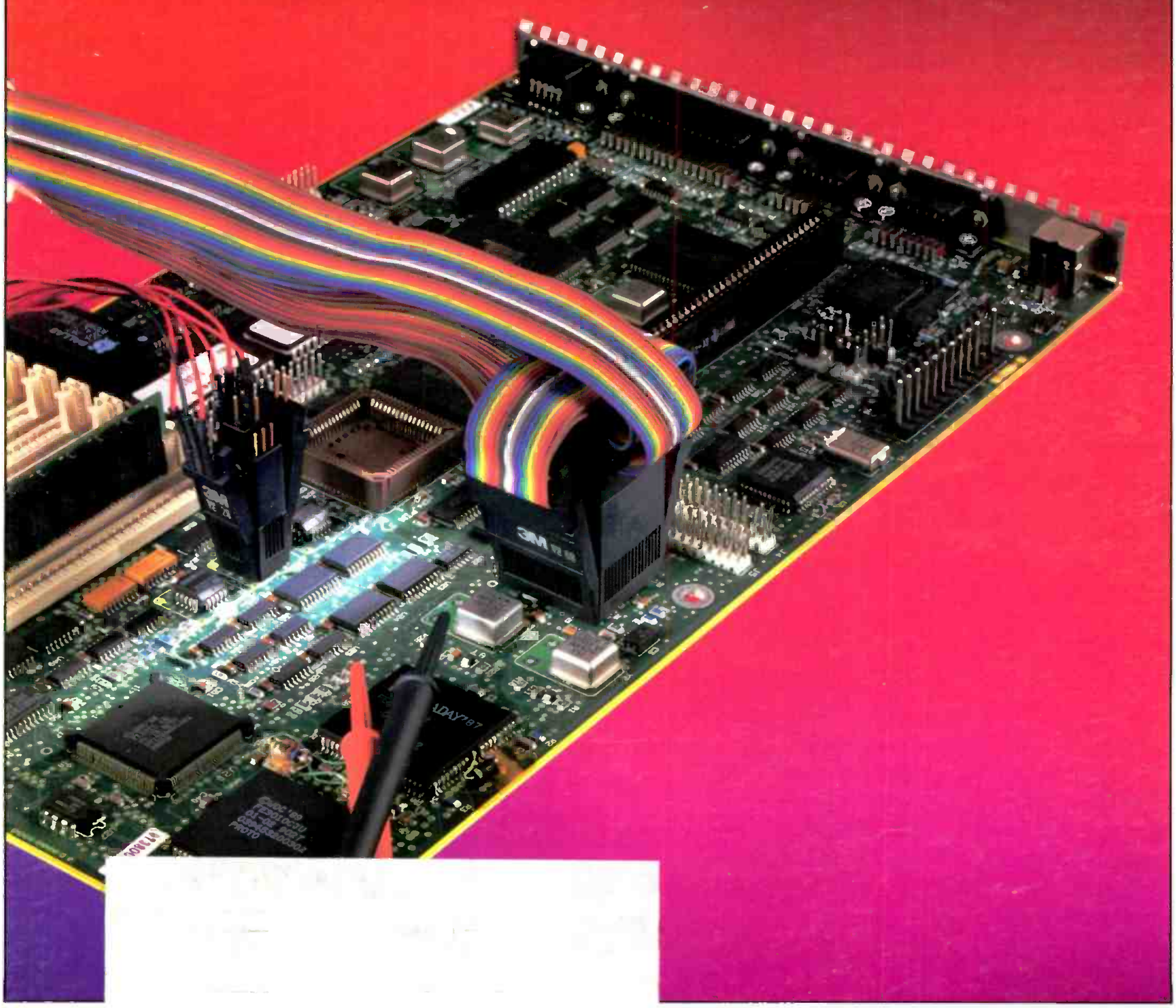
ELECTRONIC Servicing & Technology

JUNE 1994/$3.00

Solving VCR servo system problems

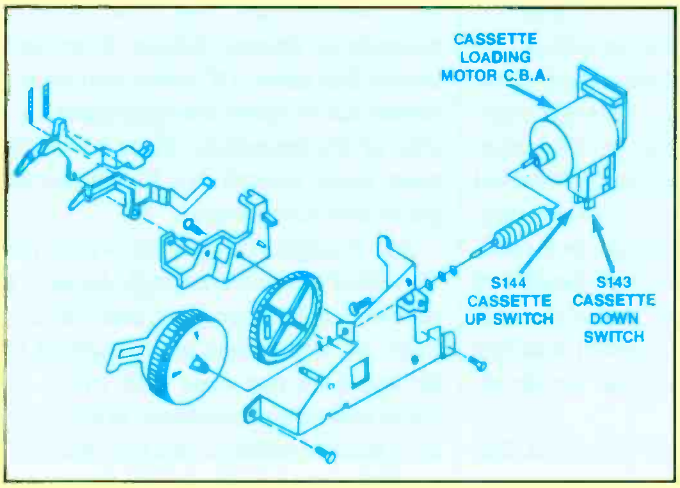
Understanding the RS232(C) serial interface

Test equipment update

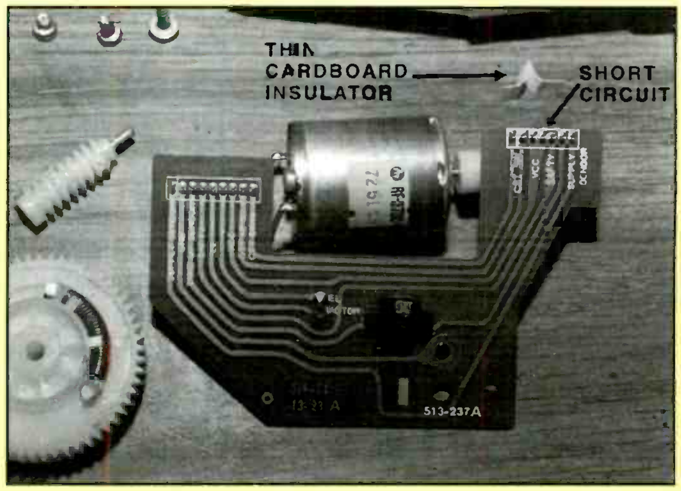


Contents

Volume 14, No. 6 June 1994



page 46



page 60

ON THE COVER

The world of consumer electronics continues to expand and evolve. While existing test equipment continues to be useful in troubleshooting, manufacturers continue to update their products to handle the latest in circuit technology. Don't throw away that old DMM or oscilloscope, but don't ignore the offerings of the latest most functional devices. (Photo courtesy of 3M.)

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING
ELECTRONIC
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Editorial

Being an inventor isn't what it used to be

One of the things that characterize today's world of consumer electronics is the sheer magnitude of invention that has gone into it, and continues to cause it to expand and evolve. Take television as an obvious example. In little more than fifty years, television has evolved from a medium of mass communication that consisted of gray images on a small screen, watched by a relative handful of viewers, to the bright, colorful, large screen, stereo sound medium watched by most people throughout the developed world.

The sheer number of inventions that had to be conceived, developed and brought to market to make today's large-screen, color, remote controlled television, delivered via broadcast, cable, or satellite, and with stereo sound, possible is mind boggling. It would be interesting to try to come up with a catalog of those inventions and developments. Here are just a few:

- the color picture tube
- the NTSC television signal
- LCD video displays
- stereo audio TV broadcast
- projection TV
- optoelectronics
- ICs of all kinds
- video tape recording

A little further research and reflection could probably extend this list so that it would fill this issue and go on and on beyond it.

But some other areas of consumer electronics would probably yield an even longer list of inventions. Take, for example, the laser and compact disc players. The patent office must have entire filing cabinets given over to the storage of patents related to digital recording. There's the recording process of the disc itself, the method by which the pits are generated. There's the laser head, the read process, and the servo system that keeps everything on track. And those are just the obvious areas.

So who are the people who invented all of these things?

If we look back in history at some of the historical inventions, we know who the inventors are. The most obvious example is Thomas Edison. Everyone knows that name. Of course part of the reason that we know him is the sheer volume of his inventions, many of which were basic inventions—inventions of entire new technologies.

For example, Edison, known as the Wizard of Menlo Park, single-handedly invented voice recording and electric light. He was tireless and persistent in his quest for materials with which he could realize his inventions. In his quest for a suitable material for a light bulb filament he sent people all over the world. Of course, another reason we know Edison so well is that he was a shameless self promoter.

We know about another inventor, Alexander Graham Bell, because he invented an entire basic technology: telephony. And he did it pretty much single handedly.

But how many of us know names like Brattain, Bardeen and Shockley. They're the men who invented the transistor, an invention that has had a far reaching effect on today's technology. And their names are known and are recorded in the annals of invention, but they don't ring through history like those of Edison and Bell.

Maybe it's less amazing when something is invented by a committee. Or perhaps it's the fact that most of today's inventions are developed by unidentified scientists working anonymously for large corporations. Or perhaps it's because the sheer volume of technological change and innovation tends to mask any specific development and its developer.

Whatever the case, inventions seem to continue to flow from the minds of inventors, and we, the viewers, the listeners, the users of this technology, and the servicers of the products, continue to benefit from the products that these inventions make possible.

Nils Conrad Persson

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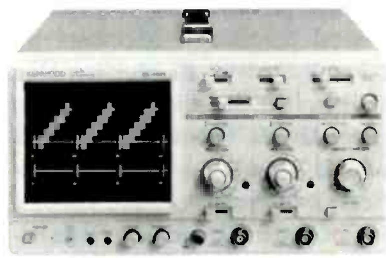

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Electronics and appliance students to compete at VICA United States Skill Olympics

Outstanding vocational students in electronic products servicing and major appliance technology programs from all across the country will gather in Kansas City, MO, on June 29 and 30, 1994. The students, all gold-medal winners in their states, will participate in the showcase of vocational-technical education: the VICA United States Skill Olympics (USSO).

VICA, the Vocational Industrial Clubs of America, is the national organization for students in trade, industrial, technical and health occupations education. It sponsors the VICA U.S. Skill Olympics annually to recognize the achievements of vocational-technical students, and to encourage them to strive for excellence. Pride in their chosen craft makes for highly motivated and quality employees with good attitudes toward work.

In Kansas City, 52 students will compete in electronic products servicing, and 24 in major appliance technology. Working within time limits, the competitors are judged by industry personnel as they put their equipment and skills to work on assigned projects, designed by a technical committee of experts in the respective field. The committees acquire equipment and supplies, obtain qualified judges, and set up the contests.

Walter Seymour, Electronic Industries Association (EIA), and Gerry Ganguzza, Sharp Electronics Corporation, co-chair the electronic products servicing national technical committee. Members include: Frank Steckel, El Mueller, Don Hatton, Brian Ott, and Elmer Poe, of the EIA; Tom Graff, Thomson Consumer Electronics; Emmanuel Henry, Matsushita Services Company; Mike Brooks, Philips Consumer Electronics; Rich Polak, Maxtec International Corporation; Mike Derosa, Sony Corporation of America; Don Multerer, Sencore; and Steve Burkhead, Toshiba America, Inc.

The major appliance technology national technical committee is co-chaired by Charlie Roberts, GE Consumer Services, and Jerry Job, Sears Service Center. David Krueger, Sears Roebuck and Company, is a member as well. They are assisted by a local committee of educators and industry personnel.

The top three high school and postsecondary winners in each of 54 competitions receive gold, silver and bronze medallions from VICA. Many receive tools, textbooks, scholarships or special training programs donated by business and labor organizations, and by trade and professional associations that support the Skill Olympics.

Kansas site picked for next ETA/SDA seminars

The headquarters of ETA and SDA in Greencastle, IN has announced the location for the next jointly sponsored technical training school. Neosho Community College in Chanute, KS will sponsor the event on July 8 and 9, 1994. NCC's address is: 1000 S. Allen St. in Chanute.

The popular SAM—Satellite/Antennas/Master Antenna TV systems—school will be produced by the Satellite Dealers Association. A segment of the school will address DBS small-dish installation and service, in addition to the core elements which teach installation, adjustment and maintenance of C-Band and other TVRO products. Antenna basics, overcoming interference, combining satellites and antennas into master antenna and cable system headends are included in this college-credit two-day course.

The Electronics Technology School is also a two-day event, running simultaneously in a separate classroom at Neosho Community College. Topics covered at this school include TV and VCR servicing, computers, fiber optics, telephone installation and servicing, and basic electronics topics such as modern electronics power supply servicing, and a session on industrial digital controls.

For the first time, ETA will produce a two-day school devoted entirely to the Federal Communications Commission Commercial Radiotelephone Operator License. A portion of this school will be devoted to outlining the topics included on the new GMDSS license exams, in addition to covering all the topics included on the General Radiotelephone Operator License. The G.R.O.L. is the most popular license and once acquired allows the holder to service and operate radio communications equipment used in the aeronautical, maritime or land mobile industries. The FCC Commercial License Examinations will be offered at the conclusion of the two-day FCC Exam school at Neosho Community College. Participation at the school is not a requirement for sitting for the examinations.

Certified Electronics Technician (CET) exams and Certified Satellite Installer exams will also be offered at the conclusion of the schools.

For complete class schedules of the three schools, hotel and registration information, call ETA at 317-653-8262, or SDA at 317-653-4301. You can also write to ETA Schools, 602 N. Jackson, Greencastle, IN 46135.

Home Electronics Installers' Association sets sites for first six regional education programs

CEDIA, the Custom Electronic Design & Installation Association, is conducting educational programs for home electronics installers in six cities. These programs began in early May and will run to the end of July, an official announced. Similar two-day programs covering topics in home entertainment and systems integration, among other areas, will be held in Los Angeles, Orlando, Chicago, Seattle, Toronto, and Philadelphia. The programs are open to non-members of the association at a higher cost.

"These regional seminars will give many installation companies a chance to offer their employees professional training without leaving their local areas and at modest expense," said Rob Gerhardt, chairman of the association's Education Committee. "Based on the initial feedback, this is going to be a very popular program."

Seminar sessions will vary in length from one to four hours, depending on subject matter, and will include courses presented by CEDIA's Home Entertainment Council and Systems Integration Council, as well as those presented by individual manufacturers. In order to provide individual instruction, each course presentation will be limited to six to eight attendees, with sessions frequently repeating the courses during the two-day event.

Attendance fees for CEDIA members are set at $40, $60 for non-members, and will cover as many of the manufacturers' courses as the registrant cares to attend. CEDIA's HEC and SIC sessions will be available to all at an additional cost.

Specific programs will be announced at a later date. Dates and cities are:

Seattle, July 10-11
Toronto, July 17-18
Philadelphia, July 24-25

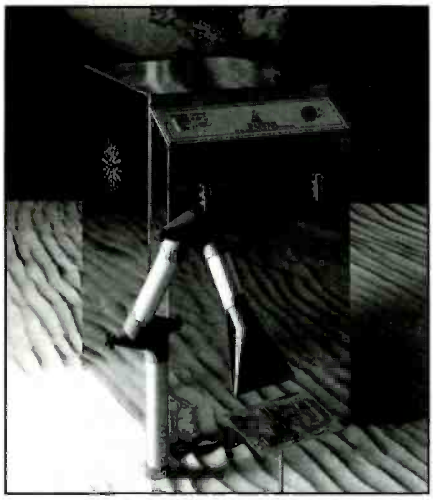
CEDIA is a national trade association of companies which specialize in planning or installing electronic systems for the home—typically, single- or multi-room home entertainment systems, home theaters, media rooms, home automation, security systems, communication systems, and other residential electronics. The association was founded in September, 1989, and has approximately 500 members.

For further information, contact Billilynne Keller, executive director, CEDIA, 8335 Allison Pointe Trail, Indianapolis, IN 46250, or call 1-800-CEDIA-30. ■

Literature

Brochure describes purification system for soldering fumes

A six-page brochure describing Hexacon Electric Company's new Purex Multi-position Arm Fume Purification System is now available. This system is well suited for handling soldering fumes and is available in a wide range of models to accommodate any number of operators.



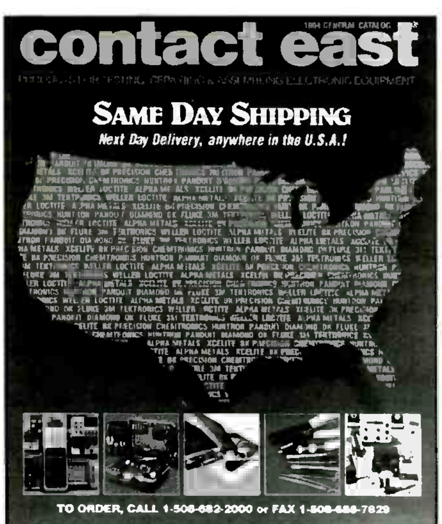
The environmental filter removes all particulate debris down to 0.3 micron and 95% of particles down to 0.01 micron. Harmful toxic gases are purified in a chemical cartridge. The expelled air has a purification factor of 99.997%, and, if desired, can be recycled back into the work place.

The literature describes the company's reverse airflow which increases filter life and efficiency.

Circle (80) on Reply Card

Catalog of test equipment, tools and supplies

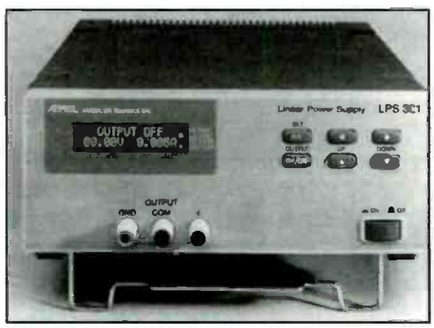
This 244-page catalog from Contact East lists test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. Product highlights include new DMMs and accessories, soldering tools, custom tool kits, EPROM programmers, power supplies, ELF meters, helpful reference books, breadboards, scope meters, datacom tools and testers, adhesives, measuring tools, precision hand tools, portable and bench top digital storage scopes. Also included are the company's lines of communication test equipment, soldering/desoldering systems, static protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, cases and more.



Circle (81) on Reply Card

Power supply brochure

Five digital power supplies, and six analog units, are featured in a four-page brochure from American Reliance. Each power supply is full-featured and easy-to-use.



The LPS-300 Series linear units are positioned as the most accurate power supplies in their class today, according to the manufacturer. All controls are front panel mounted pushbuttons. An RS-232 interface is available. Single, dual and triple output models are also available.

Circle (82) on Reply Card

Course schedule released

BMI releases their education calendar for 1994, including classes and lab instruction on power quality, power management, and harmonics, taught at their headquarters in Santa Clara, CA. Courses include: Problem Solving with the 4800 PowerScope, Problem Solving with the 8800 PowerScope, The PowerProfiler: Use and Application, The PQNode: Programming and Analysis, Power Quality for the Industry Professional, Advanced Power Quality Lab, Power Management for the Industry Professional, and End-Use Power-Line Harmonics.

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

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

SALES OFFICE
Electronic Servicing & Technology
76 N. Broadway, Hicksville, NY 11801
516-681-2922; FAX 516-681-2926

Diane G. Klusner, *Director of Advertising*
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EDITORIAL CORRESPONDENCE:
P.O. Box 12487
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Electronic Servicing & Technology (ISSN 0278-9922) is published 13 times a year by CQ Communications, Inc. 76 N. Broadway, Hicksville, NY 11801. Telephone (516) 681-2922. Second class postage paid at Hicksville, NY and additional offices. Subscription prices (payable in US dollars only): Domestic—one year $24.75, two years $45. Foreign countries—one year $30.75, two years $57. Allow six weeks for delivery of first issue and for change of address. Printed in the United States of America.

Postmaster: Please send change of address notice to Electronic Servicing & Technology, 76 N. Broadway, Hicksville, NY 11801.

CQ Communications, Inc. is publisher of CQ The Radio Amateur's Journal, Popular Communications, MicroComputer Journal, CQ Radio Amateur (Spanish CQ), CQ Amateur Radio Equipment Buyer's Guide, CQ Amateur Radio Beginner's Buyer's Guide, Popular Communications Communications Guide, and Electronic Servicing & Technology.

Test equipment update

By The ES&T Staff

Every day the things we see in the retail stores, in our homes, in newspapers, in magazines, and other sources present us with evidence that consumer electronics has changed rapidly over the past decade, is changing now, and will continue to change dramatically over at least the remainder of our lifetimes. The advances in technology, the potential for companies to profit from these new technologies, and the seemingly insatiable appetites of the public for new electronic gadgetry and the information, entertainment and convenience they provide are driving factors in all of this change.

The effect of technological change on service

Much of this change has benefited consumer electronics service centers that have had the vision to learn about the new technologies as they have been introduced. Service centers that once were suffering from the continuing decline in the demand for TV service are now thriving on service of VCRs, camcorders and microwave ovens. Yet other consumer electronics service centers have opted to take advantage of the tremendous growth of computer use by consumers and have become consultants/servicers for their customers in the areas of computer hardware and software.

The test equipment

All of the test equipment in the typical consumer electronics service center is useful in servicing the new consumer electronics. A DMM can measure voltages in a personal computer, a video game system or a cellular telephone as well as in a TV set. An oscilloscope can display a waveform in a camcorder or headphone stereo, just as well as in a home stereo amplifier.

But the consumer electronics products of new technology require that additional test equipment be added to the consumer electronic service center. Not only that, but because of the increasing complexity and variety of today's consumer electronics products, it is to the advantage of the service technician if the traditional instruments he uses feature increased functionality and ease of use offered in the latest instruments that will allow him to not only make more and more varied tests, but to concentrate on the product being tested and not on setting up or resetting, or changing the test equipment in use.

Some of the new test equipment

It's instructive, and even a little scary, to take a look at the test procedures required by the latest in consumer electronics products that were not required of the older products, and the new test equipment that makes it easier to test them.

For example, the CD player has an infrared laser pickup. Handheld remote controls for TVs, VCRs, audio equipment use infrared for transmission. Testing of all of these infrared transmitting devices is made easier using an infrared detector or laser power meter.

Thorough servicing of camcorders requires a whole host of equipment that a service center never had to have before: light box, waveform monitor, vectorscope, tension gauges and more.

Servicing of computers and peripherals also requires its own special set of test equipment and other test products: diagnostic software, logic probe and more.

More functionality in the traditional test equipment

Manufacturers of test equipment, recognizing the changing needs of service technicians and with technology and components that were not available in the past, have made their products more functional, more useful, and often, while making them easier to use, have sometimes even lowered the cost.

For example, many modern oscilloscopes offer some kind of digital readout of waveform parameters such as voltage levels, frequency and period. Some service oriented oscilloscopes offer a sync separator built in to simplify triggering on the TV video waveform.

DMMs, too, continue to become more useful, frequently smaller and lighter, and easier to use. For example, as most technicians are already aware, even inexpensive DMMs of today offer such advanced features as autoranging, diode check, frequency measurement, capacitor value measurement and more.

Some tips for this new technology

It's important to choose the right test equipment. Of utmost importance, of course, is to make sure that the test device you buy will do everything you'll need it to do. Also important is finding a test device that works the way you do, that supports the service function. The article "Choosing an oscilloscope for servicing" provides readers some food for thought when choosing a servicing instrument.

Yet to come

But these articles are only the prologue to the story that's still unfolding. Only recently we have published stories on such developing technologies as high definition TV (HDTV) as proposed by the "Grand Alliance," and the digital mirror device developed by Texas Instruments. And underway right now are actions that are expected to result in delivery of information and entertainment to homes via fiber optic cable.

We don't have any information at this time on what specialized test equipment service centers might need in order to service HDTV or to check fiber optic distribution in a home, but we'll be keeping our ears to the ground, and as it happens, we'll keep readers posted. ■

The general purpose bench oscilloscope

By Jerry Murphy

Most people who use an oscilloscope use an analog scope. There are two good reasons for this. One reason is simply that there are a lot of analog scopes in existence. The second reason is that the analog scope has performance characteristics that are well suited to the most common scope application: troubleshooting.

In order for a digital scope to be a good general purpose troubleshooting tool it must give its user superior performance at an attractive price. Recent advances in digital oscilloscope technology have allowed them to move into the troubleshooting arena. Now the choice of which scope to use is more complex.

This article will discuss the needs of the troubleshooter, and propose a set of tests that can be performed on any oscilloscope to determine its suitability to the reader's application. It will also describe how various vendor's specifications can be translated into meaningful selection criteria.

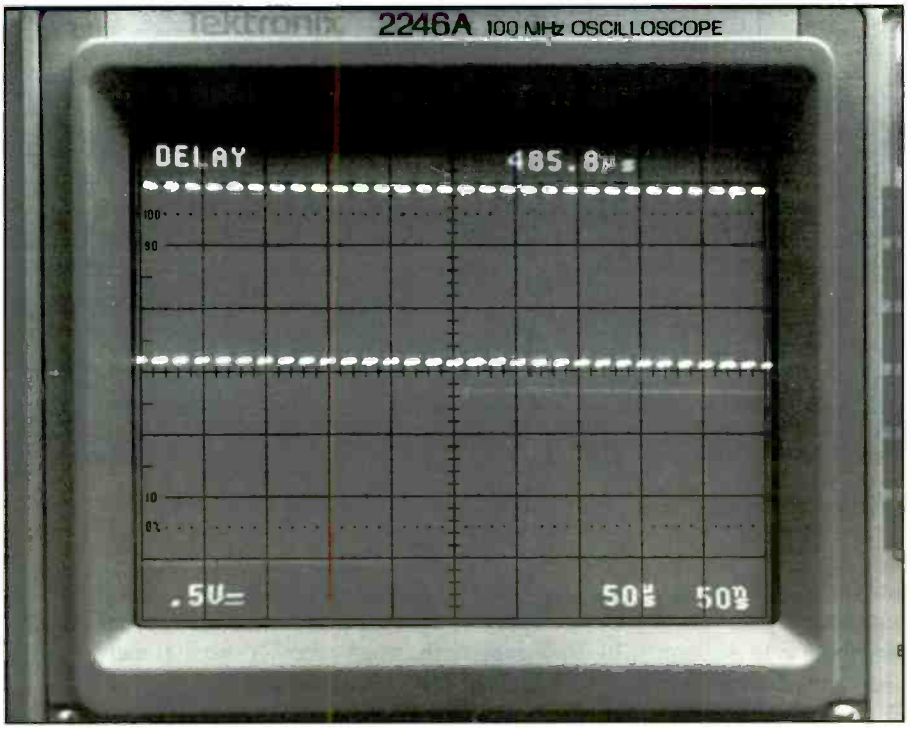

Figure 1. This is the display of a signal on an analog scope using delayed sweep.

Troubleshooting

Webster's New World Dictionary of the American Language defines troubleshooter as "the person charged with locating and eliminating the source of trouble in any flow of work." So, the troubleshooter is charged with finding the cause of problems. This could also mean that the symptom(s) of the problem are known, but the cause of the problem is always unknown.

In electronic troubleshooting the person performing the task of locating and eliminating the source of the problem usually starts with an in-depth knowledge of the system's operation. This knowledge could be supplemented with the schematic of the system, its specifications and other documentation.

The troubleshooter is searching for clues to the cause of the problem. So, in the search for the unknown, the troubleshooter must sort through many observations of the system's performance.

Murphy is a marketing engineer at Hewlett Packard Personal Measurements Operation Colorado Springs, CO

The first step in the troubleshooting process is to verify that there is, in fact, a problem. The verification of the problem could involve the use of measuring instruments to check the system under test for proper output or simply watching the display or panel lights of the device under test. If the problem is reproduced, the troubleshooter will start the search for the cause of the problem. This search is often aided with the use of electronic instruments such as a scope and DMM.

Where should troubleshooting start?

The troubleshooting process starts at a point in the system at which the troubleshooter feels it is operating correctly, and then the search spreads out into the system until a suspicious condition is observed. It is not uncommon for the troubleshooter to make observations at many points and to make a decision as to the correctness of the observation in only a few seconds.

There may be a written troubleshooting guide or (most likely) the troubleshooting procedure is present only in the troubleshooter's mind. During this process the troubleshooter's mind is focused on the circuit under test and not on the test instruments being used.

If the instrument being used is an oscilloscope the troubleshooter will simply glance at the scope's display and quickly make a judgment of the status of the circuit's operation. Is the display as expected? Does this display represent the cause of the problem or a symptom? What could be going on in the circuit to produce this display? These are some of the questions that the troubleshooter will ask as each circuit node is probed. The parameters of the suspicious signal are not known at the start of the process.

It is the skill and knowledge of the troubleshooter that is used to determine that a fault has been found. The troubleshooting process can be summarized as the application of skill and knowledge in the operation of electronic circuits to isolate and correct faults.

This process is performed in R/D labs

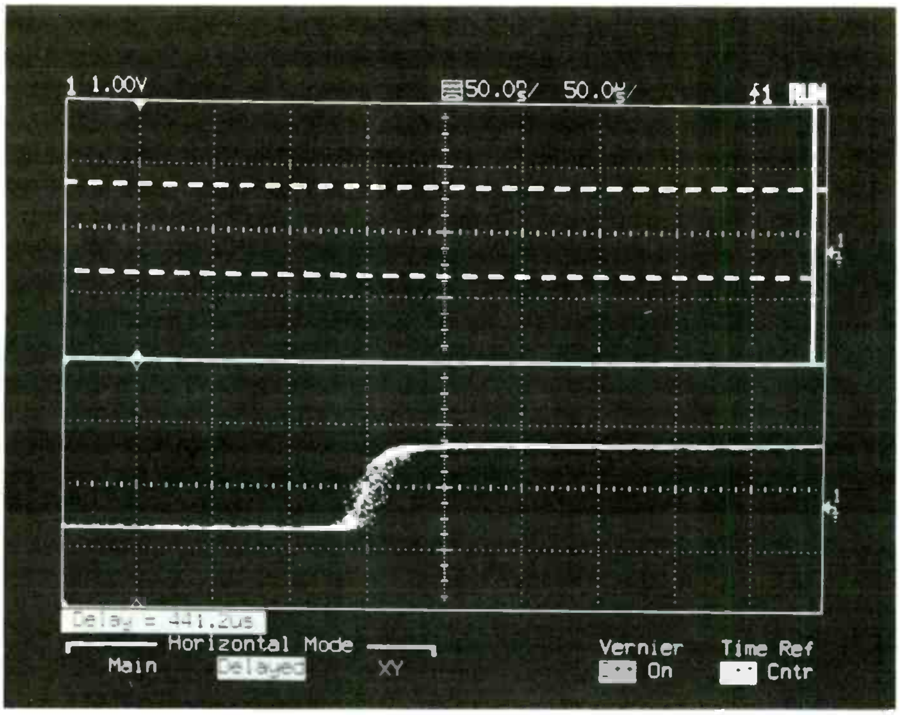

Figure 2. This is the display of a signal on a digital scope using delayed sweep.

and on production lines, as well as in customer electronics service centers. Troubleshooting is performed by R/D engineers and technicians in the development of new products, production engineers, technicians, and service technicians.

The troubleshooter's scope

Now that we have an understanding of the troubleshooting process we can establish the needs of a troubleshooter's scope. In the search for the cause of the problem, many waveforms will be viewed by the troubleshooter. These waveforms can be found at various locations in the circuit or system being tested. Input and output ports, identified test points, and circuit nodes are all places where the troubleshooter will look.

The waveforms will range from very simple, such as a power supply's dc level, to very complex control signals in a microcontroller system. The signals viewed in the process of problem isolation can range from being continuous to infrequently occurring. Sometimes the absence of a waveform at a circuit node is the clue to the solution of the problem.

When the troubleshooter places the scope probe on a circuit node, the resulting display is compared to the troubleshooter's expected result. The expected result is based on a knowledge of the circuit's design and electronic theory. For example, if a sine wave is observed at the output of a power supply's diode bridge, the troubleshooter suspects that the diode bridge is shorted.

So, the troubleshooter's scope must have a display that accurately reproduces the waveform at the probe tip. This means that the troubleshooter's scope must have a display that is free of aliases and other distortions that can be produced in the scope's conversion of the signal at the probe tip to the display. Nothing can send a troubleshooter off on a time wasting bad direction than a false or alias scope display. This means that if the waveform is changing the scope's display must follow those changes.

If the waveform is infrequently occurring, the display must be bright and clearly visible so that the troubleshooter can see the problem.

Analog scopes are good troubleshooting tools

Analog scopes continue to be used in troubleshooting applications because there are so many of them around and their direct beam vector display provides waveform viewing accuracy. When the waveform changes, that change is reflected in real time on the scope's display. This means that the analog scope's display is always alias free and correctly represents the waveform at the probe tip.

This display is not without drawbacks. At time base settings of 1ms/sec and slower the analog scope's display will be flickering. This flicker may cause eye strain and the flicker will be worse as the time base is operated at slower and slower sweep speeds (wider time windows). As the signal at the probe tip becomes more infrequent, the analog scope's display becomes dim. This can also result if delayed sweep is used to view the event of interest (Figure 1). A digital scope will always produce a bright display independent of the signal's frequency of repetition rate or the scope's time base setting (Figure 2).

The troubleshooting procedure

Because the troubleshooter's mind is focused on the problem in the circuit under test and not on the operation of the instrumentation, it helps if the troubleshooter's scope has a control panel that can be operated without having to think about it, in other words, a "minds off" front panel. "Minds off" means that the troubleshooter can make required changes in the scope's front panel without having to stop the troubleshooting thought process and think about the scope.

Often when there is a need to make a control panel change on the scope, the troubleshooter will simply grab a knob without looking at it. The knob is then tested to see if it is the desired one. This test is performed by simply moving the knob a little. If the desired result is not obtained that knob will be returned to its previous position and another knob will be grabbed and tested. Once the desired reaction is observed, the knob will be adjusted to obtain the desired result.

A scope that reacts slowly to changes to its front panel controls may cause the troubleshooter to think that the knob being tested is not the desired knob when in fact it might be. A front panel that is based on icons and menus with a minimum of knobs may not fit the troubleshooter's needs, because the troubleshooter's mind must shift focus to the menus and icons to make the desired control panel change.

Negative time triggering and automation

In some of today's systems the only stable trigger event available is at the end of the event of interest. For example, when troubleshooting a keyboard scan problem, the problem is knowing the condition of the keyboard control lines just before the key is pressed. The only trigger that can be established is the key being pressed.

A digital scope, which can look ahead of the trigger, gives the troubleshooter the ability to view the status of the keyboard before the key was pressed. This ability to look ahead of the trigger, sometimes called negative-time viewing, is an advantage for some applications of the troubleshooter's scope.

Measurement automation, that is, the numeric display of waveform parameters, can be a valuable time saving tool in troubleshooting where decisions must be made in seconds (Figure 3). Simply reading V_{pp} is much easier than counting graticule lines. Some measurements such as rise time can be made much faster and to better resolution with this feature than counting minor divisions of the graticule. Measurement automation not only saves time, but the increased accuracy can locate problems that might otherwise be overlooked.

In summary, desirable characteristics of the troubleshooter's scope include:

- bright flicker free display
- alias free display
- direct access "minds off" control panel
- instant control panel response
- negative time
- measurement automation

Oscilloscope specifications

The oscilloscope's performance specifications determine its suitability for a specific troubleshooting application. The scope's vertical system must have a wide enough bandwidth to display the highest frequency signals in the system being tested. The high frequency components of the signals in the system must be considered. For example a 50MHz clock contains components well in excess of 200 MHz. Such a signal can be viewed with a 100MHz scope but a higher fidelity display will be obtained with a 500MHz scope.

Usually a three-to-one ratio of scope bandwidth to signal speed will produce an acceptable display. For higher fidelity, a display that can show the signal's rise-time, overshoot, and other small perturbations in the signal, requires a ratio of five to one or greater.

The effects of bandwidth on the displayed waveform are usually a trade off of display fidelity and price. Higher bandwidth gives higher fidelity but at a higher price. Some people think that they need more bandwidth than they actually do. This is because high bandwidth analog scopes had more advanced CRTs with brighter displays than similar models but with lower bandwidths.

This is not true of digital models because their display is not based on driving electrons into the phosphor with great velocity. So if you're choosing a digital scope for a troubleshooting application it isn't necessary to spend extra money to buy extra bandwidth. Simply choose a bandwidth to display the fastest signal likely to be found in the system under test.

The vertical system

The vertical system needs to have enough sensitivity to produce a usable display of the smallest signal likely to be encountered. For most digital based systems, a scope with 5mV/div sensitivity will be acceptable. In analog and mixed signal systems the scope should be able to produce at least a one division high display of the smallest signal likely to be encountered.

In addition, the vertical system must have enough dynamic range so that the display won't be distorted in situations where the signal is so large that it more than fills the screen. Don't overlook the fact that a 10:1 divider probe is often used to view even the smallest signal.

Oscilloscope coupling

A selection of ac and dc coupling is required as well as the ability to limit the channel's bandwidth to minimize the display of interfering high frequency signals. In digital scopes, averaging can be used to remove noise while maintaining the channel's full bandwidth. Averaging will, however, reduce the scope's display update speed.

The troubleshooting scope needs to have a range of sweep speeds that will produce a displayed time window that covers all of the events of interest in the system under test. The narrowest window will be used to display events such as clock risetimes.

This equates to a sweep speed that is rather fast, something on the order of a few nanoseconds per division. A 100MHz scope needs a maximum sweep speed of at least 5ns/div in order to display the rise time of common TTL logic. On the other extreme the scope must have a window wide enough to display both the starts and ends of control cycles. This equates to a rather slow sweep speed, something on the order of seconds per division.

Scope triggering

Most troubleshooting scopes have a triggering system that picks the trigger point from the voltage level and slope (rising or falling) of the signal. The reason that more powerful triggering is not found in most scopes used for troubleshooting is the added complexity that comes with the added power of advanced triggering. Scopes that are designed for single shot analysis must have the advanced triggering features in order to isolate events but the troubleshooter is more interested in viewing as much waveform data as possible in the minimum time. Often the troubleshooter will be operating the scope in an untriggered mode.

When triggering is required, it must be easy to set-up and repeat. For example, a signal that requires the use of HF Reject to produce a stable display is a symptom of high-frequency interference. That interference might be caused by an external source such as a nearby FM broadcast station or coupling of a high-speed clock.

Scope performance parameters

The electrical performance needs of a troubleshooting scope can be summarized as follows:

• bandwidth at least 3x the highest frequency in the system being tested
• vertical sensitivity to produce a full division high display of the smallest signal found in the system being tested

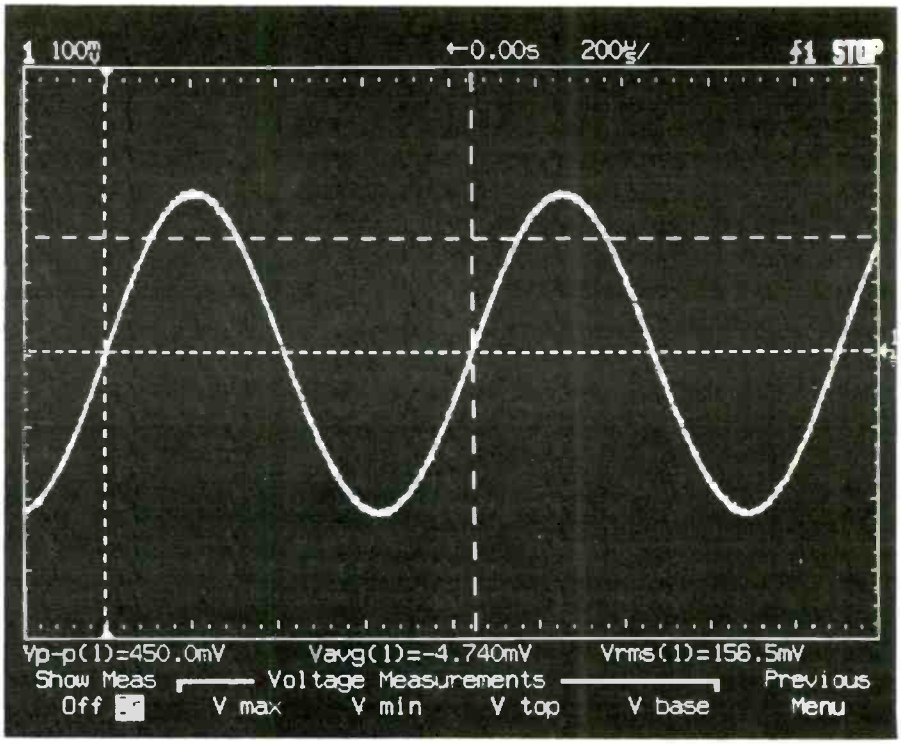

Figure 3. Measurement automation, that is, the digital display of numeric values for waveform parameters, whether on the display itself or a separate readout, can speed the troubleshooting procedure.

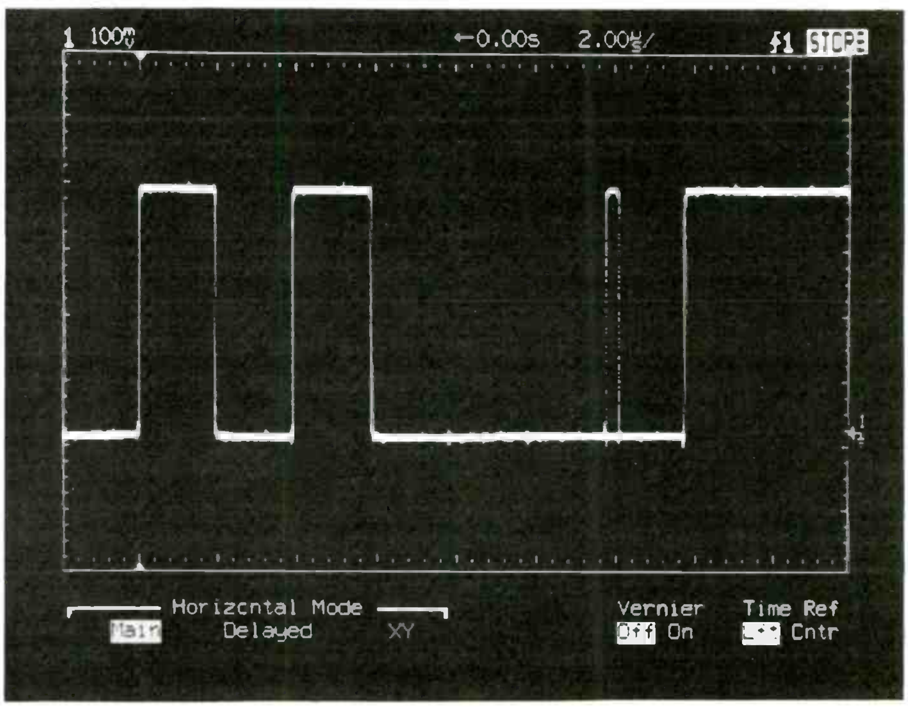

Figure 4. Acquisition dead time, also called blind time, is the scope performance factor that determines the scope's ability to capture infrequently occurring glitches.

• ac and dc coupling as well as bandwidth limit in the vertical

• fast enough sweep speed to display the rise time of critical signals

• slow enough sweep speed to display the full-time window of critical cycles and events.

• stable and repeatable triggering

Understanding banner specifications

The basic electrical performance specifications of the troubleshooting oscilloscope are easy to understand by most people who are selecting a scope. The digital oscilloscope adds two new specifications to the selection process: maximum sampling rate and memory depth.

All digital oscilloscope vendors describe their product in terms of its maximum sampling rate but no vendors provide a chart of how their product performs at less than its maximum sweep speed. The fact is that all digital scopes are based on a fixed memory depth. As a result, as the sweep speed is reduced from its maximum setting, the sampling speed must be reduced so that the memory will be filled with the full time record.

For example, a scope with a 1,000 point memory depth and a time base setting of 1ms/div must place its 1,000 data point record across a 10ms window. This means that at 1ms/div, this scope must take a sample every 1/1000ms or 1μs. This performance has no relationship to the scope's maximum sampling speed specification. That banner specification might be as fast as possible given the technology being applied by the vendor.

So the question that must be asked is not "how fast can the scope sample?," but "how fast will it sample at the sweep speed that I need to display the signals of interest in my troubleshooting application?" It can be seen from this simple example that there is a linear relationship between sampling rate and memory depth. A deeper memory scope will be able to sample faster at a given sweep speed than another scope with less memory.

A third specification that is added to the selection process with the addition of digital scopes is display update speed. How much data can the scope move from the probe tip to the display in a given time? Analog scopes connect the probe tip to the CRT phosphor screen directly. Analog scopes usually have a higher display update rate than their digital counterparts, but analog scopes don't operate without dead time. The dead time of the analog scope is caused by sweep retrace, re-arm time and trigger hold-off. These times can add up to give the analog scope a 50% display time duty cycle.

Waveform processing in digital scopes

Digital based scopes gather the waveform at the probe tip and then operate on the waveform data with a computer (or microprocessor). The resulting display is produced by the CPU operating on the data it receives from the probe tip. Oscilloscopes that are based on a single CPU don't have enough processing power to move data from the probe tip to the display in a real-time manner. Scopes like this will operate on a cycle of gather, then process, and then display the waveform data. You might compare this operation to that of a slide projector. It is easy to understand that changes in the waveform can be easily missed by such a system.

Only those digital scopes based on multiple processors have enough processing power to be able to produce real-time displays of the waveform at the probe tip. A multiple processor scope will operate so that data is gathered by an acquisition

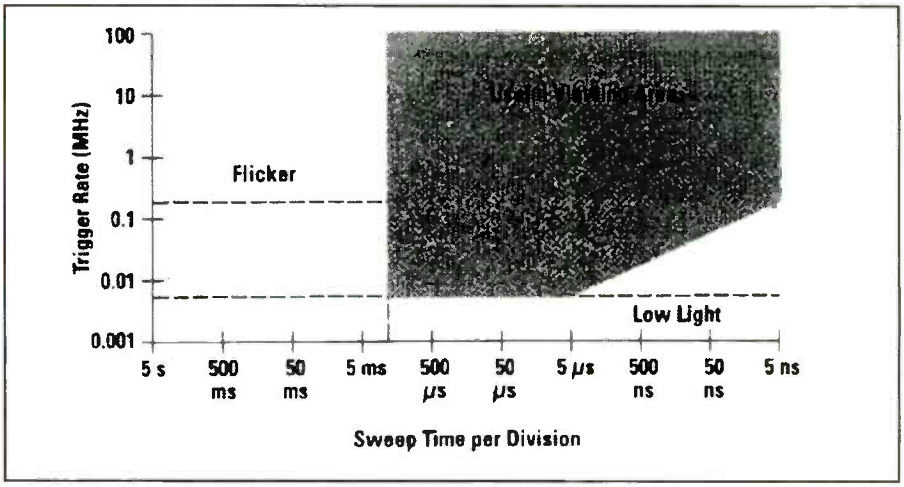

Figure 5. An analog oscilloscope is a good troubleshooting tool over a wide range of conditions. There are parts of that range, however, where the display may be dim or flicker.

processor and placed into waveform RAM. A display processor will take the data from waveform RAM and place it into the correct position in the bit map of the display. A CPU scans the front panel for control panel inputs, remote control commands, and performs software tasks such as calculations of RMS values.

Such a multiple processor system is capable of placing data on the CRT at speed limited only by the CRT's plotting speed. Such a system will be able to track changes in the waveform and it will look like a real-time analog display of the same waveform. It is possible to unload the waveform RAM so fast that there is no dead time in the process.

Capturing glitches

Acquisition dead or blind time is the performance factor that determines the scope's ability to capture infrequently occurring glitches, not maximum sampling speed (Figure 4). If the scope in question can only move small packets of data to the display in bursts of high-speed transfers with a long time to set-up to gather and transfer the next small packet, changes in the waveform will be missed. Such a scope will have a harder time capturing a randomly occurring glitch that is contained inside another waveform than another scope that has a lower maximum sampling rate but has a shorter blind time.

To evaluate a scope's ability to be a good troubleshooting tool based on its banner specifications the following questions must be asked:

- What is the sampling speed as a function of sweep speed?
- How deep is the scope's memory?
- How long is it blind in a typical acquisition cycle?

Troubleshooting scope performance tests

Are there some simple tests that can be conducted to determine how well a scope will be able to perform as a good troubleshooting tool in your lab (Figure 5)? The answer is "yes," and these tests should be added to any performance specification that you or your company might issue as a part of the purchase process. These tests should be added to the classic electrical performance tests of bandwidth, sweep speed, trigger sensitivity and accuracy. The following tests can be used as a guide to development of tests that best fit your needs.

1. *Display fidelity*: Can the oscilloscope correctly display a changing signal? The amplitude modulated carrier is a good signal for this test. Set the carrier frequency to a value well within the bandwidth of the scope, 25MHz is a good choice, and set the modulation to a level that will be easily recognized as being correct from the scope's display. Either 50 or 100% will be good choices.

Simply connect the signal generator's output to the scope and press its autoscale key. The scope will exit its autoscale routine trying to trigger on the carrier frequency. Reduce the sweep speed until at least two cycles of the modulation can be observed. You might need to raise the trigger level to near the top of the modulation to get a stable display of the waveform. Using external triggering to trigger on the modulating signal will make the triggering easier to set up.

Does the resulting display look correct? If not, the problem is either caused by a triggering problem or the scope's display system can't follow this changing signal.

Does the display slow down if an automatic measurement such as frequency or V_{pp} is selected?

2. *Display aliases*: As the scope's sweep speed is moved away from its fastest settings, will the scope display false or alaised displays?

Connect the scope's probe to the probe calibrator output and press autoscale. Does this display appear to be correct? if it does, simply reduce the sweep speed one step at a time and check that the display remains correct. Does a lower frequency display ever appear in the display? If so, this is an alias of the correct waveform and the scope in question might produce similar incorrect displays of unknown signals in your system.

3. *Control panel reaction time:* How much time does the scope require to react to a control panel change?

Connect the scope's probe to the probe calibrator output and press autoscale. If the resulting display is correct, turn the channel's position control to move the trace up one division. Does the trace move at the same time as the knob or is there a delay between your knob movement and the resulting trace movement?

Change the channel's deflection factor two settings. Again does the trace change size as the volts/division knob is being changed or is there a time lag? Perform the same test in the time axis by changing the time per division six positions. Again, does the trace change with the control or is there a time lag?

4. *Control panel operation*: How many steps must be performed to make a change in the set-up of the scope? Record the number of steps that must be followed to perform the following tasks:

While displaying two channels, move channel 1 up one division and channel 2 down one division. Steps = ________

While displaying two channels, change the trigger source from channel 1 to channel 2. Steps = ________

While running, change the display from nonstorage to storage. Steps = ________

Erase a stored display. Steps = ________

Perform a frequency measurement on the waveform being displayed on channel one. Steps = ________

The scope that requires the fewer steps to perform these common tasks will be an easier scope to use in day to day troubleshooting applications where you don't want to stop and think about the scope's control system.

Closing summary

Don't be misled by some banner specifications. Make sure that the scope you choose to be your troubleshooting tool will in fact be one that will allow you to reach your peak troubleshooting performance. Such a scope must have the electrical performance to correctly gather your most critical waveforms and display them with accuracy and fidelity that will give you the information you need to make the best decisions as to the operation of the system under test.

In addition, the scope you choose should have a front panel control system that responds instantaneously to your commands, allowing you to keep your mind focused on the circuit under test. It should also benefit you by saving you valuable test time. You won't have to stop the troubleshooting process to think about how to operate the scope. ■

ES&T READER SURVEY

Bound into this issue is the ES&T Reader Survey card. It's located on page 29.

It's a mini survey about ***you.*** We would like to hear about the problems you face, the opportunities you see and the equipment you use during the course of your work day.

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Solving VCR servo system problems

By Arthur Flavell

Servo systems are essential to producing stable, noise-free video from a VCR. Their job is to regulate the rotational speed of the cylinder and capstan motors, and to keep them synchronized with a stable reference signal. Servo problems may cause symptoms such as jitter in the picture, loss of sync, or noise bands in the reproduced video.

Servicing servo circuits in a VHS VCR requires an understanding of both circuit operation and VHS fundamentals. This discussion will familiarize you with the components of servo systems and their operation in the VHS format.

See the sidebar for an analysis of the components of the servo system of a VHS video cassette recorder.

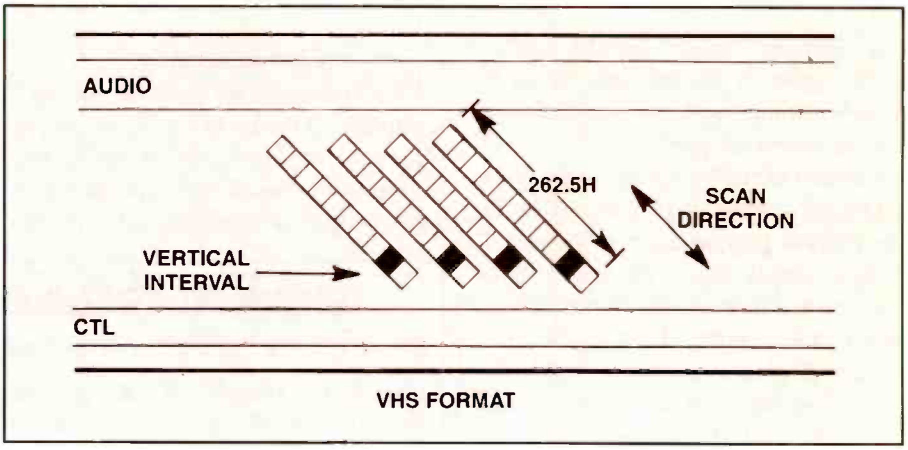


Figure 1. The VHS format uses three separate areas of the video tape on which to record and play back information: a linear track along the upper edge of the tape contains the audio information, video information on helical tracks in the center portion of the tape and a linear track along the bottom edge of the tape contains CTL, or control track, synchronizing pulses.

VHS format

The VHS format uses three separate areas of the video tape on which to record and play back information (Figure 1). A linear track along the upper edge of the tape contains the audio information. Video information is found in the center portion of the tape on helical tracks. Each track contains one field of video signal. A linear track along the bottom edge of the tape contains CTL, or control track, synchronizing pulses.

To ensure compatibility with NTSC (National Television System Committee) video systems and interchangeability with other VCRs, the timing of the signals recorded on tape must be precise and consistent. The electronic circuits of the VCR control the timing of signal generation, but constant tape velocity is necessary to maintain the timing in the finished videotape recording.

Controlling tape transport speed is the job of the capstan servo. The capstan must move the tape at a constant speed so that the audio and CTL tracks record and play back properly. It must also ensure that the video tracks are aligned under the video heads for read and write operations.

The cylinder (or drum) servo is responsible for maintaining the correct rotational speed of the drum containing the video heads. This ensures that the correct number of horizontal lines are recorded or played back on each track. In addition, it must position the heads so that read and write operations begin and end at the proper place along the track.

Servo operation during playback

In simplest terms, the servo system is a feedback loop control circuit. It senses the condition of the operating system, compares it to a reference and generates a correction signal to maintain synchronization. Operation of the servo system is slightly different in playback and record modes. Let's look at the playback function first.

The capstan servo circuit uses two comparators to control motor speed. The speed comparator compares the V SYNC and capstan FG signals. The FG signal is amplified, processed by a Schmitt trigger, and applied to the comparator. The comparator's output is used to control a pulse width modulator.

The PWM's square wave signal is fed through an integrator, which smoothes it into a dc voltage proportional to the duty cycle of the PWM output. This dc voltage is then applied to a summing amp and routed through the CAP ON switch to the capstan motor driver. If the comparator detects a slowing of the motor, the duty cycle of the PWM is increased, providing a higher dc output from the integrator and greater drive to the motor. If motor speed is too high, the duty cycle of the PWM is decreased, resulting in reduced drive.

The second comparator in the capstan circuit is the phase comparator, which acts as a fine speed adjustment. It produces an output that controls a PWM. The PWM output is processed by an integrator and applied to a summing amp, where it is combined with the signal from the speed comparator. The capstan phase comparator uses several inputs to make the fine adjustments; V Sync, the output of the tracking multivibrator, CTL and the head switching signal.

The cylinder motor servo also uses two comparators, and operates in the same manner as the capstan circuit. The cylinder speed comparator uses V Sync and the cylinder FG signal to provide coarse speed control. Fine speed control is accomplished by operation of the CYL/CAP phase comparator.

Flavell is owner of an independent consumer electronics service center in Alaska

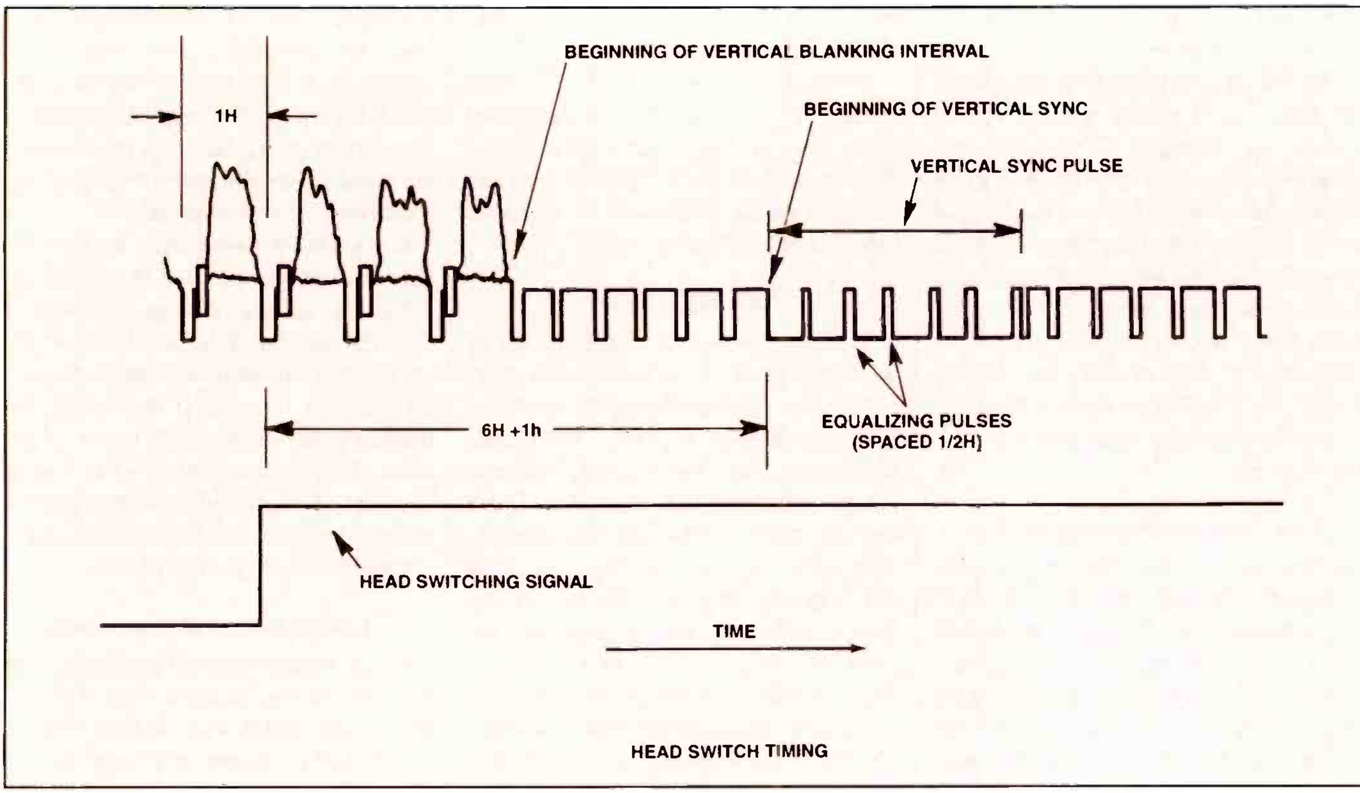


Figure 2. The head amp select circuit sends a switching signal to control operation of the playback head amplifiers, which alternately turn on and off so the signal from the head that is currently in contact with the tape is turned on. The proper timing relationship for head switching is shown here.

The H SW GEN is driven by cylinder PG pulses. The output of the generator is a 30Hz square wave which is used by several other circuits. In the playback mode, this signal supplies inputs to the CAP/CYL phase comparator, the TR MM GEN, the head amp select circuit and the V-lock gen.

The head amp select circuit sends a switching signal to control operation of the playback head amplifiers. The head amps are alternately turned on and off so the signal from the head that is currently in contact with the tape is turned on. Each head reads alternate fields of the video signal. When head switching occurs, video noise is produced. The timing of the switch from one head to the other is critical to stable picture production. Figure 2 shows the proper timing relationship.

Normal switching in the VHS format takes place 6H ±1H before the beginning of vertical sync. H is the designation for one horizontal line. This places the switching event in the overscan portion of the picture, off the bottom of the screen.

If head switching takes place too early, the switch point will be visible in the lower part of the picture. If switching takes place too late, it can interfere with reproduction of the vertical interval, resulting in vertical jitter, jumping, or loss of vertical sync altogether.

The V-lock gen provides a false vertical sync signal which is used during search mode operation. NTSC televisions or monitors can only reproduce video at a 30Hz frame rate. If the vertical signal strays too far from this figure, vertical sync is lost and the picture rolls. In search mode, vertical sync information from the video tape is not at the correct frequency and cannot be used to lock vertical scanning. The V-lock generator takes over during these periods to produce a picture that is stable.

Servo operation during record

Record operation of the servo circuits is similar to playback operation with three major differences. The first is the source of the V-Sync reference. In record mode, vertical sync information is taken from the incoming video. A sync separator and shaper circuit in the video section produces the signal.

The second difference is a change in one of the reference inputs for the CYL/CAP phase comparator. Because the tape is in the process of being recorded, no CTL signal exists to be used as a reference. The capstan FG signal is counted down to provide the necessary reference. The select switch operates to connect the FG signal to the comparator when the VCR is in record mode.

The third difference is in the CTL head circuit. When the VCR is in the record mode, the CTL amp is turned on and passes a signal from the CTL GEN which is recorded on the CTL track. At the same time, the PB ON switch opens.

Troubleshooting

Symptoms of servo troubles, such as jitter, sync problems, or noise bands in the picture, are often produced by mechanical components in the VCR. Before troubleshooting electronic circuits, be sure to check common trouble areas first. These include: dirty or blocked video heads, dirty CTL head, tape slippage caused by dirty capstan and pinch roller, or improper tape tension because of improper adjustment, dirty or worn drive belts or dried-out lubricants on the reel spindles.

The next step is to determine if the servos are malfunctioning in the playback mode, in the record mode, or both. Play a test tape and check for symptoms in the video to check the playback mode. Record a test signal and play the tape back in a known-good VCR to check the record mode. If the symptoms only appear in one mode, concentrate on the circuit elements that are exclusively related to that mode.

Determining if a symptom is caused by a capstan problem or a drum servo problem can sometimes prove difficult. A quick way to check for off-speed operation is to measure the frequency of the FG signal from each motor. The service manual contains specifications of proper signal frequency and amplitude.

If you find a discrepancy, perform the electrical alignments for the servo circuits. Depending on the age and model of the VCR, these may include: head switching position, tracking set, capstan free run and cylinder free run. If the V-Sync frequency is off in playback mode, alignment of the system control VCO may be necessary. If the trouble symptom persists after alignment, troubleshoot the servo circuits for component problems.

Troubleshoot in this sequence

Begin troubleshooting by checking supply voltages for the servo control IC and the affected motor drive. Voltages should be checked for proper amplitude and absence of noise and ripple. If problems exist, troubleshoot the power supply circuits.

Check the control inputs to the servo control IC. These include: V-Sync, tracking control, PB FM signal, CTL (in playback mode), capstan FG, PG shifter and cylinder FG/PG. These should be checked for proper amplitude, frequency and waveshape as specified in the manual. If an improper or missing signal is noted, troubleshoot the signal's source circuits.

Check the control outputs from the IC. These include: head amp select, false V-Sync, CTL (in record mode), R/S/F and the outputs of the capstan and cylinder PWMs. If all inputs are correct and faults are found in one or more outputs, isolate the defective output before concluding that the IC is at fault. To perform this check desolder the appropriate pin and check the output in an unloaded state. If the output signal is now present, check the circuit fed by that pin for faults. If the output is still not present, the control IC is defective.

If all outputs from the servo control IC appear normal, check the peripheral circuits for proper operation. These include: the integrators, sum amps, capstan and cylinder on switches, motor drivers and the motors.

Breaking the loop

Occasionally, you will find a situation where all inputs and outputs from the control IC appear to be normal and all peripheral components seem to be operating properly, yet the trouble symptom persists. This frustrating state can usually be traced to the fact that the servo system is a loop. One section of the system may be correcting in the right direction, but over-reacting. This causes the circuit to "chase its tail." To troubleshoot this type of problem, it is necessary to break the loop and observe the individual circuit elements to determine which of them is over-reacting.

A convenient spot to break the loop is the input to the motor drive circuit. Using a variable dc bench supply, apply the normal control voltage as specified in the service manual. Vary the voltage slightly above and below normal. Observe the response of the PWM outputs, the integrator outputs and the sum amp output as the motor speed changes.

VCR servo circuits are sometimes troublesome for technicians. Because of their reliability, we seldom have to deal with them and they may not be as familiar to us as other circuits. A scarcity of technical information on the servo operation also contributes to the problem. Perhaps this information will help you solve servo troubles you may encounter and reduce frustration at the bench. ■

System components

Refer to the block diagram (on page 20) of servo system elements.

Capstan motor: A direct-drive motor that rotates the capstan and produces tape motion through the VCR.

FG head: A magnetic pickup that generates a signal from the rotation of the capstan motor. The FG signal may be produced by a Hall device in some VCRs.

Capstan motor drive: An IC that uses low-level inputs to control drive power to the motor.

Cap on: A solid-state switch operated by the system control circuit. It provides on/off control of the capstan motor.

R/S/F: An output that controls the direction of capstan rotation for different modes of operation (Reverse, Stop and Forward).

Sum amp: An IC op-amp that adds two dc input signals into one output.

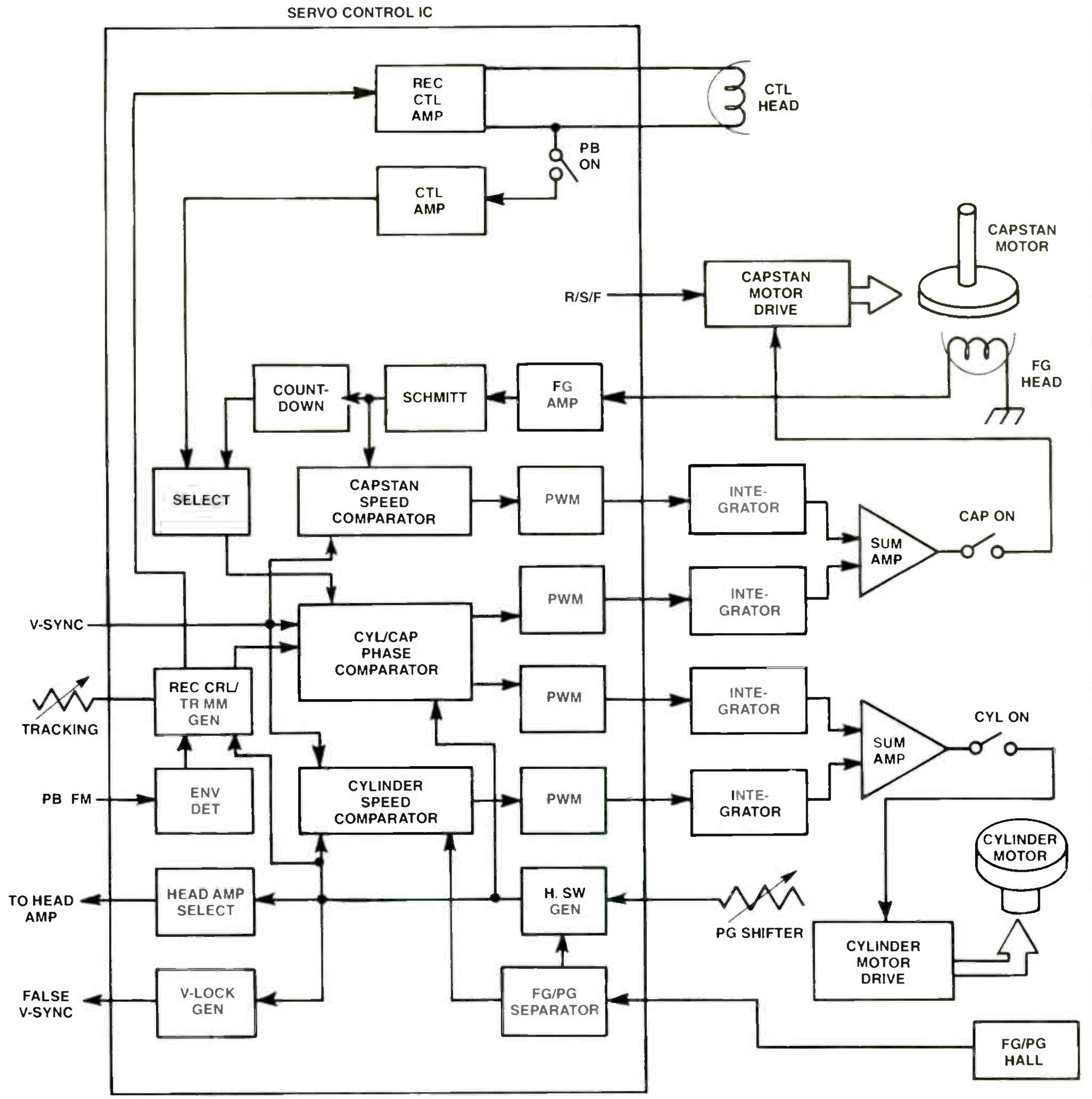
Integrator: A circuit that converts a square wave input into a dc output which is proportional to the duty cycle of the input signal.

Cylinder motor: A direct-drive motor that rotates the video head drum.

Cylinder motor driver: An IC that uses low-level inputs to control drive power to the motor.

FG/PG Hall IC: A Hall-effect IC that produces signals that result from the rotation of the cylinder motor. FG is the *field-generator* signal and PG is the *pulse generator* signal.

FG/PG separator: Separates the lower frequency PG pulses from the combined FG signal.



This block diagram ilustrates the components that make up the VHS VCR servo system.

PG shifter: Controls the timing of the PG signal applied to the head switch generator. The PG shifter determines the position of head switching in relation to the vertical sync signal.

CTL head: A magnetic head that reads control track pulses during playback and records them during record mode operation. CTL pulses occur at the TV frame rate or 29.97Hz. (This frequency is often rounded to 30Hz for convenience sake.)

Servo control IC: Contains the circuits for signal processing, comparison and control of the external components. It may be an independent IC or a portion of the system control IC.

REC CTL amp: Amplifies the CTL signal for recording.

PB on: An electronic switch that routes the playback CTL signal to the CTL amp.

CTL amp: Amplifies the playback CTL signal.

FG amp: Amplifies the FG signal from the capstan.

Schmitt trigger: A trigger circuit that shapes the FG signal into pulses.

Countdown: A circuit that counts the FG pulses down to frame rate.

Select: An electronic switch that couples the playback CTL through in playback mode and the counted-down FG pulses through in record mode.

Capstan speed comparator: A circuit that compares FG pulses and the V sync signal. The output is a dc control signal proportional to the timing of the two input signals. It provides coarse speed control of the capstan motor.

PWM: Pulse width modulator. A multivibrator circuit that produces a square wave output. Under normal operating conditions, the duty cycle of the output is 50%. Varying the control input above and below the normal level causes the duty cycle to vary above and below 50%.

CYL/CAP phase comparator: A circuit that uses several control inputs to produce a dc control signal output. This circuit provides fine speed control for both capstan and cylinder motors.

Cylinder speed comparator: A circuit that uses V SYNC and cylinder FG signals to produce a dc control output. This circuit provides coarse speed control for the cylinder motor.

V sync: Vertical sync, an input that provides the reference signal for the servo system. In playback mode, vertical sync is supplied by a crystal-controlled clock generator in the system control circuit. During record operations, it is provided by the vertical sync signals of the video signal being recorded.

REC CTL/TR MM GEN: A multivibrator oscillator that produces CTL pulses in record mode and a tracking pulse signal during playback.

Tracking: An operator control that varies the output of the tracking multivibrator. The servo system has a limited range over which it can make speed corrections. The tracking control places the circuit within those limits.

PB FM: The playback FM signal is taken from the playback head amplifier. It is used together with the head switching signal to provide fine control of the tracking generator.

ENV det: The envelope detector isolates the individual head outputs from the RF FM head signal.

H SW gen: A multivibrator circuit operating at frame rate which supplies a square wave output for head switching and other control functions.

HEAD amp select: A buffer amplifier that provides ON/OFF switching for the record or playback head amp channels.

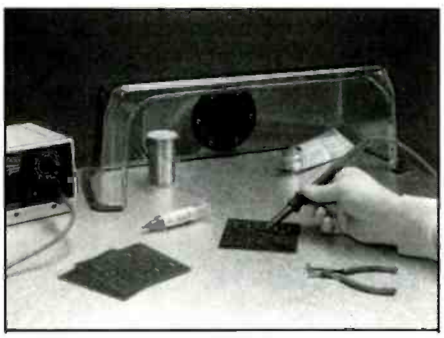
V-lock gen: A buffer and shaping amp that generates the FALSE V-SYNC signal used to keep the on-screen video locked vertically during forward and reverse high-speed search functions.

Ruggedized DMMs

A.W. Sperry Instruments, Inc. announces its new line of ruggedized DMMs, DM-7A, DM-8A, DM-9A, DM-10, DM-11 and DM-12.

This new series of economically priced DMMs are ergonomically contoured for the hand and include features such as analog bar graphs, auto-off, and data hold. All of these models have voltage protection, audible continuity, diode test, logic test, direct temperature, capacitance, phase indication, overload protection on all ranges, electronic burnout protection on ohms and continuity to 500V, current ranges to 10A ac/dc.

Circle (90) on Reply Card



Fume extraction plenum accessory

Pace has introduced its High Vac Fume Extraction Plenum designed to capture harmful fumes in the workplace. The Plenum, when connected to the company's central filtration unit, effectively removes fumes over a large working area and filters out contaminants so that cleaned air can be recirculated back into the working environment. This accessory is made from clear polycarbonate plastic for complete operator visibility and can be easily positioned on the tabletop or permanently mounted with four fastening screws.

Circle (91) on Reply Card

DMMs feature top-mount inputs

Top panel-mounted safety-input sockets, large 4000 count LCDs and "auto-select" of ac and dc modes are some of the functions found among six new DMMs from *HC Protek*.

Hand-held and powered by two "AAA" batteries, the DMMs are available in two styles: the models 121, 122 and 123 which incorporate a standard rotary switch function selector; and the models 221, 222 and 223 which use a "thumb-wheel" type function selector for single hand operation.

The models 121/221 test ac and dc voltage, current, resistance and LEDs. Other features include data hold and overload display.

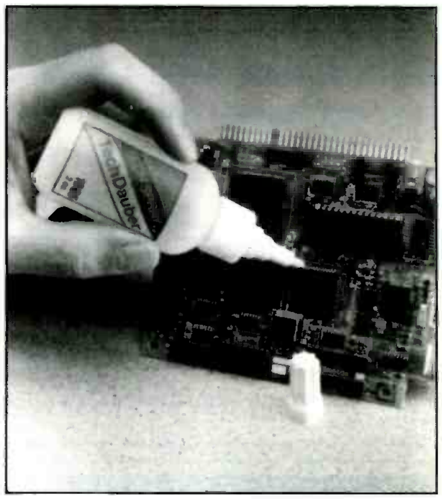
Models 122/222 feature "Easy Select" ac/dc. These automatically select and display the dominant ac or dc component of the input. Other functions include: auto ranging with bar graph, frequency, resistance, continuity testing, auto power off, data hold and diode testing.

Models 123/223 provide professionals with a variety of features, including auto ranging with bar graph; ampere warning; relative set; mode select; continuity; data hold; auto power off; diode testing; ADP (Adaptor).

Circle (92) on Reply Card

Dispenser for spot cleaning

Tech Spray, Inc. has introduced a convenient dispensing unit for use in spot cleaning applications where accuracy is a must.



The small, two-ounce bottle is topped with a sponge-like tip. When the TechDauber is inverted and dabbed on the spot to be cleaned, solvent is released.

The dispenser fits easily into crowded work areas and tool boxes, making it excellent for rework and repair stations.

Customers can buy liquid solvents in bulk and use the refillable unit. Because it is reusable, the product has the potential of reducing waste.

The dauber is recommended for use with alcohols, such as isopropyl alcohol and other light solvents.

Circle (93) on Reply Card

Non-ozone-depleting parts cleaner

Officials of *CRC Industries, Inc.* have announced the development of CRC Electrical Parts Cleaner, a unique new heavy duty cleaner and degreaser created as a replacement for electrical parts cleaners which have been eliminated due to the latest environmental regulations.

According to the manufacturer, this cleaner has completely eliminated ozone-depleting chemicals without sac-

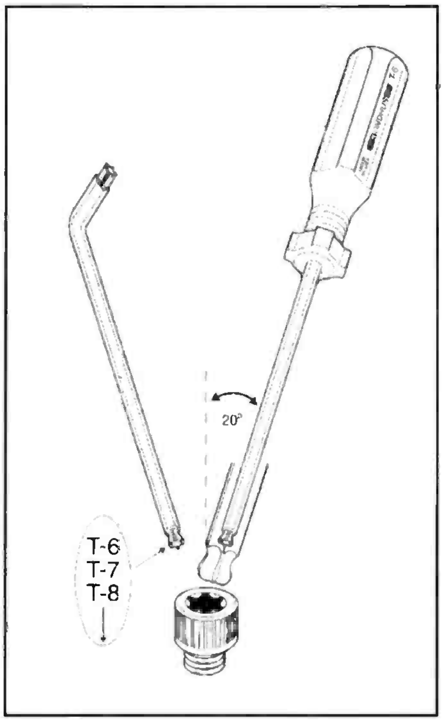
rificing cleaning power or performance. It evaporates rapidly, leaving no residue, and is environmentally sensitive, containing no CFCs or 1,1,1.

The cleaner can be used for the effective removal of grease, oil, dirt and other contaminants from motors, motor control devices, transformers, insulators, compressors, relays, switches, generators, fusible disconnecting devices, circuits, tools, and other general equipment and parts.

Circle (94) on Reply Card

Smaller ballpoint star tools

Star recessed screws, such as Torx brand screws, used to hold carbide inserts in cutting tools and also found in electronic equipment, can now easily be removed with the new sizes of BallStar



tools that are manufactured by *Bondhus Corporation*.

The patented star shaped tool has the ability of reaching screws from an angle. Even in blind locations the tool slides easily into the socket without having to "feel" for it and the screws can be fastened while the tool is tilted up to 20°.

The inclination achieved permits access to screws without having to disassemble components that interfere when using a straight, conventional tool.

Circle (95) on Reply Card

VCR service information

Howard W. Sams & Company announces that it has once again engineered and released VCRfacts.

Designed by the engineers and editors of PHOTOFACT, VCRfacts features both electronic and mechanical information arranged in the company's standardized format. The goal is to provide service dealers and technicians with reasonably priced service information that is needed for timely and cost-effective VCR repairs.

Each folder covers several makes and models. Features include: the company's complete, consistent standard-notation schematics drawn by circuit board, electronic parts list detailed for each board, mechanical alignment information with exact placement of gears and gear assemblies, extensive exploded views from several perspectives, mechanical parts list, waveforms, voltages, IC functions, schematic diagrams with cabling notations, grid locator, and grid call-outs.

In addition, a new interconnect wiring diagram system illustrates wiring design, the signal and voltage path between the boards, plug numbers of a board, and the schematic page that shows that particular connector.

Circle (96) on Reply Card

Help desk software

Astea International announces PowerHelp, its new help desk software solution which features research and problem solving capabilities.

PowerHelp gives customer support representatives the ability to customize the software to their individual needs. With PowerHelp, support specialists can capture, analyze, route and resolve customer calls in sophisticated help desk environments with unmatched event management speed and flexibility. PowerHelp combines advanced technical features with operating simplicity allowing help desk personnel to be more effective without requiring additional training. Advanced knowledge-based capabilities are at the heart of the system and come in the form of case-based reasoning, technical notes, question scripts or bug tracking as well as rule-based tools, such as decision trees.

Circle (97) on Reply Card

Insulated screwdrivers

Insulated screwdrivers available from *Jensen Tools* have been individually tested at 10,000V and are certified at 1000Vac/1500Vdc. They are made in Germany to meet the rigid requirements of German VDE Standard 0680/Part 2 and are so marked DIN 7437/38. The insulation is molded onto high-grade Vanadium steel blades, and permanently attached to shock-resistant handles.

The drivers are available in a seven-piece set containing four slotted drivers (1/8 x 3 inches, 1/8 x 4 inches, 3/16 x 5 inches, 1/4 x 6 inches) and three Phillips drivers (#0 x 2 1/2 inches, #1 x 3 inches, #2 x 4 inches).

Circle (98) on Reply Card

Understanding the RS232(C) Serial Interface

By Gregory W. Jones Jr.

Most personal computers (PCs) have a serial communications port, which allows the PC to communicate with modems, other PCs, peripherals and data communications equipment. Communication among the widest variety of these devices requires a standard. This recommended standard, the RS232 for domestic applications, and the RS232(C), developed by the EIA in 1969, defines the serial communications interface for connecting data terminal equipments (DTE) and data communications equipments (DCE).

RS232(C) defines the control, monitoring, and timing of serial data signals and their levels as they should appear on each of the 25 circuits (pins) of the interface. The International Telephone and Telegraph Consultative Committee's (CCITT) standard V24, for European applications, also defines the control, monitoring, and timing of serial data signals and their levels as they should appear on each of the twenty-five circuits pins of the interface, but this article will concern itself with the EIA RS232 Interface Standard.

This article explores RS232(C), discusses timing, control and data signals, and then explains how the signals are used to establish communications. There is also a brief discussion of some of the methods through which analog and digital troubleshooting can be performed on an inoperative serial communications line, and a glossary.

While a detailed knowledge of RS232 is not absolutely essential for a computer service technician, familarity with RS232 is useful for those who may find themselves dealing with serial data transmission problems.

The serial/parallel question

Internally, most processors and peripherals transfer a word or character of data at a time. That is, the total number of bits which the device recognizes as a single character or word are transferred simultaneously over a parallel data path. The size of the circuit's data path, usually referred to as its data bus width, depends

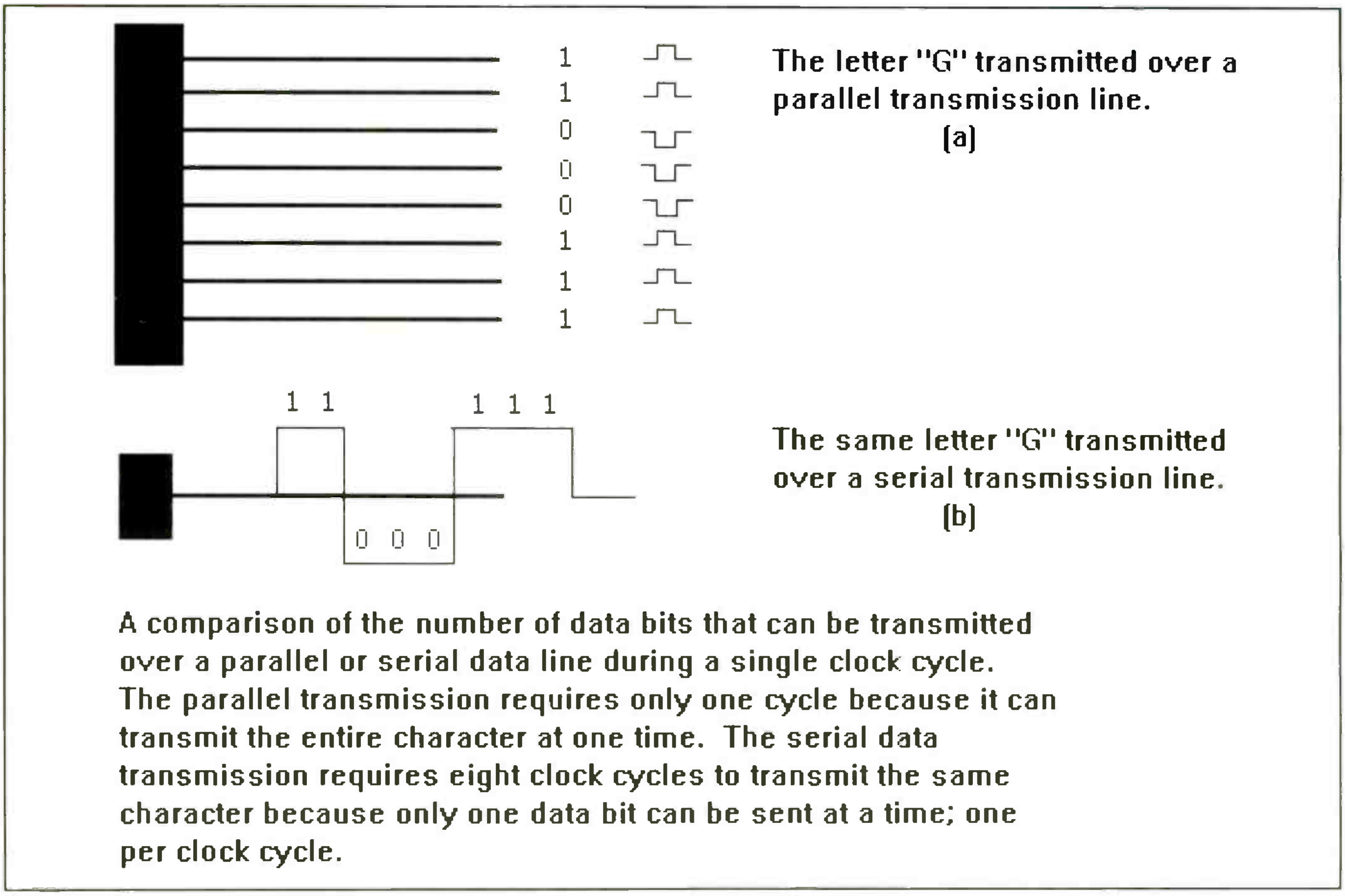
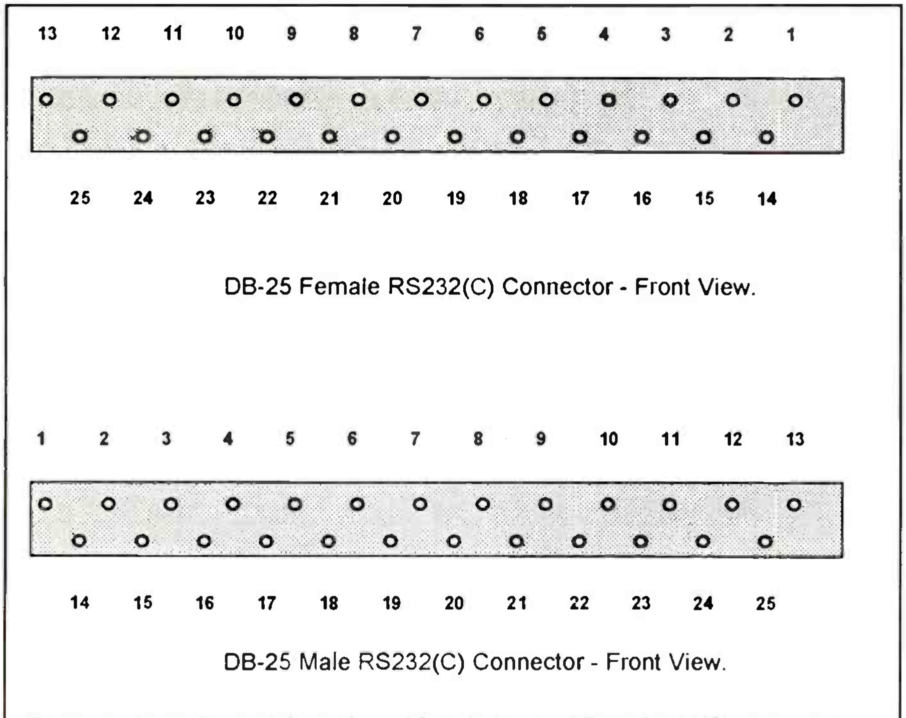
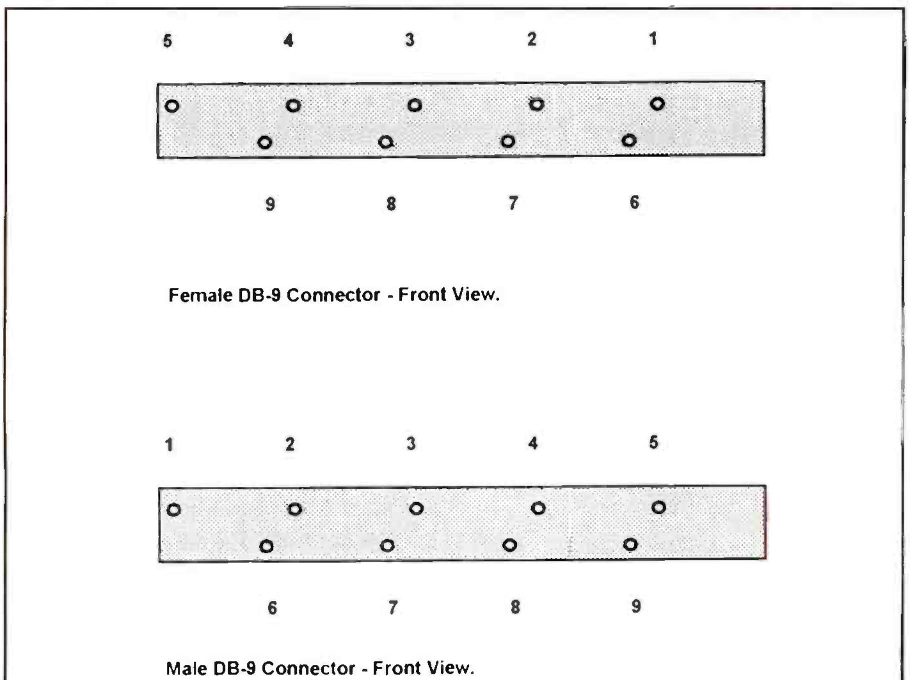


Figure 1. In parallel data transmission, all bits of a computer word are sent simultaneously over a data bus. In serial data transmission, bits are sent one at a time and then assembled into data words at the receiving end.



These are front views of the male and female 25-pin (DB-25 Rs232(C) connector.

Figure 2. Pin numbering for RS232(C) connectors.



These are front views of the male and female 9-pin DB-9 (IBM-PC/AT) RS232(C) connector.

Figure 3. Some PC manufacturers are using 9-pin RS232(C) connectors as their RS232(C) serial communications port.

upon the manufacturer's design and can be either 8, 16, 32 or 64 bits wide. Figure 1A shows an eight-bit parallel bus for the transfer of data between devices. A simple piece of flat ribbon cable is an example of a parallel bus.

In this illustration, the letter "G" is being transmitted. Each of the eight wires is carrying one of the eight bits required to represent the letter "G". All eight bits are transmitted simultaneously during a single transmit clock cycle. If this same peripheral or processor wishes to communicate with some external device, it might, because of distances or hardware types, have to transmit the data in serial fashion; one bit at a time.

Look now at Figure 1B, which shows the same character "G" being transmitted to a serial device such as a modem, serial line-printer, bar-code reader, or any other I/O device which requires a serial communications interface. Notice that each bit on a serial line must be transmitted one at a time. Each time the line is toggled on, a "high" appears and remains until the end of the clock-cycle. In this example, the highs and lows are functions of time and thus the stream of bits represents several consecutive "ons and offs" over a period of several clock-cycles.

Notice that the first two bits, (1,1) are generated by holding the line high for two clock cycles. This requires that strict timing and control synchronization be maintained between the sending and receiving devices so that the receiving device can properly interpret and disassemble the serial bit-stream into usable character data. The device must know where, within the bit stream, a character begins and where it ends so that the bits don't get all "bunched up" into an unintelligible stream of garble. Timing and control of the serial bit-stream between a DCE and DTE is managed by the signals exchanged across the timing and control circuits of the RS232 interface, all of which are discussed in detail later.

Mechanical specifications

The mechanical specification states that the RS232 female 25-pin connector (Figure 2) shall be mounted on the data communications equipment (DCE) and that there shall be a male 25-pin connector mounted on the data terminal equipment (DTE). This is the suggestion made by the EIA, but in reality, you will find yourself interfacing devices which may both have male and female plugs. There are many different manufacturers of the RS232 connector and the packaging of these connectors will vary (within reason) between manufacturers. Some PC manufacturers are using 9-pin RS232 connectors as their RS232 serial communications port (Figure 3).

Electrical specifications

The RS232 interface provides two

channels; a primary channel or signal path for the exchange of data, and a secondary, lower speed channel for backup communications, maintenance, quality control and signaling. Many hardware manufacturers choose not to implement the secondary channel with their products.

The bandwidth of the data channel (circuits BA/BB) is about 4KHz wide and the frequency range of the signals on the channel will vary between 500Hz and 3300Hz. The EIA's recommended implementation of the primary and secondary channels are shown in Figures 4 and 5.

The dc signals that appear on any of the pins must be bipolar low voltages, and they must not be greater than ±25Vdc. The region between ±3Vdc is the level at which the transition from "on" to "off" takes place. Figure 6 illustrates the association between the different signal states and the transition between states. When the distance between devices is 50 feet or more, line-drivers must be used to maintain the required signal levels.

As you know, dc signals, especially low-level dc signals, are susceptible to line loss due to the resistance associated with dc transmission lines. Assume that a +10V signal is required to represent a "high." If signal line losses cause us to receive only 4V or 5V, this could represent a loss of a bit of data. The result of such a loss of signal integrity would cause the data received over such a path to be distorted and useless. The line driver: a dc amplifier installed in series with the line between the DCE and DCT, boosts the input dc signal to its proper level, before it reaches the intended device.

The RS232 standard was written prior to the advent of transistor-transistor logic (TTL) and so the voltage levels on the interface are not compatible with TTL. While the accepted supply voltage value (Vc) for most TTL is 5Vdc, with a 5% tolerance of 250mVdc, the levels found on the RS232 interface may vary from -25Vdc to +25Vdc.

Jones/RS232

RS232(C) Serial Interface Primary Channel Connections

Category	Circuit Designator	Pin Number	Circuit Description
GROUNDS			
	AA	1	Protective Ground
	AB	7	Signal Ground
DATA SIGNALS	BA	2	Transmitted Data
	BB	3	Received Data
CONTROL SIGNALS	CA (RTS)	4	Request To Send
	CB (CTS)	5	Clear To Send
	CC (DSR)	6	Data Set Ready
	CD (DTR)	20	Data Terminal Ready
	CE	22	Ring Indicator
	CF	8	Carrier Detect
	CG	21	Modulation Detect
	CH	23*	Speed Select
	CI	23*	Speed Select
TIMING SIGNALS	DA	24	External Transmit Clock
	DB	15	Transmit Clock
	DC	17	Receive Clock
OTHER	Reserved	9	POS DC Test Voltage
	Reserved	10	NEG DC Test Voltage
	Reserved	11	Unassigned
	Reserved	18	Unassigned
	Reserved	25	Busy

Figure 4. RS232(C) serial interface primary channel circuits.

Circuit types and definitions

The signal types found on the RS232 serial interface primary and secondary channels have been sub-categorized into types, "A" thru "E", as described in the text that follows. The signals which are on circuits BB, CB, CC, CE, and CF travel from the DCE to the DTE while those on circuits BA, CA, and CD travel from DTE to DCE. The control signals govern the operation and timing of the transmit and receive data circuits.

Type A: Grounds

• **AA (Pin 1):** Protective (frame or chassis) ground.

This is the circuit or conductor used to electrically bond all frames, chassis, and metallic cabinets so that there is a zero difference in voltage between them. This circuit may sometimes be attached to earth ground.

• **AB (Pin 7):** Signal ground.

Circuit AB is the signal (common return) ground which provides the ±0Vdc reference point for all of the other interface circuits except AA. At times, this circuit may be "strapped" to circuit AA, depending upon the application.

Type B: Data signals

• **BA (Pin 2):** Transmit data.

Circuit BA is the circuit that carries the data from the DTE to the DCE for digital-to-analog conversion and subsequent transmission over the telecommunications link. This circuit will not be activated unless the request to send (RTS, ckt CA); clear to send (CTS, ckt CB), data set ready (DSR, ckt CC); and data terminal ready (DTR, ckt CD) circuits have been enabled with a "high." BA is held in a "mark" condition until those four circuits have been enabled and also during the interval between characters during the transmission of data.

• **BB (Pin 3):** Received data.

Circuit BB carries signals received across the channel from the DCE to the

Category	Circuit Designator	Pin Number	Circuit Description
GROUNDS			
	AA	1	Protective Ground
	AB	7	Signal Ground
DATA SIGNALS	SBA	14	Sec Transmitted Data
	SBB	16	Sec Received Data
CONTROL SIGNAL	SCA (RTS	19	Sec Request To Send
	SCB (CTS	13	Sec Clear To Send
	SCF	12	Sec Carrier Detect

Figure 5. RS232(C) serial interface secondary channel circuits.

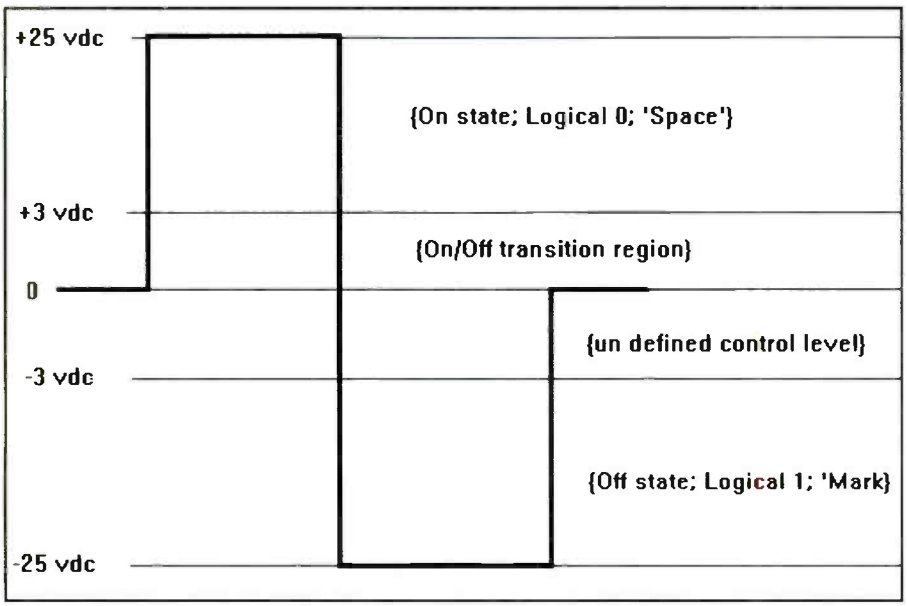


Figure 6. RS232(C) uses these voltage values to define the "on" and "off" data states.

DTE. This circuit is in the mark state as long as circuit CF (carrier detect) is off.

Type C: Control signals

• **CA (Pin 4):** Request to send (RTS). This circuit carries the signal from the DTE which instructs the DCE to go into transmit mode. The DCE then cycles through a series of routines and then responds to the DTE by enabling the clear to send circuit (CTS, CB).

• **CB (Pin 5):** Clear to send (CTS). When the DCE is ready to receive data, the clear to send signal is sent to the DTE over circuit CB in response to the DTE's request to send (RTS). If CA (request to send) is on and CC (data set ready, or DSR) is on, then the clear to send signal will be enabled.

• **CC (Pin 6):** Data set ready (DSR). Data set ready is a status indicator used to determine when the local data set/modem is connected to the communications channel, and when all timing and signalling functions have been completed.

• **CD (Pin 20):** Data terminal ready (DTR). Indicates that the data terminal equipment is ready to transmit and receive data.

• **CF (Pin 8):** Carrier detect. Indicates that a useful signal is being received on the channel. If this is in the off state the received data circuit (BB) is disabled and placed in the mark state.

• **CG (Pin 21):** Signal quality control. When this signal is in the off condition, there is a high probability of an error on the received-data circuit (CB). In some sophisticated data communications networks this circuit is often used to implement error detection and correction.

• **CH/CI (Pin 23):** Data rate selector. This is a bidirectional circuit which is used to select and sense different data signaling rates. Toggling this signal "on" selects the next higher signaling rate. When the highest signal rate is reached, the next "toggle" resets it back to the lowest and then the process may be repeated if desired. The toggling is accomplished by setting the circuit to high.

Type D: Timing Signals

• **DA (Pin 24):** External transmit clock. Provides transmit timing information from the DTE to the DCE, with the transition period from on to off being the center of each bit transmitted.

• **DB (Pin 15):** Transmit clock signal. Furnishes the transmit timing signal from the DCE to the DTE, with the transitions of transmitted signal elements from high-to-low-to-high occurring at the same time as the transition of DB from its off-to-on state.

• **DD (Pin 17):** Receiver timing clock. The DCE uses this circuit to provide receiver signal timing for signals received on the received data circuit (BB).

Type E: Miscellaneous (reserved)

The following circuits are reserved or carry the specified signals:

• Pin 9: Positive dc test voltage,
• Pin 10: Negative dc test voltage,
• Pin 11: Unassigned,
• Pin 18: Unassigned,
• Pin 25: Busy.

Establishing communications

RS232 provides a means for monitoring, controlling, and timing the signal states on the RS232C serial interface. These states are:

• The on-hook or wait state, during which time the interface is inactive;

• The control-state, during which there is an exchange of control signals for establishing or terminating communications;

Pin	Circuit	Direction To	Remarks
1	Ground	bi-directional	Provides electrical common ground for DCE
			and DTE devices.
2	TD	DCE	Transmitted data from DTE to DCE
3	RD	DTE	Received data from DCE to DTE
4	RTS	DCE	Request to send; goes high when terminal
			is able to send.
5	CTS	DTE	Clear to send; goes high when DTE on the
			other end of the link is ready to receive.
6	DSR	DTE	Data Set Ready; goes high when DCE is
			ready to receive data.
7	Signal Ground	bi-directional	Provides signal ground return for all data
			signals.
8	CD	DTE	Carrier Detect; goes high when connection
			has been made to another DTE.
20	DTR	DCE	Data Terminal Ready; goes high when the DTE
			is on and ready to communicate. Sending DTE
			low usually caused the modem to disconnect
			from the phone line.
22	RI	DTE	Ring Indicator; goes high when telephone ring
			signal is detected.

Table 1. Common RS232(C) serial communications connections and direction of signal flow.

• The data-transmission/data-reception state, during which time data is actually being exchanged across the interface.

The following summarizes the way in which the DCE device utilizes these signals to establish, maintain, and terminate serial communications:

1. At the local or calling end of the network, an operator either dials the telephone number or enters commands directly at a terminal. In some cases, the central processor at an installation may, during the processing of data, initiate the call through a special hardware-software interface. Whatever the calling method, it causes the local DTE to generate a request to send on CA which then causes the DCE to place a data tone (referred to as F1) on the data line.

2. The remote or called DCE responds to the incoming tone (F1) by enabling the ring indicator circuit (CE) and then passes the incoming RTS to the called DTE. The called DTE then turns on data set ready (CC). At 1.5 seconds after enabling DSR, the called DCE begins a count in milliseconds. At 150msec after enabling DSR it sends a data tone (referred to as F2) out on the line. At 150msec after F1 has started, the receive data circuit BB is taken off hold (mark) and control is transferred to the DTE. At 250msec later, clear to send, (CTS) on circuit CB, is enabled and then carrier detect is enabled. Transmitted data circuit BA is then taken off mark and control of the circuit passed to the called DTE.

3. The local or calling DCE receives the F2 signal and is placed in the data mode either manually when the operator presses the "data" button on the data set, or automatically if auto-call features are in effect. This causes the local data set ready circuit (CC) to be enabled. At 150msec after receipt of an F2 signal, the called DCE enables the received data circuit (BB), then passes control to the called DTE. If DSR has been enabled for 1.5sec, the called DCE counts another 265msec and then enables CTS on circuit CB as well as carrier detect circuit CF, which is turned on by the local or calling DCE. Signal F1 is turned off, and control of transmit data circuit BA is passed to the calling DTE.

When both the called and calling DCE's have passed control of circuits BA and BB to their respective DTE's, a "handshaking sequence" is initiated which, interpreted as an "ok-to-communicate," causes a series of acknowledge-

(Continued on page 41)

Logic State		DC HIGH	DC LOW
DC Voltage Levels		-25 to -3 vdc	+3 to +25 vdc
Control Circuit Signals	Binary Value	1	0
	Signal Type	Mark	Space
Control Circuit Status		off	on

Table 2

RS232 bi-polar voltage levels. Positive high levels usually refer to signals on the Control Circuits while circuits BA and BB usually have negative high logic.

Table 2. RS232(C) Voltage level to signal state relationship.

ment (ACK) signals to be exchanged between the called and calling systems and the transfer of data commences.

Terminating communications

After the exchange of data has taken place and the connection is to be terminated, the following sequence takes place:

1. The local DTE disables the data terminal ready (CD) circuit, causing the transmitted-data circuit (BA) to go high, which is interpreted as a space.
2. The remote DTE disables data set ready (DSR) circuit (CC), clear-to-send (CB) and carrier detect (CF).
3. The local DTE disables data set ready (DSR) circuit (CC), clear-to-send (CB) and carrier detect (CF).
4. Both devices are now in the on-hook or mark-hold (wait) state.

RS232 signal flow

Although the standard defines 25 circuits for use in serial communications, the common 25-pin DB25 male and female connectors are not part of the standard, which has resulted in the inclusion by manufacturers of 9-pin and 15-pin RS 232 serial ports on their devices. Of those 25, only 10 are required for most applications. Those 10 circuits and the signal flow on them are illustrated in Table 1, although for most applications only 10 of the 25 are actually required.

Some RS232(C) applications notes

Despite the EIA's efforts to standardize the serial interface, its implementation varies from vendor to vendor. This causes considerable difficulty for first-timers attempting to configure systems for home and business use. Another consideration is the relationship between signal levels and logic states. Take a look at Table 2. A binary or logic 1 should be represented by signal voltages within the range of -25Vdc to -3Vdc, and a logic 0 should be represented by voltages falling within the +3Vdc to +25Vdc range.

In reality, however, this rule of "negative-high" logic more often than not applies only to circuits BA and BB on pins 2 and 3, while the other signals on the interface are actually "positive-high." This is one of the many reasons that you must read the equipment manuals to determine the types of signals required or supplied by the device's serial communications port. This is especially true if you intend to implement *handshaking* protocols.

Handshaking is a means by which a receiving device may control the flow of data being sent to it. However, this must be done with care, because the RS232 interface was not originally intended to be used for handshaking between a DCE and DTE, but rather between the DTE and the line itself. For example, if you look at pin 4, request to send, and pin 5, clear to send, you might get the impression that all you have to do is switch them on and off in synchronism with each other to control the flow of data between two devices.

However, this is not the case. If you turn off clear to send, thinking to keep it off until our receiver is ready to receive more data, you would really be placing your DCE in mark-hold, making it necessary to re-establish the communications link.

Pin	Circuit
1	CD
2	RD
3	TD
4	DTR
5	SG
6	DSR
7	RTS
8	CTS
9	RI

Table 3. The IBM PC/AT implements RS232(C) as shown here. The IBM PC/AT implementation of RS232(C) uses the 9-pin (DB-9) connector as its serial communications port.

This led to the development of software handshaking protocols and hardware handshaking circuits and also to devices to work around these problems.

Software handshaking is achieved by communications software which embeds control characters in the data that it sends across the line. The receiving device has software which reads the control characters and knows when to receive, when to wait, etc. Hardware handshaking involves the use of RS232 control circuits, most commonly DST, RTS, and CTS, to control signal flow. Hardware handshaking is most often accomplished through the proper wiring of the data communications cables that connect the devices.

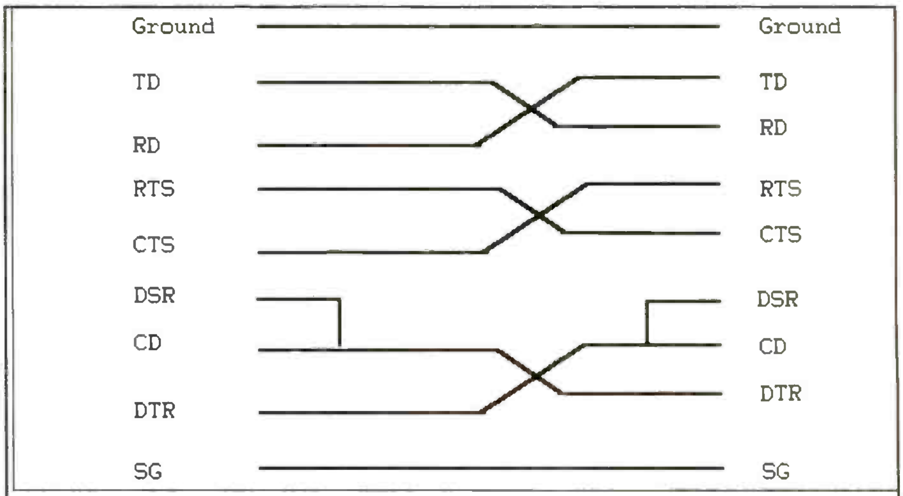
Using a modem eliminator

A *modem eliminator cable* (also known as a null modem or modem bypass) is useful when connecting terminals to terminals or computers to computers. It uses the control signal generated by one local circuit to emulate the control signal expected by another local circuit. As mentioned before, the RS232 standard was originally developed for DTE to DCE communications.

When DTE to DTE, terminal to terminal communications began, a means had to be developed whereby both devices thought they were communicating through a DCE, hence the modem eliminator, a cable which has been configured to use signals generated by the DTE to take the place of those that it would normally receive from a DCE and vice versa.

In operation, signals that normally flow from the local DCE to the local DTE are emulated by taking signals available on the DTE's RS232 port and routing them back to the circuits which require input levels. For example, RTS on circuit CA can be shunted over to circuit CB where it will function as a valid CTS signal.

Figure 7 shows a typical modem elim-



When connecting DCE to DCE or DTE to DTE, a "Null Modem" or "Modem Eliminator Cable" is useful because it allows the devices to emulate signals they would receive under normal DTE/DCE conditions. The above diagram shows such a cable with more control circuits than you will probably really need. It will handle most situation that you are likely to run into.

Figure 7. A "null modem", or "modem eliminator cable," allows connection from data terminal equipment to data terminal equipment, or data communication equipment to data communication equipment.

inator cable. Although it's called a modem eliminator cable, the easiest way to construct one is to use a male and female RS232 25-pin connector, with hoods, inside of which you can do your wiring and cross connects. To use it just insert it in series with the RS232 cables of the DTE/DCE device you wish to connect.

We spoke earlier of the different ways in which RS232C has been implemented. One case in point, the IBM PC/AT, incorporates 9 of the 25 circuits into its RS-232(C) serial port, and provides the nine-pin RS232 connector as the interface. The AT's Serial Communications Port is illustrated in Table 3. You can see how the lack of standardization of pin numbering can be quite confusing when trying to relate the serial port to the standard. *Again, you must read the manufacturer's manual in order to determine that company's implementation of the RS232 Standard.* The circuits are standard, not the pin numbers or connector type upon which they appear.

Troubleshooting the interface

The process of troubleshooting is a method of systematic checks and tests used to isolate a problem in order to determine the best course of action toward restoration of communications. By performing these tests you will be more likely to call the right person for the job to be done, i.e. the carrier representative responsible for your network lines, the vendor responsible for the hardware or software or, in a lot of instances, you will determine that the operator pushed the wrong button.

There are two parts to data communications troubleshooting; analog testing and digital testing. Analog testing is performed on the telephone side of the network to determine whether or not the network side of the link including the carrier's equipment is at fault. Here you can test for such things as phase jitter, delay distortion, impulse noise and loss of signal levels to name a few. These are the types of network that affect data reception at the receiving DTE.

Troubleshooting and isolating these "analog-side" problems can be initiated at your location under the direction of the responsible carrier authorities; the local telephone company, long distance or value added network (VAN) carriers. Many of the 212A compatible modems have provisions for analog and digital testing and when used in conjunction with analog testing devices can indicate what the source of a problem might be. A deciBel meter may also be used to measure signal levels on the analog side of the line and an oscilloscope can be used to check waveforms for distortion on both the analog and digital side.

Digital testing is used to determine the source of in-house problems which show up between the local DCE and DTE devices. One of the simplest pieces of test equipment for digital side testing is the RS232 breakout box. The RS232 breakout box gives a visual indication of the signal status of each of the interface's 25 pins. It also provides a means of cross-connecting circuits and can be used for pre-installation checks of cables. You can also use a DMM or oscilloscope to check that dc signal levels are within the ± 3Vdc to ±25Vdc range and properly timed.

A data line monitor, on the other hand gives you the ability to monitor the actual control, timing and data signals traveling across the network. Some data line monitors are capable of complete emulation of a DTE, enabling them to be used for comprehensive diagnostic testing.

Another piece of diagnostic equipment, the response time analyzer is useful in checking the overall response time on polled, multidropped, or local area networks where each node has its own recognizable address. Taken as the time between a polling interrupt and an ACK or NACK answerback, response time can be measured on all of the nodes in a network to determine the location of loss in overall response time.

Although there are many more pieces of electronic test equipment and diagnostic software that can be used to troubleshoot the interface between DTE and DCE it is beyond the scope of this article to discuss them. The point here was to familiarize you with some of the options available to you for troubleshooting your communications network. For the most part, any problems you run across will be easily diagnosed through the proper use of the RS232 breakout box which you can use to check cables and RS232 I/O ports.

Glossary of terms

Asynchronous: Often referred to as start-stop transmission because transmission is made one character at a time, with a start bit sent at the beginning of the group of bits which make up the character, and a stop bit sent after the last bit has been transmitted.

Bipolar voltage: A dc voltage that contains both positive and negative components as measured above and below the zero reference point.

Bit: The most elemental unit with which to represent data. The bit, an abbreviation for "binary digit," has only two possible states; either "on" or "off".

Bit-error-rate: The ratio of the total bits received in error to the total bits transmitted. It is expressed as a power of ten when used to define the maximum allowable bit-error-rate for a given data-communications transmission path.

Bus: Path over which digital signals may flow. A parallel bus is a set of simultaneous signal paths grouped together according to their function; i.e. a "data bus" as opposed to an "address bus." A 32-bit address bus would use 32 wires to transmit 32 bits at the same time.

Carrier: The organization that provides the send/receive path for data transmission are called carriers. Examples of carriers include AT&T, MCI, GE-TELENET, and SPRINT. The electronic signal which is modulated by the digital data signals sent over a telecommunications network is also called a carrier.

CCITT: The International Consultative Committee on Telephone and Telegraph. This European counterpart to the EIA is responsible for international communications applications, and its committee members are representatives of European communications carriers and postal telephone service authorities.

Data communications equipment (DCE): This term is used to indicate any of the various pieces of equipment used to transmit data in its analog state, over a communications channel. This includes modems, multiplexers, port concentrators, etc. The DCE takes the digital signal from the DTE, performs a digital-to-analog signal conversion and then transmits the signal. When receiving, the DCE performs an analog-to-digital conversion and then sends it to the DTE.

Data terminal equipment (DTE): A DTE can be a CRT terminal, computer, printer, remote sensor, or any device that transmits or receives digital data to or from a DCE. The DTE sends digital signals to the DCE for digital-to-analog conversion and transmission. It also receives digital data produced by the DCE from incoming analog signals.

Delay distortion: The analog signal on a data communications line is composed of many different frequencies. As tolerances vary along its length, the transmission line becomes less resonant or responsive to certain frequencies and more reso nant to others. When this occurs, some parts of the data signal fail to reach the destination at the same time as other parts of the signal, causing the overall signal to be distorted because of the delay. This distortion is called delay distortion.

Electronics Industry Association (EIA): An American trade association which specifies and publishes various standards such as those which govern the interface of computers and communications equipment in North America.

Handshaking: A means by which a receiving device may control the flow of data being sent to it. The term handshaking applies to the process of establishing timing and control synchronization between devices. Handshaking may be accomplished with hardware, software, or a combination of both.

Impulse noise: The result of signals radiated by unfiltered electronic or electromechanical equipment being operated near unshielded data communications equipment.

Line driver: A dc amplifier, installed in series with the line between the DCE and DCT to boost the input dc signal to its proper level.

Modem: This is usually required for data communications between digital devices. The term modem is a contraction of the words *modulation* (the process of superimposing information upon a carrier signal for transmission) and *demodulation* (the detection and separation of that information from the carrier signal at the receiving end). This process is used to convert digital square-wave signals into analog signals for transmission over communications channels such as telephone lines. See also the definition that is found under "universal asynchronous receiver transmitter (UART)."

Modem eliminator: A cable that has been configured to use signals generated by the DTE to take the place of those that it would normally receive from a DCE and vice versa.

Parallel transmission: All of the bits which make up the computer's "word" are transmitted simultaneously.

Peripheral equipment: Equipment which is part of the system but not physically part of the central processing unit. Examples include printers, terminals, disk drives, CRTs.

Phase jitter: Momentary instability of phase relationship between direction and amplitude of a signal on the communications transmission line.

Protocol: This term is often used to define the rules or sequence of events which must be followed to establish communications between devices.

Receive Clock: A timing pulse generated at a certain frequency upon which the events related to the reception of data bits can be synchronized. See discussion on "Putting it all together."

Serial transmission: Bipolar, bit-by-bit transmission of data over a single line.

Transmit clock: A timing pulse generated at a certain frequency upon which the events related to the transmission of data bits can be synchronized. See discussion on "Putting it all together."

Synchronous: Synchronous data transmissions are made without any intervals between characters with timing generated by the local and remote DCE's.

Universal asynchronous receiver transmitter (UART): The UART is that part of the modem that allows DTE devices to communicate with each other over serial data lines. This device, the heart of the modem performs the digital-to-analog and analog-to-digital conversions of data signals. Located between the serial I/O port and the parallel data bus within the device, it also performs serial to parallel conversions and parallel to serial conversions.

Word: A pre-defined group of bits make a computer word (each computer "word" actually represents a character). Expressed in multiples of 8 bits each, a word can be 8, 16 and with the introduction of new technology 32 bits wide.

Recommended Reading

The Distributed System Environment; Some Practical Approaches
Grayce M. Booth
Copyright 1981 McGraw-Hill

Modern Data Processors and Systems
Donald Eadie
Copyright 1971 Prentice-Hall

Data Communications; Facilities, Networks and Systems Design
Dixon R. Doll
Copyright 1978 John Wiley & Sons Inc.

Data Communications; A User's Handbook
RACAL The Electronics Group
18500-004 25M881
Racal-Vadic 222 Caspian Drive
Sunnyvale California 94086.
408-744-0810

Guidebook to Data Communications
Copyright 1977 Hewlett Packard Inc.

Telecommunications System Engineering; Analog and Digital Network Design
Copyright 1980 John Wiley & Sons.

Design and Analysis of Computer Communications Networks
Copyright 1980 McGraw-Hill.

Status Report on New Standards for DTE/DCE Interface Protocols
Harold C. Folts
National Communications System
Copyright 1979 IEEE "Computer"

Electronics Engineers' Handbook pages 23-76 to 23-82 Second Edition
Donald G. Fink; Donald Christiansen
Copyright 1982, 1975 McGraw-Hill.

Microprocessors from Chips to Systems
3rd Edition
Rodnay Zaks
Copyright 1980 Sybex Inc.

Readout and tape loading problems in RCA/Hitachi/ Sears VCRs

By Victor Meeldijk

The VCRs that were manufactured by Hitachi about eight years ago often have failed clock/readout displays. The display itself is usually not the problem, although with age it does get dimmer. This problem is usually caused by the failure of the dc/dc converter, which provides 24V for the display.

This converter is located on a vertically-mounted circuit board, called the UHF-VHF (or U-V) *tuning circuit board*, located behind the display circuit board (Figure 1). To remove this circuit board you may have to push a plastic latch out of the way (Figure 2) and disconnect some cables from a "circuit trap" (Figure 3).

This is not a two-piece connector but a connector that clamps the cable wires. The wires are released by pushing the outside of the connector toward the circuit board. While holding the connector in, pull out the cable. The cable can be reinserted without releasing the cable trap.

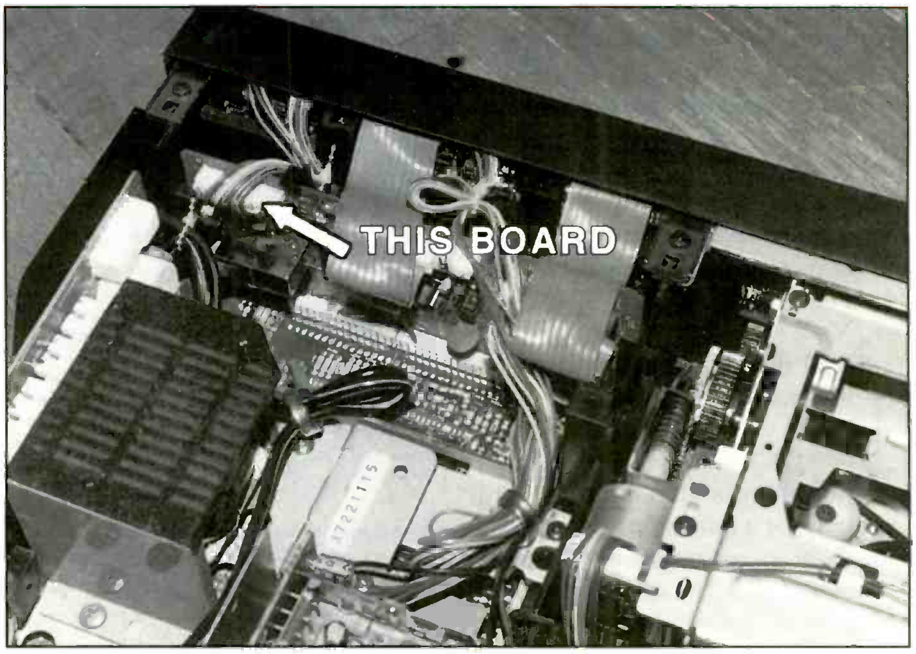


Figure 1. The UHF-VHF (or U-V) tuning circuit board which contains the dc/dc converter that provides clock/display power is located behind the clock/display circuit board.

Models with discrete components

In older models, which use discrete components (Figures 4 and 5), a failed digital transistor Q803 (type DTC124F RCA part number 157959), electrolytic capacitors C805 (100μF, 25V; open circuited) and C807 (10μF, 16V; changed value) are commonly found. There is also a semiconductor fuse, ZD801, (marked N5S, RCA 147464, also NTE 615P) that may have opened.

Other parts that may fail are electrolytic capacitors C803 (47μF, 50V), C806 (100μF, 35V), and switching transistor Q804 (type 2SD1266 RCA part number

Meeldijk is the Reliability/Maintainability Engineering Manager Diagnostic/Retrieval systems, Inc. Oakland, NJ.

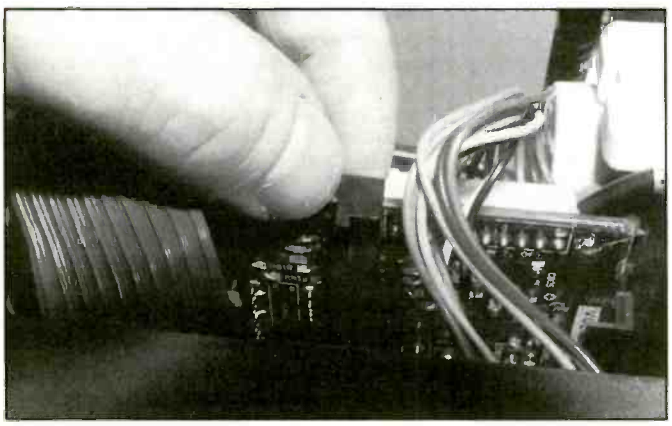


Figure 2. You may have to push a plastic latch out of the way before the UHF-VHF (or U-V) tuning circuit board can be removed.

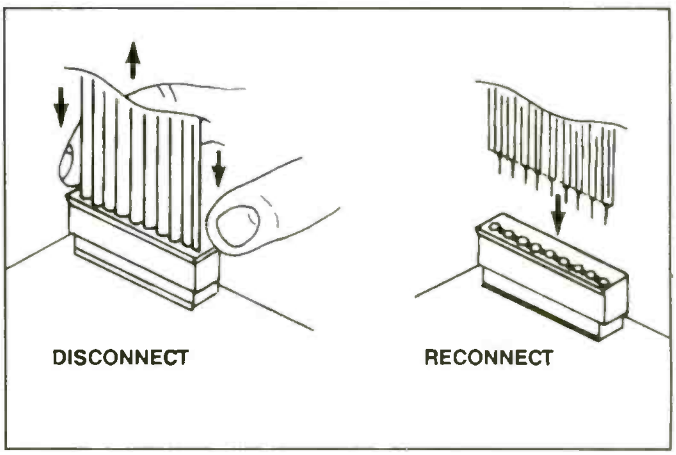


Figure 3. Disconnecting cables from a "circuit trap."

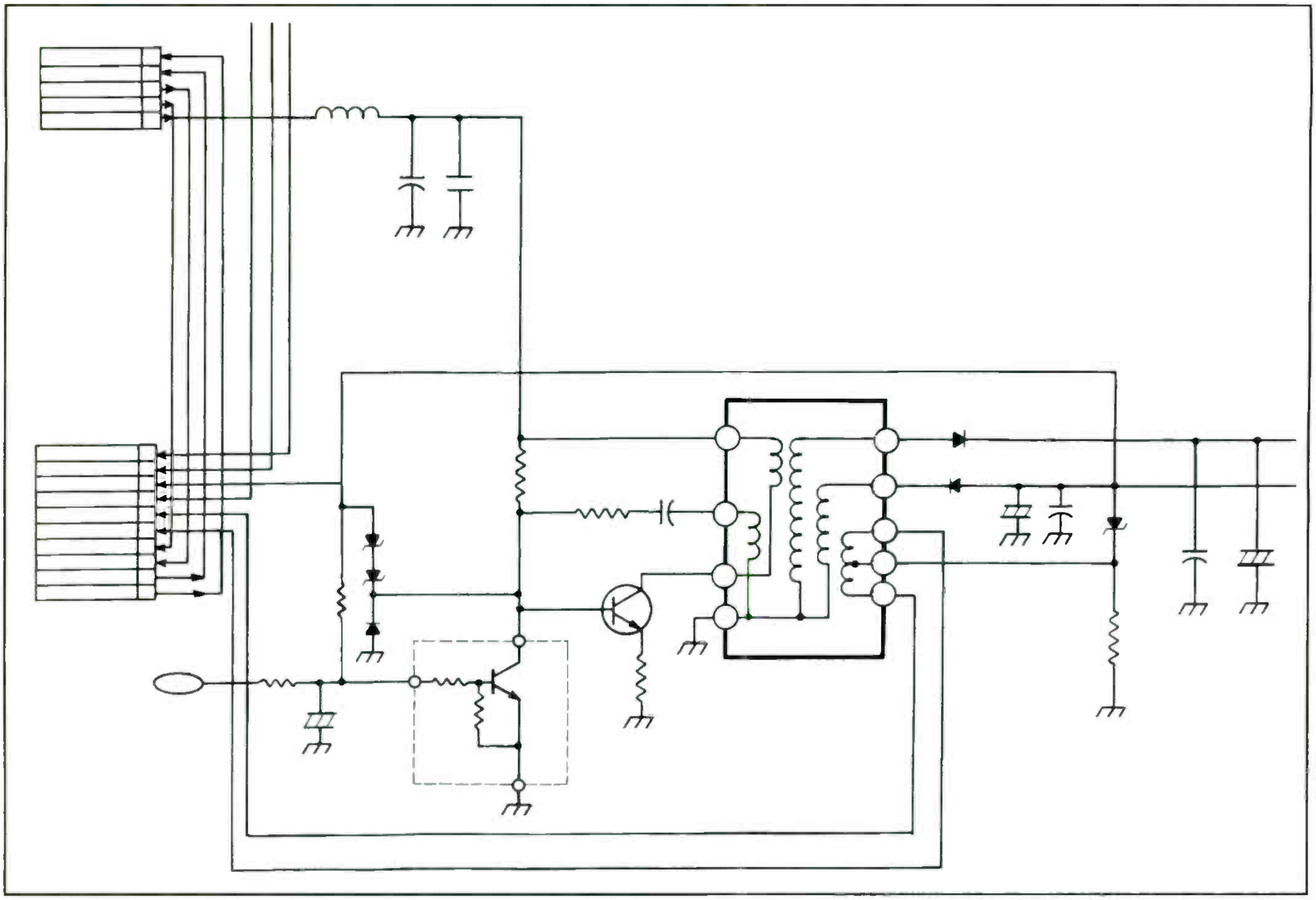


Figure 4. A schematic diagram of an older model VCR that uses discrete components in the dc/dc converter.

164231). Other parts that should be checked are the diodes, fuses, IC and power transformer in the VCR power supply section.

The semiconductor fuse looks like a TO-92 transistor with two leads, but sometimes the third lead (of the lead frame which is not connected internally) can be seen shorted to one of the other leads. A replacement device measures as a short circuit when checked with an ohmmeter.

There may also be an open winding in the switching coil L802, (Figure 6) (RCA 164232). While this part is still available as a replacement item, you may be able to repair the defective coil. If you remove the metal cover of the transformer, using a thin flat blade screwdriver to pry around the base of the part (Figure 7), you may find that the break in the winding is right at a terminal pin. If that is the case, using

Figure 5. The discrete component dc/dc converter.

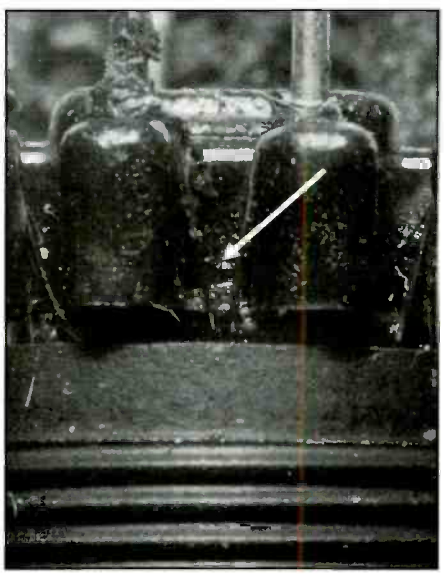


Figure 6. An open winding in the switching coil, L802.

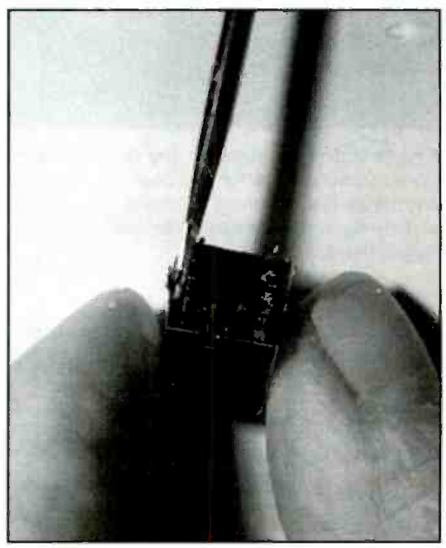


Figure 7. Use a thin blade flat screwdriver to pry around the base of the coil to free it from the metal shield.

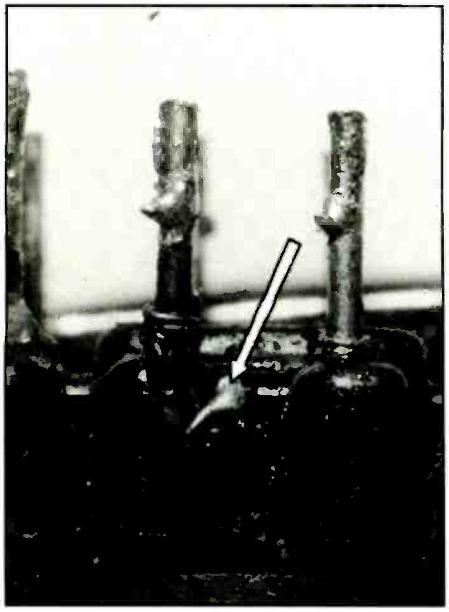


Figure 8. The coil shown in Figure 6 after the repair.

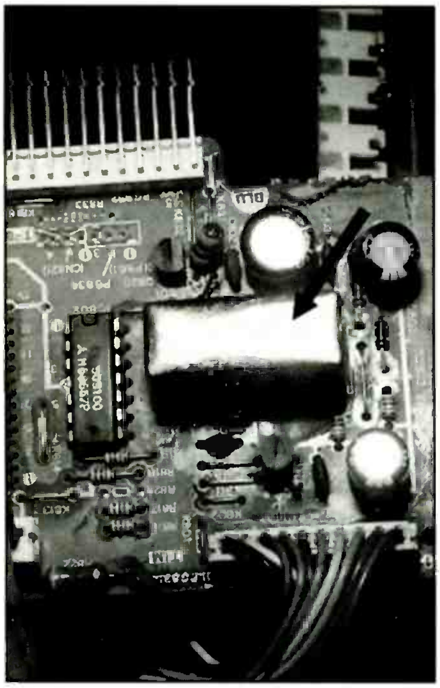


Figure 9. In later designs, the discrete component dc/dc converter has been replaced by a module. Replacement modules have a heat sink on top to improve heat dissipation and reduce failures of this part.

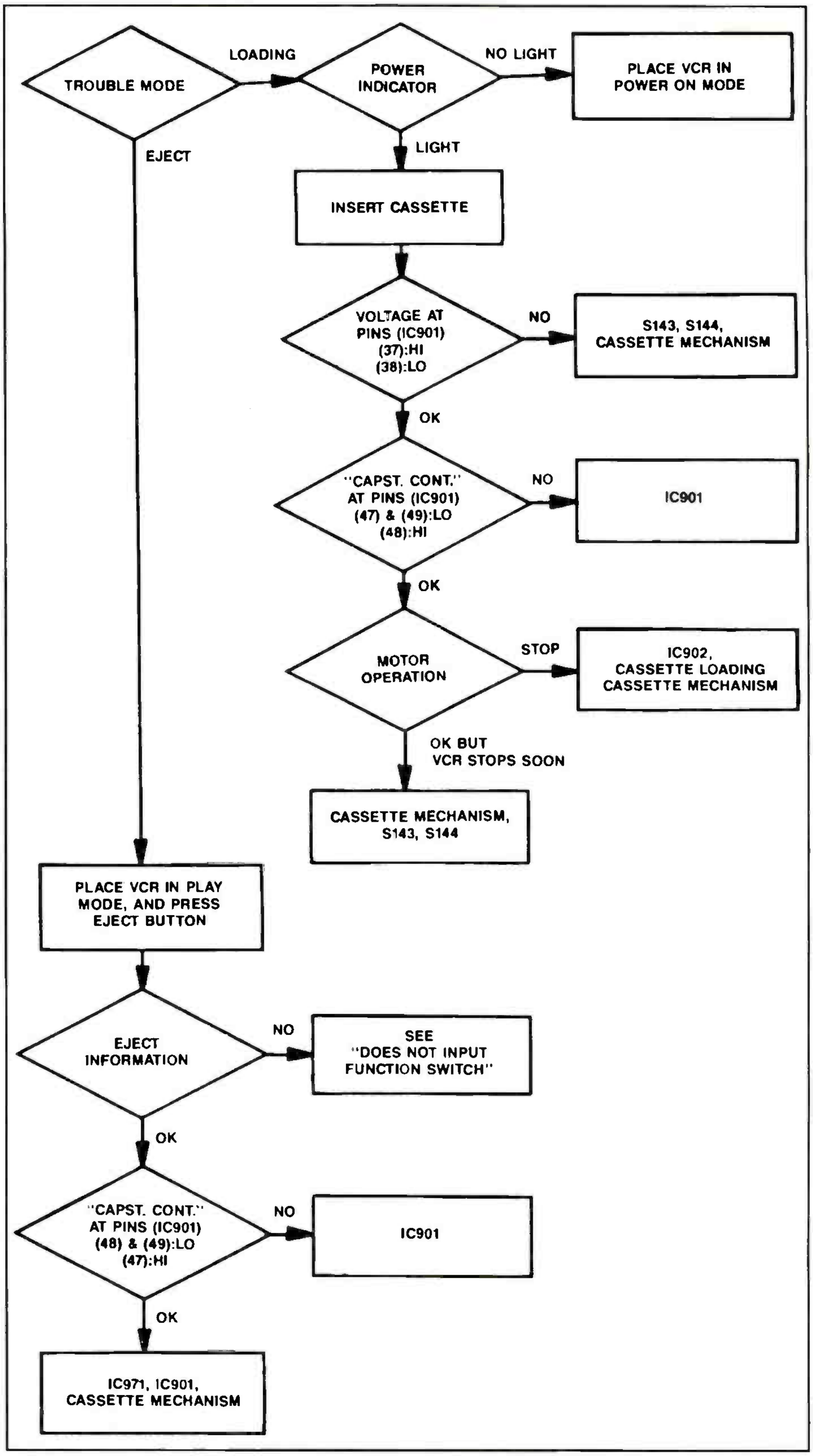


Figure 10. The cassette loading mechanism troubleshooting chart from the RCA VLT 600-603 manual.

a fine piece of wire, such as a single strand from a 22 gauge wire, you can bridge the gap between the winding and the pin.

Using a magnifying glass and a pair of pointed tweezers, make a small "J" shaped hook in the exposed transformer winding, do not pull on the wire while doing this as you can easily break it. Then make a similar "J" hook in the bridging wire. Hook the wires together and secure them with solder. The other end of the bridge wire can then be wrapped around the terminal pin and soldered in place. This procedure should take about 20 minutes. Figure 8 shows the repaired coil.

In later designs, the discrete component dc/dc converter has been replaced by a module, as in Figure 9. Many replacement part vendors sell a dc/dc converter repair kit (RCA 163818, Hitachi 5262063) that

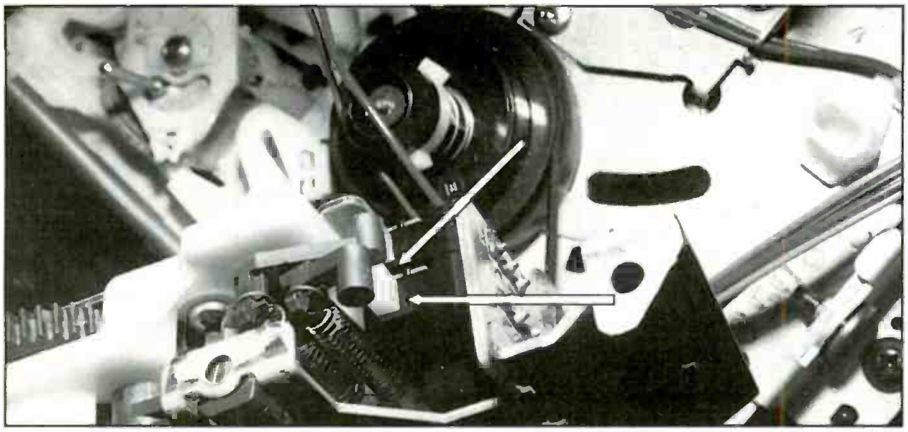


Figure 11. The cassette sensing switches (S143 and S144 in an RCA model VLT 600, 601, 602) when the right side of the stage mechanism has been removed and turned upside down.

contains an improved version of this module. The kit contains a module that has heat sink fins on it, and some replacement capacitors and a semiconductor fuse. You may find, however, that you may need capacitors in addition to those in the kit.

A tape-stage mechanism problem

Often a customer will live with various VCR malfunctions, finally bringing in the VCR for repair only when a major failure occurs, such as the display problem described above. One machine I encountered exhibited several problems. When this VCR was powered up without a cassette, the *cassette loaded* light came on. Then the stage mechanism would move out, as if to eject a tape (the stage motor is energized) and the cassette light would go off. The stage would then try to pull in, but be stopped by the cassette loading latches (the motor would be energized and then off). During this last maneuver, the cassette light would come on again and the VCR would finally automatically power off.

It was possible to load a tape only when the stage tried to pull in. Attempting to load a tape at any other time caused the gears to lock up, and go out of alignment, especially if the cassette was forced in. During the time the VCR was trying to pull in the stage mechanism, if the play button was pressed the machine would go into play mode (remember this is with the stage in an up position, without a cassette).

If you just said to yourself that this should not happen because the IR tape loading sensors should prevent this, you are correct. Just by reviewing the failure symptoms, you saved a lot of time and pinpointed the failure cause. It should be noted that the cassette loading mechanism troubleshooting chart in the RCA manual does not explicitly list the sensor as a problem area. Figure 10 is the troubleshooting chart from the RCA VLT 600-603 manual.

Solving the tape-stage problem

This erratic stage behavior is caused by a failed (open circuited) supply sensor which sent a message to the VCR microprocessor that there was a tape loaded in the machine. This sensor is a phototransistor with an emitter on the left side and

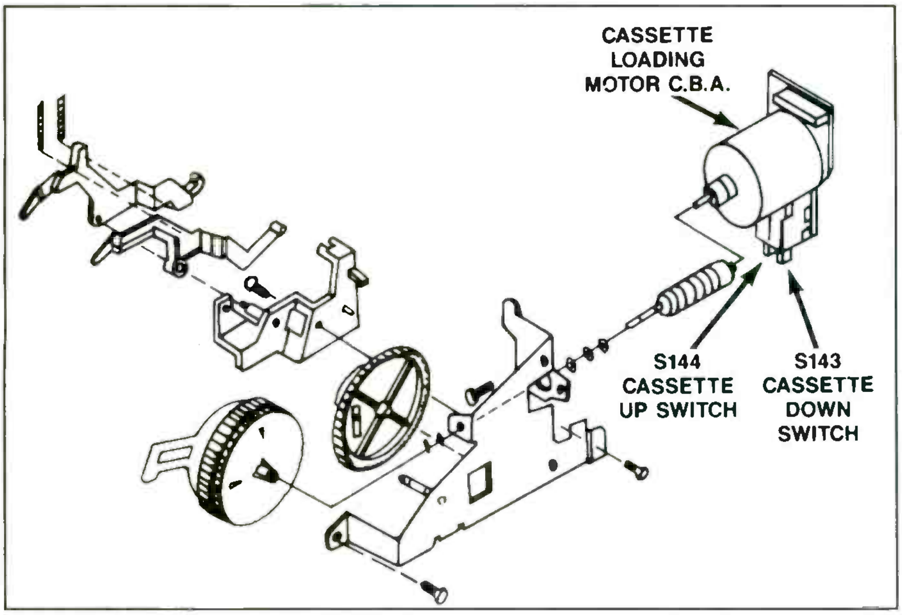


Figure 12. The cassette loading mechanism diagram from the RCA VLT600-603 manual.

a collector pin on the right. The base is biased by light. This particular stage design does not use a cassette-in sensor (which is located just above the tape loading area).

In this design, the presence of a cassette is sensed by the partial rotation of the tape-loading mechanism caused by the user pushing in the cassette. This partial rotation of the mechanism results in the actuation of two switches (S143, RCA 147281), the cassette-down and (S144, RCA 147281), the cassette-up.

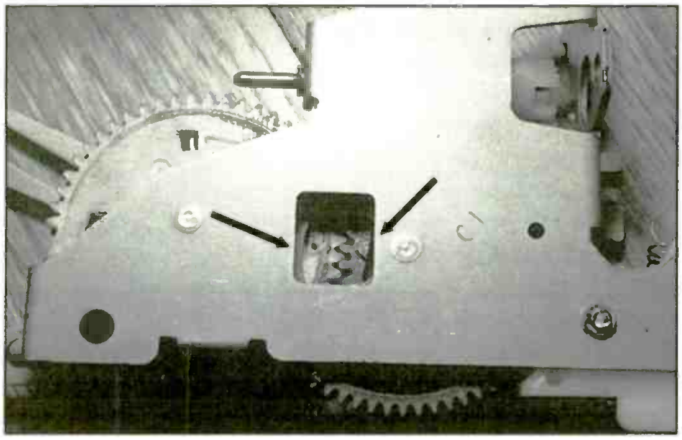
These switches, located under the cassette loading motor, tell the microprocessor to activate the stage motor. However, with a failed end-of-tape sensor, this does not occur. Figure 11 shows the switches when the right side of the stage mechanism has been removed and turned upside down.

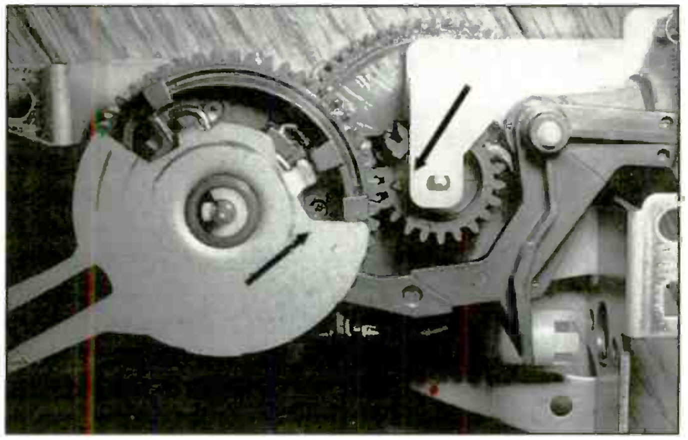
There are two levers, or arms, that ride on the gears and actuate the cassette sensor switches. The left arm is RCA 162232 for VLT 600 and 161701 for VLT601 to 603. The right arm is RCA 161702. Figure 12 shows the cassette-loading mechanism diagram from the RCA VLT600-603 manual.

Without a cassette, the left, or innermost arm, is down and the right arm is up. You can also see a cutout on the black gear that the arms are resting on. When a cassette is loaded, both arms are up, and the inner arm, which would otherwise be down, is held up by part of the stage-loading mechanism (the metal arm on gear RCA 162963) pressing on it.

Aligning the gears

To gain access to the cassette-loading mechanism, remove the VCR top cover which is held in place by screws at the back of the VCR. Remove the front cover by taking out the front screws on the bottom of the VCR and then removing the





Figures 13 and 14. The right side loading gears showing tnat they are aligned by having arrows on the gears point to each other.

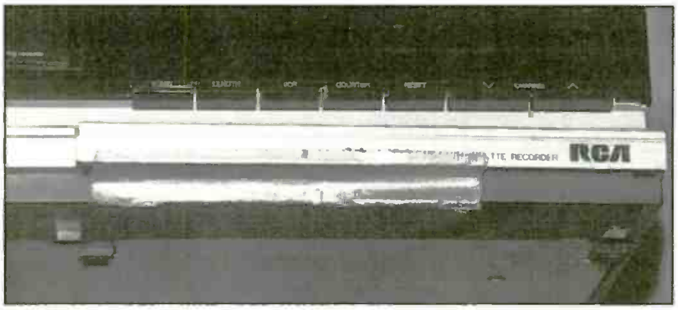


Figure 15. In this RCA VCR, the owner used a piece of duct tape to hold the control door in place.

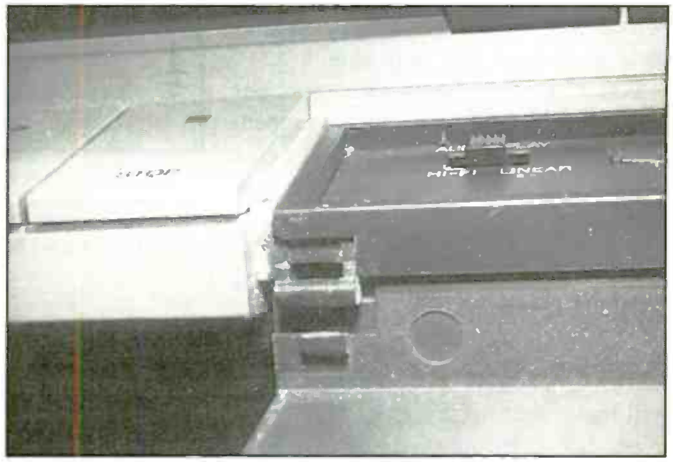


Figure 16. The hinge holding the control door of Figure 15 had been broken off.

three screws on the top of the unit. The stage is secured by two black screws in the front (where the tape is inserted) and two screws that hold it down to the VCR tape transport chassis.

When all the screws are removed, disconnect the connector going to the stage loading motor printed circuit board. The stage can then be lifted out from the rear, to clear two front tabs that are in slots in the front of the VCR chassis. The left side mechanism can be separated from the stage by removing two screws, one at the front and one in the middle of the assembly.

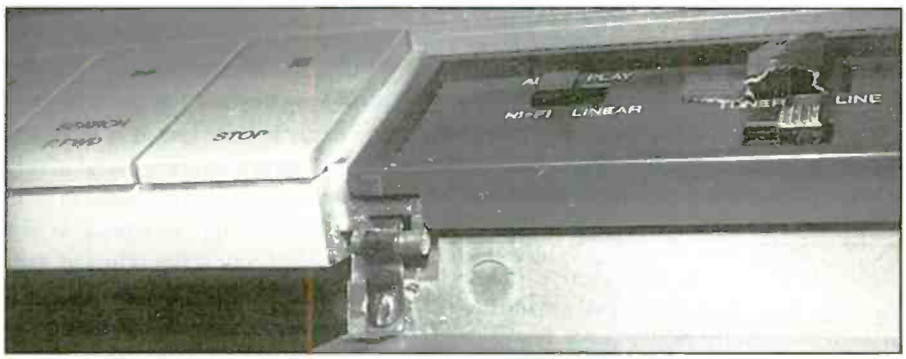


Figure 17. The hinge was repaired using a piece of thin gauge aluminum.

To align the gears, look for arrows, which have to point to each other (Figures 13 and 14). Be careful when aligning the gears as some of them are spring loaded and are under tension. The photographs should help you in the alignment process.

Cosmetic fixes

When all electrical repairs, and checkouts, are completed you should see if there are any little cosmetic repairs that can be easily performed (you probably remember advice like this from the business columns in this magazine). For example, in the RCA machine discussed above, the customer had the control door held in place by a piece of duct tape (Figure 15), which looked ugly. The hinge holding the control door in place had been broken off (Figure 16).

I made a new door hinge out of a piece of thin gauge scrap aluminum, fastened and screwed it into place (I first drilled a small starter hole into the plastic and secured the screw in the hole with some epoxy, see Figure 17). This took about 15 minutes. I then cleaned the unit up and masked some scratches in the cover with some silver model paint. While these repairs did not do anything to improve the performance of the VCR they improved the appearance of the unit tremendously and the customer was pleased.

Note: Thomson Consumer Electronics can generally supply manuals for machines less than 10 years old: TCE Publications, 1003 Bunsen Way, Louisville KY 40299, 502-491-8110. For models that are almost 10 years old, or older, such as the VLT600HF (a 1985 model), photocopies of manuals can be ordered from Alexander Graphics, P.O. Box 98, 3658 Shady Lane, Plainfield, IN 46168- 0098, 317-839-2372. ■

Electrical safety for service personnel

By Ron C. Johnson

Of all the people who work with electricity on a daily basis, electronic service personnel should be the most aware of the risks involved. Consumer and office electronics products contain both ac and dc voltages that range from a few mV to over 30kV. Every time we open up a piece of equipment we should take that extra moment to consider how to be safe.

When we don't take that time for consideration, that's when accidents happen. Maybe it's human nature; sometimes we get careless, or in a hurry, or sometimes a situation comes along that's new. We just don't consider the risks. Whatever the reason, electrical safety is an area that we all need to review from time to time. The key to safety is to maintain a balance of knowledge, attitude and good habits that will make sure we leave our workplace every day under our own power instead of on a stretcher.

What follows is a review—some facts about electricity and its hazards, especially as it applies to consumer electronics servicing, and some suggestions on how you can remain safe at work.

Electricity and the human body

First, how does electrical current affect the body? Our bodies are mostly made up of water. Actually, water itself is not a very good conductor of electric current, but ionic solutions are. The water in human tissue contains sodium, potassium and chlorine, ions which facilitate the movement of electrochemical stimulus throughout the body. These electrochemical signals control muscles and allow signals to travel from nerves to the brain.

When we receive an electrical shock, current flows through the ionic solution of cells, overriding the normal low-level signals, and causing an effect called depolarization. The effect can range from a mild tingling sensation, to muscle contractions, to fibrillation of the heart, and eventually to burns and tissue damage. (Fibrillation of the heart is a condition where the heart muscle stops pumping in a stable rhythm and quivers randomly.) Table 1 shows the effects of various levels of 60Hz ac shock current.

Johnson is a journeyman electronics servicing technician and an instructor of technology at the Northern Alberta Institute of Technology in Edmonton, Alberta, Canada.

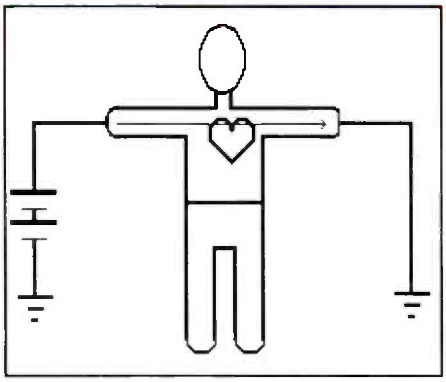


Figure 1. The type and extent of injury caused by electrical shock depends on a number of factors, including which parts of the body that the shock current flows through.

Table 1—The Effects of Various Levels of Shock Current

Current Level	Effects
100μA	Current required directly through the heart to cause ventricular fibrillation.
1mA	Lowest perceptible current level.
5mA	Muscle contractions and spasms which could cause secondary injuries.
20mA	Strong muscle contractions. Pain. Most victims cannot let go.
50mA	Significant pain. Can cause ventricular fibrillation if duration is more than a few seconds.
100mA	Immediate ventricular fibrillation. Probably fatal.
over 100mA	Burns, tissue damage, immediate death.
1A to 6A	Current levels used to restart the heart.

Considering the fact that the resistance of body tissue is very low, it is fortunate that the resistance of skin is relatively high. The range of skin resistance is from 300Ω to 100kΩ. A skin resistance as low as 300Ω could occur if the skin was very moist or if access through the skin occurred because of a cut or other injury. Dry, calloused skin might reach 100kΩ. A more typical value for skin resistance would be in the range of 2500Ω to 25,000Ω.

Of course, for current to flow, two contact points are necessary. The points of contact and the route the current takes through the body also determine the effects of shock (Also, current density, which is the magnitude of current through a given cross-sectional area, depends on where contact is made.) While 100mA from one arm to the other will cause fibrillation, less than 100μA directly through the heart can cause the same effect (Figure 1).

The effect of frequency

An interesting aspect of electrical shock is the effect of the frequency. While shocks caused by dc voltages and low frequency ac can be extremely dangerous, higher frequencies tend to be less hazardous. For example, a 100mA current at 1kHz, while noticeable, is neither painful or life threatening. At much higher frequencies the person subjected to the same current flow perceives no shock at all.

However, exposure to electromagnetic radiation in the ultraviolet, microwave and nuclear radiation ranges can cause direct damage to human tissue. While these are not examples of electrical shock,

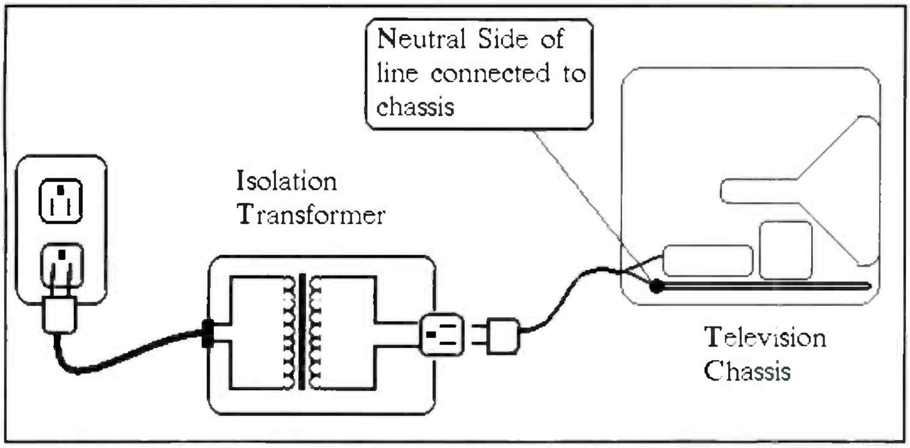


Figure 2. Always use an isolation transformer when servicing any type of electronics equipment.

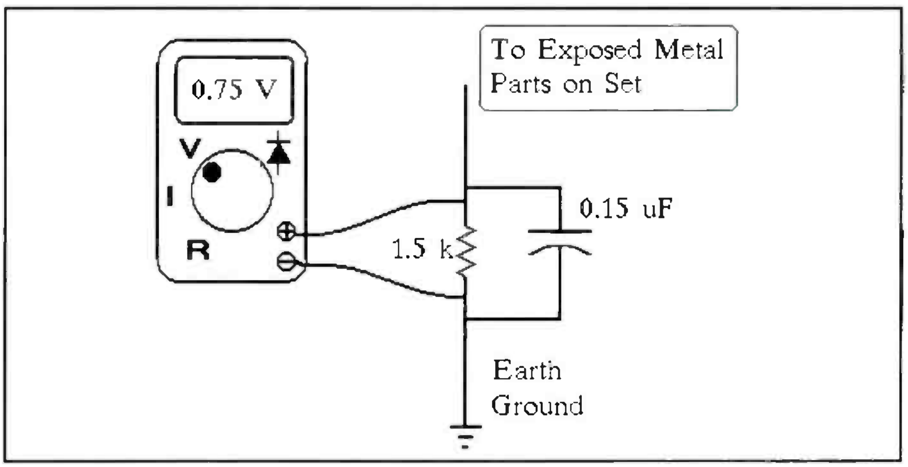


Figure 3. A leakage current check should be performed routinely as a part of any bench service or service call.

per se, they are definite hazards associated with the electromagnetic spectrum.

An interesting book to read on this subject is the biography of Nicola Tesla, the eccentric genius who invented the ac induction motor, and conceived the theory for ac power distribution as well. Tesla enjoyed performing spectacular displays using high voltages at high frequencies. He would place himself in series with a circuit carrying high levels of high frequency current and cause an arc to jump from an electrode he held in his hand. The other end of the electrode would melt with no harm to him even though all of the current flowed through his body. Don't try this at home, folks. While he was unaffected, I wouldn't risk it.

Know the risks

I think we all realize that the old line: "What you don't know can't hurt you" doesn't apply in electrical safety. You can't see the presence of high voltage inside a television chassis but it's still dangerous. We have to know enough about the situation to avoid poking our fingers into the wrong places. If we're confronted with a situation for the first time, it's our responsibility to find out what the hazards are. And, if we still aren't sure, we need to err on the side of caution.

Live chassis

One risk involved with television service is the possibility of a live chassis. Whereas most electronic equipment isolates the internal circuitry by using a power-supply transformer, many television sets derive their power supplies directly from the ac line. In so doing they connect the neutral side of the line to the metal chassis inside the set and use a polarized two prong line plug. Since the neutral is connected to the system ground in the panel this shouldn't be a problem.

But problems can occur in two ways. First, without an isolating power supply transformer, all the power supply voltages are live with respect to earth ground. If some part of your body is grounded and another part comes in contact with a supply voltage, you could receive a shock. Lethal voltages exist at several points within a television set. DC voltages in the 120V range are used for the B+ supply. Peak to peak voltages in the 1000V range on the horizontal and vertical output transistors, and up to 35,000V on the picture tube itself.

The second problem could occur if somehow the hot and neutral sides of the incoming ac line were reversed, either by incorrect replacement of the plug or an incorrect connection at the other end. This would put the television chassis at 120Vac with respect to earth ground. Again, if some part of your body was grounded and you contacted the chassis, you could be electrocuted.

Protecting yourself from a hot chassis

There are several ways of protecting yourself from a hot chassis problem:

- When working with the power off, (changing parts or modules), always unplug the set.
- Always check the ac power cord to make sure it hasn't been modified or tampered with. If you're not sure, measure the ac voltage from the chassis cold ground to the third prong ground at the receptacle. It should be 0V.
- Always use a one-to-one ratio isolation transformer when servicing any electronic equipment (Figure 2). This removes the possibility of a shock hazard from the chassis, but it also removes the current path from any of the power supplies or higher voltage signals to ground.

Another kind of hot chassis problem can be created by leakage current in transformers and other equipment connected between a voltage and the chassis. This problem can occur in any kind of electronic equipment and should be checked routinely as part of any bench check or service call. In fact, every service manual recommends this practice and gives directions on how to do it.

The test setup for this test is shown in Figure 3. A 1.5kΩ resistor with a 0.15μF capacitor in parallel is connected between the chassis and ground. If the voltage across the resistor exceeds 0.75Vac

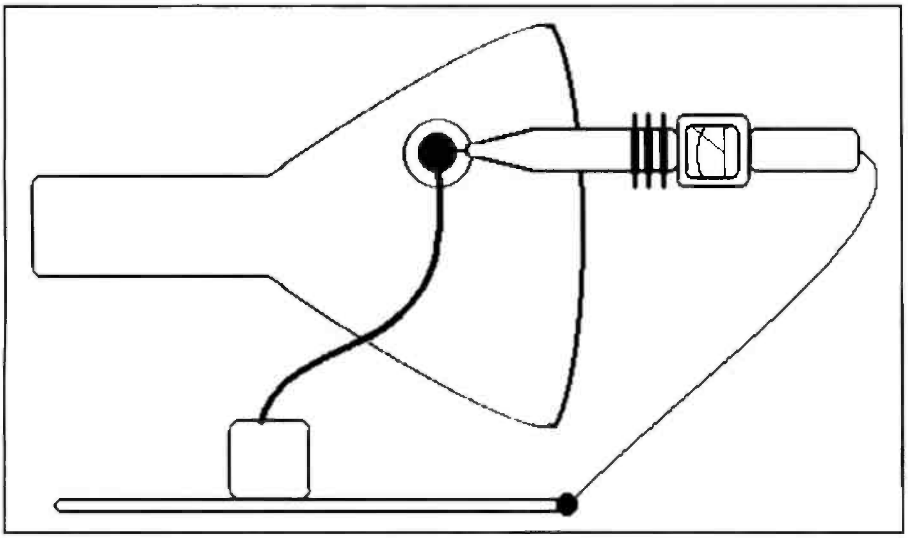


Figure 4. A good way to discharge the picture tube is to use a high-voltage probe. Not only does it drain off the charge slowly, but you can see the voltage coming down by watching the meter.

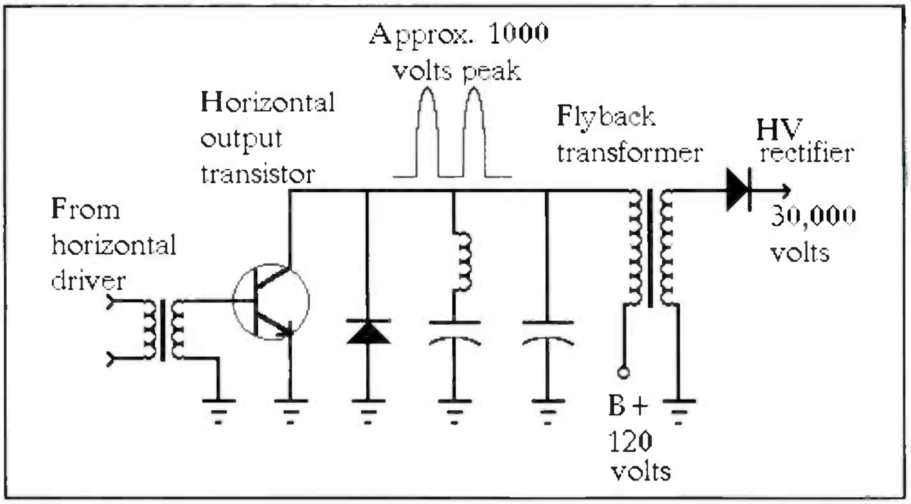


Figure 5. The voltages on the collectors of the horizontal and vertical drive transistors of a television can be dangerous. Although the average voltage may not be very high, the peak to peak voltage of the waveform can be as high as 1000V. Care and attention and the use of an isolation transformer should help avoid a shock.

(which indicates a leakage current of 0.5mA) the equipment is considered unsafe. The leaky component must be located and replaced.

High voltage

Another very dangerous hazard in televisions is, of course, the high-voltage power supply and its capacitor: the CRT itself. The high-voltage power supply runs in excess of 35,000V; nothing to take lightly. Obviously, when you are working on a live set you have to be careful about coming in contact with the circuitry in and around the flyback transformer and high voltage lead. Also, the picture tube acts as a giant high-voltage capacitor and stores electrical charges after the set is turned off.

It's always a good idea to discharge the picture tube before working on the set. One way to do that is by using a high-voltage probe (Figure 4). Not only does it drain off the charge slowly, but you can see the voltage coming down by watching the meter.

Some technicians discharge the tube by crossing two long screwdrivers, one connected to the chassis and one to the high voltage connection on the tube. This will discharge the tube but is risky with solid-state circuitry so close by. The large (albeit short duration) current flow can create induced voltages in adjacent circuitry large enough to damage sensitive components.

High voltage is also a consideration when working on microwave ovens. The magnetron in a microwave requires between 1.8kV and 4.5kV depending on the model. Again, stay away from that part of the circuit when doing service. And, of course, don't try to measure that level of voltage with your DMM. The power supplies for these use voltage doublers and have capacitors which, although they have a bleeder resistor across them, should be discharged before working on them.

The voltages on the collectors of the horizontal and vertical drive transistors of a television can be dangerous as well. Although the average voltage may not be very high, the peak-to-peak voltage of the waveform can be as high as 1000V (Figure 5). Care and attention and the use of an isolation transformer should help avoid a shock.

Critical components

Most schematics indicate which components must be replaced with the original equipment manufacturer's part. This, too, is a safety consideration, probably for both the customers' safety, and also for your protection from liability in case of fire or other accident after a repair is made. Regardless of your opinion of whether this is needed, it is important that you heed this warning.

Picture tubes

Even with the improvements which have been made to the manufacture of picture tubes over the last few years, proper handling is still important. Because of the internal vacuum and the large amount of surface area of a picture tube, implosion is a hazard. Always handle picture tubes with great care, using the proper packaging for transport. Never lift or carry the picture tube by its neck. If a picture tube must be disposed of, pack it in an appropriate carton which covers as much of the tube as possible, then break the seal to safely equalize the pressure.

Never let your guard down

Certainly these hazards and suggestions don't cover *every* hazardous situation encountered in the service center, but they do point out a few of the most comon ones. Probably by now you're saying, "Yeah, I know all that. I'm safe. . ." Interestingly, while a lack of knowledge is a big contributor to accidents in the home, statistics tell us that carelessness is the number one cause of accidents in work situations.

On the job we usually know the risks; they become familiar to us and we get complacent. Lack of concentration on the task at hand, repetition of menial tasks, tiredness, and many other factors contribute to carelessness. The following items are general suggestions to help you avoid those kinds of accidents:

• Always do your job according to the safety instructions given by the product's manufacturer, by your training or by common sense.

• Get in the habit of using that isolation transformer, discharging the picture tube and handling it with care.

• Clean up your work area after the job is completed.

• Make it standard procedure to do a leakage current test as the last step in every service procedure.

• Think before disconnecting or connecting electronic equipment. Assume the worst, check it out and then proceed.

• When working on live equipment, minimize the risk of shock—remove rings, watches and bracelets.

• Never allow two parts of your body to come in contact with a circuit. If possible, keep one hand in your pocket while probing with a meter.

Safety training

Many employers provide First Aid training or support their employees in obtaining such training. A knowledge of First Aid could make the difference between life and death for a fellow worker. Training in artificial resuscitation, the Heimlich maneuver, cardiopulmonary resuscitation and other procedures are well worth the investment in time.

Know the fire and emergency procedures set out by your employer. If none exist, your local fire department would probably help in creating them. Be aware of the location of fire extinguishers, the appropriate type for electrical fires and how to use them. Never use water to put out an electrical fire. In the event of a fire, a quick and appropriate response can save lives and property.

Safety is a habit, and an attitude. Accept responsibility for your own and others' safety. Think about the potential risk in all jobs and then take steps to avoid accidents. And, don't ever allow yourself to take shortcuts that could endanger your life or someone else's. ■

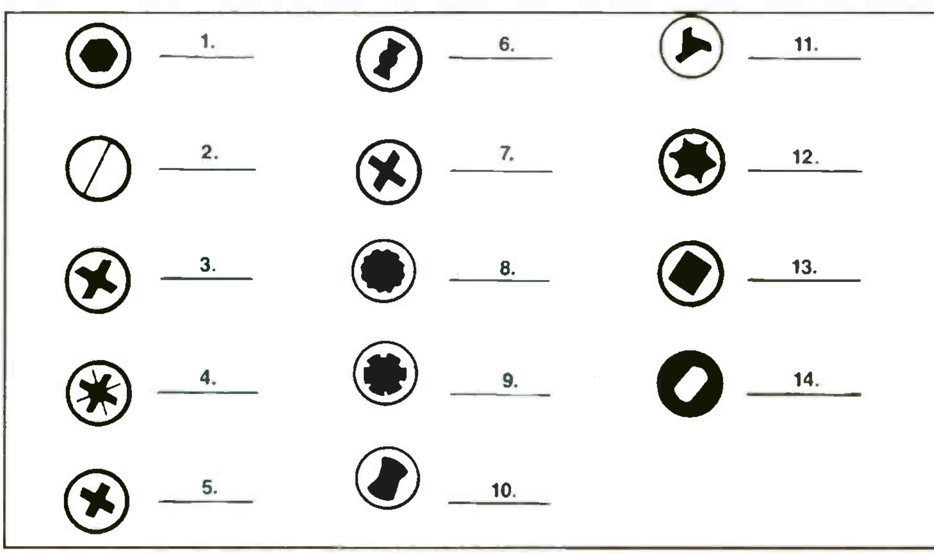
Test Your Electronics Knowledge

Tools

By Sam Wilson, WA8RMS

The information for this TYEK is provided by SNAP-ON Tools. Here is an alphabetical list of the names for the screw slots illustrated in Figure 1. Assign the correct letters to the numbered blanks in the illustration.

A. Clutch (Type A)
H. Scrulox
B. Clutch (Type G)
I. Slab Head
C. Hex Cap
J. Slotted
D. Multi Spline
K. Torq Set
E. Phillips
L. Torx
F. POZIDRIV
M. Triple Square
G. Reed and Prinz
N. Tri-Wing
(Frearson



(Answers on page 66)

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

Radio Broadcast Data System to be test marketed nationally

From the EIA Executive Report to the Electronics Industries

The Radio Broadcast Data System (RBDS) will be introduced in ten major U.S. media markets this year as part of an industry-backed effort to bring this innovative digital technology to the nation's consumers and broadcasters.

Under the terms of a promotional campaign sponsored by the Electronic Industries Association's Consumer Electronics Group (EIA/CEG), radio stations in the selected cities will be given an opportunity to test the RBDS technology for 30 days at no expense. Details of the plan were unveiled January 7 at the 1994 International Winter Consumer Electronics Show (CES).

According to Gary J. Shapiro, group vice president of EIA/CEG, "our manufacturers are convinced that the RBDS will deliver a host of new features that will benefit consumers, including the ability to relay useful control and display to radios."

Toward that end, the industry program will target the leading radio stations in ten markets: Atlanta, Boston, Dallas, Los Angeles, Miami, New York, Philadelphia, San Francisco, Seattle-Tacoma, and Washington, D.C. Participating stations will be provided with RBDS encoders, as well as a variety of materials designed to help the stations promote the new technology to their listeners.

Range of services

The RBDS technology, which was standardized under the aegis of EIA/CEG engineers in January 1993, allows broadcasters to transmit radio text as digital data on an inaudible subcarrier. Individual radio stations may purchase an RBDS encoder for as little as $2500.

This should increase the likelihood that RBDS's growth will accelerate by breaking the so-called "chicken-egg" circle (i.e., a reluctance on the part of broadcasters to gear up for a new service because so little consumer hardware has been sold, and a corresponding reluctance on the part of consumers to buy new hardware in the absence of programming in the new media). The chicken-egg problem initially hindered the growth of color TV in the 1950s and stereo TV in the 1980s, and, in the opinion of some industry observers, could well complicate the introduction of high-definition television (HDTV) in the latter part of this decade.

Consumer features

Among the specific services that can be offered through RBDS broadcasters to their listeners at home or in their cars are:

- display of the station's call letters;
- tuning by program format (e.g., Top 40, Country, Sports, Oldies, etc.);
- display of song titles and artist names;
- the ability to switch to alternate frequencies (e.g. for continuous reception of network programming on long trips);
- automatic announcements of emergency and traffic bulletins;
- paging information;
- business and navigation data.

Broadcasters, for example, would be able to send, and consumers receive, text transmission, enabling radio stations to identify themselves by call letters and frequency, convey information about the recording artist and song album/titles, and feed clock synchronization signals.

In addition, broadcasters could interrupt in-car CD and cassette players with traffic or emergency alerts. Another practical application would allow consumers to scan the car or home radio dial for a particular program format (e.g. "Soft Rock"), which could be especially useful on road trips, but equally useful in the comfort of the home.

The RBDS technology could also become part of a successor to the Emergency Broadcast System. RBDS makes possible a new-generation system that not only would transmit information when people are listening to their radios, but actually could turn on radios in the middle of the night to alert them to a potentially devastating storm, for example.

While car radios would feature an eight-character display, home RBDS receivers will offer a 64-character display making possible the transmission of stock quotes and other financial information, sports scores, and statistics, weather reports, and even brief commercials.

Auto manufacturers on board

At the Winter CES in Las Vegas, a number of consumer electronics manufacturers and marketers demonstrated RBDS products, including Coupon Radio, Delco, Denon, Goldstar, Grundig, International Jensen, Panasonic and Philips.

Radio stations participating in the promotion will be provided with an RE America RBDS encoder, distributed by Harris Allied, a worldwide distributor of broadcast products. RE America, a manufacturer of RBDS encoders based in Westlake, OH, will advise station engineers on their use.

Broadcasters will be encouraged to purchase an RBDS encoder after trying it out for 30 days. Each participating station will be surveyed for reactions to the new technology from the viewpoint of station personnel, broadcasters and listeners.

A cooperative effort

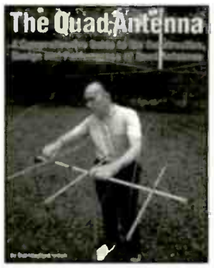
RBDS was developed for the United States and Canada by the National Radio Systems Committee (NRSC), an inter-industry panel including representatives of both EIA and the National Association of Broadcasters (NAB). The NRSC is charged with developing standards for technologies affecting both transmitting stations and radio receivers.

The RBDS effort is based on the Radio Data System (RDS) which has been in operation within the European Community since 1984.

The North American RBDS system is tailored to the market conditions of the U.S. and Canada. However, it was the goal of the NRSC to develop a system compatible with the European standard so that a single receiver can be used in both North America and Western Europe. ■

CQ Books and Videos

The Quad Antenna

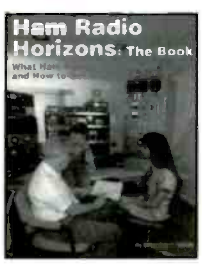


Hams love antenna books and this book is no exception. Written by world renowned author Bob Haviland, W4MB, The Quad Antenna is the authoritative technical book on the design, construction, characteristics and applications of Quad Antennas. Discover how to easily build a quad antenna for your station that will help you fill your logbook with rare DX that you have only dreamed about before. **Order No. QUAD..... $15.95**

The Packet Radio Operator's Manual

This book is written by CQ columnist and Amateur Radio Packet authority Buck Rogers, K4ABT. An all new introduction and guide to packet operation, it is the perfect single source, whether you're an advanced user or just starting out. Learn about packet radio without all the technical jargon. Also included are detailed hookups for dozens of radio/packet controller/computer combinations, making this book the definitive resource for the active packet user. **Order No. PROM..... $15.95**

Ham Radio Horizons: The Book

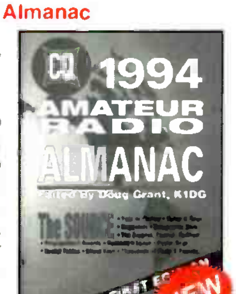


Written by Peter O'Dell, WB2D, this is a book about ham radio that every beginner can enjoy! If you want to get in on the fun and excitement of Amateur Radio, Ham Radio Horizons is the perfect way to get started. HRH is full of tips from expert hams in: DXing, Contesting, Serving the Public, Ham Radio in Space, Experimenting, Digital Communications — you name it! This exciting book is an excellent gift to a prospective ham or for use in your club's licensing classes and library. **Order No. BHOR..... $12.95**

The Vertical Antenna Handbook

Take advantage of the 20 years of research and practical experience of naval communications engineer Capt. Paul H. Lee, USN(ret), N6PL. Learn the basic theory, design, and practice of the vertical antenna. Discover easy construction projects such as a four-band DX vertical or a broadband array for 80 meters. Ever wonder how to build a functional directive vertical system? Paul Lee can get you started today! **Order No. VAH..... $9.95**

1994 Amateur Radio Almanac



If you're like most hams, you'll be fascinated by the thousands of facts, tables, graphs, maps, and other information to be uncovered in the **CQ 1994 Amateur Radio Almanac.** CQ's Almanac puts it all right at your fingertips, providing a resource that you'll refer to over and over again. This is one book you can't be without! **Order No. BALM....$19.95**

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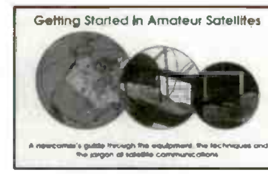

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Electronics speak

By Sam Wilson, WA8RMS

You can review a lot of interesting theory by paying attention to the words that describe it.

You will remember that equivalent series resistance (ESR) is not the series resistance of a capacitor. Instead, it is a resistance equivalent to the series and parallel (leakage) resistance of a capacitor. We have reviewed that concept in a previous WDYKAE?.

Now, let's review the familiar word "superheterodyne." Let's break it into small pieces with a little review. Heterodyning takes place when two signal frequencies are mixed in a non-linear device.

Figure 1 shows what happens. There are always four output signal frequencies available in this situation. It wouldn't make much sense to go to all of that trouble to get signal frequency A or signal frequency B because you already have those frequencies at the start. So, those possible outputs are sometimes disregarded. But you should always remember that they are available.

If the device is linear, no heterodyning can take place.

The output circuit of the non-linear device or circuit is tuned for frequency A+B or frequency A-B. All other frequencies are eliminated. The mixer in the block diagram of Figure 2 is not a linear circuit. The two signals heterodyne to produce four outputs: RF frequency, oscillator frequency, RF frequency plus the oscillator frequency, and RF frequency minus the oscillator frequency. The usual practice is to tune the output to the difference frequencies. Tuned circuits in the amplifier pass only the difference frequency.

Wilson is the electronics theory consultant for ES&T.

OK, now we have reviewed heterodyning in the mixer stage. But, why *super*-heterodyne?

The detector is usually a diode. Whatever it is, it *must* be a non-linear device or circuit, because detection in that stage occurs as a result of heterodyning.

The two signals of interest are: The carrier (which is reduced to the intermediate frequency) and the sideband (which contains the audio).

One sideband is eliminated in the detector stage. If you didn't do that the positive and negative half cycles would cancel.

When the carrier and the sideband heterodyne in the detector there are four output signals available:

- Carrier (now at the if frequency)
- Sideband frequencies (they have the same audio info.)
- Carrier plus the sideband frequencies
- Carrier minus sideband frequencies

The carrier minus the sideband frequencies heterodyne to produce the audio. *(Note: If the upper sidebands are heterodyning the audio is obtained by subtracting the carrier from the sideband.)*

The carrier and one of the sideband frequencies are usually eliminated by a filter circuit in the output of the detector stage.

The receiver is a *super*heterodyne receiver because heterodyning takes place in two places.

If you don't believe that, try substituting a nice linear carbon resistor for the detector diode and see what you get.

Mixer, converter . . .

While we are talking about heterodyning, here is something to think about.

You know that a converter is a circuit that combines a mixer and oscillator into a single stage.

OK, what is another name for this type of converter?

Yes, I know it is referred to as the "first detector," but I'm looking for a name that starts with an 'A.'

Check your answer at the end of this installment of WDYKAE?

Letters I can't answer

One reason I'm so far behind in my mail is that I'm on a fire drill. I have one month

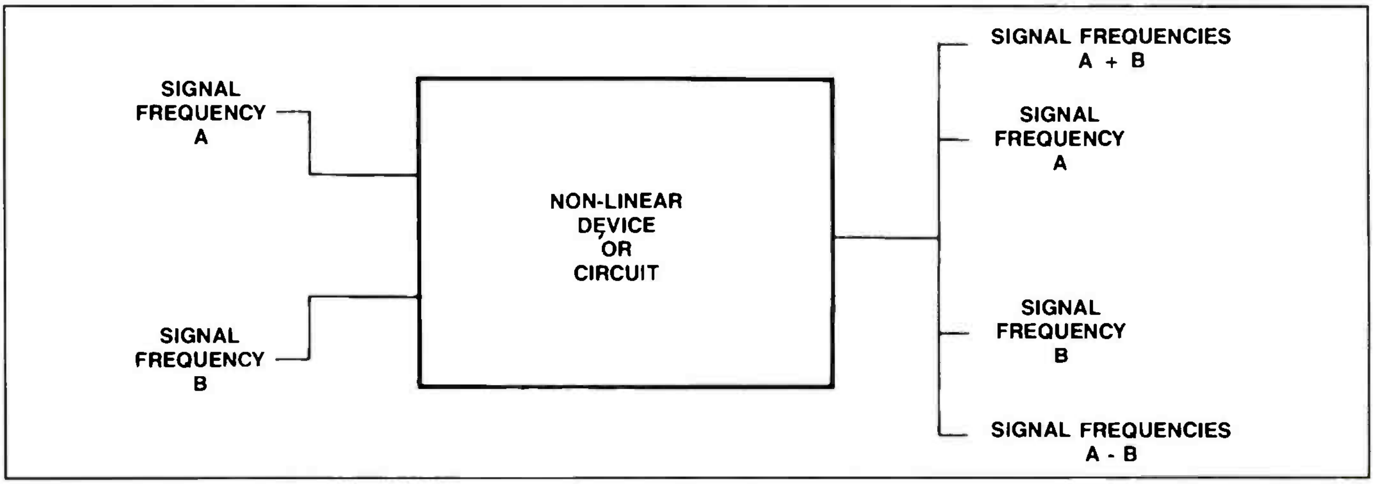


Figure 1.

to finish two books. Joe Risse (Scranton, PA) and I are co-authors and he is difficult to keep up with.

If I owe you a letter, please be patient. However, if you don't get a reply maybe you are one of the following:

A reader in Canada sent a letter that I tried to answer. For his address he gave a lot of abbreviations. I guessed that must be the way they address letters, so I copied his abbreviations. The post office in Canada marked my returned envelope "insufficient address."

Another reader sent me a FAX in care of the Kansas office for ES&T. That's OK, but all he gave me was a FAX number. They mailed his FAX to me, and, I have no address to send a reply.

Another reader sent me a technical question and said if I don't know the answer I should "ask around the office." My wife Norma is the only person who comes into this office; so, I asked her. She didn't know.

We're losing another race

You need a program to keep track of the races we are losing. I have a list of things to worry about—when I can find that list.

Put this on your list: We (the U.S.) are losing our first place position in *Techno-paradigm shift*.

It means that production leads to R&D, and, R&D leads to more production, and production leads to more R&D, etc.

As you know our lead in production is disappearing fast, so, our R&D is going with it.

Put *that* on your list.

Sound off

I have been corresponding with a very nice man in Ghana, West Africa. He has a serious problem with pests—like bugs. He sent the schematic for a sonic bug eliminator that didn't work.

He asked me for the plans of one that *would* work. I have spent hours going through articles and schematics trying to get him an answer.

The problem is that all of the material I've turned up say the devices don't work.

In desperation I ordered a commercial unit for him. It takes 4 to 6 weeks to get it. In the meantime, if any reader has any information, or, a schematic of a unit, please send it to me in care of this magazine. I'll put it in this column, and also send it to him.

His name is Joseph Anie. The way he puts it, it is very difficult to work in his shop because of the pests. I feel confident in asking for your help. After all, many technicians deal daily with bugs!

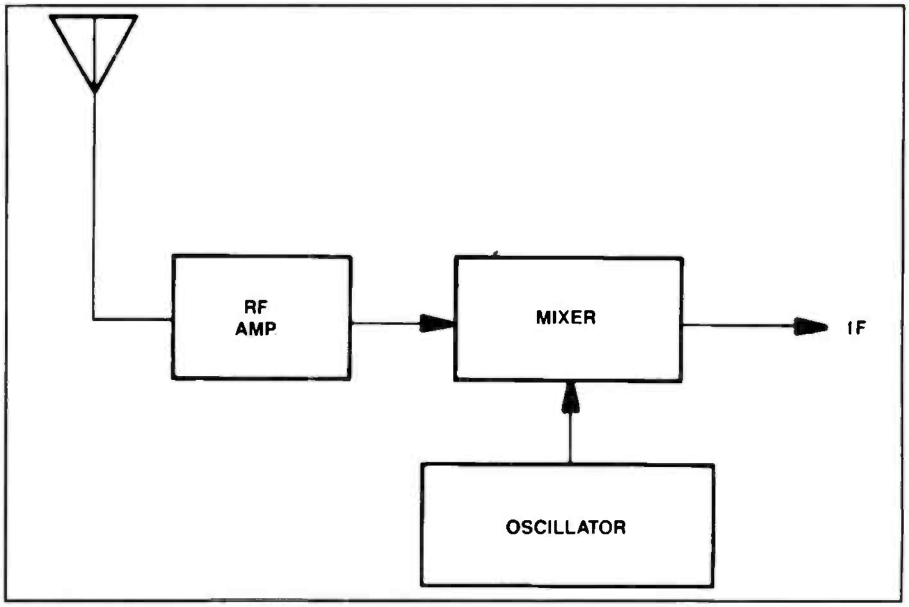


Figure 2.

Brain dead

As a technician you are certain to be aware of computer viruses. The recent Michelangelo virus has focused attention on the virus problem.

There is a sickness about a computer virus, but the sickness isn't in the computer. It's in the people that generate them.

In 1956 there were only five known viruses. Today there are over 500. Viruses are now being discovered at the rate of two new viruses per day!! That information comes from the National Computer Security Association and Marty Baumann of USA Today.

A meaningless term

When a term is made up to describe something in electronics that term should at least be technically correct. Unfortunately, there are people who seem to have enough influence to make up words that are wrong. For some reason that I will never understand, those terms catch on.

I think every child in the first grade knows that when you multiply RMS voltage by RMS current you get *average power.*

Whoever it was that decided to call it RMS Power needs a lot of help. Technically, there is no such thing as RMS power. The term is meaningless.

Here is another one that makes no sense at all: white noise. Now, white noise is noise with a frequency range of nearly zero hertz to somewhere in the GHz frequency. Noise throughout that range is nearly constant in a discussion of white noise. However, when the noise is generated by an electronic device, such as bipolar transistor, the noise is *not* evenly distributed. So, it's not white noise. That is not the issue here.

The concept of white noise is that its amplitude does not go through high amplitude variations within a given range of frequencies.

Now, if you have had experience trying to get white on the screen of a color television receiver, do you mix equal values of blue, red and green?

Hardly. If you do that, you get an ugly color. Of course, beauty is in the eye of the beholder—right? OK, try this little experiment. Set the color on your color TV CRT so that blue, red and green have equal amp-litudes. What do you think about that color?

The point is this: white color is *not* made up of even values of colors throughout the color spectrum.

I know what you are going to say. The problem is in the human eye. Well, I spent a long time in the library trying to answer this question: Is white an even mixture of the frequencies of color regardless of what a human sees when observing it, or, is white only white if a human perceives it to be white?

I believe white is only white if it is perceived by a human as white. If you agree, then you will also agree that the term white noise is silly.

The answer to the question asked in the first part of this article: *Autodyne mixer.*

Solving a VCR short circuit

By Steve Babbert

Never underestimate the value of your senses when trying to solve an electronics problem. Sometimes your senses can be of greater value than the most elaborate test bench. My senses of sight and smell recently helped me to make a repair that otherwise might have been an impossible one.

A friend brought me a Radio Shack VCR (Model 18) that had been abandoned in a house. The FCC ID number of this unit was BEJ9QK16507. These ID numbers were discussed in the December issue of **ES&T** (Page 8). The chart of FCC ID number prefix vs manufacturer in that particular issue shows that this VCR was made by Goldstar.

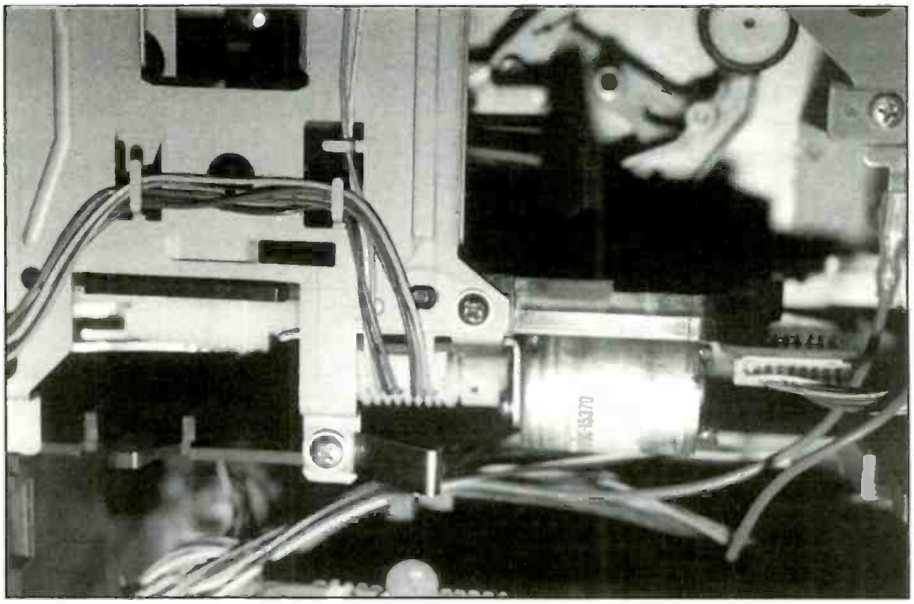


Figure 1. Here you can see the circuit board mounted on the right hand side of the tape transport mechanism. Any pressure applied to the board or the connecting wires would cause the unit to shut down.

Erratic operation

The VCR would play for a while and then shut down. Sometimes it would not play at all. I knew that it must have had a serious problem or it wouldn't have been left behind. It wasn't very old and looked good on the outside.

Because the problem was intermittent, I removed the cover of the VCR and began looking for loose connectors. Before long I found that a small board attached to the right hand side of the tape transport mechanism was sensitive (Figure 1). When I applied pressure to the board, the machine would shut down. It made no difference what mode the VCR was in. Each time this happened, I would notice a very faint odor that smelled like motor brushes sparking; however, I couldn't see or hear any spark discharge. Every time the unit shut down, I had to reset the controller IC by first unplugging the VCR and then plugging it back in.

Someone else had been here before

I had to remove the tape transport mechanism to get a closer look at the small circuit board. As I was doing this, I noticed that some plastic screw wells were stripped, probably as the result of repeated disassembly and reassembly. At this point, I was pretty sure that someone else had been on the same track I was on.

With the tape transport mechanism removed, and in its fully unloaded position, I marked the gears with a permanent marker to insure proper reassembly. Now I could remove the motor, worm gear, and idler gear that covered the board. Finally,

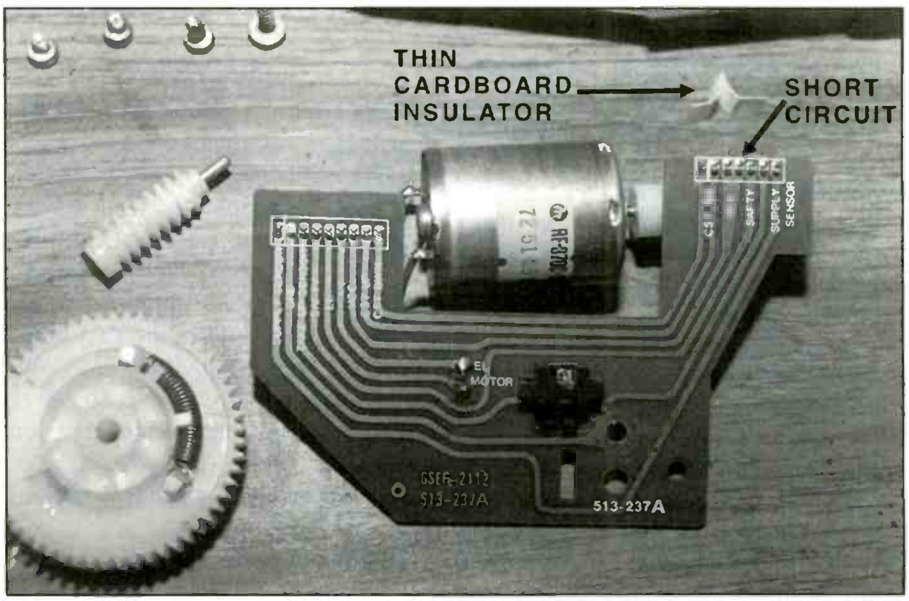


Figure 2. With the board removed, close observation will reveal a tiny burned spot where the trace came into contact with ground.

Babbert is an independent consumer electronics servicing technician.

I removed the board itself. Close inspection of the board revealed nothing unusual, and continuity checks showed no open traces or bad connector contacts.

The only component on the board was the Take-Up Reel End Sensor. Other than this sensor, the only things on the board are the traces that route signals from the tape sensors and switches to the system control. The next step was to power up the machine with the board removed from its mounting support. The purpose of this was to help localize the problem.

The VCR did seem to power up with the board removed. I repeatedly flexed the board and worked the connectors, but it never shut down when the board was removed. I even applied pressure to the mounting support and surrounding area, and again, it never shut down. Had I dislodged a particle from a connector when I removed the board? Maybe I broke through some oxide on one of the pins. I touched up the solder connections, to be safe, and then reassembled the entire unit.

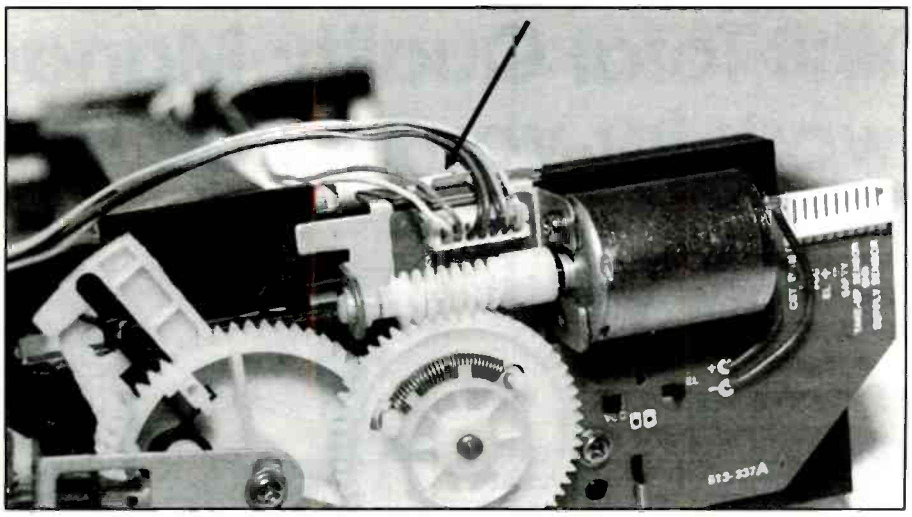
The problem reappears

I put the VCR into the play mode and everything operated perfectly. I applied pressure to the board, and just as before, the machine shut down. Again there was the faint smell of a spark discharge. Now I understood why the screw wells were stripped; someone had been down this road several times. Very possibly the unit had been diagnosed as too costly to repair.

At this point, I became more determined than ever to locate the source of this strange problem. I realized I had to find this problem with the unit assembled. I moved my lights around so that I could better view the area from different angles, and finally, I got lucky.

The next time I caused it to shut down, I saw a small spark between the mounting tab at the top of the board and the metal mounting support that held the board in place. Even with my 20/20 vision, I saw the faint spark only because a shadow covered the area. Now I knew that one of the traces was coming into contact with the mounting support, but I didn't know how this was possible?

Once again, there was no choice but to remove the board from the transport assembly, but at least now I knew exactly what section of the board to focus on.



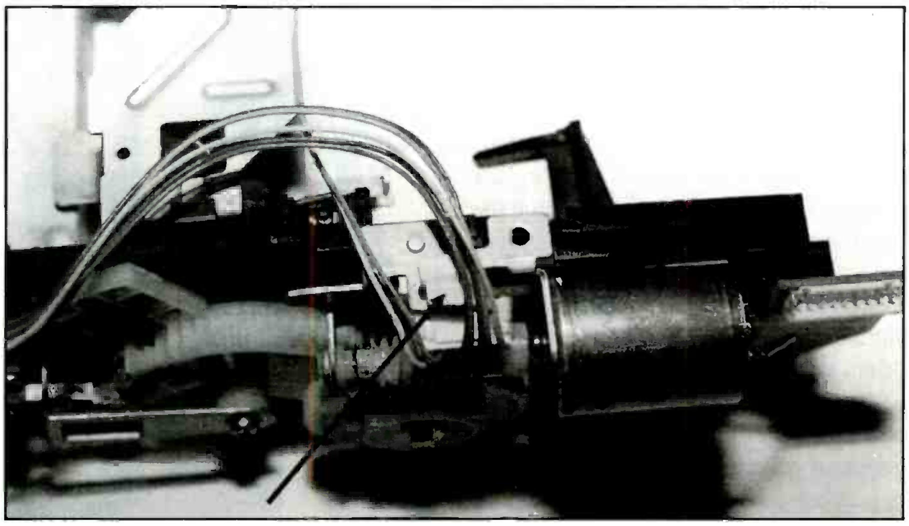


Figure 3. With the unit reassembled, and the paper insulator in place, the problem was corrected. Here are two views of the PC board with the insulating cardboard in place.

I removed the board and placed it under a good light that revealed a type of design flaw that I'd never seen before. A circuit trace was routed along the tab of the board that fits into the metal support. There was only a thin layer of enamel to insulate this trace from ground. A very small burned spot is visible in Figure 2.

The purpose of this trace is to route V_{cc} to the Tape End Sensor. When this trace came into contact with the metal support, V_{cc} was pulled to ground. No doubt a fail-safe circuit caused the unit to shut down.

When the load motor was actuated, friction eventually scraped away a bit of the insulating enamel, since there was a lot of mechanical movement in this area. I wondered how often this problem had occurred in VCRs using this transport mechanism. I had a Sears VCR on another bench that used the same mechanism, but it showed no signs of this problem.

Correcting the problem

There are any number of ways that one could correct this problem, but I chose the least costly and time consuming route. I reassembled the machine, and folded a strip of paper cut from a business card. You can see the folded strip in Figure 2. I then slipped the paper insulator between the board and the support. Next, I folded the ends over the mounting support to keep it from slipping down through the support opening. The paper insulator would be held in place by the wires once they were routed into their normal position. Now I make this modification whenever I service a VCR that has a chassis of this style. ■

Will Total Quality Management work for you?—Part 9

By John A. Ross

This is the ninth part in the Business Corner series on W. Edwards Deming's Total Quality Management.

TQM point 9

Break down the barriers between departments. Does your service organization contain separate, distinct departments? Most modern organizations consist of interrelated units that direct their efforts toward an overall organizational goal. Obviously, cooperation and communication among those departments lead to happier employees and higher profits. Yet, if the departments within the organization independently drive toward goals and have different ideas about the overall goals of the organization, the resulting competition can cause several different types of problems to arise.

The lack of meaningful communications between departments, the uneven allocation of resources among departments, or perceived favoritism can raise barriers and cause even the best of teams to fail.

Meaningful communication

When we talk to each other about the weather, we communicate, but in less than meaningful terms. Meaningful communications between departments involve conversations about issues such as servicing techniques, responses to customer inquiries, personnel policies, and technological innovations. Additionally, meaningful communications can include the establishment of a family-like atmosphere throughout the organization. Thus, when we speak about meaningful communications in this context, we have the goal of firmly rooting in-house loyalties and cooperation throughout the entire organization.

In the end, a paucity or the complete absence of meaningful communication between all units of an organization detracts from the best uses of resources, sometimes causes a duplication of efforts, or sends departments in opposite directions. If the service and sales departments of an electronics retailer do not communicate about major service problems and types of equipment sold, the company may find that customer dissatisfaction coincides with the increasing sales of an electronic product that fails regularly. Yet, because the departments have different priorities and few things in common, departmental managers and company owners may never make the connection.

Sometimes, a manager or owner will lack knowledge about a department's needs or tasks needed to efficiently allocate resources for the department. The uneven allocation of resources unnecessarily creates barriers within the organization. For subordinates, one easy solution to this problem is to provide information about departmental activities and tasks to your supervisors or the ownership.

An example of this tactic would be the presentation of a monthly or annual report showing a comparison between the number of activities and the number of manhours needed to complete the activities. Figure 1 shows a brief example of an an-

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

	1992	1993
Total number of microcomputers	889	1030
Total number of microcomputer peripherals *(printers, scanners, modems, other)*	460	528
Total number of microcomputer-related devices	1349	1558

** Numbers provided by Budget and Planning—January 4, 1994*
System purchase dates range from 1986 to 1993

1993 Requests for computing services received and completed by the microcomputer services section

Total number of requests received:	485
Total number of requests completed:	477

Completed requests by category

Total number of administrative requests completed:	228
Total number of academic requests completed:	249
Total number of requests completed:	477
Total number of hardware-related requests completed:	233
Total number of software-related requests completed:	244
Total number of requests completed:	477

Figure 1. Microcomputer system and peripheral device yearly purchase totals*

nual report. This type of information becomes especially valuable when a department head finds it necessary to justify additional resource or budget requests.

The squeaky wheel

It is an unfortunate reality in our society that the "squeaky wheel gets the oil." Many times, assertive managers, or managers who are aware of the preferences shown by the ownership win the resource battle. However, many of us cannot turn on the charm or become competitive when we need those characteristics. A careful assessment of needed resources, a constant flow of information about departmental activities, and factual justifications not only show organizational skills but help managers make good decisions.

The uneven allocations of resources or budgets throughout any organization sends a clear message to every department head. Departments that receive plenty feel rewarded, while departments that receive less begin to doubt their worth for the organization. Certainly, uneven resource allocation can spark unhealthy competition between departments, the perception of favoritism, and the type of jealousy that provokes conflict. Managers and owners need to be aware of the power of their actions when allocating scarce budget resources. Here, managers and owners must have the same awareness of departmental needs and justifications when making decisions. In addition, they need to remain aware of the values of both the entire organization and the individual departments.

as you can see, breaking down departmental barriers takes us back to human-to-human communications and a deeper understanding of the organization. In addition, breaking down those barriers becomes a matter of everyone in the organization paying attention to both the "big picture" and those sometimes hidden "little pictures." Thus the practice of managing becomes an art as it intertwines with listening, working and learning.

Books

Exploring The Internet, By Carl Malamud, Prentice Hall, 360 pages, $26.95

The global village is here and is documented in a professional reference book, *Exploring the Internet: A Technical Travelogue.* In an easy-to-understand, narrative style, Carl Malamud chronicles his Internet journey, circling the globe three times, visiting 56 cities in 21 countries in six months.

Carl Malamud, noted author in the communications field, takes readers on a voyage of discovery in this book. He provides readers with technically sophisticated descriptions of everything from new networking research to efforts to build national and international infrastructures. The *Internet* is a technical travelogue aimed at networking professionals and anyone who wants a behind-the-scenes look at the people, laboratories and institutions that make up the global village of the Internet.

"This book demonstrates what many of us have long felt: the worldwide network is here. Interoperability is not some imaginary goal at vendor briefings, but a concrete part of networks all over the world," says Dan Lynch, Founder and President, Interop Company, in the foreword. "As we read about the worldwide spread of the Internet, we get to appreciate its diversity and its usefulness to millions."

In this book, Malamud takes us on his narrative journey, three times around the globe. A few places visited by Malamud include: Hong Kong, where Malamud explored the Royal Hong Kong Jockey Club where a massive network handles millions of bets each race day, Amsterdam, where he witnessed the birth of EBONE, a long-awaited pan-European research backbone, Tokyo, where he takes a behind-the-scenes look at the world's most expensive building, Tokyo City Hall, and introduces you to Jun Murai, the Internet Samurai, one of Japan's leading researchers and the architect of Japan's national network, Singapore, where Malamud digs into the government's highly ambitious plans to make an "Intelligent Island," a digital port for the network highways, and Geneva, where he wages battle with the international standards cartel in an effort to make standards documents more widely available.

Prentice Hall, Simon & Schuster Education Group,
Englewood Cliffs, NJ 07632

Troubleshooting Tip

TT0194 Emerson Color TV Dead Set

David M. Luckner

Have you ever thought that a service procedure was going to be simple and straightforward then find that other problems arise as you're trying to complete the job? I am sure every service technician has experienced this situation before. Here's a description of one service job that I performed that looked simple at the outset, but became complicated.

A customer brought an Emerson TV into the shop with the complaint that the set was dead. After pulling the back off, I checked the obvious areas such as the power supply and horizontal output.

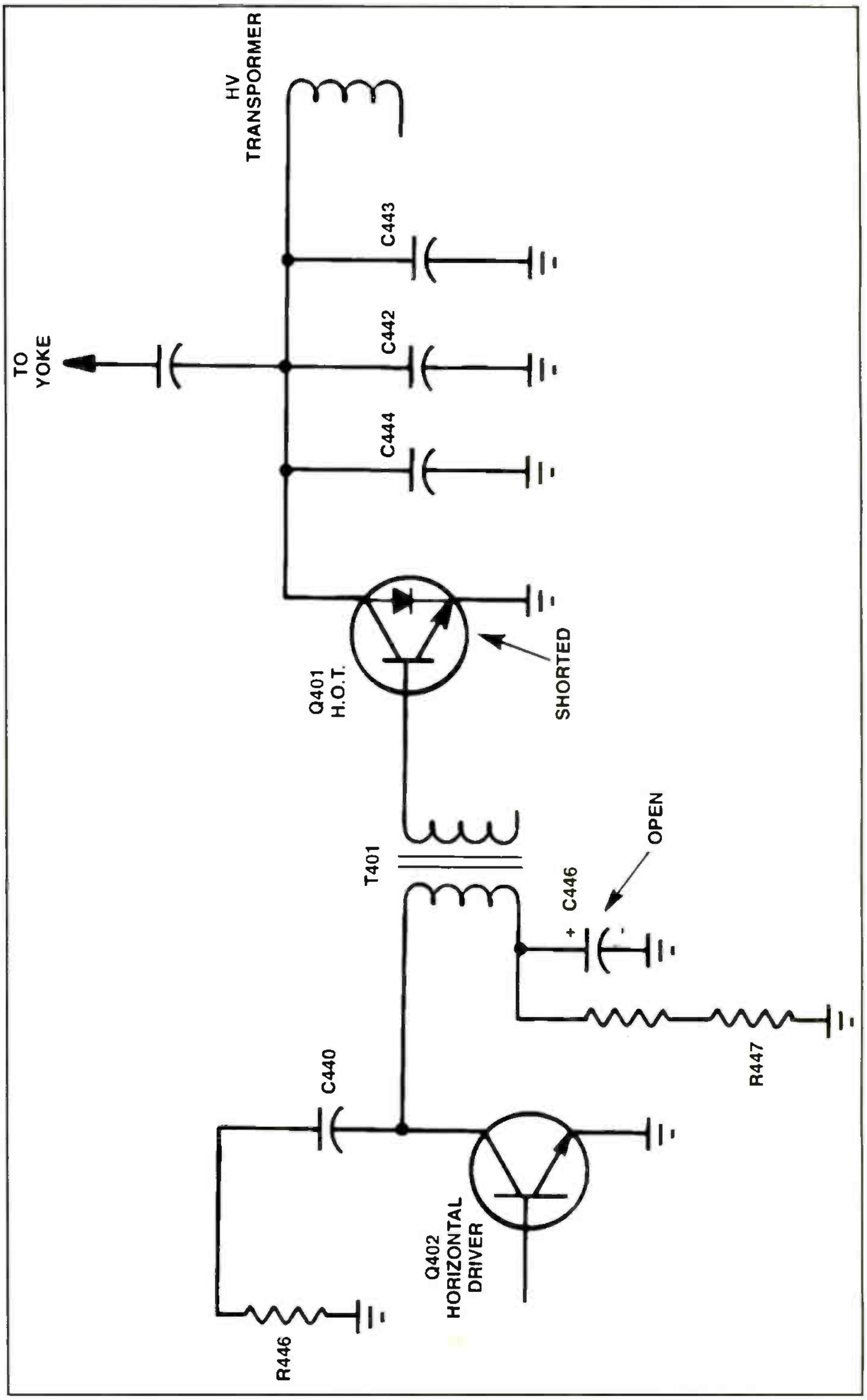
The 2SD1555 horizontal output transistor was shorted, and a resistor in the power supply, R502, 3.9Ω, was open. After replacing the horizontal output transistor with a universal replacement and R502 in the supply, I applied power to the set at reduced line voltage for about five minutes using a variable ac supply, then shut down the supply.

The high voltage transformer and H.O.T. heat sink were very hot to the touch, so I decided to replace the transformer. With a replacement transformer installed, I again ran the set at reduced line voltage for about five minutes. This time the replacement transformer was running cool, but the horizontal output transistor was excessively hot.

I increased the line voltage to check the raster for any defects, and noticed a black border coming in on the right side with ac ripple. There was also a faint drive line present in the center of the screen. In the past I've found that defects in the horizontal drive can cause such symptoms.

After careful inspection, I found that C446, a 1µF decoupling capacitor on the primary of the horizontal drive transformer, was open. After I replaced C446, the raster was greatly improved, but a slight black border still remained on the right side.

I turned my attention to the universal replacement transistor, wondering if there might be a compatibility problem.



In the past I've found that in some cases universal replacement components may not be close enough to the original to perform as necessary, so I decided to substitute the replacement with the exact part number, 2SD1555. When I turned the set on after making this change, the set operated perfectly. ■

Luckner is an independent servicing technician.

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(continued from page 55)

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4.	F	11.	N
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6.	A	13.	H
7.	K	14.	I

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DC/dc converter modules for Audiovox Model HCD-100 car stereo. *Contact Bob Crosswhite, PO Box 1907, Breckenridge, CO 80424. (303) 453-1109.*

Source of control deck schematics and chips (new/used) for Amana, Tappan, Sears and Magic Chef microwaves—and Sams collection above #1535. *Contact W. Worley, 305 Hickory Bend, Enterprise, AL 36330. (205) 347-5281.*

Service manual/schematic for JFD Model 7200, field strength meter. *Contact Marvin Moss, Box 28601, Atlanta, GA 30358.*

Need schematic for System Audio Electronics Inc., (formerly of Los Angeles) integrated amplifier Model # A14. *Contact Walter V. Ciecierski, CCC Consultants, 65-1 North Branford Rd., Brandford, CT 06405. (203) 481-5275.*

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Schematic for Panasonic Model #CT-3003. *Contact (912) 368-3874 or write Marcel Bouchard, PO Box 85, Walthourville, GA 31333.*

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