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Servicing & Technology

October 1995

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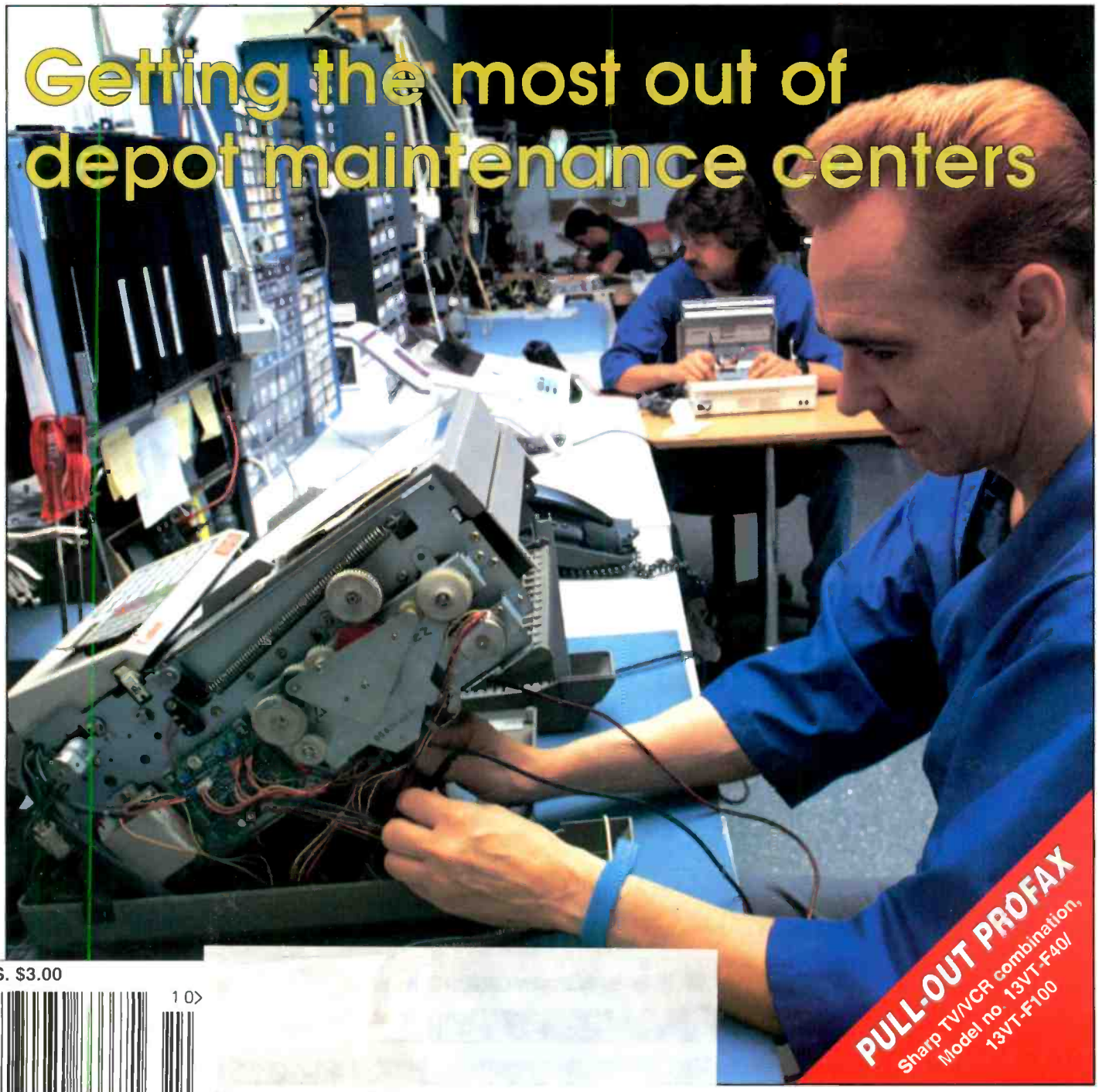

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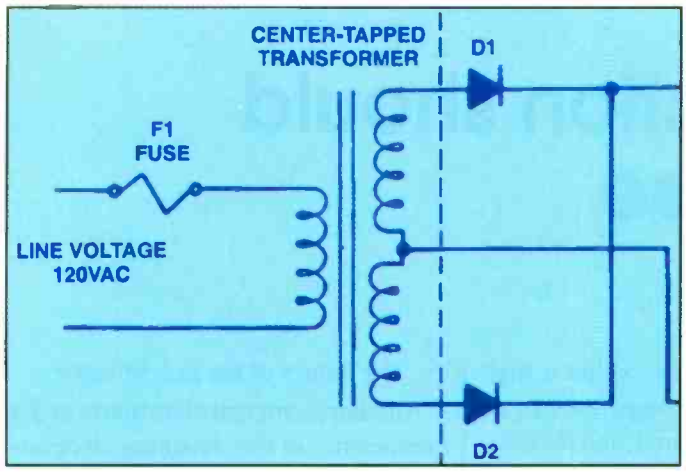

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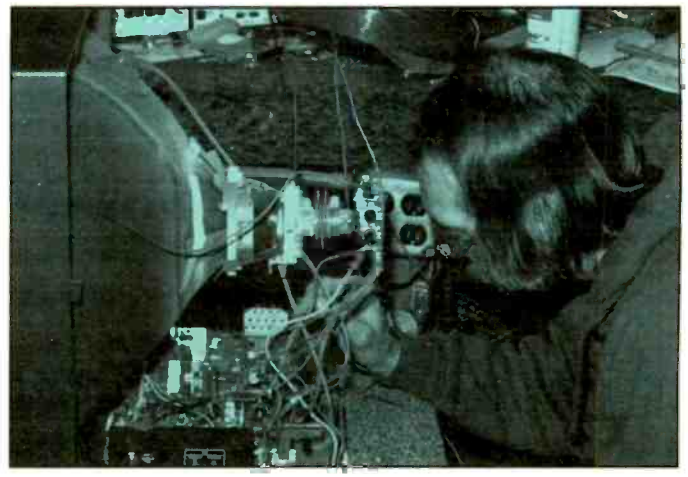

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FEATURES

DEPARTMENTS

ON THE COVER

Depots may refurbish tens or hundreds of units where a service center would see only one in the same time period. Economies of scale allow depots to own facilities such as clean rooms and automatic test equipment that a service center can't afford to own, it simply makes good economic sense for a service center to send a unit to a depot for remanufacturing/refurbsihment rather than doing it yourself. (Photo courtesy HyTec Dealer Service)

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING
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Consumer satisfaction should come as no surprise

The survey that we present in this month's *Business Corner* department is a revelation: consumers hold the companies that service their consumer electronics products, and the technicians who do the work, in high regard. Not only are they highly satisfied with the quality of work performed by independent service centers as well as factory service centers, but 80% of the people surveyed feel that technicians must possess an above-average set of skills.

Considering that most of the publicity about consumer electronics service tends to be negative, for example stories on TV about consumer electronics service centers that rip off their customers by charging for components not replaced or a service not performed, the fact that consumers have a positive perspective on the industry is a tribute indeed to the integrity and competence of the vast majority of service technicians.

It really only makes sense

But when you think about it, this positive image that consumers have of their service center simply makes sense. For starters, not just any bozo can start a service center these days. There are, of course, many businesses, too numerous to mention (and besides we don't want to offend anyone) that require little technical competence. Consumer electronics service is not one of those businesses.

If a service center is to prosper, the owner, or the technician or technicians he hires, will have to exhibit a high degree of technical competence or no products will be repaired, and the business will quickly go down the drain.

Another factor, of course, is the low cost of buying most consumer electronics products. If a consumer is trying to make a decision about whether to replace or repair a faulty TV, VCR, stereo or microwave oven, and she has had a bad experience with service in the past, or is not comfortable with the image presented by her local service center, she may opt to spend the extra money and buy a new product. This factor is, no doubt, helping to keep service centers on their toes.

Perhaps most of the incompetents are gone

There may be yet another factor involved here. Over the past fifteen years or more, hundreds, or perhaps thousands of consumer electronics service centers have gone out of business. Many of those were, no doubt, owned by fine, upstanding, competent people who simply found themselves in a difficult situation and had no choice but to go out of business. We mourn their passage.

But many who failed, were no doubt either the incompetents, or the dishonest, or both, who were driven out of business by their competent, honest competitors. No doubt the passing of these companies, who are mourned by no one, has helped to elevate the overall quality of the organizations that remain in business.

The nature of the practitioners

Another factor that contributes to the competence of the consumer electronics servicing community is the nature of the technician. The technician got into the business in the first place because he has a curiosity, a desire to know how electronics products work and why they fail, and a drive to be able to restore to normal operation a product that has failed. This drive doesn't fade, it doesn't disappear, it stays strong, or even strengthens.

So when the engineers who design consumer electronics design a new product, or a product based on new components and new principles, the technician feels compelled to learn about it, understand it, and service such products that have failed. Given that kind of drive, the competent electronics servicing technician constantly wants to keep on top of what's new. And the results of that drive help to contribute to the positive image of consumer electronics service.

Given these circumstances, and the character of the practitioners, that consumers are generally highly satisfied with the service they get and the people who provide the service should really come as no surprise.

Congratulations servicers, and keep up the good work. ■

Nils Conrad Persson

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Research finds 'unprecedented' satisfaction with home theater equipment

Home theater owners continue to voice "unprecedented levels of satisfaction" with their equipment, the Consumer Electronics Group of the Electronic Industries Association (EIA/CEG) reported today.

A survey, conducted in May and announced at the CES Specialty Audio & Home Theater Show, EIA/CEG asked 500 home theater owners to identify any other recreational and leisure time products they owned and to then compare that product's "entertainment value for the money" with their home theaters. The results:

- 83 percent say their home theater is a better value than their pool table;
- 72 percent say their home theater is a better value than their hot tub;
- 74 percent say their home theater has a better value than the value of their exercise equipment;
- 70 percent say their home theater is a better value than their motorcycle;
- 63 percent say their home theater is a better value than their boat;
- 56 percent their home theater is a better value than their swimming pool; and
- 50 percent say their home theater is a better value than their camper or recreational vehicle.

In each comparison, those not selecting home theater said the other product was a better value or that the two were equal.

In the survey, 9 in 10 home theater owners said they were satisfied with their systems' picture quality, and 6 in 10 were "very satisfied." Audio quality received even higher marks—93 percent said they were satisfied with the quality of their home theater's sound, and 68 percent reported they were "very satisfied."

In addition, by a margin of more than two to one, home theater owners agree that "watching a movie on a home theater is more fun than going out to the movies," according to the latest EIA/CEG survey.

For example, in last fall's national survey, 8 in 10 home theater owners said watching a movie at home is a better value for the money than going out to a theater, and a majority reported that the quality of both the picture and sound from their home theaters matched or surpassed the movie theater's.

In the May survey, 41 percent of home theater owners said the family had spent more time together since the home theater was installed, and a majority (52 percent) agreed that, "since getting a home theater it's easier to plan time together."

According to the research, families that own home theaters are most likely to use it to watch a movie that has been rented or purchased. More than 9 in 10 home theater owners (94 percent) report their families gather for movies on the home theater one or more times each month. Families also gather to use the home theater to: watch movies on cable or broadcast television (80 percent), watch their favorite weekly TV series (78 percent), and watch sporting events (51 percent).

The home theater boom shows no sign of letting up. There were 4.2 million home theater households at the start of 1995 and there will be 10.8 million by the end of the year. Many factors are contributing to this phenomenal success—a wide array of prices, more choices in cabinetry, and sophisticated retailers. But the most important is the unprecedented level of satisfaction from families that have purchased the components and made home theater part of their lives.

Information contained in this release was obtained during May 1995 via telephone interviews. Approximately 1,200 interviews were conducted with U.S. heads of households across three groups: 500 home theater system owners, 574 component stereo system owners, 500 randomly selected consumers not owning a home theater or stereo system. Individual samples will not add to total interviews since some consumers owned both a home theater system and stereo system. Survey questions were designed by CEG and administered by the Verity Group, Inc. from their headquarters in Fullerton, CA. All results have a margin of error of +/- 4 percentage points.

Philips announces "No repair necessary" test program

The Philips Service Company, a division of Philips Consumer Electronics Company, has announced that it will test a "No Repair Necessary" (NRN) program to improve customer service and enhance servicer profitability. The NRN program is designed to improve customer service by enhancing a service over-the-phone problem-solving capabilities and to improve the servicer's profitability by avoiding NRN calls and providing compensation should an NRN call still be required. Premiering Sept.1 and running until Dec. 31, 1995, the NRN test program will be open to select independent authorized servicers in the Southeast.

"We recognize that today's consumer buying patterns are changing from purchasing electronics from retailers with knowledgeable service operations to more mass merchandiser sales," said Mike Johnston, Senior Vice President and General Manager, Philips Service Company. "The NRN program reflects the fact that the servicer's location is probably not where the consumer bought the product. With NRN, we are providing more training to servicers to enable them to solve customer problems over the phone and compensating required on-site NRN calls."

According to Johnston, servicers who sign the NRN contract will be given an NRN training videotape and a "Save-a Call" card containing the top television and projection television problems that become NRN problems. This list was compiled from thousands of phone calls received in Phillips Service Company's information center. Johnston added that the system should save servicers time and will allow consumers to enjoy their products right away. Should NRN service still be necessary, the company will pay for the call at the minor labor rate.

Initially color televisions, projection televisions and combis will be included in the program. Other product categories will be evaluated at a later date.

Overall gain in video equipment sales for the first half of 1995

Rebounding from declines in the first two months of the year, video equipment sales ended the first half of 1995 with an overall gain of three percent, according to the Electronic Industries Association's Consumer Electronics Group (EIA/CEG).

TV sales were down 2 percent in the

first six months posting only one increase, an 11 percent surge in March. Especially sluggish were sales of 20-inch models, which fell almost 25 percent in the first half, while 19-inch sets managed a five percent gain. Sales of sets 25 inches and larger were up two percent to 4.3 million units, and sales of sets 27 inches and larger 12 percent. The industry still plans to meet sales expectations of more than $15 billion dollars for all video products, of which more than 50 percent should come from color TV sales.

"Most consumer goods have shown lower sales versus one year ago. However, growth in demand for larger screen sizes and attractive consumer pricing are optimistic consumer electronics trends," said Ron Marsiglio, Senior Vice President and General Manager of color TVs for Philips Consumer Electronics Company.

As expected with the high growth of home theater sales, projection televisions were the steadiest performer for the first six months of the year. Sales were up 33 percent in June alone and 28 percent over January through June of 1994. All screen sizes have been strong so far this year. Models 49 inches and smaller rose 12 percent in the first half, while 50 inch to 54 inch sets were up 44 percent. EIA/CEG estimates 10.8 million homes in the US will have the equipment necessary for home theater by the end of the year, a 150 percent increase from 1994's numbers.

Propelled by nearly 30 percent growth in sales of hi-fi stereo models (accounting for 33 percent of sales), more than 1 million VCRs were sold to dealers in June but are flat year to date. Some 85 percent of American TV households own a VCR, but as is the case with color televisions, there is a strong demand from second-time buyers who are seeking replacements, upgrading their equipment or adding a secondary unit to their home video systems.

The shift to larger screen size TV/VCR combinations is evident. During the first half of last year, sales of models 14 inches and larger accounted for 36 percent of total sales. This year the percentage has risen to 45 percent as sales have grown 29 percent. Sales of all models were up four percent in the first half of the year and should hit $906 million by the end of 1995.

Camcorder sales has but one down month in 1995, on the way to posting a 10 percent increase. After a 14 percent decline in February, camcorder sales set four straight months of double-digit growth, including a 16 percent gain in June. With the features and add-ons available and with the average unit price of camcorders falling each year, this hot consumer product will top the lists of numerous buyers this Christmas season, helping the industry to reach its $2 billion-plus camcorder sales goal for 1995.

Test equipment catalog

Tucker Electronics announces their new full-line catalog. This Test and Measurement Product Guide contains over 5000 new and used instruments plus hundreds of components and specifications.

The company provides instruments and services world wide, to both companies and hobbyists. Their full service, state-of-the-art laboratory offers repair, calibration, even complete refurbishment of electronic equipment.

Circle (80) on Reply Card

Virtual instrument demo and brochure

National Instruments announces new LabVIEW demonstration packages and a new, 16-page, full-color brochure. The demonstration packages and brochure contain information on the software as well as virtual instrumentation. They also explain how users can save money and increase productivity by building "user-defined" instruments. Scientists and engineers can use the software with data aquisition (DAQ) and instrument control hardware to build systems on Windows, Windows/NT, or Windows 95 PCs, Macintosh/Power Macintosh computers, SUN SPARCstations, and Hewlett-Packard 9000 Series 700 workstations.

The demo is based on Version 3.1.1 of the company's graphical instrumentation software package. This means that users can view all palettes to see the functionality that exists in the full system. It features a manual as well as a menu-based system, so users can view a variety of applications and information.

When the demo is launched, the user can automatically run a variety of applications involving instrument control and data aquisition, analysis, and presentation for test and measurement and process monitoring and control applications. In addition to the many applications featured, information about the Alliance Program, customer education, technical support, and add-on toolkits is also available at the click of a button. The menu system and each of the featured applications were created entirely using the company's software. Users can also save virtual instruments (VIs) in a special directory during a single session.

Circle (81) on Reply Card

Task lighting catalog

A new catalog featuring a wide range of task lighting products for electronics assembly, industrial, laboratory, medical, and quality control applications is being offered by O.C. White Company

The catalog describes a wide range of task lighting products and features the new Vision Lite 2000 variable illumination magnifying lamp with a large 7.5 inch x 6.2 inch lens and glare-free bulb for shadowless viewing. Magnifying,

machine, drafting, exhaust lamps, and microphone arms are also included.

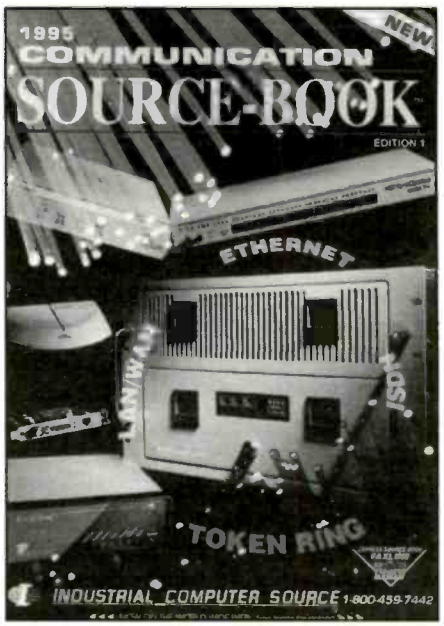
Providing descriptions, specifications, and full-color photographs of each product line, the 12-page catalog describes the features and applications for each item. All products are UL listed and many are MIL STD 2000A approved.

Circle (82) on Reply Card

Communication Source-Book

Industrial Computer Source announces its new 1995 Communication Source-Book Edition 1, a complete source for networking products and accessories.

This 56-page catalog features over 1000 model numbers for a wide variety of product solutions, including: stackable Ethernet hubs, upgradeable from 16 to 80



ports, SynOptics compatible, 8 port NetExpander FDDI concentrator, emi/rfi immune for factory networking, 7520 series chassis provide up to 20 slots for I/O intensive systems, remote access concentrators provide LAN connectivity over wide area networks, and a complete line of single-board and motherboard CPUs up to 100MHz Pentium.

Product sections include: Ethernet and token ring, FDDI, multimedia concentrators, bridges and routers, remote access, printservers, testers, operating systems, UPS, serial communications, real-time clocks, chassis and CPUs. Each product description contains specs, ordering and price information.

A reference section at the front provides an easy-to-use look-up chart for comparing the performance and specs of the most popular Ethernet network cards from 3COM, Intel, Cognet and XirCom. Additionally, detailed tutorials on the basics of Ethernet, token ring, bridges and routers are provided to bring both new and veteran networking users up to speed quickly on these products.

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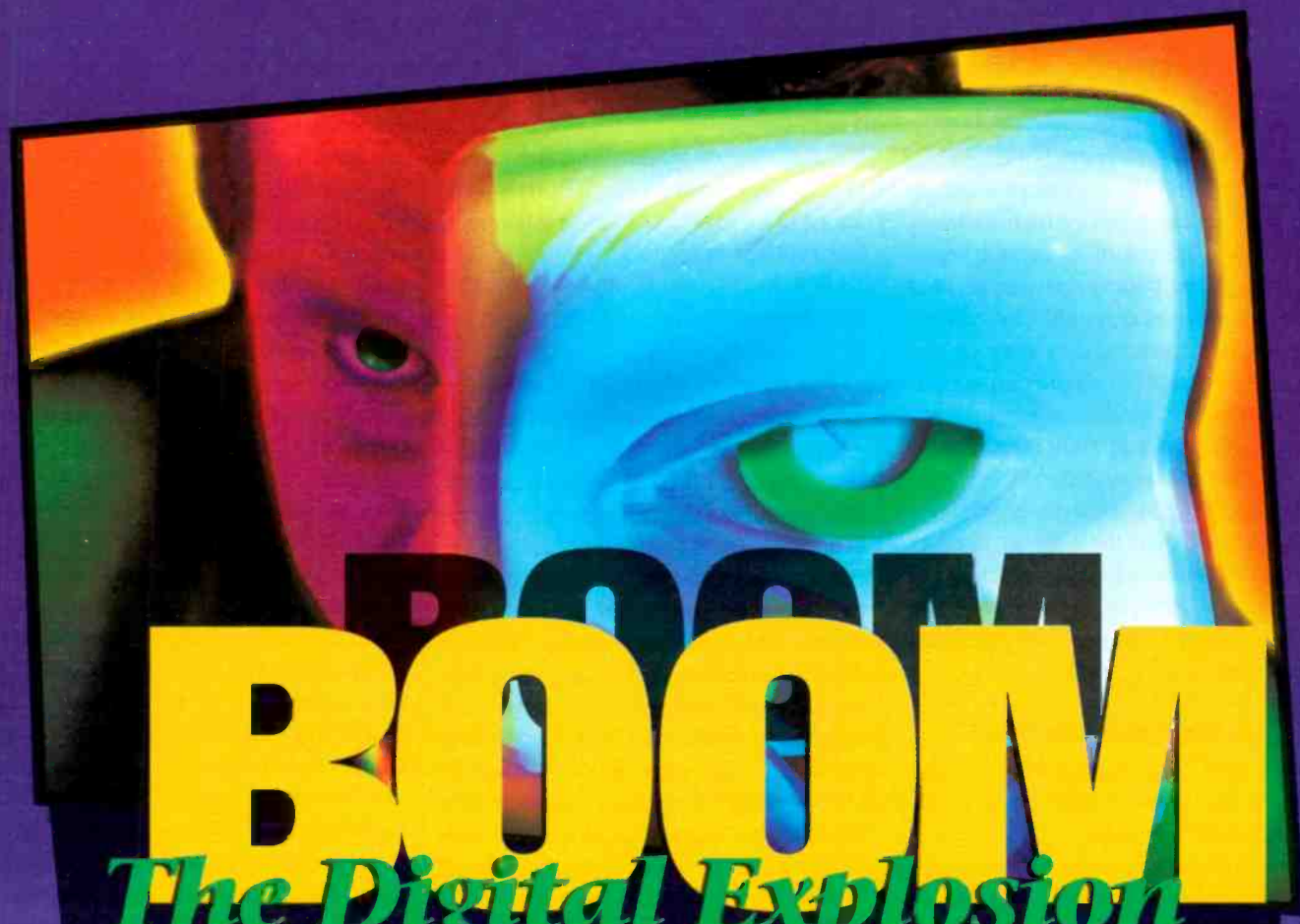

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Circle (56) on Reply Card

Switched mode power supplies

By Jurgen Ewert

The power supply is the building block of electronic equipment that provides appropriate voltages and currents to the circuits. Most pieces of electronic equipment other than battery operated products incorporate a power supply. For many applications a regulated dc voltage is necessary to operate the circuits properly.

There are two kinds of regulated power supplies: linear and switching. For the service technician switched mode power supplies (SMPS) are usually harder to troubleshoot than their linear counterparts. The following article describes the differences between linear power supplies and SMPS and provides some hints for troubleshooting SMPS.

Linear power supplies

A power supply performs several important functions in converting ac line voltage to dc voltages:

- *Voltage transformation;* changing the ac line voltage (120V) into one or more suitable voltages to power the circuits (power transformer).
- *Isolation;* electrically separating the line input and the output of the power supply (power transformer).
- *Rectification;* converting the ac line voltage (60Hz) to dc (rectifier).
- *Filtering;* smoothing the ripple in the rectified voltage (smoothing capacitor, choke).

Ewert is an independent consumer electronics servicing technician.

- *Regulation;* controlling the output voltage to a constant value in spite of variations in line voltage, load, and temperature (voltage regulator).

Figure 1 is a linear power supply that incorporates the functions described.

The elements of the power supply

A typical linear power supply consists of a transformer, a rectifier, a filter capacitor, a regulator, and an output capacitor. The function of each of these components is described in the following text.

- *Transformer T1:* A transformer is used in most power supplies to change the voltage and to provide isolation. Usually the transformer steps down the voltage for transistorized equipment. For equipment with vacuum tubes, e.g. audio amplifiers, the transformer steps up the voltage. If several different voltages are needed for the circuits, more than one secondary winding is used on the power transformer.
- *Rectifier D1:* In the circuit of Figure 1 the rectification is performed by a bridge rectifier. The output voltage of the bridge rectifier is shown in Figure 2. The configuration of the rectifier in a given product may be different from the one shown here. For some applications it is appropriate to use a half-wave rectifier that consists of only one diode. However in most power supplies full-wave rectifiers are used because the full-wave rectifier is more energy efficient, and filtering of the rectified voltage is easier. The common circuits of rectifiers are shown in the drawing of Figure 3.
- *Filter capacitor C1:* The filter capacitor C1, usually a large value electrolytic capacitor, must hold its charge between the half cycles of the rectified voltage and is charged out by short current pulses near the peak voltage (V_{PEAK}) depending on the load (Rl). The resulting voltage at the output of the smoothing capacitor C1 is shown in Figure 2.
- *Linear regulator IC1:* A linear regulator may be either a circuit constructed from discrete components, or it may be an IC regulator. The regulator provides a relatively constant output voltage in spite of line and load variations; suppresses the output ripple voltage by means of its regulating action; and provides output current limiting to protect the power supply from overload and short circuit conditions.
- *Output capacitor C2:* The output capacitor, after the linear regulator, gives the power supply a low ac output impedance. The value of C2 is usually lower than that of C1. Some linear regulator ICs require a certain value of C2 to provide for stable operation.

Switched mode power supplies (SMPS)

Switching power supplies were developed in the 1960's and gain more and more popularity because of their outstanding qualities.

Nowadays switched mode power supplies (SMPS) are used in various consumer electronics equipment. At first they

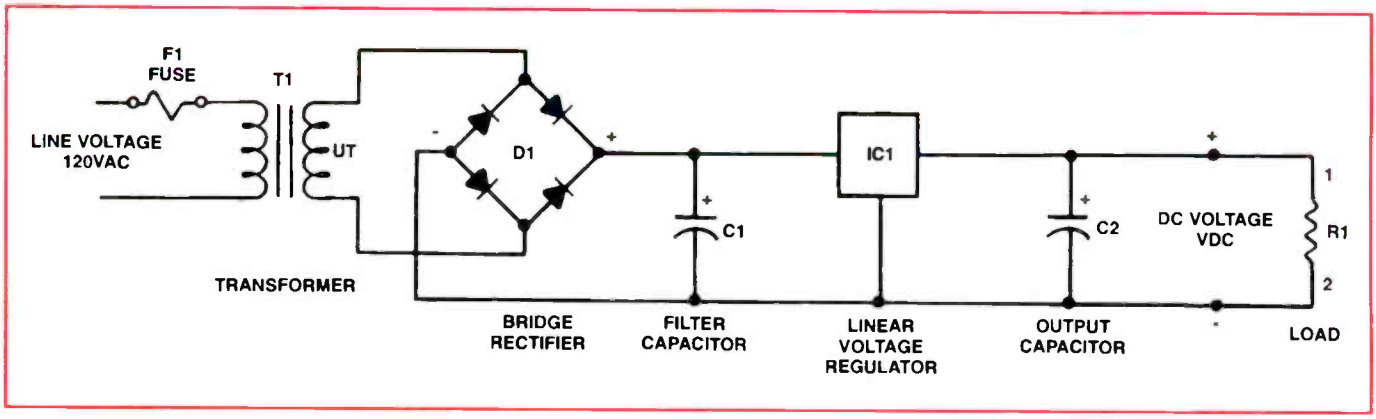

Figure 1. A typical linear power supply.

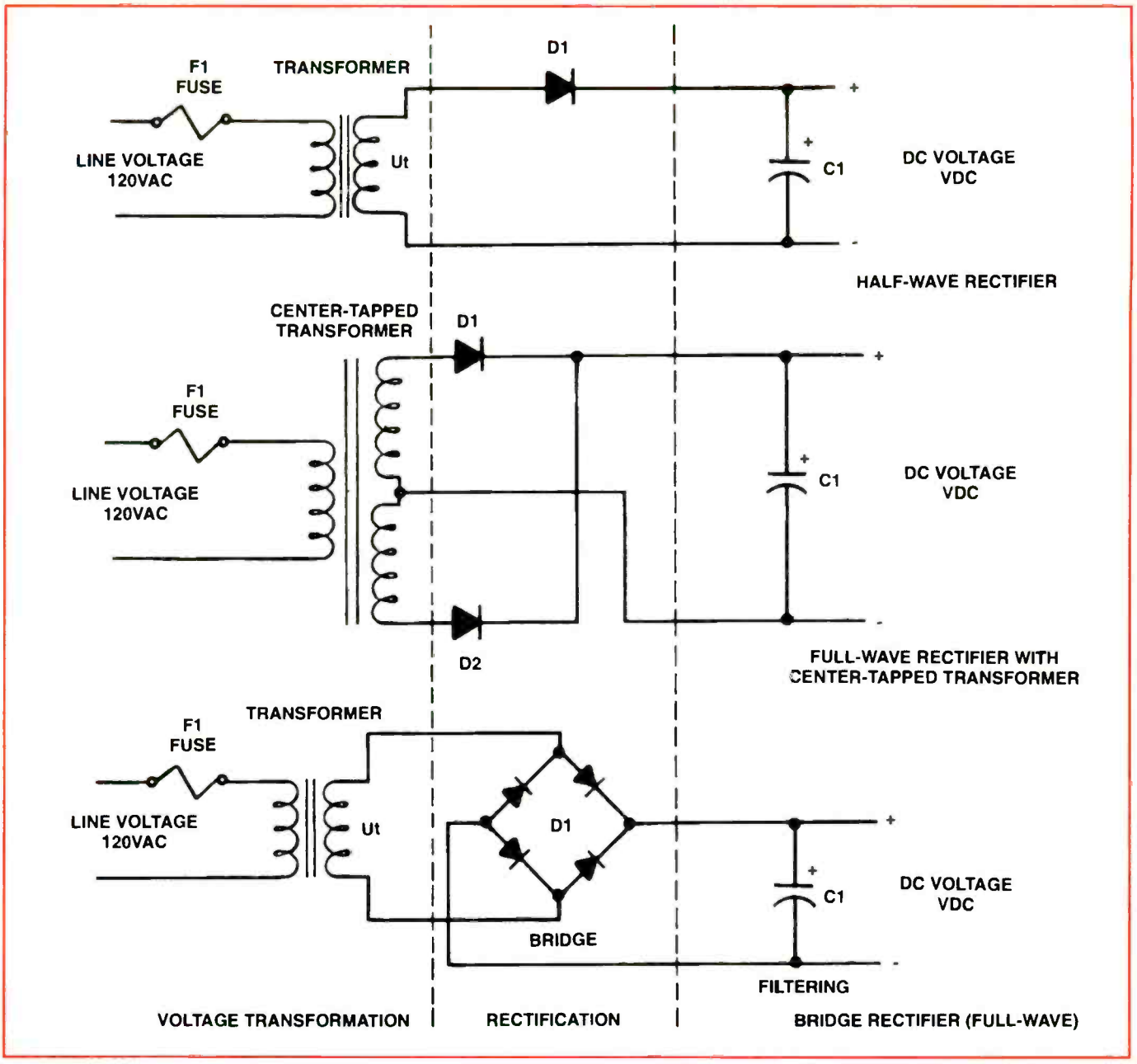

Figure 2. Several variations of the linear power supply have been commonly used in consumer electronics products.

were mainly used in TVs and computers. Now you can find SMPS more and more in VCRs and even in microwave ovens. The advantages of SMPS are obvious when it comes to weight. If you lift a VCR or a microwave that contains a SMPS and then one that contains a linear power supply, there is a noticeable difference.

In switching power supplies, rectification of the line voltage is the first step. This dc is filtered by a capacitor. The dc voltage at the filter capacitor is then pulsed by a switching device, for example a power transistor or a power MOSFET. Regulation in a SMPS is performed by pulse-width modulation (PWM) of the pulsed dc voltage. Figure 4 illustrates pulse-width modulation. During the on cycles the pulse train energy is stored in a magnetic field, and during the off cycles it is used to provide output power.

The flyback switching regulator

For many consumer applications the flyback regulator is used. A circuit diagram of a flyback switching power supply is shown in Figure 5. The 120Vac/60Hz line voltage is rectified by a diode bridge (D1). There is no need to use a power transformer before rectification. The value of the dc voltage at the smoothing capacitor C1 is approximately peak value of the line voltage (165V).

The switching transistor Q1 turns the dc voltage on and off to provide current pulses to the transformer. Magnetic energy is stored in the transformer and is used during the off cycle. On the secondary side of the transformer, diode D2 rectifies the resulting ac voltage. The filter capacitor C2 smooths out the ripple.

Regulation of the dc output voltage is accomplished by comparing the output with a reference voltage (REF/AMP). At the output of an amplifier a signal controls the pulse width modulation circuit (PWM). The PWM circuit controls the duty cycle of the pulse train that drives

the switching transistor Q1.

In order for the dc output to be isolated from the ac line, this feedback loop must have isolation (ISO). This is usually accomplished by an opto-isolator or a small transformer. There are two ground lines isolated from each other. Oneof these lines is connected to the line voltage the other one is the ground of the circuits and the equipment case.

The forward switching regulator

The forward switched mode power supply is illustrated in Figure 6. Although the circuit looks very much like the flyback converter, there are fundamental differences in their operation. This circuit does not store a significant amount of energy in the transformer. This circuit stores the energy in the output inductor.

When the switching transistor Q1 is turned on, an output voltage is generated at the secondary winding of the transformer and current flows through diode D6 into the inductor L1. The higher the duty cycle, the higher the secondary output voltage. When Q1 switches off, the current through the inductor cannot change rapidly and continues to flow through diode D7.

In the forward converter, current flows from the energy storage component during both halves of the switching cycle. Therefore the forward converter has a lower output ripple than the flyback converter under the same output conditions.

SMPS vs linear power supplies

Linear power supplies have many desirable characteristics such as excellent regulation, simple circuitry, and low output ripple, they are not noted for their high efficiency. A linear power supply converts an unregulated dc voltage into a lower regulated voltage by throwing away the power that is created by the difference between the two voltages as heat. Typically the efficiency is around 50%.

SMPS are popular because of their high efficiency and high power density. To improve line and load regulation of SMPS, linear post regulators are frequently used. The output peak-to-peak ripple of switched mode power supplies is usually higher than that of linear regulators. Although the rms value of the ripple is less, it is the peak-to-peak value that is significant in most applications.

Switched mode power supplies have a slower transient recovery time than do linear regulators. Transient recovery time is the time the power supply needs to settle within the specified output voltage tolerance after a step change in output load current. Such step changes occur, for example, in audio amplifiers, so SMPS are not used in audio power amps.

The hold-up time of a SMPS, on the other hand, is much longer. A longer hold-up time means that if the line power fails momentarily, the output voltage remains within specification longer.

Another advantage of SMPS is the possibility of operating the equipment over a wide range of line voltages. There are devices, for example, that operate between 100Vac and 250Vac with no need for a voltage range switch. The characteristics of linear and switching power supplies are shown in Table 1.

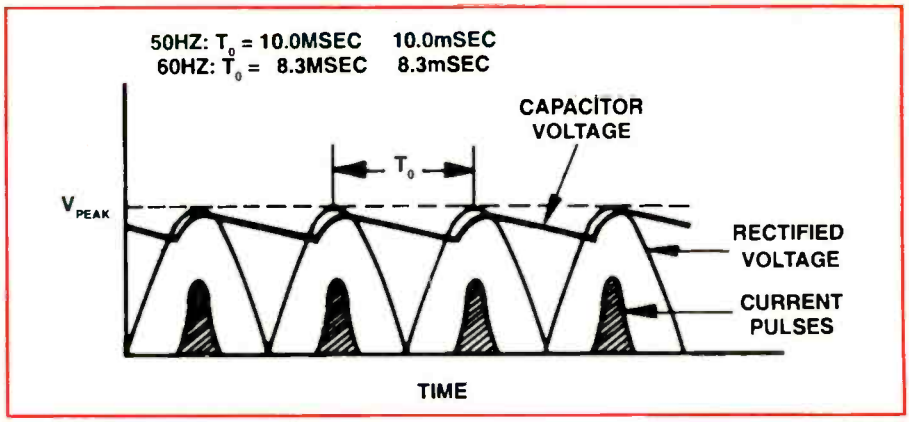

Figure 3. The filtered output of the bridge rectifier looks like this.

Troubleshooting SMPS

SMPS are a real challenge for service technicians because the circuitry is more complicated than in linear power supplies. It is sometimes difficult to troubleshoot equipment powered by SMPS because you just don't know where to start if the patient shows no signs of life. These power-up problems are common in switched mode power supplies.

A real world example of a switching power supply found in a VCR is shown in Figure 7. This power supply is a flyback regulator with multiple outputs. The schematic shows the building blocks of a SMPS described above.

To prevent interference with other electronic devices, a line filter (L1, C2, C3) is used at the input of the power supply. The rectifier (BD1) and smoothing capacitor (C5) convert the ac line voltage into dc. Switching transistor (Q1) turns the primary coil of the pulse transformer PT1 on and off. A snubber circuit (C4, C21, D1, L2, R6) prevents erratic oscillation at the switching transistor. The on/off time of the switching transistor is controlled through transistor (Q2) and the surrounding circuitry. An opto-isolator (IC1) isolates the outputs of the power supply from the line voltage and transmits the control signal to the PWM circuit. The output voltage sensing (R10, R11) and voltage comparison (IC2) is done at the 6V output. Linear post-regulators are used for the 33V and -25V outputs.

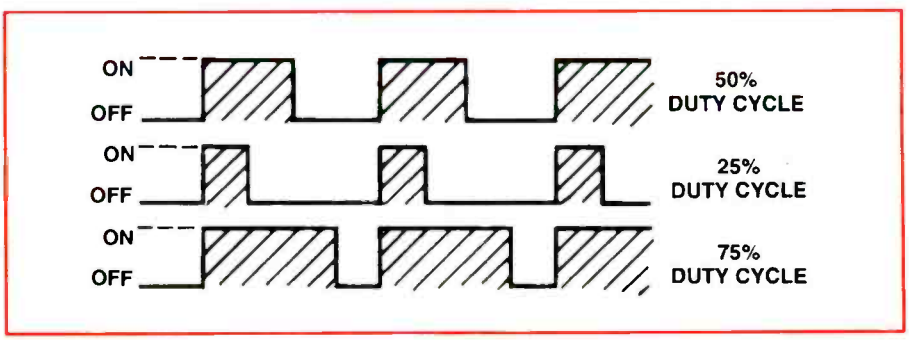

Figure 4. In pulse-width modulation, during the on cycles the pulse train energy is stored in a magnetic field. During the off cycles this energy is used to provide output power.

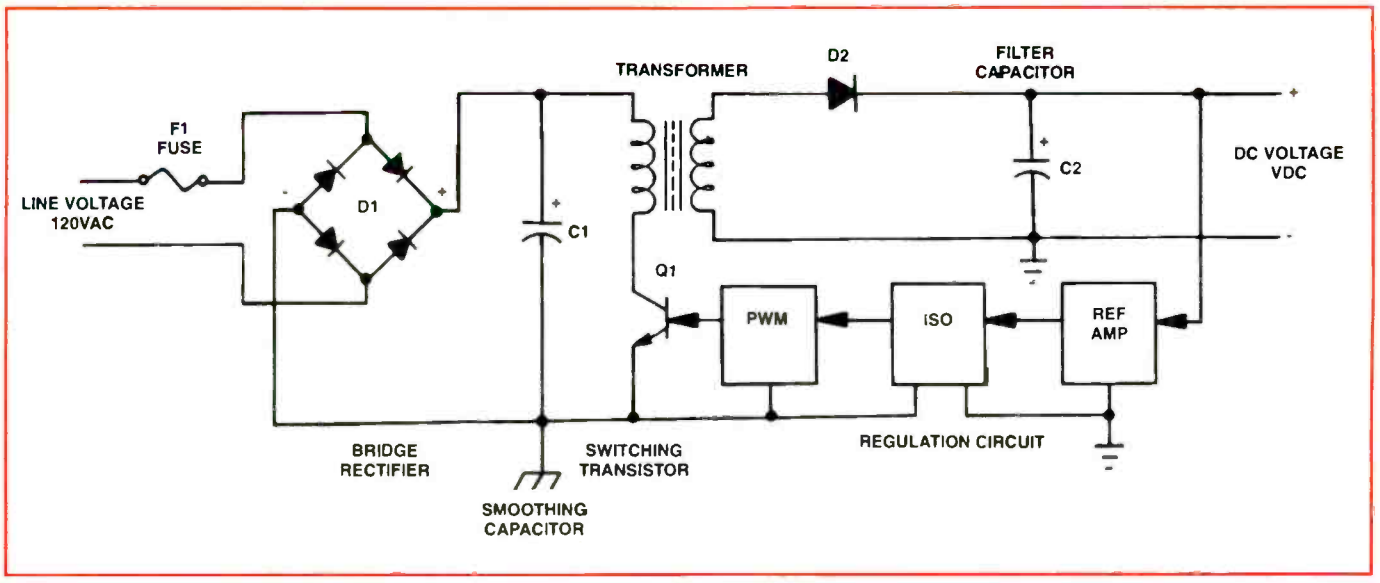

Figure 5. For many consumer electronic applications the flyback regulator, such as this one, is used. A diode bridge is used to rectify the 120Vac/60Hz line voltage. There is no need to use a line voltage transformer before rectification.

A malfunction in a SMPS may occur in a number of different trouble spots. If I start troubleshooting a piece of equipment that does not power up and I find a switching power supply, I check the fuse first. If the fuse is blown, I put a new fuse in and power the unit up very slowly using a variable isolation transformer. By monitoring the current, you can tell if there is still something wrong.

Very often after replacing a fuse, I have noticed that the equipment draws excessive current. It is neither necessary, nor is it a good idea, to continue this experiment until the fuse blows again. The bridge rectifier is directly exposed to all power surges of the line voltage and the fuse is often not fast enough to protect the rectifier. In many cases some of the diodes in the bridge are shorted causing the excessive current. Testing the diodes is next.

If the rectifier portion of the power supply is a bridge rectifier block, I use basically the same test procedure that I use

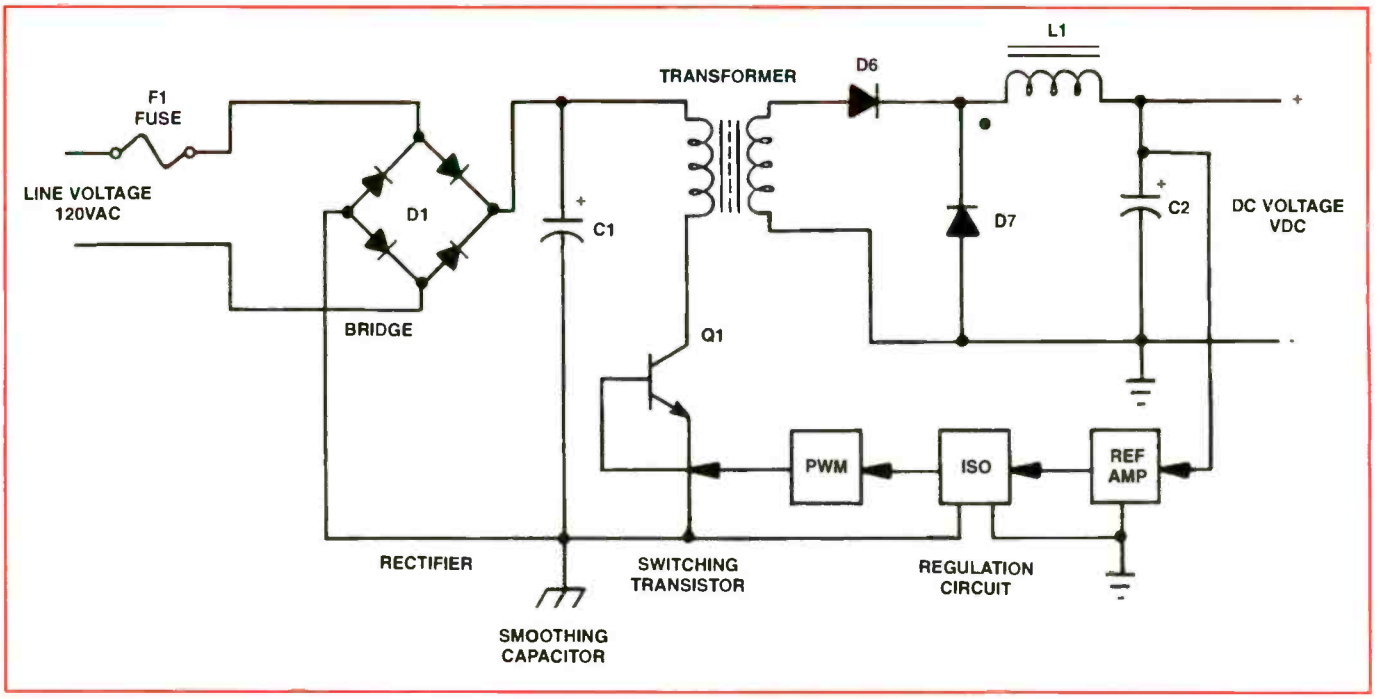

Figure 6. This is a forward switched mode power supply. Although the circuit looks almost like the flyback converter, there are fundamental differences in the operation. This circuit does not store a significant amount of energy in the transformer but in the output inductor.

when the rectifier consists of discrete diodes. Replacing the damaged diodes or the bridge solves the problem in many cases of SMDS malfunction.

If there is no power up but the fuse is good, the cause of the problem is usually tougher to find. In this case I check the dc voltage at the smoothing capacitor first. If the voltage is close to the specified voltage, in the case of this VCR, 160V, I check the voltage at the switching transistor with an oscilloscope. You can usually perform these checks without a schematic diagram because these components are usually easy to find.

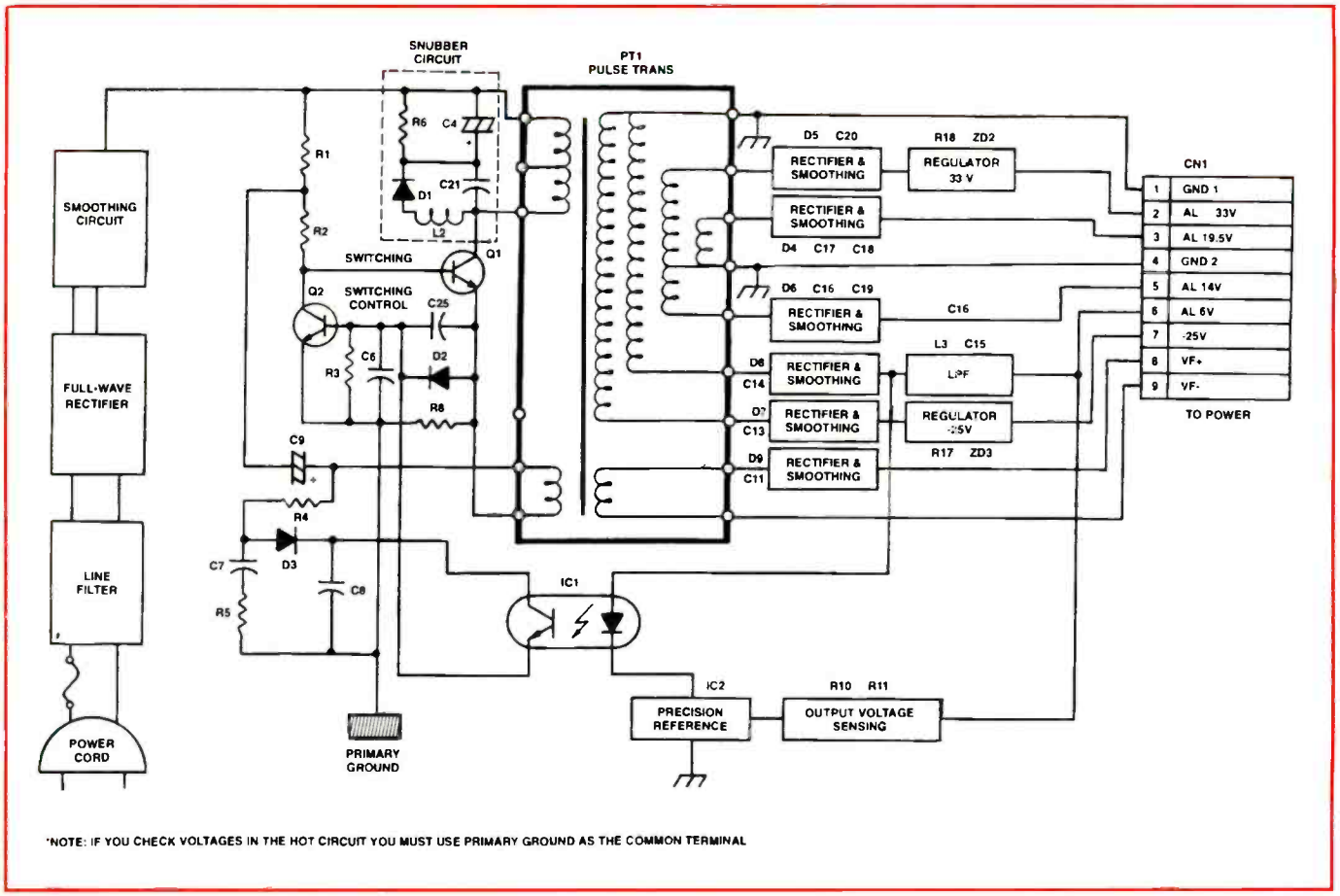

Figure 7. This is a diagram of a real world switching power supply found in a VCR. This power supply is a flyback regulator with multiple outputs. The schematic shows the building blocks of a SMPS described in the article.

If I find the specified voltage at the collector of the switching transistor, I check the transistor next. Very often the transistor is damaged by surges or overheating. If the switching transistor is damaged, there is no oscillation in the entire power supply because the feedback loop is open.

In the case where there is no voltage at the collector of the switching transistor, there could be something wrong in the transformer, or it might be a broken printed circuit board trace.

If the output voltages are too low and some pulses are seen at the switching transistor you should suspect a failure in the output sensing, opto-isolator or switching control, or a shorted output.

SMPS are complex circuits and they do not work at all if there is something wrong in the feedback loop. Sometimes it is necessary to test one component after another to find the trouble spot.

The leakage current test

To protect your customer from an electric shock and yourself from legal trouble you should perform a safety leakage current test, especially after working on a power supply. Leakage paths between line voltage and the outputs of the switching power supply are mainly the pulse transformer and the opto-isolator, but debris and burned material on the circuit board can also cause leakage.

You will find that all service manuals show you how to perform the leakage current test. Instead of building the suggested circuit to perform the test, I find it easier to use an isolation transformer with a built-in leakage tester. Troubleshooting and repairing SMPS is sometimes a difficult procedure, but systematic work and knowledge of how they work can help to speed up the process. Perhaps this article will help you to solve your next SMPS-problem. ■

SPECIFICATION	LINEAR	SWITCHING
LINE REGULATION	0.02% to 0.05%	0.05% to 0.10%
LOAD REGULATION	0.02% to 0.10%	0.10% to 1.0%
OUTPUT RIPPLE	0.5mVrms to 2mVrms	25mVpp to 100mVpp
INPUT VOLTAGE RANGE	+/-10%	+/-50%
EFFICIENCY	40% to 55%	60% to 80%
POWER DENSITY	0.5W/IN^3	2.3 W/IN^3
TRANSIENT RECOVERY	50µSEC	300µSEC
HOLD UP TIME	2mSEC	32mSEC

Table 1. The characteristics of a linear power supply vs the characteristics of a switching power supply are shown in this table.

Getting the most out of depot maintenance centers

By the ES&T Staff

Most service centers today are well equipped with the latest in tools and test equipment. They have wide bandwidth oscilloscopes, some specialized test equipment, and the latest soldering/desoldering tools. Moreover, the technicians in these modern service centers are bright, highly skilled, and continually trained in the most modern of consumer electronics products as well as being knowledgeable of the most up-to-date techniques.

In spite of these factors, there are some instances where it simply doesn't make sense for the service center to perform service. Historically, service centers did not service tuners. For a number of reasons, servicing of tuners requires specialized skills and tools that the typical service center just did not possess.

If the tuner was bad, it was either simply replaced with a new one from the manufacturer, or sent to a service depot where it was either refurbished and returned to the service center to be put back into the set, or more likely traded for a tuner that was previously taken from another set and refurbished.

When some TVs became modular, service depots began to service modules. In many cases, it just wasn't cost effective for the service center to service modular sets to the component level. Because depots would refurbish tens or hundreds of modules as opposed to a service center which would see only one, it simply made good economic sense for a service center to send a module to the depot for exchange. When the servicer received the new module all he would have to do is install the refurbished module, mark up the cost for a profit on the module, and return the renewed product to its owner for less than it would have cost had the service center done the work in house.

Even more so with computers

If depot service made sense with tuners and modules, it makes even more sense, in many cases, with computers. A personal computer consists of a number of disparate elements: the computer, hard drive, floppy drives, CD-ROM drive, interface boards, keyboard, monitor, and printer. Many service centers are equipped and trained to service many of these elements, but may not be prepared to service them all. For example, many service centers service the computer itself and the monitors, but don't wish to, or are not equipped to, service some of the computer peripheral devices.

For example, because of the close tolerances and operating distances involved in a hard drive these units are sealed to keep out dust and dirt, which could cause catastrophic failure. Because of this sensitivity to contaminants, hard disk drives must be built, and serviced, in a clean room. Clean rooms cost a great deal of money to build and maintain, and therefore in order to be cost effective a lot of hard drives have to be serviced.

But even if servicing of a given computer-related product doesn't require special, expensive facilities, it might make sense for a smaller service center to have some of its work performed by a depot. For example, if a small service center is just getting started in computer service, it will take time for the technicians to get up to speed on the products. Rather than jump right in and spend the time, effort and dollars to train technicians, buy test equipment and establish a parts inventory to fix everything at once, it might make sense to service the main computer unit and monitor, and then send the remainder of the work to a depot.

It's standard practice elsewhere

Some service centers seem to be reluctant to contract out work, but it does make sense in many cases, and it is standard practice in other businesses. For example, if you bring your car in to the auto service shop for some work, and the work includes damage to the body that will require some straightening, filling, sanding and painting, the chances are very great that the service center will perform the mechanical work to fix whatever is wrong with your engine, transmission or whatever, but will send the car out to a body shop with whom they have an arrangement and get the body work done there. It just doesn't make sense for them to maintain the skills, specialized equipment and supplies for body work when they don't do much of it.

It could help keep customers

Customer satisfaction is another good reason for working with a depot. What happens if a customer brings parts from a computer system into a service center and the receptionist says that the service center will service the computer, and the monitor, but that the customer will have to bring the printer somewhere else for service? Most consumers like the idea of one-stop shopping, whether they're shopping for a product or a service.

This customer might put up with the inconvenience of bringing the products two different places this one time, but the next time he needs service he'll probably check around until he finds a service center that can do it all.

A further complication of having the work done by more than one service center is that if the customer gets all of the units back and for some reason when he connects them together the system doesn't work; who does he turn to now?

A list of depots

For the convenience of readers, the following is a partial list of depots that provide service for consumer electronics products and for personal computers and peripherals.

3E Corporation
Monitor Repair
165 Front Street
Chicopee, MA 01013
413-594-2772
800-682-5175
Fax: 413-594-7283

AMCOR
373 Route 46 West
Fairfield, NJ
201-575-5900/800-542-6267
Fax: 201-575-8469

Analog Technology Center Inc.
62 Route 101A
Amherst, NH 03031
603-673-0404

C. Hoelzle Associates, Inc.
17321 Eastman Street
Irvine, CA 92714-5523
714-251-9000
Fax: 714-251-9291

Cerplex Group, Inc.
332 E. LaPalma Avenue
Anaheim, CA 92705
714-566-3900
Fax: 714-259-1944

Curtis Mathes Parts & Service
10911 Petal
Dallas, TX 75238
214-494-6411/800-657-1979
Fax: 1-214-494-1585

Daisy Disc Corp.
5 Northern Boulevard, Unit 2
Amherst, NH 03031
1-603-598-9918
Fax: 1-603-598-9921

Datatech Depot, Inc.
1480 North Lakeview Avenue
Anaheim, CA 92807
714-970-1600
Fax: 714-970-1670

Depot America
1340 Campus Parkway
Neptune, NJ 07753
800-648-6833

The Dot Shop
12025 NE Summer Street
Portland, OR 97220
503-256-7585
800-487-6025
Fax: 503-256-7588

EF Industries
12624 Daphne Avenue
Hawthorne, CA 90250
213-777-4070

Electrodyn, Inc.
501 E. Temperance Street
Ellettsville, IN 47429
812-876-2522
800-937-1023
Fax: 812-876-2533

Electroservice Laboratories
6085 Sikorsky Street
Ventura, CA 93003
805-644-2944
800-336-4ESL
Fax: 805-644-5006

Fessenden Technologies
116 3rd Street
Ozark, MO 65721
417-485-2501
Fax: 417-485-3133

Genicom Corporation
1 Genicom Drive
Waynesboro, VA 22980-1999
800-535-4364
Fax: 703-949-1500

Gore Laboratories, Incorporated
3 Northern Boulevard.
Amherst, NH 03031
603-672-4673
Fax: 603-672-5652

Guardian Computer Support, Incorporated
1177 Quarry Lane, Suite F
Pleasanton, CA 94566
510-846-3649
800-752-8733

HI-TEK Services, Incorporated
32950 Alvarado-Niles Road
Union City, CA 94587
510-489-8909
800-285-3508
Fax: 510-489-5908

Hy Tec Dealer Service
4548 Parkbreeze Court
Orlando, FL 32801
407-297-1001
Fax: 407-297-4310

Impact Printhead
10435 Burnet Road Suite 114
Austin, TX 78758
512-832-9151
800-677-7521
Fax: 512-832-9321

International Disk Services, Incorporated
1530 Montague Expressway
San Jose, CA 9513
408-432-0537
Fax: 408-434-1015

LaserImpact
10435 Burnet Road, Suite 114
Austin, TX 78758-4450
512-832-9151
800-777-4323
Fax: 512-832-9321

Logistics Management, Incorporated
3955 Vantech Drive, Suite 15
Memphis, TN 38115

Mac Shack
28 Willow Pond Way Suite LL3
Penfield, NY 14526
716-377-9230
Fax: 716-377-9573

Magnetic Data Incorporated
6754 Shady Oak Road
Eden Prairie, MN 55344
800-328-3441

Main Source Electronics
9260 Owensmouth Avenue
Chatsworth, CA 91311
818-882-7500
800-882-1238
Fax: 818-882-7785

Man & Machine, Incorporated
3501 Hamilton Street
Hyatsville, MD 20782
301-277-3760
Fax: 301-779-1455

Matrix Components
13581 Pond Springs Road Suite. 315
Austin, TX 78729
512-258-7590
800-726-1503
Fax: 512-219-0021

Meltek, Incorporated
3 Victor Square
Scotts Valley, CA 95066
408-438-4986
Fax: 408-438-3459

Mesa Systems, Incorporated
5729 Sonoma Drive Suite G
Pleasanton, CA 94566-7782
510-462-9491
Fax: 510-462-8752

Micro Medics
6625 Jarvis
Niles, IL 60714
708-647-1010
800-678-5300

Module Exchange
706 Space Way
Duncanville, TX 75137
214-298-1212
800-632-6637
Fax: 214-283-1778

NorthStar MatrixServ
7101 31st Avenue N
Minneapolis, MN 55427
612-591-0009
800-969-0009
Fax: 612-591-0029

Panda Printer Products
2324 Ridgepoint Drive, Suite A
Austin, TX 78754
512-832-9385
800-580-3232
Fax: 512-339-9612

Peripheral Computer Support
2219 Oakland Road
San Jose, CA 95131
408-263-4043

Princeton Computer Support
5 Crescent Avenue P.O. Box 787
Rocky Hill, NJ 08553
609-921-8889
800-682-6158
Fax: 609-921-7693

PTS Corporation
5233 South Highway 37
PO Box 272
Bloomington, IN 47402
812-824-9331
800-844-7871
Fax: 800-844-3291

Reset, Incorporated
49 Strathearn Place
Simi Valley, CA 93065
805-584-4900
Fax: 805-583-2900

Service Electronics Incorporated
Wayne, NJ
201-284-1200 X544
Fax: 201-284-1348

SMH Electronics Company, Incorporated
21 Pattersons Brook Road. West
Wareham, MA 02576
508-291-7447
Fax: 508-291-7449

Solutronix Corporation
7255 Flying Cloud Drive
Eden Prairie, MN 55344
612-943-1306
800-875-2580

Fax: 612-943-1309

Solutronix Corporation
7255 Flying Cloud Drive
Eden Prairie, MN 55344
612-943-1306
800-875-2580
Fax: 612-943-1309

The Peak Technologies Group
8990 Old Annapolis Road
Columbia, MD 21045
410-992-9922
800-950-6372

Trilogy Magnetics Incorporated
424 N. Mill Creek Road
Quincy, CA 95971
916-283-3736
800-873-4323
Fax: 916-283-3122

Unicomp, Incorporated
800-359-5092
800-275-1901

Uptime Service Association
14450 NE 29th Place Suite 116
Bellevue, WA 98007
206-869-6668
Fax: 206-869-6229

Valtron Technologies
28309 Crocker Avenue
Valencia, CA 91355
805-257-0333
800-2-VALTRON
Fax: 805-257-0114

Voltura Enterprises, Incorporated
28 Church Street Suite 7
Winchester, MA 01890
617-721-4920
Fax: 617-721-7316

Whitaker Repair Corporation
1106 Commercial Street
Athens, TX 75751
214-675-3552
Fax: 214-677-3188

List of depots

Compact disc player optical block repairs

Compact Disc player, optical block repairs have presented the consumer electronic service industry with two challenges. The first is repair quality difficulties related to the fine alignment of components. The other, the cost of repairs has forced many CD player owners to throw away their units and opt for replacement. Both of these issues could potentially hurt customer satisfaction.

Sony has found a way to overcome these concerns. The company's engineering group has developed an inexpensive and reliable repair alternative.

Compact disc player "base unit" replacement

Sony engineers have developed a "Guts Swap" design for repairing CD players. The base unit contains the optical block, motor(s), control board aligned and adjusted on a chassis. It comes preset and tested. The bench time for an optical block replacement is cut in half or better.

If service centers return all the BU's they pull out, re-manufacturing is facilitated. Re-manufactured BU's perform as new units and are fully guaranteed.

Program overview

The program currently offers six optical block base assemblies (chassis) which cover most of the hi-fi products and many of the discman products that Sony has marketed over the past few years. The optical block assembly consists of the optical pickup, spindle motor, sled motor, chassis and drive gears, and a BD PC board (in the case of hi-fi models).

In the case of hi-fi optical block assemblies, all adjustments are on the BD PC board. They have already been adjusted to match the optical pick-up supplied with the assembly. Therefore, no readjustment is necessary when replacing the optical block assembly.

Advantages of using the optical block assembly

The optical block assemblies are fully aligned and tested, eliminating subjective adjustments. In the case of skipping, the optical pickup, spindle motor and sled motor (drive train) could all be part of the cause. Rather than replace these parts one-at-a-time, the entire assembly is replaced as a unit.

The cost for the assembly is less than the sum of the individual parts and is competitive with the cost of just the optical pickup. The time to replace the entire assembly is often less than replacing components (such a the optical pickup). In the case of most hi-fi block assemblies, checking or performing adjustments is not necessary, saving more time.

The defective block assemblies will be sent back to the design groups in Japan for analysis. The design teams feel they will be able to improve the product as a result of this analysis.

For further information please contact: Sony Service Company, National Part Division, 8281 NW 107th Terrace, Kansas City, MO 64153; telephone 816-891-7550. ■

New approaches to troubleshooting

By Greg Gibson

Electrical and electronic signals of textbook origin can look deceptively simple. Not just the standard sinewave or square wave, but more complex waveforms, or even signals distorted severely by harmonics, all seem to be uniform in appearance when you first learn about them in the classroom.

When electrical or electronic signals behave predictably, that is, when they exhibit the expected waveshape, they also exhibit predictable numeric values for voltage, current, frequency, and other parameters. This fact is the very basis for monitoring or troubleshooting with a digital multimeter, or DMM. Very often a DMM is the only tool needed to confirm that electrical or electronic systems are working to specifications.

Distorted signals

The signals found in today's commercial and industrial environments, however, whether electrical or electronic in nature, can be plagued by intermittent or sporadic faults introduced by ambient electromagnetic noise or a variety of other conditions. Or, viewing a current or voltage waveform at a load such as a motor may reveal problems inherent in the motor itself, not caused by ambient electrical conditions. In either case, readings of voltage and current that appear to be within specification can be misleading. In such cases, the visual capabilities of a multimeter with graphical readout can reveal and help to solve a host of problems.

Gibson is Design Engineer, Service Tools Division, Fluke

What is a graphical multimeter?

A graphical multimeter, or GMM, could be called an integrated test tool: a multimeter that shows the numeric readings of a DMM, the waveform view of the measured signal, and a graphical display.

Although a GMM displays waveforms in the same manner as an oscilloscope, use of a GMM does not require experience with an oscilloscope. For example, with the 860 Series Graphical Multimeters from Fluke Corporation, the graphical display of the signal is presented automatically along with the numeric reading. The user sets the front panel in the same way as a DMM; no adjustments need to be made to view the waveform.

Commercial/industrial GMM applications

The wide range of measurement applications in industrial and commercial settings illustrates the value of a graphical multimeter. These applications generally meet one or more of the following criteria.

- A piece of equipment has malfunctioned even though it is in good condition and voltages, currents, and frequencies appear to be within specification. In such a case, a visual picture can reveal anomalies in the waveform.
- Signal frequencies are in the kHz range. Signals in this range are common in electromechanical or other industrial environments and do not require the high-frequency measurement specification that an oscilloscope provides.
- The user wishes to measure two parameters; for example, voltage and frequency, but resetting the instrument for the second reading is impractical. This is often the case in environments where the user needs to keep his eyes on the display to observe changing conditions or to ensure his own safety.

Electronics GMM applications

In the testing or troubleshooting of electronic circuits, applications for a graphical multimeter are many. One typical user is the "super-technician" who

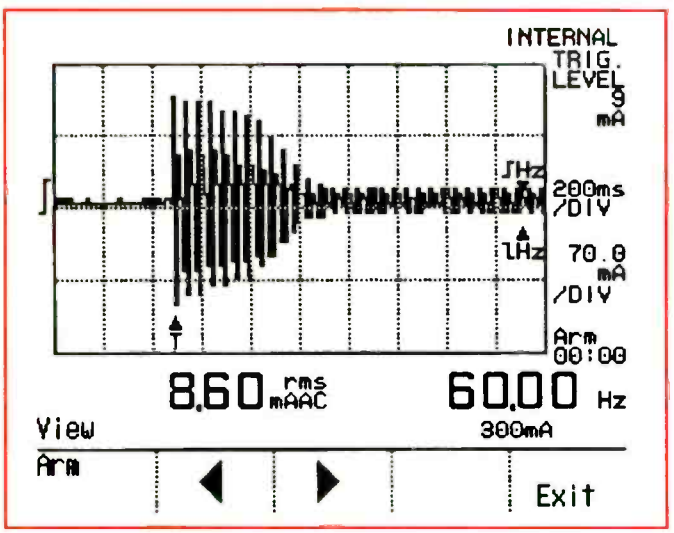

Figure 1. A comprehensive graphic view of a current waveform from an induction motor.

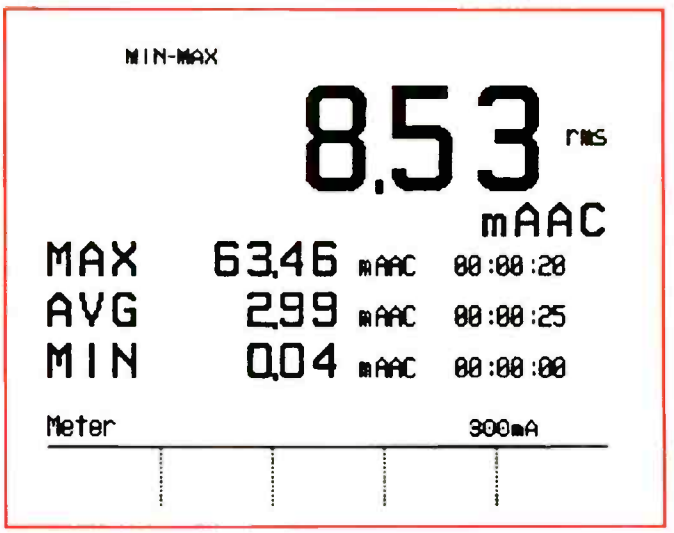

Figure 2. Minimum and maximum rms current readings from the motor.

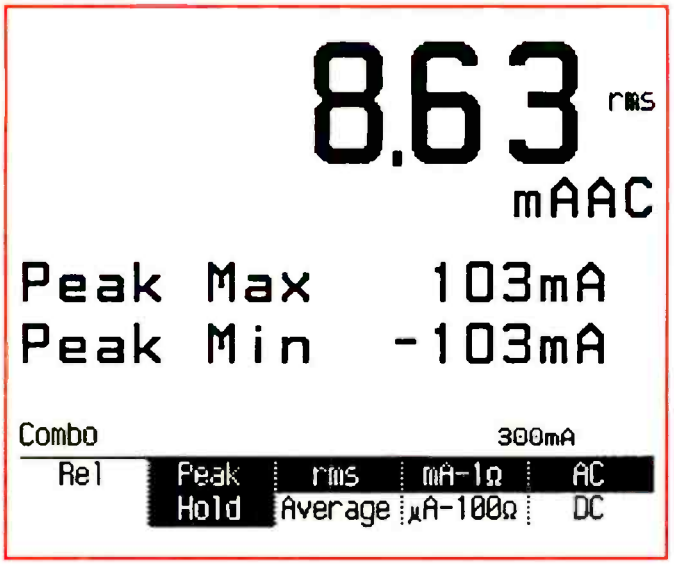

Figure 3. Peak current readings, both minimum and maximum, from the motor.

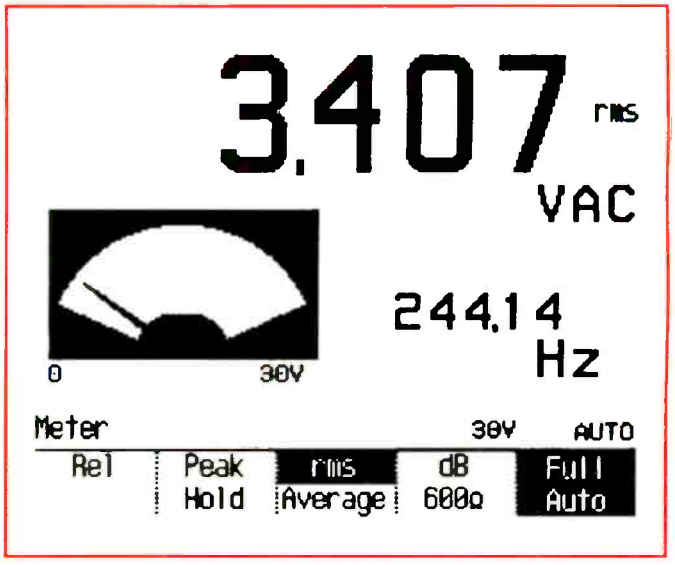

Figure 4. A numeric reading and a needle-like display combine the features of digital and analog multimeters.

troubleshoots computers, peripherals, medical instrumentation, or home entertainment equipment. These are applications requiring isolation of component failures or capturing of glitches. Yet even a technician with little understanding of the target circuit can use a GMM to monitor basic circuit activity.

A GMM is useful when the following electronic tests need to be made:

• Logic activity. A GMM with a 10MHz frequency counter is a useful tool for isolating digital failures. With this feature, the technician can make data and address checks on a 50MHz microprocessor. Or, for dc-level tests, the technician can use the GMM to make approximate duty-cycle measurements.

• Component test. A GMM with a component-testing feature allows the technician to troubleshoot problems by comparing component signatures of known, functioning circuits to those of defective circuits. The technician can also safety-check a component without having to power-up the entire circuit.

• Diode testing. In electronic repair, diode testing is a common function. A tester with this capability built-in can increase the technician's productivity.

• Low-level signal testing. Electronic test and repair typically require testing of low-level signals. Look for a GMM with the ability to make both millivolt and milliampere measurements.

Evaluating motor conditions

A GMM is useful for measuring the inrush current to a motor. Inrush current is the initial surge of current drawn by a circuit when voltage is first applied. In a motor, the inrush current occurs because the motor windings are essentially a short circuit, and before the motor begins to turn it is not yet generating a voltage that opposes the line voltage.

If you look at the peak current at start-up, the time period from initial start to normal running current, and the amount of normal running current, you can learn a lot about a motor's condition. The measurements can help identify bad bearings, excessive load, shorted rotor windings, and defective starter circuits.

Analyzing start-up current relies on several capabilities of a GMM, perhaps most important a mode that provides a view of the signal waveform (Figure 1).

A glance at Figure 1 can reveal problems to the trained eye; the start-up current may be too high, or the inrush current may not stabilize quickly enough. The maximum rms (root-mean-square) start-up current is easy to verify by using the meter's Min/Max feature to find the minimum, maximum, and average rms values (Figure 2).

Another troubleshooting technique is to measure the peak current (not just the minimum and maximum rms current) at start-up. This is accomplished easily with the Peak Hold feature, which reveals the highest peak value of both the positive and negative portions of the waveform (Figure 3).

Although peak and rms current are easy to view on a good true-rms DMM, a GMM can present a comprehensive view of the signal waveform.

Viewing modes

A graphical multimeter can be used in several modes to display signal characteristics:

One mode is a meter mode with analog-like display. In this mode the GMM can provide the numeric reading of a digital multimeter and the needle-like display of an analog multimeter. Although the needle-like display is actually digital in nature, it resembles an analog display. Most users can assimilate the degree of signal changes faster when viewing a needle graph than when looking at a numeric reading (Figure 4).

Another mode that the user can invoke is a view mode, which shows the signal's waveform, with an associated reading (such as voltage) below it; this is the primary reading. A secondary numeric reading, typically frequency, also appears. The addition of the secondary reading adds a new element to traditional troubleshooting with a meter. It means that related measurements, such as voltage and frequency, can be made without having to reset the front panel for the second measurement (Figure 5).

In normal operation the GMM automatically scales its display for voltage, time base, triggering, and position. Through the use of other, manual triggering modes, the GMM can capture and graphically display glitches, i.e.

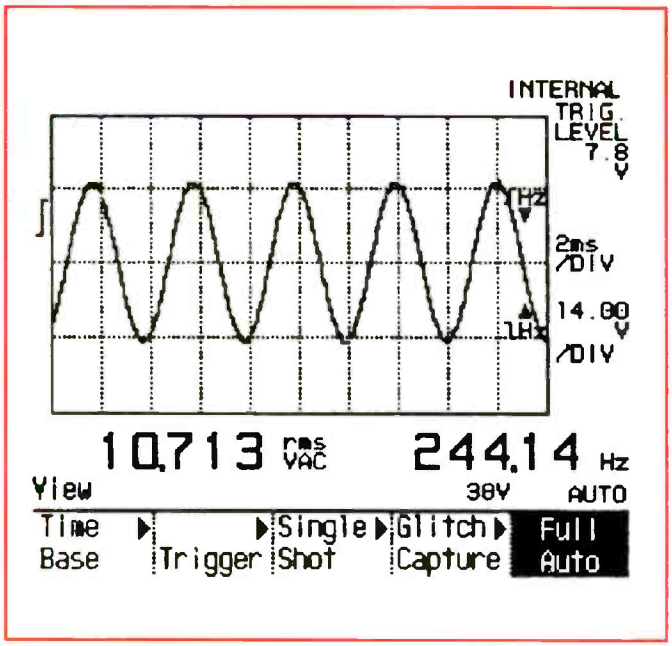

Figure 5. Primary and secondary readings show simultaneous readings of two variables, for example, voltage and frequency.

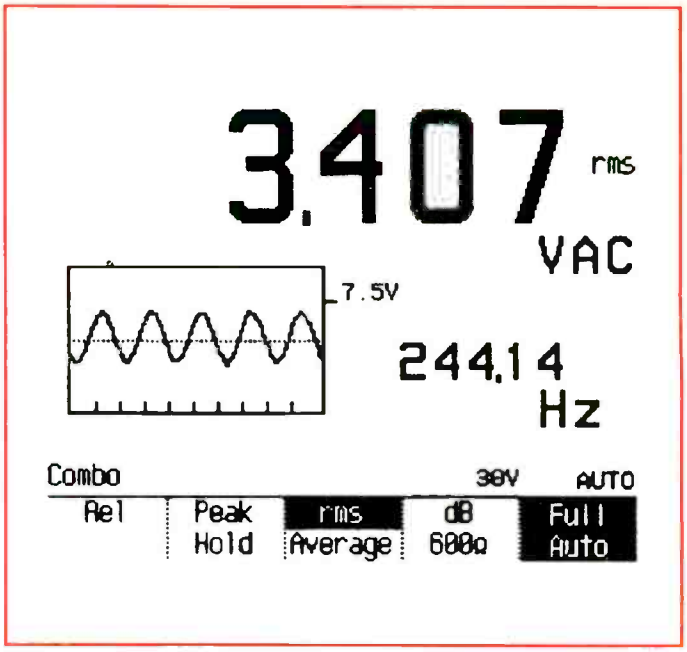

Figure 6. Numeric and graphical views combine the features of a multimeter and scope.

spurious signals, as fast as 10µ.

A combination mode available on the GMM shows the numeric reading of the meter mode with the waveform display of the view mode (Figure 6).

A graphing mode can plot electrical-signal trends over time. If the meter has an RS232 interface, you can plot data directly to a printer. This capability makes the unit the functional equivalent of a chart recorder. It should also offer the ability to time-stamp each reading, so that readings can be effectively plotted and observed over time (Figure 7).

Who needs a graphical multimeter?

Users of electrical and electronic test instrumentation are usually familiar with either DMMs or oscilloscopes. This being true, why not use a conventional digital multimeter for varied measurement applications, and augment it with an oscilloscope when a graphical display of a signal is required? One answer is purely practical: it's easier to carry and use one instrument instead of two. But there are other reasons.

There are three types of users for whom a GMM is especially useful.

- Users who need a graphical view of a signal but are not familiar with oscilloscopes. Conventional DMMs present information only as numeric readings.
- Users who need to make two readings at the same test point. A GMM with primary and secondary readings allows the user to view voltage and frequency without resetting front panel controls.
- Users in field applications who need high accuracy. Meter users who work on-site have had to sacrifice accuracy for portability and ruggedness, but many of today's applications require the accuracy of a benchtop DMM.

Dual measurement methods

One critical factor in selecting a multimeter is to understand how it derives its readings. Readings are, in part, related to how the meter responds to signals; some instruments are "average-responding," and others are "true-rms-responding." (Historically, most meters have been average-responding.)

Average-responding instruments give exact readings only for perfect sine waves. True-rms-responding instruments give exact readings for all signals within their measurement range. Although true-rms instruments are better suited to handle a range of real-world signals, there are two reasons to look for a meter that can make both average-responding and true-rms-responding measurements.

Many companies have historical data from average-responding meters, and they want continuity between new readings and historical readings. A meter that can make both true-rms and average-responding readings can reveal the presence of harmonics. Because average-responding meters produce incorrect readings on signals with harmonics, making both true-rms and average-responding readings allows the technician to compare the readings (and the degree of difference between them) to determine the approximate level of harmonics in the signal.

An average-responding instrument measures the average value of a signal, which is the arithmetic average of all values of a rectified signal throughout one period of the signal. A true-rms instrument measures the rms, or root-mean-square value of a signal. This value is more complex: it is the square root of the arithmetic mean of the squares of a set of instantaneous values of the signal.

For the purposes of this article, the exact derivation of each quantity is not important. What is important is that the heating effect of alternating current determines the current's overall effects on a circuit, and that heating effect is directly proportional to true-rms current, not to the rectified average current.

Because nonlinear loads can significantly distort sinewaves, average-responding instruments can give misleading readings, in some instances measuring 20% or more below actual currents or voltages. In systems with nonlinear loads, only a true-rms instrument measures all signals and their heating effects correctly. (Moreover, the load capacity ratings

for most electrical components are expressed in terms of true-rms voltage or current.)

A new testing alternative

Digital multimeters and oscilloscopes have complementary uses. DMMs are widely used when the value of a signal is a good indicator that an instrument, piece of equipment, or entire power distribution system is functioning properly. Oscilloscopes come into play when waveshapes are critical too, when a numeric value that is within specification does not tell the whole story.

But, at least in one troubleshooting environment, industrial electromechanical equipment, viewing signals graphically for random noise, glitches, or other anomalies is fast becoming standard practice. As this occurs, it becomes obvious that carrying both a meter and a scope to the job site is impractical. And bringing new users up to fluency with an oscilloscope could involve considerable training time and the cost of one oscilloscope per user.

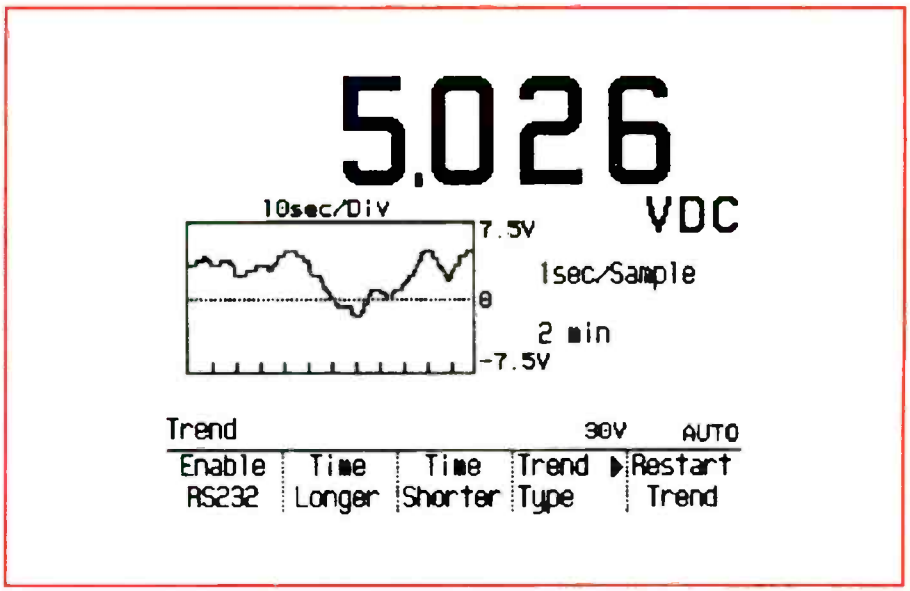

Figure 7. Graphing capabilities enable a GMM to present a documented view of collected data.

A graphical multimeter is an alternative. It's as easy to use as a DMM, and just one of its capabilities, the ability to make readings of two parameters at once, is of measurable value when either productivity or safety is paramount. Moreover, a GMM puts new power into the hands of users without the considerable retraining required to master the intricacies of an oscilloscope. ■

The RCA CTC140 chassis revisited

By Homer L. Davidson

Many different models of RCA TV sets have been based on the CTC140 chassis. A number of different malfunctions are characteristic of this chassis. The more sets produced based on the same chassis, the more breakdowns that will occur on that chassis.

A previous article concerning the CTC140 chassis reported that most problems in this chassis were found in the VIPUR output and regulator circuits. Intermittent problems in this chassis were caused by silicon diodes on the PW4700 board. Simply resoldering the diode connections solved several dead and intermittent problems.

Since that article was published, a number of other malfunctions have occurred in the RCA CTC140 chassis in other circuits. Some of those malfunctions are described in this article (Figure 1).

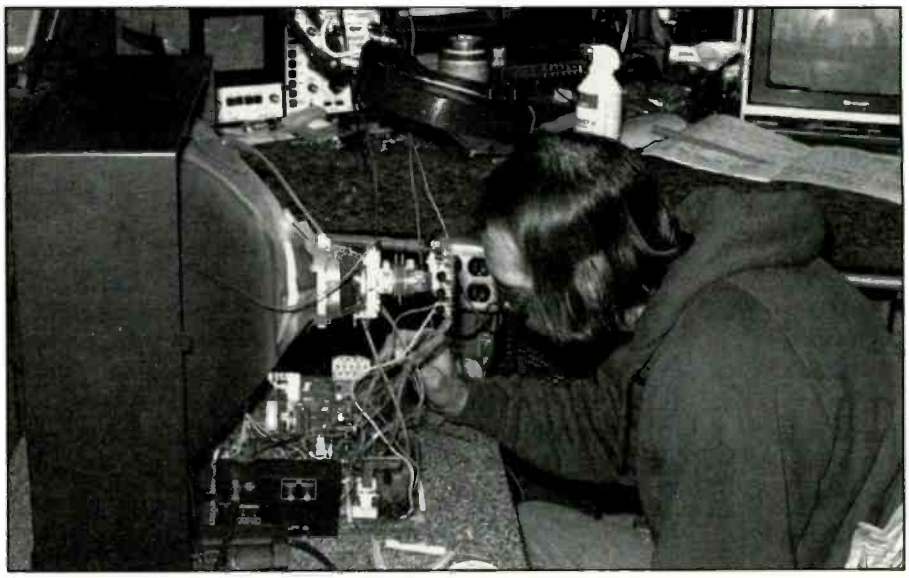

Figure 1. A technician probes a section of a printed circuit board to help locate the intermittent component

Dead Chassis

Possible causes of a dead CTC140 chassis are an open 5A fuse (F4001), an open R4003 (2.7Ω), or silicon diodes CR4001 through CR4004. These components may be destroyed if the VIPUR output transistor (Q4100) becomes leaky or shorted. If Q4100 is leaky, it may only blow the fuse.

Davidson is a TV servicing consultant for **ES&T**.

If Q4100 is shorted, both the fuse and R4003 may be destroyed.

When taking voltage measurements on the primary side of T4100, remember that all input components are tied to a hot ground. Voltage and resistance measurements will not be accurate if you take measurements from the suspected part to a common chassis ground. The hot ground includes all components within the primary side that produces the +150V source and standby transformer circuits. Actually each transformer isolates the hot ground from the common chassis ground. Simply connect the DMM common lead to the negative terminal of the main filter capacitor C4006 (470μF) when you wish to make hot ground measurements.

If you have to replace the VIPUR output transistor, Q4100, replace it with an exact replacement (part number 164599), and check both R4111 (0.15Ω) and CR-

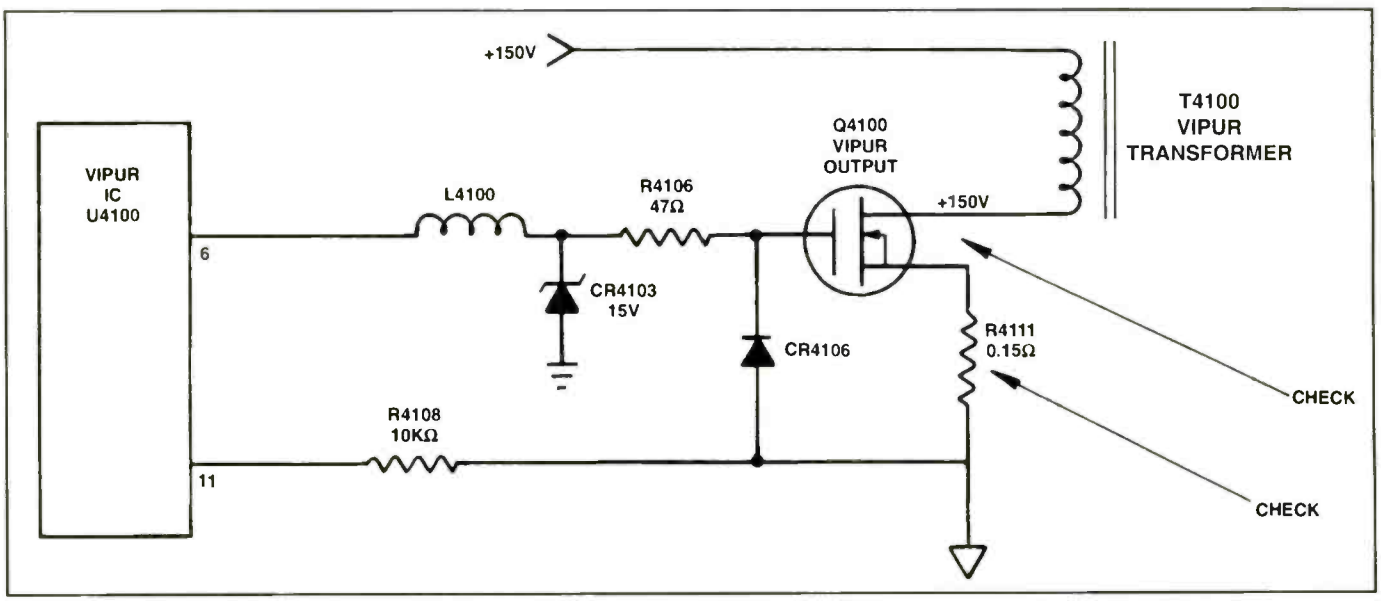

Figure 2. When replacing the VIPUR output transistor, Q4100, in an RCA CTC140, always check R4111.

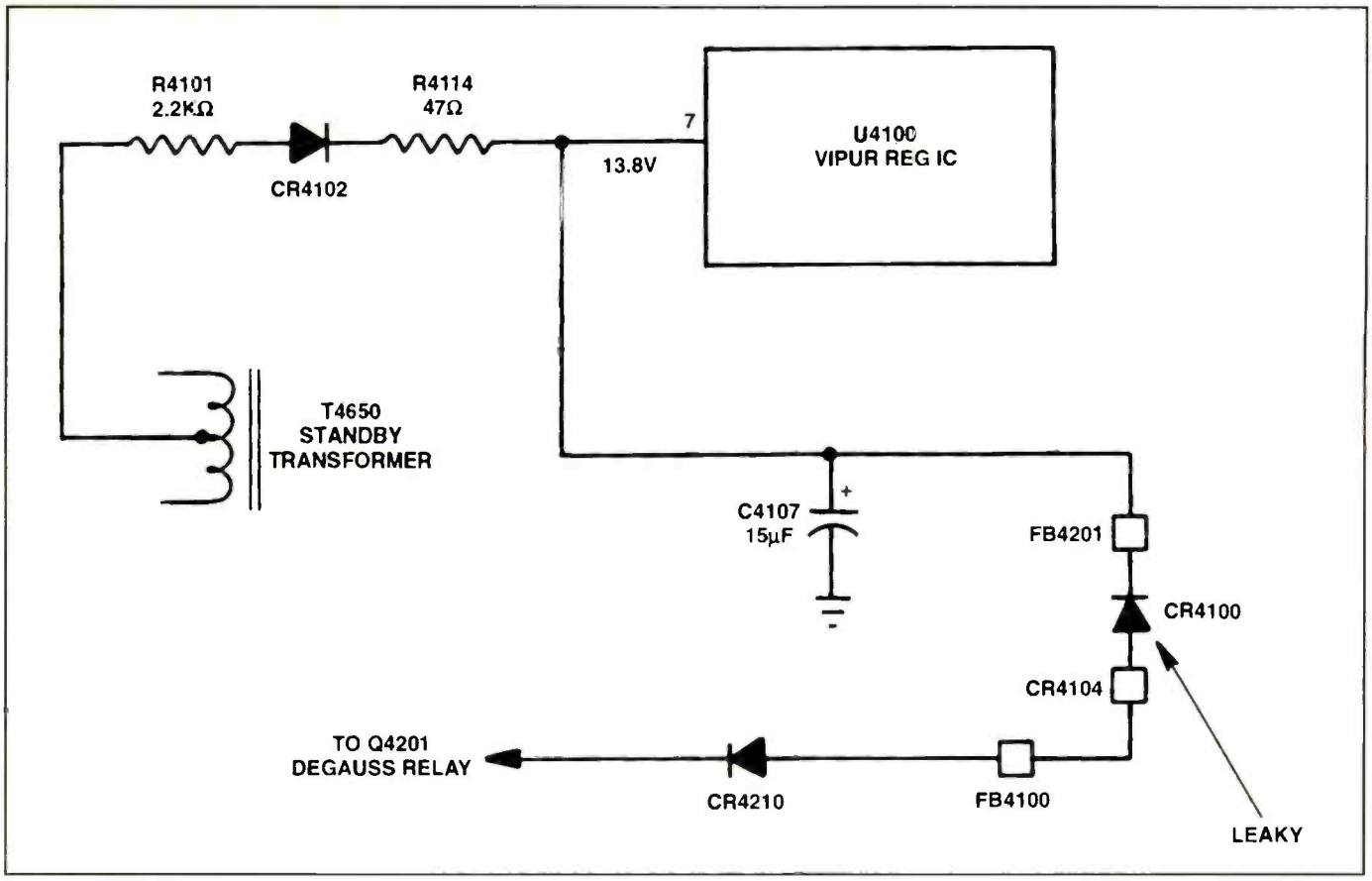

Figure 3. A leaky CR4104 produced low voltage at pin 7 of U4100, which in turn caused a dead chassis.

4103 for possible damage (Figure 2). Resistor R4111 may have been damaged if the VIPUR output transistor was highly leaky or shorted.

LEDs light, dead chassis

The LED lights were on in this otherwise dead CTC140 chassis. Raw B+, 152V was measured on the filter capacitor, C4006, and VIPUR output transistor Q4100. Voltages were extremely low on the gate and source terminals of Q4100. Voltages supplied from the VIPUR regulator IC (U4100) were very low as well.

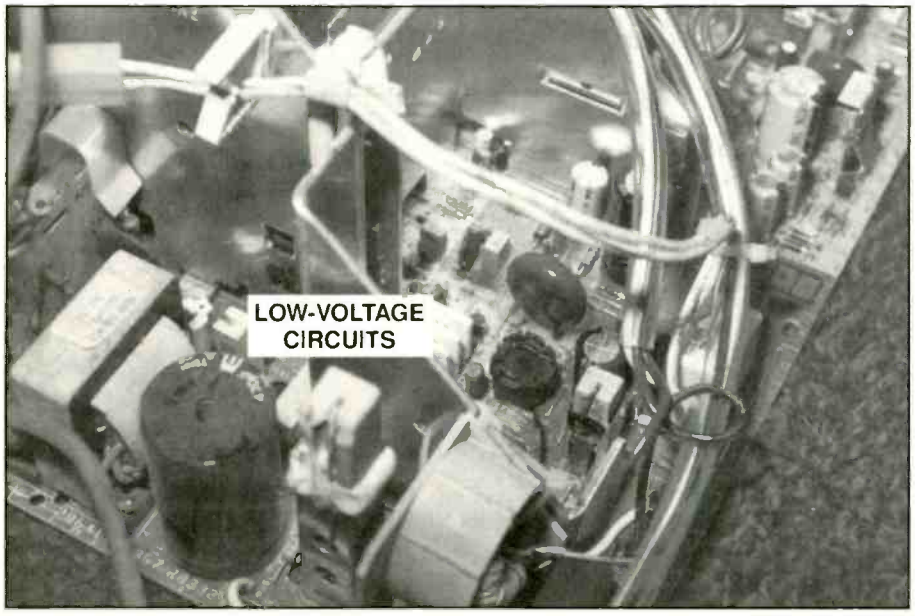

Figure 4. The low voltage circuits in an RCA CTC140 chassis are located as shown here.

The voltage at pin 7 of U4100 (the supply voltage, Vcc) measured 8.4V (Figure 3). This voltage should be at least 12V. I examined the schematic diagram and the chassis, and found that this supply voltage was taken from the center tap of standby transformer T4650. At first I suspected that zener diodes CR4101 and CR4102 were leaky. These diodes tested normal with a transistor-diode tester, however.

Another look at the schematic revealed that several capacitors, and diodes CR4201 and CR4104 were in the same circuit. I checked both diodes in the circuit. CR4104 showed signs of leakage. I disconnected one end of the diode from the circuit and tested it again. It was leaky.

When CR4104 is connected in the circuit, its anode terminal is returned to common ground through a primary winding of the VIPUR output transformer, T4700. In another CTC140 chassis, the same diode, CR4104, was leaky resulting in a voltage of 7.7V at pin 7 of U4100, causing a dead set that could not be shut off.

Low 12V source

A CTC140 chassis had low brightness, very little contrast, and a gassy, negative

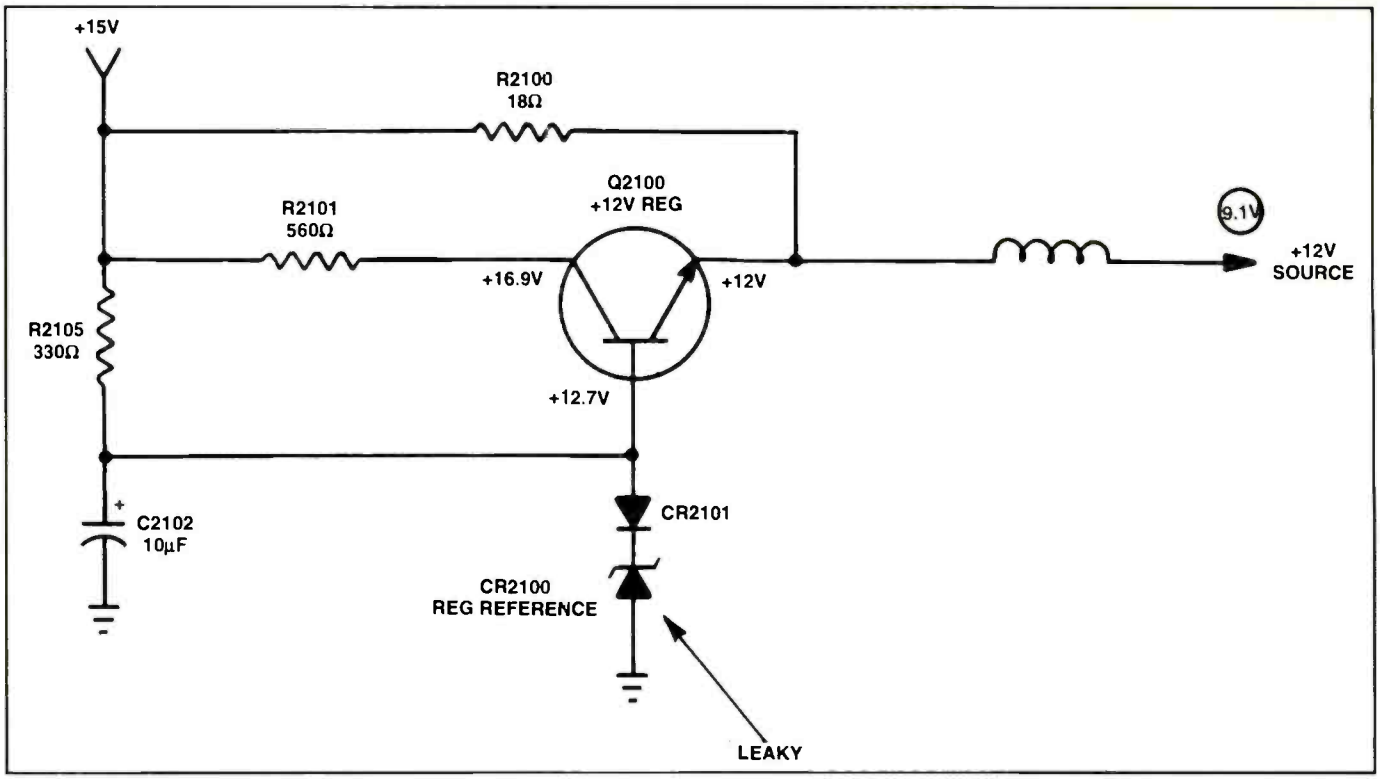

Figure 5. A leaky zener diode, CR210, caused low voltage in the 12V source, which resulted in a very poor picture.

looking picture. From these symptoms, you would think that the trouble would most likely be in the video or picture tube circuits. Because these circuits are supplied from the 12V source, I suspected that this supply might be the cause of the problem. I isolated the low voltage circuits and began testing (Figure 4).

The 12V source was low at 9.1V. The components within the 12V source that are most likely to be the cause of this problem are regulator transistors Q4053, CR4659, CR4653, and filter capacitor C4656 (2200µF). Since C4656 had a 16V source at the collector terminal of the 12V and 5V regulator transistors, the defective component must be between the 12V regulator and the 12V source (Figure 5).

The voltage at the emitter terminal of regulator Q2100 measured only 9.1V. A resistance measurement from CR2100 to common ground made me suspect that CR2100 was leaky. I disconnected one end of the diode and performed a junction test. This 5.8Ω zener diode was definitely leaky. Although the regulator transistor Q2100 appeared normal, I deemed it

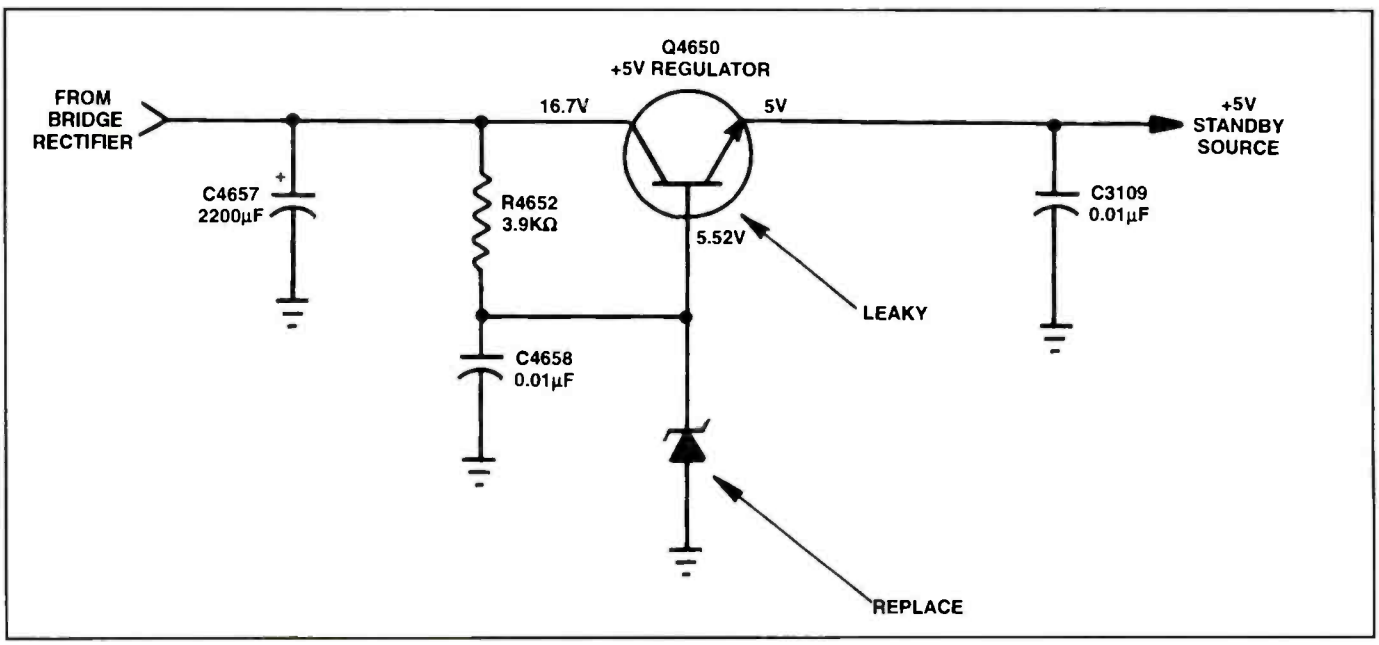

Figure 6. Absence of remote control operation was caused by a leaky zener diode in the 5V power source.

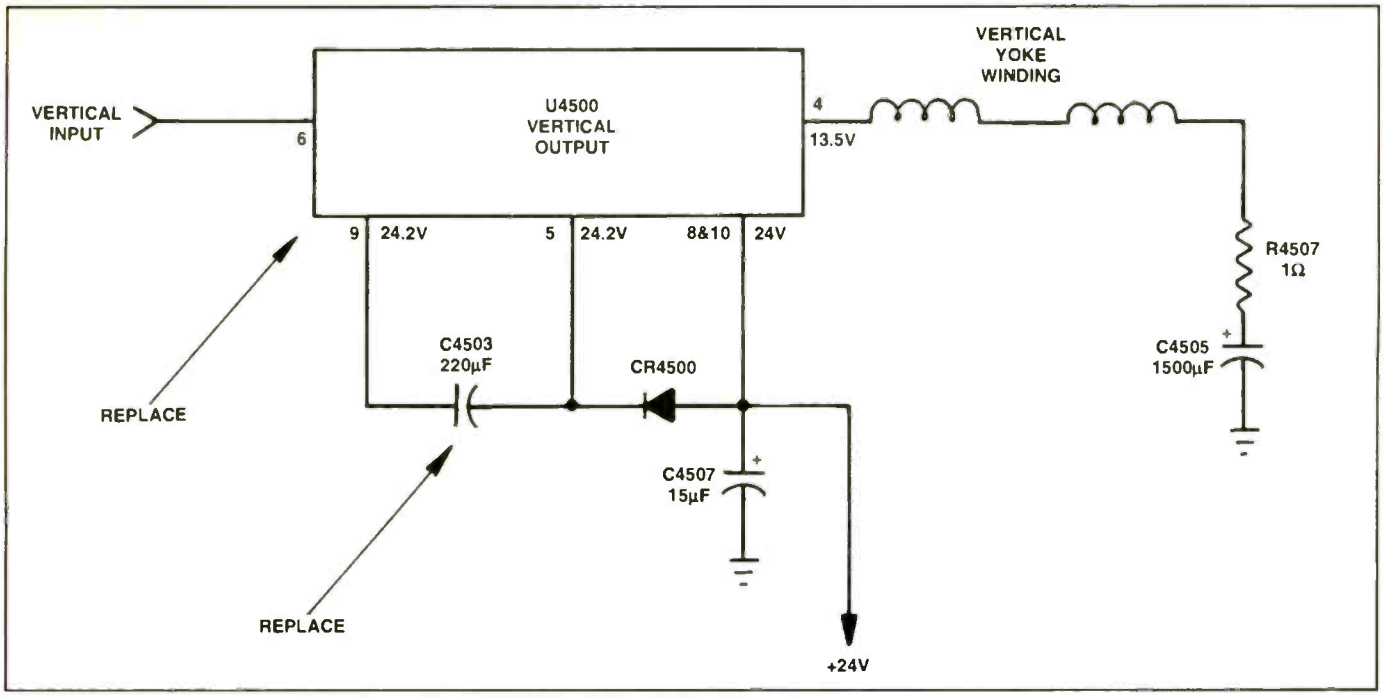

Figure 7. Intermittent vertical sweep was solved by replacing C4503 and U4500.

prudent to replace both CR2101 and CR-2100. When I turned the set on, the picture was perfect.

No remote action

When the customer complained that the remote control had been operating intermittently and now would not operate at all, I immediately suspected the remote transmitter. I installed new batteries but the remote still wouldn't operate. I tried to operate the set using another known-good remote transmitter, but the set still failed to work. The problem was somewhere inside the TV chassis.

This set has two standby voltage sources, a 12V source and a 5V source. I tested both sources. The 12V source volt-

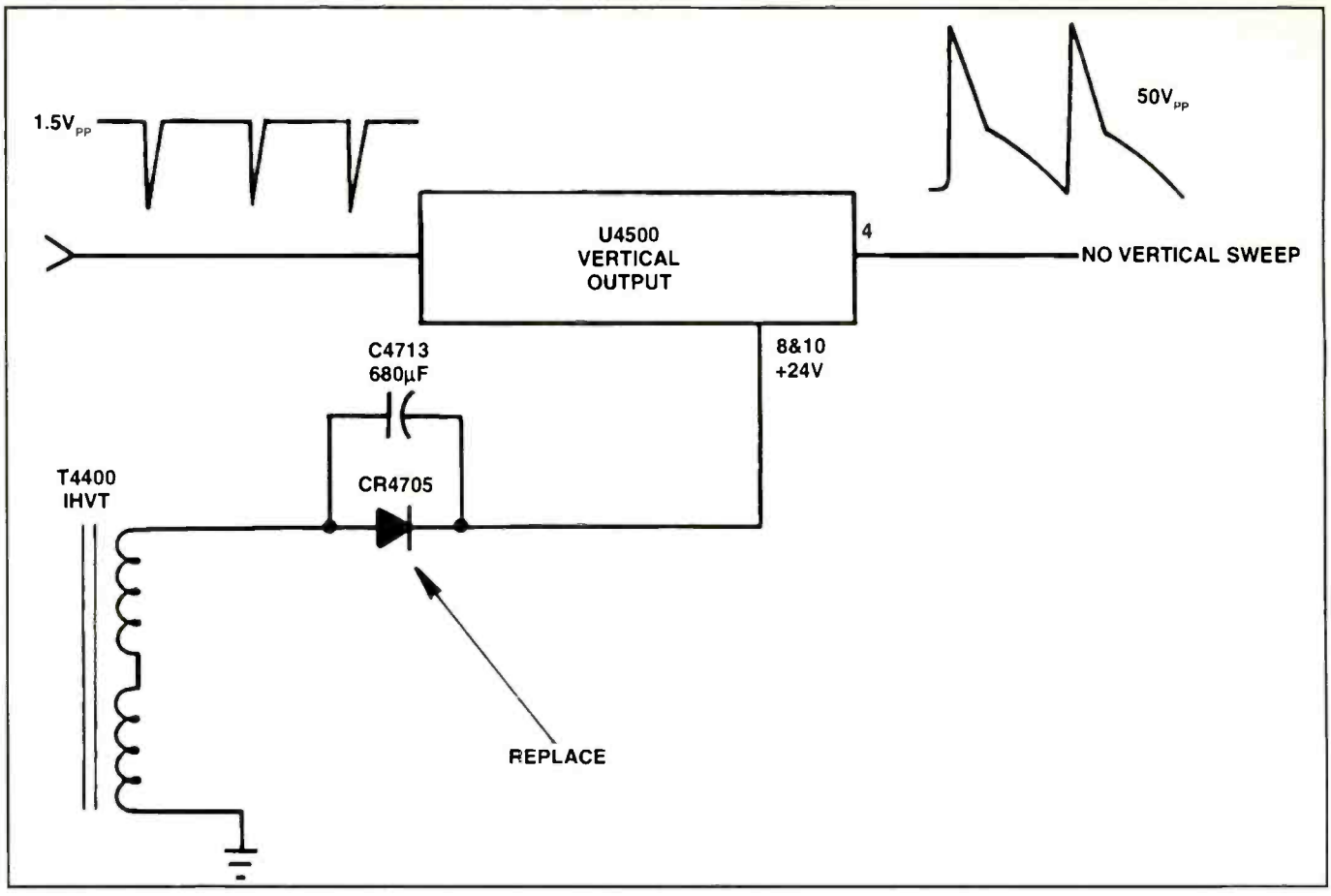

Figure 8. A leaky CR4705 in the 24V source caused the vertical sweep to collapse.

age was normal but the output voltage of the 5V source was low (Figure 6). Usually if the regulator transistor is open the voltage at the emitter terminal will be zero. I checked regulator transistor Q4650 in the circuit. It appeared leaky. I felt that the best course of action was to replace both the 5V regulator transistor 146899 and the CR4656 zener diode. The 5V regulator can be replaced with an SK3202 or NTE-210 universal replacement. The replacement components restored the remote control to full operation.

Intermittent vertical sweep

The picture on one CTC140 chassis would collapse, go into a horizontal white line, or have insufficient sweep. On occasion, however, it would operate for several hours without any problems. In this particular chassis, the vertical output circuits are contained in a power vertical output IC. I monitored the 24V power source at pin 8 of U4500. When the vertical problem occurred, the voltage at this pin was only a few volts, and the voltages for pins 5 and 9 decreased (Figure 7).

Since components tied to any IC component can cause a voltage change at the IC terminals, I checked C4503, C4507 and CR4500. I automatically replaced capacitor C4503, since these capacitors caused vertical problems in a number of later chassis.

With the replacement capacitor in the circuit, I turned the set on and operated it for several hours. After a time the picture

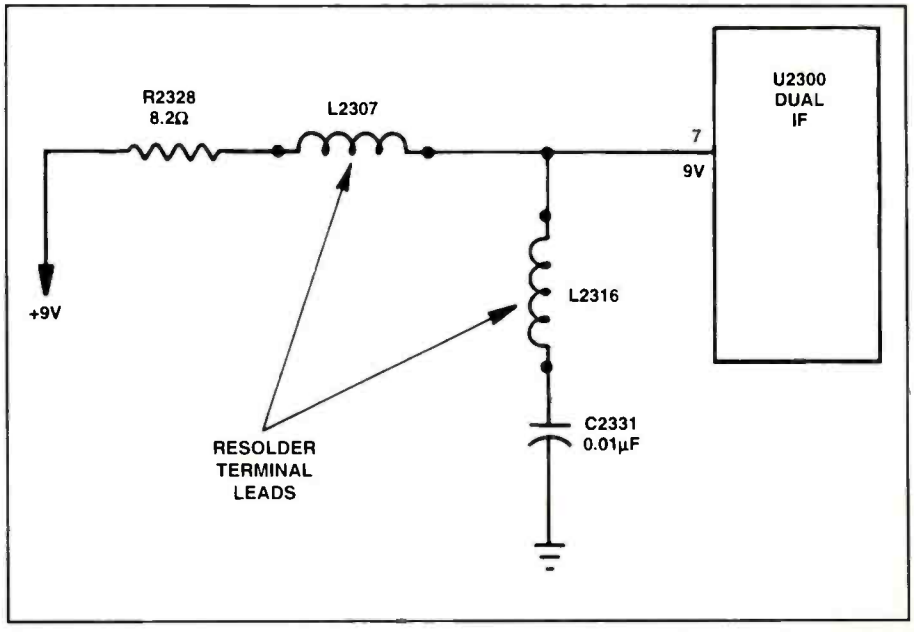

Figure 9. Poor soldered connections on L2307 caused an intermittent flashing picture.

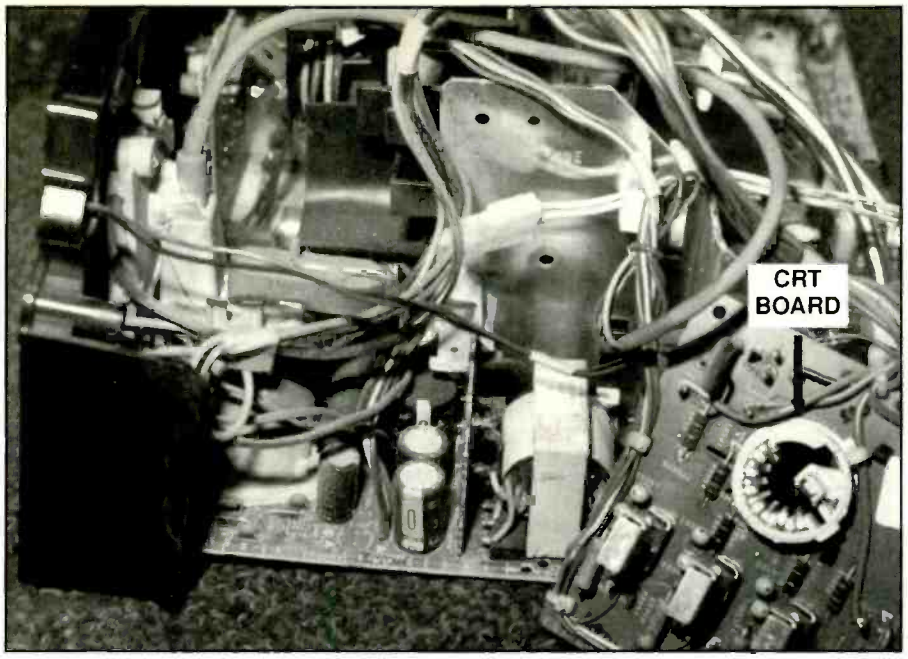

Figure 10. In most modern TV sets, color output transistors are located on the CRT board.

collapsed. Almost certainly the vertical output IC was the problem. I replaced U4500 with an exact manufacturer's replacement component. When I again allowed the set to operate for several hours the picture remained stable.

No vertical sweep

A CTC140 had no vertical sweep. I connected the oscilloscope to pin 4 of the vertical output IC, IC4500. There was no waveform. The amplitude of the waveform at pin 6 of the vertical IC was about 1.45Vpp, which was close to normal. I then measured the voltages at the vertical output IC terminals and found that the supply voltage at pin 8 (Figure 8) had decreased to nearly 0V.

According to the schematic diagram, the vertical supply voltage should be around 24V. Most vertical output ICs have a relatively higher supply voltage in the 20V to 25V range. The 24V source was supplied from the scan-derived flyback winding. I turned off the set and checked CR4705. It was open. I disconnected CR-4705 from the circuit and tested it again. This confirmed that the diode was open. Any time the output IC U4500 is shorted or exhibits high leakage, it's quite likely that CR4705 will be leaky.

Intermittent rolling and flashing pictures

An intermittent or flashing picture may be caused by malfunctions in any of the circuits from the picture tube back to the tuner. Most picture problems are caused by defects in the video and IF circuits. Rolling or intermittent pictures may be caused by malfunctions in the sync and vertical circuits. Because in this case the picture was intermittent and flashing, I decided to troubleshoot the video and IF.

I used the oscilloscope to observe waveforms in the video circuits from the Comb Filter IC (U2600) back to the Dual IF IC (U2300). When the rolling and flashing of the picture occurred, the waveform would shake, jump around and disappear. I monitored this video output signal at pin 25 of dual IF IC (U2300).

I carefully measured voltages at all

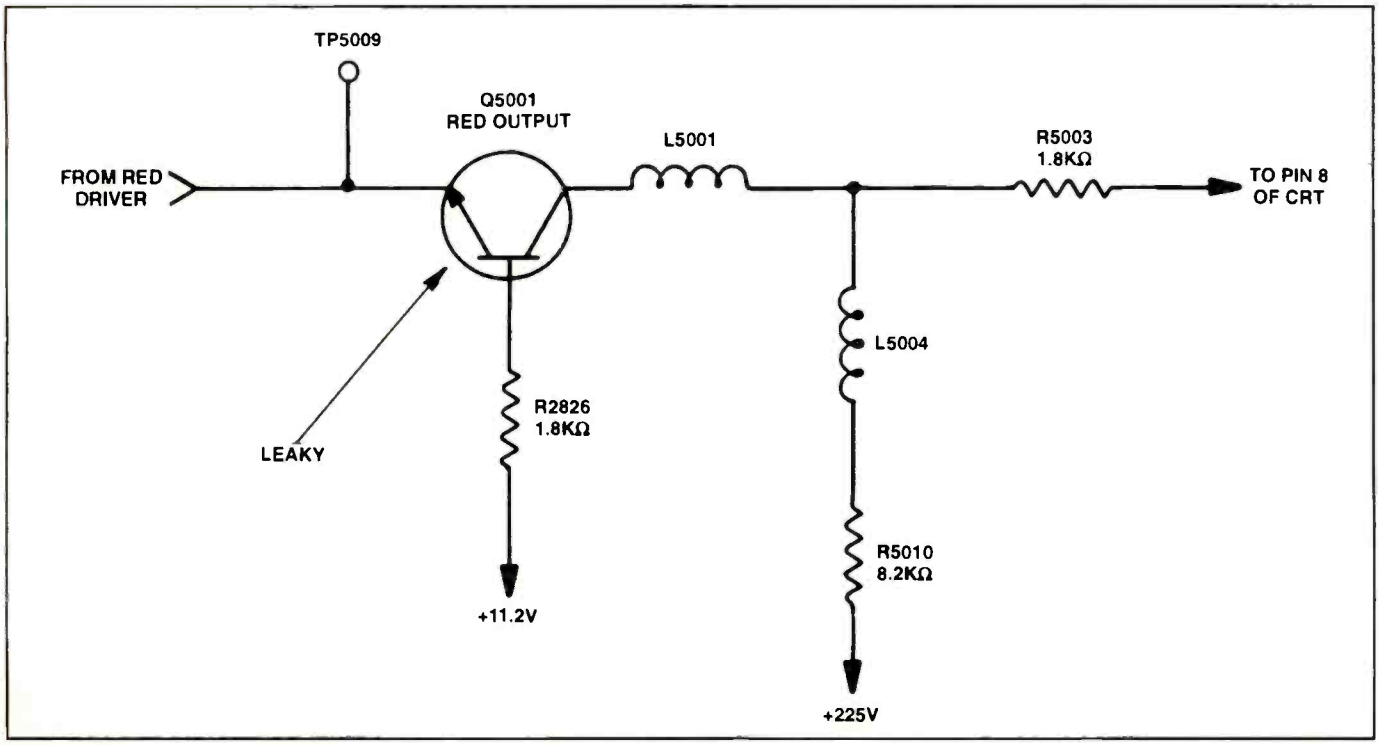

Figure 11. A leaky Q5001, red output transistor, eliminated the color red from the picture.

pins of IC U2300, both when the picture was normal, and when it was rolling and flashing. At first I suspected the IC was the problem, but then I measured almost zero volts at pin 7 of the IF IC. This time the voltage was less than 0.07V, while it should be around 9V. When I flexed and probed the board in the vicinity of this section, the picture acted up. I resoldered pin 7 of U2300, but that had no effect.

I monitored the +9V source at CR2300 with the DMM, and connected another meter to pin 7 of U2300. When the picture acted up the voltage at the zener diode, CR2300, became a fraction of a volt higher, while the voltage at pin 7 dropped to nearly 0V. I began to suspect that R2328, L2307, L2316 or C2331 might be defective (Figure 9). I resoldered both terminals of coils L2307 and L2316 which solved the intermittent picture problem.

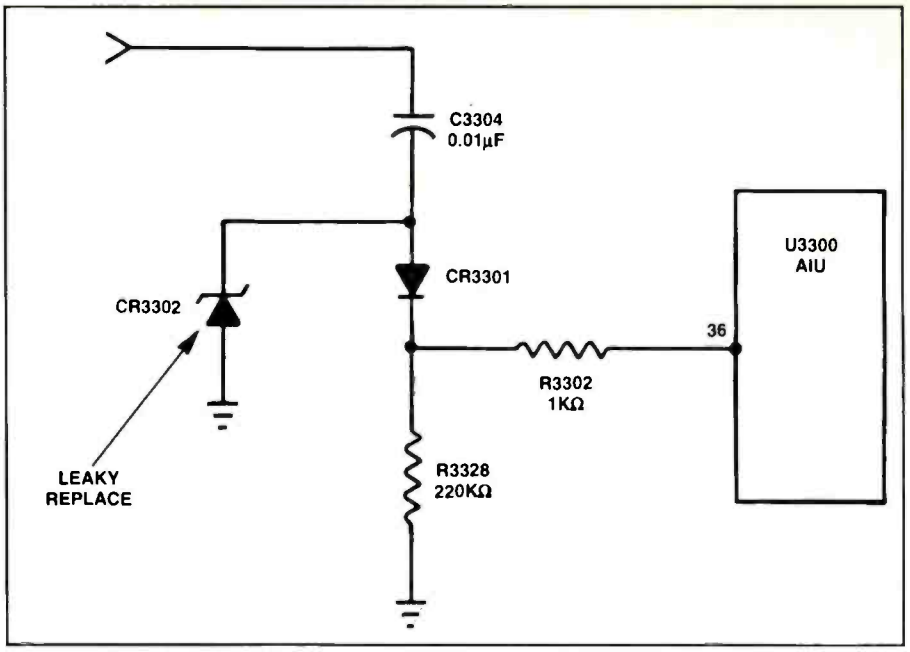

Figure 12. The remote control would not operate after several hours of operation in an RCA CTC140 chassis.

No red in the picture

When any of the colors is missing from the picture, suspect the color matrix IC, color drive transistor, color output transistor, and color gun assembly in the picture tube. Red missing from the picture may be caused by malfunctions from the Luma/Chroma IC (U2700), through the red buffer and red output transistors. Absence of red in the color picture tube output and CRT circuits causes a greenish-blue raster (Figure 10).

Because the picture appeared normal except for the incorrect color, I connected the oscilloscope to pin 26 of the chroma output IC, U2700, and connected a color-bar generator to the antenna terminals. The waveform at pin 26 was normal, and continued normal to the red driver

Photofacts

CROSLEY
CC2546P101 3527
CC2546P102 3527
CC2547A101 3527
CT2741C105 3536
25E510-00AA 3527
27B501-00AA 3536

EMERSON
VCR885A VCR-267
VCR885B VCR-267
VCR885C VCR-267
VCR885D VCR-267

FISHER
G3H-25270 3533
PC-2527 3533

GOLDSTAR
CN-14A80 3529
CN-20A80 3529
GCT1304M 3529
GCT1354M 3529
GCT1904M 3529
GCT2005S 3528
GCT2054SN 3528
GCT2064SN 3528
NC-36A 3529
NC-44A 3528

MAGNAVOX
CP4764A401 3534
27A502 3534

PANASONIC
ALEDP242 3530
ASEDP224 3530
CT-27S61S 3530
CT-31S61S 3530

RCA
EO5201BK 3526

SAMSUNG
KA50Z 3524
TCC1360 3524
TCD1350 3524
TTC1350 3524
TTC1360 3524
TXC1350 3524
TXC1950 3524
TXC1960 3524

SEARS
CTC169AS2 3532
CTC169BD2 3532
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274.43958290 3532

SHARP
20F-M50R 3537
20F-M100R 3537
27F-S200 3525

TOSHIBA
CF26C30 3535
TAC9360 3535
TAC9365 3535
TV28C30 3535

ZENITH
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SMS2049S7 3531
SMS2049SM 3531
SMS2049X 3531

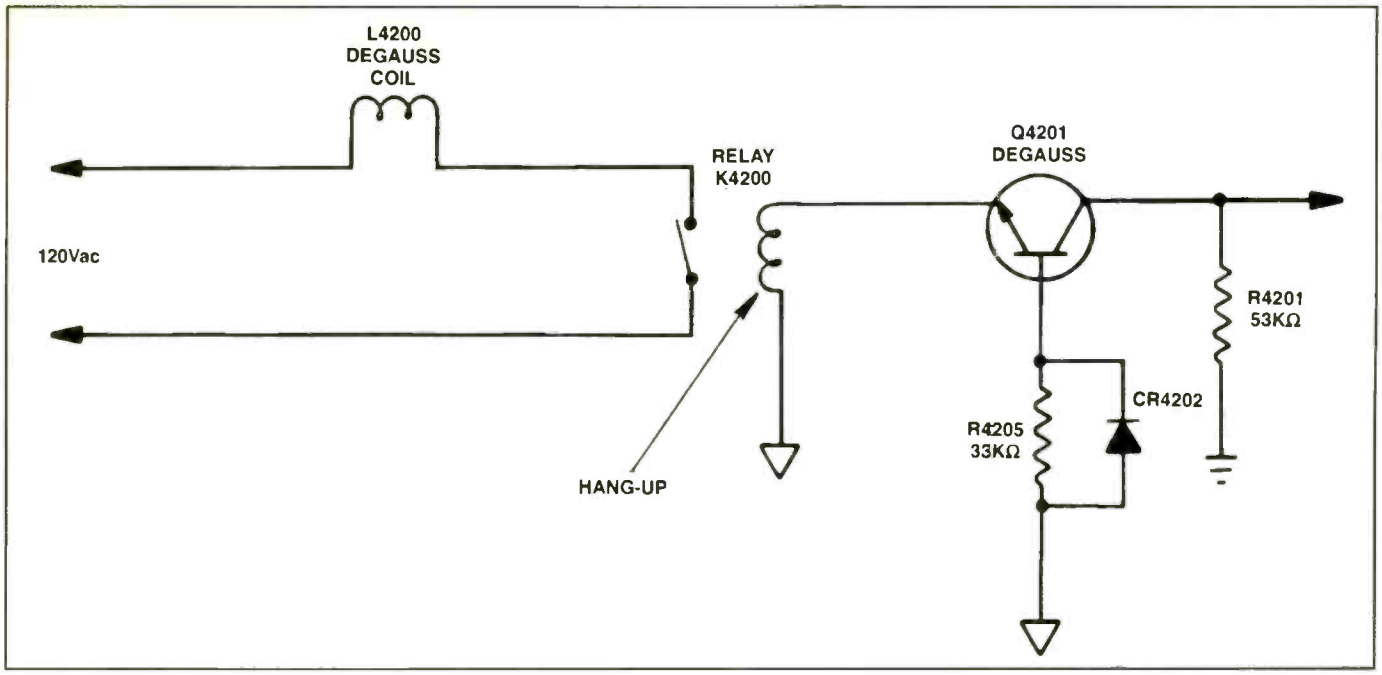


Figure 13. A defective or hung-up relay in the TV chassis may cause the TV set to fail to turn off, or it may keep the degaussing coil on all the time.

transistor (Q2901). The waveform at pin 8 of the CRT was extremely low, indicating problems in the color output circuits. A measurement at the collector terminal of Q5001 indicated low voltage. I tested Q5001 in the circuit and it appeared to be leaky (Figure 11). Replacement of Q5001, (the color output transistor) with an exact replacement, part number 146826, corrected the problem.

Remote inoperative after warm up

A CTC140 set was brought into the service center with the complaint that after the set was left on for a couple of hours the remote control would not function. The set worked fine otherwise. No doubt some component was heating up and causing the problem. The problem persisted even when another known-good remote control hand unit was used. The problem therefore had to be in the chassis. IC U3300 provides IR receiver remote control in this RCA CTC140 chassis.

I checked the voltage at IR pin 36 of U3300. This voltage was in spec at 1.05V (Figure 12). All other circuits of U3300 seemed to operate, which cleared the AIU IC of suspicion. The resistance at the cathode terminal of CR3301 measured at about the same resistance as R3328. The resistance from the anode terminal of CR-3301 to common ground was extremely low. Since the resistance of R3301 was close to 24kΩ, either C3301 or CR3302 must be leaky. Further tests confirmed that the 4.9V zener diode, CR3302, was leaky and decreased in resistance as the TV chassis operated.

Degaussing relay hang up

In modern color sets, whenever the set is turned on, the degaussing coil relay closes, causing the degaussing coil to be energized. When the coil is energized the TV screen demagnetizies, removing residual magnetism that may have been caused by sources of magnetic fields such as strong speaker magnets nearby, shutting the floor sweeper off in front of the TV set, or even the magnetic north pole. When the relay is energized the relay switch completes the degaussing coil circuit to the ac power line. A common problem is that the degaussing relay hangs up and closes the switch contacts at all times (Figure 13).

If you encounter a set in which the degaussing relay is faulty or has an open solenoid, will not energize, or hangs up, replace the relay. Do not try to repair or clean contacts upon a small relay. Simply replace it with an exact manufacturers replacement. ■

Mend a splice, save a set

By Roger D. Redden

There are cases, although they are probably uncommon, in which repairing a splice between picture tube yoke windings could save an RCA CTC146 chassis from premature obsolescence.

A congenial, retired two-way radio technician, call him Bill, brought me a 20-inch RCA TV, with a CTC146 chassis, to repair. Bill had already made the diagnosis that the set had a bad yoke. Not having worked on many TVs, especially in recent years, Bill was hesitant about replacing the yoke himself. He had decided to tackle this set only because it belonged to his daughter.

Bill was pretty sure that the vertical yoke was open. My ohmmeter showed that, indeed, an open circuit existed between pins 4 and 5 of the vertical yoke plug, P451. I traced the wires from the plug to the small terminal board where they connect to the yoke windings (Figure 1), but the connections to the windings still checked open at that point.

"Is that a common fault?", Bill asked. I told him that I thought it was rare. After I gave him a rough estimate for replacing the yoke, he left.

I've replaced some shorted yokes in the past few years, but I couldn't remember an open one since tube sets were plentiful. On those yokes, there was usually a black spot where an arc burned the wire open. Wanting bright light on every shaded area of the yoke, I removed it from the CRT and carried it outside into the sunlight for some scrutiny.

I peered at the yoke from all angles but I could not see any damaged area. I did notice a piece of yellow spaghetti about two inches long placed against the front flange of the yoke (Figure 1).

A wire from each vertical winding of the yoke entered opposite ends of the spaghetti, which was held in place by a glob of clear glue. Prying off this glue and sliding the spaghetti to one side, I found a splice between the two yoke windings. The solder joint was obviously faulty.

I untwisted the wires, scraped them, and then soldered them together again. Then I pulled the spaghetti back over them and stuck it in place with a dab of silicone sealant. Now the ohmmeter test showed continuity across the yoke. When the yoke was reinstalled onto the CRT, the set had a fine picture.

Redden is owner and operator of a consumer electronics service center.

An after the repair puzzle

Because I had been concentrating on the physical yoke, I had paid little attention to the Sams Photofact (Set 2700-1). When I did look at the schematic drawings of the yoke, I was puzzled. The schematic diagram showed the two vertical yoke windings in parallel, (Figure 2a). But if the windings were in parallel, then one bad connection could not cause an open circuit at the plug, since continuity would be provided by the other winding.

Something was askew here. Eventually it dawned on me to look for a PROFAX schematic on this chassis. PROFAX number 3058 shows an RCA CTC145/146 chassis, and the vertical yoke windings are in series (Figure 2B). The Sams was incorrect. Mystery solved.

Another RCA

Okay, but what does this have to do with premature obsolescence? Nothing, in this set. But about a week later I had another version of a 20-inch RCA CTC146 chassis to repair. Unfortunately, in this set the customer had broken the neck of the CRT. My experience with the previous yoke led me to examine the yoke on this set, where I found a similar splice covered by yellow spaghetti.

In this set, however, the yoke is permanently bonded to the CRT. Because of this bond, the CRT and yoke must be replaced as a unit. If the yoke goes bad, the CRT must be replaced along with it.

The cost for this CRT/yoke combination was only $50 less than the price of a new set that I had seen advertised. Even if I worked for free, most customers probably would buy a new set rather than repair this one which was 5 years old.

Therefore, if one of these bonded yokes had the bad connection described above, and you repaired it, you could earn your normal labor charge, probably have a very pleased customer, and save a television from premature burial in a landfill.

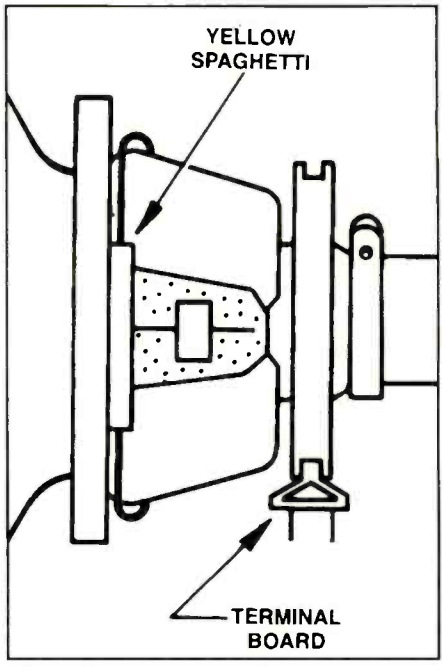


Figure 1. The vertical windings of this picture tube yoke are spliced together inside the yellow section of spaghetti.

Reverse synergy

After getting a price for the CRT yoke on this set, I began to wonder how the total cost for all of the replacement parts in this set would compare with the price of a similar new set. The list in Table 1 shows how I made a rough estimate of the total cost of the replacement parts in this set. For the less expensive parts, I took what seemed to be a reasonable average cost for each type of part and multiplied that cost by the approximate number of those parts in the set.

After totaling these costs, I added the result to the sum of the actual suggested resale prices of the more expensive items, giving it a total of $862.67. This sounds very exact, but obviously it isn't. Let's just say that the cost of building this set from replacement parts, not counting labor, would be around $800.

The price I recently saw advertised for a 20-inch RCA TV with remote control and on-screen display was $229.95. Compare this with my cost estimate, almost certainly low, of $800 for most of the parts

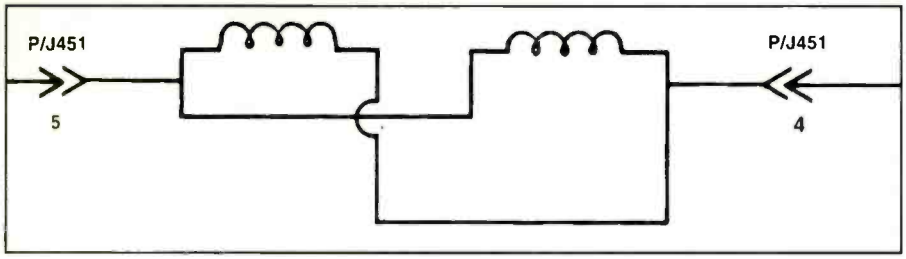


Figure 2A. The vertical windings were incorrectly shown in parallel in this diagram.

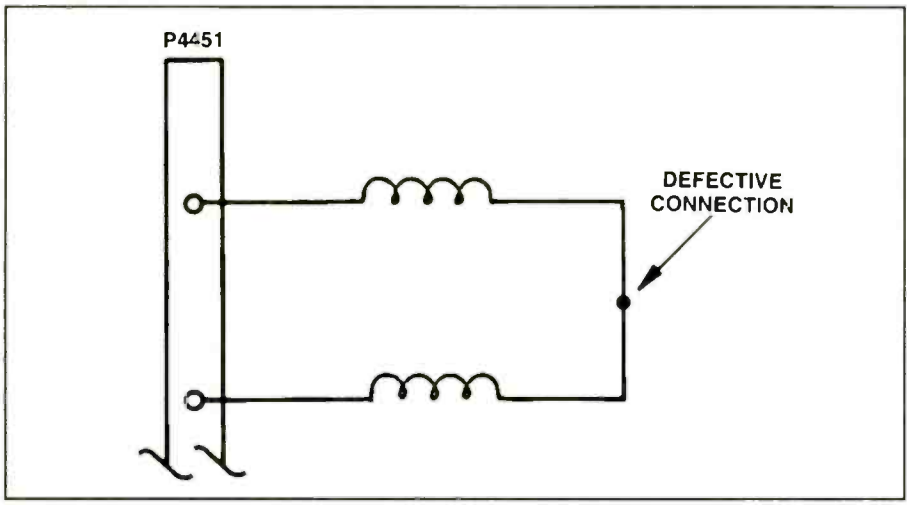


Figure 2b. The windings are in series, as shown in the PROFAX schematic.

COMPONENT	SUGGESTED PRICE	NUMBER IN SET	TOTAL
DIODES	$1.00	53	$53.00
RESISTORS	$0.20	163	$32.60
CAPACITORS	$1.00	195	$195.00
TRANSISTORS	$1.00	33	$33.00
COILS	$2.25	21	$47.25
MISC.	$1.00	45	$45.00
PC BOARD	$25.00	1	$25.00
TOTAL ESTIMATED COST			$430.85
CRT/YOKE			$179.95
TUNER (REBUILT)			$49.95
REMOTE TRANSMITTER (UNIVERSAL)			$20.00
IHVT			$27.10
ICs (5)			$67.68
H.O.T.			$6.44
MASK (CABINET)			$69.25
SPEAKER			$11.45
TOTAL SUGGESTED RETAIL COST			$431.82
GRAND TOTAL			$862.67

Table 1. If you had to build a $229.00 TV set out of replacement parts, this is about what it would cost to do it. Labor is extra

in a five-year old set. By definition, when the whole is less than the sum of the parts, that's reverse synergy. Do you suppose that the people who assemble these TV's pay over $570.00 for the fun of putting them together?

Costs add up

In fairness, there's no doubt that a multitude of legitimate costs increase the price of replacement parts. For example, I live in a state that taxes inventory each year, even on parts that just sit and ooze red ink until you finally pay to trash them.

Handling and keeping track of individual parts eliminates the efficiencies of scale available in mass manufacturing. Add in the other expenses, and profits, necessary all along the distribution chain, and the prices of replacement parts may not be excessive. But without hard facts, it's easy to wonder.

I used this set as an example simply because it was convenient for me, not to make any negative comment on the manufacturer. I'm sure that comparable markups would be found on the replacement parts sold by most other companies.

Random testing

Having counted the approximate number of parts in this set, I hated not to squeeze some use from that number, even one as farfetched as the following.

Let's suppose you had one of these sets to repair, but that you didn't want to bother with logical troubleshooting methods, and that you had a machine capable of testing any part in one minute. How long would it take you to find the problem? Counting the tuner as a single part, there are about 525 electronic parts in this set. If you tested the parts randomly, the odds of being right on the first test would be about 1 in 525. On the second test, 1 in 524, and so forth.

The odds don't matter though, because one of the corollaries of Murphy's law says that no matter where you start, the bad part will always be the very last one you test. I realize that this disputes the laws of probability, but it feels true, and assuming it occurs, you will find the problem in 8-3/4 hours: 525 parts x 1 minute /60 minutes.

That is, unless the problem is a bad connection, in which case you have about 1200 more possibilities. If you repair one connection every minute, you'll be done in another 20 hours. Then you might want to take the rest of the day off. ■

Commercial radio licenses: a step on the road to success

By Dale C. Shackelford

What do a cruise ship officer, an international airline pilot and an electronics servicing technician have in common? They all need a commercial radio license to make the most of skills they have attained to enhance their careers (and incomes). The type of commercial radio license one might need/desire will often vary with individual goals, but for those of us in the electronics servicing field, the General Radiotelephone Operator License (GROL) and the Global Maritime Distress and Safety System Maintainer's License (GMDSS/M) are just the tickets.

Why would I need a GROL or GMDSS/M license?

As of June 15, 1984, the Federal Communications Commission (FCC) requires anyone who repairs, maintains and/or calibrates any ship (including marine and aircraft), coastal station or portable marine band radio, to hold, at a minimum, a GROL. Additionally, anyone who maintains or repairs any AM, FM, TV or international broadcast stations (including short-wave), auxiliary broadcasts/services (low power TV, FM or TV broadcast translators, boosters, etc.), or any fixed radiotelephone/radiotelegraph stations, must hold (at a minimum) a valid GROL. Technicians who desire to repair, maintain or calibrate any of the new satellite-based marine emergency subsystems or equipment must hold a GMDSS/M, while those who desire to repair, maintain or internally calibrate ship radar systems must hold a GMDSS/M with a Radar Endorsement. Obviously, there is a lot of work for technicians who qualify for these licenses.

What are the qualifications for a GROL or GMDSS/M?

To qualify for a GROL, you must: be a legal resident of the United States or otherwise be eligible for employment in the US, be able to receive and transmit spoken messages in the English language, and be able to pass written examinations covering basic radio law and maritime procedures (FCC Element 1) and electronic fundamentals and techniques (FCC Element 3).

For the GMDSS/M license, the applicant must pass an additional FCC element (9), consisting of 50 questions on general radio maintenance practices and procedures, of which, 38 (or 75%) must be answered correctly. Applicants taking tests on Elements 1 and 3 must also correctly answer 75% of the questions to pass the specific element, otherwise the test will have to be readministered.

Element 1 consists of 24 written questions (requiring 18 to be answered correctly) while Element 3 consists of 76 written questions (in 8 sub-elements), requiring that 57 be answered correctly before passing the test. Applicants must also pay all applicable regulatory fees and fees that COLEM may charge (see below for the definition of a COLEM).

Upon meeting all of the criteria (as set forth above), the passing of each individual Element will qualify the applicant to hold the permit (or license) covered by that particular Element. For example, if the applicant took the test for the GMDSS/M (Elements 1,3 and 9), but only passed Element 1, the applicant could accept a Marine Radio Operator Permit (MROP), which requires passing only Element 1. The applicant could then re-take Elements 3 and 9 at a later date to qualify for the GMDSS/M, without having to retake the Element 1 test. Alternatively, the applicant could accept a PPC (Proof-of-Passing Certificate) as described below.

What exactly is the GMDSS?

The Global Maritime Distress and Safety System is an automated ship-to-shore distress alerting system using satellite and other advanced (terrestrial) communications systems which will eventually replace Morse code as a maritime distress communications medium. This system, coordinated worldwide by the International Maritime Organization (IMO) provides rapid transfer of a ship's distress call to the agency (Coast Guard, Civil Air Patrol, search and rescue, etc.) best suited to provide the necessary assistance in an emergency. The GMDSS allows each station to be assigned a unique call sign in a system which has been allocated a select band of frequencies upon which to operate worldwide. To operate a GMDSS system, one must hold a GMDSS/O (Operator) license, while one must hold a GMDSS/M to maintain, repair or calibrate these systems.

Who administers commercial radio operator license tests?

In October, 1992, the Federal Communications Commission (FCC) transferred the responsibility of commercial radio license testing to the Private Radio Bureau, the same entity that handles Amateur Radio operator examinations.

The new commercial radio operator testing program is currently being directed by nine (private) primary organizations known as Commercial Operator Licensing Examination Managers (COLEMs). Each COLEM may have any number of testing facilities across the country, though each facility will be responsible to, or licensed under the authority of, the primary COLEM. You can find the facility nearest you, as well as testing dates and costs by contacting the COLEM of your choice (Figure 1).

Upon passing each element on the road to receiving a GROL or GMDSS/M, the COLEM test administrators will complete a Proof-of-Passing Certificate, noting the element passed, identity of the applicant and the date passed. This will allow the applicant an entire year to complete other elements without having to re-

Shackelford is an independent consumer electronics technician

National Radio Examiners Division
The W5YI Group, Inc.
P.O. Box 565206
PO Box 565206
Dallas, TX 75356-5206
800-669-9594
817-461-6443
Fax: 817-548-9594

All elements are available on a monthly or quarterly basis, based on demand, at more than 250 test centers in all states.
Fee: $35.00 per license

Drake Training and Technologies
8800 Queen Avenue South
Bloomington, MN 55431
800-401-EXAM
Fax: 612-921-7248

All elements are available on a daily basis at over 200 locations in all states except Maine and at over 300 locations worldwide. Evening, weekend, and holiday appointments are available.
Fee: $60.00 per examination
Contact: Julie Johnson

Electronic Technicians Association International, Inc. (ETAI)
602 North Jackson Street
Greencastle, IN 46135
317-653-4301
317-653-8262
Fax: 317-653-8262

All elements are available at test sites throughout all states. Also at stateside and overseas U.S. military installations (DANTES). Call for schedule information.
Fee: $35.00 to $75 00
Contact: Anne Voiles

Elkins Institute, Inc.
P.O. Box 797666
Dallas, TX 75379
800-944-1603
Fax: 214-732-0244

All written examinations are available at test sites throughout all states. Scheduled and "by appointment" examinations are available.
Fee: $50.00 for first element $25.00 for each additional element taken at same sitting. Contact: Ed Lyda

International Society of Certified Electronics Technicians
(ISCET)
2707 West Berry Street
Fort Worth, TX 76109
817-921-9101
Fax: 817-921-3741

All elements are available by appointment from 360 examiners in 47 states, Guam, and some foreign countries. Examinations are not available in Alaska, Vermont and Wyoming.
Fee: $25.00 to $75.00 per element
Contact: Dept. 19

National Association of Business and Educational Radio, Inc.
(NABER)
1501 Duke Street
Alexandria, VA 22314
Registration:
800-869-1100
Fax: 612-832-1290

Written elements 1, 3, 7, and 9 are available at 95 test centers nationwide five days a week.
Fee: $63.00 to $120.00
Contact: FCC Technician Testing Center
800-759-0300
Fax: (703) 836-1608

Sea School
5905 4th Street N.
St. Petersburg, FL 33703
800-237-8663
Fax: 813-522-3155

All elements are available by appointment in 83 coastal cities
Fee: $25.00 - $55.00
Contact: Len Wahl

Sylvan KEE Systems
9135 Guilford Road
Columbia, MD 21046
800-967-1100
Fax: 410-880-8714

All elements are available seven days a week, walk-in or scheduled appointment (except holidays) at over 110 computerized testing centers in 35 states
Fee: $50.00 to $75.00
Contact: National Registration Center

The National Association of Radio Telecommunications Engineers, Inc.
NARTE
PO Box 678
Medway, MA 02053
508-533-8333
Fax: 508-533-3815

All elements available by appointment quarterly at NARTE test centers at 120 US universities and colleges. Also available at US and some overseas military bases (DANTES)
Fee: $40.00 per examination per sitting

Figure 1. If you're interested in taking the test for the GROL or the GMDSS/M license, contact one of these agencies.

take the passed element test(s) or apply for an "inferior" class of license/permit.

Studying for the commercial radio operators license

Once every few years, the Federal Communications Commission releases into the public domain a set of question pools for the various elements of the commercial radio licenses (including, but not limited to MROP, GROL and GMDSS/M). These pools contain every conceivable question (and answer) which could be asked on any of the FCC required/COLEM administered element tests, as all test questions are required by the FCC to be culled from the question pool for that specific element. While these ques-

Test Your Electronics Knowledge

Answers to test *(from page 61)*

1. Divide by twenty (÷20). The circuit is a phase-locked loop. The VCO output frequency (20 X F) must be divided by 20 so it will match F in the comparator.

2. 10W. A -3dB attenuation divides the input power by about 2. (The more accurate value is 1.995262315+, or, Log-1 0.3)

3. Modulation Index (by definition)

4. Monostable (or, one-shot). Also, it is sometimes called a pulse stretcher.

5. length, diameter, type of material and temperature.

6. Voltmeter, because voltage is work per coulomb, or, work per unit charge.

7. Not correct. The *voltage* gain is less than 1.0. The Current gain can be high.

8. C - If you stress one of your bones until it is near the breaking point it will generate a voltage and warn your brain to stop doing that thing you're doing.

9. One sixty-fourth. Read the word "of" as times. For example, one-half of 8 is 4. (1/2 X 8 = 4)

10. Wrong! The power in watts is a measure of heat per unit of time. Remember this definition: power is the time rate of expending energy. The actual value of heat - in joules or calories - is

P = (V) X (I) X (time in seconds) joules, or,

P = (0.24) X (V) X (I) X (time is seconds) calories

(The 0.24 converts joules to calories.)

tion pools do have all of the (multiple choice) questions and their corresponding answers, there are no explanations as to why the answer may be right or wrong.

To fill the void left by the question pools released by the FCC, many COLEMs, in addition to administering commercial radio tests, sell study guides or hold classes (probably in your area) which will help applicants comprehend the information required to pass a specific element(s). These study guides are often available in book or computer software form, and are well worth the investment, regardless of how experienced one is in the field of electronic repair.

Although not required to do so, COLEMs can also provide invaluable assistance in filling out the proper forms (in the proper manner) for submission to the FCC. These forms contain various codes for things such as fees, which are not readily evident or self explanatory, and can be extremely intricate. If a form is filled out wrong (or incomplete), the FCC will reject it, costing you time and money.

In addition to COLEMs, there are some independent study guides and practice tests available. One such guide is available from TAB Books: "Practice Tests for Communications Licensing and Certification Examinations," by Sam Wilson and Joseph A. Risse. Persons requiring assistance in understanding some of the Radiotelegraph Elements or subelement topics (such as Antennas and Feed Lines/ Element 3H) might contact a local amateur radio operator, packet radio operator or Radio Relay League member.

Do you, as an electronic repair technician need a Commercial Radio license to perform your duties? No, but there are many opportunities that await those who do hold such a license that are simply unavailable to those who do not. Many companies look to employ technicians who hold a commercial radio license at a higher rate of pay, as other shop technicians may work "under" the authority of a license holder (in some circumstances), meaning the license holder is ultimately responsible for the final inspection of the unit being repaired. Because of this, some shop owners will pay all fees for an employee to take a commercial radio licensing test; maybe the owner of the shop in which you work. ■

About fuses

By Tom S. Jones

As electronic technicians we replace fuses on a regular basis. If you ask another service technician about fuses, the answer usually is "Fuses blow when too much current flows. A blown fuse should be replaced with one of the same type." The heat energy created by the current flow in the wire element causes the fuse to blow. However, there is much more to learn about fuses. For example, why are fuses often bypassed by capacitors in high end audio power amplifier stages?

Fuse operation

The word "fuse" literally means "melt." The heat energy developed in a fuse is proportional to the product of the square of the current (I) and the time (t) it flows through a resistance (R) (Figure 1).

The formula of Figure 1 shows that current over time and the resistance of the element determines fuse operation. If the heat generated in the alloy link increases faster than it can be dissipated to the surroundings, when the design temperature is reached the alloy melts.

Glass cartridge fuses

The type of fuse most commonly found in electronic devices consists of a thin wire with a low melting point, terminated between two metal ferrules (caps) at the ends of a glass cartridge. The refinement of adding a cartridge which surrounds and encloses the wire prevents the flying molten-metal particles during fuse opening from damaging the equipment or possibly starting a fire. The length of the cartridge largely determines the voltage potential which the fuse can withstand before arcing across the end caps occurs.

$$W=I^2tR$$

Figure 1. Heat energy equal I^2tR

Cartridges are constructed from nonconductive materials such as porcelain, ceramic, fiber, etc. Fuses are not waterproof unless specifically designed to be. They are generally sealed to the glass with glue at the end caps (ferrules).

Often, in order to control the heating effects and arcing associated with higher currents, a filling of heat absorbing material, such as a sand mixture, may be added to the inside of the cartridge. Controlling the heating effects creates fuses which tolerate more heating before melting and therefore do not blow on surges of current. These are commonly referred to as "slow-blow", anti-surge, time-lag, or time delay fuses.

At the other extreme are fuses which are very intolerant of surges or overcurrent and are called "fast-blow", fast acting, or quick-blow. Of course there are also "normal-blow" fuses. These terms are somewhat vague, and we shall see that only the original manufacturer's specifications can really give us the "inside story" on a particular fuse.

For example, a fuse rated 1 A under the European International Electrotechnical Commission (IEC) standards will not have the same current/time characteristics as one rated by the Underwriters Laboratories (UL) in the United States. Fuses are rated in accordance with Canadian Standards Association (CSA) standards in Canada. Additionally, slow-blow fuses manufactured by different companies could have slightly different current/time characteristics due to the nature of the tolerance allowed by the standards for each fuse classification.

Slow-blow types

Slow-blow fuses can sometimes be identified by the shape of the wire within the glass fuse cartridge. They generally will have a wire attached to a low melting point pellet which is attached to a spring. The spring recoils back and opens the circuit when the pellet melts. Sometimes there will be an internal resistor which helps to heat up the pellet.

The resistance of a fuse with this type of internal structure can measure in the tens of ohms. Another type consists of a spiraled wire spanning the length of the

Jones is chief of technical services in the Engineering and Sustainment Division at Andrews Air Force Base.

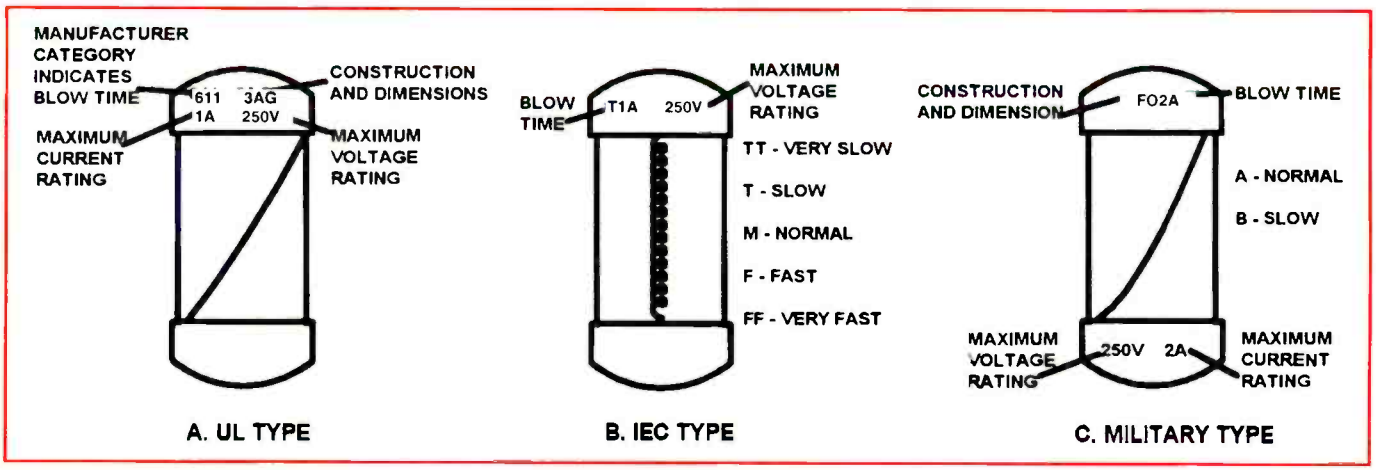


Figure 2. You may encounter different types of fuses, depending upon the type of equipment you work on. These are some of the fuse types you may run across.

cartridge. Slow blow fuses are found in protection circuits for power supplies and motors and other equipment with high initial surge currents.

Fast-blow, or quick-blow types

Although there are some exceptions, quick-blow fuses normally have a thin wire fuse. Some fast acting fuses have rather thick fuse wire. Fast-blow fuses are found on circuit cards and as individual protection for various parts of electronic circuits. Often they are used in conjunction with an electronic "crowbar," a circuit designed to short out the output of a power supply under severe overload, thus protecting the load circuits.

Ratings

The current/voltage rating of a fuse is usually imprinted on the cartridge body or on the end caps. A 125mA fuse might be marked *125mA, 250V* or *1/8A, 250V.* On some fuses, the letter A for amperes is omitted, and in other cases the voltage rating does not appear. If this is the case, the only way to determine the specifications is to consult the equipment manufacturer's service manual or data book.

The rating under the IEC system for a slow-blow 1A 250 volt fuse would be T1A 250V. The "T" denotes "anti-surge" or roughly equivalent "slow-blow." In the military fuse rating system, a particular 1A, 250A slow-blow fuse would be indicated by FO2B 250V 1A. All ratings for these fuses are RMS values.

Although it is not too hard to learn the rating and type of a given fuse, it must be pointed out that European fuses are rated for their sustained current rating at an ambient temperature of about 25C (77F). UL approved fuses are not necessarily rated for their sustained current capability.

For example, a fuse rated by a certain manufacturer at 1A slow-blow will rupture (open) within four hours at 100% of rated current. The very same fuse will also rupture at a 200% current flow (2A) after that current has been flowing between 3 and 60 seconds. The IEC 1A fuse will sustain 1A through the fuse almost indefinitely. This points out the necessity to replace fuses with the same manufacture/type if you want the protection identical to that provided by the original fuse.

Breaking or rupturing capacity

Breaking capacity refers to the maximum short circuit current and voltage the fuse is capable of breaking without arcing across the endcaps. For example, to protect a large industrial motor use a high breaking capacity (HBC) fuse in series with the power lines. The high breaking capacity will prevent a fuse "explosion" caused by the intense energy released during fuse opening at high current levels.

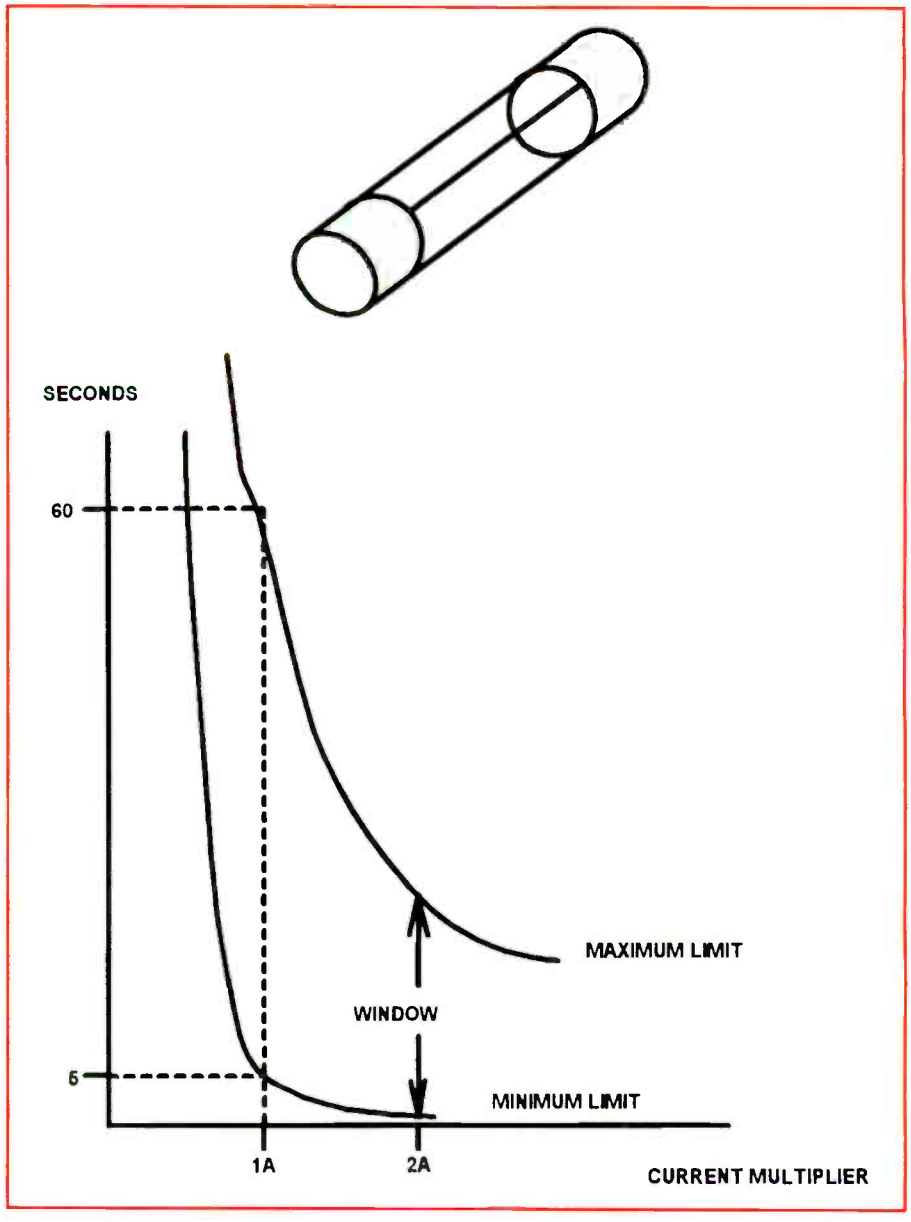


Figure 3. A typical 1A cartridge fuse is shown in A. A particular 1A fuse will accept 0.7A almost indefinitely, but at 1A will blow within 5 to 60 seconds. B is a curve of time-to blow vs current. A "window" (tolerance) is allowed by the standards to compensate for the variability of the manufacturing process and other variables.

Current/time (I^2t)

A fuse does not open instantaneously. The heat energy generated in the wire element follows joule's law (Figure 1). The curve in Figure 1 illustrates the time it takes for a particular fuse to blow at a given current. Obviously, you would not use a slow blow fuse in a current-sensitive solid-state circuit because it would allow excess current to flow before opening. Some catalogs use the term "pre-arcing" to indicate the time it takes for the fuse to open the circuit path.

Other effects

Fuse opening characteristics will depend on a number of parameters that are determined by the physical nature of the device. As ambient temperature increases, the fuse will blow quicker; that is, as operating temperature increases, less current is needed for a given fuse to blow. Moreover, the resistance of the wire itself will cause a small but measurable voltage

drop across the fuse and thus alter the opening time of the fuse.

Obviously, the type and size of the fuse clips will also have a slight effect on the time it takes for the element to fuse, because they sink heat away through the end caps. Fuses often fail for no other reason than the aging affects of repeated current surges at turn-on which physically stress the wire element. A blown fuse, therefore, does not always mean there has been a fault in the equipment.

A fuse problem specific to hi-fi

Hi-fi designers have used capacitors to overcome a particular inherent fuse shortcoming. Fuses can modulate the current through them due to the thermal lag caused by cyclic heating and cooling caused by high audio program currents. For example, immediately after a peak current surge, the resistance of the wire element will be highest and the voltage drop across the fuse will be at its greatest until the wire element cools down. This impedes the flow of lower power high frequency energy so, a capacitor is used to bypass the slightly high resistance of the heated fuse element.

Thermal fuses

Thermal fuses are designed to protect equipment from excessive temperature rises. In a thermal fuse, the heating of the exterior of the fuse causes an element inside to melt and therefore opens the circuit. A typical device would have ratings as follows: maximum opening temperature 100C, maximum current 3A, actual opening temperature 98 + 20C. These devices are mounted using screw terminals or are crimped into the circuit.

Do not solder thermal fuses into the circuit or you risk degrading or opening the fuse. The metal case on some thermal fuses is not isolated from the line.

The thermal fuse is designed to protect the equipment it's in from a defect in which the generation of heat is more dangerous than the current flow which causes it. Thermal fuses are marked with the opening temperature.

Electronic fuses

A fuse that can "reset" once the fault is cleared is called an electronic fuse. These devices are soldered into the circuit and are in series with the line they are to protect. Some electronic fuses are physically similar in appearance to a ceramic capacitor or metal oxide varistor. The on-resistance across much of the range is less than 50mΩ and current ratings can exceed 6A.

The electronic fuse offers low on-resistance until the trip point is reached. The fuse then latches to an ultra-high resistance state; a virtually open circuit. It will return to the low on-resistance state seconds after the fault is removed. A typical specification would be: 1.1A holding (will not trip), nominal cold resistance of 60mΩ, minimum trip current 1.8 amperes RMS, and maximum voltage of 30Vrms at 20C. The marking for the above fuse might be MF110 30V.

Other fuse variations

There are many variations of fuses. One type has a metal strip which is attached so as to spring forward when the fuse blows, providing a visual indication. The sizes and packaging of fuses is also subject to great variety. Some look like small light bulbs while others are similar in appearance to resistors.

There is a type of fusible resistor which looks somewhat similar to a resistor and opens when overloaded without presenting a fire hazard. Fusable resistors are used in the same circuits that slow blow fuses normally protect.

There is a color code for fuses which are as similar to the color code for resistors. The first two bands of the resistor color code are mA, the third is the multiplier, and the thicker fourth band is the opening specification: red for fast, yellow for medium, and blue for slow.

Replacing fuses

There is very little room for substitution when replacing fuses. You can substitute a fuse with a higher voltage rating. For example, you can replace a 1A 32V fuse with a 1A 250V fuse. You may temporarily replace a slow-blow fuse with an equal current fast-blow if the turn on current surge doesn't blow the fuse. Remember, fuses protect against I^2Rt losses, not overvoltage.

The safest way to replace a fuse is to remove power from the equipment by disconnecting the plug from the power outlet before touching the fuse. The manufacturer may have placed the fuse before the power switch or after the power switch. Fuses are best checked out of circuit with an ohmmeter. Visually inspect and then physically tap the fuse to ensure the wire element is firmly connected inside the end caps before testing. A continuity measurement and good physical condition indicate a usable fuse.

Do not be fooled by a fuse that looks sound when you inspect it visually. It is not unusual for the fuse element to become slightly separated from the end cap and yet appear to be connected when viewed with the unaided eye. Although an intermittent fuse is rare, it only has to happen to you once to increase your wariness of these "simple" devices. Remember, fuses are safety devices and should ideally be replaced with original equipment manufacture (OEM) devices only.

Electrical standards and the importance of good business practices

By Sam Wilson

I have mentioned this before: if you write to me and do not get an answer within two months, please write again! I am getting ready to have everything in my office sent to the dump so I can start over. I had this great idea. I would put everything on disks and eliminate the need for a lot of paper work. Then, I lost the disk.

I have to explain that this isn't all my fault. I think this apartment was built on an Indian burial ground. A very friendly ghost—who I call Joe—haunts my office. He has a distorted sense of humor, so, he likes to hide my things. So you see, if your letter is lost it is not really my fault.

When your brain is a mouse

There is a professional magazine called "Computer Video—Bridging the Gap." Among other things, it reports on the latest happenings in the computer world.

You won't find this publication on the newsstand. It has a "closed circulation" which means it goes to professional video and computer graphics equipment users. Actually, there isn't much in this publication that would be of interest to technicians. One rare exception is an article titled "Forget the Mouse! Plug in Your Brain." It tells about a company that has developed a system which controls a Mac computer using brain waves.

They developed a gizmo that mounts (like a headband) on the user's head. This device senses brain waves in the form of voltages and frequencies, and in turn uses them to control a Mac computer; something like the way a mouse is used. Who needs it? Well, people who are paralyzed for one example.

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

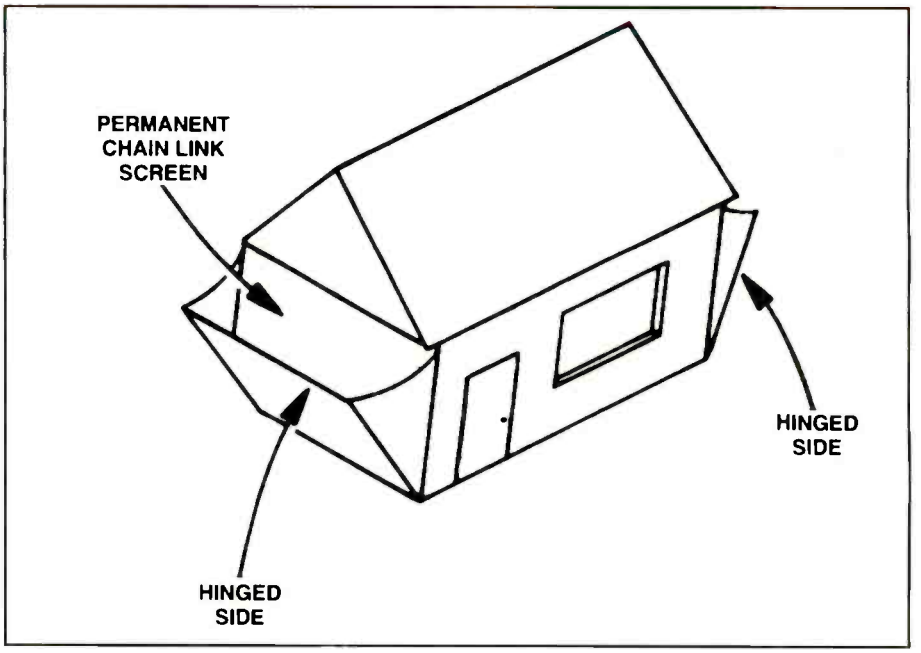


Figure 1. If you could figure out how to protect a home from tornado damage, perhaps using a scheme such as the one shown here, you might become a millionare.

Don't throw your Amiga computer away!

A company in Frankfurt, Germany has bought the rights to the Commodore Amiga and plans to resume production. Look for 10,000 units to be sold in America before the end of the year. (Can the Commodore 64 and 128 be far behind?)

When I was giving my last lecture on the road I made a valiant effort to gain prestige. I announced that I owned a Commodore 128. Some wise guy in the audience yelled out "Is it a D?"—meaning, did I have the latest model, the Commodore 128D? So much for prestige.

More million-dollar ideas—tornado proofing a home

If you have been reading **Electronic Servicing & Technology** and, following "What Do You Know About Electronics?" you know that I present million-dollar ideas from time to time. I will now give you another million dollar idea.

I hope you will forgive me for reminding you that when you get a million dollars from one of these ideas you wouldn't miss a paltry one hundred thousand dollar donation to Sam Wilson.

The storm that causes the most damage per area is the tornado. When a tornado comes near to a house, that house is likely to be destroyed. The destruction is caused by the air inside the house rushing out in an attempt to equalize the vacuum in the center of the tornado.

Now, here is your million dollar idea - Figure 1 shows how major damage to the house can be avoided. When the tornado is close enough to destroy the house, two

hinged sides open to let the air out. Built-in screens prevent personal possessions from scattering over the neighborhood. No use to re-invent the wheel. Use garage door openers to open the sides. Hinge the bottoms and you are in business.

Here is where your electronics expertise comes into play. Design a motor control that automatically opens the side when the danger (low pressure) is near. Be sure to make it a 12Vdc (battery) operation because the ac power electricity is sure to be disrupted. Keep the battery on trickle charge when the system is idle.

Standards

When electricity became a science all of the units of measurement were based upon mechanical equivalents. In other words, they were based upon length, mass, and/or time. Two examples are the standard units of resistance and current. The standard 1Ω resistor was given as a column of mercury 106.3cm. long with a cross section of 1mm. The resistance was set at a temperature of 0C.

The standard of 1A was based upon electroplating. Two silver plates were immersed in a silver nitrate solution. A voltage was applied between the plates. The positive electrode lost weight and the negative plate gained weight. When the weight gain of the negative electrode was 0.001118 gram of silver per second the current was defined as one ampere. That standard was established by an act of congress. With the resistance and current defined, the voltage standard was established by Ohm's law.

The fact that the positive plate lost weight and the negative plate gained weight helped to convince scientists that electricity travels from positive to negative and that was the basis for what electronics engineers call conventional current flow. Today there is a better explanation for this kind of current flow.

Those standards for resistance and current are no longer the basis of legal calibration today. An ampere is now defined as follows: 1A of current is flowing in two infinitely long parallel wires, one meter apart, when the force between them is 2×10^{-7} newton per meter of length.

An Ω is now defined as the resistance of a conductor such that a constant current of one ampere through it produces a voltage of one volt between the ends. Those definitions are consistent with the definitions in the Standard Handbook for Electrical Engineers by Fink and Carrol.

Why?

Many parents tell me they wish their three and four year-old child had never learned how to ask the question, "why?" Grown people know there isn't any known answer to some questions.

In an article in a previous issue at this magazine I talked about a number of different physical laws and effects that are the basis of electronics. In most cases I have avoided asking why those physical laws and effects should exist.

As an example, why should the voltage across a charging capacitor; the growth of current in an inductive circuit; the growth of a child; the growth of a bean stalk; and, the growth of an exploding star all be related to the constant *epsilon*? (Epsilon = (E) = e (on calculators) = 2.718281828+)

In our busy world we don't have much time to reflect on the question, "why?" I get letters from readers who say they like my column because it makes them think. If you can afford the time, here is something you can think about. It is a thing about which you can ask the question "why?" Why can't you increase the gain of an amplifier without decreasing its bandwidth? Yes, I know that the equation relating gain and bandwidth prevents it. But the equation does not answer the question "why?"

Why do small businesses fail?

People who know about such things say that one of the most frequent causes of small business failure is that "they fail to keep good records." (Why is that so?) You can be the best technician in town and still lose your business if you don't understand the ins and outs of business.

That is something to think about! Whoa! You say you are not running a business and you are not interested in that subject? Listen: every person who works is in some kind of business!

The product of your company is you. When you apply for a job you are the salesman. When at work you are supplying the service. When you do your taxes (or have them done) you are taking care of the records. If you fail in any part of your business *your business will fail.*

Here is a light question— you can work out in your spare time—Sir Isaac Newton said that light is made up of particles. James Clerk Maxwell said that light is made up of waves. Scientists today are still trying to figure out who is right. Can you? You must prove your answer! ■

ES&T Calendar

10th Annual PC Expo-Chicago
October 3-5, 1995
McCormick Place East
Chicago, IL
800-829-3976

CES Mexico
Mexico City, Mexico
October 10-12, 1995
703-329-1380

Personal Computer and Electronics Expo
October 19-22
Nassau Veterans Memorial Coliseum
Uniondale, NY
Expo, Inc.
800-886-8000
516-889-6000

Systems Support Expo
October 26–27, 1995
Moscone Center
San Francisco, CA
10:00 am to 5:00 pm daily
Fax: 207-846-0657

International Winter Consumer Electronics Show
January 5-8, 1996
Las Vegas, NV

Mobile Electronics Show
April 19-21, 1996
Orlando, FL
703-329-1380

CES Orlando '96—The Digital Destination
May 23-25, 1996
Orlando, FL
703-329-1380

Electronics service rates high with consumers

By the ES&T Staff

Recently, the Electronic Industries Association commissioned a survey to determine the perceptions that consumers have about the service provided when their consumer electronics products fail. According to the EIA findings, consumers have a very positive perception of the consumer electronics service business.

The survey was directed at 1,000 U.S. households who had returned some type of consumer electronics product for repair at any time in the past. The two most frequently mentioned items were TVs (35%) and VCRs (33%). When consumers need a product repaired, most (54%) take the product back to the retailer. Use of the retailer as a point of repair is more prevalent in the Midwest than any other region. Only 8% of consumers send products back to the manufacturer, while 43% prefer to use an independent service center.

High marks

All types of service centers receive high marks for timeliness, quality of work, and customer service. The equality of ratings among the repair options exists despite the fact that consumers using independent service centers are more likely, by a 4 to 1 margin, to pay at least part of the repair costs. The bottom line among all options remains: seven out of ten customers needing product repairs walk away satisfied.

On average, consumer electronics repairs take about two weeks, with 62% taking less than one week. The repair industry comes close to meeting the high ex pectations of consumers, however. Seventy-five percent (compared to an actual of 62%) of consumers think the repair process should take one week or less to complete.

High tech products, high tech service

As the perceived complexity and replacement price of a product rises, so too does consumer desire for certified service technicians. Eighty-three percent of consumers want nationally certified service technicians for their computer products versus 70% for VCRs and stereos, and 80% for TVs. These numbers are consistent with the feeling among consumers about what kinds of skills a person must possess to be an electronics service technician. Roughly 80% of consumers feel that a technician must possess an above average set of skills.

Warranties

Nearly 60% of consumers purchase additional warranty coverage above and beyond the basic level provided by the manufacturer. Retailers have a hand in 85% of additional warranty transactions. Only 11% go to the manufacturer alone.

Replace or repair

Despite the high marks, the consumer electronics service industry gets for its work, nearly half of consumers prefer exchange over repair. Forty-five percent of consumers explicitly prefer exchange, while just 11% would always choose the repair option. Consumers also want a nearly unlimited time horizon to allow for exchange. About 43% of consumers feel time periods in excess of six months after purchase are not unreasonable to allow for exchange of a failed product. If consumers are asked to spend their own money their interest in repair increases. When given the option of repair versus replace at equal cost the percent of people always choosing replacement drops to 22% from figures of 43 and 45%.

Summary Results

See the accompanying chart for a tabulation of the results of this survey. Please note that the questions are numbered as they were numbered in the original survey. The first two questions in the survey were introductory type questions that were not directly relevant to the consumer attitudes toward service, so they are not included here.

3. What kind of product or products have you returned?

35%	TV
33%	VCR
14%	Telephone
7%	Home stereo
3%	Head unit (car stereo)
2%	CD Player
2%	Answering machine
2%	Radio
10%	Other product

4. Where did you return the product or products, did you return them to... ?

54%	The store where you purchased the product
8%	Directly to the manufacturer
43%	An independent service center

5. On a scale from 1 to 5 with 1 meaning Very Unsatisfied to

5 meaning Very Satisfied, rate each of the following for the store where you returned the product for repair:

	Average	1	2	3	4	5
Timeliness in completing work	3.82	11%	4%	20%	23%	43%
Quality of work	4.01	9%	4%	14%	23%	50%
Customer service	3.98	8%	5%	17%	24%	47%

6. Did you pay any part of the repair costs?

26%	Yes
68%	No

7. On a scale from 1 to 5 with 1 meaning Very Unsatisfied to 5 meaning Very Satisfied, rate each of the following in relation to the manufacturer who repaired the product:

	Average	1	2	3	4	5
Timeliness in completing work	3.67	14%	5%	7%	28%	36%
Quality of work	4.09	8%	3%	16%	21%	53%
Customer service	4.17	4%	5%	14%	24%	53%

8. Did you pay any part of the repair costs?

31%	Yes
56%	No

9. On a scale from 1 to 5 with 1 meaning Very Unsatisfied to 5 meaning Very Satisfied, rate each of the following for the independent service center who repaired the product:

	Average	1	2	3	4	5
Timeliness in completing work	3.79	10%	9%	18%	22%	43%
Quality of work	3.94	10%	6%	13%	22%	49%
Customer service	4.02	8%	5%	15%	22%	50%

10. Did you pay any part of the repair costs?

80%	Yes
19%	No

11. Did you choose the service center, was it suggested by the retailer, or was it an authorized service center for the manufacturer?

66%	Chosen by consumer
24%	Suggested by manufacturer or was authorized service center
9%	Suggested by retailer

12. Approximately how long, in weeks, was your product in for repairs? Meaning from the time you took it in or sent it to the manufacturer how long did it take to get back?

62%	Less than 1 week
21%	2 weeks
7%	3 weeks
4%	4 weeks
4%	5 to 7 weeks
3%	8 weeks or more

13. In your opinion, what is a generally acceptable and reasonable amount of time for a product to be "in the shop" getting repaired?

75%	Less than 1 week
21%	2 weeks
3%	3 weeks
2%	4 or more weeks

14. Which of the following repair technician certifications are you aware of? Have you ever heard of .....?

43%	ASE, Automotive Service of Excellence
29%	CET, Certified Electronics Technician
19%	A Plus Computer Specialist
13%	CT-A, Certified Technician - Appliance

15. If you had to return each of the following products for repairs, how important would it be for the repair shop to be staffed by nationally certified technicians. Use a 1 to 5 rating, where 1 means Not Important to 5 which means Very Important.

	Average	1	2	3	4	5
Computer	4.38	6%	3%	7%	13%	70%
VCR	3.99	6%	6%	19%	23%	47%
Stereo components	4.01	6%	6%	19%	22%	48%
Color TV	4.24	4%	4%	13%	21%	58%
Telephone answering machine	3.60	13%	9%	23%	16%	39%
Cordless telephone	3.66	12%	9%	21%	18%	40%
Video game	3.27	21%	11%	21%	13%	34%
Cellular phone	3.85	12%	6%	16%	18%	49%
Car stereo	3.87	8%	5%	22%	21%	44%
Household appliances	4.12	6%	4%	16%	19%	55%

16. If you had a product which needed repair work, would you have more confidence sending the product to the manufacturer, or using a nationally certified repair service center authorized by the manufacturer. Assume each choice is equally convenient and equal in cost.

29%	Manufacturer
45%	Authorized service center
22%	Both equally

17. In your opinion, what level of skills do you think it takes to be an electronics repair technician? Do you think if takes a high level of skills and training, above average skills, an average set of skills, or a below average amount of skills and training?

30%	High level
52%	Above average level
18%	Average level
1%	Below average level

18. Have you ever purchased additional warranty coverage above and beyond that supplied by the manufacturer?

59%	Yes
41%	No

19. From whom did you purchase the additional warranty coverage?

70%	Retailer
11%	Manufacturer
17%	Both retailer and manufacturer

20. If your electronic product failed while under warranty which of the following options would you prefer?

45%	Exchange for a new product
11%	Free repair service of the product
42%	Either option is equally preferable

21. What would you consider to be a reasonable amount of time, after a product has been purchased, to allow someone to exchange the product for a new one if the product failed?

29%	1 month
5%	2 months
13%	3 months
1%	4 to 5 months
11%	6 months
1%	7 to 11 months
29%	12 months
4%	Over 1 year, but under 2 years
3%	2 years or more

22. Have you ever called a manufacturer's 1-800 customer service number for any reason?

53%	Yes
46%	No

23. For which of the following reasons have you called a 1-800 customer service number?

66%	Find out where to take your product for service
42%	Get help using the product
35%	Get help setting a product up
34%	To ask about warranty coverage

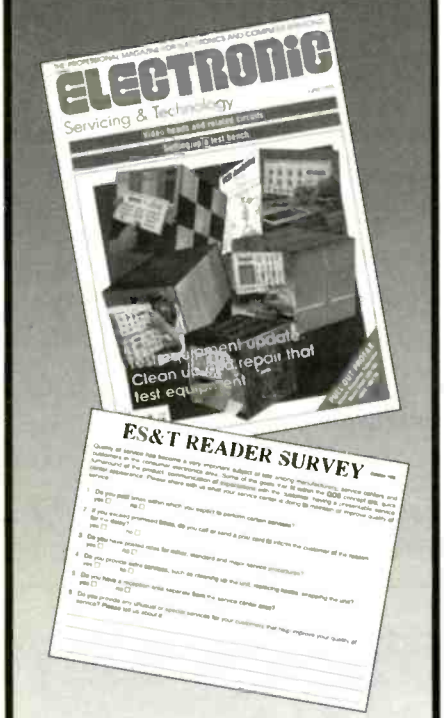
24. On a scale from 1 to 5 where 1 means Not Effective to 5 which means Very Effective, how effective have the 1-800 numbers been at helping you solve your problems or answering your questions?

7%	1 - Not effective
4%	2
15%	3
19%	4
54%	5 - Very effective
4.09	Average

25. When you think about the consumer electronics repair business how do you think they rate on things like fairness, compe-

ES&T READER SURVEY

It's a mini survey about you.



Bound into this issue is the ES&T Reader Survey card.

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.

The postage is paid. All you have to do is fill it out and mail it.

What could be easier?

Please fill yours out and mail it today.

tence, timeliness? Using a scale from 1 to 5 where 1 means a Very Negative Perception to 5 which means you have a Very Positive Perception, how would you rate the consumer electronics repair business on.. . ?

	Average	1	2	3	4	5
Fairness	3.55	4%	7%	39%	32%	19%
Competence	3.70	3%	6%	32%	37%	22%
Timeliness	3.51	5%	10%	35%	28%	22%

26. Assume a consumer electronics product you owned broke, and you were trying to decide whether to replace it or get it repaired. Suppose you decided to base your decision on how much of the product you had "used up". For example, you might repair the product if you'd "used up" X% of it, but replace it if you'd "used up" more than X%. With that in mind, up to what percent would you repair a broken a product versus replacing it? Assume repairing always costs no more than replacing but could cost much less.

22%	Consumer would always replace the product
13%	1 to 49 percent of product used up
37%	50 to 69 percent
16%	Over 70 percent
2%	Consumer would always repair the product
16%	It would depend on the product or repair costs

27. Gender

48%	Male	51%	Female

28. Age?

8%	17 - 25
23%	26 - 35
30%	36 - 45
19%	46 - 55
9%	56 - 65
9%	Over 65

29. Income?

3%	Under $10,000
7%	$10,000 to $19,000
15%	$20,000 to $29,000
16%	$30,000 to $39,000
21%	$40,000 to $59,000
11%	$60,000 to $79,000
6%	$80,000 to $99,000
5%	$100,000 & Over

30. Marital status?

20%	Single
68%	Married
9%	Widowed/Divorced

31. Number of children under the age of 18 in the household?

54%	None
16%	1
19%	1
7%	3
2%	4 or more

Test Your Electronics Knowledge

A medley of questions

By Sam Wilson

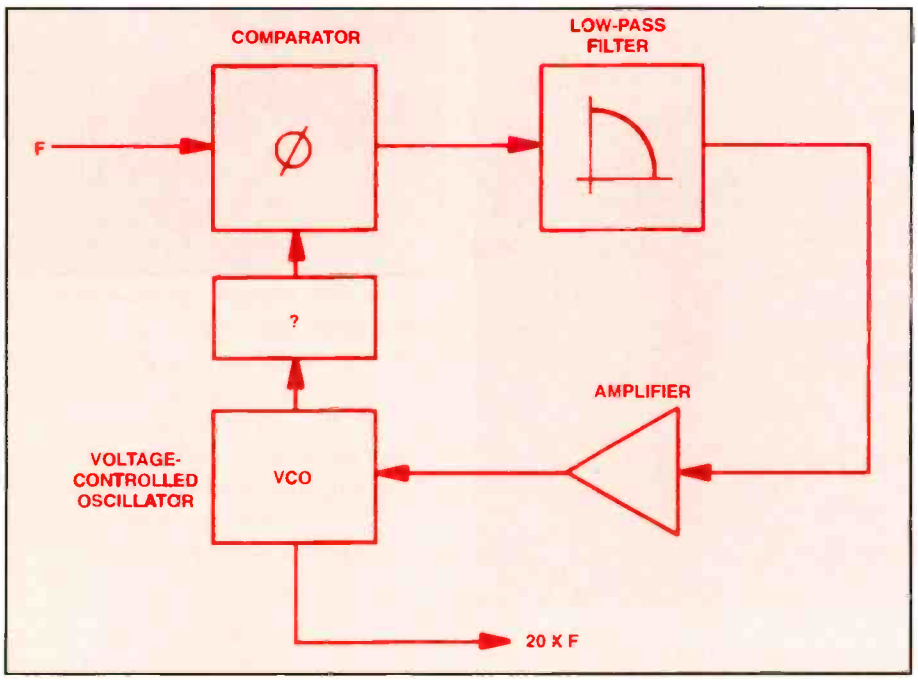


Figure 1. What is the name of the block marked "?" in this diagram?

1. What is the name of the block marked "?" in Figure 1?

Wilson is the electronics theory consultant for ES&T.

2. The input power to a certain transmission line is 20W. The line introduces an attenuation of 3 dB. What is the approximate value of output power from the transmission line?

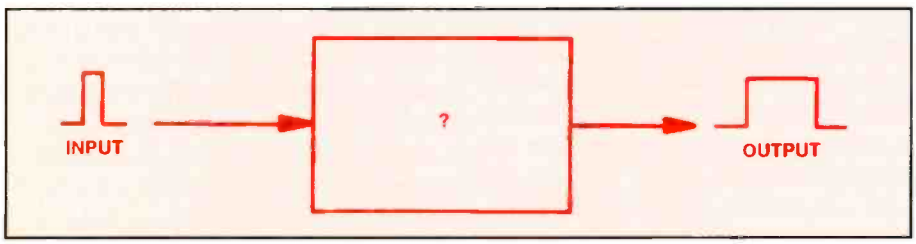


Figure 2. What type of multivibrator, "?" is represented in this circuit?

3. For an FM signal with a pure sine-wave modulating signal, "?" = _____

4. What type of multivibrator circuit (marked "?") is shown in Figure 2?

5. The resistance of a copper wire depends upon the following four things: _____, _____, _____ and _____.

6. What type of meter would you use to measure the amount of work per coulomb?

7. Is the following statement correct? The current gain of a source follower is less than 1.0.

8. Which of the following is a piezoelectric material?
   A. Possum kidneys
   B. Fresh elephant liver
   C. Human bone
   D. None of these choices is correct.

9. What is an eighth of a fourth of a half?

10. If an electric iron draws 4A from a 120V line the amount of heat is easily determined as follows:
   $P = V \times I = 120 \times 4 = 480W$
   A. Right
   B. Wrong

(Answers on page 50)

Portable scope-plus-meter

Fluke has released ScopeMeter Series II test tool, a new version of the test tool that was introduced in 1991. Like the original tool, Series II combines a dual-channel 50MHz digital storage oscilloscope and 3-2/3 true-rms multimeter in a rugged, battery-powered, handheld unit.

The new models add measurement functions such as a "Measure Menu" that automatically configures Series II for any of 30 measurement tasks. Another addition, Continuous Autoset function, eliminates front-panel reconfiguring as the user moves from one test point to the next.

The Measure Menu offers direct access to 30 common measurement functions. The user simply selects the requested measurement from the menu, and the test tool configures itself to make the measurement-without forcing the user to select the scope or meter mode or to make other manual selections.

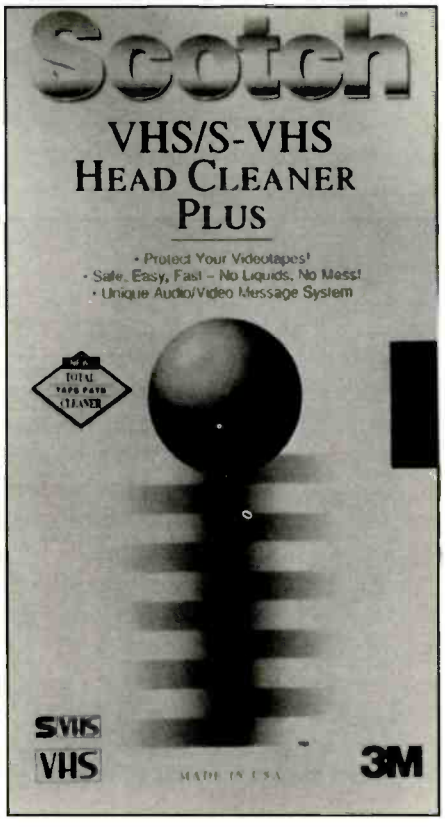
As the user moves from test point to test point, a Continuous Autoset function continues to track the input signal. As the signal changes, the tester dynamically monitors it and continually selects the proper time base, input range, trigger level, slope, and source. The continuous Autoset function allows the user to concentrate on testing rather than on test setups. The user can switch to conventional meter or scope operation at any time.

Circle (70) on Reply Card

VCR headcleaning tape

3M today introduced its new Scotch Headcleaner Plus, a magnetic-based head-cleaning system that's double coated to clean the tape path in any full-size VHS VCR or camcorder.

The product is a new VCR cleaning cassette that cleans video, audio, erasure and control heads as well as all pins and guides. On-screen displays and audible



messages guide the user through the quick and thorough operation as well as immediately test the results of the process.

Circle (71) on Reply Card

Disk manager supports Macintosh

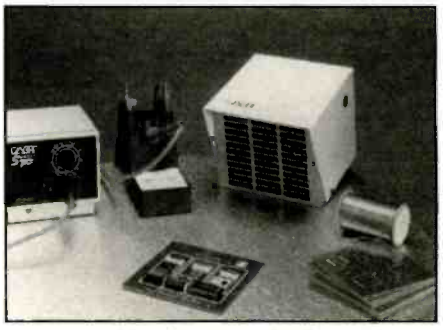
Ontrack Computer Systems announces an upgrade of its Disk Manager Mac installation utility to version 3.00. The software easily installs and completely prepares virtually any SCSI device or read/write optical/floptical drive into a Macintosh computer. This version supports the Power Macintosh, as well as SCSI Manager 4.3, which supports multiple buses, asynchronous transfer, disconnect/reconnect, direct ,memory access, and more. In addition, the Disk Manager Mac user interface is clearer and provides more complete information to users.

The program is designed to help users of any experience level easily install and maintain their disk drives. It allows users the ability to customize their desktops by creating up to 15 partitions, according to their needs. Flexible partitioning options allow users to quickly change options at any time-including password, mount a startup, and write-protect selections.

Circle (72) on Reply Card

Benchtop fume extractor

Pace announces the availability of the new benchtop fume extractor designed to



remove solder fumes and other airborne contaminants from the working environment. A powerful fan pulls the fume from the worker's breathing zone. The fumes then pass through an activated carbon filter mat to absorb the noxious gases and odors. This unit is compact in size (8"x 6" x 6") and is useful for situations where benchtop space is at a premium.

Circle (73) on Reply Card

Surface mount probe

Quick probe from *R&R Design*; a tool for connection of test instruments to surface mount type components, has been upgraded to provide additional stability features. The new model has a flexible shaft that is more rigid so it stays positioned on test points without drifting. The base of the probe is also heavier and has a non-skid pad adding even more stability. Additionally, the test point head has been enhanced for fine vertical adjustment.

Now in its second year of production, this probe offers an alternative to traditional test methodology. The unit quickly connects a test instrument, such as an oscilloscope, to multiple types of surface mount components. It can be used on most types of surface mount packages and multiple types of test points may be contacted

with only a single tool. No special tooling is required and the need for soldering test leads to components is eliminated.

Circle (74) on Reply Card

Insulated probes with improved test

Adding switchable attenuation (1X/10X) and full insulation, *ITT Pomona* has

introduced a family of insulated oscilloscope probes that are designed to provide a , replacement alternative to factory-supplied probes usually provided with the Fluke ScopeMeter 90 series, Leader Model 300 and Hitachi 5025 test instruments.

Leading the new product group is the 6033 Scope Probe Kit, which provides a paired set of 10X probes (red and gray), offering over voltage protection to 360 Vrms and full insulation of both termination's including integrally molded elastomeric stress relief for extended service life. The probe is rated at 200MHz and includes insulated leads and an insulated BNC connector for direct interface.

The company has also introduced a new family of switchable (1X/10X) insulated probes provided individually. Model 6035 provides a non-slip comfort grip handle and a slide-switch for the probe's switchable 1X/10X attenuation range.

Circle (75) on Reply Card

Disk manager software

Ontrack Computer Systems announces the release of Disk Manager Mac 4.0. This upgraded version is the first third-party Macintosh installation program in the industry to support IDE drives according to the manufacturer. The software installs and prepares virtually any IDE or SCSI drive, read/write optical or floptical device into a Macintosh computer. Version 4.0 increases performance, installation, and diagnostic capabilities for both IDE and SCSI devices.

By boosting the rate at which IDE drives read and write data, the software driver can significantly increase the speed at which data is processed and allow drives to process and transfer data at their maximum performance levels. Lab tests show that the Disk Manager Mac 4.0 driver often allows users to process data up to 40% or more faster than the current Apple driver. In addition, it contains expanded driver options to increase performance of both IDE and SCSI devices, including magneto-optical disk drives.

Apple's installer, Disk Manager Mac allows IDE users to create many custom partitions, each with their own partition options and sizes. All Disk Manager Mac utilities take advantage of the features offered by the IDE ATA Manager and SCSI Manager 4.3.

Circle (76) on Reply Card

Digital multimeter

A.W. Sperry Instruments, Inc. announces a new 31/2 digit DMM. The pocket-sized DM-9A is ergonomically contoured for the hand, has a limited five year warranty, a 200 hour battery life, and recessed safety designed input terminals. Its features include a 10A ac/dc range, overload protection on all ranges, a diode test function, phase indicator function, frequency function, temperature function and capacitance test function.

The meter is packed complete on a see through blister card with one 9V transistor type battery, test leads, case, temperature probe, a fuse and a spare fuse, and operating instructions.

Circle (77) on Reply Card

Desoldering/soldering system

For simple soldering, and desoldering, *A.P.E.* offers the EX-500-solution for any demanding thru hole application. This desoldering/soldering system features a microprocessor temperature control for the regulation of both the soldering and desoldering process. The unit also utilizes a rotary vane pump, (with a five year-factory warranty) to achieve the highest vacuum force available, and is available with finger tip activation or foot pedal for precise operator control.

Circle (78) on Reply Card

Understanding and Implementing EIDE

By Stephen J. Bigelow

Integrated drive electronics (IDE) has become a fixture of the modern PC hard drive. While SCSI (small computer system interface) remains the preferred drive type for high-end systems, virtually all entry-level and intermediate systems employ IDE drives for their high reliability, good speed, and low cost. But the classic IDE architecture is beginning to show its age, and as hard drives grow well beyond 500MB, the next generation of IDE is poised to take over the PC market.

This Enhanced IDE (or EIDE) is not as simple to implement as it might seem, however. To implement an upgrade to EIDE, your PC will require a new drive, a new drive adapter, and new BIOS. This has resulted in a wave of confusion and speculation in the PC market. Whether you are a technician or a PC user, EIDE will play an important role in your next drive upgrade or system purchase.

This article is intended to "clear the air" about EIDE, and provide you with a uniform strategy for upgrades. But, before we jump right into a discussion of EIDE, you should have a basic understanding of IDE development and technology.

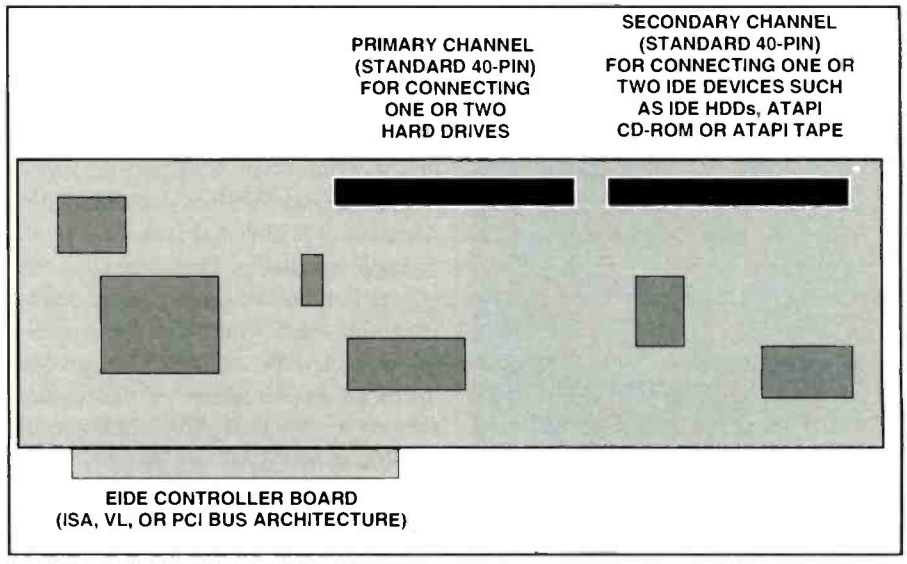


Figure 1 - IDE allows two drives (master and slave) to reside on the same port (1F0h) and Interrupt (IRQ 14), but it does not support any other devices. EIDE seeks to overcome this limitation by adding a second "channel" to the EIDE controller.

A bit of history

By 1984, it was becoming clear that the ST-506 drive, initially designed by Shugart Associates, did not offer adequate performance to keep pace with the rapid advances being made in PC design. Western Digital and IBM addressed this growing gap by defining a standard set of registers for a next-generation hard drive (referred to as an "AT hard drive"). This register set was dubbed the WD1003 standard, and manufacturers of hard drive controllers quickly adopted this uniform method of drive communication. Western Digital continued to work with Compaq to define the BIOS support which eventually made IDE possible by 1986.

Since IDE was based on the WD1003 controller, existing software could easily use the new drives directly without any changes in software. By placing most drive controller functions on the hard drive itself (rather than on a controller card), IDE devices proved cheaper, faster, and more reliable than ST-506 or ESDI drives. It was this combination of factors (standard WD1003 controller foundation, BIOS support, and integrated electronics) that propelled IDE to the forefront of general-purpose computing.

In spite of its rocky beginnings, there is little argument that IDE has quickly evolved into one of the more elegant drive solutions for a PC. Usually simple to configure and quick to install, IDE had effectively made ST-506 and ESDI drives obsolete by 1988. When we look at the IDE interface today, though, there are four important limitations that just can not be ignored: (1) drive size, (2) data transfer rates, (3) hard drive support only, and (4) limited devices. The following sections look at each limitation, and shows you how EIDE can overcome them.

Drive size

This is probably the most important and compelling limitation to IDE architecture, and is the result of a simple lack of planning between the developers of BIOS, and the developers of the WD1003 architecture. To understand the limitations of drive size, you must understand how IDE drives are addressed. The classic addressing scheme is known as Cylinder Head Sector (or CHS) addressing. Simply stated, you place the cylinder number, head number, and sector number you need to get to into the WD1003 registers, and then call the Int 13 routine in BIOS which runs the drive to the desired location for reading or writing.

Stephen J. Bigelow is the founder of Dynamic Learning Systems, and the publisher of The PC Toolbox. He can be reached by mail at P.O. Box 805, Marlboro, MA 01752 USA, by fax at 508-898-9995, by BBS at 508-366-7683, on CompuServe at 73652,3205, or on the Internet at sbigelow@cerfnet.com. Comments and questions about this article are welcome at any time. A free issue of The PC Toolbox is available on request.

	BIOS	WD1003	Resulting Limit
Cylinders	1024	65536	1024
Heads	255	16	16
Sectors	63	255	63
Max Capacity	8.4GB	136.9GB	528MB

Table 1. CHS values vs. drive size

This works just dynamite in theory, but there is a problem. You see, the limiting values for cylinders, heads, and sectors are not the same for BIOS and WD1003 architecture. Table 1 illustrates these values, and you can see their impact on drive size. BIOS specifies a maximum of 1024 cylinders, 255 heads, and 63 sectors per track. If you multiply these together, then multiply 512 bytes/sector, you get 8,422,686,720 bytes (or 8.4GB) of theoretical capacity.

For the WD1003 controller, you should be able to have 65536 cylinders, 16 heads, and 255 sectors per track. When this is multiplied by 512 bytes per sector, you get a whopping 136,899,101,100 bytes (or 136.9GB) of theoretical capacity. So where's the problem?

Well, the problem is that you can only use the lowest common number for each approach, so the maximum number of cylinders you can use is 1024, the maximum number of heads is 16, and the maximum number of sectors is 63. When you multiply these out, then multiply that times 512 bytes/sector, you only get 528-MB. It's sad that if BIOS designers and WD1003 designers had only sat down and come up with the same numbers, we could easily have had IDE drives with capacities up to 136.9GB, and this entire issue would be moot for another 20 years. Instead, we can only use up to 528MB. It's enough to make a grown technician cry.

Breaking the barrier with IDE and EIDE

This explains why IDE worked so well with drives up to 528MB but not more. People are quick to criticize IDE designers for this shortcoming, but let's be reasonable: how were IDE designers to know that drives would rocket from 100MB to over 1GB in only 7 or 8 years?

Of course, there have been big IDE drives around for a few years now, and like most parts of the PC, there are ways to work around this limitation. Since BIOS is essentially software, the easiest and most economical way to overcome the 528MB barrier is to "augment" the BIOS Int 13 routine by introducing a driver when the PC is initialized. Int 13 enhancements allow the support of drive sizes up to 8.4GB. The Drive Rocket and Disk Manager by Ontrack are two of the most popular drivers available. They allow the PC to access the entire space of a large IDE drive; not just 528MB.

EIDE can work with such drivers, and Disk Manager (or one of its similar cousins) is frequently bundled with large IDE drives and the new EIDE-compatible hard drives. There are some compelling reasons why drivers are not desirable, however. First, drivers take memory space, typically, precious space within the first 640KB of RAM. Few systems have space remaining in the upper memory area for a disk driver. Second, disk drivers do not accommodate Windows very well at all, so using large hard drives under Windows 3.1 and 3.11 has traditionally been a problem. Third, the disk driver may conflict with other device drivers and TSRs that may already be on your PC.

Ultimately, the preferred method of large drive support for EIDE is to update the BIOS itself with a BIOS that contains the Int 13 enhancements. AMI and Micro Firmware are early entrants into the EIDE-compatible BIOS arena, and other BIOS makers are sure to follow. While upgrading a BIOS is a bit more involved than adding a driver, the rewards (more free memory and better OS compatibility) are almost always worth it. As an effective alternative to the trials of a motherboard BIOS upgrade, you can choose an EIDE adapter with on-board BIOS extensions for Int 13.

What about LBA?

Another great source of confusion in

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Western Digital
8105 Irvine Center Drive
Irvine, CA 92718
714-932-4900 (Tech Support)
Fax: 714-932-4300 (Fax Back)

*Note: the author gratefully acknowledges the cooperation and enthusiastic support of Promise Technology in the development of this article.

the migration to EIDE is its need for logical block addressing, or LBA. Where CHS addressing requires the specification of a discrete cylinder, head, and sector, an LBA address simply requires the specification of a sector (i.e. "go to sector 324534") - the LBA algorithm (implemented in BIOS) will translate the sector to the appropriate CHS equivalent. FAT-based (file allocation table) operating systems such as DOS (and Windows since Windows works on the DOS file system) *require* the use of LBA addressing. As a consequence, you will need to update your motherboard BIOS, or use an EIDE controller with on-board BIOS.

On the other hand, non-FAT operating systems (such as OS/2 and Novell Netware) do *not* require LBA addressing. When you actually have an EIDE controller in-hand, you may note that the controller provides a jumper allowing you to enable or disable LBA addressing. If you are using DOS (or Windows), keep this jumper enabled.

An important consideration in choosing CHS or LBA addressing is the format of your hard drive(s). If you choose to invoke LBA addressing, you will need to reformat your hard drive(s). You must also remember that once a hard drive is formatted for LBA, the drive will only be recognized by PCs that support LBA. As a result, if you take an LBA-formatted drive and install it into a PC whose BIOS does not support LBA, the drive will simply be unrecognized, and you will have to reformat the drive again. In all cases, remember to perform a *complete* backup of your hard drive(s) before implementing EIDE on your system.

Data transfer rates

The concept of a data transfer rate has always been a confusing one; especially since the rate can vary tremendously depending on where you measure it. The rate of data coming off the R/W heads, the rate of data coming across the IDE cable, and the rate of data moving across the expansion bus can all be very different numbers. Practically speaking, a hard drive data transfer is only as fast as its slowest stage, so traditional IDE installations were effectively limited to only 2MB/sec to 3 MB/sec across the ISA bus. It wasn't that the drive itself could not pass data faster, but the practical transfer was now limited by the slow ISA bus. As a result, building faster drives offered no real advantage since the faster drives would still be limited by a slow expansion bus architecture.

Two factors have made it possible to enjoy the advantages of high-performance IDE and EIDE drives—integrated chipsets, and advanced expansion busses. IDE and EIDE chipsets allow the drive interface to be implemented directly on the motherboard rather than on an expansion bus adapter. This allows faster data transfer by eliminating the expansion bus bottleneck. The disadvantage here is that you are committed to using the motherboard drive controller scheme. An outstanding compromise has been the introduction of EIDE adapters for high-per- formance bus architectures (VL and PCI). You get the speed afforded by a better bus, with the ability to simply plug in better adapters later as they become available.

These superior hardware schemes provide new data transfer modes. For example, the PIO Mode 3 scheme allows data transfer up to 11.1MB/sec across the EIDE interface, while the Multi-word DMA Mode 1 scheme allows up to 13.3MB/sec across the interface. Modes 4 and 5 are being proposed, which would allow interface transfer rates of 16.6MB/sec and 20MB/sec respectively. However, to take advantage of these modes, you need to upgrade your IDE drive adapter to an EIDE drive adapter.

Companies such as Western Digital, AccuLogic, and Promise Technology are actively manufacturing EIDE adapters for the VL and PCI busses. GSI is the only company now producing EIDE adapters for the ISA bus. When you choose an EIDE adapter, make certain that the adapter supports PIO Mode 3 (as a minimum), and that the IORDY line is being used. This is very important because the faster data transfer rates require a tight interaction between the adapter and the system using the IORDY signal.

Hard drive support and limited devices

One of the key advantages of SCSI is its ability to support up to 7 varied devices on the same bus (hard drives, CD-ROMs, tape drives, and so on). This approach went a long way toward eliminating the proliferation of proprietary controllers and system configuration problems that remain prevalent in non-SCSI systems. While IDE allows two drives (master and slave) to reside on the same port (1F0h) and interrupt (IRQ 14), it does not support any other devices. EIDE seeks to overcome this limitation by adding a second "channel" to the EIDE controller as illustrated in Figure 1.

Make no mistake, the "Primary EIDE Interface" channel is still designed to handle two EIDE drives in a master/slave relationship. But the "Secondary IDE/EIDE Interface" channel allows up to two additional devices (ideally an EIDE [ATAPI-compatible] tape drive and EIDE CD-ROM drive) to be added. It is important for you to remember that while EIDE marketers tout the ability to support 4 devices, only 2 are EIDE hard drives; the other two are non-hard drive devices. Moreover, the second channel is located at 170h using IRQ 15, so you will need to check for any hardware conflicts with other devices in your system before installing the EIDE adapter. In fact, the secondary channel is often tied in directly to the ISA bus (although later implementations may tie in to the VL or PCI bus). Since a CD-ROM or a tape drive do not exceed maximum ISA transfer speeds, there is no problem doing this—just don't be misdirected by marketing hype into thinking your new EIDE adapter will support 4 high-performance EIDE drives.

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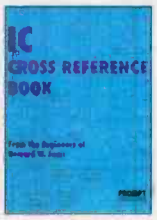

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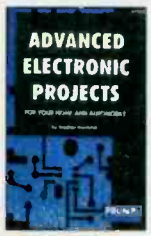

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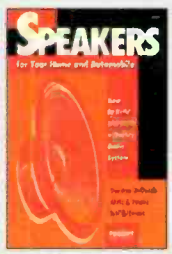

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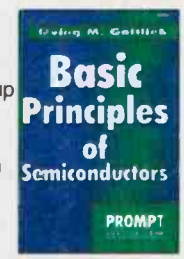

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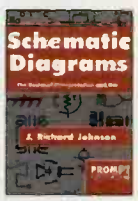

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Electronic Servicing & Technology, 76 N. Broadway,Hicksville, NY 11801

FOR SALE

Sencore SC61, $1500, Leader LFM-39A wow/flutter meter $400, Leader LDM-170 distortion meter $400. *Contact: Richard, 305-584-2826.*

Sencore: CVA94 fresh calibrated and new VR940, $2600.00. SC61 calibrated and updated with VA48, $2000.00. VC93 and accessories, $1900.00. Separate or all for $6000.00. *Contact: Jim 915-235-9850 (9 a.m.-5 p.m.)*

RCA service data books 1967 to 1978. B&K analyst 1077. *Contact: Ann Bichanich, 151/2 W. Lake Street, Chisholm, MN 55719, 218-254-4421.*

Sencore VC-93, VCR analyzer $1250.00, VA48 TV-Video analyzer $300.00. Jackson 648-1T tube tester $100.00, B&K 1460 Scope $100.00. All in mint condition, complete with manuals and test leads. *Contact: 607-754-2126.*

Sencore VA62A, $1800.00, ST65, $400.00, VC93, $1500.00. All equipment in excellent condition. All cables, manuals, and original boxes included. *Contact: Bruce, 603-878-2815.*

Sencore SG80 AM/FM stereo analyzer. Like new, operation manual, and original box. Listing new at $3400.00– $3800.00, will sell for $2500.00, or best offer. *Contact: 218-927-2765, Jim after 4:00 Central Time.*

Sencore VC93, like new condition, $2300.00. Viz WP-27A isolation XFMR 2.5-4A, $75.00. Software (IE MS FoxPro). Best offer on all. *Contact: Raymond Ellsworth, 111 Long Lake Avenue, Alpena, MI 49707, 517-354-5636, fax: 517-356-3081.*

Sencore VC93, All format VCR analyzer with standard probes, manuals. VHS & BETA test tapes. Hardly used, perfect condition in original box, $1900.00. Tektronix 2335, 100 MHz. Portable Oscilloscope with service manual, 2 probes. Excellent condition, $900.00. *Contact: Craig at 307-765-4426.*

Hundreds of obsolete, hard to find Curtis Mathes Boards (1973-90 year models). All new or factory rebuilt, in boxes. Make offer. List Available. *Contact: Dave, 501-621-7013, Fax 501-631-6452.*

TSM Sams manuals, 200 assorted AR, CB, MHF, TR. $3.00 postage for each manual. *Contact: Andrew D. Bruck, RT #1, Box 356, Cleveland, VA 24225, 703-889-5591.*

Sencore VG91, VC93, PR570, CR70, TVA92,with HP200. New August 1994 cables included. $8500.00 or take over payments of $240.00. *Contact: 316-251-4887.*

Huntron Tracker 2000 with 410 switcher. Slightly used, $1500.00. *Contact: 203-635-6800.*

Sencore SC61, in original box with all probes and manuals, $1500.00. Pre-paid postage. *Contact: Frank, 813-546-7060.*

Sams Photofacts 100-2823, 141 sets, $1400.00 or 3/$20.00. Viego VCR Course Elm with tapes $30.00 adv $35.00 — NR1 Master Course in Appliance $30.00. *Contact: Frank, 601-253-2261.*

Sencore SC61, VA62, with VC63 and NT64, and PR57. All for $3900.00. *Contact: Harvey Martin, 8810 Churchill Pl., Jonesboro, GA 30236, 404-471-1407.*

Sencore VC93 VCR tester used less than 15 hours—$1800.00, Huntron Tracker 2000-like new—$850.00. *Contact: Jimmy Hinely, 912-826-5017 after 9:00 PM Eastern time.*

TEK 2445 150MHZ scope - manuals - 2 probes - excellent condition. $1500.00. TEK 7854 400 MHZ scope(2) - NA26, 7B80, 7DOI & DFI. Manuals - 2 probes excellent condition, $2500.00. *Contact: J. Kasperski, Box 4665, Rome, NY 13442-4665.*

VCR test equipment, new $500.00. Beltron 8080A tube checker rejuvinator with all adapters, new condition, $650.00, Microwave oven test equipment, new, $350.00. *Contact: Martin E. Wiedenbeck, 7773 Akron Road, Lockport NY 14094, 716-434-7395.*

FOR SALE

Panasonic video head unit #VEG41A; Thordarson flyback #395; 3000 assorted TV tubes. All new. *Contact: Leon, 818-994-5517, day or evening.*

Sencore SC61 waveform analyzer. Manuals and probes, mint condition, $1050.00. Microfiche reader, new bulb, $60.00. Will pay shipping. *Contact: Fred Allen, IDC Electronics, 612-558-6898.*

Sams 381-3313, best offer. B&K model 1249A NTSC generator. $350.00. B&K model 2125, oscilloscope, $350.00. Other items available. *Contact: Steve Mack, 1335 Avenue F, Billings, MT, 406-245-0799.*

Sams Photofacts from 200-2480, 427 folders to be sold as a group only, $625.00 plus 1/2 of shipping cost. *Contact: Mike's Repair Service, PO Box 217 Aberdeen Proving Ground, MD 21005, 410-272-4984, 11 AM-9PM.*

Sencore VG91, TVA92 and VC93, still boxed, never used. $3000.00. *Contact: Ed, 916-742-9195.*

BC220XLT Bearcat Scanner, new in original box with all attachments, never used. Retail $240.00, sell for $150.00. BC200XLT older model new, unused, $125.00. *Contact: George Demaris, 7387 Pershing Avenue, Orlando, FL 32822, 407-277-3746.*

Sencore SC61, in original box, like new, best offer. *Contact: Major, 913-467-8431, 913-467-392.*

Sencore VG91, TVA92. Extras, never used, still in boxes. Cables and manuals. *Contact: Don, 608-883-2134, after 6PM CST.*

Sencore CR70 beam builder, like new $700.00. Hitachi model V-301, 30 MHz oscilloscope. $150.00. *Contact: 503-889-9416.*

WANTED

Pioneer amplifier, model #SPEC-1, part #ACV-314-0. Volume control Potentiometer. *Contact: Keith Bates, 1811 N. Blvd., Maple Hts., OH 44137, 216-475-8952.*

Video training tapes, consumer video and digital in VHS format only. New or used. *Contact: RAM Television Service, 144 Pablo Casals Street, Mayaguez, PR 00680.*

Mitsubishi tuner module part 295P20701. *Contact: Gary Thornton, 413 Kaye Street, Coppell, TX 75019.*

Kikusui 5516ST dual trace storage oscilloscope, need instruction and service manual. Any help or advice would be appreciated. *Contact: Walter Jackson, 718-604-0640.*

JVC cassette deck KD-95J, need service literature. *Contact: Anchor VCR & TV Repair, 4044 Shasta Way, Klamath Falls, OR 97603, 503-884-5985.*

Sharp SF8200 copy machine, need schematics and shop manual. *Contact: John Detroyer, 13405 Burt Road, Riley TWP., MI 48041, 810-395-7819.*

JVC stereo receiver, R-X400, need service information. *Contact: Mike Warner, 522 Yorktown Road, Lancaster, PA 17603, 717-392-7205, Fax-717-392-0888.*

Sharp 'My Video' portable VCR, model VC-2250, need parts or complete unit. *Contact: Rick Meiners, 5500 Douglas number 2, Des Moines, IA 50310-1842, 515-278-2843.*

Fisher VCR service manual. Quasar VCR VH-6400 need remote control. Profax through April 1990. *Contact: Ed Herbert, 410 North Third Street, Minersville, PA 17954.*

Sencore Z-Meter for hobby purposes. Schematics or service manuals for WYSE 60, 50 & 30 terminals. *Contact: William Weathers, PO Box 51412, New Orleans, LA 70151-1412, 504-595-1576.*

Audiovox 832-SD automobile cellular phone, part #THX25, need handset. Audiovox CMT-400 automobile cellular phone, need black box (transceiver). Audiovox states both are no longer available. Please state price and condition. *Contact: LMS Electronics, 11241 Northwest Seventh Street, Coral Springs, FL 33071-7659.*

Zenith S43 adaptor to convert S-video to RGB. *Contact: Tom Wenrich, 312-876-9154, Box 8426, 404 Garza Garcia, NL (Mexico) 66250.*

Singer/Gertsch FM10CS station monitor, would like to borrow service manual. *Contact: Marvin Moss, Box 28601, Atlanta, GA 30358.*

Marine transceiver for Regency Polaris model MT7000, part #2001-6064-200, membrane key pad. *Contact: Sea & Shore Electronic Service, 517-893-1354.*

Sony model #SL-5800 need remote control. *Contact: Don Hicke, 4131 Mt. Everest Boulevard, San Diego, CA 92111, 619-994-3406.*

Tektronix oscilloscope 7403N, part 070-1124-00 need operation manual. *Contact: Cyprian, PO Box 167541, Irving, TX 75016, 214-255-3944.*

Uniden ARU 251 repeater, need ARX 200 community repeater panel. *Contact: David Johson, 5285 Bobbie Jo Lane, Apt B, Las Vegas, NV 89110, 702-452-3318.*

Sony part #1-231-705-00, it is a IC601-DM-4. Magnavox part #A10002-A002 tuner system. *Contact: Phil Del Vecchio, VCR Electronics, 520-797-3315.*

Textronix service manual for type 190B constancy-amplitude signal generator, serial 009032. *Contact: A.J. Boecker, Rt. 1, Box 120, Manor, TX 78653.*

IC602 (DM4) Sony part 1-231-705-00 for Sony model KV1952R. *Contact: Jerry B. Lewis, Bid's TV Service, 101E. Winkler, Kermit, TX 79745, 915-586-3911.*

Copies of Citizen's band radio schematics covering 1980-1995 models. Will pay $1.00 U.S. for each schematic copy plus shipping. *Contact: Jordan Hillrich, 732 Queen Street, Regina, Sask, Canada, S4T 4A3.*

RCA 159802, need remote control for color TV set model FLR 488WR. This is ultrasonic, not infra red. *Contact: Don Stevens, 1005 North Brookfield, South Bend, IN 46628, 219-233-3746.*

Magnavox TS8 tuning control, A10120 A0001 or 612425 0002 IC. Mitsubishi fly 334P09403 model #CK2582. New or used. *Contact: John Dale, 7601 US Hwy60, Moutainview, MO 65548, 417-934-6655.*

RCA yoke #114741 and plastic yoke housing #114747 or equivalant. Used in CTC-17 and other RCA models. *Contact: Jay Ballard, 39 Boston Street, Middleton, MA 01949, 212-664-3033.*

Magnavox VHF tuner 340276-1 for Montgomery Ward model #GNB18915A, chassis M32-63. Please advise price. *Contact: Moberly Communications, PO Box 96, Moberly, MO 65270-0096.*

Knight 83YX123 sweep generator and B&K capacitor analyst. *Contact: Charles T. Huth, 229 Melmore Street, Tiffin, OH 44883, 419-448-0007.*

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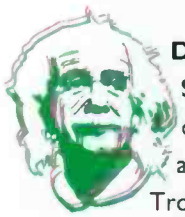

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