THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

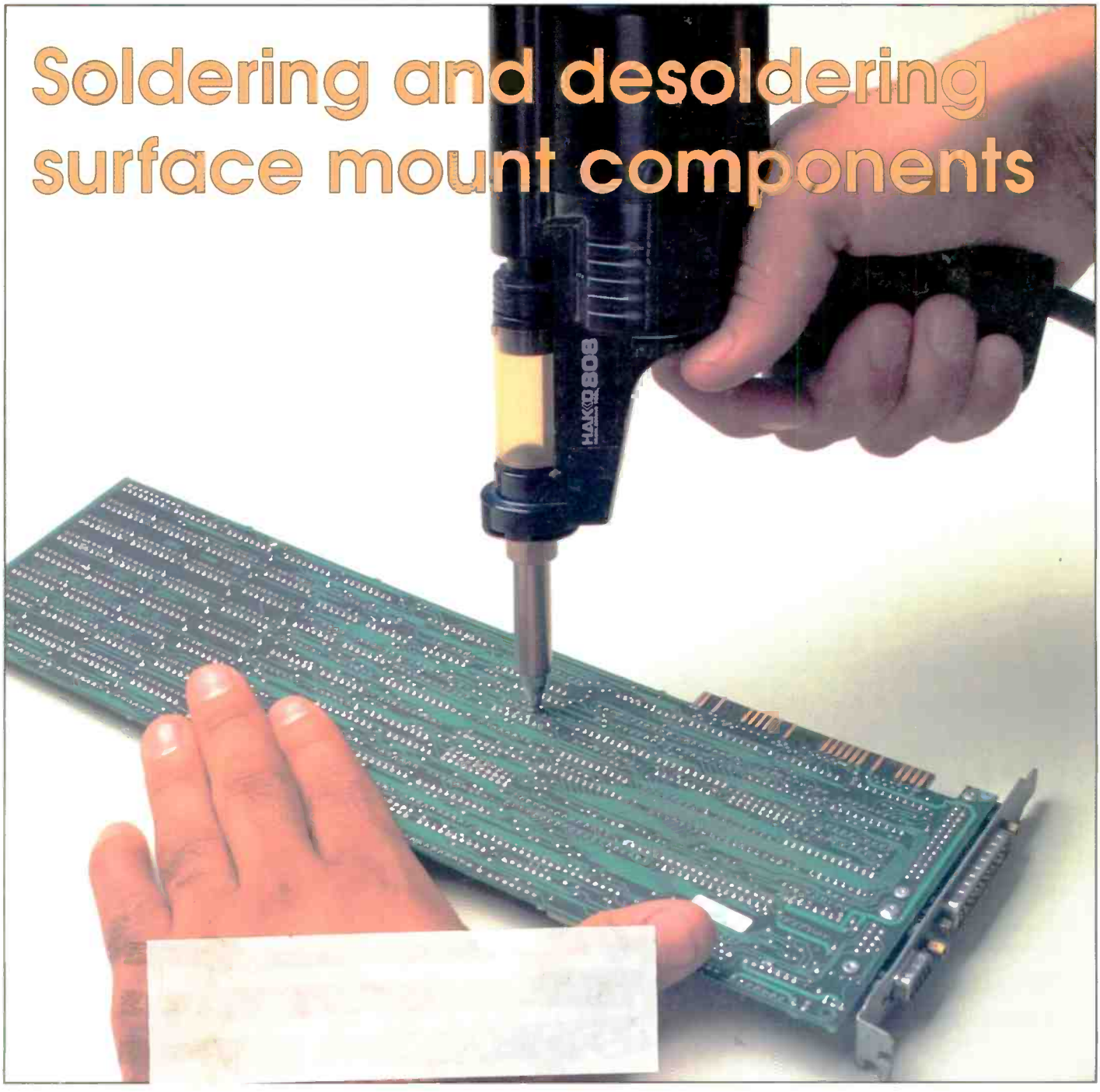
T.M.

November 1994/$3.00

Troubleshooting VCR motor problems

Service problems in the CTC145 and CTC146 chassis

Soldering and desoldering surface mount components



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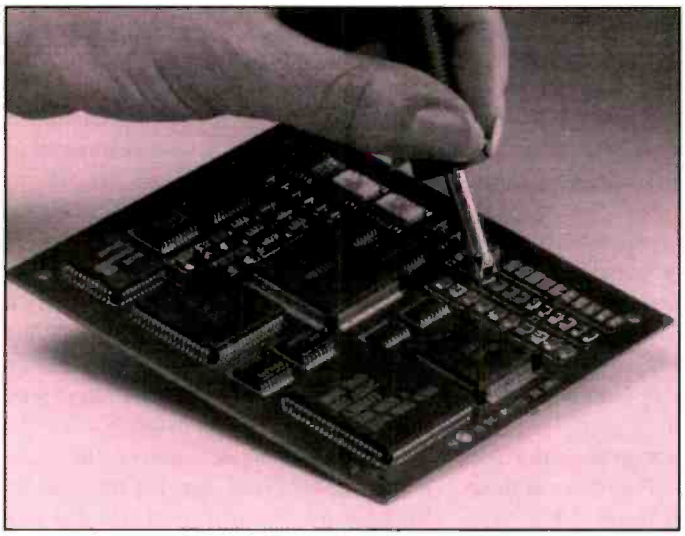
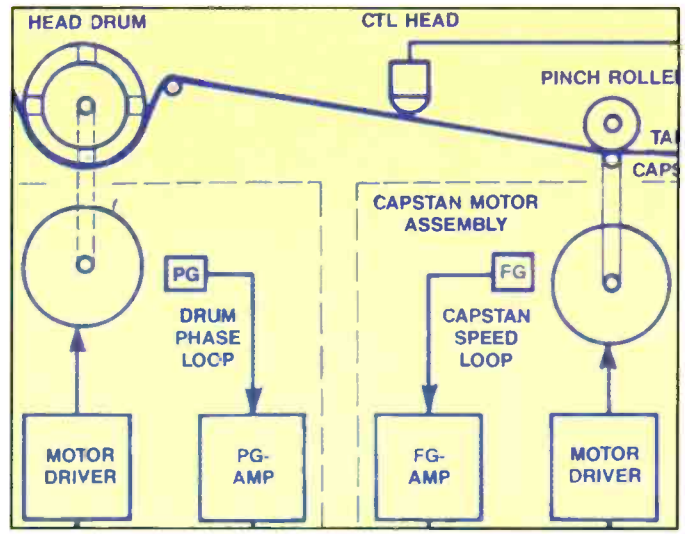
Contents

Volume 14, No. 11 November 1994



page 7



page 18

FEATURES

DEPARTMENTS

ON THE COVER

The use of surface mount components in the manufacturing of consumer electronics products has required that service technicians learn a new set of skills for dealing with them, and in some cases requires the purchase of new tools, accessories and materials. (Photo courtesy American Hakko Products, Inc.)

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

The constancy of change

Have you ever read Twain's "Life on the Mississippi?" I read it around ten years ago and have been recommending it to all of my friends ever since. It's far more than the title implied to me. It's not just a story of the life of one river pilot back when the Mississippi was perhaps the most heavily traveled trade route in the United States. It's also a chronicle of change.

The book starts with a narrative account of the discovery of the Mississippi by European explorers, and describes the development of the waterway throughout its history up until the narrator, Mark Twain (Samuel Langhorne Clemens), who spent many years on the river, has become an old man.

In the early days, commerce on the river consisted of flat boats. The crews of those boats poled, or rowed them, down river, loaded with goods from cities in the north, destined for cities farther down river. With no means of propulsion, once the flat boats reached the mouth of the river, they were either used in local navigation, or possibly broken up, and the wood used as raw materials for other building projects.

The river boatmen would then turn around and walk or ride back north via the Natchez Trace, then maybe do the same thing again.

Later came steam-powered paddle wheel boats: side-wheelers and sternwheelers. When these powered boats appeared on the river, the flat boats were history. The flat boatmen had to find some other means of employment; perhaps on one of the steamboats. Photographs of the St. Louis docks during the heyday of the steamboats show river traffic that's just about as dense as freeways of today.

But change wasn't limited to the river traffic. Rivers, being what they were before the Corps of Engineers began to regulate their flow, pretty much went where they wanted to. One day a town might be a thriving river port. Then over a period of a few days the river would flood, cut a new channel, and leave the town "in the country," in Twain's words. With the watery highway gone from its door, the town might wither and die, and a new town would spring up along the river's new course.

When the railroads came along, the era of the steamboats as the critical link between cities along the river came to an end. While there is still a great deal of commerce by boat along the river, it's only a fraction of all of the commerce that now takes place there.

The story of "Life on the Mississippi" is of interest to all of us today, because it tells us that the changes that we're experiencing today is not unique to our time, or to our way of life. A study of any period of history done with a careful eye will show that changes took place, sometimes gradually, sometimes abruptly. Sometimes cataclysmicly. And in every case, businesses changed, livelihoods changed; and sometimes even entire nations went through changes.

Consumer electronics service centers have had a difficult time of it over the past two decades. Thousands of consumer electronics servicers have found it necessary to find another way to make a living. Thousands of service centers have closed. Still, thousands of others have found ways to not only survive, but to thrive.

For some service centers that have remained successful, some of their success has been at least partly good luck, but good luck alone will not keep a business alive. Other ingredients include having good technical skills, good business skills, and good supervisory skills. It also helps to be aware that the technology and the economic climate will change. They always do. And, it helps to be prepared to change with them.

Toward the end of "Life on the Mississippi," Twain relates that he has been traveling as a passenger on riverboats, and that he has had conversations with a lot of other passengers. One of these was a drummer (salesman) who was selling a brand new product: oleomargarine.

Some of us are old enough to have lived through an era when the dairy lobby successfully kept the companies who supply margarine from coloring it to look like butter, in the hopes that people would not buy it. It was white. In some cases, it came with a little dab of color that the purchaser could stir in to turn it butter yellow. In spite of the efforts to keep margarine off the market, we have it now in profusion.

This is just another reminder that no one, no matter how powerful or influential, can halt change. We can, however, adapt as best we can to the changes.

And many service centers have successfully adapted. We feel that by reading of their successes, other service centers may also be able to thrive in hard times. Read our department, "Successful Servicing," starting in this issue, to see what some other service centers are doing to remain successful in spite of the magnitude of the currents of change going on around us.

Nils Conrad Person

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Mobile Electronics Certification Program

The Mobile Electronics Certification Program (MECP) is the only industry-wide, nationally-recognized testing program for installers. The benefits to mobile electronics manufacturers, retailers and installers are clear. By improving the quality of installation, product returns are decreased while customer confidence is increased and this raises the professionalism of the 12V industry.

So far, the MECP has been administrated to more than 7,000 installers. Some 5,000 have been certified as installer, in specialist exams for autosound, security and cellular; at the First Class level, and as master installer.

The following is the schedule for MECP Testing:

November 1994	December 1994
Boise, ID	*Scottsdale, AZ*
November 3	December 1
5:30 pm	5:30 pm
Philadelphia, PA	*Los Angeles, CA*
November 10	December 8
5:30 pm	4:30 pm
Hartford, CT	*Miami, FL*
November 10	December 8
5:30 pm	5:30 pm
Columbia, SC	*Tulsa, OK*
November 17	December 15
5:30 pm	5:30 pm

The Electronic Industries Association endorses the MECP which is administered by Bobit Publishing Company.

Registration deadlines are two weeks before the tests. To receive more information on test locations, study guides and cost, contact:

Mobile Electronics Certification Program, 2512 Artesia Blvd., Redondo Beach, CA 90278, Telephone: 310-376-8458, Fax: 310-798-4598.

Consumers better informed on home theater, but still have much to learn

Consumers know more about home theater today than they knew a year ago, but the gaps in their knowledge and understanding are still wide and deep according to a new survey of nearly 2,000 retail audio/video sales personnel.

By a nearly 4-to-1 margin, the sales people queried said consumers are better informed about home theater, yet only 38% said that half or more of the consumers coming through the door are familiar with the name Dolby. Only 15% of the respondents indicated that consumers had "no idea about home theater," but nearly 84% agreed that "they have some idea, but want to ask many questions."

The study was conducted by an independent company for Yamaha Electronics Corporation, as part of its Product Advisory Board program. The proprietary survey documents a high level of consumer interest in home theater and the continuing need for greater information and demonstration.

For example, the sales people responding reported that consumers seem to know that surround sound requires multiple speakers. More than 88% of them checked that box in a multiple-choice question dealing with consumers' knowledge of features defining surround sound. Indicating the need for education, only 6% marked the box for "knows it means 5 channels or more," while 3% indicated that consumers know "nothing."

The survey also probed consumer preferences. The sales people were presented with a list of five "greatest consumer concerns about purchasing a home theater system" and asked to select the top two. Nearly three-quarters responded that consumers wanted something "that is good for both movies and music," and more than two-thirds checked "getting something that sounds really good."

"This initial study demonstrates a tremendous opportunity," said Tom Graham, Yamaha's director of marketing. "It's clear that home theater is currently the driving force in the traditional areas of consumer electronics. If the survey is right, we are only at the initial stages of home theater's growth. The more information we can bring to the consumer, the more explosive its expansion will be."

NSCA seeks ideas for standardized device symbols

The National Systems Contractors Association, NSCA, is looking for device symbol ideas, as part of its program to develop standard symbols for use by its members and the entire electronics systems industry.

The Device Symbol Committee, chaired by Richard Fyten, Electronic Design Co., St. Paul MN, is currently looking for symbol ideas in the following categories: telecommunications, sound, fire alarm, nurse call, security, television, clock, CCTV, and data network. "Our committee was formed to develop a list of standard device symbols that are easily recognized and that the industry will feel comfortable using," said Fyten, "and we are looking especially to our members and sponsors for their input," he said.

When completed, the recommended list of device symbols will be available to members in both hard copy, plastic template, and Auto Cad disk. The Committee is scheduled to have the completed list of recommended device symbols available to members by the time of NSCA's Expo '95, next April 30 in Indianapolis, IN.

In order to standardize the entire industry's device symbols, the NSCA's recommendations will be submitted to the other associations in the industry for their review and comments.

The work of Fyten's committee was described by Per Haugen, NSCA President, General Communications, Murray, UT, as exemplifying the spirit of the NSCA. "Pro-active leadership is the style of the association that connects the industry for the industry that connects the world," Haugen said.

Not only NSCA members, but all members of the electronics systems industry are invited to submit their ideas to the Device Symbol Committee. Send all symbol ideas to NSCA General Manager Mary Beth Rebedeau, at association headquarters, 10400 S. Roberts Rd., Palos Hills, IL, 60465. Telephone: 708-598-9777 or 1-800-446-NSCA, fax: 708-598-4888.

CES Specialty Audio & Video Show

The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) has announced that it will sponsor, produce and manage the 1995 CES Specialty Audio & Video Show which will debut next June in Chicago. The trade-only show is being launched at the direct request of more than 65 members of the specialty audio and video industry who have all signed letters of intent to support the new venture.

Staged as a stand-alone trade show, CES

Specialty Audio & Video will provide a concentrated forum for the market with product-specific educational sessions and exhibits. Because of the nature of the exhibits, which require isolated listening rooms, the show will be located in a hotel.

"The high-end manufacturers have demonstrated that they are committed to a successful, trade-only show dedicated to the specialty audio and video industry," said Jerry Kalov, president of Cobra and chairman of the board of EIA/CEG. "EIA's role as an association is to support all segments of the consumer electronics industry, and to promote industry sales in any way possible. This group is very pro-active and aggressive and feels the need for a show dedicated solely to meeting their needs."

The grassroots campaign to develop the new show was headed by EIA/CEG Specialty Audio Subdivision chairperson Kathy Gornik of Thiel and Conrad-Johnson Design's Lew Johnson.

"Exhibitors in specialty audio had one of their best shows ever at the 1994 Summer Consumer Electronics Show, and that led us to believe that this group would benefit from a focused show dedicated to our segment of the industry," said Kathy Gornik, president of Thiel. "CES Specialty Audio & Video will attract our buyers because it will have a different character without the distraction of a larger trade show, and we are certain the buyers will enjoy the relaxed atmosphere. We want to work with the EIA and the CES staff because they have consistently provided us with the buyers, international distributors and the media exposure that we can't find anywhere else."

Video market experiences best month of the year

The pace of color TVs combined with a resurgence of VCR sales catapulted the video market to its best month so far this year according to the Electronic Industries Association's Consumer Electronics Group (EIA/CEG). Color TV sales set a strong pace in July, recording the fourth consecutive double-digit increase.

"Consumers' confidence in product quality and competitive prices are driving these sales," said Joe Clayton, Executive Vice President of Thomson Consumer Electronics. "Lower shipments earlier in

(Continued on page 62)

Literature

Tools catalog

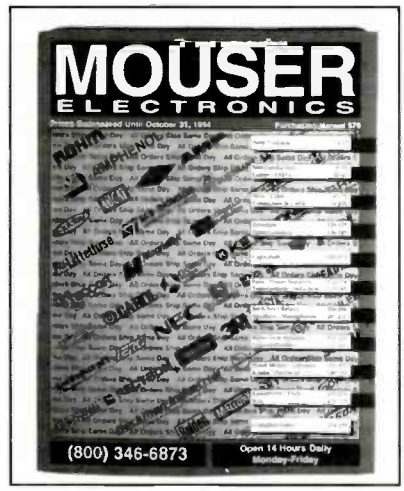
Jensen's 1994-1995 Master Catalog is now in a new format. The pages, pictures and type have all been enlarged to make the catalog easier to use.

The catalog features a full line of specialty tool kits and cases, plus the latest portable field test instruments from major manufacturers. Also included are hard-to-find tools, static control products, circuit board accessories, lighting and optical aids, workbenches, soldering supplies, cable, connectors, LAN installation and maintenance products, cases, shipping containers, and more.

Circle (80) on Reply Card

Components catalog

Mouser Electronics announces the publication of its latest industrial electronic components catalog. This is a guide for buyers, engineers and manufacturing managers. The catalog provides specification drawings and up-to-date, guaranteed prices. It is easy to use with a Quick Index on the front cover and a comprehensive index of both manufacturers and product categories. The company provides same day shipping on all orders.



The 276-page catalog contains over 45,000 in-stock, factory-authorized product selections from more than 100 manufacturers and features new product listings from AMP, Teccor, SGS Thomson, Littelfuse, Amphenol, 3M, and Belden. Select from semiconductors, passive components, electromechanical devices, resistors, capacitors, switches, transformers, inductors, wire and cable, connectors, publications, equipment, and supplies.

Circle (81) on Reply Card

UPS Selection guide

Computer Power Inc. offers a guide to selecting uninterruptible power systems. The guide is designed to help users sort through the confusing selection and claims of UPS and related power protection products.

(Continued on page 60)

Selecting a soldering iron for surface mount components

By Doug Wilkerson & Catherine Woneis

Every day another technician is faced with the onerous task of repairing a board that contains surface mount components. When technicians only had to deal with through-hole components, desoldering, repair, and replacement were fairly easy: get a desoldering gun or pencil and the right size tip to remove them, and a good iron to put in a new component (Figure 1). You had to keep perhaps five or six tips on hand to do 95% of the work that crossed your bench.

Now there are over 100 different surface-mount components, with new ones being developed every day. These chips are costly and cannot be easily removed with standard soldering and desoldering tools, causing the task of being able to remove these components without damaging others to become far more important.

When you first look at the world of surface mount rework, solutions can be costly and complex. It can give you sticker shock like you wouldn't believe; huge $10,000 machines, laden with knobs, dials and readouts, chugging away loudly. Fortunately, these machines are required only for high-volume production and are not necessary to simply repair boards that come across the bench.

Wilkerson is a Technical Services Manager and Woneis is a Publications Specialist for Metcal, Inc.

Two methods for replacement of surface mount components

Choosing the correct equipment can be a daunting task—especially when you realize that the equipment you choose can dramatically affect both the amount of training you will need and your final cost. The two most important things to consider are ergonomics and reliability (both of the tool itself and of the job it does).

There are basically two ways to remove and replace surface mount components in low-volume environments: the "hot air" or "convection" method, in which heat is transferred to solder joints via a directed hot gas stream; and the "conduction" method, in which heat is transferred directly to solder joints via contact with a heated metal tip. Conduction tools include soldering irons and tweezer grips.

The typical service center has to keep in mind this question: "What method of surface mount removal will be the most versatile, reliable and easy to use?"

Hot air

Hot-air tools are effective and easy to use once you have mastered certain techniques. The key is to manage the amount of air flow, the direction of air flow, and the temperature.

Too much air flow can cause solder balls to be blown across

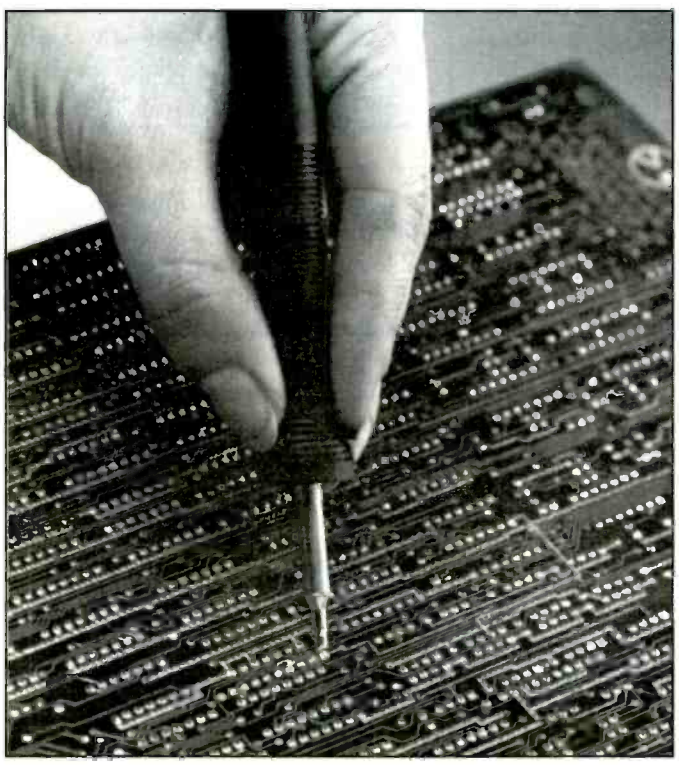


Figure 1. With through-hole components, desoldering, repair and replacement were fairly easy: get a desoldering gun or pencil and the right size tip to remove them, and a good iron to put in a new one.

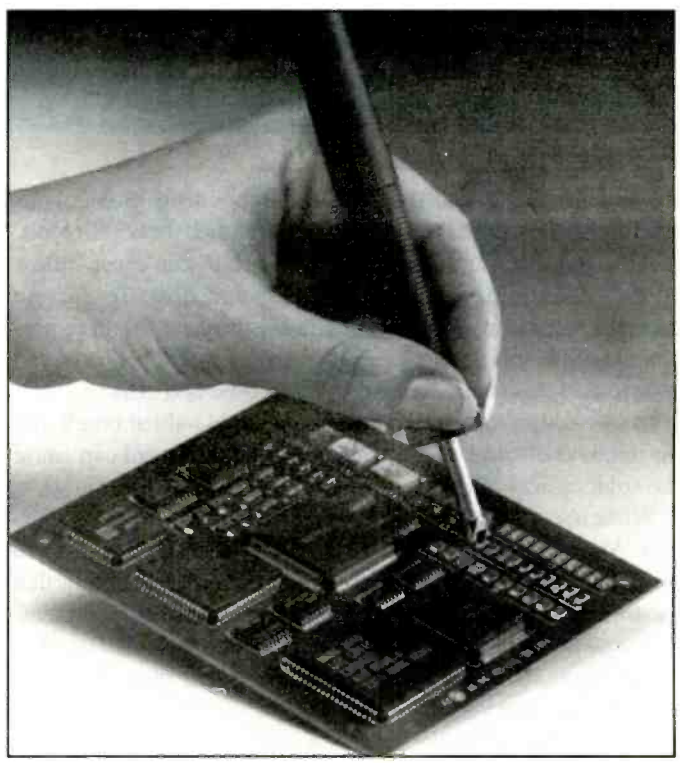


Figure 2. For conduction rework of surface mount components, many soldering iron manufacturers make tips that fit into their through-hole soldering systems, such as this tip for surface mount diodes and resistors.

Removing and installing SMDs on a budget

By Kevin Wagner

Servicing today's compact consumer electronics equipment can be a challenge, especially now that surface mount devices are being used in great numbers. Some of the major manufacturers already require that service centers purchase specialized SMD (surface mount device) rework/repair stations, which can cost as much as $1,200, before they will authorize them to repair their products.

Handling SMDs with existing tools

If you don't need to qualify for such work, and want to learn an economical method for replacing SMDs, try the system I have developed. The only major purchase required is a butane-fueled soldering pen, available from most electronics distributors for less than $60. You'll also need a pry tool. I use a small screwdriver with its blade filed down to make it thin enough to get under SMDs.

If the SMD to be removed was not already defective, this method of removal will apply enough heat to destroy it, so, as with removal and replacement of any densely-leaded SMD, make all necessary tests to be sure that the device to be removed is in fact defective, and never reinstall an SMD that you have removed from a PC board.

Wagner is a consumer electronics and business equipment service technician and is also on the International Society of Consumer Electronics Technicians' (ISCET) Board of Directors.

Preparation

The first step in removing an SMD is to remove all solder from all pins with desoldering braid or a vacuum device. In most instances, you will find that the SMD was glued to the circuit board to hold it in place for mass soldering during the manufacturing process.

Dissolve the adhesive by applying a small amount of acetone near the component to be removed. Use an acid brush and tilt the circuit board slightly to allow the acetone to flow under the SMD.

Removal

After installing a 1.5mm hot-air tip on the soldering pen, and following the manufacturer's instructions for igniting the hot-air orifice, adjust the flow level to the lowest setting. Insert the pry tool at one corner of the SMD device and heat it. Keep the tip of the soldering pen about 1/4 to 1/2 inch away from the SMD and heat the body of the device first, then gradually work outward to the pins. This heating process should take approximately two minutes.

Once the SMD is evenly heated it should start to lift off the circuit board. Use your pry tool to continually apply a gentle upward pressure until the device is completely free of the board.

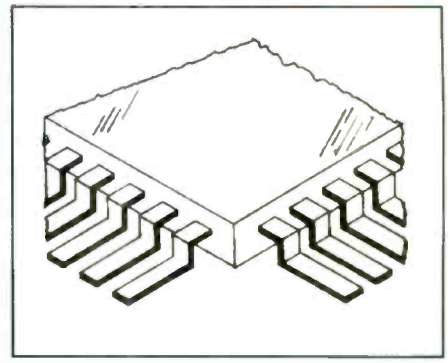


Figure 1. Solder should be evenly distributed between the upper and lower portion of the IC legs.

the board, possibly shorting adjacent components. Solder balls can be prevented by using solder paste designed for hot-air tools.

Also, too much air, or misdirected air flow, can cause reflow of the solder joints of surrounding components. To prevent reflow, components must be shielded with a heat shield or protected with Kapton tape. Learning how to shield properly and how to aim the jet stream takes a lot of time and effort.

In addition, if you are working on a double-sided board, hot air removal of components on one side of the board can cause the solder joints of components on the other side to reflow.

When using a hot air tool, proper fixturing can be very important. Various manufacturers make rework stands designed to hold a hot air pencil or tool in a vertical holder, ensuring that the tool's distance from the board remains constant.

If your temperature is too high, you can hurt the board or other components. Use too low a temperature and placement and removal can be a very slow process.

Finally, proper venting must be given due to the emission of a hot gas stream during use (and often during idle).

However, once you have mastered these techniques, a good hot air tool can be quite useful for tasks such as reattaching ceramic chip caps, preheating a board, and removing epoxy residues. Things to look for when evaluating a good hot air pencil include precise, variable air flow and easy calibration. In addition, some hot air tools come with vacuum pick-ups, which automatically lift the component from the board when the component is completely reflowed.

Replacing components using hot air tools is fairly easy. You just put solder paste down, put the component down, and the surface tension of the solder draws the component to the leads. In addition, you are less likely to break a lead, since no direct contact is made between the tool and the component.

Conduction

For conduction rework, many soldering iron manufacturers make rework tips that fit into their through-hole soldering systems. The advantage to using conduction rework tips for your surface mount rework are two-fold:

- These tips are much easier to use, since you are basically using the same skills you have used before, and
- Instead of having to purchase a whole new tool dedicated

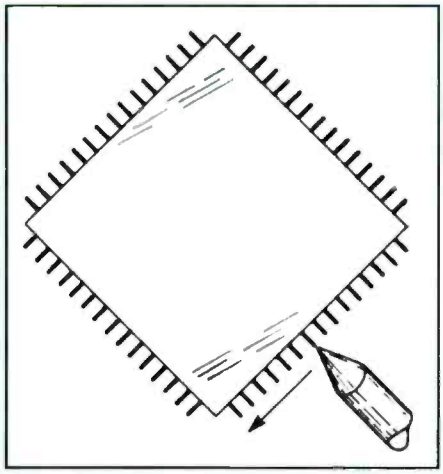


Figure 2. Hold the PC board upright at a 45-degree angle so that the solder will flow smoothly when the iron is moved across the pins in a downward motion.

Cautions

Be careful not to concentrate too much heat in any one area for an extended period of time, as this can damage the circuit board. Also, be sure you do not disturb any surrounding components. Practice on some scrap boards first. This method does require some patience at first, but I now find it easier to remove SMDs than to remove dip ICs.

Preparation for installation

Once the SMD is off the board, you will have to remove any solder left on the lands with desoldering braid. This will make it easier to set the replacement SMD squarely in place on the circuit board. At this time, clean the entire area with an acid brush and acetone.

Setting the replacement SMD into place

For this portion of the procedure, switch from the butane-fueled soldering pen to a standard soldering iron.

Be sure while installing the new SMD that you observe all electrostatic discharge precautions. SMD ICs are particularly susceptible to damage from electrostatic discharge.

Once the surface of the board has been cleaned and all excess solder has been removed, position the replacement SMD and apply solder flux (a flux pen is handy for this application) to all SMD pins and lands of the circuit board. Precisely align all pins with the lands and tack down all four corners of the SMD with solder.

Soldering method

One way I solder SMDs into place is commonly termed "solder globbing." An excessive amount of solder is applied to all the SMD pins and it appears as one big "glob." When you first attempt this method, apply a strip of electrical tape at the ends of the pins on all sides of the SMD to keep the solder glob from spreading out onto surrounding components.

The final result of this installation will be factory quality because all SMD pins will have an even amount of solder after the excess has been removed.

Once you have the SMD tacked into place and have applied the electrical tape, start the solder globbing process by heating the pins of the SMD and applying a generous amount of solder to bridge all the pins (see Figure 1). Do this as quickly as possible to avoid damaging the SMD with heat. Repeat the process for all sides of the SMD.

To remove the excess solder, tilt the circuit board and use the tip of the iron to draw all the excess solder in a downward flow (see Figure 2). After removing all excess solder, you may need to touch up a few connections. However, when you have finished, all pins should have an equal amount of solder.

Cleanup

To make your repair look even more professional, clean the entire area with acetone and an acid brush to remove excess solder flux. After cleanup, perform a final inspection by using an adequate light source and a magnifier to be sure that there are no remaining solder bridges.

I regularly use this method of handling SMDs. It works well and does result in a professional repair. You'll be surprised at how well it works.

to surface mount technology (SMT), you can buy one or two tips when you run across a particular component that you need to remove.

It's a good idea to call the manufacturer of your current soldering iron(s) to find out what surface mount solutions they have available.

For larger components, some manufacturers make special tips that can fit in two handles and be used together (Figure 3). There are also tweezer units that lock down around components. Tweezer units cannot be used for through-hole work.

Factors in selecting a soldering iron for SMT

Six factors should be considered when selecting a soldering iron for SMT work:

1. *Precise heat where the tool meets the soldering load.* To deliver heat to a load, systems can do one of two things: vary their temperature while delivering constant power, or vary their power while delivering constant temperature. In a system that relies mainly on changes in tip temperature to change heat delivery, too high a tip temperature can hurt components, boards, or lands, and too low a tip temperature can greatly increase your reworking time. In a system designed to deliver direct power in proportion to the amount of heat required, tip temperatures needed to rework are much lower than in conventional technology.

2. *The variety of tips available to address the specific application at hand.* Most soldering system manufacturers have data sheets on the various tips available for their systems. In general, you want to pick a manufacturer who has a proven track record of developing tips for newer components when they are needed. Manufacturers with custom tip programs typically do the best development.

3. *Heat-up and recovery time following tip changes.* Obviously, you want a system with tips that will be ready within seconds to remove and solder components. It also helps to have a system which can allow you to rework or solder five or six components in succession in an orderly, quick fashion, while maintaining as low a temperature as possible.

4. *Time required and difficulty to change.* Some soldering sys-

Remove and replace SMDs and flat packs with standard tools

By Ramos J. Cespedes, CET

Surface mount integrated circuits may have 48, 64, or more pins mounted on a high-density board with foil prints that are as thin as a human hair. Commercial tools available have attachments to fit a soldering iron and melt the solder on all pins at the same time. The chip is then twisted off the board.

This procedure can be difficult because it takes skill to heat all pins at the same time. If it isn't done properly, the result may be foil damage. Moreover, the bulky tool can easily damage other components located very close to the removed chip if the operator isn't very careful.

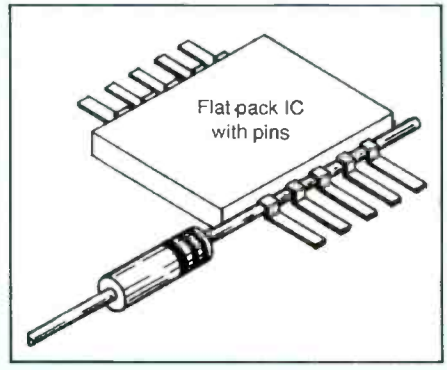


Figure 1. Passing a heavy resistor or capacitor lead under the pins on one side of the IC package will allow you to cut the leads without damaging the PC board.

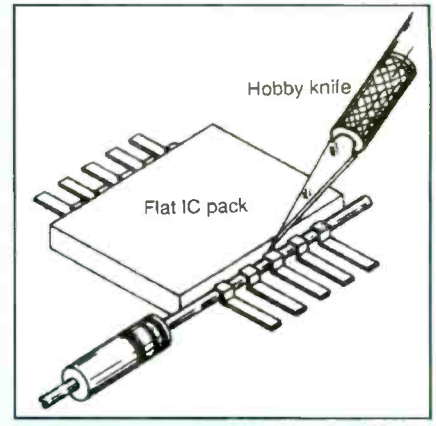


Figure 2. With a hobby knife, use just enough pressure to cut the pin between the heavy resistor or capacitor lead and the package.

The solution

After trying several methods and tools for removal and replacement of chips, I arrived at a satisfactory method using tools already on my bench. With a little patience and practice any technician should be able to accomplish this task. There are seven steps to this method:

1. Pass a heavy resistor or capacitor lead under the pins on one side of the IC package (Figure 1).
2. With a sharp hobby knife, carefully cut the individual pins one at a time close to the body of the IC package. Use just enough pressure to cut the pin between the resistor or capacitor lead and the package (Figure 2).
3. When all pins have been cut, lift the leadless body of the flat pack off the board leaving all leads still soldered to the board (Figure 3).
4. Using a soldering iron and desoldering braid, remove the leads from the board, using a sweeping motion in the direction of the foils (Figure 4.)
5. Clean remaining adhesive or foreign material from the work area and carefully inspect the board for shorts or delamination. Denatured alcohol and a cotton-tipped swab work well for cleaning.
6. Install the new flat pack over the print pattern and solder one pin only (Figure 5). Readjust the position of the flatpack as necessary, assuring that all pins are in line and in contact with the foil.
7. Apply solder to the ends of the pins along one side of the flat pack. The solder will flow between the pins and the foil. Do this to each side of the flat pack. If solder bridges occur, remove excess solder with the soldering iron and desoldering braid. Inspect the repair under a magnifier to assure that all pins are soldered and no bridges exist.

***Note: It is important to observe proper electrostatic discharge damage preventive precautions while carrying out this procedure!*

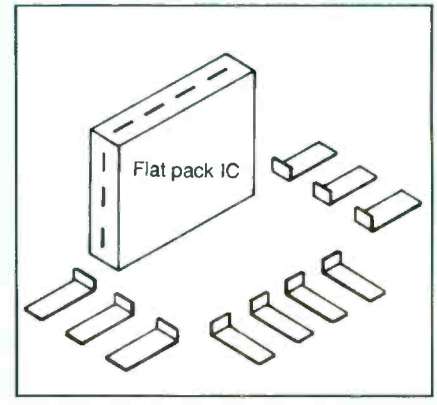


Figure 3. When all pins have been cut, lift the leadless body of the flat pack off the board leaving all leads still soldered to the board.

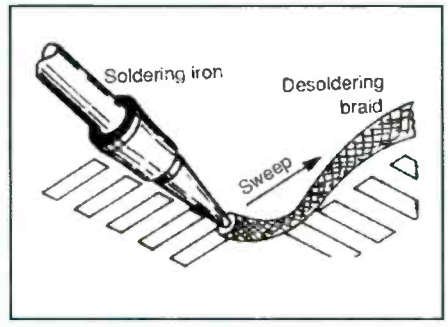


Figure 4. Using a soldering iron and desoldering braid, remove the leads from the board, using a sweeping motion in the direction of the foils.

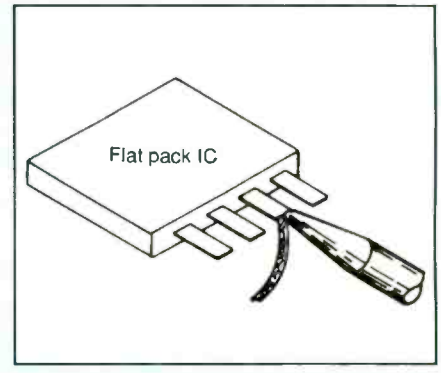


Figure 5. Install the new flat pack over the print pattern and solder one pin only.

Cespedes is an instructor at Rets Technical Training Center.

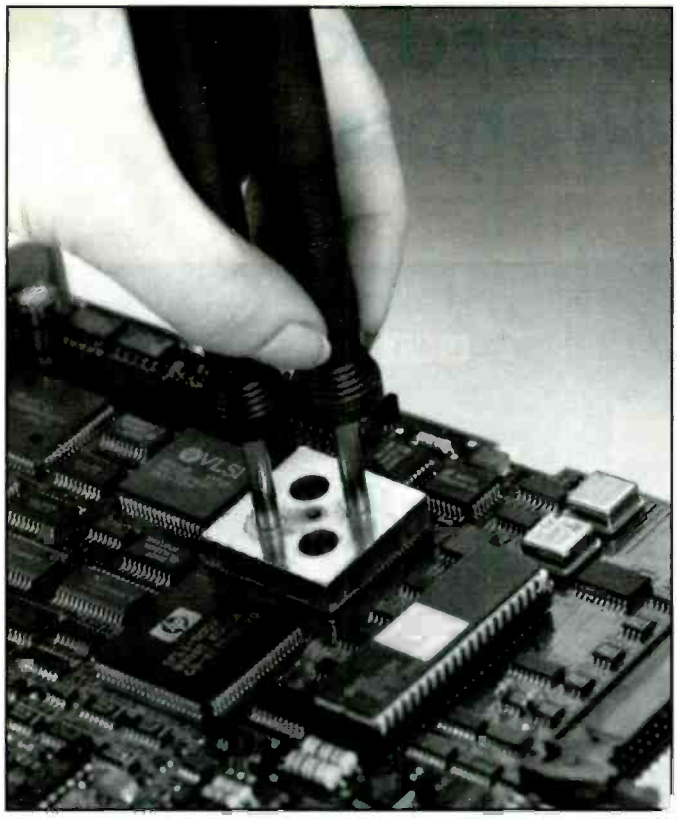


Figure 3. For larger components, some manufacturers make special tips that can fit in two handles and be used together.

tems require unscrewing handles to change tips, while others are just "plug and go." Unscrewing handles is fine if you only rework one or two components a day, but any more than that, and you are wasting a lot of time and effort. "Plug and go" systems are also invaluable if you plan to use the same system for repair of surface mount and through-hole components.

5. *Total operating cost.* How many different jobs can the system do? How much training is required? What are the calibration and repair costs? And, what are the warranties, return procedures, and such? Irons that are less expensive up-front may have more expensive repair or service requirements over time. In addition, you have to consider the reliability of the tool. Nothing is worse than having to spend your time fixing a system you bought to fix things with.

6. *Technical support.* Does the manufacturer maintain a toll-free tech support line? Is there training information available? Are engineers ready to help solve your soldering problems? Reputable manufacturers will have all these for you—and they'll even be glad to help you out with soldering problems not related to their systems

Try them

Probably the easiest way to find the best SMT rework solution for you is to simply try out what's out there. Many of the soldering product manufacturers are represented at trade shows. At these shows manufacturers are more than happy to let you test out a system for yourself. Some manufacturers offer a free evaluation period at your service center (you pay only for the tips you use), so be sure to ask. ■

Service problems related to RCA's CTC145 and CTC146 chassis

By Homer L. Davidson

In the RCA CTC145 and CTC146 chassis, the IF, SIF, chroma, vertical, horizontal and luminance circuits are all contained in a single IC, U1001. You might think that this IC would be one of the most frequent causes of problems in these sets. If that's what you thought, you'd be right.

Other than U1001, the vertical output IC (U4501), microcomputer (U3100), and analog interface unit (U3300) provide most of the functions in this chassis (Figure 1). A few additional transistors account for the balance of operations.

Just look at the main schematic. All of the circuits you can see are operated by U1001. The microcomputer IC (U3100) provides keyboard, data in and out, reset, clock enable, timing and oscillator operations. U3300 provides band spread tuning, AFT, communications of data, clock, enable, and reset, contrast, color and tint, brightness, sharpness, volume, treble, balance, bass menus, and infrared remote receiver features. IC4501 amplifies the weak vertical sweep signal and couples directly to the vertical yoke winding.

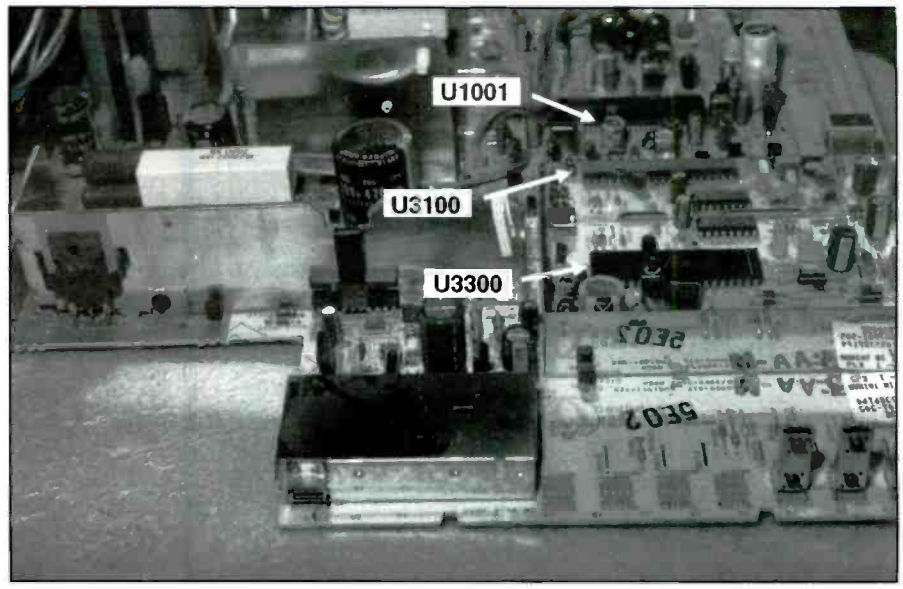


Figure 1. Most of the circuits in RCA's CTC145 and CTC146 chassis are in one large IC (U1001).

Old faithful

Because horizontal output transistors have to handle large amounts of power, they are arguably the single largest cause of failure in TV sets. When one of these components fails, often one or more associated components fails: the main and secondary fuses are blown, the surge resistor (2.7Ω) is damaged, the chassis shuts down. When you encounter a set in which these components are damaged (Figure 2), in addition to replacing the line operated components, the leaky horizontal output transistor must be replaced.

In one set that had HOT problems, I replaced Q4402 with an exact replacement component (177791). This transistor has a damper diode inside the case. If an exact replacement is not available, replace this HOT with an SK9422, ECG-2302 or NTE2302 universal replacement. This output transistor has a TO-48 mounting instead of the usual TO-43 socket. Q4402 mounts vertically, with its terminals soldered directly to the pc wiring.

I plugged the set into a variable isolation transformer, then slowly increased the output voltage while monitoring the 160V source at F4102 (1A) fuse, hoping that no damage had been done to the regulator, flyback, and horizontal circuits. I monitored drive waveform at pin 64 of U1001 using an oscilloscope. As the line voltage was increased, a square waveform began to shape up and then high voltage came up. Replacing the horizontal output transistor Q4402, fuses F4101, F4102 and resistor R4101 (2.7Ω) solved the old faithful dead chassis (Figure 3).

Turn on followed by shutdown

A CTC146 would come on then shut down. Since I had seen several of these sets with this same symptom in which the

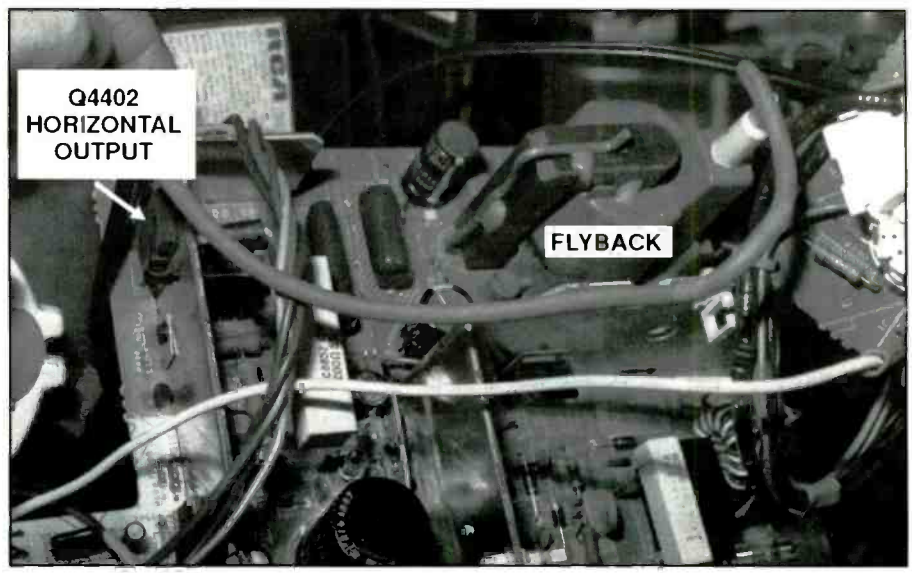


Figure 2. The TO-48 horizontal output transistor with a damper diode inside is mounted on a long metal heat sink.

Davidson is a TV servicing consultant for ES&T.

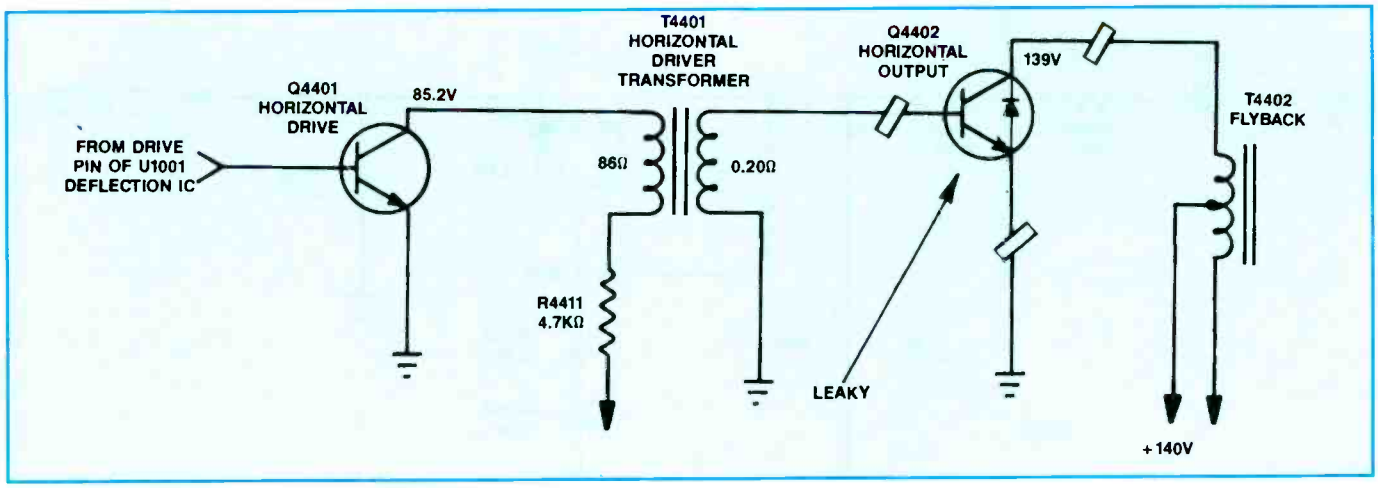


Figure 3. A defective horizontal output transistor (Q4402) in the CTC145 and CTC146 chassis may be replaced with an SK9422, ECG2302, or NTE2302 universal replacement.

solder joints at the horizontal driver transformer (T4401) terminals were the problem, I resoldered these joints. The resistances of both primary and secondary windings of this transformer were normal. But, the set remained inoperative.

I checked the horizontal output and driver circuits, but everything was fine there. I thought that perhaps the horizontal deflection IC was the cause of the shutdown. The deflection IC supply voltage source at pin 58 (6.8V) is derived from the secondary circuits of the flyback. I substituted a 7V bench power supply source for this voltage at pin 58 of U1001. With this substitute voltage at pin 58, the oscilloscope waveform at pin 64 was a normal horizontal drive waveform.

I left the set to operate for an hour while I thought about the problem. Upon reflection, it occurred to me that it might not be caused by a fault in the horizontal circuits. This was one of those unfortunate situations in which experience sent the troubleshooting procedure in the wrong direction. Most case histories do provide useful information, however.

Since problems in the horizontal circuits and low voltage sources cause most shutdown problems, I checked the 160V and 140V sources. These were quite normal, indicating that the voltage applied to the driver transistor and horizontal output circuits was as specified. When I measured the voltage at the scan derived 6.8V source that feeds the deflection IC supply

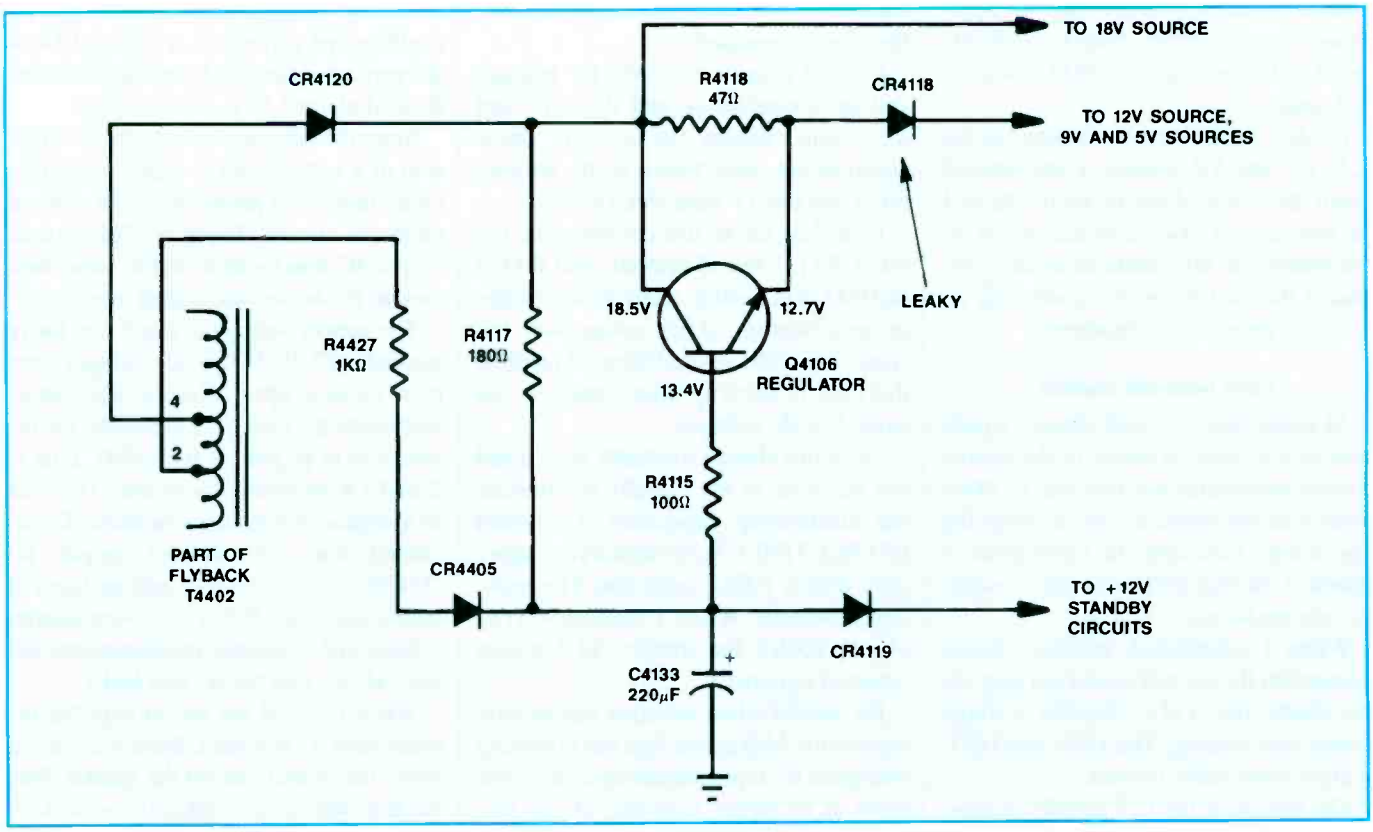


Figure 4. Low dc standby voltage was caused by a leaky fast-recovery diode, CR4118, in the 12V standby power supply.

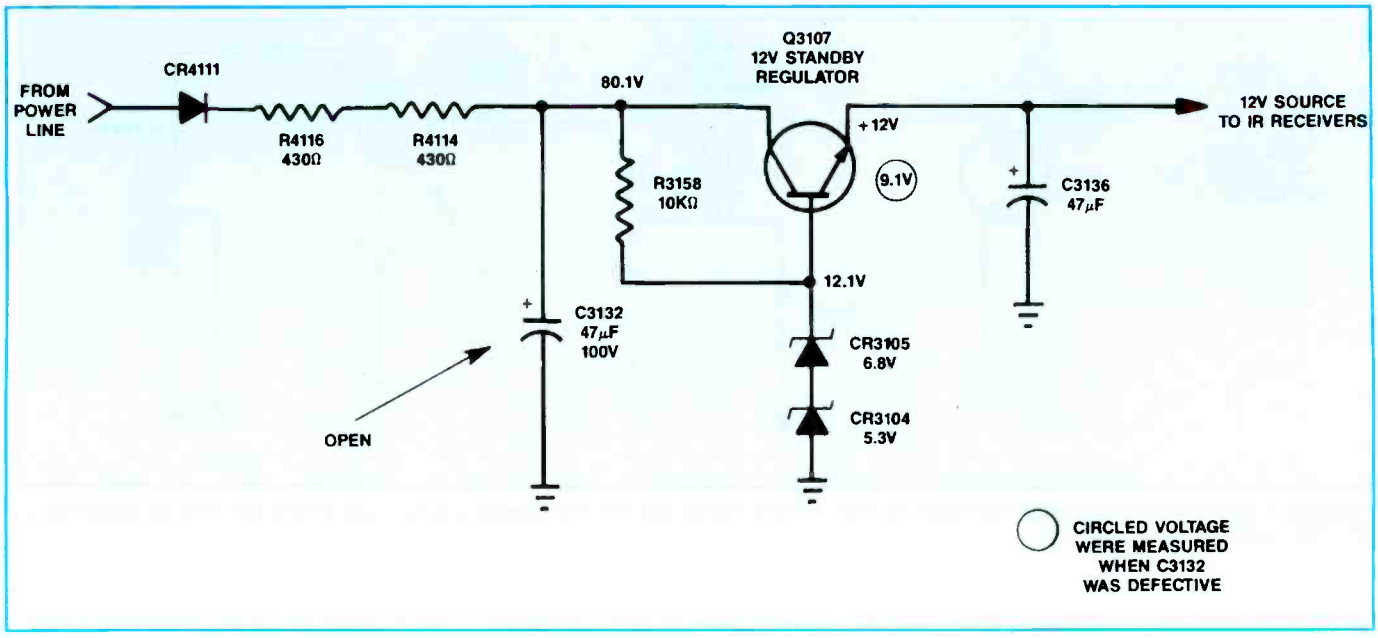


Figure 5. An open C3132 capacitor in the low voltage supply source caused a turn-on dead remote chassis.

terminal, it was 0V. This was expected in the absence of horizontal operation.

I decided to test all of the voltage source regulator transistors and diodes in the scan derived voltage sources. No regulator transistors were found open or leaky in these voltage sources. While checking diodes and zener diodes in the low voltage source (6.8V), I noticed that CR4118 exhibited some leakage (Figure 4). I desoldered one end of the diode from the PC board and tested it again. CR4118 was, in fact, leaky.

Diode CR4118 supplies voltage to the 12V, 9V and 5V sources. I had tracked down the cause of the problem. Since I did not have an exact manufacturer's replacement for this diode in stock, I replaced this fast recovery diode with an ECG177 universal replacement.

Turn on/dead chassis

At times this CTC145 chassis would start up when the on button of the remote control transmitter was pressed. At other times it would refuse to operate from the transmitter. I checked the transmitter; it operated another CTC145 chassis without any problems.

When I substituted another remote transmitter the set still would not turn on. No doubt the +12V standby voltage source was missing. The 160V and 140V sources were fairly normal.

The voltage at the 12V standby regulator Q3107 was low at 9.1V (Figure 5). Both the 12V and 5V standby sources were low. The chassis would surge when turned on, but remained dead.

The schematic diagram indicated low dc voltage applied to the collector terminal of 12V standby regulator. To determine if the 12V line was overloaded, I disconnected the 12V source from the IR receiver circuits. When I applied a 12V external source to the IR receiver circuits, the chassis operated.

I tested regulator Q1307 for leakage and open conditions, and the 6.8V and 5.8V zener diodes for leakage. These components were found to be normal, including the 5V regulator, Q3108.

I checked the ac line components. Diode CR4111 tested normal, and R4118 and R4114 dc voltage resistors were within specification. After going over the standby circuits several times, I recalled that open or dried up filter capacitors can cause low dc voltages.

Since this chassis was fairly new, it had not occurred to me initially to consider the electrolytic capacitors. I shunted C3136, C3129, C3128 electrolytic capacitors with a 100μF capacitor. The problem persisted. When I shunted C3132 (47μF, 100V), the standby 12V source returned to normal.

Be careful when shunting electrolytic capacitors. Make sure that the operating voltage of the replacement capacitor is the same as or higher than that of the suspected capacitor. Moreover, clip the capacitor into the circuit with power off, then apply power. I tested C3132 after removing it from the circuit. It was open.

Picture only two inches high

The picture on the screen of this CTC-146 set was dark at the top and bottom, with only about two inches of picture at the center of the screen. The cause was evidently insufficient vertical sweep. The oscilloscope waveform at terminal 54 of the vertical deflection IC and amplifier indicated about $1.5V_{pp}$ drive voltage.

Since the voltage was only down a fraction of a volt, the drive signal was sufficient, indicating problems in the vertical output IC circuits (Figure 6). The vertical output IC was located on the same heat sink as the horizontal output transistor.

The supply voltage at pin 8 was fairly normal at 22.2V. In fact, all voltages were quite close to specifications. After shutting down the chassis, I measured the resistances at all pins of IC U4501. Pins 1, 2, and 3 were shorted to ground. This was in accordance with the schematic. I concluded that the vertical output IC (176853) was defective and replaced it with a universal ECG1797, even though voltage and resistance measurements did not indicate that the IC was leaky.

When I turned the set on with the replacement IC installed, there was only a white horizontal line on the screen. Was the new replacement defective or did I replace it with the wrong part number?

Voltage measurements at the supply and other terminals were quite high compared with voltages listed on the schematic. When I touched terminal 3 with the DMM probe, the raster popped in. The raster collapsed after I removed the test probe from terminal 3.

Inspection with the magnifying glass indicated a break in the pc wiring between terminal 1 and ground. No doubt the thin pc wiring was damaged when I removed the IC from the board. I corrected this problem by soldering a piece of fine copper wire across the break.

This experience suggests that it would be a good practice after installing a new IC to double check each pin with a low ohmmeter test to determine if a crack in wiring might have occurred during replacement of the IC, especially if the IC was difficult to remove.

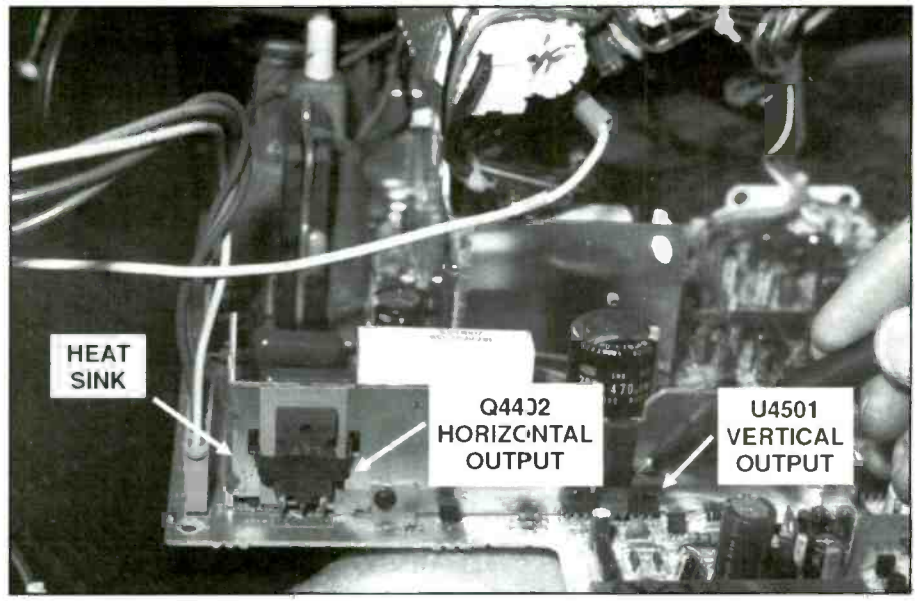


Figure 6. A defective vertical output IC, U4501, reduced the raster height to two inches. This IC is mounted alongside the horizontal output transistor on the heat sink.

Vertical foldover

Almost one third of the raster was doubled over in this 13-inch TV chassis. The vertical size control had little effect in unraveling the doubled up picture. Since most foldover problems originate in the output circuits, I measured voltages at each terminal of U4501. These voltages were normal. The supply voltage at pin 8 was a little over 24V (Figure 7).

The vertical deflection yoke resistance was normal at 12Ω. Vertical foldover is frequently caused by defective electrolytic capacitors, or a change in resistance of resistors in the feedback circuits, so I proceeded to check them. The resistance of R4505 was normal at 3Ω. The resistance of R4508 (22KΩ) was lower when

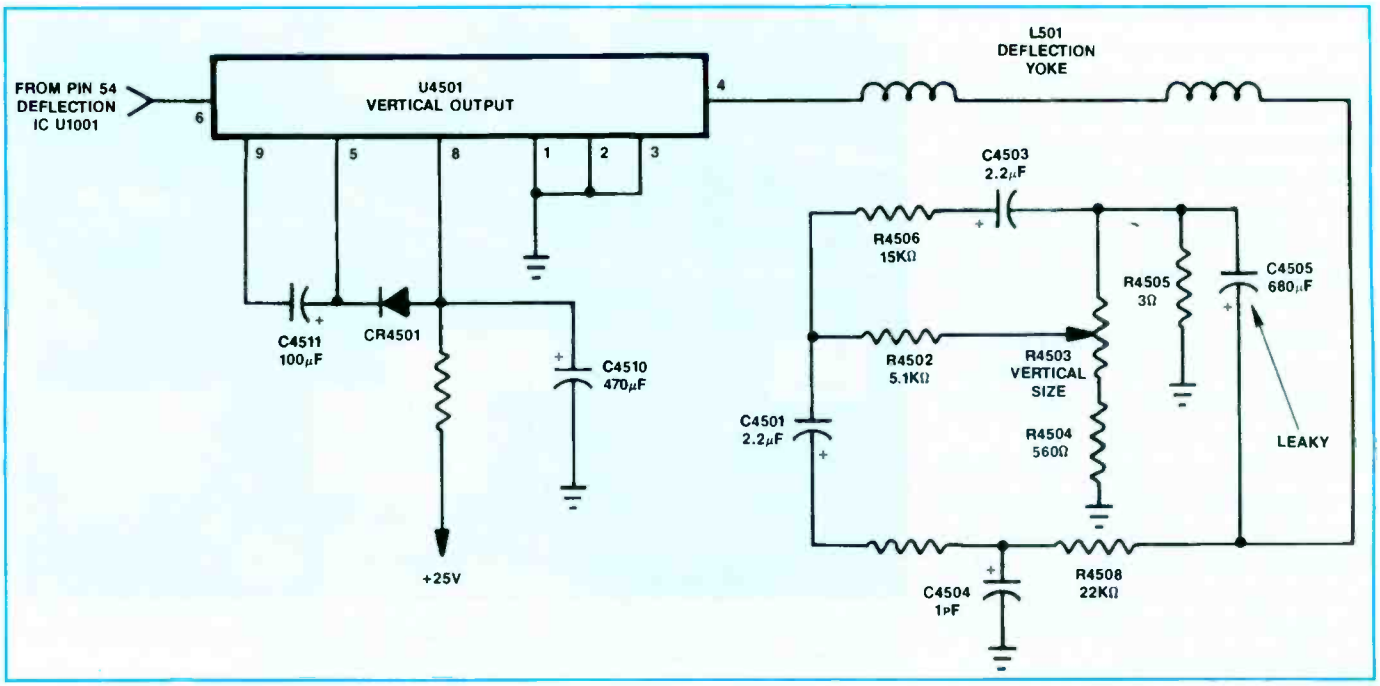


Figure 7. Although capacitor C4505 caused the vertical foldover problem in this case, check C4501, C4503, C4504, C4510 and C4511 as well for poor vertical linearity and foldover problems.

tested in the circuit and higher when one end was removed from the circuit. The actual measurement was close at 21.9KΩ. Diodes CR4503 and CR4502 showed no signs of leakage when I measured them out of circuit.

Next, I shunted each of the electrolytic capacitors in the vertical circuits with a known good capacitor. The results were the same. Somehow I had missed the component that was causing the foldover. When I measured the resistance of each electrolytic capacitor, I found that C4505 (680μF) was leaky.

I removed CR4505 from the pc board and when I tested it out of circuit it showed leakage. Perhaps I should have checked this capacitor first thing, since it was in the return path of the vertical output and yoke winding to ground.

Remember, electrolytic capacitors C4501, C4503, C4504, C4505, C4510, and C4511 can cause poor linearity or foldover problems in the vertical circuits.

Intermittent video

The picture on one set would fade out, pop in and fade out again. I began my troubleshooting of this unit by dividing the video circuit into three sections and monitoring each with the oscilloscope. To determine if the input video amp was nor-

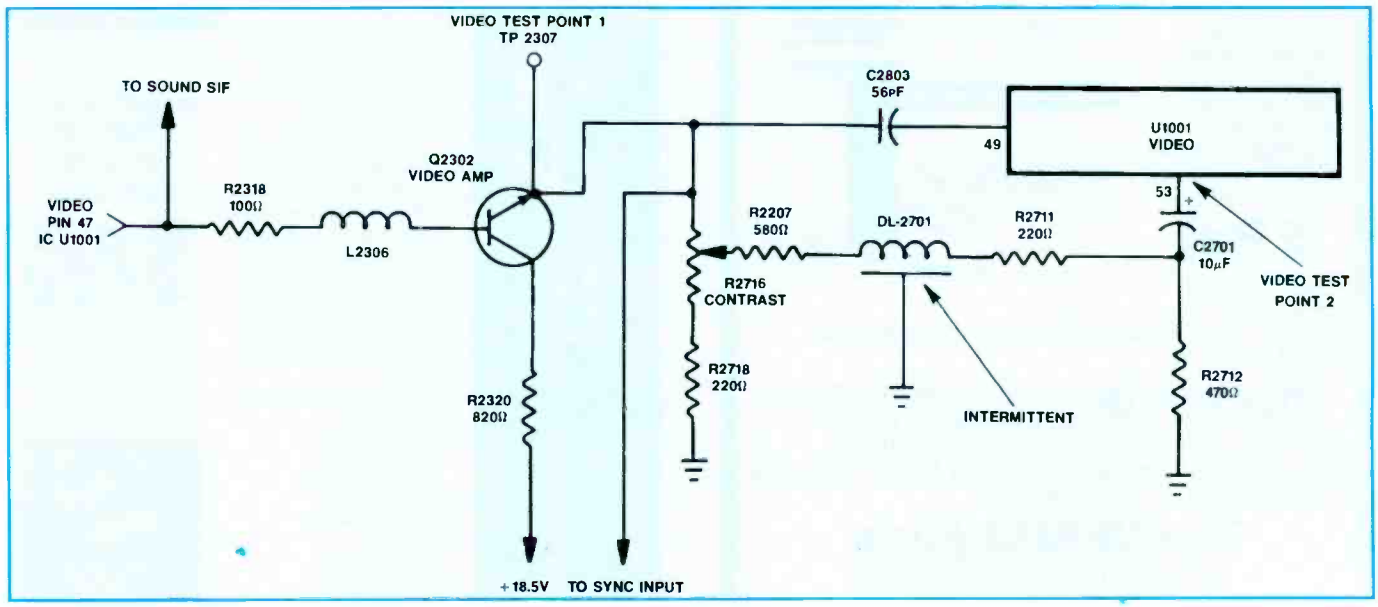


Figure 8. Monitoring the video circuits at test point 1 and 2 uncovered an intermittent delay line (DL-2701).

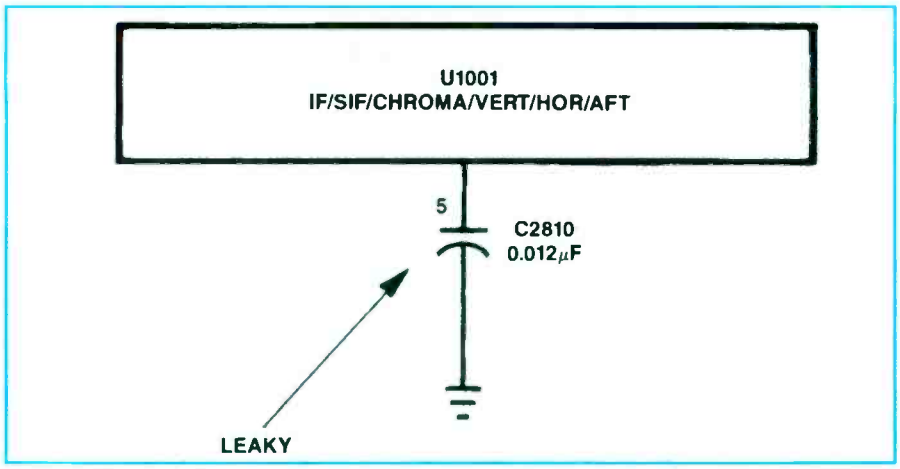


Figure 9. Now you see it, now you don't color picture resulted from a leaky C2810 (0.012μF) bypass capacitor at pin 5 of U1001. This is a common problem.

mal after the sound take off from U1001 (IF/SIF) circuits, pin 47, I connected the scope probe to test point TP2307. With a strong local TV station tuned in, Q2302 signal was normal.

Next, I connected the scope probe to pin 53 of U1001 to monitor the video input signal. To keep the probe tip on the correct terminal, I soldered a short piece of hookup wire to pin 53. After the chassis had warmed up, the waveform became intermittent, as did the picture on the TV screen. I traced the intermittent picture back to a defective delay line DL2701 (Figure 8). I replaced DL2701 with the original part number, 177795, which restored the set to normal operation.

The flasher

The picture on one RCA CTC146 was intermittent. At times the screen would go into retrace lines at the top. At other times the picture was normal. From time to time there was only one color in the raster. Bright retrace lines may be caused by problems in the vertical sweep, video or picture tube circuits, or may be the result of a defective CRT.

The easiest way to begin troubleshooting of this symptom was to lightly tap the neck or end of the picture tube to determine if the gun assembly was defective. I knew I was on the right track when the picture flashed in and out.

At first I suspected the picture tube gun assembly, but it tested normal in the CRT tester while I tapped the end of the tube. When I twisted and tapped the CRT socket assembly board, the picture acted up. After I replaced the defective picture tube socket with the original part number (193105), the flasher flashed no more.

Now you see red, now you don't

I was observing the operation of a CTC145 on the bench. Sometimes the picture color would spontaneously disappear leaving a normal black and white picture. The color would come and go, at will, even though the set wasn't disturbed. I suspected that the chroma section of U1001 had become intermittent.

Since I had found capacitor C2810 to be leaky in a number of CTC156 and CTC157 chassis, as well as other chassis, I started by measuring the voltage at pin 5 of U1001 (Figure 9). I referred to my notes on my experience with intermittent color problems in other CTC156 and CTC157 sets.

My notes reminded me that when the voltage at pin 5 dropped to around 5V, the color disappeared. The color operating voltage of the CTC157 was normal at 8.8V. In the CTC145 chassis the normal voltage at pin 5 measured 5.3V and when the color disappeared the voltage dropped to 2V. Replacing the leaky 0.012μF capacitor solved another intermittent color problem. Replace this capacitor with one that has a 5 or 10 percent tolerance.

Conclusion

When the TV chassis begins to age, many different service problems crop up. Although the service problems in this article are fairly straightforward, sometimes you'll run across a tough dog. By referring to case histories, and your own experience with other chassis, even the tough TV service problems can be solved. ■

Troubleshooting VCR motor problems

By Juergen Ewert

Two of the most important components in a VCR are the capstan motor and head drum motor. Picture and sound quality depend on the accurate operation of these motors, which are controlled by servo circuits.

To troubleshoot motor related problems it is necessary to know the functions of the connected servo circuits, since motor assemblies usually include some servo components. Sometimes it is not easy to determine if the motor is the cause of a malfunction, or if the servo circuits are faulty. However, it is a good idea to look at the motors if there is a problem with the tape speed or the drum rotation because the reliability of a motor is less than that of microcontrollers or other electronic components.

The following is a review of capstan and drum servo operation theory, a guide to troubleshooting motor problems, and three real-world examples. Figure 1 shows the capstan and head drum servo block diagram of a VHS-VCR and represents the components that are included in the motor assemblies.

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Capstan servo operation

The capstan motor is the key component in a VCR's tape transport mechanism. Together with the servo system it is responsible for the accurate forward speed of the tape to insure that the video

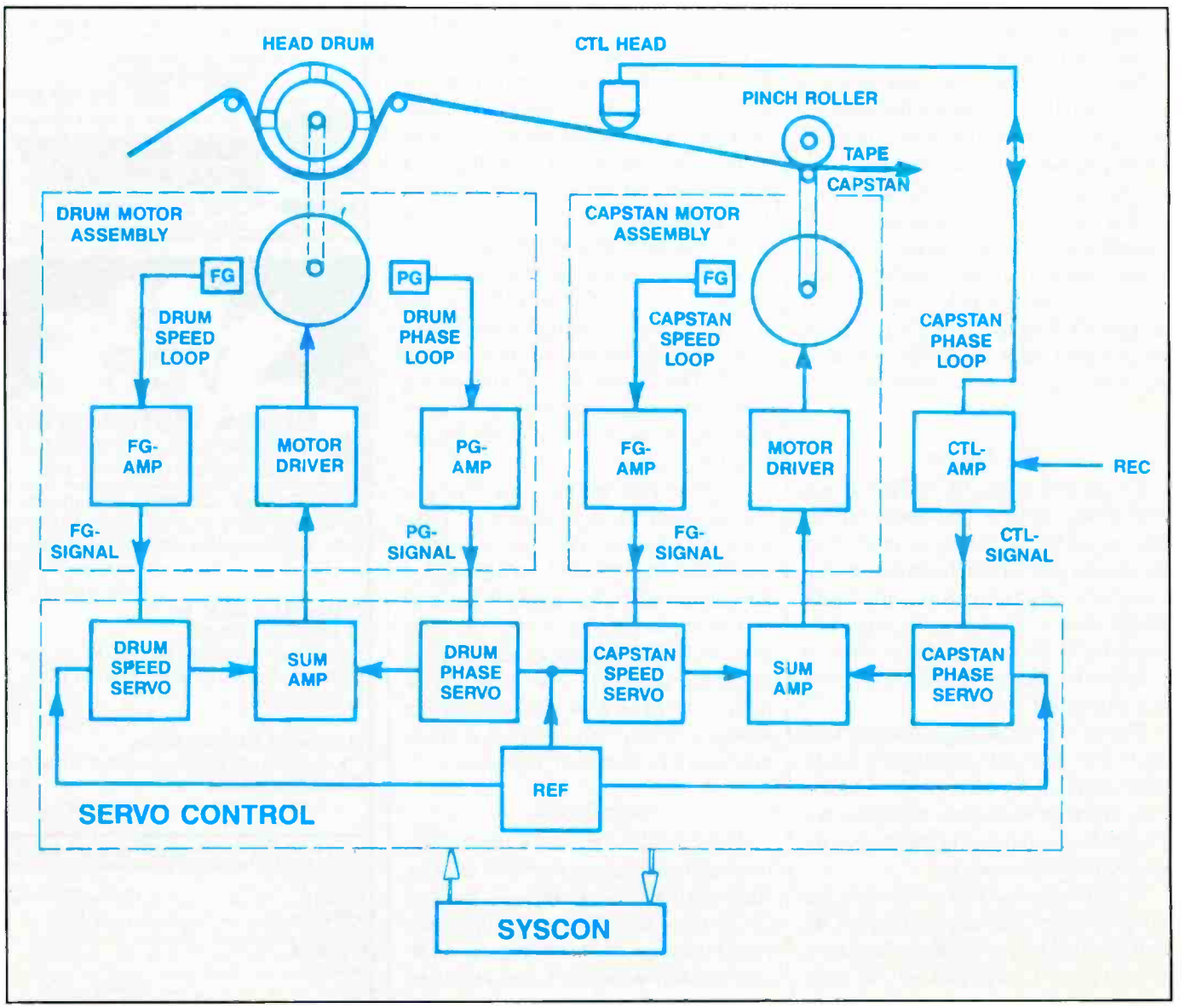
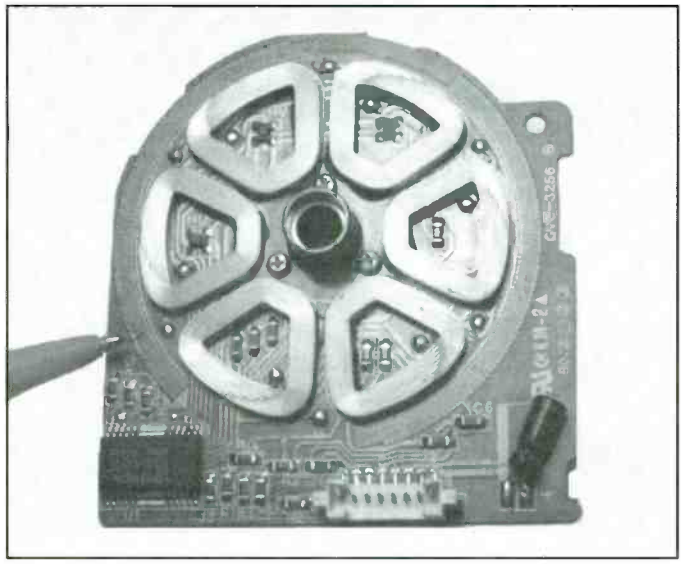


Figure 1. VHS capstan and head drum servo block diagram.



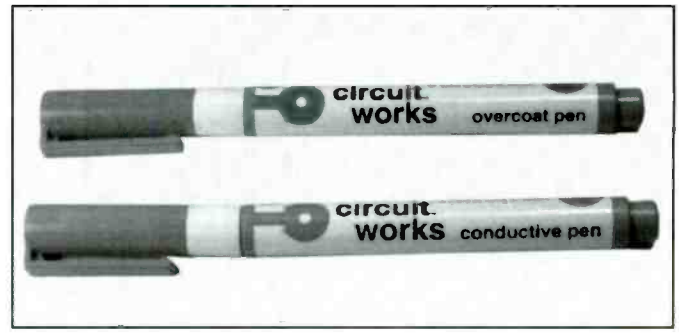


Figure 3. Use of a conductive pen and overcoat pen allowed me to repair the broken meander trace.

Figure 2. This capstan motor board had a broken meander trace.

heads track correctly, and to play back the audio signal at the right speed.

The capstan motor and the pinch roller pull the tape through the tape path of the VCR. Capstan motor assemblies usually include the motor driver, the frequency generator (FG) and pulse generator (PG). In many VCRs the frequency generator is a meander-shaped trace on the printed circuit board of the motor assembly.

This meander-shaped trace is essentially a small coil, and when a magnet in the motor assembly passes over it, a pulse is induced in it. The frequency generator monitors the motor's rotation and supplies a correction signal to control the motor speed through the capstan speed servo and the motor driver (speed loop).

The VHS system uses a control track to position the video heads correctly on the video tracks in playback mode. In record mode a CTL head writes the control track on the lower edge of the tape. In playback mode the CTL head picks up the control signal from the tape, which is compared in the capstan phase servo to a 30Hz reference signal. Any phase difference between these signals creates a correction signal to speed up or slow down the capstan motor (phase loop).

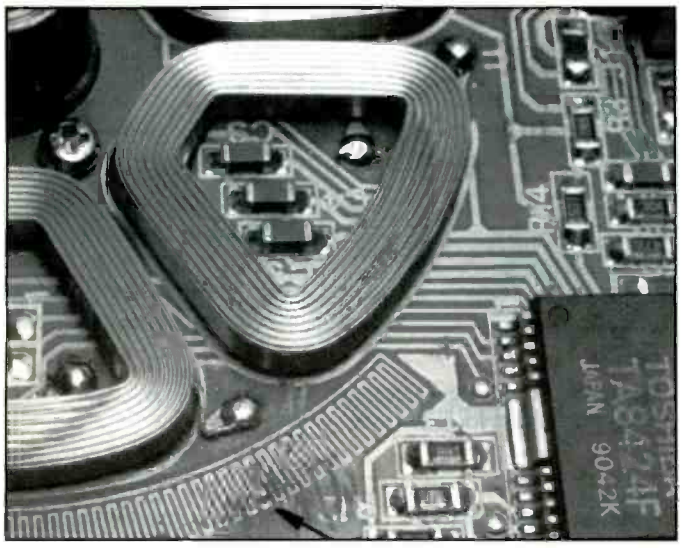


Figure 4. The broken trace on the capstan motor board.

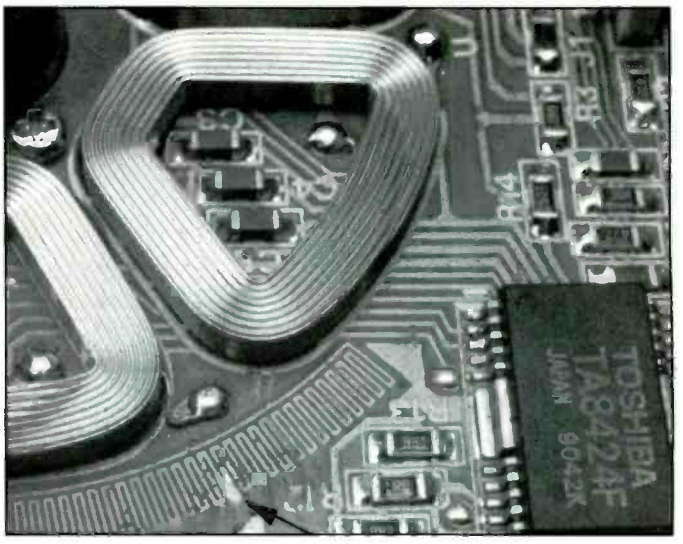


Figure 5. The trace repaired with the conductive pen.

The correction signals from the capstan speed loop and from the phase loop are added in a sum amp. The output signal of the sum amp is used to control the capstan motor driver which is usually located on the motor board.

Head drum servo operation

A high relative speed, 5.8 meters per second, between video heads and tape, is necessary to record and play back the video FM signal. To achieve this high relative speed, the drum motor rotates at 1800rpm. The drum motor assembly contains the motor driver, the FG sensor and the PG sensor. Many drum motors use only one sensor to create the FG signal and the PG signal, then a special stage in the servo circuits is used to split the signal into both (FG and PG).

The head drum servo operation is similar to that of the capstan servo. Many drum motors use a meander-shaped trace on the motor board to generate the frequency (FG-signal) for the speed servo.

To position the heads precisely at the beginning of the video track there is a pulse generator and a phase servo. The pulse generator is also a part of the drum motor assembly. Often a hall sensor is used to generate these pulses.

The correction signals from the phase loop and the speed loop are added in a sum amp. The output signal of the sum amp controls the drum motor driver on the drum motor board.

Troubleshooting tape speed problems

The tape speed is determined by the rotations per minute of the capstan motor. If there is something wrong with the capstan motor, or the capstan motor driver, including the capstan servo circuits, you may be able to see or hear the symptoms. One symptom is that the audio sounds strange: it may be too slow, or it may be too high pitched, sounding like Mickey Mouse. However, most VCRs are designed to mute the audio when the servos are not locked.

You may also observe the symptoms of incorrect capstan motor speed in the video. The picture may look as though it is being played back in fast forward mode or is just not steady. If the capstan servo doesn't work at all, it is possible that the capstan motor may run in playback mode at fast-forward speed (unregulated).

If you encounter problems such as these, you should look first at the pinch roller to make sure it touches the capstan so that the tape cannot slip. It is a good idea to clean the capstan and pinch roller in any case, usually a lot of dirt collects there. If everything is clean and the rubber of the pinch roller looks all right but the symptoms persist, you should always suspect a mechanical problem before looking at the servo circuits. The average reliability of mechanical parts is far less than that of electronic components.

If playback, fast forward and rewind don't work, then it is possible that the capstan motor is dead. In this case it is a good idea to check all the mechanical parts such as gears, belts and rollers first. If there is nothing wrong and the capstan motor doesn't turn, check the connections and the voltages at the capstan motor board.

The trouble with capstan speed circuits is that they operate in a closed loop. This means that the FG signal to control the motor speed is created in a frequency generator (FG-Sensor) that is a part of the capstan motor. Then the signal goes into the servo circuit where the comparison with the reference signal is made and the state of the SYSCON determines if the motor turns on or not. Troubleshooting this part of the circuit is usually a challenge.

To check the phase loop, the first step is to make sure that the CTL signal is present. This signal is compared in a PLL circuit in the servo control IC with a 30Hz reference signal. The servo control IC provides the signal to control the capstan motor drive. If there is no signal at the CTL head, then the phase loop has nothing to compare with, so the capstan motor determines its own speed. Take the time and use a signal tracer or an oscilloscope to check the signal at the CTL head.

The following example from my own experience demonstrates that you can sometimes find the trouble spot without any measurements.

Tape speed too fast—bad capstan motor

A Sears VCR model 580.53326090 produced a playback picture that was broken into small horizontal portions and there was no sound. When I looked at the tape it was running too fast. First I suspected a slipping tape between pinch roller and capstan, but the pressure of the pinch roller was perfect. After I cleaned the pinch

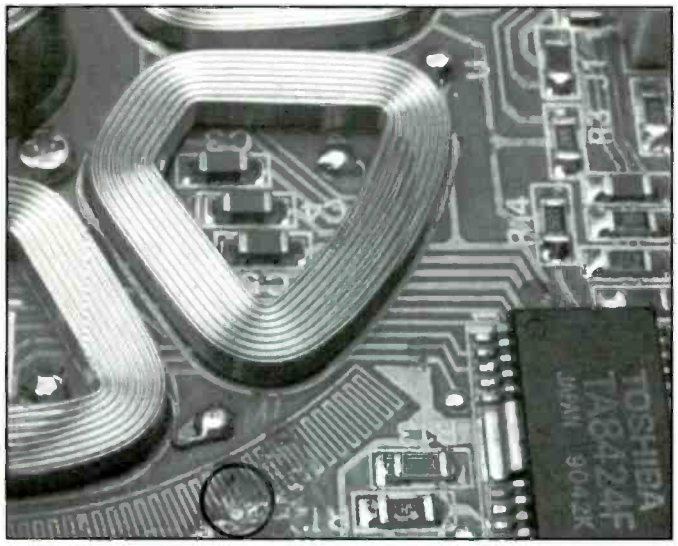


Figure 6. The solder mask repaired with the overcoat pen.

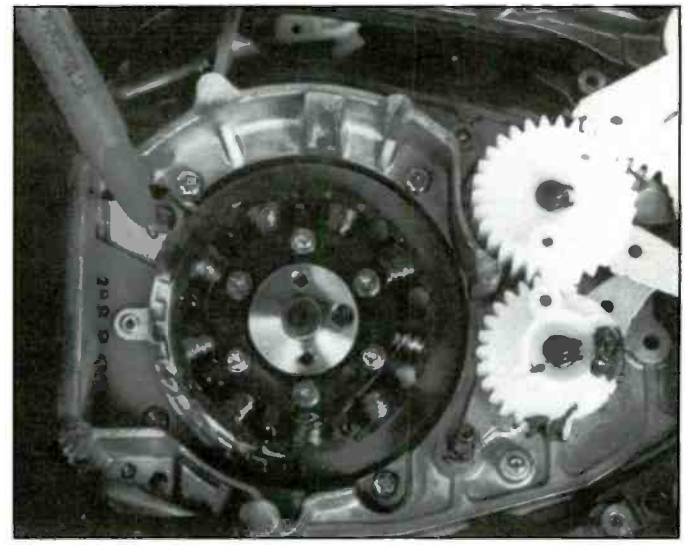


Figure 7. Damaged traces on flexible board of the drum motor.

roller and capstan there was no change.

When I checked the functions there was no visible difference in speed of the capstan motor wheel going from fast forward to play. The capstan motor was running unregulated at full speed. To make sure the CTL signal was not missing I checked the signal at the CTL head. The CTL signal was present but the frequency was too high because of the fast tape speed.

Next I took a closer look at the capstan motor: I checked the connections to the motor first, and everything looked fine. Then I removed the rotor, and discovered the real trouble spot.

The capstan motor on this VCR uses a meander-shaped trace for the frequency generator. Figure 2 shows the capstan motor board with the stator coils and the meander trace. I discovered some scratches on the board. Perhaps someone worked on the motor before and did a rough job; or it could have been a piece of sand that got between the rotor and the board and scratched the trace. Under a magnifier I discovered a scratch that cut the meander trace. That caused the speed loop to go out of control because the FG-signal was missing (Figure 2).

The cure for this kind of problem is usu-

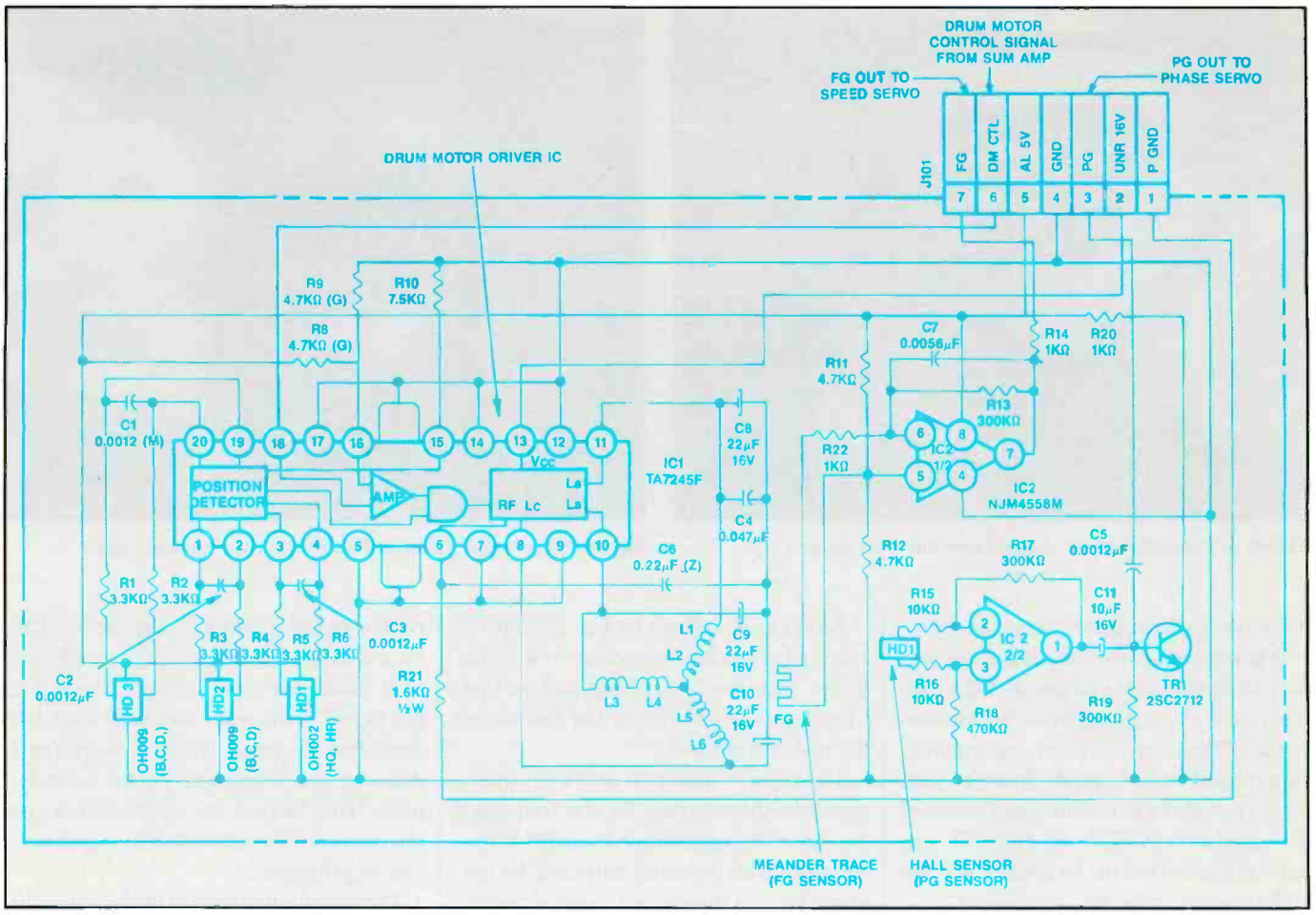


Figure 8. Drum motor schematic diagram.

ally a new motor, which is very expensive. I found a cheaper solution in a distributor's catalog: a conductive pen that can be used to repair broken traces. I chose a pen with a fine tip (Figure 3).

The pen contains a conductive silver polymer with high electrical conductivity. To use the pen I removed the solder mask around the area of the damaged trace with fine sandpaper. It is important to first shake the pen for 20 to 30 seconds. It contains balls to assist the mixing process. It is a good idea to try the pen first on a scrap board to practice.

To apply the right amount of polymer to the board it is necessary to squeeze the pen. The polymer dries in about five minutes but the maximum air-cured conductivity is reached after 30 to 45 minutes. For maximum conductivity and adhesion the manufacturer recommends to cure at 250F to 300F for five to ten minutes. I cured the conductor by using a hair dryer.

To protect the repaired trace and the other scratches, I used the overcoat pen to repair the solder mask. The overcoat pen contains a conformal coating material. It is necessary to shake the overcoat pen before use, and it is very important to completely cure the conductor created with the conductive pen before applying the overcoat to the new conductor.

After this procedure (Figures 4, 5 and 6) I reassembled the motor and started the VCR. It worked.

Troubleshooting drum motor problems

The horizontal position of the lines and pixels on the playback TV-picture are determined by the exact position of the video heads on the video track. If there is a problem with the drum speed the picture shakes horizontally and sometimes collapses altogether.

The SYSCON shuts down the VCR if the drum speed is too far off or if the head drum stops. If the head drum doesn't start turning at all when the VCR is in play mode, it usually unloads the tape.

In drum motors the FG and the PG sensors are integrated into the motor assembly. This creates a problem in troubleshooting drum servo or drum motor problems, because access to these sensors is only possible if the rotor of the drum motor is removed—but that means the motor will not be able to operate once you have gained access to the FG and PG sensors.

If you have the schematic you can check the voltages and signals at the motor connector first. The motor control signal at the input of the motor drive should change if you try to stop the head drum with your finger.

Without a schematic it sometimes pays to poke and probe around and inspect carefully while you're doing it. Just remove the rotor and look for obvious damage before you order the service manual, as I did in the following examples.

A drum motor problem

A Mitsubishi HS-348UR VCR didn't play back but fast forward and rewind worked fine. The VCR loaded the tape completely but the drum motor didn't start spinning. After a second, it unloaded the tape. With the tape unloaded and the VCR in stop position I tried to turn the head drum by hand to find out if the drum

motor was stuck. It turned easily and I couldn't feel any mechanical resistance.

Then I started playback again and when the tape was loaded I tried to turn the head drum again. This time it was not easy to turn the drum. There was the magnetic field in the motor trying to hold the drum in place. I applied a little more force to the drum and it started spinning but the picture was very fuzzy because the head drum didn't rotate at the right speed.

To see where the problem was I checked the motor connections and didn't encounter a problem. Now I took the rotor off and found the problem. There was a flexible circuit board glued to the metal base of the motor that contained the meander trace for the frequency generator. Somehow the material of the flexible board popped up and the rotor worked like a grinder as it spun and damaged the traces (Figure 7).

To fix the problem I had to replace the whole motor because the manufacturer doesn't sell the flexible board as a replacement part. With the new motor the VCR was back in perfect working condition. The next example shows that it isn't always this easy to fix a motor problem.

Another drum motor problem

An Akai VCR, model number VS-565U, played back only for five minutes (sometimes for half an hour), before the picture started shaking horizontally. After a while the picture got very fuzzy and finally the head drum slowed down and stopped. I checked the drum motor connections and didn't find anything wrong. There was no visible problem.

The schematic of the motor in Figure 8 shows the connections to the different signals of the servo circuit.

First I checked the supply voltages 5V and 16V, which were fine. When the VCR was in playback mode I watched the DM CTL signal with an oscilloscope. The voltage was 2.7V, which was the value given in the schematic. When I tried to slow down the motor with my finger, the DM CTL voltage increased and the motor tried to keep up the speed. That showed me that the speed control worked. Then I disconnected the DM CTL signal and replaced it with a voltage from an adjustable power supply. The motor speed responded when I changed the DM CTL voltage from 1.5V to 4V; so the motor worked fine.

I connected my oscilloscope again, started the play mode and waited for things to happen. When after about five minutes the picture started to shake, the DM CTL voltage started shaking at the same frequency. When the drum finally slowed down the DM CTL voltage increased. The servo obviously tried to increase the motor speed, and I noticed that the integrated circuit with the motor driver (IC 1, TA7245F in Figure 8) got very hot; it smelled and I burned my finger when I touched it.

I replaced the DM CTL signal again with the voltage of the power supply. There was no response of the motor speed when I altered the DM CTL voltage.

I ordered a new board for the drum motor. The manufacturer probably knew about this overheating problem because the new drum motor board had a big heat sink on the motor driver IC (Figure 9). With the new board the VCR worked again.

These examples show that some VCR motor problems are not too hard to troubleshoot if you know the basics of servo operation and where to look for problems. Perhaps this article will help when you have to deal with your next drum or tape speed problem. ■

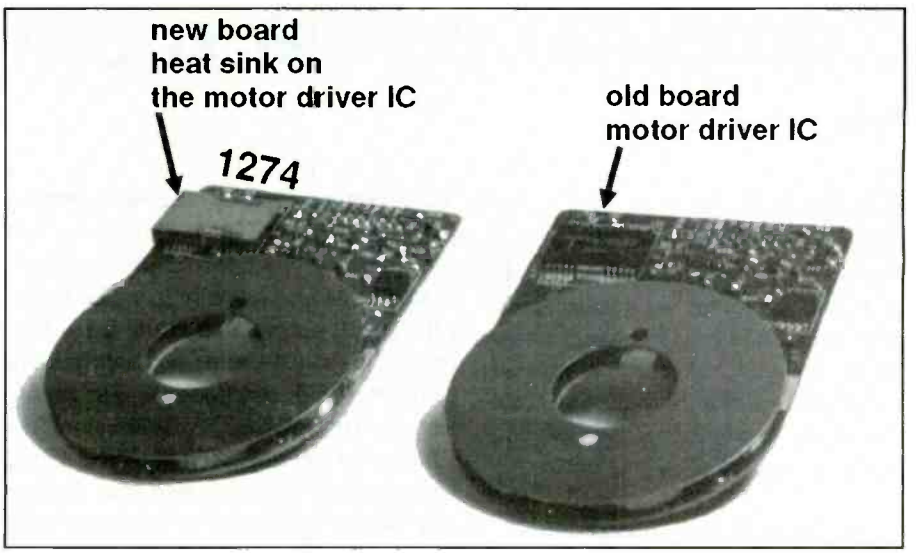


Figure 9. The old and new drum motor board of the VS-565U.

Computer power supplies—Part 2

By David Presnell

Part one of this two-part article looked at the theory of operation of computer power supplies. This segment will present some common diagnostic procedures and cost effective component level repairs you can make without schematics. It will be difficult, if not impossible, to find service information for most of the foreign power supplies you service.

Determining if the power supply is the problem

When a computer power supply fails, it usually manifests itself in the form of a dead computer. When you encounter a dead computer, check the power cord and surge suppressor. If power is getting to the supply, then check the supply for proper output voltages (usually listed on top of the supply). Also, note if the fan is running. If any of the output voltages are missing (with computer on and supply plugged into all boards/modules), or if the fan is not running, then you have found the problem. You may also note that one of the fuses mounted on the power supply case is blown.

Presnell is owner of an independent computer servicing business and a freelance technical writer.

Removing the power supply

Once you have determined that the power supply is the source of the problem, unplug the computer and all internal power supply connections, and carefully remove the power supply from the case. Make note of how the P8 and P9 motherboard connectors mount. The black ground wires are always side by side when mounted on the motherboard. Usually, there are four screws holding the supply at the rear of the computer.

Next, locate the screws holding the two-part power-supply case together. Most supplies have eight screws. Remove these screws, and carefully separate the supply case. You may also need to remove the four fan mounting screws on some supplies. Note the location of the fan before you remove it. Most supplies use a fan to draw air into the supply case.

Now plug a dummy load into one of the four-pin female connectors from the red

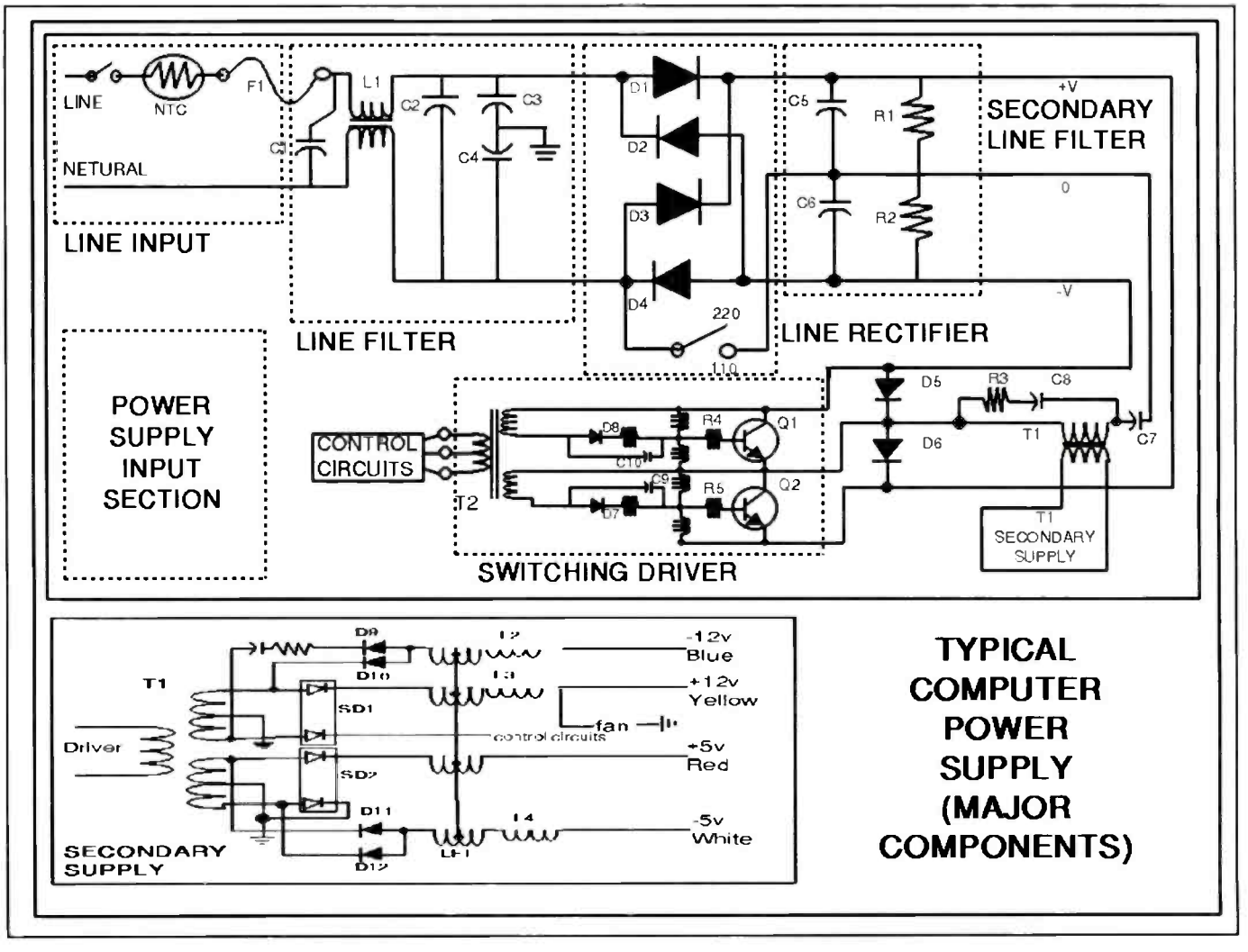


Figure 1. If there is a short circuit in the power supply, check the resistance of the thermistor (marked NTC in the drawing). It should have a reading of less than 100Ω but not zero. The thermistor I tested for this article gave a reading of 8.2Ω.

+5V line to the black ground line on the connector. A 100Ω 1W resistor with male connectors soldered to each lead works well for this. If you leave the supply on for long periods, this resistor will become very hot—so be careful.

Testing the supply

Once you are inside the supply and have a dummy load installed, test the continuity of the fuse (usually soldered to the PC board) with a meter. Don't just look at it; check it with a meter.

If the fuse (usually 5A, 220V) is blown, you can try another fuse. A blown fuse may be the only problem. If this one blows, then you probably have a short in the input section of the supply.

I use what I call a short lamp in such cases to save on fuses. You can make one by obtaining or making a three or four foot three-wire extension cord and wiring a 120V lamp socket in series on one line of the cord about center between the two plugs. You can start with a 60W bulb.

Start by replacing the blown fuse. Plug the power supply into the extension cord. Plug the extension cord into an isolation transformer. Switch on the supply and see if the bulb lights. If it does you have a short on the input side of the supply.

If the fuse blows, try a higher wattage bulb in the short lamp. The operation of the short lamp is simple. Since the bulb is wired in series on one wire of the extension cord, a short in the supply closes the line side to the common or ground side and causes the bulb to light. The current into the supply is limited by the resistance of the bulb, so it doesn't reach a value high enough to cause the fuse to blow. Many of you may already have a short lamp on your service bench.

Locating a shorted input

Once you have determined that there is a short circuit in the power supply, remove power to the supply. Remove the screws (usually four) holding the PC-board to the case. Locate the ac lines coming into the board. Locate the NTC (negative temperature coefficient) thermistor coming off one leg of the ac line.

Perform an in-line resistance test of the thermistor. At room temperature, the thermistor should have a reading of less than 100Ω, but not zero. The thermistor that I tested for this article gave a reading of 8.2Ω (Figure 1).

Next, check the continuity of each coil of L1, a small inductor close to the fuse and thermistor. It has two coils and four leads. Each coil should show continuity through the coil, but the coils should be electrically isolated from eachother.

Next, hook the meter's negative lead to the PC-board input ground (usually the mounting hole close to the fuse). Check capacitors close to this ground. Only one lead (possibly none) should be shorted to this ground.

If all components are showing a short to ground, then locate the rectifier. This may consist of four input rectifier diodes or a four-pin bridge rectifier chip. Desolder and lift up the input side of the diodes one at a time (or remove the bridge rectifier), and recheck for short with the short lamp.

If the short is gone, you have located the problem. Replace the four input rectifier diodes or the bridge rectifier. If this does not resolve the short, then desolder one at a time, the large 200V, 220µF input capacitors (usually two) and see if the short remains. If this removes the short, replace both capacitors at the same time.

Check the two large resistors (R1 and R2 on Figure 1) in the same way. If you still have not located the short, check the few other remaining capacitors and resistors on the input section in the same way.

If after this, the short still remains, you probably will do well to replace the supply. The cost of further isolation of an input short will not be cost effective. The above procedures, however, will have fixed a short most of the time.

When the fuse is good

If you find that the fuse is good when you go inside the supply, then make sure that the dummy load is installed as described earlier. Also make sure that the PC-board is mounted into the case and the green ground wire is firmly attached to the wall of the supply case. Check all of the internal wires and make sure none have come loose or burned in two.

Always use your senses while checking the power supply. Look for burned or damaged parts. Listen for burning and cracking sounds. Feel suspect parts to see if they're overheating and causing the switching supply to shut down. Set your DMM to read 300Vac. Connect the black negative lead of your DMM to the metal power supply case. Apply power to the supply and carefully probe (with the red positive lead of your DMM) the 120Vac line coming from the ac plug on the side of the case. Follow this line through the switch and to the board to be sure that power is reaching the PC-board.

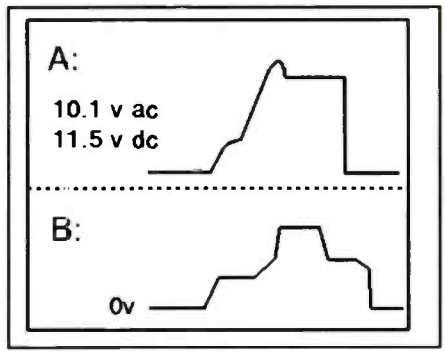


Figure 2. Waveforms can reveal a lot about the health of the circuit. The waveform at the rectifier diode heat sink should look like waveform A. The waveform at the emitter lead of the power amplifier (usually the equivalent of an NTE379) should look like waveform B.

Carefully probe each lead of diodes D1 to D4 (Figure 1), or bridge rectifier leads to be sure you have 120Vac at these points. If not, then look for an open resistor, capacitor, thermistor, L1, or possibly a burned trace on the circuit board.

If all is well at this point, check for proper voltages at the power supply output connectors if you have not done so already. If no voltage is present on one or all connectors, disconnect power and check for open windings at the leads of T1, the larger transformer, and T2, the smaller transformer, (Figure 1), or a short between input and output sides of each transformer. If either transformer is faulty replace the supply.

If the transformers seem to be sound, locate any 78xx or 79xx voltage regulator chips (Figure 1 has a 7905, -5V regulator) usually mounted on an upright heat sink. Remove them from the circuit and test as follows. With a DMM set for diode check, test E to C, then reverse leads and check C to E. Then test B to E both ways, then B to C both ways.

The E to C test should show open both ways. The B to E test should show open only one way and a reading of around 0.500 to 0.800 the other way. The B to C test should show a reading of 0.500 to 0.800 one way and open the other way. In many cases, you can determine the pin layout by looking on the PC-board or looking the chip up in a semiconductor replacement guide.

At this point, you may wish to replace the supply if you have not yet found the problem. But for those of you who have the time and a good oscilloscope, you can dig a little deeper.

Diagnosing the switching circuit

Connect your oscilloscope common lead to one of the dc output ground leads. With the scope set for 0.2mV/div and 0.1ms/div, connect the probe to dc outputs +5V and +12V, and check for an ac ripple. You should not see any ripple with the scope at these settings.

If you observe ac ripple here, check the two large rectifier diodes (usually standing upright on a large heat sink) where they are soldered to the heat sink. You should observe a waveform similar to that shown in Figure 2, Waveform A. This point should also show around 10Vac and 11.5Vdc voltages. If either is significantly different from these values, remove the diodes and test them with your DMM (D5 and D6 on Figure 1).

Next locate and check the TO220 NPN power amp (usually the equivalent of an NTE 379) located on a large heat sink mounted either by itself or close to other larger three-pin chips. On this one, the NTE 379, the lead on the left side of the transistor (when you're looking at the side where the printing is) is the base, the middle lead is the collector, and the right lead is the emitter.

With power off, connect the oscilloscope probe to the right facing lead (emitter). Make sure that this probe is not touching any other leads. If it is, you will burn out the NTE 379. With the scope set to 5V/div and 5µs/div, apply power. Carefully adjust the trigger and you should see something similar to waveform B in Figure 2 at a frequency of around 27.9KHz.

Turn the power off to the supply, hook your probe to the middle lead (collector), and set your scope to 5V/div and 2ms/div, then turn the power on again. You should see dc superimposed on a good ac sine wave. My scope indicated 121.1Vac and 165.9Vdc at this point. Next, hook the probe to the left facing lead (base). With the oscilloscope set as above, you should see a good ac sine wave. If the waveform or frequency is off, then desolder the NTE 379 power amp and test it as outlined above for the voltage regulator.

Locate the LM339N IC linear voltage comparator (equivalent to NTE 834) found on most power supply PC boards. Refer to a pinout chart in a semiconductor replacement guide of IC's mounted on the PC board. First, check for a short from pin 3 (V+) to pin 12 (gnd). Power up the supply and check for +5Vdc at pin 3 (V+), and pins 9, 14, 15.

Pins 5, 6, 7, 8, 10, 11, 12, and 13 should show up to 3Vdc and up to 1.5Vac or less. If the chip seems suspect, then try a replacement. If this does not fix the problem, then carefully check the traces coming to the pins for faulty readings associated with other parts.

You will usually have an IC that is equivalent to the NTE1729 chip on the PC board as well. This IC is a pulse width modulator control circuit. It and its related components replace the older style control module often mounted on a separate PC board and encased in epoxy. Refer to an IC pinout in a semiconductor replacement guide.

Check pin 13 (V_{cc}) for 25.2Vdc and 0Vac. Also, with power off, check pin 7 (gnd) and pin 13 (V_{cc}) to see if there is a short. Check pin 5 for a good sawtooth waveform with the oscilloscope set at 50mV/div and 20µs/div. By referring to a semiconductor replacement guide you can also check other pins on the chip for proper operation.

Summary

Most computer service manuals will give you hundreds of pages of theory and only a page or two of technique. With computer power supplies, you will find much information on how they work; but when it comes to servicing them, you will read something along the lines of, "If the supply does not have a +5Vdc output then replace the supply." Why teach the theory of how the supply operates only to finish by telling the reader to replace it when it breaks?

Cost of repair is certainly something to consider when a new supply can often be purchased for less than a hundred dollars, but I've opened the case on many power supplies to find that the only problem is a couple of burned out input rectifier diodes and a fuse.

Repair time in a case like this is about 10 minutes, and the cost of parts is less than $2.00. Replacing this supply would have cost the customer about $175.00 or more at many service centers, and would have taken only a little less time than repair. Repairing it would have cost the customer your minimum bench fee plus parts; (around $85.00). Now which would have given you a higher profit margin?

Power supply servicing can be very rewarding at the bottom line, and in reducing the cost to your customer; something you must keep in mind, because customers can always say "no" if they feel that the cost of servicing is excessive. ■

ES&T Calendar

January 6-9, 1995
1995 International Winter Consumer Electronics Show (CES)
Las Vegas, NV

April 7-9, 1995
1995 Mobile Electronics Show (MES)
Philadelphia, PA

May 11-13, 1995
CES Interactive '95 and 1995 Personal Communications and Computing Show (PCC)
Philadelphia, PA

A pair of improvised adapters

By Roger D. Redden

If you own a TV test jig but often can't use it to help repair a TV because you don't have the correct adapter, the ideas presented here may be useful, particularly if your jig is a Sylvania CK300.

If you don't own a jig, some of the advantages and disadvantages of using one, which are listed below, might help you decide if a used one would be worthwhile. I searched a number of catalogs without finding any new jigs listed for sale. They may, however, become available again.

Although jigs are fairly reliable, they can have problems. During the time that I've owned my jig, I've replaced the CRT (arcing), the HV divider network (focus blurred), and made repairs to the cables and adapters. The possibility of needed repairs, compounded by the fact that parts to make repairs may not be available, is something you should keep in mind if you decide to purchase a used jig.

What's in a jig?

For those not familiar with these jigs, they basically consist of a substitute CRT, yoke and speaker. An autotransformer that can be interconnected in different ways alters, or programs, the jig's yoke impedance to match the impedance needed by the chassis under test. A high-voltage meter mounted on the front of the jig indicates the amount of high voltage produced by the chassis, and an internal voltage divider provides focus voltage for the jig if the focus voltage from the chassis is too low or too high for the jig's CRT. Extension cables from the jig allow the chassis being worked on to operate about three feet from the jig, and adapters connect these cables to different chassis.

Advantages and disadvantages of using a test jig

A test jig allows one person to bring the chassis of a console set to the service center for service and, as a side benefit, avoids the possibility of damaging the set's cabinet during transport. On the negative side, a technician may spend up to an hour or more removing and re-installing a chassis if it's difficult to gain access to the tuner, control panel, remote receiver, LDR, and various connectors. In addition, if there is a problem in the CRT, yoke or speaker left in the cabinet at the customer's home, an extra trip may be required to complete the repair.

Once the chassis is in the service center, the next advantage of a jig is evident. It's much easier to work on a chassis that sits on a bench: you don't have to bend down, the chassis can be positioned for easy access to the circuit boards, and the light is normally better.

Two minor drawbacks accompany these advantages. There is often a slight blurring of the video caused by the CRT extension cable, and on some chassis there is distortion of the raster's height or width because the yoke in the jig is not perfectly matched to the deflection circuits of the chassis. If there is a defect in the chassis in either of these areas, finding it may be more difficult when the chassis is operated on the jig.

A final, but marginal, advantage of the jig is that it may occasionally be useful when servicing a portable set if the cabinet of the set prevents reasonable access to the chassis and short leads from the yoke or CRT prevent moving the chassis to a more convenient position. But fortunately, the chassis of most modern portables are fairly accessible, and time would be wasted hooking them to the jig.

Two persistent disadvantages of the jig are the setup and the adapter problems. The information in the setup book, which shows the programmer plugs and adapters to use with each chassis, is often one to three years behind the latest chassis on the market. And even with a shelf full of adapters, the ones needed for this particular set may never have been purchased, or may not be available.

Help for the missing-adapter problem

If a test jig is used often with a particular chassis, there is no question that the exact adapters save time, irritation and errors. But for those one-time or rare occasions when a chassis needs to be connected to the jig, universal adapters, such as the ones described here, often can do the job.

The adapters described are for the Sylvania CK3000 test jig, the one with which I am most familiar, but the principles probably can be adapted to other jigs.

Figure 1 shows a simplified schematic diagram of the yoke, autotransformer, and yoke extension cable in the CK3000 jig, re-drawn from the schematics in the instruction manual. Only one of the possible ways of connecting (programming) the autotransformer is shown. Missing yoke programmer plugs can be made using octal plugs from the yokes of older discarded TV sets, wired as shown in the CK3000 manual.

The point to note on the schematic of Figure 1 is that regardless of how the yoke is programmed, the connections to the horizontal yoke in the jig are always to pins 4 and 6 of yoke extension cable B207. I suspect that the horizontal yokes of other types of jigs also connect to a non-varying set of pins on the yoke extension cable, but I have no other types of jigs available to verify that.

The yoke programmer plugs control the impedance of the horizontal yoke in the jig; the adapter, added to the extension cable, determines which pins of the extension cable, and thus the jig's yoke, get connected to which pins on the chassis' yoke connector (plug or socket).

By using an adapter with a set of leads that can be soldered or clipped to the yoke connection points of the chassis (usually the circuit board foil under the yoke plug or jack), the jig can be connected to a wide variety of deflection circuits. Figure 2A is a drawing of an octal tube socket wired as a universal adapter for use with the B207 extension cable of the CK3000. The jumper between pins 7 and 8 connects the vertical yoke coils of the jig in series. The leads from the other lugs of the socket, which should be labeled as horizontal and vertical, go to the chassis, using the schematic of the TV to determine the connection points.

Coping with toroid yokes

The use of toroid yokes in TV sets added another complication to matching yoke impedances. The inductances of the vertical coils of these yokes are drasti-

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

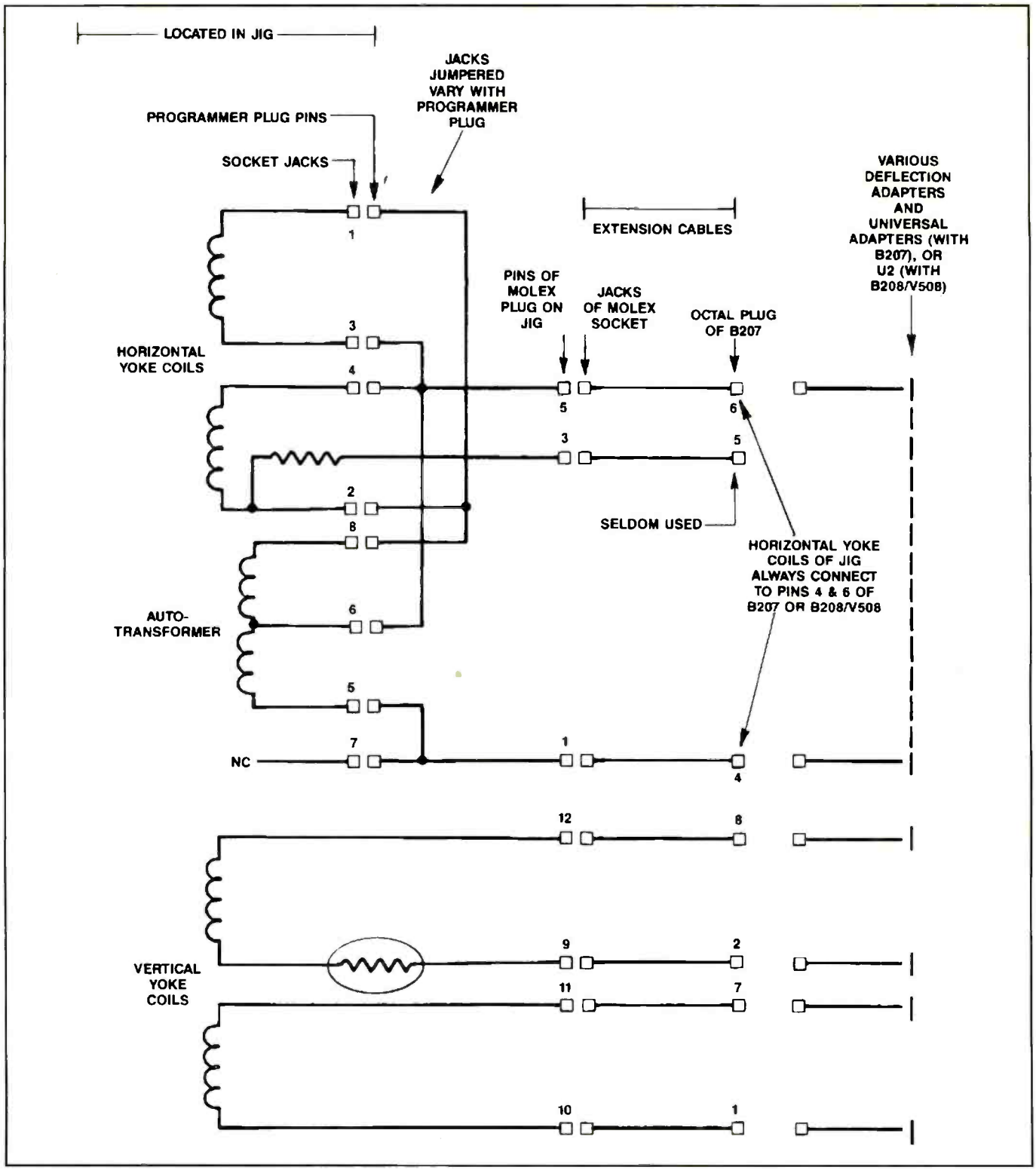


Figure 1. This schematic shows the yoke interconnections for the CK3000 using one programmer plug. The horizontal yoke connections are always to pins 4 and 6 of B207 or (not shown) pins 4 and 6 of V508 after it connects through B208.

cally different from those of other yokes, requiring that another autotransformer be added to match the impedances of the jig's vertical coils to the chassis. Figure 3 is my reverse engineered schematic of the V508 autotransformer for use with the CK3000. The horizontal coils of the yoke are not shown since they are unchanged by V508, which simply connects them through on pins 4 and 6.

Depending on which end of autotransformer V508 is turned toward the TV chassis, the total vertical inductance of the jig becomes 1.2/1.9mH or 65mH. Figure 3A shows the 1.2/1.9mH end toward the chassis, while 3B shows the 65mH end toward the chassis.

Note that when the 65mH end is toward the chassis, pin 1 of V508 connects to pin 8 and pin 2 connects to pin 7. Pins 1 and 2 are the jig's vertical yoke input. But the

Continued on page 41

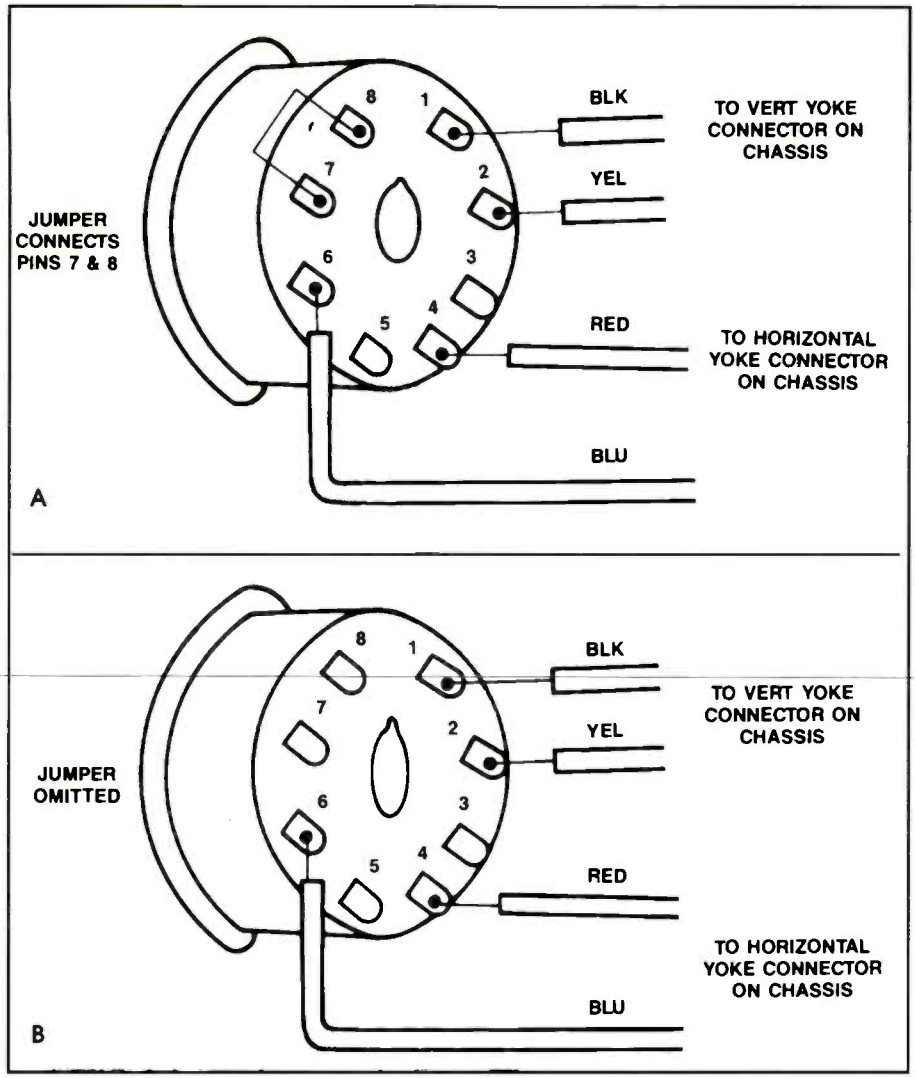


Figure 2. This drawing shows the wiring of universal sockets U1 and U2. Figure 2A is the universal yoke adapter, U1, for use with B207. Figure 2B is the universal yoke adapter for use with V508.

universal adapter shown in Figure 2A (U1) had pins 7 and 8 jumpered together. If that adapter is used here, there will be a short across the vertical output of the TV chassis, almost guaranteed to produce a small disaster.

To prevent such a disaster, we need a second universal (semi-universal?) adapter. Such an adapter is shown in Figure 2B. As you can see, it is identical to the adapter of Figure 2A, except that the jumper between pins 7 and 8 is omitted. While a single adapter could be made having a jumper between pins 7 and 8 that could be connected or disconnected, the odds of the technician eventually forgetting to disconnect the jumper while using V508 seem high.

By using two adapters and labeling the one shown in 2A "U1, use with B207" and the one shown in 2B "U2, use with V508," there is less chance of an error. To further help avoid carelessly interchanging adapters, I normally leave U2 connected to V508 all of the time since I have no other adapters for use with V508. (Extension cable B207 ends in a plug. When using V508, B207 is replaced with B208, which ends in a socket which will accept either end of V508).

Miscellaneous hookup notes

Some chassis require a B+ jumper, or interlock, between certain pins of the yoke plug. A few older chassis need a resistor or capacitor added to the vertical yoke circuit to work properly. A close look at the yoke circuit on the schematic should show you if additional connections are needed.

Since yoke plug and socket numbering can be confusing, it helps to note on the chassis plug or socket where a B+ jumper connects to before removing the match-

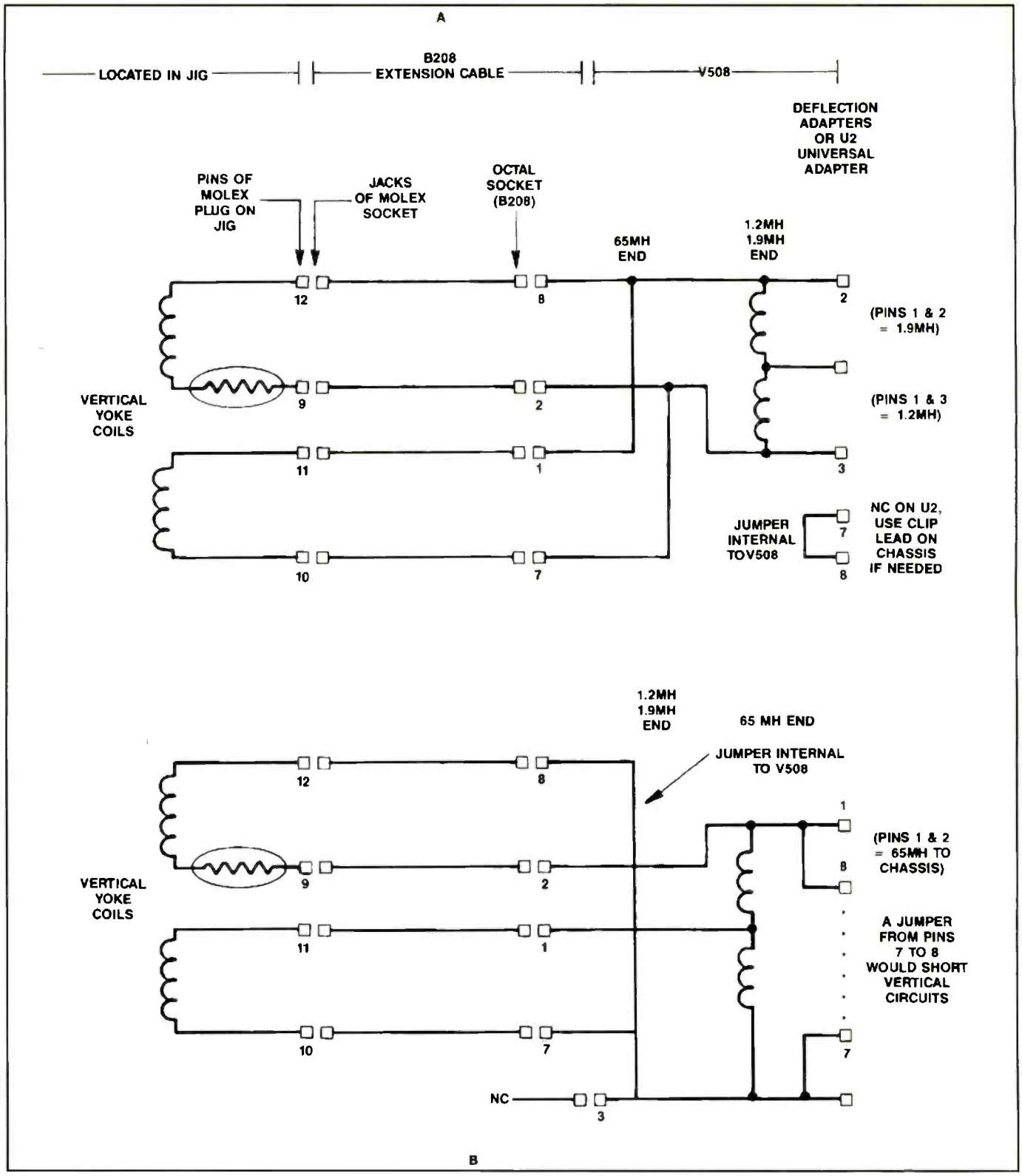


Figure 3. These schematic diagrams show how the connections to V508, an autotransformer used to match the impedance of toroid yokes, change when V508 is reversed. Figure 3A shows the connections of V508 with the low-inductance end toward the chassis. Figure 3B shows the connections of V508 with the high-inductance end toward the chassis.

ing yoke connector. It also helps to note where each color of yoke lead connects. Usually, the horizontal yoke leads are blue and red, while the vertical leads are black, green or yellow. Knowing which color of lead connects to which pin or jack on the chassis can help you double check the plug or socket numbering. On round plugs and sockets, count clockwise from the wiring end of a socket or the pin end of a plug.

If, after you do a final check of the jig connections and power up the set, the picture on the jig is backward, reverse the connections of the horizontal leads from the universal adapter to the chassis. If the picture is upside down, reverse the connections of the vertical leads.

When the chassis setup is not shown

Suppose now that not only is the yoke adapter not available, but the setup manual does not list the chassis. Which yoke programmer plug should be used to match the impedance of the chassis? If the set's yoke is available, the horizontal and vertical inductances of the yoke can be measured at the disconnected yoke plug or socket with an inductance checker and then a programmer plug chosen that gives a value very close to the ones measured. The inductances provided by the different yoke programmers are listed in the CK3000's manual.

Hooking up the CRT

If you are desperate, a universal adapter for the CRT can also be used; at least sometimes. A 90-degree CRT socket with 12 leads (14 jacks, 2 unused), taken from an older discarded TV, can be connected to the CRT extension adapter (B230) of the CK3000. The leads of the socket can then be soldered to the set's CRT circuit board or to the board to which the leads of the CRT socket attach when there is no CRT circuit board.

The CK3000's manual shows which pins of CRT extension adapter B230 are grids, cathodes, etc. Label the leads from the corresponding jacks on the 90-degree CRT socket (filament, red K, red G1, green K, etc.). When the chassis being tested has only one G1 (control grid) lead, the three G1 leads of the universal CRT adapter should be soldered to that G1 connector on the chassis' CRT board. Similarly, if there is only one G2 (screen) connection on the chassis' CRT board, all three G2 leads of the adapter are soldered to their corresponding points on the chassis' CRT board.

But the focus connection can be a problem. While the internal focus tap of the jig can be used to focus the jig, the chassis' CRT socket still has 5kV to 7kV on its focus jack. This voltage tends to arc off the focus jack into the air or to any other jack that is near. If the socket jack opening is small and well separated from the other jacks, it may not arc, or one or two layers of black tape over the opening may contain the arc. If the socket uses the bare arched spring connectors that are compressed against the CRT pins when installed, stopping the arc is probably hopeless, short perhaps of covering the pin with silicone, letting it dry, then scraping it off after the repairs are made. But that seems like taking improvisation a step too far.

A source of items for Sylvania jigs

The following is one source of items for Sylvania jigs.

Custom Components Corporation
W224 S8445 Industrial Drive
Big Bend WI 53103
414-662-5266
Fax: 414-662-3781

This company sells adapters, repair parts and supplementary setup manuals (the latest is 1991) for Sylvania CK3000 Jig. Further, I was told that they expect to have new jigs for sale in the near future that will work with big-screen TVs. This should renew interest in jigs, at least among servicers of these mammoth sets.

TV Classics

By John Hanson

A television set that was donated to a local museum didn't work. This was no surprise. Instead of spending money to have the set serviced, the donor opted for a tax receipt. The museum administration asked me if I could restore the set to working condition. After my obligatory tour of the museum, I was shown the TV, which I recognized as a Sony KV1722.

John Hanson is an independent servicing technician and a retired service engineer from a major consumer electronics manufacturer.

Introduced in 1973, this model is a classic in both design and performance. Following RCA's 1970 Model EP506, the first in the XL100 line, the set featured a 110-degree CRT with a slim-

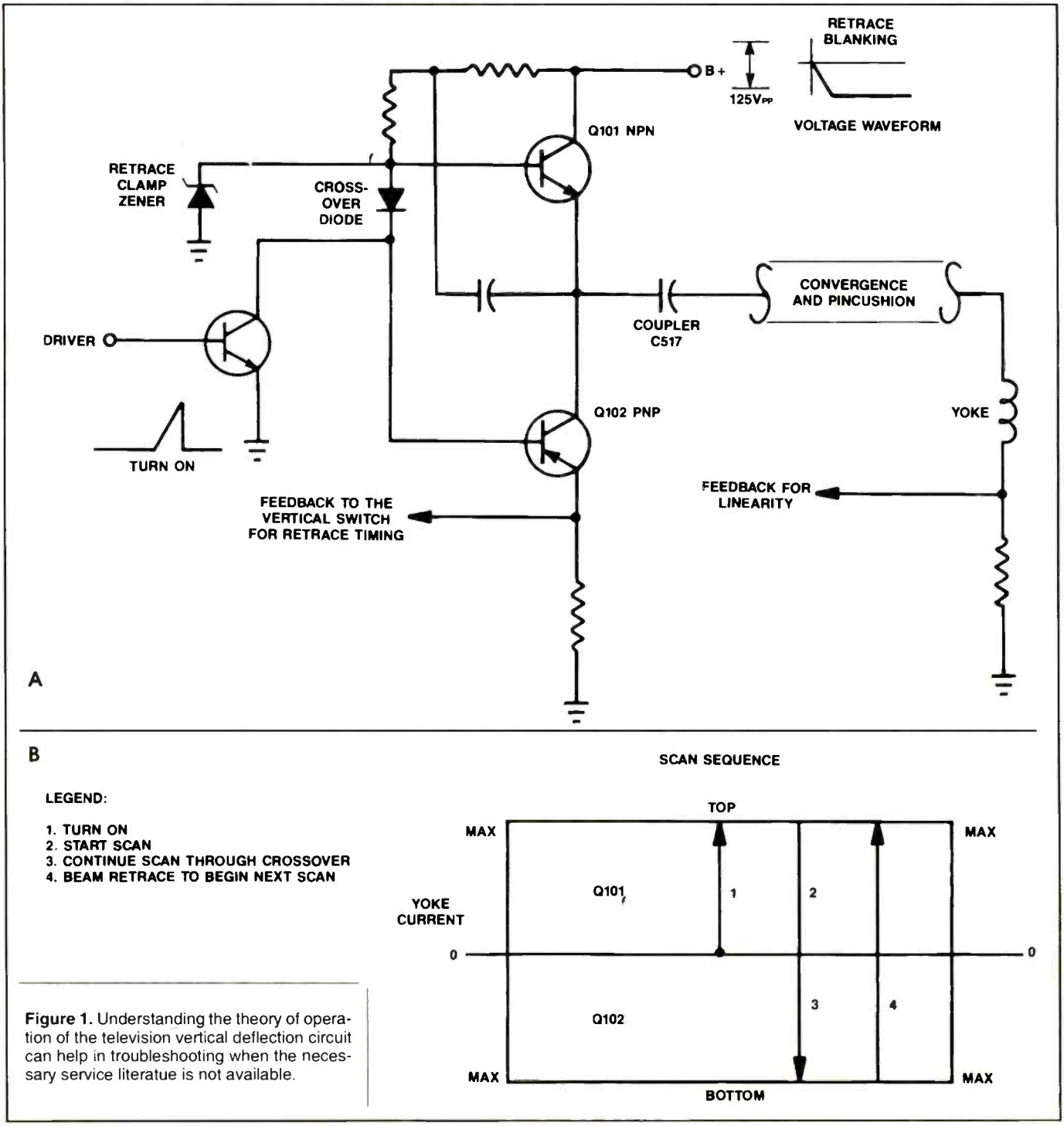


Figure 1. Understanding the theory of operation of the television vertical deflection circuit can help in troubleshooting when the necessary service literatue is not available.

line cabinet profile. RCA refined the modular board concept pioneered by Motorola's Quasar Line, by incorporating 11 customer affordable modules.

RCA marketing strategy had the module service caddies at the distributors in time for the product introduction. A Red Book service guide was included in order to direct the service technicians to the problem module.

In the KV1722, Sony introduced a new pulse-width chopper power supply. Variations of this design would go on to become the world standard for consumer TV design. The 110-degree deflection featured in both the Sony and the RCA required more yoke power than did standard sets. At the time when these sets were introduced, bipolar transistors used for horizontal deflection applications were expensive and unreliable. Consequently, both RCA and Sony chose SCR switching devices instead of transistors.

The RCA set used two SCRs, separating the trace and retrace functions with a tricky timing circuit. Sony opted for a single GCS (gate-controlled switch) originally developed as an industrial switch. Both circuit applications were efficient, providing the yoke with more than ample current, consistent with good high-voltage regulation, thus assuring excellent CRT focus.

Sony's GCS operated in a manner that was the reverse of conventional theory. At turn-on, the device conducted, and was essentially a short circuit across the power supply. A critically shaped and timed pulse from the horizontal driver would cut off the gate, hopefully at the 14µsec duty cycle, or the device would self-destruct, often taking the power supply with it. The failure mode was so fast that no fuse or circuit breaker could save the supply. Technicians unfamiliar with the circuit soon dubbed it the kamikaze circuit.

Servicing was a problem

During the years these designs were in production, both RCA and Sony conducted numerous training seminars with the intent to gain the confidence and loyalty of the servicers. Time proved both circuits to be too costly in terms of both in-warranty service and customer complaints. This was a case of classic design that worked well on paper, but whose tight circuit parameters negated practical servicing in the field.

RCA recommended the use of a variable isolated transformer for servicing at reduced line voltage, and developed a technique that allows technicians to service the trace and retrace functions separately. Sony servicers were advised to cold service the chassis using an external 18V, 2A power supply. Techs who ignored the advice often would have the replacement GCS fail immediately, or worse yet, about two weeks after an expensive repair.

This situation eventually led some techs to say "Sony sets are great, but if they break, you can't fix them." This irresponsible statement was made in spite of the fact that they had the best picture on marginal cable TV signals and were obviously superior as VCR monitors.

Evaluating the condition of the museum TV set

Enough for the history lesson. Let's get back to the museum TV set. I was surprised to hear a rush of sound as I plugged in the 20-year-old set. The power supply was working even though the screen was dark. Slowly advancing the brightness control I could make out a thin white line across the screen. I had horizontal sweep, high voltage, and from the sharpness of the focus on the white line, probably a good Trinitron picture tube. "There's hope," I said as I left the museum with the TV set.

Figure 2. Sony's classic Model KV1722 featured a 110-degree CRT and a slim profile. The horizontal deflection circuit of this set is based on a single gate-controlled switch.

On my service bench, with the antenna connected, I heard sound on all channels; another big surprise. At this point it was off with the cabinet to troubleshoot the vertical deflection circuit. With no schematic, I would be working at a disadvantage. The KV1722 was beautifully laid out for troubleshooting, with plenty of test points in view on all three of the circuit boards.

No provisions for board replacements were planned, so all service would be down to the component level. In subsequent models, Sony would design sets with plug-in modules, but only to facilitate production; not for service. Zenith remains the only manufacturer who has consistently over the years made service modules available to the trade.

Troubleshooting

Before starting to troubleshoot, I remembered that this set has a hot chassis, and plugged the TV into my line isolation transformer; an important consideration if you value your test equipment. Forgetting could come as a shock to you. Forget the pun and do it.

Locating what I surmised to be the vertical output transistors, I measured the B+ on the collector case, then measured the emitter voltage. The emitter voltage was about half of the voltage at the collector, so I reasoned that the transistors were conducting in proper class B fashion. No dc problem was indicated at this point. I had narrowed the problem to the yoke, convergence or pincushion circuit. It was either an open or an ac coupling failure.

I remembered a problem with capacitors in old Sony sets. For some reason, the caps just dry out and become slightly resistive (200KΩ typical). Unfortunately, in low-impedance circuits the capacitors can't be tested in circuit. I wondered if bridging a suspected capacitor with a known-good one of the same value would provide me with any useful information.

I looked around and located a capacitor near the output devices with the highest voltage rating (C517, 22µF, 160V). I

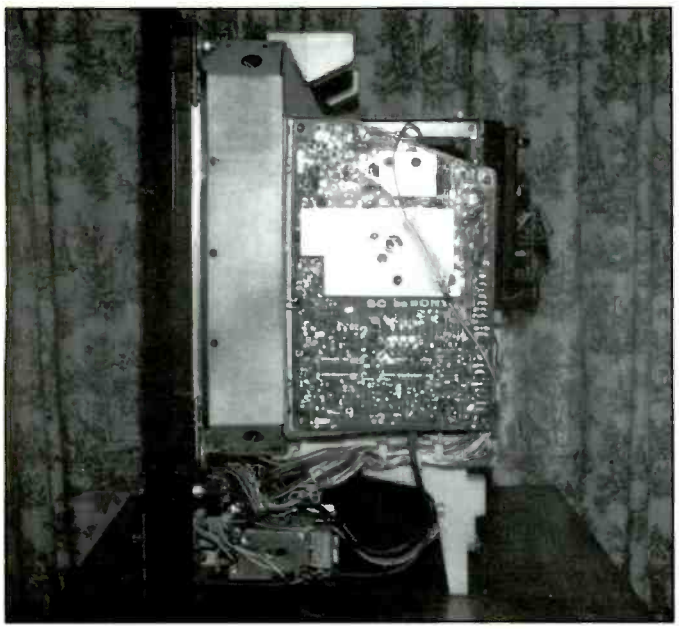


Figure 3. The 110-degree CRT allowed Sony to produce a TV with a large screen that had a slim profile.

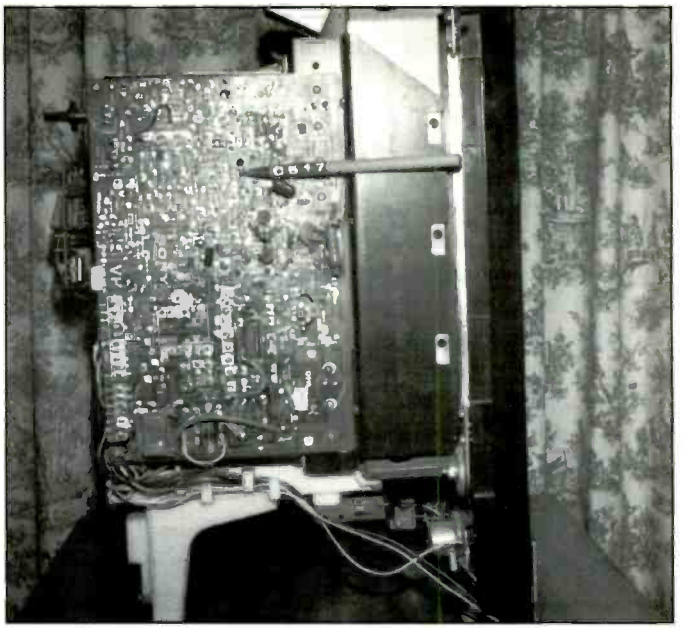


Figure 4. The absence of vertical deflection in this set was caused by a defective capacitor, C517, indicated by the horizontal pointer in this photo. Note the lbel on the pointer that says C517.

bridged this cap with a replacement and was delighted to see the white line on the screen disappear. I turned up the brightness, and voila! I saw a perfectly scanned Vanna White flipping her letters. Removal of the bad capacitor and installation of a replacement component completed the service procedure.

Why did I luck out on the servicing of this set? I do have a working knowledge of how vertical deflection works. That helped. The rest, you might say, was pure luck. For those of you who have forgotten, I offer the following description of the vertical deflection of this chassis.

The ups and downs of vertical deflection

Think of the vertical deflection circuit as a one note audio amplifier operating near 60Hz, and brought up to exact frequency by a synchronizing signal (Figure 1). The yoke reflects back a load impedance similar to that of a speaker voice coil. Both circuit applications depend on feedback to cancel distortion and to maintain linearity. The value of the coupling capacitor is selected for the maximum power transfer. The principal difference between the audio amplifier and the vertical deflection circuit is that the input for the one is the frequency range for audio and the input of the other is the retrace pulse for TV.

Accurate retrace timing is essential to both sync and interlace. The timing begins with the sync starting the cycle. At turn on, the beam moves from the center to the top at a linear rate. Both the NPN and the PNP vertical output transistors are progressively driven less positive during this interval. Current flows from ground up through the yoke and the conducting Q101 to charge the coupling capacitor. At this time, the voltage on the capacitor is at maximum. The current is 90 degrees out of phase. As the scan passes from the center down, the capacitor discharges current through the yoke and the conducting PNP, Q102.

With this rudimentary explanation, you can see why my first choice for a component failure was the coupling capacitor. It's a good candidate whenever the circuit appears to be operating in a dc mode. This is a rather common failure in TV sets, but rare in audio amplifiers. The only reason I can offer for this disparity in failure rate is that for audio the frequency is random with no constant current demand. Another effect that may account for more frequent failure of capacitors in the vertical deflection circuits of TV sets is that the vertical retrace peak contributes to capacitor failure. The only exception for audio would be a guitar amplifier where the musician plucks on one string repeatedly at full power.

Vertical troubleshooting

Assuming the absence of dc problems, open diodes and capacitors will be the likely culprits if a TV set has no vertical deflection. As capacitors age they become less efficient and the power transfer suffers. The symptom is the same as turning down the vertical size, a linear reduction in picture size.

If the reduced scan is accompanied by a loss of linearity, suspect the feedback capacitor from the yoke going back to the vertical driver. This is the Miller capacitor, which maintains picture size and linearity with changes in the power supply. Another feedback loop is the sample from the high-voltage block that tracks both vertical and horizontal size with changes in the CRT beam current.

If you have a normal full-sized linear scan with a pairing of the scan lines in the center, suspect an open crossover diode. There may be more than one diode connected in series. The purpose of this diode is to hold the PNP transistor (Q102) exactly at cutoff and not in reverse bias. This allows for a smooth transition of conduction from the NPN to the PNP device.

Summary

Service technicians are often required to service and estimate without schematic diagrams. In order to be cost effective, we can't afford to spend time on repairs that can't return a profit. Learn how to make fast checks and charge for estimates. You are selling a valuable product: your time. ■

Test Your Electronics Knowledge

Waves, meters and a law

By Sam Wilson

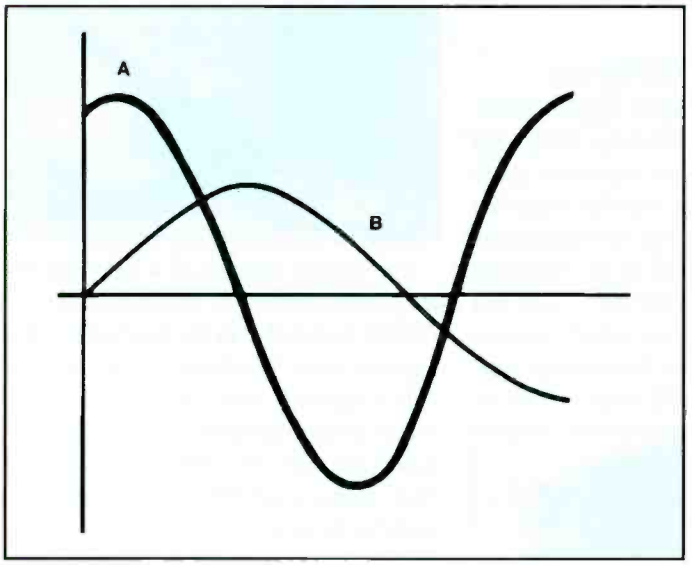


Figure 1

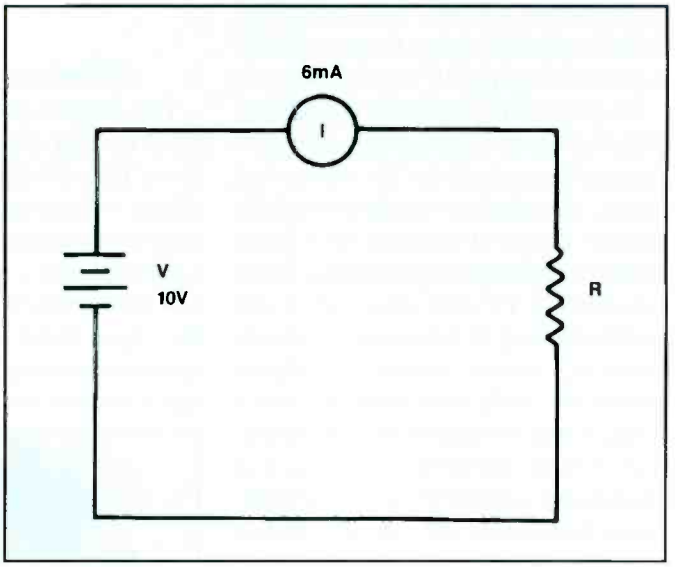


Figure 3

1. The period of a certain radio wave is 0.0000001 second. What is the wavelength in feet?

2. What is the name of a meter used to measure work per coulomb?

3. Refer to Figure 1. Which of the following statements is correct?
A. Wave A leads Wave B.
B. Wave B leads Wave A.

4. What is the name of the block with the question mark in Figure 2?

5. Is the following statement correct?
Class A amplification has a higher efficiency than Class B amplification.
A. Correct
B. Not correct

6. The unit of conductance is
A. the daraf
B. the MHO
C. the gorun
D. None of these choices is correct.

7. What is the name of the meter that measures energy?
A. Phasor
B. Watt-hour meter
C. Z angle meter
D. Energy meter

8. Which of the following is a preferred value of resistance?
A. 5.4K
B. 5.5K
C. 5.6K
D 5.7K

9. A power ratio of 10 to 1 represents a power gain of
A. 0.1dB
B. 1.0dB
C. 10.0dB
D. 100dB

10. Correct this sentence:
According to Watt's Law the power dissipated by the resistor in the circuit of Figure C is 0.06W.

Wilson is the electronics theory consultant for ES&T.

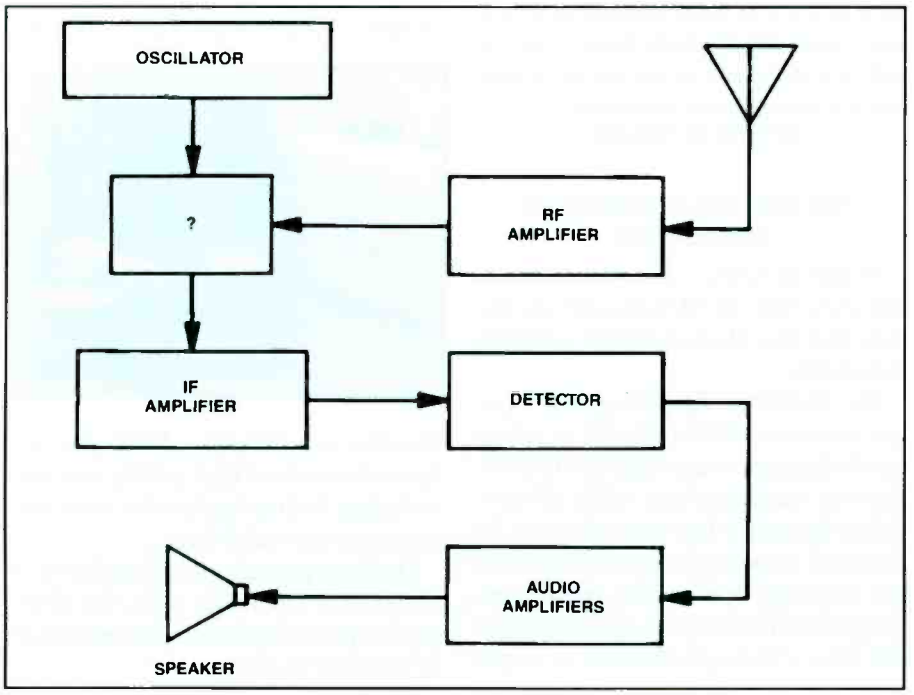


Figure 2

(Answers on page 62)

Products

Signal generators for TV/video service

Fluke Corporation introduces three new models in its PM 5410 TV signal generator line. The new units incorporate BTSC compliant signals for testing MTS stereo/SAP equipped TV/video products.

The new testing capability provides 25 different signal combinations and three preprogrammed modes for convenient testing, adjusting and troubleshooting the decoder section of products that support the BTSC standard. The functions speed and simplify TV and video testing and troubleshooting by television set manufacturers, service centers or depots around the world who build or service products that incorporate the latest functions of many television systems, such as closed caption and MTS stereo/SAP. Other new features recently added to the line include test patterns designed for 16 x 9 wide screen television, Y/C video outputs for S-VHS and Hi-8 recorders, VPS/PDC for automated video recorder operations, and teletext functions for information delivery systems in use worldwide.

Circle (60) on Reply Card

Device for cleaning potentiometers

P. K. & Associates introduces the Guzintah, a device that aids in cleaning potentiometers. To use this device, first thread the correct cleaning device onto the potentiometer that needs cleaning, then attach the small tube from the cleaning device to any chemical spray cleaner and spray several times. Disconnect the tube from the spray canister and unscrew the cleaning device from the potentiometer. After it is removed, rotate the potentiometer shaft several times to get maximum cleaning effect.

The device will internally clean the resistive element and wiper of the potentiometer. Different thread size potentiometers will require different thread size cleaning devices. The company can supply any thread size required in unified or metric thread.

Circle (61) on Reply Card

Video generators

TEAM Systems offers the UNI VG-5000pc Series of PC-Based Programmable Video Generators with such features as: pixel (dot clock) frequencies to 220-MHz, full pattern creation, simple Windows interface, full programming of timing, and sync and output level.

Circle (100) on Reply Card

Digital static field locator

The compact handheld Digital Static Field Locator (TI-400) from *Richmond Static Control Services* measures static charge voltage up to 2 inches from the material being tested. The TI-400 features a red light with a center focus mark that sets the distance between the TI-400 and the object being tested, which insures optimum accuracy. The static charge voltage is read on the LED display. One of

two convenient hold switches on the unit can easily slide into position to preserve the voltage read.

An available option, the Ionizer Plate Adapter (PA 400), can slide onto the TI-400. A hole on the Ionizer Plate Adapter is positioned for the red light to be seen through the hole. The PA 400 option measures static energy on the human body as well as ion balance in the air and evaluates antistatic device performance.

Circle (62) on Reply Card

Add-on system extends life of soldering tips

Virtual Industries, Inc. announces an add-on system for Metcal soldering stations that they claim increases soldering iron tip life.

The TMS4000 Tip Management System increases soldering tip life by reducing the amount of time that the tip is exposed to maximum heat, while still providing the proper heat upon demand. As a result of reducing the temperature when the soldering iron is idle, power consumption is reduced, the tip lasts longer, and there is less accumulation of oxides on the tip.

The system consists of a base unit for the power supply box, an electric eye sensor that is installed in the iron holder, and a power cord. Installation to the Metcal unit is typically under two minutes. The sensor in the iron holder detects the position of the iron: "in" when not in use, and "out" when in use. This information is relayed to the base unit control box that controls the amount of power to the soldering iron.

Circle (63) on Reply Card

Universal fiber optic splice kit

Metrotek Industries, Inc. now offers a Universal Fiber Optic Splice Kit, Model KY25US. The kit contains 25 individual tools necessary to prepare single-mode and/or multi-mode fiber optic cable for mechanical or fusion splicing. The tools are provided by major manufacturers and include a cleaner made by AT&T Fitel.

The case is a distinctive fiber optic yellow color made of high quality materials including locking latches for maximum protection and durability.

Designed primarily for general field installation or laboratory work, the kit includes options for fusion splice protectors or mechanical splices.

Circle (64) on Reply Card

Pen oiler features precision applicator

A new pen oiler filled with lubricant containing Teflon that is ideal for maintaining a wide variety of products ranging from scientific instruments to cameras, guns, and fishing tackle is being introduced by *Syon Corp.*

The Lubit-8 Pen Oiler is filled with a blend of natural and synthetic oils containing microminiature particles of Teflon and Fluon held in permanent suspension. Featuring a needle-tip which precisely dispenses lubricant, one drop at a time, this oiler is useful where sprays and oil cans are impractical.

Designed to be clipped to a shirt pocket or carried in a field service kit or other small tool box, the oiler is about the size of a fountain pen. The lubricant is unaffected by -60F to +500F temperatures, is very slippery, resists dust, does not coagulate, and leaves no oily residue.

Circle (65) on Reply Card

Power supply

B&K has designed a high current variable 3Vdc to 14Vdc power supply expressly for continuous duty operation as a substitute for an auto or truck battery. Model 1688 produces nominally 25A maximum at 13.8Vdc continuously, without overheating. (Maximum current output is lower at lower voltages).

The unit is useful for servicing or demonstrating mobile electronics equipment, such as mobile cellular phones and datacom equipment, high power car stereos, and ham radios.

Voltage can be varied from 3Vdc to 14Vdc. Current and voltage can be monitored simultaneously on separate analog meters. Outputs are fully isolated, so either output terminal can be floated or grounded. Line and load regulation are tight (±0.8%) and ripple is low (less than 10mVrms). Two or more supplies can be connected in series or parallel to double the voltage or current output. And to withstand accidental abuse, the supply has reverse polarity protection, overload protection, short circuit protection, thermal protection, and current limiting.

Circle (66) on Reply Card

Customer feedback recorder software

Spectrum Computer Technologies, Inc. announces the release of Complaints Desk for Windows. The PC software helps a business or institution to record, organize, and monitor customer complaints, requests, and suggestions. The new Windows version of the product is based upon the company's DOS product of the same name.

The software allows users to establish complaint, product and service codes tailored to suit their business. Graphs enable the business to display complaints by time period, by complaint type, department or product, etc. This helps spot trends. The query system allows the user to inquire and report on any combination of data fields. An integrated, full-featured word processor enables the user to generate response letters or to create reports that can be routed to the parties responsible for handling the complaint.

Circle (67) on Reply Card

Digital solder station

A.P.E. introduces the EX-685, a digital controlled solder station for critical-temperature, high-capacity production sol-

dering on all surface mount and thru-hole components. A programmable, digital controller regulates the temperature of the solder iron, providing a continuous display of the operating temperature in a clear LED readout.

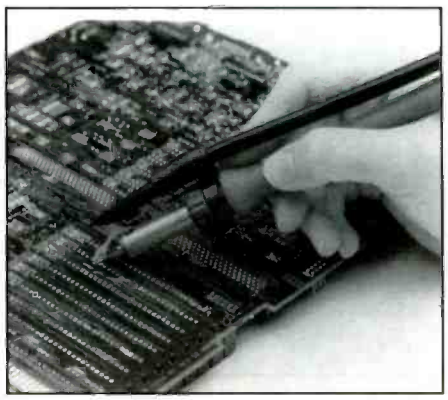
This controller monitors and regulates the temperature at the solder iron tip to maintain a temperature tolerance of ±2F between the actual temperature of the iron and the desired temperature programmed into the controller.

Standard design control features include: high capacity soldering iron with sensor and zero voltage thyristor to minimize transient spikes, digital closed-loop microprocessor-based PID for tight temperature control, selectable temperature range of 300F to 900F, and a programmable security lock to prevent unauthorized changes of preset maximum or minimum temperature limits, timing of heat control and sensor calibration.

Circle (68) on Reply Card

Fume extraction tube accessory kit

Pace, Incorporated announces its new fume extractor tube for the Pace Sodr-Pen Handpiece. The Fume Extractor Tube removes harmful soldering fumes right at the soldering tip, before they reach the operator's breathing zone, without affecting tip temperature. The fumes are then pulled back through a central filtration unit to remove noxious pollutants and return clean air back to the working environment. The tube is composed entirely of lightweight, static-safe materials, is quickly attached to the handpiece and

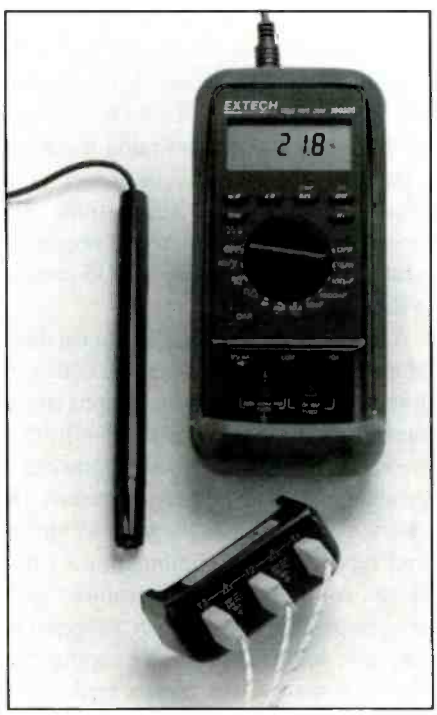


doesn't compromise balance and manipulation during soldering. Due to its flexible construction, the suction tube allows access for soldering components on high density boards. The Fume Extraction Tube Kit comes complete with static-safe extractor tube, flux traps, hose clips and cleaning brush.

Circle (69) on Reply Card

True rms multimeter

Extech's new 40,000 count multimeter (Model 380245) measures ac/dc current/voltage, resistance, capacitance, frequency and, optionally, temperature and humidity (Model 380250K/T). More digits provide greater resolution and the bright LCD display ensures error-free readings and allows data to be read from greater distances. Autoranging, autohold, a null function, audible alarms, and a min/max



mode ensure quick, accurate, and quality measurements. Auto power off saves battery life and the 6-foot drop-proof design (with rubber holster) make for a rugged and feature-packed instrument. The Model 380250-K accepts a combination relative humidity and air temperature probe which measures humidity (a high precision capacitance sensor) and temperature (thermistor sensor). The 380250-T measures temperature from up to three thermocouples with its adapter module.

Circle (70) on Reply Card

IC CD-ROM PLUS for Windows

Hearst Business Publishing/UTP Division, publisher of the IC Master catalog, announces the release of the new IC Master CD-ROM PLUS for Windows and DOS. It provides electronic direct access to technical information on all commercially available integrated circuits and related products.

The new CD-ROM is designed for the 386 and more powerful machines. The newer machines, with more memory, processing speed, and graphics capability, can employ the enhanced and sophisticated search mechanisms.

The Windows version permits device selection by a flexible category search as well as a new keyword search. This ability to select parts by description, with filters . . . such as military temperature, rad hard, and manufacturer . . . make the CD-ROM a valuable tool. The new Windows version features high speed sort and rubber band zoom capability for the manufacturers' data pages.

Both of the CD-ROM PLUS versions contain part identification by device number or base number, with wild card capability. The CD-ROM provides immediate access to the 1994 IC Master Alternate Source Directory, Part Number Index, Military Parts cross-reference, Application Note Directory, Advertisers' Technical Data, Manufacturers & Distributors Directory, and the directory of IC Manufacturers' Data Pages. CD-ROM PLUS for DOS is on the same disk. The DOS version accommodates a broad base of hardware, including the PC-XT. Both versions are available for single and multi-users.

Circle (71) on Reply Card

Will Total Quality Management work for you?—Part 14

By John A. Ross

TQM Point 14

Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

From the traditional viewpoint, good management was defined through delegation and the near-constant monitoring of employee performance. Employees worked to satisfy the needs of the organization. Quality was a characteristic that existed as an end result of the organization reaching its goals. At times, the importance of profit has outweighed the importance of quality and has also outweighed pride in workmanship.

Good management equals participative management

Today, good management and participative management are the same. The key point, *quality*, exists through the cooperation of management and employees. It also exists through the recognition of the human side of business and departments.

Effectively, quality gained through that recognition produces additional and sometimes intangible profits. TQM-style managers have the responsibility for maintaining and distributing organizational resources for the achievement of quality production.

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

This responsibility involves training, the statistical monitoring of organizational processes, the coordination of organizational activities so that no barriers can block the processes, and the realization that a common organizational purpose must exist.

All these responsibilities blend into the overall philosophical objective of implementing a continuously improving process.

Transforming the organization

Transformation for the organization requires an understanding of interaction within the organization. All this begins with a commitment by either top-level managers, or the ownership, to quality. Thus, quality improvement must have the same status as financial improvement or the number of customers.

Without the cooperation and commitment of all levels of management, individual efforts to achieve quality will fail. The transformation occurs when managers cease to look at the organization as a collection of independent parts, but rather as an interactive whole.

Making the units work together

Top management in the TQM scheme has the responsibility of maintaining the cohesiveness of the units. If the units within the organization drive toward goals independently, and have different concepts of the organizational goals, the competition between the units can result in a lack of communication.

In the end, little or no communication between all units of an organization detracts from the best uses of resources, sometimes causes a duplication of efforts, or sends the organizational units in opposite directions.

TQM as an ideal

As an ideal, TQM has all the ingredients that would attract top-level management attention. Every supervisor would like to have an organization in which individuals consistently strive for the best, constantly keep improving, and where empowered employees make decisions. In short, the ideal is a winning team.

However, TQM can fail because of the lack of commitment given to organizational change by top-level management. In some cases, top managers may consider the implementation of TQM as a cost-cutting strategy and withhold support for the approach when the cost benefits do not become evident.

Organizational change is a long-term effort

Complete managerial commitment requires the recognition that organizational change is not a short-term effort. In addition, although empowerment has

rapidly become a cliche, that concept is one fundamental piece of the TQM strategy since empowerment implies trust.

Managers who have little or no trust of their employees or are highly competitive often find empowerment difficult if not impossible. From this perspective, the top-level manager's actions, not his words, carry more weight for the employees.

Actions speak louder than words

The conflict of words versus actions becomes most evident in actual practice and often becomes a factor in the failure of TQM. As an example, I interviewed a school official, call him "Gary," about the implementation of TQM in his district. In this case, the conflict of words and actions of the new superintendent cuts the amount of trust offered by those working within the organization.

In commenting about use of the TQM approach by the new school superintendent, "Gary" said "I haven't found anything to make me trust him yet." From Gary's perspective, the TQM rhetoric of the superintendent about erasing fear and blame from the workplace did not match his actions when challenged. Indeed, the increasing use of, and emphasis on, TQM phrases by the superintendent has increased public doubt about his intentions.

Merger of commitment with the definition of quality

To avoid failure, the commitment of top managers to TQM must merge with the definition of quality. TQM works from the position that improving quality throughout an organization will improve its productivity.

This method builds on the relationship between quality, productivity, costs and profit, and the belief that higher quality results in lower costs. Quality, from the TQM perspective, begins with the consumer and with top-level management. Before any organization can move toward TQM, the management must make a commitment to the process that takes the form of their training about TQM, the decision to hire a TQM consultant, the time taken to draft an organization vision statement and goals, the time taken to draft policies, and tangible resources.

Employee centered leadership

With TQM, the goal of employee-centered leadership is evident. Given his commitment to this goal, the leader is interested in developing a cohesive work group, concerned about the feelings of subordinates, and respectful of the ideas of the employees.

This type of relationship produces mutual trust, respect, and two-way communication. To make the TQM strategy work, top managers must demonstrate a visible commitment to the strategy and to cultural values that denote quality.

Transforming the American management style

While Deming, the initiator of the TQM concept, calls for the transformation of the American management style, that transformation requires the institutionalization of a quality culture. Going full circle, the institutionalism of a quality structure or the institutionalism of cultural change hinges on the capacity of the individual in the leader position to gain the approval of those who make up the culture. ■

COMING NEXT MONTH!

In December, **ES&T** will present several features that will help service technicians get the job done:

Replacement parts/servicing information sourcebook

Locating servicing information and obtaining replacement parts are the two toughest problems faced by consumer electronic servicing technicians.

In the December issue, we will publish a replacement parts and servicing information sourcebook that will provide service companies with several tools to help them overcome these problems.

This sourcebook will contain the following sections that should be helpful to any service center in finding service literature and replacement components, even for those hard to find items:

- A list of recommended references.
- A list of FCC (Federal Communications Commission) ID number prefixes that identifies the manufacturer of any product so labeled.
- A sidebar on how to use the FCC public access system to look up the manufacturer of a product on which you have found an FCC ID number.
- A list of UL (Underwriters' Laboratories) ID numbers.
- A completely revised and up-to-date list of manufacturers with addresses and telephone numbers.

Troubleshooting techniques

Troubleshooting is sometimes a straightforward procedure in which the technician analyzes the trouble symptom then proceeds step by step to a discovery of the cause. Other times, unfortunately, troubleshooting is anything but straightforward.

In December, we will publish some tips, tricks and hints from the master troubleshooters that will help technicians go from problem to solution more quickly and easily.

Test equipment showcase

Test equipment changes rapidly and constantly to keep up with the technology it's built to test. In this showcase, test equipment manufacturers have an opportunity to tell us about themselves and what they're doing to update their products.

What Do You Know About Electronics?

Speed control of a dc motor

By Sam Wilson

The basic motor described so far (See "What Do You Know About Electronics, October 1994) is not without problems. For example, brushes wear down. That is a maintenance problem.

Remember, when a conductor is moved through a magnetic field there is always a voltage induced in that conductor.

In the simple motor of Figure 1 the armature (called the loop in the illustration) is turning in a magnetic field. The same is true for the PM motor in Figure 2. A countervoltage is induced in the rotating armature because it is moving in a magnetic field.

This induced voltage is now called the countervoltage. In the good old days it was called the counter-EMF.

The countervoltage tries to set up a current in the direction opposite to the direction of the armature current. The stronger the magnetic field, the greater the countervoltage. That means if you increase the strength of the field you automatically decrease the armature current.

Here is the punch line: You can control the speed of a dc motor by controlling ei ther the armature current or the field current. Also, you can reverse the direction of rotation of a dc motor by reversing the direction of current in the armature or the field (but not both).

In the illustrations for the various motor windings you can see the effect of varying the armature or field winding current.

Here's an interesting question that relates to this phenomenon: In the early days of slot car racing, enthusiasts would sometimes remove turns of the field windings in their dc car motors. Why?

The answer is that by reducing the field they could get a better top speed.

Electronic and electrical servo controls adjust the speed of dc motors by automatically adjusting the armature or field current, or, by adjusting both.

Why do I say "electronic" and "electrical" servo control? Well, you can control the speed of a shaft driven by any electric motor if you turn the job over to mechanical engineers. They use gears, clutches, chains and belts, and things that go bump in the night. If you are designing an electric car you are likely to run across stuff like that. Mechanical controls are also used in some industrial electronic systems.

There are also combinations of electronic (or electrical) controls and mechanical controls. I'll give examples of these in a future issue. Right now, we will concentrate on controls obtained by electronic methods.

Types of dc motors

We need to look at one more aspect of dc motors before we get back to speed control (we may also want to control the motor torque).

There are two windings in a conventional dc motor: armature and field. There are four ways to connect these windings and those connections determine what you can do with the motor. In some cases you may want to use one connection to get things started. Then, after the motor is up to speed you will change to another.

Here's a surprise. If you are going for an FCC license you may encounter some of this stuff in the questions asked.

The four methods of connecting the armature and field windings of a conventional dc motor are shown in Figure 3. The characteristics of dc motor operation

Wilson is the electronics theory consultant for ES&T.

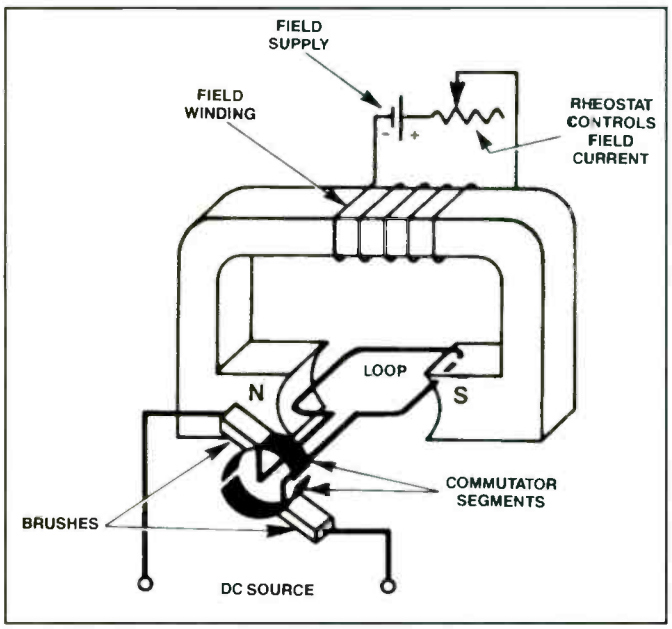


Figure 1. In this simple motor, the armature, called the loop in this drawing, is turning in a magnetic field generated by the field supply.

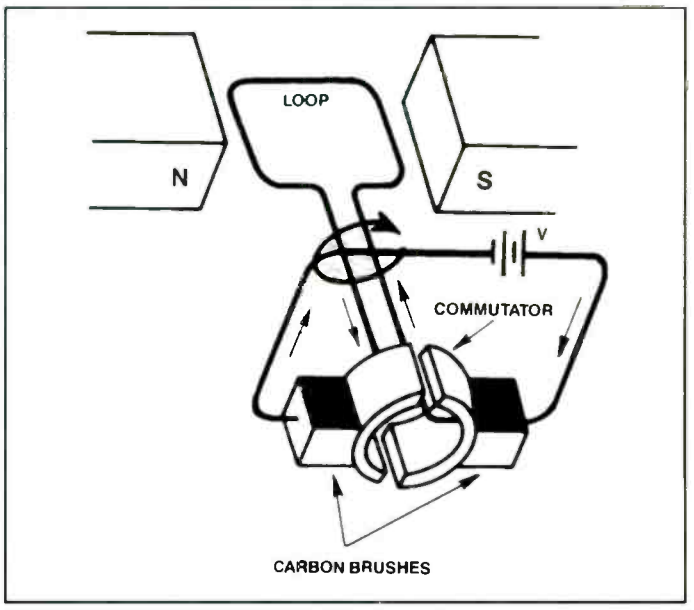


Figure 2. This permanent magnet (PM) motor operates on the same principle as the motor in Figure 1, except that the magnetic field is provided by a permanent magnet, rather than an electromagnet.

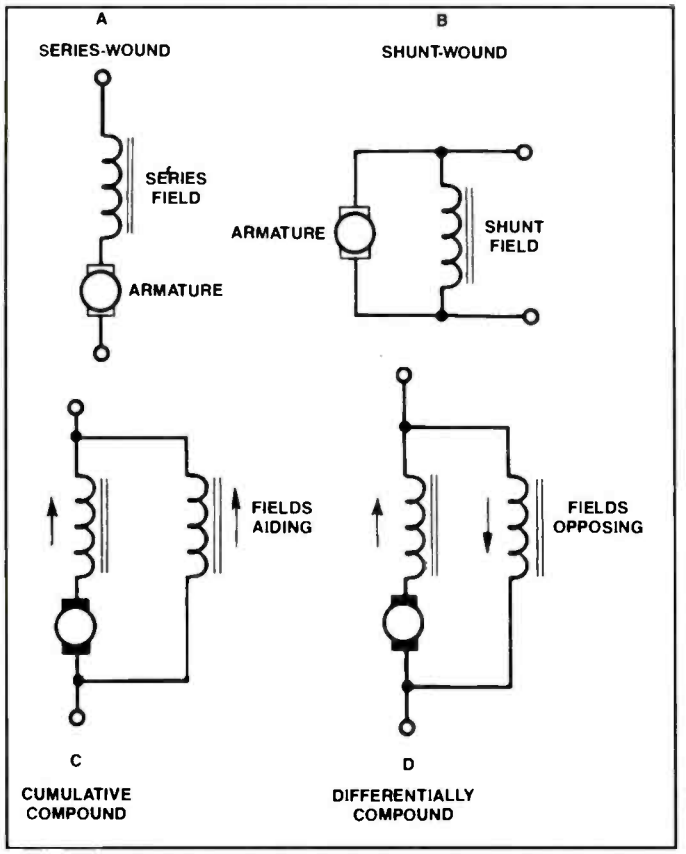


Figure 3. The armature and field windings of a conventional dc motor can be connected in four different ways.

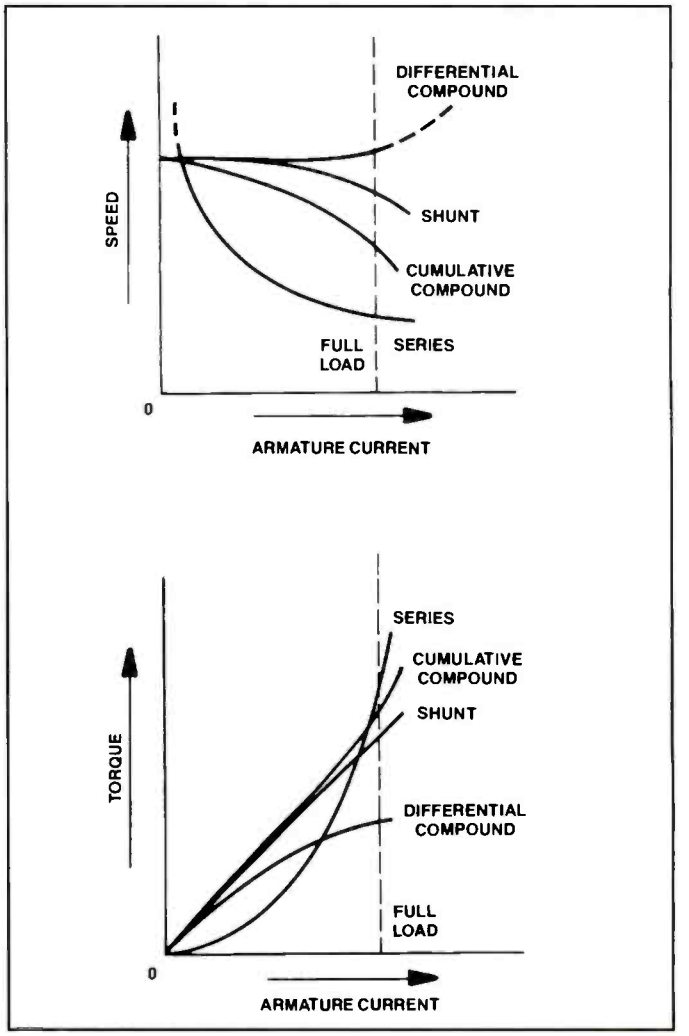


Figure 4. The characteristics of a conventional dc motor will depend on which method of connection of armature and field windings is used.

depend on the method of connection. The type of speed control also depends upon the method of connection.

Series motors

Series-wound dc motors (Figure 3A) are known for their very high starting torque. Torque is the turning force exerted by a motor. This type of motor must not be operated without a mechanical load. A mechanical load is an opposition to turning.

If operated without a load, the speed of a series-wound motor will increase until it self destructs.

Having said that, I know you may have encountered small series-wound motors that operate without a mechanical load. That is possible when the friction of the bearings acts as the mechanical load. I once got a "grab bag" full of little motors that operated that way. The bearings were the type that are impregnated with oil.

The high starting torque of series motors is ideal for startup, but the motors are often switched to some other mode once the desired running speed is reached. A centrifugal switch is used for this very purpose.

Series motors have very poor speed regulation. In other words, if you increase the mechanical load on the series-wound motor it will slow down. In many applications that relationship between the speed and load cannot be tolerated.

It is important to note that you cannot increase the armature current in a series-wound motor without also increasing the field current. That accounts for the reduction in motor speed with an increase in armature current.

Shunt motors

In a shunt-wound motor (Figure 3B) the field current is independent of the armature rotation. When a shunt-wound motor is first turned on, its speed builds. Eventually, the countervoltage in the armature limits the motor to its running speed. At that speed the armature current and induced current are almost equal.

After a shunt-wound motor reaches the running speed, its speed can be increased or decreased by varying the armature or field current as stated earlier. The speed regulation of the shunt-wound motor is very good. That is another way of saying that the speed is not greatly affected by the mechanical load.

If the field winding should open, the strong magnetic field in the motor will be eliminated, leaving a small amount of remnant magnetism. The counter voltage in the armature will be greatly decreased and the speed of the motor will increase. In fact, the speed may increase to a point where the motor is destroyed.

The speed and torque characteristics of dc motors are shown in Figure 4.

Motor starting and controlling

When you are talking about large in-

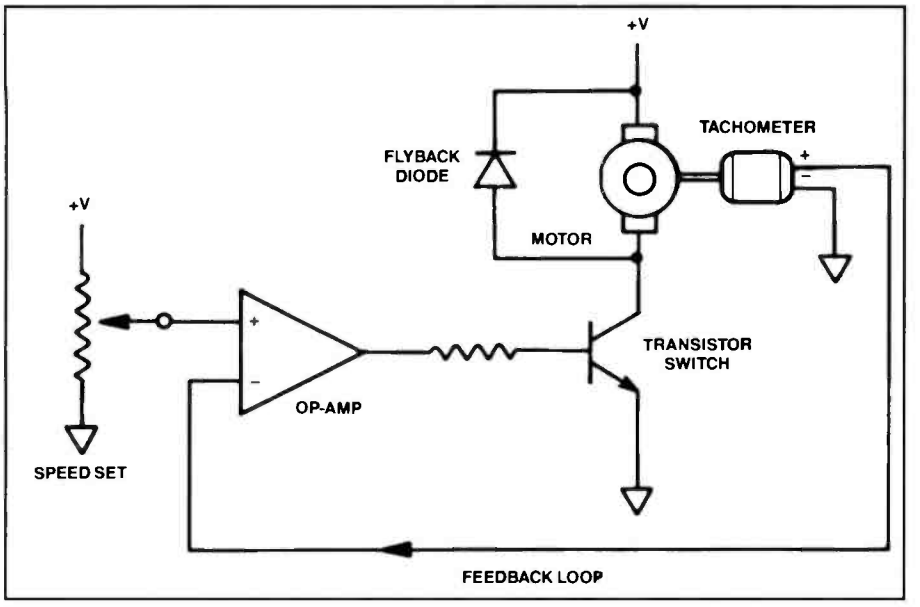


Figure 5. This closed-loop dc motor uses a manual control for speed adjustment. Once the speed is set, it is held constant by the closed-loop circuit.

dustrial motors it is necessary to use special circuits for startup. The reason is that when the motor is first started there is no countervoltage in the armature and destructive armature currents can result. We won't take the space to consider those circuits here. For anyone planning to get into industrial electronics it is essential to know about those motor starting and controlling circuits.

In this series we will consider the problems of electronically controlling motor speed and torque in small motors. Specifically, we will concern ourselves with electronic controls. At this time it is the dc motor that is of interest.

Innovations in speed control of dc motors

Returning now to the motor speed controls, always keep in mind that the speed can be regulated by controlling either the armature or the field current; or, by controlling them *both*.

For automatic speed control, some kind of sensor is required. The system cannot maintain a constant motor speed unless it knows what the speed is. Knowing that, it can increase or decrease the speed as needed to maintain constant speed.

Refer to the closed-loop dc motor control shown in Figure 5. It uses a manual control for speed adjustment. Once the speed is set it is held constant by the closed-loop circuit. The tachometer is a dc generator that senses the speed. A dc voltage that is proportional to speed is used to control an operational amplifier. That amplifier, in turn, sets the motor speed through a transistor switch. This circuit was shown in an article by John Shepler which appeared in the January 1991 issue of **ES&T**. ■

Success through imagination and resourcefulness

By The ES&T Staff

The world is a tough place today in which to own a business, or to be an employee. Competition is intense. Companies are "downsizing," "rightsizing," or whatever they call it. The fact of the matter is, the company has had to make itself smaller, and people are going to lose their jobs.

As anyone in consumer electronics servicing knows, it has hit this segment of the economy at least as hard as any other, and perhaps harder. Servicers are faced with trying to service products that continue to decline in price, even while they increase in complexity and difficulty to service, and in reliability. It's axiomatic: anything that costs the consumer under $100 is disposable. If it's in warranty, the manufacturer replaces it. If it's out of warranty, the owner tosses it and decides whether or not to replace it.

Of course there are exceptions to this rule of thumb. It is possible to make simple repairs of obvious faults to inexpensive products, but the arithmetic is pretty straightforward. If it takes more than a few minutes, or requires an expensive replacement part, a faulty $100 product is ready for the dumpster.

High ticket items will be serviced

There are, however, a lot of products that are repairable. Look in any large discount store. The $89.00 CD player sits on a shelf just a few feet from the 100-disk changer that costs around $800. The $79.00 monochrome TV is just across the floor from the $4000 projection set.

The current generation of young people has been raised with a lot of entertainment options available, and has been watching wide-screen movies with surround high-fidelity sound at the theaters. They are buying expensive products that will provide them with high quality audio and video at home. Those products will not be thrown away when they have a problem. Rather, they will be taken out to be serviced by someone.

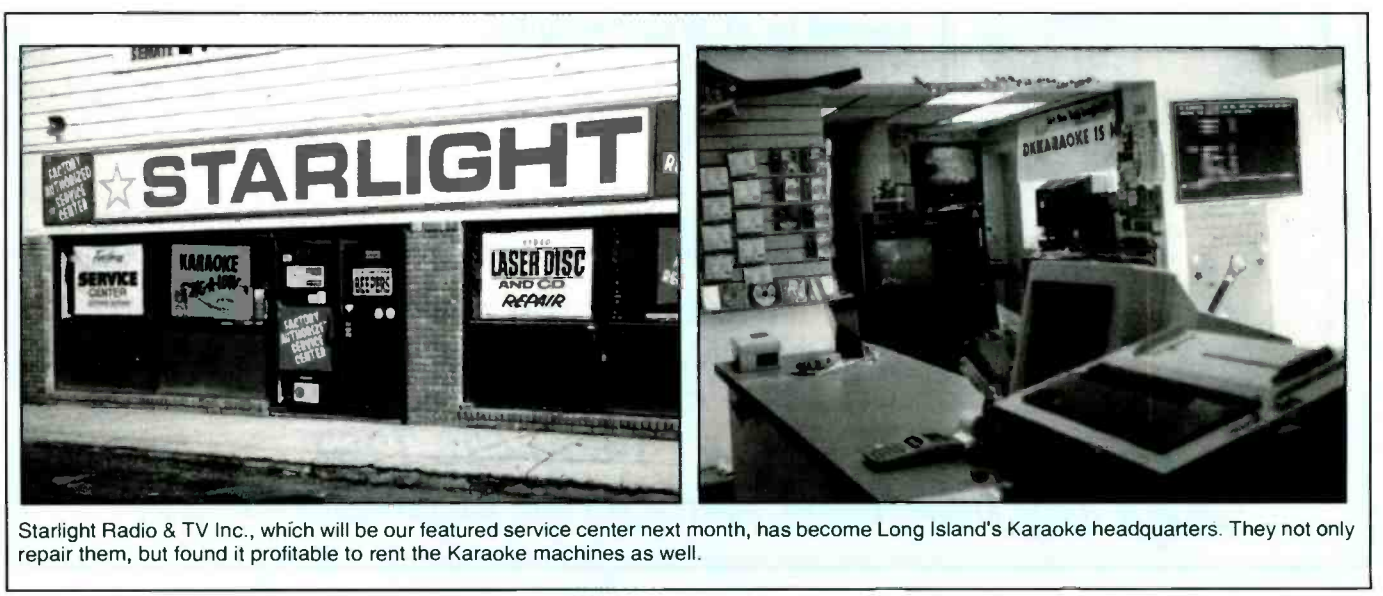
But for some service centers, the traditional consumer electronics, even the expensive ones, don't provide as much revenue as they'd like. So, in the future, we will be bringing you stories of service centers that have been highly successful in attracting customers to their traditional service, and those that have moved outside of traditional service.

Generating more service business

Some of the stories we will be bringing you are about service centers that have found ways to generate more service business. The most important of these ways is really no secret at all. As the old saying goes "nothing succeeds like success." The easiest way to generate more business is to be very good at what you do.

We will be bringing you stories about service centers that do good work, such that their customers, and sometimes the representatives of the companies for which they're authorized, spread the word about them, and business just comes their way.

Another important factor in generating more service business is to provide customers and potential customers with the confidence that in dealing with your company, they're dealing with a professional; that servicing the product makes more



Starlight Radio & TV Inc., which will be our featured service center next month, has become Long Island's Karaoke headquarters. They not only repair them, but found it profitable to rent the Karaoke machines as well.

sense than throwing it away. Many service centers that we know of are able to instill that kind of confidence in their customers. We'll publish stories that show you how they do it.

Don't be too quick to say no

One of the best ways to be unsuccessful in the service business is to reject service of certain kinds of products out of hand. When a customer comes in asking if you will service a certain product and you say something like "we don't touch those," you may be sending him to your competitor, and he might just give that competitor all of the business that you otherwise might have gotten.

One of the hallmarks of the successful service companies that we know of is that they are open to the servicing of new products: products that they perhaps have never considered before. For example, one servicer whom we know, let's call him Andy, was asked to take a look at a controller for a farm product. The alternative for the customer was to buy a replacement controller. Andy was reluctant, but agreed to take a look at it and asked the customer a few questions.

It turns out that the unit was a quite simple printed circuit board that was easily diagnosed without a schematic diagram or other service literature, and that was fabricated using nothing but standard, easily obtainable components. Andy quoted a ballpark price to the owner, who said eagerly, "do it."

Andy serviced the product easily and quickly and made a tidy little profit on the job. His only regret was that he hadn't quoted the price a little higher. He found out later that the replacement unit would have cost six times what his repair cost.

There are many stories like this one of servicers who have been presented an opportunity to service products that are somewhat unlike anything they have ever serviced before, and who have taken that opportunity. In some cases they have been given thorough training by the manufacturer, and have added a valuable skill and product to their inventory, and made a pretty good chunk of money besides.

Adding other services

Some centers have branched out by adding services that are totally outside the electronics repair area, and have become successful in those areas. We'll be telling you about companies that sell accessories, which adds to the bottom line.

One company that we know is in a city where there's an annual event of national fame. They also publish a periodical newsletter. When the time becomes near for the national event, they publish a brief article in that newsletter with tips on how to take videotapes of the goings on to make sure that they come out well. And they also say that, "by the way, you can buy high-quality tapes from us."

Another company was asked to service a line of karaoke machines. After looking into it, they decided that they would also profit by renting them as well. This is another way to make a profit that we'll describe in detail in a future issue.

Success is a state of mind

Sales of consumer electronics products are brisk these days. And while there is an increasing tendency among consumers to throw low-ticket items away, and increasing competition from a number of different sides, independent consumer electronics service will be around for the foreseeable future. A few service centers will continue to fall by the wayside. A few will manage to barely get by. A few, on the other hand, will be wildly successful. Most will fall somewhere in between.

The degree of success will have a lot to do with technical skill, a lot will have to do with business skill. A little will have to do with luck. But much of the success of consumer electronic service will have to do with the imagination and resourcefulness of the owners and managers.

Our main objective by bringing you "Successful Servicing" is to present accounts of imagination and resourcefulness of the subjects of the articles, in the hope that they will stimulate imagination and resourcefulness in our readers. ■

***Foundations of Electronics, 2nd Edition*, By Russell L. Meade, Delmar Publishers, Inc., 892 pages, $49.95 hardcover.**

From introductory concepts through principles of circuit analysis, this new text provides a comprehensive understanding of modern electronic theory and application. With an emphasis on troubleshooting and the ability to apply electronic concepts to real-world situations, this book covers electronics and critical thinking skills needed for careers in the electronics industry. Contents include: basic concepts of electricity, electrical quantities and components, Ohm's Law, series circuits, basic ac quantities, the oscilloscope and dc measuring instruments.

Delmar Publishers, Inc., Albany, NY 12212-5015

***The Master Handbook of Acoustics, 3rd Edition*, By F. Alton Everest, Tab Books, 480 pages, 250 illus., $19.95 paperback, $32.95 hardcover.**

This text is completely updated and expanded to include new chapters on computer-aided acoustical room design, digital and analog sound processing, and synthesizer/MIDI studio acoustics. It also covers: frequency, white and pink noise, the Schroeder Diffusor, digital recording systems, harmonics, digital reverb systems, multitrack recording, and recording studio design.

A well-known author in the field of acoustical science, F. Alton Everest is a Life Fellow of the Society of Motion Picture and Television Engineers, Life Member of the Acoustical Society of America, and Life Senior Member of IEEE.

TAB/McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***Upgrading the IBM PC Family 8088 to 486*, By Michael F. Hordeski, Prentice Hall, 340 pages, $32.00 paperback.**

If the latest software and hardware advances make your old PC look like a dinosaur, why not upgrade your PC? Computer expert Michael F. Hordeski shows you how to maximize the capabilities of your PC in *Upgrading the IBM PC Family 8088 to 486*. This text offers practical advice and tips of enhancing your existing PC system and in easy-to-understand language, Hordeski shows how to make an old PC perform like a 486. The book provides working knowledge of how PCs are built and function. It discusses how performance-critical hardware and software elements of a PC work, and offers practical tips for dealing with problems that inhibit performance.

This new book shows how to perform PC upgrades, how to add more hard disk space for storage, more random-access memory for software, modems for communications and the exchange of data, and graphics boards and monitors for improved visual output. *Upgrading the IBM PC Family 8088 to 486* shows how to: save time and money by upgrading a PC, diagnose computer performance problems, make more informed decisions regarding a PC's performance and functionality, select the best products and install the appropriate hardware and software, determine which system problems require a hardware upgrade or can be handled with software.

Michael F. Hordeski, MSEE, BSEE, PE, is a system consultant at Jablon Computers and has over 18 years of consulting experience. He is the author of ten books on microcomputers and their applications, including *Microcomputer Design and Microcomputer LANs*. He has consulted for major companies such as General Telephone Electronics, General Motors and Gateway Computer.

Prentice Hall, Englewood Cliffs, NJ 07632

***Industrial Electronics for Technicians*, By J.A. Sam Wilson and Joseph Risse, PROMPT Publications, 352 pages, $16.95 paperback.**

This text provides an overview of the topics covered in the Industrial Electronics CET test, and is also a valuable reference on industrial electronics in general. This workbench companion book covers the theory and application of industrial hardware from the technician's perspective, giving the explanations needed to understand all of the areas required to qualify for CET accreditation. With more producers of both consumer and industrial goods turning to automated manufacturing methods, careers in industrial electronics have skyrocketed.

Topics covered here include: passive and active transducers, electronic amplifying components, including diodes, thyristors, relays, switches, and ladder diagrams, digital logic gates, power supplies, motors, generators, and robotics.

J.A. Sam Wilson, CET, has written numerous books covering all aspects of the electronics field. He has a Radio Amateur General License, a lifetime First Class Commercial FCC License with Radar Endorsement, and a Journeyman Certified Electronics Technicians rating in consumer electronics. Wilson also served as the Director of Technical Publications for NESDA and as CET Test Consultant for ISCET and is currently the Electronics Theory Consultant for ***Electronic Servicing & Technology.***

Joseph Risse, CET, has been a chief engineer at radio/TV commercial broadcast stations and has published several books on electronic test equipment. His career is now devoted to developing and writing courses, lessons, and laboratory experiments in both self-study and industrial electronics for International Correspondence Schools.

PROMPT Publications, Howard W. Sams & Company, Indianapolis, IN 46214

***Power Supplies, Switching Regulators, Inverters, and Converters, 2nd Edition*, By Irving M. Gottlieb, TAB Books, 496 pages, 300 illus., $21.95 paperback, $32.95 hardcover.**

This text is an all-in-one, hands-on guide to design, applications, and operation—with schematics and diagrams—that includes important technical data and design techniques gathered from hundreds of sources.

It is updated to cover new IC technology, low-voltage logic devices, and one-watt power supplies for ISDN equipment and is detailed enough for professional engineers and technicians yet simple enough for students and hobbyists.

Topics covered include everything from TV sets and radio transmitters to computers and robots.

State-of-the-art theory and practice are covered in illustrated detail, with only the bare minimum of math included.

TAB Books, McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***The Semiconductor Cross Reference Book*, By Howard W. Sams staff, Howard W. Sams & Company, 656 pages, $24.95 paperback.**

The Semiconductor Cross Reference Book is a comprehensive guide to semiconductor replacement data. The engineering staff of Howard W. Sams & Company has assembled this cross reference to help you find replacements or substitutions for more than 490,000 semiconductors. This Book is compiled from manufacturers' data and from the analysis of consumer electronics devices for PHOTOFACT service data.

This Cross Reference is divided into two sections:

• Section 1: Original Device Types. This section lists device types in alphanumeric order by manufacturer's part number, type number, or other identification. Next to the part number is a replacement code that you will use to look up replacements in Section 2.

• Section 2: Replacements. This section provides substitutions and replacements for the semiconductors that are listed in Section 1.

This guide lists part numbers from the United States, Europe, and the Far East. All major types of semiconductors are covered: bipolar transistors, FETs, diodes, rectifiers, ICs, SCRs, LEDs, modules, and thermal devices. The book is four cross references in one, showing replacements from NTE, ECG, Radio Shack, and TCE, with an up-to-date list of original equipment manufacturers.

Prompt Publications, Howard W. Sams & Company, Indianapolis, IN. 46214

***Troubleshooting and Repairing Compact Disc Players*, By Homer L. Davidson, TAB Books, 544 pages, 500 illus., $24.95 paperback, $44.95 hardcover.**

In this second edition of his guide *Troubleshooting and Repairing Compact Disc Players*, Homer L. Davidson gives practicing electronics technicians and students at all levels the hands-on service information they need to repair problems in the latest CD player makes and models.

Starting with clear explanations of the basic principles common to all CD players, Davidson then moves on to cover in illustrated detail every circuit found in these remarkable, but often problem-prone machines. Readers learn how to remove and replace defective laser heads; troubleshoot and replace low-voltage power supply circuits; repair servo systems; build an infrared tester; use an oscilloscope to service signal circuits; locate and replace defective slide, load, and disc motors; and more. Schematic diagrams from more than 11 CD player manufacturers are featured.

Davidson is one of the best known and most respected names in electronic troubleshooting and repair. He has more than 40 years of experience operating his own successful business and is the author of more than two dozen books. Currently, he is the TV Servicing Consultant for Electronic Servicing and Technology.

TAB Books, McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***The Encyclopedia of Electronic Circuits, Volume 5*, By Rudolf F. Graf and William Sheets, TAB Books, 800 pages, 1000 illus., $34.95 paperback, $60.00 hardcover.**

The Encyclopedia of Electronic Circuits, Volume 5 gives electronics and computer technicians, hobbyists, and students at all levels access to more than 1,000 of the latest circuit designs. In this latest addition to their best-selling series of circuit encyclopedias, Rudolf F. Graf and William Sheets present an all-new selection of designs from current literature and leading industry trade journals from all over the world.

This volume covers in 135 chapters a large variety of useful circuits, with hundreds of diagrams and schematics for circuits used in alarm and security systems, oscilloscopes, audio amplifiers, computers, waveform generators, frequency meters, entertainment electronics, music systems, and many other applications. Together with volumes I through IV, more than 5,000 modern electronic circuits re featured from almost every known area of electronics available today.

Readers will also find a brief explanation of each circuit's operation and a reference to applicable detailed articles. This book features a cumulative index that covers all of the circuits included here and in each of the previous four volumes.

The author of more than 30 books, Graf holds a degree in communications engineering from Polytechnic Institute of Brooklyn. Sheets is a consulting engineer and has more than 30 years' experience as a design engineer in communications. He and Graf are the co-authors of other publications as well.

TAB Books, McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***Interactive Television: A comprehensive Guide for Multimedia Technologists*, By Winston William Hodge, McGraw-Hill, 256 pages, 300 illus., $39.95 hardcover.**

Aimed at those who find themselves on the front lines of the information highway, this high-level guide offers an insider's firsthand account of the concepts, design approaches and technology requirements for interactive TV, advanced multimedia, and Video on Demand (VOD) systems.

Winston Hodge examines each of these emerging technologies in detail, covering architectural standards, storage and compatibility requirements, image compression technologies, the cost consequences of true vs. near VOD, switching and traffic control management, user interfaces, and what the future holds for this hot new area of technology.

TAB Books, McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

***McGraw-Hill Electronic Troubleshooting Handbook*, John D. Lenk, McGraw-Hill, 350 pages, 200 illus., $39.50 hardcover.**

Experienced technicians and at-home hobbyists alike will welcome John Lenk's latest handbook. This practical how-to guide shows readers, in step-by-step fashion, how to pinpoint component faults and correct design flaws for virtually every type of electronic circuit.

And, in user-friendy style, Lenk delivers a wealth of specific troubleshooting tips for popular consumer items such as TV sets, VCRs, camcorders, and CD players.

This storehouse of information serves as a complement to Lenk's McGraw-Hill Electronic Testing Handbook (1993).

TAB Books, McGraw-Hill, Inc., Blue Ridge Summit, PA 17294-0850

Literature (from page 6)

The guide is entitled Complete Solutions in Power Protection and Conditioning. It describes everything a user needs to know when choosing uninterruptible power systems for critical applications, such as those found in industrial, medical and office environments. Application notes, product selection guide, photos and ordering information are provided in a concise, easy-to-read format.

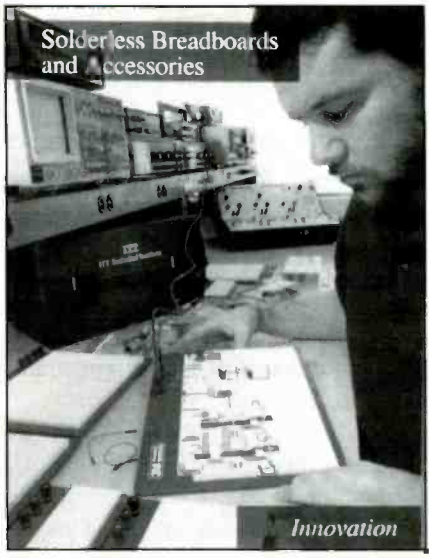
Circle (82) on Reply Card

Brochure describes solderless breadboards and accessories

A new brochure describing 3M's complete line of solderless, plug-in circuit-building technology is now available from 3M Electronic Specialty Markets (ESM).

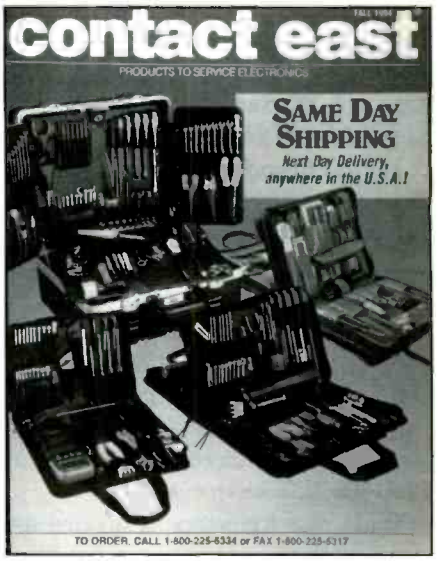
The eight-page color brochure provides information about the Series 300 Breadboards system for the quick, safe and easy design and testing of printed circuit boards. The literature includes product descriptions, parts information, color photos, and technical drawings of the breadboards and the following accessories: jumper wires, patch cords, probes, tie-point blocks, and breadboard strips.

Circle (83) on Reply Card



New test equipment and tools catalog

A 48-page supplementary catalog from Contact East offers hundreds of new test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. Product highlights include new: DMMs and accessories, soldering tools, custom tool kits, EPROM programmers, power supplies, "create your own tool kit," ELF meters, reference books, breadboards, scope meters, datacom tools and testers, adhesives, measuring tools, precision hand tools, portable and bench top digital storage scopes. Also included are the company's lines of communication test equipment, soldering/desoldering systems, static protection products, ozone safe cleaners, magnifiers, inspection equipment, tool kits and tool bags, workbenches, cases and more.



Circle (84) on Reply Card

Photofacts

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CTC177AK 3387
25GC710KF1 3387
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25GT506FE1 3387
25GT506JX1 3387
35GT680NM1 3385
35GT680NX1 3385
35GT681FM1 3385
35GT681JX1 3385

HITACHI
VT73AY ..... (sim. to) VCR-257

MITSUBISHI
CS-26201 3395

PANASONIC
AEDP233 3393
CT-20S2CS 3393
CT-20S2S 3393

PHILIPS
27S200C401 3397
27Z105 3397

QUASAR
ALEDC228 3389
SXF3125J 3389

RCA
CTC175K 3396
CTC175L 3396
F19201BKTX1 3396
F20231WNFA1 3396
F20231WNTX1 3396
VLT375 ..... VCR-257
VLT385 ..... VCR-257
VLT386 ..... VCR-257
VLT387 ..... VCR-257
VLT388 ..... VCR-257
X20131GSFA1 3396
X20131GSJX1 3396
X20131GSTX1 3396

SAMSUNG
K52A1 3392
TXB2015 3392
TXB2015CX 3392

SANYO
A8Y-13030 3384
AVM-1303 3384

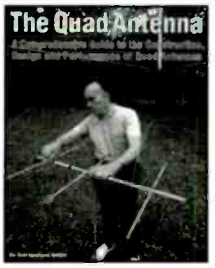
SEARS
580.40368390 3390
580.40378390 3390
934.43308390 3388

SHARP
19E-M100 3394
19E-M120 3394
20E-M50M 3394
20E-M100M 3394
20E-M120M 3394
25E-S110 3391
25E-S130 3391

ZENITH
SL0953X 3386

CQ Books and Videos

The Quad Antenna

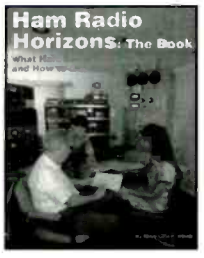


Hams love antenna books and this book is no exception. Written by world renowned author Bob Haviland, W4MB, The Quad Antenna is the authoritative technical book on the design, construction, characteristics and applications of Quad Antennas. Discover how to easily build a quad antenna for your station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

The Packet Radio Operator's Manual

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

Ham Radio Horizons: The Book



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

The Vertical Antenna Handbook

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

1994 Amateur Radio Almanac

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

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Whether you're a newcomer to contesting or an experienced veteran, CQ's **Getting Started in Contesting** is for you! You'll get advice and operating tips from some of contesting's most successful competitors, including Ken Wolff, K1EA, Dick Newell, AK1A, and CQ's own contest columnist, John Dorr, K1AR. Order our contest video and watch your scores begin to climb! **Order No. VCON....$19.95**

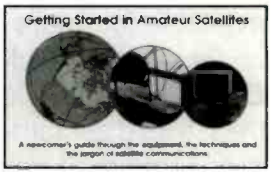
Getting Started in Packet Radio

This video will help de-mystify the exciting but sometimes confusing world of packet radio. Learn how to get started using your computer on the radio. Included are step-by-step instructions on making packet contacts and using packet bulletin boards, networks and satellites. **Order No. VPAC.. $19.95**

Getting Started in Ham Radio

This is a fast-paced video introduction to the fascinating world of ham radio. CQ's experts show how to select equipment and antennas; which bands to use; how to use repeater stations for improved VHF coverage; the importance of grounding and the basics of soldering. How to get the most out of your station, whether it's home-based, mobile or handheld. **Order No. VHR $19.95**

Getting Started in Amateur Satellites



Learn with this video how veteran operators set up their satellite stations. Find out how to locate and track ham satellites with ease. Watch operators access current satellites and contact far ranging countries around the world. This video is filled with easy to understand advice and tips that can't be found anywhere else. **Order No. VSAT..... $19.95**

Getting Started in DXing

Top DXers share their experience with equipment, antennas, operating skills, and QSLing. You'll see hams work rare DX around the world. If you're new to DXing, this video is for you! All this valuable information may well give you the competitive edge you need to master the exciting world of DXing.
Order No. VDX..... $19.95

Ham Radio Horizons: The Video

This introduction to Amateur Radio is an excellent complement to the Ham Radio Horizons book. Enjoy seeing all aspects of ham radio ranging from what it takes (and costs) to get started to how you can get your ham license. Designed for the general public, HRH is ideal for public events, presentations to community groups and as an opening to your club's licensing courses! There's no better way to introduce someone to ham radio. **Order No. VHOR.....$19.95**

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News *(frompage 5)*

the year left room in dealer inventories, and early inventory building for the Christmas selling season is leading dealers to stock up now. We're pleased with this news because it confirms our predictions for a strong second half. Additionally, it shows that retailers have good expectations for the fourth quarter. And it shows that products are being well received by a wide cross section of consumers, because July is typically the lull before the peak shipment months of September through December."

Strong sales in months which are typically a smaller proportion of annual shipments is a positive indicator of retailer and consumer confidence.

EIA's Video Tracking Survey showed that TV sales rose 12% in July, the fourth successive month in which sales were up at least 10%. After starting the year slowly, direct-view color TV sales are back on record pace through the first seven months of the year, posting a gain of 6% over 1993, and an increase of 4% over the previous seven-month record set in 1989. Consumer awareness of home theater is a primary reason that sales have surged. A recent CEG survey of 2,000 U.S. households revealed that 47% are aware of the concept of home theater, up 5 percentage points from a similar survey conducted in December of 1992. CEG's Video Tracking Survey also confirms the retail strength of the large screen market. Through the first seven months, retail sales of 25 inch and larger sets are up an estimated 20%, and are accounting for almost 45% of the replacement sales market.

Unit sales of projection TVs grew 21% in July, and were up 37% through the first seven months of the year. Interest in home theater has also been a big reason that the projection TV market has boomed in 1994. Projection TVs, once the domain of smaller specialty video retailers, are now available from a myriad of retailers at attractive price points.

VCR sales rebounded from two consecutive months of decline with a robust 8% gain in July, leaving sales about on par with the record pace of last year. Stereo models were the big winners in July with a volume of more than 300,000 units, up 13% from last year, and camcorders rose 3% in July, and were up 5% year to date.

Many consumers are looking at the entire video market to explore products that will bolster their home entertainment systems. "Retailer demand for video products hasn't wavered much during the year, and I believe it reflects the consumer's tendency to look at upgrading their existing video systems to include another VCR player for the bedroom, a larger screen TV, or other video products to enhance their home entertainment systems," concluded Clayton. ■

Test Your Electronics Knowledge

Answers to the quiz *(from page 47)*

1. (186,000 Mi/Sec) x (0.0000001 Sec)
= 0.0186Mi
0.0186 Mi x 5280 Ft/Mi = 98.2 Ft

2. Voltmeter

3. A. Time gets later as you move to the right. Note that the peak of waveform A occurs before the peak of waveform B.

4. Mixer. If you said converter your answer is wrong.

5. B. Not correct. Class A amplifiers have the lowest efficiency of all classes.

6. D. Conductance is measured in Siemens. In the past, it was the mho.

7. B. The watt-hour meter is used by the power company to measure the energy used at your house.

8. C.

9. C. dB = 10 log 10/1
= 10 x 1
= 10

10. It is not Watt's law. It is Joule's law. Also, the power is not 0.036W. It is 0.06W. (P = V x I)

Classified

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

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****NewsFlash . . . TROUBLESHOOTING TIME DOWN—PROFITS UP!!!**** Our **NEW COMPUTERIZED TIP PROGRAM** helps reduce your bench troubleshooting time. Servicing today's electronic equipment is Time and Labor intensive. The Fact is, if you can complete more repairs in a given time period, you will **INCREASE your PROFITS. Repair that equipment FAST!!!** The **COMPUTERIZED TIP PROGRAM** contains over **15,000 VALUABLE, TIME SAVING, MONEY MAKING TIPS!!!** TVs, VCRs, CAMCORDERS & other electronic equipment. **PROFESSIONAL BOARD LEVEL REPAIRS. ADD** Your tips to the TIP PROGRAM!!! **PRINT** any tip. We are a Professional Software Development Corporation associated with many Professional Electronic Repair Service Centers throughout North America & Canada. We produce only High Quality Software. Our clientele includes many repair facilities, just like yours. Honest Respectable Businesses with Hardworking Owners & Technicians providing the best service they can to their customers. Owners of our **COMPUTERIZED TIP PROGRAM** say this is the ****BEST**** technical tip program on the market today. Want to hear it for yourself? Talk to our customers and let them tell you how much they like our **TIP PROGRAM. Pays for itself with 1 or 2 repairs**. Works on **ANY** IBM compatible computer INCLUDING Pentium, 486, 386, & **older 286 & XT models**. The Price? **Only $100.00!!!** (for a limited time only) (High density disks). Prepaid orders within the continental U.S.A. are shipped **FREE**. Call for: C.O.D., Double density disks, & shipping outside continental U.S.A. ****FREE**** Demo. Have your own tips? Ask about our **TIP EXCHANGE** policy with **FREE Updates!!! CALL NOW !!! (516) 643-7740 HIGHER INTELLIGENCE SOFTWARE, 60 Farmington Lane, Melville, NY 11747.**

*** * * "SERVICE TIPS" now has 16,068 Technical Tips on TVs, VCRs, Camcorders, and other Electronic Equipment!! YES, you can ADD YOUR OWN TIPS, REVISE or PRINT any SERVICE TIP in the program. SERVICE TIPS HAS NO HIDDEN COSTS!! IT ORGANIZES 16,068 CURRENT SERVICE TIPS IN ALPHABETICAL ORDER BY Brand, Model/Chassis & Symptom each tip contains 3 lines for Symptom and 8 lines with Concise Solutions, Part Numbers, Values & Locations.** Created by 2 CET's with over 20 YEARS experience in there own SERVICE CENTER's and a full-time computer programmer, **IT'S AN INDISPENSABLE TOOL FOR ANY SERVICE CENTER.** Members of electronics associations such as **NESDA-NYS, NESDA, METSDA, TESA-LI as well as technicians across the country** are using this program and confirm there is no better program available today.******You receive 16,068 TECHNICAL TIPS from technicians like yourself FOR $129.95****** Demo Disk & Quarterly Updates are Available. **CALL 1-800-621-TIPS (621-8477) (from US & Canada)** or Write **ELECTRONIC SOFTWARE DEVELOPERS, Inc. 826 So. Main Street, South Farmingdale NY 11735.**

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VHS-VCR Repair Solution Sets I - IX. Each contains 150 symptoms and cures, cross reference chart, free assistance, $19.95 each, all nine $49.95. Visa/MC. **Eagle Electronics**, 52053 Locks Lane, Granger, IN 46530.

SENCORE SC61, EXCELLENT condition w/probes & manual, calibrated $1095. VA62A with VC63 calibrated w/90 Day Warranty from Sencore $1695. Philips PM3216 35MHz scope with TV Trigger $250. Call **TEST EQUIPMENT SALES** (603) 434-2544.

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STD 580 transistor. *Contact: Bob Green, RR1 Ridgetown, Ontario N0P 2C0 Canada.*

VCR service manual for Goldstar GHV-42 FM. Will purchase or copy and return. *Contact: R.H. Wood, 1422 Fawcett Ave., White Oak, PA 15131. (412) 672-0079.*

Information on Sears 562.53221250 beta VCR, or on any beta VCR. Need reassembly information for Quasar GC143 or UP1775E color TV/monitor. Also, if anyone has a wiring diagram on a FX-80 Epson printer. *Contact: Dan's TV, (316) 665-5901, or 316 East Ave., E. Hutchinson, KS 67501.*

Horiz. Stat. Sony # 1-230-212-11 for Model KV2680R. Zenith upper drum Assy. #835-163 Asti-325 for VR-1805. Sams # 189-7. *Contact: John's Repair Service, 142 Jackson St., Philadelphia, PA 19148. (215) 389-1147.*

Service manual, original or copy, of Technics cassette deck Model RSM234X. *Contact Scott Tannenbaum, 4 Jarvis Ct., Erial, NJ 08081. (609) 627-3606.*

Tektronix-545 oscilloscope in as-is, non-working condition. *Contact: Greg Hingle, Rt. 2, Box 584, Port Sulphur, LA 70083, (504) 564-2517.*

Sams TV photofacts. Send list and price. *Contact: James Shoults, 535 12th St. W., Grafton, ND 58237.*

Sony 25 inch TV Model KV2680R horizontal stat #1-230-212-11. Also. Zenith VCR VR 1805 video heads #835-163. Used in working order, O.K. *Contact: John Repair Services, 142 Jackson St., Philadelphia, PA 19148, (215) 389-1147.*

Phone number of a tech support BBS (national), if any. Will pay $10.00 for owner's manual or photo copy for IBM printer #5152 (5152002). $10.00 for copy. Service manual Yaesu FT-23R, 2 meter FM walkie talkie. *Contact: Augustine's TV & Radio Service, 3129 Earl St., Lauderdale, PA 19605, (610) 929-8850.*

Power output module, part no. F-2656 (stuffed board-good used. OK), for Sansui model No. 9090DB stereo receiver, no longer available from manufacturer. *Contact: William M. Suhy, 309 Terrace Ave., #12, West Haven, CT 06516, (203) 934-0446.*

Schematic or service literature for Sony stand-alone television tuner Model #VTX-1000R. *Call or Fax: Gunnison Electronic Repair at (303) 641-1669; or write to P.O. Box 344, Gunnison, CO 81230.* Will pay.

Service manual and wiring wanted for VHS JVC HR 71000. Sears 564-530-70350. Lloyds Color TV Model L520-ch101B. *Contact: E. Cardona, Apemimox G33, Puerto Nuevo, Puerto Rico 00920.*

A Conar Model 320 regulated power supply. Also, would like to obtain a Ramsey COM 3 communcations service monitor made by Ramsey Electronics. *Contact: Sea & Shore Electronics Service, 1045 Heavenridge, Essexville, MI48732, (517)893-1354.*

Will buy or copy and return service manuals and/or schematics for an RCA scope Model WO-91C, a Hickok Video Universal Generator Model 650C and a Panasonic PV6600 (PV-6000/PV-A600.). *Contact: W.H. Calhoun, RT. 5 Box 331, Colquitt, GA 31737-9089.*

Knight KG-688 audio generator, 83Y135 signal tracer w/probe, Knight KG-687 sweep generator, B&K 415 generator with manuals, and Sencore MU150 tube tester. *Contact: Charles T. Huth, 229 Melmore St., Tiffin, OH 44883, (419) 448-0007.*

Schematic for a Magnavox TV chassis 26C809 Model RG4549 AKO2. *Contact: Robby Robensin, 4662 Esther St., San Diego, CA 92115-3834, (619) 583-2377.*

Vertical Output Transformer (T202). Zenith PN 95-3072 & VDR (R289), Zenith PN 63-5472 for a Zenith TV Chassis 25DC56, new or used. *Contact: Rob Manthey, 8136 Hwy., 19 Blvd., Cannon Falls, MN 55009, (507) 263-5415.*

Willing to pay for schematic or copy of 1976 Sylvania Model No. C3855 W TV set. *Contact: Merrill Lonnen, 6206 Thonotosasso Rd., Plant City, FL 33565, (813) 986-6383.*

Sharp TV yoke #KYS-60159, Fisher loading motor assembly 143-0-3404-03700, schematic for Magnavox TV 13C202. *Contact: Ed Herbert, 410 N. 3rd., Minersville, PA 17954.*

Mitsubishi Flyback-part # 334P13201. *Contact: VCR Electronics, 970 Lost Dutchman Pl., Tucson, AZ 85737, (602)797-1720.*

Complete chassis and boards for Heathkit model GR 900 or similar color TV. Need not to be operational, but usable condition. *Contact: Bruce Hudler, 1398 Rainbow Dr., Pasadena, MD 21122, (410) 360-8163.*

CRT tester and restorer. Also Heath analog/digital microprocessor trainer. *Contact: Bob Snow, c/o VCR Repair Service, 6 Anglin Crescent, St. John, Canada, E2K 3R3, (506) 652-3146.*

Flyback for Ward TV Model Gen. 12394, marked FB181K. Unit is no longer available. *Contact: John Bahman, 6054 W. Wellington, Chicago, IL 60634, (312) 237-3070.*

Hitachi VT-3A portable VCR for parts. Call w/price and condition. *Contact: Gary, (715) 635-6205.*

24-PIN IC, A/D converter, part no. 20-786 (may be Motorola 7846) for Sabtronics digital multimeter Model 2010A. *Contact: Lewis Cook, 10466 SE 149th St., Summerfield, FL 34491.*

Service literature, schematic, parts list for a Westinghouse Model H326C7 am/fm tube type radio; chassis no. E49211. Any help will be appreciated. *Contact: David W. Splinter, Box 8, Dickeyville, WI 53808, (608) 568-7222.*

New or good used AY-3-8112 IC, made late 70s by General Instruments. Any info. (catalog pages, owner's manual and/or service info.) on Spectro Acoustics Model 220R FM tuner. *Contact: Dave's Electronics, PO Box 151, Poway, CA 92074-0151.*

Used Sencore VA-62 in working condition to replace fire damaged unit. Quote your price. *Contact: Max, 4060 Peachtree Rd. N.E. #D147, Atlanta, GA 30319.*

Fisher VCR loading motor assembly #143-0-3404-03700. Sharp plug-in yoke #KYS-60159, schematic for Magnovox TV chassis 13C202. *Contact: Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Information on Conn organ parts. Need adjustable inductor. Conn part 57013-2R. *Contact: Lando K. Moyer, Box 38, Bedminster, PA 18910.*

Model 1502 analog signature tester made by Jim Clinton dba Information Devices, Inc. in any condition. Also, Sencore LC102 capacitor analyzer. *Contact: Jeffrey, (203) 529-3700 (days).*

Sams or other citizens band radio service manuals. Please send a list of which ones you have and the price. *Contact: Jordan Hillrich, 732 Queen St., Regina, Sask, Canada S4T 4A3.*

Will buy/copy service manual for Quadraflex 777 receiver amp. Pacific Standard store brand by CBS. *Contact: Jon L. Batters, 5110 Riverbanks Rd., Grants Pass, OR 97527.*

B&K 747,520, schematic diagrams for TVs car audio stereos. VCRs, camcorders, B&K 530, B&K 1045A, Leg 400, B&K 1050, PR57. *Contact: Ian, (704) 743-2031, 2810.*

Schematic and parts list or service manual for a Sansui audio amp. Model # A1200P. *Contact: Bill Wells, 1727 A. East Holly St., Goldsboro, NC, 27530, (919)734-6692 collect.*

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Sams PF #81 to #1997. Some missing. 62 various TSM-MHF-TR-AR books. Also, Sams PF #935 to #1265. Also, several missing. Make offer. *Jim Doggett, RR1, Box 23, Ames, IA 50010, (515) 232-1134.*

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One Panasonic capstan stator part # VEMS0157 ($20.00), one Sony flyback part # 1-439-372-13 for KV27, GS-7000, ADM-21B ($40.00). *Contact: Mike Choate Gadget Repair, 1800 N. Mays, #105, Round Rock, TX 78664, 512-255-7931.*

Sencore scope, SC61 (like new) with manual, probes, cables, original carton. $1,395.00 plus UPS. *Call Major, 913-467-8431 or 913-467-3921.*

Sencore transistor tester model TF161 and B&K TV analyst model 1076 above with all manuals and test leads both for $165.00. *Contact Daniel Seidler, 3721 W. 80 St., Chicago, IL 60652, 312-284-8221.*

Over 5000 new tubes in boxes. Giveaway prices. Object: to get rid of them all. 25¢ to $1.50. SASE for list. *Contact Rober Nelson, 1458 N. Blackfoot, Lake Havasu City, AZ 86406.*

Jackson oscilloscope (CR03), Hickok signal generator (615). Rem cathode recovery unit CRT checker. *Contact Ann Bichanick (Jays), 15½ W. Lake St., Chisholm, MN 55719, 218-254-4421.*

B&K 2120 20MHz dual-trace oscilloscope for sale for $200.00 with one probe. Also, TEK 561, $100.00 and scope cart for TEK 561 for $75.00. *Contact Leo Lafaver, 19501, E. Admiral Space #5, Catoosa, OK 74015.*

B&K model 820 with charger capacitor tester, $150.00; Sencore TF 40 transistor tester, $75.00; Sencore M4150 T4BE checker, $295.00. For a list of other equipment, SASE (legal size) to *Fred Ingersoll, 6845 Lathers, Garden City, MI 48135.*

TV/VCR test equipment (RCA, B&K, Tentel, etc.); Sams Photofacts through 2676 (1100-2676 in file cabinets), $9,500.00; brand name electronic repair parts-service data library free with purchase. Send SASE for complete list to R.V. Alaniz, 307 S. Maiden Ln., Tecumseh, MI 49286.

Heathkit RLC Bridge, model # IB-5281, $35.00; Tentel model # T-2 tape tension gage, $40.00; video head tester, $25.00. All with manuals. *Contact Gerald, 919-745-4493.*

Lectroteck TO-55 scope, $150.00; RCA WO-33A (incl. probes), $125.00. TF-26 Cricket, $125.00. All in working condition with manuals. *Contact Harold at 216-297-1491.*

Eico model 239 solid-state FET-TVM battery operated meter complete with test leads, RF probe and service manual. Seldom used, in very good condition, $65.00 plus shipping. *Contact T.T. Walton, 3403 Crestmont Dr., Midland, TX 79707.*

Sencore VA62, LC75, VC63, NT64, BK20B, Leader LC2006 and LMV181, Hitachi V665, and Heathkit IM2410. All for $4500.00 or best offer. Will sell separate. *Contact: Anita Fugiel, 55 E. 227th Pl., Chicago Heights, IL 60411, 708-758-7530.*

Sencore SC3080 scope/waveform analyzer. Very low use—beautiful condition. All manuals, probes, etc. for $1,695.00 or best offer. *Call Scott, 707-961-1091.*

Leader dual-trace 10MHz oscilloscope for $250.00, B&K 1077 television analyst for $200.00, B&K 415 sweep/marker generator for $200.00. All original boxes and excellent condition. *Contact John at 201-432-7635.*

RCA factory service manuals (1955-1970). All three for $15.00; RCA TV troubleshooting Pict-O-Guide, vol. 1 and 2 (1949), both for $5.00; TAB Books TV service manuals (different brand names), $3.00 each or all 13 for $30.00; Electronic Technician Magazines (1965 to 1976), all for $15.00; and new filter capacitors 125µF, 350Vdc, $4.00 each. All prices plus shipping. *Contact John, 247 Valley Circle, Charleroi, PA 15022, 412-483-3072.*

Textbooks, service manuals, parts, tubes—90%+ off list price. Send two 29¢ stamps. *Contact: M Seligsohn, 1455-55th St., Brooklyn, NY 11219.*

Sencore VC63 VCR tester, cable, manual, $150.00 + shipping. Diehl Mark III H.V. scanner, includes manual, $90.00 + shipping. Contact Wieland TV/VCR, 237 Talbot Dr., Bedford, OH 44146, (216) 232-8653.

Sencore CR70 CRT analyzer/restorer, $700.00, Leader LVS-5850B NTSC vectorscope, $900.00, Leader LDC-823S digital counter $250.00. All for $1,750.00. Mint condition. *Contact Showtime Video, Service Department, 21 Essex Way, Essex Jct., VT 05452.*

Sencore VC93 all format video analyzer in mint condition with all cables, etc. Still in original box. New $2,995.00, asking $2,500.00. *Contact Mark at 318-448-0204 or 318-445-8062.*

Sencore PR57, SC60, SG165, SC61, with cables. All in good condition, little use. Best offer. *Contact Pat Montague, 707-545-1195, 422 Wilson St., Santa Rosa, CA 95401.*

Sencore VA62A video analyzer, boxed and all leads $2,500.00; Sencore VC93 VCR analyzer, same, $2,000.00. *Contact Kevin Westerhaus at 316-672-3350 or 316-672-6722.*

Tektronix oscilloscope 100MHz, Model 465. Real nice condition, $575.00. Sencore SC-61 analyzer, very cared for, $1500.00. Both test sets have manuals and probes. *Contact: Bob Snow, c/o VCR Repair Service, 6 Anglin Crescent, St. John, Canada E2K 3R3, (506) 652-3146.*

Hickok signal generator 615, Hickok color bar generator 246. *Contact: Ann B. (Jays), 15½ W. Lake St., Chisholm, MN 55719.*

Huntron Tracker 2000, $900.00; Wilson MWX-1000MR MFM/RLL hard drive tester, $500.00. *Contact: (703) 777-9280.*

Viz WA-504B/44D Sine/Sq. wave audio generator (new) $129.00. *Contact: John's Repair Service, 142 Jackson St., Philadelphia, PA 19148, (215) 389-1147.*

Pico horizon to horizon dish mount, new. Model HHMT. Manufactured by Pico. $100.00. Bob Nelson (602) 453-7972.

Sencore CR70 pix tube checker B&K 1251 NTSC color generator., B&K 465 CRT tester. Best offers. *Contact: Bob Green, RR1 Ridgetown, Ontario N0P 2C0 Canada.*

Our of Business. Send SASE for shop test equiment list, schematics, parts, tubes, fixtures and merchandise. *Contact: Electronics, PO Box 2405, Aptos, CA 95001-2405.*

TEK Scope 7904, 500MHz main frame with two 7A26, one 7B53A, one 7B92, $900.00; one HP 1725, 250MHz with multimeter, $900.00. *Contact: Andy, (914) 236-4773.*

Sencore SC61 w/probes and shipping box, 1,250.00; Sencore VA62 w/probes and shipping box, includes VC63 and NT64, $1,250.00; B&K 520B transistor tester, $125.00. *Contact: Ted Franco, Electronics, N.W. 18008-44th Ave. W., Lynnwood, WA 98037, (206) 778-9008, or Fax (206) 771-5812.*

Sencore SC3100 auto tracker scope, Sencore VG91 universal video generator, Sencore LC101 Z-meter with SCR and TRIAC test accessory. All in excellent condition. Contact: (612) 845-2522, preferably after 6 p.m.

New radio/TV tubes–Thordarson Y-88–Y-141 yokes $10.00 each; Thordarson flyback 268–$10.00; new Sony parts/price varies/Sencore SS137 TV sweep analyzer new condition; Sencore PS-148 5-inch scope w/probes, $200.00 each plus shipping and handling. Contact: (716) 434-7395 or M. Wiedenbeck, 7773 Akron Rd., Lockport, NY 14094.

Systron Donner Model 1037-62, neon display, 3Ghz frequency counter; Leader LBO505 dual trace oscilloscope, both working condition, best offer. Contact: Andre Matos, (908) 290-7486 (after 5pm).

Tektronix CMC250 2CH 8 digit 1.3GHz frequency counter, $350.00, also B&K precision 1249A NTSC video generator with R.G.B., $300.00. New condition with original box and manual. Contact: Bruce (516) 437-2277.

Sencore VC-93, $1,800.00; LC 101, $1,000.00; Super Cricket TF46, $325.00. Contact: Barrett Sylview, Lancaster, CA (805) 943-7238.

Sencore TF26 transistor-FET tester, $65.00; CG25 color bar generator, $30.00. Both in good condition with manuals, $85.00 for both. Contact: Dennis, (603) 641-5793.

Text books, service manuals, parts, tubes-90% + off list price. Send two 29¢ stamps. Contact: M. Seligsohn, 1455-55th St., Brooklyn, NY 11219.

Old Electronic Magazines, 1960s-1970s-1980s-1990s. Sams Photofact sets. Mostly older sets. New receiving tubes in original boxes. If interested, make offer. Contact: Elmer J. Alderman, 135-1 Theatre Rd., Madison, NC 27025.

Sencore VC93 VCR analyzer, $1,995.00; ST66 stereo TV analyzer $300.00 TVA92 TV video analyzer + VG91 video generator, $3,995.00. Contact: (616) 383-2641 (leave message).

Heath power transformer 54-45, Nos. Also, swap Heath SG-8 kit for recording head Bell & Howell #188-37, or Brush #BK109U or equivalent. *Contact: Harold Lejuez, 46-16 160St., Flushing, NY 11358, (718) 463-4110.*

Sencore SC-61 dual trace wave analyzer in excellent condition w/all probes and manual. Will sell for $1,500.00. Also, Sencore/IBM Electronic Management Software complete with all revisions and latest upgrade multi-user version. Original cost $3,500, will sell for $1,500/obo. *Contact: Marge, (409) 935-3321.*

Sencore VC93 VCR analyzer with test tapes, test leads, manuals, and a PR-57 Powerite. Both 2 years old and in new conditon. $2,300 for both plus UPS charges—$3,700 when new. *Contact: Andy's Electronics, PO Box 21, Millville, PA 17846.*

Jackson dynamic tube tester model # 648-1T, excellent condition, $350.00. Also, Photofact auto series volumes 17-340, $250.00. *Contact Ed at 515-672-1515 between 6 and 10pm CST.*

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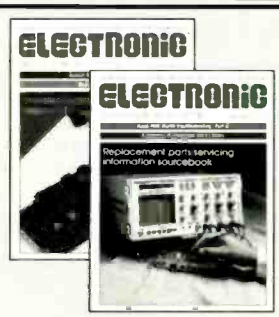

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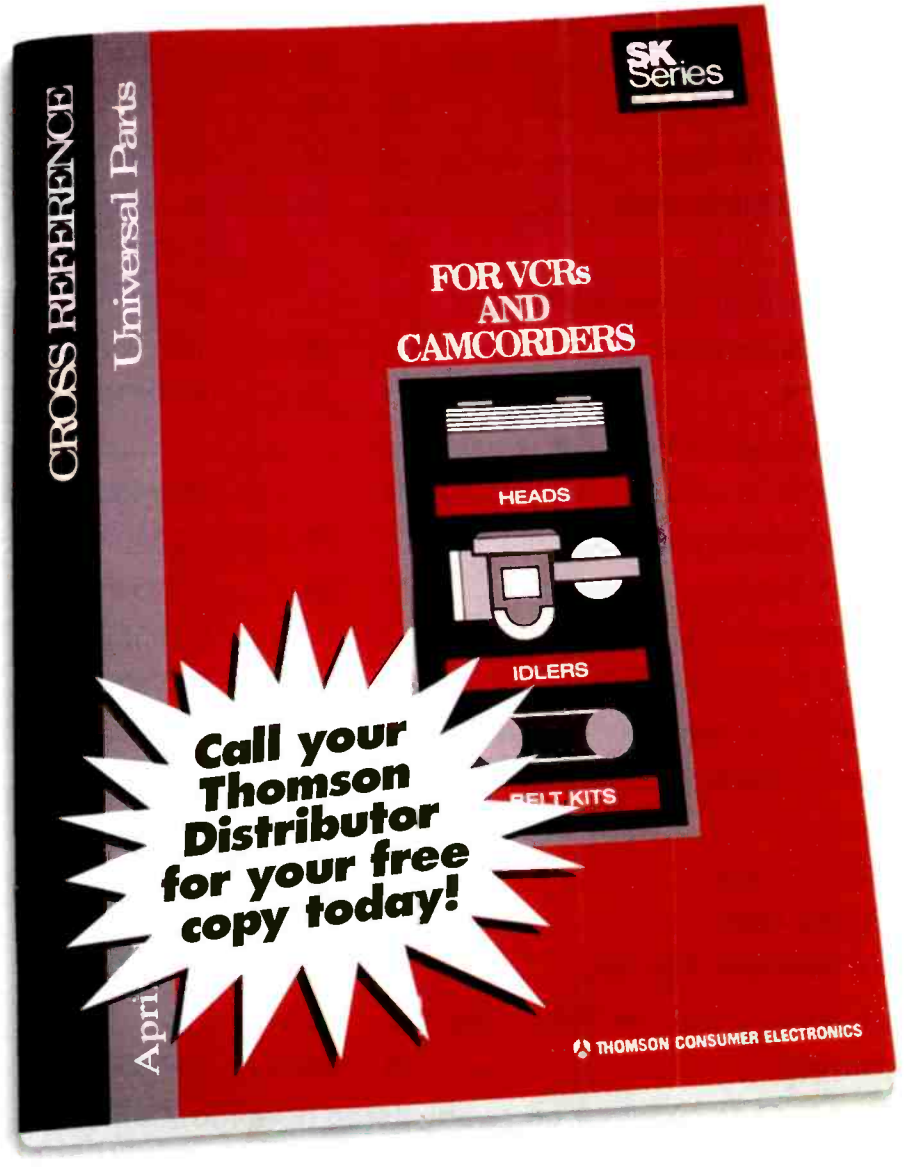

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