THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

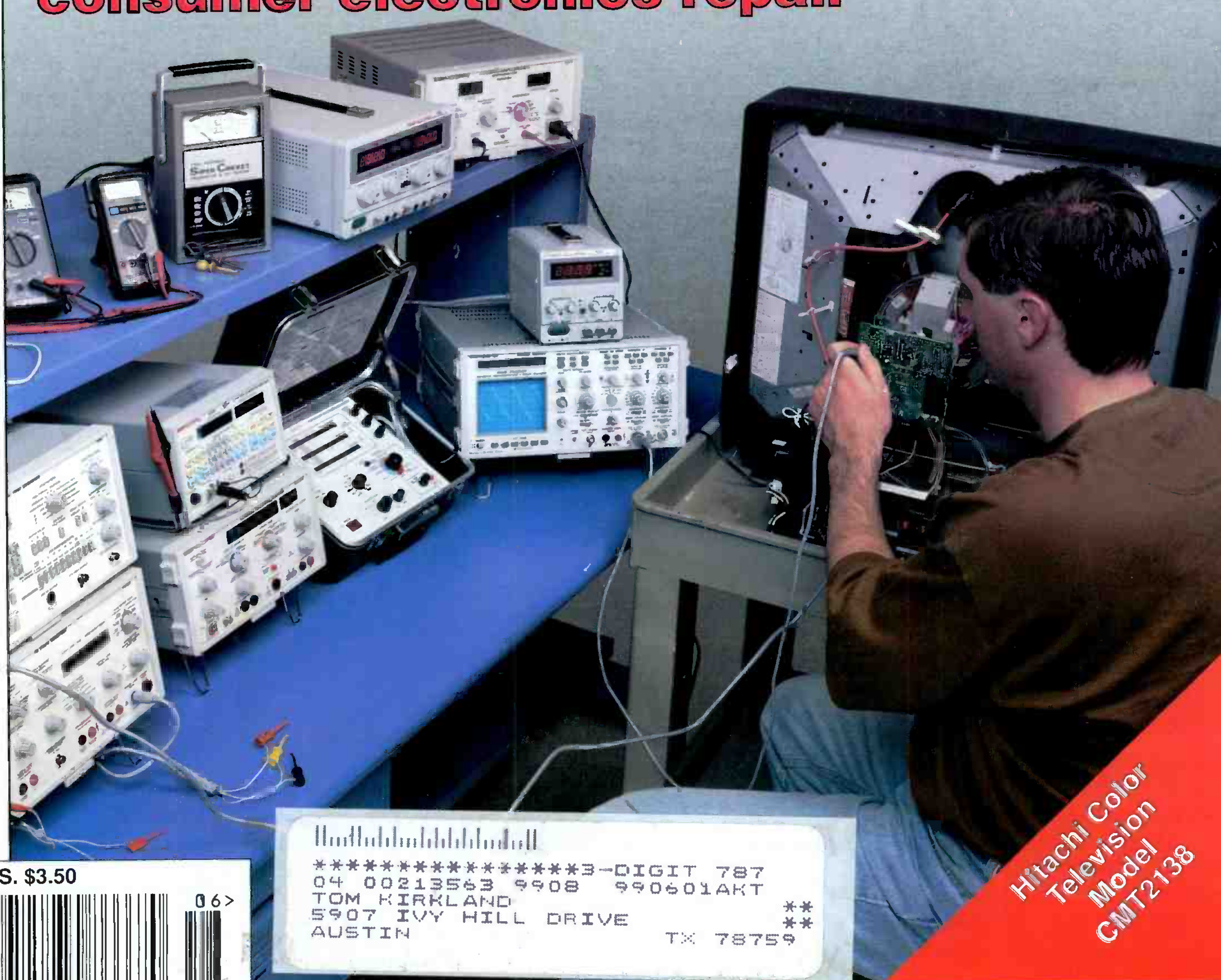
June 1999

Ways to deal with intermittent problems

The Magnavox electronic tuner

Test Equipment Update

The changing nature of consumer electronics repair



Hitachi Color Television Model CMT2138

****************3-DIGIT 787
04 00213563 9908 990601AKT
TOM KIRKLAND **
5907 IVY HILL DRIVE **
AUSTIN TX 78759

U.S. $3.50

06>

7 25274 86667 0

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC
Servicing & Technology

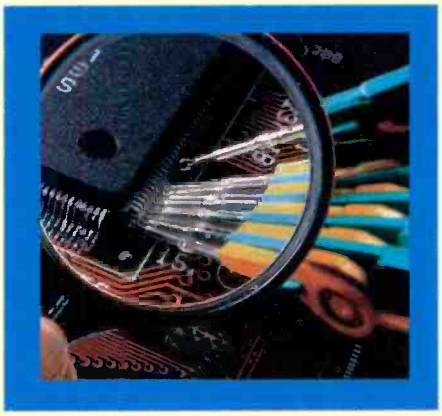
Volume 19, No. 6 June, 1999

Contents

ON THE COVER

The scope of consumer electronics is constantly changing and expanding. It once meant only television and radio, and now encompasses those as well as VCR, DVD, CD, personal computers, microwave ovens, and more, much of it digital. Technician skills, as well as the test equipment mix in the service center, have to be constantly changing and expanding to stay current. (Photo courtesy of Sencore)

page 6



page 24

page 9

More about HDTV

For several years now, we've been talking about HDTV. The industry has been talking about how wonderful it was going to be to be able to see a television picture that looks as sharp and clear as a motion picture, and with high-fidelity surround sound. HDTV is now a reality. Some large stations in the larger markets have begun broadcasting in HDTV. Just a few weeks ago, the Tonight Show began broadcasting via HDTV.

According to the manufacturers, consumers are buying HDTV sets in reasonable quantities, but not in the numbers that had been projected.

At the moment, there is still not a great deal of service information from the manufacturers. Several manufacturers have published general information about the nature of HDTV, and some informational publications about how HDTV transmission and reception work. Some of this material includes conceptual block diagrams and the like, but we haven't seen any details, no actual block diagrams, schematic diagrams, circuit board photographs, or the like, as yet.

This probably should not be surprising, considering how new this technology is. We hope, though, that more details will be forthcoming, and as soon as we are able to obtain some technical information on HDTV, we'll publish it.

For the time being, though, we'll tell you what we have found out, and we'll share with you some things that we have surmised. For starters, the digital television process is extremely complex. And, just as with NTSC, it's probably a good idea for any service technician to have a passing familiarity with the process, but technicians shouldn't feel that they have to be experts in the field of digital television transmission.

For starters, the DTV transmission process is extremely mathematical, and there are probably only three people in the world who truly understand it. Okay, that's an exaggeration, but it really bends the mind to try to get a handle on what's going on. In order to take a program that consists of high-definition video and five channels of high-fidelity audio with low-frequency enhancement (commonly referred to as 5.1 channels of audio) and fit it into a 6MHz bandwidth channel took a lot of compression. And the compression process is extremely, and rigorously, mathematical.

Just consider this, keeping in mind that the ideas are somewhat oversimplified (and might even be just a little distorted). In the transmission process, the video signal is compressed by sending only the information about the portion of the scene that has changed from frame to frame. In other words, if the station is sending a still picture, such as the logo and the words "Just Do It" at then end of the Nike commercial, for however many frames as that represents, the station has to send very little information. Just enough to tell the receiving set to display that frame again. If the picture being sent is, instead, nonstop action in a basketball game, the transmitting station would have to send much more information to update the changes that have taken place in the scene from the previous frame.

This video information is converted to digital form, a stream of bits. This stream of bits is then divided into "packets" of information. A packet of information may contain the data that makes up a number of video frames. The packets also contain data, called header information, that tells the receiving set what is contained in the packet. This video information is multiplexed with the audio information, and possibly other data, and transmitted via a 6MHz bandwidth channel.

Actually, this is true if the program information is to be transmitted through the air via a standard broadcast station. Because of the possibility of interference, the broadcast program has to contain certain information that helps the receiver be able to receive the signal reliably in spite of this interference, and the rate at which the data is transmitted has to be correspondingly slower. If the program is to be sent via some transmission system that is protected from interference, such as a cable channel, the signal can be sent at a higher data rate, and two programs can be sent in one 6MHz channel.

The receiving set has to have circuitry that allows it tune one channel from among many HDTV channels, to access the data that is in the received signal, to recognize the received data packets, to decompress them, to convert the data into video frames and audio information, and to display them. All of this is very complex, and will present a challenge to technicians.

But HDTV sets should also contain much that is already familiar to technicians. There will be a picture tube in there, or in the case of projection sets, three picture tubes. And the picture tube will have to have some kind of device that deflects the electron stream that writes the picture on the screen: a yoke. And that deflection device will have to have some circuitry that provides the deflection signal: horizontal and vertical deflection circuits. Moreover, every circuit in the set will need a source of power, so HDTV sets will have one or more power supplies.

Many recent standard definition television sets have contained circuits that should help technicians develop the skills needed to service these advanced TV sets. Many of today's sets contain microprocessors that control many of the sets functions. The EEPROMs in some sets that have given many technicians fits have provided them with further information that should help them understand the digital sets. Moreover, any technician who has every serviced computers has developed some useful skills that should be transferable to HDTV service.

As further information on HDTV becomes available, we'll publish as much of that information as possible. If any readers have any specific areas that they'd like to see coverage on, we'd like to hear from them. And, if any readers have any details or insights in the area of HDTV that they'd like to share with the editors of **ES&T**, or other readers, we'd be more than happy to hear from them.

Nils Conrad Persson

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

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

EDITORIAL
Nils Conrad Persson, *Editor*
(Internet e-mail: cpersedit@aol.com)
Alycia Nicholsen, *Associate Editor*
(Internet e-mail: AlyciaEST@aol.com)
Richard S. Moseson, W2VU, *On-Line Coordinator*

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

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

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

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

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

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

National Electronics Service
NESDA
Dealers Association, Inc.
Member, Electronic Servicing Dealers Association

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

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

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

CEMA welcomes new digital music initiative

Standards development must include consumer technologies manufacturers.

The following statement was issued in December 1998 by Consumer Electronics Manufacturers Association (CEMA) President Gary Shapiro in response to an announcement of the new Secure Digital Music Initiative (SDMI) undertaken by the Recording Industry Association of America (RIAA) and five music recording companies:

"I'm pleased to see the recording industry take steps to embrace the new opportunities to distribute pre-recorded music presented by the Internet and other emerging digital technologies. Our industry has long believed that distributing copy-protected music and other entertainment, educational and informational content via the Internet is a win-win proposition, spurring the development of exciting new technology innovations and providing new entertainment and educational options for consumers. Consumers ultimately will determine which technology best hits the 'sweet spot' between cost and functionality.

"Any effort to eliminate online piracy, however, must balance legitimate concerns surrounding copy-protection with the right of consumers to have access to the full functionality of our products. To that end, the members of the new SDMI must include all interested parties - particularly consumer technology manufacturers - in the development of any standard for downloading music from the Internet. Locking our industry out of the standards process would be like constructing a house without consulting with architects."

CEMA to develop rating for "wired" homes

Integrated Home Systems (IHS) Division will provide realtors and builders with technology standards

The Consumer Electronics Manufacturers Association (CEMA) announced on January 29 that its Integrated Home Systems (IHS) Division is developing a rating system to help consumers identify the technology systems and capabilities of a home. Intended for use by builders and realtors, the system would allow consumers to compare homes based on their technology rating, much like consumers can now compare homes based on other standardized criteria.

"It used to be that buyers would consider features like heating systems or built-in appliances when buying a home. Increasingly, technology considerations are becoming a priority for consumers who rely on technology in the home for entertainment, communication, and work-related use," said Richard Holtz, a member of CEMA's IHS Division. "This rating system will help builders and realtors list a home's features, while giving consumers a way to compare apples to apples in terms of technology capabilities."

The system will rate a home according to its built-in technology capabilities. Rating considerations are expected to include telephone and cable access, built-in security, lighting and audio/video wiring, and access to data and internet services. CEMA is seeking industry input and expects to introduce the rating system in the first half of 1999.

The rating system is part of CEMA's on-going effort to build consumer understanding of integrated home systems. Recently, CEMA introduced a consumer Web site — <www.TechHome.org> — to provide a resource for home systems information and products.

Microsoft introduces universal plug and play initiative for home electronics

Home networking showcased at the 1999 international CES

At a standing-room-only executive briefing on January 7, 1999, at the Consumer Electronics Show, Craig Mundie, senior vice president, consumer strategy for Microsoft, announced the Universal Plug and Play initiative to enable PCs, intelligent appliances, and smart objects to communicate with each other and share resources in a home environment. Microsoft's announcement was one of a host of home networking products and systems that were showcased at the 1999 International CES.

Mundie said the Plug and Play initiative is an important element in Microsoft's standards-based strategy of simple networking between consumer devices that will encourage consumers to implement home networks to add value to their lives.

"However," warned Mundie, "connectivity presents some tough technical problems. It is a daunting task to administer these networks. We needed a new strategy that features simplicity, reliability, and privacy and is done through the network."

During the briefing, Mundie conducted several demos including a tour of the home of the future; a mobile search conducted by Romer, an auto-PC speech-based interface product; and a presentation of digital and security cameras to show the automatic configuration of traditional devices.

"We are changing the user interface so that it is appropriate for the venue and the task," Mundie reported. "With wireless connectivity, we are building a bridge between work and home."

According to Mundie, the initiative takes a pragmatic approach that will simplify connecting multiple devices in homes. It will build upon existing standards and technologies without requiring consumers to replace the existing device driver infrastructure or adopt one specific networking medium.

The International CES has long been a showcase for integrated home systems products and training. This year's show has seen a 23 percent increase in home systems and custom home theater exhibits over last year. A new CEMA Website, unveiled at the 1999 CES, is dedicated to educating consumers on the subject of integrated home systems. TechHome.org is divided into five areas of home systems: Environmental Control and Energy Management; Security and Access Control; Audio/Video Entertainment; Voice and Data Communication; and Lighting and Window Treatments. Each area explains how separate home systems can be configured to work together, increasing their efficiency and effectiveness. The site contains a "How

(Continued on page 60)

Environmentally safe electronic chemicals and soldering apparatus

The new 1999 catalog from Caig features a variety of products to improve conductivity and maintain optimum signal quality on connectors, probes, switches, and other contacts and connectors. The company offers a complete line of non-aerosol applicators (wipes, pens, precision needle dispenser, etc.) for aerosol-sensitive customers. Products include: lubricants, deoxidizers, solvents, pastes, anti-static and shielding compounds, lint-free accessories, solder pots, plastic cutting and welding tools, heat shrink ovens, process convey or ovens, and more.

12200 Thatcher Ct., Poway, CA 92064-6876, Phone: 800-CAIG-123, Fax: 619-486-8398, E-mail: caig123@aol.com, Website: <http://www.caig.com>
Circle (100) on Reply Card

Repair/rework guidebook on CD

Circuit Technology Center offers an "all and everything CD" containing a wealth of information, beginning with the company's color catalog, FAQs, contract services descriptions, and order forms, and also its comprehensive guidebook on PC Board Rework and Repair. This 185-page guidebook is supplemented by a 100+ page Metcal rework guide, and a Weller guide to better soldering.

This illustrated guidebook includes over 75 procedures ranging from repairing surface mount pads to replacing components. These procedures cover repair and rework of both surface mount and through hole PC boards and assemblies.

45 Research Dr., Haverhill, MA 01832-1293, Phone: 978-374-5000, Fax: 978-372-5700, E-mail: info@circuitnet.com, Website: <www. circuit.com>
Circle (101) on Reply Card

Application note on jitter and timing analysis

LeCroy has released L.A.B. Briefs IV, its latest compilation of technical notes on performing jitter and timing measurements. The first section, containing three application notes on clock oscillators, discusses the basic operating principles of TCXO (temperature-controlled oscillators) and OCXO (oven-controlled oscillators) circuits, measuring clock oscillator frequency stability, and characterizing envelope shape and stability of gated oscillators. The next set of three application notes deals with PLL (Phase Locked Loop) circuits starting with a discussion of basic design considerations and moving to methods for making precision measurements of cycle-to-cycle jitter of CPU clocks.

700 Chestnut Ridge Rd., Chestnut Ridge, NY 10977, Phone: 1-800-453-2769, E-mail contact.corp@lecroy.com, Website: <http://www.lecroy.com>
Circle (102) on Reply Card

Basic instrument catalog

Hewlett-Packard Company announced the new HP Basic Instruments (BI) Catalog, 60-pages of benchtop test and measurement product information and case studies. The catalog also is available on a completely redesigned Website (http://hp.com/go/bi), with easy-to-download data sheets, application notes, and customizable "how to" scenarios.

The new customer-focused BI Catalog features four interwoven case studies. Each of the case studies focuses on a specific product measurement application.

In addition to the case studies, the catalog provides a detailed roster of the company's test and measurement products — from oscilloscopes, probes, logic analyzers, multimeters, and data-acquisition systems to counters, function generators, power supplies, multifunction portables, and radio frequency (RF) instruments.

For more information, call 1-800-452-4844.
Circle (103) on Reply Card

Proximity switches and photoelectric sensors catalog

The new ECG Power Switches and Photoelectric Sensors Catalog from Philips features 51 proximity switches and 23 photoelectric sensors.

Inductive proximity switches are precision, solid-state, metal-sensing devices that provide an alternative to physically activated limit and control switches with mechanical contacts, moving parts, and attendant wear characteristics.

Photoelectric sensors are for applications requiring precise "no-touch" detection of objects. They offer dual outputs NPN/PNP, light or dark ON, adjustable sensitivity, and built-in amplifier. Detectable objects range from solid to opaque and even transparent. Leading edge detection for precise positioning is also possible.

For more information call 1-800-526-9354 or visit their website at <www.ecgproducts.com>
Circle (104) on Reply Card

Power device catalog

The new ECG power device catalog from Philips features 322 industrial high current (3 to 2200 amps) semiconductor parts numbers in 44 different package outlines with complete product electrical specifications.

For more information, call 1-800-526-9354 or visit their website at <www.ecgproducts.com>
Circle (105) on Reply Card

Wire and tubing processing equipment catalog

The Eraser Company announces the availability of their new 1999 catalog; available in a 132-page full-color printed version or on a new interactive CD-ROM. The company manufactures a wide range of wire and tubing processing equipment, including wire, cable, and tubing cutters of all types, lead wire and cable strippers, coaxial cable strippers, magnet wire strippers, Glo Ring infrared heat tools, component forming tools, and, fybRglass brushes and wheels. The catalog provides complete technical, operational, and ordering information for each product. The CD-ROM will run on any IBM compatible PC with Windows 95 or 98.

Phone: 1-800-724-0594, Fax: 315-454-3090; E-mail info@eraser.com; Website; <www.eraser.com>
Circle (106) on Reply Card

CRT convergence

by Hulon K. Forrester

For some reason, many technical schools associate the CRT (cathode ray tube) with the receiving tube and consider it obsolete because it is a "tube." Nothing could be further from the truth. In the year 2K, it has been estimated, 300,000,000 CRTs will be built. In addition, the CRT can be adapted to the new 9 by aspect 16 ratio and the new sweep frequencies. Because of its cost compared to the flat screen, the CRT will continue to be in service for many years to come. Few people can afford to spend some $20,000 for a large screen that can be hung on the wall!

The CRT has been around, and will be around

The CRT is actually older than the receiving tube by some 10 years and has been in constant refinement ever since. The transistor has replaced most receiving tubes, but there are still applications that the receiving tube is best suited for. Therefore, the receiving tube business still thrives. The cathode ray tube, however, is in a class by itself.

The CRT has some similarities to the receiving tube in that it has *a heater, a cathode, a grid, a screen, and an anode*. In addition, a CRT has a focus anode and uses a magnetic field (yoke) to direct the electron beam to pinpoint any specific area on the screen.

If a superior method of producing a picture on a screen were invented, it would take forty years or more to phase out today's CRT. The future for the CRT is still bright. The new digital format with a different screen dimension ratio and faster sweep frequency is easily adaptable to CRT technology. Nothing will be required of the CRT by digital television that it hasn't done already.

They're everywhere

If you plan to make electronic service your vocation, you will find the CRT in every facet of the electronic industry. Whenever a screen is needed, it is usually a CRT and now, most exclusively color. Therefore it is to your advantage to know as much as you can about CRTs. Finding and buying replacement tubes is an important part of service, therefore, understanding the technology puts you in a better position to buy more economically. A surprising number of tubes are identical. The only difference in many tubes is the yoke and mounting hardware. Knowing how to exchange yokes and converge a unit, opens the door to greater flexibility in your service and a greater profit. Anyone can install a color CRT, but getting a sharp image in true color from corner to corner, has been a challenge to many

Forrester is a retired CRT consultant.

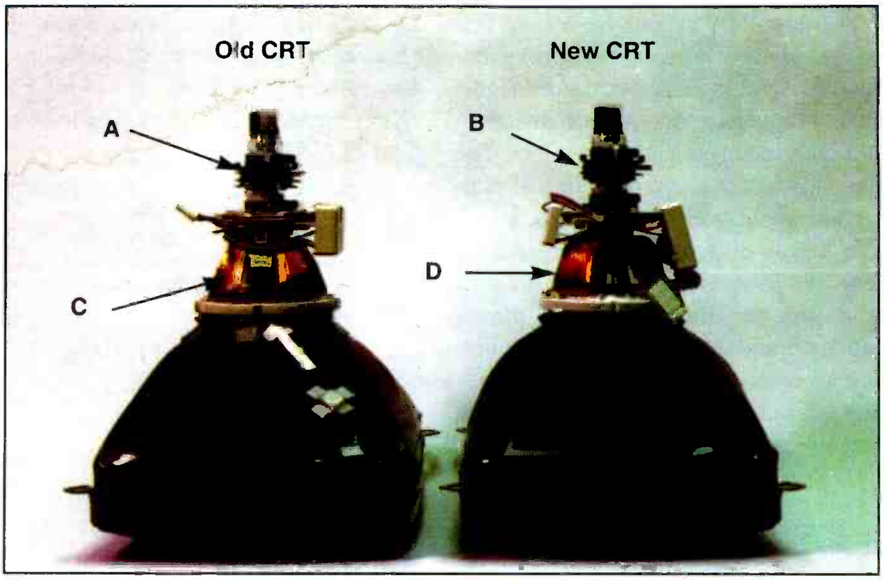


Figure 1. Begin by placing the old tube and the new tube side by side, face down on a *clean padded surface*. Do both the old and the new tubes have a yoke with a plug and a magnet assembly mounted on each one? The CRT manufacturer's order most often includes a yoke fully converged.

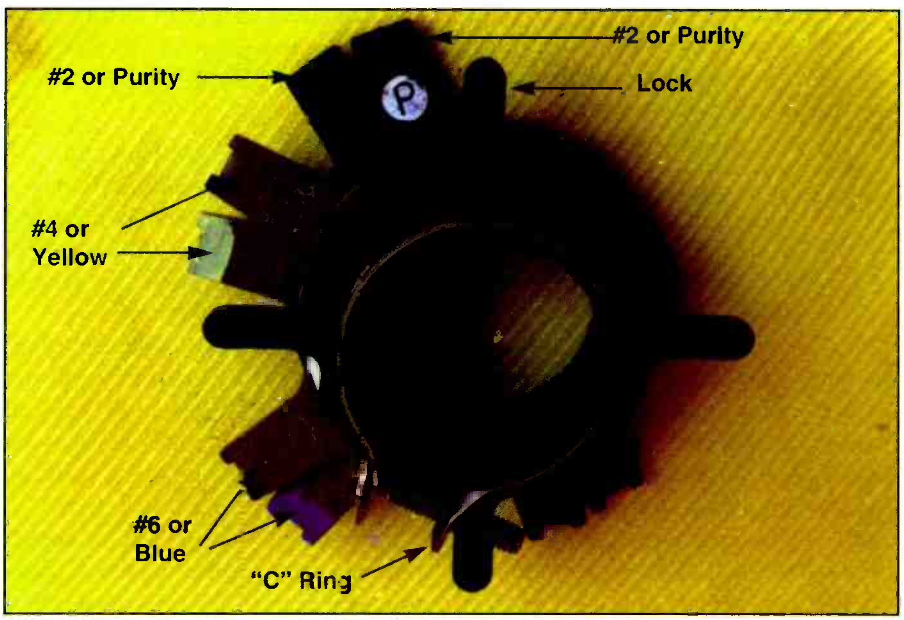


Figure 2. The convergence magnet assembly (CMA) is held in position on the CRT by a "C" ring.

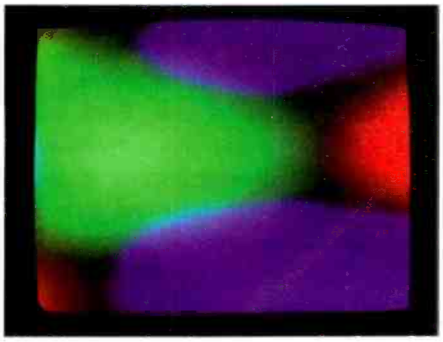


Figure 3. When you slide the yoke back against the CMA in the first step in converging the new CRT, you will see a pattern on the screen similar to this.

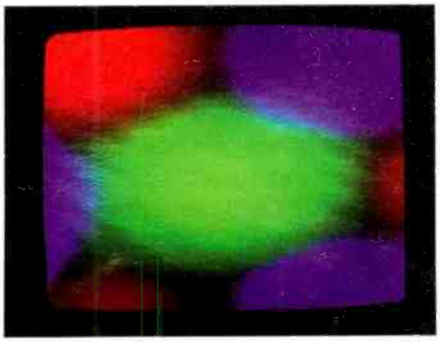


Figure 4. When you adjust the purity tabs marked either "P" or RED, the object is to move the green "blob" as nearly to the center of the screen as possible.

Figure 5. Slide the yoke forward until you have a solid green screen. Twist the yoke to make the raster level and tighten the "C" clamp. Also touch up the focus.

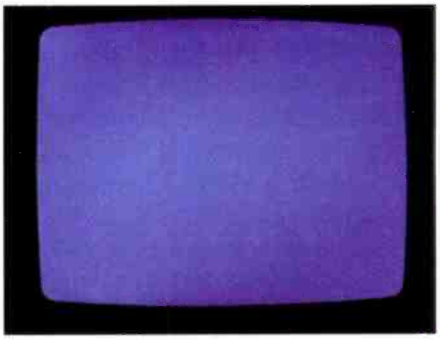


Figure 6. Turn down the green gun and turn up the blue. You should have a solid blue screen.

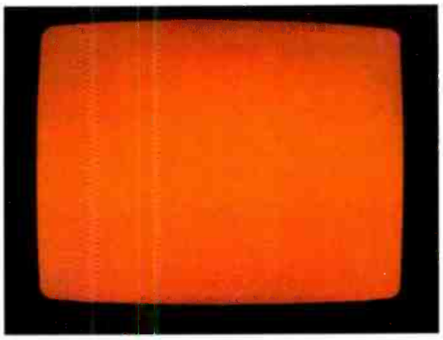


Figure 7. Repeat the procedure of Figure 6 for red, as in this photo.

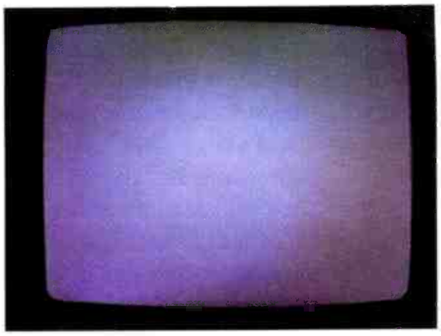


Figure 8. With no video signal, adjust the red, green, and blue guns for a solid white screen. You may have some discoloration, but if the center is white, you're still in the game.

service technicians. That procedure is called convergence.

Convergence

In this article, we are talking about "in-line" tubes only. Convergence of "delta" tubes requires an entirely different procedure. Begin by placing the old tube and the new tube side-by-side, face down on a *clean padded surface* (Figure 1). First, let us assume that both the old and the new tubes have a yoke with a plug and a magnet assembly mounted on each one (Figure 1). Check to see if the yoke plugs are identical, or if they're different. The CRT manufacturer's order most often includes a yoke fully converged. If that manufacturer shipped the same CRT with a different yoke or plug, the item would have a different part number.

If the yokes appear to be different, it is possible that the only difference between the two yokes is the plug. If you suspect that might be the case, measure the resistances of the vertical and horizontal windings. The vertical winding operates at a lower frequency, and therefore has a higher resistance, than the horizontal winding. If the vertical winding and the horizontal winding of the yoke "C" on the new CRT are both within plus or minus 10% of the corresponding windings of the yoke "D" on the CRT being replaced, there is a possibility that you can use the new yoke without disassembly and convergence. It's worth the effort to change the yoke

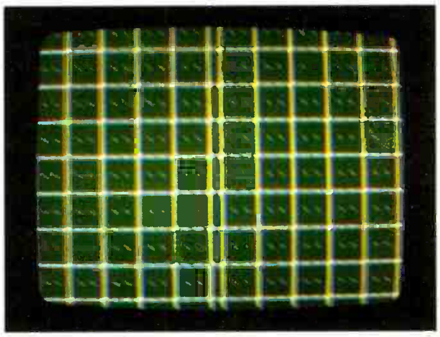


Figure 9. If everything has gone properly up to this point, when you clean up the wedges and turn on your cross-hatch generator, you should have an image similar to this.

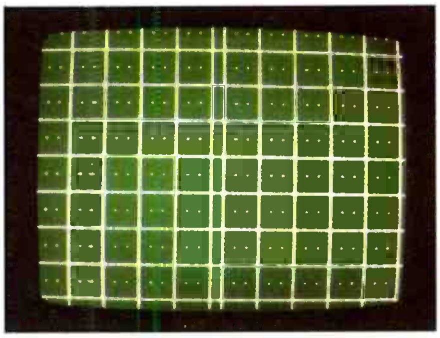


Figure 10. Proper adjustment of the yoke using the wedges will produce an image that looks like this. You may have to repeat the various wedge adjustment steps several times in order to achieve this situation.

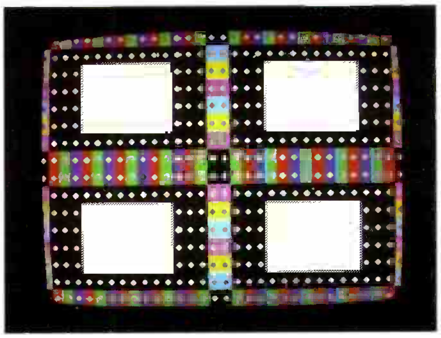


Figure 11. If the set is properly converged, when you put a color pattern on the screen, it should look like this.

plug (if necessary) and try it. If you get a picture and can adjust the height, width, and linearity, you're through!

Exchanging yokes

If the resistances of the windings of the yoke that came with the new CRT do not correspond to the resistances of the respective windings of the old yoke, you'll have to swap yokes. Take a look at the photograph of Figure 1. The convergence magnet assemblies (CMA) are marked "A" & "B." In the close-up (Figure 2), you will note that the CMA is held in position on the CRT by a "C" ring. The nomenclature will be mentioned later.

To replace yoke "D" with yoke "C," you'll have to remove the CMAs. If there is no yoke or CMA on the new tube, you will use the old ones on the new tube. Otherwise, using a marker, you will carefully mark the position of the *new* CMA (both vertically and clockwise) on the *new* CRT, remove it, and put it to one side. Then remove the CMA on the old tube and put it someplace where it won't be confused with the new one.

Loosen the "C" clamp on the old tube yoke, slide a knife between the *tube and the rubber wedges,* then remove the yoke. Now, the rubber wedges may be removed from the yoke with a twisting motion, being careful not to break or bend the windings or break a wire. Do the same to the new yoke, then put the new yoke and wedges to one side. Place the yoke from the *old* tube on the new one, tightening the "C" clamp enough to hold the yoke in place. Now take the *new* CMA and carefully place it in its original marked position. The old CMA and the new yoke may be saved for future use. You can probably return the old tube for dud credit.

Mounting the new tube

As you mount the new tube, remember to reconnect the HV and plug in the yoke (the fastest way to burn the phosphor in a CRT is to turn a unit on when the yoke is not plugged in). Be sure that the grounding springs are in contact with the outer coating (DAG) of the CRT and the plug is firmly in place on the back of the tube. Now, we are ready to reconverge the unit.

At this point, if the unit has been off long enough, turn it on and the built-in degausser will operate and degauss the tube. If you think it might be necessary, use a separate degausser to degauss the tube before turning the set back on. Adjust the brightness to medium and the contrast to full. Then adjust the focus control for a sharp raster. Now take a 20 minute break and allow the unit to operate so that things in the new CRT will "settle down" before it is converged.

Beginning the convergence procedure

After your break, connect a cross hatch generator to the unit for a raster and adjust G2 by turning the control just enough to blank out any "hash" in the background. After making this adjustment, do not turn G2 any more. Turning it will adversely affect the resolution.

Now slide the yoke back against the CMA. You will see a pattern similar to that shown in Figure 3. You may turn the lock on the CMA (Figure 2) counterclockwise so you may move the tabs, but it will be tight enough to stay where you leave them. Turn the brightness to midrange and the contrast to full. Turn the red and blue screens all the way down. Then slide the yoke back against the CMA. (It may be necessary to adjust the brightness). Now adjust the purity tabs marked either "P" or RED. The object is to move the green "blob" as nearly to the center of the screen as possible, as in Figure 5. Then slide the yoke forward until you have a solid green screen, (Figure 6). Twist the yoke to make the raster level and tighten the "C" clamp. Also touch up the focus.

Turn down the green gun and turn up the blue. You should have a solid blue screen (Figure 7.) Repeat for red as in Figure 8. If as you go through the steps in this procedure the screen is solid Green, then solid Blu,e and then solid Red, you now have achieved "Purity." (It may sometimes be necessary to repeat the procedure for optimum results.) With no video signal, adjust the red, green, and blue guns to achieve a solid white screen (Figure 9). At this time, you may or may not have some discoloration in the corners or sides, but if the center is white, you're still in the game.

Completing the convergence procedure

Now we are in the last lap. Clean up the wedges and turn on your cross-hatch generator. You should have an image on the screen similar to that of Figure 10. You will note that you have areas with three different colored lines. There may be some discoloration in the corners, but don't worry about it now. Back to the CMA: Adjust the tabs marked yellow (or 4) so the red will superimpose on top of the blue both horizontally and vertically.

Remember, the green is stationary. You may use the CMA tabs marked with 6 (or blue) to move the combined red and blue on top of the green. (It may be necessary to repeat the procedure.) Now, you should have the white lines looking good in a large area of the center. Turn the CMA lock ring clockwise to lock the tabs in place.

Converging the corners and sides

Tilt the yoke toward the 12 or 6 o'clock position to converge the red and blue vertical lines at the top and bottom of the raster. Insert a wedge as necessary to maintain this position.

Next, tilt the yoke to the 3 or 9 o'clock position to converge the red and blue lines at the sides of the raster. Placing the wedges about 120 degrees apart around the yoke will maintain the yoke position. You may have to repeat these steps several times in order to get an image, that looks like the one in Figure 11. When the convergence is done, glue the wedges in place with hot glue or silicon cement and make sure the "C" clamp is tight.

With no signal being fed to the set, you should have a solid white screen. You may want to adjust the red, green, and blue guns to get the best possible white. Turn the brightness down just below the point of visibility and put one or two color patterns on the monitor. Figure 12 shows good examples of a good convergence.

One last note. In spite of your efforts, convergence may not meet your expectations and efforts in the corners. You will note in Figure 1 that the old tube has a strip taped to the tube. That is a "Strip Magnet" that was used for touch-up.

By inserting one or more of these strip magnets in different positions under the yoke, you may clear up any problems in the corners of your image. These are available in different sizes from your CRT supplier. It never hurts to have several in stock for just such purposes. ■

This information was compiled with the assistance of the Engineering department of Video Display Corporation, Tucker, GA.

Test equipment update: The changing nature of consumer electronics repair

by Bob Rose

I just recently watched a two-hour television documentary on the microprocessor. The producers led the viewers on a visual tour of who produces them, how they are manufactured, where they are used, how they are used, and, as you should expect, how they have come to dominate, or should I say "control," life at the close of the millennium. For example, I have forgotten how many of these silicon-based entities control the various functions of the van my wife drives, but there are a lot of them. I recently did some shopping for an electric razor, and would you believe the top-of-the-line electric razor I thought about buying was controlled by, guess what, a microprocessor? They are used everywhere!

You can't fight change

There was a time when my partner and I sold electronics. Those were the days when manufacturers sold to dealers like us at the same price they sold to WalMart and Lowe's and other discount houses. I distinctly remember a woman coming in and asking to buy a television that was not remote-controlled. She said she didn't think she could learn to use a remote control or "those fancy buttons" on the front of the TV. We couldn't help her because mechanical tuners and analog controls had at that point become a thing of the past.

Service centers have to adapt

I have the privilege of talking to and exchanging correspondence with electronics technicians from several states. Every once in a while, someone bemoans the changes through which the industry is going, changes due for the most part to the microprocessor. I have seen service center after service center in West Tennessee close because the owners either could not make a decent living or would not adapt to the changes the industry is undergoing, again due, for the most part, to the microprocessor.

Rose is an independent consumer electronics business owner and technician.

The documentary to which I referred earlier compared the advent of the microprocessor to the Industrial Revolution in the eighteenth century. I suspect the documentary is correct.

What am I trying to say? If we techs are smart, we're going to have to learn to work with these little silicon demons! The sooner we get on with it, the happier and more productive we shall be.

Rethink the way you apply test equipment

Moreover, inclusion of microprocessors in consumer electronics products requires that, in many cases, technicians must rethink the way they apply their test equipment to a given type of fault. Read on to see some examples.

Having stood on my soapbox and said my piece, I will now proceed to share with you a few of the interesting problems I have encountered in my work with "the lord of twentieth century" electronics; the microprocessor. Needlessly to say, some of these problems are nothing short of bizarre. If I don't have hair on my head, and I don't, it's because I have lost it working on televisions.

RCA

The first examples come from Thomson Consumer Electronics' CTC175 chassis. However, these symptoms could crop up in any TV that is microprocessor-controlled.

TV fails to turn on

A customer brought an RCA CTC175 set in the other day and said, "I can hear it click when I turn the power on, but the TV won't come on." The tech who works with me in the service center confirmed the symptom. The degauss relay would click several times when the power button was pressed. And sometimes, the high voltage would come up and immediately die. But he had some difficulty determining what was keeping the TV from powering up. Before I knew it, he was troubleshooting the B+ regulator because he thought the set was going into XRP (x-ray protection) shutdown.

Always, I repeat, *always*, confirm the standby voltages. Don't assume, because the TV comes on and then goes off, that the standby voltages are correct. If you are working on a new generation RCA television, you can quickly confirm the standby +5V at pin 8 of the EEPROM (electrically-erasable programmable read-only memory). The standby voltage at pin 8 of this set was about 3V, enough to permit system control to execute an *on* command some of the time, but not enough to permit the microprocessor to run.

Now take a look at Figure 1. The input to U4102, the +12V standby regulator, comes from a step-down transformer and associated components. The +12V output provides the standby +12V and feeds to +5V regulators. Q4105 in this set was leaky base-to-emitter, pulling down the +5V supply to system control. We installed a new transistor, and the set attempted to start but failed!

Same set, new problem

The failure to start this time was different. We checked the output of the B+ regulator (Figure 2) and found it to be at about +175V after the TV started up and just before it shut down. Was Q4150 and/or associated circuitry defective? No, they checked okay.

If you study Figure 2 carefully, you will note that Q4150 is controlled by Q4153,

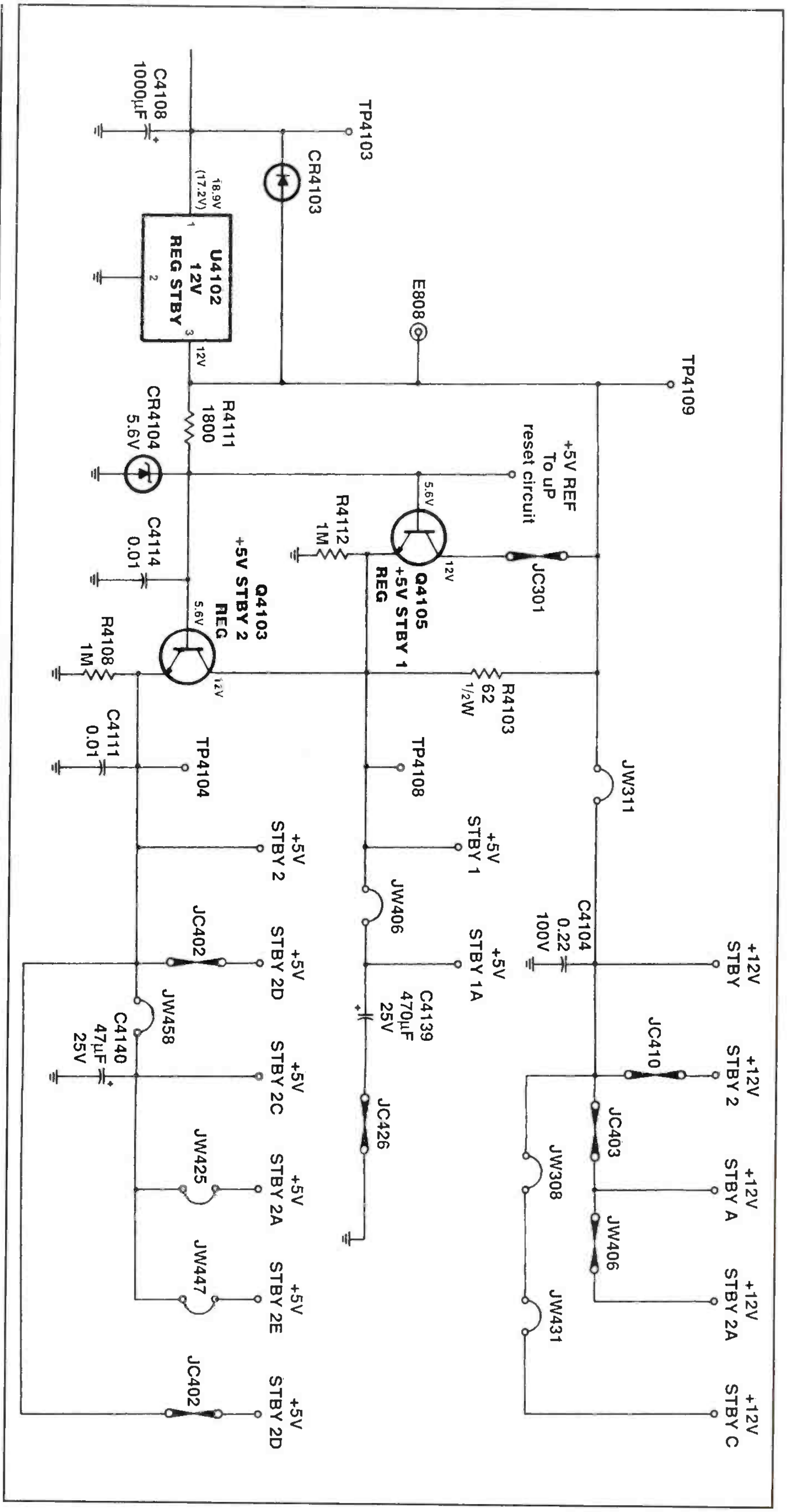


Figure 1. The standby voltage at pin 8 of the EEPROM on this set was about 3V, enough to permit system control to execute an *on* command some of the time but not enough to permit the microprocessor to run. We found that Q4105 was leaky base-to-emitter, pulling down the +5V supply to system control. We installed a new transistor, and the set attempted to start but failed.

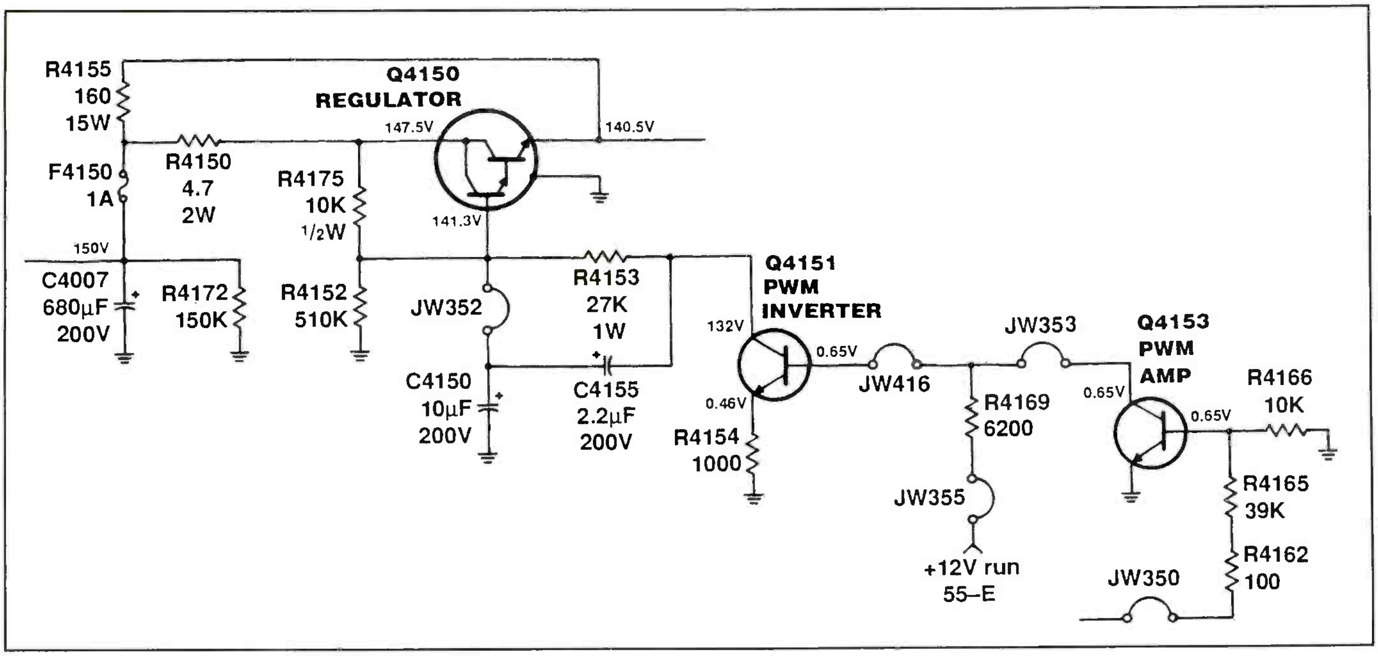


Figure 2. The no-start problem in this set was eventually tracked to a bad EEPROM. Replacement of this device restored the set to operation.

the PWM (pulse-width modulation) amp, which is in turn controlled by pulses from pin 29 of the T Chip, which is controlled by information from the microprocessor. In other words, the B+ regulator is managed by system control! If you check page two of the service menu, you will note that item eighteen is called "B+ trim."

In other words, if you want to set the B+ on a CTC175, you don't adjust a variable resistor as you would in a host of other sets. You access the service menu and adjust parameter 18 for the appropriate B+ voltage. Well, you guessed it. The problem was the EEPROM. So, we removed power, repaired the tuner wrap, installed and programmed a new EEPROM, and the TV worked like a new one.

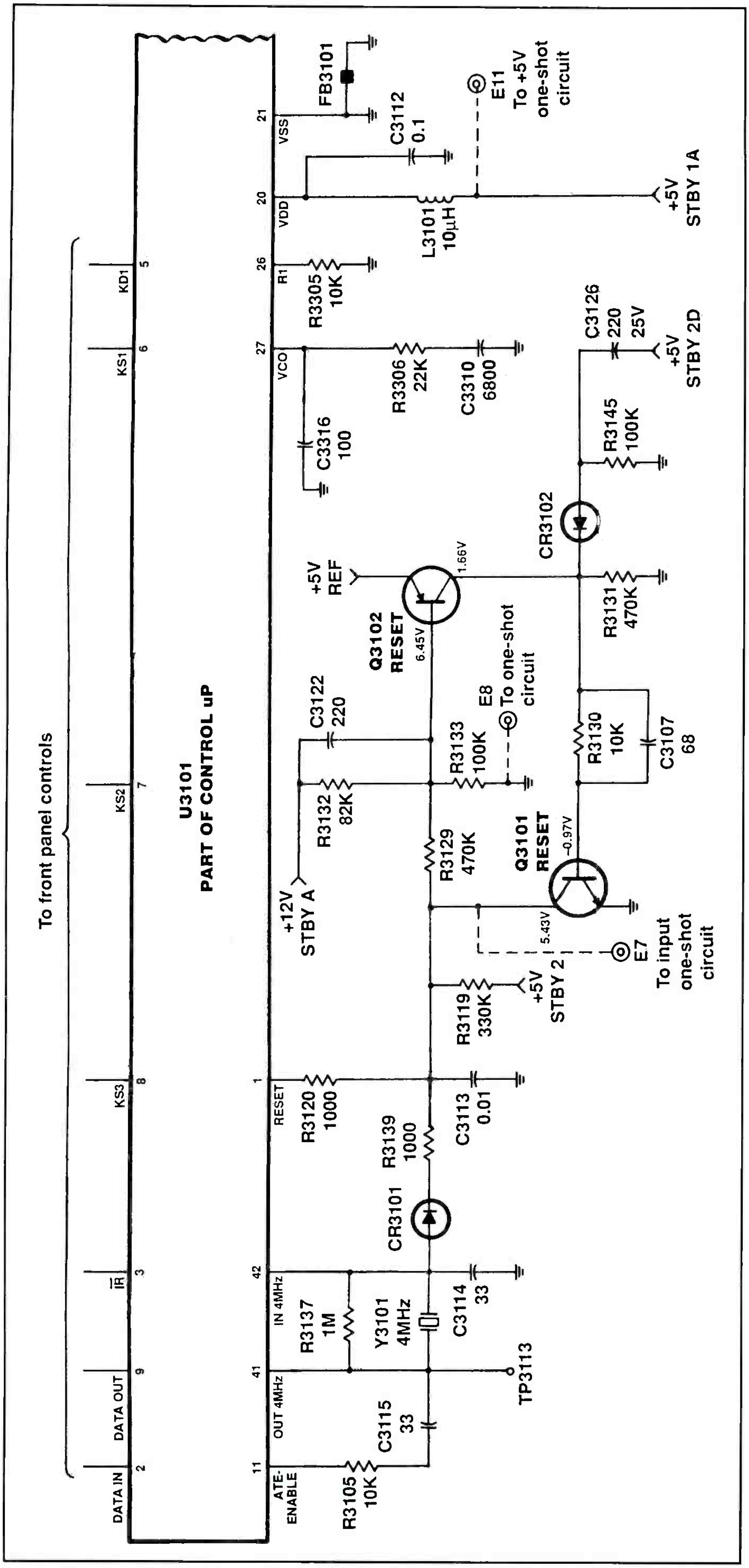


Figure 3. A faulty U4102 caused this set to fail to respond to any of the front panel controls. It wouldn't even turn off. Replacement of U4102 restored normalcy.

This was a more-or-less routine problem, like a host of ones you solve on a day-by-day basis. The next problem I am going to discuss belongs in the category of the truly bizarre. It too concerns a CTC175.

A bizarre problem

The customer said after the TV played for about ten minutes, it would just go off. We plugged the TV in and fired it up and discovered it had an excellent picture and good audio. I went about my business. In about ten minutes, I noticed the audio had disappeared. Thinking the TV had shut down, I walked over to it and discovered it still had an excellent picture. I thought I would turn it off and back on to see if the audio reappeared, but I found I couldn't turn the TV off with the remote control or the front controls. In fact, *all* of the controls were dead.

I removed ac power for about a minute, reapplied it, and picture and audio came on. After about a minute, the audio disappeared again, and I was confronted with the same set of symptoms. The symptoms had to point to a system control problem.

Looks like the microprocessor

I picked up a can of freeze spray and cooled the microprocessor. Audio returned, and the controls began to work until the chip warmed up. Before I bothered to check any voltages and waveforms, I yanked the microprocessor out and installed a new one because I just knew the old chip had to be the problem. Didn't the freeze spray confirm it? Well, the new processor did exactly what the old one did. I had solved nothing.

Check voltages and waveforms

When all else fails, check voltages and waveforms. Follow me by looking at Figure 3. The voltage at pin 20 (VDD) was right at 4.85V and did not vary even when the chip acted up. VDD should always be the first thing you check if the problem seems to be related to the microprocessor. I always check the ground connection as well, because I have encountered a situation in which a loose ground connection caused a TV to fail. You can check ground (VSS) and VDD at the same

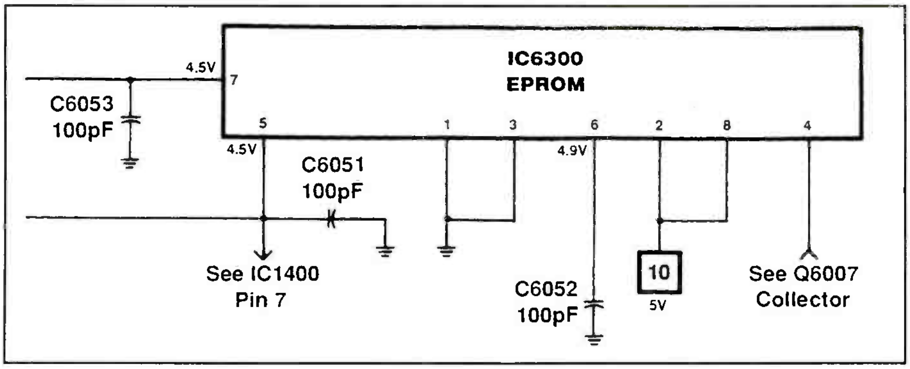


Figure 4. This detail shows the connections to IC6300, the EEPROM that became faulty and caused the audio and video in a Zenith chassis to disappear.

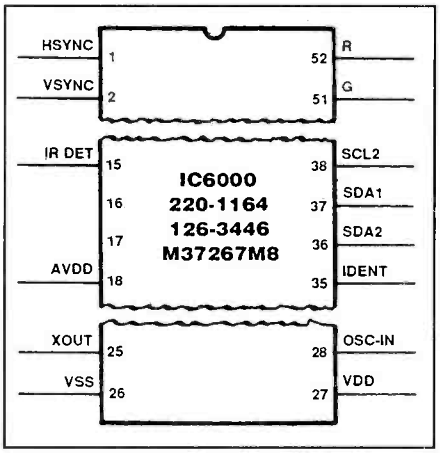


Figure 5. In this Zenith television set, the symptoms were no raster, no picture, no audio, but the menu functions work. You might think the problem is the IF/video processor, and that would be a good guess, but it would be wrong. The problem is the tuner.

time by connecting the negative lead of your meter to VSS and the positive lead to VDD. I had good ground connections.

The next check should be the oscillator. I fully expected to find the oscillator at pins 41 and 42 working because the TV was still on. The oscillator worked fine *until the TV began to act up*. When I checked it after audio had failed and the front controls ceased to work, I was surprised to learn that the oscillator had stopped. The chip was new and therefore likely to be good. Was the failure due to Y3101, C3114, or C3115? Possibly. But before we change additional components, let's make another check or two.

The next check should be reset at pin 1. The voltage at this pin ought to be +5V after the set has been plugged into an ac receptacle. This voltage was initially at +5.3V, but the longer the TV played, the lower the voltage dropped until it just disappeared. When reset disappeared, the oscillator stopped, and the bizarre symptoms I noted set in. I judged that the problem was due to loss of reset voltage. As you can see, there are a number of components that could turn out to be the culprit. All of them appeared to be good.

Standby voltages

If you are familiar with this particular circuit, you will know it must have two voltages to work, +5V standby and +12V standby (Figure 1). It is always a good idea to have a circuit description handy. I can't remember everything, therefore, I keep a library. According to the literature, the reset circuit monitors the condition of the 12V standby supply. If this supply voltage drops below 10V, the reset circuit activates and puts the microprocessor into a low power mode (CTC175/176/177 Technical Training Manual, page 12). I moved my meter probe to pin 3 of U4102 (Figure 1) to monitor this voltage. The standby +12V line began at about 11.9V when the TV was first plugged into ac. However, it began to drop shortly thereafter. When the standby +12V dropped below 10V, the reset voltage disappeared, the oscillator dropped out, and the strange symptoms I noted earlier appeared. I fixed the TV by replacing U4102.

Zenith

My next set of illustrations of how to deal with microprocessor-related problems was generated by problems I encountered in servicing Zenith sets. EEPROMs cause their share of problems.

Everything works, but no picture or sound

The first problem concerns an unusual set of symptoms I encountered while repairing a 9-1130 module. I have since found out that these symptoms also occur

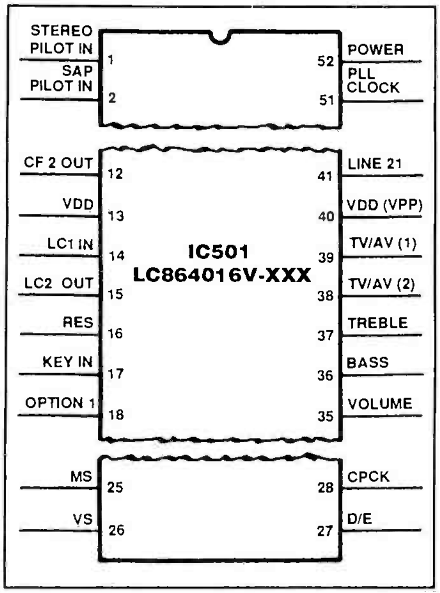


Figure 6. This Sanyo TV, model DS13430 exhibited a classic symptom: it was a dead set. On the microprocessor, IC501, VDD and ground connection were fine, the oscillator was in spec, reset voltage was correct. Pressing the power-on button caused no response at pin 52 ("power"). The microprocessor was defective.

in the 9-1118, 9-1132, 9-911, and 9-897 modules (and possibly others as well). The televisions turn on and off, will change channels, will indicate that volume up and volume down functions work, and have all menu functions, but have no picture and no audio.

The first time I encountered these symptoms, I thought I had a problem with IC1200, the IF/video processor IC. At least, it seemed like the culprit. The relevant voltages were present, but there was not even a hint of video or audio out at the appropriate pins. However, a new chip did not solve the problem. Having worked on a lot of RCAs, I wondered if the symptoms pointed to a corrupted EEPROM, IC 6300 (Figure 4). I had a junk module in my inventory and wondered what would happen if I just switched EEPROMs. When I installed the other EEPROM, the TV came on and worked fine.

Some general guidelines

I have seen this problem several times since then, but I can't give you hard-and-fast diagnostic information. I think, repeat, I think, that if you scope pins 5 and 7, the data and clock lines, and find no activity after the TV turns on, you are on safe ground to change the EEPROM. If your research points you in a different direction, I would appreciate hearing from you. Even the consultant I talked to at Zenith was unable to give me adequate diagnostic information. Then again, maybe I didn't talk to the right person. Anyway, if you have additional information, I would appreciate your sharing it with me.

Set turns on, won't turn off

I serviced another EEPROM problem in which you might be interested. This particular TV came on the minute it was plugged in and would not turn off via front controls or the remote control. If you look at a schematic of the 9-1130 module, like Sams Photofact Folder 3181, you will find several things that can cause this problem, most of them in the power supply. However, in this set these components checked good, and every diagnostic indicator pointed to the microprocessor. But for some reason, I wasn't convinced that the microprocessor was defective. Having a little time on my hands and another junk 9-1130, I decided to switch the EEPROMS just to see what would happen. Would you believe replacement of the EEPROM solved this problem?

A friend of mine has just recently been involved in a similar repair situation. He tried to order an EEPROM for the 9-1130 and was told the part is not available. He could buy a blank EEPROM, but he could not buy a programmed one because the programming information is "proprietary," and the manufacturer will not release it. He was forced to purchase a new module because he couldn't get a $4.00 part. This is one reason, among others, why I usually will not sell defective Zenith modules. A tuner or an EEPROM or a flyback is worth more to me than the dud fee or the price I can get by selling it to a depot.

No raster, no picture, no audio

Now let's look at a bizarre problem that crops up in the new Zenith TVs. The illustration I will use is a partial schematic of the system control circuit for a 9-1831 module (Figure 5). However, these symptoms, and the cure, apply to many of the new Zenith televisions. The symptoms are as follows: no raster, no picture, no audio, but the menu functions work. You might think the problem is the IF/video processor, and that would be a good guess, but it would be wrong. The problem is the tuner.

If the tuner controller IC fails, it shunts clock and data information from the microprocessor to ground. If there is no clock and data activity, the EEPROM and the IF/video processor IC shut down. If you don't have a scope (and if you don't, you should be ashamed of yourself) or won't use the one you have, simply unsolder the tuner. If you get raster and "white noise," you have found your problem. Incidentally, I keep two of the new tuners in stock. The last time I sold my tuner duds to a depot, I counted ten Zenith tuners in the batch I sent off. In other words, this is a common problem in the new Zenith TVs.

Sanyo

The last system control problem I will deal with grows out of my attempt to service a Sanyo TV, model DS13430. As system control problems go, this one was routine, but it illustrates the importance of knowing and using good troubleshooting techniques. The symptom was a classic one, a dead set.

If you suspect a system control problem, you need to make a minimum of five checks:

- VDD,
- VSS,
- oscillator,
- reset, and
- data in/data out functions.

Take a look at Figure 6 as we walk through these steps. VDD was at the stated value, and there were no problems with the ground connection. The oscillator was at the correct peak-to-peak value and right on frequency. Reset voltage was correct. That leaves data in and data out pins to check. While monitoring pin 17 ("key-in") of IC 501 with a scope, I depressed the power on button and noted an appropriate response. I moved the scope to pin 52 ("power") and depressed the power on button and noted no corresponding activity. The microprocessor was defective.

Conclusion

It is a fact: these days consumer electronics change at least twice a year. The changes are so rapid and sometimes so radical they are difficult to keep up with. Many of the changes are due to the changing nature of microprocessor technology. However, with a little study and effort, you and I will be able to keep up with the technology and make a good living at the same time. ■

Test benches

by the ES&T Staff

Most of us don't think a great deal about the conditions in the workplace, but those factors can make a great difference in the attitude and efficiency of workers. If a worker has an appropriate place to do his work, comfortable working conditions, few distractions, and the right tools and supplies, the company has gone a long way toward making him efficient.

The bench

One of the most important items in the work area, for a consumer electronics technician, is the test bench. Everything the technician will be working with will be there at the bench: the unit to be serviced, the test equipment and test equipment accessories that the technician will use to diagnose the problem, the electricity to power the unit and all the tools to disassemble and reassemble the product, and to solder and desolder as necessary, supplies, manufacturer's literature and a telephone. These days, a computer is becoming more and more a part of the scene at the service bench. And of paramount importance is plenty of light of the right kind in the right place.

An efficient bench allows a technician to find room for all of those, and to be able to work unencumbered by cords that might be hanging all over, or lack of appropriate electrical outlets.

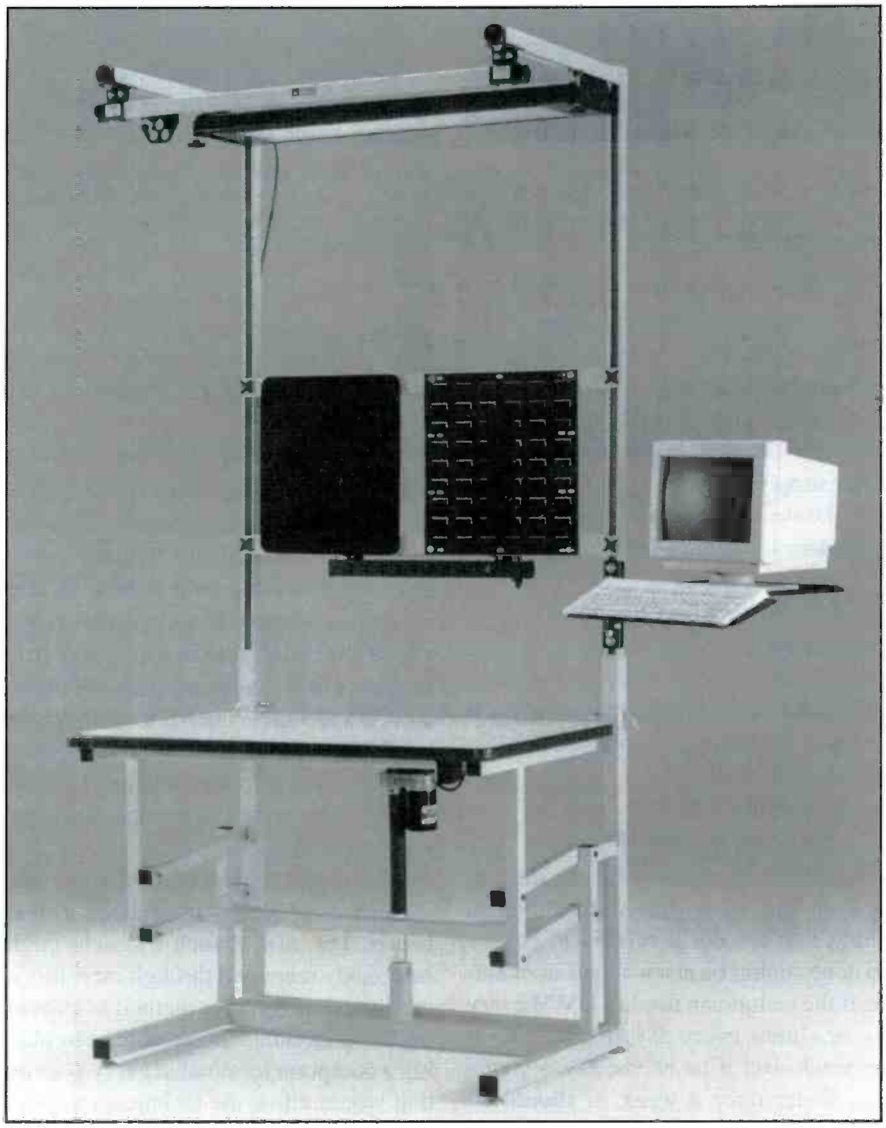


Figure 1. A modern workbench offers the technician conveniences, such as adjustable surface height, space for a computer, overhead standards for tools, and more. (Photo courtesy All Metal Designs)

Make it yourself or buy

Some service centers make their own benches, or buy existing standard benches and modify them. And if that works, there's nothing wrong with it. But there are some tasks that are better left to the experts, and this might be one of them.

One of the problems with making or modifying a bench in the service center is that it consumes labor that should be being expended on servicing products, attending seminars, or just brushing up on servicing skills.

And here's another. Even though everyone in the service center is very familiar with test benches and the needs of the technician at the bench, and even though they might have a lot of ideas to make the bench an efficient workplace, without the expertise of people who make benches as a business, the test bench that they come up with might not be as efficient as it could be.

Things to think about when designing a service bench

In planning a project, it helps to prepare a checklist. It's useful just to sit down, picture the project in your mind, maybe look at the current situation, and brainstorm to list as many of the requirements as you can think of. It might even be useful to sit down with a group of technicians and managers and generate as many ideas as possible as to what is, or might be, required at the service bench.

Here's a partial checklist of the things that make up a test bench. No doubt most technicians and service managers could add to this list.

• Surface area for the product, test equipment, tools, etc.

• Storage: drawers, shelves, bins, etc.

• Tools

Figure 2. Manufactured workbenches can provide lighting options that help get the light on the work where it is needed. (Photo courtesy Teclab).

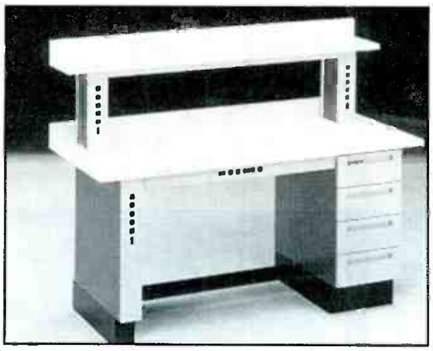


Figure 3. A choice of arrangements and sizes of drawers enhances the convenience and usefulness of workbenches. (Photo courtesy Teclab).

- Soldering/desoldering equipment
- Test equipment
- Supplies
- Lighting: general, task, and spot
- Power: ac, isolated ac, variable ac/dc power supply
- ESD (electrostatic discharge) protection
- Holder for service literature
- Communications
- Forms/writing implements
- Chemicals
- Computer or terminal
- Replacement parts/supplies reception
- Fume extractor
- Foot rest

Stocking the service bench

Everything necessary to get the job done should be at the service bench. Things that are not necessary to get the job done should be elsewhere. For example, if the technician needs a DMM every day, or almost every day, it should be at the bench. But if he needs, say, a signal level meter once a week, it should be available nearby, but shouldn't be cluttering up the work area.

The items in the checklist are pretty much self-explanatory, but here's a little detail about some of the critical elements.

ESD (electrostatic discharge) protection

Almost every consumer electronics product made today contains large-scale integrated circuits that are susceptible to electrostatic discharge damage. If these devices are handled without the necessary precautions, they may be destroyed or damaged.

Every service position should provide as much protection from this type of damage as possible — grounding wrist straps, static dissipative work surfaces, and static protective bags for storage.

Communications

In a small service center, it wouldn't be necessary to set up an elaborate communications system; the technician merely has to speak to someone nearby. In larger service centers, however, the technician at the bench may be a long way from the office or the replacement parts/supply area. If a technician needs to check on the availability of service literature, certain parts, or other requirements, it could mean several trips a day, causing productivity to suffer.

Such trips could be minimized by providing intercom communications at every bench. The cost of such a system might be quickly recouped through increases in productivity. Another method of providing this communication would be by placing a computer terminal at every position that would allow the technician to place requests via the keyboard.

Parts/materials

Hand in hand with good communications goes good parts handling. In the average medium to large service center, when a technician has isolated a problem to the component level, he walks to the parts/supplies area and submits a request for what he needs. The supply person may be busy at the time, thus causing delays. A system such as this can cause a great deal of wasted time.

In one service center operated by a major manufacturer, every service position has not only a means of communication, but a pneumatic tube station. Under this system, once the technician has isolated the problem, he can order the parts or supplies he requires and have them delivered to him, without ever moving from the bench.

Of course, a system such as this requires a considerable up-front investment, but the increased efficiency realized by making the best use of a skilled technician's time can more than offset the cost.

The little things

Servicing a product, such as a TV, presents some peculiar problems. For example, while servicing a larger set, it frequently becomes necessary to perform adjustments on controls at the rear of the set while observing the results on the screen at the front of the set. One of the more efficient and well thought out service centers we know of has a large mirror fastened to the wall at the back of the bench. With this setup, it is not necessary to find a mirror and try to place it where it can be seen. It's always right there.

Fume extraction

According to literature from one manufacturer of soldering fume extractors, the fumes produced when a technician solders may cause, or aggravate a number of problems in people exposed to the fumes: allergies, headaches, acne. In many service centers, for example, those that are large and well ventilated, fumes might not be a serious problem. The existing air handling system might be able to sufficiently diffuse the fumes so that they're not a bother. In other service centers, those that are small, or have low ceilings, or in which some of the technicians do a lot of soldering, it might be wise to consider the benefits of fume extraction, especially if any of the technicians complain of discomfort caused by fumes.

There are a number of ways to eliminate soldering fumes, ranging from the simple and inexpensive to the elaborate and expensive. Which of these solutions should be chosen by a particular service center would depend on the size of the service center, the number of technicians, and the amount of soldering that the service center does.

For example, one solution to soldering fume extraction is to eliminate it at its source. Some soldering/desoldering systems either come with, or can be fitted

Figure 4. Full-size file drawers are an option in workbenches where storage of documents is required. (Photo courtesy Teclab).

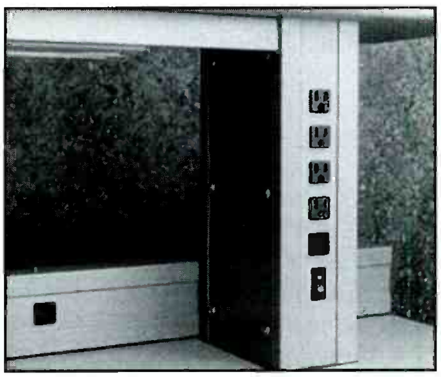


Figure 5. Manufactured workbenches offer a multitude of options for electrical power outlets.

with, tubes that are attached to the soldering iron in such a way that the fumes generated during soldering are sucked into a the tube and either vented to the atmosphere, or, more likely, routed to a canister where the fumes are absorbed and the purified air is recirculated.

Another approach is to place a larger, higher volume air nozzle that sucks the air in the vicinity of the work area, including the soldering fumes, and conducts it to a canister where it is purified and recirculated into the service center. Systems such as these can be purchased that either ventilate a single work station or that ventilate several work stations.

The most elaborate fume extraction is the type that has a vent hood at each work station and ductwork that leads to a central fan that exhausts the fumes to the outside. The advantage of such a system is that it completely rids the service center of the unwanted fumes.

The exhaust method does have a couple of disadvantages. For one thing, there are environmental laws at every level; local, state, and Federal that control the type and concentration of any fumes vented to the outside. You might have to prove that your installation is in compliance with those laws.

The other disadvantage is that air that is exhausted to the outside has to be made up by drawing air in from the outside. In the winter, that makeup air has to be heated. In the summer, the makeup air has to be cooled. Heating and cooling extra volumes of air can be a considerable expense.

Ergonomics

Another important, but often overlooked, aspect of workbench design is ergonomics, the study of how tools and workplaces should be designed to make a human worker more efficient and to minimize injury or distress to the worker. The popular and business press frequently carry articles on the problems that can arise when a worker performs certain tasks repetitively. It's more likely to occur on an assembly line where a worker might perform a certain task over and over hundreds of times throughout the day, but it can also occur to someone who performs the same types of task repeatedly over many years. Sometimes, this results in inflammation of the muscles or tendons that are used to perform the task. This kind of problem can cost the service center in many ways: loss of a productive technician for a period of time, payment of that technician, as well as a replacement, while he is out.

Many factors play a part in these problems: design of the tool, method of using the tool, number of times the tool is used during a work period, the height of the workbench, the height of the chair, placement of the chair in relation to the workbench. There are many good books on the subject. And for those who own a computer, a visit to the internet and a search on the word "ergonomics" will result in a list of many sites where the visitor will find help and advice on buying or designing an ergonomic workplace.

Some features of manufactured benches

With all manufactured products, whether it be test equipment, tools, etc., generally, the manufacturer has many years of experience in designing and building the product, and has had the input of hundreds of people who have used those products to help them refine the products. Moreover, they have the specialized tools, jigs, etc., that help make manufacturing efficient, as well as access to the correct materials and supplies.

As one example, one manufacturer of technical benches makes a point that the legs and other structural members of their benches are, in essence, channels for wiring. And the covers of these channels just unscrew. This means that this company can build exactly the bench a customer wants, with as many various electrical outlets as the customer wants, but down the road, if the requirements change, the customer can easily make changes accordingly. Moreover, they have a myriad of ways to add outlet strips, or customize existing products to make them more useful to the service center.

And the benches themselves come in a variety of shapes, sizes, heights, numbers of shelves, number and type and size of drawers, and other varieties that allow them to provide exactly the bench that the purchaser needs. Or they can provide a wall of benches for a given room, or line all of the walls with benches.

Adjustable benches

If a stationary bench isn't exactly what you need, another manufacturer offers benches that can be adjusted by the user to suit what the technician is doing at the moment. In some benches, the bench top can be made to move up and down. If an adjustable-height top that is motorized for easy adjustment is needed, they can supply that. If the service center needs to have a computer at the bench, appropriate shelves, that can be adjusted in height and angle to the bench are available.

Some of these benches are available with overhead sections so that tools can be suspended so that they don't get in the way.

Take the time to look around

For some service centers, a home-built, or modified, bench will work just fine. For other service centers, something more sophisticated and versatile is desired. Whichever a given service center chooses, in these times when efficiency is of paramount importance in consumer electronics service, and every one of a technician's minutes counts, thor-

BOOKS

***IC Cross Reference Book: Third Edition*, by Howard W. Sams & Company, PROMPT Publications, 152 pages, paperback $24.95**

The engineering staff of Howard W. Sams & Company assembled the *IC Cross Reference Book* to help readers find replacements and substitutions for more than 35,000 ICs and modules.

The third edition of the *IC Cross Reference Book* is divided into two sections. Section one lists IC or module part numbers in alphanumeric order by manufacturer's part number, type number, or other identification. At the right of the number is a replacement code/block number that you will use to look up comparable replacements in section two. As indicated, section two provides substitutions and replacements for the ICs and modules listed in section one.

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

***Schematic Diagrams*, by J. Richard Johnson, Prompt Publications, 196 pages, paperback $16.95**

Step by step, *Schematic Diagrams* shows the reader how to recognize schematic symbols and determine their uses and functions in diagrams. Readers will also learn how to design, maintain, and repair electronic equipment as this book takes them logically through the fundamentals of schematic diagrams. Subjects covered include component symbols and diagram formation, functional sequence and block diagrams, power supplies, audio system diagrams, interpreting television receiver diagrams, and computer diagrams. *Schematic Diagrams* is an invaluable instructional tool for students and hobbyists, and an excellent guide for technicians.

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

***The Microcontroller Beginner's Handbook Second Edition* by Lawrence Duarte, PROMPT Publications, 272 pages, paperback, $24.95**

Microcontrollers can be found everywhere - microwave ovens, coffee makers, telephones, cars, toys, TVs, clothes, etc. This book will bring you the information you need to understand, repair, or design a device incorporating a microcontroller.

This book examines all elements of microcontroller use including such industrial considerations as price vs. performance. Firmware will also be extensively analyzed and explained. A wide variety of third-party development tools, both hardware and software, will be seen. Emphasis is on new project design; however, once the reader has the knowledge to use a microcontroller, it will greatly enhance the ability to repair such devices.

Theory is fine, but doing is better. Once readers gain a solid knowledge of hardware and firmware, they will be able to put it to use by building five projects. They will progress from simple to very sophisticated. All relevant schematics, board layouts, and firmware will be provided and explained. This second edition also contains a CD-ROM with source code examples from the book, sample assemblers, and data sheets.

Lawrence Duarte is an electrical engineer at Display Devices, Inc.

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

***Basic Home Theater* by Gordon McComb, PROMPT Publications, 144 pages, paperback, $19.95**

This book will serve as a guide for you to create a movie theater environment in you own home. It discusses all aspects of this audio/visual revolution from TV sets, DVD players and satellite dish antennas down to the speakers, wires, connectors, and plugs you will need to plan, install, and maintain your home theater system.

In this book, you'll learn how to design, install, troubleshoot, and maintain your own home theater system. You'll discover the options available in TV screens, sound systems, and speakers, and how to connect everything together. If you've priced full home theater systems and you're worried about sticker shock, relax. This book does not assume you are buying a home theater system from scratch. You will find plenty of information on updating your current television and sound system to create a functional, enjoyable home theater.

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

ough research before making the build/buy decision, and before settling on a bench design once that decision has been made, can have a profound effect on the future profitability of the service center.

To help make this very important job a little easier, we provide a list of manufacturers who offer an array of technical furniture. Also, keep in mind that many distributors also carry workplace furniture.■

List of companies that supply workbenches

All Metal Designs
700 Windcrest Drive
Holland, MI 49423
616-392-3696
Fax: 616-392-2922
Website: http://www.allmetal.com

I.A.C. Industries
895 Beacon Street
Brea, CA 92821
714-990-8997
Fax: 714-990-0557
Website:
http://www.iacindustries.com

Lista International Corp.
106 Lowland Street
Holliston, MA 01746
508-429-1350
800-722-3020
Fax: 508-429-8653
E-mail: sales@listaintl.com
Website: http://www.listaintl.com

Teclab
Kalamazoo Technical Furniture
405 W Michigan Avenue, Suite 115
Kalamazoo, MI 49007-3747
616-372-6000
800-832-5227
Fax: 616-372-6116
E-mail: jsweezy@teclab-bench.com
Website:
http://www.teclab-bench.com

Workplace Systems, Inc.
562 Mammoth Road
Londonderry, NH 03053-2101
603-622-3727
800-258-9700
Fax: 603-622-0174
Website: http://www.rapid-response.com/ads/workplac/s7000.htm

Modules: Should service centers use depot service?

by the ES&T Staff

In almost every business or profession, there are certain tasks that it makes sense for the organization to have done elsewhere. Or, as they say in management circles these days, it makes sense in some cases to "outsource."

When someone goes to the dentist, for example, and needs caps, or crowns, or false teeth, the dentist takes the needed impressions and then sends the work out to a company that makes these items. It just doesn't make sense for the dentist to do that kind of work. The same thing usually happens at the doctor's office. If you need lab work done, or sometimes x-rays, they may send you to an office that specializes in that type of work. And if you bring your car in for some work, and the work includes straightening dents or paint work, the automotive service organization will probably send your car out to a body shop to get that work done.

For consumer electronics service, it's the service depot

When it comes to consumer electronics service, there are usually certain things that most service centers are just not equipped to deal with. For example, for years, mechanical tuners presented peculiar problems to service centers, so rather than try to service tuners themselves, service centers sent the tuners to a depot for refurbishment or exchange. The depots had the specialized equipment, knowledge, and information to restore the tuners to normal operation quickly and efficiently.

For the most part, mechanical tuners have disappeared from TV sets, but even modern electronic tuners, based on varactor diodes, present difficult problems to service centers, so it still makes sense to send these devices to a depot for service.

Hard drives

Another example of a product that a typical service center is not equipped to service is hard drives. Hard drives are sealed. If just a speck of dust gets between one of the read/write heads of a hard drive, and the disk, the head will crash and cause loss of data, at the least. Servicing of a hard drive requires clean room conditions and the ability to reseal the drive system to keep dust out.

Of course, given the low cost of today's hard drives, it doesn't always make sense to have these devices serviced when they fail. On the other hand, if the owner of the hard drive has some critical data on the hard drive, and there's no backup for it, it may be absolutely necessary to send the drive to a depot where they can either service the existing drive, or extract the data and put it on a new drive.

Other reasons for depot service

There are cases in which a service center has decided that it either does not intend to service a particular product, either because it does not get a lot of calls to service that type of product, or because they're doing all the service they can handle and don't wish to expand. In this case, the service center has some choices.

- They can send the customer away. If this is a valued, long-standing customer, the service center is taking a chance that the customer will find a service center that does good work, but on a broader line of products, and they will never come back to this service center.
- They can recommend another service center that services that type of product, but the same problem exists.
- They can try to service the product. Either doing so without the necessary service literature and specialized equipment, or at the expense of purchasing those things for this one service job, and hope that they get more of that same product to service in the future.
- They can take the product in provisionally, find a depot service center to send it to, and add a small markup on the work when the service is finished.

Inexpensive experimentation

There are so many new consumer electronics devices in homes, in cars, in home offices, that it's nearly impossible to keep up with it all. But some of those products might prove to be lucrative for service centers to repair. So, how does a service manager determine this without going out and buying all of the necessary test equipment, test accessories, test jigs, service literature, and spending time and effort hiring or training a technician? Depots might provide at least a partial answer.

If a valued client comes in with a computer monitor, or a satellite receiver, or some other product for which the service center doesn't normally provide service, instead of simply turning the client away, the service manager might talk with the client, explain that this is something that they don't ordinarily service, but they would be willing to take it in provisionally and get a reading quickly on whether, and how soon they can get it fixed. Most clients will not find this unacceptable. They come to your service center because you solve problems that they have with their consumer electronics products. They really don't care exactly how you get the problems solved, as long as it's done within a reasonable amount of time and is reasonably priced, and the repair lasts a reasonable amount of time.

Make it a policy?

In fact, if this is something that sounds appealing, it might be useful to establish a policy and make sure that everyone, from the technicians to the front desk personnel, is aware of it. If a client, especially someone who has done business with the service center for some time, brings in a consumer electronics product that does not fit in with the mix of products that the company normally services, whoever talks to the client should call the service manager, or someone else in authority to discuss it with the client.

Another thing that's important is to develop some guidelines to help the service center make a decision. Do a little research, find out what service depots are out there, what kind of products they service, what kind of rates they charge for various products and various kinds of service, and what their turnaround time is. Then if a client comes in with an unfamiliar product, he can be given a realistic evaluation of the chances that you'll be able to get it fixed, how long it will take to make a determination of that for certain, how long it will take to actually get the product back into service, and how much it will cost.

One place that you can find this type of information is in the **ES&T** annual March Buyers' Guide issue.

Selling duds to a depot for cash

Another area in which a service center can work with a depot is in the sale of modules, printed circuit boards, and the like to the depot for cash. Depots that refurbish and resell such assemblies are always looking for faulty units that sell fast when they're rebuilt. Let's say, for example, that you accept a TV, or other product, for service, and after you look it over find that it's not repairable; the picture tube is shot. That's rare, but it happens. So you call the owner, who tells you to keep it. He's paid a deposit, but that doesn't cover the work you've already done.

So you take another look and several modules, and/or the main circuit board is salvageable, but not working properly. You look over a price list, or call your favorite service depot/module exchange company. They pay cold, hard cash for such units. So you put it with several other duds and send it off to the depot. You get a check by return mail, or a credit.

There are several benefits if you can do quite a few of these sales. Number one, the benefit to the customer is that you can keep your fees for technical evaluations a little lower than you might otherwise do. It also benefits your service center, because it makes your rates a little more attractive. It benefits the environment by keeping those units out of the landfill. And, of course, it gives business to the depot, as well as the shipping company.

A final benefit

A final benefit of working with a depot, in some cases, is that you might be amazed at just how many of a certain type of repair clients bring your way. It might eventually begin to make sense to you to gear up to do such work in-house. Then, when the next unfamiliar items start coming in the door, you start the cycle all over again.■

Test Your Electronics Knowledge

by J.A. "Sam" Wilson

By way of review, for this month's "Test Your Electronics Knowledge," I have selected questions and answers from previous TYEKs.

1. Which is used to broaden the response of an audio amplifier?
A. Regenerative feedback B. Degenerative feedback

2. A thin air gap may be added to the core of an inductor to make it:
A. saturate at a lower current. B. almost impossible to saturate.

3. In an ac circuit, the product of rms voltage multiplied by rms current gives:
A. rms power. C. VARS.
B. true power. D. average power.

4. Gain-bandwidth product is a:
A. current unit. C. frequency unit.
B. voltage unit. D. time unit.

5. Since 20KΩ for one type of resistor is the same as 20KΩ for another type, you can always replace a metal-oxide resistor with a carbon-composition resistor. This statement is:
A. true. B. false.

6. According to a survey, the highest current will flow when the test leads of an ohmmeter are shorted together and the ohmmeter is on the:
A. highest resistance scale. B. lowest resistance scale.

7. 10 decibels = ____________ nepers.

8. Is the following statement correct? The address bus in an 8-bit microprocessor has eight parallel conductors.

9. What is the conjugate of j16?

10. If you heat one end of a metal rod, there will be a voltage across the rod. What is the name for this effect?

(Answers on page 56)

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

Test probes update

by the ES&T Staff

If you need to make a measurement, what could be simpler: you connect a set of test probes to the DMM or oscilloscope, or other piece of test equipment, then connect the probe tips to the unit to be tested and make your measurement. Well, it's almost that simple. As most readers already know, making accurate measurements with test equipment is actually not simple at all. Well, it's not really terribly difficult, but as with anything else, you have to have the right equipment, and you have to know how to use the equipment.

Getting to the conductor of interest

There was a time when getting a test probe in contact with a conductor from which a technician wanted to make a measurement wasn't a problem. Conductors were, generally, easily accessible, and large enough to put a probe tip on. And conductors were generally far enough apart that there was little danger of accidentally coming in contact with another conductor that might cause a short circuit.

Those days are gone forever. Over the last couple of decades, components have steadily shrunk, more and more functions have been packed into integrated circuits, and consequently, conductors and component pins are tiny and packed extremely close together. Moreover, some of the surface mount components are so small that you can barely see them, never mind their connectors. Sometimes, you just look at the innards of one of these new TVs or VCRs and scratch your head.

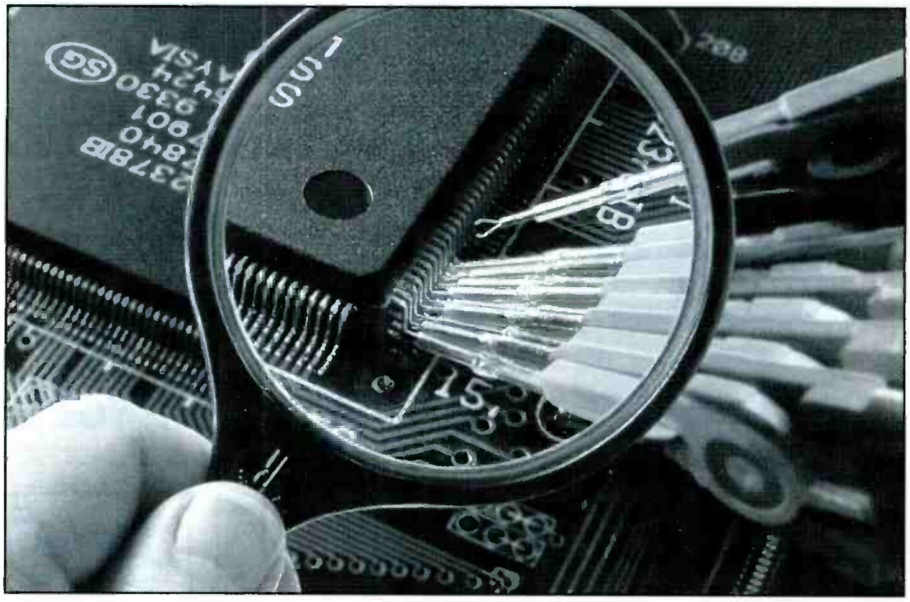


Figure 1. These tiny probes consist of wires that grab, around the leads of an IC. The technician can attach the DMM or oscilloscope probe to the other end of the probe lead. (Photo courtesy Pomona Electronics)

The brute force method

In an article that appeared in **ES&T** many years ago, one of our good and well-respected authors described a troubleshooting procedure that he used.The pins of an IC were so close together that he couldn't get to them with power applied to make voltage measurements without taking the very serious chance that he might accidentally short at least two pins together, causing enough damage that he would no longer have to worry whether the IC was good or not. It would be ruined.

His suggestion, and it worked quite well, was to disconnect power to the set, carefully solder fine wires to each of the pins of the IC that were of interest, connect the common DMM probe wire to the appropriate ground, apply power to the set, then carefully probe the extender wires that he had soldered on to read the voltages at those pins of the IC. It worked. The technician/author got the voltage readings, and he didn't cause any damage to the set.

If a technician will only encounter a situation such as this on infrequent occasions, this is a useful method of getting the job done. Rather than spend money on specialized probes that will only be used once, or a few times, it makes sense to sacrifice another precious commodity, time. If, on the other hand, a technician will frequently be servicing such sets, it would make more sense to buy specialized probes, if available. In this case, a one-time investment in a specific test accessory will save precious minutes over and over.

Tiny test probes

One thing that technicians can count on is that test equipment and test accessory manufacturers will keep up with the testing needs of electronics service centers. In the case of the steady shrinking of components, connectors, and spacing, test accessories manufacturers began offering probes and probing systems that could grab onto one, or a number of pins of an IC without touching any other pins.

One example of this is the spring-loaded microprobe (Figure 1). With this type of device, the technician still has to be very careful, and might perhaps have to disconnect power to the unit being tested before attaching a probe to the pin, but

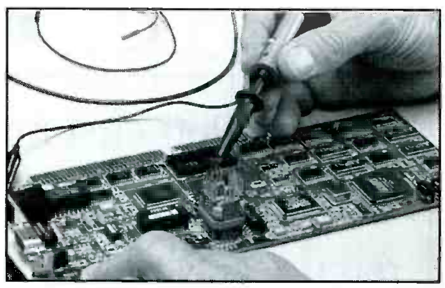


Figure 2. Another way to get a probe connected to a lead that's in a tight spot is to use a test clip. The technician simply turns off the faulty unit, clips the test clip over the IC. Then the technician turns on power to the set and probes the test points on the IC test clip. (Photo courtesy Pomona Electronics)

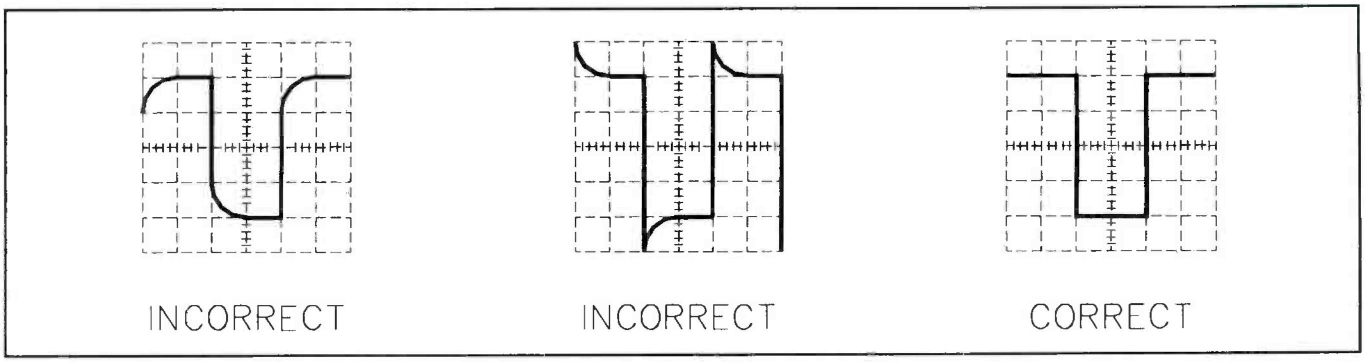


Figure 3. If the oscilloscope probe is not properly matched to the oscilloscope input, the waveforms displayed on the screen will be distorted. Low frequency response of an oscilloscope probe can be matched to the oscilloscope by adjusting the compensation trimmer on the head of the probe.

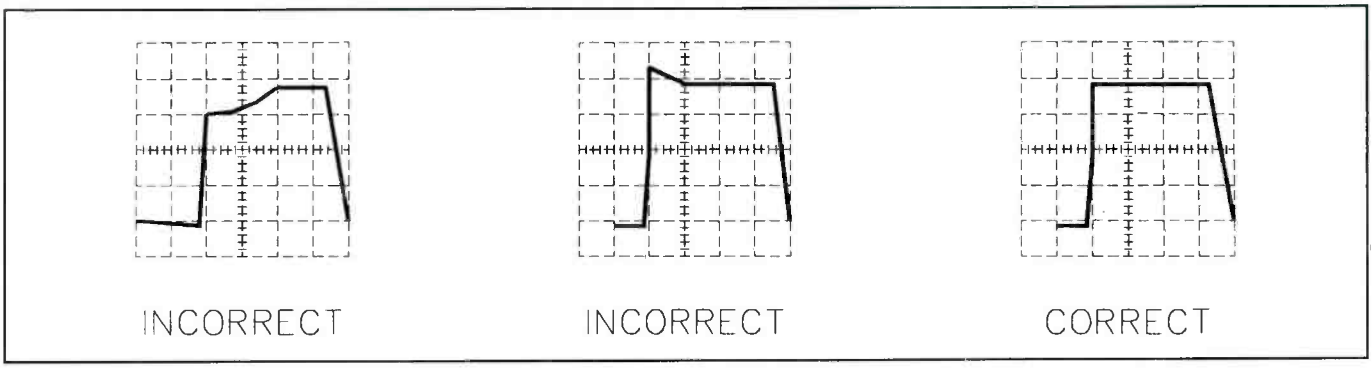


Figure 4. The high frequency compensation of an oscilloscope probe may have been preadjusted at the factory, however, if the waveform on the oscilloscope screen looks like either of the two on the left, when the input is a square wave, adjustment may be required.

he won't have to get out the soldering iron and apply heat to pins that really shouldn't be heated unnecessarily. The idea of this type of probe is that the business end of it consists of tiny wires that either hook, or grab, around the leads of an integrated circuit, and the technician can attach the DMM or oscilloscope probe to the other end of the microprobe.

In some cases, one microprobe will do. In other cases, the technician might just need to measure voltages at a couple of IC pins, so he would just be able to turn off the set, attach the microprobe (or grabber, or whatever), turn the set on, make a measurement, turn the set off, move the probe, turn the set on, measure, and so forth. But if there will be more than just a few pins to measure this way, the technician will be much better off to buy a set of grabbers so that he can shut the set down once, attach probes to all of the pins of interest, then turn the set the set back on, and probe to his heart's content.

Test clips

Another way to make the business of probing tightly spaced pins easier is to find a test probe manufacturer that makes a test clip that fits over an IC of specific dimensions and number of pins. With one of these products, the technician simply turns off the faulty unit, opens the spring-loaded clip by squeezing, places it over the IC, and carefully releases the clip. Then, of course, he checks to make sure that the clip is properly attached. Once that is done, the technician turns on power to the set and probes the test points on the IC test clip (Figure 2).

Adjusting oscilloscope probes

Once you've connected the probe to the point of interest, you should be able to take the DMM readings you need, or observe the waveform you need to look at. But if that oscilloscope probe is not properly adjusted, you may see waveforms that don't match the waveform drawings provided by the manufacturer's literature, even if that part of the product circuitry is working properly. That can lead to incorrect diagnoses.

Here's a procedure, recommended by Pomona Electronics, that you can follow to make sure that your oscilloscope probe is properly compensated, assuming that the probe you use is adjustable.

Low frequency response of the probe can be matched to the oscilloscope by adjusting the compensation trimmer on the head of the probe.

1.) Connect the probe to the oscilloscope and to a 1 KHz square wave source, the rise time should not exceed 10usec (most oscilloscopes provide a probe compensation output). For X1/X10 probes, switch to the X10 position.

2.) Set the oscilloscope to display two to three cycles of the square wave and two to six vertical divisions.

3.) Carefully adjust the trimmer tool to obtain the flattest tops to the square waves displayed on the oscilloscope (Figure 3).

The *high frequency compensation* may have been preadjusted at the factory, however, if adjustment is required, use the following procedure.

1.) Remove the compensation box cover located near the connector. Using the BNC adapter, connect the probe to a square wave generator operating between 10kHz and 100kHz terminated into 50Ω. The square wave generator rise time should be approximately 0.125ns. Adjust each control until the leading edge of the waveform is as flat, square, and horizontal as possible (Figure 4).

2.) Readjust the low frequency compensation if necessary. ■

PRODUCTS

Signal generator

Ramsey Electronics, Inc., announces the RSG-1000 DDS based synthesized RF signal generator. Capable of generating from 100 KHz to 1 GHz, the generator will find applications in R&D labs, production test, schools, and repair facilities. Frequency range is from 100 KHz to 1 GHz in 10 Hz steps, standard frequency reference stability is 1.0 ppm. Both calibrated FM and AM modulation are available, an internal 1 KHz source can be used or external signals from 50 Hz to 25 KHz. A two line vacuum fluorescent display shows all operating parameters. Data is entered via the keyboard or the analog-style spinner knob, optionally, an RS-232 port is available. Standard output level is 0 dBm (+13 dBm optional) with solid-state GaAs calibrated output attenuator down to -130 dBm, flatness is specified at ±0.5 dB. Options include external reference input, RS-232 interface, 0.1 ppm high stability timebase, and 0.1 dB amplitude level flatness.

793 Canning Pkwy., Victor, NY 14564, Phone: 716-924-4560, Fax: 716-924-4555, Website: <www.Ramseyelectronics.com>
Circle (90) on Reply Card

PCB test tool

PCB test tool has been launched by Circuit Trace, a start-up company that intends to sell direct from the World-Wide-Web. The new CT100 is a small handheld connectivity tester that enables service engineers and technicians to accurately locate all interconnected points on a PCB within seconds, simply by wiping a conductive brush over the surface of the board and listening for an audible tone. This approach can be used to significantly reduce fault-finding time on virtually any type of PCB, regardless of component technology or board complexity.

The company's Website, <www.tone ohm.com>, contains information about the tool, including an application note and a cost benefit section.

P.O. Box 70, Redford DN22 OSY, UK Phone: +44(0) 1777 248993, E-mail: mrbass@globalnet.co.uk
Circle (97) on Reply Card

IC cross-reference database on CD-ROM

Hearst Business Communications, Inc./UTP Division announces the release of the 1999 IC MASTER Alternate Source Directory, a cross-reference of original devices to functional equivalents, on CD-ROM. Now on a single compact disk, engineers have easy and flexible access to this complete directory in both DOS and Windows.

In DOS, users can customize the database by adding or deleting device listings and by adding comments to any listing.

(Continued on page 61)

Ways to deal with intermittent problems

by Jim Van Laarhoven

The perfect troubleshooting case, or at least the most comfortable, is the one in which the problem is apparent right at the outset of inspection. The truth is, this is not always the case, as you well know. Difficulties arise and your mettle as a technician tends to be tested more than the equipment you're working on. Here are two examples:

• A computer printer initiates a message that it's out of paper when it's really not, yet every component on the board checks out perfectly. You think it might be operator error so you send it back out to the customer. The next day it's waiting on your bench with a tag that says it still shows a paper-out error.

• Or, you are working on a PC board with both ac/dc components and you find a blown 3A ac fuse. You replace it and the board works fine. You ask yourself what made the fuse blow and begin to test the transformer and rectifier circuits. You even check the ac/dc interface relay and everything checks out. Possibly an external spike, you finally decide. However, a week later the PC board comes back with the same fuse blown.

These kinds of problems can get you and your customer frustrated. You start to feel that the problem is far too complicated to figure out and your brain flatlines. Don't feel alone, because these kinds of problems trouble every technician. Using these two examples, we will go through different ways to deal with intermittent problems.

Checking out that printer problem

In the first case of the false paper out on the printer, our next step would be to simulate the ambient conditions the printer works under. Does it operate in a hot environment or a cold environment, is it subjected to vibration, or is it constantly being moved? Very often one thing will lead you in the right direction. After a conversation with the customer, it was discovered that the printer operated in an environmentally-controlled atmosphere (around 75 degrees). The printer sat on a stand and was never moved. When asked to describe when the printer would show the fault, the customer said it always happened first thing in the morning when he turned the computer on, but it usually started working later on in the day.

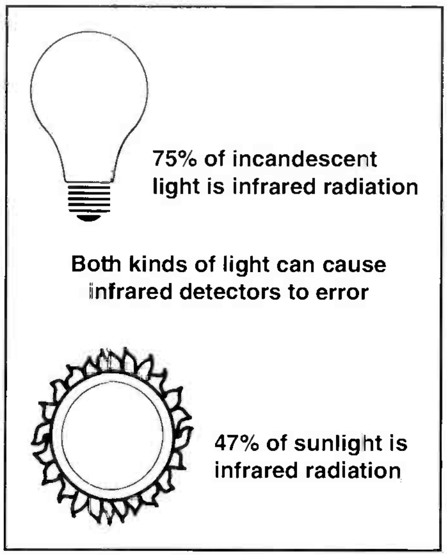


Figure 1. Ambient light can on some occasions cause intermittent problems for products that feature infrared sensors.

There was a pattern to the fault and at the first appearance, it would seem the computer might be to blame. However, the customer had also said that he had plugged another printer into the same computer port and that printer did not have a problem. The words of Sherlock Holmes now come to mind: "When you have eliminated that which is impossible, then whatever remains, however improbable, must be the truth." Crazy as it sounds, the only pattern that remained, was that the printer problem happened in the morning. I wondered if it might have anything to do with the lighting conditions in that office at that time of day.

Another call to the customer confirmed the suspicion that the printer sat next to a window that faced towards the bright morning sun. The next step was to simulate this same condition. This was accomplished by using a flashlight aimed at the infrared interrupter module that senses the paper, while the printer is in operation. When I aimed the flashlight at this module, the printer reported the error. Even though the paper was interrupting the optoelectronic module's infrared source from the detector, the flashlight's beam, flooding the module's detector, still induced the error. This confirmed that the sun shining on the printer was more than likely causing the error (Figure 1).

Fixing the problem

The next step, of course, is to stop the problem from happening again. You could ask the customer to change the printer's location, but that is not a true fix. A shield of some sort probably would be a better idea. In this instance, the manufacturer was called and they approved the placement of a phenolic type shield that guarded the emitter and detector from outside sources of light. Further testing proved that even with intense light shining at the interrupter module, the printer would not false error after the shield was installed

This case of an intermittent problem happened to be easy once the detective work was completed, but when a single component fails intermittently, it can be one of the hardest things to isolate. Sometimes, this type of problem can be solved by setting up a test situation that loads the suspected component until it fails. The idea is to make the unit do a job that delivers the most stress to its circuits and make it do it often or on a continuous basis.

Why is the fuse blowing?

The next case is to consider what is blowing the fuse on the ac/dc PC board. Since it has been established that the individual components have been tested, we might consider what load or shorting condition could have caused a 3A fuse to blow. Three amps is quite a load in electronics, so looking at what devices the board controls may be helpful.

Jim Van Laarhoven is an independent technician and consultant for computer based lighting.

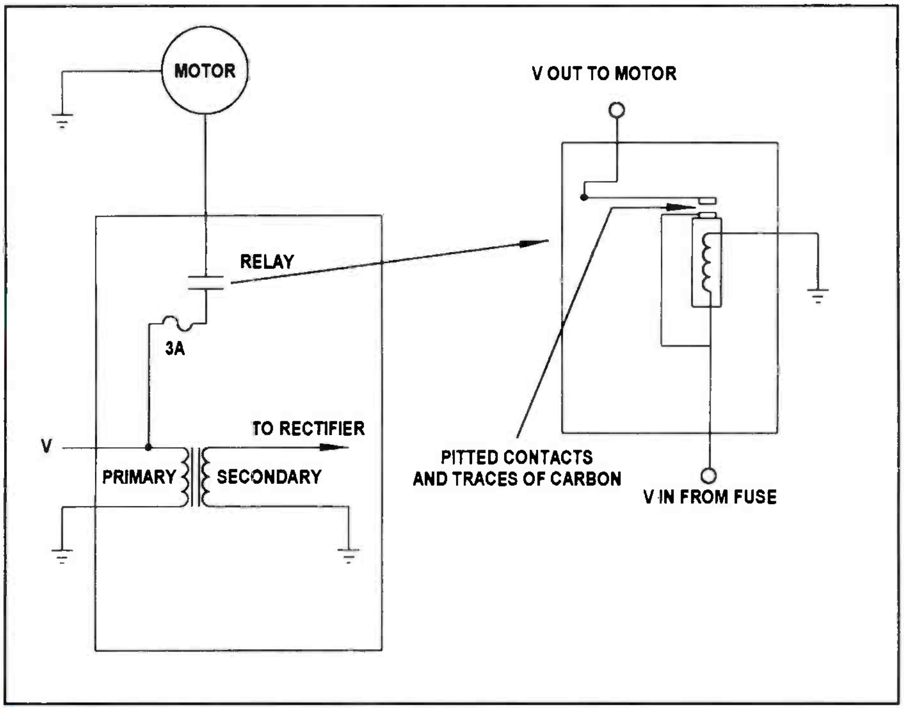


Figure 2. When one of the symptoms of a problem is overcurrent, if there's no obvious cause, suspect arcing. On this PC board, relay arcing caused the 3A fuse to blow repeatedly. Replacement of the relay cured the problem.

In this case, the board controlled a small shaded-pole motor. The nameplate indicated that the motor under full load pulls about 1A and it should really only pull about 80 percent of that under normal load. The motor was tested and showed no problems. In addition, judging from the job that the motor performed, it was impossible to get an intermittent locked or overloaded rotor. It should also be noted that the motor's voltage was supplied from the PC board.

At this time, it would seem we hit a brick wall in troubleshooting. Clearly, nothing is wrong, but of course, there is something wrong. To break the paradox, some deeper examination needed to take place. What could cause an overcurrent situation on that board? Arcing is a potent cause of overcurrent, and there's a relay on this board that might be arcing (Figure 2).

The relay cover was removed by means of a sealed nut at the top. Carbon arcing was evident. The contact points were pitted and what looked like spattered solder lay about the interior of the relay case. It seemed to be safe to assume that every so often the contacts would not seat cleanly, causing the relay to arc. The arcing, in addition to the normal motor load, caused a current in excess of 3A. The relay was replaced and the PC board was then thoroughly tested. The fuse did not blow again.

Creativity is a useful troubleshooting tool

In both of these two cases, solid troubleshooting techniques were adhered to, but imagination and intuition ended up being the key to a quicker solution. The problem in each case could have been other components acting intermittently, and in similar circumstances might have led in a different direction. However, the thinking process, and persistence, should always be the same.

In either of these two cases, it did not take an inordinate amount of repair time, but time could have easily been an issue. Time might have been so critical that your only concern was servicing the customer quickly. If a spare working unit can be located in these kinds of situations, it may be wiser to replace the customer's unit or PC board with that working one. Later, when you have more time, a repair may be completed without all the extra stress.

Business considerations

Many of the difficulties in dealing with intermittent problems are more related to business considerations than to technical considerations. First, tracking down the

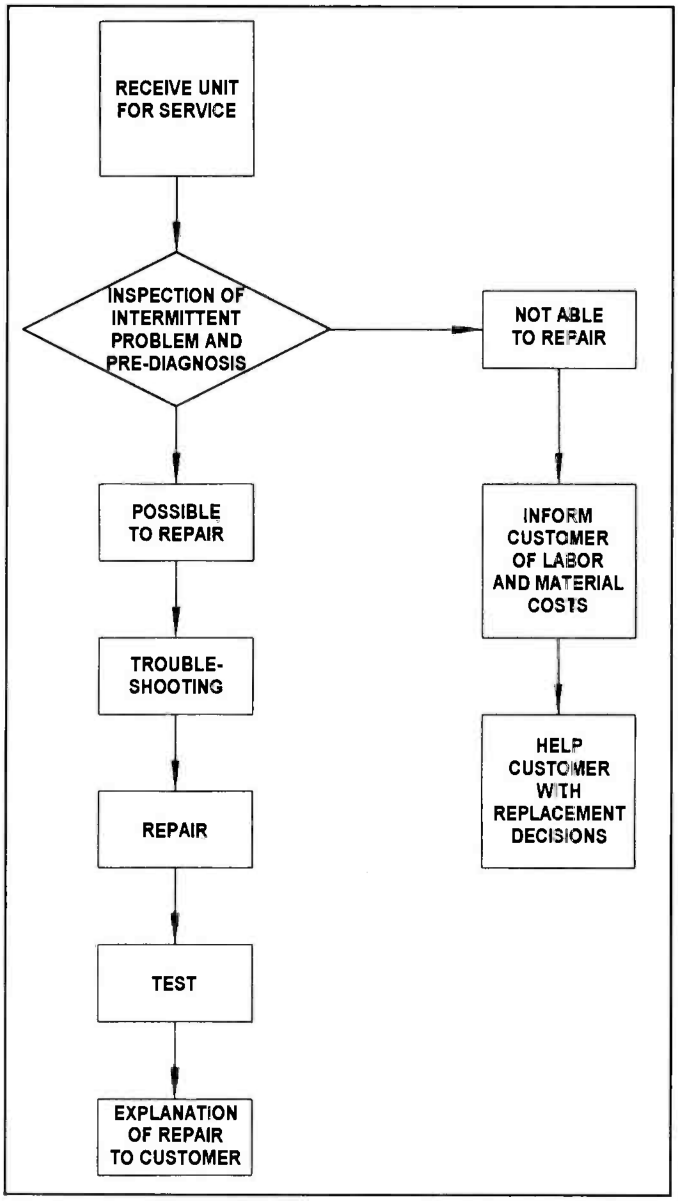


Figure 3. We don't always think of it this way, but the decision that a repair just is not economically justified, and that purchase of a new product is in the best interest of the customer, is part of the service process. In such a case, proper customer service requires a careful, detailed, explanation of the facts to the customer.

cause of the intermittent problem consumes the technician's valuable time and may add up to a service bill that the customer does not want to pay. Second, the cost of labor and material can sometimes approach the cost of replacing the entire unit. You are not shirking your responsibility as a good technician by suggesting that the customer buy a new one if that's the best solution (Figure 3). Knowing when *not* to fix something can be as grand a skill as repairing some of the most challenging electronic equipment. Even though your customer is probably not mechanically inclined, they do know when you are trying to steer them in the right direction. Future business is assured if your initial contact with the customer leaves them with a feeling of trust.

In summary, the characteristics that lead to a more successful outcome when dealing with intermittent problems are: a solid troubleshooting technique, use of your imagination, communicating with the customer, and finally good business skills. ■

PHOTOFACTS

CROSLEY
CT3254C102 4149

GE
CTC185AA3 4155
25GT507TX1 4155
25GT511TX1 4155
27GT560TX1 4155

JVC
C-20810 4144
C-20811 4144

PANASONIC
AEDP307 4146
ANDP304 4148
ASEDP307 4146
CT-13R25DW 4148
CT-27G23CW 4146
CT-27G23UW 4146
CT-27G23W 4146
PV-7450 .... VCR-310
PV-7451 .... VCR-310

QUASAR
VHQ760 .... (sim to) VCR-310

RCA
CTC185AB3 4154
F25216BCTX1 4154
F25216WTTX1 4154
F25217BCTX1 4154

SANYO
DS13SPH 4150
DS19SPG 4145
DS27580 4147
DS27780 4152
13SPH-00 4150
19SPG-00 4145
27580-00 4147
27780-00 4152

SONY
KV-27S45 4143
KV-29SL45 4143
SCC-S01J-A 4143
SCC-S03F-A 4143
SCC-S04Y-A 4143

TOSHIBA
CF32H40 4153
CN36H90 4151
CX32H60 4151
TAC9806 4153
TAC9812 4151
TAC9820 4151

The Magnavox electronic tuner

By Steven J. Babbert

The state-of -the-art TV series continues here with a look at the tuner used in the Magnavox chassis #25P506-00AA. Before we begin, a brief review of tuner theory is in order.

The purpose of the tuner is to select a single channel in the VHF or UHF band and convert it from an RF (radio frequency) to an IF (intermediate frequency) for processing in the IF section. The IF frequency remains fixed. Frequency conversion is achieved by mixing or "heterodyning" the RF signal with a suitable signal from a local oscillator. This mixing of signals, which takes place in a nonlinear device (typically a diode or transistor), generates so-called sum and difference signals. For example, mixing a100kHz signal with a 1kHz signal results in the generation of 101kHz and 99kHz signals. By selecting a local oscillator frequency that differs from the RF frequency by the proper amount for each selected channel, the appropriate IF frequency conversion will be made.

In the early days of the mechanical tuner, inductors and capacitors were mechanically switched in or out of the tuner circuit to change channels. The input and output of the first RF amp was tuned in this way for channel selection. The local oscillator was also tuned this way to obtain the required mixing frequency.

Electronic tuner

Nearly all newer TVs use electronic tuners, which require no switch contacts or moving parts. Instead, they rely on an effect discovered long ago to be inherent in semiconductor diodes: under conditions of reverse bias (blocking current flow), these diodes exhibit capacitance which is proportional to the level of reverse bias. Diodes manufactured so as to enhance this effect are known as variable reactance, or "varactor," diodes. Electronic tuners use varactor diodes in place of capacitors so that circuits can be tuned simply through the adjustment of a dc voltage. Typically, this voltage is generated by a voltage synthesizer circuit.

Babbert is an independent consumer electronics servicing technician.

The operation of the tuner in the Magnavox chassis being discussed is handled by IC302, an I2C bus-controlled voltage synthesizer IC (Figure 1). This IC electronically enables the appropriate section of the tuner (Vh, Vl, or U) as needed and develops the tune voltage (Vt) required by the various varactor diodes. IC302 is controlled by the SYSCON (system control micro) via the I2C bus.

Three sections

The tuner consists of three more or less independent tuning sections. Dual gate FETs Q101, Q102, and Q103 are the first RF amps for U, Vl, and Vh respectively. Note that each of these has one gate tied to a common line, which is connected to pin 5 (AGC). The AGC voltage is developed in the main signal processor. This will be covered later. The remaining gates are tied to their respective input tuning circuits consisting of LC networks and varactor diodes. Likewise, FET outputs are tied to their respective tuned circuits comprising LC networks and varactor diodes.

Q401, Q403, and Q405 act as switches to pass or block RF signals. Each of these has its emitter tied to a tuned circuit. Collector outputs are tied to a common line, which is connected to the input of the mixer circuit designed around Q501. Bases of Q401, Q403, and Q405 are connected to IC302. By pulling the appropriate base high, IC302 enables the proper section of the tuner.

Q402, Q404, and Q406 are the local oscillators for U, Vh, and Vl sections. Collector supply voltages are routed via Q401, Q403, and Q405. For example, if switch Q401 is on, it will conduct applying voltage to the collector of Q402 via L401. So the switches not only pass the RF signal to the mixer, they also supply voltage to the oscillator. Note that the oscillators are also tuned through the use of varactor diodes. Oscillator outputs are taken from the collector and injected through the switch along with the selected RF signal. These are then mixed in the mixer. The resultant IF signal is output at pin 17, where it is routed to the IF section (part of the video processor) via a SAW (surface acoustic wave) filter.

TUNER VOLTAGE CHART

Pin	VHF Low Band	VHF High Band	UHF Band
5	4.8V	5.0V	5.0V
6	12.0V	12.0V	12.0
11	0.9V	1.5V	1.7V
12	5.0V	5.0V	5.0V
13	5.4V	5.4V	5.4V
14	5.4V	5.4V	5.4V
15	0V	0V	0V
16	0V	0V	0V
17	0V	0V	0V

Note: VHF Low Band voltages taken on channel 2
VHF High Band voltages taken on channel 7
UHF Band voltages taken on channel 14

Table 1. This listing shows the voltages that will be found on various pins of the tuner. Note that the voltage on pin 5 (AGC) will vary with signal strength. Voltages on pin 11 will vary with channel selection.

Tune voltage

All varactor diodes are tied to a common line through one or more 10k resistors. This line is tied to a 33V source via a 22k resistor external to the tuner. This line is also tied to the collector of Q301. This transistor controls the tune voltage by conducting more or less in response to changes in its base bias, which comes from IC302. When the transistor is fully on, or saturated, Vt drops to near zero, increasing the capacitance of the varactors and raising the resonant frequency of the tuned circuits. When the transistor is off, it presents maximum resistance to ground. This allows Vt to float to around 33V, maximizing reverse bias and minimizing capacitance, thereby lowering the resonant frequency.

Tuner supply

In addition to the 33V source used to develop Vt, the tuner requires a 12V and a 5V source. 5V source A is used by the

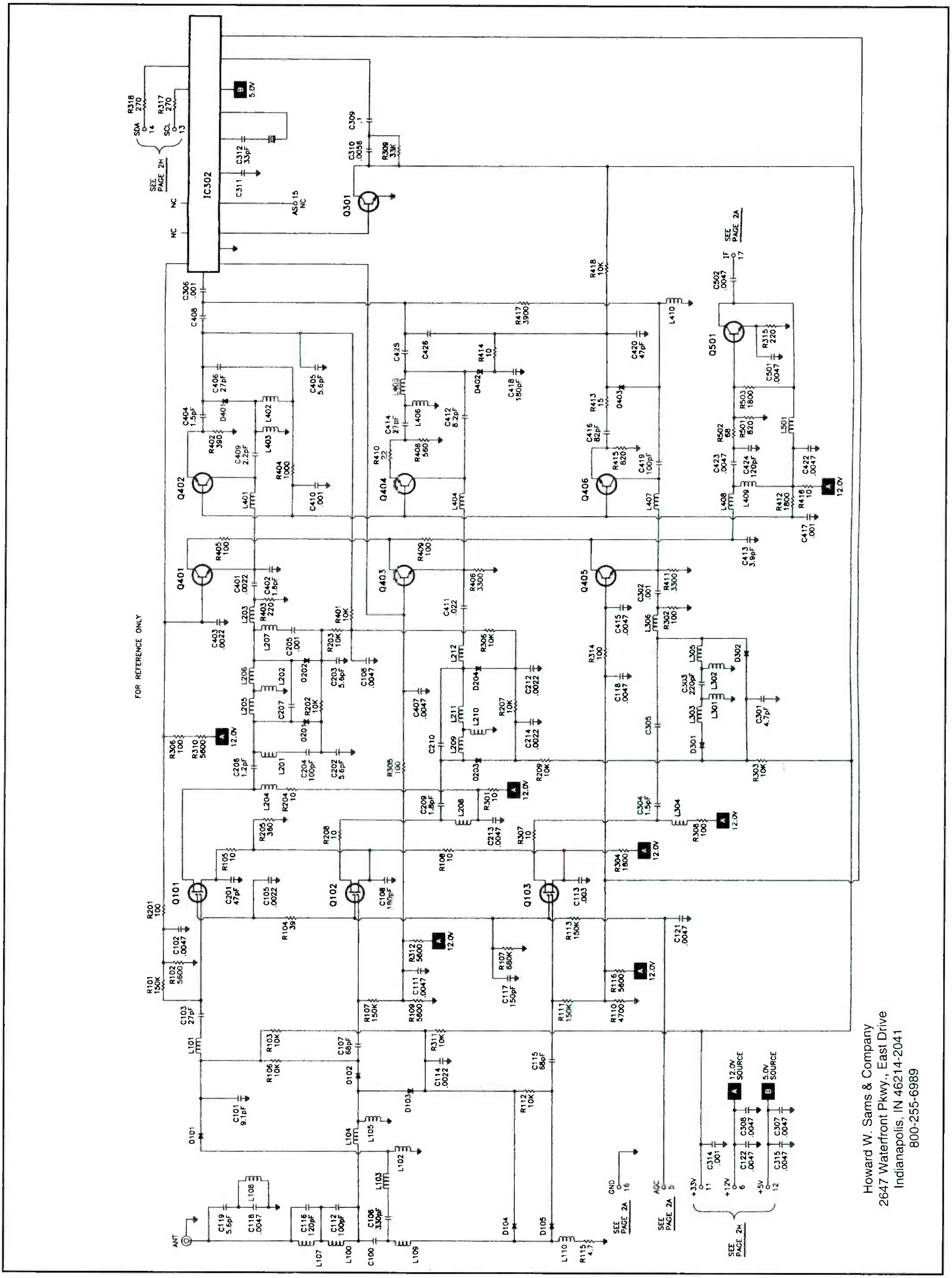


Figure 1. Schematic diagram of the tuner section of the Magnavox chassis #25P506-00AA. (Photo courtesy Howard W. Sams & Company)

transistors and 12V source B is used by voltage synthesizer, IC302. Both of these are derived from source #10 of the main power supply which was covered in detail in a previous installment.

The 33V source is derived from source #1 (B+) by a Zener shunt regulator. This is shown in the SYSCON diagram, also part of a previous installment of this article. Check these voltages first anytime that the tuner is inoperative. Note that the schematic shows 33V on pin 11. Actually, this is a mistake. While 33V will always be found on the other side of the above mentioned 22k resistor, the voltage directly on pin 11 is dependent on channel selection. Table 1 shows approximate voltages that will be found for various channels.

Troubleshooting

The old-fashioned tuner subber is still the simplest way to determine whether a problem is in the video processor or the tuner itself. Remove the solder from pin 17 and inject the output of the tuner subber directly into the SAW filter input. If the set operates, then you have verified that the problem must be in the tuner or tuner control circuits.

In some electronic tuners, Vt can be substituted to determine whether the problem is in the control circuits or the tuner itself. Since the voltage synthesizer IC is an integral part of the tuner module in this chassis, there is not much point in making this kind of test. The tuner will normally be replaced as a unit if defective.

If the tuner is not outputting an IF signal and the supply voltages are okay, it is probably defective. A SYSCON problem could cause the tuner to be inoperative, but if other bus-controlled functions, such as menu selection and picture adjustment, are okay then it is most likely that the SYSCON is okay. It is unlikely that a SYSCON problem would affect only the tuner. Unfortunately, checking the data on the I2C bus is beyond the capabilities of most technicians.

AGC

AGC (Automatic Gain Control) enables the tuner's sensitivity to be increased or decreased as needed to compensate for varying signal strength between stations. Symptoms of improper AGC range from no stations tunable to overload of local stations. Overload can cause pulling and bending of the picture possibly accompanied by a buzzing sound. Severe cases can cause loss of sync and negative picture.

In this chassis, AGC comes from the main video processor and is applied to pin 5. This voltage typically ranges from 3.7V to 8.5V with the lower voltage corresponding to strong reception. If you suspect an AGC problem, you can remove the solder from tuner pin 5 and connect a variable power supply. If the tuner operates and responds normally to adjustment of the substitute voltage, then the problem must be in the video processor. The video section will be covered in a future installment. This concludes the discussion of the electronic tuner. ■

ES&T Calendar

Golden Opportunities '99
High Tech Training
• Fiber Optics Installer Certification
• Computer Service Technician
• FCC Licensing Training
• Customer Service Certification
Conferences, Exhibitions, Electronics Industry Trade Show, Certification Examinations, High Tech Certification Program, Electronics Indutsty Job Fair.
June 21 through June 25
Virginia Beach Pavilion
Virginia Beach, VA
Sponsored by The Communications Workers of America (CWA) and The Electronics Technicians Association, International (ETA)

ETA
602 N. Jackson
Greencastle, IN 46135
765-653-8262
Fax: 765-653-8262
Website: http://www.eta-sda.com

National Professional Service Convention
August 2–7, 1999
(Trade Show August 4 and 5)
Hotel Intercontinental
Dallas, TX

NESDA
2708 W. Berry
Fort Worth, TX 76109-2356
817-921-9061 • Fax: 817-921-3741
Website: http://www.nesda.com

PCS '99
September 22–24, 1999
New Orleans, LA
703-739-0300

Consumer Electronics Manufacturers Association (CEMA)
2500 Wilson Blvd.
Arlington, VA 22201-3834
703-907-7600
Website: http://www.cemacity.org

An encounter with a CTC197

by Bob Rose

Getting older doesn't necessarily make one wiser, and adding to one's technical experience does nott always enhance one's troubleshooting competence. A recent encounter with an RCA CTC197 has led me to these conclusions and reintroduced me to that attitude to which the word "humility" implies.

Rose is an independent consumer electronics business owner and technician.

A brief overview of the CTC195/197 chassis

The CTC195/197 is "the latest in Thomson Consumer Electronics line of digitally-controlled television receivers."

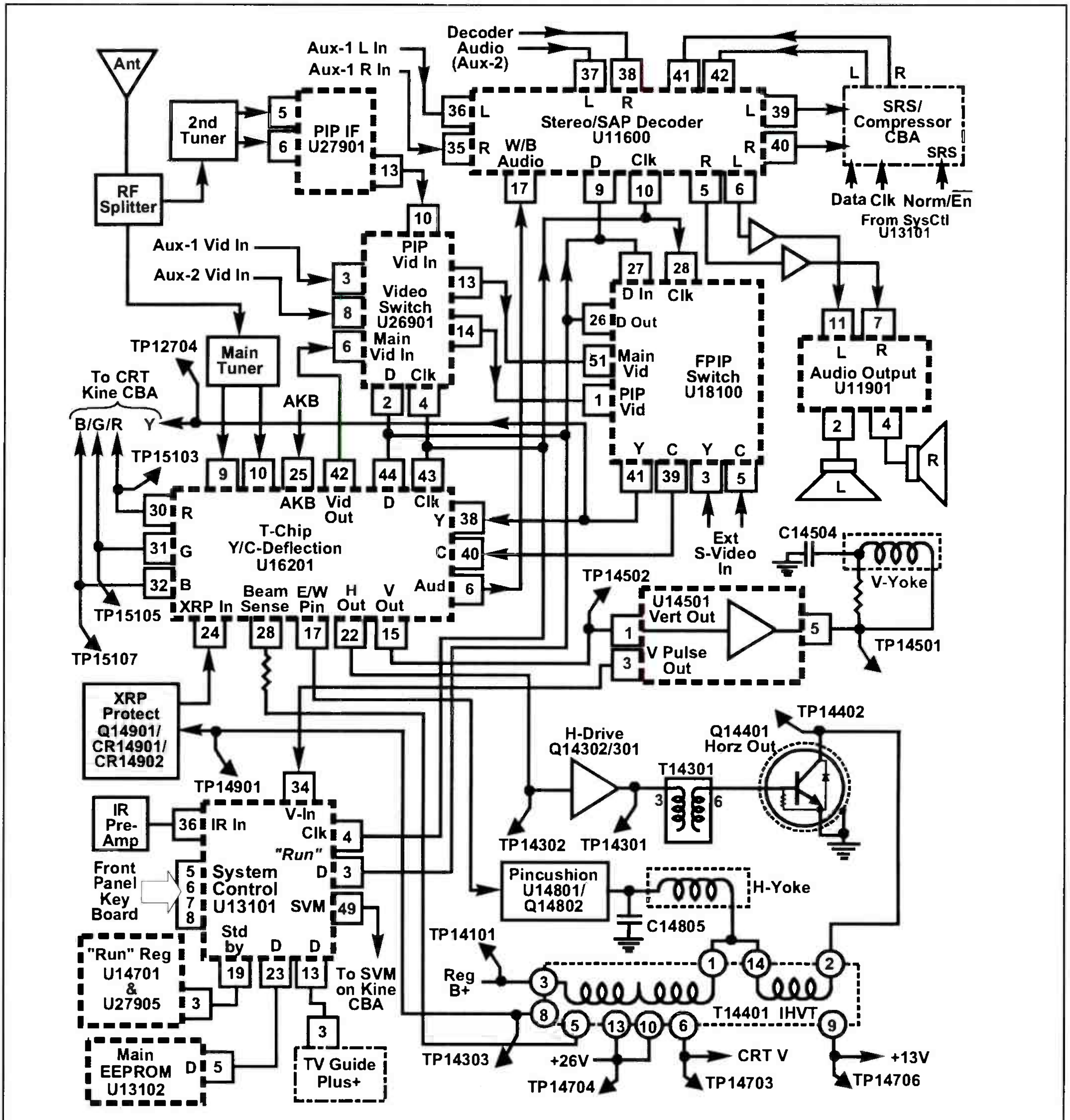


Figure 1. This block diagram, printed from the CTC197 service manual that was part of the service literature CD-ROM, provides another type of overall view of the circuits in the set and their relationship to each other.

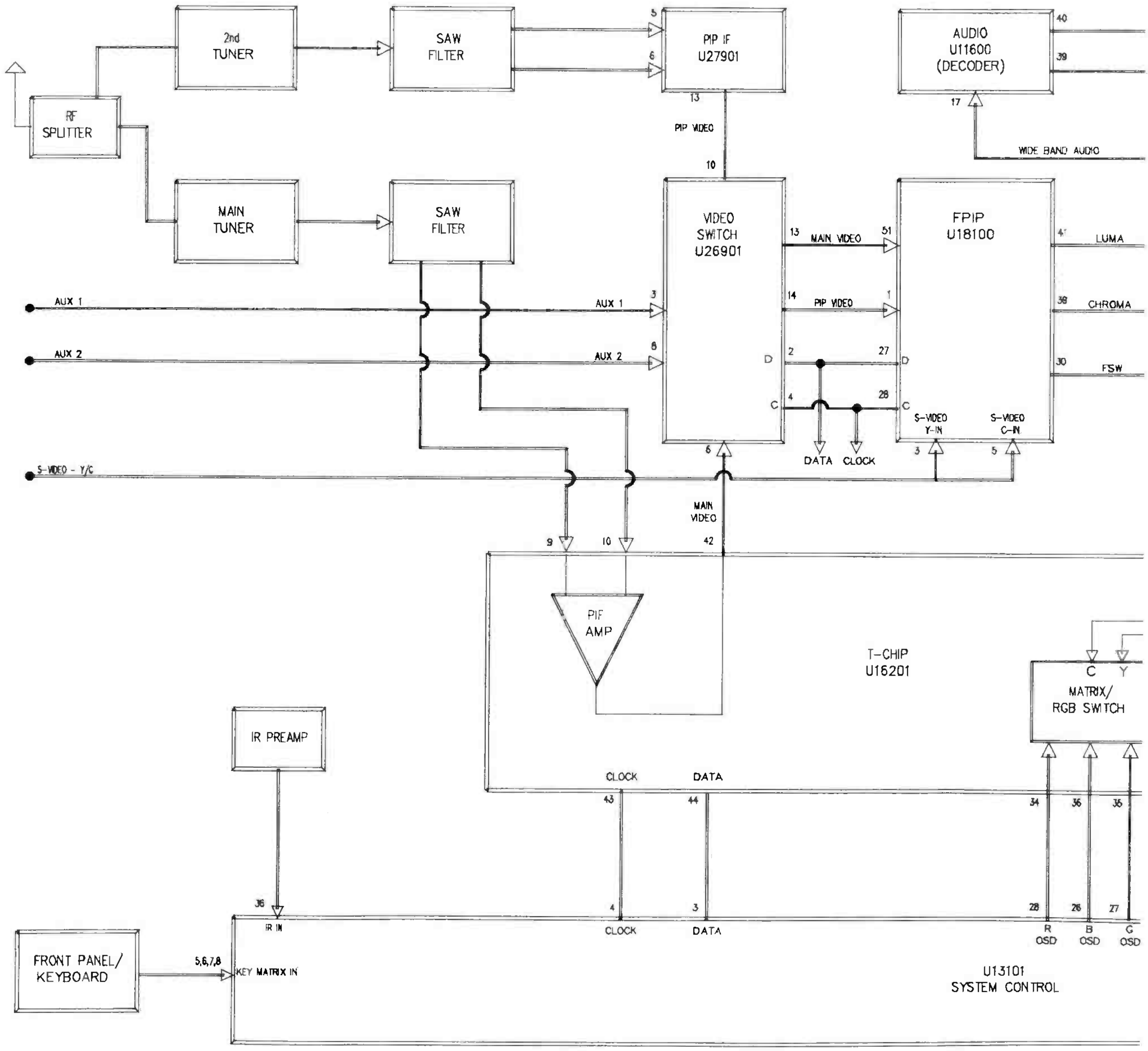
The CTC197 is the chassis used in direct view models, while the CTC195 is the chassis used in projection models. They are based on what Thomson has already done in the CTC175/176/177, CTC 187, and CTC185 chassis, but incorporate features that stagger one's imagination.

The system microprocessor is responsible for the total operation of the set and for aligning the various circuits that work together to make up the television. These chassis utilize the now familiar EEPROM (electrically erasable programmable read-only memory) and the TOB (tuner-on-board). The difference between these chassis and previous chassis is their newly designed circuits and integrated circuits that the various models incorporate. The new integrated circuits include a T4 Chip, a FPIP (comb filter picture-in-picture) IC, and a new stereo IC. The new features available on this television set include a dBx decoder that is serial bus-controlled, an SRS (sound retrieval system) circuit, a main tuner plus a PIP tuner, TV Guide, and TV Guide Plus+, to name a few.

If you would like to get a "feel" for these chassis, take a look at two block diagrams. Figure 1 is taken from the Electronic Service Information (ESI) CD-ROM for the CTC197, while the block diagram of the set in Figure 2 is taken from the technical training manual on the same CD-ROM.

I obviously can't give you a complete preview of the

Figure 2. This block diagram of the CTC197 chassis, which was printed from the "schematics" section of the Electronic Service Information, CD-ROM-based service literature, provides one type of overview of the circuits in this set.

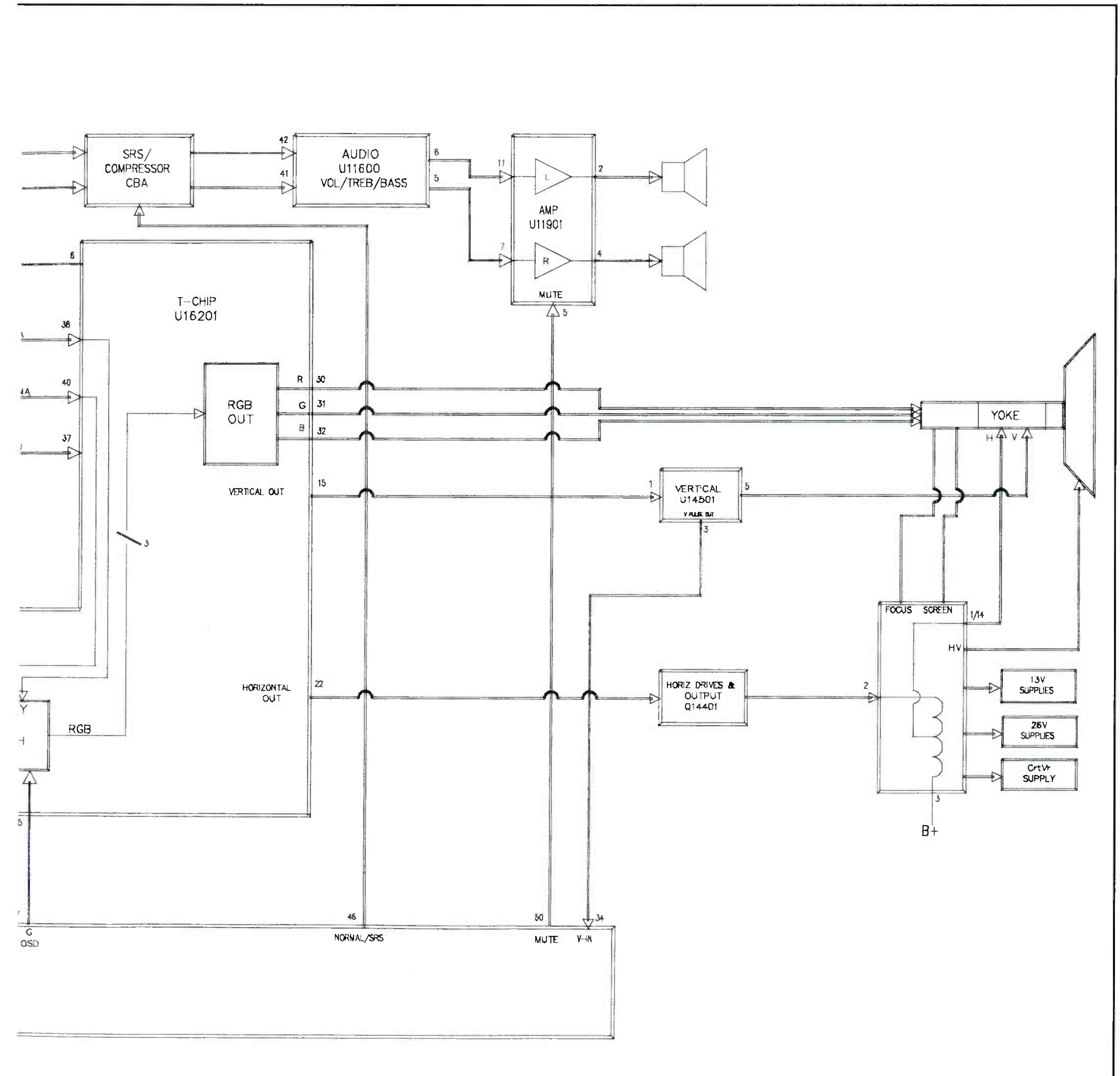


CTC195/197. If you are interested, and I hope you are, I suggest you spend time with the technical training manual, CTC195/197 Color Television Technical Training Manual, published by Thomson Consumer Electronics. Please note that this manual is 171 pages long. Schematics come in two formats, Thomson Consumer Electronics Color Television Basic Service Data, which is on paper, and Electronic Service Information available on CD-ROM. My new book, "Servicing RCA/GE Televisions," published by Prompt (Howard W. Sams & Company), has 76 pages devoted to the CTC195/197.

"The system microprocessor is responsible for the total operation of the set and for aligning the various circuits that work together to make up the television."

A "dead set" CTC197

The CTC197 I encountered came into the shop as a dead set. I applied ac, pressed the power-on button, and heard the degauss relay click three times and stop. The set was indeed dead. Fortunately, the service literature (paper and electronic) is replete with troubleshooting guides that the servicer



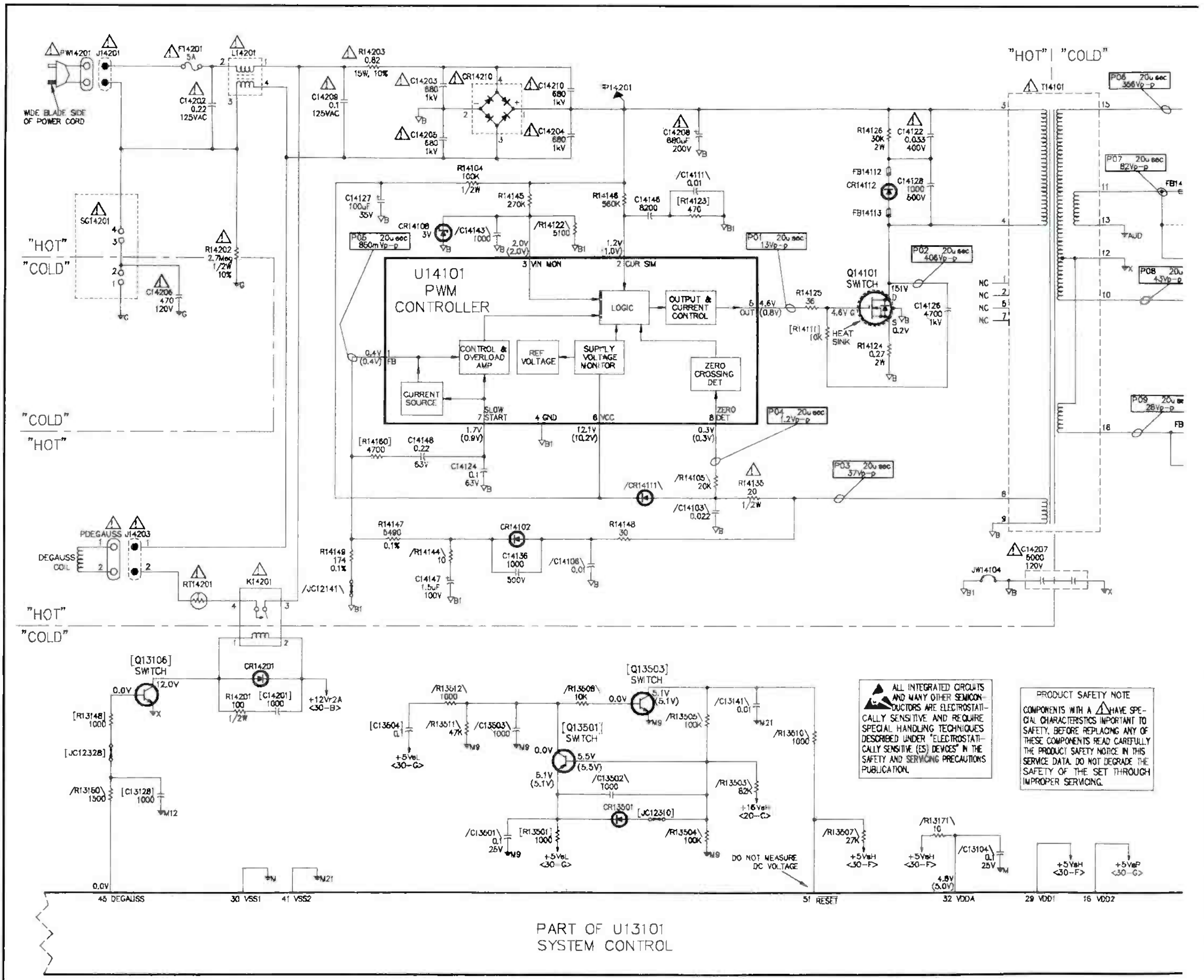
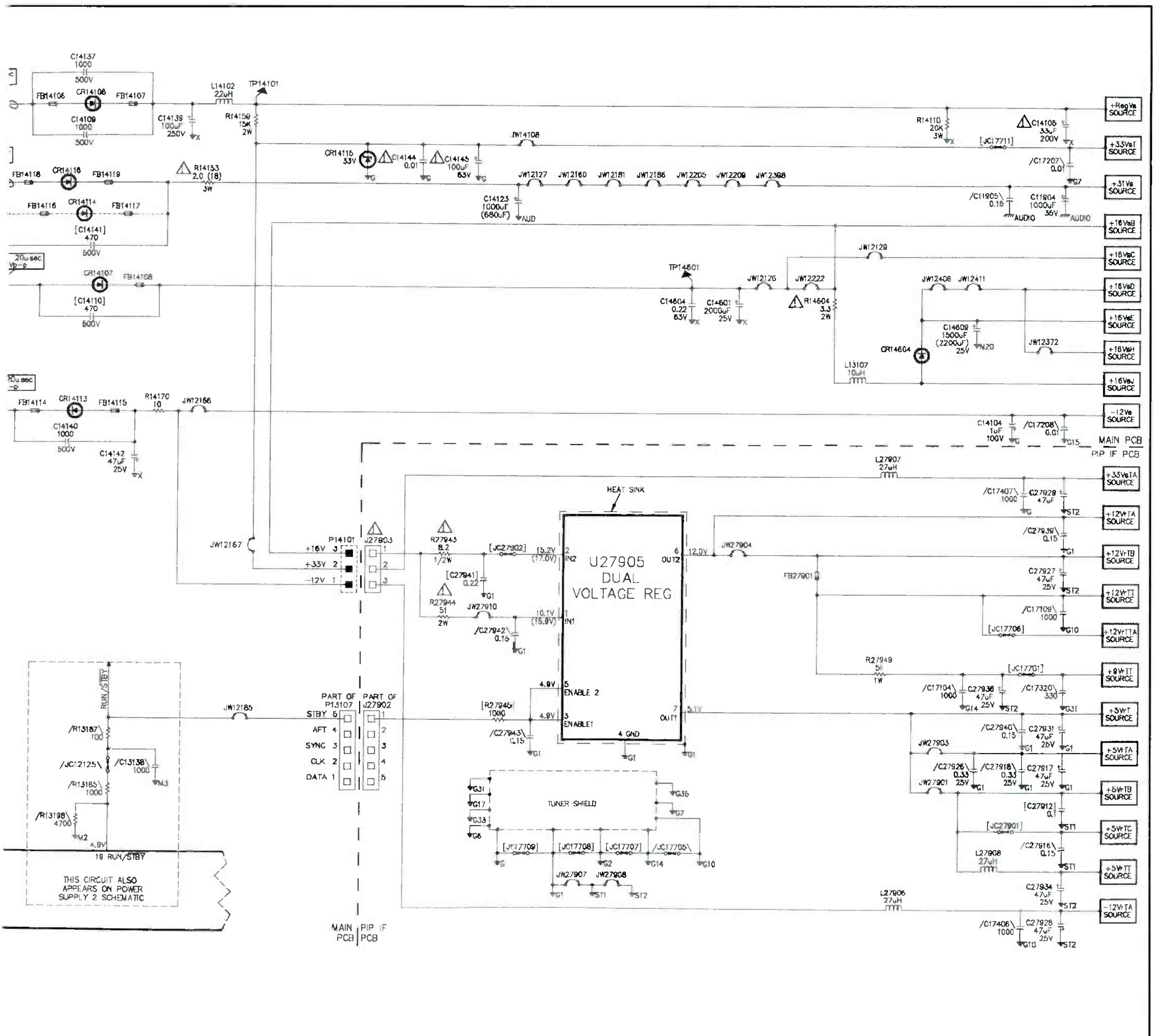


Figure 3. This drawing will give you an idea about the complexity of the power supply in the CTC197 chassis. The complete power supply schematic diagram is printed on a foldout that is equivalent to three 8 1/2" x 11" pages.

should take the time to read. The literature says, for example, if the television tries to start three times and stops, evidenced by the clicking of the degauss relay, the EEPROM and the T-Chip are working and the problem will most likely be related to the power supply or the deflection circuits. If, on the other hand, the set does not try to start but you don't hear the degauss relay click, the cause of the problem could be almost anywhere in the circuits of the set, and the servicer will have to use a different set of procedures to locate the problem.

Since the degauss relay clicked three times, I will follow the procedure outlined to isolate this problem, saving the "no click from the degauss relay" dead-set symptom troubleshooting procedure for another time. The troubleshooting guide, as RCA gives it, is found in Table 1, which is just one of many "trouble trees" given in both the paper and and electronic literature. To follow this trouble tree, I had to deal with three circuits which

"The literature says, for example, if the television tries to start three times and stops, evidenced by the clicking of the degauss relay, the EEPROM and the T-Chip are working and the problem will most likely be related to the power supply or the deflection circuits."



I will have to introduce to you. My treatment of these circuits will be very brief because of time and space limitations.

The power supply

Figure 3 will give you an idea about the nature of the power supply. The power supply schematic diagram is printed on a foldout that is three 8 1/2" x 11" pages long. Please note that U27905 is not relevant for this discussion because it provides power to the PIP module, and the PIP module does not contribute to the "dead set" problem I was facing.

I cannot take the time to discuss the operation of the power supply beyond a few casual comments. It is a variable-frequency/variable pulse-width SMPS (switch-mode power supply) that uses a controller IC to drive a MOSFET. The power supply begins to operate as soon as it receives ac, producing +140V, +16V, and –12V. The +16V is routed to U14701, a single-in-line, seven-pin IC, that, when switched on by system control, provides +12V and +5.1V for full power operation of the chassis (Figure 4). The +16V also provides power to U14601, a three-terminal voltage regulator that provides standby +5V for the chassis. As you can see, the +16V is a very important voltage for operation of this set.

Horizontal deflection

The second circuit, illustrated in Figure 5, is horizontal deflection. It is a basic, straightforward circuit that should require no

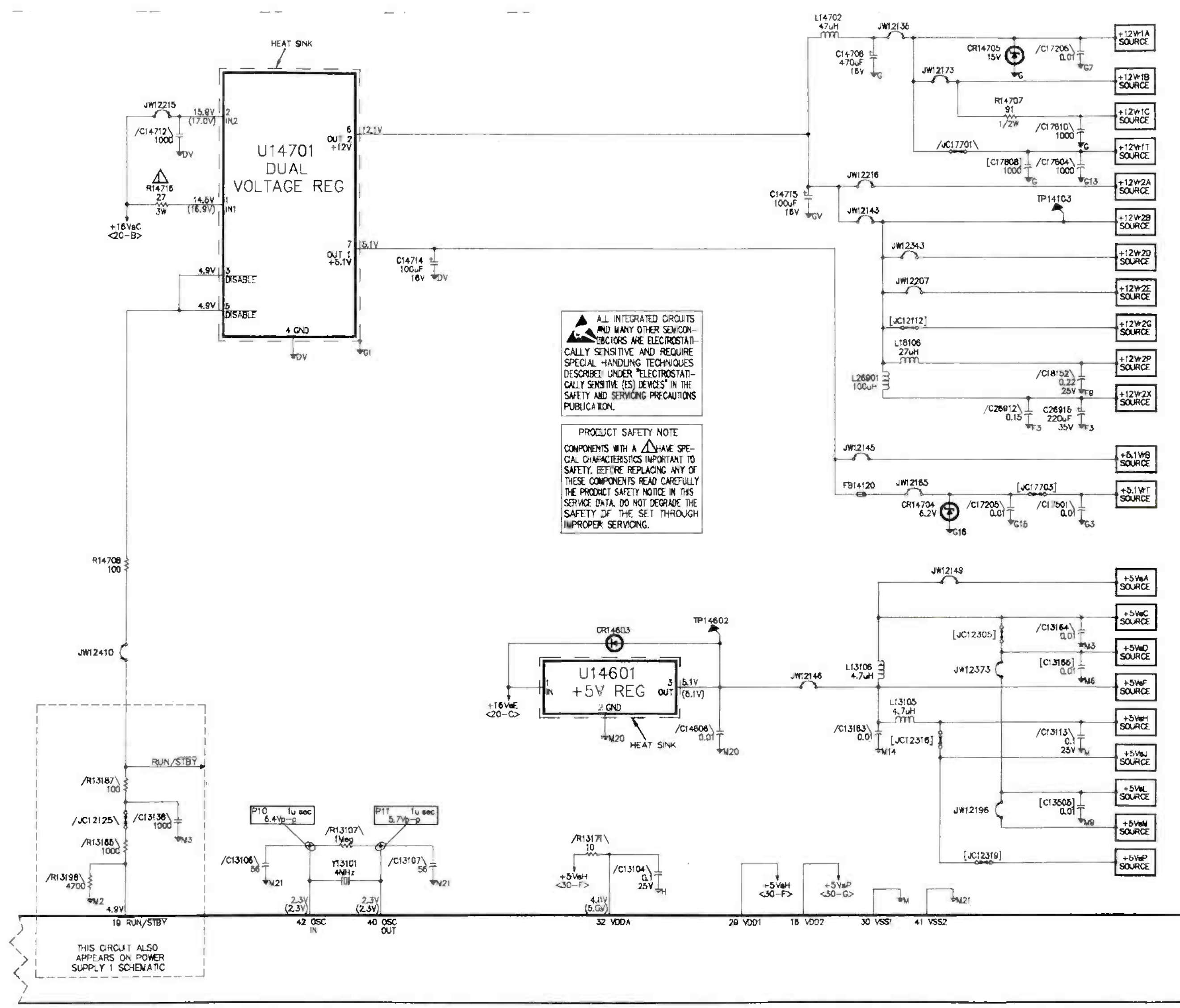


Figure 4. The power supply in the CTC197 television set begins to operate as soon as it receives ac, producing the following voltages; +140V, +16V, and –12V. The +16V is routed to U14701, a single-in-line, seven-pin, IC, that, when switched on by system control, provides voltages of +12V and +5.1V for full power operation of the chassis.

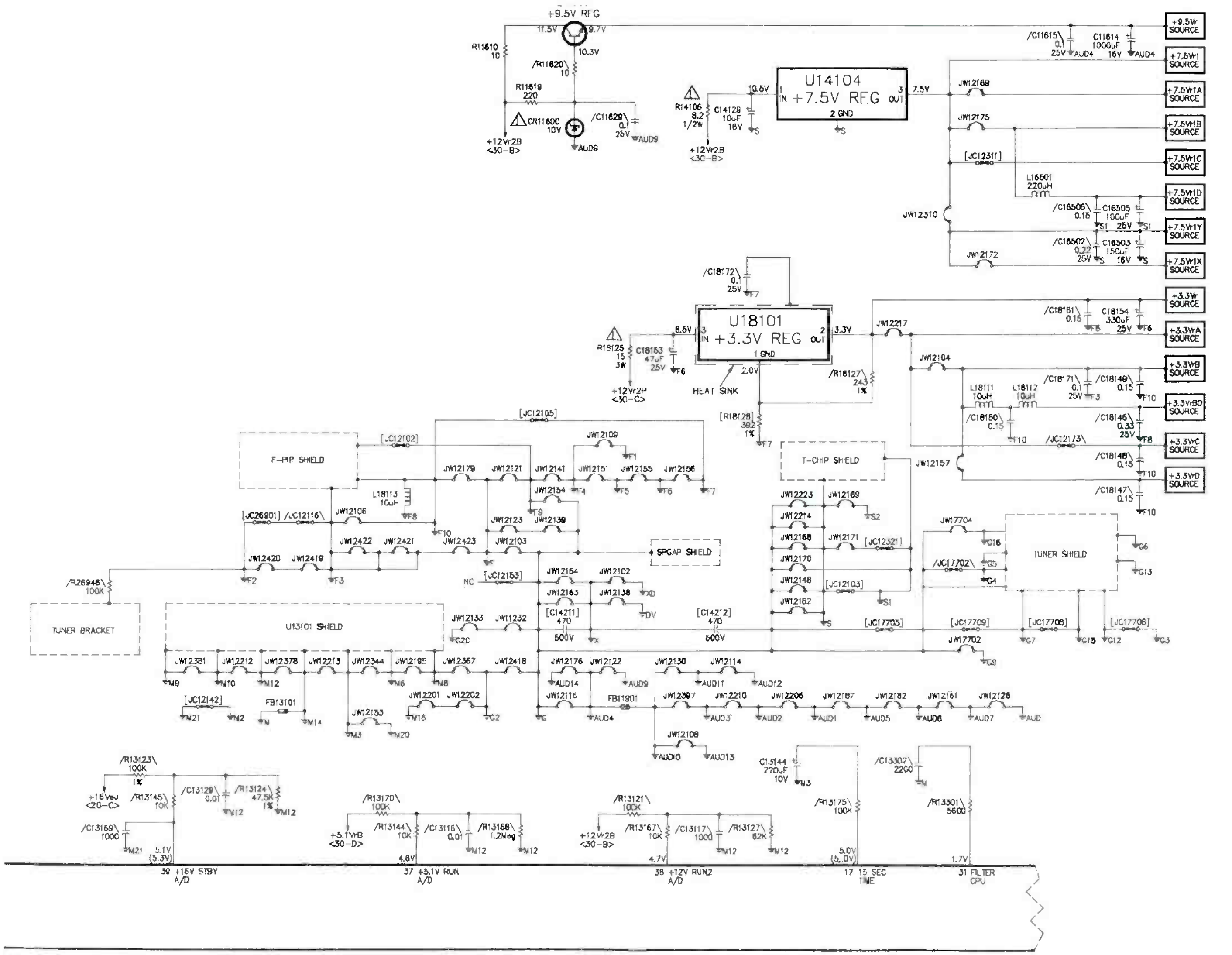
comment because you are already familiar with it from servicing other similar previous Thomson chassis. The additional components are for pin cushion correction.

System control

The third circuit of interest to this article is the system control circuit. The relevant schematic is laid out in the paper service data on a foldout page, which is also three 8 1/2" by 11" pages long, too big to reproduce here. A pin-out of the microprocessor, Figure 6, is printed here in lieu of a complete schematic. You may correctly assume that the microprocessor for the chassis I am discussing was working correctly. That is, it had all the "must haves:" B+, ground, reset, oscillator, and it appropriately responded to power-on commands.

In addition to the monitoring functions with which we are familiar, the CTC197 microprocessor monitors the +5V run supply at pin 37, the +12V run supply at pin 38, and the +16V standby at pin 39. If these voltages drop below a certain level, the microprocessor will shut the TV down.

The literature says if the TV tries to start three times but fails, check pin 19 for a "high" (about 5V). This voltage is necessary to turn on U14701. If U14701 fails to turn on, the chassis will be deprived of necessary run voltages. If you want to bypass system control because you think it might be defective



or if you just want to force U14701 on while you are troubleshooting, cut jumper JW1240, with power off of course, which will permit pins 3 and 5 of U14701 to go high, supplying the chassis with +5V and +12V run voltage.

Finding the cause of the dead set

Now you have enough information to follow along. Since the degauss relay clicked three times, I needed to check the power supply. To confirm proper operation of a SMPS, always check at least two output voltages. The collector of the horizontal output transistor had about 160V on it, which was okay because the set was not up and running. I even monitored the voltage and waveform while the tech who was working in the shop with me pressed the power-on control. Since it is crucial to the operation of the television, I checked +16V supply and noted that it was both steady and ripple free. I concluded that the power supply was working as it should.

Following the instructions in the service literature, I checked pin 39 of U13101 (the microprocessor) for 16V and found that

"To confirm proper operation of a SMPS, always check at least two output voltages."

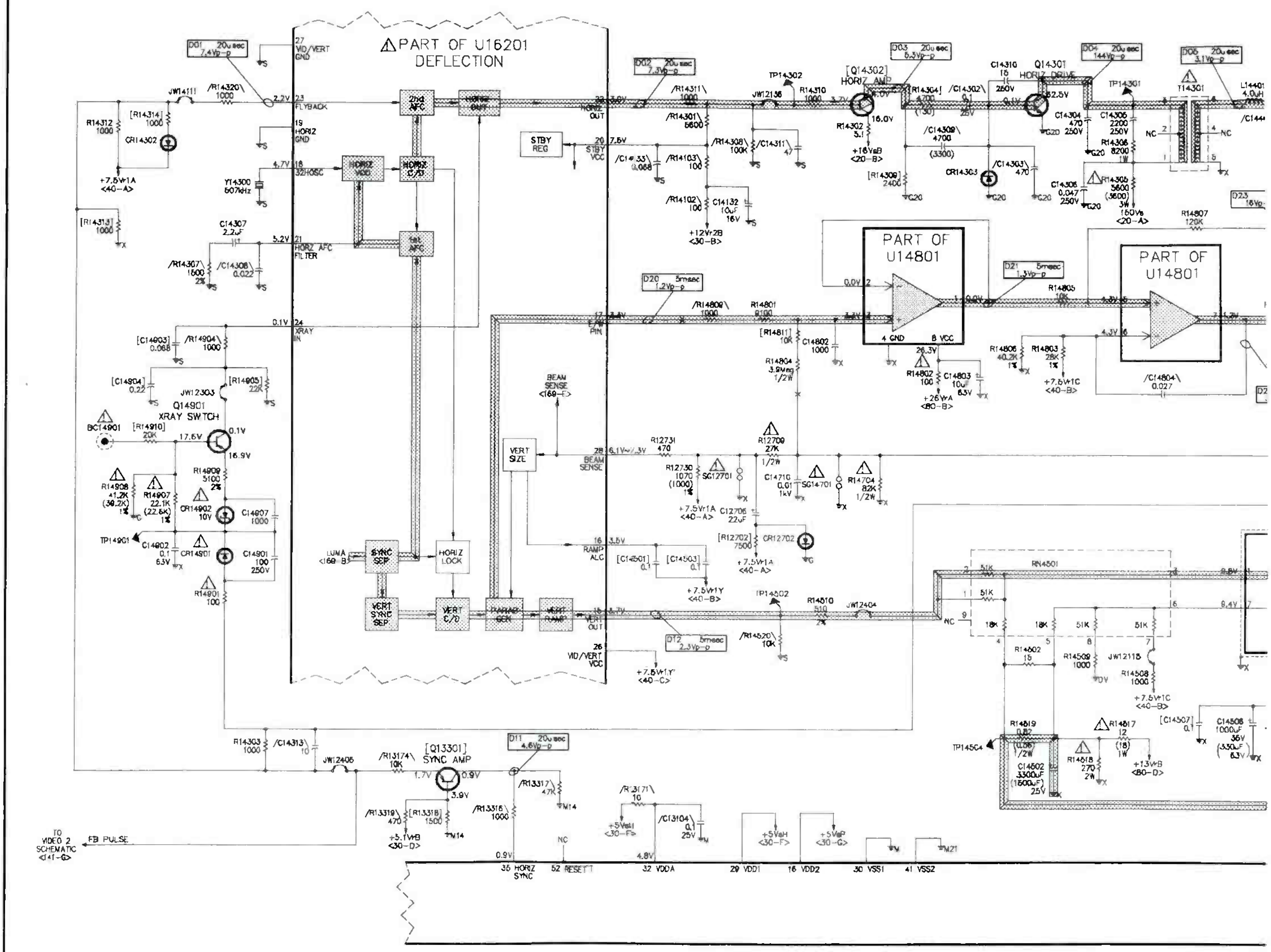


Figure 5. Horizontal deflection in the CTC197 is performed by these circuits. This is a basic, straightforward circuit that should require no comment because you are already familiar with it from previous Thomson chassis. The additional components are for pin cushion correction.

"The troubleshooting procedure also calls for confirmation of the horizontal oscillator because the problem could be caused by a fault in the horizontal deflection system."

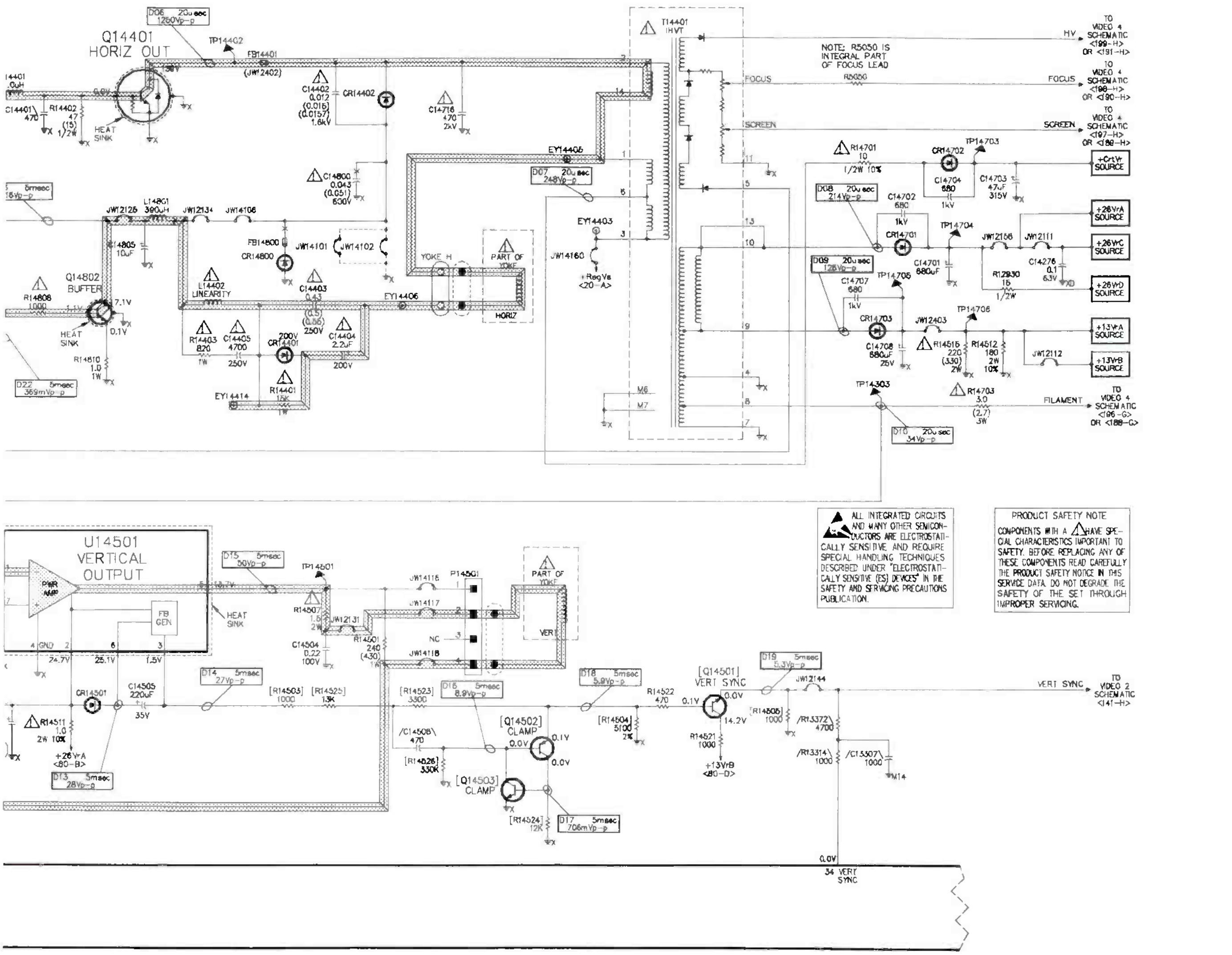
it was not at +16V but was close enough. Note that I had already checked to make sure the power supply was putting this voltage out. I then checked pin 19 for a "high," and it wasn't there. I cut jumper JW12410 to permit pins 3 and 4 of U14701 to go high and checked for +5 and +12V out, and found those voltages present. However, the TV still would not start. I rechecked pins 37, 38, and 39 of system control and noted that pins 38 and 39 did not have the voltage the literature called for. However, as I later learned, these voltages *will not be present* unless the TV is running, even when U14701 has been forced on by cutting the jumper wire, JW12410.

The troubleshooting procedure also calls for confirmation operation of the horizontal oscillator because the problem could be caused by a fault in the horizontal deflection system. I checked and found that the T-Chip was indeed putting out horizontal drive pulses as required for the set to operate.

Here's one important note. If you have had to cut any jumpers on one of these sets during troubleshooting, don't forget to solder them back together before connecting the set to the power line again or you'll be facing other problems.

Calling the tech line

In my haste to explore new technology, had I overlooked



something? I am not shy about asking for help, so I called the tech line. The people who operate RCA's technical assistance hot line are in my opinion among the best in the business. I certainly owe them a debt that shall not soon be paid. The tech to whom I talked walked me through the procedure I had just completed. I retraced those steps gladly because I thought I had missed something the first time around, but we found nothing amiss. Then he asked me to disconnect the kine socket and hor-

"Here's one important note. If you have had to cut any jumpers on one of these sets during troubleshooting, don't forget to solder them back together before connecting the set to the power line again or you'll be facing other problems."

Test Your Electronics Knowledge

Answers to the test

(from page 22)

1. B — Remember that gain and bandwidth are tradeoffs. A degenerative feedback reduces the gain, so it increases the bandwidth.

2. B — It is not possible to saturate air with magnetic flux lines, so putting an air gap in the core prevents saturation.

3. D — (I know, in audio speak it is called "RMS power" even though that term doesn't make any sense.)

4. C — The gain (no units) times the frequency (Hertz) is a frequency. Gain-bandwidth is a value supplied by the manufacturer for its transistor. It is the frequency at which a transistor beta is equal to unity (1.0).

5. B — Resistors are sold by resistance value, percent tolerance, and reliability. Even if those are the same for two resistors, a fourth parameter, temperature coefficient, may make it undesirable to exchange resistor types with different temperature coefficient ratings.

6. B — The data for various ohmmeters made by several manufacturers was given in an previous article.

7. 1.151 nepers — Number of dB x 0.1151 = number of nepers (a neper is the foreign equivalent of decibels.)

8. Not true — The address bus of an 8-bit microprocessor carries 16 bits.

9. Write it as: 0 + j16. The conjugate is 0 - j16, or -j16.

10. The Thompson Effect — It is one of several important thermoelectric effects.

"Well, it's difficult to troubleshoot from afar. He suggested as a final comment that I change the flyback because he had found a number of them to be bad."

izontal yoke, saying he had encountered some bad picture tubes in the model on which I was working. I did as he instructed, but the TV still would not start.

Well, it's difficult to troubleshoot from afar. He suggested as a final comment that I change the flyback because he had found a number of them to be bad. He said even though the flyback checked good, it could still be bad. We terminated the conversa-

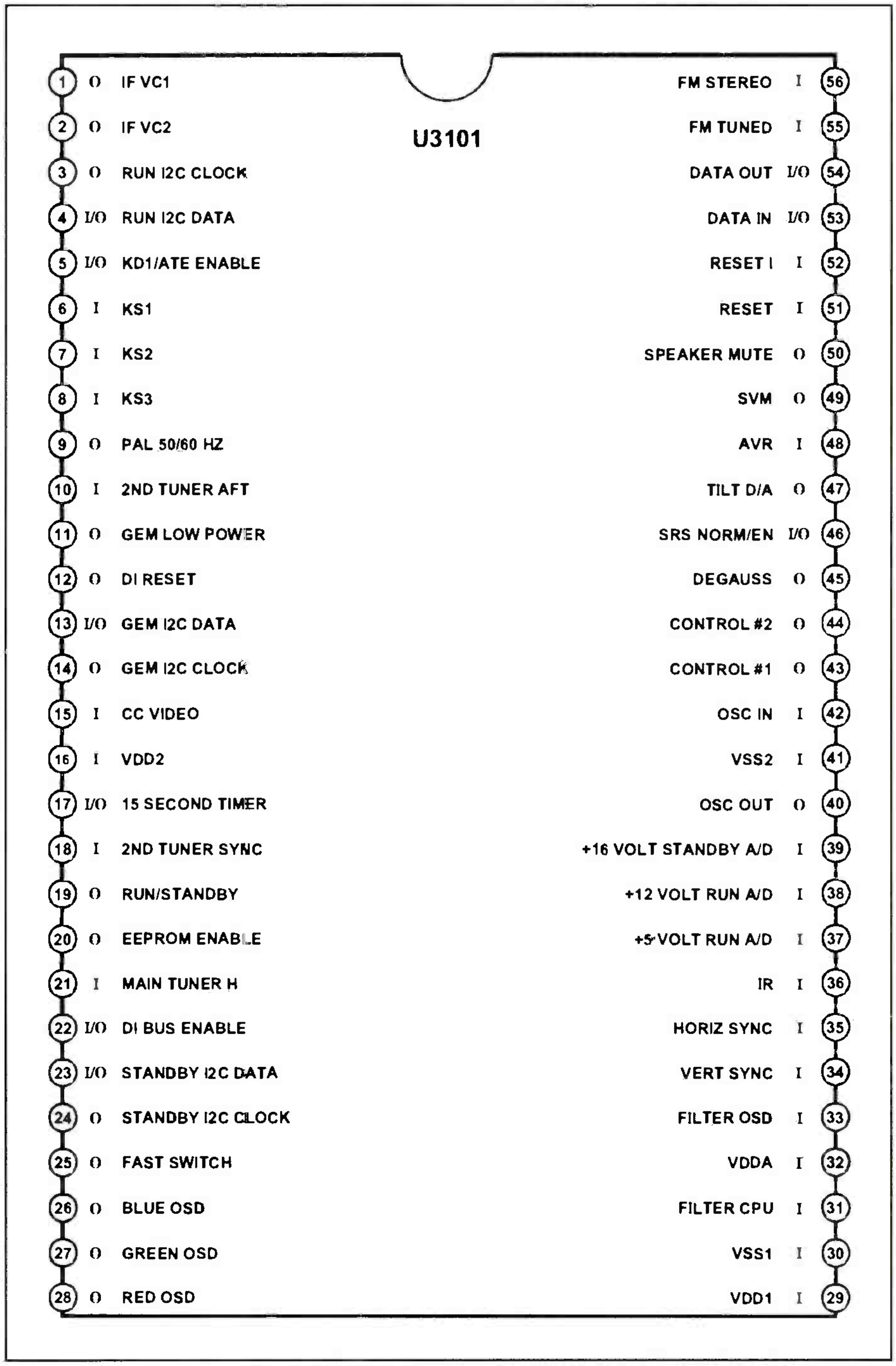


Figure 6. The system control schematic for the CTC197 chassis is laid out in the paper service data on a foldout page that is three 8 1/2" by 11" pages long, too big to reproduce here. A pinout of the microprocessor is printed here in lieu of a complete schematic.

Set Will Not Turn On

If the television tries to start three times and then stops (you can hear the clicking sound of the degauss relay), the EEPROM (U13102) and T-chip (U16201) are working - hardware OK. Problem is most likely power supply or deflection related. Use the following flowchart to isolate the fault.

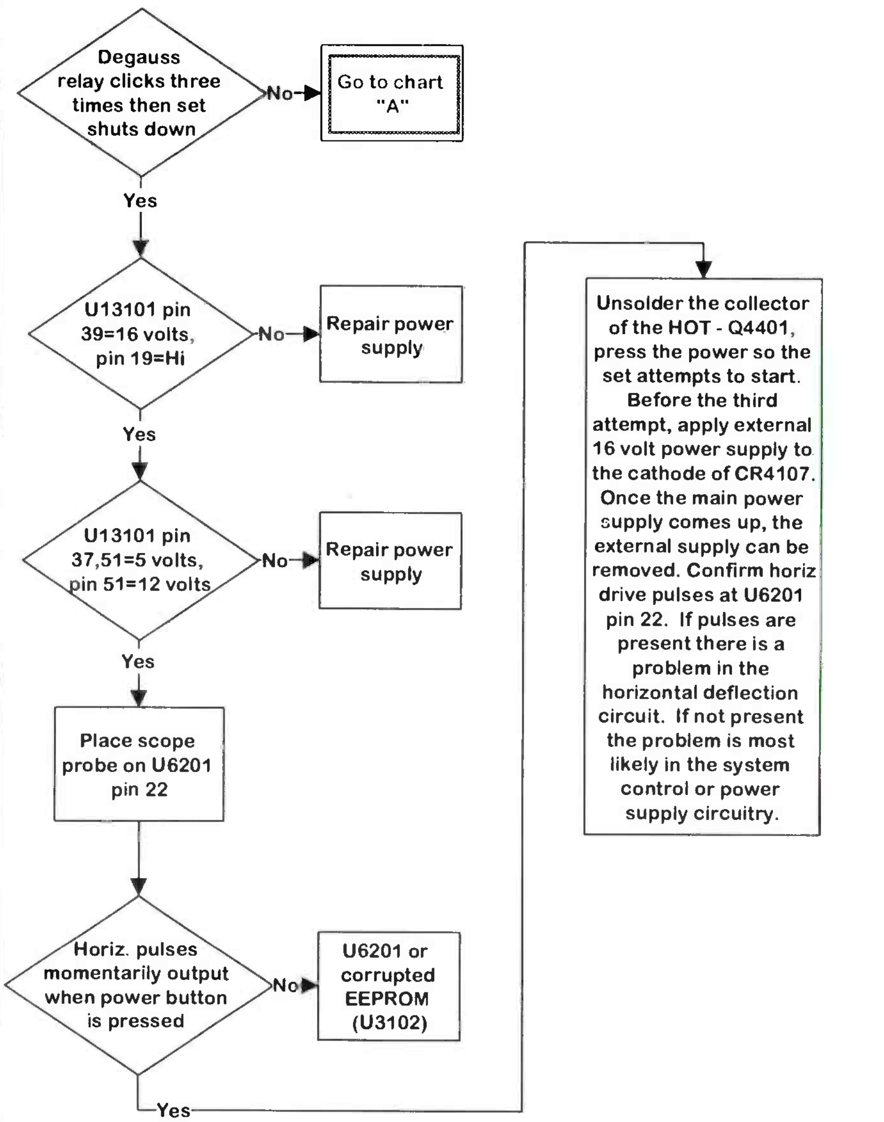


Table 1. This troubleshooting flow chart provides a step-by-step guide to the actions a technician should take take if a CTC197 set will not turn on.

tion at that point. I promised to call him back after I had changed the flyback.

Back to the beginning

I still was not satisfied. I don't like to change a part without at least a little assurance that the part is defective. So, I did what I had done at the outset. I put the probe of my oscilloscope on the collector of the horizontal output transistor, made a couple of adjustments that would permit me to observe the waveform as the TV tried to start, and pressed the power-on button on the remote control. Do you know what I saw? Not the clean retrace pulses that should have been there before the set died, but a distorted retrace pulse followed by significant ringing. The flyback was bad. The waveform had been there when I checked it early in the troubleshooting process, but I just had not seen it. Enough said. ■

What Do You Know About Electronics?

by J. A. Sam Wilson

A letter from a reader in Sunnyvale, California:

Dear Sam,

Can you explain to **ES&T** *readers how to solve for the total resistance of the bridge circuit shown in* **ES&T** *February of "WDYKAE?" by using Thevenin's theorem and also by using delta to wye conversions?*

Thank you,
Tom G.

The Delta (Δ) Wye (Y) Transform

I'll start with this because it's an easy answer to one of Mr. G's requests.

An explanation of what you can do with a delta-wye transform: Figure 1 shows the circuit we'll be working with.

In the upper delta of Figure 1, the delta circuit is terminated by terminals BCD. The wye configuration that we're going to calculate has been inserted in the delta. If the values of resistors in the wye (RA, RB, and RC) are properly calculated, the delta circuit can be eliminated and replaced by the wye. The resulting circuit is shown in Figures 2A and 2B. Observe that it is now a basic series-parallel circuit. The resistance of the resistors in the wye can be easily calculated by the equations in Figure 2A.

Understand that the replacement circuit of Figure 2B will have exactly the same resistance between B and E as the original bridge circuit.

Here are the calculations for RA, RB, and RC:

$RA = (R_1R_2)/(R_1 + R_2 + R_3) =$
$(10 \times 20) \div 70 = 2.857\Omega$

$RB = (R_1R_3)/(R_1 + R_2 + R_3) =$
$(10 \times 40) \div 70 = 5.714\Omega$

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

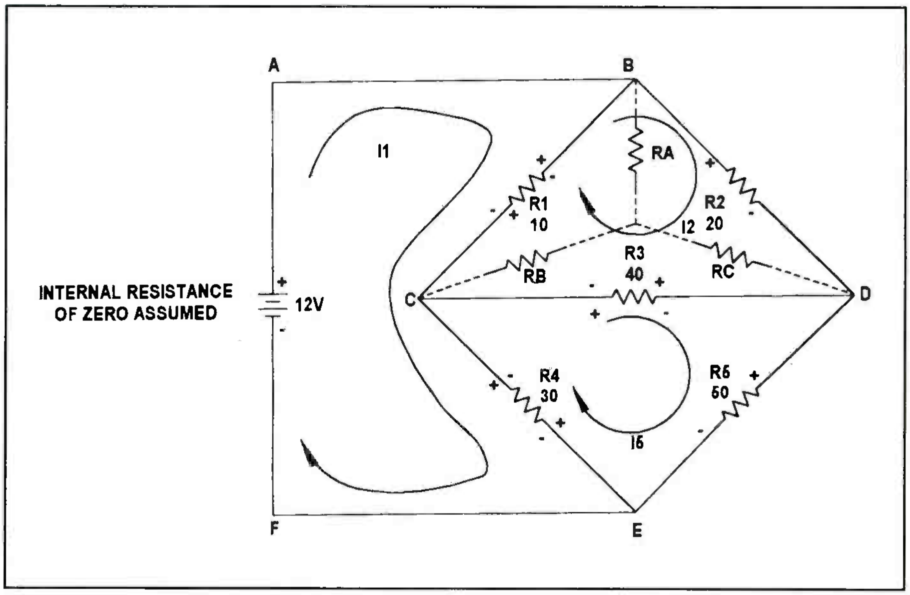


Figure 1. Resistances connected in a delta configuration cannot be combined by using traditional series/parallel resistor techniques. They can, however, be combined into their equivalent "wye" (Y) configuration, from which further calculations can proceed.

$RC = (R_2R_3)/(R_1 + R_2 + R_3) =$
$(20 \times 40) \div 70 = 11.43\Omega$

With the wye conversion, the circuit now looks like the one in Figure 2B.

The resistance of Figure 2B (from B to E) is equal to RA plus the resistance of the parallel branch. I calculated the parallel resistance by the product over the sum method:

$(35.714 \times 61.429) \div [(35.714) + (61.429)]$
$= 2194/97.14 = 22.6\Omega$
$22.6\Omega + 2.857\Omega =$ about 25Ω (answer)

You can see in Figure 2 that the parallel resistance must be added to RA (2.857Ω) to the parallel branch to get the total resistance between B and E.

$R_{TOTAL} = 2.857 + 22.6 = 25\Omega$ (approximately)

(This is the total resistance of the bridge from B to E.)

Since there are so many multiplications and divisions and so much rounding off of values, you can say that value of the bridge resistance is *about* 25Ω. Save that number to check the wye to delta resistance solution of the same bridge circuit in the next issue.

An application of a delta/wye transform

I know that readers of "What Do You Know About Electronics?" are aware of the fact that you cannot solve for the resistance of the bridge circuit (BCDE in Figure 1) by using combinations of series and parallel calculations. The bridge resistors are just not connected that way. However, you might be surprised by the number of different ways in which the value of the resistance of the bridge from points B to E *can* be solved.

A few errors

I think I should let you know before I

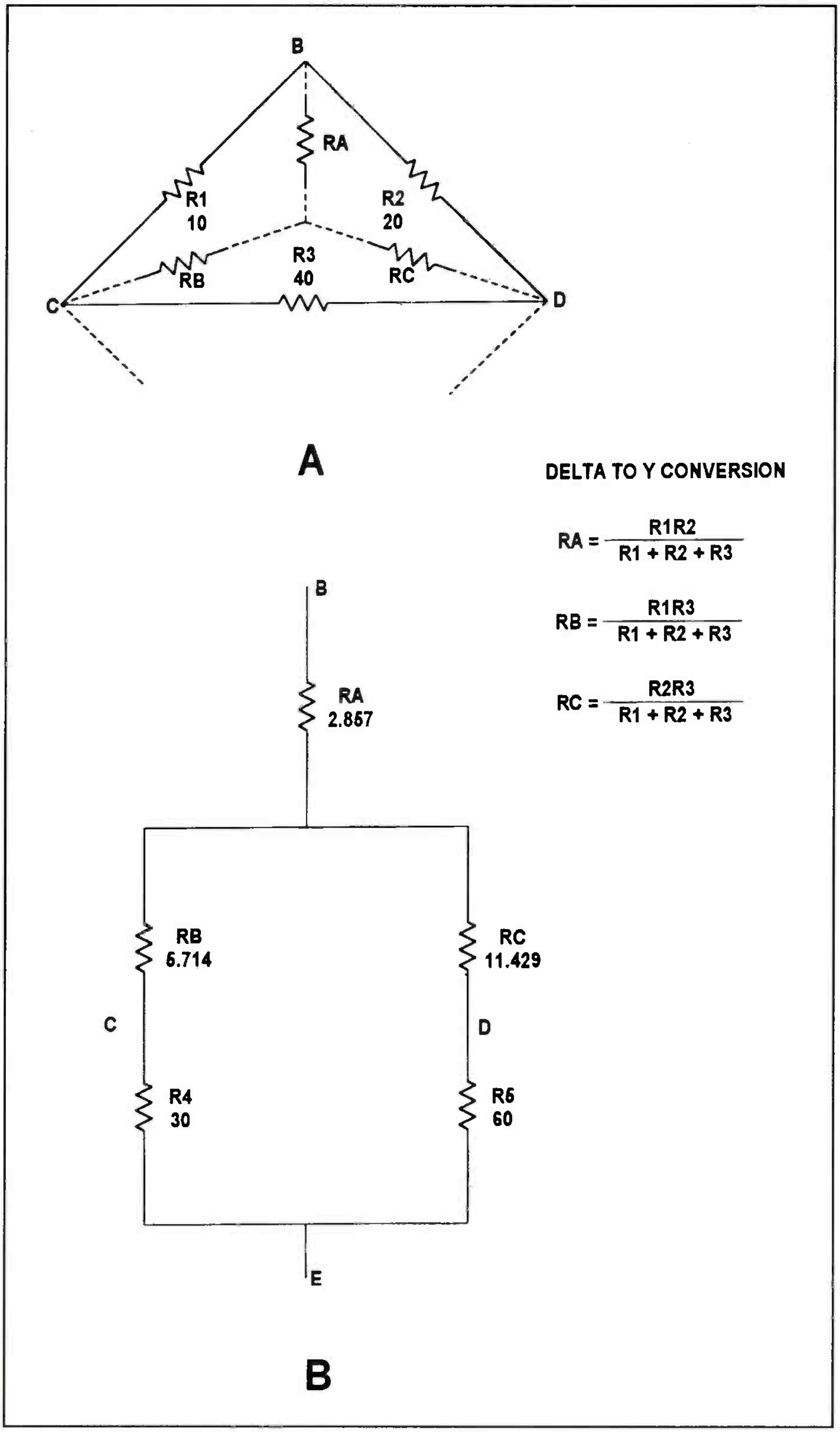


Figure 2. The resistances of the circuit illustrated in Figure 1 can be converted and combined using delta-to-wye calculations as shown in this diagram.

go any further that I have had some serious trouble with my brain. The big honchos with MDs thought I had a stroke, so they had my brain scanned at the hospital and concluded, "There is nothing in there." That didn't surprise anyone! (Also, no stroke!)

For a time I couldn't even write my name. I have a good reason for telling you this. In the February 1999 issue, I made a valiant effort to solve for the resistance from B to E in the circuit of Figure 1, and, when I started to get over whatever was wrong with me, I went back over that article again. I found some errors. The real mystery is why no readers mentioned them. I'll rework that article later as a way of making it up to you, but, I'm wondering if you are getting tired of math in "WDYKE?" Please write and tell me. I don't want to make my readers unhappy!

The Symbol Truth

Can you name the devices symbolized in Figure 3?

Answer: Three different manufacturers use the symbols for an IGBT (Insulated Gate Bipolar Transistor).

Some article review questions

Every once in a while, we like to go back through articles and ask questions about their content. Remember, one way to remember these things is to periodically review them.

1. Any system operation or signal that may be due to mere chance is called ___________.

2. Video heads are always used in pairs. As the tape plays, each video head picks up _____________.

3. Which of the following is the true shape of a bubble in a bubble memory?

A. Triangle
B. Circle
C. Cylinder
D. Paraboloid
E. Epicycle

4. Voltage (is, is not) an electromotive force.

5. Even the most knowledgeable technicians cannot achieve their goals without the ___________.

6. In 1982, an IBM study concluded that the best way to degrade a PCB connection is to ___________.

Late news flash

In our Florida newspaper, there is an article about a company that is making circuit boards out of spinach. They probably solder it with iron wire(?)!

Technical Chit Chat

This is from an article by Frances J. Stifter:

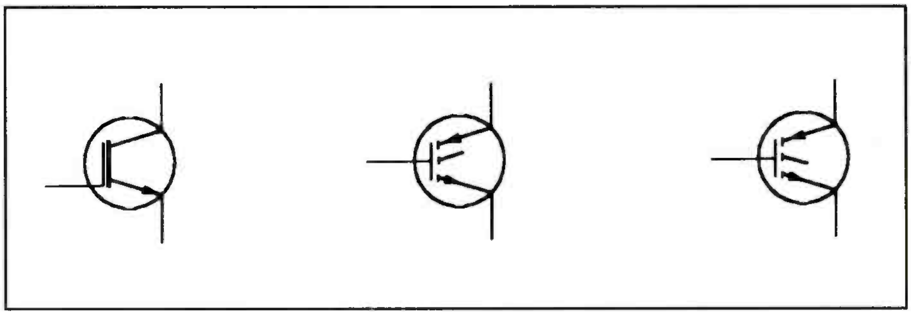


Figure 3. What component is represented by these various symbols?

"Spikes, surges, noise, interference, and interruptions have disrupted satellite reception since the earliest dishes were installed. Early system viewers learned to accept interference and interruption. Poor overall satellite system performance was the accepted standard. Viewers with little viewing experience were pleased to receive any reception at all. Interference and interruptions were considered a natural part of satellite viewing.

Modern satellite systems are much more predictable. Modern viewers expect interference free entertainment. Unfortunately, present day systems are more complex than earlier equipment, making them more vulnerable to disturbance and interference." ■

Answers:

1. stochastic
2. half of the horizontal lines in the picture.
3. C — They look like circles when viewed from the top.
4. is not — Actually, work is a measure of work per unit-charge.
5. proper tools.
6. touch it with a soldering iron.

NEWS *(from page 4)*

To" section that describes the various integration methods and how to get started. A links page directs consumers to manufacturers of products in each category and a glossary explains the terms that might be unfamiliar to consumers new to integrated home systems.

New CEMA/NCTA standard helps TV and cable system designers

The Joint Engineering Committee (JEC) of the Consumer Electronics Manufacturers Association (CEMA) and the National Cable Television Association (CTA) developed standard EIA-23, the RF Interface Specification for Television Receiving Devices and Cable Television Systems. With the standard, the consumer electronics and cable industries have pinned down important definitions that will help improve the performance of both the cable system and consumer electronics equipment, such as television receivers and VCRs.

Both TV receiver engineers and cable system engineers now will have a better understanding of how to design their respective parts of the system to avoid problems for the customer. For example, cable engineers will know how strong their signal can be before overloading the receiver, and the TV engineer will know what maximum signal to expect and design the set to be able to handle it.

CEMA Urges FCC to develop terrestrial digital radio service establish performance objectives

CEMA has urged the FCC to implement the development of the most effective terrestrial digital audio radio (DAR) service, one that meets listeners' expectations in terms of sound quality and does not interfere with existing analog radio services or other digital services.

CEMA filed comments at the Federal Communications Commission (FCC) in support of a rulemaking proceeding to implement terrestrial DAR. The introduction of DAR technology is in the public interest, asserts CEMA, and its implementation will provide improved radio broadcast services to consumers and help promote the future viability of radio broadcasting in the U.S.

While CEMA does not endorse any particular DAR technology, the association urged the FCC to establish performance objectives that should be attained by any proposed DAR technology. Specifically, CEMA asked the FCC to:

1. Establish comprehensive technical assessments to weigh the performance of competing systems,

2. Ensure that DAR systems do not adversely affect existing analog radio services while providing high quality and robust digital coverage, and

3. Rely on laboratory tests and not just field testing to define performance.

A complete filing can be found on the Web at <CEMAcity.org/govt/topics.htm>

In Windows, the CD-ROM can launch the user's web browser and link directly to the manufacturers home page.

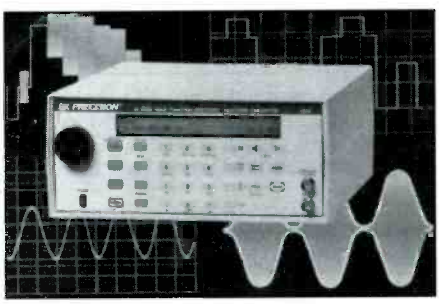
This is a specialized search tool designed specifically to make searching for second sources or replacement devices faster and more efficient.

Expanded to include NTE and Philips ECG parts, the directory lists over 140,000 functional equivalents for both current and discontinued ICs.

Data includes device category information, such as Memory-EPROM or Linear-Telecommunications. Complete manufacturer contact information includes address, telephone number, fax numbers, and web address. Full device specifications do not appear on the compact disk. For this information, engineers can refer to some of the company's other listings.

645 Stewart Ave., Garden City, NY 11530,
Phone: 516-227-1330, Fax: 516-227-1453,
Website: <http://www.hearstelectroweb.com>

Circle (91) on Reply Card



Multi-mode signal generator

B&K Precision introduces the Model 4070 Synthesized Arbitrary Waveform/ Function/Pulse Generator.

For use by engineers, technicians, designers, scientists, and enthusiasts in a wide variety of applications, including communications, audio, video, power systems, and consumer electronics, the unit is one of a new class of signal generators that are based on Direct Digital Synthesis (DDS) technology.

The generator acts as an Arbitrary Waveform Generator, Function Generator, Pulse Generator, and Synthesized Waveform Generator that produces modulated sinewaves from dc to 21.5 MHz. The 4070 uses a separately synthesized sample clock for the ARB function that allows for significantly reduced phase shift and jitter found in competing signal/arbitrary waveform generators.

Other features include an RS-232 remote control, full-size numeric keypad and encoder, which provide direct editing of each parameter without confusing submenus, and allows instant access to all the primary functions of the instrument. A large, easy-to-read illuminated LCD display allows the user to see all modulation parameters simultaneously.

1031 Segovia Circle, Placentia, CA 92870,
Phone: 714-237-9220, Fax: 714-237-9214,
Website: <www.bkprecision.com>

Circle (92) on Reply Card

Video signal generator

The CM2250-PC "PRO" from Sencore simplifies the setup for troubleshooting monitors. The user selects the make and model of the monitor and the unit automatically configures to its setup. Over 2,000 monitor setups can be stored in the generator and be made available through a convenient charting system. Or, you simply scroll through the monitors and press enter.

The user will be able to control the testing and alignment process in their business. The unit will automatically change the video patterns, signal parameters, wait for the user to make a test or adjustment and then take you through the next step.

3200 Sencore Dr., Sioux Falls, SD 57107,
Phone: 1-800-SENCORE, Fax: 605-339-0317,
Website: <www.sencore.com>

Circle (93) on Reply Card

Triple output dc supply

The PS402 power supply from Sencore contains two 0V to 30V outputs that deliver 0V to 30V with adjustable 3A current limit. The output can be connected in series to double the voltage. The PS402 also contains a fixed 5V output rated at 3A.

The unit features low ripple and noise, selectable digital display at the push of a button to monitor the dc voltage or current supplied to the load, automatic "constant current" and "current voltage" crossover point indicated by two front panel LEDs that matches the changes of the load thus eliminating the need to constantly adjust the output voltage or current, adjustable current limiting which protects both the power supply and the device under test from damage, single, series, or parallel (master/slave) operation which allows the user to connect multiple supplies for higher voltages or currents to match the demands under test and triple output.

3200 Sencore Dr., Sioux Falls, SD 57107,
Phone: 1-800-SENCORE, Fax: 605-339-0317,
Website: <www.sencore.com>

Circle (94) on Reply Card

Digital multimeter

The DM501 digital multimeter from Sencore features analog bar graph, auto or manual ranging, ac/dc voltage and current, resistance to 30MΩ, color coded inputs, true RMS, auto power off, beep guard input protection, continuity/diode test, data hold, continuity/diode test, water resistant, shockproof and current up to 20A (limited).

3200 Sencore Dr., Sioux Falls, SD 57107,
Phone: 1-800-SENCORE, Fax: 605-339-0317,
Website: <www.sencore.com>

Circle (95) on Reply Card

Troubleshooting and test system

International Test Systems (ITS) introduces the CircuiTest 1000S Troubleshooting and Test System, a device used to test for faults in printed circuit boards. The tester allows for power-off and power-on component level tests. The unit can connect via a BNC connector to any standard oscilloscope.

Once connected to the oscilloscope, the tester allows for powered-off troubleshooting utilizing Voltage/Current (V/I) signature analysis, using any combination of four ac levels, six impedance levels, plus scanner capability to scan ICs or other multiple-pin component's V/I signatures up to 12 pins at a time. Another feature is the function generator, which provides 3 waveforms, as well as variable amplitude and frequency either of which can be set by the user. Also included is a shorts locator, which when combined with any standard meter, allows the user to easily locate shorts on unpowered boards.

4703 Shavano Oak, Suite 102, San Antonio, TX 78249,
Phone: 210-408-6019, Fax: 210-408-1856, E-mail: its@itestsystems.com, Website: <www.itestsystems.com>

Circle (96) on Reply Card

CLASSIFIED

CLASSIFIED

WANTED

INSTRUCTIONAL OPPORTUNITY: Lake Michigan College is seeking a full-time instructor who will foster student success and retention in the Technology and apprenticeship programs. Working directly with the Dean, the instructor will be responsible for academic leadership and teaching within their specific Technology program. The instructors will also develop, implement, and sustain the specific courses, programs, and cirricula mandated by the educational mission and goals of the College.

ELECTRONICS TECHNOLOGY:In additional to academic instruction, will participate in the selection of equipment for the Electronics program in conjunction with advisory committee members. Convenes advisory committe and works cooperatively with local employers. Bachelor's Degree required. Master's Degree preferred, with major in Electronics, Electronic Engineering or related area. At least two years full-time industrial experience in area or vocational certifications development preferred. Strong interpersonal skills. Teaching demonstration required at interview. Screening begins June 1, 1999 and continues until position is filled.

SALARY: Placement on the faculty grid is according to education and experience. Excellent benefits package.

TO APPLY: Submit letter of interest requesting an application, resume, transcripts and 3 references to: Lake Michigan College, Human Resources, 2755 E. Napier Ave., Benton Harbor, MI 49022.

INTERNET: lmc.cc.mi.us, Infoline: (616) 927-8100 ext. 5028 LMC is a comprehensive community college located in the southwest corner of Michigan, 90 miles from Chicago, fully accredited by the North Central Association. LMC is an equal opportunity institution with a strong commitment to diversity among its employees.

READERS' EXCHANGE

Readers' Exchange is a free service.

The following restrictions apply to Readers' Exchange:

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

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

FOR SALE

Sams Photofact 151 to 1787 in file cabinets. *Contact: Ben Albin, 313 Conduit Rd., Colonial Heights, VA 23834-3809.*

VTVMS (2), $20.00 each, multitester (2), ohms range 60 megs, $8.00 each, digital voltmeter, $10.00 new. *Contact: Joseph Oracki, 410-254-0284, 3502 E. Northern Pkwy., Baltimore, MD 21206-1632.*

Sencore model SC61 waveform analyzer. Includes probe and manual, like new, $800.00 plus shipping. *Contact: Chris, 860-449-8607.*

HP 54602A 150 MHz digital storage scope, mint condition w/2 probes, $1200.00. Leader LDC822 80 MHz frequency counter, good condition, $70.00. Service manuals, schematics, various manufacturers from1980s to 1994, $5.00 to $10.00 each or sell as whole. *Contact: Frank, 516-661-3820.*

Sencore VA62, SC61 and over 200 TVs, some working, with manuals, for free, hardly used, must vacate. *Contact: 912-784-9788.*

Sencore model SC61 dual trace oscilloscope, all original leads and manuals, $500.00 plus shipping. *Contact: David, 605-647-2661.*

VCR and audio service manuals. Call or send SASE for more information. *Contact: Don Hicke Video, 4131 Mount Everest Blvd., San Diego, CA 92111, 619-994-3406.*

Sam Photofact from 375 to 2025. 1835 tubes (new). Emerson lighted double-sided sign, original carton, 4-inch stand. *Contact: White's TV, 580-688-2612, 622 N 5th St., Hollis, OK 73550.*

Complete collection of Sams TV schematics and old tubes. *Contact: 281-337-2337.*

Elco signal tracer model 145, $50.00. RF probe, $50.00. Philco old-time tube tester Q7050 model with charts, $45.00. RCA VTVM, $45.00. Older picture tube tester, $12.00 each. Heathkit vibrator checker, $35.00. Sams AR books, 10 for $12.00. Old cathode beamer first picture tube checker, $125.00. Shipping not included. *Contact: Maurer TV, 29 S. 4th St., Lebanon, PA 17042.*

Camcorder repairs. Free estimates. All makes, 18 years same location. UPS. *Contact: Atlas Electronics, 724-444-0011.*

Sencore VA62A universal video analyzer, $750.00. SC61 waveform analyzer, $450.00. Like new with manuals and accessories. *Contact: Mike, 781-396-6023 after 5 p.m.*

WANTED

NLS (Non-Linear Systems) oscilloscope model MS 230 parts location diagrams. *Contact: Richard Gilman, P.O. Box 633, King City, CA 93930, 831-385-9248.*

Colortyme TV chassis H14-1 service manual, Contec TV model MF-1951 chassis N19-07 service manual, Zenith TV flyback 95-4203. *Contact: Ray's TV, Box 70, Lacombe, LA 70445, 504-882-5685.*

Emerson 13" TV TC1316RN schematic. *Contact: Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Sansui model QRX-7001 four-channel receiver service manual/schematic. *Contact: Marion Delfert, 314-739-5175, 11695 Donnycave, Bridgeton, MO 63043-1322.*

B&K Model 530 semiconductor tester operators manual. Copy o.k. *Contact: Bob, 570-226-6840.*

Oscilloscope for learning purposes, anything usable. *Contact: Fred Collins, 123 Watson St., Enfield, NC 27823.*

Used picture tube equipments. *Contact: Steven, 408-223-6214 or 408-926-8685 or e-mail steventl@hotmail.com*

Magnavox model CRN 130 AT 01, Zenith model SL2753 schematics. Will buy or copy. *Contact: Jim, 815-398-7446 or e-mail jimbow1313@aol.com.*

JVC model C-1918 yoke assembly, Sansui model QRX3500 and Marantz model 2330 schematics. *Contact: Glen, 613-837-1294 or e-mail holbegr@infonet.ca*

Panasonic and Quasar flyback, TLF 6012-IS, TLF 60 42F. *Contact: 410-282-4460 (phone/fax).*

Conrad-Johnson, Audio Research, Marantz, McIntosh, all tube pre-amp, no solid state, dead or alive. *Contact: Joe Bagnata, Box 26, Harleigh, PA 18225-0026.*

Orion model TV 1925 schematic and remote control. Zenith model SB2591, S2550 S2518RK, RCA model X13101GS, Wards GDD 12305 schematics. *Contact: White's TV, 622 N. 5th St., Hollis, OK 73550, 580-688-2612.*

Turntables, Technics SP10MK3, MK2, SP02, tonearms, tube limiters, Ampex decks, automotive record player, Hickok or Precise 111M tube tester. *Contact: 612-869-4963.*

Ikegami TKC-970 color film camera extender card and color corrector board. *Contact: 614-899-9049 or e-mail tech113@juno.com.*

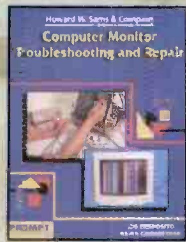
Sanyo model 91C89 color TV, any repair information you may have. *Contact: Jim, 812-854-2060, fax 812-854-3023.*

ADVERTISERS' INDEX

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

ES&T BOOK SHOP

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



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

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

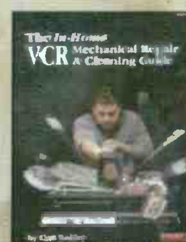
ES&T Presents the Test Equipment Guide
Includes the latest information on how to choose the best equipment, how to build test equipment and accessories, how to set up the ideal service bench, and how to put together a practical tool kit.
61089 . . . . $24.95

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

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

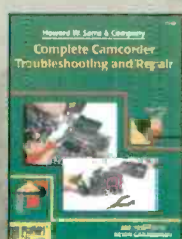
ES&T Presents TV Troubleshooting & Repair
Presents important and new information that will make it possible for technicians, students, and electronics hobbyists to service TVs faster, more efficiently, and more economically.
61086 . . . . $24.95

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

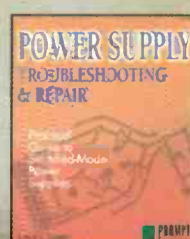


In-Home VCR Mechanical Repair & Cleaning Guide
Regular VCR maintenance is critical to prolonging the life of your equipment, and this book shows readers the tricks and secrets of the trade using just a few small hand tools.
61076 . . . . $24.95

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



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



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

TO ORDER TOLL FREE CALL 1-800-853-9797

When ordering books please include the following information: Name, address, city, state & zip. Please make a list of the books you're requesting. When paying by credit card send the number along with the expiration date. Check, Money Order, Mastercard, VISA, Discover and AMEX accepted. Please make your check or money order payable to: Electronic Servicing & Technology.

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

Please mail your orders to:
Electronic Servicing & Technology
25 Newbridge Road, Hicksville, New York 11801 FAX 516-681-2926

Video Heads

Pick A Number Any Number

When you're looking for a replacement head, SK *Series* is way *ahead* of the competition.

SK *Series* replacement video heads cross over to 4,500 different models and 68 different brands.

And when you're in need of any exact semiconductors, belts, tires, flyback transformers or video replacement parts, we have them too.

But we don't stop there.

Every SK *Series* product comes with the quality assurance and accuracy you expect from all Thomson products.

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

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

SK *Series*

Circle (67) on Reply Card