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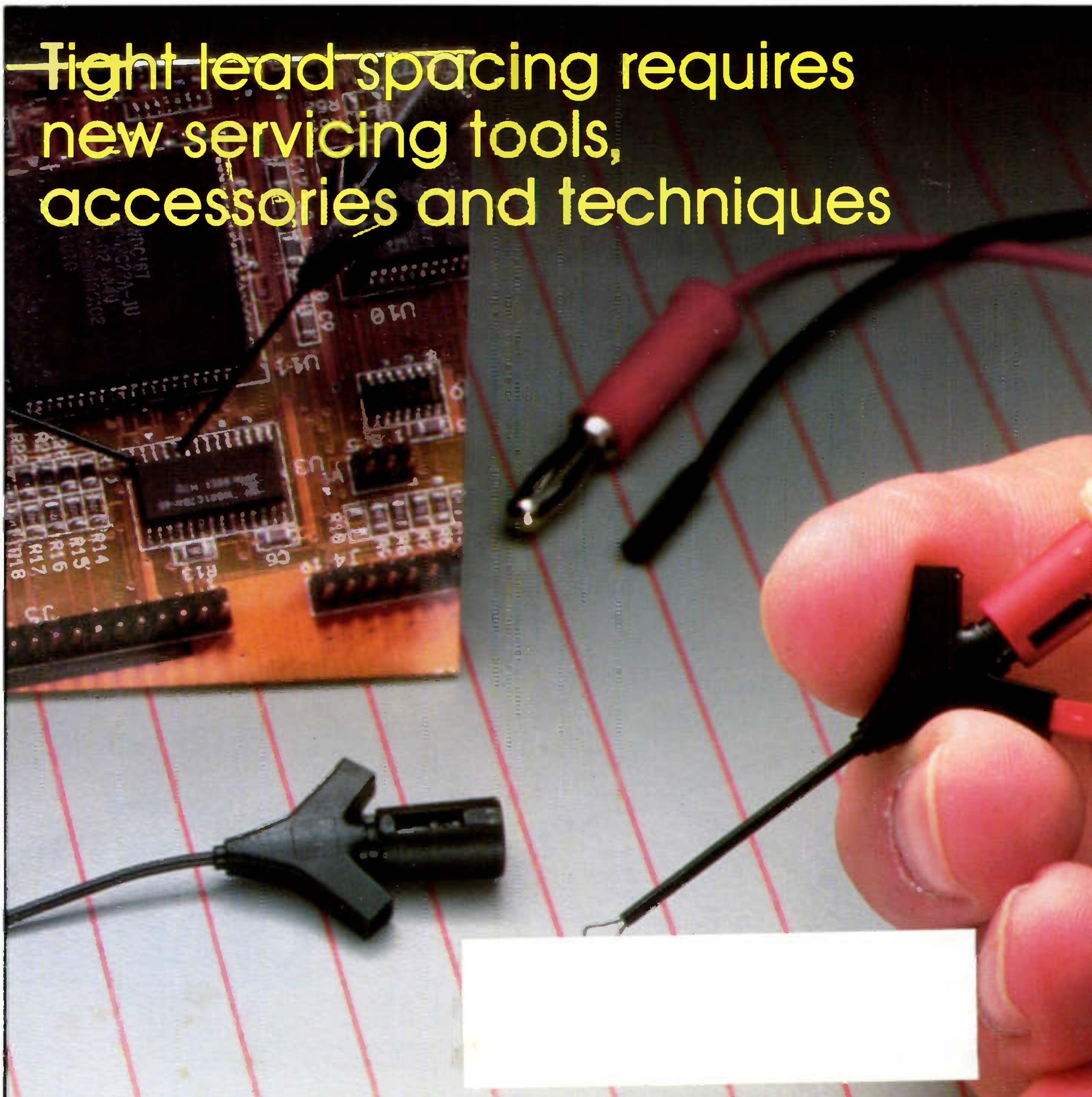

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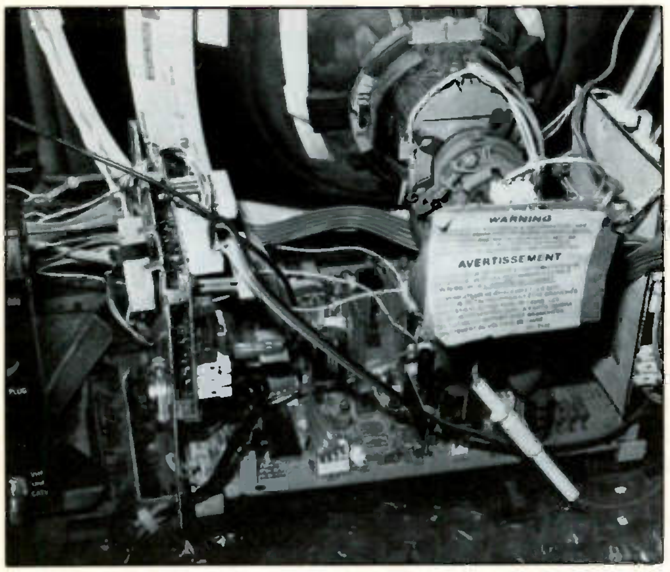

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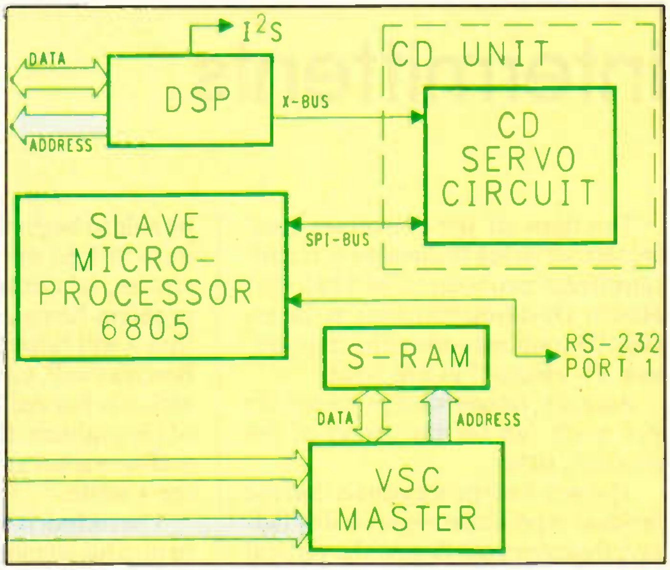

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FEATURES

DEPARTMENTS

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING
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ON THE COVER

Modern consumer electronics products, such as CDI, computers, and VCRs, and even the old standbys like TV, have IC and component leads so tiny and closely spaced that the only way to get to the source of the signal or voltage or resistance you're trying to measure is to use probes and other accessories that are especially made for the purpose. (*Cover photo courtesy ITT Pomona)*

Intermittents

The bane of the consumer electronics servicing technician is the intermittent problem. The kind that Homer Davidson discusses in the article "Troubleshooting the intermittent TV chassis" in this issue.

Actually, intermittent problems are not much fun for the owner of the product, either.

The way it often happens is that the product experiences some kind of failure; the color goes funny, the vertical collapses, the sound gets buzzy, or something like that. But it only persists for a short while, then corrects itself.

The viewer may then go up to the set and tweak a few controls, turn it off and then on again, and it returns to operation.

Then what seems to happen is that the set operates with no problem for quite some time: hours, days or weeks, then, when the owner has all but forgotten that the problem has ever occurred, it happens again.

This time it seems to last a little longer, but it eventually goes away, Over a period of time the problem becomes more frequent, and more annoying, so the owner eventually just gets so frustrated that he brings the set into the shop and turns it over to the technician.

Of course every technician knows what happens next. He puts the set on the bench, applies power, and waits for the problem to show up. It doesn't. The set plays for hours, even days, on the test bench. The technician reports NTF, no trouble found, and returns it to the owner.

At this point the owner thinks that the technician is insane or at least incompetent, and the technician doesn't have too high an opinion of the owner, either.

When the owner gets the set hooked back up in the home, it may operate for a little while, but it usually isn't long before the set begins to act up and sends the owner back to the service center.

With any luck, the set will act up for the technician on this trip and he will be able to begin the diagnostic procedure to find out what is wrong. Of course, it's only natural, with the problem being an intermittent one, that it will be intermittent on the test bench as well, and just when the technician is hot on the trail of the cause of the problem, the set returns to normal operation and stays in that mode for a while.

The technician has no recourse but to turn his attention to some other unit on the bench while he waits for the intermittent set to act up again. Sometimes covering the set with a blanket, or applying heat from a hair dryer will cause a thermal intermittent to act up, but some problems will come and go in their own time, and nothing the technician does to accelerate the problem will force it to happen.

No doubt there are times when the technician feels that he has chosen the wrong profession, that in any other line of work he wouldn't be faced with an intractable problem like this. Actually, no doubt such problems happen no matter what the profession.

For example, how many time have you heard of the case of the person with a toothache who goes to the dentist. Almost miraculously when he enters the waiting room the toothache seems to go away spontaneously, leaving the patient probing his teeth with tongue or fingers trying to find some way to bring the problem on. Of course in this case it's probably psychosomatic. The patient really doesn't want to have the dentist working on him, so his mind masks the pain.

And it happens to cars, too. Most of us have heard the story about the driver whose car ran miserably, some of the time, but not all the time, so he brought it to the auto service shop where the mechanics there couldn't get it to act up the way the driver said it did.

In fact, I had just such a problem with an old Oldsmobile. Several years ago I left work on a cold winter's day to go to lunch. The car, which normally started fine wouldn't start. No matter what I did, turning the key had absolutely no effect on it.

I called the gas station just down the street. They came amazingly quickly with a tow truck. The tow operator tried to start the car, but the solenoid didn't even pull in. He hooked up the tow truck to the car and hauled it away. He didn't have time to look at it that day, so he pushed it into a parking space, outside.

The car sat outside all night in freezing cold weather. The next morning before starting work on it, the mechanic tried to start it. In spite of the extreme cold, it started right up. As long as it was working, he couldn't troubleshoot it to see what was wrong.

Shotgunning the problem by replacing all of the starter system parts would have been prohibitively expensive. For weeks the car started just fine, but every time I got in and put the key in the ignition I held my breath as I turned it. I was also very careful not to park the car very far from somewhere I could call a tow truck from.

I don't even remember what the problem turned out to be, exactly, but I believe it was the starter aging, it's brushes pretty well worn, and gradually refusing to carry current.

Intermittent problems probably waste more time and cause more frustration than any other kind of problem. The owner of the product winds up having to bring the unit in for service several times. The service center winds up doing paper work on the unit several times, and ending up with an indication of NTF.

If the world worked the way it's supposed to, intermittent problems wouldn't happen. But they do, and the best any of us can do, technician and customer alike, is recognize such problems will happen, they will test the patience of everyone concerned, but like the rest, ultimately they will be solved.

Nils Conrad Persson

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The U.S. market for electronic home entertainment equipment will top $34 billion by the year 2000

The U.S. market for electronic home entertainment equipment had a factory level value of more than $22 billion in 1990, up nearly 7% annually from $14 billion in 1983. Accordingly to a newly published study by Leading Edge Reports, a Cleveland-based market research firm, this market expanded rapidly during the 1970s and 1980s with average annual growth reaching double-digit levels for some products. In the late 1980s, however, the rate of growth slowed as the phenomenal market penetration of video cassette recorders (VCRs), camcorders and compact disk (CD) players approached maturity.

The Leading Edge study, The U.S. Market for Home Entertainment Equipment, finds that a single historical factor has been primarily responsible for the expansion of this market. This has been the ability of the industry to boost sagging sales by unleashing new blockbuster products from time to time. Such was the case with the introduction of color television in the 1960's, and the VCR, camcorder and CD player during the 1970s and 1980s.

Now, however, major segments of the home entertainment market, such as television and audio systems, have reached household penetration rates of 95% or above. Even the amazing VCR, the industry's most successful product since color television, is nearing maturity with a market penetration rate of 74% and unit sales slipping from their 1986 peak.

Copies of this study are available at a price of $1,750. Write to Leading Edge Reports, at 12417 Cedar Road, Suite 29, Cleveland Hts., OH 44106, or by phone toll-free at 800-866-4648; or by fax at 216-791-0333.

Video product sales gain in second quarter

Video product sales posted an 8.6% gain in the second quarter of this year, building on the 6% gain recorded in the first quarter, according to statistics released by the Electronic Industries Association's Consumer Electronics Group (EIA/CEG).

Total unit sales of video products grew 7.3% in the first half of 1992 versus the same period last year, and rose 2.3% percent in June 1992 over June 1991.

The increase in second quarter video sales was led by sales of color televisions, which rose 8.9% over the second quarter of 1991. Color TVs posted a 2.2 million unit annual rate, up from 19.3 million in the first quarter of this year. Sales of portable and table televisions 25 inches and larger were particularly strong in the second quarter of this year, rising nearly 28% over the same period last year.

VCR decks posted record sales in the first half of this year, despite second quarter sales falling off slightly from the first quarter sales pace. Sales to dealers of VCR decks totaled 2.54 million units in the second quarter of this year, an increase of 15% from the first quarter.

Camcorders posted a 1.4% decline in the second quarter of this year from the second quarter of 1992, as both full-size and compact units lost some sales momentum. Sales of videocassette players dropped 48% during the second quarter of this year.

Mid-year conference presentations available from NASM

Audio cassette recordings of presentations from the National Association of Service Manager's Sixth Annual Mid-Year Conference. "Warranty, Legal and Safety Impacts on the Product Service Industry," are available from NASM Headquarters.

Information and pricing on the tapes are available from NASM, 1030 W. Higgins Rd., Hoffman Estates, IL 60195, FAX 708-310-9934. Programs, titles and speakers include the following: "Future Trends: What Consumers Will Want in the Decade Ahead," Mike Behrens, Consumer Federation of America. "Lemon Laws and the Use of Warranties in Marketing," Mike Wittman, Director of Marketing, Consumer Market Development Division of Hyundai Motor America. "Providing a Safe Environment for All," Tom Hoogheem, Manager of Field Environmental Operations Monsanto Agricultural Co. "Impacting the Marketplace Through Reliable Products and Warranties," Mike Dettorre, Product Manager, AT&T, "Coalitions: A Win-Win Approach to Public Policy Change," Camille Haney, President & Owner of Haney/Knauer, Inc. Additionally, a 75-page handout, "Product Liability and the Service Manager," by Dick Moll, Professor, University of Wisconsin-Madison, is available.

Technician of the year award presented at New Orleans

Each year at the convention of the Electronics Technicians Association, International, a technician is selected as the Technician of the Year. This year, at the joint ETA/SDA annual convention and trade show in New Orleans, Mr. Don Howell, CETsr, of Kirkland, WA, was announced as the Technician of the Year award winner.

The award presentation was made by Ms. Robin Adair, a newly elected member of the ETA Board of Directors. Ms. Adair was the recipient of the award in 1990.

Don Howell is the past chairnamn of ETA. He is an electronics instructor at Lake Washington Technical College in Kirkland which annually graduates 80 technicians. His methods of teaching are being used in surrounding states. He has served as Director of ETA's Certified Electronics Technician program and has served as ETA's Western Office Executive Director. He organized the national conference of ETA-I in 1991.

Circle (5) on Reply Card

GPIB product brochure

National Instruments has a six-page, full-color GPIB products brochure that describes the company's line of GPIB hardware and software kits, including its new line of IEEE-488.2 compatible products. The brochure features GPIB products for virtually every computer platform, including PC/XT/AT, EISA, and Macintosh personal computers, and IBM, Sun, DEC, and Silicon Graphics workstations. Products include a variety of interfaces, converters, extenders, workstation interface kits, an analyzer, an expander, and software. The company offers low-cost and high-performance hardware/software choices to meet a variety of applications requirements.

The new IEEE-488.2 compatible products use the company's NAT4882 custom chip to achieve 100% IEEE-488.2 compatibility and increased software throughout. High-performance boards use the Turbo488 chip with the NAT4882 to achieve data transfers rates of over 1 Mbytes/sec for reads and writes.

The company offers complete software support for its GPIB hardware, including driver-level and application software. Driver-level software is available for operating systems such as DOS, Windows, OS/2, UNIX, and Macintosh OS. Further, support for popular programming languages such as Microsoft C, BASIC, QuickBASIC, Pascal, and FORTRAN is also available. The company's LabVIEW 2 and LabWindows application software can also be used for easy development of complete application programs.

Circle (30) on Reply Card

Computer product reference guide

Addressing an increasing number of end users and a large number of first time data storage consumers, Maxell Corporation of America has introduced a new Cross Reference and Compatibility Handbook to make it easier for distributors and retailers to serve customers.

The handbook of the company's computer storage products is designed to allow distributors and retailers to quickly access information for in-store service as well as telemarketing sales. It includes complete specifications and cross reference charts (on drives and competitor's products) for all of the company's diskette, data grade tape, and optical disk products.

Computer products can now be bought in discount stores, office superstores, warehouse clubs and even supermarkets. The cross reference guide is the company's way of educating these new participants in the computer market, which include both consumers and salespeople.

Circle (31) on Reply Card

Tool kit, test equipment

The 1992 catalog from Techni-Tool features a broad selection of tools, tool kits and test equipment. This 2400 page Catalog 42, with easy to follow icons, is filled with more than 18,000 items from over 8500 manufacturers. You can find anything you need from electro-mechanical and assembly devices to electronics, telecommunication and field service tool kits. Also included is a full-line of items for aerospace production, computer maintenance and the fast growing field of surface mount technology, as well as a complete line of ESD, static control and clean room items.

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Instrument catalog

More than 55 test instruments are featured in a new, six page, condensed short form catalog from Protek, Inc. of Norwood, N.J.

This publication details product functions, features and brief specifications in clearly delineated categories and includes: oscilloscopes, spectrum analyzers, bench instruments, portable and bench dc power supplies, digital and analog multimeters, ac clamp-on meg-ohmmeters, temperature and digital panel meters, as well as a new portable power source for 12Vdc operation. ■

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THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

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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.

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Advanced DOS 5, By Peter Norton, Ruth Ashley and Judi Fernandez, Prentice Hall Computer Publishing, 433 pages, $29.95.

Brady offers avid Peter Norton enthusiasts a new title to add to their library. Advanced DOS 5 is written in Norton's classic style to provide users with vital information they need to reach peak productivity.

Peter Norton, acclaimed DOS authority and creator of the award-winning Norton Utilities, returns as the author to reveal insider's tricks to squeezing the most out of DOS.5. This book is the state-of-the-art follow-up book to the best selling, industry classic, Peter Norton's DOS Guide. Peter Norton's Advanced DOS 5 is a comprehensive, reference book for intermediate to advanced users. These DOS users learn to maximize their system's performance with this book.

The secrets to building effective batch programs with color and graphics are at your fingertips. The best techniques for efficient memory management, data recovery, antivirus, and Plus users get a thorough explanation of DOSKEY macros, GW-BASIC and BASICA programming.

Prentice Hall Computer Publishing, Englewood Cliffs, NJ 07632

Project Studio, By Greg Galluccio, Prentice Hall Computer Publishing, 199 pages, $24.95.

Recent leaps in technology have made the professional-quality "project studio" dream a reality for many musicians and audio enthusiasts. Project Studio is the ideal book for anyone who has ever dreamed of owning or building their own studio. The book helps audio buffs with the critical details of putting together a custom "project studio" for home or business use. From planning and budgeting to construction, wiring, and audio connections, readers discover the latest equipment and methods in this do-it yourself guide.

Expert advice and explanations of the latest audio technology are included in Project Studio, so readers make educated equipment selection decisions. Throughout the book, the author offers practical tips for crucial "little things," like acoustic design, construction, proper wiring, equipment, compatibility, and patch bay design. The book also covers exciting multimedia capabilities, checklists, and a sample business plan to make most any project studio profitable.

Prentice Hall Computer Publishing, Englewood Cliffs, NJ 07632

Designing and Building Electronic Filters, By Delton T. Horn, TAB Books, 224 pages $14.95

Virtually every kind of electronic application and system contains filter circuits. Their job is to allow some frequencies to pass while blocking others. This book provides a complete workbench guide to filter theory and practice.

Whatever sort of filter you need information on, you'll find it covered here. And the author makes the math required for this kind of circuitry easy to understand, providing specific examples for each of the equations used. Practical circuit plans show you how to build almost every type of filter circuit including passive low-pass, passive high-pass, active low and high pass, active bandpass, active band reject, state-variable and all pass, voltage controlled and more including sophisticated digital filters. For each filter, the author lists its characteristics, uses, specifications, and substitution values. This book also features 12 useful projects, all of which use real-world components so you can easily implement them in your own designs.

TAB Books, Blue Ridge Summit, PA 17214

The Modern Power Supply and Battery Charger Circuit Encyclopedia, By Rudolf E. Graf, TAB Books, 144 pages, $10.95

This books contains the largest number of up-to-date power supply and battery charger circuit designs available in a single, low-cost, special-focus volume according to the publisher. It is useful for electrical engineers, technicians, hobbyists, and students, this book provides fast, easy access to more than 250 practical, ready-to-use circuit designs that represent state-of-the-art circuit technology.

Readers will find a selection of modern circuits covering the entire range of power supplies, including fixed, high-voltage, variable, power supply monitors, and power supply protection circuits. Circuit designs are also presented for battery charges that can be used with batteries of different voltages and chemistries.

Organized by application to appeal to readers with special interests, the circuits are in their original form to prevent transcription errors. For each entry, there is a schematic and a brief explanation of how the circuit works. Finally, the original source for each circuit is given in the back of the book —invaluable for any reader who wants additional information.

TAB Books, Blue Ridge Summit, PA 17294

Electronic Troubleshooting, By Don Matsuda, Prentice Hall Computer Publishing, 472 pages

Beginning with a description of the correct approach to troubleshooting electronics equipment, and ending with suggestions on how to troubleshoot intermittent faults, this book provides a detailed look at troubleshooting all kinds of electronics products and circuits. Included are chapters on troubleshooting branching paths, in-circuit tests on electronic components, understanding and troubleshooting basic power supplies, troubleshooting transistor circuits, troubleshooting basic amplifier circuits and more.

Prentice Hall Computer Publishing, Englewood Cliffs, NJ 07632

Understanding and Troubleshooting Digital Electronic Circuits, By John-Douglas Young, Prentice Hall Computer Publishing, 170 pages

Covering a broad spectrum of basic circuits and supporting analog circuits to help digital technicians to troubleshoot with simple, effective methods using low-cost equipment, the author treats a wide range of basic and practical applications of digital circuits. Content highlights presents a logical approach to analyzing problems in digital circuits to get fast and accurate results. It also explains how to use low-cost equipment and covers a wide range of integrated circuits. It also features practical examples of circuits using ICs that can be built on a solderless circuit board.

Prentice Hall Computer Publishing, Englewood Cliffs, NJ 07632. ■

Troubleshooting the intermittent TV chassis

By Homer L. Davidson

Intermittent problems may occur in any circuit in the TV chassis. Most intermittent problems, however, occur in the vertical and horizontal circuits, or in any circuit where there are poor PC board connections (Figure 1).

If you're lucky, the intermittent condition may be repaired within minutes. On the other hand, it may take several hours, or even many days.

When you encounter difficult intermittent problems, it's best to work at it for only a few hours. If you haven't solved it by then, leave it for a while. Tackle intermittents in the morning when your mind is clear and sharp. Try to correlate customer complaints with the chassis symptoms that you observe to determine the precise cause of the intermittent problem.

When and where

An intermittent problem may come and go rapidly, once every hour, or every day, or even less frequently. When the intermittent takes days to act up, leave it in the customer's home until the intermittent gets worse or the set fails to operate altogether.

A defective output transistor, IC or driver transistor may cause an intermittent problem within the vertical section (Figure 2). A common intermittent problem is one in which the vertical sweep collapses to a white line just at the top of the screen or half way down. Most intermittent problems that involve the vertical sweep are caused by problems in the vertical output stages.

Intermittent shutdown may be caused by faulty solid-state components within the horizontal circuits. Improperly soldered pins and PC board connections are a frequent cause of intermittent problems in the horizontal circuits. The horizontal

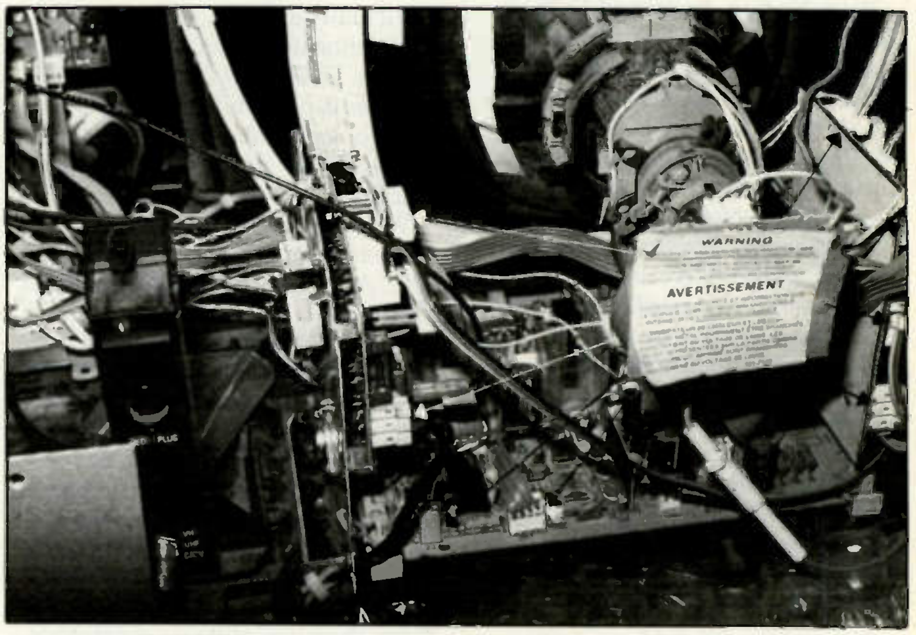

Figure 1. Check for poor socket and board connections on this Zenith portable.

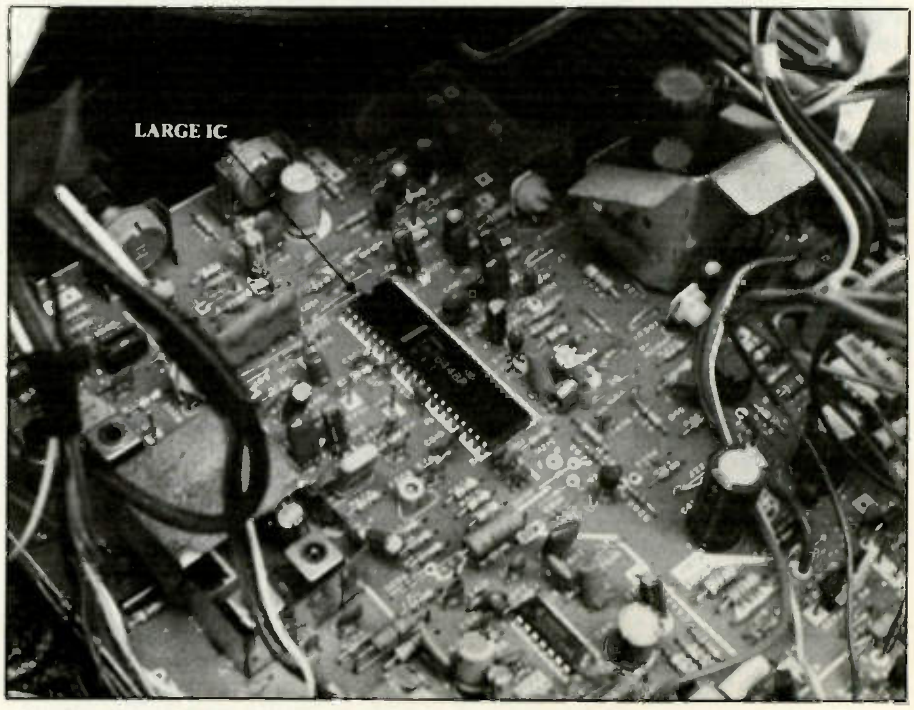

Figure 2. The vertical drive or oscillator circuits may be included in a large IC.

Davidson is a TV servicing consultant for ES&T.

output transistor, drive transistor, flyback and PC board connections cause most of the intermittent horizontal shut down problems.

Defective PC boards and component connections cause a lot of intermittent problems in all TV circuits. Occasionally a TV set is dropped or handled roughly in transit and the occurrence is not reported. This may cause poor connections, cracked boards, or broken components that will eventually surface as intermittent problems.

Fine printed circuit traces or poorly etched PC wiring may contain hairline breaks. Dirty or oxidized cable socket connections at the PC board may be the cause of intermittent problems. Eyelet connections or through-hole connections on double-sided boards may produce intermittent problems. Another culprit is cracked soldered connections around surface mounted components.

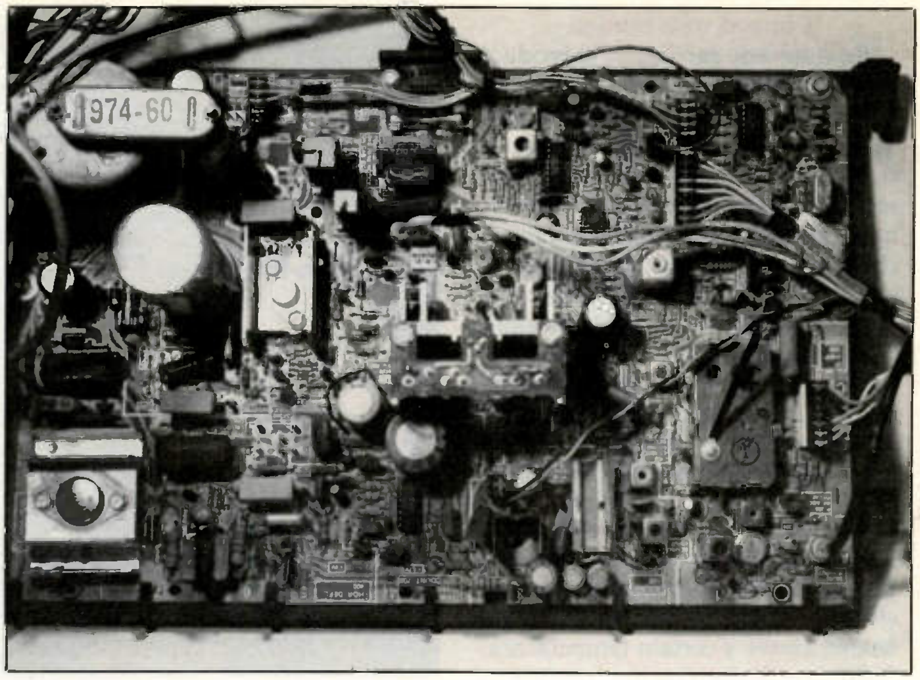

Figure 3. The vertical output transistors are usually located on a heat sink within the horizontal-vertical sweep.

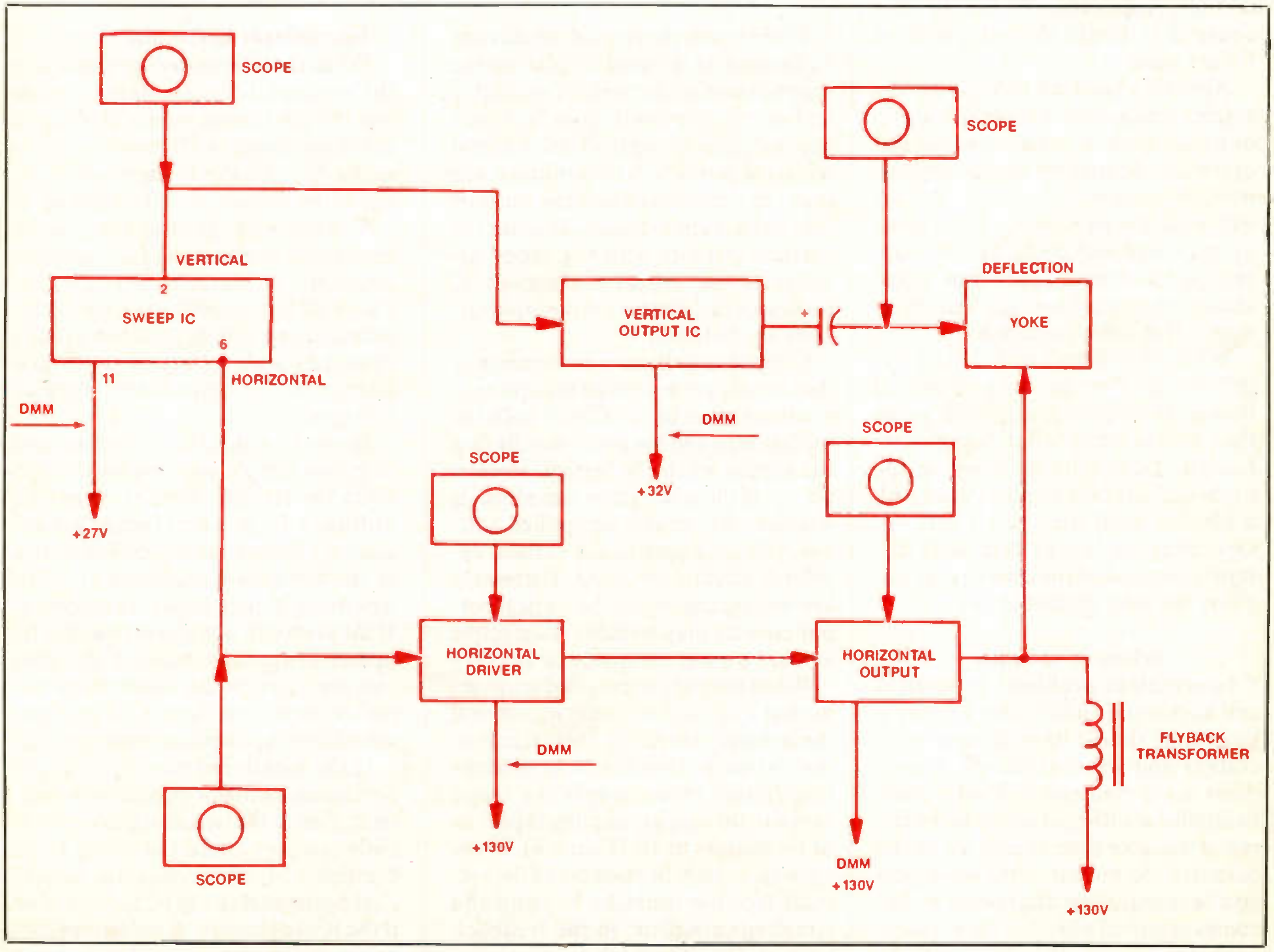

Figure 4. Monitor the various vertical and horizontal circuits with a scope and DMM.

Proceed with caution

Because any jarring of a product with intermittent problems can change the conditions under which the unit will experience an intermittent failure, service technicians should handle such sets with extreme care. Carefully remove the back cover and do not move the chassis until the intermittent is isolated. The intermittent chassis must act up before you know where to look.

Some technicians touch the chassis as little as possible until it is monitored and the intermittent section is isolated. Just touching the chassis or certain areas may locate the defective stage.

Hot and cold treatment

Many intermittent problems are caused by components that change electrical characteristics when they are heated above a certain temperature. Solid-state devices, such as transistors, ICs and surface mounted parts can act up under heated conditions. Spraying a thermally-sensitive transistor or IC with coolant may cause it to return to normal. Application of hot air may cause it to begin the intermittent failure state.

Applying coolant directly to the suspect component may make it act up or it may cause it to return to normal operation. Sometimes several applications of coolant followed by hot air will make the part act up. If spraying a component with coolant returns operation to normal, apply heat to the same component to see if it will act up again. If it does, replace it.

When the intermittent chassis will only act up after operating for several hours, the problem is very likely a part that breaks down after being overheated. To accelerate onset of the problem, cover the back of the set with a blanket until the chassis acts up. Operating the hot air drier over different sections of the chassis may uncover the intermittent circuit.

Where to monitor

Intermittent problems in vertical and horizontal circuits that require a lot of time should be monitored with voltage and waveform tests. Sometimes more than one voltmeter must be applied at different points in the circuit at the same time, to help locate the defective component. If the waveform you're monitoring disappears or becomes distorted when the intermittent problem occurs, this helps you to quickly locate the intermittent stage.

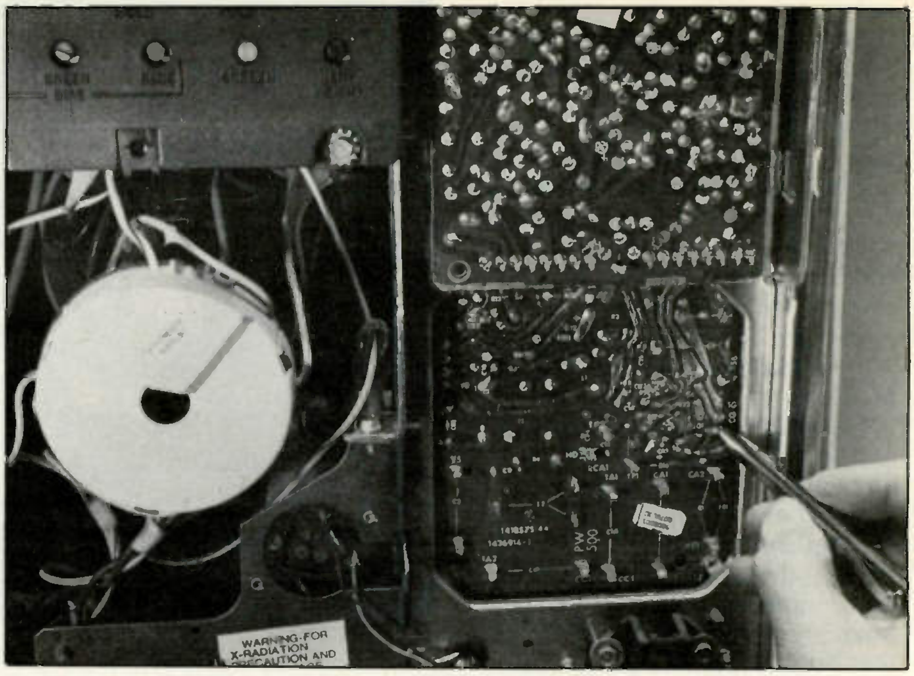

Figure 5. Intermittent pc wiring and component connections within the horizontal circuits are sometimes difficult to locate.

Problems in the vertical circuits can be located or isolated by placing the scope probe at the vertical oscillator and output circuits (Figure 3). Don't use injection of vertical drive signal when the problem is intermittent; the injected signal may mask the cause of the intermittent problem. Monitor the vertical circuits with the scope attached to the vertical oscillator or IC processor to determine if the input circuits are normal.

Connect a voltmeter to the circuits that supply power to the vertical output transistors or IC. Check both the oscilloscope and the meter monitoring the supply when the vertical circuits act up. If the scope input waveform is normal with proper dc applied voltage, you may assume the vertical oscillator circuits are good. Extremely low voltage applied to the vertical output circuits may indicate a defective vertical output transistor or IC.

When the instruments that are monitoring both the vertical circuits and the dc supply are giving normal indications when the chassis is in its intermittent failure mode, apply the scope probe to the output coupling capacitor or transistors or IC (Figure 4). If the signal is normal here, cause of the vertical trouble must be beyond the coupling capacitor; in the feedback circuits, the yoke or the vertical pincushion circuits.

Intermittent horizontal circuits

When the intermittent problem is in the horizontal circuits, likewise monitor the horizontal input drive signal at the oscillator or IC terminal. Connect a dc voltmeter to the supply voltage of the flyback primary winding. If a different voltage is applied to the horizontal driver transistor, connect another voltmeter to this circuit. Check all instruments when the symptoms appear. Often, shutdown that's caused by high voltage or horizontal output circuits eliminates applied voltages.

In sets in which the horizontal and dc power supply voltages are derived from the flyback circuits, inject dc voltages from an external power source. Connect the external dc source to the horizontal oscillator or IC to determine if these stages are defective. If the sawtooth waveform from the IC processor appears normal at all times, you may assume the intermittent occurs in the output flyback, yoke, shutdown circuits or pincushion circuits.

If the monitored waveform at the horizontal oscillator or processor is intermittent at the horizontal drive transistor, suspect a defective sweep IC or transistor. Monitor voltages at the vertical-horizontal sweep IC to determine if the IC is defective. A defective power supply is another possible cause of the problem.

It's difficult to determine the intermittent component within a scan-derived voltage source that is derived from the flyback circuits. Alternately spraying the solid-state sweep components with coolant, and applying heat from a heat source such as a hair dryer, may help to identify the defective stage or component. Scope waveforms at the horizontal input and base terminal of horizontal output transistor may help to locate the intermittent circuit.

Defects in PC wiring

If you suspect that the intermittent problem is caused by defects in the printed circuit wiring, monitor the pc wiring with voltage, resistance and scope tests. If the video section is intermittent, connect the scope probe after the delay line where you can observe the chrominance and luminance signals independently. Connect the voltmeter probe to the voltage source feeding the video circuits.

Intermittent board connections and broken pc wiring are difficult to find in the horizontal circuits (Figure 5), because moving the board in any direction may cause the intermittent problem to occur, which may, in turn, cause shutdown. Look for changes in color of the pc wiring or connections that may reveal overheated or poor connections. In the case of scan-derived voltage sources the horizontal circuits must operate before voltages can be taken from the flyback circuits.

Intermittent Montgomery Ward GSK12981B model

Our service center was examining a Montgomery Ward GSK12981B set. The screen would be normal for several hours before the raster would collapse to a horizontal line. At other times the raster might be only three inches high at the bottom half of the raster. Usually, when this intermittent problem occurred the problem persisted. The set did not spontaneously return to normal.

In this set the vertical driver and oscillator, the horizontal oscillator, x-ray protection, sync amp and afc detector are all part of IC 1501. The vertical rate pulse appears at pin 2 of IC1501. The vertical drive pulse is fed to the base of Q502 of the vertical output circuits (Figure 6).

Because this set continued to operate normally for several hours, I monitored the vertical pulse at pin 2. The DMM was connected to the collector pin of vertical output (Q501) to monitor the vertical dc source. The TV set operated all morning without a hitch.

When I checked the set in the afternoon, the vertical raster had collapsed down to one inch. I switched the scope probe from pin 2 to the output yoke coupling capacitor (C509). There was no vertical sweep at this point. A dual-trace scope can be used to observe the waveforms both here and at pin 2 simultaneously.

Because a vertical drive pulse was observed at pin 2 of IC1501, the defect must be in the vertical output circuits. I assumed that the vertical yoke and pincushion circuits were normal with no sweep at C509. The voltage source at TP404 and collector of Q501 had increased 7V.

I suspected that Q501 and Q502 might be open or leaky. I sprayed coolant directly on both transistors but this did not cause the raster to return to normal. Voltages at the col-

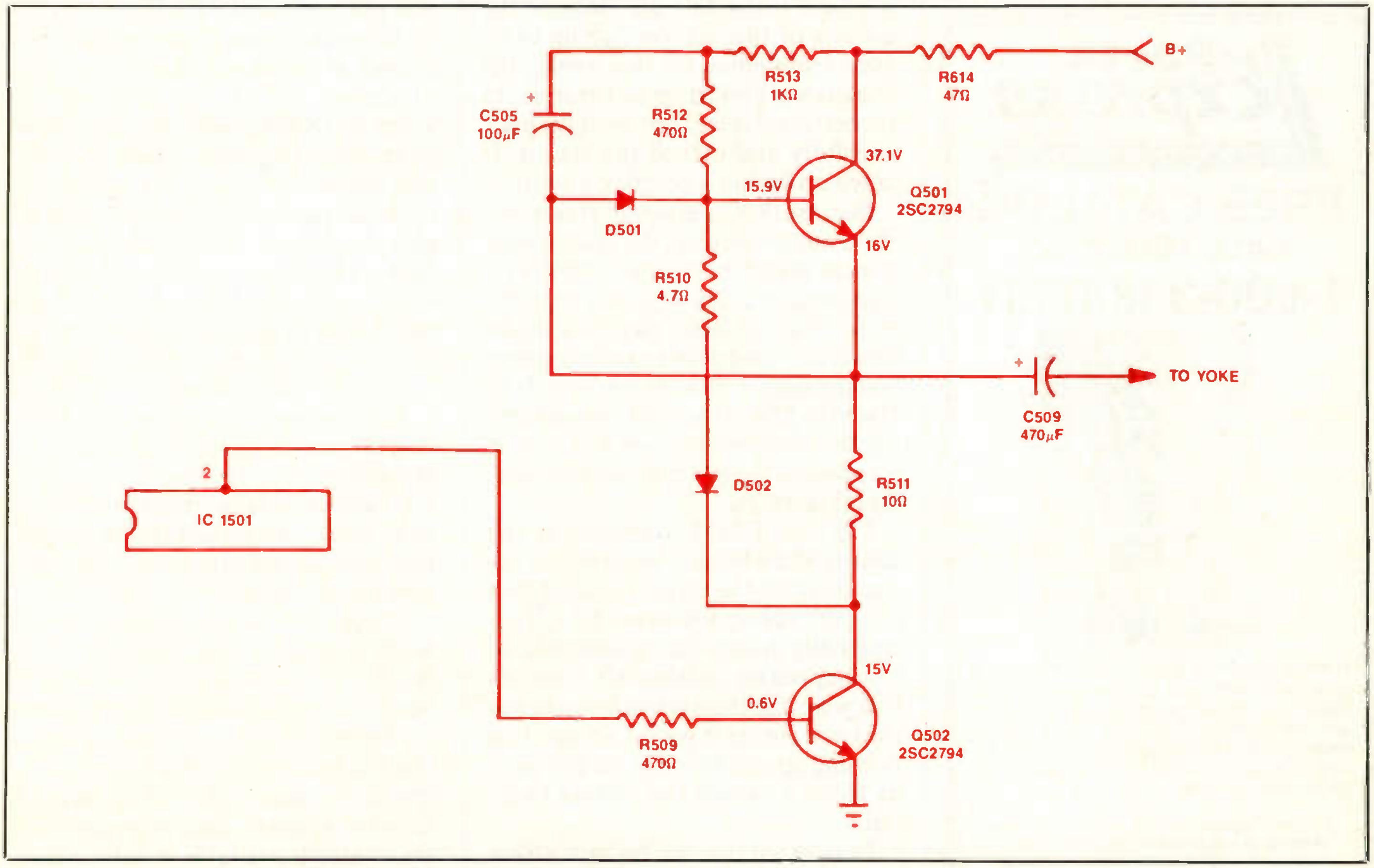

Figure 6. Check the vertical drive pulse at pin 2 of IC1501 and measure voltages on Q501 and Q502 in locating defective output transistors within a Montgomery Ward GSK12981B TV.

lector and emitter terminals of Q501 were higher than specified in the service manual, which indicated that the transistor might be leaky. High collector voltage on Q502 suggested that it might be open.

I turned off the set and measured the resistances of the junctions of both Q501 and Q502 in-circuit. Q501 appeared to exhibit high leakage, although a false measurement may be caused by diodes D501 and D502 in the base and emitter circuits. I removed the transistors from the circuit. Q502 tested good and Q501 was leaky.

I replaced both transistors (2SC2794) with RCA SK9041 universal replacements. The chassis ran perfectly for two full days without any problems. No doubt Q501 was leaky and Q502 was open when the vertical raster collapsed. Always replace both vertical output transistors when one is found defective.

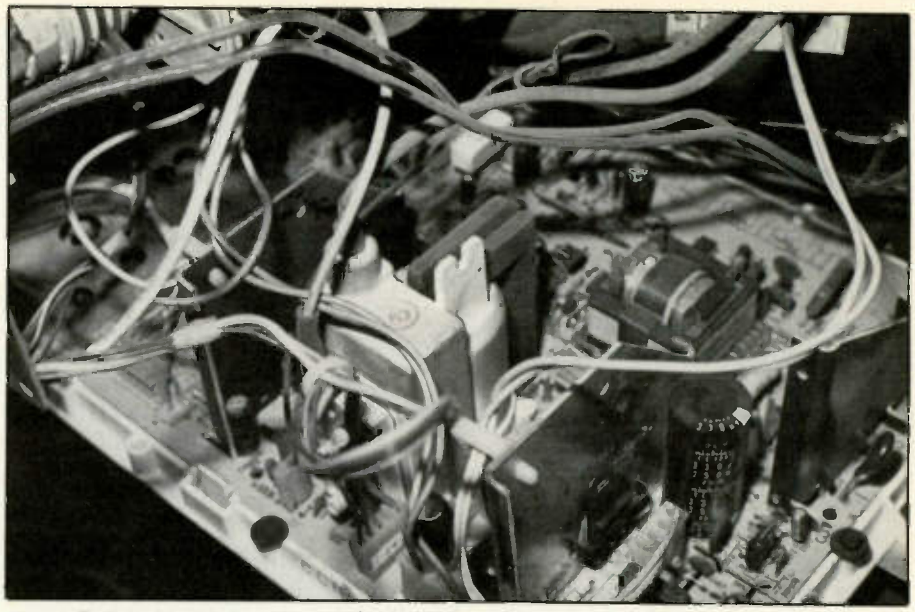

Figure 7. Resoldering pc wiring connections under horizontal flyback sections restored this intermittent Philco TV to normal operation.

Intermittent Philco 19C803 portable

The customer complained that the Philco portable TV would shut off spontaneously, sometimes after operating a few hours and sometimes immediately after being turned on. On other occasions, the set might play for days with a normal picture. Sporadically, the screen would go black, but the sound would remain. Sometimes the sound had hum or distortion.

Ordinarily, a set that operates normally for long stretches should be left in the home until the intermittent problem really acts up. Because the owners of this set were going to be gone from home for two weeks, the chassis was picked up and brought to the service center. I removed the back carefully and turned the set on. It acted up within a couple of hours.

Because there was sound even when there was no picture, the faulty component might be in the horizontal, high voltage, video or picture tube circuits. This set has a switched mode transistor and power transformer voltage supply. When I connected the DMM to TP4 of the 130V source feeding the horizontal driver and output transistors, the raster returned to normal (Figure 7).

I left the DMM connected to the chassis and when the intermittent occurred again the meter revealed that the 130V supply increased 3.5V. I accidentally moved the set and the picture popped on and then off. I noticed that when the chassis was disturbed at the back corner it would act up. Just pushing up and down on the pc board or flyback caused the picture to go out.

I suspected that the bottom wiring around the flyback transformer and horizontal circuits might have some burned or overheated component connections, but none were found. The pc wiring seemed to be okay. I could hear the yoke collapse when the raster disappeared, indicating that the high voltage dropped out. I assumed that the horizontal circuits were normal since the horizontal output transistor was not destroyed each time.

At times, when I just touched the chassis at the back, the raster would disappear. Before I could apply the scope or DMM probe the raster was gone. After I resoldered the pc wiring and connections from the middle of the board to the rear corner the chassis played perfectly. No doubt a component lead or section of pc wiring had a poor soldered connection causing the chassis to shut down.

Comments

Proceed with caution when handling or connecting test instruments to the intermittent TV chassis. Monitor the various isolated intermittent circuits with the scope and DMM. Apply heat and coolant to the most likely intermittent components.

Check cracked pc board and wiring with a magnifying glass. Splice cracked or broken pc wiring with bare hookup wire, rather than simply melting solder across the crack or break. Use hookup wire to repair the pc wiring on a broken board. These boards must be repaired, since replacements are no longer available in most cases. Resolder the entire intermittent section of pc wiring to correct a poor connection. ■

Compact Disc Interactive - Part 2

By Marcel R. Rialland

In the first part of this series of three articles, which appeared in the August issue, we described compact disc interactive (CDI), as a multimedia system that is capable of delivering audio, graphics, pictures and text interactively. The term "interactive" means that instead of simply listening to music or watching a movie, the user can interact with the system to alter the order in which the system retrieves the disc information, and select which portions of the information will be retrieved.

Compact Disc Interactive (CDI) software contains data in the form of audio, video, text, and control data. The first article looked at the applications of CDI and the method of formatting the different types of data. This article will examine how that information is retrieved and processed by the CDI player.

Microprocessor and operating system

The microprocessor and operating system form the heart of the CDI control system, allowing real time operation and interactivity as required by CDI applications. The operating system also allows for control of CD-DA (Compact Disc Digital Audio) and Photo-CD. Thus the control system must determine the type of disc that has been loaded.

Real time applications require machine language to execute specific tasks. All machine language sets are specific to a microprocessor family. Specifying the microprocessor family and operating system makes it possible to produce discs carrying audio, video, text, binary data and application programs that will work on all CD-I players from all manufacturers. The microprocessor family specified for CD-I is based on the 68000 family. The Philips CDI910, CDI601 and CDI602 use the SCC68070 microprocessor.

The Compact Disc Real Time Operating System (CD-RTOS) used in CD-I is based on the OS-9 real time operating system. CD-RTOS is customized to fit the needs of the CD-I system. Figure 1 illustrates the CD-RTOS organization.

A series of instructions (CD-RTOS) is loaded from ROM into memory (booted) to create the user shell and load the operating system libraries, managers and drivers when the player is turned on. The user shell along with the peripheral devices, such as the

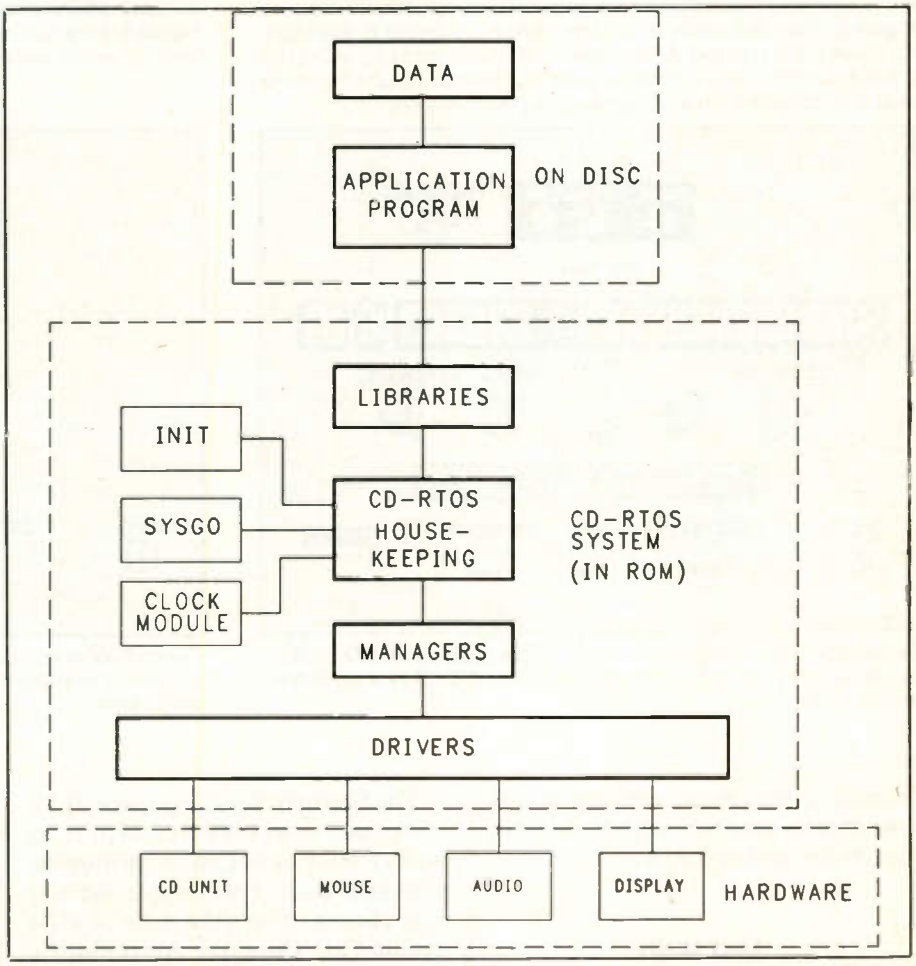

Figure 1.The Compact Disc Real Time Operating System (CD-RTOS) used in CD-I, based on the OS-9 real time operating system, is customized to fit the needs of the CD-I system. CD-RTOS is organized as shown here. A series of instructions (CD-RTOS) is loaded from ROM into memory (booted) to create the user shell and load the operating system libraries, managers and drivers when the player is turned on.

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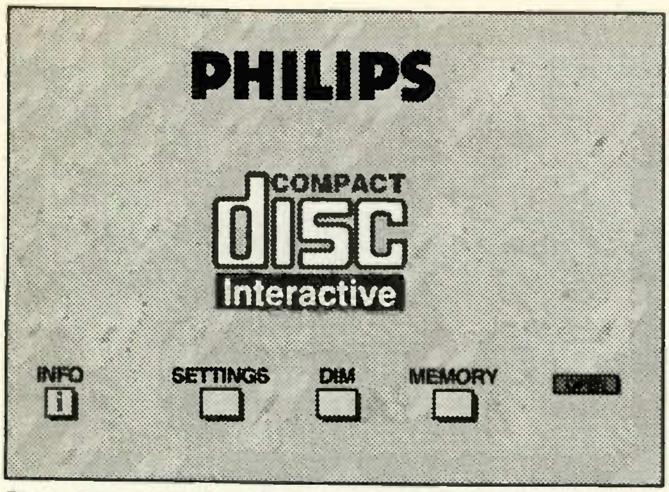

Figure 2. When the player is turned on without a disc in it, this Start-up screen is displayed. A function selection is made by using the infrared control, mouse or other pointing device to place the arrow over a command icon and pressing the Activate key.

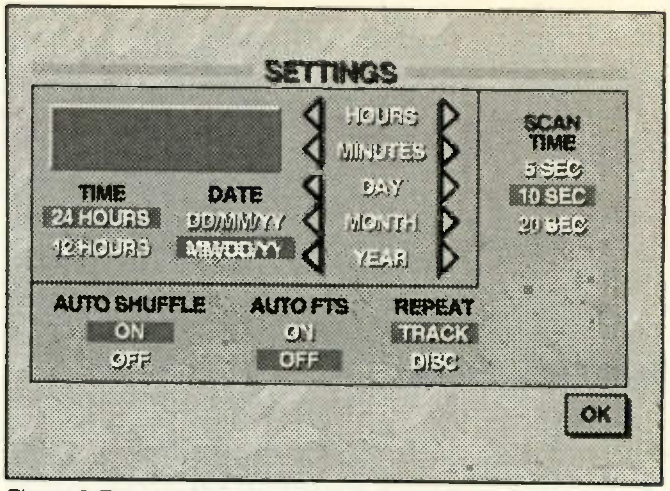

Figure 3. This Settings Screen allows the user to set the date and time, or select options regarding the playing of discs.

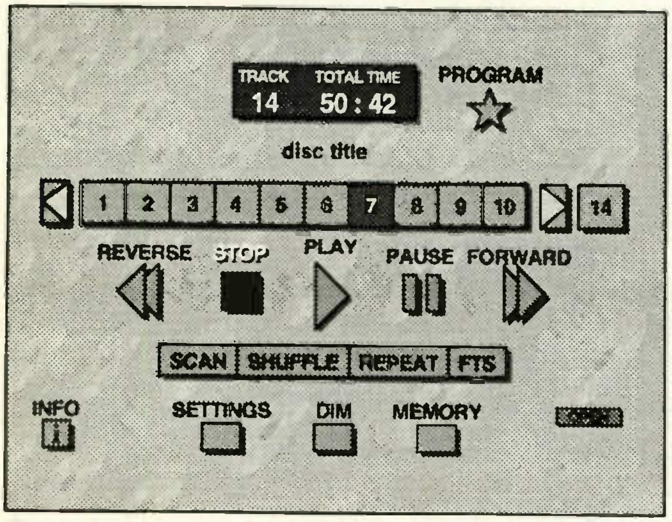

Figure 4. The user shell shown here is displayed when a CD-DA disc is loaded. All functions normally available on CD players are shown in this shell.

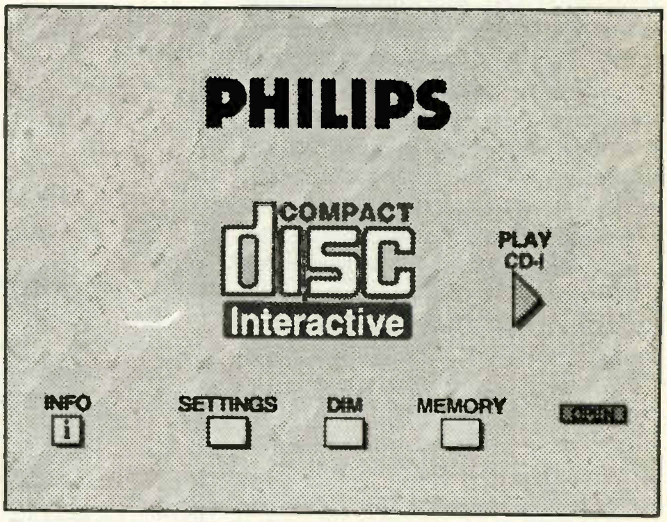

Figure 5. When a CD-I disc is loaded in the player, this CD-I Startup Screen is displayed. Clicking on "Play CD-I" begins the CD-I application.

mouse or the remote control, allows the user to interface with the system hardware and software.

User shells

A Start-up Screen (Figure 2) is displayed when the player is turned On without a disc. The infrared remote control or other pointing device, such as a mouse, is used to make screen selections. A selection is made by placing the arrow cursor over a command icon and pressing the Activate Key (one of the keys around the joystick). Alternatively, dedicated keys, such as the Play or Open Keys, may be used to perform player functions. Other screens are accessed from the Start-up Screen, including the Info Screen (Help), Memory Screen and Settings Screen.

The Settings Screen (Figure 3) allows a user to set the date and time, as well as selecting options regarding the playing of discs. For example, the user may choose to turn the Auto Shuffle option On. Then, the Auto Shuffle option is activated any time a CD-DA is loaded into the player.

Figure 4 illustrates the user shell that comes up when a CD-DA (Compact Disc - Digital Audio) disc is loaded. All functions normally available on CD players are found in this shell. Tracks may be programmed for play or the whole disc may be played. Also, a programmed play sequence may be stored in FTS (Favorite Track Selection) for later playback.

FTS programming also allows the user to enter a title. From then on, when that disc is played the title will appear above the Track Bar. The FTS may also be changed at any time by the user or may even be deleted. Selecting the Memory Icon allows the user to select and delete a disc from FTS.

The CD-I start-up screen (Figure 5) is displayed when a CD-I is loaded in the player. Clicking on "Play CD-I" begins the CD-I application. The next displayed screen, normally an introduction screen, is dependent on the software.

CDI910 processing

The major processing and decoding circuits in the CDI910 are contained on four circuit boards (see Figure 6):

- the CD Unit
- the MMC (Multi Media Controller) Unit
- the APU (Audio Processing Unit)
- the Video Encoder Unit.

Other assemblies found in the CDI-910 include:

• the Power Supply Unit (switch mode power supply)
• the Front Panel Assembly
• the RF Modulator/Switch
• the CDM-9 single beam compact disc mechanism.

Let's look at the function of the four processing and decoding circuits.

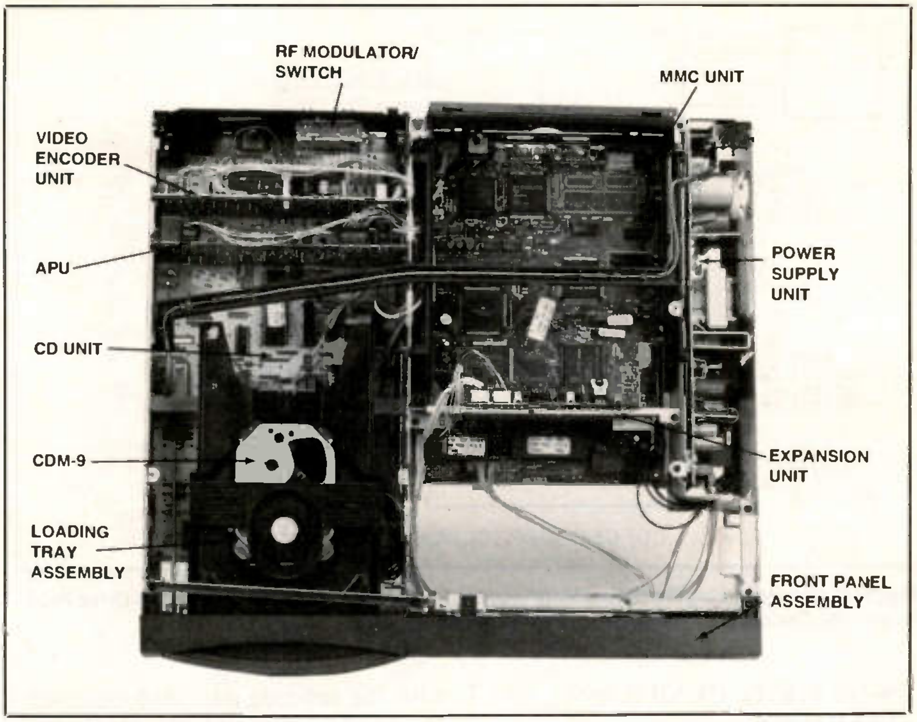

Figure 6. The major processing and decoding circuits in the CDI910 are contained on four circuit boards, as shown here.

The CD unit

Before the information on the disc can be decoded, it must be read as in any compact disc system. So the CDI player is first basically a CD player. The CD Unit (see Figure 7) must optically read the disc, demodulate the EFM, regenerate the bit clock, control the speed of the turntable motor, and decode the interleaved data.

The CDI910 incorporates the new CDM9 assembly to optically read the disc. The CDM9 is a swing-arm disc reading mechanism. This system uses single-beam disc tracking and operates in conjunction with the servo IC's, TDA8808 and TDA8809.

The Drive Microprocessor controls and monitors the servo and decoding circuits. The Drive Microprocessor also controls the player's tray motor. The microprocessor receives disc-access commands (for example: Jump to an absolute time, Pause, Stop, and Read-TOC) from the Master Microprocessor, MC68070 (located on the MMC Unit), via the DSP and X-bus (control and communications buses).

The Drive Microprocessor initiates the start-up sequence of the CD Unit. It activates the focus start-up circuit of the Photodiode Processor, controls the position of the CDM9 Swing Arm via the Radial Processor, and starts the CDM Motor by way of the Decoder SAA7310.

The Drive Microprocessor also monitors error conditions from the Photodiode Processor and Decoder circuits. At the same time, the Drive Microprocessor sends messages (such as radial error or no disc detected) to the MMC Unit via the SPI-bus.

When the CD Unit is in the play mode, the OPU (Optical Pickup Unit) picks up the Low Frequency Signal developed from the wobble signal (generated in the Radial Processor) to make focus and radial corrections as the disc plays. Also, the HF signal (digital data) is picked up by the OPU and is amplified by the Photodiode Processor. The HF is coupled to the Decoder (SAA-7310) for further processing.

Decoder section

Decoding of the HF is accomplished by the Decoding Section (see Figure 8), which comprises four major active components:

• the Drive Processor (CD Drive Microprocessor)
• the SAA7310 Decoder IC
• the DRAM (MN4269-15) and
• the ADOC (PCF3523, Audio Digital Output Circuit).

The SAA7310 Decoder IC incorporates the functions of demodulator, subcode processor, motor speed control, error correction, and error concealment. The decoder accepts data from the disc and outputs serial data via the Inter-IC signal bus (IIS or I2S bus) directly to the ADOC IC. The I2S bus consists of three lines: WSAB

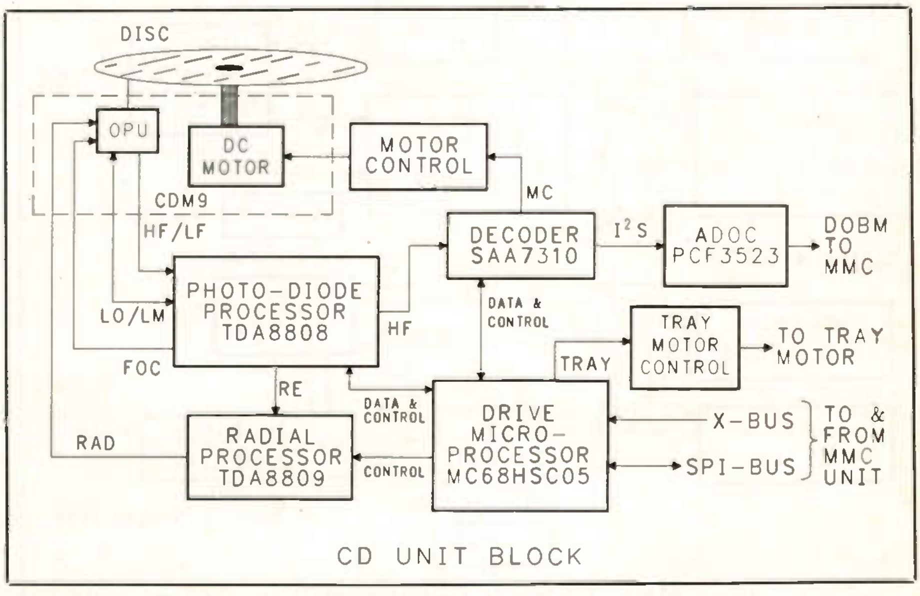

Figure 7. The CD Unit portion of the CD-I system is the portion that optically reads the disc, demodulates the EFM, regenerates the bit clock, controls the speed of the turntable motor and decodes the interleaved data.

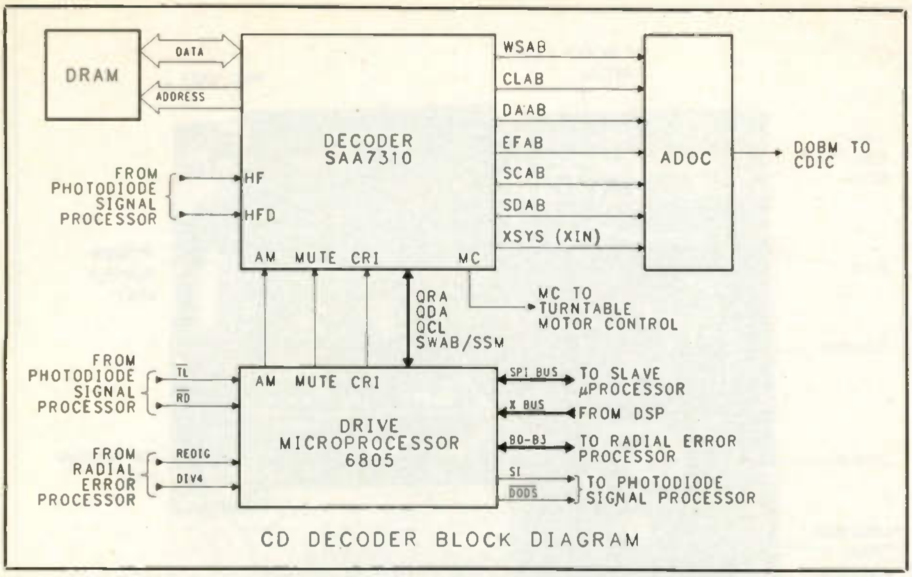

Figure 8. The Decoding Section comprises four major active components: the Drive Processor, the Decoder IC, the DRAM and the ADOC.

(Word Select), CLAB (Clock), and DAAB (Data).

The Decoder IC also sends error codes via the EFAB (Error Flag) line. In the case of CD-I, the error concealment function of the Decoder IC is disabled. This is because of the added error correction encoding included in the CD-I format. In addition to the I2S signal, subcode data is sent to the ADOC via the SCAB (Subcode Clock) and SDAB (Subcode Data) lines. The System Clock (XSYS) is also transferred to the ADOC IC.

The ADOC combines the I2S signal with the subcode data and the error flags and converts this signal into the DOBM (Digital Output Bi-Phase Mark code) signal format. The DOBM signal from the ADOC includes not just the audio digital data, but also all the digital data (control codes, video data, text data, and program data) picked up from the disc. The DOBM data stream is applied to the MMC Unit for decoding.

MMC (Multi Media Controller)

The MMC Module is the heart of the CDI system (see Figure 9). The Master Microprocessor (68070) controls and manages all the activity in the CD-I player, including the CD section. Bidirectional communication between the Master Microprocessor and the Drive Microprocessor is by two communications buses. One is the SPI Bus (Serial Peripheral Interface) via the Slave Microprocessor and the other is by the X-bus via the DSP (Digital Signal Processor). The Slave Microprocessor is also connected to other peripheral devices, such as the Remote Control receiver, the front panel keys, and Port 1 (RS-232 Serial Port).

When the player is first turned On, all of the microprocessors are reset. Next, the instructions from ROM are executed by the Master Microprocessor, setting up the operating system for CD-I. The start-up procedure for detecting and reading a disc is also followed. When a disc is detected, the TOC is read to determine the type of disc installed. The appropriate user shell is then displayed on the monitor. The front panel also displays the type of disc detected.

The key MMC components and their functions are summarized below:

- CDIC (CD Interface Circuit): sends commands to the CD unit via the DSP and decodes DOBM (Digital Output) from the ADOC.
- DSP (Digital Signal Processor): interface between CDIC data and address lines and X-bus to communicate with CD Unit.
- VSC's (Video and System Controllers): build images for planes a and b respectively; control access to video RAM and EPROM.
- VSD (Video Synthesizer): combines or selects inputs from both VSC's. Also adds special effects (wipes, fades, dissolves, etc.) when switching between planes. Note: The CDI601/602 uses a VSR IC, which incorporates the Video DAC.
- Video DAC: eight-bit Digital to Analog Converter. Converts the video digital data to analog RGB.
- Master Microprocessor (68070 MPU): central control microprocessor. Manages all functions and data of the MMC Unit.
- Slave Microprocessor: control of port 1, RC5 decoding, and attenuation control.
- System ROM (512k bytes): stores CD-RTOS software executed by Master Microprocessor (68070).
- NV RAM/Clock: Random Access

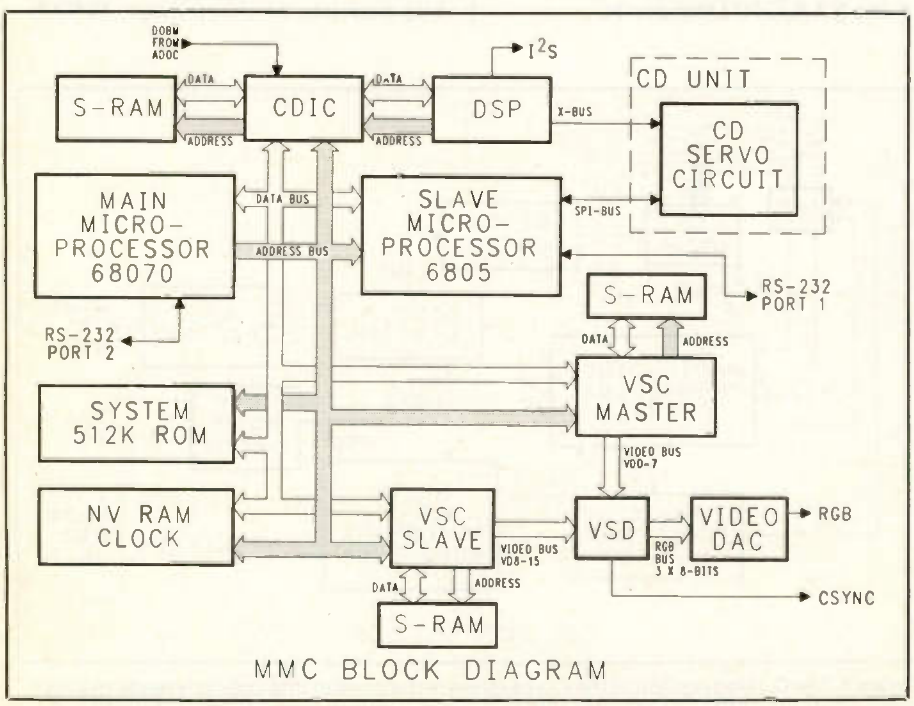

Figure 9. The MMC Module is the heart of the CDI system.

Memory containing data for system configuration at system boot.

The Main Microprocessor (68070) manages all of the MMC Unit's activity and data. All the data transfer (control, video, and audio) within the MMC board is over the 16-bit data bus and 24 bit-address bus structure. The system ROM's (4 in the CDI601/602 professional CDI players and one in the CDI910) contain the operating system (CD-RTOS), the user shell and the service shell.

The NV RAM contains the Configuration Status Description (CSD) and settings of the player shell. The CSD allows an application to determine what devices are available and contains entries for each available device. When the player is turned On, and after reset, the kernel (operating system housekeeping routine) stored in ROM is always executed by the microprocessor.

Audio processing

The audio processing path is illustrated in the simplified Audio Processing Block diagram, Figure 10. The HF (high-frequency information) is read from the disc, decoded (demodulated) in the Decoder (SAA7310) and transformed by the ADOC chip (PCF3523) into a serial data stream as DOBM (Digital Output Bi-phase Mark Code).

The DOBM signal is sent to the CD interface circuit (CDIC) on the MMC panel. The heart of the CD interface consists of the CDIC (IMS66490) and the DSP (Digital Signal Processor) IC's. The CDIC in conjunction with the DSP determines the type of DOBM data received.

If the data is CD-DA the CDIC is switched to the transparent mode. That is, the DOBM is converted back to the I2S format, but there is no other decoding or data management of CD-DA. The CD-DA signals are sent to the APU for digital to analog conversion.

The video data and ADPCM audio data are routed under the control of the main Microprocessor data bus. The ADPCM audio can thus be memory managed to allow synchronization with the video information. The ADPCM audio data is decoded using both the CDIC and the DSP circuits. The decoded ADPCM or PCM (CD-DA) is applied to the D/A converter in accordance with the I2S format.

The digital information is now converted into an analog audio signal by the Bitstream D/A (Digital to Analog) Converter. The APU also provides additional analog audio processing, such as volume control and mixing for CDI applications. The L (Left) and R (Right) audio signals are applied to the Headphones circuit, RF Modulator, and Analog Audio Output jacks (for stereo amplifier or TV monitor).

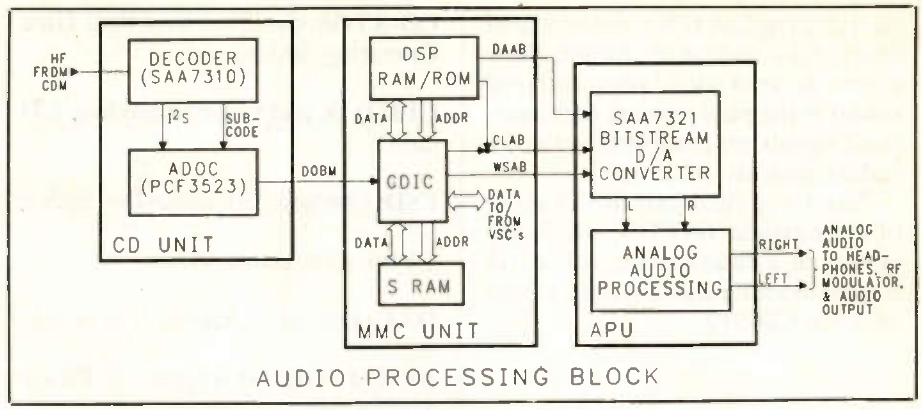

Figure 10. The audio processing path is illustrated in this simplified Audio Processing Block Diagram.

Video signal processing

The Video Processing Block diagram (Figure 11) shows the overall signal flow for developing the video signal. The HF information coming off the disc is processed the same way as in the Audio Processing circuit. The difference in the processing takes place on the MMC Unit in the CDIC.

Data (16 bits), under the control of the Main Microprocessor, is sent to the Master and Slave VSC (Video and System Controller) circuits to develop the a and b video layers to be displayed. The VSC's output both video planes in digital form (8 bits) to the VSD (Video Synthesizer). The VSD receives the encoded image data at a rate of 7.5MB per second from the two VSC's.

The VSD decodes the RGB, CLUT, or DYUV encoded data and adds blanking, weighting, and visual effects (dissolves, wipes, and mosaic transitions) to the data.

The cursor and backdrop are also developed and added to the decoded video in the VSD. The decoded video data is then passed to the Video DAC as eight-bit parallel data for each component (Red, Green, and Blue). The DAC converts digital RGB to analog RGB.

The analog RGB and sync signals are transferred to the Encoder Panel where RGB is converted to composite video (CVBS) and S- Video (Y/C) signals. The composite video and analog audio are also modulated to provide RF (channel 3 or 4) to a standard TV

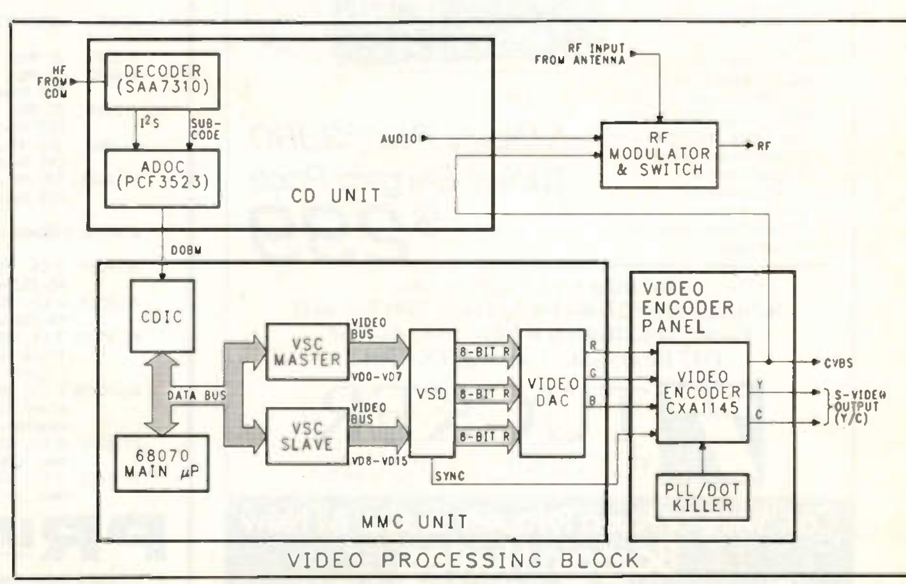

Figure 11. This illustration of the Video Processing Block shows the overall signal flow for developing the video signal.

receiver. The Dot Killer circuit is used to remove dots (due to chroma phase errors present with non-interlaced video) in the picture when non-interlaced signals are generated by the decoding circuits.

Part 3, the final part of this series of three articles on CD-I, which will appear in a future issue, will cover troubleshooting and diagnostics built in to the CDI910.

Glossary

ADOC: Audio Digital Output Circuit

ADPCM: Audio Digital Pulse Code Modulation

APU: Audio Processing Unit

CD-DA:Compact Disc Digital Audio

CDI: Compact Disc Interface

CDIC: CD Interface Circuit

CDM: Compact Disc Motor

CD-RTOS: Compact Disc Real Time Operating System

CLUT: A method of encoding CD data

CSD: Configuration Status Description

CVBS: Composite Video

DAC: Digital to Analog Converter

DOBM: Digital output Bi-Phase Mark Code

DSP: Digital Signal Processor

DYUV: A method of encoding CD Data

EFM: Eight to Fourteen Modulation

FTS: Favorite Track Selection

HF: High Frequency

IIS: Inter-IC Signal Bus. The following lines make up this bus:

CLAB: Clock Line
DAAB: Data Line

I2S: Same as IIS

MMC: Multi Media Controller

OPU: Optical Pickup Unit

Photo-CD: A CD system that provides for storage and retrieval of photographs on CD

RGB: Red, Green, Blue Video Signals

SPI Bus: Serial Peripheral Interface

TOC: Table of Contents. The list of the disc's contents which is digitally encoded on the disc. Includes information on which kind of disc this is so that the system can handle it properly.

User Shell: Information that is displayed on the screen of a monitor or TV that provides the user with information about the software that is operating at the moment, and allows the user to select some function of that software.

VSC : Video and System Controller

VSD: Video Synthesizer ■

Working with Microcomputer Display Technology

Part Four–Flat Tension Mask Video Display Technology

For more than ten years, Zenith Data Systems and Zenith Electronics have offered many microcomputer video display innovations. Early innovations include combining text and graphics modes with high-resolution color, and manufacturing video monitors that supported analog television and digital computer information.

In 1987, Zenith patented another industry first: 14-inch flat-screen color monitors featuring flat tension mask or FTM picture tube technology. During the same year, Zenith became the first pc-compatible manufacturer to ship microcomputer systems with VGA-level video.

Table 1 lists the technical specifications for the Zenith ZCM-1492 VGA monitor. No longer in production, the ZCM-1492 is one of a series of flat tension mask monitors sold by Zenith from 1987 through the present. The flat technology series includes the older ZCM-1490 and the recently introduced ZCM-1495 and ZCM-1790 models.

Because of the flat tension technology on which they are based, these models share characteristics that set them apart from standard monitors: a stretched shadow mask, non-glare treatment and high contrast and high resolution CRT's.

As the table shows, the monitor operates at 31.49KHz and is compatible with the VGA graphics standard. Support of the video cards includes a text resolution of 720 × 400 and a graphics resolution of 640 × 480.

While the ZCM-1490, ZCM-1492

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Table 1.

CRT	Flat technology, 14 inches, 0.28mm dot pitch
Display Area	10.07 inches × 7.67 inches
Number of Displayable Colors	Infinite (dependent on video card)
Characters	80 characters × 25 rows
Character Block	9 × 16 (VGA) 8 × 16 (MCGA) 8 × 14 (EGA) 8 × 16 (CGA, 400 line) 9 × 14 (MDA) 9 × 14 (Hercules)
Video Input Signal	Analog RGB (0V to 0.714Vpp)
Bandwidth	28MHz
Vertical Scan Rate	60Hz to 70Hz
Horizontal Scan Rate	31.468kHz
Horizontal Sync Input	31.49kHz positive TTL 350-line mode negative TTL 400-line mode negative TTL 480-line mode
Vertical Sync Input	70Hz negative TTL 350-line mode 70Hz positive TTL 400-line mode 60Hz negative TTL 480-line mode
Resolution	640 dots x 480 lines (VGA, MCGA) 640 dots x 350 lines (EGA) 320 dots x 200 lines (MCGA, CGA) 720 dots x 350 lines (MDA, Herc.)
Video Interface *******	15-pin Sub-miniature D-type

Connector Pin Assignment:

1 (Red Video Input)	7 (Ground for Green)
2 (Green Video Input)	8 (Ground for Blue)
3 (Blue Video Input)	10 Digital Sync Ground
4, 9, 12, 15 (NC)	11 Digital Ground (mode)
5 (Self test)	13 Horizontal Sync
6 (Ground for Red)	14 Vertical Sync

Table 1. Specifications for the ZCM-1492 monitor

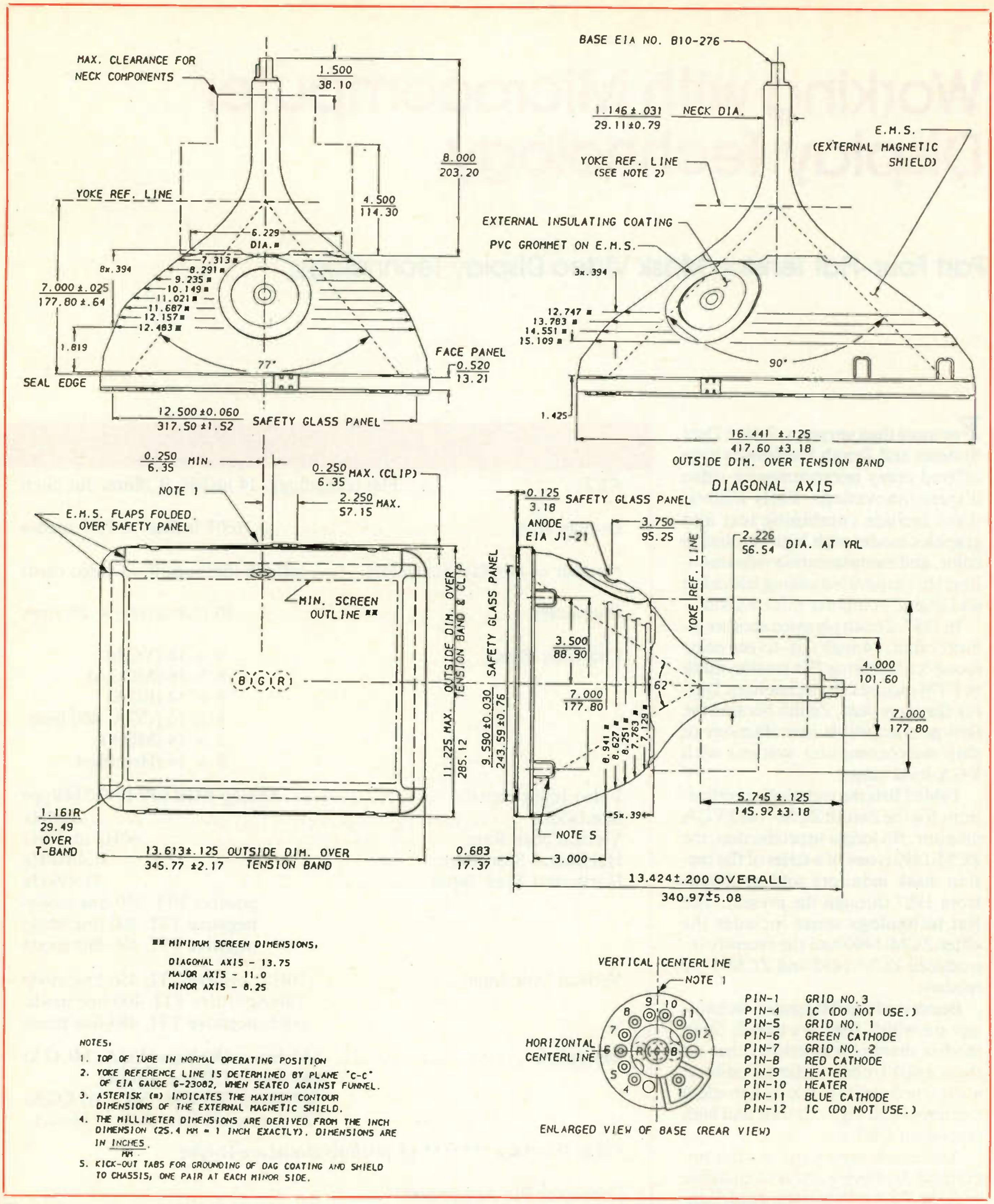

Figure 1. The Rauland M36AEB22XX03 is a flat tension mask CRT. These several views show the flatness of the screen face. Among the advantages of this technology are improved resolution and color purity, and enhanced contrast and brightness.

and ZCM-1495 monitors fully support VGA graphics adapters, the ZCM-1790 offers multi-syncing capabilities and automatically adjusts to the frequency of the video adapter. Thus, it will interface with video technologies ranging through VGA, Super VGA and others.

Even though they are 100 percent compatible with existing VGA video sources, Zenith's flat screen technology monitors differ from other VGA monitor technologies in several ways. Obviously, some of the differences begin with the CRT.

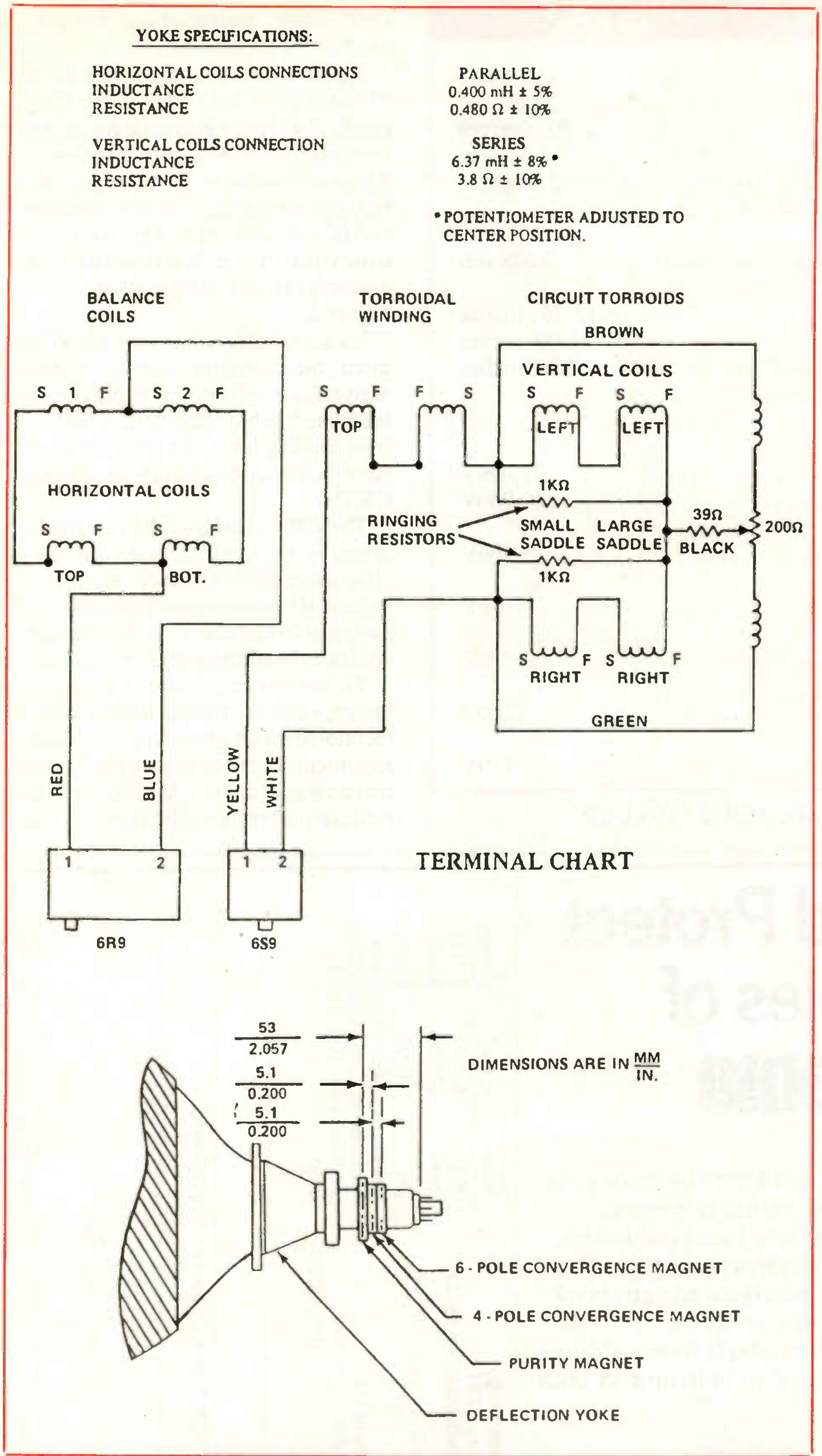

Figure 2. In the Rauland CRT, the combination of the electron gun with a high resolution saddle-saddle toroidal yoke furnishes a dynamically self-converging deflection system.

The Rauland M36AEB22XX03 data display tube

The ZCM-1492 monitor features a CRT that has a perfectly flat face. The technology behind the flat tension mask technology is a product of a partnership between Zenith Data Systems, Zenith Electronics and Elgin Precision Glass. The Rauland company, a division of the Zenith Electronics

Table 2.

Focusing Method	Electrostatic
Convergence Method	Magnetic
Diagonal	90 degrees
Horizontal	77 degrees
Vertical	62 degrees
Spacing Between Centers of Adjacent Dot Trios	0.028mm
Screen Dimensions	
Diagonal	13.75 inches
Horizontal Axis	11.00 inches
Vertical Axis	8.25 inches
Anode Voltage	
Absolute Maximum	27,000V
Absolute Minimum	20,000V
Cathode Voltage	+ 100V
G1 Grid Voltage	0V
G2 Grid Voltage	+ 720V
Focus Voltage	7200V
Dynamic Focusing	150V

Table 2. Specifications for the Rauland M36AEB22XX03 CRT.

CRT group, manufactures the CRT used in the ZCM-1492.

Figure 1 shows several views of the M36AEB22XX03 CRT. The CRT employs a high bi-potential focus high resolution electron gun. Moreover, Rauland combines the use of the electron gun with a high resolution saddle-saddle toroidal yoke. This combination furnishes a dynamically self-converging deflection system. See Figure 2.

Rauland's phosphor screen is a fine pitch, black matrix, dot trio system with an anti-reflective coating. Given the same levels of resolution and contrast, the display is 80 percent brighter than conventional high-resolution CRT's.

The CRT also has a 70 percent increase in the contrast ratio that provides more definite blacks. Along with enhanced brightness and blackness, the design offers a lower tradeoff between contrast, brightness and resolution.

To further improve the displayed image, Zenith combines the flat screen technology with a two-stage anti-glare treatment. Part of the anti-glare treatment extends from a multilayer anti-reflection coating on the front surface

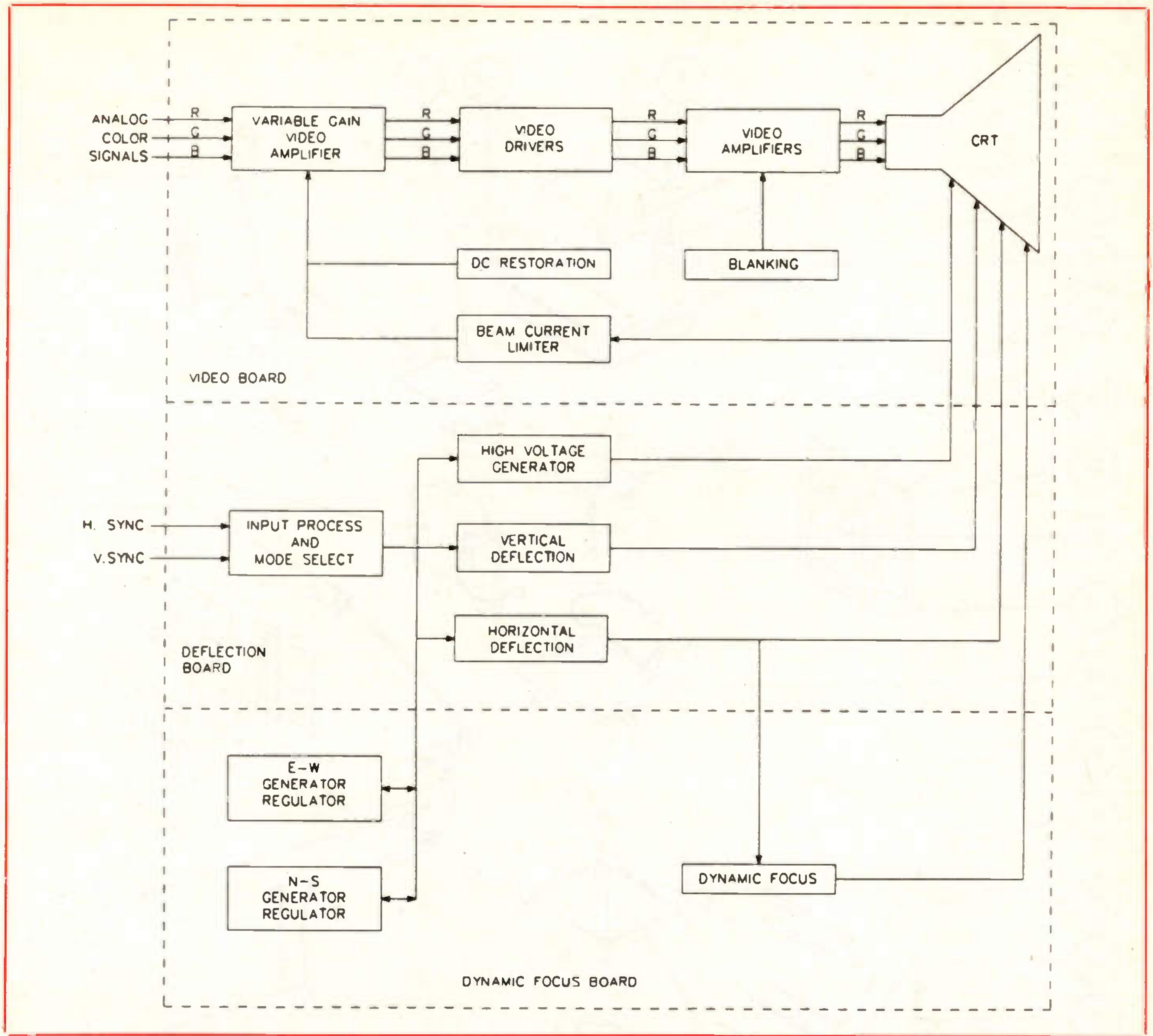

Figure 3. Functional block diagram for the ZCM-1492 monitor

of the viewing screen. An optical anti-reflective coating applied to the inner screen surface of the CRT rounds out the anti-glare treatment. The anti-glare treatment reduces glare problems by nearly 95 percent.

In addition, the ZCM-1492 relies on precision printing of the red, green and blue phosphor elements and black matrix to its flat faceplate. This replaces the traditional method of using a photolithographic process to apply the phosphors.

The traditional process paints the phosphors onto the screen during a multi-stage process while the newer process is simpler. Also, the newer process prints the phosphor elements into the respective red, blue and green apertures within a precise set of parameters.

Machining techniques used by Elgin Precision Glass produce the precision glass panels necessary for the screen printing process.

Table 2 lists several specifications for the Zenith/Rauland M36AEB-22XX03 monitor/data display tube.

Placing the shadow mask under tension

In a traditional CRT, the shadow mask curves to follow the shape of the curved screen. Zenith's flat-screen technology differs from this in that the shadow mask is stretched under tension and placed directly behind the flat faceplate. Furthermore, the mask is welded to the faceplate support structure. The traditional method supports the shadow mask with a frame and suspends it by springs within the CRT.

Some image distortion occurs in traditional CRTs because temperature changes affect the shape of the shadow mask. With the FTM design, temperature changes do not affect the shape of the stretched shadow mask, which is under tension. This reduces purity loss due to electron beam heating of the mask. Also, the design prevents shadow mask movement under most display conditions.

Because the mask is under tension, resolution is improved. Along with higher resolution, the displays have better color fidelity. Tension on the

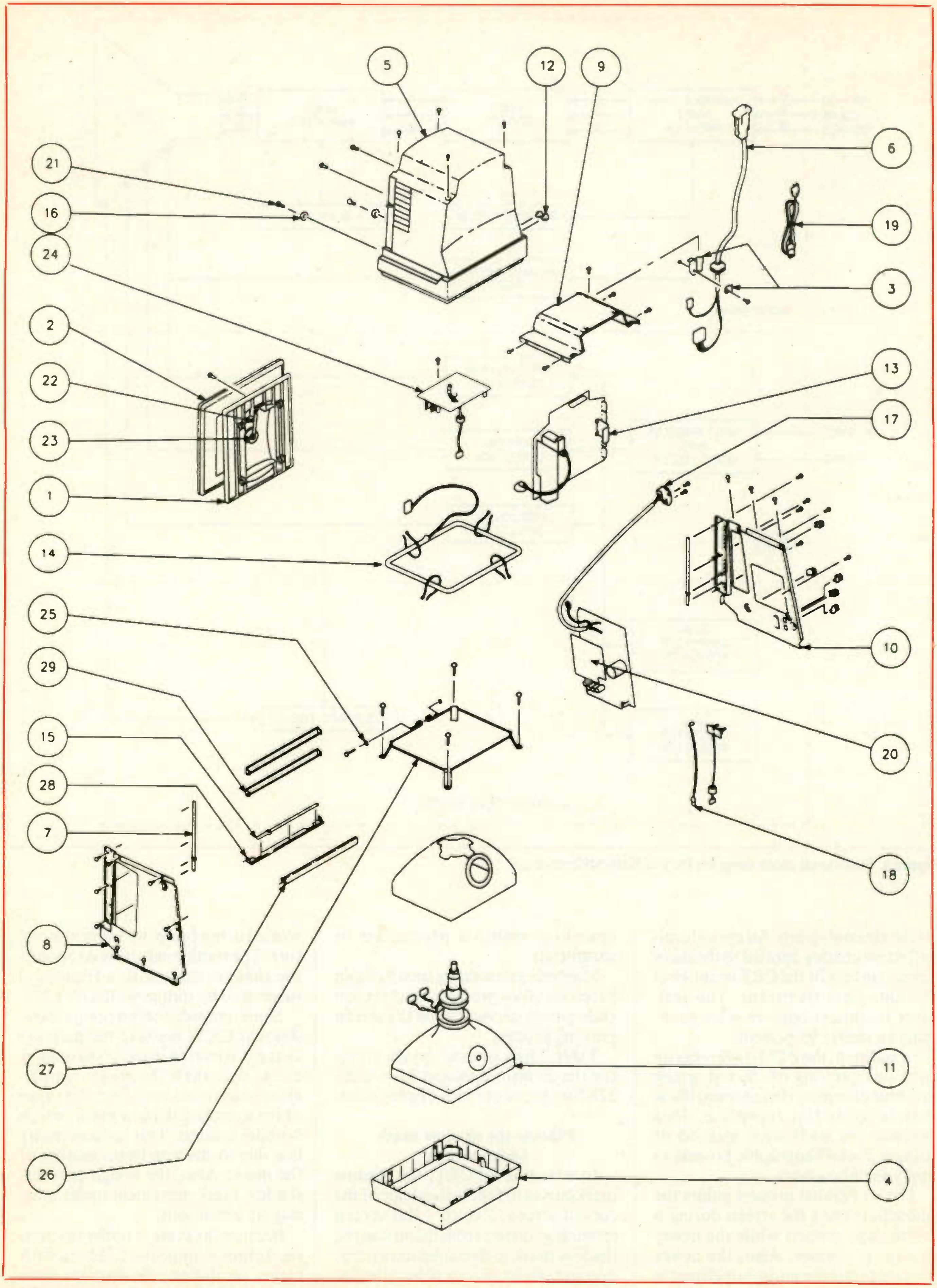

Figure 4. Exploded view of the ZCM-1492 monitor

shadow mask prevents the mask from deforming when bright patches of color remain displayed for any length of time. Conventional masks deform or "dome" when displaying bright patches of color and ultimately discolor the images.

Combining the CRT with electronic circuitry

Figure 3 is a block diagram of the ZCM-1492, while Figure 4 is an exploded drawing of the monitor. As the diagrams show, the monitor consists of four circuit sections and the CRT. The four sections include the video modules, deflection module and the dynamic focus and pincushion module.

As with other monitor designs, the ZCM-1492 video board contains a video amplifier for the analog color signals, video drivers, dc restoration circuits, a beam current limiter and video output amplifiers.

In the exploded view of the monitor, the video module is indicated by reference number 24. The deflection module, indicated by reference number 13 in the drawing, incorporates the sync processing, horizontal deflection, vertical deflection and high voltage circuitry. Reference number 20 points out the switch-mode power supply used in the monitor.

Because the flat tension mask technology CRT requires a geometrically perfect display, the ZCM-1492 monitor features a more sophisticated pincushion circuit than most color monitors in its class. Enhanced pincushion circuitry provides the correction needed to provide the correct display.

The pincushion circuitry includes circuits that provide display correction from east to west and from north to south. A perfectly symmetrical display occurs with the superimposing of the pincushion correction waveforms onto the horizontal and vertical scanning signals.

More to come

The next article of this series will divide the large sections of the ZCM-1492 display into smaller subsections. In order to illustrate the circuits described, the article will contain schematics and component layout charts.

All information, drawings, photographs and schematics are courtesy of Zenith Data Systems, Zenith Electronics and Rauland.

List of components shown in Figure 4.

1	Tilt base
2	Tilt base
3	Video output assembly clamp
4	Cabinet
5	Cabinet
6	Interface cable
7	Guide
8, 9, 10	Chassis plates
11	CRT and yoke assembly
12	Control knobs
13	Deflection Module
14	Degaussing coil
15	Fastener
16	Cabinet foot
17	Power switch
18	LED indicator
19	Line cord
20	Power supply
21	Screw
22	Spring
23	Swivel retainer
24	Video output module
25	Washer
26	Spring
27, 28, 29	Braces

Operational amplifiers

By Joseph F. Klimes

Operational amplifiers are integrated circuits that provide excellent gain over a wide range of frequencies. Op amps are used in a wide variety of consumer electronics products and other electronic circuitry that consumer electronics technicians encounter. This article will discuss the characteristics of basic operational amplifiers, describe some of the applications they are used in and provide some tips on how to troubleshoot them when they exhibit problems.

Differential amplifiers

A differential amplifiers is the first stage of an operational amplifier. Its function is to amplify the difference between the two inputs of the op amp. Figure 1 shows an example of a basic differential amplifier.

The differential amplifier in Figure 1 is biased by a positive and negative supply voltage. You will also notice that it is set up for an inverting and noninverting input. Looking at this circuit, you will see that if an ac signal is applied to the base of Q1, the signal at the emitter of Q1 will be of the same value and phase as the input signal. This is because the transistor acts as an emitter follower.

Following this signal, you will see that it is then applied to the emitter of the common base amplifier, Q2. Remember, a signal applied to the emitter of a common base amplifier will be amplified and in phase with the input. Now checking this process you see the signal applied to the noninverting input is amplified and in phase with the input.

In the beginning it was stated that a differential amplifier amplifies the difference between the two inputs. Referring to Figure 1, if you connect input 2 to ground you can figure the difference by the following:

Vin = Input 1 − Input 2
= 10mVpp − 0V = 10mV

Based on this formula, if both inputs are equal and the transistors are perfectly matched the output would be zero. Any signal that appears at both inputs of the differential amplifier is not amplified; it is rejected.

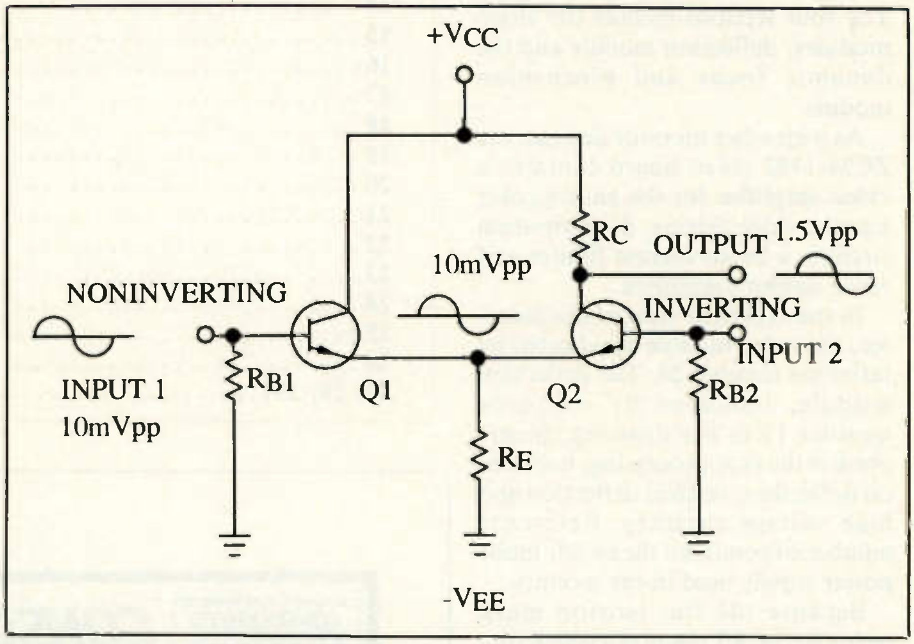

Figure 1. A differential amplifier is the first stage in an operational amplifier. Its function is to amplify the difference between the two inputs to the op amp.

Common mode rejection

This ability of the differential amplifier to reject signals that are common to both inputs is defined as common mode rejection. This feature is very useful for rejecting noise that may be present at the inputs. This makes the differential amplifier able to reject noise while at the same time amplifying the input signal.

The common mode rejection ratio (CMRR) is the ratio of the difference mode (desired signal) gain to the common mode (noise) gain. It indicates how well the op amp is able to reject the noise. It is expressed as

CMRR = Ad/Ac

and is usually given in decibels. Remember the larger the common mode rejection ratio the better the amplifier is able to reject noise.

Now referring to Figure 2, let's discuss the inverting operation. Here Q2 acts as a common emitter amplifier and the signal applied to the base is amplified and inverted (180 degrees) at the collector.

When both inputs are connected together this is known as a common mode connection. A signal delivered to this connection should produce no output signal because the voltage at the output terminals is rising and falling at the same rate.

An important feature of the differ-

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ential amplifier is a constant-current device controls the current for both amplifiers. This means that anything done to increase the current in one will automatically decrease the current by the same amount in the other. In differential amplifiers, long-tailed bias is used to supply the operational voltage. In the newer operational amplifiers, single ended power supplies can be used.

Voltage and current offsets

While transistors in the differential amplifier are very closely matched, there will be a difference in the Vbe characteristics. This imbalance creates what is known as the output offset voltage. With an op amp's inputs grounded, the output shows a measurable voltage. This voltage is the result of the imbalance, which causes one transistor to conduct harder than the other.

One method to eliminate the output offset voltage is to apply an input offset voltage between the input terminals. Another method is to connect the op amp's offset null pins to a supply. When properly connected and adjusted, this will correct the imbalance causing the output to go to 0V.

After the output offset voltage problem is eliminated there will be a slight difference between the input currents. This difference is called the input offset current and is caused by a beta mismatch between the transistors. There is no way of predicting which of the two input currents will be greater when the output offset voltage is eliminated.

Bias current

Operational amplifiers require some amount of dc biasing current for the input transistors to operate. The average quiescent value of dc biasing current drawn by the signal inputs is the input bias current rating. Op amps may draw between 80nA and 500nA from the external circuitry when no signal is applied to the input. Both transistors in a differential amplifier require an input bias current. This leads to the following operational restriction: an op amp will not operate if either of its inputs are open.

Another area of discussion is the output short circuit current rating of the op amp. These amps are protected internally from excessive current caused by a shorted load. This helps explain why the output voltage from an op amp drops when the load resistance decreases.

One other important factor about op amps is the slew rate. Slew rate is a measure of how fast the output voltage can change in response to a change in input voltage. The slew rate can be used to determine the maximum operating frequency since frequency is a measure of time.

Op amp electrical characteristics

When working with operational amplifiers it is best to refer to their specification sheets. These sheets contain information about subjects already discussed here. Here is an explanation of four electrical characteristics from these sheets.

- The *input voltage range* indicates the maximum value that the amp can accept without damage to the internal differential amplifier.
- The *large-signal voltage gain*, is the open-loop voltage gain of the amp. Checking with a chart you would find this is a very high number which agrees with an earlier statement that they have a very large gain.
- The *supply current rating* is the quiescent current that is drawn from the power supply, that is, the current drawn when there is no input signal.
- The *power consumption rating* indicates the amount of power that the op amp will dissipate when it is in its quiescent state.

Note: when the input voltage polarities match the input polarities of the schematic symbol, the output voltage is positive, and when they do not match, the output will be negative.

Figure 3 shows the pinouts for the 741 op amp.

Applications of op amps

Because of their useful characteristics, op amps find use in a number of products, from consumer electronic products such as radios and TVs to electronics measuring and control circuits. Some of the many applications of op amps are listed below.

Audio amplifier

In consumer electronics and communications receivers the final stage is the audio amplifier. The following characteristics are for an ideal audio amplifier:

- High gain
- Minimum distortion in the audio frequency range

• High input impedance
• Low output impedance for optimum coupling to the load
• The basic characteristics of the op amp fulfill these requirements very nicely.

High-impedance voltmeter

Operational amplifiers used in conjunction with a current meter will produce a relatively high impedance voltmeter. Even though this circuit would cause some circuit loading, it would be much more accurate than a common VOM with a 20kΩ input.

Voltage controlled current source

In earlier discussions, we discussed the constant current capabilities of the feedback circuit. The voltage controlled constant current source is a circuit that has a constant current output that is controlled by the input circuit voltage.

Precision diode

This is a relatively simple circuit that can be used for any diode application. This circuit is characterized by the ability to conduct at extremely low forward voltages.

Schmitt trigger

The positive feedback of this circuit provides two functions: it forces the amplifier into saturation and allows setting the values of the trip points. Adjusting the points above and below zero can eliminate unwanted noise triggering.

The Schmitt trigger is used as a wave shaper. A sine wave is applied to the inverting input. As the positive and negative trip points are reached, the output saturates in the opposite direction. This results in a square wave with a peak-to-peak voltage equal to the saturated voltage.

Averaging amplifier

The averaging amplifier may look like the summing amplifier, but it has a much different purpose. The averaging amplifier is used to produce a voltage that is the average of the inputs.

Voltage follower

This circuit is sometimes referred to as the *unity gain amplifier*. This amplifier has a gain of one with no phase shift between input and output. This amplifier is normally used to isolate a high impedance circuit from a low impedance load. The output is tied directly to the inverting input providing for maximum feedback, so that as the input signal increases the output signal increases.

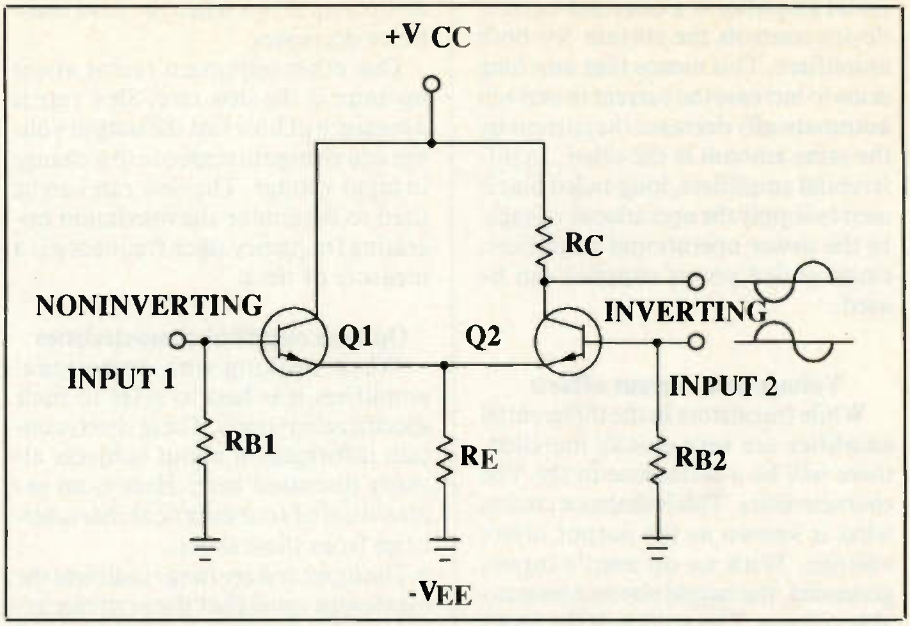


Figure 2. The output of the inverting amplifier is a signal that is 180 degrees out of phase with the input.

Troubleshooting op amp circuits

For technicians, troubleshooting the operational amplifier is said to be a dream come true. The basic operational amplifier circuit has only three or four components that can become faulty and each fault has a distinct symptom. Referring to Figure 4, assuming that the load resistor, input signal, and power supply are all operating properly, there are only four components that could be at fault.

One possible fault is an open Rf feedback resistor. An open Rf would remove all feedback from the circuit, which will cause the gain to increase to the open-loop voltage gain of the amplifier. When this fault occurs, the gain of the amplifier will become so great that the output will be clipped on both positive and negative peaks.

Another possible fault is an open resistor Ri. A look at the circuit might lead you to think that in this case you would have loss of input signal and therefore that there would be no output. This may not always be the case. Let's assume that the output of this

(Continued on page 41)

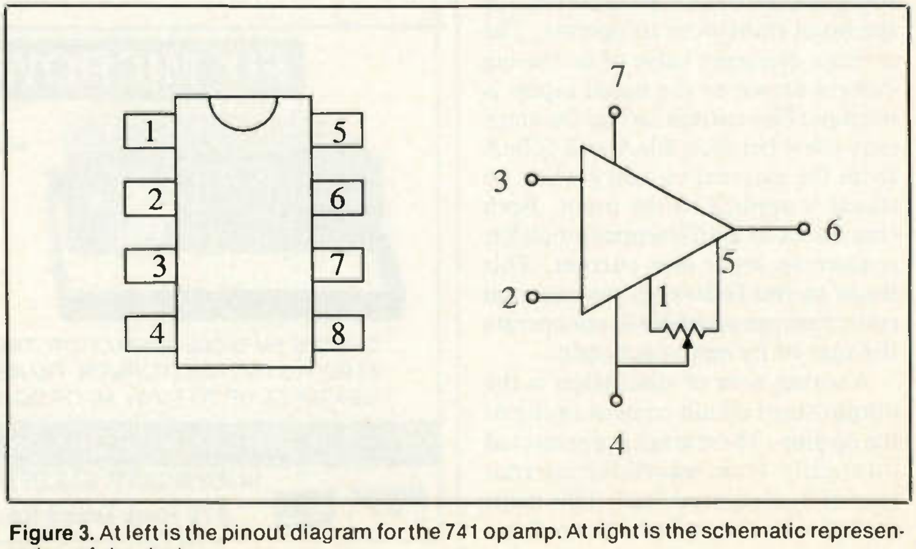


Figure 3. At left is the pinout diagram for the 741 op amp. At right is the schematic representation of the device.

ES&T Manufacturers' schematics PROFAX

October 1992

Profax Number

Sharp
Color Television Sigma 9700 Chassis Model 13C-M100 9032

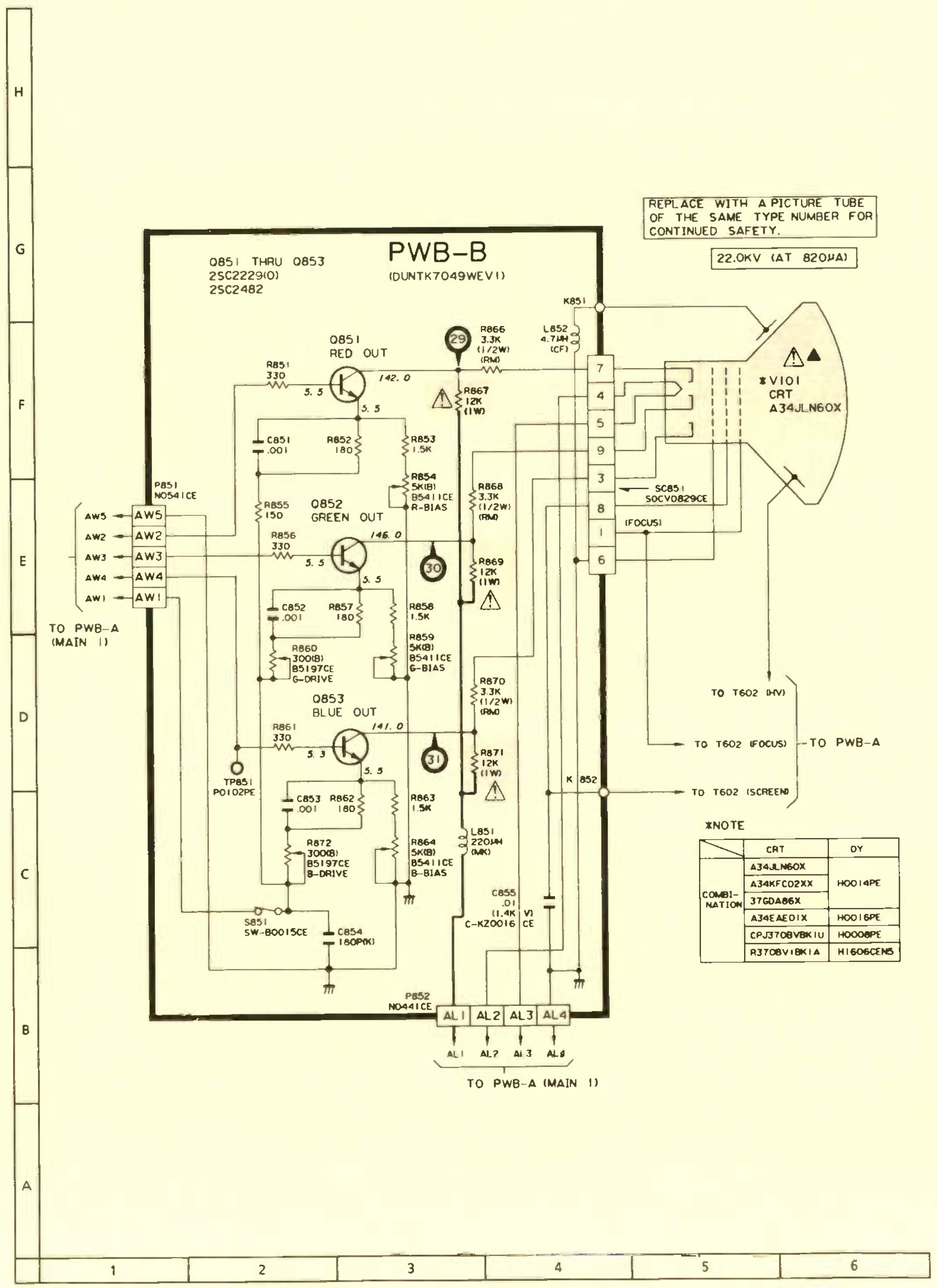
SCHEMATIC DIAGRAM: CRT SOCKET UNIT

Product safety should be considered when component replacement is made in any area of an electronics product. A star next to a component symbol number designates components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

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

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

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



BLOCK DIAGRAM

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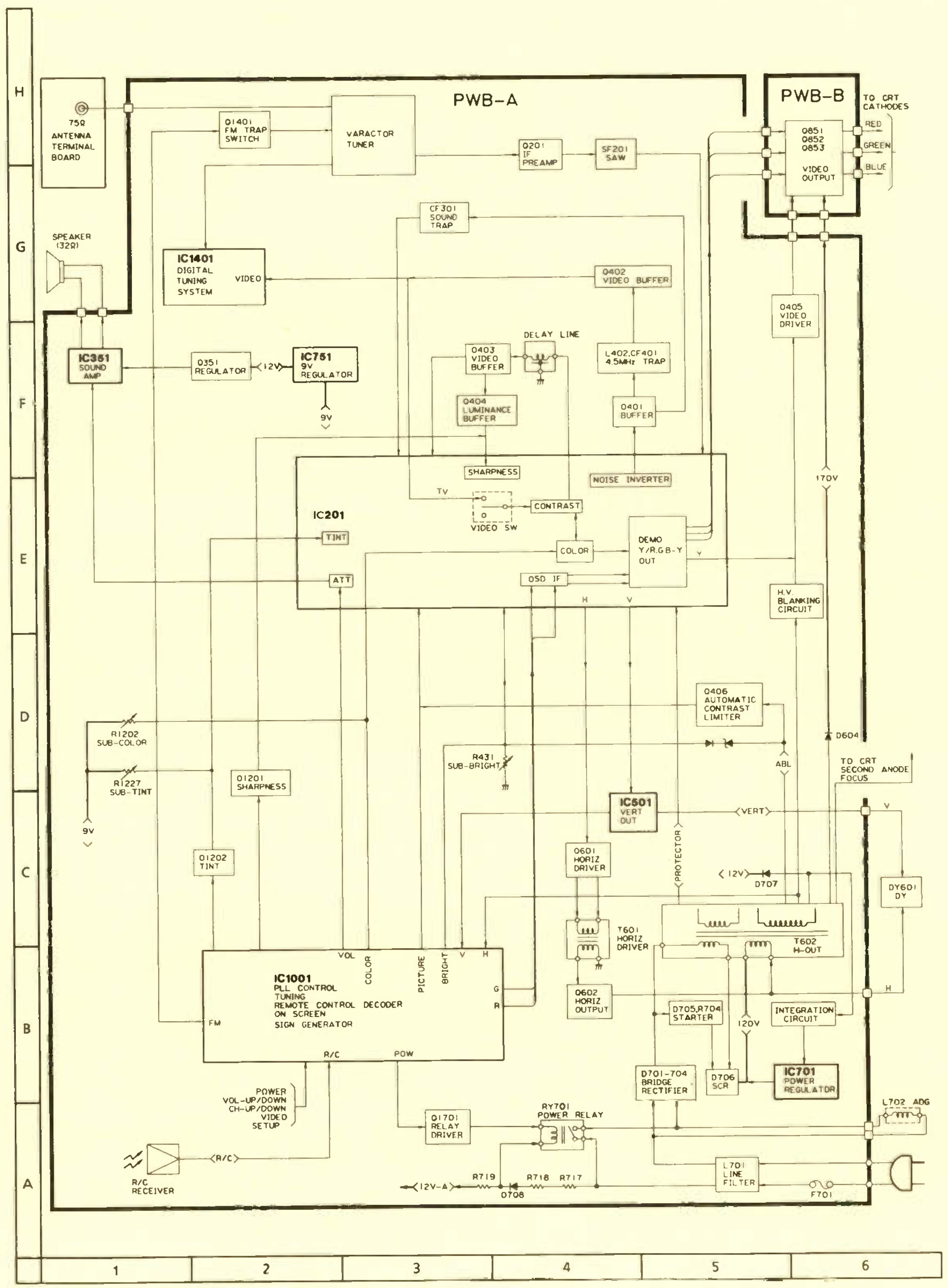
All integrated circuits and many other semiconductors are electrostatically sensitive and require special handling techniques.



SCHEMATIC DIAGRAM: MAIN 1

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9032 PROFAX Manufacturers' schematics

SCHEMATIC DIAGRAM: MAIN 1

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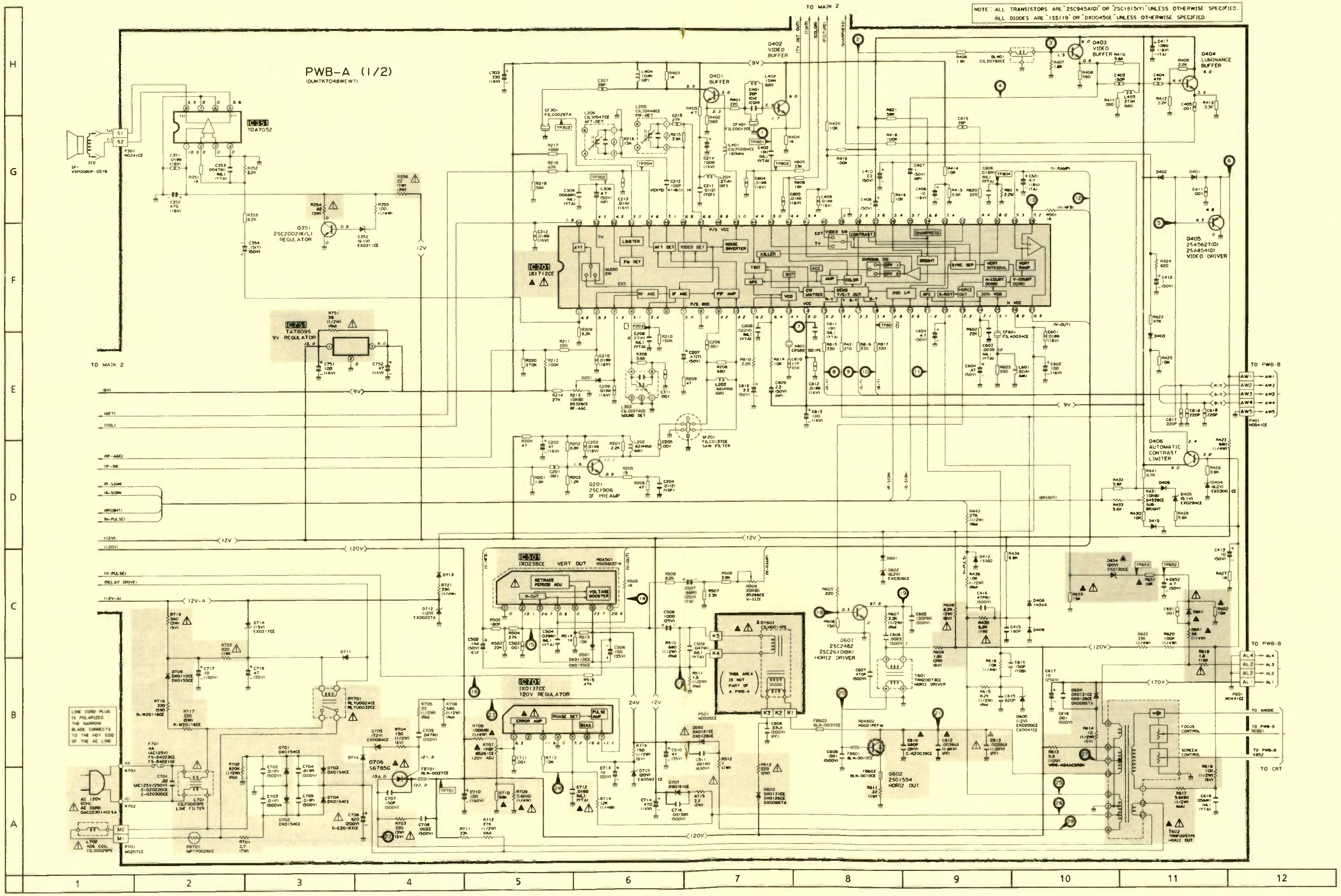

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AS&T Manufacturers' schematics PROFAX 9032

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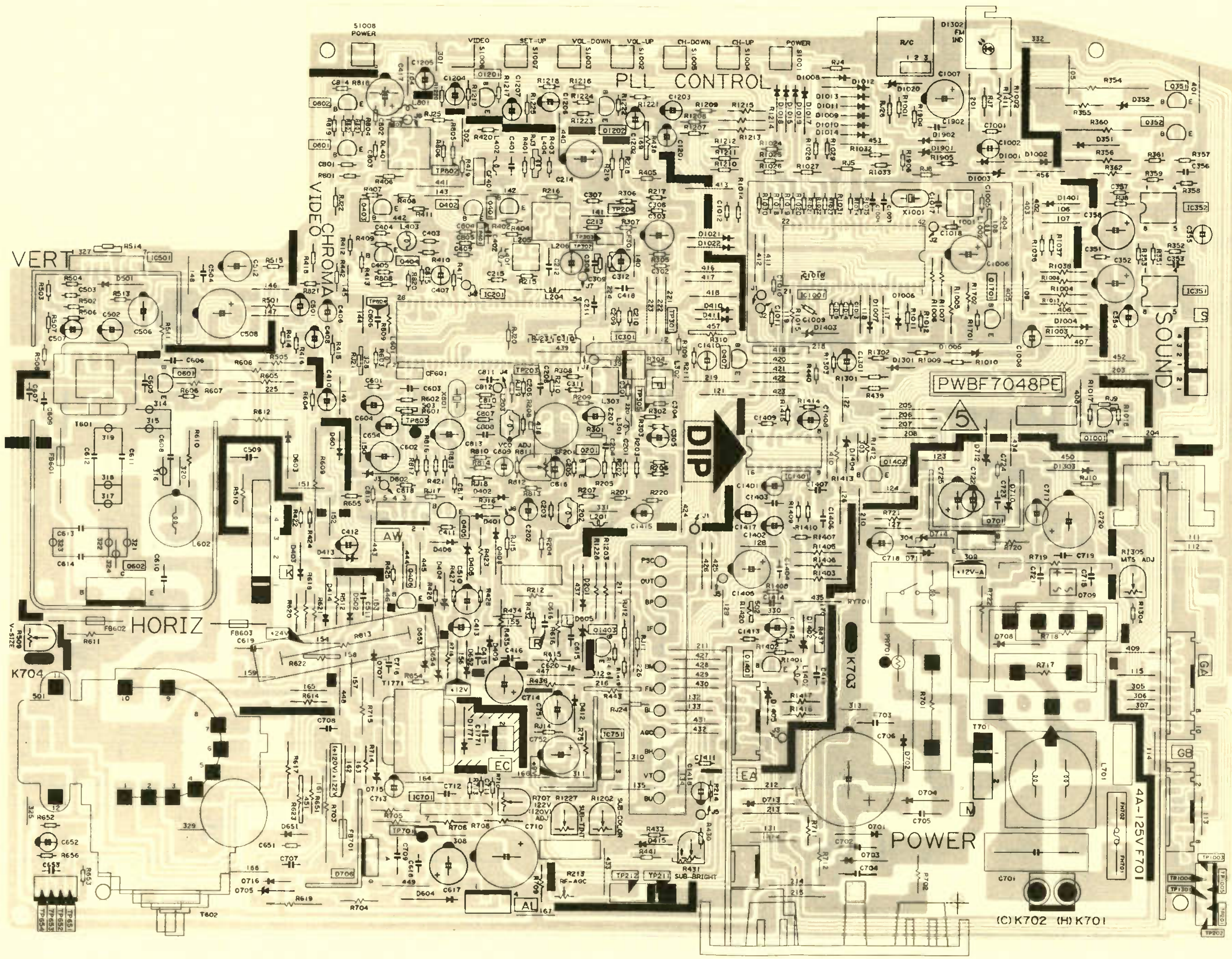
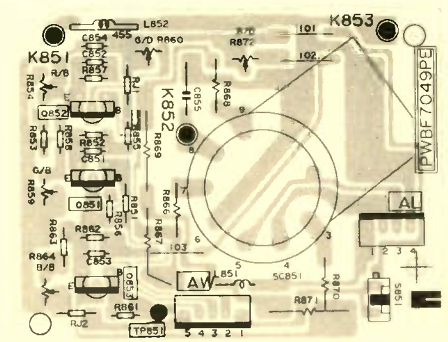
PRINTED WIRING BOARD ASSEMBLIES

(All the PWB's here are shown as viewed from their wiring sides.)



PWB-A



PWB-B

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PROFAX ES&T Manufacturers' schematics

October 1992

SHARP
COLOR TELEVISION
SIGMA 9700 CHASSIS
MODEL 13C-M100

SCHEMATIC DIAGRAM: MAIN 2

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PROFAX ES&T Manufacturers' schematics 9032

SCHEMATIC DIAGRAM: MAIN 2

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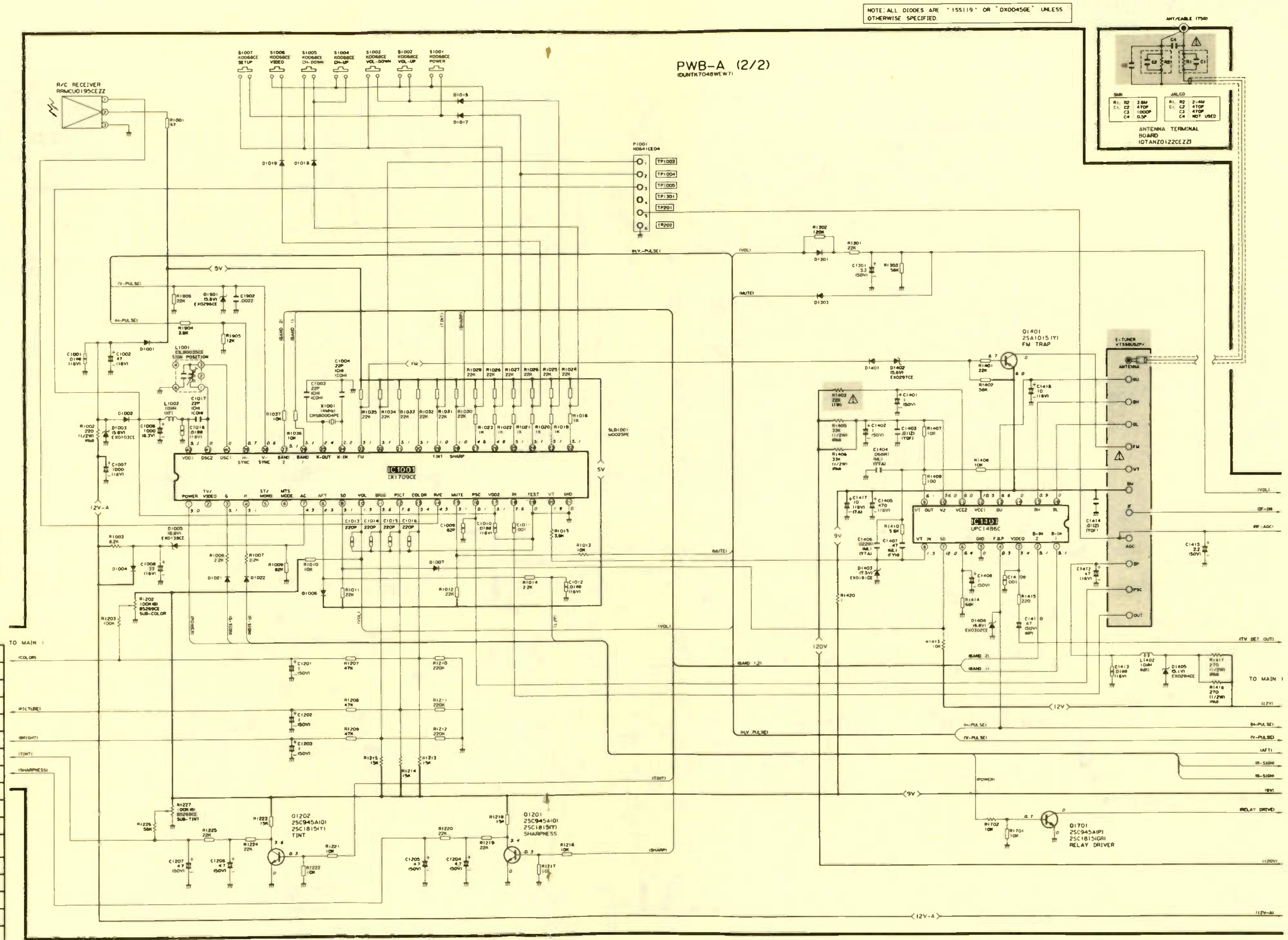

INDICATION OF E-TUNER TERMINAL VOLTAGE

CH No.	V_T	B_L	B_H	B_U
2~B	1V~22V	12V	0V	0V
C~KK	1V~25V	0V	12V	0V
LL~69	1V~27V	0V	0V	12V

INDICATION OF SENSOR IC VOLTAGE (IC1001)

Pin No.	IC1001 Logic or Voltage Levels
1	H(Power on) L(Power off)
3, 4	Active High (Pulse)
7	4.8V (Active High)
8	2.0V~3.5V
9	5V or 0V
10~13	Pulse
14	Active Low (Pulse)
15	5V or 0V
16, 18	Pulse
20	Pulse
22~27, 32, 33	Key Input Active Low (Pulse)
28, 29	Pulse
34, 35	Osc. 4MHz
36, 37	5V or 0V
38	V-Sync. Pulse Input
39	H-Sync. Pulse Input
40	OSC 1 During ON SCREEN operation: Osc. On
41	OSC 2 During ON SCREEN Inoperative: Osc. Off

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Operational amplifiers

(from page 28)

circuit is equal to + V at the moment when Ri opens. The following is what might happen:

- The positive signal is fed back to the inverting input from the output.
- The positive inverting signal causes the output to go negative toward − V.
- Now this negative signal is fed back to the inverting input from the output.
- As the inverting input goes negative the output goes positive and this takes you right back to the first step. This process will repeat itself over and over producing an output signal with no input. This circuit is then a basic oscillator.
- Now let's look if offset opens. This will cause the output to be clipped either on the positive or negative peak. Well what else is left, the op amp itself. Simply stated, the best way to determine if the op amp is bad is to check everything else. If everything is operating properly change the operational amplifier.

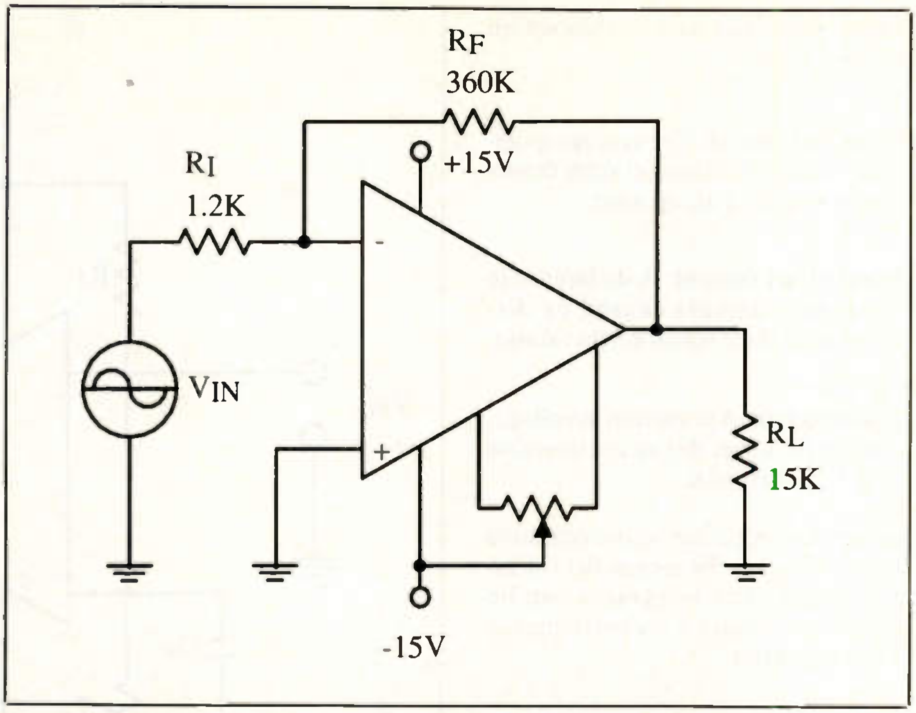


Figure 4. Troubleshooting the op amp is considered by many technicians to be a dream come true. Assuming that the load resistor, the input signal and the power supply are all operating properly, there are only four components that could be at fault.

Active filter troubleshooting

An active filter is a filter in combination with an op amp. Troubleshooting an active filter can be easy if you know the common fault symptoms.

- Determine the type of filter you are dealing with.
- Verify that the filter has an input signal.
- Verify that the load is not the problem by isolating the filter from the output load.
- Check all supply voltages.
- If none of the components is faulty, change the op amp.

Comparator troubleshooting

A comparator is a circuit that employs an op amp to produce an output that is proportional to the difference between two voltages. Troubleshooting a comparator can be a really easy task, because there isn't really a whole lot that can go wrong. See Figure 5. There are only three problems that could develop:

Problem
No output at all.

Possible causes
- No input signal
- One or both supply voltages out
- Bad op amp

Problem
The output changes at a voltage that is too high:

Possible causes
- R2 out of adjustment
- R1 shorted

Problem
The output changes at an input voltage that is too low.

Possible causes
- R1 open
- R2 out of adjustment
- Cb shorted

Glossary

Attenuate: To reduce the strength of a signal.

Bandwidth: a range of frequencies.

Closed loop: Indicates that some form of feedback is used.

Common mode rejection ratio (CMRR): Indicates how well an op amp is able to reject noises. The larger the value the better.

Common mode signals: Signals that appear simultaneously at the two inputs. These are usually undesired signals.

Comparator: A circuit used to compare two voltages.

Cutoff frequency: The frequency at which one-half of the total power appears at the output. Defines the usable frequency limits.

Damping: Energy loss due to absorption by a circuit.

Decibel: A logarithmic way of expressing gain.

Differential amplifier: A circuit that amplifies the difference between two input voltages.

Feedback: The returning of all or part of the output signal back to the input. Positive feedback enhances, while negative feedback subtracts from the input.

Filter: a circuit that passes certain frequencies and rejects others.

Impedance: The overall opposition offered to ac.

Input bias current: The average quiescent value of dc biasing current drawn by the signal of an op amp.

Input offset current: A difference in the input currents caused by differences in the transistor beta ratings.

Insertion loss: A reduction in voltage, current or power due to the insertion of a filter network.

Integrator: A circuit whose output is proportional to the area under the input signal. The integrator can be viewed as a square wave to triangular wave converter.

Inverting input: an op amp input that produces an output 180 degree voltage phase shift.

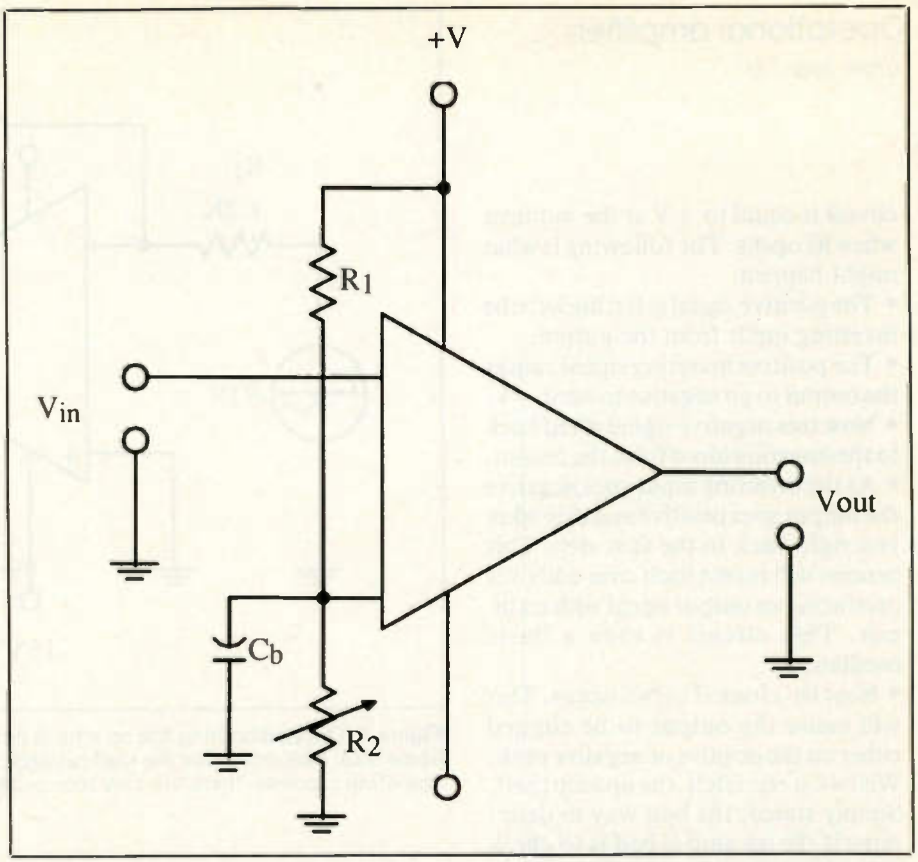


Figure 5. A comparator produces an output voltage that is proportional to the difference between the two input voltages.

Level detector: Name for a comparator used to compare an input voltage to a fixed dc reference voltage.

Miller integrator: Another name for an op amp integrator.

Noninverting input: An op amp input to output with no phase shift.

Offset voltage: An unwanted voltage that may exist between the inputs of an op amp. Offset null inputs are used to eliminate offset voltage.

Open loop: This is a circuit that does not employ feedback.

Operational amplifier: A high gain dc amplifier with high input impedance and low output impedance. The op amp was originally named so because it was used to perform mathematical operations in computers.

Ramp voltage: A voltage that either increases or decreases at a linear rate.

Reactance: Opposition to ac offered by inductors or capacitors.

Slew rate: The rate of change of output voltage in reaction to a change of input voltage.

Summing amplifier: Produces an output that is proportional to the sum of the input voltages.

Variable comparator: Comparator with an adjustable reference voltage.

Virtual ground: A point in the circuit that appears at ground potential but is not directly connected to ground.

Voltage-controlled current source: A circuit with a constant current output that is controlled by the circuit input voltages.

Voltage follower: an op amp equivalent of the emitter follower and source follower.

Test your electronics knowledge

By Sam Wilson, CET

1. In the circuit of Figure A the voltage at point 'x' should be

A. positive
B. negative
C. zero volts

2. Refer again to the circuit in Figure A. Resistor R_c is open. The emitter voltage should be

A. very low
B. equal to the supply voltage

3. The amplifier in Figure A has a

A. common emitter configuration
B. common base configuration
C. common collector configuration

4. For an SCR having the symbol shown in Figure B, turn-on is accomplished with

A. gate current
B. gate voltage

5. If one-half cycle of a pure sine waveform takes 50μsec the frequency of the waveform is ____________kHz.

6. Which of the following is NOT a method of obtaining electron emission?

A. Photo emission
B. Piezo emission
C. Secondary emission
D. Thermal emission
E. Field emission

7. Calculate the dc beta of a transistor that has the following currents: I_c = 100mA, I_b = 1mA and, I_e = 101mA.

A. dc beta = 1.01
B. dc beta = 101
C. Neither choice is correct

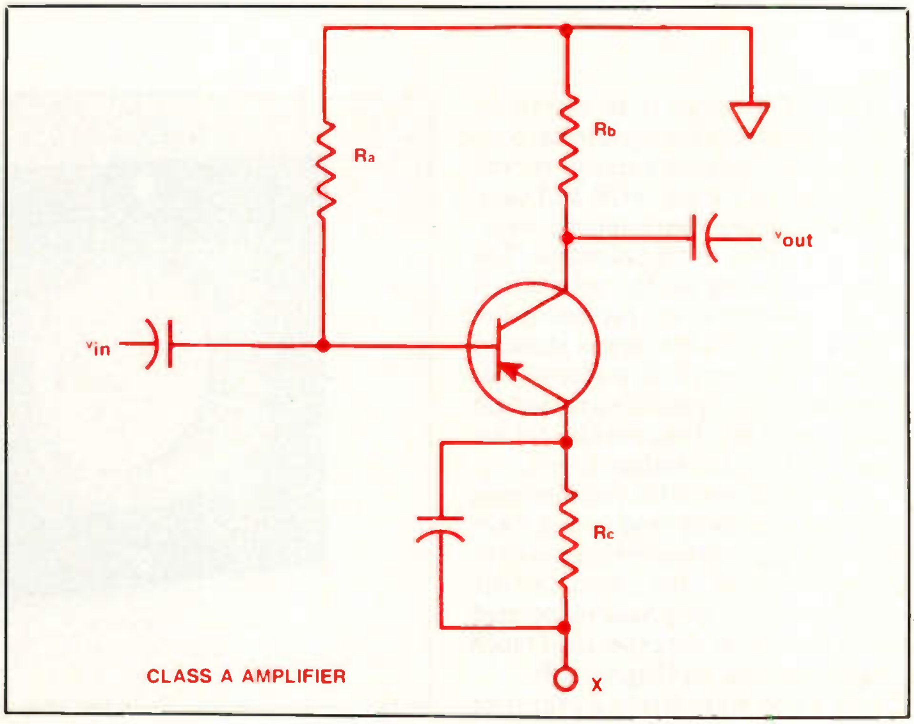


Figure A.

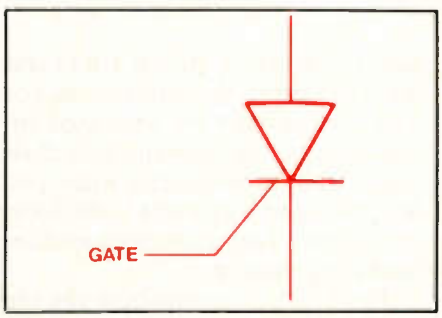


Figure B.

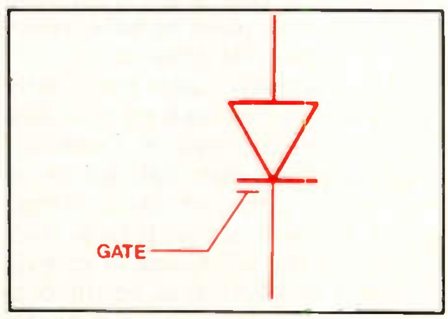


Figure C.

8. What is the percent regulation of a power supply that has the following characteristics:

Full-load voltage = 5V
No-load voltage = 8V

A. $\% \text{ regulation} = \frac{8V - 5V}{8V} \times 100 = 37.5\%$

B. $\% \text{ regulation} = \frac{8V - 5V}{5V} \times 100 = 60\%$

9. For a power supply which has an output voltage that is least affected by changes in load current it is more desirable to have a supply with

A. a high percent regulation
B. a low percent regulation

10. For a class A amplifier, a square-wave test is used to identify

A. non-linear distortion
B. frequency distortion

(Answers on page 52)

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

Using scope cameras to record waveforms

Vaughn D. Martin

The oscilloscope is an extremely valuable piece of test equipment to the consumer electronics service technician. Every TV set, VCR and camcorder exhibits characteristic waveforms as part of its operation. The oscilloscope can tell the technician if those waveforms are present or not and if they're of the correct shape or if they're distorted. Waveforms that are distorted in specific ways can help to pinpoint the components that are the cause of the product failure.

One limitation of the oscilloscope is that once the faulty product that it was used to diagnose has been restored to proper service, the characteristic waveform that may have pinpointed the problem, at the expense of much interpretation, no longer exists.

One way to preserve waveforms that may be of use in the future in diagnosing similar products with similar problems, is to record them and save them along with the service literature for that product.

Until recently, there have really been only two methods for recording waveforms displayed on a standard analog oscilloscope: make a drawing of the waveform, or take a picture. Today's oscilloscopes present challenges to the technician in making records of waveforms, but innovations in oscilloscope circuitry, photography, and electronic waveform recording offer a variety of ways to capture a waveform for future reference.

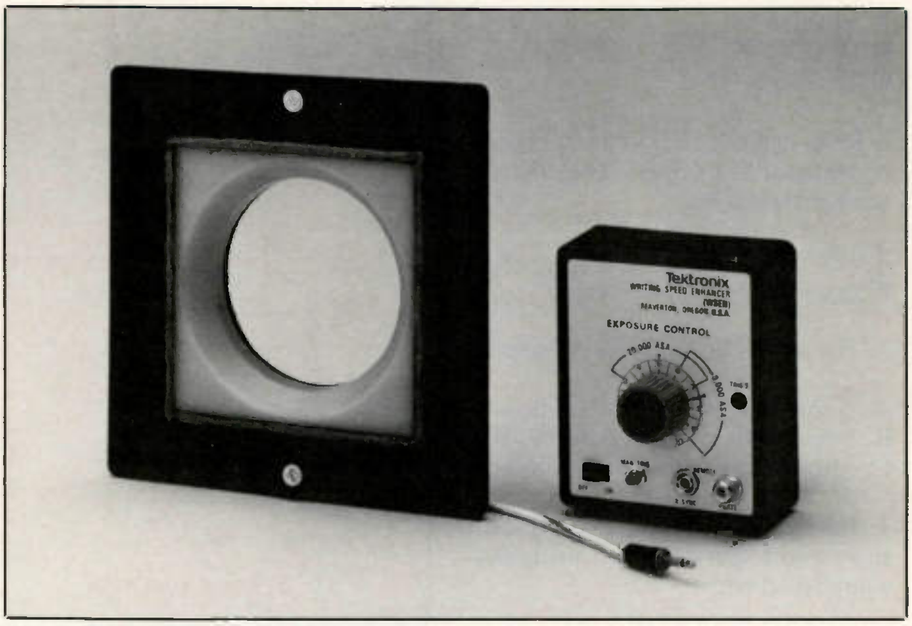


Figure 1. This writing speed enhancement attachment to a CRT fogs the film in the camera. This slight exposure to light increase the maximum sensitivity of the film.

Advanced scopes require advanced waveform recording products

Oscilloscopes have been quietly undergoing vast technical improvements. Examples of innovative features now available are multiple colored liquid crystal shutter CRTs and interfaces permitting direct plotting of data. While these are welcomed enhancements, they present both challenges and opportunities when you want to capture an event in the form of a scope photo or through another hard copy medium.

This article examines how you use a conventional scope camera, the theory behind such scope camera systems, and it also examines some truly state-of-the-art products. These products provide a direct plot of the scope's CRT images. These new products have impressive parameters and capture CRT events at speeds, and with resolutions, never before possible, even with the best conventional scope camera systems. One example of a technique for capturing high-speed CRT events is shown in Figure 1.

Scope cameras

The simplest possible scope camera, or any camera for that matter, consists of three essential elements. These are: 1) A means of holding sensitized film flat in an unexposed condition. 2) A means of bringing the image to a focus on the film's surface. 3) A means for metering the light coming from the object. Let's look at each of these requirements separately.

Holding the film

Early cameras used glass plates to expose images upon. Despite the dimensional stability and flatness of glass plates, however, this proved to be very inconvenient. Roll film is the most convenient and popular type of wet process film. It is rolled up on a spindle with black backing paper. As the film is unrolled it is exposed. The emulsion side of the film, facing the lens, is drawn across a window which is held at a fixed distance from the lens.

For the film to work well, it must be

Martin is Chief Engineer in the Automatic Test System at Kelly Air Force Base.

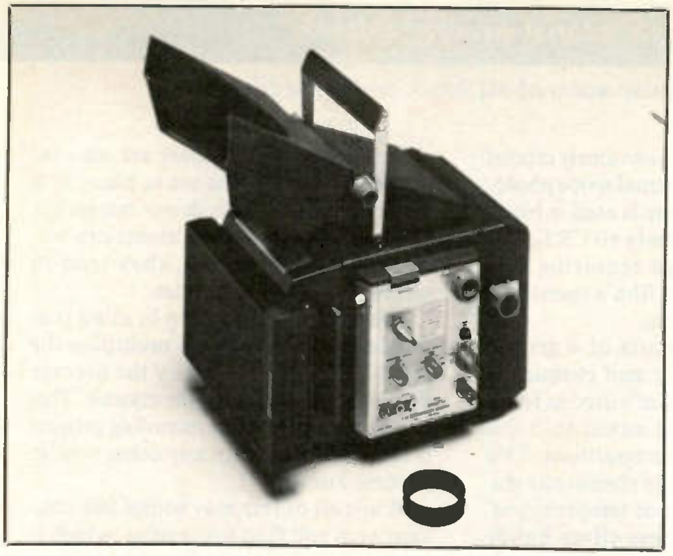


Figure 2. The small circular object to the side of this basic oscilloscope camera (the C-53) is a corrector lens and provides one way of solving the problem of the large distance from camera lens to scope face.

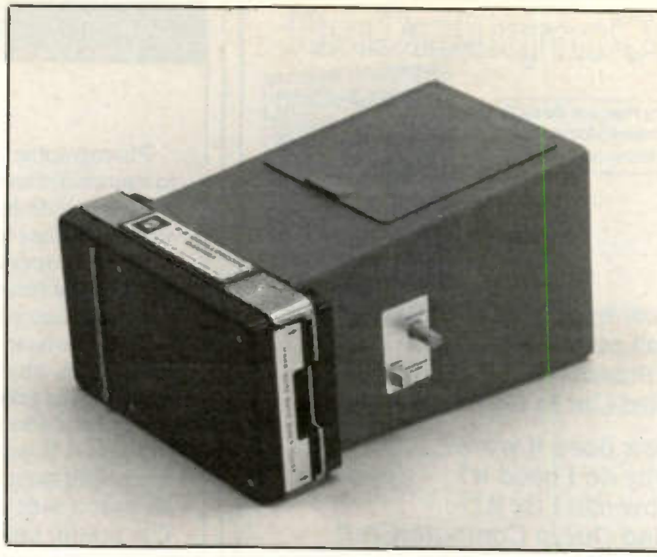


Figure 3. The C-5 camera uses a standard Polaroid film pack. The aperture is fixed at f/16 and has a three element lens to overcome the massive length otherwise required if it were just a single element lens.

thin (0.005") and under a slight tension. All of these criteria are met with a roll of 35mm film.

Polaroid film also works well in oscilloscope screen photography. In this case, a special Polaroid camera back is used to hold the film while it is exposed by the camera.

Focusing

Focusing the Image is accomplished with an optical glass lens. The image-to-object ratio is represented by the letter M. It is called M because it represents the "magnification" factor; although this number can be less than one.

The maximum working distance will be (u + v). In the case of our attempts at taking a scope photo, the u + v distance will be the distance from the face of the CRT to the film's surface. If the working distance is very short, the semifield angle, arctan y'/y will be large and distortion and astigmatism will result. As a result of this constraint, the "rule of thumb" is that focal length should equal the image diagonal. This results in a semifield angle at infinite focus whose tangent is y'/f = 1/2 or arctan 1/2 = 26.5°.

If you work through the numbers, keeping in mind that a normal scope CRT is a 10cm × 8cm rectangle and a 35mm piece of film actually has only 33mm (3.3cm) of surface height, you will realize that you need a camera with an M or magnification factor of 33mm/80mm or 0.4125. Further using this M = 0.4125 in the u + v equation, you will see that the working distance, using an ordinary 35mm camera with a standard 50mm lens will cause you to be 241.8mm or 9.6 inches away. This distance from the surface

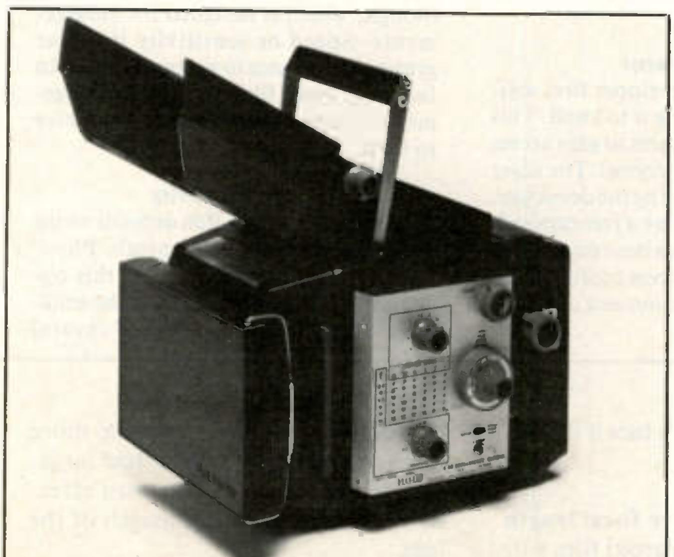


Figure 4. The C-59 camera is designed specifically for larger CRTs up to 6 1/2". With the field of view expansion kit, it allows the camera to fully cover larger CRTs.

Figure 5. The C-30A camera is designed for loader scopes using the 0.8 cm/div CRT. It has a continuously variable lens arrangement for variable magnification, interchangeable film backs, and it swings away from the scope to allow viewing of the CRT.

A tutorial on scope cameras

Some notes about black and white film

Photographic film is obviously crucial to a successful conventional scope photo. A silver-halide emulsion is used in black and white films for nearly all CRT photographic operations requiring fast speeds. The faster the film's speed, the less resolution possible.

The emulsion consists of a gelatin compound, physically and chemically similar to the gelatin that's used as food. Silver halide salts are mixed into this compound in precise proportions. This compound must remain chemically stable over a wide range of temperatures. The gelatin holds these silver halide crystals in a suspension which is evenly distributed over the film surface.

Silver halides

The silver halides — silver chloride ($AgCl$), silver bromide ($AgBr$), and silver iodide (AgI) — are all light sensitive compounds. Photons (light) striking the emulsion releases electrons from the halide ions. These electrons meet with silver ions to form atoms of free silver in the crystal.

If another atom of silver is formed adjacent to the first one, a stable molecule is established. Additional silver ions in the same crystal, converted by free electrons, will readily assemble with the free silver molecule.

These atomic incidents occur between atoms on the crystal surface and are ionized by the gel and the salt molecules (and impurities) that make up the crystal structure. While this is happening, the film is still in a dry state and carries latent images, (the "seed" for a subsequent visible image) in the centers of free silver molecules.

Development

The water in the developer first softens the gelatin, causing it to swell. This permits the reducing agent to gain access to the silver ions in the crystal. The silver ions, which are reduced by the developer, congregate rapidly where a free exposed-to-light silver center has been established in the crystal. This process continues until the whole crystal becomes a chunk of silver.

The unexposed crystals are also reduced; however, this takes place at a much slower rate. This slower rate results because unless the silver atoms can collect other silver atoms, they tend to recombine with the halides.

Summarizing this, keep in mind that the development process multiplies the effect of a few photons by the average silver-ion population of the crystals. This is why the silver-halide recording process is more sensitive than any other similar process known.

While all of this may sound like conventional roll film processing, which it is, it also applies to the Polaroid process as well. The Polaroid process begins with the same silver halide emulsions and developing process; it is just more compact and self contained within this unique "instant" film.

Spectral response

The film's spectral response is limited to wavelengths less than 500 nanometers (5,000 Angstroms), depending on the proportions of these silver halides. This emulsion by itself would respond well to a P16 phosphor screen. However, this is blue, and in most instances, is not useful to a normal scope. By adding selected dyes, such as cyanine dye, you can extend this spectrum to even reach the infrared wavelength of 1,100 nanometers.

Film Grain Size is important in ordinary photography because it is a major source of noise and limits resolution. Grain size depends on the size of the silver halide crystals.

For scope waveform photography you will rarely be interested in fine grain film though, which is designed for enlargements. Speed or sensitivity is of far greater importance to a scope camera. In fact, fine grain films, used for enlargements, are much slower or less sensitive to light.

Light sensitivity

The sensitivity of a film depends on the light being absorbed by crystals. Physical considerations determine this optimum crystal concentration in the emulsion on the film surface. If crystal

of the film to the CRT's face is uncomfortably large.

Changing the effective focal length

If you are using Polaroid film with its much larger image area, the M factor approaches one, and the working distance with a 50mm lens with an M factor of 1 would be 200mm or 7.87 inches. This starts to become more realistic, but may still be too large. Therefore, somehow you must effectively shorten the focal length of the lens.

To shorten "u" you must find some means of bringing the lens forward to increase "v". A small extension tube can be inserted between the camera population is too thin, much of the light will pass through without direct effect.

ASA film speeds

The ASA film speed is determined according to a predefined process describing film samples exposed to a graduated test strip of film processed under specified conditions of development chemistry, temperature and agitation. The ASA speed is a concept developed for films designed to be used for monochrome continuous-tone negatives in pictorial still photographic settings.

Scope photos are most often taken of very fast moving traces. This is why the phrase "ASA equivalent speed" is used since assigning it an ASA speed would be on the basis of a system not at all designed for this application.

Film fogging

When a scope/camera system is working at the extremes of its energy-transfer capability, another useful technique providing additional writing speed is the practice of film fogging.

It was noted earlier in the discussion of film emulsions, that when exposed to light, the silver-ion and electron combinations become unstable until another ion and electron appear at the site to form a molecule, or at least a photomolecule of free silver.

This molecule becomes a development center, and a few more molecules congregating at this center establish a latent image. When exposure to light does not provide enough energy to establish development centers, the single ion-electron combinations disappear because they require company to merely survive.

A method of providing these additional ions is to deliberately introduce light, in a uniform manner, onto the film's surface. This application of an additional amount of light energy is called fogging.

Fogging provides "starting" centers distributed throughout the film. When the film is finally exposed to light through a scope photo, many more development centers occur as a result of this fogging.

The concept of photographic writing speed measures the ability of a particular camera/oscilloscope system to provide a useful photographic record of a fast single-sweep trace. It is stated as a scope performance parameter and is specified in cm/microsecond or cm/ nanosecond. As a concept, it answers the question "What is the speed of the fastest single-sweep trace the system can record?"

A method to enhance the writing speed of a scope

By use of a writing speed enhancer, Figure 1, you can actually increase writing speed. This attachment to a CRT fogs the film in the camera before, during, or after it is exposed. This slight exposure to dim diffused light increases the maximum sensitivity of photographic film, as just discussed.

The writing speed enhancer installs in minutes and can be triggered in one of three ways. First, you can use the pushbutton on the control box (refer to the object to the right in Figure 1). Secondly, you can remotely trigger the device by using a switch which provides closure to ground such as a camera's shutter X-sync switch. Lastly, you can let the scope's sweep + gate trigger this device.

Another Use of the Writing Speed Concept

Storage oscilloscopes capture fast occurring events (such as a transient or glitch) and can hold them stationary on the screen. But how fast of an event can they capture is a key measurement parameter. This is often specified by the scope's Useful Storage Bandwidth (USB). The following formula describes this parameter:

$$USB(MHz) = WRITING\ SPEED\ (DIV/\mu SEC)/10$$

The preceding formula corresponds to a fully-written sine wave 3.2 divisions in amplitude. Writing speed units are in screen divisions per microsecond and not centimeters since screen sizes vary and because measurements are made in terms of divisions. This is a general "rule of thumb" formula but yields fairly good results.

body and the lens, or you may have the ability to rotate the lens and draw it further away or closer to the camera.

Take a look at the scope camera in Figure 2. This camera has a Graflok back designed to accept cut film. The small circular object to the side of this camera is a corrector lens and provides another option to solving the focal length problem. It is designed for a magnification of only 0.8, but various options allow different magnification powers. The supplementary lens, shown in Figure 2, actually decreases the focal length.

Controlling the amount of light

This is the last of the three essential

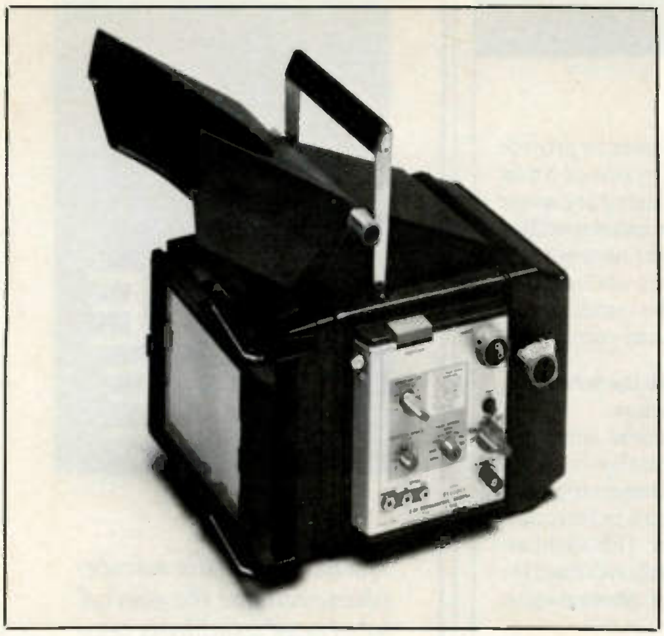


Figure 6. This very inexpensive camera (C-51) is designed for ease of use. It has only a fixed focus lens arrangement. Its lens has a range of f/4 to f/32.

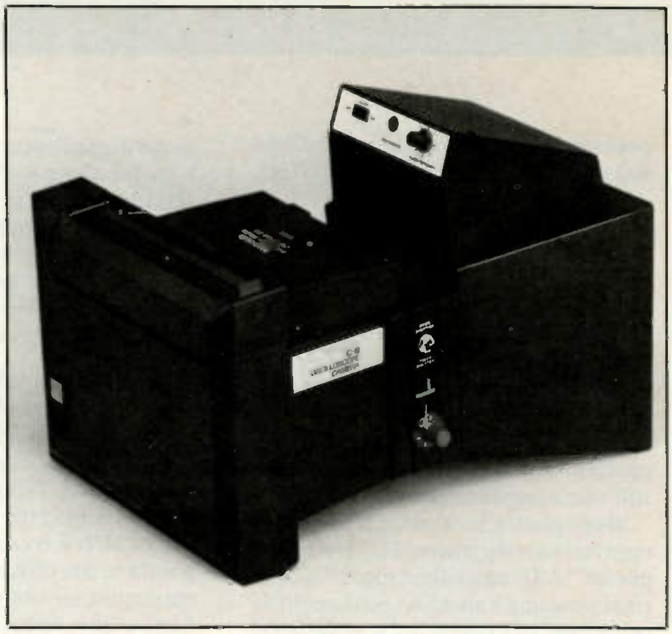


Figure 7. The C-9 scope camera.

elements necessary for a camera. Light passes through the shutter, the light-metering device, which is essentially an on-off switch for light. The shutter is usually mounted between lens elements, along with the variable-aperture or adjustable stop.

The camera's shutter

The focal-plane shutter was originally developed for commercial cameras with a 4 x 5 inch or larger film format. This shutter effectively moved a slit across the film plane, allowing the film to be exposed progressively from one end to the other. The amount of exposure was determined by the width of the slit and the speed of travel.

Most modern 35mm cameras that allow interchangeable lenses use two independent curtains. One curtain covers the film before exposure and is drawn away during exposure. The other is originally rolled up and follows the first across the film to finish the exposure. As the exposure time is made shorter, the closing curtain begins to follow the opening more closely until an actual slit is moving across the film plane.

Light metering

One great advantage of a 35mm single lens reflex (SLR) camera is that it allows through the lens metering of light. This allows you to directly observe the object on a ground-glass screen whose surface is at the image plane. An SLR camera allows the point of focus to be determined visually. This is further advantageous because when using this system, there are no computations necessary for filters or f-stops.

While there are numerous types of light sensors, ranging from the earliest cadmium sulfide (CdS) sensors to modern LEDs, they all are placed in the optical path of the viewfinder. This meter usually does not read luminance values, but rather indicates a balanced condition of the electronic exposure computer. After you set the film speed, this compensates a circuit

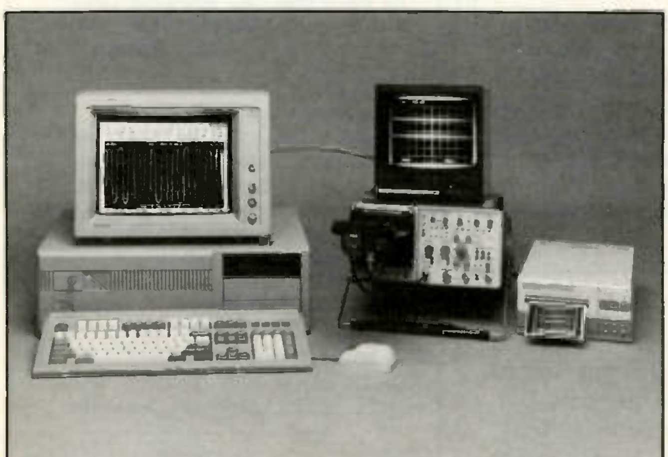


Figure 8. This computer-based scope trace recording system consists of a black and white 9" diagonal monitor, a video camera (note the camera over the CRT), a video copier and an oscilloscope.

Figure 9. This 9 pin dot-matrix printer can be used to print out a copy of the scope trace captured by a computer-based scope trace recording system.

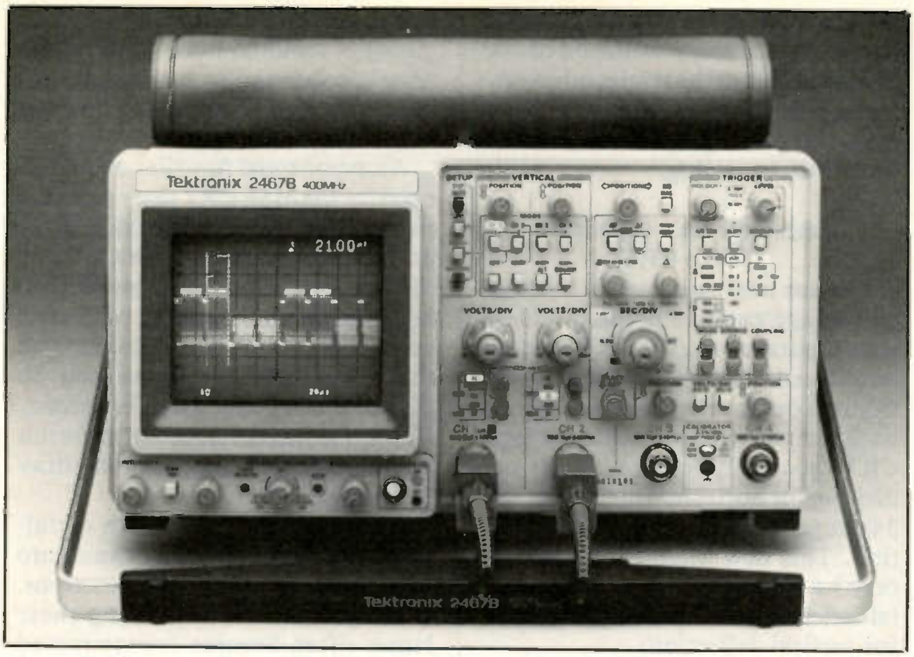


Figure 10. A modern oscilloscope, such as this meshless scan-expansion scope provides a fine clear CRT trace which presents a challenge to someone who wishes to photograph it. The faster films used with the cameras and systems presented within this article can take such photographs.

or adjusts the meter movement itself.

More modern cameras provide complete automatic exposure by controlling aperture and time electromechanically. You need only to frame, focus, and respond to "IN" and "OUT" of tolerance indicators showing either enough, too little or too great amounts of light.

Capturing the image

If you have an ordinary 35mm SLR camera, there are scope hoods that fit up to the CRT and hold the camera, allowing you to take scope photos. The disadvantage might be that most arrangements like this have no ability for nearly instant Polaroid film developing.

Manufacturers of oscilloscopes, and other manufacturers offer a variety of cameras that are specifically designed for taking pictures of scope waveforms.

For example, the model C-4 is the least expensive scope camera made by Tektronix, costing approximately $410. This scope camera has a contoured pistol grip to fit the hand, a four element lens and requires no focusing. The aperture is a continuously variable f/32 to f/4.5. The focal length of the lens is 105 mm without the CRT hood (note the rectangular cover on front of the camera).

The magnification is dependent upon the CRT hood you select since they are interchangeable. The resolving power of this camera is 6 lines/mm. Keep this figure in mind to compare against an all electronic system soon to be presented. This means that you could clearly see without any fuzziness up to six lines per mm. This camera's shutter is variable from 1/125 to 1 second.

Other oscilloscope cameras offer refinements such as a flash unit to illuminate the graticule and a motorized Polaroid film back that automatically ejects and self develops an exposure after each shot. See Figures 2 through 7 for examples of oscilloscope cameras.

Electronic hard copy media systems

The instrument system of Figure 8 is a long way from the convenient scope camera most of us traditionally have as an image in our minds. This system consists of a black and white 9" diagonal monitor, a video camera (note the camera over the CRT), a video copier and a Tektronix model 2400 series scope. This system provides what is called a "looped through" video connection which means it can be used in series with video devices such as other video copiers or video cameras. Figure 9 shows a printer that is used in a modern scope camera system.

The power of this system is in its versatility. You can obtain high resolution black and white copies in just 21 seconds. You can use inexpensive thermal printing paper to make up to 180 4.3″ × 4.1″ prints or 75 8.5″ × 11 prints per roll with the HC02 video copier. You have 64 gray scale levels from which to change darkness, (4 bits digital and 2 bits dithering). There are 16 gray levels in the dot matrix graphics mode and once an image has been captured on the on-board frame memory, you can make as many copies as you like.

Another video system is the HC100 color plotter. This low cost (approximately $895) system is a four color plotter designed to make waveform plots directly from a variety of Tektronix digitizing instruments without an external controller. The HC100 connects directly to a compatible instrument and is controlled by the attached instrument's keyboard or front panel. The plotter plots stored waveforms with their instrument setup information such as the volts/cm and timebase settings. This now suddenly allows very fast electronics internal to the scope to capture waveforms and later display them. Waveforms can be plotted as fast as the semiconductors' access time will allow. This is far faster than the photographic method of waveform recording.

A meshless scan-expansion (MSE) CRT

The last innovation in CRT design and image capture is the meshless scan-expansion (MSE) CRT recently introduced into the 2400 series Tektronix scopes, refer to Figure 10. As background, traditional mesh type CRTs generally require 7 volts per division for horizontal deflection and 3 volts per division for vertical deflection. This new MSE CRT requires only 3.6 volts per division for horizontal deflection and 2.6 volts per division for vertical deflection.

The CRT's minimum beam size was reduced from 12 mils to 8 mils creating a sharper image with better resolution. The price paid for this breakthrough was a trade-off in the CRT being more sensitive to defocusing as beam current increases. Therefore, dynamic focusing is required during intensified zone display and to maintain minimum spot size regardless of changes in intensity level.

An exponential function was developed for the MSE CRT that relates the required focus electrode voltage to the grid voltage (raised to a power). To do this you need exponential amplifiers, but when they are made out of discrete components they do not function all that well at the highest frequencies. So SHF-III or a Super High Frequency III process was developed to make this high voltage high frequency amplifier in IC form.

Conventional CRTs with metal-mesh lens focus electron beams onto phosphor-coated luminescent screens. During their manufacturing these lenses often become contaminated with particles which cause a high reject rate. Also, they tend to cause both aberrations (defocusing) and, by intercepting electrons, reduce display brightness.

The new MSE CRTs use lenses similar to those used in nuclear particle accelerators. These lenses replace the mesh screens with contoured metal electrodes. Such quadrupole lenses, as they are called, make CRTs more compact with crisper images. They form a high quality electron optical system functioning very closely to a 35 mm single lens reflex camera's objective lens.

Note dual quadrupole lenses (Q1 and Q2) which focus the electron beam before it passes through the vertical deflection plates of the CRT. After the beam is through the plates and deflected, the beam passes through a third quadrupole lens (Q3).

This refocuses the beam and increases the angle of deflection as the beam next travels between the horizontal deflection plates.

The scan and geometry of the horizontally deflected beam is made more linear as it passes through a linear geometry correction electrode. Finally, the beam passes through the fourth and last quadrupole lens (Q4).

This lens is composed of parallel tubes having contoured sections which accelerate and expand the scan of the beam (thus the word expansion in the name MSE). What results is a superbly fine clear CRT trace which presents a photographing challenge, but the faster films used with the cameras and systems presented within this article can definitely do it justice. ■

What do you know about electronics?

Continuation of the computer series

By Sam Wilson, CET

In the past few issues I have been discussing a form of memory called *mass storage*. It is also called *mass memory*. This discussion has been in the form of a conversation with my friend Ron Weinstein. Ron is working at the Cape. He has to do with the computer stuff that goes on with the Shuttle and other launches. He is one of the most highly-qualified computer people in the field.

Wilson is the electronics theory consultant for ES&T.

I have to say this, though, he is sometimes hard for me to understand. I sent him a copy of this article - as I always do - and he hasn't spoken to me since. I suspect he is too busy, or something, so I will keep trying. His input has been very valuable.

I have also made use of some materials provided by Lou Frenzel and I am grateful for that material.

As I have said before, I stand by my contention that microprocessors and computers are systems that utilize memory. I see them as traffic cops that control the inputs and outputs to all types of memories. They permit the technician or engineer or operator to add information to the information that comes from memories.

But, when it is all said and done, microprocessors cannot operate without memories because all of the operations

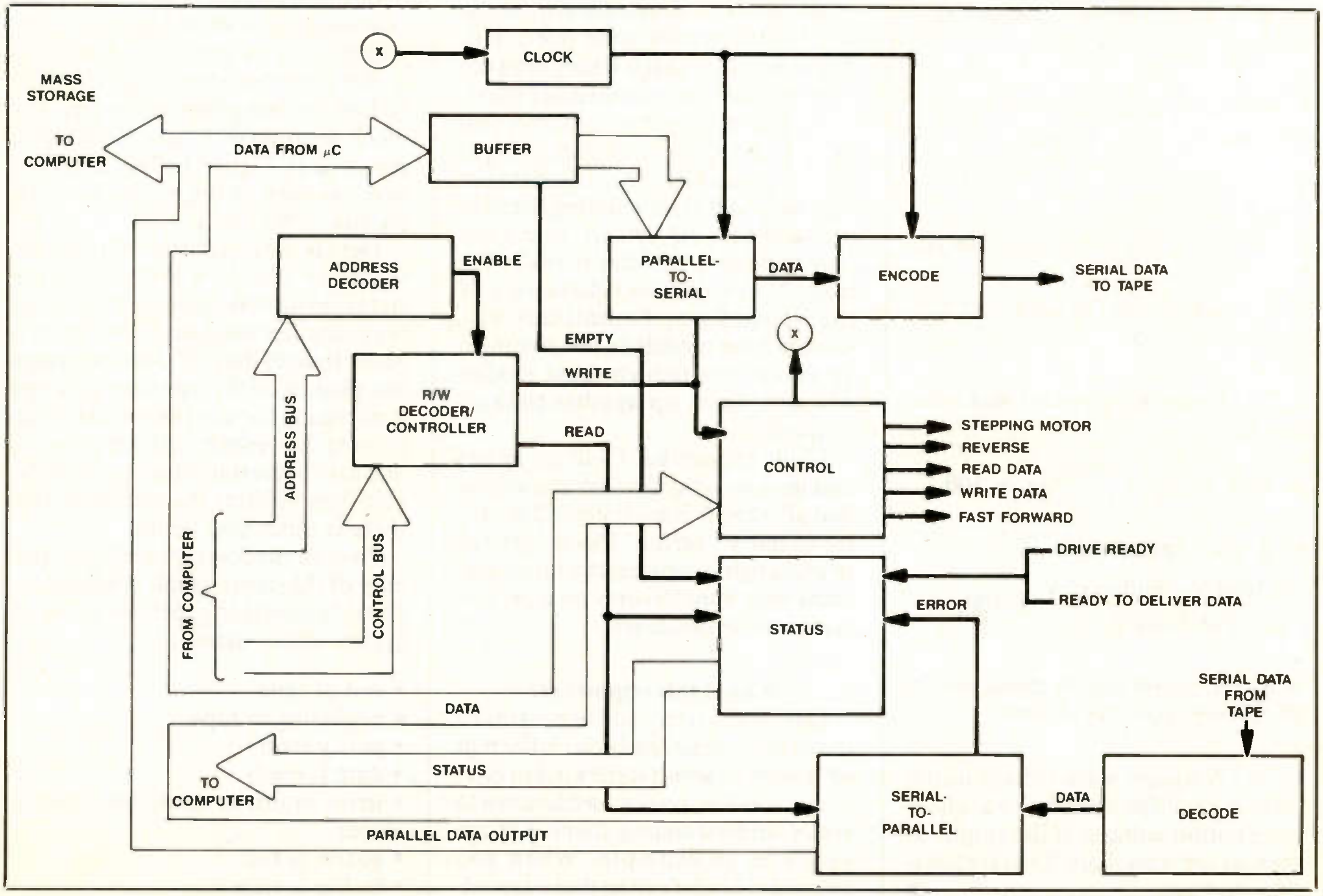


Figure 1.

Test your electronics knowledge

Answers to the quiz

(from page 43)

1. A - In a PNP transistor class A amplifier, the emitter must be positive with respect to the collector.

2. A - A voltmeter connected to the emitter should read nearly zero volts (or, zero volts - depending upon the meter.)

3. A - The input signal is to the base and the output is at the collector. The emitter is common to the input and output signals. The dc voltages do not have anything to do with the configuration.

4. A - Figure C shows the symbol for an SCR that is turned ON with a gate voltage.

5. 10kHz - A complete cycle takes 100μ sec

$T = 100\mu sec$

$f = 1/T = 1/(100 \times 10^{-6}) = 10KHz$

6. B - All others can be used to obtain electron emission.

7. C - The correct equation and solution is:

$\text{dc beta} = Ic/Ib = 100mA/1mA = 100$

8. B - % Regulation =

$$\frac{\text{No load V - Full load V}}{\text{Full load V}} \times 100$$

9. B - The power supply mentioned in #8 has very poor regulation.

10. B - A square wave voltage into a Class A amplifier should give a square wave output voltage. If the amplifier changes the waveshape it has frequency distortion. ■

(and much of the data) originates in the memory.

I have searched through many publications and talked with many experts (like Ron Weinstein) and I have never learned of any application of microprocessors and computers that do not require memory in some form or other. (Let me stop here for a moment and say that from now on I will refer to microprocessor's as μP's and refer to computers as C's. If I don't do that I will end up with pages of those words. It is just my way of saving space).

I have found definitions of μP's and C's that could cause brain cramps if you take them seriously. For example, I've seen them defined as electronic brains. That's too silly to talk about. I've seen them described as processors of data. That's O.K., but the processing procedures and most of the data comes from some form of memory. I've seen and heard many other definitions, but, nothing has convinced me that μP's and C's are nothing more than ways of using memories.

Before you send me pages and pages of reference material (as some readers do) let us lay down a rule. You must start by giving a few examples of uses of μP's and C's that do not require the use of memory for their operation. The reason I say that is if they must use memory then they are memory users.

As a reader of this column you know I have spent much time trying to get rid of models - that is, analogies that were useful for entering the field of electronics but detract from a full understanding of what is really the truth. You would not believe some of the letters I get. Technicians who learned from models do not give them up easily even though those models will not stand up against today's technology.

I fully expect that I will get letters making a stand against my contention that μP's and C's are systems that utilize memory - period! I look forward to exchanging arguments with technicians who want to carry on a professional correspondence.

Why is this important?

Once the mystery and hype is taken out of the subject, and you realize that μP's and C's aren't some kind of electronic voodoo, you can settle down to really understanding them. Let me give you an example. When you learned in kindergarten that a capacitor will pass ac but won't pass dc you were given a useful model for understanding some basic circuits in beginning electronics. When you become a professional electronics technician you need to discard such models and go to the real story.

Likewise, when you learn that μP's and C's do all kinds of magic you are getting a good ideas of *applications*. Later, you need to get down to how they really work. That is why I have started the discussion of μP's and C's with a study of memories.

Tape storage - concluded

In the past two issues I have been reviewing a conversation with Ron Weinstein on the subject of magnetic tape storage. Magnetic tape storage is one type of mass memory. It is one of the many kinds of memory used by computers. The tape form of mass storage can retain huge amounts of data. However, it has the disadvantages that the data cannot be retrieved as fast as data in other types of memory. For that reason, tape storage is usually used only as a backup memory. If, for any reason, the original storage of data is lost the tape backup can be used for data retrieval.

In the typical computer setup the tape system is operated by a tape controller. The purpose of a tape controller is to relieve the computer of the task of operating the tape system. The block diagram of a tape controller is repeated in Figure 1. The emphasis here has been on the purpose of each section in the block.

Here is the conclusion of that conversation with Ron Weinstein: The status circuit in the tape controller tells the computer when the tape system is ready to send data. If there is no tape installed, or, if the tape storage device is not ready for any reason, error signals are delivered by the status circuit and held in the status register. The circuit then informs the computer that there is something wrong.

As with the control circuit, knowledge of the status signals is helpful for troubleshooting. Here is a list of typical status signals:

- end of tape
- beginning of tape
- parity error
- data is ready
- drive motor is ready and door is closed
- buffer is full
- buffer is empty

During playback the serial data from the tape is delivered to the decode circuit. Its job is to interpret the markings that were put on the tape by the encoder. Serial data is converted to parallel data in the serial-to-parallel converter. The parallel output data is delivered to the computer.

The tape controller of Figure 1 is used for 8-bit, 16-bit, or higher-order computer systems. It is only one of many tape controllers on the market today.

An important letter

I received a letter from a reader who felt that it was inconsistent that in the July 1991 issue of **ES&T** I said: I have always maintained that the equation:

$$[db = 20 \log (V_2/V_1)]$$

is completely useless. Later in that article I said: Well, that equation is OK for amplifiers in transmission lines where the input and output impedances are the same. Of course, that is an isolated case.

The reader takes the position that the equation is either useful or useless, but it can't be both.

I assumed it would be clear that saying an equation is OK is NOT the same as saying it is necessary. Since there is never an occasion where that equation must be used I consider it to be worthless! I made it clear that the equation - as written above can give very wrong results! That was the main point of the article.

In the isolated case - where the input and output impedances are the same - the equation is OK, but, it is not necessary to use the equation to get the correct dB gain! In my way of thinking, if the equation is not necessary and never required it is useless. The correct and useful equation for all applications is the one given earlier in the article:

$$db = 20 \log (V_2/V_1) + 10 \log (R_{in}/R_{out})$$

Learning equations that only apply to certain special cases is a waste of valuable time and effort! There is plenty of material you have to know without spending time on useless equations.

Later in his letter the reader takes issue with me on the term electromotive force. He says all of his dictionaries define voltage as electromotive force. To me that is very unfortunate but it doesn't alter the fact that voltage is not any kind of force! The IEEE dictionary notes that the term electromotive force is deprecated. Physics textbooks and handbooks in these days do not use EMF to mean voltage. Up-to-date books on electronics technology do not use EMF to mean voltage.

Look in the catalogs of large companies. They no longer use EMF to mean voltage.

Simplified definition: Voltage is a difference of potential. One volt is the difference in potential needed to produce one ampere of current through a resistance of one ohm.

When the expression EMF became deprecated the use of the abbreviation 'E' (for voltage) also went out of style. Why should technician literature be years behind the latest trends in technology?

You tell me. ■

Computers continue to evolve toward consumer product status

By Conrad Persson

Have you taken a look at computers and computer accessories lately? There's no question that they're becoming closer and closer to being true consumer electronics products. And that means that more and more, consumers are going to be looking to bring their personal computers to the local radio/TV/electronics service center.

Sound systems

One of the enhancements helping to bring computers such as IBM and clones into the realm of consumer products is the sound systems that are now being offered for personal computers.

Most personal computers as they come from the store have almost no sound system at all. They usually have a tiny transducer that's capable of making a beeping sound to communicate to the user that the computer is doing certain things. It's also there to sound to alert the operator that he has done something wrong; for example if he enters a command that the computer doesn't recognize.

Software companies have been manufacturing software that is capable of producing sound that's much better than the quality of sound that those rudimentary speakers are capable of reproducing.

Now several companies are offering sound systems that can produce far more realistic sounds from the computer. They consist of a pair of speakers, small by stereo hi fi standards, but much larger than the sound device that comes with the computer, and all the interconnecting cables and other accessories needed to hook the speakers up to the computer.

With one of these sound systems, games, educational programs that reproduce speech and/or music, and other software for which sound is an important factor, become much more enjoyable to operate.

Persson is editor of ES&T.

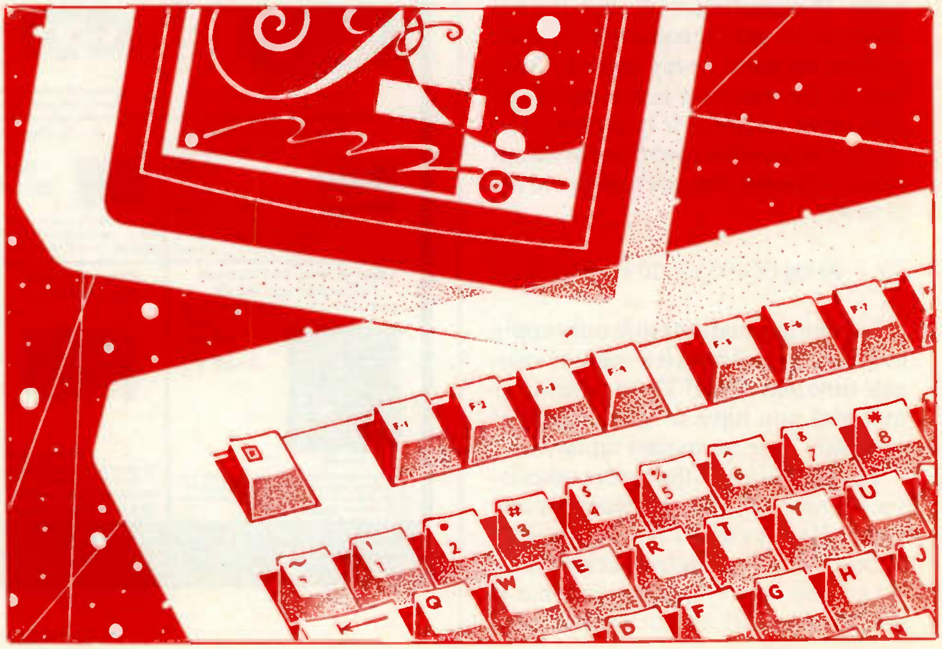
A TV board

Or how about this for TV fans. a company called 50/50 Micro Electronics in Sunnyvale, CA now offers a product that can turn a personal computer into a full-screen television. The product, called PC Tele-Vision, is an add on board that according to the company literature "is an add-on board for IBM and compatible computers that enables PC owners to turn their computers into full screen, enhanced television monitors." This product does require that the computer that it will be used with has a VGA or super VGA board.

The product is available for 80286, 80386 and 80486 computers that use MS DOS 3.1 or higher. The controls for the TV are operated from the computer's keyboard. These controls can be operated either through DOS, Windows 3.0 or higher, or via a terminate and stay resident (TSR) program that allows the operator to access the controls (they're displayed on the screen) by pushing one of the keyboard keys.

The circuit board takes up one of the computer's 8-bit bus slots. The system can be used with any of several types of monitors: color VGA, super VGA and multifrequency monitors.

The board offers a number of inputs and outputs. Inputs include RF video inputs including F connector, for VHF, UHF and cable TV; Laser-



disc, or network supporting RF modulated NTSC video signal.

In order to provide the kind of sound quality that a TV viewer expects, the board provides a mini phone jack output for connection to a speaker or headphones. The product even includes an external speaker.

Special features of the PC TV unit

The board incorporates a 119 channel tuner that can tune VHF, UHF and cable TV frequencies. According to the manufacturer, the product, which operates in non-interlaced mode for flicker-free viewing, provides a sharper image than standard TV sets.

As mentioned earlier, the TV controls are software operated via the computer keyboard. Initial Configuration, video source and channel selection, mute, volume control and display settings are all controlled from the keyboard.

CD-ROM

Another consumer-oriented product that is essentially an enhancement of the personal computer is CD-ROM. The CD-ROM (compact disk-read only memory) is a system that allows the computer to retrieve and operate with huge amounts of data. CD-ROM is a close relative of the CD-I system that is described in another article in this issue.

The CD-ROM system consists of a CD-ROM drive, not unlike a standard CD player, an interface circuit board that plugs into the computer, the software that makes the drive and the computer work together, and the interconnect cable.

Software for CD-ROM includes a huge variety of informative products, such as encyclopedias, atlases, libraries of books such as "War and Peace," "A Tale of Two Cities," "The Odyssey," and others.

Consumer service for consumer products

Products such as these are destined to be manufactured and purchased in larger quantities. As more consumers own them and they begin to malfunction, the owners will be looking for someone to service them. Successful service centers will want to keep an eye on this potential opportunity.

High voltage power system problems in projection sets

By Robert M. Russell, CET/CSM

When you encounter a dead projection set, a likely cause is a problem in the switched mode power supplies. In this article, the Curtis Mathes model FP4600, 46 inch projection television set serves as an example of troubleshooting procedures on one of these supplies. While the procedures outlined are specific for this model, the principles can easily be transferred to switched mode power supplies in other brands of projection sets.

To make it easier to troubleshoot, the high voltage power supply can be removed to your service bench.

Initial checks with the supply in the set

Before you take the power supply out of the set, there are some checks that you can make that may aid in the diagnosis. There are several shutdown protection circuits that act on the switched mode power supply to protect the projection tubes from damage in the event of a loss of key voltages or drive signals.

Your first quick check should be a glance at the CRT filaments. In this set, the glow of the filaments tells you that filament voltage is present, and therefore that the main board switched mode power supply is working. At this time, you may notice that audio is present, but that the screen is blank.

The presence of both CRT filament voltage and audio, suggests that the only problem is that you have low or no high voltage. Another quick check using your high voltage probe on your trusty DMM reveals that you, indeed, have no high voltage.

To simplify the troubleshooting, shut the set down and remove the high voltage board from the set for bench servicing. In order to power up this board on your bench, you must follow the procedures outlined below.

CAUTION!!! Remember that high voltage will be generated once this power supply is connected according to the following instructions. There will be about 14KV present at the high voltage anode lead.

Russell is the Curtis Mathes National Service Manager.

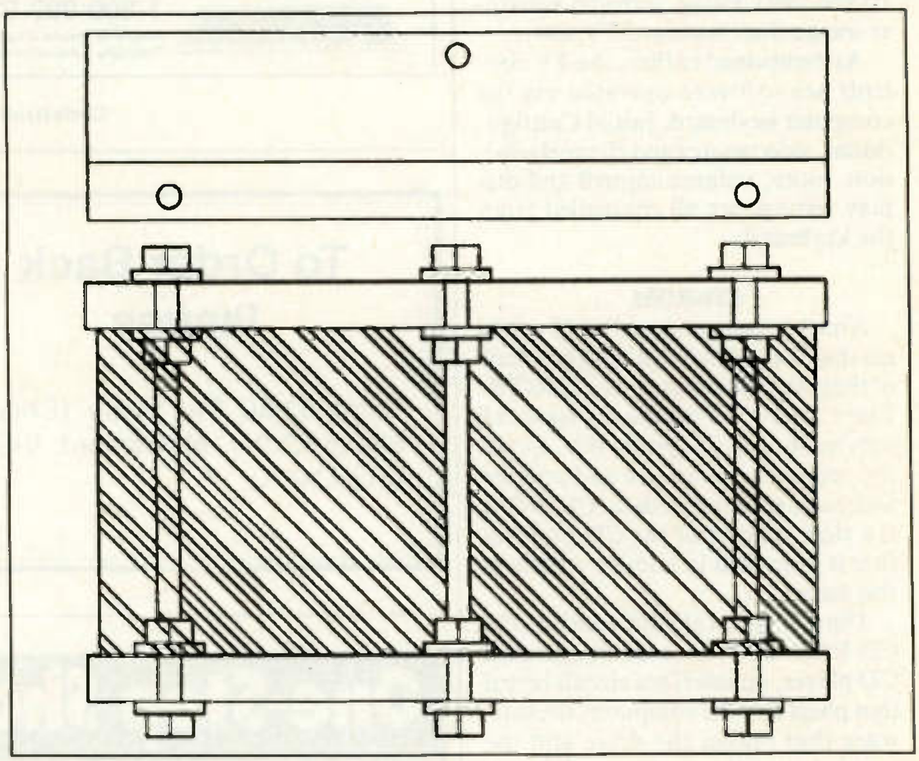


Figure 1

Hooking up the power supply out of set

Carefully remove the high voltage power supply from the set. Protect the board from excessive flexing while servicing on the work bench. You can make a simple jig from a couple of 1 by 4's with a saw slot to hold the printed circuit board. The cost including necessary threaded rods is less than two dollars. See Figure 1. Dress all test equipment leads toward the rear of the service bench to reduce the possibility of inadvertent disconnection while performing tests.

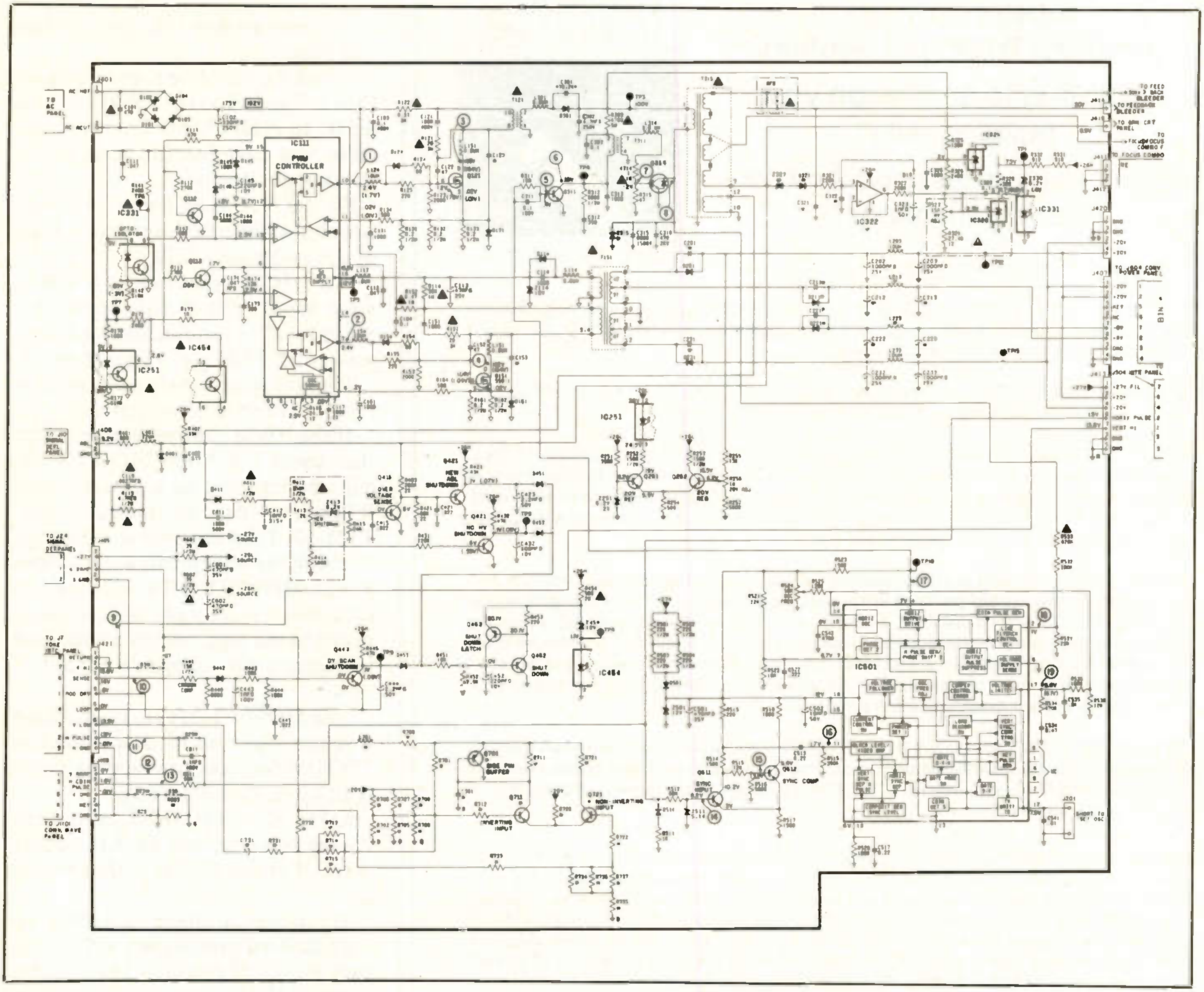


Figure 2

Equipment Requirements

A 27Vdc power supply (can be 24Vdc to 28Vdc), capable of supplying at least 0.5A.

- A 14Vdc power supply.
- A variable isolation transformer
- A DMM
- An oscilloscope, dual trace, at least 35MHz bandwidth.
- Various lengths of miniature clip leads for connections.

Procedure

Refer to the schematic of Figure 2 in applying this procedure. Connect the +14Vdc at the junction of R114 and C113 (TP5). Use a hot ground for the return of this power source. The heat sinks in the middle of the power supply are connected to the hot ground and make a convenient connection point. When you power the unit on the bench, check the Pulse Width Modulation Controller (PWM), IC111, Pin 16, for at least 14V.

In order to allow the turn-on of this supply, You must disable the shutdown latch. This can be accomplished by shorting the base-to-emitter of Q452.

Connect the 27vdc supply to J405-3. Use cold ground as the reference. The heat sink at the end of the board is connected to cold ground, and also provides a convenient connection point for a clip lead. This provides power to the opto-isolators and the shutdown circuits thus allowing the power supply to operate for testing.

Check pin 15 of the PWM controller IC with an oscilloscope. If you observe a steady 5Vdc at this point, the IC and the unit are probably okay. If the 5V is pulsing, rather than a steady dc level, there is a short circuit in the output of the standby or run supply, or the input voltage to pin 16 of the controller IC is too low to activate the internal Low Voltage Lockout Circuit of the IC.

This circuit is not referred to in the block diagram of the IC functions, however it has been the cause of many technicians changing the IC unnecessarily, only to find that the problem still exists.

Check for the correct waveforms at Pins 2, 7 and 10 on the PWM controller IC to determine if it is working. After you complete this step, verify the output circuits.

- Pin 2 IC111 should have a triangle waveform with a peak-to-peak voltage of approximately 2.5V
- Pin 7, IC111 should have a square wave about 15Vp-p. (See Figure 3).
- Pin 10, IC111 should have a square wave with 14.5Vp-p. (See Figure 4).

If any of these waveforms is not correct, IC111 may be defective.

If the PWM controller is working, then check the Power MOSFET circuits by hooking up a jumper from R114 (14Vdc) to transformer, T121-10. Then use your oscilloscope to check the waveforms at the drains of the MOSFET's. In addition, be sure to connect your high voltage probe to the high voltage anode lead to measure the voltage developed, if any.

The MOSFET, Q121, should have a square wave on its drain which is 55KHz in frequency and approximately 61Vp-p. (See Figure 5).

Q451, also a MOSFET, will, if operating properly, have a 55KHz square wave of about 125Vp-p. (See Figure 6).

If you compare these waveforms using a dual trace scope, you will see that they are out of phase by 180°. An inverter in IC111 evens out the load on the bridge rectifiers by ensuring that the pulses are out of phase.

CAUTION!!! Remember that high voltage will be generated if all is working at this point. There will be about 14KV present at the high voltage anode lead.

Low voltage ac checkout

Another way to check the switched mode power supply is to connect an ac supply voltage of 10V to 15V (capable of supplying about 0.5A to 0.6A) at the input of the bridge rectifiers to allow a low voltage checkout of the waveforms and voltages. This can be helpful if an isolated variable transformer is available for use.

While using a low ac voltage checkout will give you a lower than normal high-voltage output, the output high-

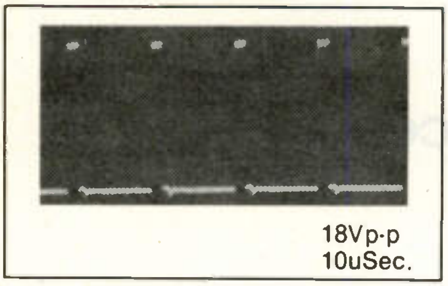


Figure 3

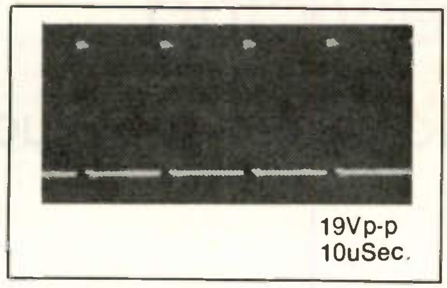


Figure 4

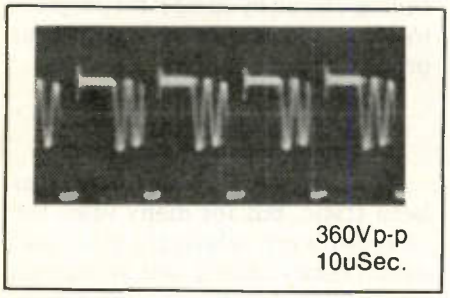


Figure 5

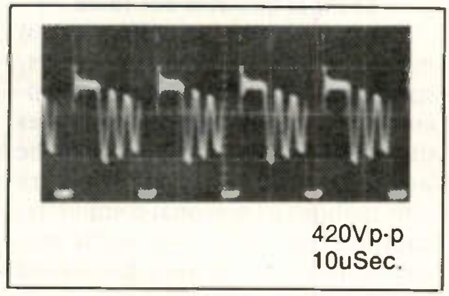


Figure 6

voltage will still be dangerously high, so exercise the same caution that you would if you were operating the high-voltage supply in any other manner.

I strongly recommend the first method described here, using the dc voltage of 14V clipped to the input of the transformer, T315, since the power supply will operate and produce high voltage with any dc voltage applied to the transformer.

After you check the operation of the MOSFETs with the 14Vdc or reduced ac input voltage, check the high voltage circuit with your oscilloscope for shorts, a defective high voltage bleeder resistor network and a proper waveform at the base of the horizontal driver and output transistors.

Also, if (and only if) your oscilloscope input is designed to read high voltage pulses safely (up to 2000Vp-p) check the collector of the output transistor. The output waveform will be reduced and distorted severely if the bleeder network has reduced in value.

Commonly, this should be reading in the 250MΩ range. If defective, you will find an ohmmeter reading of about 10KΩ quickly confirms the problem.

You will find that test points may be labeled differently on similar chassis. The functions of the PWM controller and associated circuitry are similar in all chassis; therefore, simply find the same functional circuits and apply these procedures.

Some final words of caution and suggestion

CAUTION!!! WHEN YOU INSTALL THE BOARD IN THE SET BE SURE TO REMOVE THE SHORT FROM BASE-TO-EMITTER OF THE SHUTDOWN TRANSISTOR (Q452). ALSO, REMEMBER THAT THE SET COULD STILL HAVE SHUTDOWN PROBLEMS CAUSED BY OTHER FAULTS. YOU WILL HAVE TO INVESTIGATE THEM SEPARATELY.

One final word. The use of an isolation transformer when servicing these projection sets is an absolute necessity! The following components on the high voltage SMPS module will almost certainly be destroyed if you attempt this service without one.

D101
R122
Q121
IC111
Ground foils on ac interconnect and HV power supply. ■

Successful servicing

Combination of factors leads to success

By the ES&T staff

In the September issue, we introduced a new department, "Successful Servicing." In this new department we plan to bring you information about successful service businesses that have made changes that have made it possible for them to survive and prosper even in a difficult economy. The first service that we featured was Frick Electronics of Independence, MO which we reported on in the September issue.

We've decided to feature this kind of story to bring about a sharing of ideas that have led to success for many service centers. The litany of consumer electronics service businesses that have gone out of business in the past two decades is discouraging and dismal. Service centers that were successful for years have lost whatever it was that made them successful and gone belly up.

This department, on the other hand, will focus on the many service businesses that were threatened with failure, or at least seriously reduced revenues, and that responded to the challenge and turned things around. Even while some service centers were going out of business, other businesses were being formed that took their places, or businesses that were already in business expanded to replace the vacuum left by the companies that went out of business. If one business fails, but another is formed or expands to take its place, then it's safe to conclude that it wasn't solely the adverse business climate, but some kind of problem with the business that caused it to fail.

This article will present an overview of the things that a number of successful service centers have reported to us that they have implemented and which in most cases have not only kept their heads above water, but have actually led them to be more successful in servicing than they have ever been.

There is business out there

For starters, there are millions upon millions of TVs, VCRs, camcorders, stereo systems, tape recorders and microwave ovens in millions of homes throughout the U.S. and the rest of the world. In addition, though, there are now millions of personal computers, computer monitors, facsimile machines and copiers in use in homes and home offices.

Almost all of these products will fail at some time during their useful life. Some, of course, being inexpensive, notably monochrome 13-inch TVs, low cost single play CD players, cheap two-head VCRs, will be thrown away rather than being serviced. But many of them will be brought in to a local independent service center for service.

The service centers that can boast technicians who are highly skilled, well educated, well equipped, and well paid will be able to efficiently service these products. If these same service centers employ desirable customer service techniques and run their business in a businesslike manner, they should be successful in both the short run, and in the long run. Following are some of the things that have led to success for many service centers.

Competence

The single most important factor that we have observed in successful service centers is, simply, competence. In successful service operations, the managers are good managers, the technicians are highly skilled, well trained, and motivated. In an organization that has competent people in management roles, at the customer service desk, and at the service bench, customers are treated properly, products are serviced promptly and reliably, and the administrative work gets done right and on time.

The best way to assure that a service business is run by competent people is to hire good people and train them properly.

Willingness to change

Consumer electronics has never been static, but for many years the changes were relatively slow and evolutionary. Black and White sets were replaced with color sets. Screen sizes increased gradually. Transistors gradually replaced vacuum tubes, and were gradually replaced by ICs.

More recent changes have been revolutionary rather than evolutionary, and not only have the old standby consumer products continued to undergo changes but newer products previously undreamed of have flooded the marketplace. Besides TVs, and audio, the consumer electronics marketplace now includes, or will soon encompass, computers and accessories, video games, compact disc, digital audio tape and more.

The successful consumer electronics service center of today and tomorrow will be the one that is aware of this rush of new high-tech products to the marketplace and takes steps to be ready to service them.

Customer service and customer education

Consumers have come to depend on their electronics products. They have become accustomed to being able to turn on the TV and find out what's going on across town or across the world. They have become accustomed to being able to put a tape in their VCR and watch a movie or record an important program while they're doing something else.

When those products break down, they want them restored to service quickly, and they expect them to remain in operation for a reasonable time after they're fixed.

Successful service centers are the ones that are aware that customers want quick turnaround time, they want to be informed immediately if a problem such as lack of service information or lack of the necessary replacement part is going to cause a delay.

Association

Some of the most successful service center owners are the ones who belong to associations such as NESDA, NARDA, ETA. Membership in such organizations provide members with a number of advantages. For starters, members associate with other people in the same profession. They share information on what is going on in the business. They learn about how other companies are doing things.

Most associations provide some kind of training. For example, at a monthly meeting, a local organization might invite a trainer from one of the manufacturers to come in and teach a course in servicing some new circuitry that that manufacturer has recently introduced.

Education

The world of electronics is changing so rapidly that constant education is necessary to keep up. Successful service centers are the ones that attend classes that are made available by the manufacturers. If a service center is to be successful, it's important that the technicians be able to quickly, efficiently service every product that the service center chooses to provide service for. Constantly upgrading the education of the technicians makes it possible to keep up with the changes in the technology.

Innovation

Another hallmark of successful service businesses is innovation. Rather than simply sitting back and waiting for the business to walk in the door, these businesses go out and aggressively seek business.

One example of innovation is to have the company placed on bid lists for organizations such as military installations and schools. This is one of the ways in which one very successful service center, McCann Electronics in Metarie, LA, has expanded its business.

How does a service center go about finding out about work that's being put out for bid and go after it? "It's so simple it's incredible," says Gerry McCann, owner of McCann Electronics, "you pick up the telephone and call purchasing departments and ask to be put on their bid list. We have done so, and now every day when the mail comes in we normally get between five and fifteen bid solicitations."

McCann says that in order to be successful at bidding on such jobs, it's important to try to find what he calls the "gray" areas: those jobs that are too small for the big companies to bother with, but that you can bid profitably.

In just the past year McCann has generated a substantial amount of business by bidding for it. For example, a U.S. Navy organization solicited for bids on some computer software. McCann submitted a bid and was awarded a sales contract for 70 copies of a major word processor program and 30 copies of a popular spreadsheet program, "primarily," McCann says, "because apparently no one else bothered to put in a bid on them."

In another case, a U.S. Marine Corps organization solicited for bids on 40 megabyte hard disk drives. McCann bid on this business and was awarded the contract because they included the UPS shipping to 40 separate locations in the price. "Saving the customer the trouble of packing and shipping is value added selling," McCann says.

Read management books

Some of the best managers in the U.S. have written extensively on the subject of management. Reading books by such talented managers as Kenneth Blanchard, Peter Drucker, Robert Townsend and Harvey Mackay can provide a service center manager with ideas on how to manage his business, how to promote the business, how to deal with customers and how to manage the technicians and administrative people who are working for the business.

These authors have been very successful managers, and have an insight into management matters such that they are able to analyze the management job into its individual tasks, and to describe each of those tasks in general terms such that they apply to any business. The most successful service managers are quick to let people know that reading these books has enabled them to become better managers and make their businesses more successful.

Decide who you are

Most successful service centers take the time periodically to pause and reflect on the nature of their business. They have a review annually or more frequently in which they evaluate the business as a whole and decide if they're really going where they wish to be going.

Some of the subjects that are examined in sessions like this are:

- What is the range of products that we're servicing?
- Are all of these areas profitable, or should we drop some?
- Are there lucrative areas of servicing that we're missing and should expand into?
- Do we possess the resources to do the job we want to do, or do we have to acquire more or different resources?

There are of course many more questions such as this that a business should periodically ask itself in order to be sure that it is going in the right direction. Failure to perform self evaluation such as this is probably the single biggest cause of failures among service centers.

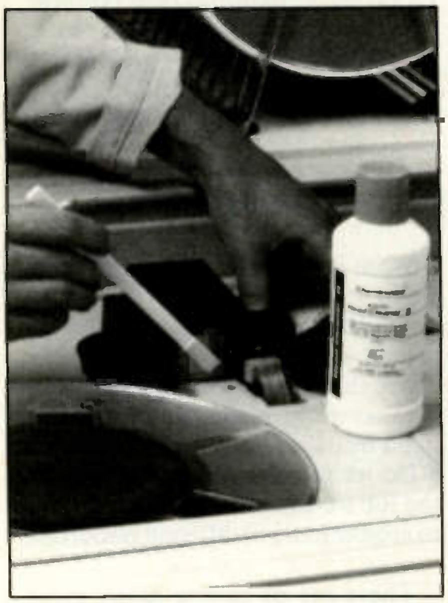
Making service more accessible

The easier it is for customers to find you and to bring their products to you for service, the more business you will do. For example, some of the most successful service centers have a technician who travels to store locations to provide on the spot service, such as VCR cleaning and adjustment. This has several advantages: it keeps the customer satisfied, and keeps the service business coming to your service center instead of someone else's. Would such an approach improve your business?

Planning and managing

Business success doesn't happen by accident. Many of the service businesses that have gone out of business in recent years were not destined to fail. The success of so many service businesses today shows that by keeping informed of what's happening in consumer electronics and employing good, sound business practices, service companies can remain healthy, and grow, even while others are going out of business.

In future installments of this department, we'll bring you more stories about the service centers that have found the formula for success. ■



Head cleaner

Chemtronics has introduced Head Cleaner II as a replacement for CFC-containing cleaners used in commercial/industrial tape systems, film/video cameras, magnetic/optical pickup assemblies and VCRs. The cleaner removes oxides, dust and other contaminants from magnetic tape/disk heads and tape transport mechanisms. This liquid evaporates quickly, has low surface tension and leaves no residue. A mild cleaning agent, the cleaner helps reduce head wear, improves performance and is safe for use on most plastics.

Circle (34) on Reply Card

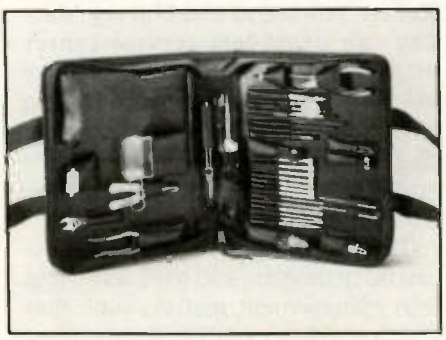
True rms multimeter

Extech introduces a 4 1/2 digit true rms multimeter combining 9 functions including frequency, capacitance and temperature. Displays up to 20,000 counts for measurements of dcV: 200mV to 1000V; acV: 20mV to 750V; dcA/Aca: 2mA to 10A; resistance: 200Ω to 20MΩ; capacitance: 200pF to 400 frequency: 20KHz to 200KHz; and temperature: -40F to 250F. Features include 0.5% basic dc accuracy, MAX-MIN recording/recall mode, 42 segment analog bargraph, ZOOM mode to increase sensitivity by a factor of ten, DATA HOLD, EDIT mode to program reference value, and RELATIVE to display differences from reference value, COMPARE for GO NO GO tests, REC mode to calculate average readings, % mode displays % difference from reference value, overload protection, diode test and auto power off.

Circle (35) on Reply Card

PC support kit

The PC tool kit from *Jensen Tools Inc.* contains a comprehensive selection of electronic tools for maintenance of PCs, workstations, networks, and other electronic office systems. Featured in the company's new 1993 Master Catalog, the JTK-61000 PC kit



contains over 40 quality tools in a rugged, blue Plus zipper case. The case has cushioned-grip, web-strap handles with D-rings for optional shoulder strap, three roomy outside pockets for additional storage, and a pocket inside for optional Fluke Model 878DMM or breakout box. The kit's tool selection is also offered in a case with ESD safe work mat permanently attached and wrist strap and grounding cords included (ask for the JTK-6000).

Circle (36) on Reply Card

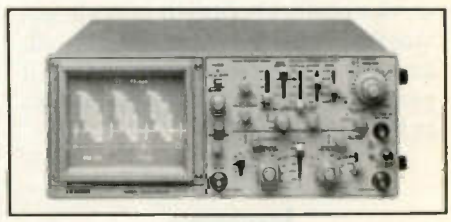
1992 IC Master alternate source directory

IC Master introduces the 1992 IC-MASD Version 4.1. It is the IBM PC-based software version of the Alternate Source Directory that appears in Volume Two of the 1992 IC Master printed catalog. ICMASD is the fast and convenient way to locate hard-to-find second sources and replacement devices. The 1992 database has been completely revised and extensively updated. Over the last twelve months the editors worked with manufacturers throughout the IC industry to re-verify every device listed for fit, form and function. Completely menu driven, the 1992 data base is fast and user friendly. There are no tricky commands to learn.

Circle (37) on Reply Card

100 MHz oscilloscope

Leader Instruments announces the availability of a new 100-MHz, 20-channel dual time base oscilloscope, Model 8101, featuring four trace operation with on-screen readout of basic settings and cursor measurements of voltage, time, fre-



quency, voltage ratio and phase. Sensitivity ranges from 1mV/div to 5V/div in twelve steps with bandlimiting to 20 Mhz in the 1 and 2 mV/div settings. X-Y operation is provided and dedicated sync separators ensure stable waveforms at video H and V rates. Variable holdoff corrects triggering on long, complex wavetrains.

Circle (80) on Reply Card

Neutralizer ion gun

The Charleswater Neutralizer, neutralizing air nozzle is a self-contained,

ready to use unit designed for use in applications and areas where contamination can create manufacturing or handling problems. It employs a high voltage ac to create an ion field. The emitter on the neutralizing air nozzle is located at the end of the nozzle. This emitter produces large amounts of positive and negative ions, which mix with the air and create a highly effective neutralizing field. Any material within this field will be neutralized rapidly. The air nozzle also eliminates contamination by dislodging dust and debris which is attracted to a material's surface by static charges.

Circle (38) on Reply Card

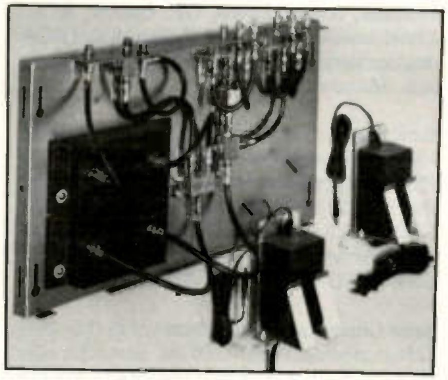
Monitor repair database

AnaTeK announces the release of ResolvePlus 1 the first update of its monitor repair database. This release adds nine monitor models by eight different manufacturers. This addition brings the database to more than 525 repairs on 54 models by 23 manufacturers. One feature that is added by this release is component sourcing information. Component sources for semiconductors and magnetic components are added to all existing repairs as well as the new ones in the update.

Circle (39) on Reply Card

Coaxial cable panel for multi-room video

The *Channel Plus* Coaxial Panel provides a central point of distribution for multi-room video installations. Complete with all necessary components to balance the signals the system requires minimal design-in time. The connections are labeled to make installation easy. The panel provides a foundation for future upgrades. The panel delivers a picture to eight locations from up to seven sources, including satellite receivers, CCTV cameras, VCRs, laser disc players, off-air antennae, and CATV. To compensate for different input signal levels and losses due to cable length and frequency, the panel combines broadband amplifiers with splitters, combiners, taps and a tilt compressor. The panel delivers strong signals without exceeding FCC limits at the TV.



Circle (40) on Reply Card

Electrically conductive coating

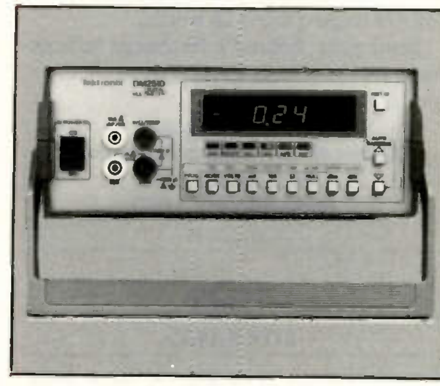
A new air-dry electrically conductive coating for electroplating, electroforming, shielding, radar cross section modeling, application onto tantalum capacitors, and circuit board repair is being introduced by *Carroll Coatings Company*. C-646 electrically conductive coating can be applied by brush or spray onto nonconductive surfaces and air-dries tack-free within 2 minutes. The coating provides effective shielding over a 100MHz to 10GHz frequency range. It adheres well to primed and un-primed metals, most plastics, various waxes, fabric and leather, and can be soldered using low-temperature solder.

Circle (41) on Reply Card

Test and measurement series

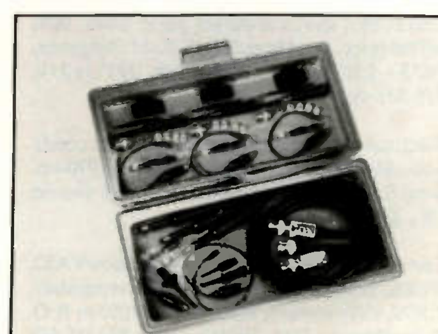
Tektronix has unveiled its new test and measurement equipment. The DM2510 and DM2510G autoranging digital multimeters (DMMs) are the first in a continuing series that provide low cost and broad functionality. Designed for benchtop use, the DM2510 and DM2510G offer a wide range of advanced features including full programability with 4 1/2 digit accuracy, an integral power supply and autoranging or manual operation.

Circle (42) on Reply Card



Oscilloscope probe

Probe Master Inc has developed a gold master kit containing 3 slim designed heavy duty probes and accessories. The 43 piece kit contains a 1X 30MHz, 10X 150MHz and a 1X/10X switchable 10/150MHz probe in a high impact protective case. The convert-a-tip concept provides two screw-in rugged replaceable tips (0.55" and .030). Gold finishes accessories provide superior contact for low-level analog signals and high speed digital data. Signal characteristics are improved by the use of gold plating throughout the probe.



Circle (43) on Reply Card

Readers' Exchange

Reader's Exchange has been reinstated as a free service.

The following restrictions apply to Reader's Exchange:

• Only individual readers may use Reader's 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 Reader's Exchange.

• Readers Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).

Send your Reader's Exchange submissions to:

Reader's Exchange
Electronic Servicing & Technology
76 N. Broadway
Hicksville, NY 11801

FOR SALE

Textronix scope 514D $95.00, scope dolly $25.00, H.P. 608 B Signal generator $95.00, HP 5233L counter $35.00, Tektronix scope 503, Heath audio/square Gen AG-7 $30.00. *Leonard Duschenchuk, 255 Stewart Ave, Bethpage, NY 11714.*

Sams Photofacts 1-1094, auto radio series 9 through 16. *Ann Bicharick, 15 1/2 W. Lake Street, Chisholm, MN 55719. 218-254-4421.*

1 Sencore VA62 -NT64 -ST66, excellent condition - all for $1500.00. *Dwight's Electronics, 719-539-7571.*

Sencore VA-62 video analyzer w/ VC63 & NT64 generators. Sencore SC-61 oscilloscope. Sencore Z-Meter cap tester. Sencore PR-57 powerite isolation transformer. Bell and Howell MM2000 engineers microfiche dual trays, all in excellent condition and includes instructions and test leads. $4200.00 for all, may separate. *Call Dave, 708-452-7314.*

Text books, service manuals, parts, tubes - 90% off list price. Send large S.A.S.E. *M. Seligsohn, 1455 - 55th Street, Brooklyn, NY 11219. 718-851-6487.*

Electronics test equipment in excellent condition. Also servicing magazines from 1970-up. Send SASE to *Albert Nemchek, 2868 Groves Dr., Sterling Hts. MI, 48310.*

Sencore equipment, all in exc. condition VA62, VC63, SC61, $2995.00 or will sell separately, CR70, CRT restorer $595. LC77 $1095 or B.O. Telequipment D32, 20MHz scope $95.00, HP 5381A 80MHz counter $125.00. Also have several multimeters cheap. Must sell, closing shop. *Marc Derkrikorian, 603-434-0041.*

Sencore VA 62, leads and operation manual. $1500.00. O.B.O. *Jerry Huff, 5228 Gus Thomasson Rd., Mesquite, TX 75150. 212-279-7574.*

Modules, new and used, GE, Quasar, RCA, Zenith send S.A.S.E. for list. Zenith and RCA outdoor signs. *Max E. Bingman, 177 So. Roosevelt, Moscow, ID 83843.*

B&K transistor tester 520B $140.00, B&K 100MHz frequency counter. 1803 $120.00, RCA FM signal generator WR-52A $120.00. Elenco Precision 20 MHz dual trace oscilloscope 1251 $200.00. All above in excellent condition. All UPS. *Harvey Montgomery, 1602 Antelope Rd., Elberton, GA 30635. 706-283-3055.*

Sams Citizen band photofacts vol #1 thru 293. #266 is missing. Weight 200 lbs. Best offer plus shipping. Sams Auto Radio Photofacts. Vol #19 thru Vol. 86 plus vol #110, 125, 133, 187. Vol #24, 26, 31, 32 are missing. Weight 60 lbs. Best offer plus shipping. Sams TSM Photofacts, 18 vol. between #1 and #121 inclusive. Weight 17 lbs. Best offer plus shipping. *Wallace W. Huffman, Quality Electronics, 2579 E CR 550 N Warsaw, IN 46580.*

Sams photofacts folders 1801 thru 2300. $4.00 each approximately 415 sets. *Sal Cribari, 1312 Well Dr. Camp Hill, PA 17011. 717-763-4547.*

Nine Texfax books 101-114. Texfax schematics 600-606, 628-633, 670-675, 962-987, 1514-1923, $30.00 18 lbs shipping or trade for early catalogs or Radio, Amateur's Handbooks. *Robert Morrison, 231 Perkin St., Havelock, NC 28532. 919-444-1660.*

Manuals, schematics and cables. VC93, VA62A, PR57, NT64, LC102, SC61, LMV-182A, TSH-V5, TQ-600. Will send as a package $7500.00 or separately. *Mark, 510-706-2927.*

Sams Photofacts set #1000 to 1700. $1.00 each of all $560.00 Wyse monitor, Model WY-50 and keyboard $70.00 plus shipping. *Lien Nguyen, 2373 Pruneridge Ave., #3* Santa Clara, CA 95050.

Diehl Mark III scanner $100.00 (includes shipping) with manual. GE HVXFMRS, EP77X44, $40.00. EP77X55 $60.00. *Elmer Wieland 237, Talbot Dr. Bedford, OH 44146 216-232-8653.*

VCR components for Panasonic MDL PV1700. RF Modulator #ENPD611 $7.00, Mitsubishi capstan motor 8.5 VDC Model MYN13VILK $7, Battery VFA5000-1 $3.00 or all for $12.CM "Chuck" Kelly, 3336 Waukegan, IL, 60087. 708-623-2597.

VA62A with VC63 and NT64 $2700.00, Tentel tape tension Gauge, $275.00, like new. *Call Tom 803-647-1002.*

TV Modules and parts, now 8 page list. Electroylic and misc. capacitors for Radio, TV motors, etc., 10 pages. Sned SASE for each set and specify group. *Chuck Vaccaro, 708 Booth Ln., #E,* Amber, PA 19002-5014. 215-646-3641.

1500 tubes in boxes. Sell all or part. Send S.A.S.E. for list. *John Reynolds, 1942 Sandalwood Lane, Fort Collins, CO 80526. 303-484-2715.*

B&K CRT tester and restorer excellent condition 6 months old with manuals and adaptor sockets $440.00. *Call Gus at 416-354-5465.*

Emerson model VCR 754 parts. Clock, timer, PC board, audio and erase heads, complete drum assembly. Reel and loading motors. *Nathan Jackson, Rt. 1, Box 483 Gayesville, AL 35973.*

Like new. Sencore VC93 asking $1600.00 plus shipping if interested please call *Tom Engle, 708-837-1028.*

Heath kit component tracer, model –IT-2232 with manual and probes. Excellent working condition $250.00 plus shipping. Sams photofacts sets -864-thru 1092. $1.50 each or all 56 sets for $60.00 plus shipping.

Sencore SC61 and probes HP200, PL207, TP212, DP213 - $1750.00, VA62, VC63, NT64, EX231, $1800.00. SGI65 - $550.00 All two years old, like new, seldom used, w/original boxes, cables, and manuals. *Dave Huddlestone, Rt. 4 Box 99, Maple Ridge Rd. Richalnd Center, WI 53581.*

Philips 3264 O'scope with two probes 100MHz, four channel main and delayed time base with manual $700.00. *Pete Hyde, 510-525-8653.*

Electronic servicing, electronic technician, PF reporter, Hi-Fi and other magazines. Send for list. *Ray Schmidt, 507-433-0069.*

Several Hundred SAMS Photofacts from the 100's to 2000's. Selling entire lot only. For a complete list send SSAE to *Scott Cohen, 4640 N. Brittain PL., Tucson, AZ 85705. 6002-888-1316.*

Sams most between 22-1400. Antique radio techs Vol 6-16 of John F. Rider Troubleshooters manual. Best offer plus shipping. *David Lynch 925 Market, Mt. Carmel, IL 62863. 618-262-8259.*

WANTED

Power transformer for Precision ES-550 oscilloscope and 50 micro Amp meter for Precision series 856 multimeter or equivalent. *Harry Strober 48 Market St., Ellenville, NY 12428. 914-647-5860.*

Sams AR service manuals from 110 and up. *Don Harris 3332 North 57th Avenue, Phoenix, AZ 85031. 602-247-7020.*

Sams for servicing transistor radios. Complete set wanted but will buy individual volumes. Also individual Sams transistor schematics. *Eric's TV, 87 Sandra Dr., Parsippany, NJ 07054. 201-316-8461.*

Magnavox Pwr. Supply Model #703661-1, Fisher VCR RF Modulator 4-1164-011610, Panasonic flyback #14712F. *Ed Herbert, 410 N. Third Street, Minersville, PA 17954.*

Schematic for old Voice of Music stereo receiver model 1498-1 deluxe 200. Will pay! *Joe Sloop Rt-Z, Box 168, Ararat, VA 24053. 703-251-5753.*

Schematic or service information on Pioneer Ampl. Model SX 780. Will pay for copy. *G. Lopez, 1280 S. W. 131 Pl., Miami, FL 33184.*

Tripler for a KV-1201 Sony T.V. part # 8-983-835-95. *Ken Williams, 511 Spring Street, Peoria, IL 61603.*

Macintosh computer discontinued models 128, 512K plus schematics and troubleshooting, Apple manuals, and books. Also source for Sony 400/800K drive parts. *J. Wegner Jr. P.O. Box 262, Glendale, CA 91209.*

VHF tuner for GE PC-A chassis, GE part #EP86X88. *Ray's TV, 4821 East View Dr., New Orleans, LA, 70216. (504) 246-6205.*

Tentel gauges needed for VCR repair. *Jeffrey C. 203-529-1262, days 203-657-9855.*

Service manuals or copies for general electric VCR model #1VCR2002X and Hitachi VCR model VT-3005A. *James Powell, 4237C FCN. McGuire AFB, NJ08641. 609-723-1103.*

ICL7103ACPI, SC-58863P, CXP50116, and HD6140425. *Augustines TV, 3129 Earl Street, Lauredale, PA 19605. (215) 929-8850.*

Schematic for Harvard Model #LU1320. *Robert Nelson, 2067, McCulloch Blvd. Lake Havasu, AZ 86403.*

Schematic or TM manual for a military handheld radio set RT-1113/PRC-68. *Boris Stegmar, 1829 Geroege Ave, Annopolis, MD 21401. 410-263-4540.*

Front-end tuner module for Alpine model 7347 car receiver. Their part number is TR5AP210 and claim NLA. Will pay for new or salvaged module. *Chris Scarborough, 614-899-9049, leave message.*

Will pay $10.00 for a copy of a FISHER model 400 receiver portion of SAMS MHF 24, or for renting MHF 24. Please contact Scott Cohen, 4640 N. Brittain PL., Tucson, AZ 85705.

Magnavox flyback part #361846-3 or 483514887048 or deflection board in working condition. APW002-D004 or 483512957222. *Keith's TV service 7233 Centerville Rd., Manassas, VA 22111. 703-368-1300.*

Schematic diagram for a Philco B'W model # B442HY2 - chassis #5BL2614 manufactured April 1977 with low vert sweep. *J. Harris P.O. Box 1624, Roanoke Rapids, NC 27870. 919-535-1272.*

Idler assembly (with or without tire) for Lloyd model L838, VCR. Made in 1985. *Nathan Jackson, RT 1, Box 483, Gayesville, AL 35973.*

Schematic for afterburner and bi-linear amp model 482, Vertex Model 3000, TI 865 printer. Will pay for copy. *Don Smith, 24507, Spring Creek Rd, Washington, IL 61571.*

Pwr Trns for Eico 950B Cap/Res Comparator P/N 30005, Pwr Trns for EMC 801 Cap/Res Comparator P/N 801, B&K Telephone product tester. *Larry Sobelman, LMS Electronics, 11241 Northwest 7th Street, Coral Springs, FL 33071.*

Schematic and parts list or service manual for a Dumont 25" television Model DLC2560KR, Chassis, H12-1. *Carl C. Rockhill, 58 Birchwood Drive, Rhinebeck, NY 12572. 914-876-4239.*

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COMPUTER AIDED TV/VCR REPAIR SOLUTIONS: 5 1/4" IBM Compatible disks. 1,000 VCR, Printout $83, Disks $72. 5,400 TV, Printout $135, Disks $113 (Hardrive). Add to or quick scan by chassis, model and stage. Two solutions pays for it. Electronic Solutions, 407 W. Ave. "N" San Angelo, TX 76903. 10-92-3t

PHOTOFACTS: Folders and specialized books; AR, CB, CM, HTP, MHF, SD, TR, TSM, VCR. A.G. Tannenbaum, P.O. Box 110, E. Rockaway, NY 11518. 516-887-0057. 10-92-1t

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FLOPPY DRIVE REPAIR: 5.25" 360K & 1.2 Meg $25.00; 3.5" 720K & 1.44 Meg $30.00; IBM PS/2 3.5" 720K & 1.44 Meg $35.00; Macintosh 3.5" 400K, 800K & 1.44 Meg $40.00. Prices include parts, cleaning, alignment and final testing (head replacement additional charge) 6 month warranty on all units. UPTIME COMPUTER SUPPORT SERVICES, (805) 254-3384 10-92-1t

VHS-VCR Repair Solution Sets I, II, III, IV, V, VI, VII. Each contains 150 symptoms and cures, updated cross reference chart, free assistance, $11.95 each, all seven $69.95. Schematics available. Visa/MC. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530. 6-92-7t

ATTN. VCR SERVICERS: 1600 VCR symptoms/cures by make and model printout $45. IBM disk $85. VCR Tune-Up Center, 2610 Bay Road, Redwood City, CA 94063. VISA, Mastercard on phone orders. 1-800-777-7883. 9-92-4t

TV-VCR SHOPS: Now fix those tough dogs a package of over 2,800 fixes on disk ASCII or data for popular data bases (PFS, QA, etc.) One fix could pay for all. Only $99.95. Call (314) 336-2100 ask for Ron. 10-92-2t

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Manufacturers Parts and Literature Directory

This monthly section is sponsored by manufacturers to help you find the parts and technical literature needed to service their equipment. Call them for replacement parts or for the name of their nearest distributor.

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Panasonic 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672	**Philips ECG** 1025 Westminister Drive Williamsport, PA 17701 800-526-9354 fax 800-346-6621	**Quasar** 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672
Technics 50 Meadowlands Parkway Secaucus, NJ 07094 800-545-2672	**Thomson Consumer Electronics** 2000 Clements Bridge Road Deptford, NJ 08096 800-257-7946 fax 800-524-1498	**Zenith Electronics Corp.** 1900 N. Austin Avenue Chicago, IL 60634 312-745-2000

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