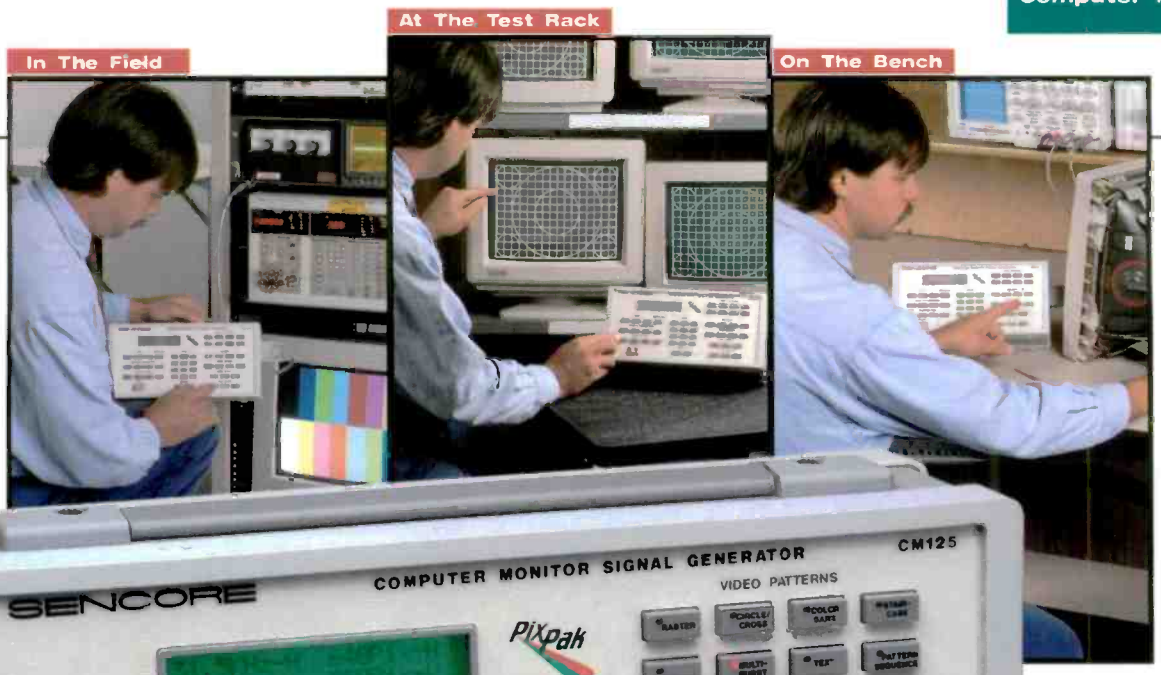
THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC™ Servicing & Technology

October 1994/$3.00

VCR servo problems—Part II

Ten TV color problems



New–

It's Portable & Affordable!

CM125 "Pix Pak"™ Computer Monitor Signal Generator

The new CM125 "Pix Pak" Computer Monitor Signal Generator provides you with full computer monitor testing capabilities on the bench, in the field or wherever you service and test computer monitors. The new "Pix Pak" provides you with a fully programmable RGE scan frequency and pixel generator (video bandwidth to 125 MHz and 2048 x 2048 pixel resolution) plus, a complete set of troubleshooting and performance testing video patterns to help you identify all types of monitor defects.

PixPak

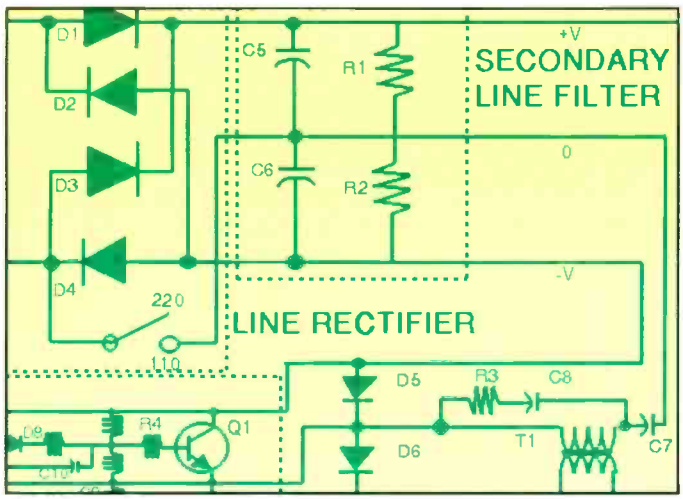
To find out more on how the new CM125 "Pix Pak" Computer Monitor Signal Generator will enhance your servicing operation, simply call 1-800-SENCORE (736-2673) today.

SENCORE
3200 Sencore Drive, Sioux Falls, SD 57107
Direct (605) 339-0100 Fax (605) 339-0317

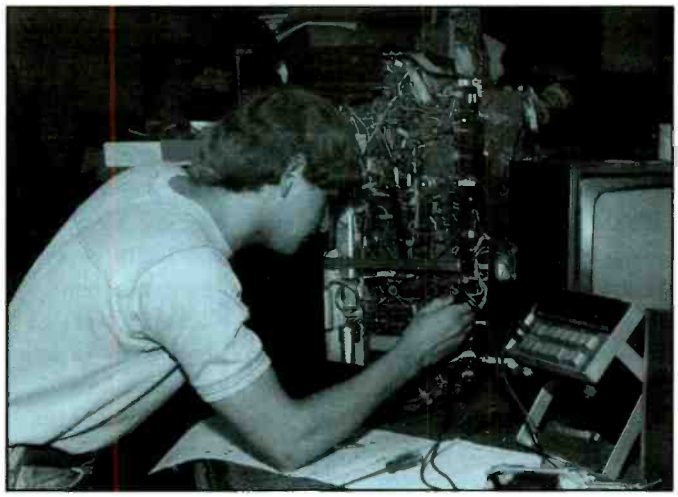
Circle (119) on Reply Card

Contents

Volume 14, No. 10 October 1994



page 13



page 41

FEATURES

DEPARTMENTS

ON THE COVER

The cathode ray tube is still superior in reliability, cost and performance to anything else in use or proposed for use for video display. CRTs would be in use for years to come even if a better substitute were introduced tomorrow. That means that for years to come, consumer electronics servicing technicians will still be required to evaluate whether a fault in a TV set is caused by a faulty CRT, or if it can be traced to problems in the surrounding circuitry. (Photo courtesy of Video Display Corporation)

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

Coping

Any consumer electronics service center that has survived the changes in the industry over the last several years and is still thriving has shown that it knows how to cope. Cope with what? With all kinds of things:

- products that are so cheap that it seems to make more sense to replace them than to fix them,
- products that have become so complex and sophisticated that it takes ten pages of schematic diagrams and explanation where one page used to suffice,
- components that have become so small that it takes magnification just to see them, and with so many leads that soldering and desoldering one becomes a major project.

Any service technician or service manager reading this could no doubt add several more problems that service centers have to cope with these days.

The really interesting thing about this entire situation is that many service centers have not simply coped with these problems and managed to get by; many of them have thrived on what seems to be bad times and are profitable.

So, what is it about some service centers that allows them to buck the trend and succeed where others are either failing or just getting by? Well, it's not magic, and they haven't sold their souls to the devil: they've just learned how to run a successful business.

Many service centers have insured their success by branching out. When it became evident that TV sets were becoming ultra-reliable and increasingly difficult to service, many service managers saw the handwriting on the wall and began to service new products, such as VCRs and personal computers.

Other service centers have become or remained successful by concentrating on service. These companies, which once both sold and serviced consumer electronics products, have found it increasingly difficult to compete for sales against the major retailers and discounters. Many have found that the discounter down the street is able to sell products for less than their cost. How can they compete? Many of these companies have discontinued selling TVs, VCRs, etc., and have successfully concentrated their efforts on servicing them.

Some service centers, facing the increasing variety of products and models have hired additional technicians so that they could have people trained to specialize either in certain brands or certain types of products.

Some service centers have added sales of TV, audio and video accessories, while still others even have gotten into distribution, and sell replacement components to their fellow service centers.

There is no single recipe for success, but there are many success stories out there. We at **ES&T** think that many of our readers would benefit by a sharing of this kind of information.

Beginning with the November issue, **ES&T** will publish success stories featuring service centers that have made changes that have allowed them to become or remain successful in spite of the adversities facing the service business.

We think that any service center that has managed to be successful in today's business climate deserves recognition, and we'd like to tell our readers, other service centers, about them.

If you'd like to nominate your own service center, or a service center that you think is worthy, for this recognition, please send us the name, address and telephone number of the organization and the manager, and a little bit about that organization. If you're nominating your own company, please send us a complete description of what you're doing to remain successful in these times, along with black and white photographs.

Schematics special issue to offer prizes

In the September issue, we told you that this year's schematics issue will be different from those we have published in the past. This one comes with an entry into a prize drawing. We wanted to let you know well ahead of time that there will be a special opportunity in the schematics special issue this year: The first-ever prize drawing in **ES&T** history. Readers will have an opportunity to win a DMM, a gift certificate for $250 worth of replacement parts, or some other prize that any consumer electronics technician would be happy to win.

There will, of course, be specific instructions in the issue, but in essence, all you will have to do will be to pull out one of the special entry cards in the issue, fill out the requested information, including which prize you'd like to receive, and mail it in. Pass the second card along to a good friend or associate. Don't fill out the second card for yourself: all duplicate entries will be discarded.

And please keep in mind that you must provide all of the information that's requested of you on the card. All questions must be filled out, or the entry will not be valid.

We now have a little more information about the drawing. Several more companies have said that they wish to offer prizes. Here's the list so far.

The grand prize will be a service management software package from Sencore.

Other prizes will include:

- SmartMan service literature software from Philips Technical Training Division
- A Tentelometer from Tentel
- A Fluke DMM
- A computer monitor service tips software package from AnaTek
- $250 worth of components from Premium Parts +.

And lots more!

The schematics special issue will be arriving in a few weeks. Don't forget to send in your entry card.

And good luck!

Nils Conrad Person

Electronic products servicing competition winners

The winners of the thirtieth annual VICA United States Skill Olympics in Electronic Products Servicing were announced Friday evening, July 1, at the Awards Session of the VICA National Leadership Conference. The Conference was held June 28—July 1, 1994, at the American Royal Complex and the H. Roe Bartle Hall in Kansas City, MO. More than 3,600 outstanding vocational students joined in the hands-on competition in fifty-four different trade, technical, and leadership fields.

Working against the clock and each other, the participants proved their expertise in job skills for occupations such as electronics, technical drafting, precision machining, medical assisting and culinary arts. There were also competitions in leadership skills, such as extemporaneous speaking and conducting meetings by parliamentary procedures.

The Vocational Industrial Clubs of America (VICA) is the national organization for students in trade, industrial, technical and health occupations education. It sponsors the VICA United States Skill Olympics annually to recognize the achievements of vocational students and to encourage them to strive for excellence and pride in their chosen occupations.

Place	Division	Student	Hometown	State
First	Secondary	Thomas Harris	Sykesville	MD
Second	Secondary	Philip Carmichael	Tyler	TX
Third	Secondary	Edward Neipris	Plainville	MA
First	Post-secondary	Jonathan Jensen	Bountiful	UT
Second	Post-secondary	Carlos Lovera	Whittier	CA
Third	Post-secondary	Timothy Rau	Pocatello	ID

Section I of the contest consisted of six individual test stations that provided a

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC
Servicing & Technology

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

EDITORIAL
Nils Conrad Persson, *Editor*
Linda Romanello, *Associate Editor*

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

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

BUSINESS
Richard A. Ross, *Publisher*
John Dorr, *General Manager*
Frank V. Fuzia, *Controller*
Simon Schatzmann, *Circulation Director*
Catherine Ross, *Circulation Manager*
Melissa Nitschke, *Operations Manager*
Carol Licata, *Data Processing*
Denise Pyne, *Customer Service*

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

Diane G. Klusner, *Director of Advertising*
Emily Kreutz, *Sales Assistant*

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

NESDA
Member, Electronic Servicing Dealers Association

ETA

Audit Bureau of Circulations Member

Electronic Servicing & Technology (ISSN 0278-9922) is published 13 times a year by CQ Communications, Inc. 76 N. Broadway, Hicksville, NY 11801. Telephone (516) 681-2922. Second class postage paid at Hicksville, NY and additional offices. Subscription prices (payable In US dollars only): Domestic—one year $24.75, two years $45. Foreign countries—one year $30.75, two years $57. Entire contents copyright 1994 by CQ Communications, Inc. Electronic Servicing & Technology or CQ Communications, Inc. assumes no responsibility for unsolicited manuscripts. Allow six weeks for delivery of first issue and for change of address. Printed in the United States of America.

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

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

variety of challenges in servicing "state-of-the-art" consumer electronics products: personal computer, color television/monitor, VCR, audio, electronic test equipment, and digital technology. Section II activities evaluated the contestant's soldering and desoldering skills, and the student was required to assemble an electronic kit. Section III was a written safety/theory exam designed to test understanding of safety procedures, electronic concepts, and product servicing procedures.

The contests are planned by technical committees made up of representatives of labor and management and are designed to test the skills needed for a successful entry-level performance in given occupational fields. Safety practices and procedures—an area of great concern to labor and management alike—are judged and graded and constitute a portion of a contestant's score.

National committee members for the Electronic Products Servicing Contest include co-chairpersons Walter Seymour, Electronic Industries Association and Jerry Ganguzza, Sharp Electronics Corp.

In the electronic products servicing contest, the top students are shown in the photo below.

Each of the winners received several awards including a one-year gift subscription to **Electronic Servicing & Technology. ES&T** wishes to congratulate the six medalists along with all those who participated in the awards.

EPA selects electronics industry as one of six participating in improvement of environmental programs

Environmental Protection Agency (EPA) Administrator Carol Browner announces that the EPA has selected the electronics industry as one of six industries to participate in its new Common Sense Initiative, aimed at improving and enhancing environmental programs.

The Common Sense Initiative will bring together selected industries with EPA, state regulators, environmental groups, and other members of the public, with the objective of developing improved and more cost effective approaches to environmental protection. Each selected industry sector will begin work with EPA and stakeholders to develop a work plan which would lay out specific steps, issues, tangible indicators of success, and timetables for each sector group. If a work plan is achieved that is mutually agreeable to all the parties involved, participants would move forward with the Common Sense Initiative.

"The electronics industry supports the goals of the Common Sense Initiative. Administrator Browner's initiative recognizes we can build sound environmental policy through greater collaboration. We are committed to working with the EPA, states, environmental groups, members of the public, and other stakeholders to develop a work plan. Following the completion of a mutually agreeable plan, the electronics industry will cooperate in moving ahead with the Initiative. Our industry brings to this effort a strong commitment to environmental protection and to making our environmental laws work more effectively," said Peter F. McCloskey, president of the Electronic Industries Association (EIA).

Wireless cable digital alliance formed

Six leading companies in the wireless cable industry announce a new research and development alliance to develop digital technologies for the over-the-air delivery of hundreds of channels of digital video programming and other services.

The new "Wireless Cable Digital Alliance" is expected to make wireless cable systems more competitive with traditional wired cable and telephone systems launching digital video networks. Members of the alliance are: American Telecasting Inc., Colorado Springs, CO; Andrew Corporation, Orland Park, IL; California Amplifier, Carmel, CA; EMCEE Broadcast Products, White Haven, PA; Microwave Filter Company, Syracuse, NY; and Zenith Electronics Corporation, Glenview, IL. The alliance may be expanded depending on the needs of the group.

Speaking on behalf of the alliance, Jon Schumacher, director of engineering and technology for American Telecasting, the nation's largest wireless cable television company, explained the alliance at the annual convention of the Wireless Cable

Association. The six companies in the alliance "each bring complementary perspectives and expertise in the wireless field," he said.

"As a result of the alliance's breadth and diversity of knowledge, we will be able to efficiently and rapidly facilitate the development of technology that will enable wireless to expand its services and compete more effectively for new customers," Schumacher said.

The alliance plans to develop wireless digital technologies that will enable consumers to receive from 150 to 300 channels, including near video-on-demand pay-per-view movie offerings. Efforts will also be directed toward wireless telephone service and interactive services.

The scope of the alliance's work will involve working with the FCC in the development of rules for the application of digital equipment and transmissions using microwave technology.

The Wireless Cable Digital Alliance brings together all of the key elements for the digital wireless systems of tomorrow. "The strength of this alliance, with participation by the largest wireless cable operator and key hardware providers, will benefit the entire wireless industry as we pave the way for the digital future," said John Bowler, Zenith's vice president of R&D and Network Systems Engineering.

"Together with the contributions of other alliance participants, Zenith's VSB digital modulation technology and two-way interactive set-top decoder expertise will be keys to enhancing the competitiveness of wireless microwave systems," Bowler said.

Schumacher said, "The wireless industry is the low-cost provider of cable service, and we intend to be ready with the needed technologies and services for the future while at the same time maintaining the technology's low-cost competitive advantage. Our technology is one that will help keep costs down for the consumer because we will offer viable choices."

As the digital superhighway evolves, consumers will pay for the vast amount of services that become available, Schumacher said. "We will develop the cost-effective digital technologies for the wireless industry, technologies that fit the needs of our industry's targeted customer base." ■

Is it the CRT that's bad?

By Hulon Forrester

The cathode ray tube (CRT), or "picture tube," has become an integral part of our everyday living for so long that it is just as commonplace as the steering wheel on our car. Everyone knows it's there, but no one thinks very much about it until it doesn't work.

In the many years that I have been in the electronics business, I can't remember seeing any article that describes how a tube works or how to determine when there is a problem with a CRT in a TV set, whether the problem is in the tube or in the circuits supplying it. We hope that this article will rectify the situation.

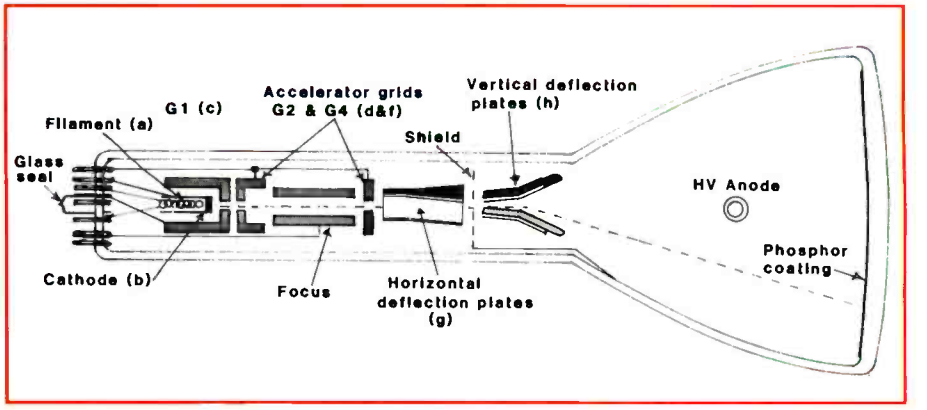


Figure 1. The deflection plates in electrostatic deflection tubes are built inside the tube.

The importance of the CRT

In the almost one hundred year history of the CRT, the last fifty years have seen the cathode ray tube grow into one of the most important parts of electronic equipment, yet it has been taken for granted as a black box. Some of the most recent and best selling publications describing how CRTs work contain errors. Even manufacturers of CRT rejuvenators are not always totally correct in describing exactly what their equipment does.

TV service technicians have lived with TV tube replacement long enough to feel at home with it, but there are many computer technicians who have not had the opportunity to learn as much as they would like to. Many trade and technical schools avoid servicing that has to do with the CRT.

As an example of the ignorance that exists about CRTs, a customer called me not too long ago and said: "The picture tube I bought is no good. It has a straight line across the center of the screen!" Of course, this is an indication of a problem in the vertical deflection circuits, not in the tube.

Many types of CRTs

Over the years, more than 5,000 different types of cathode ray tubes have been developed for many high volume applications. Thousands more have been produced for special applications. All of this arises out of the development of radar during World War II, from which evolved the high-frequency circuits necessary for the introduction of TV immediately after the end of the war in 1945.

The continuing demand for CRTs

The instant popularity of television created a never-ending demand for larger and larger screens that continues to this day. Color, which was introduced in 1957, created a larger TV audience than anyone could have ever imagined.

The tremendous growth of the data display market, including medical, aircraft, automotive, navigational and computer electronics, caused an explosive demand for all types of displays that produced images in monochrome and color.

It's important to understand CRTs

The cathode ray tube is still superior in reliability, cost, and performance to anything else in use or proposed for use. Flat LCD panels are great for portable equipment, watches and other applications where small size and light weight are essential, but when it comes to performance at the lowest cost, where space, weight, and power are of lesser consequence, the CRT is superior. The CRT is so well entrenched that it will be in use for many years to come even if a better substitute were introduced tomorrow.

It is important for those of us in the business to understand CRTs in order for us to get the most out of them, as well as to properly replace them when necessary. With HDTV, DATV and high resolution

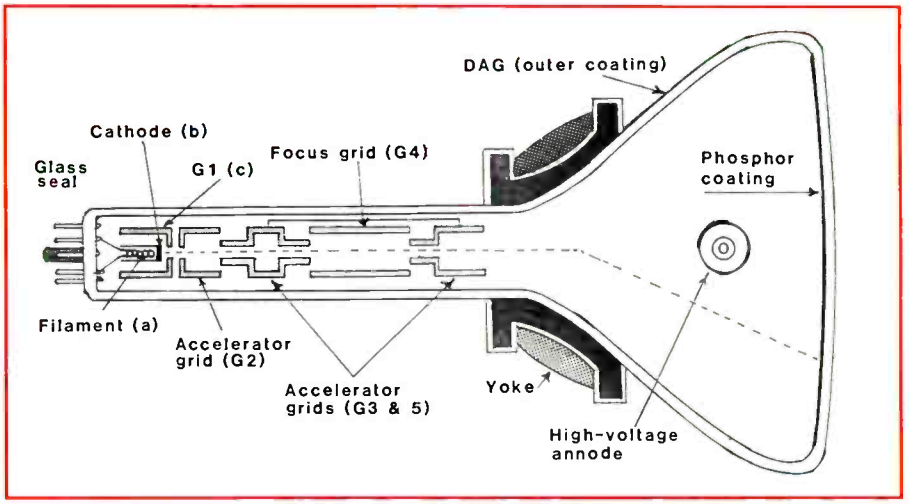


Figure 2. The more commonly used magnetic deflection tubes require a "yoke" mounted on the neck of the tube to deflect the electron beam.

Forrester is a CRT consultant.

data display already here or on the horizon, understanding CRTs is even more important for proper maintenance. Today, there are enough tubes in service that each human being in the world could have a screen to themselves.

Two types of monochrome tubes

There are two basic monochrome tube types: those that employ electrostatic deflection, and those that employ magnetic deflection. Electrostatic deflection tubes have deflection plates built inside the tube (Figure 1). The more commonly used magnetic deflection tubes require a "yoke" mounted on the neck of the tube to deflect the electron beam (Figure 2).

Electrostatic deflection tubes are still the only way to look at waveforms in "real time." You will find this tube used in oscilloscopes and some types of medical equipment. Most electrostatic tube screens are no more than seven inches in diameter.

Magnetic deflection tubes may have screens smaller than one inch and larger than 35 inches across. These require a magnetic deflection yoke on the outside which replace the deflection plates on the inside of the electrostatic types.

Although electrostatic tubes for special applications have been built in larger diameters, modern TV and computer monitors all use magnetic deflection. The advantages will be explained later.

Electrostatic deflection

Electrostatic deflection tubes (Figure 1) are superior when a wide variety of frequencies need to be viewed such as in an oscilloscope. The better CRTs enable the user to view frequencies from dc to several gigahertz. No other display method has this capability.

In electrostatic deflection, the signal to be viewed is fed to the vertical (Y) plates. The output of an internal variable linear sweep circuit is fed to the horizontal plates (X). The signal produced by this sweep circuit is at the same frequency as the signal that is to be observed, or a fraction of that frequency.

For example, in order to view a single cycle of a 60Hz waveform, the frequency of the horizontal waveform must be a linear 60Hz. This waveform is called a "sawtooth waveform," (Figure 3) because of its appearance, but it must move the electron beam in the tube horizontally at a constant rate of speed in order to faithfully reproduce the signal applied to the vertical plates.

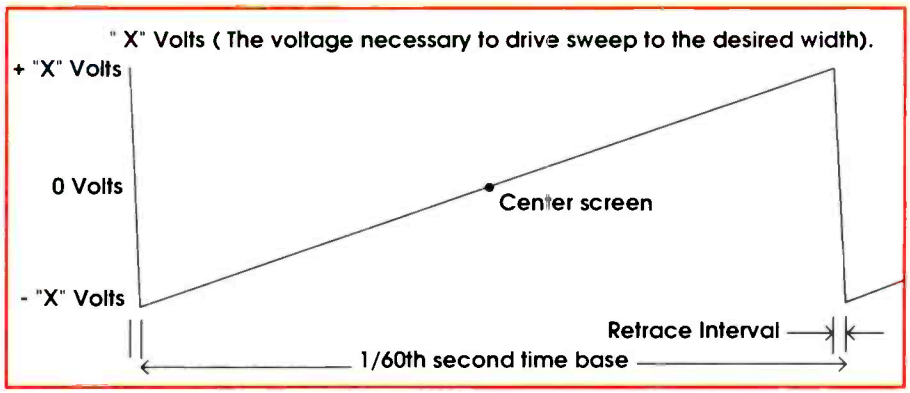


Figure 3. The waveform that provides horizontal sweep in a CRT is called a "sawtooth waveform" because of its appearance. It must move the electron beam in the tube horizontally at a constant rate of speed in order to faithfully reproduce the signal applied to the vertical plates.

The vertical line of the sawtooth is not totally vertical. It represents the time required for the beam to return to the left side of the screen to begin subsequent linear sweeps. This is known as the return trace or "flyback time." This quick pulse is used in magnetic deflection circuits to generate high voltage and is where the term "flyback transformer" comes from.

All horizontal sweep waveforms must be linear. If these waveforms are not linear, the picture is distorted. This applies to a "raster" or a single line sweep in either the electrostatic or magnetic deflection format. In essence, it is a time base. Any half inch of that line represents the same time period in any other half inch.

Displaying multiple cycles of a waveform

In order to display more than one 60Hz image of a waveform on the oscilloscope screen, the frequency of the horizontal waveform must be some fraction of the vertical frequency. For example, to see four cycles of a 60Hz waveform, the horizontal frequency must equal the vertical frequency divided by four, or 15Hz.

During a single horizontal sweep of 15Hz, four 60Hz images are fed to the vertical plates. This results in four 60Hz images being shown on the screen. The last reproduction of the last waveform will not quite reach the base line because the retrace time takes that last fraction of a second to return to the left of the screen for the beginning of the next sweep.

Theory of operation of a CRT

In Figure 1, the filament heats the cathode which emits electrons. The brightness of the beam is determined by the degree of negative voltage on grid (G1) relative to the cathode. If the voltage on G1 is sufficiently negative, no electrons will pass and nothing will show on the screen. Because of the effect of the grid on the electron beam, the brightness control usually controls the voltage of G1. The exact point where electron flow stops is known as the cutoff voltage.

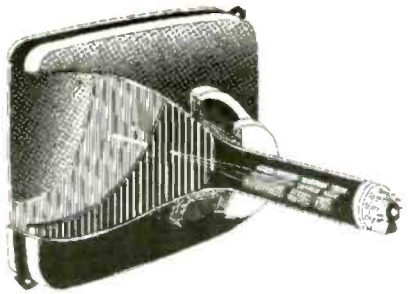
The next element after G1 is G2. G2 and G4 are usually tied together and the focus grid (G3) is sandwiched in between. Grids G2 and G4 are accelerator grids and G3 is the focus anode which "puts a point" on the electron beam.

The screen is at a potential of greater than 2,000V with respect to the cathode, which attracts the beam. The electron's last obstacle to the screen are the deflection plates: two vertical and two horizontal. Depending on the polarity, voltages applied to those plates will deflect the beam up or down (vertical) and side to side (horizontal).

Deflection angle

The X and Y plates are in a "V" configuration which allows the beam to bend vertically and horizontally without touching either set of plates. The maximum angle at which the plates allow the beam to bend in a combined vertical and horizontal configuration is called the "deflection angle."

You will notice that the deflection angle in an electrostatic tube is very low; some 50 degrees or less. A large tube in this configuration would be quite long. In fact, a 21-inch diagonal tube would be over three feet long, which would make this tube type somewhat cumbersome in manufacturing cabinets for large screen units.



A

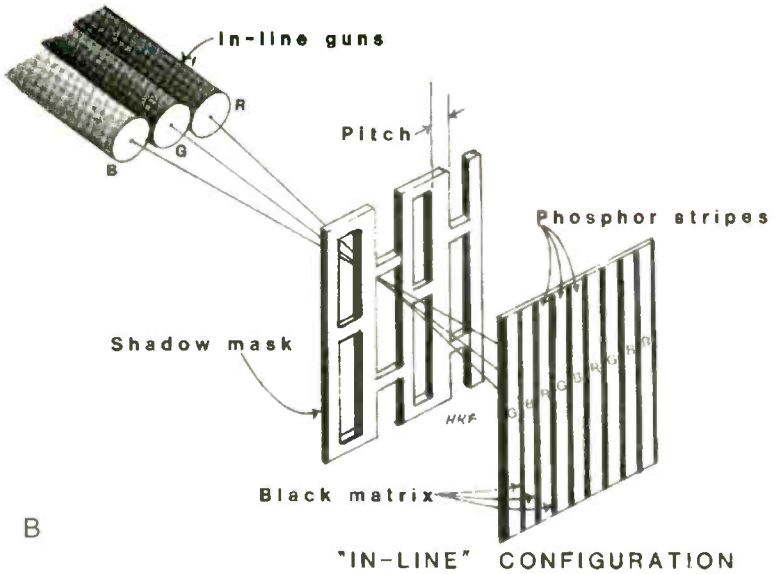


Figure 4. In a delta-gun CRT, the guns are in a delta (triangular) configuration. The drawing marked "A" is a detail of the mask, which prevents electrons from one color gun from striking phosphors of the other colors.

Manufacturing an inexpensive source of high voltage for these tube types is not easy. Usually, the voltage difference between the cathode and the screen is around 4,000V. This is achieved by a more complex version of the "voltage doubler" circuit which can get about 2,000V from the 120Vac power. By creating a -2,000V supply to the cathode and a +2,000V supply to the screen, the 4,000V difference is achieved. Therefore, it is not unusual to find the cathode, G1, G2, G3 and G4 "floating" at about a -2,000V below ground potential.

Electromagnetic deflection

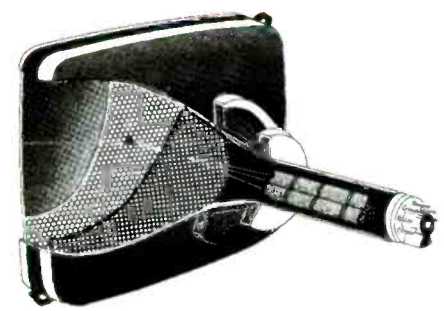
The electromagnetic deflection scheme is where the "yoke" comes into being. First, the yoke (Figure 2) replaces the electrostatic deflection plates inside the tube. In a rectangular tube, it is difficult to align the electron gun with the sides of the tube so that a rectangular picture would be in line within the rectangular screen. This alignment is done by adding an extra winding around the neck of the tube with a variable low voltage applied to it. This is called a "twist coil."

With a yoke, it is simple to position the picture within the tube by twisting the yoke. Also, since the yoke is outside the tube, there is no danger of the electron beam striking the deflection plates and the coil design permits a higher deflection angle; 114 degrees is common. This allows the gun to be closer to the screen, which in turn allows the cabinet for even a 25-inch screen to sit close to the wall.

Electromagnetic sweep circuits

Sweep circuits may now be applied to the yoke while focus, brightness and the video signal is applied to the tube. In addition, the neck may be smaller, which in turn requires less power to the sweep circuits. (The closer the magnetic field is to the electron beam, the less power is required to deflect it).

The absence of internal deflection plates also allows a shorter neck overall. You may note that the vertical sweep circuit may fail causing a single horizontal line to appear across the tube. A vertical line on the tube can only be caused by an



A

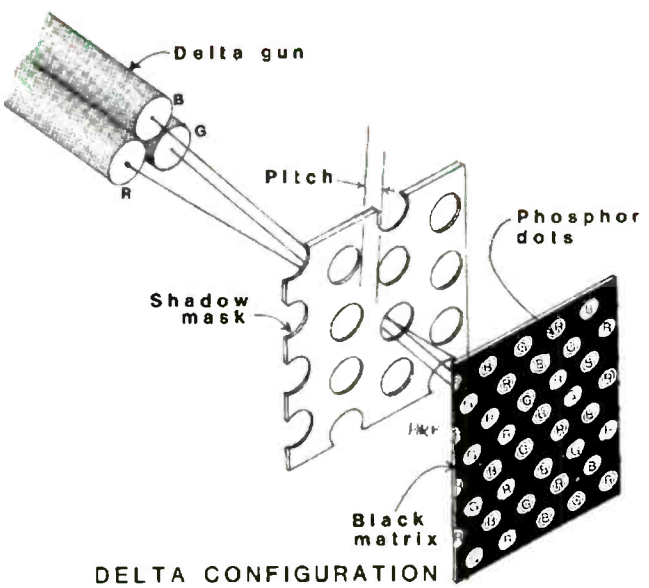


Figure 5. In another type of CRT, the guns are side by side, also called "in line." The drawing marked A is a detail of the mask which blocks each electron beam from striking phosphors of the other two colors.

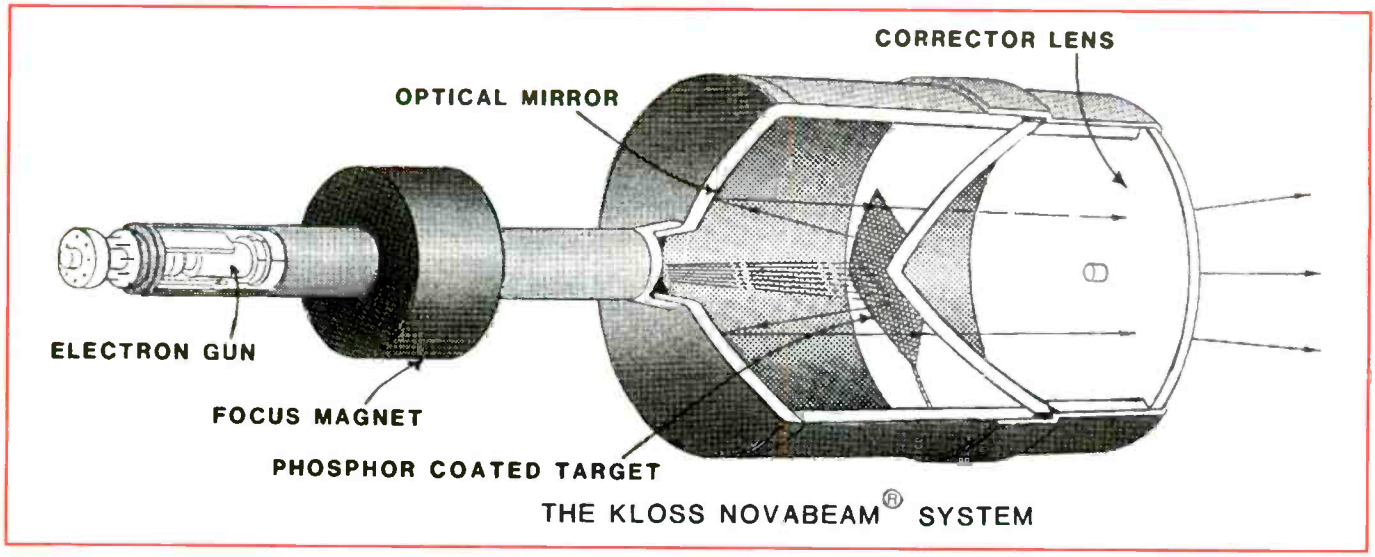


Figure 6. Some projection systems use three separate CRTs: a red tube, a green tube and a blue tube. When the pictures from these three tubes are superimposed into a single picture, a color picture is produced. This is a Novabeam tube, based on the Schmidt optical system, developed by Henry Kloss.

open horizontal yoke winding. The high voltage supply and the "flyback" transformer is dependent on the horizontal sweep circuit working properly. If the sweep fails, the HV goes too, causing a blank screen instead of a vertical line.

A short in a single turn of either yoke winding will cause the raster to turn into a "keystone" pattern: the top of the raster may be wider than the bottom or vice versa; or one side higher than the other, depending on the location of the short.

If you should encounter a set in which the display on the CRT screen is a vertical or horizontal line, use a probe to test the solder joints of the yoke windings. Sometimes the solder flux will cause the wire to deteriorate at the joint. It will appear to be conductive, but it isn't.

In a typical magnetic deflection tube, G1 is the control grid, G2, G3 and G5 are accelerator grids, with G4, the focus grid. The voltage on G2 is an indicator of resolution. A voltage of 100V is low resolu-

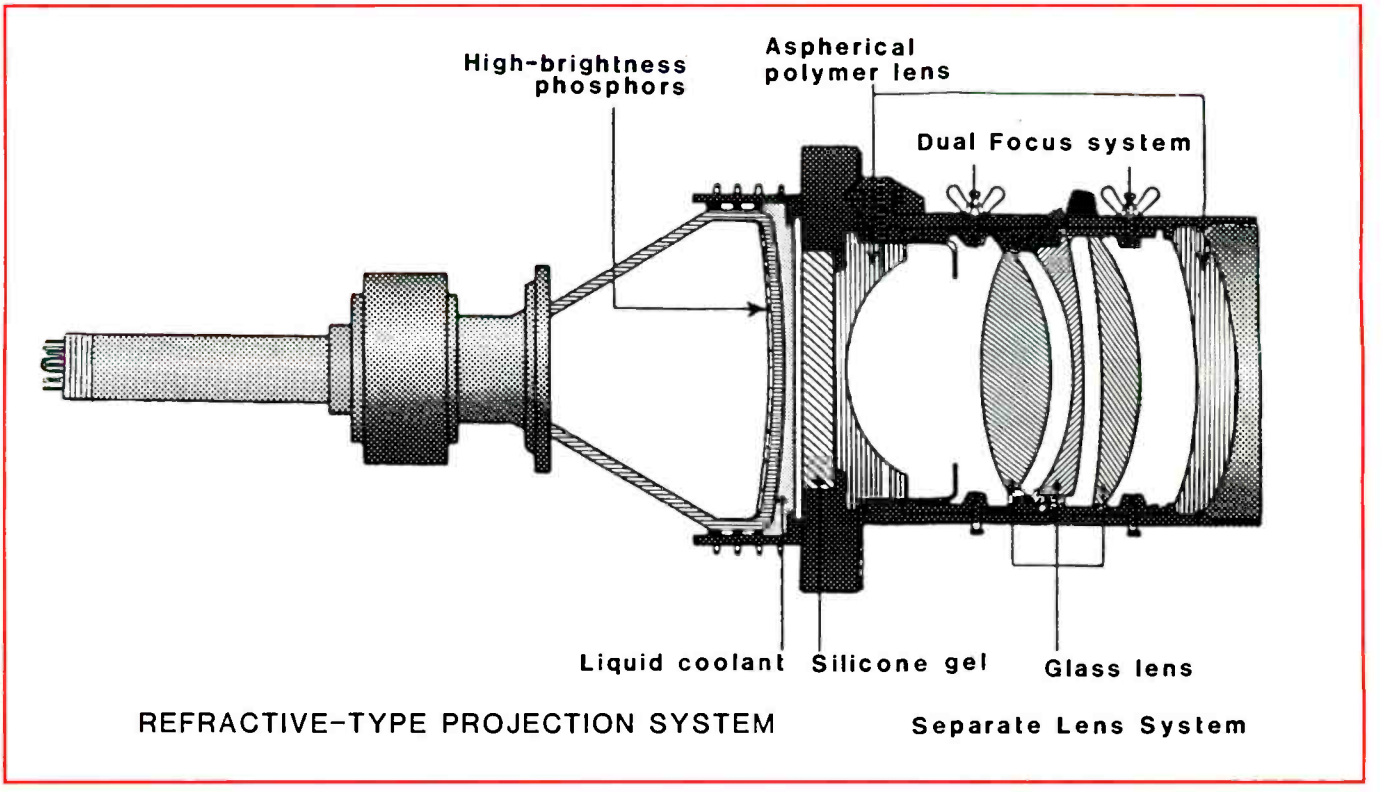


Figure 7. Another type of separate-tube projection CRT is the refractive system.

tion, and 300V and up indicates high resolution. In a typical circuit, the signal is fed to the cathode, G3 and G5 are connected to the screen and use the HV as an accelerator voltage, and G4 is the focus anode that is connected to the focus control.

In some modern tube designs, G4 is grounded and there is no focus control. G1 is typically connected to the brightness control and the negative voltage necessary to cut off the electron beam is known as the "cutoff voltage." You might note that inability to control the brightness is usually indicative of a cathode to grid short. There are always exceptions to circuit design. Some signals are fed to G1 rather than the cathode.

Data display CRTs

Monochrome data display tubes come in a variety of colors like amber, green, page white, and black and white. You may replace a CRT of one screen color with one of another color, provided that the "persistence" is the same. Persistence is the length of time that the phosphor remains lit after the electron beam leaves it.

For example, P31 and P39 (the pacific rim uses "B" instead of "P" but otherwise it is the same) are the same color but are of different persistence. Some IBM monochrome monitors use P39 and if the phosphor is replaced with any color that has a lower persistence, the picture flickers. So be careful to maintain the same persistence when you change color.

This mistake in persistence doesn't occur often when using the same color. The error usually happens when the user wants to go from a green screen to amber or "page white."

Solving CRT-related problems

If the screen of a CRT is blank, in most cases you should look at the back of the tube and see if the filament is lit. Typical filament voltages are 6.3V to 12.6V. If you see a warm glow, you know that the filament is lit.

Electron beam flow starts at the cathode and in most cases, the video signal is fed to the cathode. There should be a resistor from the cathode to ground and a capacitor from the output transistor to the cathode. If there is no current flow from the cathode, there will be no voltage drop across the resistor. If the capacitor is shorted, the voltage will be the same on both sides of the capacitor.

If you find nothing remarkable, turn the unit off and measure the resistance between the cathode and G1 with an ohmmeter on a low scale (a hot cathode will give you a false reading). With the unit on, if there is no short between the cathode and G1, you will also see a change in the voltage when you turn the brightness control up and down. On the other hand, a cathode to G1 short will cause a bright, usually out of focus, picture, and the brightness control will have no effect. The tube is bad.

A gassy tube will give you a bright blue glow in the neck of the tube. If there is enough gas in the tube it will short out the HV. It is a good idea at this point to see if you have high voltage. Usually, the "rushing" sound that a TV makes is the sound of the HV being applied. That sound is a clue that there is HV at the CRT. If that sound is not conclusive, you can test the HV with an HV meter.

Remember, the high voltage supplied to a monochrome CRT may be 20,000V or more. Always use extreme caution when measuring this voltage.

The picture on a weak gassy tube will "balloon" when you turn up the brightness and/or go negative. A tube that exhibits these symptoms is also bad.

If there is air in the tube, you will see arcing inside the neck of the tube. High voltage will not arc in a vacuum.

You may choose any sequence you want to take in these steps; the order is not important as long as you cover all of the bases. Two more things to check are

G2, which should be at least 100V, and the focus voltage, which varies from a minus voltage through zero to a positive voltage. If you see an extra lead coming from the flyback to the focus anode, the focus voltage could be several thousand volts, but would not normally kill the picture. Some G4s in newer types are connected to ground and have no focus control at all.

Summary of monochrome tubes

The most important thing to remember in checking a monochrome tube is that it should have filament voltage, high voltage, G2 voltage and brightness control. If the cathode is shorted to G1, you can measure that with an ohmmeter. You will also find that the brightness control will not have any effect on the voltage of G1.

If you have no HV, check the horizontal circuit and transistor. If you have a horizontal line, check the vertical circuit including the vertical transistors, output transformer and the vertical winding on the yoke. (Turn down the brightness so you won't burn the tube. A complete picture compacted into one horizontal line packs a hard punch and will easily burn the phosphor).

Color tubes

In the neck of a color tube there are three monochrome guns which fire three electron beams at the screen simultaneously except when the screen area is meant to be black. The guns may be in a delta (triangular) configuration, or side by side, called "in line" (Figures 4 and 5) depending on the tube and mask design. Figures 4A and 5A are simply engineering drawings to give more detail of the two systems. The mask is simply a "gate" which blocks each electron beam from striking phosphors of the other two colors.

Convergence

When the electron guns are adjusted into that configuration, it is called "convergence." Convergence of the dot matrix configuration is more demanding than the convergence of the stripes, but the principle is the same. The smaller the dots or stripes, the closer they are together. This measurement is called "pitch."

The smaller the pitch, the higher the resolution, but a smaller pitch usually requires more horizontal lines and possibly a higher vertical frequency as well. Together, they make a sharper picture. However, strange patterns called moire patterns appear with the image when a tube with the wrong pitch is used with improper sweep frequencies.

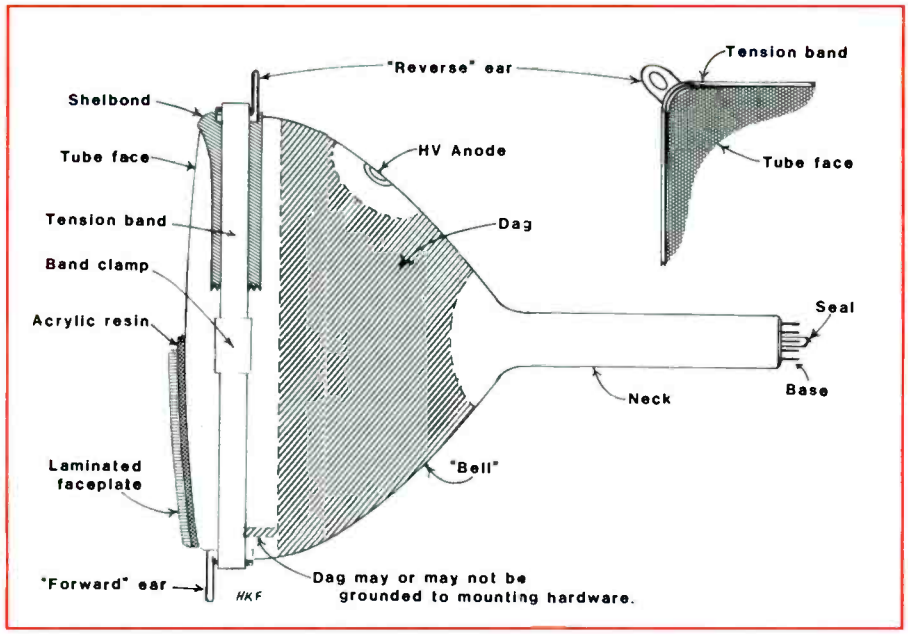


Figure 8. The nomenclature most commonly used when discussing a CRT.

Refresh rate

TV broadcast must use the standards, set by the FCC in 1945, of 525 horizontal lines and a "refresh rate" of 60Hz. This is the NTSC standard. For a sharper picture, computer technology and new TV design may have as many as 1050 lines in a picture. Some ultra-high resolution (usually monochrome) CRTs have as many as 4,000 lines and approach 35mm film quality. The "refresh rate" may be higher also.

The minimum recommended refresh rate so that any flicker of the video image is invisible to the human eye is 72Hz. CAD/CAM and other high resolution computers are not bound by the TV standards and each complete system may have its own standards, so both the horizontal and vertical frequencies could very well vary from system to system. The basic theory, however, remains the same.

Interlaced scanning

The old TV standard raster also produced an alternate line raster (interlaced scanning) which was designed to reduce flicker, but did affect the sharpness of the picture. In interlaced scanning, within the first 30th of a second, the odd lines were drawn (1,3,5,7,9, etc.) and within the second 30th of a second, the even lines were drawn (2,4,6,8,10 etc.). The new TV circuits and data display circuits will not have this feature.

If there's no picture

If there is no picture, the chances are that the HV is gone. If the tube is gassy, it could be bad enough to short out the high voltage and kill the picture.

The HV should be the first thing to check. Since the HV comes from the horizontal sweep circuit, the cause could be anywhere in that circuit if disconnecting the HV lead does not bring back the HV.

In a color tube, in essence, you have three picture tubes in one envelope with a red, blue and green picture. If the color of a picture is bad, it may be in the color circuits in the set, or it could be that one gun is bad or shorted.

If the screen is one color when the unit is first turned on and another color after it has been on awhile, or if it is out of focus with a blue glow in the neck, the tube is weak or gassy or both. It is rare indeed when all three guns fail at the same time which makes it easier to tell whether the problem is the tube or the circuit.

Phosphor burn

A computer monitor may sit for hours with a single image on the screen; this often causes the phosphor to "burn." If you begin to see the image on the screen after

the monitor is turned off, the screen is burned. Prolonged use of the monitor after the burn begins to show when the monitor is off will permanently damage the tube and make it irreparable.

In many instances, a light burn in a color tube may be "repaired" if the tube is remanufactured. A recycled monochrome tube also has a new phosphor. However, a badly burned monochrome tube may have irreparably damaged glass.

Symptoms of power supply problems

A double dark bar across the screen means that ac is getting through your power supply. Depending on where your sync voltages are coming from, the bars may roll or be stationary. If you will look at an ac power supply, one half of each cycle is turned into 120Hz of pulsating dc, then smoothed out to smooth dc with chokes and filter capacitors.

A bad capacitor will allow a 120Hz ripple. A single bar across the screen means a cathode to filament short in the CRT, because that is 60Hz ac. The tube is bad, but sometimes an isolation transformer or a dc filament supply may prolong the use of the tube.

Color display variations

There are "hybrid" and some "off the wall" types of color displays. For example, there are some "in line" guns used with a dot matrix and vice versa. These are most common in high resolution CRTs. Then there are projection tubes and some flat CRTs used in miniature portables where the electron beam curves to the screen from a gun parallel to it. Zenith has developed a flat screen CRT that has some unusual characteristics, but it has been built on the same basic principles as a standard tube.

Refinements continue to be developed. No matter how good a CRT is, someone is always trying to make it better or larger. The sharpest possible picture is still from the original design, the dot matrix.

Some years ago, GE used a 13-inch color tube and a lens to make a projection color set but it was not bright enough. Now GE is producing their "Talaria" projection system that is very complex and expensive and used only in theaters.

Sharp has come out with a system using a high intensity lamp and three liquid crystal screens converging through a single lens. This system will focus a picture from about 25 inches to 15 feet. It does not use a CRT at all.

Separate CRTs for each color

Two color video display systems use separate red, green and blue tubes. When the pictures from these three tubes are superimposed into a single picture, a color picture is produced. One is a tube called a Novabeam, based on the Schmidt optical system, developed by Henry Kloss (Figure 6). The second is the Refractive System used by a number of other manufacturers (Figure 7).

The Novabeam is the most efficient but as with all of the rest, has some disadvantages. It is presently used by only one manufacturer: Ampro. Several other manufacturers use the Refraction System. Both systems are used in front and rear projection. Even though neither of them has a mask, and each produces a solid red, green and blue picture. Having no color dots, the picture has more pixels. It is still limited in clarity in the number of lines that make up the picture.

Projection TV sets have their place in large rooms for large audiences. They are more expensive and the CRTs have to be replaced more often. Except for the liquid crystal units, the tubes are designed to work at an exact distance from the screen. A curved screen produces a brighter picture, but narrows the viewing angle. Each system has its advantages and disadvantages. The choice of which system to use is a matter of personal preference and application.

Figure 8 lists the nomenclature most commonly used when discussing a CRT. This should help tell your supplier what you want without miscommunication. ■

VCR servo problems: The diagnostic device revisited—Part II

By Steve Babbert

Part one of this article on troubleshooting VCR servo systems, which appeared in the September issue of **ES&T**, focused on the capstan speed and phase loops. This part will examine the role that the servo circuit plays in maintaining the correct speed and phase of the head drum or "cylinder" motor. This discussion will be based on the circuitry used in a Magnavox Model VR9547AT01. After a brief circuit description we will look at a specific problem. As in part one, the diagnostic device will be used to open the loop and manually control the motor's speed.

Babbert is an independent consumer electronics servicing technician.

The servo circuit

In this chassis, most of the circuitry associated with the capstan and drum servo is contained in IC 2001, an MN6178VAD

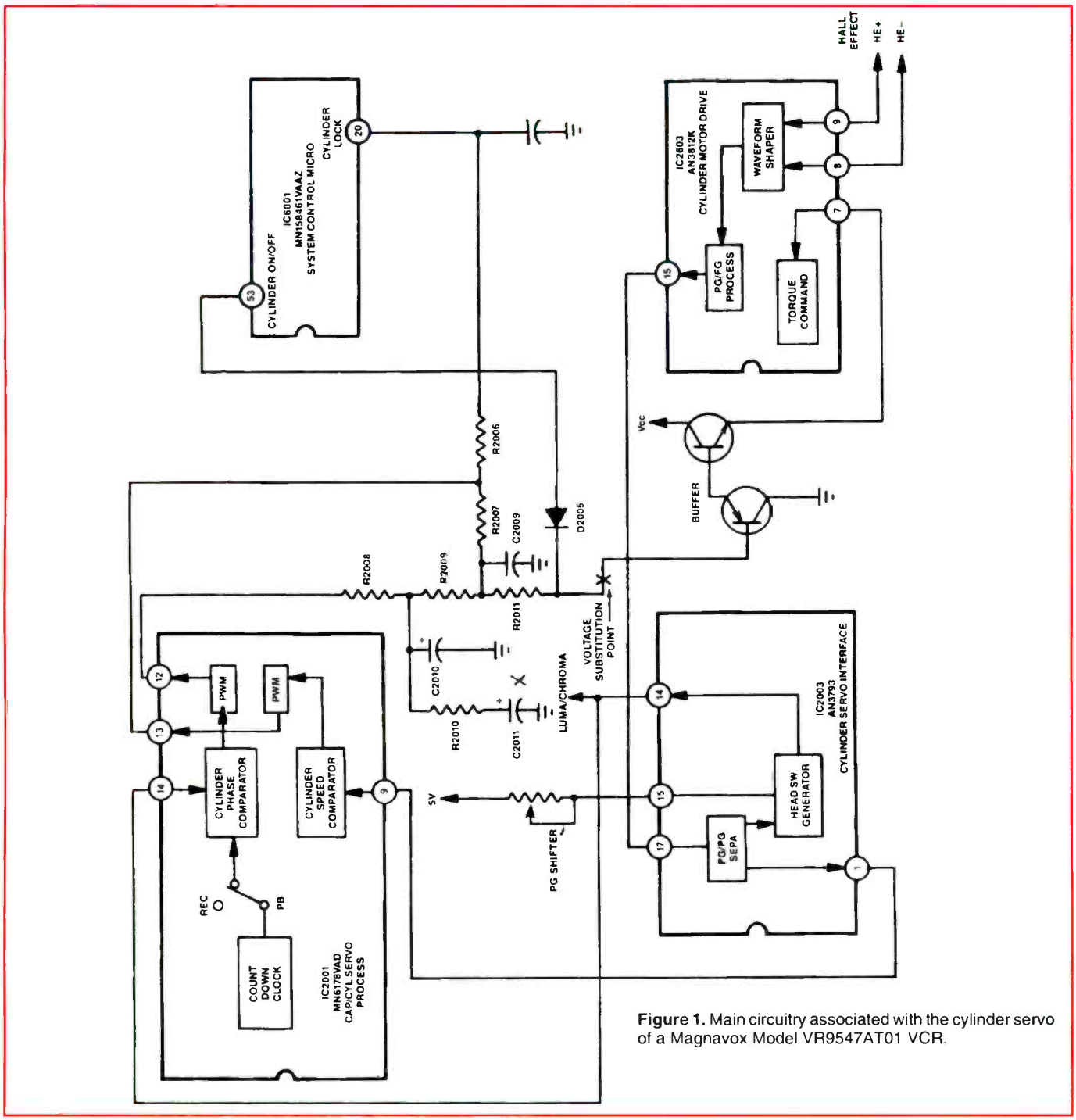


Figure 1. Main circuitry associated with the cylinder servo of a Magnavox Model VR9547AT01 VCR.

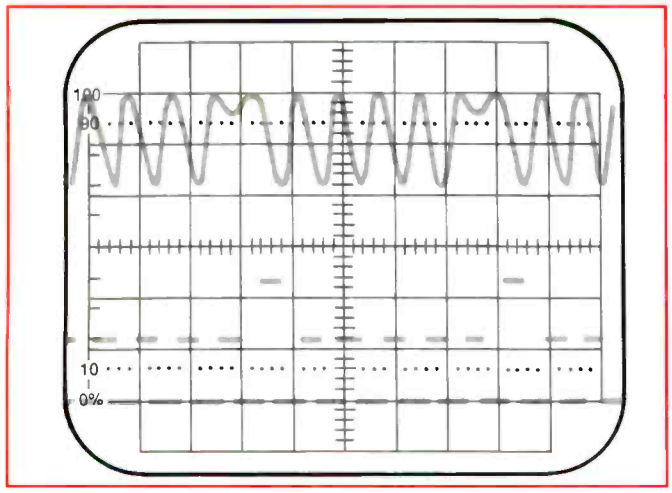


Figure 2. The top waveform here is the output of the Hall device, observed at pin 9 of IC2603. The lower waveform is the output of the PG/FG processor at pin 15 of IC2603.

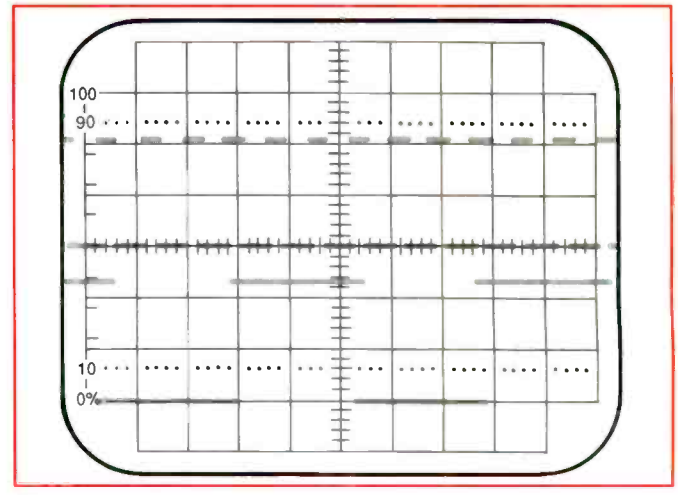


Figure 3. The top waveform is the separated PG pulse output at pin 1 of IC2003. The lower waveform is the separated and stretched PG pulse at pin 14 of IC2003 used for headswitching and phase compar-

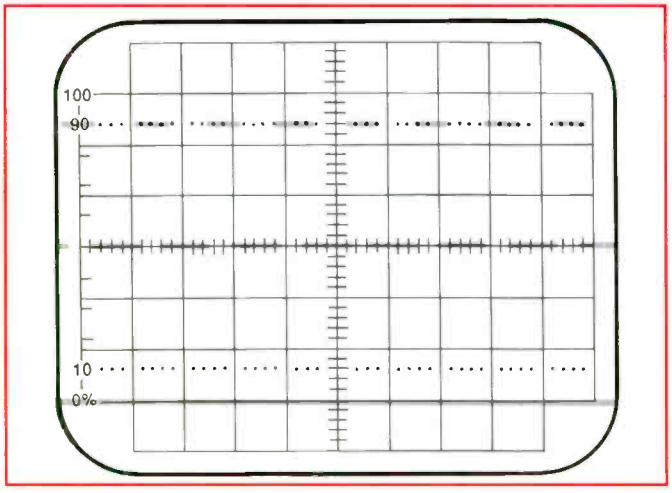


Figure 4. The upper waveform is the speed PWM output (pin 13). The duty cycle of this waveform varied during acceleration bursts. The lower waveform is the phase PWM output at pin 12. This waveform showed 5V between acceleration bursts.

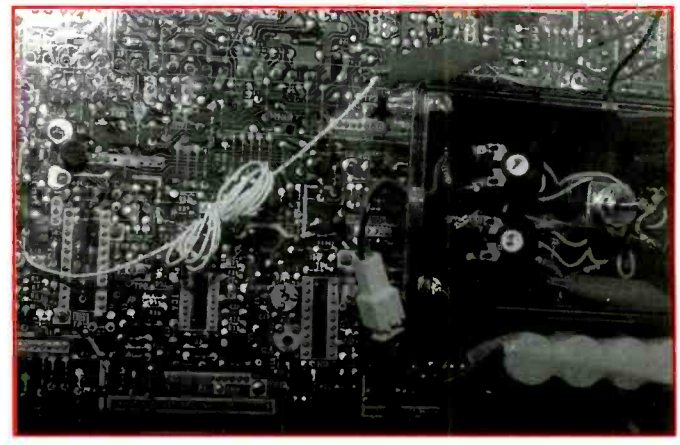


Figure 5. To break the servo loop and control the motor manually, used desoldering braid to remove the solder from one leg of R2011 and lifted it from the board. This completely isolated the low-pass filter from the motor control line labeled "cylinder error." I then tack-soldered the diagnostic device to the land at the cathode of D2005, the input to the buffer amp.

capstan/cylinder servo processor. Two other ICs used are IC2003, an AN3793 cylinder servo interface and IC2603, an AN-3812K cylinder motor driver (Figure 1).

In this system the FG and PG pulses that are used as feedback signals are both generated by a single Hall-effect device, which is part of the drum assembly. The positive and negative outputs of the Hall device are routed to pins 8 and 9 respectively of the cylinder motor drive IC. Inside this IC these outputs are applied to the PG/FG generator block. The output from this block at pin 15 is a composite signal consisting of the amplified and shaped pulses.

At this point the PG pulse has a frequency of 29.97Hz and an amplitude of about 4.6V_{PP}. The FG pulse frequency is 179.8Hz with an amplitude of about 2.4-V_{PP}. Viewing this pulse train on an oscilloscope shows five FG pulses followed by one PG pulse per cycle (Figure 2). This pulse train is applied to pin 17 of the cylinder servo interface IC where it will be routed to the PG/FG separator block.

The PG/FG separator

The separator has two outputs. The FG output exits at pin 1 and enters pin 9 of the capstan/cylinder servo process IC. It is used for comparison in the speed comparator block.

The PG pulse is applied to the head switch generator. The output of this block is a 50/50 duty cycle square wave that shares the frequency of the PG pulse (Figure 3). The phase of this signal can be retarded or advanced with respect to the incoming PG pulse through adjustment of the PG shifter control connected to pin 15.

The output of the head switch generator follows two paths. One path leads to the luma/chroma circuits where it will be used for headswitching. The other path leads to pin 14 of the servo process IC where it will be used for comparison by the phase comparison block. A 3.58MHz signal is also applied to this IC where it will be divided to produce the stable comparison references.

Error voltages

Error voltages are generated by the speed and phase comparators in response to differences in the frequency and phase of their input signals. These voltages are applied to their respective PWM blocks to control their duty cycles.

The outputs of the two PWM blocks, after being low-pass filtered and combined by a passive RC network, are routed to pin 7 of the cylinder motor driver IC. In this IC the control voltage is applied to the torque control block. This block coordinates the three phase voltages that are applied to the windings of the direct drive motor.

Solving a servo problem

When the VCR was placed into the play mode and the tape was fully loaded, I could hear what sounded like a motor speeding up then slowing down at a frequency of about once per second. The video on the monitor was pulling to the left and flagging at the top in step with the speed variations. The sound from the linear sound track was normal. Normal sound from a linear track usually indicates that the capstan motor speed is okay. For this reason, I focused my attention on the cylinder.

Though the motor sounded like its speed was fluctuating, I couldn't see any change. Before I began troubleshooting I wanted to be certain. There are several ways to determine the speed of a cylinder motor. One way is to monitor one of the feedback pulses. Their frequencies are proportional to the motor's speed. Another way is to use the strobe method.

The strobe method

If a spot is placed on the upper surface of the cylinder toward the outer edge, it will produce a characteristic pattern when viewed spinning under a fluorescent light. A fluorescent light has a 120Hz flicker rate when powered by a 60Hz voltage. The rotational speed of the cylinder is close to 30 revolutions per second. This results in illumination of the spot four times per revolution.

The pattern produced by this stroboscopic effect on the spot on the cylinder looks like a ring with four gaps spaced at 90-degree intervals. If the cylinder speed was exactly 30rps the pattern would appear stationary. Since it is 29.97rps, the pattern rotates slowly clockwise. It takes approximately 36 seconds for the pattern to make one revolution in a normally working machine.

When I perform this test I place a piece of tissue paper in one of the holes near the outer edge of the cylinder's upper surface. After saturating the paper with the ink from a pink fluorescent highlighter, I view the rotating cylinder under an ultraviolet (black light) lamp. This makes the pattern very bright.

In this case, the pattern reversed direction from clockwise to counterclockwise in step with the speed variations that I could hear. This verified that the cylinder speed was unstable.

Scoping the PWM outputs

With the vertical inputs of the scope set for dc, I simultaneously scoped the phase PWM output (pin 12) and the speed PWM output (pin 13) of IC 2002. During the acceleration burst there was a square wave present at the phase PWM output. Between bursts, the output became a steady line.

Counting graticules showed that this line represented a 5V output. At the speed PWM output a squarewave was always present with a duty cycle that increased during acceleration of the cylinder, and decreased during deceleration (Figure 4). Because R2011 couples the low-pass filtered control voltage to the motor driver it was a good place to open the loop.

Opening the loop

After wicking the solder from one leg of R2011, I lifted it from the board. This completely isolated the low-pass filter from the motor control line labeled "cylinder error." This line leads to a two transistor buffer amplifier before being applied to pin 4 of the cylinder motor drive IC. By taking control of the line at this point I could test the buffer amp, the motor drive control circuits, and the motor.

Using the diagnostic device

Because I couldn't find a convenient place to tie into the cylinder error line, I tack soldered a jumper to the land at the cathode of D2005 (Figure 5). The anode of this diode is connected to pin 53 of the system control IC6001. In any mode other than play or record this pin goes high, forward biasing the diode and forcing the cylinder motor to stop.

Next I connected the positive lead of the diagnostic device to the jumper and the negative lead to ground. While still scoping the two PWM outputs of IC 2002 and watching the video monitor, I placed the VCR into the play mode.

This VCR model uses "negative logic" in which a lower dc output from the PWM blocks causes the motor to speed up and a higher voltage causes it to slow down. This must be considered when using voltage substitution. Once the tape was fully loaded I used the reverse kick-start function on the diagnostic device. This lowers the control voltage causing the cylinder motor to begin running at a higher than normal speed. I then returned the switch to the run position and began to adjust the coarse control while watching the speed PWM output.

Adjusting the cylinder motor speed

As the speed of the motor became close to normal, the PWM output approached a 50/50 duty cycle. At this point the video on the monitor locked in. I found that through careful adjustment I could make

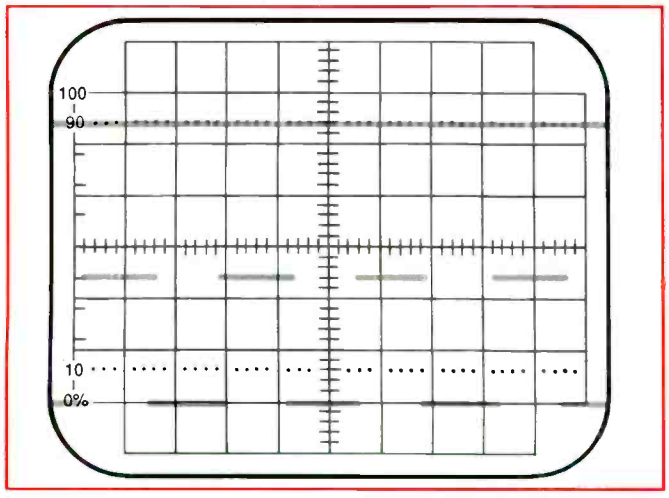


Figure 6. The upper waveform shows the speed PWM output (pin 13) at 100% duty cycle with the motor speed raised above normal. The lower waveform is the phase PWM output (pin 12). This signal defaults to a 50-50 duty cycle when the motor speed is raised above normal.

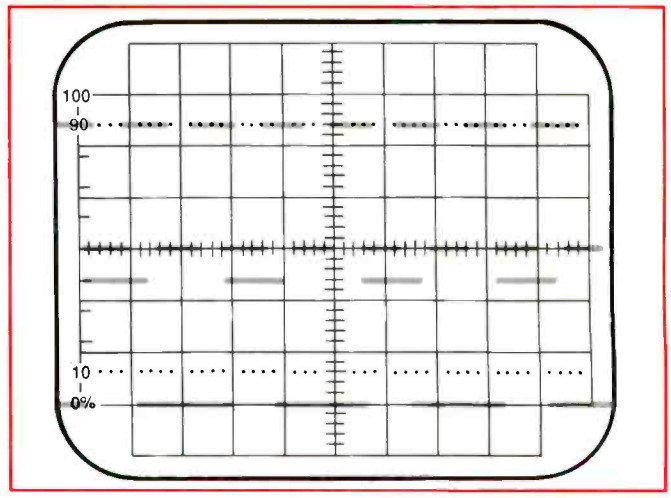


Figure 7. These waveforms show the speed PWM (top) and the phase PWM (bottom) outputs after the problem was corrected.

the video lock in for 15 to 20 seconds at a time. This is usually not possible when controlling a capstan motor.

The cylinder motor is inherently more stable than the capstan motor because of its greater inertial mass. This is one reason why the video can be locked in for longer periods. On the other hand, this leads to a more sluggish response. When you adjust the controls on the diagnostic device you must allow time for the motor to come up or down to speed. After some practice it becomes easy.

Scoping the phase PWM output showed that it would begin toggling between high and low as the speed was changed. Since the scope was set for dc, the trace would shift up and down between 0V and 5V. When the motor was brought close to the correct speed, I saw that just prior to these transitions the flat line would break into a square wave. The duty cycle would increase or decrease depending on whether the transition was from low to high or vice versa.

If I made careful adjustment, I could get the square wave to lock in for a few seconds, though its duty cycle wavered. The phase PWM output is normally very touchy when making this test so this section was not suspect.

If I raised the speed of the cylinder motor much above normal, the output of the phase PWM would default to a 50/50 duty cycle. At the same time, the duty cycle of the speed PWM output would become 100%, which results in the 5V flat line (Figure 6). When I slowed the speed of the motor to the point where the duty cycle of the speed PWM was about 20%, the machine would shut down. This shut-down function will be discussed shortly. In the shut-down mode the phase PWM output defaults to a 50/50 duty cycle and the speed PWM output will show a zero volt flat line.

What the tests showed

So far the tests had shown that the cylinder motor and its drive circuits were functioning normally. The PWM blocks seemed normal too. From this it followed that the comparators that drive the PWM blocks were normal. Since the error amps require feedback from the motor in the form of FG and PG pulses, apparently the feedback was present and correct. This ruled out the cylinder servo interface IC, and any sections of the motor drive IC associated with feedback and the Hall device. The only section left untested in the loop was the low-pass filter.

The low-pass filter

The speed PWM output is low-pass filtered by an RC network consisting of C2009 and R2007. This output is also routed via R2006 to the "cylinder lock" (pin 20) of the system control microprocessor IC6001. If the cylinder speed becomes too low for any reason, the resulting lower duty cycle with its lower average dc value will pull pin 20 of IC6001 low. The system control responds to this by forcing the machine into the stop mode. The normal voltage on this pin is about 3.2V. When it drops to about 2V, shutdown will occur.

The phase PWM output is low-pass filtered by the RC network consisting of R2008, R2009, C2010, C2011 and R2010. The two capacitors in this filter are electrolytics. I checked these first, because electrolytics are prone to failure. A plug-in circuit board assembly which held most of the voltage synthesizer circuitry had to be removed to gain access. Capacitor C2011, a 6V 100µF unit tested bad. After I replaced this capacitor and reconnected R2011, the machine ran normally.

Analysis of the problem

When the low-pass filter fails, the output of the PWM blocks won't be smoothed to the dc value. As the cylinder drive circuits attempt to follow the ac component, the motor's speed will become unstable. This causes the FG and PG pulse frequencies to fluctuate, which creates additional instability. The sluggish response of the motor limits the rate at which its speed can fluctuate.

Whenever I complete a repair, I make it a habit to take a second look at all pertinent waveforms and voltages taking notes as needed. Observing various parameters of a normally working machine will be helpful when trying to spot abnormalities in the future. Natural curiosity, a willingness to snoop and a good understanding of electronics lead to proficiency.

With the VCR in the play mode I scoped the outputs of the two PWM blocks. There were clean square waves at both pins with duty cycles of about 50% (Figure 7). The frequencies of the speed and phase PWM outputs were about 7KHz and 3.5KHz respectively. Loading the cylinder motor by applying light pressure with my finger resulted in a reduced duty cycle of both of these signals.

This concludes part two of this series on troubleshooting VCR servo systems by using voltage substitution. Using the diagnostic device or another suitable voltage source to open the loop will save time and enable you to see cause and effect relationships. ■

Computer power supplies—Part 1

By David Presnell

This two part feature takes an in-depth look at computer power supplies; what they are; how they work; how to repair them when they fail. Part one discusses what a computer power supply is, its advantages and disadvantages, and the theory behind its operation. Part two looks at procedures for diagnosing and repairing common power supply problems at the component level.

Characteristics of the computer power supply

The computer power supply is usually a switching (switch-mode) power supply. The switching power supply is designed primarily for use with digital circuits. The computer power supply must fulfill certain minimum requirements:

- It must isolate and filter noise,
- It must prevent computer signals from returning to the ac line,
- It must provide highly regulated operating voltages that are needed by the computer circuits.

In a typical IBM-compatible computer, the power sources that the supply must provide are +5V, -5V, +12V, and -12V. The 5V supply primarily powers chips located on the motherboard and some I/O cards in the computer. The 12V supply powers the motors used in disk drives and the fan, some I/O cards, and some external devices.

A description of the power supply

The power supply is located inside the computer case as a separate component. The supply is contained in its own metal case with external connectors. This case helps provide necessary shielding for both the computer and the ac line. Most of today's supplies have a fuse mounted internally, but some have a fuse mounted in the supply case for easy removal.

A fan mounted at the rear of the supply case provides cooling for the supply and other computer components. This fan operates on +12V. Also on the rear of the case is a 120V/220V switch to select proper input voltage for the computer. This should be set for 120V operation in the United States.

Some power supplies have a case-mounted DPDT switch, and some have a switch mounted on a cable that connects to the front of the computer case. This type of supply will usually have four or more external four-pin female connectors to power floppy disk and hard disk drives. The supply will also have two six-pin connectors, called P8 and P9, that plug into the motherboard. P8 and P9 are always plugged in so that the black ground leads are side-by-side when mounted on the motherboard.

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

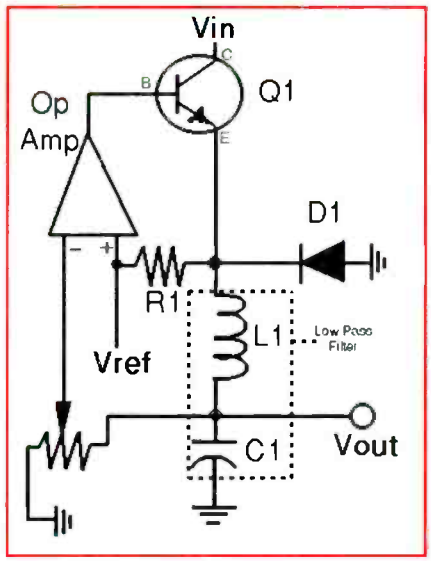


Figure 1. This switching circuit is known as a self-oscillating regulator. The transistor Q1 used in this circuit is commonly known as a pass transistor. L1 and C1 form a low pass filter. When Q1 is off, the current stored in L1 and C1 during Q1's last on state, becomes the source of load current. The diode D1 gives the inductor current a return path, and it is often known as a freewheeling diode.

Advantages of the switching power supply

The use of the switching power supply in computers provides many advantages over linear power supplies. The switching power supply operates directly from the ac line. It has no large iron-core transformer to step-down voltages, as does a linear supply.

Because there is no transformer, the supply weighs less, is smaller in size, generates less heat, costs less, and is more efficient. Switching supplies can operate with a variety of input voltages and frequencies. Input voltages can range from 110Vac to 120Vac or 220Vac to 240Vac. Operating frequencies can range from 47Hz to 63Hz without any change in the operation of the supply. The switcher provides multiple voltages more efficiently than does a linear supply.

Some disadvantages

The switching power supply has some disadvantages that must be considered. First, because the switcher does not have a step-down transformer, it is not isolated from the ac line, and therefore can be more dangerous to service. Always use an isolation transformer to power a switching power supply being serviced to

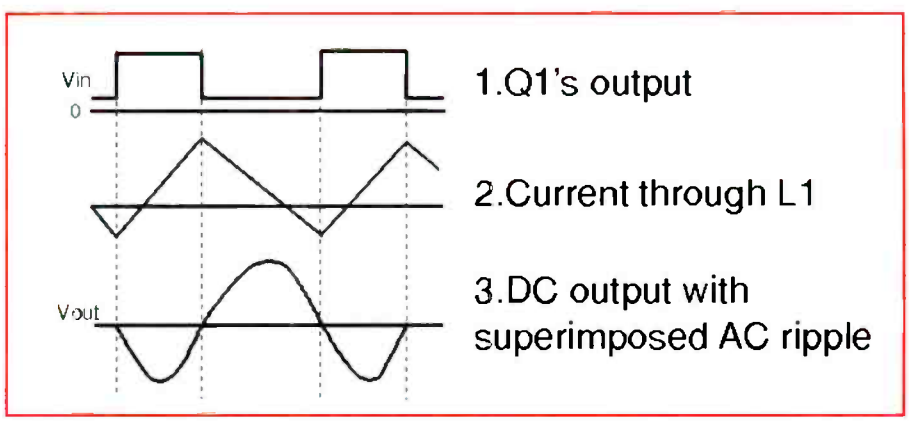


Figure 2. The self-oscillating regulator of Figure 1 will produce an output signal that looks like this.

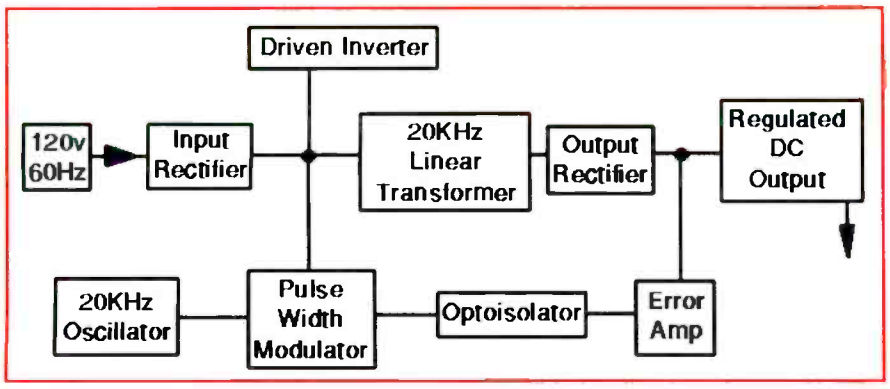


Figure 3. This block diagram of a typical computer power supply bears a family resemblance to circuit in Figure 1.

protect you from the power line.

Second, the switcher produces high frequency signals that can get into the ac line and interfere with other electronics products. These signals are hard to filter, but modern technology has provided FCC approved switching supplies that do the job of filtering quite well. There are many supplies available that are not FCC approved or UL listed. Avoid using any such supply as a replacement in your customers' computers.

Switching theory

Let's look at the theory behind a switch as used in a switching power supply. In the computer power supply, a transistor acts as a switch. The ideal situation would be one in which the transistor has infinite off-resistance and zero on-resistance. Ideally, this transistor would switch in zero time.

This switching must take place at very high frequencies (which would cause noise and interference on the ac line because of stray coupling). A linear (non-switching) supply generally operates at close to zero frequency.

A simple switching power supply circuit

Adding an inductor, capacitor, and a freewheeling diode to a linear supply will result in a simple switching circuit (Figure 1). The switching circuit shown in Figure 1 is known as a self-oscillating regulator. Transistor Q_1 is commonly known as a pass transistor. Inductor L_1 and capacitor C_1 form a low pass filter. When Q_1 is off, the current stored in L_1 and C_1 during Q_1's last on state, becomes the source of load current. Diode D_1, which gives the inductor current a return path, is often known as a freewheeling diode.

A small sample of voltage at the junction of R_1 and the emitter of Q_1 is applied to the noninverting terminal (+) of the op-amp. This results in positive feedback. Also, dc negative feedback is produced at the same time due to the sampling of the dc output voltage by the inverting terminal (-) of the op-amp. This circuit oscillates at a rate determined primarily by L_1 and C_1 because of simultaneous feedback produced within the circuit. As a result, the noninverting input of the op-amp is driven equally above and below V_{ref}.

Switching regulation

If the output voltage drops, Q_1 will remain on longer to equalize the voltage with V_{ref}. If the output voltage rises, Q_1 will remain off longer to equalize the voltage with V_{ref}. Thus, V_{ref} is alternately increasing and decreasing. This causes a ripple at the switching frequency to be superimposed on the dc output voltage (Figure 2). This ripple is usually filtered with another inductor and reduced to acceptable levels.

Switching rates of the switching power supply can vary from 20KHz to 120KHz. As the frequency of the supply goes up; size, weight, and costs go down. An IC regulator, such as the LM105, can be added to the simple circuit in Figure 1 to improve the dc output voltage stability, reduce ripple, and allow increased switching speed. A large inductor, both before and after the regulator, can reduce ripple to nearly zero.

Using too small an inductor for L_1 would increase the ripple current at V_{out}. This could also cause Q_1 and D_1 to carry currents in excess of what might be required by the load. An abnormal or excessive ac ripple at any of the dc outputs of the computer power supply could indicate a problem with any inductors or filter capacitors involved (a short changing the value), which could cause high current levels across switching transistors and diodes causing them to heat up (hot to the touch) or fail completely.

Input section

The switching supply does away with the 60Hz transformer. A smaller, lighter, less expensive 20KHz (or higher frequency) transformer is built into the switcher. An optoisolator is sometimes used to isolate the supply to a level almost equal to that of a linear supply. The computer supply must still be considered non-isolated by the servicing technician, however.

Figure 3 is a block diagram of a typical computer power supply. Study this diagram before you continue. You should begin to see a relationship between the circuit in Figure 1 and the diagram in Figure 3.

Figure 4 is a schematic diagram of a typical computer power supply input section. In the line input section of Figure 4, you will notice the off/on switch, fuse, and the NTC (negative temperature coefficient) thermistor. This thermistor has a high resistance when cold, and as it heats up its resistance decreases. The high cold resistance limits the surge of current when the supply is switched on, but when the thermistor warms up, which happens very quickly, the lowered resistance allows full line current to flow.

Capacitors C_1 and C_2 and inductor L_1 in Figure 4 form a line filter which helps filter the ac input waveform. Rectifiers D_1 through D_4 form either a full wave bridge rectifier or a full wave voltage doubler circuit, depending on how the 120V/220V switch is set. Capacitors C_2 through C_6 are filter capacitors. R_1 and R_2 keep the voltage equal across C_5 and C_6.

Transformer T_1 feeds the secondary supply (output) discussed later. T_1 is usually a 20KHz ac step-down transformer. Q_1 and Q_2 are separate switches driven by signals from the control circuits. These signals are coupled to the transistors by transformer T_2. The primary of T_1 connects from 0_V input to Q_1 and Q_2. This is an ac connection. T_1 is tuned with C_7 to be resonant at approximately the rate that Q_1 and Q_2 are switched by T_2. This assures very rapid switching of the primary current, with resulting low power dissipation in Q_1 and Q_2. This also produces a highly efficient circuit.

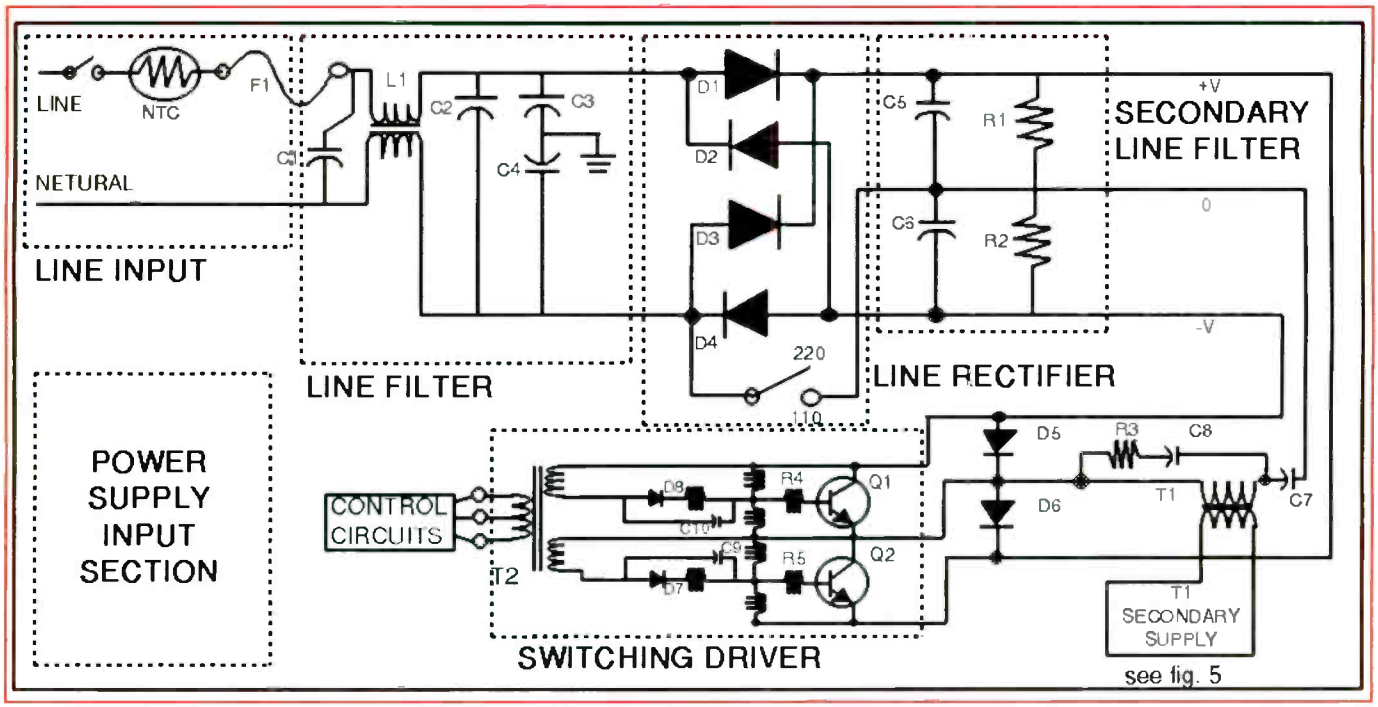


Figure 4. A typical computer power supply input section. In the line input section you will notice the off/on switch, fuse, and the NTC (negative temperature coefficient) thermistor. This thermistor has a high resistance when cold, and as it heats up its resistance decreases. This limits the surge of current when the supply is switched on.

When power is turned on, resistors R_4 and R_5 at the base of Q_1 and Q_2 provide a pulse of current at the primary of T_1. This pulse starts the oscillator control circuits operating. Once started, the control circuits drive Q_1 and Q_2. These circuits freewheel (usually around 20KHz). It is because of this freewheeling operation that the switching power supply will operate with virtually no load.

Proper operation requires a load

For the supply to regulate correctly and operate properly, however, it must operate under a load. The switcher must also be tested under load to give correct readings. The oscillator control circuits monitor the output voltages and control the oscillator (switching drivers) to regulate the outputs. These circuits may be mounted on a separate board and encased in epoxy, and are not generally serviceable.

On certain imported supplies, the oscillator control circuits are incorporated into the main power supply board on heat sinks and are repairable, if you can locate schematics and parts for the supply. However, it is often quicker and less expensive to replace the supply.

Output section

Now look at Figure 5. This schematic section starts at T_1 on Figure 4. Diodes SD_1 and SD_2 are often Schottky diodes mounted on heat sinks. These diodes rectify the +5V and +12V supplies. Diodes D_9, D_{10}, D_{11}, and D_{12} are used to rectify the -5V and -12V supplies. Inductors L_2, L_3 and L_4 and the large choke LF_1 are used to filter any remaining superimposed ac ripple from the outputs.

These outputs are normally +5V, -5V, +12V and -12V under load. Typical rated output of these supplies is 150W to 250W. The average full-power current capability of these supplies is 20A on the +5V line, 5.5A on the +12V line, 0.6A each on the -5V and -12V lines.

Repair or replace

When you locate a faulty power supply in a computer, you need to decide whether to repair or replace it. You cannot afford to spend several hours trying to repair a "dog" when a replacement will cost less in both time and parts. However, you can quickly open the supply and perform a few simple tests to see if it would be cost effective to repair the supply.

It may be nothing more than a fuse or a shorted input rectifier; very common problems in all power supplies.

Part 2 of this article looks at procedures for locating and repairing defective components without a schematic, and some of the cost effective repairs you can make to these supplies. ■

Integrated circuit packages

By Victor Meeldijk

As semiconductor devices become more and more complex, with some containing as many as 10,000 gate arrays and over a million transistors, the interconnections from the die to the circuit hardware keep evolving in order to keep pace.

While there are standards for some IC packages, such as the dual-in-line packages and the TO registered JEDEC packages, there are many other IC package styles, some initially unique to the vendor that developed them. For example, in 1990 Intel Corporation developed the molded plastic quad flat package (MM-PQFP) and the land grid array LGA.

The MM-PQFP enhances the electrical performance of the molded lead frame by incorporating isolated ground and power planes within the molded body. The LGA is a standard co-fired ceramic package like a pin grid array, except instead of pins there are gold plated pads (that are called landing pads).

A quick look at a few consumer electronics products will reveal an amazing variety of IC types. A look at the service literature for those products will reveal an extensive vocabulary of abbreviations of IC types. We present this list of IC package types to familiarize readers with devices that they may have encountered, or may one day encounter.

JEDEC

JEDEC is the Joint Electronic Device Engineering Council, a subdivision of the EIA (Electronic Industries Association). All JEDEC semiconductor outlines are included in their Publication 95.

The following information about storage and use of ICs is really more applicable to manufacturers who use ICs in their products. However, this information may be of interest to some service centers, so we include it here.

IC's can be shipped in tubes, tape and reel or in trays. Plastic parts shipped in sealed bags with desiccant usually are designed for a 12-month storage and should only be opened when the parts are used.

Meeldijk is Reliability/Maintainability Engineering Manager, Diagnostic/Retrieval Systems

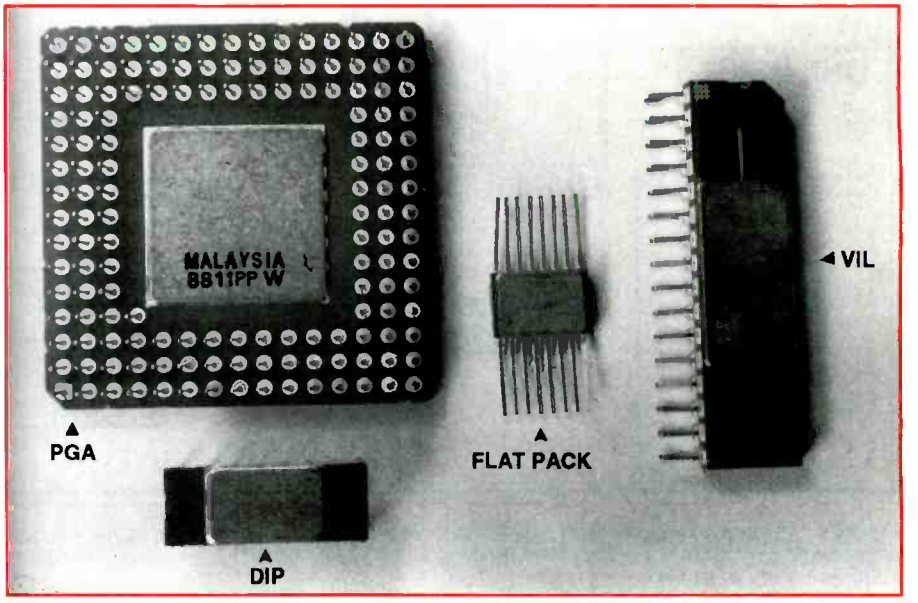


Figure 1. Advances in IC technology, and the needs of todays electronics circuitry, have led to the design and fabrication of IC packages such as the ones shown here.

Parts stored for longer than this time, especially PQFP packaged devices, should be baked to remove moisture that has entered the package (plastic packages are hydroscopic and absorb moisture to a level dependent upon the storage environment). This moisture can vaporize during rapid heating, such as in a solder reflow process and these stresses can cause package cracking. Subsequent high temperature and moisture exposures can allow contaminants to enter the IC and cause failure at a later time due to corrosion.

If you should ever find it necessary to rebake components to remove moisture, bake them at 40C (+5C to 0C) at less than or equal to 5% relative humidity for 192 hours if the parts are baked in the original shipping tubes. If they are installed in high temperature burn-in trays, they can be baked out at 125C for 24 hours.

Generally, devices can be rebaked at the lower temperature as many times as necessary. The high temperature rebake should only be done once. Consult the device manufacturer for details on proper device handling.

Some IC packages, both standard and non-standard

In the early days of integrated circuits, just a few years ago, there were only a handful of package types that electronics technicians needed to be aware of. The number of package types has grown rapidly. Here are descriptions of some of them.

- **Batwing:** a package (sometimes a DIP type) with two side tabs that provide for heat dissipation.
- **Bumped chip:** see flip chip.
- **CC:** chip carrier.
- **CERDIP:** ceramic dual-in-line package (a ceramic DIP). The DIP package was developed by Fairchild Semiconductor and was used for DTL (diode-transistor logic) devices purchased by Hughes for the Phoenix Missile System. Texas Instruments followed with a metal topped ceramic package that resolved problems with the early ceramic packaged parts.
- **Cerpack:** a flatpack composed of a ceramic base and lid. The leadframe is sealed by a glass frit. A frit is a sort of glass washer that is placed between the base and lid of the IC, then fused at a high temperature to form a hermetic seal. The term "frit" refers to the fusing of the glass.
- **Cerquad:** a ceramic equivalent of plastic leaded chip carriers consisting of

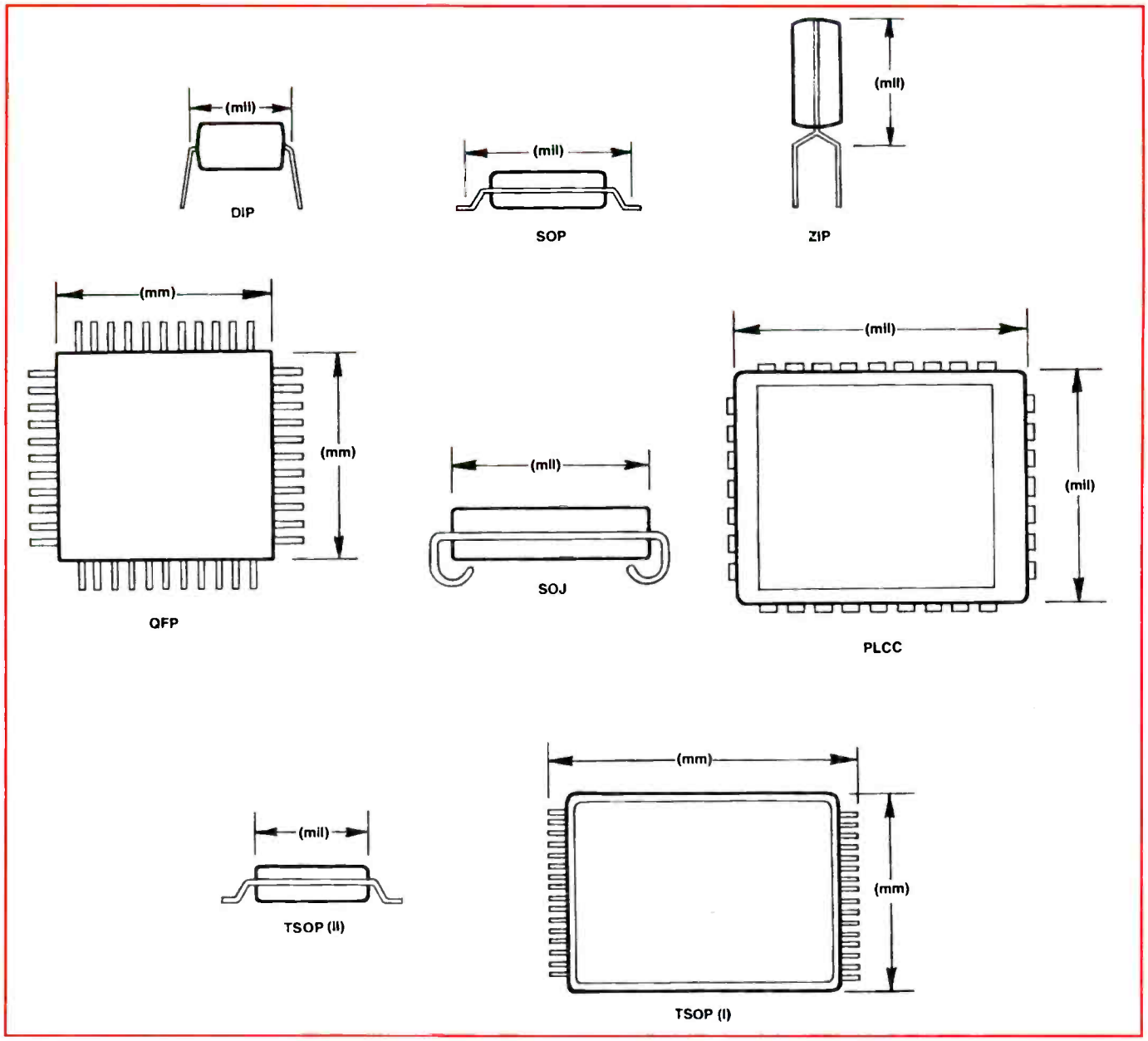


Figure 2. These IC package drawings illustrate some of the package shapes, and give a rough idea of the magnitudes of the packages.

a glass sealed ceramic package with "J" leads and ultraviolet window capability.

• **Chip carrier:** a rectangular or square package with I/O connections on all four of the sides.

• **CLDCC:** ceramic leaded chip carrier.

• **CLCC (or CLLCC):** ceramic leadless chip carrier. See LCCC; leadless ceramic chip carrier.

• **COB:** chip on board; a device for which the die is mounted directly on the printed circuit substrate (or board). See TAB and TCB.

• **CPGA:** ceramic pin grid array.

• **CPLD:** complex programmable logic devices. Generally the difference between a CPLD and a FPGA (field programmable gate array) is that the CPLD has an erasable and reprogrammable memory (and therefore can be tested and reprogrammed). CPLD's are also usually dense (with pin counts to 288 pins) and faster than FPGA's.

• **CQFP:** ceramic quad flatpak; an aluminum ceramic integrated circuit package with four sets of leads extending from the sides and parallel to the base of the IC. EIAJ approved sizes are 20mm x 20mm and 28mm x 28mm packages. Pin counts include 80, 100, 144, 160 and 208 pins. Parts are available with and without formed leads.

• **CSOJ:** ceramic small outline that contains "J" leads.

• **DIL:** dual-in-line package.

• **DIP:** dual-inline package; 8, 14, 16, 20, 24, 40 up to 68 pin packages (although more than 75% of DIP devices have 14 to 16 pins), 0.100mil pin spacing with width anywhere from 0.300mil centers to 0.900mil centers. There is also the skinny (or shrink) DIP (SDIP) which is a

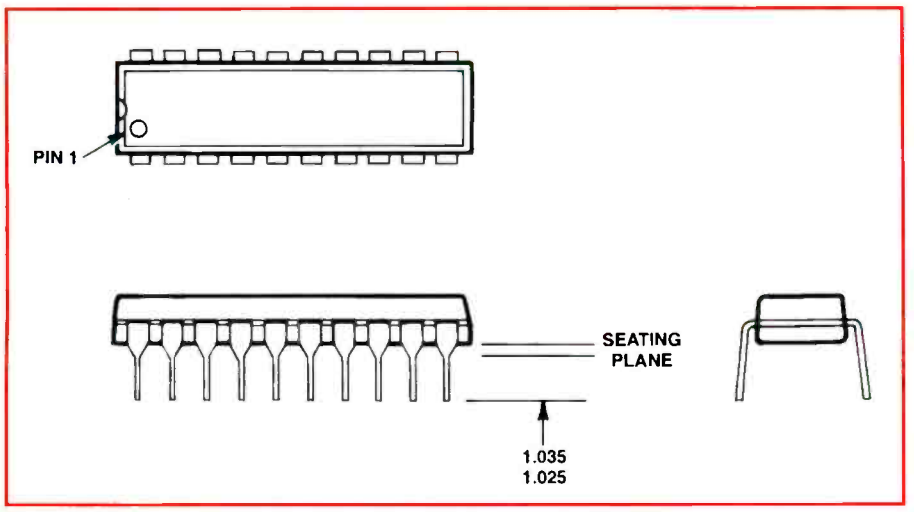


Figure 3. The 20-pin plastic dual-in-line package (PDIP) was one of the early, and still popular, types or IC package.

0.300mil center part (spacing between the rows) versus a part originally introduced as a 0.600mil center packaged device.

The SDIP usually has 24 to 28 pins. May be a ceramic DIP (pins go through a glass frit seal), sidebrazed DIP (pins are brazed onto metal pads on the side of the package) or plastic DIP (where the die is molded into a plastic package). There is also a shrink DIP.

• **Flatpack (also known as quad flatpack):** one of the oldest surface mount packages. Typically flatpacks have leads on both sides of the body on 0.050 inch centers. Most packages have from 14 to 50 flat ribbon leads. Mostly used on military programs.

• **Flat SIP:** a SIP package, except that the leads have a 90° bend.

• **Flip chip:** a semiconductor package where the I/O terminations are in the form of bumps on one side of the package (also called bumped chip). After the surface of the chip has been passivated, or treated, it is flipped over and attached to a matching substrate. Flip chip (C4) refers to controlled collapse chip connection.

• **FRAMM:** flexible-rigid-assembly memory module; a memory packaging scheme by Memory X, Inc., in San Diego CA. FRAMM modules use a combination of rigid and flexible PC board assemblies, with the flexible board interconnecting two rigid PC boards. The modules have standard JEDEC 30 and 72 pin SIMM outputs. TSOP DRAMS are mounted on both sides of the rigid PC boards.

• **GCC:** gull winged leadless chip carrier. The gull wing solder joint is easy to inspect, but the solder joint is in shear, and is slightly weaker than the "J" lead solder joint (see JCC).

• **Gull wing:** an IC in which leads exit the body and bend downward then outward, resembling a seagull in flight. They are typically used on an SO (small outline) package. They are however, very fragile, easily bent and difficult to socket for testing or burn-in. "J" leaded chips do not have these problems.

• **HCC:** hermetic chip carrier.

• **HDIP module:** a hermetic DIP module has hermetic components mounted on the top and bottom of a ceramic substrate. This package style is generally used in anticipation of a monolithic part which will be available at a later time which will fit the same footprint as the module. Typical examples are memory devices where lower capacity parts are combined before a single higher density part is available.

• **HD-PQFP:** a term originated by the Intel Corporation to indicate a PQFP package with greater than 196 leads and a pitch of 0.4mm.

• **H-SOT:** hermetic SOT packaged electronic component.

• **HVDIP module:** hermetic vertical DIP. This is a vertically mounted ceramic module with pins along both edges for through-hole mounting. The components used in this module are hermetically sealed. Pins on opposite sides of the module are aligned and on 0.100 inch spacing.

• **"I" lead:** IC leads that are formed perpendicular to the printed circuit board making a "butt" solder joint.

• **"J" leads:** leads that are rolled under the body of the package in the shape of the letter "J". They are typically used on plastic chip carrier packages. Unlike gull wing leads, they are protected from bending and are easy to socket, but this lead form is more difficult to manufacture and produces a higher profile part.

• **JCC:** "J" bend leads, leaded chip carrier. The "J" lead is stronger than the gull wing lead, but it is harder to inspect the solder joint with this lead.

• **LCC:** leadless chip carrier. This chip package has I/O pads that are on the perimeter of the package. The package types include ceramic packages with hermetically sealed metal lids. Cavity up (lid up) or cavity down (lid down) orientations are available depending on how the part is to be mounted for thermal heat sinking. Cavity up packages have the back of the die in contact with the substrate, so that heat is dissipated through the substrate.

This type of package (JEDEC B and C ceramic packages) is not suitable for air-cooled systems or for the attachment of heat sinks. Lead spacing of 0.050 and 0.040 is common but there are also 20, 25 and 33 mil center packages for fine pitch.

Cavity down parts have the die facing away from the substrate. This design is suitable for air cooled systems (JEDEC A and D ceramic packages fall into this category). Leadless E and F ceramic packages are rectangular and are intended for memory devices. They are designed for attachment with the lid up. The heat is dissipated through the substrate.

• **LCCC:** leadless ceramic chip carrier (or ceramic leadless chip carrier, CLCC). JEDEC registered type A LCCCs must be socketed (when used on a printed circuit board or a ceramic substrate board), and type B must be soldered. The LCC minipack must be soldered on to printed circuit boards.

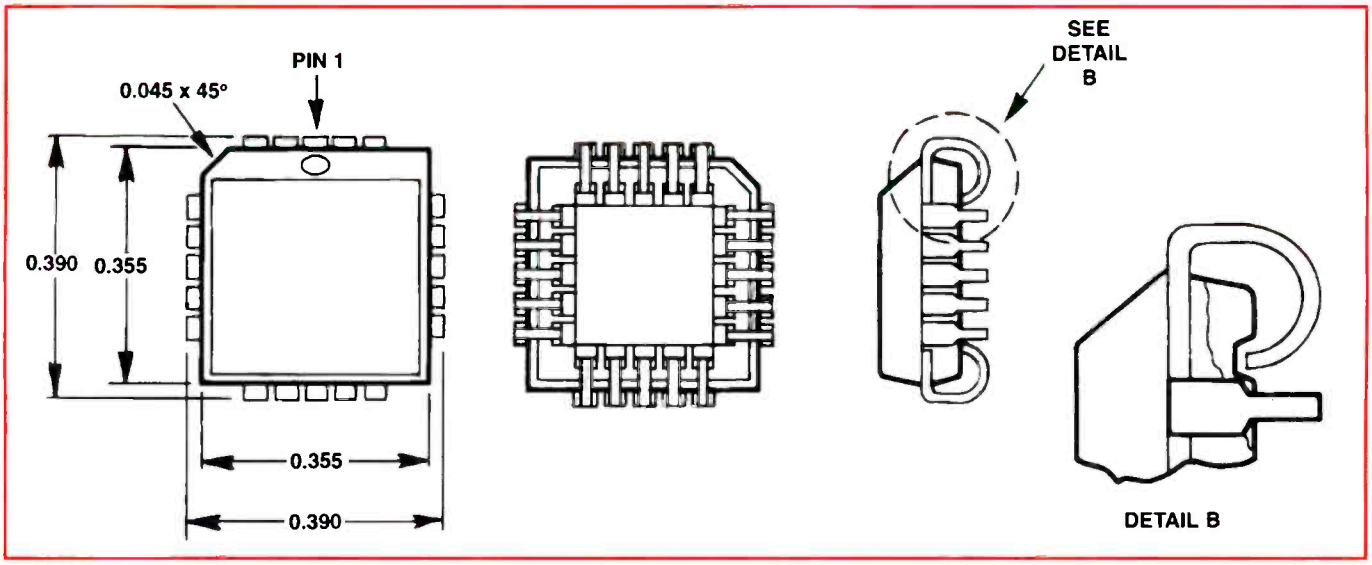


Figure 4. The J-lead plastic chip carrier (PLCC) has leads that exit the body then turn under the component in a curve that resembles the letter J. The leads and the solder joints are relatively strong, but because the solder pads are under the package, removal of these ICs during service can be a problem.

• **LDCC:** leaded ceramic chip carrier. When leadless ceramic chip carrier packages (JEDEC types A, B, C or D) are mounted with leads for direct soldering to a substrate they are called leaded type B parts. Leaded type B parts can not be socketed because of the nature of the lead configuration. They have to be soldered directly to the board.

Leaded type A parts include sub-categories: leaded ceramic (and premolded plastic and postmolded plastic which are not designated as LDCC devices). All type A packages can be either socketed or soldered directly to the substrate.

• **LGA:** land grid array, an Intel package used for parts like the 80386L microprocessor. This package is like a PGA except that instead of pins there are gold plated pads (called landing pads).

• **LID:** leadless inverted device; a shaped metallized ceramic form used as an intermediate carrier for the semiconductor chip (die). It is especially adapted for attachment to conductor lands of a

thick film or thin film network by reflow solder bonding.

• **Little Foot:** a trademark of Siliconix, a tiny SOIC package.

• **LLCC:** leadless ceramic chip carrier.

• **LMM:** leaded multichip module (LMMC is the abbreviation for a leaded multichip module connector).

• **MCM:** multichip module; a circuit package with SMT IC chips mounted and interconnected via a substrate, which is like a multilayer PC board except that instead of FR-4 the dielectric is a polymer. This package was first standardized by JEDEC JC-11 committee.

The dielectric substrate can be either laminate, ceramic or thin film. MCM devices inherently offer higher speed and performance at lower costs of conventional devices. MCM modules for military uses fall under MIL-H-38534.

• **MFP:** mini flat package (used by various companies including Sharp Electronics Corp. and NEC Electronics).

• **Miniflat:** a flat package (approximately 0.102 to 0.113 inches high (2.6 mm to 2.85 mm) which may have leads on two or four sides of the package (this package is used by various companies including Sharp Electronics Corporation and NEC Electronics, Inc.)

• **MM:** multilayer molded package; a PQFP package developed by the Intel Corporation that includes separate power and ground planes to significantly reduce power and ground capacitance (thus improving high speed device operation).

• **MQFP:** metal quad flatpack. Among the packages the EIAJ has approved is a 14mm x 20mm package.

• **PDIP:** plastic DIP.

• **PGA:** 1) pin grid array; a square package with pins covering the entire bottom surface of the package. Lead pitch is either 0.1 or 0.05 inches perpendicular to the plane of the package. Packages have various pin counts (68 or more), and can be either plastic or ceramic. The chip can be placed opposite the pins (cavity up) or nested in the grid array (cavity array).

2) programmable gate array.

• **PLCC (also known as PLDCC or a quad pack by some manufacturers):** plastic leaded chip carrier, 18, 20, 28, 32, 44, 52, 68 and 84, up to 100 pin packages, commonly 0.050 pin spacing. Unlike DIPs and SOICs, pin 1 is at the top center, when there is an odd number of pins on each side, or one to the left of center when there is an even number of pins on each side.

In larger PLCC packages, pin 1 can also be at the top left hand corner of the package, the corner with the beveled edge. The location of pin 1 is confirmed by a dot in the molding and the progression of the pin count continues counterclockwise. The leads are "J" shaped and protrude from the package. These parts can be either surface mounted or socketed. (This package was originally known as a postmolded type A leaded device.)

• **PMP:** premolded plastic package.

• **PPGA:** plastic pin grid array.

• **PQFP:** plastic quad flatpack. This JEDEC approved package is used for devices that have 44 to 256 I/O's. 100 (20 x 30), 120 (30 x 30) and 160 (40 x 40) pins,

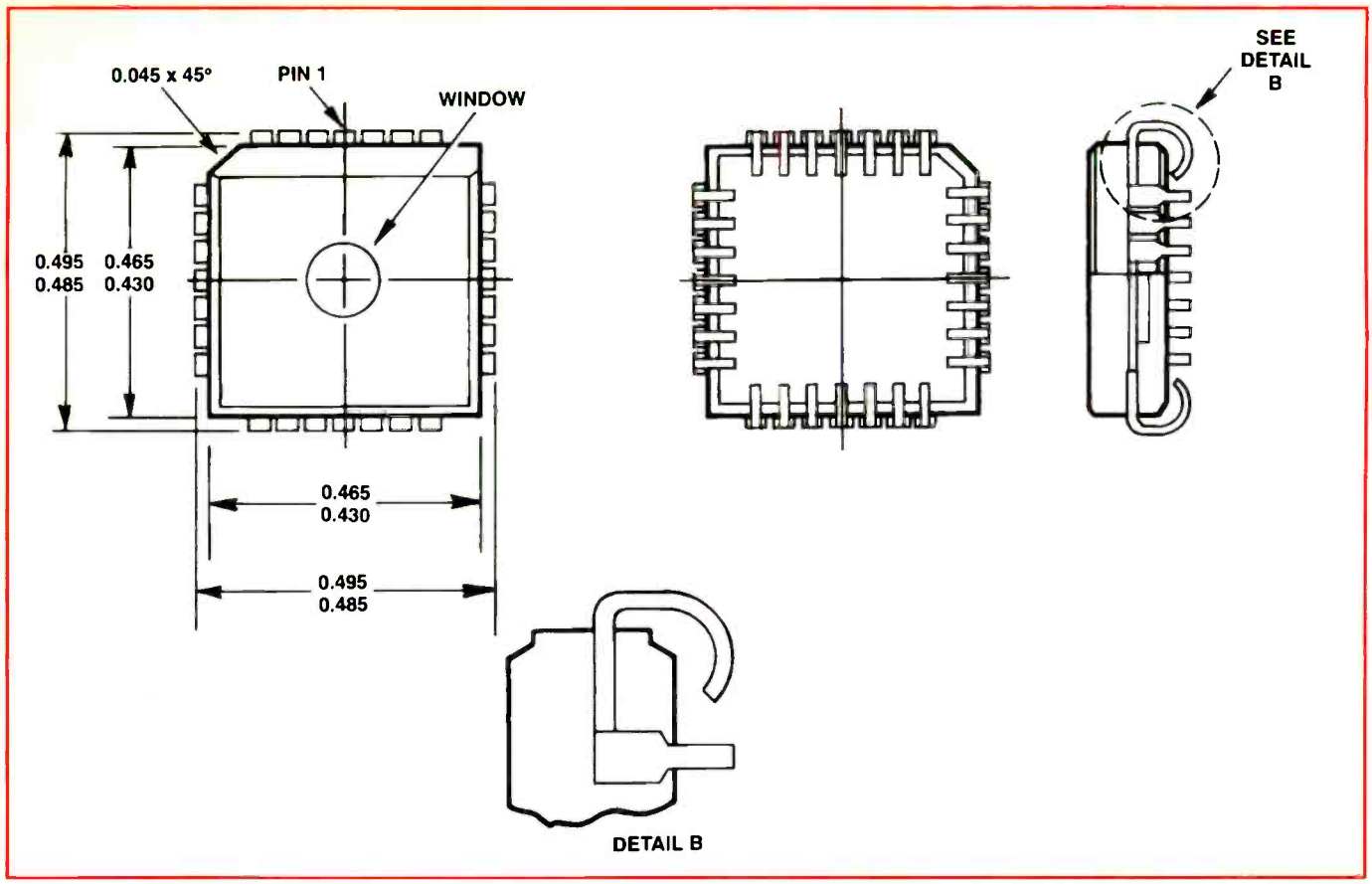


Figure 5. The J-lead ceramic chip carrier (JLCC) is similar to the PLCC shown in Figure 4, except that instead of plastic, the body is made of ceramic material. Ceramic ICs are found in military applications where the package must be hermetically sealed.

0.025 lead spacing is found on EIA-JEDEC packages, 0.0256 and 0.0316 spacing is on EIAJ approved packages. There is also 0.0135 pin spacing. This package has gull wing leads on all four sides and is characterized by bumpers on the corners. The body is slightly thicker than the QFP. PQFP packages are susceptible to moisture induced cracking in applications requiring reflow soldering.

• **PSMC:** plastic surface mount component IC package.

• **PUMA II:** pinned uncommitted memory array. A PGA package ASIC (application specific integrated circuit) memory array with four 32 pad LCC sites on top of a 66 PGA. Each of the four sites can be individually accessed via a chip select signal thus allowing a user definable configuration (i.e., x8, x16, x24, x32). It provides for an ASIC memory array without tooling. The substrate is a multilayered co-fired alumina substrate with three rows of 11 pins.

There is a channel between the pins so the part can be used with a heat sink rail (or ladder). In a recess in this channel are mounted on board decoupling capacitors. This type of device is available from various companies including Mosaic Semiconductor (1.12 by 1.12 inch square), Cypress Semiconductor (their 66 pin PGA module the HG01 is 1.09 by 1.09 max), and Dense-Pac Microsystems (Veraspac or VPAC family, 1.09 by 1.09 max.).

• **QIP:** quad-in-line package.

• **QFJ:** quad flat "J" leaded package.

• **QFP:** quad flatpack; a flatpack with leads on all four sides. The typical JEDEC approved pinouts are 100, 132 and 196. Lead pitch varies from 0.040 to 0.016 inches. The QFP family is standardized by EIAJ and conforms to metric standards. The EIAJ types are slightly thinner than the JEDEC equivalents.

• **QPL:** qualified parts list; relates to a list of manufacturers that can supply a part that is qualified to a certain military specification. For IC's this would be QPL-38510-XX, where the XX is the issue of the document.

• **QQFT:** quarter quad flat pack.

• **QSM:** quad surface mount.

• **QSOP:** quarter size SOP (small outline package).

• **Quad pack:** see PLCC.

• **QUIL:** quad-in-line package.

• **QUIP:** a quad-in-line package. This package is similar to a DIP except the QUIP has a dual row of pins along the package edge. Row to row spacing is 0.100 inches, with adjacent rows aligned directly across from each other.

• **SCC:** square (body) chip carrier.

• **SCOT:** sealed chips on tape; chips mounted on tape supported leads and sealed (usually with a blob of plastic).

• **SDIP:** skinny (or shrink) DIP.

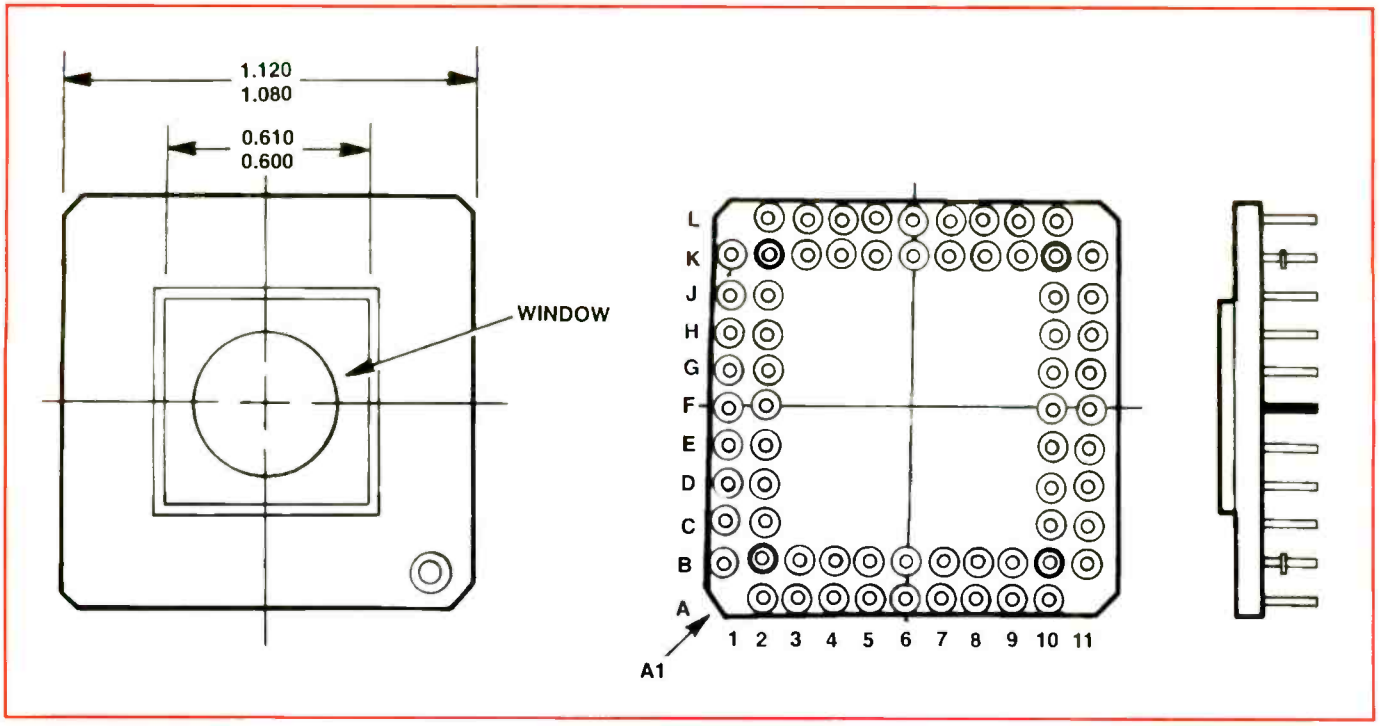


Figure 6. A pin grid array (PGA) is a square package with pins covering the entire bottom surface of the package.

• **Shrink DIP:** a dual-in-line package with 24 to 64 pins with 0.070 inch spacing between the leads.

• **SIL:** single-in-line.

• **SIM:** single-in-line module; a module to which connections are made to a row of conductors along one side.

• **SIMM:** single-in-line memory module; an assembly containing memory chips. The bottom edge of the SIMM, which is part of the substrate material, acts as an edge card connector. SIMM modules are designed to be used with sockets, which may hold the SIMM upright or at an angle, which reduces the height of the module on the circuit board.

Typical SIMM parts are 4 x 9 (4Mbyte memory by 9), 1 x 9, 1 x 8, 256 x 9 and 256 x 8 (9 bit data width SIMM Modules are produced under license to Wang Laboratories who developed the SIMM module and socket in the early 1980's as an inexpensive memory expansion for a small secretarial workstation).

• **SIP:** single-in-line package; a vertically mounted module with a single row of pins along one edge for through hole mounting. The pins are 0.100 inches apart. There are SIPs with heatsinks.

• **SK-DIP:** skinny DIP. See also SDIP.

• **Slam pack:** a square ceramic package, that looks like an LCC, that is always used with a socket.

• **SLCC:** stackable leadless chip carrier. Developed by Dense-Pac Microsystems, CA, this is a multidimensional module consisting of stacked chip carriers. Stacking is accomplished by aligning the packages together and tin dipping each of the four sides. SLCC can achieve a density of 40:1 over conventional packages.

• **SO:** small outline (with versions such as SO wide, SO narrow or SO large). This design originated with the Swiss watch industry in the 1960's (and was reportedly nicknamed SO for Swiss Outline) and was used in the modern electronics industry by N.V. Philips (Signetics in the U.S.) in 1971. This package is also known as a mini-flat (which has slightly different dimensions than the JEDEC parts) by the Japanese.

• **SOIC:** small outline IC (integrated circuit), 8, 14, 16, 20, 24, and 28 pin packages, commonly 0.050 pin spacing, with gull wing leads. The pin orientation is the same as for DIPs; pin one is at the top left hand corner of the package and progresses counterclockwise. This package style is about 50% to 70% of the size of a standard DIP part (30% as thick), and is surface mounted.

• **SOJ:** small outline package with "J" leads on two sides. The leads are bent back around the chip carrier.

• **SOL:** small outline large; generally refers to a package 0.300mils wide versus 0.150mils wide (for an SO package).

• **SOP:** small outline package; a package with two rows of narrowly spaced gull-wing leads.

• **SOT:** small outline transistor; a plastic package originally for diodes and transistors but also for some IC's (for example surface mounted Hall effect sensors).

• **SOW:** small outline wide. See SOL.

• **SQFP:** shrink quad flatpack; typically a 64-pin small quad flat package (1/4 height of QFT), also known as QQFT: quarter quad flat pack.

• **SSM:** square surface mounting.

• **SSOP:** shrink small outline package;

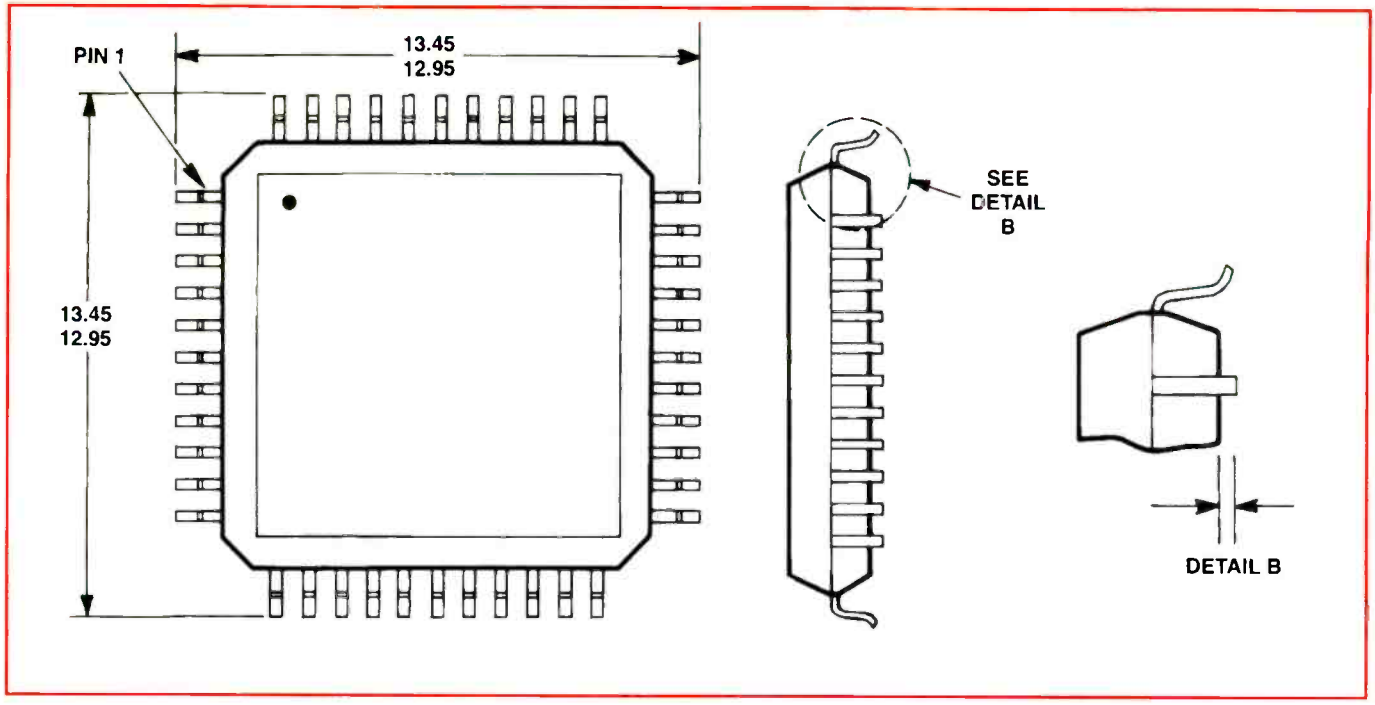


Figure 7. A plastic quad flatpack (PQFP) is a JEDEC approved package for devices that have 44 to 256 I/O's. 100 (20 x 30), 120 (30 x 30) and 160 (40 x 40) pins. The package has gull wing leads on all four sides and is characterized by bumpers on the corners. The body is slightly thicker than the QFP.

various pin outs (28, 48 and 56).

• **SQFP:** shrink quad flat package. A QFP with 0.016 inches spacing between the leads or less.

• **SSOIC:** shrink small outline IC. A plastic package with gull-wing leads on two sides, with a lead pitch equal to or less than 0.025 inches.

• **TAB:** tape automated bonding.

• **TCP:** tape carrier packages, formerly called TAB packages. The chip is mounted to a dielectric film, which has copper foil connection patterns on it. The chip is sealed with a resin compound. This device assembly is mounted directly to a circuit without a plastic or ceramic package. This contrasts with a COB (chip on board) part which is a bare IC chip directly mounted on a printed circuit board.

• **TCR:** tape carrier ring, or a guard ring package, similar to the TCP package but includes a plastic ring to support the outer rings during test, burn-in and shipment.

• **TO-XX:** transistor outline-XX. Refers to a package style registered with JEDEC.

• **TQFP:** thin QFP. Typical sizes are 1.0mm and 1.4mm body thickness in sizes ranging from 10mm x 10mm to 20mm x 20mm and lead count from 64 to 144 leads.

• **TSOP:** thin small outline package. The Type 1 plastic surface mount parts have 0.5mm gull wing leads on the edges of the parts (the shorter dimension) rather than along the sides (the longer dimension). The Type 2 parts have the leads on the longer dimension. These packages are generally used for memory ICs.

• **TSSOP:** thin shrink (or sometimes called scaled) small outline package; half the height of a standard SOIC.

• **VDIP module:** vertically mounted modules with plastic encapsulated com-

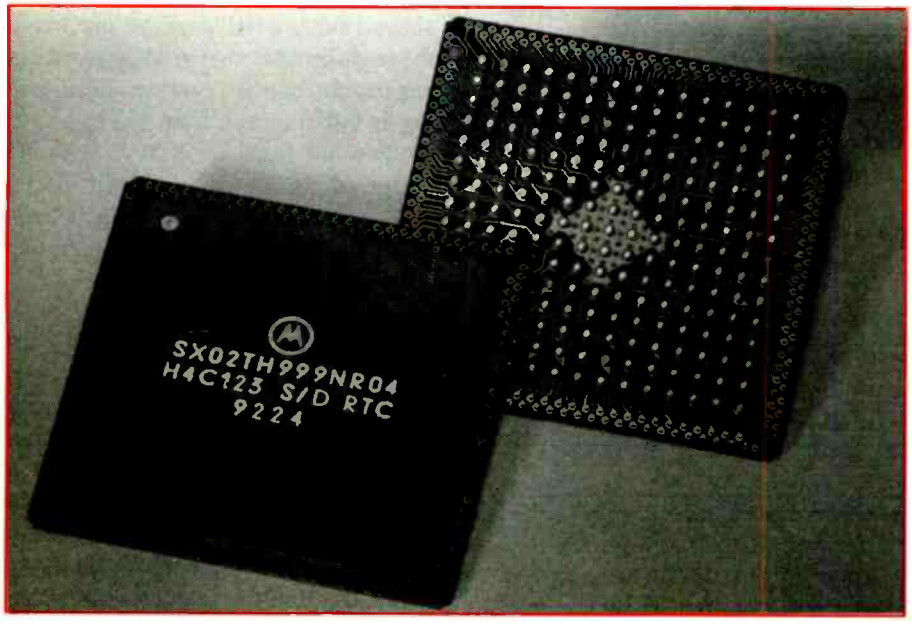


Figure 8. This IC package, the OMPAC ball grid array, comes with solder balls attached to the connectors. It is placed on the PC board and the solder reflowed. Fortunately, these ICs, which would be all but impossible for a consumer electronics service center to handle, are not used in consumer products. (Photo courtesy Motorola)

ponents and epoxy encapsulated chips on them. VDIP modules have pins along both sides of the substrate, with the pins on the alternate sides aligned. Spacing between pins is 0.100 inches.

• **VIL:** vertical in line package.

• **VPAK:** vertical mount package; a package conceptually like a zig zag package (ZIP) except instead of through hole leads it has surface mount leads (L shaped Leads). This package was introduced by Texas Instruments in late 1991.

• **VQFP:** very small quad flat package; lead pitch is 0.5mm, 32, 48, 64, 80, 100, 128 and 208 pins per package.

• **VSO:** very small outline, usually used to denote 25mil pitch packages with gull wing leads.

• **VSOP:** very small outline package; with 25mil spaced leads at the ends (also TSOP and SSOP and SSOIC).

• **Wafer Dice:** the wafer with all the IC dice on it before it is cut up into individual dice.

• **Waffle pack:** individual IC dice are in a package that resembles a waffle, with each die in its own cavity.

• **ZIP:** zig-zag in-line package. Based upon manufacturer literature this is considered either a DIP package, that has all the leads on one edge in a staggered zig-zag pattern, or a SIP package. Lead spacing is 0.050 inches from pin to pin. In modules the leads are on both sides in a staggered zig-zag pattern. Lead spacing is 0.100 inches between pins on the same side (or 0.050 inches from pin to pin).

Package use

The hermetic packages (metal cans, ceramic and cerDIP packages) are used in harsh applications (such as military and space applications) where water vapor and contaminants can shorten the life of the device. The metal packages, with glass seals, provide the highest level of hermetic sealing followed by glasses and ceramics. For thermal considerations, aluminum oxide, the most commonly used ceramic material, has a thermal conductivity that is an order of magnitude less than that of a plastic packaged device.

Ten TV color problems

By Homer Davidson

In early color television circuits, the color bandpass, oscillator and amplifier circuits were fabricated using discrete semiconductors. Today all of the color circuits may be included in a single IC along with the luminance processing circuits. Television color problems, however, remain the same: poor color, intermittent color, absence of color, color bars, and missing color signal (Figure 1).

Make sure that the black and white picture is good before attempting to service the color section. Don't open up the set and begin testing until you first readjust the color and tint controls. Also, observe the picture to see if the problem is absence of color, intermittent color, or color bars. Once you have ascertained the nature of the problem, troubleshoot the color IC circuits with voltage measurements and observation of oscilloscope waveforms.

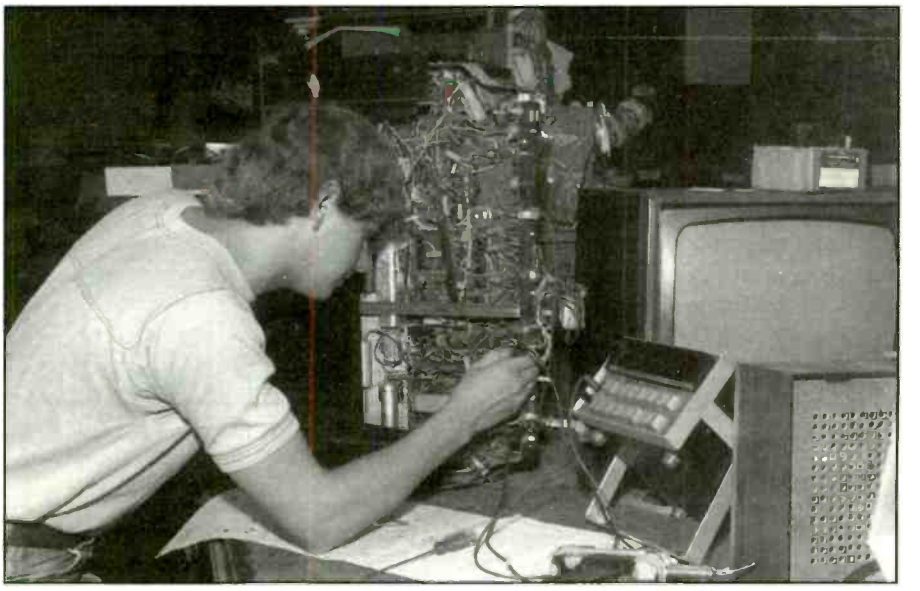


Figure 1. Voltage measurements in the color circuits can help to determine the cause of color problems.

Some technicians prefer to measure critical voltages before observing waveforms with the oscilloscope. In most cases, the schematic indicates the specified voltages and waveforms on each IC terminal. Although the color circuit waveforms can be observed when the input to the circuits is a color broadcast signal, use a color dot-bar generator connected to the antenna terminals as a source when you want to check critical color waveforms.

Most problems that originate in the color circuits are caused by a defective com-

Davidson is a TV servicing consultant for ES&T.

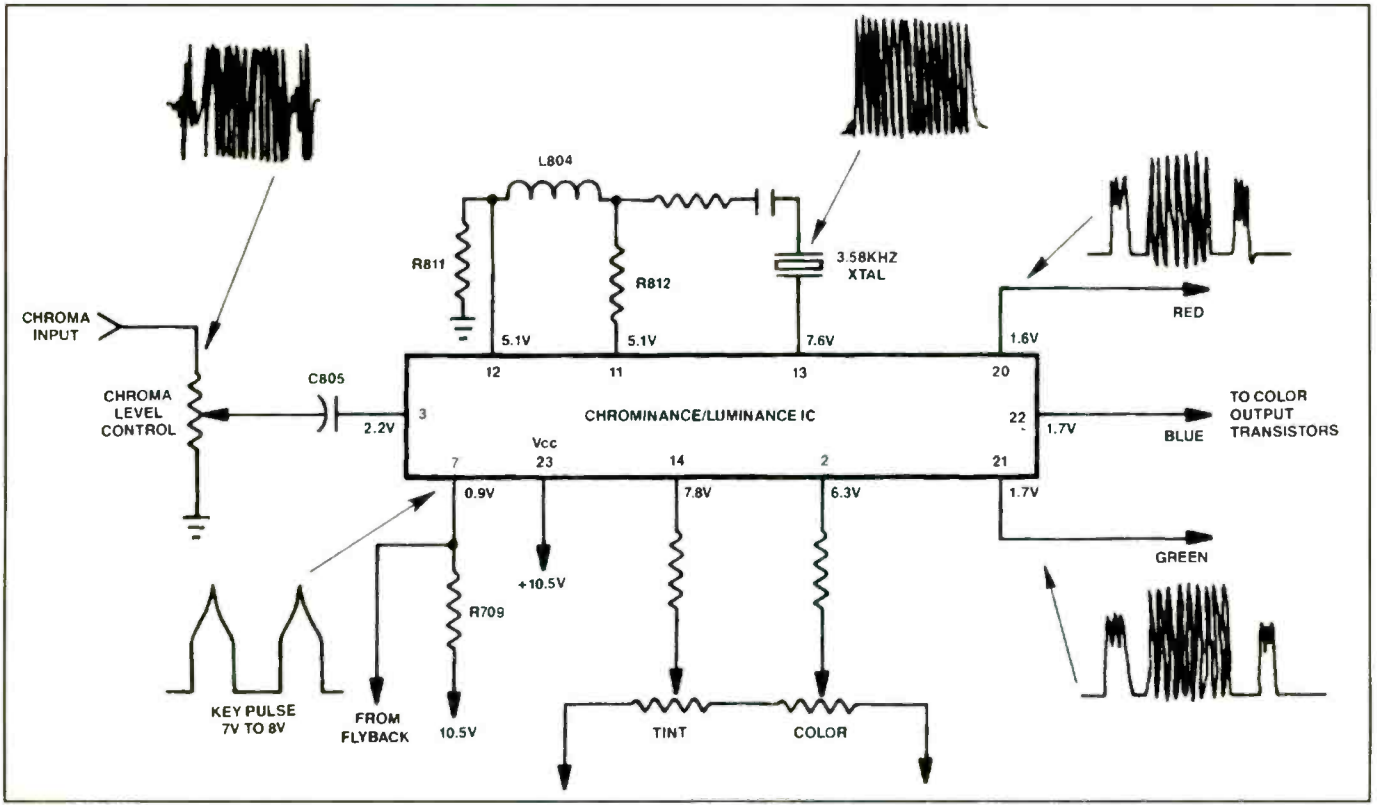


Figure 2. These are typical waveforms and voltages on the chrominance/luminance IC.

ponent: an IC, a transistor, a 3.58MHz crystal, a diode, a bypass capacitor. Another frequent cause of problems in the color circuits is an incorrect supply voltage.

Critical test points

Check to see if the supply voltage to the color IC is correct. In Figure 2, it's at pin 23 (V_{CC}) of the color IC. If the supply voltage is not as specified, the problem may be a defective power supply source or a leaky color IC. If the voltage is within 1V of the specified voltage, the power supply is most likely good. Proceed to check all pins of the color circuits.

When the voltage at the color IC supply pin is extremely low, disconnect the supply pin from the circuit with desoldering braid or a vacuum tool. Make sure that the pin is not making contact with the circuit. Again, measure the voltage from the supply pin to common ground and notice if the voltage has increased. A low resistance measurement from the supply pin to common ground may indicate a leaky color IC.

Now check the waveform on the color oscillator (pin 13). No color will be present in the picture if the oscillator is not functioning. Measure the dc voltage at pin 13. It should be 7.6V. Go directly to the pin that ties the crystal directly to the chroma IC. This color crystal and its capacitor adjustment components have been known to cause intermittent color and color bars in the picture (Figure 3).

Next, scope the input and output color waveforms at the pins of the color IC. Make sure the color level control is wide open, especially if the color is weak. The color input signal may come from a sandcastle or comb filter network in some TV chassis. Check the color input waveform at pin 3 and output at pin 20, 21 and 22.

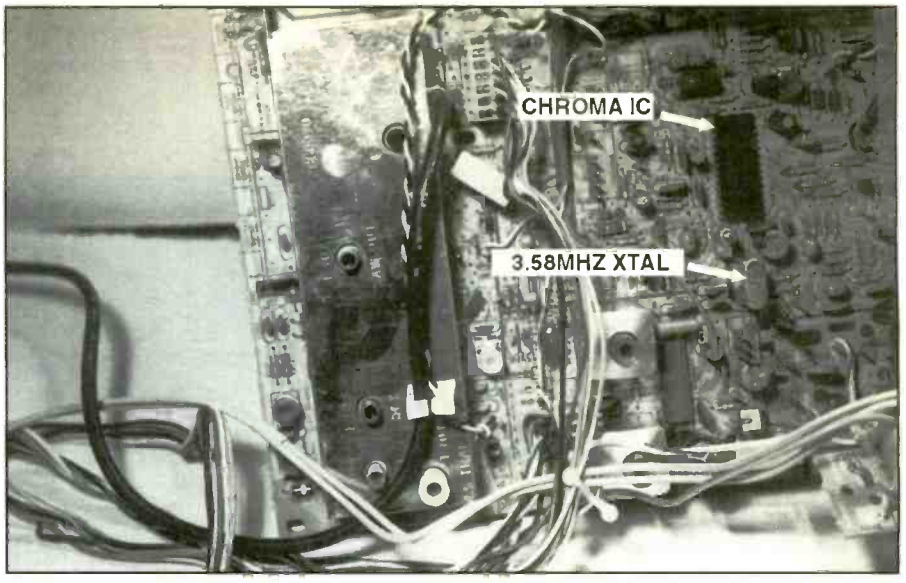


Figure 3. If you're having trouble locating the luminance/chrominance IC, locate the 3.58- MHz crystal by its distinctive shape. The chroma IC will be nearby.

A normal demodulator waveform at terminals 20, 21, and 22 indicates that the color circuits are normal at the chroma IC. Measure the voltages at the color output terminals of the IC. Compare the three color voltages. They should be within a fraction of a volt of each other.

Go directly to the color output transistors if one color is missing from the picture and output waveforms are normal at the chroma IC. Measure the voltages at the transistor that generates the color that is absent in the picture. If red is missing from the color picture, check voltages at the red output transistor. Don't overlook the possibility that a defective color gun assembly in the picture tube could be the cause of a missing color in the picture.

Finally, check the waveform supplied by the flyback transformer (pin 7). There will be no color in the picture if this horizontal waveform is not present. A burned resistor or leaky diode in the blanking, burst keying and black level clamping circuits, may prevent the waveform pulse from reaching the chroma IC (Figure 4).

Following are some actual color problems that have been encountered in television color circuits. Reading about how these color symptoms were corrected may help you solve similar color problems in

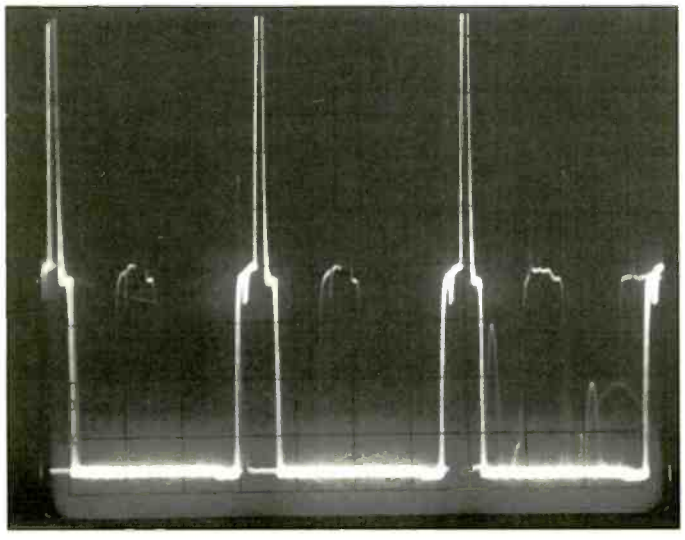


Figure 4. If the keyed-burst waveform is missing from the color IC, there will be no color at the output of the chroma IC.

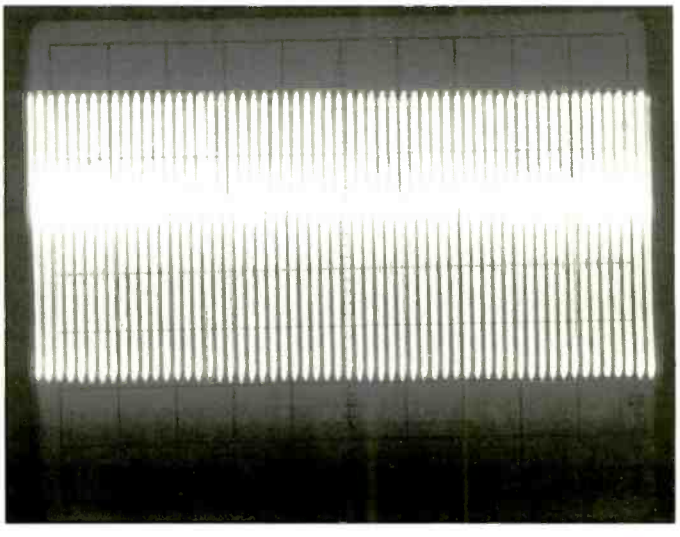


Figure 5. The waveform of a normal 3.58MHz crystal tied to one of the chroma IC terminals.

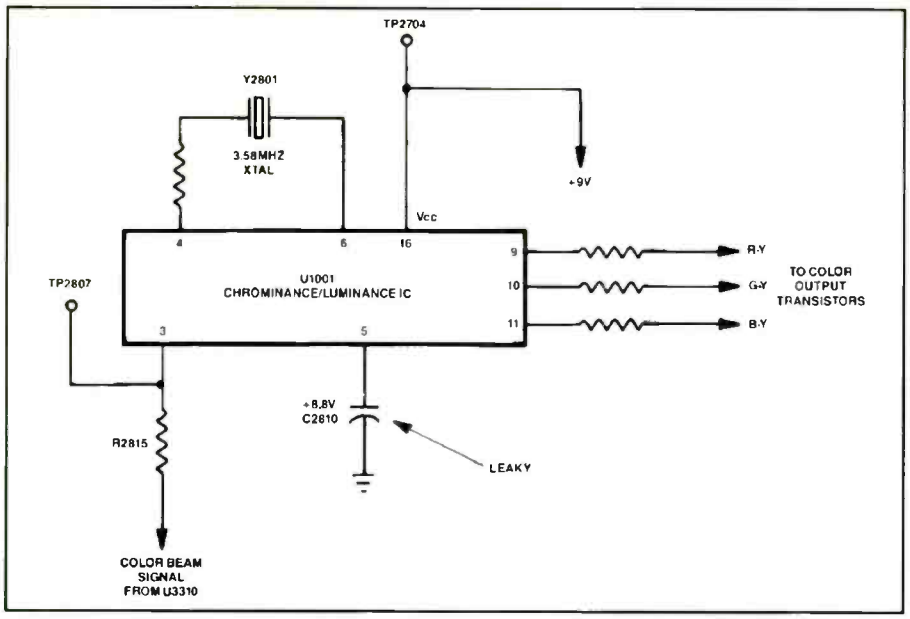


Figure 6. Capacitor C2810 was found to be leaky in an RCA CTC156 chassis that had no color in the picture.

sets that you have on the service bench. Even though the set in which the problem exists may be different from the ones covered here, these case studies may help you locate and troubleshoot the various symptoms in the color circuits of other sets.

No color—Sharp 19J63

A Sharp 19J63 portable TV had a normal black and white picture, but there was no color in the picture. In this set, the color circuits are in IC801, along with the sync/X-ray, protector, vertical and horizontal deflection and video circuits. Voltage on pin 3 of this IC was close to nominal at 11.97V. According to the schematic diagram, it should be 12.2V.

I connected the color bar generator to the antenna terminals and tuned the set to channel 3. I connected the oscilloscope probe to TP801. The color waveform that should have been present at this test point (pin 9 of IC801) was absent.

Next I connected the oscilloscope to the 3.58MHz crystal (pin 16 of IC801). Usually a waveform test on either side of the crystal terminals may indicate that the crystal is oscillating (Figure 5). This color oscillator waveform should be at least $1V_{pp}$ to $2V_{pp}$ in most color chassis. In this case, the oscilloscope showed only a horizontal line. Replacing the 3.58MHz crystal solved the no-color symptom.

At times it's difficult to know what pin numbers of the luminance/chrominance IC correspond to the color circuits because the service literature shows only an outline of the color IC. Locating the var-

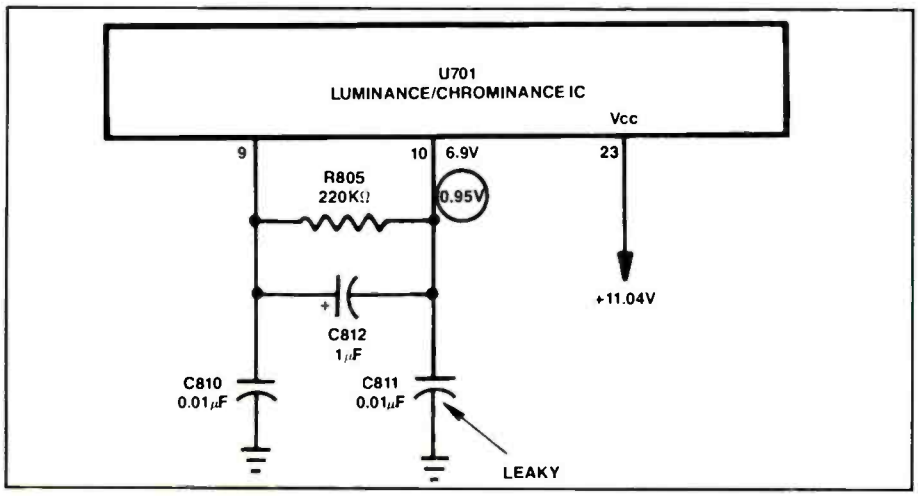


Figure 7. Absence of color in the picture of an RCA CTC117 was found to be caused by a leaky capacitor C811.

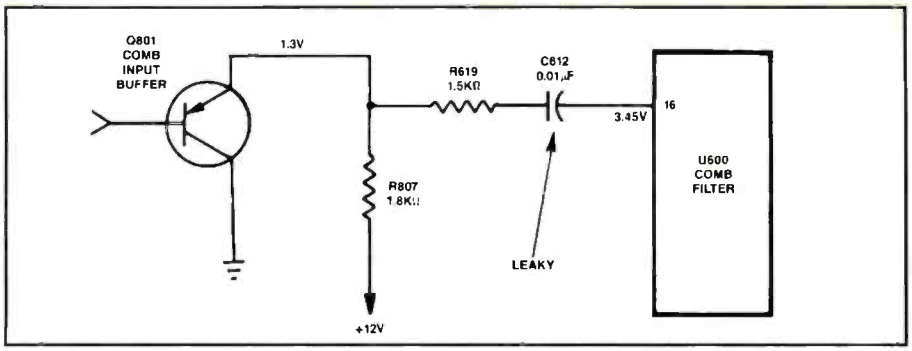


Figure 8. The cause of a negative picture and no color in an RCA CTC131 was determined to be a shorted capacitor C612.

ious test points may help to take critical waveforms. You can always locate the color crystal by its shape and trace the terminals to the chroma IC nearby. The drawings of chrominance and luminance ICs in the manufacturers' literature have only a boxed outline and do not list the internal color circuits.

It is possible to obtain some information about the internal circuitry of these ICs, and what portions of that circuitry is connected to what pins, by checking the information available in semiconductor replacement manuals published by RCA, ECG and NTE. In this case, I located the color pin terminals of the IC by checking the Sharp IC0212CEZZ IC replacement in the RCA replacement manual.

This IC, IC801, can be replaced with an RCA SK7676 universal replacement as listed in the universal manual. I looked up this IC in the RCA replacement manual and checked the corresponding linear integrated circuit outline showing the various pin numbers on chroma IC801 or SK7676 replacement. This diagram told me what internal color circuits connect to the IC pins.

No color—RCA CTC156 chassis

The chroma circuits in the RCA CTC-156, 157, 158 and 159 chassis are identical and can be serviced in the very same manner, referring to a schematic of any of these chassis (Figure 6). The color BRM signal from U3300 is found at TP-2807, or pin 3 of chroma IC (U1001). The color crystal is connected to pin 4 and 6, with the color demodulator output terminals at pins 9, 10 and 11. The color-killer detector is found at pin 5, and the power supply source at pin 10 (TP2704).

Absence of color is a common problem in these sets. In many cases, the cause was traced to the color-killer circuit. The color killer voltage in these sets should be around 8.8V. When this voltage drops below 5.2V, the color-killer circuit remains on all the time, causing a black and white picture.

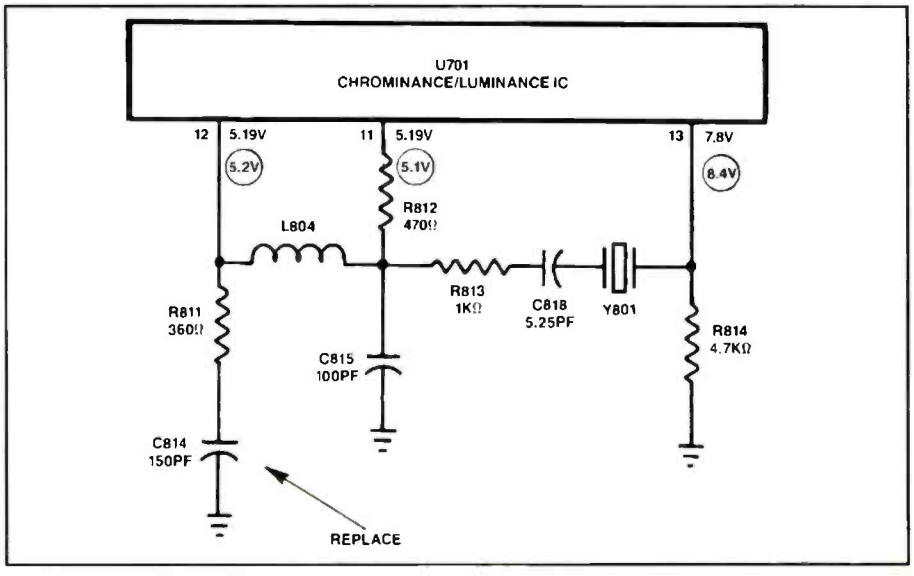


Figure 9. Intermittent color in the RCA CTC120 chassis was caused by an intermittent bypass capacitor, C814.

The cause of this lowered voltage value is a leaky capacitor, C2810. Anytime you encounter one of these sets with no color in the picture, measure the voltage on pin 5 of ICU1001. If it's below 5V, then you should replace C2810.

No color—RCA CTC117

An RCA CTC117 had no color in the picture. I measured the voltages on the luminance/chrominance IC (U701). Everything seemed normal. The input color and 3.58MHz oscillator waveforms were normal at pins 3 and 13 (Figure 7). The color output waveform that should have been present on pins 20, 21 and 22 was absent. At first, I suspected U701, but I knew that I should first check components tied to the IC pins before attempting to remove the IC.

I again measured voltages and noted them on the pins on the schematic diagram. This methodical procedure revealed that I had been hasty when making these measurements at first. The voltage at pin 10 was less than 1V. This voltage should be around 6.9V.

After carefully examining the schematic, I concluded that the component that was most likely leaky and causing this reduced voltage was C811 (0.01μF). The resistance from pin 10 to common ground was 41Ω. Either U701 or C811 was leaky. Disconnecting the high end of C811 from the circuit caused the voltage at pin 10 to return to normal.

Replacing the leaky 0.01μF bypass capacitor solved this no-color problem. Electrolytic capacitor C807 is another possible cause of problems in RCA color chassis using this same luminance/chrominance circuits for a no-color symptom. When you run across this type of problem in one of these sets, check both of these capacitors.

No color—video and sound normal

In a JC Penney 2505 model the picture and sound were normal, but there was no color. The luminance and color IC, IC-300, was located close to the color 3.58 MHz crystal (X300). With the color dot-bar generator connected, color input signal was found on TP301 and pin 4. A quick waveform test at the crystal (pin 9) and color matrix outputs on pins 15, 16 and 17 indicated the absence of any color signal output from the IC.

The voltage at the supply pin (V_{CC} pin

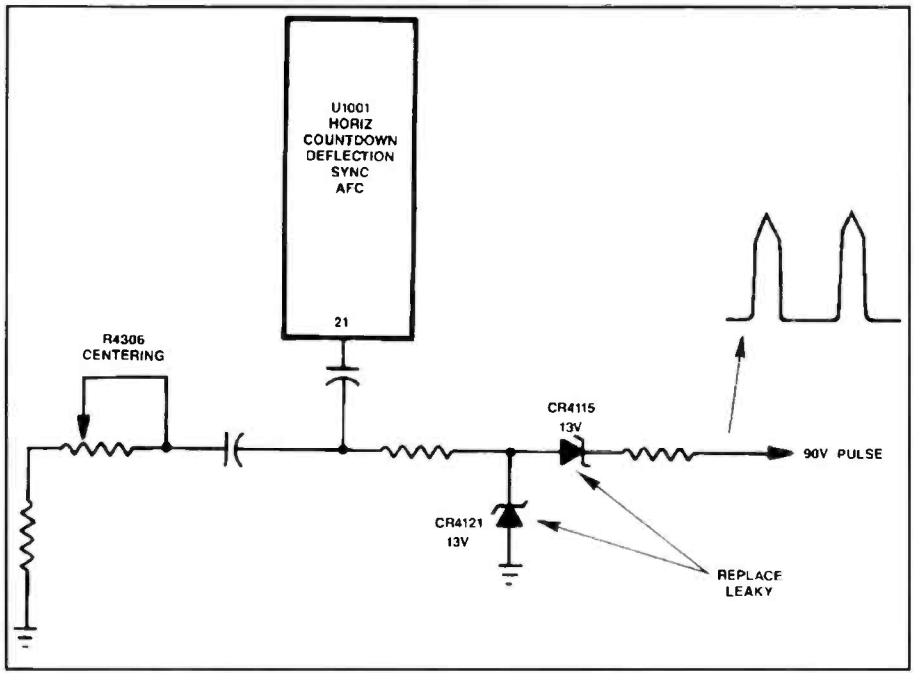


Figure 10. Weak horizontal sync and loss of color in an RCA CTC169 were caused by leaky zener diodes CR4121 and CR4115.

20) measured 11V. It should have been around 11.5V. Most of the pin voltage measurements were almost exactly as specified on the service literature. However, a variance of 0.5V or less from the specified voltage does not necessarily indicate a problem. Since most voltage measurements were normal and there was no color output, IC300 was suspected.

In this case, although the luminance circuits inside IC300 were normal, the color circuits were dead. Replacing IC300 (EP-84X221) with a universal RCA SK7606 replacement solved this television's no-color problem.

No color—negative video

The picture in an RCA CTC131 chas-

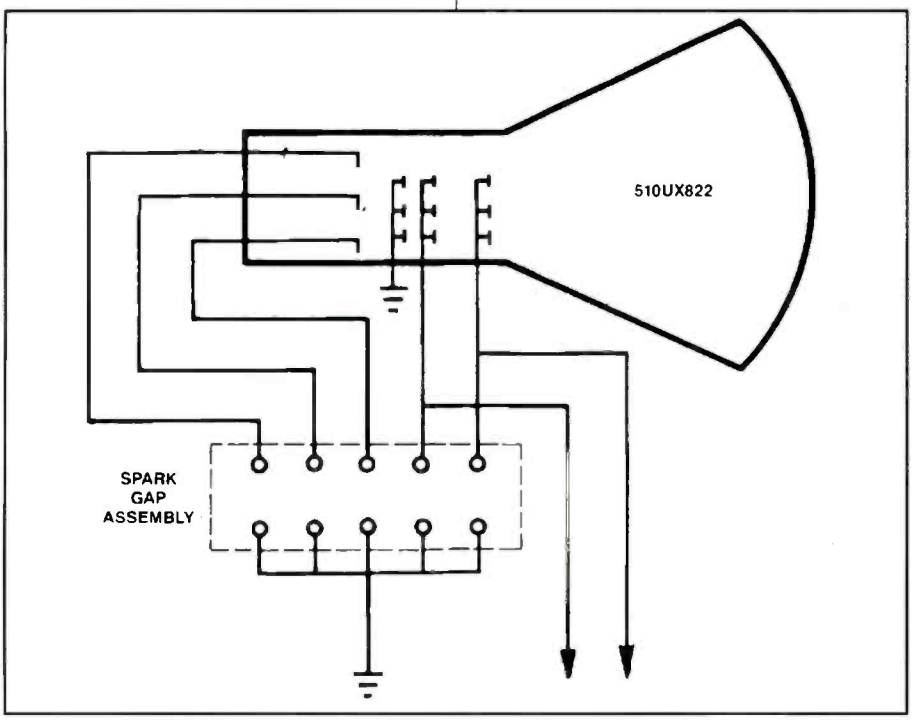


Figure 11. A bright blue raster followed by chassis shutdown was caused by dust in the spark gap assembly of a Samsung K25 chassis.

sis resembled a film negative. This was the clue to the cause of the no-color symptom. Since the absence of color made the picture appear negative, I suspected possible problems within the luminance circuits. In this set, the chrominance input signal is fed to pin 3 of the color IC, U700. The chroma waveform was missing at this terminal (Figure 8). Tracing back through the circuit, I found that there was no color output signal at pin 1 of the comb filter IC (U600).

At first the comb filter IC was suspected, since the supply voltages at pins 6 and 19 were exactly as specified at 12V. In fact, most voltages on all pins were fairly normal.

However, the amplitude of the input signal at pin 16 of U600 was low. When the input signal was traced back to the emitter terminal of the comb filter buffer transistor (Q601), the signal amplitude was quite high compared to the amplitude at pin 16. R619 was checked for correct resistance. C812 was found to be shorted, causing the reduced color signal amplitude and resulting in the negative picture and no-color symptom.

Intermittent color—CTC120 chassis

The color picture would sometimes stay on for hours and at other times the color would come and go in an RCA CTC120 chassis. Voltages at all pins of the color IC (U701) measured fairly normal (Figure 9). Because C818 and Y801 had been known to cause color problems in the past, they were checked. These components checked out fine. Because all of the voltages at the IC pins were fairly normal, I replaced the color IC. The symptom remained.

Taking a closer look at various service notes, I found that C814 and C815 had been the cause of a no-color symptom in these sets. When C814 (150pF) was replaced, the intermittent color symptom was solved.

Color in—no color out

When a Sylvania 20B1 chassis was brought in with a complaint of no color in the picture, I checked voltages and waveforms in the luminance/chrominance circuits. The chroma signal was present at pin 36 of the chrominance/luminance IC, IC250, but there was no matrix signal out at pins 27, 28 and 29. The chroma amp amplifies the color signal and applies it to a second chroma amplifier. The dc voltage at the color level control sets the color level at pin 30 of IC250.

All voltages were fairly normal, except those at the matrix output terminals. These voltages were 1V low (4.3V), with a supply voltage of 9V (V_{CC2}). Since the black and white picture was normal, the luminance circuits of IC250 were functioning. The waveform at 3.58MHz crystal terminal 31 was normal. Since the outputs of the matrix terminals showed no signs that any connected components were leaky, it was reasonable to conclude that IC250 was leaky. When IC250 was replaced, a normal color picture returned.

Weak sync—loss of color

The picture on an RCA CTC169 color set would go out of sync and lose color. I immediately suspected C2808 connected to pin 30 of U1001, and replaced it. The symptom remained. Since poor sync was noted in addition to the color problem, the horizontal sync and AFC circuits were checked at the deflection IC (U1001).

The amplitude of the sync pulse at pin 21 was low (Figure 10). A closer look in this area of the circuit revealed that CR4121 showed signs of overheating. This 13V zener diode was leaky. Both CR4115 and CR4121 were checked, found leaky and replaced. This returned the set to normal operation.

Red color missing

The red color was missing in the picture on a Sylvania 25C501/07 color set. Since one color was not present, the color matrix, color output transistor and color gun assembly in the CRT were suspected. Voltage on the collector of the red output transistor, Q226, was only 27V. This voltage should be around 151V.

Collector load resistor R226 (15kV) was running red hot. I turned the set off and checked the junction resistances of Q226 in-circuit. This transistor appeared to be leaky, so I removed it from the circuit and checked it again. The out-of-circuit tests confirmed that the transistor was indeed leaky. Replacing Q226 brought red back to the picture.

Unusual all-blue screen

The picture came up with an all blue screen and shut down at once in a Samsung K25 chassis. I turned the set back on with the same results. A shorted picture tube can cause this problem, but this picture tube tested normal. The chassis was entirely covered with dust and dirt. In fact, investigation revealed that dust down inside the spark assembly was causing the all blue raster and chassis shutdown. Simply blowing dust from the spark gaps solved the all-blue problem (Figure 11).

Conclusion

Measurement of voltages and observation of input and output waveforms at the color IC pin terminals can solve most color problems. Check the resistance of each IC pin to common ground to locate leaky or open components. If necessary, look up the IC replacement in a semiconductor replacement manual to determine the functions of color IC circuit pins. ■

Is there a fax in your future?

By Sheldon Fingerman

Have you been going insane trying to deal with voice-mail? "Push 3 if you... Push 5 if you..." What about sitting on hold for what seems like an eternity—sometimes on your quarter. Well, using a fax machine is like coming in the back door. At least at this point in time, you'll find that the odds of getting a busy signal on a fax machine are far less than the odds of getting a busy signal on a voice line.

Try using a fax next time

Remember that flyback you received instead of a transistor? What about all of those "wrong" parts that cost more to send back than to just keep. You know, the ones that have been sitting in your inventory the last five years.

If you use a fax machine instead of a voice telephone to order parts, you can not only send exact part numbers with less likelihood of miscommunication, but you can also send sections of schematics, hand drawn diagrams, pictures of parts, whatever. True, an 800 number is free, but what's your time worth?

I also believe the people at tech support would much rather deal with a fax than a phone call. It gives them a chance to research your problem, and even fax over a bulletin or two. If you can fax a section of the schematic where you think the problem is, along with voltages and other information you've gathered, it really helps tech support help you.

Properly used and maintained, a fax machine (short for facsimile) can actually pay for itself in a very short period of time. And finding the right fax machine for your business is not that difficult.

Selecting a fax machine

A bare bones fax machine should cost you less than $200; a real bargain when you consider that a comparable machine was almost triple that amount not long ago. It will send and receive documents, and that's about it. If placed on the same phone line as your telephone or answering machine, you may have to purchase one of those switch boxes to automatically route incoming calls to the right device. This added cost must be weighed against the cost of spending the money to buy a machine with more features.

The next step up in fax machines includes an integrated telephone. This is the most popular type of fax machine. If you inadvertently pick up the phone and hear a fax "tone" on the other end, simply push the start button and hang up.

Maybe what you need is a combination fax/phone with an answering machine. Because these products use internal switching, they can easily be used on one line, and they are perfect for a small service center. Additional business phone lines aren't cheap, and if the unit is loaded with the right features it can be a powerful communications center.

Some choices

At the top of the pile is the "plain paper" fax. For a business that does a lot of faxing, especially on the receiving end, these are great. As the name implies, plain old copy paper works just fine. What you have in reality is a marriage between a fax machine and an inkjet printer.

If you have a computer, you have no doubt heard of the new fax/modems (available either as an internal card or external unit) that allow you to send and receive files as either computer data or facsimile images. A step above a simple modem, they actually work quite well—sort of. It's a breeze to transmit parts orders, letters, and documents that are already in your computer with one of these units. However, unless you have a scanner to scan material into your computer, it may not be possible to transmit diagrams, drawings, or a signature. Furthermore, in order for you to receive faxes, your computer must be online, and if the fax/ modem is one of the inexpensive ones, the computer must be idling in "receive" mode. Better models will receive documents even while you are doing something else on the computer. They store the document in memory for retrieval later.

Always remember that faxes received by computer are stored as graphic images. These must then be converted to text files, unless you simply want to read them off the monitor. Intel makes some of the better fax/modem cards, but the good ones cost as much as a stand-alone fax machine. Check the features on these carefully. This is one time when you do get only what you pay for. If your fax of choice is a fax/modem, a few more dollars here can make life, or at least faxing, a lot easier.

Some useful features

Optional features are available for fax machines that make using them easier. An automatic paper cutter, for example, may

Fingerman is an electronics and computer consultant and servicing technician.

seem like a luxury. Until, that is, you get back to work and find what looks like the "Dead Sea Scrolls" all over the floor.

Anti-curl is another nice feature: no more faxes that come out looking like a pea-shooter. On the other hand, don't expect miracles. If your faxes must be absolutely flat, buy a plain paper fax machine.

Many models come with autodialing, and will store up to 100 or more phone numbers. If the machine has some sort of LCD display, another nice feature, you can store the numbers by name, and then find them using a directory. This is a real time saver, not only for faxes but for phone calls as well.

A speakerphone

For the one-person service center, a model with a speaker-phone is icing on the cake. This is ideal for working with technical support. No more trying to take a voltage reading while cramming the handset between your ear and shoulder.

Remember, not all speakerphones are created equal. If you can, try the unit out before you buy, or see if the seller will allow a trial period. It's pretty frustrating to have to pick up the handset all the time because the speakerphone is inadequate. Another useful feature is the ability to use a fax machine as a copier; standard now on most models. Keep in mind that you can't copy a page from a book or manual, without removing the page, and the copies are far from perfect on a machine that uses thermal paper. It's still a handy feature, especially if you don't have a real copy machine.

Want to really cut your phone bill? Some machines will let you preprogram them to send a fax during off-peak calling hours when rates are lower. You don't even have to be there.

Today's fax machines have features that are just too numerous to mention. The user's manual that came with my unit is almost as thick as a phone book. I doubt that I'm even using a small portion of the available features.

My favorite feature is the LCD phone directory. You punch in the names and numbers and it alphabetizes them for you. Just scroll through the directory and push a button. It will even print the directory.

You'll want to think about where the documents go in, and where they come out. All models differ. The amount of room you have on your bench or desk can make this an important consideration.

An opportunity for service

Fax machines, in addition to being useful in the operation of a service center, provide the centers with a new opportunity for servicing. Servicing a fax machine, whether it's your own or a customer's, can be rewarding but nerve-wracking. Most fax users have come to rely heavily on this new technology, and you'll find that servicing it yesterday won't be soon enough.

I've had many customers buy a new machine rather than wait for a part. And if your customer has brought in their fax/telephone with answering machine for you to service, you now have their entire communications system on your bench.

As with most of today's electronics, fax machines tend to be extremely reliable. Fax/phone/answering machines are as reliable as their individual components.

Some common problems

On the "telephone" section of many units I've found a lot of bad solder joints where the handset cord attaches to the base unit. This area can usually be accessed by removing the bottom cover.

The answering machine section needs the same maintenance as any answering machine. Many times a cotton swab and some alcohol will solve the problem. And, remember that tapes don't last forever. Mechanical problems will have to be addressed as needed, and if you stock a selection of small belts you will often be able to get any answering machine out the same day.

Since most fax machines open to the user in a clamshell fashion, it's relatively easy to clear paper jams and perform routine maintenance. Assuming that all motors, gears, and belts are operating properly, recurrent paper path problems can often be solved by "reconditioning" rubber rollers with some alcohol. Be careful not to leave behind any fluids that the paper can pick up.

Errors that seem to occur for no reason, such as a document jam when there is no document present, can often be traced to a malfunction of one of the document sensing switches. When a stack of documents is loaded for transmitting and the machine grabs more than one page at a time, there may be nothing wrong. The user may be pushing the pages into the feeder too far, or it can even be the type of paper they are using. Also, fax machines are highly allergic to staples.

Problems with received documents

If problems appear on received documents, try cleaning the thermal head. You

can use isopropyl alcohol for this purpose. You might even try different brands of thermal paper, or just a newer roll. Thermal paper is heat, and somewhat light sensitive, so rolls of paper must be stored properly. Never use a highlighter on thermal paper. What you have highlighted today will be gone tomorrow. Also, never park a soldering iron on top of a thermal fax page. You'll soon discover why they call it "thermal" paper.

Problems on transmit

Problems sending a document can often be solved by cleaning the glass, or clear plastic strip where the unit "scans" the document. Also, directly opposite this clear window is, usually, a white opaque strip. The document feeds between these two elements. Both should be cleaned.

If you are receiving documents with thin, black lines running top to bottom the problem could be, and usually is, the transmitting machine. If a customer complains of this problem you may discover that the cause is another machine a thousand miles away!

An easy test is to simply use the copy function. Although making a copy will not verify the correct operation of the complete system, it does more or less duplicate sending and receiving at the same time.

If the copy is clean and clear, you know that the image sensing and image printing portions of the unit, and the document transports, are all functional. Some models will even print a test pattern. This is a good indication of the health of the thermal head.

If cleaning does not solve the above problems, logic would indicate that there is either a problem with the thermal head (receive), or the scanning mechanism (send). Also, because both outgoing and incoming signals must be coded and decoded into an audio signal, this circuitry cannot be overlooked.

Since the printing mechanisms on plain paper fax machines are basically inkjet printers, and since inkjet printers use a disposable combination reservoir/printhead, replacing this element will solve most printing problems on these fax machines. And because the print head in a plain paper machine moves back and forth, just as in the case of a normal printer, some cleaning and lubrication couldn't hurt.

Fax/modem problems

If you encounter a problem with the operation of a fax/modem card in a computer, "reseat" the card, reinstall the software, look for serial port conflicts, and check the phone lines. I've seen many cases where the "phone" and "line" wires were swapped. If the connections appear to be correct, check the warranty, and either replace the unit or return it for repair, depending on its value.

Finally, remember that phone lines can go bad as well. Don't spend hours trying to diagnose a problem that may turn out to be caused by a hungry rodent. Also, a phone line that works fine for voice communications may not necessarily transmit data reliably. I've found that some long-distance carriers transmit data poorly, even if voice transmissions sound fine.

If you don't have a fax machine now, you really should look into one. It's one of those products that you may not think you need, but once you get it you'll wonder how you did without it. ■

Informing your customers

By Dale C. Shackelford

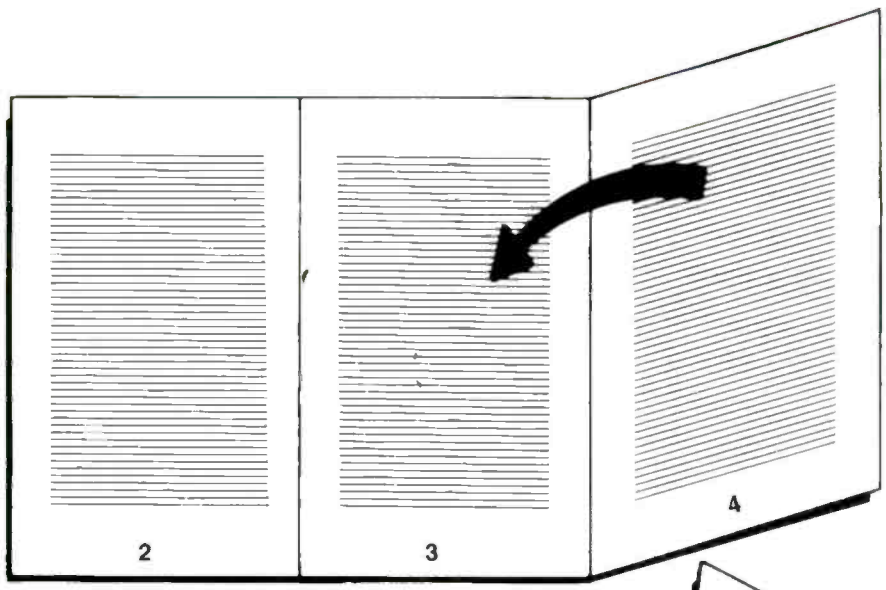
Need a way to make your customers remember the great service you have provided? Want to help those customers help themselves when it comes to taking better care of their electronic products? Here's a way to do both.

Accompanying this article is a form you can copy on any copying machine (both front and back) and fold (as shown in Figure) to make an attractive pamphlet that you can give to your valued customers when they pick up the product that they brought to you for service. This informative pamphlet covers many of the problems that average consumers face when dealing with their electronic products, and gives them advice on how to properly maintain them.

Before you make a number of copies of this form, you may want to make one clean, sharp copy, then type your company name, address and telephone number in the space provided on page 6. You may also include your company logo, list specializations or other information that will help customers identify with your company, or would promote your business.

If your copier is not capable of reproducing documents both front and back, you may consider having a local print shop do the reproductions for you. The cost of this service (which may include not only the printing, but folding of the documents as well) usually costs only a fraction of a cent per copy, a small price to pay for a happy informed customer.

Shackelford is an independent electronic servicing technician



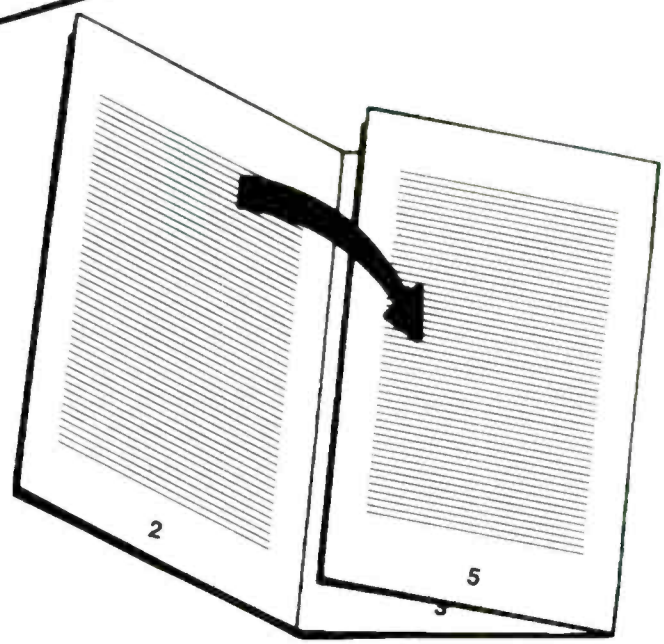


Figure 1. Folding the page as shown in the illustration will result in a very professioonal looking pamphlet that you will be proud to distribut to your customers. This will show them that you appreciate their business, and that you care for their safety.

set, contact the manufacturer's representative (the address and telephone number should be listed in the owner's manual).

Safety

Never attempt to open the cabinet of an electronic product, because many of them can deliver a very nasty shock, even with the power disconnected. At the very least, you may destroy a sensitive (and quite often, expensive) electronic component simply by touching it. In any event, even if you did get into the cabinet, there is virtually nothing you can do to repair the product, as specialized knowledge and test equipment are required to diagnose and correct most problems.

Most electronics products are now equipped with a polarized plug: one blade is wider than the other. If you have problems inserting the plug into the receptacle, turn the plug over. If the plug still will not go into the receptacle, contact a local electrician (not an electronics technician) to replace the obsolete outlet. Never try to defeat this important safety feature, as this can create a shock hazard, and may even void the product's warranty.

If your product is ever dropped, or if the case has become damaged, and you suspect that some of the circuits inside may have become damaged, have a technician inspect the product before turning it on. The amount that the service center might charge for this inspection and to correct any damage that might have occurred to the circuitry inside may be small compared to the damage that could occur if you turn on a damaged product.

The technician who worked on your unit has performed all of the safety checks recommended by the manufacturer in an effort to make the operation of your product as safe as possible for you and your family. If you need any more information concerning the safety aspects of this product and how to avoid hazards, refer to the owner's manual.

Type of Device:_____
Owner:_____
_____
Service Performed:_____
_____
_____
_____
_____
_____
Date of Service:_____
Total Cost: $_____
We recommend that you return this product for a scheduled preventive maintenance check on: _____ Keep this pamphlet for your records!

If you need any assistance, have any questions, or simply want to discuss service for any product, call or stop by our service center at:

Properly caring for your consumer electronics products

You have just had your electronics product serviced, cleaned or modified. As part of our continuing service to you, our valued customer, the electronics servicing technician who serviced your equipment would like to use this informative pamphlet to acquaint you with the techniques and precautions you should observe when operating your product.

Cleaning

If you have the user's manual available, follow its directions for cleaning the exterior of the product. Most consumer electronic products with plastic or metal cabinets/housings; televisions, stereos, VCRs or computers, can be cleaned when they need it with a solution of one part vinegar to three parts water, or a mild household cleaner. Simply dampen (slightly) a lint-free rag in the solution and wipe away fingerprints, dust and other debris.

Products with hardwood cabinets/ housings may generally be treated with traditional furniture polish. In either case, be sure that no liquid is allowed to enterthe area containing electronic circuitry through openings in the cabinet (such as vents or gaps). Never use abrasive or chemical cleaners on this product unless specifically directed to do so by the manufacturer's literature.

Temperature changes

Ideally, electronic products used in the home should be maintained at room temperature, somewhere between 65F and 75F. If for some

reason your product is exposed to temperatures below 40F for any length of time (you accidentally left the VCR in the car overnight, for example), allow the unit to reach room temperature before turning the unit on. This cold weather warning is very important for audio and video tape recorders/players, as the tape may become stuck, thereby damaging not only the tape, but the player.

In cases where temperature changes are drastic, condensation may form on the inside of the cabinet of various devices, especially if the relative humidity in the warming area is too high. This moisture may well damage sensitive electronic circuitry, requiring another trip to the service center.

When warming a device that has been exposed to extreme cold, warm it gradually in a dry area, and don't turn it on until it has plenty of time to warm through. The money you may save in unnecessary service will be well worth the time involved.

Magnetism

Many electronic products can be adversely affected by magnetic fields, which can cause a wide variety of problems, depending on the relative strength of the magnetic field and the type of product involved. Never place stereo speakers or other devices containing magnets close to electronics products.

One of the most common effects of magnetism on an electronic product is the appearance of blotches of color on a color TV set or computer monitor. If you notice color blotches (usually

yellow, green or blue) on the screen of your television or computer monitor, simply remove the suspected source of magnetism, and turn the unit off for at least an hour. If the blotches are still present when the unit is turned on, the set will have to be degaussed (demagnetized) by a trained service technician.

Remember, even if your television set or monitor is turned off, it can still be magnetized by other devices. Additionally, televisions, monitors, and other devices can generate magnetic fields. Never place computer disks on or near these devices as the disk might be damaged and the data lost. Consumer products that are capable of generating magnetic fields that can cause lost information on computer disks include: telephone ringers, the displays of television sets and computer monitors, speakers, and microwave ovens.

Ventilation

Like people, electronic products must be able to breathe in order to operate efficiently. They all generate heat to some degree (amounts vary according to the size and type of product), and must dissipate this heat to the atmosphere while drawing in cool air. That is why you will find small holes in the back, bottom or sides of most electronic products.

These vents should never be covered or blocked with dust, books, papers or other materials that will impede or otherwise restrict airflow through the cabinet. Don't operate your electronic product while it is sitting on a bed, sofa, or other soft surface. A soft surface might

block airflow into ventilation holes in the bottom of the product, causing it to overheat and become damaged.

Never place electronics products in enclosed spaces, such as book cases or cabinets, unless provisions are made for proper air circulation. Never place electronics products near heating devices (such as radiators) or expose them to direct sunlight. This can cause the temperature within the cabinet to increase dramatically. If necessary, install a small fan behind the unit for air circulation.

General maintenance

Periodically, inspect power cords and antenna and speaker wires for nicks, cuts or signs of abrasion. Never run wires across doorways, under carpets or rugs, or near heating sources where they may be tripped over, stepped on or melted. Exposed conductors in power cords can create a severe fire/shock hazard. Damaged power cords should be replaced as soon as they are detected.

If any type of liquid is spilled into an electronics product, turn it off immediately and disconnect the power. In many cases, the product can be cleaned by a qualified technician with little or no damage to the circuitry. Don't assume that if you just allow the product to dry out that it will function properly.

The only controls that consumers should attempt to adjust on any consumer electronics product are those that are listed in the owner's manual. If the owner's manual doesn't explain the function of a particular adjustment on your

Products

North American Satellite Guide Poster

Keystone Communications, publishers of the *North American Satellite Guide*, is now offering its communications satellite poster for sale.

The 22 inch by 28 inch full-color poster features the North American communications satellite arc, C-Band and Ku-band frequency tables, Ku-band half transponder formulas as well as a Greenwich/military time conversion chart.

The poster is a companion piece to the company's *North American Satellite Guide*, a one-stop reference source to North American satellites that carry video traffic. The guide is published six times a year and features one satellite per page, listing all of that satellite's technical information, from its position on the arc, to its downlink polarity, channel number, owner/lessee and more.

Circle (60) on Reply Card

Educational videos

UCANDO VCR Educational Products Co. has released three new titles in their line of educational videotapes that teach electronics. UCANDO's computer-animation allows the electronics professional or enthusiast to actually see how a device or circuit works.

Understanding Fiber Optics takes the viewer step-by-step through the basics of fiber optic technology. Prepare for the future by learning about cables, connectors, couplers, splicing, transmitters, and receivers.

"FM Radio" Parts 1 and 2 teaches the ins and outs of FM radio technology, including the new RDS/RDBS methods of digital data encoding and decoding.

Circle (61) on Reply Card

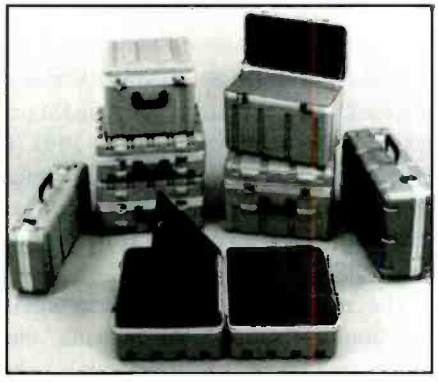
Neutralizer Jr. bench top ionizer

The Charleswater Neutralizer Jr. ionizing unit is a compact and lightweight auto-balancing bench top ionizer. The unique active feed-back, balance circuit automatically ensures and maintains the unit's ion balance, despite variations in line voltage, air speed or emitter electrode condition. The feed-back circuit also gives a visual alarm indication when maintenance is required. The compact, efficient design minimizes bench top space requirements. This unit is calibrated to NISI traceable standards.

Circle (62) on Reply Card

Foam-filled cases for sensitive equipment

Jensen Tools, Inc. offers foam-filled cases for shipping or storage of sensitive instruments or equipment of any kind.



Cases come in many different case configurations, with pads of dense, high quality foam inside. Foam may easily be custom fitted for any type of equipment.

Circle (63) on Reply Card

Compact dc power supplies

Kikusui International introduces the new compact PMC-A power supply series, featuring two highly visible digital meters for independent output voltage and current monitoring. All calibration pots and remote control switches are located on the front panel for quick access.

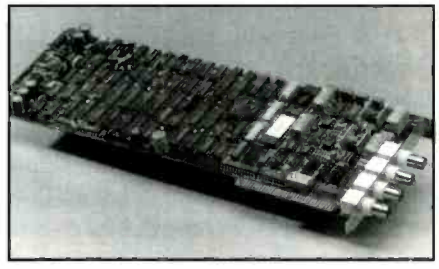
Additional capabilities include 10-turn pots for excellent voltage and current setting resolution; external analog remote control of voltage and current; front panel output on/off switch so voltage can be set prior to application to the unit under test so potential damage can be limited; and remote sensing to compensate for voltage drops caused by load cable resistance.

Models in the series feature output voltage ranges of either 0Vdc to 18Vdc with output current ranges of 0A to 1A, 0A to 2A and 0A to 3A or output voltage ranges of 0Vdc to 35Vdc with output current ranges of 0A to 0.5A, 0A to 1A and 0A to 2A. All units can continuously supply maximum current at maximum voltage.

Circle (64) on Reply Card

PC-based arbitrary waveform generator

The PCI-311 and PCI-312 arbitrary waveform generators from *PC Instruments* occupy one PC expansion slot and combine the performance of stand-alone generators with the convenience of the personal computer. Key features of the single channel PCI-311 and the dual channel PCI-312 include: 12-bit output DACs with update rates to 50 MSPS, 32k sample memory on each channel, memory segmentation with looping and linking, and $12V_{PP}$ into 50Ω.

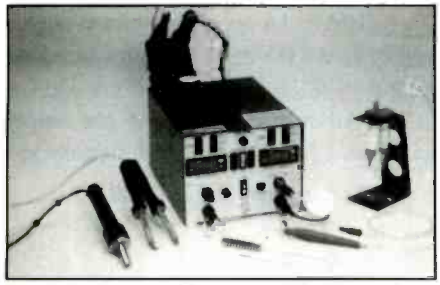


The generators also provide 0.01% frequency accuracy, five selectable output filters, gain and offset controls, and nine built-in waveforms. The output waveforms are accessible via BNC connectors as is the sync out signal. An input BNC connector is provided for signals triggering the generator or for use with an external reference clock. Both generators are capable of 10MHz sine waves and pulses with 20ns widths and 12ns risetimes.

Circle (65) on Reply Card

Surface-mount solder station

The SMD-250 system is the most advanced SMT/PTH repair center from *APE*. Two programmable digital controllers feature responsive closed-loop temperature control with LED readout of set and operating temperature and an instant-rise vacuum rotary pump. The unit is a complete surface mount and conventional component repair and rework station, that will perform the following functions: SMD removal (hot air method), thermal SMD removal, conventional thru-hole



desoldering, reflow soldering, heat tweezing, vacuum handling, conventional soldering, and solder paste dispensing.

The center incorporates electronic circuitry, which enables the user to change the temperature at the tip from 350F through 875F without changing the tip or heater element. "Zero voltage" thyristor switching protects voltage and current sensitive components against transient voltage spikes caused in stations using mechanical switching action. Temperatures are displayed by dual three digit LED readout with resolution of ±1F. Quick rise rotary vane vacuum pump provides high vacuum and flow at 23 inches Hg in 150mSec. withdrawing molten solder in 30mSec. Variable pressure output control allows adjustment of hot air flow for SMD component reflow. Fixed vacuum port provides access for desoldering handpiece to internal vacuum source and quick disconnect fitting eliminates vacuum loss.

Circle (66) on Reply Card

Pocket fiber tester

Metrotek Industries, Inc. now offers a fiber optic test set. Model D410 is a simple, low-cost alternative for checking fiber optic cables and connectors. It is simple to use and small enough to fit in a shirt pocket. The easy to read bar graph indicator measures absolute optical power in 2dBm steps. The tester is available with ST or SMA connectors. Since it contains both a source and a receiver, the unit can be used to test a jumper or a spool of cable. A pair of testers can be used to test long fiber runs between equipment bays or between buildings.

Circle (67) on Reply Card

Portable scope-plus-meter

Fluke introduces ScopeMeter Series II test tool, a new version of the ScopeMeter test tool that was introduced in 1991. It combines a dual-channel 50MHz digital storage oscilloscope and $3^{2}/_{3}$-digit true-rms multimeter in a rugged, battery-powered, handheld unit.

The new models add measurement functions such as a "measure menu" that automatically configures the unit for any of 30 measurement tasks. Another addition, continuous autoset function, eliminates front-panel reconfiguring.

The menu offers direct access to 30 common measurement functions. The user selects the requested measurement from the menu, and the test tool configures itself to make the measurement.

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

The test tools are available in four models: the dual-channel 99, the dual-channel 96, the dual-channel 92, and the single-channel 91. Each comes standard with a backlit display and also includes context-sensitive hints and a button for additional information about functions and instrument operation.

A 600V, optically isolated RS-232 interface for direct printout is available on the 96 and 99. Optional software for DOS- or Windows-based personal computers is available for the Model 99, giving users an easy way to communicate with or control the Model 99.

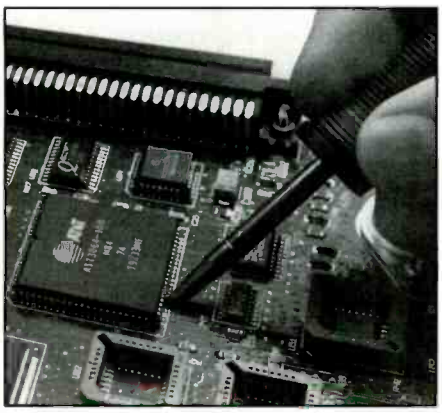
Circle (68) on Reply Card

ESD safe magnification light

Waldmann Lighting Company introduces its ESD safe magnification task light, the Focus ESD. This lamp, which uses conductive and static dissipative materials and coatings which eliminate electrostatic discharge, is suitable for electronics assembly or service areas to help in maintaining the effectiveness of ESD control programs.

All plastic luminaire parts are manufactured with static dissipative materials. The optical quality glass magnifier has a multi-layer conductive coating, and all metal parts are coated with a static dissipative varnish. The lamp diffuser also has a tin oxide conductive coating.

Circle (69) on Reply Card



Tips for multi-lead SMT

Metcal's SMTC-x147 soldering tips are specially designed for multi-lead soldering, a fast and increasingly popular technique for attaching surface mounted components including J-leaded, fine pitch, and gull-wing packages. In multi-lead soldering, an operator applies solder directly to the tip of the soldering tool and then draws the tip with its reservoir of solder across a row of leads, one side of the component at a time, until the device is firmly attached. One pass per row of leads is sufficient. The use of flux, the product's direct power delivery, and the nature of multi-lead soldering naturally "meters" the correct and uniform amount of solder for each connection without solder wicking, lengthy dwell times, or other problems that can result in defective rework.

These tip cartridges, designed for multi-lead soldering, hold the right amount of solder for the process, and have extra-thick plating to resist the effects of abrasion. The tips are designed for use with the company's STSS-002E Soldering System and STSS-005E Rework System; they are removable and interchangeable, and available in three design temperatures to suit every need.

Circle (70) on Reply Card

Benchtop cleaning starter kit

Micro Care Corp. offers a new, low-cost Starter Kit for controlled application of benchtop circuit cleaning chemicals.

The kit consists of Trigger-grip dispenser; a 30 inch length of reinforced plastic tubing; four ergonomically designed spray tips which include one for surface mount boards; one for stencils; a brush for through-hole circuit boards and a syringe for cleaning under dense packaging such as plastic quad packs.

The new kit is designed for use with the company's non-CFC cleaners including non-linear alcohols, HCFCs, terpenes and other cleaning solvents formulated to meet "planet-safe" requirements.

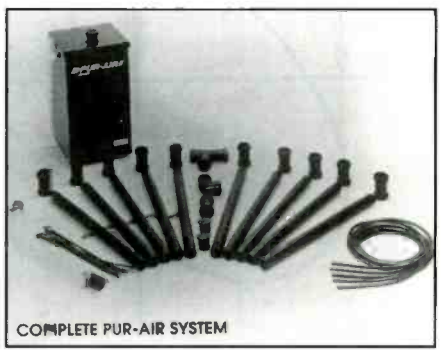
According to the manufacturer, this controlled dispensing system helps reduce solvent consumption by as much as 40% over other methods. It eliminates cleaning compound waste, boosts overall productivity and protects against employee overexposure to chemicals. The system also helps technicians successfully phase-in the use of ozone-safe chemicals now required over old-style solvents.

Circle (71) on Reply Card

Fume extraction arm

Pace, Incorporated introduces its High Vac Fume Extraction Arm designed to capture harmful fumes in the workplace. The arm, when connected to the company's High Vac central filtration unit, effectively removes fumes over a large working area and filters out contaminants so that cleaned air can be recirculated back into the working environment. This accessory can be easily positioned and readjusted to suit individual needs, and can be permanently mounted on a workbench. The arm is 30 inches long, 3 inches in diameter and is supplied with 8 feet of flexible hose plus a bench mounting bracket for quick connection to the central filtration unit.

Circle (72) on Reply Card


COMPLETE PUR-AIR SYSTEM

Fume extraction systems

OK Industries offers a range of Pur-Air fume extraction systems to deal with nearly all dangers associated with solder flux fumes. The system provides powerful local ventilation through a three-stage filtration and purification system that removes 99.997% of airborne particulates down to 0.3 micron as well as eliminates the hazardous gases and noxious odors from the fumes. The systems come in various configurations from 3 to 100 stations.

Circle (73) on Reply Card

Hard disk installation utility

Ontrack Computer Systems annouces a new version of its Disk Manager hard disk installation utility for DOS. Version 6.03 provides an enhanced FastDisk driver to support the software's drive configuration for IDE drives larger than 528MB. The driver supports all configurations supported by the original Windows FastDisk driver, in addition to Ontrack features.

This software is the original disk installation program which installs and completely prepares virtually any hard drive for use in IBM PC, XT, AT, PS/2 or compatible computers. Version 6.03 supports DOS 6.2 and Windows 3.1.

Circle (74) on Reply Card

Test Your Electronics Knowledge

Lissajous patterns, etc.

By Sam Wilson

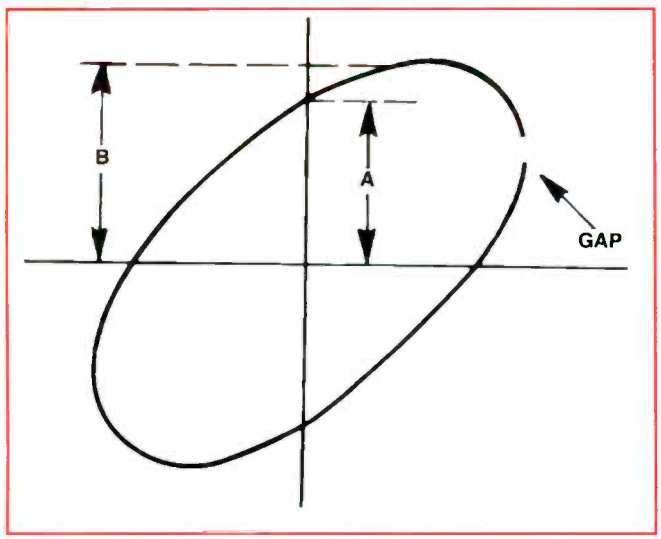


Figure 1. If A=5 and B=6, what is the phase angle between the sinewaves that produced this pattern?

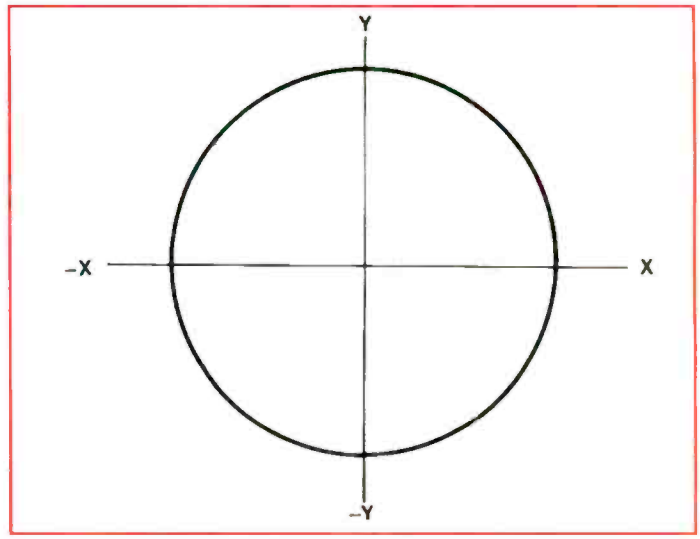


Figure 2. This Lissajous pattern is obtained with two sinewaves of equal frequency and equal amplitude. What is their phase relationship?

1. Refer to the Lissajous pattern of Figure 1. If A=5 and B=6, what is the phase angle between the sinewaves that produced the pattern?

2. The Lissajous pattern in Figure 2 is obtained with two equal-frequency and equal-amplitude sinewave signals that are:

A. in phase.
B. 90 degrees out of phase.
C. 180 degrees out of phase.
D. (None of these choices is correct.)

3. Using an oscilloscope, the gap in the Lissajous pattern of Figure B is obtained by applying a third signal to _____ _____.

4. Assume that the gap in the Lissajous pattern of Figure 2 is obtained with a pulse that has the exact same frequency as the reference input sinewave. What does it mean when the gap is moving slowly around the circle?

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

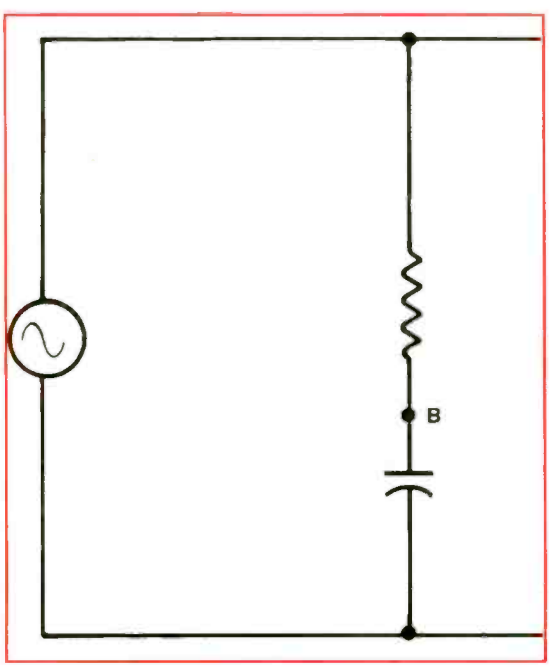
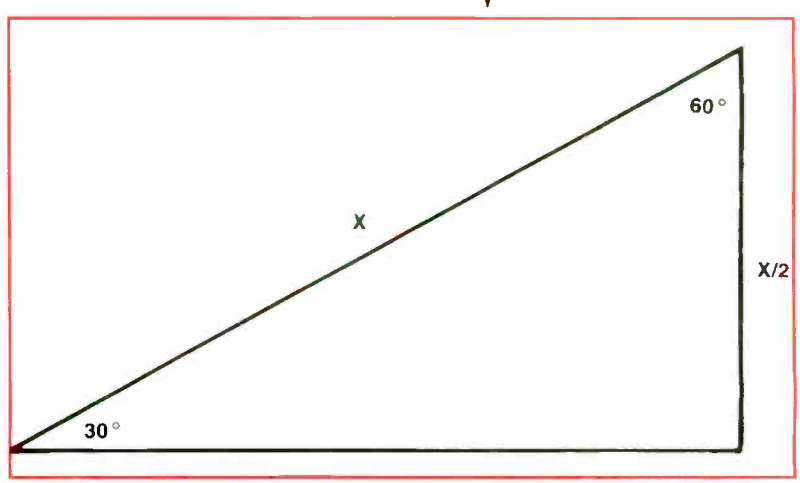


Figure 3. Does the voltage at point B in this circuit lead or lag the applied sinewave voltage?

Figure 4. To solve the problem presented in Question 7 graphically, draw a triangle like this. The cosine of an angle is the ratio of the length of the adjacent side to the length of the hypotenuse; in this case 0.5, or 1/2.



5. Regarding the test setup for the Lissajous pattern of Figure 2, what does the direction of gap rotation (clockwise or counterclockwise) tell about the sinewave input signals?

6. How long does it take a 3600Hz sinewave to go from zero to a positive point 45 degrees later (from zero) in a positive direction?

7. If the cosine of an angle in a right triangle is known to be 0.5, what is the angle? Work this problem graphically.

8. Refer to Figure 3. The voltage at point B
A. leads the applied sinewave voltage.
B. lags the applied sinewave voltage.

9. You drive by an A.M. broadcast station and observe that a Marconi antenna is being used. The radio wave from this antenna is
A. vertically polarized.
B. horizontally polarized.

10. The interval of time between calling for information in memory and receiving that information is called _____.

(Answers to quiz on page 62)

Software upgrades can cause problems

By Conrad Persson

Upgrading software can cause unforeseeable problems in the operation of applications software. These problems can cause heart failure in the operator and take a great deal of time to get sorted out.

As an example, I just recently upgraded the DOS on my 386 IBM compatible computer from DOS 5.0 to DOS 6.22. The primary reason for doing so was to take advantage of the disk compression that this DOS version makes possible. My hard disk was full and I needed to find more room.

When I installed the new DOS, everything went smoothly. I inserted the disk, typed B:install and my 3.5 inch drive started up and began loading the new DOS. I changed disks when I was instructed to do so by the on-screen prompts, and in no time the new DOS was loaded. Of course, at this point I had less disk space available, not more, because DOS 6.22 takes up more room, with all of its additional features.

Approach with caution

I wanted to be sure that everything was operating properly with the new DOS before I tried to compress the data on the disk, so I decided to operate all of my programs before going any further. I had no problem with the DOS-based word processor I use. Everything went fine when I called up Windows and operated my Windows-based word processor. I didn't have any problems with my spreadsheet program either.

In fact, I didn't have any problems with any applications program, DOS or Windows based with the new DOS installed.

A DBase nightmare

Then I loaded up DBase IV and began working with it. At first everything seemed to be going just fine. Then, as I was working with my database of **ES&T** articles, I got the message "SERIOUS ERROR WRITING TO DISK....." and everything locked up. No matter what keys I touched, even CTRL+ALT+DELETE, the screen stayed frozen. There was nothing to do but turn the computer off then back on again.

I was optimistic at first. Occasionally, something happens. Some rare combination of keystrokes, data in memory, or some power glitch that hits the computer and a once in a lifetime event occurs. I was sure that this was the case, so once the computer was back in operation, I loaded DBase again.

I began working with a database, and was able to make some changes. Then, it happened again. That same ominous message, "SERIOUS ERROR....," appeared and again the computer locked up tighter than a drum.

An interesting sidelight is that I also have a DBase III application that I use to keep track of all of the contacts for **ES&T**. It worked without any problem.

Checking the disk

I thought that checking the disk itself might provide me with a clue, so I ran ScanDisk, a new feature that comes with DOS, that provides more information than CHKDSK does. ScanDisk revealed that I had a lot of useless data in chains that had somehow become separated from files. No doubt that my serious error of writing to disk had been the cause of these chains.

When I responded to the prompt, I told ScanDisk to convert the chains to files, then looked at them with a word processor. It was completely unreadable, so I deleted those files.

Diagnosing the problem

I had some important work to do within DBase, so I couldn't ignore the problem. I began to think of some things that might possibly be wrong. I thought that my CONFIG.SYS file might have something to do with it, so I looked at it using my word processor. I thought that maybe I didn't have enough files or buffers available. That would cause a problem with a data base program.

I experimented with my CONFIG.SYS file, but no matter what I did, when I returned to DBase, I got the same message, my computer locked up, and the same garbage was again spewed over my disk.

Checking the AUTOEXEC.BAT file

I continued to try to think of what could possibly be wrong. I even consulted with a couple of computer technicians, but they couldn't think of anything. Then another idea occurred to me: it might just possibly be my AUTOEXEC.BAT file. Perhaps one of the instructions in it might be causing the problem.

To determine if my AUTOEXEC.BAT file was the cause of the problem, I copied it into my word processor directory with a different name, and then erased it from the root directory.

Problem solved

Once I erased my AUTOEXEC .BAT file, I did a warm boot of the computer, then loaded up DBase. I steeled myself as DBase loaded, and then began using it. I called up a database and began working with it, expecting every minute to have the computer lock up and give me the dreaded message "SERIOUS ERROR WRITING TO DISK...." To my delight, the system never locked up, the error never appeared, and I have been working with my databases without a problem.

More to come

I have been extremely busy, so I haven't really had the time to experiment, eliminating lines from my AUTOEXEC.BAT file then running DBase to see if elimination of a line eliminates the problem, so I'm not sure what line or lines of the file caused the problem. This is the file as I have it on my computer. It consists of the following:

```
C:\DOS\SMARTDRV.EXE
C:\DOS\SHARE.EXE
@ECHO OFF
PROMPT $p$g
PATH C:\DOS;C:\DBASE;
C:\WINDOWS;C:\BITFAX;C:\EZC;
C:\TC\BIN;C:\123;C:\DB;
C:\MOUSE\;C:\RECFILES;C:\QPW
SET TEMP=C:\DOS
SET BITFAX=C:\BITFAX
SET RECVFAX=C:\RECFILES
```

Once I find out which of these lines the computer doesn't like, I'll let you know.

Persson is editor of **ES&T**.

Books

***Build Your Own Low-Cost Signal Generator*, By Delton T. Horn, TAB Books, 320 pages, 100 illus., $19.95 paperback, $32.95 hardcover.**

Electronic signals are vital components of virtually every type of electronic equipment. *Build Your Own Low-Cost Signal Generator* describes how to generate almost any kind of signal the hobbyist or experimenter is likely to need. In addition, it is packed with subassembly projects that combine to form one complete project—an inexpensive signal generator with a wide range of electronics applications, including troubleshooting, repair, and circuit design.

Electronics author Delton T. Horn supplies readers with complete circuits and parts lists for generating all kinds of signals, from direct current to complex digital synthesis. In this intermediate-level guide, readers will learn about subjects such as: sinewaves, amplitude and frequency modulation, op-amp-generated square and rectangular waves, sawtooth and staircase waves, special-purpose waveforms, pink and white noise-generators, RF and IC-based signal generators, and more.

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

***High Reliability PC Board Repair–A Comprehensive Guide*, Manual Number MN-RS, Circuit Repair Corporation, $79.00.**

Circuit Repair Corporation has published a comprehensive guidebook for the repair and rework of printed circuit boards and assemblies. *Manual MN-RS* provides nearly 100 pages of step-by-step proven repair procedures and covers virtually every aspect of repair and rework. Sections in the manual include basic procedures; base material repair/rework; conductor repair; conductor rework; and plated hole repair. All repair procedures in the manual have been prepared by the company's quality department. The outline for the specifications is referenced from IPC-R-700C, published by the IPC in Lincolnwood, IL.

MN-RS is an easy-to-follow, highly simplified and readable manual describing the step-by-step procedures for solving many common circuit board repair problems. Each specification has been tested and proven. Each procedure also includes a description, limitations, tools and materials required, the step-by-step procedure itself, and methods of evaluation. Each procedure also lists the appropriate IPC specification for reference.

Circuit Repair Corporation, Bristol, RI 02809

***Digital Electronics–Third Edition*, By James Bignel and Robert Donovan, Delmar Publishers, 512 pages, $21.95 hardcover.**

This new edition provides complete, practical coverage of digital principles, techniques, and hardware. Hands-on lab projects in each chapter help connect digital theory to real-world, technician-oriented applications. Topics covered range from basic digital concepts to an introduction to microcomputers. In addition to the labs, a separate, correlated Lab Manual offers more opportunites for hands-on applications of digital concepts.

Contents include number systems, gates and inverters, waveforms and boolean algebra, exclusive-or gates, adders, specifications and open-collector gates, CMOS, flip-flops, master-slave D and JK flip-flops, shift registers, counters, Schmitt-trigger inputs and clocks.

Delmar Publishers, Albany, NY 12212-5015

***IC Cross Reference Book*, By Howard W. Sams & Company, PROMPT Publications, 168 pages, $19.95 paperback.**

PROMPT Publications presents a comprehensive guide to IC and module replacements, the *IC Cross Reference Book*. The engineering staff of Howard W. Sams & Company has assembled the Cross Reference to help readers find replacements or substitutions for more than 35,000 ICs or modules. It has been compiled from manufacturers' data and from the analysis of consumer electronics devices for PHOTOFACT service data.

This *Cross Reference* includes a complete guide to IC and module replacements and substitutions, an easy-to-use cross reference guide, listings of more than 35,000 part and type numbers, and part numbers for the United States, Europe, and the Far East.

The book is divided into two sections: Section 1—Original IC or Module Part or Type Numbers, and Section 2—Replacements. Section 1 lists IC or module part numbers in alphanumeric order by manufacturer's part number, type number, or other identification. Next to the part number is a replacement code/block number that you will use to look up compatible replacements in the second section. Section 2 provides substitutes and replacements for the ICs and modules listed in Section 1.

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

***Harmonics: A Field Handbook for the Professional and the Novice*, By Mark Waller, PROMPT Publications, 144 pages, $24.95 paperback.**

PROMPT Publications, an imprint of Howard W. Sams & Company, presents *Harmonics: A Field Handbook for the Professional and the Novice*. *Harmonics* is the essential guide to understanding the issues and areas of concern surrounding harmonics and the recognized methods for dealing with them. Covering non-linear loads, multiple PCs, notching, K-factor transformers, and more, the author prepares you to manage problems often encountered in electrical distribution systems that can be easily solved through an understanding of harmonics, current and voltage. The *Harmonics Handbook* is a useful tool for system and building engineers, electricians, maintenance personnel, and all others concerned about protecting and maintaining the quality of electrical power systems.

Written in easy-to-understand, nontechnical language, and fully illustrated with helpful graphs and insightful diagrams, *Harmonics* offers fundamental information about the theories, issues, and scope of the harmonics problem, and helps the reader to implement studies and solutions. Topics covered include: harmonics–what are they?, non-linear loads, mulfiple PCs and single-phase harmonics, lighting ballasts and harmonics, power quality problems, harmonics and the ground path, single-phase harmonics solutions, notching ASDs, VFDs, and UPSs, harmonics and resonance, K-factor transformers, and worldwide standards, measuring, and analysis.

What Do You Know About Electronics?

Tantalum exonerated

By Sam Wilson

I recently received a letter

Dear Mr. Wilson:

I have read your recently published article entitled "Capacitors, color codes, aluminums, tantalums, etc." that was published in the February 1994 issue of **Electronic Servicing and Technology**.

On page 57 at the top of the second column (second line), it states:

"WARNING!!! Tantalum is highly poisonous! Tantalum capacitors should never be discarded in a way that will allow tantalum to get into the environment."

Please send me the reference material that you used as the basis for this very severe caution regarding the "highly poisonous" character of tantalum.

Tantalum metal is a very inert material. It is commonly used as a medical implant in the form of suture wire, screws, or pins to hold broken bones together, and sometimes as a plate or sheet.

Cabot Corporation is a leading producer of tantalum powder and wire in the world for capacitor applications. We look forward to your reply.

C. Edward Mosheim
Product Manager
Cabot Performance Materials
Boyertown, PA

My answer

Dear Mr. Mosheim:

Please excuse the delay in getting a response to you. The route through New York is partly the cause.

I haven't found the original reference that I used regarding tantalum capacitors. The warning in the February '94 issue is a repeat of a warning I used in an article several years ago and that is why I am having trouble locating that reference. I intend to send you a photocopy when I track it down.

As I remember, the warning was about discarding tantalum capacitors. I erred in saying that tantalum is "highly poisonous." I will amend that in a near-future printing of my column. (Consider it done.)

Now, let me explain what I think may be the message. It is possible that tantalum capacitors are poisonous even though tantalum is not.

Not too many years ago we had paper capacitors that were highly poisonous, but no one would call paper poisonous. It was the material used to make the capacitors that was the culprit.

Casarett & Doull's Toxicology—The Basic Science of Poisons, published by MacMillan, states:

"Oral salts of tantalum are poorly absorbed. After intermuscular injection, the liver, bone and kidney contain significant amounts. A few animal experiments have suggested that after inhalation tantalum may produce some pulmonary effects benign and nonfibrotic in nature. No adverse effects have been reported as a result of industrial exposure. Implantation of tantalum has not shown any adverse tissue reaction in either man or experimental animals."

I am asking for a response from readers. Thank you very much for your letter.

Sincerely,
Sam Wilson

It is the law!

I make it a habit to go through past WDYK and TYEK articles. I am looking for things that can be stated in another (hopefully, better) way.

I was reviewing my effort to convince technicians that voltage is not an electromotive force—or any kind of force.

One way to demonstrate that voltage is not a force is to show that you cannot rationalize equations involving voltage if you treat voltage as a force. I gave a poor example and I now intend on explaining this matter with a clearer example.

I will start with some basic definitions.

Power is the rate of doing work or using energy. By definition, power is work per unit of time or energy per time. Always interpret the word *per* to mean divide by. Therefore:

Power = work/time, or, power = energy/time

Current is the rate at which charge flows. Using the same procedure as we used for power:

Current = charge/time

You will remember that current in amperes equals coulombs per second.

Voltage is *not* a force. Instead, it is the work *per* charge. (That is numerically equal to energy per charge.)

At this time I must pause because at least 250 good and faithful readers have left us to find paper and pencil.

They intend to write to me saying that voltage is "work per unit of charge" or "work per coulomb."

When I receive those responses I will send my canned letter (already in envelopes) explaining that when you divide by charge the result is the unit of charge in the denominator. Example:

Current (I) = 100 charge units/10 coulombs
= 10 charge units/coulomb

Note that the denominator goes to 1 coulomb making the answer "10 work units per unit of charge."

Since the denominator is equal to 1.0, the voltage is always numerically equal to work units.

We now have three definitions that permit us to rationalize the equation for power.

P = V x I

work/time = work/charge x charge/time

The charge units cancel and the result of the equation is:

work/time = work/time

(If that wasn't true I would have told you so.)

Speaking of power . . .

I have run across several technical articles and sections in technical books that identify the power equation as Ohm's law. (Capital O because I'm speaking of the person. I have to explain that in order to head off some meaningless sarcasm that has appeared in another publication.)

The gist of the error in the articles and books is something like this:

. . . and by Ohm's law, $P = I^2R$ (or, V x I, or, V^2/R).

The fact is that the power equation is *not* Ohm's law. It is properly referred to as *Joule's* law. ■

Wilson is the electronics theory consultant for ES&T.

Catalog supplement lists PC service products

This 68-page catalog supplement from Jensen Tools Inc. introduces new additions to the company's comprehensive line of PC workstation service products, plus latest test equipment and diagnostics from other major manufacturers. Wavetek, Datatran, MicroHouse, Landmark, Fluke, and Tektronix are all included.

Among the products featured are a universal crimp tool, and 13-piece PC repair kit, Fluke's 650 cablemeter and other Fluke meters (with calibration on select models), the DM255, 256 and 257 diagnostic tools from Tektronix, plus a selection of wire/cable and connectors, LAN connectivity devices, PC reference guides, soldering and static control products.

Circle (79) on Reply Card

Encyclopedia of PC main boards

An illustrated Encyclopedia of PC Main Boards, available now from Jensen Tools, provides PC technicians with essential, in-depth data on over 850 motherboards. Released by MicroHouse, this 2,500-page, six-volume set is a comprehensive library of information on PC main boards ever assembled.

The set includes a Reference Volume with general information about motherboards, coprocessors, chipsets, memory and cabling configurations, bus interfaces, crystals, batteries, and switches, I/O, power connections, and BIOS. The Reference Volume also contains an illustrated glossary, directory of manufacturers, setup CMOS configurations, and documentation on dozens of chip sets and how they operate.

Circle (80) on Reply Card

Datasheet describes fiber optic test instruments

A new datasheet from Fotec, Inc. describes a new product line of "Smart" fiber optic instruments. These testers use the latest microprocessor, memory and digital signal processing technology to automate and simplify fiber optic testing.

The smart instruments are preprogrammed to automatically test according to accepted industry standards. When used with a PC running the manufacturer's software, they will also prompt the user to make measurements, print test reports and log the data for later reference. The software has been written to run on any PC, including the HP-100LX palmtop.

Circle (81) on Reply Card

New tool catalog

A new 84-page, full-color tool catalog is now available from Time Motion Tools. This Summer Edition is full of field service tools and tool kits for the electronics technician professional.

Many new and expanded sections include: lighting and magnification equipment and optical and microscopes. This easy-to-use catalog also features computer, telecommunication, LAN, test and measurement equipment and maintenance and repair tools.

Circle (82) on Reply Card

Technical and electronic book catalog

Omega Engineering announces the release of an expanded and updated version of the company's Book of Books Handbook. The full-color, 136-page publication describes technical, engineering, and electronics books and videos that may be ordered from the company.

The catalog update covers 16 subject areas, with books from 15 leading publishers, including many from professional societies such as IEEE, ASME, ACS, and ASM International. Also featured are industry standards, with topics ranging from energy conservation to metropolitan telecommunications networks.

Circle (83) on Reply Card

A "Quick" computer program

Video Service Company offers Quick, a collection of computer programs designed to aid the VCR/camcorder technician. According to the company, the software allows the user to quickly access part numbers, cross part numbers, service tips and organize the service department. The software consists of: VCR Quick Reference, Parts Cross Reference, Service Manual Cross Reference, Quick Tips, Service Manual Data Base, and more. The company offers a free demo disk.

Circle (84) on Reply Card

Photofacts

These Photofact folders for TV receivers and other equipment have been released by Howard W. Sams & Co. for October 1994.

OCTOBER

GE
CTC175A 3383
TX82MB 3373
TX82QB 3373
09GP106C02 3373
09GP106F02 3373
09GP107F02 3373
20GT320FA1 3383
20GT320TX1 3383
20GT322TX1 3383
20GT324FA1 3383
20GT324JX1 3383
20GT324TX1 3383

HITACHI
A2LXU 3372
CZ35 3372
35TX50B 3372
35TX59K 3372

JC PENNEY
NC-27A 3371
685-0747 3371
685-4146-00 3371
4146 3371

JVC
AV-27BM4 3379
AV-27CM4 3379

MAGNAVOX
CR4523A401 3370
CR4524P401 3370
HD2506 3370
RD0945C102 3381
RD0946T102 3381
RR2535W 3370
RR2541A401 3370
RR2547A401 3370
25Y100 3370
25Y104 3370
25Y111 3370

PANASONIC
ALEDP228 3377
CT-31SF20R 3377
PC-33SF20R 3377
PV-3700 ..... (sim. to) VCR-256
PV-3700-K ..... (sim. to) VCR-256
PV-3720 ..... (sim. to) VCR-256
PV-4700 ..... (sim. to) VCR-256
PV-4700-K ..... (sim. to) VCR-256
PV-4720 ..... (sim. to) VCR-256
PV-4720-K ..... (sim. to) VCR-256
YALEDP228 3377

PHILCO
VT8725AT01 ..... (sim. to) VCR-256
VT8730AT01 ..... (sim. to) VCR-256

QUASAR
VH5370 ..... VCR-256
VH5371 ..... VCR-256
VH5470 ..... VCR-256
VH5470-K VCR-256
VH5471 ..... VCR-256
VH5471-K VCR-256

RCA
CTC177AA 3382
X25101GSFE1 3382
X25101GSJX1 3382

SANYO
AVM-2003 3380
G4Z-20030 3380

SEARS
NC-39A 3375
580.41028390 3375
580.41068390 3375

SYLVANIA
SRB1965401 3376
SRB1965421 3376
SRB1965422 3376
SRC1960401 3376
SRC1960421 3376
SRW1969401 3376
SRW196421 3376
SSA4547406 3374
SSP4548406 3374
VC8942AT01 ..... (sim. to) VCR-256
VC8936AT01 ..... (sim. to) VCR-256
19Y101 3376
19Y400 3376
25Y105 3374

ZENITH
SLS1937SM 3378
SLS1943S 3378
SLS2053SM 3378

Test Your Electronics Knowledge

Answers to the quiz

(from page 56)

1. Phase angle = Sin^{-1} A/B = Sin^{-1} 5/6 = 56.5 degrees

2. B. By definition

3. A relatively short-duration rectangular wave applied to the Z-axis will introduce the space. Make the frequency of the rectangular pulse equal to the frequency of the input sine waves and the space will be easy to recognize.

4. The unknown frequency is slightly different from the reference frequency. You can count the number of times the gap rotates per second and determine the frequency difference between the reference frequency and the unknown frequency. (Note: One trick is to count the number of gap rotations in 10 or 30 seconds and divide by 10 or 30).

5. It tells whether the phase of the unknown signal is leading or lagging the reference signal.

6. The time for one cycle is obtained from the equation
T = 1/f = 1/3600 = 277.8 microseconds
Since 45 degrees is 1/8 of a complete cycle, the time to 45 degrees is 277.8/8, or, 34.7 microseconds.

7. You don't even need a ruler for this one! You know that the side opposite the 30 degree angle in a right triangle is half the hypotenuse. Sketch the 30 degree/60 degree right triangle (See Figure 4). Note that the cosine of Angle B (adjacent over hypotenuse) is 0.5.
So, cos 60 degrees = 0.5

8. B. This circuit is used in SCR power controls. If R is a variable resistor, the angle of lag can be controlled.

9. A. The vertical polarization is in the same direction as the vertical hertz antenna. (The polarization of a radio wave is the same as the direction of the electric vector of that wave).

10. Cycle time (by definition).

Will Total Quality Management work for you?—Part 13

By John A. Ross

TQM Point 13

Institute a vigorous program of education and self-improvement.

In earlier articles in this TQM series it has become evident that a key part of the Deming management theory is the continuous improvement of employees within the organization. Indeed, point 13 builds on points one and six by emphasizing the importance of education and self-improvement within the organization. This emphasis makes any organization stronger, heightens the self-confidence of employees, and allows managers to assume and give new responsibilities. All this lessens the chances for employee turnover and increases respect within the workplace.

Stereotyping

One of the worst attributes of many traditional organizations is the stereotyping of employees either because they possess valuable skills or they lack some necessary skills. In either case, stereotyping "pigeonholes" an employee into one job during his work for the organization.

If all of us happily worked in widget factories and were satisfied just to produce the highest possible number of widgets per day, this type of categorization might be effective. However, most, if not all, of us work as professionals in an industry that demands knowledge and responsibility and we entered these professions because of a desire to advance.

Employee education and self-improvement

Instituting educational programs and encouraging self-improvement adds to the list of responsibilities given to managers and owners. Rather than simply assign daily tasks or monitor expenses, managers and owners must maintain an awareness of individual wishes, capabilities and needs. Effective managers should remember that not all employees wish for or react favorably to new challenges. In addition, the movement of an organization toward employee education and self-improvement demands that managers and owners adjust their thinking for the long term. With this type of thinking, educational and improvement efforts become investments rather than expenses.

Employees given that opportunity often exhibit greater self-confidence because of their knowledge. In turn, self-confidence and knowledge often evolve into better judgment. As a result, employees become better team players, gain a better vision of organizational goals, and find it easier to progress even further.

Participative management

Because of the harried pace of our world and the increasing demands on managerial knowledge, managers find that they must rely on the delegation of responsibilities and the distribution of task load. Educational and self-improvement programs allow organizations to move toward participative management and team building. With participative management, employees have the opportunity to direct their own efforts toward common organizational objectives.

When employees have the opportunity to manage their organizations, they have an increased sense of self-respect and better chances of attaining their full potential. The organization benefits because the employees are both less dependent and less submissive.

Process-action teams

A key part of continued process improvement is the establishment of process-action teams. These teams consist of individuals who have expert knowledge about given areas. Members of process-action teams apply the principles and tools of TQM and their knowledge about the processes to identify opportunities for process improvement. In addition, the process-action teams seek to understand existing processes and identify where the greatest gains can be realized from process improvement; to provide recommendations for process improvement; and to implement process improvement.

Adding quality continuously through employee expertise

Rather than wish for quality products or attempt to build quality into the end of the process, the TQM approach adds quality throughout the entire process by emphasizing employee expertise. Quality becomes an organizational attitude and drives the organization to a higher level.

With the TQM approach, quality extends from employees who are secure in the workplace and are allowed to exhibit pride in their workmanship.

Leadership at all levels

Thus through the use of the educational and self-improvement programs, TQM asks for leadership to emerge at all levels. Because employee expertise is valued, everyone contributes actions and knowledge toward a common cause. With everyone involved in the decision making, it becomes easier for everyone to understand the everyday processes and easier for everyone to gather information.

Some problems require the coordinated efforts of people from different areas, while other problems are so complex that only integrated group discussions yield quality problem-solving decisions. From there the collective group of individuals can make rational, fact-based decisions. With everyone participating in the decision, the solution will reflect the interests of the group, and the implementation of something new will be easier. ■

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

Classified

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

Send your order, materials and payments to:
Electronic Servicing & Technology, 76 North Broadway, Hicksville, New York 11801
Attn: Linda Romanello
Phone: 516-681-2922 FAX: 516-681-2926

FOR SALE

HELLO! WE ARE NOT COMPUTER SOFTWARE SALESMEN. WE ARE ELECTRONIC REPAIR TECHNICIANS REPAIRING THE PRODUCTS YOU ARE SEEING IN YOUR SERVICE CENTER TODAY. Our program is one of stability as well as quality. Unlike our competitors, we do not have to lower our price because of poor sales and customer dissatisfaction. We are here to stay! We don't need a "going out of business," "last ditch" price for our valuable ongoing program. **REPAIRING AND TECH-TIPS IS OUR FULL-TIME PROFESSIONAL BUSINESS.** We were the first nation-wide Tech-Tip program and we will be the last Tech-Tip program you will ever need. If you are a good businessman and technician, you know good support tools are not cheap. Remember, you cannot blame anyone else but yourself, if you expect wonders from a cheap program. **Doctors Do It! Airlines Do It! Lawyers Do It! TV/VCR TECHNICIANS SHOULD DO IT!** In any profession, knowledge coupled with the ability to quickly access case or service history **"PAYS BIG."** A Doctor's ability to diagnose quickly and confidently is largely attributed to use of and access to, data and information of previously diagnosed symptoms. Lawyers can predict the outcome of their present case by using prior case histories exhibiting similar symptoms. A productive TV/VCR technician will not rely on memory alone to diagnose symptoms and part numbers. Instead, they will call upon past case histories, which will enable the smart servicer to avoid the costly mistakes of mis-diagnosed part orders and loss of extremely valuable time . . **UNLIKE OTHER PROGRAMS, OUR TECH-TIPS ARE NOT UNVERIFIED MAIL-INS. WE KEEP OUR PROGRAM BASE QUANTITY AT 12,000 REPAIRS.** Old repairs are removed and replaced daily with 2,000 new repairs through each 8 month update period. **THIS ASSURES YOU OF HAVING THE REPAIRS OCCURRING TODAY, AND NOT SOME UNBELIEVABLE QUANTITY OF, FOREVER GONE, NON-PROFITABLE REPAIRS OTHER TECH-TIP PROGRAMS MAY OFFER ON A ONE SHOT DEAL.** From the original world-wide Tech-Tip program comes 3 million dollars worth of actual solid repairs, **1987 THROUGH JUNE OF 1994.** Whether you are computerized or not, our Tech-Tip program provides the most current, comprehensive published paper format that there is today. You may also wish to choose our Tech-Tip computer program, licensed world wide under **(PARADOX)** by the Boreland International Co. We're not fooling around and neither should you. **REMEMBER, IT'S NOT THE QUANTITY OF TIPS BUT THE CONSTANT UPDATE QUALITY OF PART NUMBERS AND SOLUTIONS THAT MAKES THE DIFFERENCE.** Our initial 12,000 Tech-Tips cover VCR-VCP-TV/VCR Combo CD LD-FAX Camcorder-VHS/SVH/C/8MM-Stereo-Monitors-Amps Projection Front and Rear Microwave-Satellite. Category is easily cross-referenced first by Model, Chassis or FCC ID Number and printed or simply scanned by Make and Category. Unlike other programs, we provide OEM part numbers and substitutes. **OUR ON-GOING PROGRAM IS ACTUAL DAY-TO-DAY REPAIRS WRITTEN ON THE BENCH BY TECHNICIANS FOR TECHNICIANS. ALSO, YOU MAY ADD YOUR OWN TIPS TO OUR COMPUTER PROGRAM. ALL OF OUR SUBSCRIBERS HAVE RECEIVED THIS NEW FEATURE AT NO COST!** No need for you to spend time updating your database or paper binders. We send you a complete revised program at each update. Outside technicians and students love the portability and say it is a must in the field where time is very critical. As an added Extra, **WE PROVIDE AN EXPANDING FCC ID CROSS-REFERENCE LIST WHICH SAVES THE EXPENSE OF PURCHASING SERVICE MANUALS YOU MAY ALREADY HAVE AND DON'T KNOW IT.** This program is produced by Ed Erickson, technician and owner of TV-Man Sales & Service, Inc., and president of the Professional Electronics Association of South Florida. **OUR PROGRAM START-UP FEE FOR THE PAST 3 YEARS HAS BEEN $350.00 AND FOR A GOOD REASON. OUR ON-GOING PROGRAM REALLY WORKS. THERE IS A 30 DAY MONEY BACK GUARANTEE ON OUR COMPUTER PROGRAM.** We accept M/C, Visa Amex & Discover, Co. checks or C.O.D., no shipping fees, with the exception of our overnight fee of $20.00. The phone call is **"FREE"** and so is the disk or paper sample demonstration. **CALL (800) 474-3588** or Write **TV-MAN (TECH-TIPS), 7040 W. PALMETTO PK. RD. #2-112, Boca Raton, FL 33433.**

FOR SALE

> > * * * * * * * * * * TIME IS MONEY * * * * * * * * * * < <
Servicing today's electronic equipment is Time and Labor intensive. The Fact is, if you can complete more repairs in a given time period, you will **INCREASE your PROFITS.** The **TIP COMPUTER PROGRAM** helps you do just that by reducing your bench troubleshooting time. Repair that equipment **FAST!!!** THE **TIP COMPUTER PROGRAM** contains over **15,000 VALUABLE, TIME SAVING, MONEY MAKING TIPS!!! TV's, VCR's, CAMCORDER's** & other electronic equipment. **PROFESSIONAL BOARD LEVEL REPAIRS. ADD Your tips to the TIP program!!! PRINT any tip.** Technicians say this is the **** BEST **** technical tip program available. **Pays for itself with 1 or 2 repairs.** Works on **ANY** IBM compatible computer **INCLUDING** 486, 386, **& older 286 & XT models.** The **TIP COMPUTER PROGRAM is now on sale for Less than half ($1/2$) price.** Your cost (for a limited time only) is **Only $100.00 !!!** (High density disks). Prepaid orders within the continental U.S.A. are shipped **FREE.** Call for: C.O.D., Double density disks, and shipping outside continental U.S.A. ****FREE** Demo.** Have your own tips? Ask about our TIP EXCHANGE policy with **FREE Updates!!!** P.S.–can't find the right software for your business? We write **CUSTOM SOFTWARE** to fit your needs. **CALL NOW !!! DIAL (516) 643-7740 HIGHER INTELLIGENCE SOFTWARE, 60 Farmington Lane, Melville, NY 11747.**

*** * * SERVICE TIPS IS DIFFERENT FROM ALL OTHER TECHNICAL TIP PROGRAMS* * * With SERVICE TIPS you can ADD your own TIPS. IT ORGANIZES 15,700 CURRENT SERVICE TIPS IN ALPHABETICAL ORDER BY Brand/Model each tip contains** 3 lines for **Symptom and** 8 lines for **Solution with Part Numbers, Values & Locations** on ALL CONSUMER ELECTRONIC EQUIPMENT. Created by 2 CET'S with over 20 YEARS experience and a full-time computer programmer. Members of electronics associations such as **NESDA-NYS, NESDA, METSDA, TESA-LI** use this program and confirm there is no better program available. *** * * NOW,** UNTIL Ooctober 31st IF YOU PURCHASE **SERVICE TIPS at $129.95 you will receive FREE Volume #1 DATA UPDATES containing 368 ADDITIONAL SERVICE TIPS FOR A TOTAL OF 16,068 TIPS. VISA, MASTERCARD or CHECK ACCEPTED.** Demo Disk Available. **CALL 1-800-621-TIPS (621-8477) (from US & Canada)** or Write **ELECTRONIC SOFTWARE DEVELOPERS, Inc. 826 So. Main Street, South Farmingdale NY 11735.**

TEST EQUIPMENT BOUGHT & SOLD: OSCILLOSCOPES, ETC. 1-408-738-4206. FAX 1-408-736-6946.

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

SENCORE VA62A, SC61, SC3080, VC63, LC102, PR57, CR70 and TP212. All in **EXCELLENT** condition. Also have Hitachi parts and schematics available. Call **Test Equipment Sales** (603) 434-2544.

*** * * * * ZENITH MODULE REPAIR BOOK * * * * ***
Save Money Repair Your Own ZENITH Modules Our ZENITH MODULE REPAIR BOOK Covers THOUSANDS of Models and has CURES for Modules 9-124 thru A-9740 FOR ONLY $29.95 in LASER printout form (including shipping & handling) ALSO AVAILABLE in book format technical information on GOLDSTAR ($24.95) , NEC ($19.95), SANYO/FISHER ($29.95) each BOOK has information on COLOR TV's & VCR's **ORDER ANYONE OR** ORDER **ALL 4 EDITIONS FOR $69.95** (a $34.85 savings). MAIL CHECK OR MONEY ORDER TO: **ELECTRONIC SOFTWARE DEVELOPERS, INC.** 826 So. Main St., South Farmingdale, NY 11735.

Classified

FOR SALE

* * * * * * * * * * * * **FREE ZENITH CURES** * * * * * * * * * * * *

Earn $$$ Repair Zenith TV modules found in over 1000 models, 1983-1993. Symcure manual shows you how. $89.95 or send SASE for **FREE** samples. **ZMEX,** 807 Queen Palm Lane, Sarasota, FL 34243.

REDUCED 85%. Diehl Mark III $69, Diehl Mark V Horizontal circuit tester $179. New. Conductive coating for remote control keypads $9.99 ppd. **WEEC,** 2411 Nob Hill Road, Madison, WI 53713. 608-238-4629, 608-233-9741.

Sencore—CM2000, $1,750.00; VA62, VC63, $500.00; 300 mixed Sams Photofacts 599 to 2700, 0.50 EACH. Call Ken (716) 795-9394.

A 1993 Sencore SC3100 "Autotracker" analyzer. Sold business. Used 3 months. Paid $3,400.00, sell for $2,400.00. (314) 970-6086.

SERVICE DATA & HARD TO FIND PARTS previously-owned SAMs, manufacturers data, books, FREE catalog. AG Tannenbaum, Box 110, E. Rockaway, NY 11518. 516-887-0057, Fax 516-599-6523.

VA-62A, VC-63 combo CR-70 Lube Rejuvinator, B&K 1541A O'scope, Dual-Trace assortment of H.W. Sams. Contact E.J. Sharp at 314-888-2237 between 9AM & 2PM C.S.T.

FOR SALE

TV CASE HISTORIES: Booklet with 2,150+ histories. Satisfaction assured. Only $45 (plus $2.90 for 2-day priority). **Mike's Repair Service,** P.O. Box 217, Aberdeen Proving Ground, MD 21005. Same mailing address 30 years. Send SASE for samples. 410-272-4984, 11am-9pm.

Sencore SC61 waveform analyzer used very little, $1,295.00; Heathkit vectorscope, $75.00; Mod 10-101 Heathkit generator wave shaper model 10-57A, $149.00. Best offer (509) 483-6240.

TUBES WANTED—Top prices paid for sweep tubes—6KV6, 6LF6, 6LQ6, etc. Send list for bid. **Antique Electronic Supply,** 6221 S. Maple Ave., Tempe, AZ 85283. Phone 602-820-5411. Fax 800-706-6789.

BUSINESS OPPORTUNITIES

TV/VCR Repair. 15 Yrs. reputation, only shop in town, beautiful Ketchikan in S.E. Alaska. Everything for $40K. 907-225-2350.

Readers' Exchange

Readers' Exchange has been reinstated as a free service.

The following restrictions apply to Readers' Exchange:

- Only individual readers may use Readers' Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropriate place for your message is in a paid advertisement, not Readers' Exchange.
- Readers' Exchange items must be restricted to no more than three items each for wanted and for sale, and may be no more than approximately four magazine column lines in length (about 20 words).
- All submissions must be typed or printed clearly!

Send your Readers' Exchange submissions to:

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

WANTED

CRT Restorer, Beltron preferred, will consider others. *Contact Tom, (510) 825-0300.*

IC STK040/ECG1324/NTE1324. Need at least one, two if possible. *Contact Bill Tipton, 108 Milton St., Salisbury, NC 28146. (704) 855-1220.*

Sams CB manuals. Please send price and manual numbers. Jordan Hillrich, 732 Queen St., Regina, Sask., Canada S4T 4A3.

Flyback (new or used) wanted: Hitachi 2432091, G.E. EP77X48, and Philco 32-10146-1 (Thordarson FLY-474). Also, SAMs above #1535. *W. Worley, 305 Hickory Bend, Enterprise, AL 36330, 205-347-5281.*

Owner's manual or Xerox copy wanted for IBM graphics printer model 5152002 (5152) and service manual or Xerox copy (or microfiche) for Honda Car ('87) radio/cassette PN08118-SE303AH Ref. No: CM3306. Please send or call the price. *Augustine's TV & Radio Service, 3129 Earl St., Laureldale, PA 19605, (610) 929-8850.*

Wanted Toshiba M-5900 VCR working or non-working condition. Also, TV Repair course for starter. Headstart III computer's keyboard PCB. *Contact: Agbert Hillary, 12 Saturn La., Staten Island, NY 10314. (718) 698-1094.*

Wanted Tripler (blue gun) for G.E., Model # 45EP1000P, Part #EP62X133 or EP62X155. *Jim Jordan, 2602 FM 1960 W. #114, Houston, TX 77068, 713-444-7070.*

Need good used test equipment, manuals (no TVs) & books, parts for inventory, and any other related items. Transistor checker and frequency counter needed now. *Contact Chuck Milam, First Class Electronics, 5888 25th Way South, St. Petersburg, FL 33712.*

Want to buy JVC VCR service manuals. *Contact: Truman McGregor, 3601 Jefferson Ave., Texarkana, AR 75502. 501-773-6488.*

Schematic and service data for Panasonic SE3057 stereo radio-cassette; Panasonic TV model CT-228, chassis NMX-L1 (not L1-A). *Contact D. Kurstin, 13462 Villadest, Highland, MD 20777, 301-854-0327.*

Good test equipment—cheap! Also, info on power supply for GE VCR model #VG2019. Send list and prices to: *Jerry Wilson, 290 Mell Ridge Rd., Edmonton, KY 42129.*

Anyone who will hire me as a technician. *Contact 1919 Lincoln Blvd., Venice, CA 90291, 310-578-2040.*

Questions and answers on diskettes for CNE (certified netware engineer) examination. *Contact Agbert Hillary, 12 Saturn La., Staten Island, NY 10314, 718-698-1094.*

Service and/or operators manuals for H.H. Scott (1959) stereo amplifier (LK-72) and Fisher (1963) am/fm stereo receiver 800C. *F.J. Wrice, 9636-42nd Ave.-So., Seattle, WA 98118, 206-725-5052.*

S/M or schematic for Tektronix 535A oscilloscope. Will pay for copy and postage or copy and return. *Contact John, 904-477-6736.*

Flybacks (new or used) Hitachi 2432091, GE EP 77X48, Thordarson Fly-474 and touch panel (used) for GE microwave JETI 12 OA2. *Contact W. Worley, 305 Hickory Bend, Enterprise, AL 36330, 205-347-5281.*

CRT 75ARB1 for leader LAS-5500 audio analyzer or buy complete unit (must have good CRT) if under $100.00. *T.J., 613-392-3588.*

Service manual or schematics to buy or borrow for JVC stereo cassette deck model # KD-A55J. *Contact Ivan Rodriguez, 325 E. 106th St., 13th Fl., New York, NY 10029-4843.*

Schematic diagram for a Magnavox TV chassis # 13C202. *Contact Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Need Motorola 7652/Heath 442-74/industr. MC 1344 14 pin AGC/sync chip. *Contact 615-288-7343.*

IC901-NEC D75516GF remote control for Hitachi VCR-VT-M231A. Also, for Sony 25 inch TV model KV2680R chassis # SCC548K-A high voltage rectifier. *John's Repair Service Center, 142 Jackson St., Philadelphia, PA 19148, 215-389-1147.*

CRT socket for Quasar DTS976F chassis. Quasar part number 9S13775A11/0913775A11. *Mike Choate Gadget Repair, 1800 N. Mays, #105, Round Rock, TX 78664, 512-255-7931 day or night.*

Schematic/service manual for Curtis Mathis model # TC2501 RL, chassis # M8C45K1. *Price TV, PO Box 291, Parker City, IN 47368, 317-468-6858.*

Need operators manual for Soltec oscilloscope model 515-2. Top price paid for manual or copy. *Contact C. Hudson, PO Box 3032, Port Arthur, TX 77643, 409-962-4155.*

Need service manual/schematic for Sinclair black and white pocket TV. *Contact David Sudduth, 2418 Shady Ln. #19, Kansas City, MO 64118, 816-454-6783.*

AC motor for Garrard phonograph model AIf—no part #. *Globe TV 1-909-684-9393, 3407 Arlington Ave., Riverside, CA 92506.*

Need schematic for Silvertone amplifier Sears model 1396. *Contact O.T. Loe, 7383 Rowanta, Cincinnati, OH 45230, 513-231-3219.*

Fisher VCR loading motor Assembly # 143-0-3404-03700, B&K 470 CRT checker adapter socket # CR42, 16 RPM records. *Contact Ed Herbert, 410 N. Third, Minersville, PA 17954.*

Flyback 50-3017659-01 for Sylvania model CLA372AR, chassis E51-28. Part no longer available from NAP. *Contact Schaefer TV, 6131 So. 19th Ct., Milwaukee, WI 53221.*

Deflection yoke for a Sharp color TV model # 9B12A, Yoke # RCILH1125CE22. *Contact 313-368-6899 after 7:30 p.m. (home) or 313-224-4777 (work).*

Need service manual/schematics for Sylvania CXA178WR, Pioneer SX-201, and a Kenwood KR7200 reciever. Can copy and return to owner if you do not wish to sell outright. *Contact Greg LaCava, 3900 Mumphrey Rd., Chalmette, LA 70043, 504-277-3256.*

Service manual and/or schematics for Shakespear 35 12V infinately variable speed trolling motors, with battery saver. Has electronic motor speed control. Send postcard to *Ed Drake, 921 Liberty Rd., Roanoke, VA 24012.*

FOR SALE

J.C. Penney technical service data books, I.V. 219-238. *Jay's, 151/2 W. Lake St., Chisholm, MN 55719, 1-218-254-4421 (evenings).*

Approximately 200 new tubes still in boxes. Make offer. *Contact Bobby, (601) 636-7590.*

Sencore VA62 video analyzer, w/VC63 VCR tester and NT64 NTSC pattern generator, cables and manuals, used very little, like new. Paid $3,450.00, asking only $2300.00. *Call (512) 992-0223.*

Must sacrifice Sencore CM2000 computer monitor analyzer, almost brand new, original box, w/accessories, manuals, etc.; paid $3200.00 but need $1500.00 ASAP. *Contact Scott, (501) 646-6142, M-F, 8:00-5:30 CST.*

Over 120 copies of electronic magazines, all for $30.00 plus postage. Want to pinpoint transistor troubles in 12 minutes? *Contact Daniel Seidler, 3721 W. 80 St., Chicago, IL 60652, (312) 284-8221.*

Sencore VC93 VCR analyzer with all test leads, manuals, VHS and Beta test tapes; PR 57 iso-variable ac supply included with purchase of VC93. Purchased new in 10/92. *Mail offer to PO Box 21, Millville, PA 17846.*

Heath Video Alignment generator, model IG-5260; handheld, channel 3 RF/video level output, 6 patterns produced. Sold new for about $150.00. Works great, schematics and manual incl. Heath 40KV handheld probe with meter in probe. Model IM-5215. Manual incl., works great. Telematic UHF/VHF sub tuner. Subs TV Tuner to produce IF output to inject past tuner. *Mail offer to Andy's Electronics, P.O. Box 21, Millville, PA 17846.*

Sencore SC61, Sencore VA62 with NT64, VC63 & EX231, $2500.00 for either or $4000.00 for both. *Contact Terry, (706) 647-4300 or fax (706) 647-5061.*

Hitachi V-509 50MHz portable dual-trace oscilloscope; like new condition with two x10/x1 probes and one x100 probe; $600.00. *Contact Ron, (916) 397-4233.*

Complete Sencore TV, VCR, camera workbench; includes VC93, SC3100, LC102, CVA94, VR940, CM2000, TVA92, SC61, VA62, 4-PR57, VG91. *Contact Rick, 2773 Crescent, San Bernardino, CA 92405, (909) 883-1021.*

Sencore VA62, SC61, and LC77 for sale. Excellent condition, complete with all cables, manuals, etc. *Contact Kevin at 716-265-4113.*

Diehl Mark VII diagnostic computer with original operators manuals and literature. *Larry Dillon, (800) 720-1942.*

Sencore CM2000 computer monitor analyzer. In A-1 condition, $2250.00. (Closing shop). With manuals, adapters & original shipping box. I will pay shipping and COD fee(s). *614-554-3301, Ron.*

Sencore SC61 waveform analyzer, excellent condition, used one year, $1600.00. Complete with all probes, accessories and manuals in original box. Includes shipping. *Kent Wilke, 3724 El-Char Lane, St. Louis, MO 63125, 314-892-5682 days.*

Assorted parts for various VCRs (used). *Jerry Wilson, 290 Mell Ridge Rd., Edmonton, KY 42129, (502) 565-1615.*

Advertiser's Index

Company	Page Number	Reader Service Number	Advertiser Hotline
American Hakko Products	23	18	800/88 HAKKO
Chemtronics	5	40	800/645-5244
Chip Quick	67	36	800/836-CHIP
Computer & Monitor Maintenance	46	19	800/466-4411
Dalbani Corporation Of America	3	20	800/325-2264
Electronic Technicans Asso.	45	21	317/653-4301
Fluke Corporation	BC	118	800/87FLUKE
H.C. Protek	15	24	201/767-7242
Howard Electronics	48	37	800/394-1984
ISCET	45		817/921-9101
International Components Corp.	67	25	800/645-9154
NESDA	24,49,66		800/433-5557
National Advancement Corp.	24	26	800/340-EXAM
Parts Express	19	27	800/338-0531
Philips ECG	9	28,29	800/526-9354
Sams, Howard & Company	57	35	800/428-7267
Sencore	IFC	119	800/SENCORE
Serviceware	49	30	613-521-7391
Sperry Tech	67	31	800/228-4338
Tentel	12	32	800/538-6894
Thomson Consumer Elec.	68, IBC	38	
Wholesale Electronics	67	33	800/351-2233

We'd like to see your company listed here too. Call Diane Klusner at 516/681-2922 to work out an advertising program tailored to suit your needs.

SALES OFFICE

PHONE
(516) 681-2922
FAX
(516) 681-2926

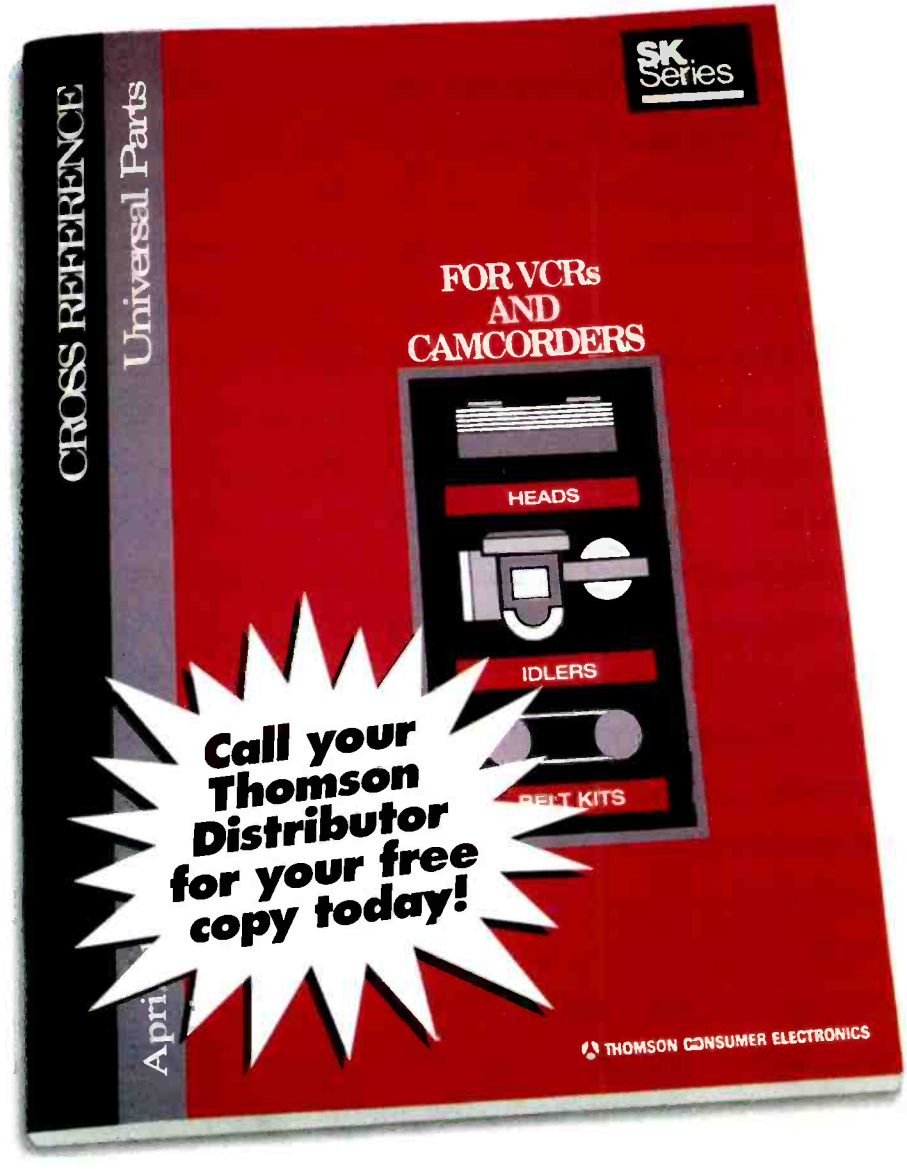
To Order Back Issues

Send $3.50 Per Issue (Check, Money Order, Mastercard, VISA, AMEX and Discover).

Send All Correspondence To:

CQ Communications
76 North Broadway
Hicksville, NY 11801
Or Call
516-681-2922
FAX 516-681-2926

SK's JUS



ALABAMA
CARMICHAEL ELECTRONICS INC
DOTHAN AL • 800-633-0911

ARIZONA
ARIZONA WHOLESALE SUPPLY CO
PHOENIX AZ • 800-877-0771

CALIFORNIA
ANDREWS ELECTRONICS INC
SANTA CLARITA CA • 800-289-0300
ARDCO ELECTRONICS SUPPLY
SAN FRANCISCO CA • 800-652-1023
CHUCK HURLEY'S ELECTRONICS INC
SACRAMENTO CA • 800-655-4004
INLAND ELECTRONIC SUPPLIERS
HIGHLANDS CA • 800-833-9254
INLAND ELECTRONICS SUPPLIERS
MODESTO CA • 800-692-5788
INLAND ELECTRONICS SUPPLIERS
SAN JOSE CA • 800-262-1130
JACK C ARBUCKLE CO
BAKERSFIELD CA • 805-325-5816
JACK C ARBUCKLE CO
FRESNO CA • 209-264-6554
MARTIN DISTRIBUTING CO
HUNTINGTON PARK CA • 800-660-8771

FLORIDA
C&S ELECTRONIC SUPPLY CO.
ORLANDO FL • 800-321-6993
DOW ELECTRONICS INC
JACKSONVILLE FL • 800-627-2870
DOW ELECTRONICS INC
ORLANDO FL • 800-627-2950
DOW ELECTRONICS INC
TAMPA FL • 800-627-2900
FOURAKERS ELECTRONICS INC
TALLAHASSEE FL • 800-635-0420
HERMAN ELECTRONICS
MIAMI FL • 800-938-4376
RES MARKETING INC
TAMPA FL • 800-444-7304
TRITRONICS INC
FT LAUDERDALE FL • 800-365-8030
VANCE BALDWIN INC
FT LAUDERDALE FL • 800-432-8542
VANCE BALDWIN INC
MIAMI FL • 800-432-8542
VANCE BALDWIN INC
TAMPA FL • 800-299-1007
VANCE BALDWIN INC
WEST PALM BEACH FL • 800-367-1641

GEORGIA
DOW ELECTRONICS INC
ALBANY GA • 800-627-2810
DOW ELECTRONICS INC
NORCROSS GA • 800-627-2810
DOW ELECTRONICS INC
SAVANNAH GA • 800-627-2890
FOURAKERS ELECTRONICS INC
MACON GA • 800-554-4347
FOURAKERS ELECTRONICS INC
VALDOSTA GA • 800-422-2801
WHOLESALE INDUSTRIAL ELECTRONICS
NORCROSS GA • 800-282-1857

ILLINOIS
DELTRONICS DISTRIBUTING CO
BELLEVILLE IL • 618-236-0366
HOWARD ELECTRONIC
CHICAGO IL • 312-254-9091
KLAUS RADIO INC
PEORIA IL • 800-475-5287
LACO ELECTRONICS INC
DECATUR IL • 217-423-0494
LACO ELECTRONICS INC
MT VERNON IL • 800-642-4960
TRI-STATE ELECTRONIC CORP
MOUNT PROSPECT IL • 800-445-0896
UNION ELECTRONICS INC
SOUTH HOLLAND IL • 800-648-6657

INDIANA
ESP/ELECTRONIC SERVICE PARTS
INDIANAPOLIS IN • 800-382-9976

IOWA
GIFFORD-BROWN INC
DES MOINES IA • 800-369-4433

KANSAS
ACME RADIO SUPPLY CO
TOPEKA KS • 800-544-8521
MANHATTAN ELECTRONICS CORP
OVERLAND PARK KS • 800-821-3114

KENTUCKY
RADIO ELECTRONIC EQUIPMENT CO
LEXINGTON KY • 606-255-6661
RANDOLPH & WARREN
LOUISVILLE KY • 800-765-7278
RANDOLPH, HALE & MEREDITH INC
BOWLING GREEN KY • 502-781-1460

LOUISIANA
SOUTHERN ELECTRONICS INC
SHREVEPORT LA • 800-521-4391

MASSACHUSETTS
E A ROSS CO INC
FALL RIVER MA • 800-828-4901
ELECTRONIC DISTRIBUTORS CORP
NORTH QUINCY MA • 617-328-7800
NASH ELECTRONIC SUPPLY INC
LEOMINSTER MA • 508-537-0707
TEE-VEE SUPPLY COMPANY INC
MEDFORD MA • 800-255-5854

MARYLAND
FAIRWAY ELECTRONICS INC
HAGERSTOWN MD • 800-654-5052
FAIRWAY ELECTRONICS INC
KENSINGTON MD • 800-352-1474
TRITRONICS INC
ABINGDON MD • 800-638-3328

MICHIGAN
BURSMA ELECTRONIC DIST. INC.
BENTON HARBOR MI • 800-777-6261
BURSMA ELECTRONIC DIST. INC.
GRAND RAPIDS MI • 800-777-2604
BURSMA ELECTRONIC DIST. INC.
TRAVERSE CITY MI • 800-777-6261
ELECTRONIC PARTS SPECIALIST
FLINT MI • 810-238-7311
REMCOR ELECTRONICS INC
OAK PARK MI • 800-482-2133

MINNESOTA
NESS ELECTRONICS INC
MINNEAPOLIS MN • 800-247-1318
PACE ELECTRONICS INC
ROCHESTER MN • 800-444-7223

MISSOURI
CENTRAL MISSOURI DISTRIBUTING CO
JEFFERSON CITY MO • 314-636-3149
CITITRONIX INC
ST LOUIS MO • 800-846-2484
DELTRONICS DISTRIBUTING
ST LOUIS MO • 800-443-0665

MISSISSIPPI
N & H ELECTRONICS
HATTIESBURG MS • 800-264-8808

NEBRASKA
SCOTT ELECTRONIC SUPPLY CORP
LINCOLN NE • 800-333-7952
SCOTT ELECTRONIC SUPPLY CORP
OMAHA NE • 800-333-7953

NEW JERSEY
LINWOOD WHOLESALE INC
WALL TOWNSHIP NJ • 800-326-0313

T GREW!

Quality Universal Video Parts.

The only way we can make your business our business is to grow in your direction. That's why we've expanded our product line to include the video and camcorder parts that take more wear and tear than other parts. And, we've done it at such a minimal cost, these quality parts have generic pricing. Plus, our new product line is so inexpensive, yet so efficient, it allows you to turn your job estimates into jobs completed. The SK Universal Line, it's quality without the cost.

Now for a limited time, you can get our complimentary Cross Reference. This cross-reference guide was designed by a professional serviceman, to accurately help you find the right part. Just one more way Thomson Consumer Electronics is making life a little easier. Call your TCE distributor today.

- **Parts That Are Easy To Order–Just ask your TCE Distributor.**
- **Parts That Come With An Easy-To-Use Cross Reference.**
- **Parts That Have Quality Without The Cost.**

Use SK Universal Parts With Confidence.

THOMSON CONSUMER ELECTRONICS, INC.

PANSON ELECTRONICS
PINE BROOK NJ • 800-255-5229

NEW MEXICO

R & R ELECTRONIC SUPPLY CO
HOBBS NM • 505-393-1613

NEW YORK

EIGER ELECTRONICS INC
DEER PARK NY • 800-835-8316

GMB SALES
FARMINGDALE NY • 800-874-1765

RADIO EQUIPMENT CORP
BUFFALO NY • 716-874-2690

STANDARD ELECTRONICS INC
AMHERST NY • 800-333-1519

STANDARD ELECTRONICS INC
SYRACUSE NY • 800-333-1639

NORTH CAROLINA

SOUTHEASTERN ELEC SUB/CAMBAR
FAYETTEVILLE NC • 800-682-3670

SOUTHEASTERN ELEC SUB/CAMBAR
RALEIGH, NC • 800-682-5707

OHIO

EXCEL DISTRIBUTING INC
CINCINNATI OH • 800-733-3329

FOX INTERNATIONAL LTD INC
BEDFORD HTS OH • 800-321-6993

MCM ELECTRONICS
MORAINE OH • 800-543-4330

SUPERIOR ELECTRONIC PARTS CO INC
PARMA OH • 800-875-7942

OKLAHOMA

RADIO SUPPLY INC
OKLAHOMA CITY OK • 800-522-3821

OREGON

DOUBLE O ELECTRONICS DISTR INC
PORTLAND OR • 800-452-7688

PENNSYLVANIA

CLEARFIELD ELECTRONIC SUPP CO
HYDE PA • 800-635-0325

CRS ELECTRONICS
PITTSBURGH PA • 412-431-7700

CUMBERLAND ELECTRONICS INC
HARRISBURG PA • 800-922-2271

CUMBERLAND ELECTRONICS INC
LANCASTER PA • 800-242-3703

CUMBERLAND ELECTRONICS INC
YORK PA • 800-632-9025

H B F ELECTRONICS INC
PHILADELPHIA PA • 800-426-4230

LINWOOD WHOLESALE INC
MARCUS HOOK PA • 800-326-0313

SOUTH CAROLINA

HARLEY'S WHOLESALE ELECTRONICS
SPARTANBURG SC • 800-326-7961

WHOLESALE INDUSTRIAL ELECTRONICS
CHARLESTON SC • 800-868-2211

WHOLESALE INDUSTRIAL ELECTRONICS
COLUMBIA SC • 800-868-2213

WHOLESALE INDUSTRIAL ELECTRONICS
GREENVILLE SC • 800-868-2215

TENNESSEE

ELECTROTEX TENNESSEE INC
MEMPHIS TN • 800-460-1808

RANDOLPH HALE & MATTHEWS INC
CLARKSVILLE TN • 800-227-8652

RANDOLPH & RICE INC
NASHVILLE TN • 615-255-5601

SHIELDS ELECTRONICS SUPPLY INC
BRISTOL TN • 800-325-0007

SHIELDS ELECTRONICS SUPPLY INC
CHATTANOOGA TN • 800-508-0733

SHIELDS ELECTRONICS SUPPLY INC
KNOXVILLE TN • 800-235-7615

TOWNSEND ELECTRONIC SUPPLY
JACKSON TN • 800-926-8726

TEXAS

APOLLO WHOLESALE ELECTRONICS INC
FT WORTH TX • 817-877-5854

APOLLO WHOLESALE ELECTRONICS INC
IRVING TX • 800-488-2782

ELECTROTEX INC AIRLINE
HOUSTON TX • 800-275-7801

ELECTROTEX INC AUSTIN
AUSTIN TX • 800-460-1806

ELECTROTEX INC BEAUMONT
BEAUMONT TX • 800-460-1803

ELECTROTEX INC CORPUS CHRISTI
CORPUS CHRISTI TX • 800-460-1805

ELECTROTEX INC DALLAS
DALLAS TX • 800-460-1807

ELECTROTEX INC RICHMOND
HOUSTON TX • 800-460-1801

ELECTROTEX INC WINKLER
HOUSTON TX • 800-275-7801

ELECTROTEX INC SAN ANTONIO
SAN ANTONIO TX • 800-460-1804

INTERSTATE ELECTRIC CO
DALLAS TX • 800-527-4029

R & R ELECTRONIC SUPPLY CO
ABILENE TX • 915-677-2974

R & R ELECTRONIC SUPPLY CO
AMARILLO TX • 800-300-7991

R & R ELECTRONIC SUPPLY CO
DALLAS TX • 915-566-9693

R & R ELECTRONIC SUPPLY CO
EL PASO TX • 915-566-9693

R & R ELECTRONIC SUPPLY CO
LUBBOCK TX • 800-299-7000

R & R ELECTRONIC SUPPLY CO
ODESSA TX • 915-332-9167

WILTRONICS SUPPLY INC
PARIS TX • 800-426-6317

WILTRONICS SUPPLY INC
TYLER TX • 800-657-2404

UTAH

BALLARD SUPPLY CORPORATION
SALT LAKE CITY UT • 800-662-8561

WEST VIRGINIA

ELECTRONIC SUPPLY INC
HUNTINGTON WV • 303-523-6443

WISCONSIN

G M POPKEY CO
GREEN BAY WI • 800-444-5920

G M POPKEY CO
MADISON WI • 800-444-5320

G M POPKEY CO
NEW BERLIN WI • 800-444-9320

G M POPKEY CO
WAUSAU WI • 800-444-7920

TAYLOR ELECTRIC CO
MEQUON WI • 800-558-6970

Not all 800#'s are interstate.

Circle (38) on Reply Card

We Only Skimped On The Price.

Introducing The Fluke Series 10—From $69.95

Fluke quality: Made in the USA by Fluke, with the same rugged reliability that's made us the world leader in digital multimeters. Count on hard-working high performance—and a two-year warranty to back it up.

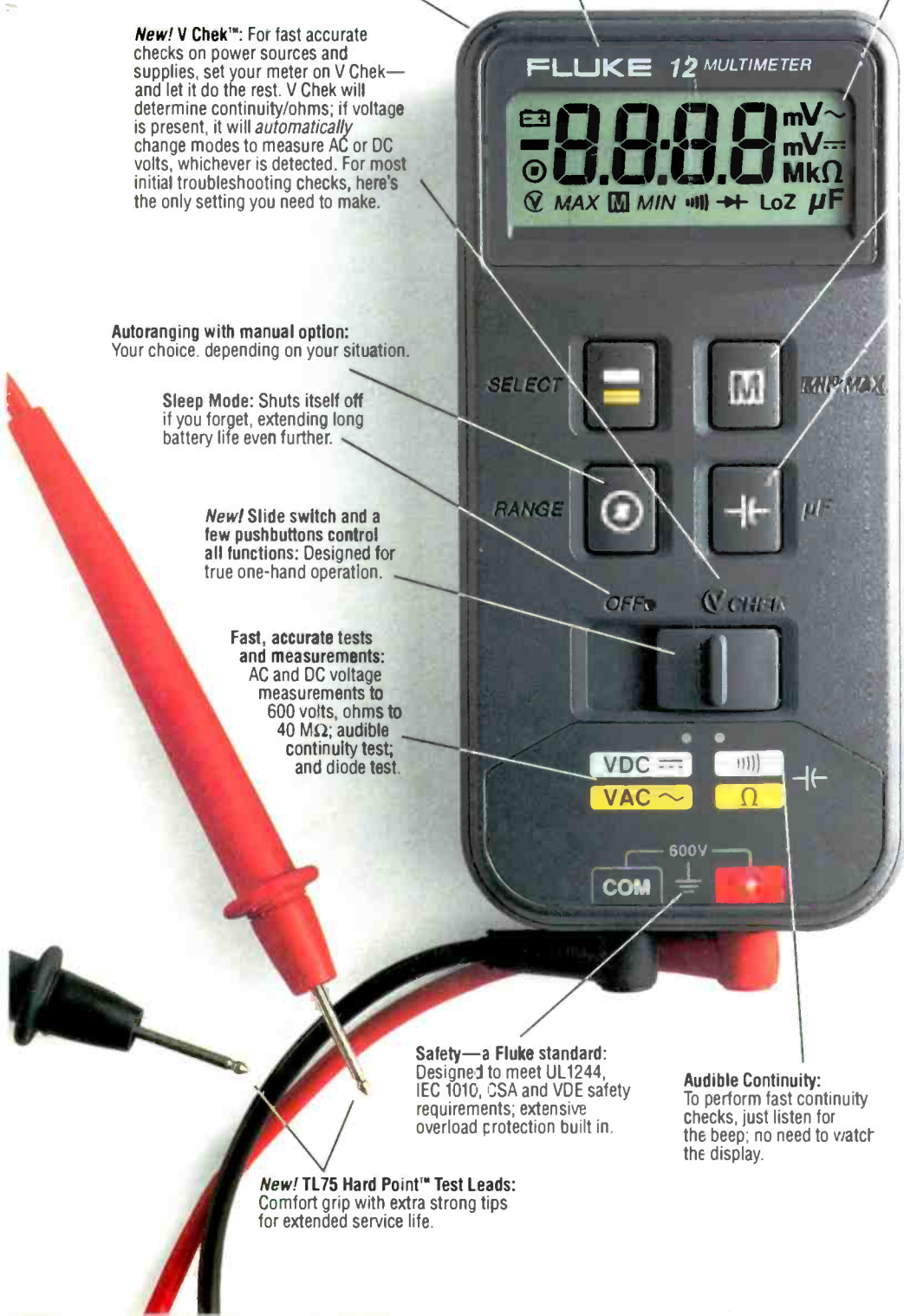
Large, easy-to-read display: 4000 count digital readout.

Actual size: Easy to carry, easy to use.

***New!* Min/Max record with relative time stamp and Continuity Capture™:** Makes intermittent problems easier to find. Records highs and lows—and "time stamps" when they occurred. In continuity mode, opens or shorts as brief as 250 µs are captured and displayed.

***New!* V Chek™:** For fast accurate checks on power sources and supplies, set your meter on V Chek—and let it do the rest. V Chek will determine continuity/ohms; if voltage is present, it will *automatically* change modes to measure AC or DC volts, whichever is detected. For most initial troubleshooting checks, here's the only setting you need to make.

Capacitance: Autoranging from .001 µF to 9999 µF. No need to carry a dedicated capacitance meter.



Autoranging with manual option: Your choice, depending on your situation.

Sleep Mode: Shuts itself off if you forget, extending long battery life even further.

***New!* Slide switch and a few pushbuttons control all functions:** Designed for true one-hand operation.

Fast, accurate tests and measurements: AC and DC voltage measurements to 600 volts, ohms to 40 MΩ; audible continuity test; and diode test.

For high performance at Fluke's lowest price, get your hands on the new Series 10. Stop by your local Fluke distributor and feel what a powerful difference the right multimeter makes—at the right price. For a free product brochure or the name of your nearest distributor, call **1-800-87-FLUKE**.

Fluke 10	Fluke 11	Fluke 12
$69.95	$79.95	$95.00
4000 count digital display	V Chek	V Chek
1.5% basic dc volts accuracy	Capacitance .001 to 9999 µf	Min/Max recording with relative time-stamp
2.9% basic ac volts accuracy	4000 count digital display	Continuity Capture
1.5% basic ohms accuracy	0.9% basic dc volts accuracy	Capacitance .001 to 9999 µf
Fast continuity beeper	1.9% basic ac volts accuracy	4000 count digital display
Diode Test	0.9% basic ohms accuracy	0.9% basic dc volts accuracy
Sleep Mode	Fast continuity beeper	1.9% basic ac volts accuracy
Two-year warranty	Diode Test	0.9% basic ohms accuracy
	Sleep Mode	Fast continuity beeper
	Two-year warranty	Diode Test
		Sleep Mode
		Two-year warranty

*Suggested U.S. list price.

Optional holster with tilt-stand available.

Safety—a Fluke standard: Designed to meet UL1244, IEC 1010, CSA and VDE safety requirements; extensive overload protection built in.

Audible Continuity: To perform fast continuity checks, just listen for the beep; no need to watch the display.

***New!* TL75 Hard Point™ Test Leads:** Comfort grip with extra strong tips for extended service life.

The New Series 10. A Small Price For A Fluke.

FLUKE®

Circle (118) on Reply Card