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ELECTRONIC

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Multimeter update

New consumer electronics technology: A special report

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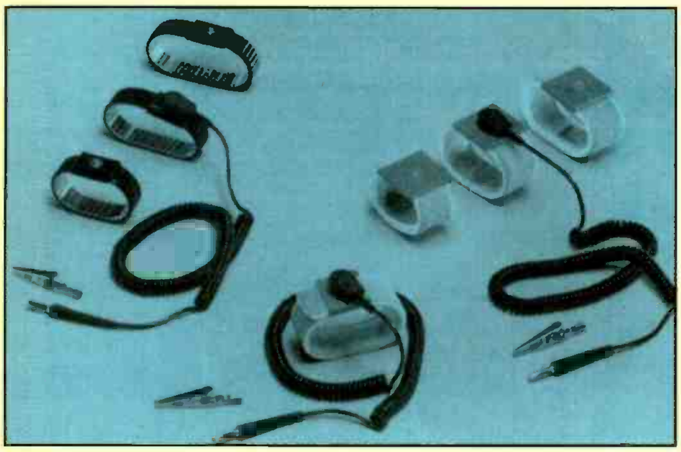

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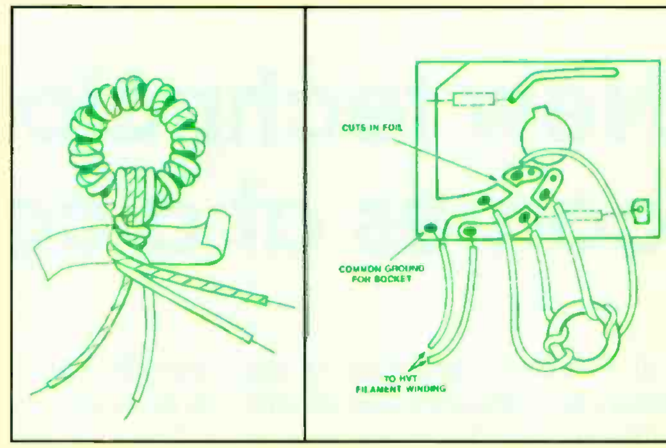

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ON THE COVER

The increasing vulnerability of the circuitry of consumer electronics products to electrostatic discharge (ESD) damage requires that every service center and every technician be aware of the problem and take steps to insure that they don't inflict damage on the very products that they are servicing. (Photo courtesy of DESCO Industries)

New technology comes at a cost

It is always fascinating to read about new technology, such as some of the products that we are reporting on in this issue in the article "New consumer electronics technology: A special report." Products such as the eyeglass TV, the Trakker, and others have the capacity to enhance our lives. Services such as that offered by Oracle and US WEST provide us with new ways to access large amounts of information.

One of the things we tend to forget as we succumb to the euphoria induced by the hype and the hoopla, and even the true merits of these wonderful new technologies, is that there is frequently a downside to the introduction of new technology.

For one thing, when a truly new technology is introduced, there are frequently several variations, and, until the consumers, the manufacturers, or some regulatory agency agree on a single standard, consumers face the possibility that they will buy a new product that will not be in the forefront of the technology tomorrow, next month or next year.

We don't have to go back very far to find evidence of this problem. Just a few years ago, two standards were vying for preeminence among purchasers of VCRs, blank tape and prerecorded tape: Beta and VHS. According to many viewers, Beta VCRs actually produced a somewhat better picture. Nevertheless, for a number of reasons, VHS eventually shouldered Beta out of the marketplace. Of course, owners of Beta machines can still use them, but how many Beta format videos do you find at the video store?

The same problem occurred with the video disc. In the beginning, there were two separate technologies: the laser disc and the capacitive disc. Many consumers bought the capacitive disc, only to find that it quickly became truly obsolete.

This type of imbroglio was avoided when the technology for the audio compact disc was developed. In this case, two recognized world leaders in consumer electronics, Philips and Sony, worked together to develop the technology. When the product was announced to the world, it was the standard.

Of course, many of the problems encountered as a result of the introduction of new technology could be avoided by the imposition of a single standard by some regulatory agency or other governing body. In fact, the FCC was criticized by some when it failed to establish a standard for AM stereo broadcast during the infancy of that technology.

The disadvantage of establishing a standard, and not necessarily the best one, in the formative stage of a technology, is that such regulations tend to stifle the creativity and competion that could, in the end, result in the best, most truly advanced technology.

An example of this is the NTSC television broadcast system used in this country. Establishment of this standard early on did assist in bringing broadcast television to the people of the U.S. However, the 525-line standard continues to be criticized for the lower quality of the picture it provides.

Lest anyone get the idea that this is strictly a modern problem engendered by the recent rush of electronics technology, it should be said here that it goes back much further than that. A few readers may remember when there was a great fuss about which recording speed would be the standard. Of course, in that case the problem was neatly handled by making record players capable of playing at three speeds: 78, 45 and $33^{1}/_{3}$ RPM.

And further back than that, in other areas of technology, there have been some approaches that succeeded and some that fell by the wayside. Take cars, for example. Way back when, automotive experimenters tried both electric and steam power for automobiles, but only the internal combustion engine is in general use today.

The same is true of electrical power distribution. Thomas Edison himself was an advocate of distribution by direct current, going so far as to suggest that ac was dangerous.

We are fortunate to be living during a time in which new technology is being introduced at a rapid pace. We must, however, be aware that when several approaches to a technology compete, as has always been the case in the past, there will be chaos and confusion until a winner emerges.

Nils Conrad Persson

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC
Servicing & Technology

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

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Literature

Soldering equipment catalog

A new 36-page catalog of soldering equipment is available from Hexacon Electric Co. It features state-of-the-art soldering stations and soldering irons in full-color and a wide range of sizes from micro-mini for fine pitch to 1000W heavy duty tools for mechanical soldering. Many soldering accessories are included to aid in production soldering. Selection of the best tool for the job is made easy from the complete performance and technical description of each product.

The HTC series is the company's newest line of temperature controlled soldering stations. It includes a dual station which is available with a standard power iron and/or a high heat capacity iron. The Therm-O-Trac line is now expanded to nine models, including the highest thermal capacity Magnum station.

New equipment includes a flux fume extraction kit to remove noxious fumes from the work area. Hex-Wik desoldering braid is now available on ESD safe spools in a variety of lengths up to 500 feet and thicknesses down to 0.025-inch for today's miniature circuitry.

A full-line of specialized miniature irons and stations is described for use together with dozens of tips for soldering surface mount devices.

Circle (1) on Reply Card

1993 edition of U.S. Consumer Electronics Industry in Review now available

A review of the consumer electronics industry in 1992 reveals that total sales of consumer electronics products rose an estimated 7.9 percent over 1992. The total U.S. retail market for consumer electronics was estimated at over $49 billion.

The 1993 Edition of *The U.S. Consumer Electronics Industry In Review: Entertainment and Education—Yesterday, Today and Tomorrow* discusses these and other growth trends in the consumer electronics industry. Consider this:

- Total sales of audio products rose 7 percent over 1991, and 94 percent of U.S. households own an audio system.

- Home information equipment rose 9 percent over 1991, with dramatic sales in home computers, telephone answering devices and home fax machines. Thirty-five percent of U.S. homes have a home computer.

The Review offers both an historical and current overview of the consumer electronics industry, product by product and issue by issue. There is a special emphasis placed on future trends. CaptionVision (CC), Radio Broadcast Data System (RBDS), new digital formats—DCC and MD, as well as multimedia, personal digital assistants, mobile electronics and a wide variety of other technologies and product categories are covered thoroughly in the new publication.

The Review also discusses the impact Congressional legislation and FCC (Federal Communications Commission) decisions—such as the Audio Home Recording Act and the cable re-regulation bill of 1992—will have on the consumer electronics industry in the coming years.

All data was compiled by the Electronic Industries Association's Marketing Services Department, which has developed comprehensive statistical reporting programs for over three decades.

EIA is the 69-year-old Washington, D.C.-based trade association representing all facets of electronics manufacturing. EIA's Consumer Electronics Group represents U.S. manufacturers of audio, video, home office and home automation products, mobile electronics, accessories, as well as assistive devices for people with disabilities.

Circle (2) on Reply Card

Catalog supplement of telecom/network products

A new catalog (Supplement Y2) from Jensen Tools makes a handy purchasing guide for the installation and maintenance of plant electrical and telecommunications systems. Included is a special 16-page insert describing state-of-the-art voice/data test equipment from major manufacturers.

The catalog offers the company's new JTK-44000 Deluxe Telecom Installers Kit with four different pallet options for greater versatility; an economical Telvac General Purpose Electronics Kit; IDS, PEI and other major brand voice/LAN test equipment; a broad selection of calibrated Fluke digital multimeters; tools and accessories for outside plant, and more.

Circle (3) on Reply Card

News

Updated standard for musical instruments safety

Underwriters Laboratories Inc. (UL) is proposing the updated Standard for Safety for Musical Instruments and Accessories, UL 469, for recognition as an American National Standard.

UL 469 covers power-operated musical instruments and accessories rated 300 volts or less, intended for household and commercial use on supply circuits in accordance with the National Electrical code, NFPA 70.

Musical instruments include organs, electronic pianos, music synthesizers, and other such products that produce music under the direct control of the player.

These requirements also cover accessories for use with musical instruments, such as rhythm generators and similar equipment having self-contained tone generators, tone cabinets, music tuners, and the like.

UL 469 does not cover commercial audio equipment, such as amplifiers, mixers, and signal processors for general use; or special effects units, amplifier-speakers, and the like, that are intended for use by professional musicians.

These requirements do not cover musical instruments that are categorized as electrically operated toys and are covered by the Standard for Electric Toys, UL 696.

The standard is a revised version of ANSI/UL 469, which is presently recognized as an American National Standard. UL is seeking review and comment from interested individuals and organizations to help develop a consensus upon which continued recognition of UL 469 by the American National Standards Institute (ANSI) can be based. ANSI is a clearinghouse for information on standards and coordinates development of consensus standards through voluntary action.

VCR decks rebound, camcorders surge, as video product sales rise in May 1993

Video product sales rose seven percent in May 1993 over the same period last year, due in part to a rebound for VCR decks and a surge in camcorder sales, according to statistics released by the Electronic Industries Association's Consumer Electronics Group (EIA/CEG).

Although the video market was sluggish early in May, due to strong buying earlier in the year, slower consumer spending, and retailer caution, the last week of the month saw dealers snapping up an average of 75 percent more video products than in the same week in 1992.

Consumer electronics retailers fared better in May than other types of retailers, if information reported in the June 7 edition of *TV Digest* is any indication. Comparable store gains in dollar sales averaged near nine percent in May 1992 for Circuit City, Tandy, Best Buy, and Audio/Video Associates.

At the same time, retail sales for many large U.S. retailers (such as K-Mart and J.C. Penney) rose between two and three percent, according to a story in the June 4 edition of the *Washington Post*. The conference Board's latest report also sounded a positive note for the U.S. video market. The conference Board's consumer confidence index fell to its lowest point since October 1992 during May, but it also reported consumer buying intentions for color TVs in May were on par with last year, a period of surging confidence.

Color television sales rose two percent in May, posting the highest total for the month since 1989. Large screen sets, 27 inches and larger, rose 21 percent on volume of almost 246,000 units.

VCR decks reversed a four percent April 1993 decline by gaining six percent in May, the largest total on record for the month sales of stereo-equipped VCRs rose seven percent.

Camcorder sales posted double digit growth at 11 percent. The surprise in the camcorder market continued to be sales of full size units, which have risen eight percent in the first five months of the year. Full size camcorder sales increased in May for the second consecutive month, a feat last accomplished in September 1990. May also marked the second month in a row that growth in sales of full size units surpassed that of compact models.

Projection TV sales increased 11 percent, the largest May total since 1988. Projection television sales have grown 10 percent in the year to date.

"The industry's strong finish in unit sales during May is encouraging in view of today's overall sputtering economy," said Joseph P. Clayton, executive vice president of marketing and sales—Americas, Thomson/RCA. "The 11.4 percent gain in projection color TV sales is significant since it reflects the consumer's continued interest in acquiring high-end products for home theater systems."

Sales of TV/VCR combinations were responsible for the category's fourth consecutive month of at least 49 percent growth, rising 51 percent in May. Over the last 12 months, this category has experienced average monthly sales growth of 52 percent.

Laserdisc player sales accelerated in May, jumping 44 percent from the same period last year, and building on the 29 percent increase recorded in April.

NAB, EIA announce initiative on television data broadcasting

The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) and the National Association of Broadcasters (NAB) have jointly announced a national initiative to develop a new broadcasting service for dissemination of high-speed data-based information services to the public.

The EIA and the NAB will form a National Data Broadcasting Committee (NDBC) to develop a voluntary technical standard for high-speed data broadcasting for NTSC television stations. A national voluntary technical standard would help create new markets for dissemination of information to new data-based consumer receivers. A data receiver could be implemented as a new feature for NTSC television receivers or a new class of consumer electronic products called "data receivers" with outputs to fax machines, computers, or televisions.

Services that may one day be offered by television stations include advertiser-supported fax broadcast services, information/news summaries broadcast to large numbers of portable and desktop computers in homes and businesses, and coupon or promotional information as a supplement to on-air advertisements.

The NDBC will be open to any interested parties, operate under EIA guidelines for voluntary standard-setting, and be jointly administered by NAB and EIA.

Controlling static at the service bench

By Bob West

The best-equipped service bench in your shop can be a real money maker when set up properly. It can also be a source of frustration and lost revenue if the threat of electrostatic discharge (ESD) is ignored.

Static electricity is nothing new; it's all around us and always has been. What has changed is the proliferation of ESD-sensitive semiconductors in almost every consumer product we buy. Couple that with the fact that as device complexity becomes greater, many times its static sensitivity increases. Some semiconductor devices may even be damaged by as little as 20V to 30V.

ESD damage to the product during service

It occasionally happens that an electronic product is brought in for service, properly diagnosed and repaired, then found to have a new and different problem necessitating additional repair.

In many cases, the product undoubtedly had the problem when it was brought in. However, the possibility that the damage resulted from static electricity cannot be ruled out, unless the technician understands the ESD problem and has developed methods to keep it in check.

It is important to note that we are addressing the issue of ESD in terms of control, and not elimination. The potential for an ESD event to occur cannot be totally eliminated outside of a laboratory environment, but we can greatly reduce the risk of inducing ESD damage with the proper training and equipment.

By implementing a good static control program and developing some simple habits, the problem can be controlled.

The source of the problem

As mentioned earlier, static is all around us. We occasionally will see or feel it by walking on carpet and touching something or someone, and feeling the "zap" of a static discharge. The perception level varies, but the static charge is typically 2000V to 3000V before we can feel it.

Remembering that some components can be damaged by electrostatic discharges of less than 100V, it's easy to see that we might never know that an ESD event has occurred.

Even though carpet may not be used around the service bench, there are many other, more subtle, static "generators" frequently found around or on the service bench (Figure 1).

The innocent looking styrofoam coffee cup can be a tremendous source of static. The simple act of pulling several inches of adhesive tape from a roll can generate several thousand volts of static. Many insulative materials will develop a charge by rubbing them or separating them from another material. This is known as "tribocharging" and it occurs often where there are insulative materials present.

People are often a major factor in generation of static charges. Studies have shown that personnel in a manufacturing environment frequently develop 5000V or more just by walking across the floor. Again, this is "tribocharging" produced by the separation of their shoes and the flooring as they walk.

A technician seated at a non-ESD workbench could easily have a 400V to 500V charge on his or her body caused not only by friction or tribocharging, but additionally by the constant change in body capacitance that occurs from natural movements. The simple act of lifting both feet off the floor can raise the mea-

West is a design engineer for DESCO Ind. Walnut, CA, a manufacturer of static control products.

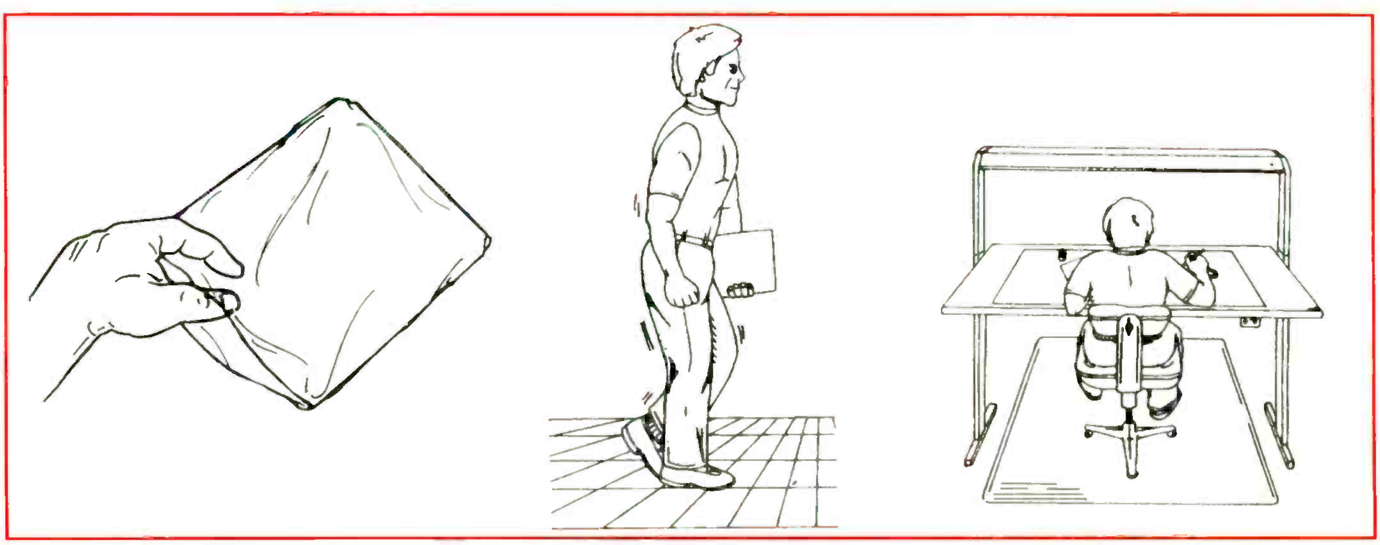


Figure 1. Many common activities can generate charges that are potentially harmful to components.

sured voltage on a person as much as 500V to 1000V.

Setting up a "static safe" program

Perhaps the most important factor in a successful static control program is developing an awareness of the unseen problem. One of the best ways to demonstrate the hazard is by using a static field meter (Figure 2).

Although this is not something a service center would typically purchase, it often can be borrowed from a local static control products distributor. The visual impact of locating and measuring static charges in excess of 1000V will surely get the attention of the skeptics.

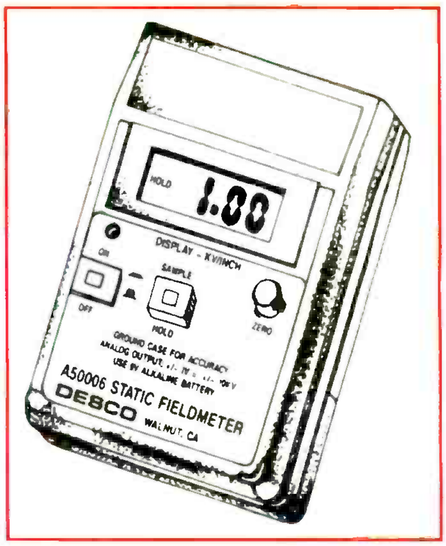


Figure 2. A handheld static fieldmeter or static locator provides a graphic demonstration of unseen ESD hazards.

Education of personnel

Education is an essential basic ingredient in any effective static control program. A high level of static awareness must be created and maintained in and around the protected area. Once personnel understand the potential problem, it might help to reinforce this understanding by hanging up a few static control posters in strategic locations (Figure 3). The technician doesn't need an unprotected person wandering over and touching things on the service bench.

Information on static control and setting up a static-safe work station is readily available from a variety of sources. Your local electronic parts distributor will often have a variety of ESD control products and may also have literature from manufacturers and others on setting up a static safe area.

The EOS/ESD Association has a comprehensive library of standards that may be used as guidelines in setting up your ESD program. They cover issues such as wrist straps, work surfaces, testers, and the like. Their address is:

Electrical Overstress/Electrostatic
Discharge Association, Inc.
200 Liberty Plaza
Rome, NY 13440
315-339-6937

Workstation grounding

To minimize the threat of an ESD event, we need to bring all components of the system to the same relative potential and keep them that way.

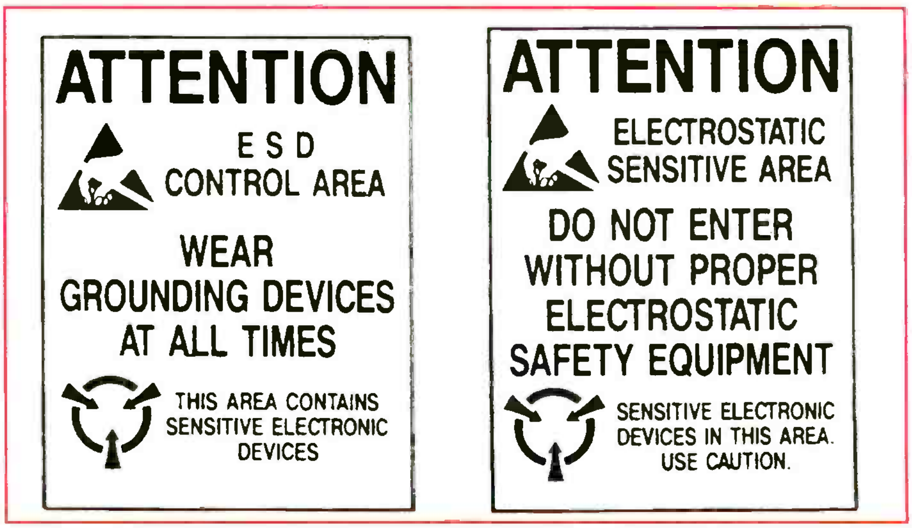


Figure 3. Large, colorful, ESD awareness posters are frequently used to identify static-sensitive work areas.

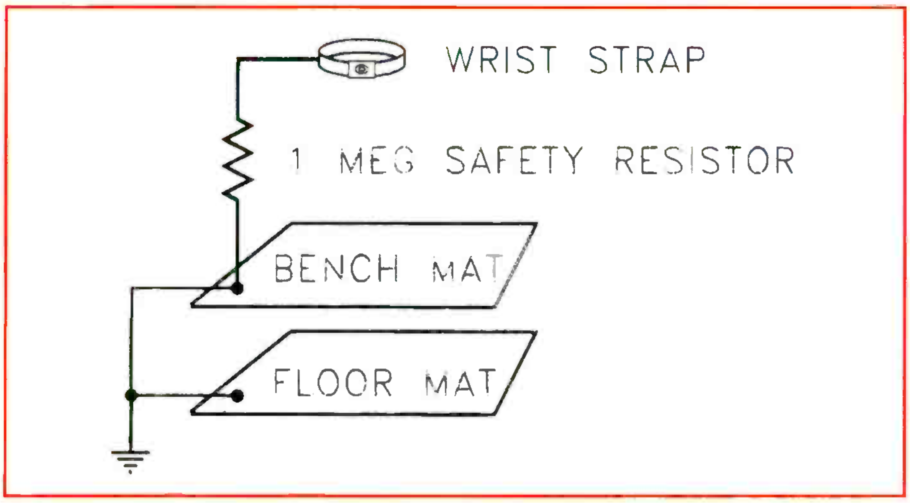


Figure 4. The wrist strap, the bench mat, and the floor mat, should all be tied to a common ESD Grounding point, usually the equipment/ green-wire ground.

• Establish an ESD common grounding point, an electrical junction where all ESD grounds are to be connected (Figure 4). Usually, a common ground point is connected to the equipment ground or green wire at the nearest electrical service outlet. For safety, the bench power circuit should be GFI (ground fault interrupter) protected, and proper outlet wiring should be verified and not taken for granted.

• The service bench surface should be covered with a dissipative material. This can be either an ESD-type high-pressure laminate formed as the benchtop surface, or it may be one of the many types of dissipative mats placed upon the benchtop surface. The mats are available in different colors, with different surface textures, and with various cushioning effect. My personal preference is one of the lighter colors: they show insulative soil better and small parts show up more readily.

Whichever type is chosen, look for a material with surface resistivity 10^9 or less, as these materials are sufficiently conductive to discharge objects in less than one second. The ESD laminate or mat must be grounded to the ESD common grounding point to work properly. Frequently, a one MΩ current limiting safety resistor is used in series with the work surface ground.

Several manufacturers make what is called a "common point ground" cord that attaches at one end to the equipment/ green wire ground, the other end attaches to the work surface and also provides one or more banana jacks for connection of personnel wrist strap cords.

• A dissipative floor mat may also be used (Figure 5), especially if the technician intends to wear foot grounding devices. The selection of the floor mat should take into consideration several factors. If anything is to roll on the mat, then a soft, cushion-type mat will probably not work well. If the tech does a lot of standing, then the soft, anti-fatigue

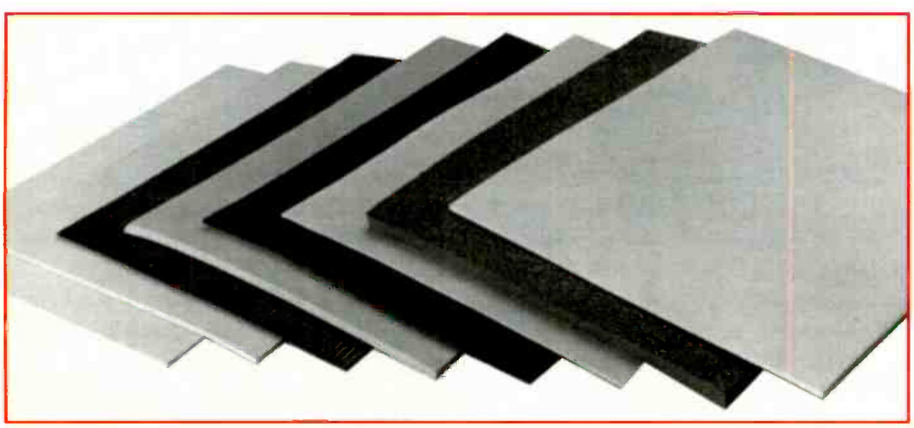


Figure 5. Dissipative or conductive vinyl or rubber mats for the bench and floor come in various colors, thicknesses, and densities.

Coming next month. . .

Compact disc service and adjustment

Compact discs have all but completely replaced vinyl disks as the most popular recording medium. Since the CD players are reliable, compact, and load from the front, they are easy to place almost anywhere in an audio system.

The discs themselves are small, rugged, and far less susceptible to damage than their vinyl counterparts.

Together, the disc and player produce music that's very close to the sound of the original performance.

But CD players are not invulnerable; they wear and go out of adjustment. The laser that reproduces the audio becomes weak and must be replaced. The circuitry occasionally fails and must be serviced.

Because there are now so many CD players in use, many of which will require service, the October 1993 issue of ES&T will feature two articles on CD servicing: one will be an introduction to the theory of operation and troubleshooting, the other a detailed description of how to adjust and align this popular product.

TV tuner and control problems

Clunky, noisy, trouble-prone tuners and controls have been largely replaced by electronic tuning and control systems. The problems caused by these mechanical devices have largely been eliminated.

But, any electronics circuit may fail, including the new electronics tuners and controls.

An article in the October issue of ES&T will provide an overview of how some of these controls function, how they fail, and how to troubleshoot them and determine if they should be repaired or replaced.

type will be much appreciated. Again, the mat should be grounded to the common ground point, with or without the safety resistor as desired.

• Workstation tools and supplies should be selected with ESD in mind. Avoid insulators and plastics where possible on and around the bench. Poly bags and normal adhesive tapes can generate substantial charges, as can plastic cups.

If charge-generating plastics and the like cannot be eliminated, consider using one of the small, low-cost air ionizers available from some manufacturers (Figure 6). It can usually be mounted off the bench to conserve work area, and then aimed at the area where most work is being done.

The ionizer does not eliminate the need for grounding the work surface or the operator, but it does drain static charges from insulators which do not lend themselves to grounding.

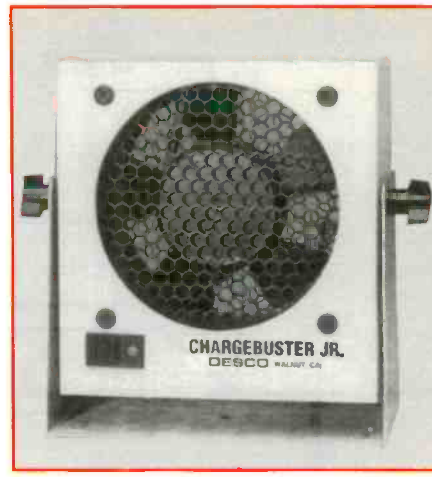


Figure 6. Small, efficient, ionizers have become very affordable and are valuable for removing charges from insulators, like plastics, where grounding doesn't work.

Personnel grounding

As was mentioned previously, people are great static generators. Simple movements at the bench can easily build up charges as high as 500V to 1000V. Therefore, controlling this charge build up on the technician is essential. The two best-known methods for draining the charge on a person are wrist straps with ground cords and foot or heel grounds.

• Wrist straps are probably the most common item used for personnel grounding. They consist of a conductive band or strap that fits snugly on the wrist, with a cord connected to the strap to connect it to a grounding point (Figure 7). The wrist strap is frequently made of an elastic material with a conductive inner surface, or it may be a metallic expandable band similar to that found on a watch.

• Ground cords are typically made of a highly flexible wire and often are made retractable for additional freedom of movement. There are two safety features that are usually built into the cord, and the user should not attempt to bypass them.

The first, and most important, is a current limiting resistor (typically 1MΩ)

Figure 7. Wrist straps are available as metal expansion or elastic types in either fixed sizes or adjustable versions.

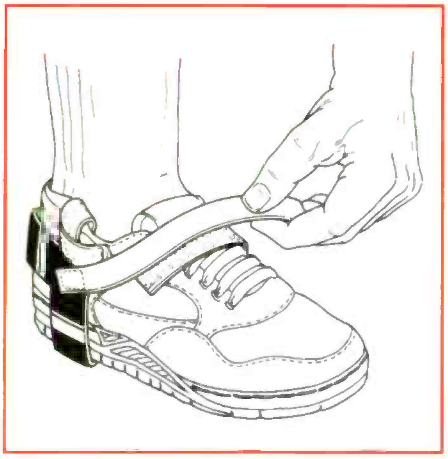


Figure 8. Foot or heel grounders allow more freedom of movement but, to be effective, they must be worn on both feet and used with a dissipative floor surface or floor mat.

which prevents hazardous current from flowing through the cord in the event the wearer inadvertently contacts line voltage. The line voltage may find another path to ground, but the cord is designed to neither increase or reduce shock hazard with voltages under 250V.

The second safety feature built into most cords is a breakaway connection to allow the user to exit rapidly in an emergency. This is usually accomplished by using a snap connector at the wrist strap.

• Foot or heel grounders are frequently used where the technician needs more freedom of movement than the wrist strap and cord allow. The heel grounder is often made of a conductive rubber or vinyl and is worn over a standard shoe (Figure 8). It usually has a strap that passes under the heel for good contact and a strap of some type that is laid inside the shoe for contact to the wearer.

Heel grounders must be used with some type of conductive or dissipative floor surface to be effective, and should be worn on both feet to insure continuous contact with the floor. Obviously, lifting both feet from the floor while sitting will cause protection to be lost.

Summary

An effective static control program doesn't have to be expensive or complex. The main concept is to minimize generation of static and to drain it away when it does occur, thereby lessening the chance for an ESD event to happen. The ingredients for an effective ESD program are:

• Education: to insure that everyone understands the problem and the proper handling of sensitive devices.

• Workstation grounding: through the use of a dissipative work surface material and dissipative flooring as required.

• Personnel grounding: using wrist straps with ground cords and/or foot-grounding devices.

• Follow-up: to insure compliance, all elements of the program should be checked frequently to determine that they are working effectively.

The ESD "threat" is not likely to go away soon, and it is very likely to become an even greater hazard, as electronic devices continue to increase in complexity and decrease in size. By implementing a static control program now, you will be prepared for the more sensitive products that will be coming. ■

Multimeter update: Component testing with the DMM, power supply and tracker

By Ron C. Johnson

These days a typical electronic service job might consist of cleaning and adjusting the mechanism in a VCR, soldering cracked solder joints on a television circuit board, or replacing a module in a video camera. We don't replace as many individual components as we used to, but it still happens, and the most common devices to go are power components. Many of these are mounted off the circuit board or are easily removable; as in the cases of triacs, SCRs and power transistors.

Before you spend the money on a costly replacement part you need to be sure it really is bad. Sometimes that can be done in circuit, under power, using an oscilloscope or a meter. Other times you remove the component and verify that it is faulty, before tossing it out. Understanding the operation of the component and how to creatively use test equipment can help determine whether it really is faulty.

Let's take a look at how to test a few common components using equipment most of us have on our benches. We'll also consider some simple test jigs which could be built to make the job easier. Maybe a lot of this will be old hat to you veterans but, who knows, there might be a few new tricks you haven't tried before.

Testing components with a meter

It almost goes without saying that the basic minimum requirement for any shop is a decent multimeter. Two would be better in most situations. And simply owning one isn't enough; it's important to know how it works and how to use it.

Specifications, such as input impedance, sensitivity, voltage on the diode check range, etc., are important as they can help you to know the meter's limitations for certain applications.

Johnson is a journeyman electronics servicing technician and an instructor of technology at the Northern Alberta Institute of Technology in Edmonton, Alberta, Canada.

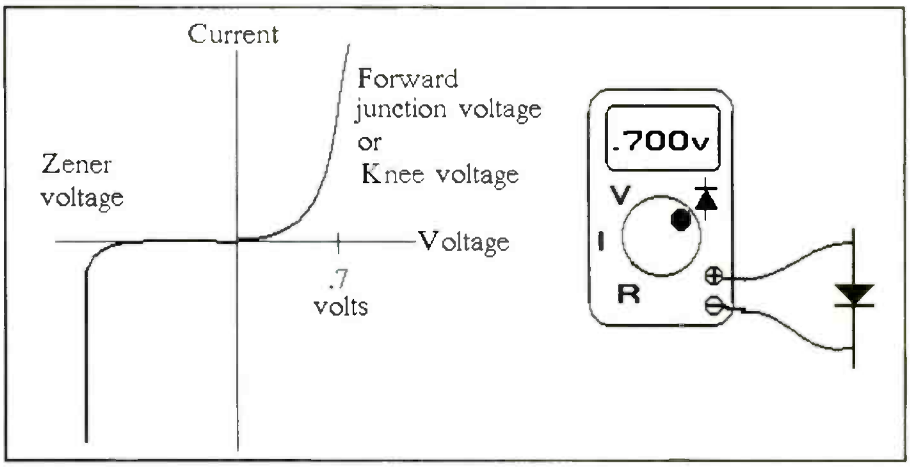


Figure 1. Zener and Knee Voltages of a Diode.

Testing semiconductor junctions

For example, when checking semiconductor junctions using the diode check range, you need to know which lead is positive (usually the red lead, but not always). It also helps to know what the source voltage is. A diode check range must supply more than the 0.7V needed to forward bias the junction (see Figure 1).

Most digital multimeters with diode check functions display the actual voltage of the junction. Older analog meters had sufficient voltage to forward bias the junction on at least one resistance range and so showed the actual forward resistance of the junction.

In a meter where the voltage supplied on the diode check range is only slightly higher than 0.7V (1V, perhaps) the meter will not effectively test LED's. LED's are diodes, but they are manufactured out of different semiconductor material. Depending on the color of the LED, the forward voltage could be 1.2V to 2.2V.

I've seen some meters that supplied enough voltage (and current) to illuminate the LED. This is not necessary (it requires more current from the meter bat-

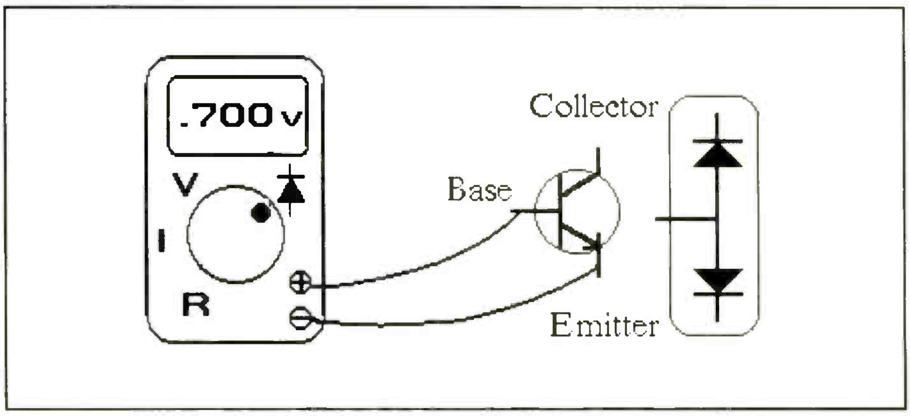


Figure 2. Meter testing a transistor.

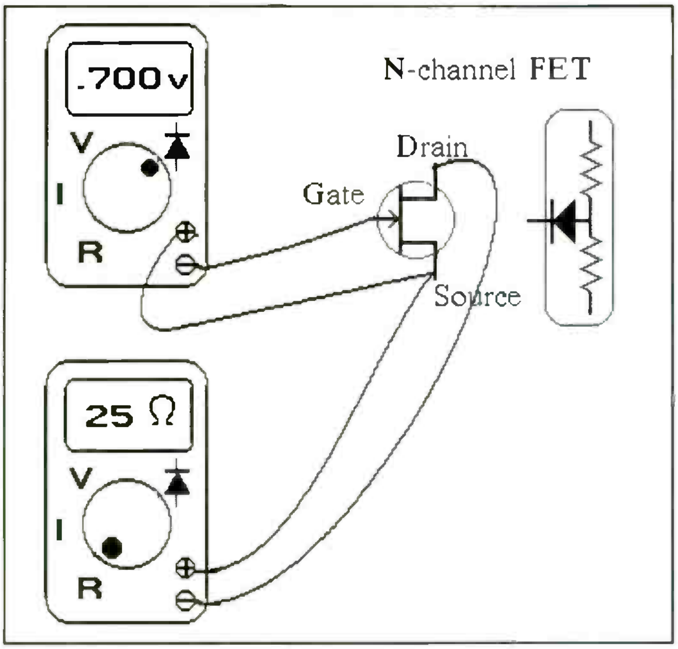


Figure 3. Meter testing a FET

tery) but it is a handy feature. Meters that don't have sufficient voltage to overcome the forward junction voltage show an open circuit in the forward direction; not very useful for this application.

The same diode check range can be used to test any semiconductor junction: germanium diodes, germanium and silicon transistors, FET's, and even thyristors. Germanium diodes are tested the same as silicon except that their forward voltage is about 0.3V.

Testing transistors out of circuit

Figure 2 shows how to test transistors out of circuit. A transistor is just two semiconductor junctions. In the case of the

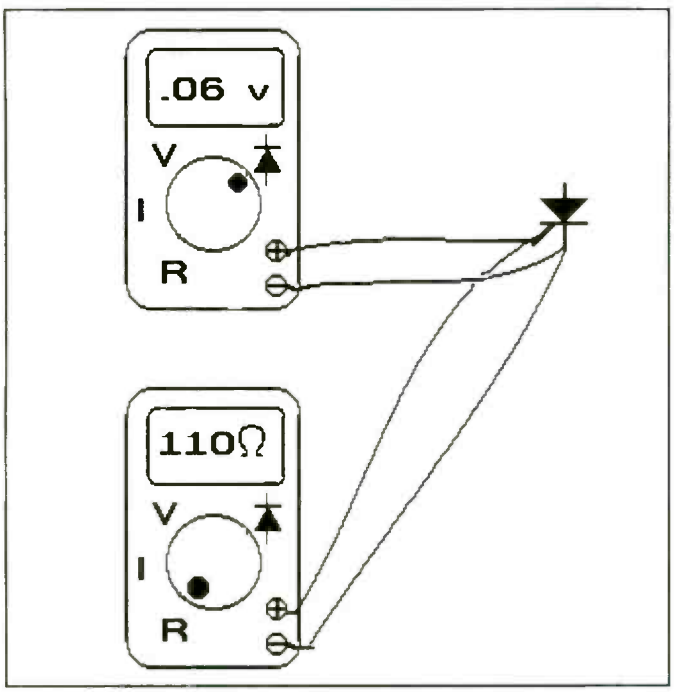


Figure 4. Meter testing an SCR.

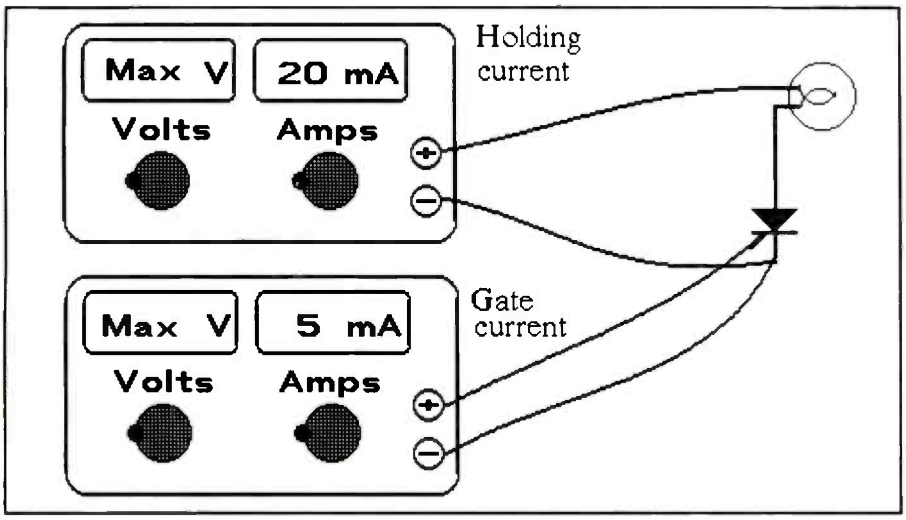


Figure 5. Power Supply testing an SCR.

NPN transistor, the junctions are connected at their anodes; in the case of PNP, they are connected at their cathodes.

Measuring from collector to emitter of a good transistor should give an out-of-range reading (open circuit, high resistance, "OL" on some meters). On NPN transistors, with the positive lead on the base, the meter should read about 0.7V when the negative lead is connected to each of the other two leads.

Reversing the polarity of the leads should show an out-of-range, or high impedance reading. Again, PNP transistors can be tested the same way, using opposite polarities to those above.

Junction FET's can be quickly checked using a multimeter too. Figure 3 shows how. N-channel JFET's are made of a piece of N-type silicon. The gate is connected to a ring of P-type material in the middle of the device. This leaves a channel of N-type material down the middle.

With no voltage on the gate, the resistance from drain to source (or vice versa) is low: anywhere from about 5Ω to 50Ω depending on the device. This can be measured using your ohmmeter.

The resistance from gate to drain or gate to source is high because this is a PN junction. Using your diode check range, however, will show 0.7V from drain to gate or source to gate. The opposite polarity will show out of range. So you can measure the resistance of the channel and the junction voltage of the PN junction. Again, P-channel can be checked by reversing the polarities.

Testing thyristors

Figure 4 shows how to test a thyristor using a multimeter. The anode to cathode (on an SCR), or MT1 to MT2 (on a triac or diac) should show a high resistance (or out of range). Using the diode check range from gate to cathode (or gate to MT1) should give a voltage reading of somewhere in the area of 0.06V. The resistance range will give anywhere from 50Ω to 1kΩ, depending on the device.

What to remember about using a meter to check semiconductors is that it's a quick check only. It will tell you if a device is shorted or if a junction is open.

But even if the test shows good you can't be 100% sure the device doesn't have some less obvious problem like leakage, an intermittent, the wrong beta, temperature drift or an incorrect value of holding current. More sophisticated tests are required to nail down these kinds of problems. To be sure, replace the component with one you know is good.

The new digital multimeters available today often have additional features for testing components and circuits. Some have sockets to test transistors by plugging them directly into the meter. The meter has a built-in circuit which biases the transistor and displays its Beta (or h_{FE}). This kind of test can be fairly useful and quite reliable. Again, it does have some limitations in the case of some of the more obscure problems.

Meters with capacitor checkers

Capacitor checkers on meters have become popular lately. They read out the value of capacitance directly, allowing you to determine whether the cap is good and, if so, how close to the specified value it is. This test won't usually tell you if the cap breaks down with voltage across it, though. It will give you limited information on whether the cap is leaky because usually the capacitance will read low.

Of course, the old method of simply checking the resistance of the cap still works for finding shorted caps. With larger caps (1µF and up) you can usually see the capacitor charging up if it is good.

Power supplies

The next most important piece of test equipment for testing discrete components is a good bench power supply. To be useful for this kind of testing you really need a dual supply with individual controls for each channel. The voltage should be controllable (ideally adjustable down to zero volts) and well regulated.

The maximum current specification depends on your uses but current limiting is very desirable for testing components. Your power supply needs to have both

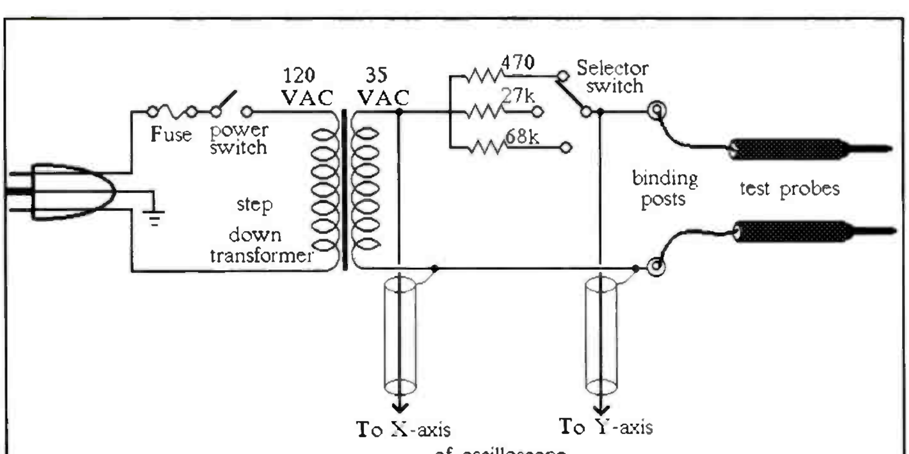


Figure 6. Schematic of tracker.

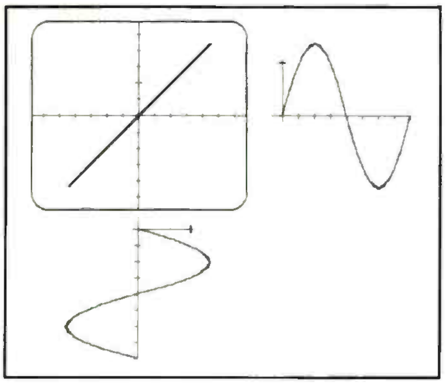


Figure 7. Open circuit Tracker Display.

voltage and current meters on each channel, preferably digital, but good quality analog will do. If not, use your multimeter for exact measurements.

Using a power supply to test a zener diode

One example of using a power supply for testing components is when you have a zener diode that may be faulty, or if you have one in stock but you're not sure what its zener voltage is.

Turn the voltage control of the power supply up to maximum. The power supply must be capable of delivering a voltage greater than the zener voltage. Then turn the current limiting control all the way down to zero. Connect the zener across the terminals of the supply (cathode to the positive terminal), turn on the supply, and carefully increase the current control. Be careful or you'll fry the zener.

Almost immediately the voltage meter will jump up to the zener voltage and stay there regardless of the current flowing through the device. Again, if you turn up the current too high the device will be damaged. You can also use this test to check the forward voltage drop (0.7V).

Testing SCRs and triacs with a power supply

A similar test can be used to test SCRs and triacs. Figure 5 shows a test setup to check the gate current and holding current of typical thyristors. The thyristor is triggered on by a gate pulse and the lamp illuminates.

By monitoring the anode current while decreasing the current limit control you can determine at what level of current the device stops conducting. This is the holding current and should be close to the specified value for the device.

The gate current can be determined by adjusting the current to the gate and noting when the thyristor starts to conduct. This should also correspond to device specifications.

Sometimes thyristors can seem to work in simple tests but be insensitive to gate pulses or tend to drop out of conduction at too high an anode current. This test setup should uncover those problems.

Trackers

Oscilloscopes themselves won't test components out of circuit; they display voltages with respect to time, usually. They will also show X-Y plots (sometimes call Lissajous patterns) by applying voltages to both axis at the same time.

A very simple circuit can be added to the inputs of the scope which will produce distinctive patterns, or signatures when connected to components. You may already be familiar with the tracker, a commercially available unit which has its own CRT display and incorporates a number of refinements on the basic idea.

Some oscilloscopes also have this feature built into them. While you could go the route of buying one of these, you could also build the simple version and connect it to your own scope.

Circle (21) on Reply Card

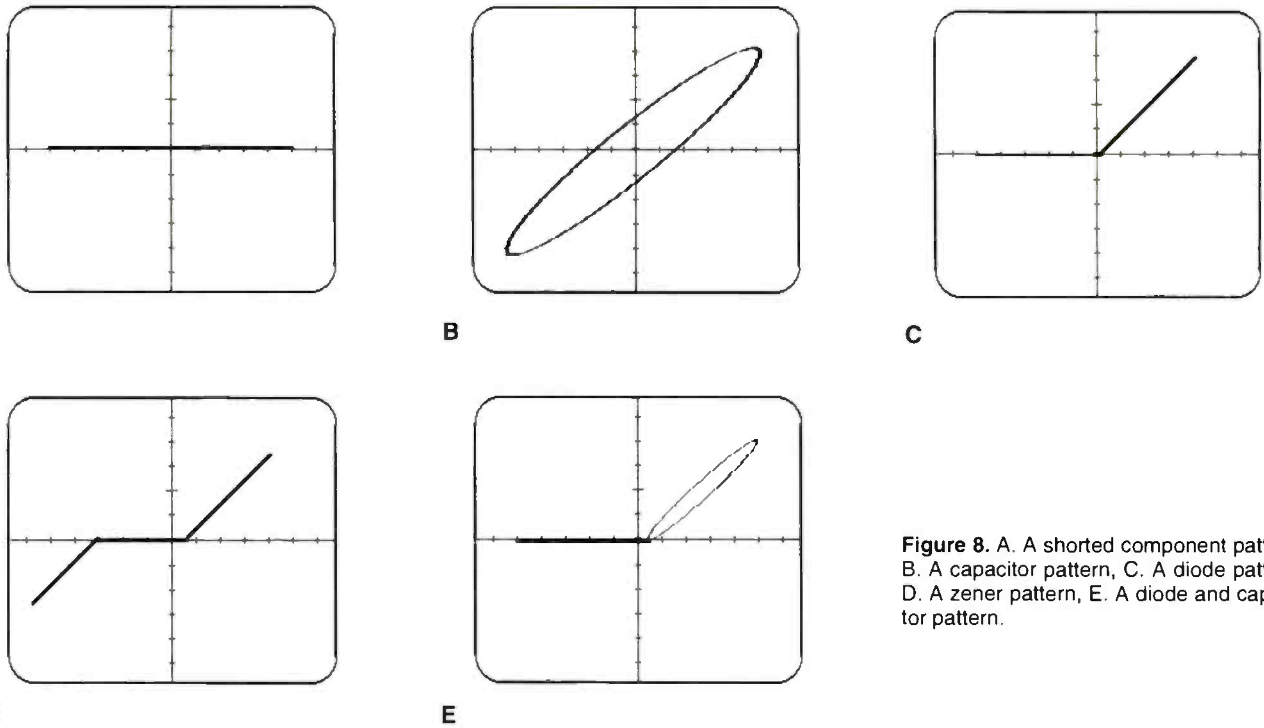


Figure 8. A. A shorted component pattern, B. A capacitor pattern, C. A diode pattern, D. A zener pattern, E. A diode and capacitor pattern.

The circuit is shown in Figure 6. As you can see, it isn't very complicated: just a step-down transformer, three resistors and a switch. The output of the transformer is applied to the horizontal input of the scope. The same ac voltage is applied to a voltage divider made up of a resistor (three are provided to give three ranges) and the component under test.

The voltage across the component under test is applied to the vertical input of the scope. Note that with a simple version such as this there is no current limiting to the component under test. Also, the voltage applied is about 35V.

With some sensitive components it is possible to damage the component while testing it. So far I have found very few problems although I did damage a CMOS chip once using the device.

Theory of tracker operation

A bit of theory might help understand how the tracker works. Applying a sine wave to both inputs at the same time results in a vector of the two deflections in a diagonal direction on the display. If you think about it for a moment it makes sense: as the voltage increases positively, the vertical and horizontal deflections trace a line upwards and to the right (see Figure 7).

If the vertical input voltage is decreased, (as it would if the leads were connected across a low resistance), the horizontal deflection remains the same but the vertical is less: you get a flatter diagonal line. Shorting the test leads together gives a horizontal line (Figure 8).

With the leads connected across a capacitor the vertical plane is attenuated as before but, also, a phase shift is created between the two signals (because voltage lags current in a capacitor). This phase shift creates a loop in the display. The size of the loop is an indication of the magnitude of the capacitance.

Connecting the leads to a semiconductor junction creates a sharp angle in the trace because of the non-linear characteristic of the PN junction. The voltage applied is ac.

During the half cycle that the junction is reverse biased, the trace will look like an open circuit: a diagonal line. On the positive excursion of the ac voltage and after the voltage impressed across the diode exceeds 0.7V (for silicon) the trace will indicate a short: a horizontal line. Connecting the leads across a zener results in two angles: one for the 0.7V knee voltage, and one (in the opposite direction), for the zener voltage.

Using this device to test transistors, FET's and other devices becomes more complex because of the junctions in-

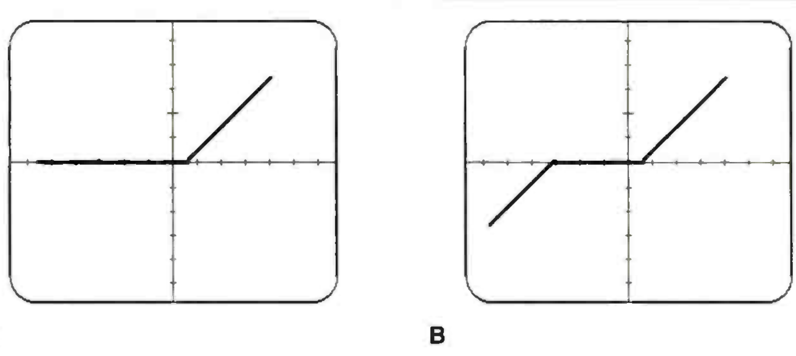


Figure 9. A. A base-collect or collector-emitter pattern, B. A base-emitter pattern.

volved and some of their specifications. For example, testing a 2N2222 small signal transistor yield the patterns shown in Figure 9.

The pattern for the base-to-collector junction, as would be expected, looks like a PN junction. The pattern for the base-to-emitter junction looks more like a zener, showing both the forward junction voltage and the reverse breakdown characteristic of the junction. Collector-to-emitter seems to indicate a single PN junction. Moreover, there will be slight differences in the patterns between types and ratings of transistors.

The tracker can be used for power-off, in-circuit testing of components. Combinations of semiconductors, resistance and capacitance in a circuit create even more complex patterns on the display. Angular patterns with loops on one end indicate the presence of both semiconductors and capacitance.

Obviously this is a qualitative test and is best used when comparing a known good component to an unknown. In fact, some trackers take this many steps further by automating the test procedure using a computer.

The computer stores patterns from a known good board for each test point and does a comparison. The range of variation from the standard can be set. The computer will then accept or reject the board, retaining the test data to be used in troubleshooting.

These same procedures can be done manually using the circuit I've shown here. It just takes more time and diligence. Considering the low cost, the tracker canbe useful for quick checks of components and, in cases where a known good board is available, helpful in repairing boards themselves.

Let us hear from you

There are probably lots more ways to do quick tests on components that you have developed yourselves. Write me via the magazine and we'll share your innovation with the readers. Perhaps you have a special test jig for testing a component or board. What other test equipment (curve tracers, capacitor/inductor analyzers, automated test equipment) have you had success with? I'm sure the readers would be interested. Anything that speeds up the process and can improve profits in this business is worth considering. ■

New consumer electronics technology: A special report

By The ES&T Staff

The consumer electronics revolution seems to be like an avalanche; every introduction of new technology touches off several other innovations, until the revolution is rumbling along causing sweeping changes in every area.

In recent years, electronics companies have introduced a host of products, which, when they were introduced, met with a mixture of awe and disbelief: VCRs, CD players, video game systems, personal computers, cellular telephones and more.

Today these products are all commonplace, accepted as part of daily life as though they had always existed. And every day products in these categories arrive in the service center suffering from a variety of ailments that some technician is expected to cure.

But as the avalanche continues and builds momentum, consumer electronics products are being made more sophisticated, are offered with more features. In addition, new products and services are constantly being introduced.

This article is being brought to the readers of this magazine in order to make them aware of some of the many product innovations that are being introduced today, which, one day, may turn up on the service bench.

But in spite of the benefits of these technological advances for manufacturers, consumers and servicers, all is not sunny in the world of new consumer electronics. There have been storm clouds over some areas, such as delivery of TV signals via cable. Because the thousands of cable systems in the U.S. may employ many different ways to bring the signal to the subscriber, many TV owners/cable subscribers are not able to fully utilize all of the functions of their products. For example, in many places, a cable subscriber cannot watch one TV program while they are recording another.

Because of these impediments to the full utilization of consumer electronics products, in addition to the exposition of new technology, also included in this article is a report on the position of the EIA/CEG on delivery of television programming via cable.

PC to video converter

Now it's possible to transfer images generated by a personal computer to a big screen TV or a VCR. The "VGA to Elite," PC-to-video converter from Advanced Digital Systems (ADS), Inc. (Figure 1) is a presentation tool for educators, trainers, salespeople and other PC users who wish to present computer graphics, text or Windows applications on a big screen TV—or just want to play games on a larger area. The product is an alternative to using large overhead projectors and LCD panels for presentations. It may also be used to record computer-generated images on video tape using a VCR."

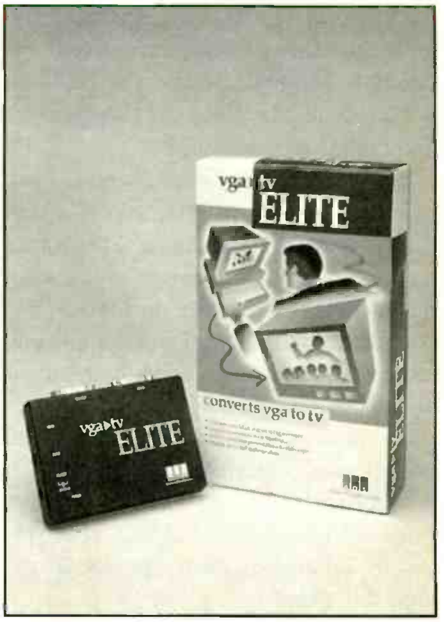


Figure 1. This PC-to-video converter allows the user to transfer images generated by a personal computer to a big screen TV or a VCR.

Compatible with any VGA card, the unit supports VGA resolutions of 640 by 480 in up to 16.7 million colors, delivers flicker-free VGA to TV conversion, and allows users to view their VGA monitor and TV simultaneously. Other features include a brightness control, chromalock switch, auto TV blanking, hot key controls for screen positioning, and dual text font sizing.

The package consists of a VGA to TV encoder, an ac power adapter, and all the necessary cables—a six-foot RCA cable, a six-foot S-Video (S-VHS) 4-pin cable, a VGA card to Elite 15-pin adapter cable, and an Elite to VGA monitor 15-pin adapter cable. Included in this package are a "Flickfree" software diskette, animated demo disk and a users manual.

Demodulator distributes cable signals throughout house

Channel Plus has announced a new series of Channel 3 demodulators for enhancing their whole house video distribution system (Figure 2). With the demodulator, the channel 3 output of a VCR, cable box, or any other source can be viewed on any TV in the house.

Both models 6031 and 6032 convert VHF channel 3 inputs to baseband video and audio. When a modulator is added, the signal is put on an unoccupied UHF or cable channel for distribution to all the TVs in the house, along with normal cable or off-air channels. Multiple cable boxes can be placed in the garage with the demodulators and the modulator. The 6031 converts one channel 3 input. The model 6032 converts two.

The demodulator takes the signal off channel 3, then converts it from RF to baseband video/audio. The modulator puts the signal on an unused channel by converting the baseband video/audio to RF. This new signal can then be assigned to unused channels. Any TV set can select that channel for viewing.

Phil Strauss, president of Multiplex Technology, states, "many video sources are only a channel 3 output, not the audio/video outputs that are used by our modulators. Now we can put the signals from nearly any video source on a channel for all the TVs to see."

Rey Harju, Multiplex marketing manager added, "you can put a couple multiplex boxes in the equipment room with modulators and see your premium channels on every TV in the house. Not only can you select any program you want by changing the channel, you can also use all the functions and features of your TV, such as picture-in-picture.

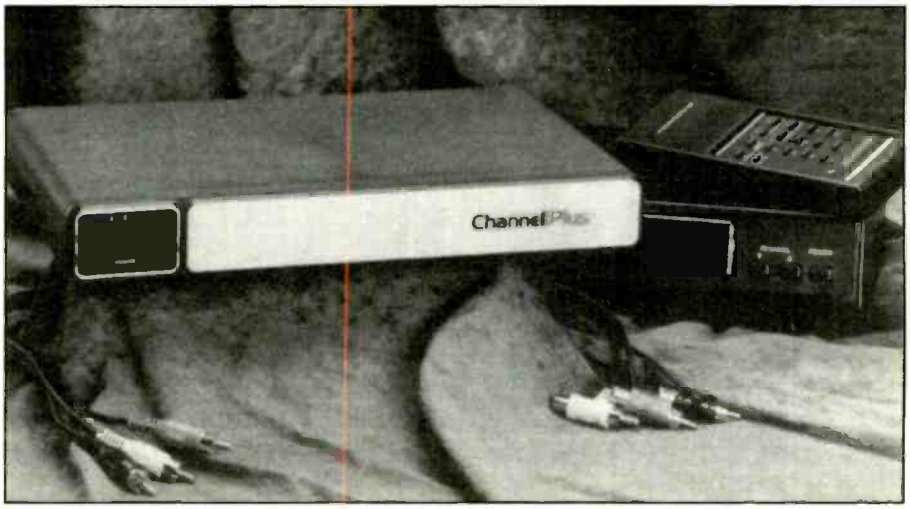


Figure 2. With this demodulator, the channel 3 output of a VCR, cable box, or any other source can be viewed on any TV in the house.

TV eyeglasses

Have box seats for a baseball game, but don't want to miss the NBA playoffs on TV? Now you can watch both, thanks to a pair of five-ounce portable eyeglasses that enable people to watch big screen TV wherever they go (Figure 3). This new product is called the Virtual Vision Sport.

With the glasses on, viewers see a big screen, color TV image that appears to float about 10 feet in front of them. The glasses also contain earphones that provide stereo-quality sound.

The complete system consists of video eyeware and a belt pack that contains a TV tuner, a rechargeable battery and interface system to connect to all makes of camcorders, VCRs, cable TV, video games and any other product with NTSC video output.

Dr. Tom Furness, director of the Human Interface Technology Laboratory at the University of Washington, and a world leader in virtual reality research, says that this product signifies a prelude to the virtual reality era.

"While this is not a virtual reality product per se, it is a first step in that direction," said Furness. "The Virtual Vision Sport will give consumers a taste of things to come."

Retailers believe that the new product will help stimulate sales in their stores.

"We're very excited to have it," said Kris Peterson, manager of Magnolia Hi-Fi's Roosevelt Video Store. "It's a first-of-its-kind product that uses exciting new technology. It's both practical and fun. It's American made. This could be the beginning of a completely new category in consumer electronics.

The product is also being featured in the current issue of The Sharper Image catalog that was mailed out in May, 1993.

"So far, sales have well exceeded our expectations," said Sidney Klevatt, senior vice president of marketing for The Sharper Image. "We sold out of our initial supply of product in a matter of days and have already placed a new order for more," he continued. "People are so anxious for this product that we sold six systems before the catalog circulated to our customers."

Remote control mouse

The AirMouse remote control is a single button handheld remote that operates like a computer mouse, but has no wires (Figure 4). Click the single button to choose from a menu on the TV screen, a menu which might resemble the now familiar Windows menus. You are now in the drama section and a listing of current movies appears on the screen. Click and you are watching your choice of movie. Click on the little open window at the top of the screen and Dino's will deliver the extra cheese pizza.

Figure 3. This pair of five-ounce portable eyeglasses with its attendant belt pack enables people to watch big screen TV wherever they go. With the glasses on, viewers see a big screen, color TV image that appears to float about 10 feet in front of them. The glasses also contain earphones that provide stereo-quality sound.

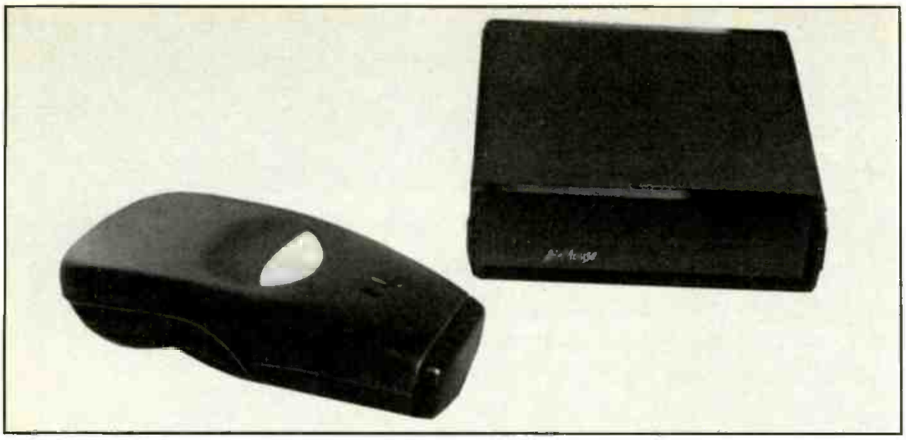


Figure 4. This remote control is a single button handheld remote that operates like a computer mouse, but has no wires.

Jim Richards, president of the company says "it's not just by the numbers anymore." Many homes now receive 75 or more video channels. Finding a program worth watching has become a time consuming task, even for those not prone to channel hopping.

As more and more channels become available through our cable hookups, satellite dishes, broadcast antennas and even our telephone lines, new methods of channel selection are required. "Leading the way will be the concepts of Channel-by-Content and Channel-by-Picture," says Richards.

Selecting channel by content means asking your TV "what's on?" or "is the Lucy Show on now?" Your TV or associated equipment will maintain an internal database of available programs. When requesting the Lucy Show, the viewer need not know, or care, which particular video source (i.e. cable, dish, etc.) is used to fulfill the request.

Alternatively, selecting channel by picture entails having a few "master" channels that present composite pictures composed of iconized views of up to 16 normal channels. The viewer simply selects such a composite channel, watches all the little pictures until ready to choose, and then clicks the mouse on the little picture of choice. The Videoway cable TV system in Montreal, Canada, already offers Channel-by-Picture to about 150,000 home subscribers.

A home theater

The AirMouse, and a few attendant devices, offer the basis of a control system for a home theater system. Many homes now receive video signals from satellite dishes, cable and VHF/UHF broadcast.

Telephone company fiber optics are expected to soon also carry video into homes. Figure 5 shows a home theater system that is connected to programming from all of these sources. The satellite and fiber icons on the diagram refer in general to these external sources of video and data.

Local video generation in most homes is currently limited to playback of VHS/Beta tapes, or video disc. CD-ROM playback and computer-generated video will add to alternatives for local video generation. The CD-ROM and VCR icons on the diagram generally refer to local sources of video and data.

The video switch performs two functions. Primarily it selects the external or local video source chosen by the viewer. Alternatively, upon request from the user, the switch replaces, or "overlays" the current video picture with control menus that allow the user to change sources and control various equipment functions.

The projector reproduces the selected video on a large theater-like screen. Large screen size is intended to allow group viewing and to surround each individual viewer with visual stimulation. In some installations, the projector and screen are replaced with self-contained big-screen TV units.

The control computer is responsible for generating and sequencing the control menus for the user and for carrying out the equipment control actions requested. Typical computer power should meet or exceed that of a 386SX, MacII or Amiga 300. In some installations a VGA to NTSC converter will be needed to "downshift" the computer-generated menus to the NTSC format.

The remote control mouse is held in the user's hand, anywhere in the room and used to request display of the control menus and to make selections. The mouse is simply pointed at the menu selection of interest and then clicked.

The base station receives commands from the remote, and passes them on to the computer.

The copilot contains control codes for the various projection, player, decoder, switching and amplification equipment contained in the theater. User menu selections are converted to device and function commands in the control computer and then sent to the copilot for IR code lookup and transmission to the appropriate device. The copilot also provides control of ac powered items such as room lights.

Operating sequence

The numbers in this sequence correspond to the numbers on Figure 6.

1. Menu presentation. Upon any click of the remote, the control computer commands the video switch to present the main control menu on the screen (if no menu is currently in use).

2. User selection. The remote is used to select the desired action from the on-screen menus. In some installations, the menus may cover the entire screen. This diagram, however, illustrates the more typical case of having a smaller menu overlay only a part of the picture.

3. Base-station reception. The base station receives infrared signals, converts these signals to computer compatible RS-232 packets, and forwards these packets to the control computer.

4. Equipment control. The control computer now recognizes the user's menu selection, decides which equipment and which functions need to be used to accomplish the user's request, and sends device names and function names to the copilot. The copilot then issues IR commands to the appropriate equipment.

The information highway

Oracle and US WEST announced in May 1993 an alliance that will bring new interactive information services to business, education and consumer markets within the next year. The companies announced their joint development of a multimedia information server that allows customers to access information any time,

TV/cable compatibility problems

Cable subscribers have the right to enjoy all of the features that TVs and VCRs offer, according to the Electronic Industries Association's Consumer Electronics Group (EIA/CEG), in comments filed in March with the Federal Communications Commission (FCC).

These comments were filed in response to the FCC's request for more information on compatibility between cable systems and consumer electronics equipment in compliance with the Cable Television Consumer Protection and Competition Act of 1992.

Summary of EIA/CEG comments

The Consumer Electronics Group of the Electronic Industries Association (EIA/CEG) welcomes the opportunity to assist the Commission in developing rules and policies to promote compatibility between consumer electronics equipment and cable systems, as required by the Cable Television Consumer Protection and Competition Act of 1992 ("Cable Act"). EIA/CEG was a strong supporter of the legislative initiative that became Section 17 of the Cable Act, and we are eager to solve the problems that made this legislation necessary. A separate document, prepared jointly with the cable industry, responds to some aspects of the Notice. The views that are presented here are our own.

Like the congress, we are concerned by the growing impediments to the ability of cable subscribers to enjoy all of the features of their television sets and videocassette recorders ("VCRs"). These problems are not caused by faulty consumer product design but by worrisome trends in the cable industry: fewer channels are delivered "in the clear," diverse scrambling technologies are in use, converter boxes are proliferating, and various digital compression technologies are being readied for deployment. These circumstances make it increasingly difficult to design full-featured consumer products for a national market.

The same TVs and VCRs that provide highly satisfying performance when used to receive broadcast signals cannot be used so successfully with cable. The root cause of this problem is that cable is not standardized in the same manner as electricity, AM and FM radio, and TV broadcasting, to name but a few examples. To the contrary, there are literally thousands of cable systems, and they provide signals in a patchwork quilt of formats.

If each of 11,000 cable systems can unilaterally choose its own technical standards for channelizaton, scrambling, digital transmission and compression, etc., the competition, innovation and value that are the hallmark of the consumer electronics industry will be needlessly jeopardized. The Cable Act was intended to chart a different course.

Policies to address compatibility problems must start with an appreciation of the massive installed base of TVs and VCRs—close to 300 million products currently in use, many with expected useful lives stretching well beyond the turn of the century. There is no practical way to alter these products to make them more accommodating of the increasingly diverse characteristics of the local cable systems. Changes to future models of TVs and VCRs cannot solve the problem; these would require many years to become pervasive in the marketplace. Fortunately, there are many measures that can be taken to make cable service more consumer friendly.

Certain limited measures can be adopted expeditiously, to address such matters as operation of remote controls, commercial availability of remote controls and converter boxes, and information that cable operators must provide to subscribers. The short-term solutions in these limited areas must not distract attention nor divert progress from the more fundamental problems of cable imposed limitations on use of TV and VCR features.

The most pressing problem is the way in which converter boxes "ration" consumer access to the programs for which they have paid, allowing access to only a single channel at a time. Alternative means of preventing theft of service avoid this problem. Traps, interdiction, and broadband descrambling all can eliminate compatibility problems allowing for simultaneous "in the clear" access within the home to all authorized channels.

The commission should also act now to prevent compatibility problems from being perpetuated and exacerbated, as digital formats are introduced into cable systems. We believe that national digital transmission and compression standards —for high-definition television and for compressed 525-line video— are essential to permit the continued line of full-function consumer products. We also believe that the digital environment will enable development of a national renewable security system, probably based on "smart card" technology, which can be incorporated directly in future consumer electronics products. To prevent creation of a new generation of compatibility problems, some in the consumer electronics industry believe the Commission should consider prescribing a moratorium on use of digital formats for cable signals until standards issues are properly addressed.

The legislation requires the Commission to establish criteria to permit TVs and VCRs to be marketed as "cable ready." We are prepared to help define that term. But the exercise will be meaningless unless the cable environment is defined in stable terms. What is cable-ready today will not be so tomorrow, if the cable companies are permitted to change constantly and unpredictably:

1. the number of channels delivered to the home.
2. their channel mapping schemes.
3. the remote control IR (infrared) codes for cable converters.
4. overall signal performance parameters.
5. standards for transmission, compression and scrambling.

By the time most of the TVs and VCRs in use today in American homes are retired, it will be close to the year 2008, which is the date by which the Commission plans to discontinue NTSC broadcasting. Meaningful progress on compatibility problems should start immediately. The Commission can permit increased use of consumer electronics functionality—and foster continued innovation in cable services and consumer products—only by using its ample au-thority under the law to require changes in cable industry behavior. In particular, efforts are needed to promote simultaneous "in the clear" access to all authorized channels delivered to the home. And, to avert the chaos that multiple digital formats could cause for consumers, manufacturers and retailers, work should begin now on digital transmission, compression and security standards as well.

More to come

As always, technology is changing faster than anyone can be expected to keep up with it, but the consumer electronics service facilities that are doing the best job are the ones that are finding themselves the most successful.

We have tried to give ideas of a few of the new, technologically advanced products that have recently become available. Unfortunately, it is impossible to do justice to this subject in an article such as this one.

Other new products and services that are currently being made possible are satellite direct broadcast systems (DBS), computer multimedia, and digital broadcast systems.

As developments are introduced in these areas, we will bring them to you.

Information on companies

AirMouse Remote Controls
Selectech, Ltd.
30 Mountain View Drive
Colchester, VT 05446
802-655-9600
Fax:802-655-5149

Advanced Digital Systems, Inc.
20204 State Road
Cerritos, CA 90701
800-888-5244

Multiplex Technology, Inc.
3200 E. Birch Street
Brea, CA 92621
714-996-4100
Fax: 714-996-4900

United Video Satellite Group
7130 South Lewis, Suite 410
Tulsa, OK 74136-5486
918-496-7500

Virtual Vision, Inc.
7659 178th Place NE
Redmond, WA 98052
206-882-7878
Fax: 206-882-7373

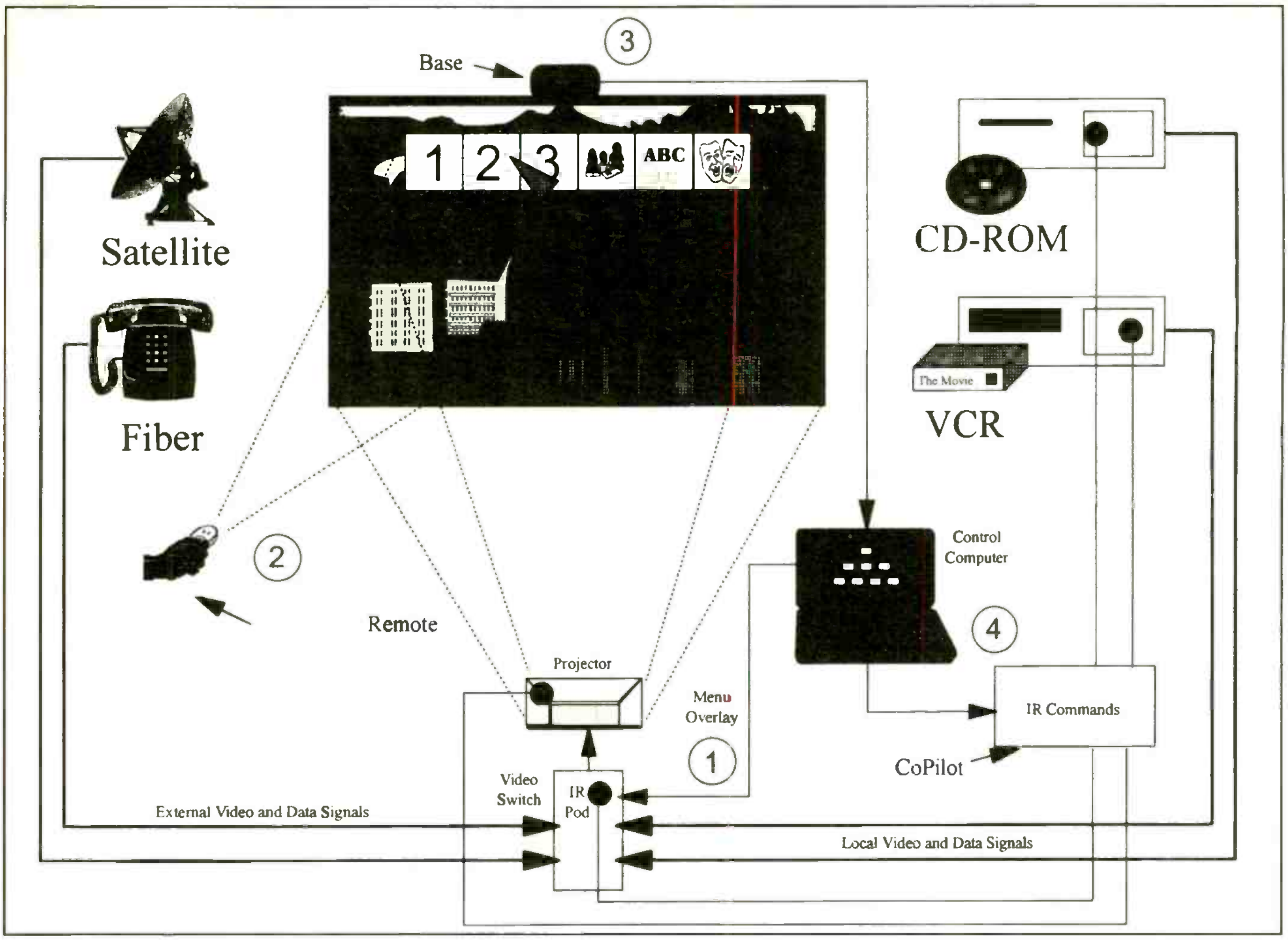


Figure 5. This home theater system is shown as receiving video signals from satellite dishes, cable and VHF/UHF broadcast, as well as telephone company fiber optics which are expected to soon also carry video into homes. All functions are selectable using a remote control mouse.

from any place, in any form, with the appropriate device.

While announcements concerning the so-called "Information Highway" have focused on the new forms of information and entertainment that will be available through television, screen phones and portable computing devices, none have focused on the enabling link that brings together information and consumers.

The multimedia information server is this key link that defines how information is stored, retrieved and reaches its destination. Based on powerful database and messaging technology that can support parallel computers, the multimedia server can process the thousands of transactions per second and manage the multiple data types, such as audio, video and text, that are required for interactive services.

The two companies are already at work on the multimedia information server and new information services. Oracle, a supplier of database management solutions and massively parallel software technology, will expand its leadership by providing information management technology for business and public consumer needs. US WEST, a global communications concern and one of the seven Regional Bell Operating Companies (RBOCs), will leverage its position in advanced telecommunications technologies, such as CDMA cellular to provide low cost information services to millions of subscribers. The first service, multimedia messaging, is targeted for delivery in late 1993 or early 1994.

"While much of the focus of 'digital convergence' has been on delivery devices and entertainment providers, the revolution in information access will not be possible without powerful information management services, storage and messaging," said Larry Ellison, president and CEO of Oracle. "Oracle's extensive experience with massively parallel systems combined with our broad family of information management software will accelerate the availability of interactive services for consumers and business."

Interactive multimedia services will enable customers to perform their daily activities—making purchases, watching video entertainment, obtaining information and leaving or receiving messages—using the different types of technology that they already have in their homes and in their businesses.

For example, customers will be able to retrieve the same message through a personal computer, facsimile machine, or a cellular or conventional telephone—and eventually through a screenphone, an interactive television set, or a personal digital assistant. The message could come in various forms, such as a voice or electronic mail, a fax, or even a video clip. In addition, customers will be able to conduct electronic information searches, complete financial transactions or select interactive video services.

"Our goal is to enable customers around the world to get the information they want at any time, from any place, in any form, using any equipment," said Chuck Lillis, US WEST executive vice president and chief planning officer. "To do that, we're developing a kind of software 'engine' that will help us quickly and cost effectively create interactive multimedia services to ride on today's information highways."

Lillis said Oracle will develop the software framework the new services require and US WEST will partner with high-quality information providers to bring the services to the marketplace.

Interactive electronic program guide

TV Trakker, an interactive TV service, is delivered to cable subscribers' homes via an FM subcarrier that takes up no channel capacity. Using a compact, easily installed "sidecar" and a remote control, viewers follow colorful on-screen "windows." Available on-demand information includes: eight hours of programming (a four-hour current program grid and a four-hour primetime grid); the day's sports and movie highlights; plus program descriptions.

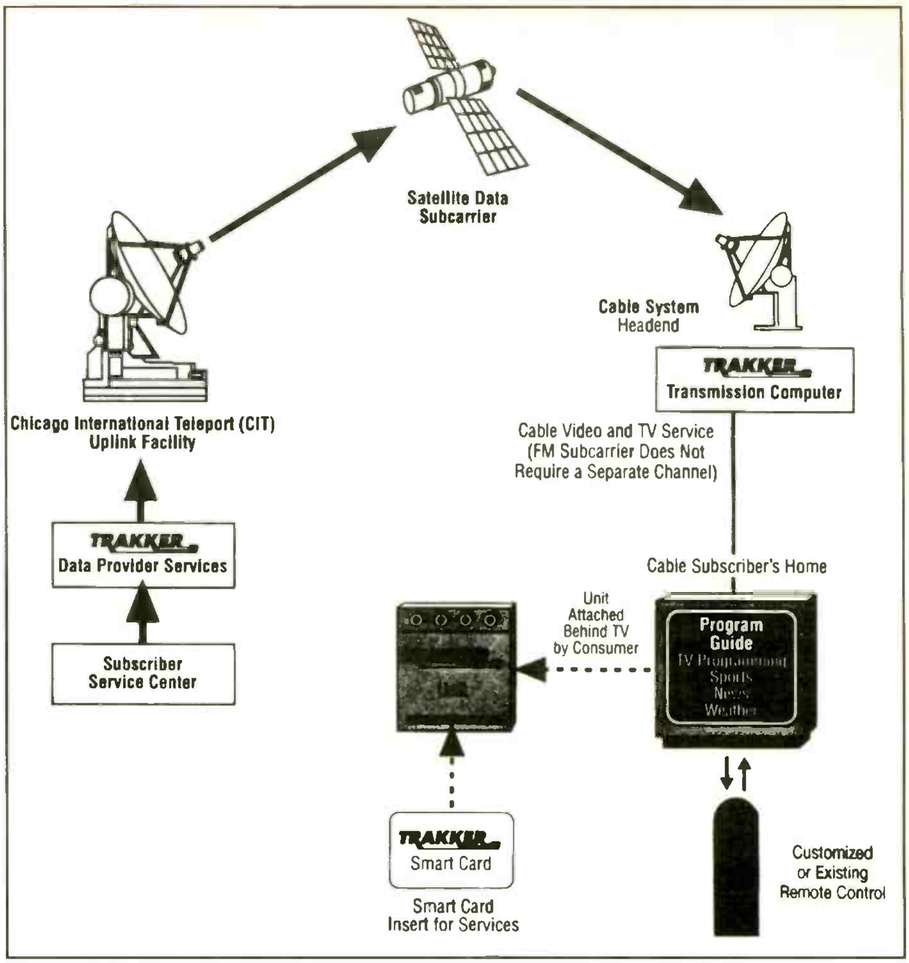


Figure 6. This home theater is operated in the following sequence: 1. Menu presentation, 2. User selection, 3. Base-station reception, 4. Equipment control.

A specially designed Smart Card, which is inserted in the sidecar, authorizes the reception of TV Trakker and any combination of forthcoming Trakker services.

"During this test marketing phase, we will have an excellent opportunity to fine-tune TV Trakker, thanks to the system's unique downloadable software," says Trakker chief operating officer Mark Brenner. "Downloadable software allows us to respond rapidly to consumer feedback, refining virtually any parameter of the system without expensive hardware modifications. This upgradeability makes it easy for Trakker to respond to viewer needs and new markets."

Trakker is an affiliated company of Prevue Networks, Inc., a supplier of electronic programming information to the cable industry with 33 million subscribers, and United Video Satellite group, a pioneer in the cable and satellite industries. Because of such corporate ties, Trakker has access to an existing satellite data infrastructure capable of system-specific customization.

In addition to TV Trakker, the company will soon test market a service called Sports Trakker, which offers late-breaking scores, game information, statistics and other news of importance to sports fans. Other Trakker services scheduled to come on line in the future include an advanced version of TV Trakker, which will allow point-and-shoot VCR programming, plus a variety of entertainment, news, weather and business services.

Installing and operating a Trakker is simple. First, viewers attach a compact adaptor ("sidecar") behind their TVs. Although the sidecar is currently an outboard component, its functions are expected to be incorporated into set-top converters, TVs and VCRs in future generations of the system. Next, a Smart Card that authorizes the desired combination of Trakker services is inserted into the sidecar. Consumers can use their existing remote, or a custom remote, to find the information they want by following on-screen menu windows. ■

Test your electronics knowledge?

A little bit of everything!

By J. A. Sam Wilson

1. The diode detector in an AM superheterodyne broadcast receiver is the receiver's
   A. first detector.
   B. second detector.
   C. ratio detector.
   D. only detector.

2. Heterodyning occurs when two signals are beat together. In an AM superheterodyne broadcast receiver, heterodyning
   A. takes place in the diode detector stage.
   B. does not take place in the diode detector.

3. Undesirable heterodyning between two audio signals in an audio amplifier is called
   A. A-B distortion.
   B. GL distortion.
   C. 2F distortion.
   D. IM distortion.

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

4. As shown in *Figure 1*, two pure sinewaves with frequencies f_1 and f_2 are introduced into a perfectly linear amplifier. List all the frequencies at the output.

____

______________________________.

5. Name four types of multivibrator circuits using the first letters shown.
   - A______________
   - B______________
   - M______________
   - S______________

6. Which of the MOSFETs shown in *Figure 2* is in the OFF condition?
   A. the one marked 'X'.
   B. the one marked 'Y'.

7. For the value of epsilon given here, what are the next two numbers?
   2.718281828_ _

8. What is the length of the side of a square that has exactly the same area as a circle with a 3-inch diameter?

9. Disregard the voltage drop across the unknown component in this question. Add a component that will give the output waveform shown in *Figure 3*.

10. Everyone knows this one: You walk south ten miles, then, east ten miles, then, north ten miles and you end up at your original starting point. Where are you? *Answer*: at the north pole.

Now, do this one: You walk south ten miles, west ten miles, and then north ten miles. You end up ten miles from your starting point. Where are you this time?

(Answers on page)

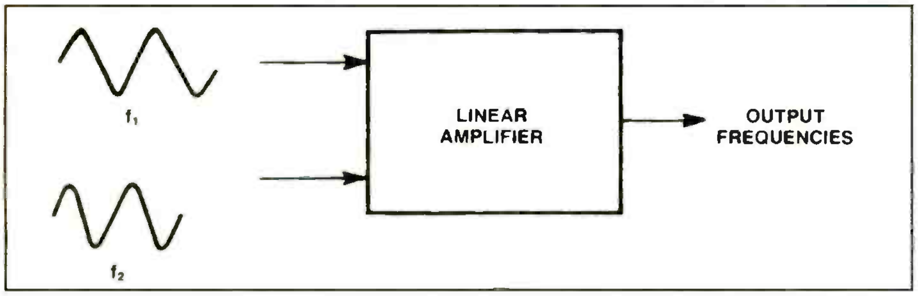


Figure 1. What frequencies will appear at the output of this perfectly liner amplifier if two pure sinewaves are introduced at the inputs?

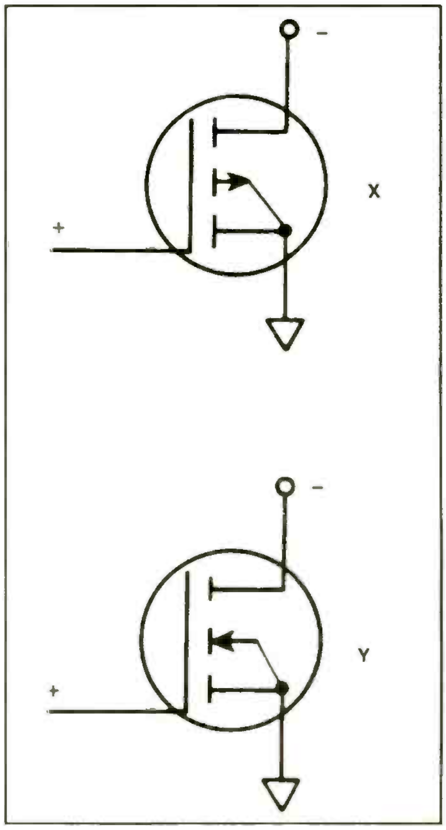


Figure 2. Which of these two MOSFETS is in the OFF condition?

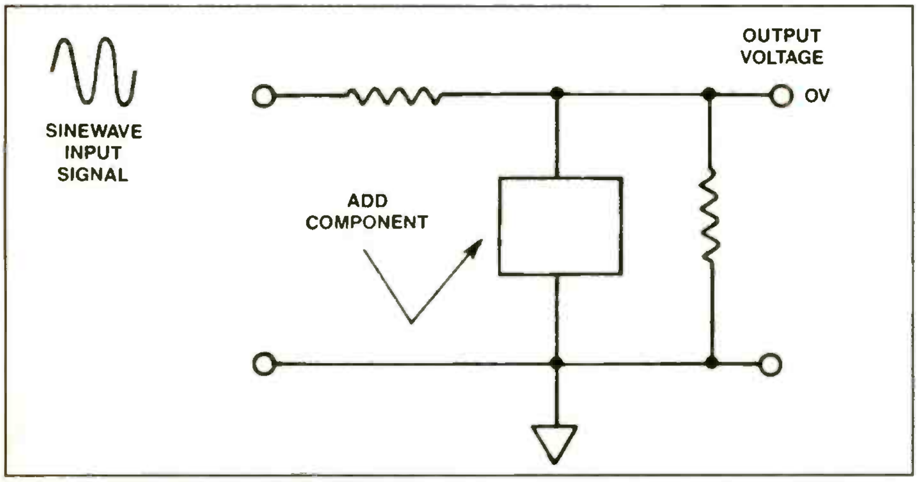


Figure 3. What component added in the location shown will give this output waveform?

A primer on color TV

By Vaughn D. Martin

This article takes a look at a color TV from a signal flow point of view from the antenna to the picture tube. It also traces the history of the first attempts by semiconductor manufacturers to fabricate TV circuitry using integrated circuits rather than discrete components.

The frequencies used in this explanation are based on the American NTSC (National Television System Committee) system; however, the basic theory also applies to the European PAL (Phase Alternating Line) system. It is only in the chroma section that the two systems differ significantly.

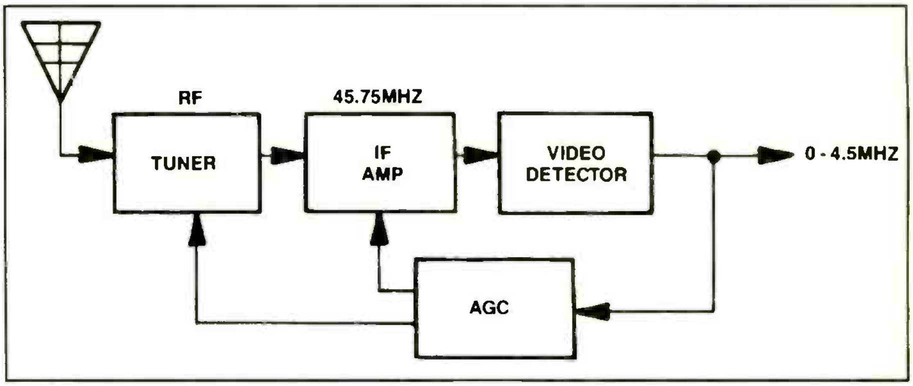


Figure 1. A block diagram of the RF and IF sections of a color TV..

RF and IF sections

All signal components received from the antenna pass through a tuner and an IF amplifier on their way to the video detector (Figure 1). The RF signal ranges in frequency from 55MHz for channel 2 up to 885MHz (tuned with the aid of an UHF converter) for channel 83. The tuner amplifies the desired frequency and converts it to an intermediate frequency (IF) of 45.75MHz. The IF signal is then amplified in the IF amplifier.

The amplified 45.75MHz signal is called the video carrier. The video carrier is amplitude modulated (AM) with the picture information so the video detector must strip this information from the carrier by using some form of envelope detector. Thus far it sounds as if we are describing a basic AM radio, with the exception that instead of having audio at the detector we have video.

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

Controlling the gain

The output level from the video detector is usually about $3V_{PP}$. Keep in mind that the amplitude of the signal at the antenna is often as low as $10\mu V$ rms. This means that the three blocks in Figure 1 must provide 110dB of gain. This same antenna might receive signals as strong as $0.5V_{PP}$, but still be required to produce $3V_{PP}$ at the video detector.

This broad range of input signal amplitudes necessitates an automatic gain control (AGC) system that detects variations in the peak amplitude of the composite video signal and automatically adjusts the gain of the tuner and IF amplifier.

Signal information

The picture you see on a color TV set is actually created by three electron beams. There is one beam for red, green, and blue and they are scanned horizontally over the screen. As these beams are scanned, their currents are varied to create the light and dark areas on the picture tube face which form the image you view.

MANUFACTURER	PART NUMBER	FUNCTION
NATIONAL SEMICONDUCTOR	LM18222N	VIDEO IF AMP/PLL DETECTOR
RCA	CA3070	TV CHROMA SYSTEM IC
RCA	CA3199	TUNING CONTROL VHF/UHF
RCA	CA3154	TV SYNC/AGC/HORIZONTAL IC
RCA	CA3210	HORIZONTAL/VERTICAL COUNTDOWN FOR SYNC SYSTEM FOR 525 LINES
RCA	CA3223	SAME FUNCTION AS CA3210 EXCEPT FOR 625-LINE SYSTEM
RCA	CA3237	IR REMOTE CONTROL
RCA	CA3135	TV LUMINANCE PROCESSOR
RCA	CA3156	VIDEO/CHROMA PROCESSOR IC
RCA	CA3224	AUTOMATIC CRT TUBE BIAS IC

Table 1. An overview listing of some modern color TV ICs showing their functions, salient characteristics and manufacturer's part number.

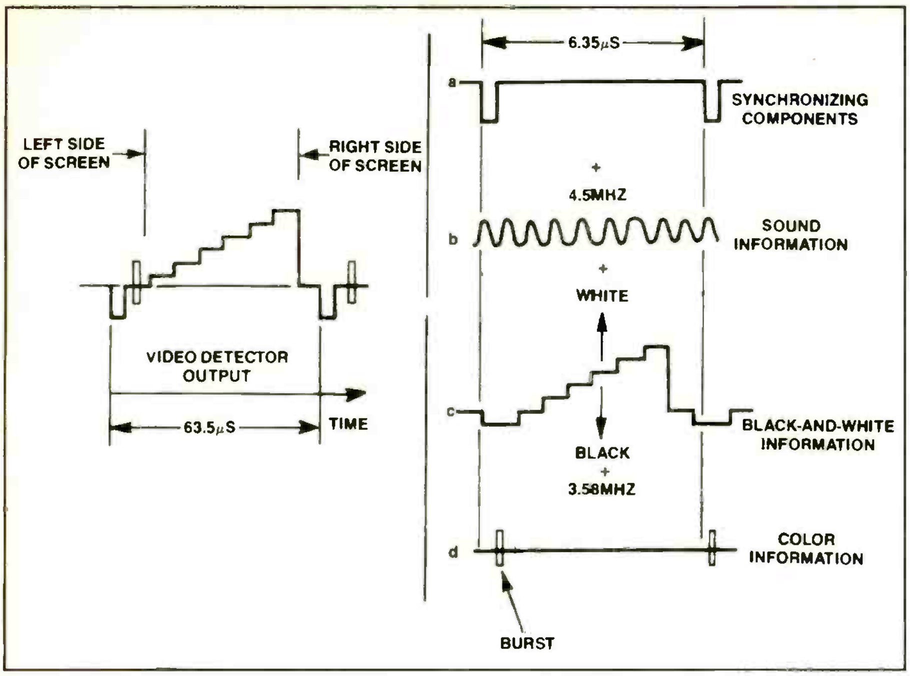


Figure 2. The video detector, shown during one complete cycle in which the electron beams make one horizontal scan across the screen.

See Figure 2, which shows the video detector output during the time it takes for one horizontal scan across the screen. The output is really made up of four composite signal components which are needed to form a color picture with sound. The four components are:

1. Synchronizing components
2. Sound information
3. Black-and-white information and
4. Color information.

Synchronizing components

The synchronizing information is a series of pulses that tell the horizontal section when to return to the left of the screen to start a new line. They tell the vertical section when to start at the top of the screen to start a new frame.

In the NTSC system each frame contains 525 lines. The TV picture is created by scanning at a rate of approximately 30 frames per second (the vertical scan rate is actually 60Hz. However, it takes two trips down the screen to complete one frame). The retrace process of returning to start a new scan is called "flyback."

Sound information

The sound information is carried in the form of frequency-modulation (FM) of a 4.5MHz carrier which in turn modulates the video carrier. That makes the 4.5MHz signal a "subcarrier." This subcarrier is very similar to the IF signal in an AM radio. Although the sound subcarrier is available at the video detector, a separate

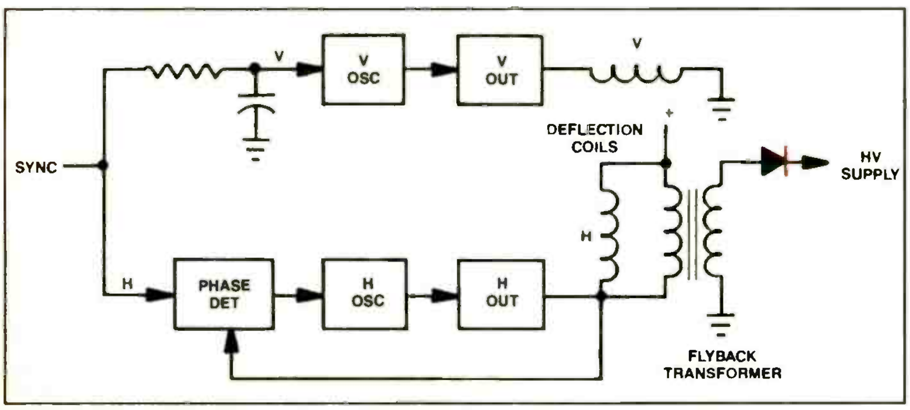


Figure 3. A block diagram of the scanning and high voltage sections of a color TV.

Products

Philips Puts Power In Your Repairs

In keeping with their tradition of quality, Philips has developed two new ideas to save you time and money. Philips introduces two new power supply kits designed to cover 80% of all power supply failures for Philips manufactured products. Each package is available with the most commonly used capacitors, resistors, transistors, and IC's

Included in each package is a handy Technical Tips book compiled by a team of servicers and Philips' own engineering/technical support group. The book serves as a guide for identifying and repairing power supply problems.

Kit number PK9301AAM001 covers Series/Linear Power Supplies and contains 22 components. Kit number PK9302AAM001 covers Switch Mode Power Supplies and contains 36 components. Philips is offering the kit for only two-thirds the total cost of buying the components separately.

Both kits are packaged in sturdy compartmentalized styrene storage boxes. The cover grids list the part numbers, descriptions, chassis, technical specifications and reference locations for each component.

Circle (120) on Reply Card

(Continued on page 54)

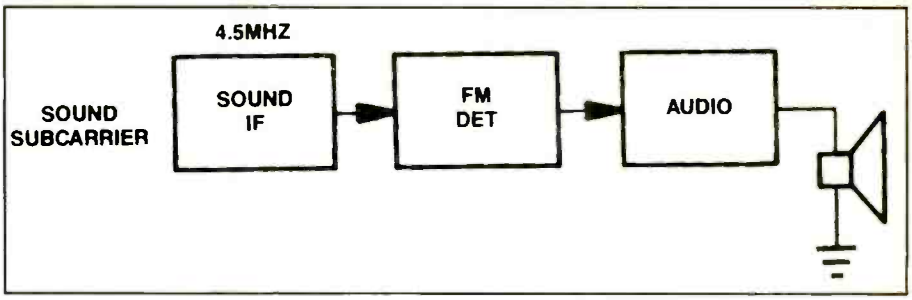


Figure 4. A block diagram of a sound channel on a color TV.

detector is often used to reduce crosstalk between signal components.

Black-and-white information

This is also called luminance, and is the information that determines the instantaneous brightness of the screen as the electron beams are scanned over it. In fact, the luminance information is all that is used for the single electron beam in a black-and-white TV.

A negative-going video detector detects a luminance signal in which the negative signal extremes correspond to dark areas of the picture and positive going extremes correspond to bright areas.

Keeping that in mind, refer to the signal in Figure 2(c) and note that this would produce vertical bars of increasing brightness from left to right. Note that the output is black during retrace so the electron beams will not be seen. The luminance signal is designated by the letter Y.

Color information

Color, also called chrominance, is ignored in a black-and-white TV, but in a color TV it is made up of red, blue and green signals required to drive the picture tube, minus the luminance information.

These color difference signals, designated R-Y, B-Y, and G-Y, modulate a second subcarrier which has a frequency of 3.58MHz.

Although the type of modulation used on the subcarrier is of a complex nature, it provides two simple results:

1.The instantaneous phase of the 3.58MHz subcarrier determines what color will be displayed (called hue or tint).

2.The instantaneous amplitude of the 3.58MHz signal determines how intense the color will be (called saturation).

Overlooking the obvious

A question which has yet to be answered is, "what are the phase and amplitudes of this 3.58MHz signal relative to?" The answer is *a short burst*, simply called *the burst*, which has a constant amplitude and phase. The burst is used to determine the tint and saturation of the color to be displayed. As an example, refer to Figure 2(d) and note that here each bar would have a different saturation.

The four signal components are separated and sent to their respective sections in the TV according to the type of signal. Since the sync pulses are the negative peaks of the composite video signal, a phase-detector circuit, called a sync-separator, is used to separate them.

The sound and chroma information is contained in subcarriers which are separated with 4.5MHz and 3.58MHz tuned-circuits respectively. The luminance information contains frequency components from 0MHz to 4MHz and therefore uses wideband dc coupling.

Scanning and high voltage

The sync pulses separated in the sync separator, as shown in Figure 3, are divided into vertical and horizontal compo-

(Continued on page 43)

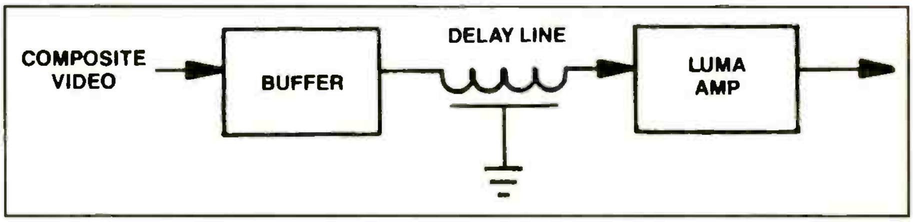


Figure 5. A block diagram of the luma processing sections of a color TV.

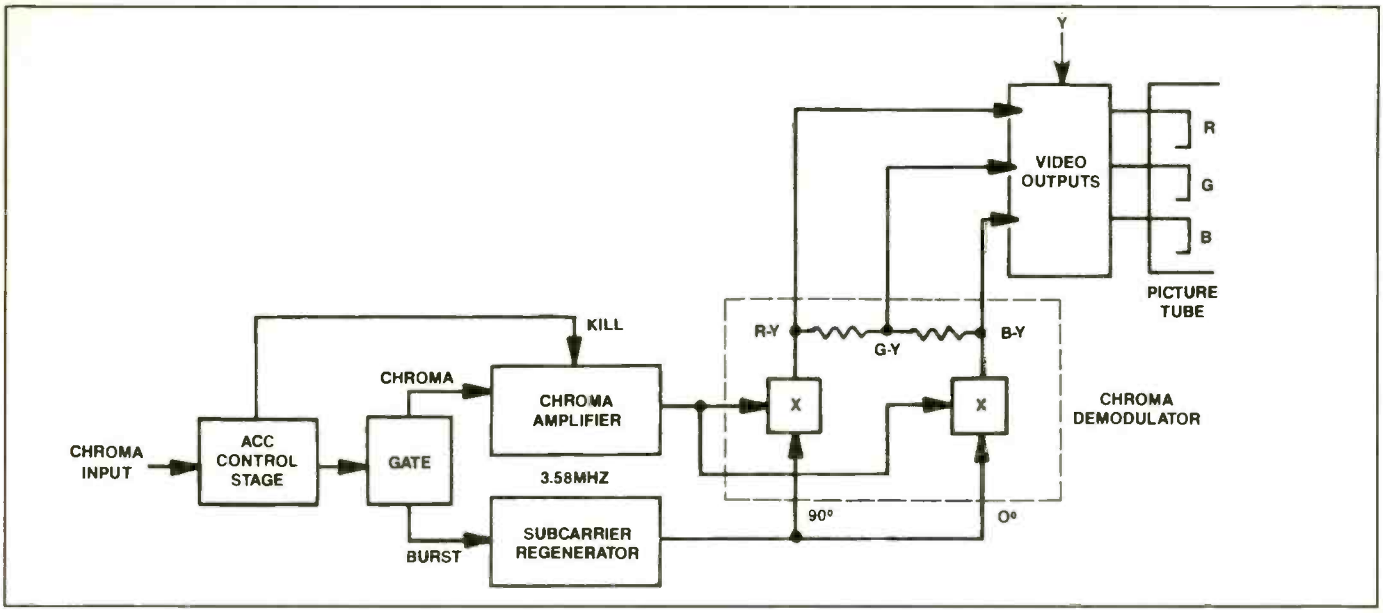


Figure 5. A block diagram of the luma processing sections of a color TV.

nents according to their pulse widths. The vertical sync pulse is a string of wide horizontal sync pulses.

When these pulse widths are fed through an integrator, they average to form the vertical sync pulse. The vertical oscillator is "injection-locked" by the vertical sync pulse to initiate vertical retrace at the correct time. The output stage then delivers a ramp to the vertical deflection coils to produce vertical scan.

The horizontal section uses a different locking system since horizontal retrace is started before the sync pulse is received in order to assure correct centering of the picture. A phase-locked loop (PLL) does this to insure proper timing between the horizontal sync pulse and the flyback pulse produced by the output stage during horizontal retrace.

The horizontal output stage serves two

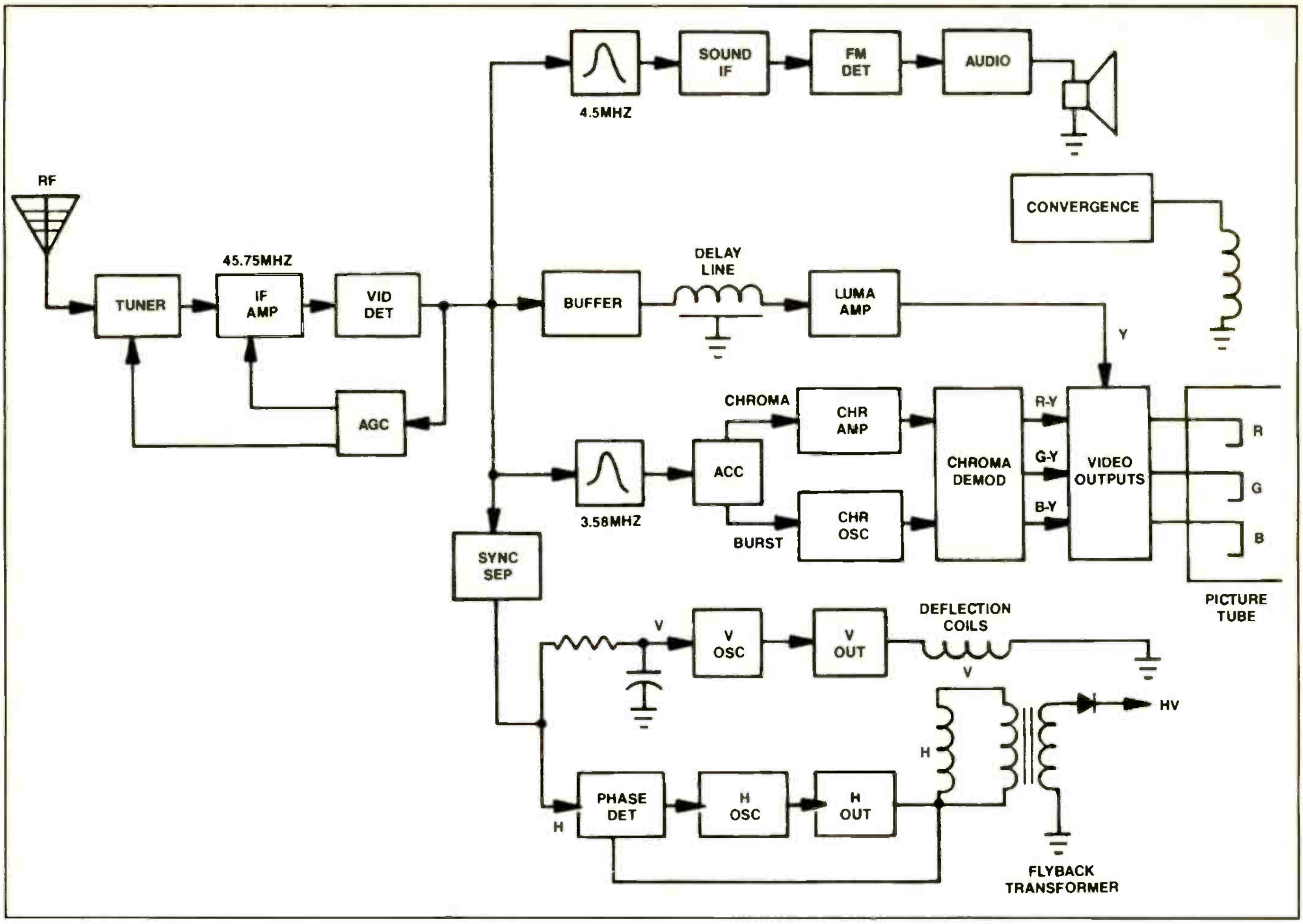


Figure 7. A block diagram of a complete color TV.

purposes. First, it drives the horizontal deflection coils, and secondly, it drives the flyback transformer for the picture tube anode's high voltage. This high voltage is in the 25KV to 30KV range and is produced by directly rectifying or voltage tripling the HV (high voltage) flyback pulse derived from a large turns ratio on the flyback transformer.

The sound channel

The 4.5MHz sound-subcarrier signal is amplified and limited in the sound IF stage to remove undesired amplitude information (Figure 4). The FM is then detected by an FM detector and applied to the audio amplifier. Limiting sensitivity for the sound system is typically 100µV and the output power is from 1W to 4W, depending on the receiver site.

Luma processing

The luminance signal "Y" is amplified and delayed by 0.8µsec on its way to the picture tube (Figure 5). The delay is needed to insure that the black-and-white information does not arrive at the picture tube before the color information. Remember, this color information is delayed by the comparatively narrow bandwidth of the 3.58MHz chroma section.

The contrast and brightness controls are also located in the luminance amplifier. The contrast control changes the peak-to-peak amplitude of the signal while the brightness control changes the dc level of the signal.

Chroma processing

From the signal taken off the 3.58MHz tuned circuit, the chroma section must derive two signals:

1. The 3.58MHz chroma subcarrier signal of the correct amplitude, and
2. A continuous 3.58MHz chroma reference signal of the correct phase relative to the burst.

The desired color difference signals R-Y, B-Y, and G-Y result when these two signals are applied to the chroma demodulator (Figure 6).

The chroma signal

Even though the AGC system holds the peak-to-peak video level constant, the chroma subcarrier can vary in amplitude with transmission, antenna and fine tuning. The chroma section then requires its own AGC loop and it has one called an automatic chroma control (ACC). This block compares the amplitude of the burst to a reference to keep the chroma output constant over a 20dB input range.

The chroma signal is gated into two components by a pulse derived from the horizontal section. The chroma subcarrier (during horizontal scan) is sent to the chroma amplifier. Here a gain control varies the saturation of the color picture. If no burst was present in the ACC, the output of the amplifier is "killed" for black-and-white reception.

During the horizontal retrace the burst is sent to the subcarrier regenerator. This

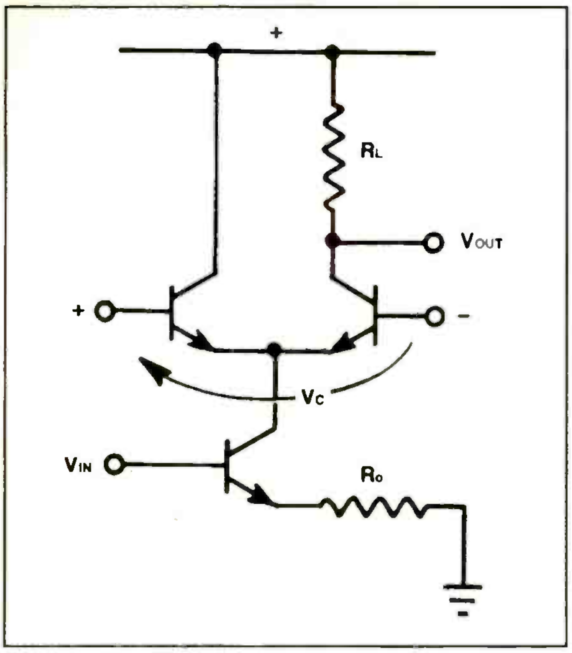


Figure 8. A schematic of a current-sharing gain control stage.

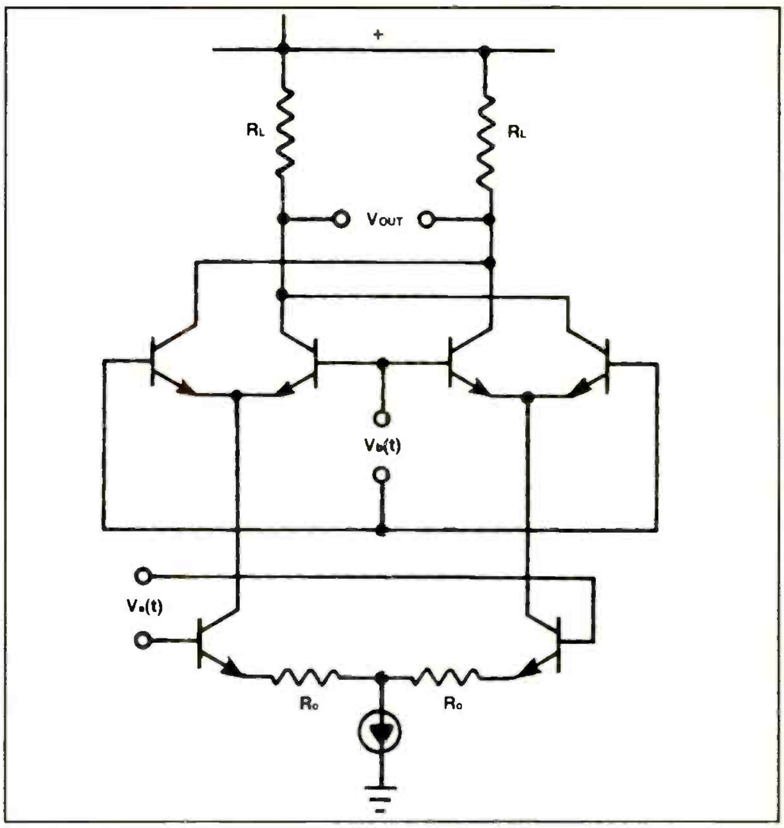


Figure 9. A schematic of a multiplier, an IC used widely for amplitude, phase and frequency detection. →

is nothing more than a crystal-controlled 3.58MHz oscillator which is locked to the frequency and phase of the incoming burst by either injection-lock or a PLL technique. This is the reference output and is passed through a variable phase-shift network to vary the tint.

The output of the chroma amplifier and subcarrier regenerator are required by the chroma modulator. This consists of synchronous detectors operated in quadrature, that is 90 degrees out-of-phase with one another.

The reference phase applied to the B-Y detector makes it responsive only to chroma input phases that are blue. The reference applied to the R-Y detector, which is 90 degrees out-of-phase with the B-Y detector, makes it responsive only to red. The G-Y signal is realized by combining the R-Y and B-Y signals in the correct proportions.

Finally, the luminance signal, Y, is added to the chroma difference signals R-Y, B-Y, and G-Y to arrive at the desired hue of red, blue and green. These signals are amplified to $100V_{PP}$ in the video output stage and applied to the appropriate cathodes of the color picture tube.

Convergence

When you have three color beams being produced by electron guns located slightly apart, and all being scanned over a flat rather than a round surface, you will inevitably have color convergence problems. Each beam of electrons must be modified so that it lands in the same location as the other beams and this must occur over the entire screen. This is the last remaining circuit which now completes a color TV receiver (Figure 7).

Color TV ICs

All of this circuitry requires large numbers of components. Therefore, in modern sets, ICs are used wherever possible for economy. Another reason for using ICs, is that, within ICs the parts are physically closer together, which cuts down on stray capacitance.

A history of color TV IC's

Integrated circuits made especially for TVs (mostly color TVs) began in the early to mid 1970's. The first ICs made, which worked well at 45MHz, were an IF system using two chips. These were made by Motorola and were a two-stage, gain-controlled IF amplifier, the MC1349, and a video detector, the MC1330.

Why aren't these two related obviously adjoining ICs combined into a single IC? The major obstacle, at that time, was the stability due to internal and/or external coupling of the output and the input.

In fact, when TV ICs were in their infancy, several whole areas were "off limits." These were the tuner, video outputs, and horizontal/HV output sections. The problem of combining the video detector and the IF amplifier was first solved by a European company, Telefunken, with their TDA440.

Another IF function used in most color TVs is automatic fine tuning (AFT) which keeps the tuner correctly tuned to the IF. The National Semiconductor LM3064 type of IC was one of the first ICs to perform this function. However, the first IC to incorporate all of these functions was the National Semiconductor LM1807. This IC uses a PLL to tune the tuner to the IF frequency set by a local oscillator right on the IC.

The deflection circuits

The deflection circuit area of a TV was among the most difficult areas to address and was understandably then one of the last to be integrated. Early attempts included vertical drivers and even a whole output stage. Some of the notable first ICs addressing horizontal deflection included the Motorola MC1391 and the Philips TBA920. The SGS TDS was one of the first ICs to address vertical deflection.

In the United States, the vertical and horizontal scanning frequencies of a TV are related by the following formula:

$$f_V = 2f_H/525$$

Keeping this relationship in mind, National Semiconductor made their DM-8890 which divided down a horizontal signal to generate a vertical timing signal. This eliminated the need for a vertical hold control.

The sound channel

In most modern TVs, the sound channel usually consists of an IF/FM detector IC and a class B IC audio amplifier. However, later, both these features were combined into a single IC such as National Semiconductor's LM1808, which was one of the earliest ICs to do this.

Luma processing

This area of a color TV lagged in IC development because of the questionable economics in developing such an IC. However, Zenith and Sylvania were two early companies which had custom chips made for this purpose.

Chroma processing

The first IC in a color TV was the chroma demodulator. One of the first such ICs was the National Semiconductor LM-1828. Motorola later introduced an IC which added the luminance signal to the color difference outputs, this was their MC1324.

The earliest chroma amplifiers and subcarrier regenerator sections were made as two ICs, using a PLL (phase locked loop) technology. An example is the National Semiconductor LM3070 and 3071. Motorola used an injection-locked system and realized it with a single IC, their MC-1398. Second generation ICs to do this same function were the RCA CA3126 and the Motorola MC1399. Hitachi was the first company to implement the entire chroma section onto a single IC.

Jungle ICs

A "jungle" IC is industry jargon for an integrated circuit which combines a number of functions on a single IC. Zenith was one of the first companies to do this with an IC which was both a sync separator and an AGC circuit.

Inside color TV ICs

With the exception of the basic differential amplifier, the two most common circuits within a color TV IC are the current-sharing gain control and the linear multiplier. Let's look at each of these.

The current-sharing gain control derived its name because the input current is shared between two outputs depending on the dc control voltage V_C. For the circuit in Figure 8, the small signal gain at room temperature is given by:

$$A = dV_{OUT}$$
$$= R_L/R_e/(1 + \exp[V_C(\text{in mV})/26]$$

As V_C is increased, the circuit acts like a logarithmic attenuator. It reduces gain at a rate of approximately 20dB for each 60mV of applied voltage. The same basic gain stage is used in IF AGC and chroma ACC circuits, as well as volume, contrast, and chroma controls.

The multiplier circuit

The multiplier circuit (Figure 9), is designed for detection of phase, amplitude and frequency. In the circuit shown, the bottom pair of transistors is derated for linear operation while the top four transistors are switched. If $V_a(t)$ is an amplitude modulated carrier $F_m(t)\cos(wt)$ and $V_b(t)$ is a square wave of the same frequency, wt, and relative phase, ø, then the filtered output is given by:

$$V_{OUT} = [2/\pi]\,[R_L/R_e]\,F_m(t)\cos(wt)$$

The output depends on the amplitude of V_a and the relative phase, ø, between V_a and V_b.

If ø is made 0 degrees so cos(ø) is 1, the multiplier acts as an amplitude detector and can be used to detect the video modulation on the IF carrier. Note that around 0 degrees, cos(ø) changes very little with phase. To use the multiplier as a phase or frequency detector, $V_b(t)$ is limited to remove amplitude information and ø is centered at 90 degrees where cos(ø) produces the largest change in output for a given change in phase. This is the mode of operation used in chroma burst phase detectors and sound FM detectors. Both the amplitude and phase sensitive properties of the multiplier are used in chroma demodulators.

Summary

The color TV industry has come a long way, and working in concert with the semiconductor industry, has managed to emerge from color TVs in the early 1970s with just a single pair of ICs to an almost totally integrated receiver today. Table 1 is an overview of some of the newer ICs developed for the color TV industry. ■

Books

Servicing PC-Based Equipment, By Don D. Doerr, PTR Prentice Hall, 384 pages, $26.95 paper.

When a PC goes down it's an opportunity for a consumer electronics servicing technician. In a book from PTR Prentice Hall, *Servicing PC-Based Equipment*, Doerr shows you how to service PC equipment.

Based on more than ten years experience, Doerr shows you how to service PC-based equipment quickly and easily. The book is an indispensable source for diagnosing PC problems. Flow charts take you step-by-step through the troubleshooting procedure, until the problem is isolated. Troubleshooting tips help you solve problems without needing to send parts out for service. You learn how simple it is to protect and recover data quickly and easily. Doerr shows you how to locate the best sources for parts, diagnostics, schematics and board repair. The most common questions asked by service technicians are covered.

Servicing PC-Based Equipment features a DOS reference guide and a list of recommended utilities and step-by-step instructions for repairing and installing a hard disk. The book contains sections about common diagnostic software, boards and drives, system boards, expansion bus, diagnostic and post error codes, hard drives, floppy drives, monitors and keyboards, power supplies and power protection, automatic test equipment types, soldering equipment, fault isolation guides, and switch and jumper settings. It also contains the most frequently referenced service information. The book devotes a full chapter to buying a new PC. *Servicing PC-Based Equipment* features special reference sections on opportunities in the service industry, a vendor support list, a glossary, and complete index.

PTR Prentice Hall, Paramount Publishing Education Group, Englewood Cliffs, NJ 07632

Operational Amplifiers, Second Edition, by Jiri Dostal, Butterworth/Heinemann, 360 pages, $49.95 hardcover.

The new second edition of *Operational Amplifiers* by Jiri Dostal, the authoritative technical resource on operational amplifiers, is now available from Butterworth-Heinemann publishers.

The latest volume in the popular EDN Series, this up-to-date book provides the reader with the practical knowledge necessary to select and use operational amplifier devices. The author has combined design-philosophy, theory and practice in providing in-depth coverage of topics ranging from operational amplifier properties and parameters to good laboratory practices. Covering the newest technology in the field, *Operational Amplifiers, Second Edition* presents an extensive treatment of applications.

Contents include the operational amplifier, basic concepts, operational amplifier parameters, operational amplifier properties, the operational circuit, the ideal operational circuit, analysis of the real operational circuit, static and dynamic errors in the frequency domain, etc.

Author Jiri Dostal works at the Research Institute for Mathematical Machines in Prague, Czechoslovakia.

Butterworth-Heinemann, Stoneham, MA 02180.

1993 Electronic Market Data Book, Compiled and published by the Electronic Industries Association, 230 pages, $125.00 paper.

To keep pace with the fast changing economic climate and globalization of industry the *1993 Electronic Market Data Book* has been reworked to provide detailed information on electronic sales, trade, and economic trends. New data series include U.S. and international electronic market updates as well as economic overviews. The book details consumer electronics, electronic components, telecommunications, defense electronics, computers and peripherals, government electronics, industrial, and electromedical electronics.

Containing pages of tables, supplemented with visuals and explanatory text to highlight key areas, the *Data Book* is referred to regularly by electronics manufacturers, market research firms, consulting agencies, financial houses, academic institutions, libraries, government agencies, and electronic-related businesses around the world.

Electronic Industries Association, Washington, DC 20006-1813

Maintain and Repair Your Notebook, Palmtop, or Pen Computer, By McGraw-Hill, 352 pages, $18.95 paper, $28.95 hardcover.

For those portable computer owners who cringe at the thought of troubleshooting their own equipment, this book offers an overview of the tools and techniques used to service today's notebook, palmtop, and pen computers.

Bigelow's coverage builds confidence in the reluctant do-it-yourselfer by giving easy-to-follow, low-tech descriptions of components and test instruments, precise service guidelines, and easy-to-understand, step-by-step instructions for performing routine maintenance and basic repairs. Illustrated troubleshooting procedures and charts make diagnosis easy for owners of portable PCs.

Other topics covered include how to achieve peak performance, avoid costly downtime, how to save on expensive repairs, and suggested money-saving sources for replacement parts.

Windcrest/McGraw-Hill, TAB Books, Blue Ridge Summit, PA 17294-0850

Lenk's Laser Handbook: Featuring CD, CDV, and CD-ROM, By John D. Lenk, TAB Books, 288 pages, 150 illus., $22.95 paper.

Lenk's Laser Handbook is a guide to servicing laser audio and video equipment. It focuses on compact disc players and laserdisc video, but many of the procedures can be applied to CD laserdisc, CD interactive, CD-ROM, and most other laser units. Lenk takes a general approach that is reliable and practical, yet unaffected by changes in the products.

Aimed at technicians, field engineers, and skilled amateurs, this manual explains professional diagnostic and repair techniques, making liberal use of schematics, block diagrams, and discussions of the theory behind laser operation. Circuit-by-circuit, component-by-component examples show how laser equipment works, how to pinpoint and fix malfunctions, how to perform routine maintenance, even how to install laser modules using current test and repair instruments.

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

Notes about the homemade isolation transformer

By R.D. Redden

I've been asked some questions about the homemade isolation transformer that I described in the article "A homemade isolation transformer to cure H-K shorts," which appeared in the September 1992 issue of **ES&T**. Readers asked questions like: How do you determine for sure that an isolation transformer is needed? How does it work? Exactly how do you hook it up? I hope that this article answers those questions. The original article is reprinted in its entirety after this article for easy reference to the information it contains.

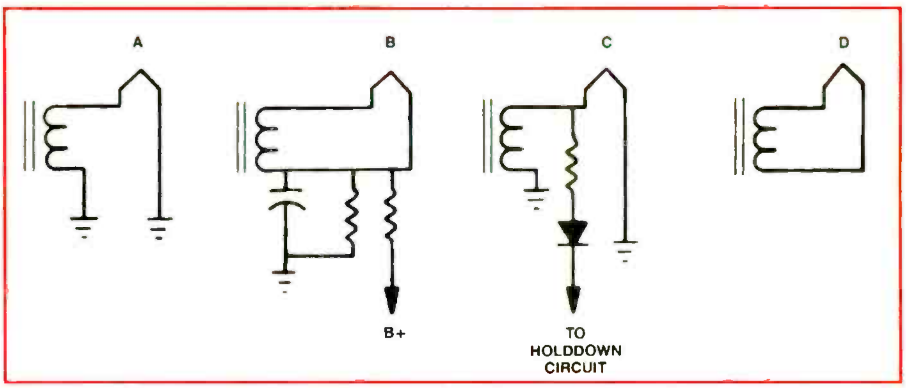


Figure 1. Some typical examples of CRT filament connections to the high voltage transformer (HVT). See text for details of each type of connection.

Some typical filament circuits

First, let's look at some typical examples of connections of the CRT filament to the high voltage transformer (HVT). See Figure 1.

In Figure 1A, one lead of the HVT filament winding and one lead of the filament are grounded. In Figure 1B, one lead of the HVT filament winding goes to ground through a resistor, and to B+ through another resistor. In Figure 1C, one lead of the HVT filament winding is grounded and the other lead powers another circuit in the set. The point is that in each of these circuits there is a dc path from the filament to ground, or to another circuit.

But notice the circuit in Figure 1D. The transformer filament winding is connected only to the filament, with no grounds or connections to any other circuit. If all filament circuits were like the one in Figure 1D, then an isolation transformer would never be needed. The filament would already be isolated from any connections that would affect the picture if a heater to cathode (H-K) short occurred.

The terms "filament" and "heater," as used here, describe the same part of the CRT; the resistive component that heats the cathode and causes electron emission. The terms are interchangeable.

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

Why isolating the filament removes the symptom

By far the most important voltage that controls the conduction of the red, blue and green electron guns in the CRT is the voltage difference between the control grid (G1) and each cathode. For normal brightness, the cathodes are positive with respect to the control grid, as shown in Figure 2. Now let's assume that a short occurs between the red cathode and the filament, as shown by the heavy line in Figure 2.

If the filament is grounded, then the short connects the red cathode to ground also, forcing the cathode voltage to drop to nearly zero volts. The red electron gun, with its cathode now grounded, will conduct heavily. This will cause a bright red screen. If the set has overcurrent protection, it may even shut down after the screen turns red, due to the heavy current through the CRT.

If the filament is not grounded, and is like the circuit of Figure 1D, neither the HVT filament winding nor the filament has any dc connections. If a cathode shorts to the filament, the dc voltage of the filament becomes the same as the dc voltage on the cathode which shorted to it. If the cathode voltage doesn't change,

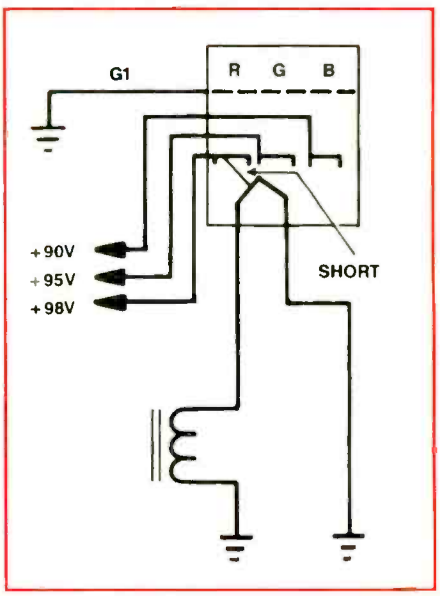


Figure 2. If a short develops between a cathode and its filament (heater), as shown by the heavy line in the drawing, it may cause picture problems, or possibly even shutdown of the set.

A homemade isolation transformer to cure H-K shorts

This article originally appeared in the September 1992 issue of **ES&T**. *It is repeated here in its entirety so that readers can easily refer to this original article while following the author's more detailed explanation.*

A bright red, green or blue screen with retrace lines often means a heater to cathode (H-K) short in the CRT. When TVs used 60Hz to power the CRT filament (heater), technicians bypassed this problem by installing a large, heavy isolation transformer for the filament.

Now that filaments are powered by the high-voltage transformer, which operates at a much higher frequency, isolation transformers are small and light. And it's easy to wind your own. The materials for the ones I make cost me under two dollars, and I can wind one in about five minutes.

Actually, the first isolation transformers I used were free. Some TV sets used toroid transformers of about 1-1/2 to 2 inches in diameter near the ac input as a line choke. I snipped these out of junked sets and they worked well as isolation transformers. But as with most good freebies, they seem to have become scarce.

Not all toroid cores are the same. The core material affects the permeability and thus the inductance for the same number of turns on similar sized cores.

I wanted a small, light core that would require few turns of wire. Ocean State Electronics (800-866-6626) has a wide selection of cores. Their stock number FT82-75 has a permeability of 5,000, allowing 14 turns of No. 22 wire to produce about 500µH to 550µH.

I use GC hookup wire, which has thick insulation. Such thick insulation may not be necessary, but I wanted to be sure a CRT arc would not cause a short in my isolation transformer.

Wiring the transformer is easy. Just cut two 18-inch lengths of the No. 22 hookup wire. You can use the same color and mark one wire for the primary, but a different color for each wire is recommended. Stretch the two wires side by side and slide a core to about the center of the two wires. Make fairly tight turns around the core, alternately doing two or three turns on each side of the starting point. (All doubled turns are the same direction, but starting in the middle of the wire means less wire to thread through the core).

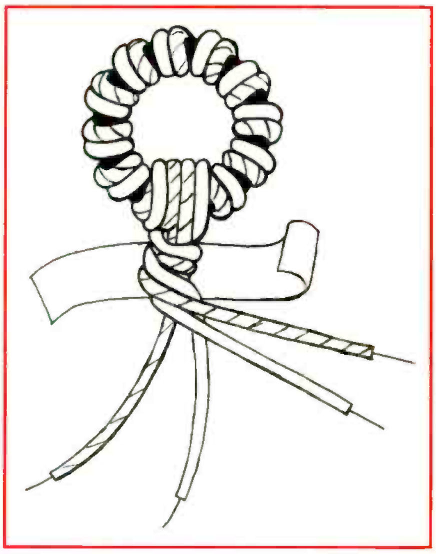


Figure 1. If you encounter a TV set with a heater to cathode (H-K) short, an isolation transformer such as this one, which you can make yourself, will allow you to restore the set to almost perfect operation.

You should be able to just fit 12 turns on the core in a single layer. Then make one more turn with each set of wires in a second layer for a total of 14 turns. Give the ends a twist next to the core and wrap a little tape around the twist to hold it together. You should have about two inches of wire left over for external hookup. See Figure 1.

I needed to answer three questions about the transformer before using it. Did it cause an excessive load on the HVT? Did it supply enough current for the filaments? Would it cause distortion of the TV's picture?

Since the voltage going to the primary of the isolation transformer is shaped like the retrace pulse that is its source, calculating the current drawn by the isolation transformer with its secondary open (no load current) would be difficult.

But by leaving the secondary open and hooking the primary to the filament supply from the HVT of a used 19-inch set, I could monitor the B+ current to the horizontal output transistor and check for the additional load current caused by the isolation transformer. I found the current increased from 0.315A to 0.316A, or 0.317A (the last meter digit fluctuated). This increase of only 1mA to 2mA did not seem excessive.

Still monitoring the horizontal output current, but with a test pattern on the TV and the contrast and brightness turned to maximum, I got a reading of 0.625A, whether the filament was powered directly or through the isolation transformer.

I was not able to see any difference in the brightness or contrast of the picture whether the isolation transformer was installed or not. This indicated that enough current was being supplied for the filaments. Of course, if there had actually been an H-K short, there would have been some slight smearing of the video due to the short.

I also checked the filament waveform from the HVT with a scope. It was a 28V pulse with a small dip in the center of the peak. With maximum brightness/contrast of the set, I could see no difference in either waveshape or amplitude whether or not the isolation transformer was installed, another indication of no excess loading on the HVT.

The point of the transformer, of course, is to allow the dc voltage of the filament to be the same as that of the cathode to which the filament is shorted so as not to pull the cathode's voltage low. So if a filament pin is grounded on the CRT socket board, you may have to cut a strip out of the foil going to the grounded filament pin. Only the secondary of the isolation transformer should hook to the filament pins. The primary of the isolation transformer goes to the filament leads from the HVT, either the actual wires, or their connections on the CRT socket board. The transformer is so light that it can be mounted by taping it to a low voltage wire from the CRT socket.

then the brightness of the shorted gun will not change. So even though the short remains, the picture is barely affected.

Ways to isolate the filament

So how can we make the other filament circuits in Figure 1 as free of dc connections as the one in Figure 1D?

In Figure 1A, the ground wire of both the filament and the filament winding of the HVT could be removed from ground and wired together. Then the circuit would be the same as the one in Figure 1D. Naturally, this removes the symptom of the H-K short, as explained for Figure 1D.

The circuit in Figure 1B could be made like the one in Figure 1D by removing the capacitor and resistor to ground and the resistor to B+. Some circuits have a resistor in series with the filament. When making modifications, be sure to leave any series resistor in the circuit.

Though circuits like in Figure 1A and 1B can be modified to isolate them, it is often both easier and quicker to install a separate isolation transformer than to modify the circuit.

In a circuit like Figure 1A, the HVT filament winding is sometimes physically grounded very close to the core of the transformer, so it's hard to splice and insulate a wire to the winding after it's removed from ground. If you decide to modify the

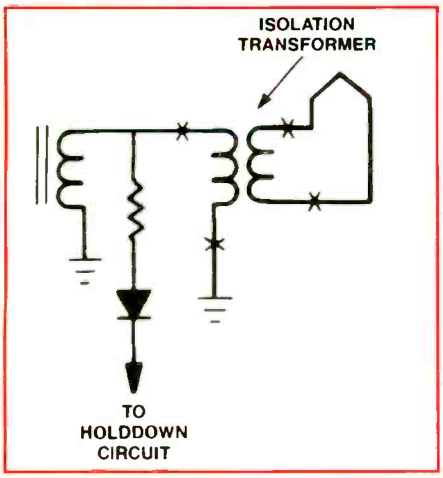


Figure 3. The isolation transformer is connected into the circuit as shown here. This allows the filament to rise to the same dc voltage as the cathode. The presence of the isolation transformer eliminates the symptom of the H-K short, yet leaves the other connections of the HVT filament winding unchanged.

circuit, be sure the result is like Figure 1D and that all splices are insulated.

Now we come to the circuit in Figure 1C. Here the transformer winding supplies another required voltage to the set. If you disconnect the ground, you will lose the other voltage source. The solution in this case is to use a separate isolation transformer to couple the HVT filament winding voltage to the filament while isolating the filament from ground.

The separate isolation transformer is simply a 1 to 1 ratio transformer which is connected into the circuit as shown in Figure 3. The secondary of the transformer has no dc connections to any other circuit, which allows the dc voltage on the filament to rise to the same dc voltage as the cathode to which the filament is shorted. Again, this eliminates the H-K short, yet leaves the other connections of the HVT filament winding unchanged.

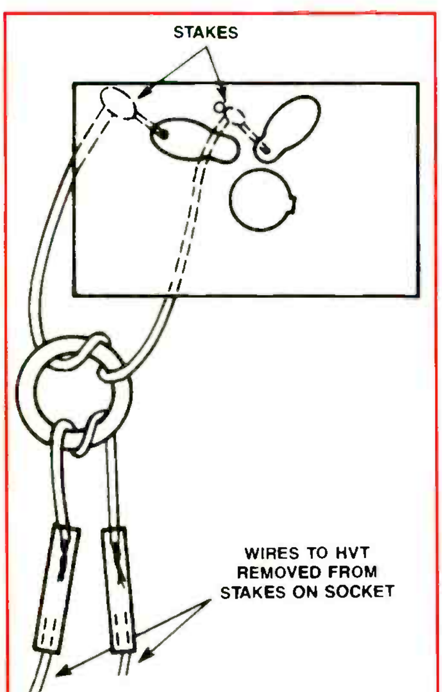


Figure 4. Connect the isolation transformer as shown here.

Confirming a shorted CRT

Naturally, no amount of CRT heater isolation will help if the CRT is not the problem. Here's how I confirm whether or not the CRT has an H-K short.

If the screen constantly stays one bright color, I check the voltages on the CRT socket pins that go to the cathodes. If one cathode voltage is low, as I expect it will be, then I shut off the power and remove the socket from the CRT. I reapply the power and again check the voltage on the socket pin that had the low voltage. If that voltage is normal with the socket removed, then the CRT is shorted. It's time to try the isolation transformer.

If the voltage at the same pin of the socket is still low with the socket off the CRT, then the problem must be in the circuit supplying that cathode voltage, often the red, blue or green output transistor, or the IC supplying base drive to it.

If the symptom is intermittent, with the screen just briefly going bright red, green or blue, then it's harder to determine if the CRT is shorting. If I have the right adapter, I check the CRT with a CRT tester. If it shows a short, then I need check no further. If a short doesn't show on the CRT tester, I try tapping gently on the neck of the CRT with a screwdriver handle. If it still doesn't show a short, the problem is intermittent and so far I haven't proved anything.

If I'm not able to check the CRT with a CRT tester, or I don't find a short using it, then I remove the socket from the CRT. When I find the socket pin of the cathode that would cause the bright screen color I've seen, I measure the voltage on that pin while I tap on the socket, the main board, and any connectors hooking the socket and the main board together.

If the reading drops, I know the problem is not the CRT. If the reading stays high, I assume the CRT is bad and install an isolation transformer. Then I let the set cook, occasionally tapping the circuit board and CRT socket. If the screen does not show the symptom in a couple of days (depending on how intermittent it was) then I conclude that it was a bad CRT.

If the symptom does reappear after the transformer is installed, then I know it is a circuit problem. But I don't remove the isolation transformer right away. A few times I've had an intermittent bright screen with both a circuit problem and a bad CRT. So I leave the transformer connected, and after I've repaired the circuit, I again let the set cook a couple of days. If the symptom is gone after the circuit repair, but then returns again after I take out the isolation transformer that I had installed, I know that both the circuit and the CRT were bad.

Installing the isolation transformer

The CRT filament in most sets made in the last twelve years or so is powered by the HVT, but if I have any doubt, I check the schematic or trace the filament wires to the HVT. The homemade isolation transformer won't work on a 60Hz powered filament.

When I'm ready to install the transformer, I remove the socket from the CRT to avoid any possible damage to the CRT. I look carefully at each foil which goes to a filament pin on the CRT socket and follow one of these two procedures:

- If the only connections to each foil are a filament pin and a stake, with each stake having a single wire attached (each conductor just ties the filament to the power lead), I remove the wire from each stake.

While the socket is off and the wires are disconnected, I double check with an ohmmeter to make sure that none of the foils have other connections. Then I slip lengths of heat shrink tubing over the wires from the HVT. I splice an end of one winding of the isolation transformer to each wire.

After I solder the splices, I use the heat shrink tubing to insulate each splice. Then I solder the ends of the other isolation transformer winding to the stakes to which the wires from the HVT were attached originally. See Figure 4.

- If either foil to a filament pin is long, or snakes around the board, it's almost a sure bet that it has other connections. If it does, I cut both foils so an area that goes to only the filament pin is on one side of each cut and hook the transformer as shown in Figure 5.

This is probably the most universal way of installing the isolation transformer and should work on nearly all circuits. Before I install the isolation transformer as shown in Figure 5, I hold the core below the CRT board and estimate if the leads will be long enough for the core to hang below the CRT socket board.

If the leads will be too short, I wind another transformer with longer leads. I want the core to hang below the board where I can tape it to one of the wires from the filament winding of the HVT, or, if that's difficult, to another low-voltage wire—but definitely not to a focus or screen grid wire.

A general H-K short solution

As long as you keep in mind that the filament must have ac voltage across its terminals, but when there's an H-K short, its dc voltage must be the same as the voltage on the cathode to which it is shorted, you should be able to hook up the isolation transformer to any circuit variation you come across. At least until some engineer totally changes the game again. ■

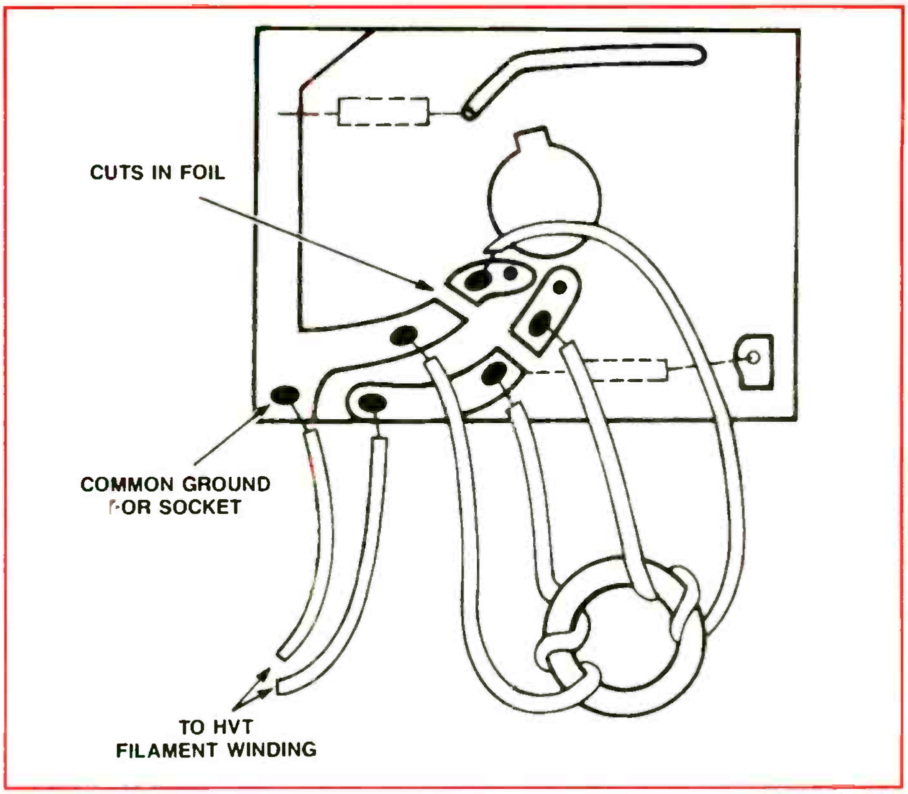


Figure 5. If either foil to a filament pin has other connections, cut both foils so an area that goes to only the filament pin is on one side of each cut and hook the transformer as shown.

Practical active filters

By Dale Shackelford

A previous article on active filtering circuits (**ES&T**, November 1992) focused on the basic concepts of the operational amplifier (op amp) as the active component within the filtering network. Because op-amp based active filters are so widely used, a look at their applications in modern circuits may be beneficial.

The three most popular active filters

While there are a wide variety of op-amp based filter designs in use, there are three that lead the field in popular acceptance, because of their unique frequency-response characteristics: Chebychev, Bessel and Butterworth filters.

Chebychev filters, for example, exhibit a "rippled" pass-band frequency response. Increasing the order of the filter, or cascading the Chebychev design results in a "roller coaster" response, which, in some applications, is desirable, but may wreak havoc in other circuits unless the passed signal is clipped at some point.

Chebychev filters enjoy the reputation of having one of the sharpest frequency cut-off slopes in active filtering circuits.

Another active filtering design is the Bessel filtering network. Like the Chebychev, Bessel filters vary gain with frequency, though due to the minute amount of voltage gain (A_v) of the Bessel circuit, they often exhibit linear phase shifts of the passband signals, sometimes resulting in undesired oscillations.

Shackelford is an independent electronic servicing technician.

In addition to requiring an extremely stable power supply, Bessel filters have the longest cut-off slope of the three popular designs.

In applications where a relatively flat pass-band signal is desired, the Butterworth active filtering circuit will provide the best results. Because the Butterworth design exhibits uniform voltage gain across the entire pass-band spectrum, regardless of frequency, they are often used as the primary filtering/pass-band amplification stage in many modern devices.

Because the Butterworth family of filters is commonly used and popular, a short review of the design and application of these circuits may prove to enhance understanding of all active filters.

Butterworth filters

As mentioned previously, Butterworth filters have a unique frequency pass band response in that all of the passed frequencies are amplified at virtually the same rate (gain). This uniform amplification is primarily the result of the closed-loop or feedback gain of the filter. In order to meet the Butterworth design criteria, the closed-loop gain of the circuit must be equal, or nearly equal, to $1.586A_{CL} = R_1/R_2 + 1$ (Figure 1).

Although this example of a first-order filter is a low-pass circuit, the same mathematical considerations must be made with all Butterworth filters, be they high-pass, low-pass, band-pass or notch filters.

Second-order Butterworth filters

In the second order (also known as two-pole) Butterworth filter depicted in Figure 2, the ratio of R_1 to R_2 is approximately 1:1.7. For example, R_1 may have a value of 10Ω, while R_2 has a value of 17Ω. In this scenario, $R_1/R_2 = 10/17 = 0.5882$. Therefore $R_1/R_2 + 1 = 1.5882$, well within the parameters of the Butterworth concept.

Of course, the actual values of R_1 and/or R_2 may be varied, depending upon the need of the circuit, but if the ratio of R_1 to R_2 is maintained, so will the Butterworth response.

Once A_{CL} has been determined, we may calculate the cut-off frequency (f_C) in much the same manner as f_C in any other filter, whether active or passive as: $f_C = 1/2\pi \times X_C \times C$, where $X_C = R$ or $X_C = R_S - R_L$, and $X_C = 1/2\pi \times f \times C$. Additionally, the overall gain of the circuit may be calculated as V_{in}/V_{out}.

Even the most effective second order filter will not exhibit the filtering/pass-band amplification qualities available from higher-order filters. As the order of the filter is increased, so is the quality of

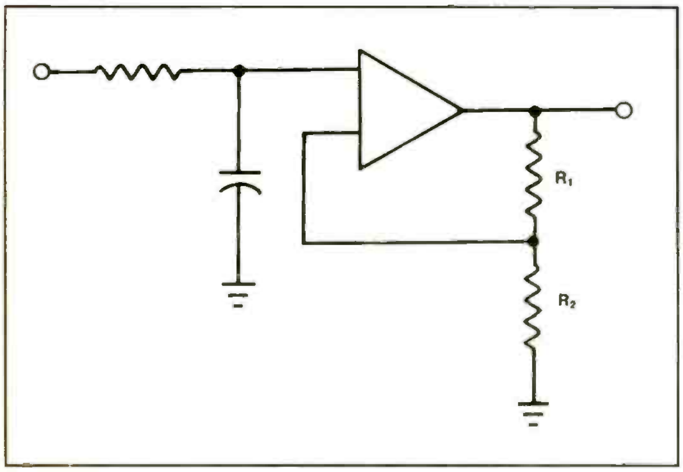


Figure 1. In order to meet the Butterworth design criteria, the closed-loop gain of a filter circuit must be equal, or nearly equal, to $1.586A_{CL} = R_1/R_2 + 1$.

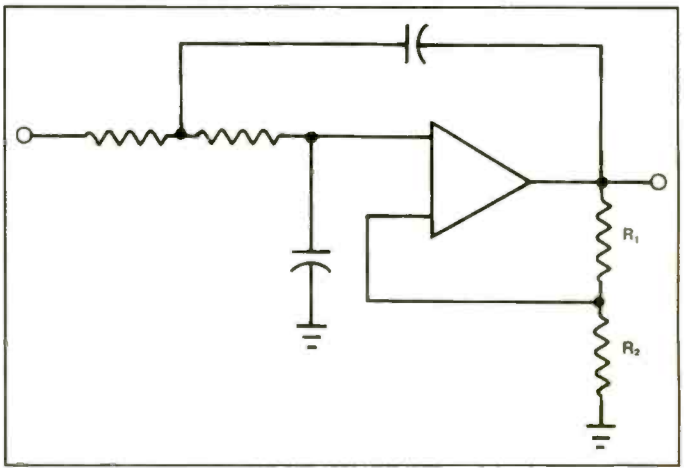


Figure 2. In the second order (also known as two-pole) Butterworth filter, the ratio of R_1 to R_2 is approximately 1:1.7. For example, R_1 may have a value of 10Ω, while R_2 has a value of 17Ω.

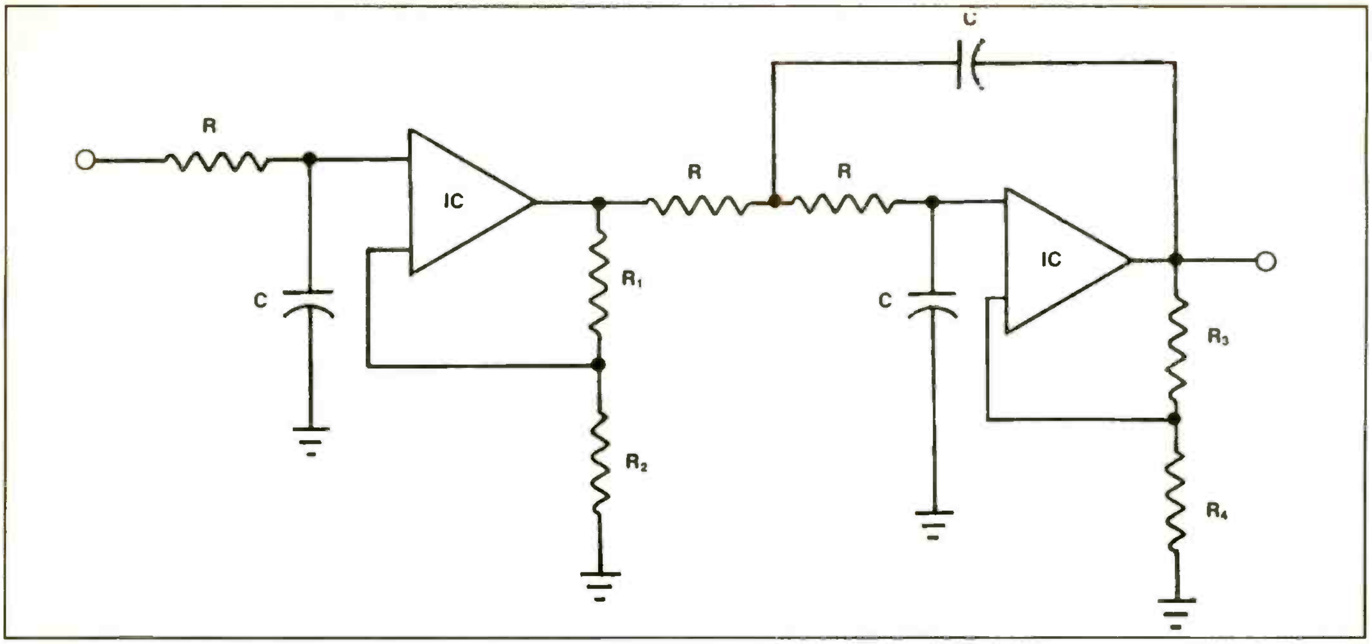


Figure 3. The second-order filter depicted in Figure 2 has been increased to a third-order filter, identified by the number of lag networks (some technicians simply count the number of capacitors in the circuit to determine the "order").

the filter in both f_C slope and passband amplification.

The third-order Butterworth

In Figure 3, the second-order filter depicted in Figure 2 has been increased to a third-order filter, identified by the number of lag networks (some technicians simply count the number of capacitors in the circuit to determine the "order").

In this configuration, the filter is still being used as a low-pass circuit, identified by the lag network. In high-pass applications (which will be discussed later), the number of lead networks will determine the order of the filter.

In most designs, the voltage gain of each order will roll off (slope) at approximately 20dB. Thus, increasing the order of the filter will result in added roll-off: a second order filter will roll-off twice the amount of voltage gain as a single order filter, but only half as much as a fourth order filter.

This roll-off is usually figured as about 20dB per decade, with the overall voltage gain down about 3dB at f_C, and 40dB per decade, (12dB) above f_C (low-pass) for a second-order Butterworth filter.

Because we have increased the order of

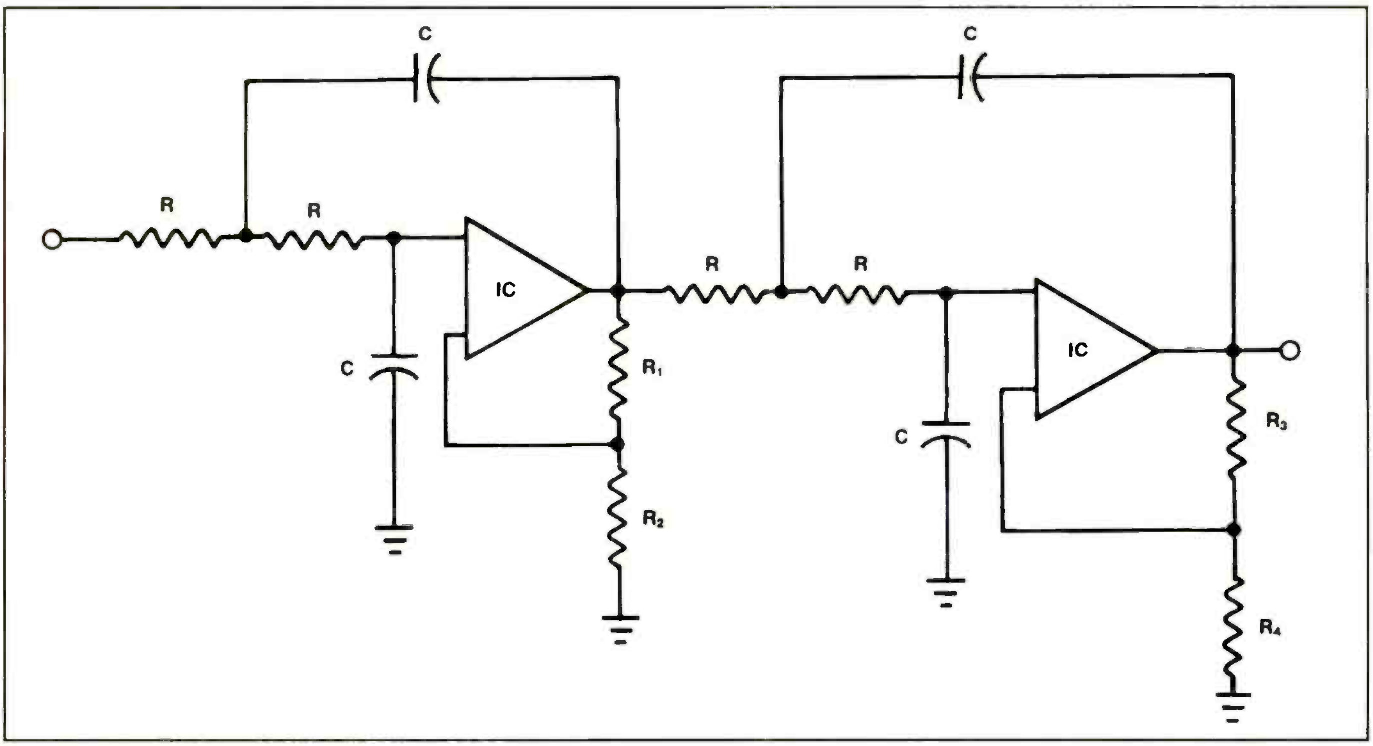


Figure 4. Adding another pole to a third-order filter makes it a fourth-order network. Notice that this fourth-order Butterworth filter is nothing more than two separate second order filters which have been cascaded to form a single circuit.

Products

Portable digital storage/ analog scope

The new *B&K Precision* model 2522A combines the flexibility of a DSO (digital storage oscilloscope) with the versatility of an analog oscilloscope.

Like other digital storage oscilloscopes, the unit can freeze and greatly magnify waveforms for closer inspection. Digital display modes include roll, refresh, hold, save CH2 and pretrigger storage. It offers 20 megasample/second real-time sampling on each channel, enabling transient waveforms to be stored with resolution to 10µS/division. The scope has an equivalent time sampling bandwidth of 200MHz for repetitive waveforms.

It also provides full 20MHz dual-trace analog scope operation. Features include up to 1mV per division vertical sensitivity and V-mode for viewing two signals unrelated in frequency.

Digital mode operation includes X100 time/division ranges to extend sampling time to as much as 50 seconds per division (500 seconds per screen). This permits viewing of slow events not possible on an analog oscilloscope. Stored waveforms may be further expanded X10 for closer examinations.

Circle (58) on Reply Card

CFC-Free electronic equipment cleaner

Chemtronics introduces CFC-free Tun-O-Wash, a non-CFC solvent that quickly cleans, degreases and removes oxidation from electronic equipment. The product is useful for washing down VCRs, cleaning controls and relays, as well as for flushing PC boards and motors. The product contains no ozone-depleting compounds and is formulated to meet the stringent regulatory requirements of the 1990s.

The cleaner is engineered with a very low surface tension for deep penetration into inaccessible areas, cracks and crevices. Once applied, its self-cleaning action effectively penetrates to loosen and wash away oils and oxidation particles, then evaporates instantly. The product is available in a 12.5 oz. aerosol container (ES2400).

The manufacturer provides environmental impact data for all its products as a part of its Environmental Impact Program, designed to help chemical users evaluate both performance and environmental impact to make the best overall choice for their use.

Circle (59) on Reply Card

(Continued on page 68)

No. of Poles	Roll off (Decade)	First Section (Single/Double)	Second Section (Double Pole)
1	20	Optional	
2	40	1.586	
3	60	Optional	2.000
4	80	1.152	2.235
5	100	Optional	1.382
6	120	1.068	1.586

the filter from a two- pole to a three-pole (third order), we must recognize the cumulative loss of voltage gain at f_C that will occur if the closed-loop gain of the second order remains at the 1.586 voltage.

It is therefore imperative that this loss be compensated, otherwise the loss of the second section will adversely affect the desired flatness of the passband signals.

By increasing the A_{CL} of the second section, we can maintain the Butterworth response of the filter, with the gain down 3dB (70.7%) at f_C. If both the second and third sections of this filter were to have an A_{CL} of 1.586, the overall gain would be down 6dB; 3dB per section.

The fourth-order Butterworth

Figure 4 depicts a third-order filter with the addition of yet another pole, making it a fourth-order network. Notice that this fourth-order Butterworth filter is nothing more than two separate second order filters which have been cascaded to form a single circuit.

Again, if we were to calculate $1.586A_{CL}$ for each second order section, the overall voltage gain would once again be down 6dB at the frequency determined by the formula $f_C = 1/2RC$. By using different gains for each second-order section, we can strike a balance that will provide a maximally flat response.

In the fourth-order circuit illustrated, the first second-order section would typically have an A_{CL} of approximately 1.152, while the second second-order section would have an A_{CL} of approximately 2.235.

Just like the low-pass circuits previously illustrated, high-pass Butterworth filtering circuits use the A_{CL} of the feedback loop to control the passband frequency response, as are the calculations for f_C, A_{CL}, and the optimum voltages for each "order" given in Table 1.

The only difference between the high and low pass Butterworth active filtering circuits is the use of lead and lag networks (Figures 5 A and B). Note that the lead network in and of itself is a high-pass (though passive) filter, and the low-pass lag network is very similar to the construction of a very basic passive system. Often, circuit designers will construct elaborate passive filters in place of the lead and lag networks shown.

Butterworth band-pass filters are simply high and low-pass filtering networks which have been cascaded, with each of

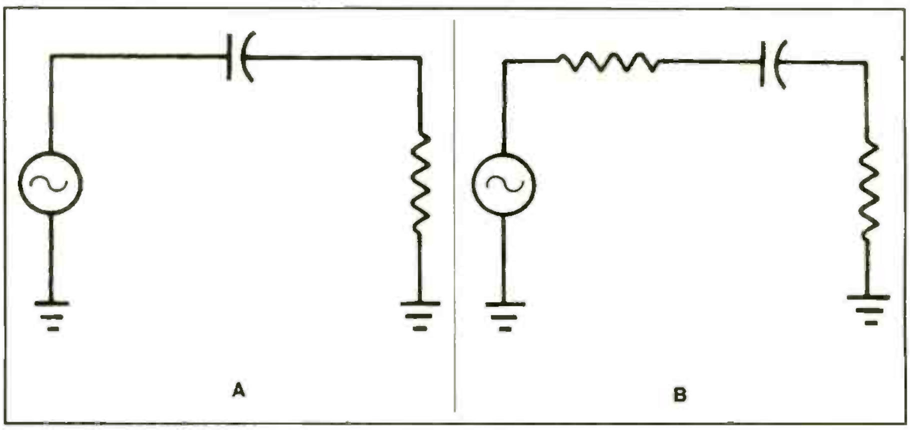


Figure 5. The only difference between the high- and low -pass Butterworth active filtering circuits is the use of lead and lag networks (A and B). Note that the lead network in and of itself is a high-pass (though passive) filter, and the low-pass lag network is very similar to the construction of a very basic passive system.

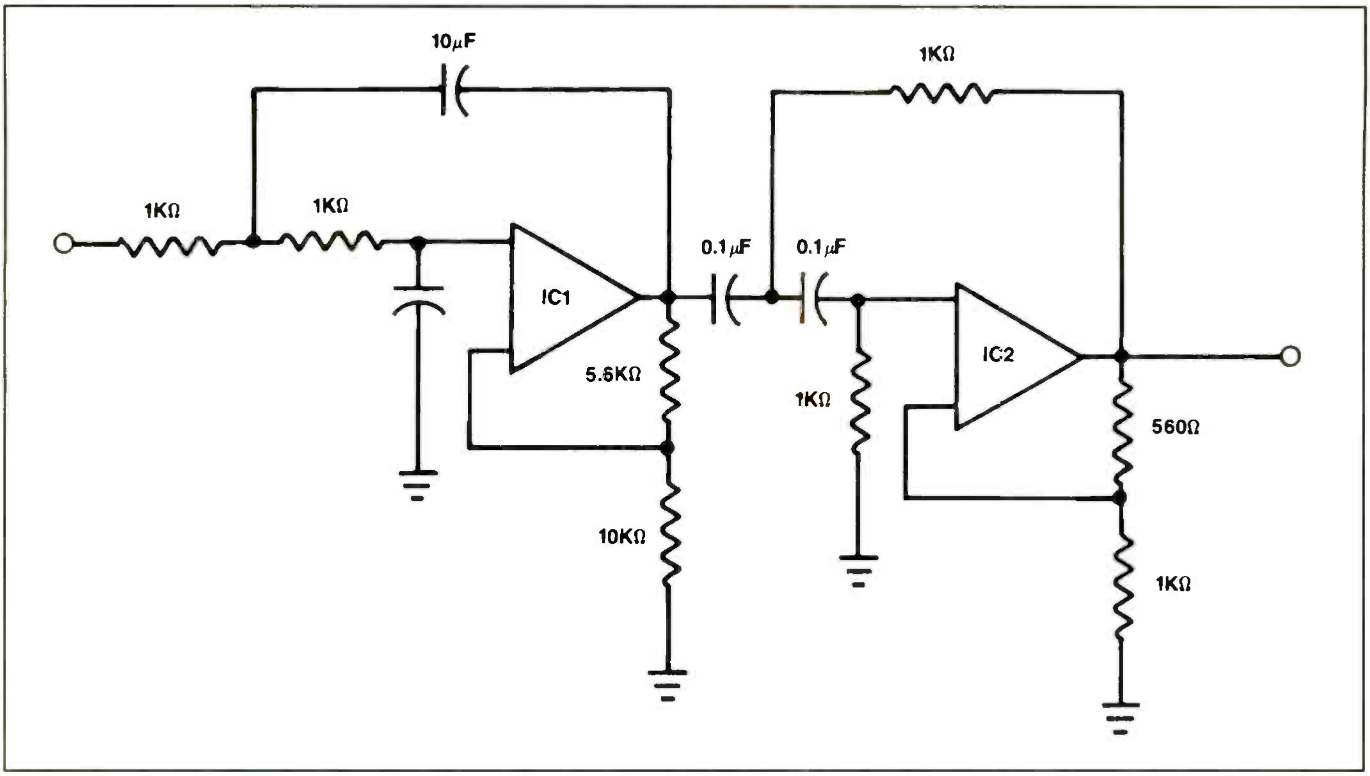


Figure 6. This practical Butterworth band-pass filter may be used in any number of applications. Simply inverting the positions of the high- and low-pass circuits will result in a notch filter, a filter which will have the same value of upper and lower f_C in either configuration (f_{CU} = 15.9KHz; f_{CL} = 796Hz).

the two types having an equal number of orders from one to six. One of the drawbacks to this configuration however, is that the upper f_C must be at least 10 times higher than the lower f_C, as is the case with Butterworth design band-rejection (notch) filter.

A Butterworth band-pass filter

Figure 6 is a practical Butterworth band-pass filter which may be used in any number of applications. Simply inverting the positions of the high- and low-pass circuits will result in a notch filter, a filter which will have the same value of upper and lower f_C in either configuration (f_{CU} = 15.9KHz; f_{sub}CL = 796Hz). Both designs allow for the flattest passband signal response possible at this point in our technology.

As should be obvious, the closed-loop voltage gain of the active filtering circuit may be varied to meet specific needs in regard to signal output response. Equalizers used in modern reproduction equipment, for example, may well benefit from the midband response of the Chebychev circuit, while the Bessel design may be used as a unity gain filter. Regardless of their current uses, however, the parameters of active filtering circuits have yet to be defined. ■

Test your electronics knowledge

Answers to quiz

(from page 27)

1. B. It is called a *super*heterodyne receiver because heterodyning takes place in the mixer (or, converter) *and* in the diode detector.

2. A. See the answer to question #1.

3. D. By definition.

4. Only the two frequencies introduced at the input will appear at the output. In a perfectly linear device, no mixing of signals takes place.

5. Astable, Bistable, Monostable and Schmitt trigger.

6. B. Enhancement MOSFETs must be forward biased like bipolar transistors.

7. 45. I am trying to make a point here. Epsilon (Œ, or, e) is an irrational number. It has no continuous recurrent number patterns that reach to infinity.

8. If you have solved this we are famous! Don't tell anyone else how you did it! Send details of your solution directly to me! Mathematicians have been working for hundreds of years on this problem and *they can't solve it*! The problem is called *squaring a circle*.

9. A piece of wire will do it. However, I know I would get nasty letters for that answer because some people do not call a piece of wire a component. So, use a large fuse.

10. On the equator, or, ten miles north of it. ■

Applying lateral thinking to troubleshooting

By Ron C. Johnson

One of the problems with learning to troubleshoot electronic equipment is the gap between theory and practice. Those of us who have done significant amounts of troubleshooting know that making the connection between "the way it's supposed to work" and "the way it's working right now" is one of the major headaches we have to overcome.

Today I'm an instructor, but I used to survive by servicing whatever came through the door of my own business. As such, I'm acutely aware of the problems involved in teaching how to use technical knowledge in practical ways.

Why do we struggle to link the "head knowledge" with the hardware? Is the problem actually that circuits don't really work the way the theory says they work? Partly, maybe. Or are we not analyzing them properly? Can we take it for granted that understanding the operation ensures troubleshooting success?

I don't have a definitive answer on this. One problem I do see, though, is that we often don't have the right mix. What I mean is: We need both: an incisive attitude, or sense of troubleshooting direction, and a knowledge of theory that extends beyond an understanding of how individual components work. I've also come to believe that the idea that troubleshooting is a linear, logical process, is only partly true. Allow me to illustrate.

Johnson is a journeyman electronics servicing technician and an instructor of technology at the Northern Alberta Institute of Technology in Edmonton, Alberta, Canada.

Approaching the problem

My first real electronics job was testing and repairing digital telecommunications equipment in a manufacturing plant. We repaired the same boards day after day and were expected to repair a minimum number in a given amount of time.

The boards came to us after being assembled and tested. By the time they reached us they were known to be faulty. We would immediately open up the module and start testing, eventually replacing the components necessary to make them operational.

After repairing a few dozen boards, patterns started to emerge: shorted transistors, cold solder joints, defective IC's. All of this was pretty straightforward stuff.

By comparison, my next job was in an industrial plant: many kinds of equipment in various locations, doing a variety of functions. In the shop I had a stack of controllers, transmitters, etc. that had been removed from service, supposedly faulty.

My first impulse was to pull the schematic, analyze it and then proceed to open the module up and start testing using meters, scopes and other test equipment. Wrong move. Often after an hour of analyzing and testing I found that there was no problem with the module; it had been removed by the tech on night shift in hopes of curing a problem, but the problem was elsewhere.

This situation called for a different approach: read the work order, question the operator and technician who removed it, power up the unit and milk the controls, etc. Once a problem is established, go on to analyze and test.

Making the connection

Well, that still doesn't answer the question of the gap between theory and practice in terms of actual circuits. Why does that gap exist? One thing I've noticed

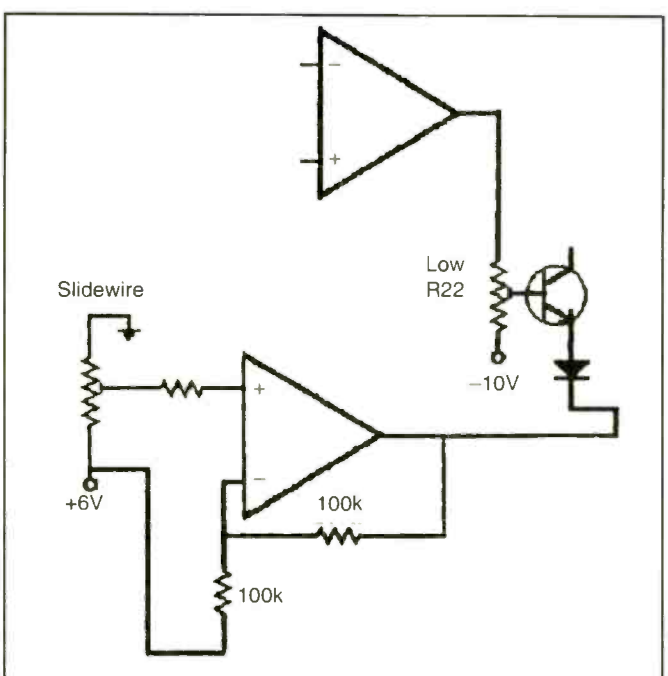
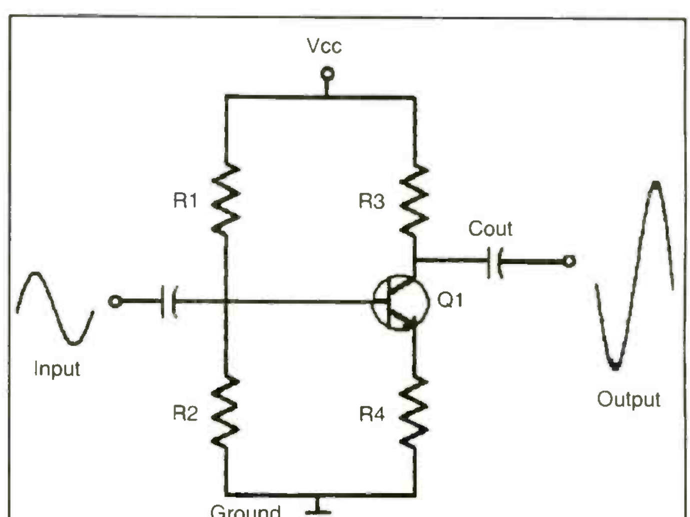


Figure 1. Partial Schematic of a Recorder circuit.

Figure 2. A typical transistor amp.



about text books, course materials and even many magazine articles (I must include some of my own in here, unfortunately) is that they deal with basic circuit configurations but never link them to real circuitry.

Don't get me wrong; the basics are very important. If you don't know how an op amp, for example, works, you will have problems understanding it within the context of a larger circuit. But op amps are a fairly good example of how this problem actually occurs.

In my classes I teach all the basic op amp configurations, their gain formulas, which ones invert, which ones don't, etc. I talk about the offset inherent in the chip, common mode rejection ratio and slew rate (how fast the output can change voltage).

A few weeks later in the course we look at a real chart recorder circuit which uses a non-inverting op-amp configuration. But in this configuration, the voltage divider (which sets the gain) is not connected between the op amp output and ground; it is connected between the output and a positive 6V supply (see Figure 1).

Making this circuit still more alien is the fact that it is drawn in a different way than the students have usually seen it. And, to add to the confusion, there are extra resistors in the inverting and non-inverting input leads. Often the student takes one look at the schematic and gives up.

Overcoming human nature

The problem here is not that I don't teach the students all of these things. I discuss all the basics. If they have learned the basic theory well enough, and perhaps have done extra reading, they would be able to figure it out for themselves.

The problem is human nature. Often, when confronted with too many new variations from the original, our tendency is to be overwhelmed and to back away from the problem. We give up before we get started.

For the record, the truth in this situation is that the six volts connected to the voltage divider causes a negative voltage offset on the output of the op amp, and this can be easily determined by analyzing the circuit operation.

The resistors in the input leads are input bias current correction resistors, added to minimize offset; very common in real circuits. As for the way the circuit is drawn; redrawing that part of the circuit by itself will quickly show up the familiar configuration hidden in the larger picture.

The point is, a knowledge of theory, coupled with a tenacious will to understand, will go a long way toward linking the basic theory to the actual circuitry on a schematic. From there, predicting the voltages and waveforms is much easier than before.

Understanding the fault

Armed with a fairly clear picture of how the circuit should work, and test data on how it is actually working, we can move toward finding the source of the problem. Here, an understanding of how components fail can be helpful.

For instance, in the manufacturing plant where I first worked it was not uncommon to find resistors on the board that measured other than the value marked on them. They were simply marked wrong at the factory where they were manufactured. Also, I sometimes found the wrong resistor installed on the board.

Neither of these situations is typical for consumer electronics equipment that is brought in for repair by a customer. We have to assume that the equipment has been operational at some point in time.

Since resistors simply do not magically change value, we can almost rule out failed resistors as a typical fault. (There are a few exceptions to this rule, however. Older tube circuits, in which higher voltages and heat played a more important role, were prone to resistor failures. Also, sometimes power resistors open up or change value due to excessive heat dissipation, but these are fairly rare cases in my experience.)

Understanding component failure

So, with experience we learn more about how components fail. Electrolytic capacitors sometimes short out; bipolar transistors short from collector to emitter or open from base to emitter; op amps get stuck at one rail or the other, etc.

Knowing that an output transistor is likely to fail by shorting the collector to emitter, for instance, helps understand the test information. Figure 2 illustrates this. We know the sine wave on the input of the amp should give a larger and inverted sine wave on its collector. When we see a dc level on the collector, and the emitter is at the same voltage, we know that the collector and emitter must be shorted.

We've all experienced the cold or cracked solder joint. Not a component fault, but a common source of circuit failures. Often these show up as intermittent and can be cured without understanding the operation of the circuit at all by tapping on the printed circuit board and observing the symptoms. Sometimes bad joints can be identified by sight or through a magnifier but other times resoldering all the joints in the area is the fastest cure.

Thinking your way through

So far we've covered several steps: we've established that the equipment really does have a fault, then determined (as well as possible) how it is supposed to work, observed its current symptoms, and finally, compared what we know so far, in light of past experience such as known types of failures.

Chances are, if you have extensive experience with the equipment, you will identify a common fault and then repair the equipment immediately. But sooner or later all of us come across those frustrating problems that go beyond our training and experience.

Really, it's at this point that the difficult aspects of troubleshooting occur.

This is the situation I referred to earlier when I said that the idea of troubleshooting as a linear, logical process is only partly true. Again, I'll use an experience of my own to illustrate.

A few years ago I was taking a university class on adult education; adult development, to be more exact. I was looking for information on how adults solve problems when I came across some interesting information by Edward DeBono; an educational psychologist, I believe.

DeBono maintained that the thought processes which we use to solve problems are the same ones that are used in creating and understanding humor. Most humor, when you examine it closely, is just a matter of looking at a familiar aspect of life from a new perspective, a different point of view.

DeBono went on to talk about effective problem solving by approaching situations from different perspectives. The whole idea developed into a fairly deep thesis on the concept of lateral thinking. I tried to apply lateral thinking to troubleshooting and found some interesting correlations to real life.

Using lateral thinking in troubleshooting

We generally think that troubleshooting is a linear, or vertical thinking process. You start at the beginning, and pursue the

Audio Corner *(from page 67)*

the projection booth I left my Hills Brothers antenna and followed the coax back. In the booth, the mic worked perfectly with no sign of any interference. I later learned that this is a common problem in Las Vegas. Techs even use miniature Yagi type antennas to eliminate signal drop outs caused by interference.

This problem would affect the remote repeater as well

Now I was starting to think that I would have the same problem with the remote repeater. The IR transmitter unit was placed about ten feet from the podium allowing a 30-degree acceptance pattern on both sides of center. Watch out for daylight and interference from quartz spot lights. Both can cause IR crosstalk and can blank the remote's transmission.

In the projection booth I mounted the IR repeater translater receiver in the back corner near the ceiling. The beam operated both units thanks to the mirror. When the interference problems that I had anticipated did not surface I was delighted.

Time for the demonstration

The library board came in and took random seats in the theater as I used the wireless mic to demonstrate complete remote operation from the podium. I powered up the video projector, turned on the VCR, started, paused and stopped the video tape. For an encore, I mode switched the VCR to access a cable TV program. The board was delighted. My check for the balance came in the mail without delay.

Conclusion

With consumer electronics sales and service becoming less profitable, it's time to explore commercial electronics. My library story is an example of a profitable project that was fun.

My next project will be a sports bar. Television started in the bars, saloons and taverns and it's coming back. This time it's with big bucks installation complete with a satellite dish and multiple monitors. The bar has gone high tech. Sell now.

Learn how to bid successfully. Don't sell the worth of your time short. Price becomes less of a factor once you establish a can-do reputation.

WDYKAE *(from page 65)*

that number into 1.0 you get the number of electrons per coulomb. It comes out to 6.24×10^{18}.

The *approximate* value of charge for the electron is 1.6×10^{-19} coulombs. *If you use that approximate value you get the often-seen 6.25×10^{18} number.*

I have trouble imagining a number like that. Maybe we can count the electrons.

You know that when one coulomb flows past a point in a wire in one second the current is 1 A. Suppose scientists have devised a counter that can actually count the number of electrons flowing past a point in a wire. Using the test setup of Figure 3, the current is adjusted to 1 A.

Assume the counter can accurately count one million electrons per second, and it can do that 24 hours a day, 7 days a week, and 52 weeks per year. How long will it take the counter to count 6.24×10^{18} electrons?

First, determine how many electrons can be counted per day at the rate of one million electrons per second. Observe the way the units are cancelled to get electrons per day (see Figure 4).

In future issues we will look at some other units of measurement. ■

fault step by step toward its solution. Eventually, you find the source of the problem and fix it. The truth in real life is much different, if you think back on some of the repairs you have made.

You start out to determine the problem only to find that the symptoms reported are incorrect, so you test the operation to see what the symptoms really are. Next, you look for technical information on the equipment. Sometimes it is available, other times it isn't, or must be ordered.

This kind of process continues into the actual testing process. You try to get the information using a meter but the voltage is borderline, and varying slightly. It might be acceptable, but the information is inconclusive.

You back up and try again using another piece of test equipment, your oscilloscope, perhaps. You find noise riding on the dc voltage. Where is it coming from? How do you find out?

Instead of pursuing the problem from this point you have a flash of insight. You turn off the power and replace a module with a known good module. It still doesn't correct the problem.

You then check the power supply capacitors with a tracker type instrument; a capacitor seems leaky. You remove it and check it on a capacitor tester. The process continues with still more tests.

In this scenario you have approached the problem from several angles. The possibilities are as endless as your ability to look at the situation from new points of view. You move toward the problem; a linear, logical process; until you are stopped by an obstacle, whatever it is. Then you move sideways, or laterally; a more intuitive process of creating new ideas or approaches to the problem. You then attempt to move forward again. Eventually you are successful, and each success develops your skill and confidence in the method you are using.

All of this might sound a bit esoteric for the practical, service-oriented person but I suspect that the more we think about it the more we'll see that it's true: the best troubleshooters combine logic and intuition to solve those difficult problems.

In the same way that we see humor by looking at situations from a new perspective, we see possibilities for success in new approaches to technical problems. And I suspect that it's the same approach that helps us make the leap from the theory of schematics to the reality of faulty equipment on our benches. ■

Will total quality management work for you—Part 2

By John A. Ross

In Business Corner last month, we began looking at the management theory called Total Quality Management. As Deming's Point 1 shows, an organization that maintains a consistent commitment to purpose has a better chance of achieving success. The second facet of Total Quality Management tells us something new about maintaining that purpose.

TQM Point 2

Adopt the new philosophy. Management must awaken to the challenge, learn their responsibilities, and take on leadership for change.

Point two says that the responsibility for making TQM an organizational priority rests with top-level managers and the owners. The use of Deming's management theories and his conclusions about quality can only occur through organization-wide acceptance of TQM. Indeed, Deming urges workers to "Build quality into the product from the start" and to have "pride-in-workmanship."

Interestingly though, employee acceptance of TQM begins with worker empowerment. That empowerment originates with the top-level management acceptance of TQM and the providing of resources, education and training for all employees.

Why should upper management or ownership care about making TQM an organizational priority? Well, the very simple answer is that without a firm commitment from the top, attempts to achieve Total Quality Management will fail. A quick story gives this statement added emphasis.

When top managers don't support TQM

An acquaintance of mine, let's call him "Stan," works as a mid-level manager in a large electronics service and sales business. After attending a management conference, Stan became intrigued with the Total Quality Management concept and began to devise methods for implementing the theory. Some of the methods were making quality control checks during the repair process, improving customer scheduling, training and sending completed task checklists to the customer.

To Stan's surprise, his employees enthusiastically accepted the new ideas. Indeed, during a staff meeting, several employees presented ideas for improving his original suggestions. Almost immediately, the ideas were implemented and resulted in a positive customer response.

However, when Stan presented his managerial changes to the ownership, he did not receive the same expected, positive reaction. One of the owners criticized him for acting without their consent. The other complimented my friend for attempting to improve the company but cautioned him against making dramatic changes. While both later endorsed Stan's ideas, the endorsements were lukewarm.

For a time, Stan's changes bore fruit. Employees dutifully followed the new procedures and, interestingly, their morale improved. After failing to win any compliments from the ownership for higher quality workmanship, though, a few employees began to stop adhering to the procedures.

When Stan cautioned the employees about their actions, they reminded him about the lack of confidence the owners shown in the procedures. Although the owners had endorsed Stan's ideas, they did not fund training or additional resources for the employees. The beginning steps towards Total Quality Management slowly stalled and then disappeared.

Why TQM didn't work without management support

Stan's story tells us several things about why TQM has to be a priority with upper management. Unless the responsibility begins with upper management, TQM can never gain the status needed for its success. Employees will view procedural changes aimed at achieving Total Quality Management as another production-oriented ploy by management.

Also, Stan's predicament shows the value of informing upper managers about procedural changes before their implementation. Quite possibly, the owners might have fully endorsed the changes had they been given the chance to claim some responsibility for the changes.

Finally, the story emphasizes the importance of trusting the abilities of all employees. Without the owner's wholehearted backing, Stan implicitly lost not only their trust but also the trust of his employees.

Adopting this new TQM philosophy involves trusting in the abilities of your employees and taking on all the responsibilities of leadership. Allowing your employees to have access to the resources and the training needed to properly complete their tasks is a major step towards instilling quality in the workplace. Trusting the knowledge and judgment of those employees builds loyalty, eliminates second-guessing and begins the building of pride-in-workmanship.

Accepting responsibility

Every organization and every individual goes through difficult times. For example, all of us have encountered angry customers. Whether the customer is right or wrong, passing the buck during those times and allowing employees to take the fall is the easiest and most destructive way out. Looking good at the expense of your employees causes long-term problems within the organization. Often, leadership means taking responsibility for problems and standing steadfastly behind your employees. ■

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

The unusual Magnavox problem solved

By The Readers of ES&T

In the June issue of **ES&T**, we published an article by Homer Davidson entitled "Servicing an unusual Magnavox TV problem." The problem was described as follows: "In my years of servicing television sets, I have never seen another set with the unusual symptom that I encountered in this Magnavox T815-02AA chassis. The screen showed a half-circle image at the top center. The circle was darker at the bottom and lighter at the top. The remainder of the screen was black."

"The CRT was bad and required replacement."

Davidson went on to describe another unusual aspect of the symptom: "The CRT arrived within a week and was installed at once. When the set was turned on, the same half circle was still at the top of the screen. Off and on they checked circuit after circuit with no results. They did notice when the red lead of the yoke was removed the pulsating action stopped. Then one morning while the technician was working on the set, he heard a light snapping sound and the neck of the picture tube dropped off, including the yoke assembly (Figure A).

"Inspection of the neck of the picture tube revealed that the glass had broken above the area where the new gun assembly had been attached in the rebuilding process."

The article went on to say that another replacement picture tube was installed, and again the same strange raster appeared on the screen, and ultimately the picture tube neck broke.

Eventually, Davidson traced the problem to faulty components on the vertical module: a burned resistor, a diode that had overheated and become leaky, a leaky transistor, and an open coil. Davidson replaced the transistor, diode and resistor and rewound the coil and replaced it in the circuit. This restored the set to normal operation.

The article concluded: "I'm still wondering what the half-circle had to do with a defective vertical section?

"I can understand the motorboating or oscillating of the half-circle, maybe caused by the leaky parts in the vertical section, from flyback to the vertical yoke section. But how does the failure of the vertical section produce a half circle? I also wonder why both picture tube necks broke above the gun assembly."

The mystery solved

Thanks to a number of readers who wrote or called in response to the questions raised by that article, we now know what caused the strange looking raster, and what caused the necks of the picture tubes to snap.

Here is what Mr. Jerry M. Rains of Ford Electronics in North Little Rock, Arkansas had to say:

"Homer.

"I enjoyed reading about your problems with the Magnavox T815 chassis with the half circle at the top. I have been warranty authorized on Magnavox since 1977 and I have seen the white half-circle at the top of the screen several times.

"The half-circle is caused by the CRT beam being deflected into the neck of the tube by a failure of the vertical circuit. It then reflects off the bell of the CRT and bounces onto the screen. Although the

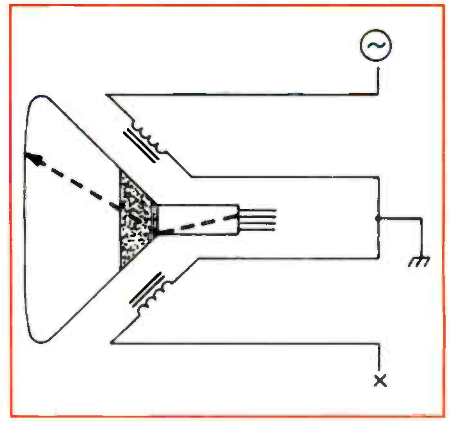


Figure 1.

Figure A.

beam can theoretically go up or down, in all of the failures I have seen (about 10) the beam was deflected upward.

"Usually it was just a whitish glow and not well defined like it was in your story, and often there was no discernible glow, only a no-raster situation. We got to the point where any time we had no raster but had high voltage we would first remove the vertical module to see if we got a 'service line.' If we did, replacement of the vertical module always brought the picture back.

"In October of 1979, Magnavox published a service tip about this problem and also linking a loss of RGB collector voltage to it. I never saw a failure of a tube due to the RGB problem, though. I have enclosed a copy of this service tip.

"What has puzzled me, and I am sure many of your readers, is why the original CRT's neck did not break off also. I have a theory that I am pretty sure is correct.

"The G2 voltage on the T815 chassis averages 1100V and can go as high as 1300V. According to your story, the G2 was excessive when you finally got the picture back on. My experience has been that the CRTs in the T815 chassis wear out in 3 to 5 years if used heavily due to the high G2 voltage. I suspect that the original tube was weak and had insufficient beam current to crack the neck. However, the new tubes had plenty of beam current, which caused their failure."

Figure 1 is a concept drawing sent in by Phillip M. Jones, CET, of Virginia to go along with his explanation of the same phenomenon.

We would like to thank Mr. Rains and Mr. Jones, and the following other readers who sent in their explanations and comments:

- Star Lockwood of Lockwood TV & Stereo in Omaha.
- Robert J. Meigs of PTL TV & Video Service in Webster, NY.
- Edward Dupart of New Castle IN
- Gerry McGinty, of Mattituck, NY

We also received several phone calls from readers who commented on the same subject.

Thanks to all of you for taking the time and putting forth the effort to enlighten us and your fellow technicians.

Here's what the Magnavox service tip said

This is a direct quote from the Magnavox Service Tips bulletin, Issue No. 5, October 1979.

T815 color TV chassis broken picture tube replacement.

If you encounter a picture tube that is broken in the neck area, proceed as follows so the replacement tube will not be damaged in the event of a chassis fault.

1. Replace picture tube, but do not connect CRT socket board.
2. Disconnect CRT focus leads at tripler.
3. Turn on set and measure each of the RGB output collector voltages at W3, W4 and W5 of the CRT board. They should each be about +180V. Measure the vertical output dc voltage at pin 5 of the yoke plug on the pincushion module. This voltage should be 0V ± 3V.
4. If the vertical output or any of the RGB circuits do not check OK, the fault must be corrected prior to energizing the new picture tube. ■

What do you know about electronics?

Conversion factors

By J.A. Sam Wilson, CET

Here are some conversion factors for the worked problems in this issue:

If the area of a square is x square meters, then, the length of one side of the square—in meters—is the square root of x.

Number of meters x 3.28 = number of feet.

Number of feet ÷ 5280 = number of miles.

All calculations are rounded to 3 significant figures. Thanks to Ken Muncey for double checking the calculations.

Understanding those basic units

When you first started to study electronics you were introduced to some important units of measurement. If you studied at a typical school you learned much of your basic theory through models. We have talked about this before. By models I mean *explanations of what is happening in a component, circuit or system by using easy-to-understand analogies that are not exactly correct in the scientific way of looking at things.*

As an example, it is not uncommon for a beginning student to be given a word-picture of electric current. The student is told to imagine current as a flow of electrons passing through a conductor. Sometimes a film is shown in which the electrons are illustrated as tiny red balls marching in unison through a wire.

Let me say this again, as I have said it many times before: *There is nothing wrong with starting your study with models.* The sad part is that students aren't always told that they are models and that they would have to be modified when the subjects are studied in greater depth.

A closer look at the farad

There is another subject I want to discuss with regard to early studies of theory. It sometimes happens that units of measurement are given without an explanation of the real meaning of those units. Don't blame the instructor for that. Remember that teaching beginning theory is an extremely difficult job because the instructor has to start everywhere at once.

However, now that you are working in the field you can afford to take a more leisurely look at some of the units of measurement. By doing that, you can fine-tune some of the basic ideas. That is one purpose of the stories I tell in this issue.

The one-farad parametric dc generator

If you have been reading this column you know that moving the plates of a charged capacitor farther apart will cause the voltage across the capacitor to increase. That is the way a parametric amplifier works.

The signal to be amplified is delivered across the capacitor. Just as the signal voltage reaches its peak value the capacitor plates are moved farther apart. That raises the peak value of the signal voltage, so, amplification takes place.

Using this information, a brilliant young student named M. Nott decided that this would be a cheap and easy way to get the 120Vdc needed for one of his school experiments. He would charge a very large 1F capacitor to 1V, then move the plates apart to get the needed 120V. (See Figure 1.)

Wilson is the electronics theory consultant for ES&T.

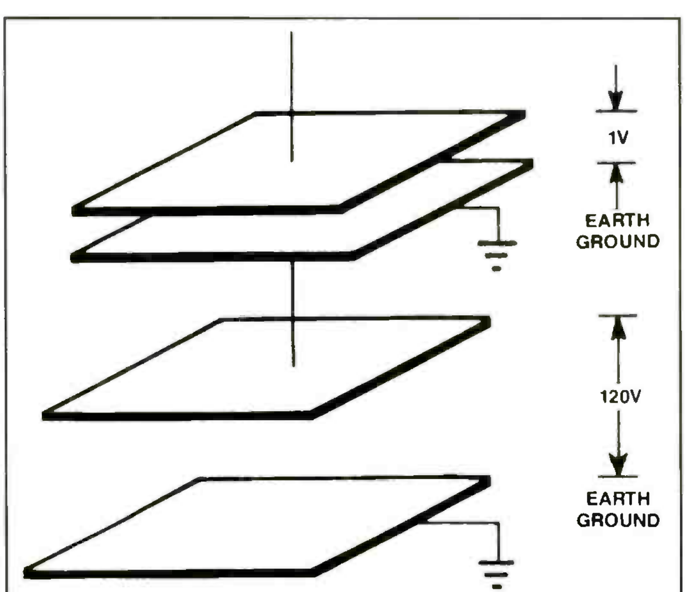
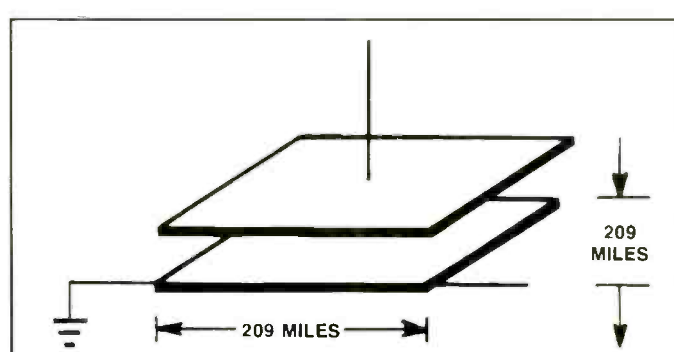


Figure 1. Increasing the distance between the plates of a charged capacitor increases the voltage across the capacitor.

Figure 2. In order to build a flat plate capacitor of 1F using dry air as a dielectric, you would have to make the plates 209 miles by 209 miles.



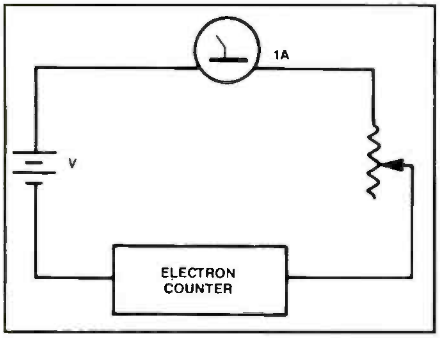


Figure 3. If you had a counter that could count electrons that pass through it, and it could count one million electrons per second, it would take almost 198,000 years to count the number of electrons in one coulomb.

The reason that this student wanted such a large capacitor was to get a very long discharge time.

There is another good reason for using the 1F capacitor. Physics books tell us that a 1F capacitor with a stored charge of one coulomb has 1V across its terminals. That makes the design of the capacitor very easy. We will assume that the dielectric is air because air has a dielectric constant that is approximately the same as that of a vacuum. That's a good approximation considering the dry air in the place where M. Nott lives. (The equations in this section assume the dielectric is a vacuum.)

Let's help M. Nott with a little elementary math. After all, he has only been studying for one month.

I am using one of my favorite physics books for reference: Complete University Physics by Sears and Zemansky. That book defines the capacitance of a capacitor by the equations:

$$C = (\epsilon_0)(A/S)$$

where C is the capacitance in farads, A is the area of one plate in square meters, s is the distance between the plates in meters, and, ϵ_0 is a constant of proportionality that depends upon the material used for the dielectric. In our case, (using the MKS system) $\epsilon_0 = 8.85 \times 10^{-12}$.

Solve the equation for A to get:

$$A = CS/\epsilon_0$$

If you plug in the values given for M. Nott's capacitor you find that the area of the plates (facing) is about 1.13×10^{11} square meters. That means the square plates are about 209 miles on each side! (See Figure 2.)

Having determined that the required capacitor is made with square plates that are 209 miles on each side, and, they are one meter apart, we can now determine how far the upper plate must be raised to get the required 120V.

One way to do that is to calculate the capacitance of the capacitor when the voltage across it is 120V. A well-known equation that relates capacitance (C), charge (Q), and voltage (V) is:

$$Q = CV$$

I will use 1 as a subscript for the capacitor when the plates are one meter apart, and, 2 as a subscript for the capacitor when the upper plate is raised to produce the 120V.

$$Q_1 = C_1V_1$$
$$Q_2 = C_2V_2$$

The amount of charge (Q) is not changed by moving the plates. Therefore, $Q_1 = Q_2$. If $Q_1 = Q_2$ it follows that:

$$C_1V_1 = C_2V_2.$$

Solving that equation for C_2:

$$C_2 = C_1V_1/V_2$$
$$= 1F \times 1V/120V$$
$$C_2 = 1/120F = 0.00833F$$

Now the equation $C = (\epsilon_0)(A/S)$ can be solved for the distance between the plates (S):

$$S = (\epsilon_0)(A/C)$$
$$= (8.85 \times 10^{-12})(1.13 \times 10^{11})/0.00833$$
$$S = 120 \text{ meters}$$

So, M. Nott will have to raise the upper plate about 394 feet to generate the 120Vdc.

Faced with the mechanical problem just described, M. Nott still claims he can do it. However, he will have to wait until he has taken a course in mechanics. That will be next fall.

M. Nott is not discouraged by the size of the plates.

His father owns a ranch in Brazil and he believes his father will be willing to level off the required rain forest to build the capacitor. He admits that raising the upper plate does offer a challenge. However, he assumes he will be able to solve that problem after he takes a course in mechanics next fall.

$$\frac{1{,}000{,}000 \text{ ELECTRONS}}{\text{SECOND}} \times \frac{60 \text{ SECONDS}}{\text{MINUTE}} \times \frac{60 \text{ MINUTES}}{\text{HOUR}} \times \frac{24 \text{ HOURS}}{\text{DAY}}$$

$= 8.64 \times 10^{10}$ ELECTRONS PER DAY

Multiply the number of electrons per day by 365 to get the number of electrons counted per year:

$$8.64 \times 10^{10} \frac{\text{ELECTRONS}}{\text{DAY}} \times \frac{365 \text{ DAYS}}{\text{YEAR}}$$

$= 3.15 \times 10^{13}$ ELECTRONS PER YEAR

Now, divide the number of electrons per year into the number of electrons in a coulomb you get:

$$\frac{6.24 \times 10^{18}}{3.15 \times 10^{13}} = 1.98 \times 10^5 \text{ YEARS}$$

Figure 4. By counting one million electrons per second it will take almost 198,000 years to count the number of electrons in one coulomb!

A closer look at that coulomb

You know that a coulomb is the total charge of 6.24×10^{15} electrons packed in a bunch.

Wait a minute! Shouldn't that number be 6.28?

No, 6.28 is the value of 2π and it doesn't belong here.

Well, shouldn't that number be 6.25 as shown in some books?

No, that is an approximation as will now be explained.

The charge on an electron is 1.60207×10^{-19} coulombs. You can find that number in physics books. When you divide

(Continued on page 60)

Sound advice

By John S. Hanson

The town library board called to invite me to bid on renovating the sound system in the library theater, which had been donated to the community by Baxter Pharmaceuticals. The library shows noon time movies to the senior citizens. There had been complaints about the sound. The budget for the renovation included funds for the purchase of both a video projector and a VCR.

Research for the bid

To prepare for the bid I performed a sound level test using an audio test cassette and a Radio Shack 33-2050 sound level meter. The theater's projection booth had two Bell and Howell 16mm film projectors, a rack for the audio amplification equipment, and controls for the stage and auditorium lighting.

I inserted the audio cassette in the tape deck and turned it on, then moved from one seat to another taking sound level measurements in the 200 seat theater. I noted dead spots in the front center rows going back four aisles, and the music on the test tape sounded muffled (Figure 1).

Two column speaker systems were mounted up front in a vertical plane; one at each side of the stage some distance from the movie screen. The result was that in addition to the dead spots and muffled sound, the film sound appeared to be out of sync with the picture.

At this point I didn't believe that the problem was in the amplifier. Inspection revealed that it was a top brand commercial grade 100W model with separate mixer and equalizer.

My initial assumption was that the problem was caused by poor speaker placement, perhaps an impedance mismatch, or possibly an out-of-phase connection. Back at the shop I began writing my proposal.

Hanson, previously an engineer for several major consumer electronics manufacturers, is now a self-employed electronics consultant and freelance writer

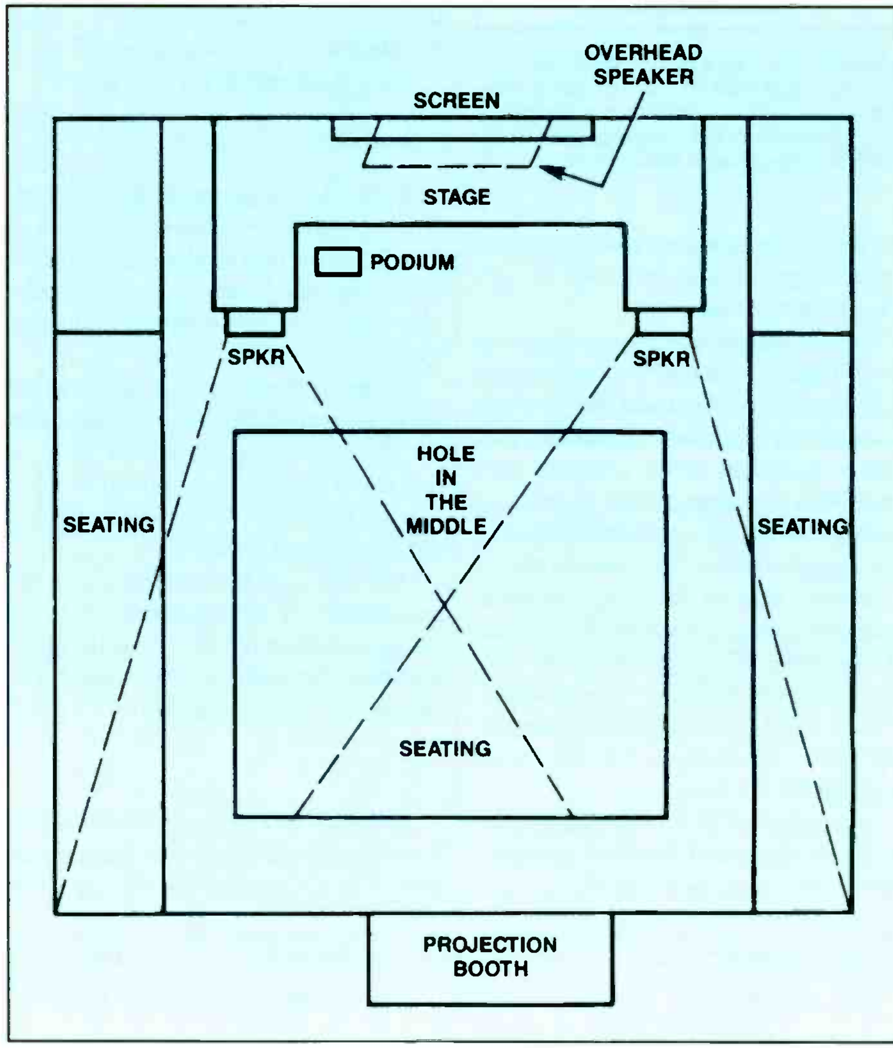


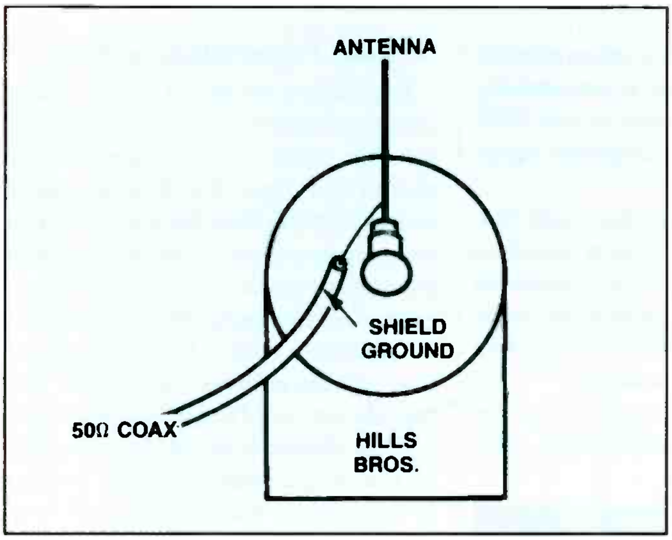
Figure 1. The arrangement of speakers in Baxter Hall in the Morton Grove, IL library, connected out of phase, caused several sound system problems: muddy sound, a hole in the middle of the sound stage, and lack of synchronization between the film and the sound.

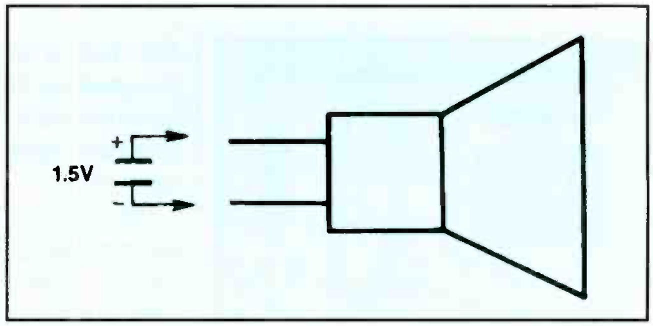
Elements of the new system

At a trade show I had been impressed with the new LCD video projectors. I specified the leading maker's unit with a zoom lens and keystone correction that could be remotely operated. A wireless mic was a must, with the FM receiver in the projection booth. I preferred the handheld model using a 174MHz carrier picked up by the six-inch antenna rod in the receiver.

Both the video projector and the VCR would be remotely operated from the front stage podium. As this distance is more than 30 feet, I included an IR repeater system. In this case, the IR remote data is RF transmitted on a 417MHz carrier, which is recovered and returned as IR data for commands at the receiver. Provided that the receiver is approximately ten feet away, the data will be in a 60-degree light pattern.

As I prepared the bid, my concern for the hole in the middle sound dispersion





◄ **Figure 2.** I used an old trick of connecting a 1.5V cell across the speaker terminal to determine phasing.

▲ **Figure 3.** In order to eliminate audio interference cause byswitching in the LCD projection TV, I used a coffee can and lid to provide grounding and shielding for the wireless microphone system.

problem prompted me to specify an additional speaker system. Altec Lansing Voice of the Theatre speakers are installed directly behind the movie screen, which is porous, similar to a speaker grill cloth. I compromised with an over-the-screen installation with the speaker tilted down at 45 degrees.

Before I totalled my bid, I factored in my consulting time and technical labor time. My quote would assume I could use the library maintenance people and equipment.

I got the bid

The bid was presented and I awaited the pleasure of the library board. I knew of at least three competing bids. Weeks passed and I heard nothing. After some 60 days the call came saying that I had been awarded the contract. Before I started I made it clear that I wished to be paid along the way as the project progressed. This is an important clause you should include in any similar bids that you might make, to avoid a cash flow problem. The board agreed that I could invoice each month on the completed work.

Upgrading the speaker system

First priority was the speaker system. The new speaker went in above the screen, and the column speakers remained in place. Using an old trick, I connected a 1.5V flashlight cell across each speaker system to confirm that all speakers were moving in the same direction when the same battery polarity was applied (Figure 2).

This test revealed that the column speakers were connected out of phase, explaining sound cancellation in some parts of the theater. I corrected this situation as I rewired the speakers. All three speaker systems were wired separately with 16-gauge lamp cord. The reason for separate leads was to have provisions for a future stereo connection. For now, the system would remain monophonic. I calculated the connection of the three speakers in parallel to present an impedance of 6Ω to the amplifier, so I used the 8Ω output tap on the power amplifier.

With the speaker system renovated, it was time to test the sound again. Using the same test tape, I sampled the theater with my sound meter and noted that the hole in the middle was gone, and all the seats had the same relative sound level. Making things even better was the fact that the music now had sparkle; the muddy sound was gone.

Installing the video equipment

Next came the installation of the video projector and the VCR. It was my understanding that cable operators generally provide free taps to public buildings, so I decided that I would ask the local cable company if they would provide cable at no charge for the library theater. The cable company brought in a cable tap for the VCR and tuner.

As I looked at the video projector I saw a problem. The IR remote sensor was mounted up front, under the lens. The VCR faced the opposite direction. I wondered if a mirror would effectively reflect the IR beam into the sensor. An 8 inch x 10 inch mirror placed under the lens about six inches from the sensor did the trick. Needles to say, I was elated. Backing off, about 10 feet in the booth, I was able to operate all functions of both the projector and VCR remotely.

After turning on the projection TV and adjusting the keystone screen size and focus, I saw the brightest, sharpest video display on a movie screen that I had ever seen. The picture rivalled the brightness on the film projectors with no convergence problems and no arcing and slumping of CRTs. I was truly impressed.

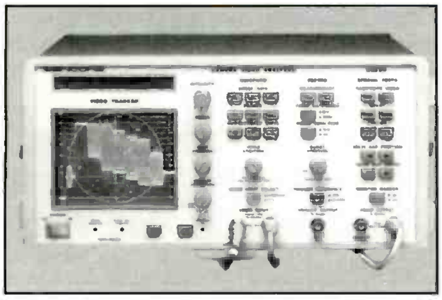
Correcting some audio problems

The audio posed an immediate problem. With the wireless mic on, a strange sound emanated from the speaker system. It sounded like a big windshield wiper blade swishing in the rain. As it only occurred when the video projector and wireless mic receiver were both on, I concluded that the problem was pickup of switching harmonics from the LCD panel pixel switching pulses. After some testing, I concluded that I needed a shielded antenna input and an external antenna for the mic receiver.

First I removed the rod and antenna and hard wired a length of 50Ω coax right to the PC board. A metal coffee can lid would make a perfect antenna mount and ground plane (Figure 3). Mounting the antenna rod to an insulator, and then to the can lid, I soldered the other end of the coax to the antenna rod and the shield to the can, disappearing into the attic to work my way back to the area over the stage.

Fiber glass insulation penetrated my pores. I was miserable. Some 80 feet from

(Continued on page 60)



Camera video analyzer

The new CVA94 Video Tracker Camera Video Analyzer quickly and accurately analyzes camera video signals with timesaving digital measurements, waveform and vector displays, and exclusive special tests designed for fast camera servicing and alignment. The unit is part of Sencore's "Tech Choice System"—a complete line of product specific analyzing instruments.

The analyzer includes both waveform monitor and vectorscope functions with digital measurements to make both camera and camcorder analyzing faster and more efficient. Special hum, video noise, chroma noise, and burst frequency tests positively identify and localize defects to any part of the camera.

Selectable video inputs are compatible with both composite and high resolution Y/C camera outputs. Plus, the scope trigger output marker trigger reference allow you to signal trace any signal defect to its source.

Composite and Y/C outputs match the input of any video monitor. The exclusive integrated monitor marker positively identifies signal measurements with marker bars on the video image. The exclusive beam saver feature automatically prevents CRT phosphor burns by shutting off the CRT after 10 minutes of non-use. The unit also contains built-in calibration signals and is RS232 computer interface-ready.

Circle (50) on Reply Card

Current leakage tester

The Simpson Electric Company Model 228 Current Leakage Tester is designed specifically to meet the requirements set by IEC-990 and adopted in ANSI C101.1 (1991) which has just been published. The stringent new specifications mandate new methods for testing ac current leakage in electrical equipment such as 120V household appliances, telephone equipment, etc.

The unit is a special purpose ac/dc milliammeter designed to measure hazardous currents (leakage currents, sometimes called "touch currents") which may occur when an individual contacts the surface of an electrical or electronic device.

The new standards require special uniform measurement circuits to test com-

pliance with specifications. These circuits require precision networks and new instruments for measuring Perception/ Reaction responses, Let Go response and Electric Burn. This tester incorporates all these circuits in one instrument.

The tester is designed to measure leakage current while matching the body's decreasing sensitivity to electric shock sensation as frequency increases. The new tester is also designed to measure possible electrical burn hazards in frequencies of 30KHz or lower.

Solid state circuitry permits readings as high as 10MIU (Measurement Indication Units) full scale for shock hazards, while allowing resolution to 0.005MIU (on the 0.3MIU range). The burn hazard feature allows measurement of currents as high as 100mA rms. A 0V to 300V scale is included to provide a convenient means to measure open circuit voltage between accessible parts and ground.

Circle (51) on Reply Card

Laser Printer Cleaning Paper

PerfectData introduces 'Laser Printer Cleaning Paper'—a simple to use product that removes accumulated toner residue and paper dust from the paper path of laser printers. Regular use of this specially manufactured sheet helps keep laser output looking sharp. It also dissipates static electricity charges as it passes through the printer. Using the product is as easy as printing a document. The paper is not coated and will not leave any residual chemicals inside the laser printer. This unique cleaning sheet is specially designed to withstand the high temperatures inside laser printers. The paper includes no toxic substances.

Circle (52) on Reply Card

SCSI diagnostic tools

Peripheral Test Instruments (PTI), an international manufacturer of SCSI diagnostic tools for multi-platform systems, has announced the addition of new features to the company's product, SCSI Toolbox.

The product is a series of software programs for diagnosing, troubleshooting and testing all SCSI peripherals. Through utilization of a parallel-to-SCSI adapter and the company's copyrighted software, the unit will plug into the printer port of any personal computer, offering functionality and efficiency through the use of five distinct modules for SCSI devices: Tester Module, Workstation Module, Multi-Drive Module, and the newly completed Declassification and Media Modules. Each module allows service providers and systems integrators to reduce time spent formatting, testing and diagnosing SCSI disk, tape and optical drive problems.

The new Declassification Module allows users to purge data from disks, an ideal feature for anyone operating in a secure environment. The Media Module provides for the closing of disks and the transcription of media from one format to another, e.g., from 9-track to 8mm, 8mm to 4mm, 1/2" to 8mm.

Circle (53) on Reply Card

Clamp-on digital multimeter

Wavetek Corporation has introduced the new CDM600 clamp-on (DMM), which can measure ac and dc current up to either 200A (high resolution of 100 mA) or 600A without disturbing the test circuitry.

The meter has two ranges for measuring ac and dc current—200A and 600A. It can resolve down to 100mA on the 200A range and 1A on the 600A range. An auto zero control eliminates stray magnetic fields while measuring dc current. The clamp can be used on conductors up to $1^1/_8$ inches in diameter.

In addition to measuring both ac and dc current to within 1% accuracy, the unit measures ac voltage to 750V, dc voltage to 1000V, and resistance to 200Ω. The instrument has a continuity beeper and a data hold switch to freeze the measurement value on the display.

Advanced Hall-effect technology, allows the meter to measure dc currents without requiring the meter user to break circuits.

Circle (54) on Reply Card

Solder smoke extraction system

Weller Fumex systems remove more than 95 percent of all solder smoke at the source before they can be inhaled by operators. The new central models can serve 15 to 150 stations. Five different completely self-contained central models are available and can be mounted on a wall, above a drop ceiling, roof mounted or attached by other means.

The Ambient model is another new

addition to the system. This self-contained, portable unit controls process odors where source capture is impossible. Its HEPA filter removes 99.97 percent of all airborne and nuisance particulates.

The portable model is a self-contained unit for high-efficiency particulate removal: 99.97 percent efficient HEPA filter, and activated carbon filter. Mobile and hassle-free.

The four original self-contained models serve one, two, three or four work stations. Each is portable, includes a convenient carrying handle and is impact resistant.

All units are built for continuous duty and operate in a similar fashion. An adjustable tube is attached to each fume extractor soldering iron and positioned just above the soldering tip. As fumes rise from the heated solder, they are sucked into the tube and captured within the vacuum pump fitted with special filters.

Circle (55) on Reply Card

Cleaning sprays

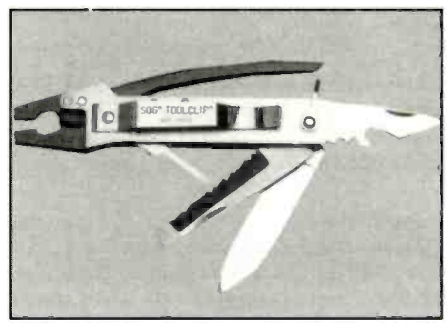
Caig's OpticALL is a new formula that cleans, polishes and eliminates static electricity on optical viewing surfaces. It provides a long lasting protective barrier from static, and buildup of dust and dirt. It is also effective as a general purpose anti-static cleaner for plastic, glass and metal surfaces. Use on CRT screens, TVs, scopes, dial faces, computer and equipment enclosures, keyboards, working surfaces, etc. Contains no ozone depleting CFCs.

StaticALL effectively neutralizes static buildup caused by friction and low humidity conditions. Use on carpets, floors, work surfaces, conveyor belts, furniture, clothing, etc. Reduces risk of equipment failure, data errors due to electrostatic discharges. Contains no ozone depleting CFCs.

Circle (56) on Reply Card

Technician's pocket knife

A compact ToolClip, combining 13 functions in one pocket tool, has been introduced by SOG Specialty Knives and is available from *Jensen Tools*.



The features pliers, gripper and wire cutter combination that can handle chain link fencing, a spear point blade, serrated edge and utility blade, two screwdrivers, two wire strippers, a file, pry bar, and bottle opener—plus a heavy duty pocket/belt clip.

The ToolClip is made entirely of stain resistant steel and guaranteed for life against defective workmanship and materials. All parts may be cleaned with fresh water or non-corrosive solvents and lubricated with light machine oil.

Circle (57) on Reply Card

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

Need service manuals/schematics for Sears color TV model 564-42103250, FCC ID AIN9X642103, also for Panasonic color TV model CT-9042, chassis NMX-GX. Quote price. *Gilberto Hernandez, Calle 10, Bloque 18, #18, Santa Rosa, Bayamon, PR 00959.*

Lower cyclinder head assembly, part no. 5459792 for a Hitachi VCR model no. VT1450A, new or used. *David Hartle, 6194 Main St., Hailesboro, NY 13645, 315-287-4083.*

Flyback for Sears model 580-40051650 5 inch color TV/radio. Number stamped on transformer: 154-119A. Will pay up to $25.00. *Spangler Electronics, 2339 W. Prospect, Ashtabula, OH 44004. Phone 216-992-5870, 10 a.m. to 6 p.m. EST.*

Owners manuals and/or service manuals wanted for automatic turntables BSR McDonald 6500 CX and Panasonic RD-7503. Will copy and return or pay for copies. *Robert J. Blackwell, 2925 Riggs Ave., Baltimore, MD 21216, 410-362-6678.*

Fisher VCR service manuals; adapter socket no. CR-42 for B&K 470 CRT checker. *ED Herbert, 410 N. Third St., Minersville, PA 17954.*

Need schematic/service manual for a Zenith model no. SC2747P color TV. *R.B. Wetherell, 14 West St., Wakefield, R.I. 02879. 401-783-2255.*

Volume control for a model 89193 Bradford stereo player. *Paul, 637 West 21 St., Erie, PA 16502.*

Looking for three (3) integrated circuits Nos. M50790SP/M50740-607SP/DN811. Please quote price. *Gilberto Hernandex, Calle 10, Bloque 18, #18, Santa Rosa, Bayamon, PR 00959.*

Need source of processor chips and touch pads for Magic Check microwaves, and schematic for Sencore CR-70 CRT restorer. *W. Worley, 305 Hickory Bend Rd., Enterprise, AL 36330. 205-347-5281.*

Main circuit board (Mother Unit) for a Sharp TV model no. 25NT58, part no. DUNTK5555WEVO or DUNTK5692WEVO. Board needing repair is ok but no cracks. *Bob Moore, 717-226-6840.*

Need datasheet, cross reference, or any technical information on electronic part no. SMP50N06 in a TO-220 package. Will gladly pay for copy, and postage costs. Also, willing to sell this semiconductor; I have about twenty. *John Senchak, PO Box 427, Seymour, CT 06483-0427.*

Sams Quickfacts TV books and Sams Photofacts for Zenith TV. Send price list to *JF, 807 Queen Palm Lane, Sarasota, FL 34243.*

FOR SALE

Zenith TV paper and microfiche schematics for the F and G lines (1990-1993), all service bulletins and training manuals. Also Zenith's TV component charts, A through G lines. Unused condition, make a reasonable offer on package. *Bob Moore, 717-226-6840.*

Video Wonderbox pattern generator. $275.00. Cost $525.00. New. Excellent condition. *Call John, 916-399-9697.*

Sencore VC93 VCR analyzer. Buy outright or take over monthly payments. Easy terms. *Call 1-604-645-3783 after 6:00 PM MST.*

MUST SELL—Closing shop! Sencore SC3080, 12 months old, used in "part-time" operation. Less than 25 hours of use. $2000.00 or best offer. *Phillip Banks, 912-283-4309.*

B&K model 1653 ac power supply $150.00, model 1803B frequency counter $125.00, model 510 transistor tester $125.00. All like new. *Call Roger after 4:00 pm, at 814-239-2761.*

AVCOM PSA-35 portable 4GHz spectrum analyzer. Internal rechargeable battery and 18V LNB supply. Includes carrying case/strap, instruction manual and videotape. Made for satellite system field work. $1500.00. *Keith Conroy, 10310 Woods Rd., Utica, NY 13502. 315-735-1554.*

Jukebox Service Manuals. Send SASE for list. *Charlie Maier, 3016 Derry Terrace, Philadelphia, PA 19154.*

Sams VCR manuals 168-219, $500.00 for all or will trade for Riders manuals or old radios. *Ray Schmidt, 507-433-0069 or 507-433-3250, 607 1 Ave. SW, Austin, MN 55912.*

Sencore CM2000 computer monitor analyzer with all accessories. Sencore SC-61 waveform analyzer. Excellent condition. *Call 701-663-7243.*

Photofacts 188 through 2767, $3.00 each. Some CB and TSM manuals. Early Zenith parts and tubes. *Keith's TV, Box 185, Adams, NY 315-232-4556.*

Sencore VC93, $1995.00. Excellent condition, includes complete package—tapes, connectors, etc. *Call Jay—days, 603-595-9040.*

B&K 510 transistor tester used with manual. Has case and works. $80.00. *Dr. Radio—Stan Lopes 1201-74 Monument Blvd. Concord, CA 94520. 510-825-6865.*

TVA-92 TV video analyzer and VG-92 video generator. Excellent condition under waranty. $3300.00. CR-70-CRT Restorer, $900.00, 3 months old. *Paul Farrow, 217-446-1147.*

Sencore: VA62–$1400.00, SC61–$1300.00, CR70–$650.00, LC76–$550.00, VA48–$450.00. And lots more! All like new with original manuals, leads, and boxes! *Call Steve at 908-725-1200.*

Three 25 inch by 13 inch size boxes packed full of service manuals, schematics, and Photofacts for $150.00 or best offer. *216-923-4989, Charlene.*

Heath electronic switch, ID-101$25.00. Heath FET/transistor tester, IT-121$35.00. Heath vectorscope, IO-101$70.00. BK-415 sweep/marker generator$75.00. *Call 516-731-3868.*

Retired hi-fi in storage. 400 cubic feet. New, used, dead components, accessories, parts, misc. Sell or trade for video production equipment. $15K. *George, 4913 Goldfinch, Madison, WI 53714. 608-221-2855.*

Leader scope model no. LB0-526, 60 MHz, Dual trace, time delay sweep, w/2 1x, 10x probes—good condition. $500.00. *Call Rich, 304-269-7850 or 304-269-7233.*

Sencore SG165, $775.00. Tektronix distortion analyzer system: AA501 with Opt. 01, SG505 with Opt. 02, TM503, $2700.00. *305-963-3613.*

Sencore equipment. SC61-$1500.00, VA62-$1500.00, CR70-$650.00, VC63-$100.00, NT64-$100.00, LC53-$300.00, PR57-$300.00, R667-$400.00, Ex231-$75.00. Will sell as package at firm price for $4900.00 or as individual items at stated prices. All excellent condition, original cartons. *216-923-4989, Charlene.*

Sencore SM152, PS29, YF33, MU150, TF30, BE156, FE21, RC146, CG153, PS103, CR31A and Triplett 630, $699.00 for all or offer—after 6:00 pm. *Alex Nikora Sr., 5298 Argyle Ct., Sterling Hgts., MI 48310, 313-268-6938.*

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 Emily Kreutz 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 additional. 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: Emily Kreutz
Phone: 516-681-2922
FAX: 516-681-2926

FOR SALE

REMEMBER, It's not the quantity of TIPS but the Quality of Solutions that makes the difference. Our 10,000 TECH-TIPS cover VCR-VCP-TV/VCR Combo CD/LD-FAX-Camcorder/VHS/SVH/C/8MM/ Camera-Stereo TV Monitors/TV/Computer-Rear/ Overhead Projection Amplifiers-Microwave-Satellite. Our program is actual day to day repairs, written by technicians for technicians. No need for you to spend time updating your data base or paper binders. We send you a complete revised program at each update of your choice (computer or paper format). Outside technicians & students love the portability and say it is a must for the field where time is very critical. As an added extra, we provide you with an FCC ID Cross reference list which saves the expense of purchasing service manuals you may already have and just don't know it. Also, when you join our ongoing program we will send you a key to streamlining your company into profitability overnight! (We actually did it!) **CALL NOW (800) 474-3588 FOR A "FREE" DEMONSTRATION DISK OR PAPER FORMAT** or mail request to **TV-MAN SALES & SERVICE, 8614 SR-84, Ft. Lauderdale, FL 33324.**

VCR AND TV SERVICERS ** Make those hard repair jobs easy with our up to date symcure information **1800 item VCR symcure file and 1200 item TV tough dog symcure file available on IBM compatible disk and print out. VCR disk w/po $85.00 print out only $45.00. TV/dog, disk w/po $85.00 print out only $45.00. VCR Tune Up Center, 2610 Bay Road, Redwood City, CA 94063. 1-800-777-7883

****** **The TIP Computer Program** ******
The **BEST** technical tip database program on the market today. **One of the largest tip databases in the country — over 12,000 tips!!!** Used by National Association members & officers. HIGHER INTELLIGENCE SOFTWARE, 60 Farmington Lane, Melville, NY 11747 **(516) 643-7740**

NAP 340309 & 340313 TUNER CURES! Repair yourself and save! For compete instructions send $15.00: **TEK Enterprises** 212 Marabou Dr. Newark, DE 19702.

MONITOR REPAIR SOFTWARE. Designed for the bench technician, fast easy to use, eliminates costly testers. Write or call for details. Fessenden Technologies, 116 North Third Street, Ozark, MO 65721 (417) 485-2501.

TEKTRONIX SCOPE SALE! New & used scopes with TV Trigger. Many models to choose from. Also have Sencore Equipment available. Call **TEST EQUIPMENT SALES** (603) 434-2544 or write to P.O. Box 986, Londonderry, NH 03053

REDUCED 85%. Diehl Mark III $69, Diehl Mark V Horizontal circuit tester $179. New. Conductive coating for remote control keypads $9.99 ppd. WEEC, 2805 University Ave., Madison, WI 53705. 608-238-4629, 608-233-9741.

VHS-VCR Repair Solution Sets I, II, III IV, V, VI, VII, VIII. Each contains 150 symptoms and cures, updated cross reference chart, free assistance, $11.95 each, all eight $79.95. Schematics available. Visa/MC. Eagle Electronics, 52053 Locks Lane, Granger, IN 46530.

TV/VCR REPAIR SOLUTIONS: 1,000 VCR printed $83. 5¹/₄" IBM disk $72. 5,400 TV prints $135. Disks $113. 1,000 latest TV $54. Electronic Solutions, 407 W. Ave. "N", San Angelo, TX 76903.

TV–VCR SHOPS: A program of over 2800 fixes on disk. Only $99.95. TECH-DAT, 212 Earth Row, Waynesville, MO 65583. Call 1-800-280-2100. VISA & M/C.

Tech ReSource, a computerized directory of over 650 listings in over 90 manufacturer and other catagories. Help for finding those hard to get parts. Add suppliers or change some information yourself. 3¹/₂" or 5¹/₄". IBM compatible. **Visa/ Mastercard 1-800-580-4562. Still introductory priced $24.95.** M.C. Humphrey & Co. P.O. Box 1414 Noblesville, IN 46060.

"SAMS TV MONTHLY SETS Jan 92 - July 93 unopened. Paid $893.00. Sencore CR70 new in box. Best offers. AJ 508-775-0008 8-5 est."

TV CASE HISTORIES: Booklet with 1,750+ histories. Satisfaction assured. Only $35 (first-class shipping add $1.50). Mikes Repair Service, P.O. Box 217, Aberdeen Proving Ground, MD 21005. Same mailing address 29 years. Send SASE for samples.

SENCORE VA62A+VC63+NT64 mint condition $1650 (was $4500 new), SC61 oscilloscope $1150 ($3300 new), SG165 AM/FM stereo generator $600 ($1500 new), more . . . Alex 1-408-738-4206, FAX 1-408-736-6946.

Earn $$$ Repairing Zenith TV's To Component Level—110 module cures 9-90 thru 9-1119. **Guaranteed effective** and reliable cost cutting symptom/cure format. Big profit potential. $10/sample, $100 for all: **ZMEX,** 807 Queen Palm Lane, Sarasota, FL 34243.

TVA-92 - TV video analyzer and VG-91 - video generator. Excellent condition under warranty $3,300. CR-70 - CRT restorer $900, 3 months old. Paul Farrow (217) 446-1147

SENCORE SC3080 Scope - New - Call and discuss price 704-437-9241.

BUSINESS OPPORTUNITIES

MOVE TO SUNNY SOUTH FLORIDA: A Turn of the key guarantees minimum take home of $100,000. Owner retiring. Fully staffed in largest growth area of Ft. Lauderdale. Established 12 years, no competition. Authorized 15 major brands. 100 percent computerized. Simple to operate business. Owner financing available. Call for details 305-474-2677.

ESTABLISHED 15 YEARS authorized service center: good location, great potential. authorized 17 major brands, 100% computerized, well equipped with tools and schematics. Call 212-447-7562

VIDEO REPAIR & VIDEO TESTER LAB. Established 8 years, Modesto, CA. Fully equipped bench & lab. Good customer base and reputation. Call 209-576-1094

WANTED

EXPERIENCED ELECTRONIC TECHNICIAN - VCR Television repair - factory trained a strong help. Live in the beautiful Smoky Mountains near lakes and waterfalls. Very good pay - full time. Modern store - "top of the line" equipment. Call Dave, Mountain Electronics, Glenville, NC (704) 743-2810.

Use Your Free Reader Service Card For More Information On Companies Advertising In This Issue.

Circle (19) on Reply Card

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To Order Back Issues

Send $3.50 Per Issue

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Send All Correspondence To:

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

ORDER YOUR BACK ISSUES TODAY!

Advertiser's Index

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.

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The classic
Multimeter
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Fluke 83
Full-featured
Multimeter
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Look to Fluke for the tools you need to get the job done right.

See your Fluke distributor, or call 1-800-87-FLUKE for a catalog and the name of the distributor nearest you.

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Auto-function
Multimeter
$95.00

FLUKE 12	FLUKE 77	FLUKE 83
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Capacitance measurements	Auto Touch Hold®	Auto Touch Hold® and Relative modes
V Chek™ (auto function)	Current measurements	Current measurements
Min/Max Record with Relative Time Stamp	Analog/Digital display	Analog/Digital display
Two-year warranty	Three-year warranty	Three-year warranty
Continuity Capture™	Yellow holster with Flex Stand™	Yellow holster with Flex Stand™
Basic accuracy 0.9%	Basic accuracy 0.3%	Input Alert™
	For measurements to 4800 V-A	Capacitance measurements
		Frequency and Duty Cycle
		Min/Max/Avg. Recording
		Basic Accuracy 0.3%

John Fluke Mfg. Co., Inc.
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For more information call:
(416) 890-7600 in Canada
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