

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONICTM

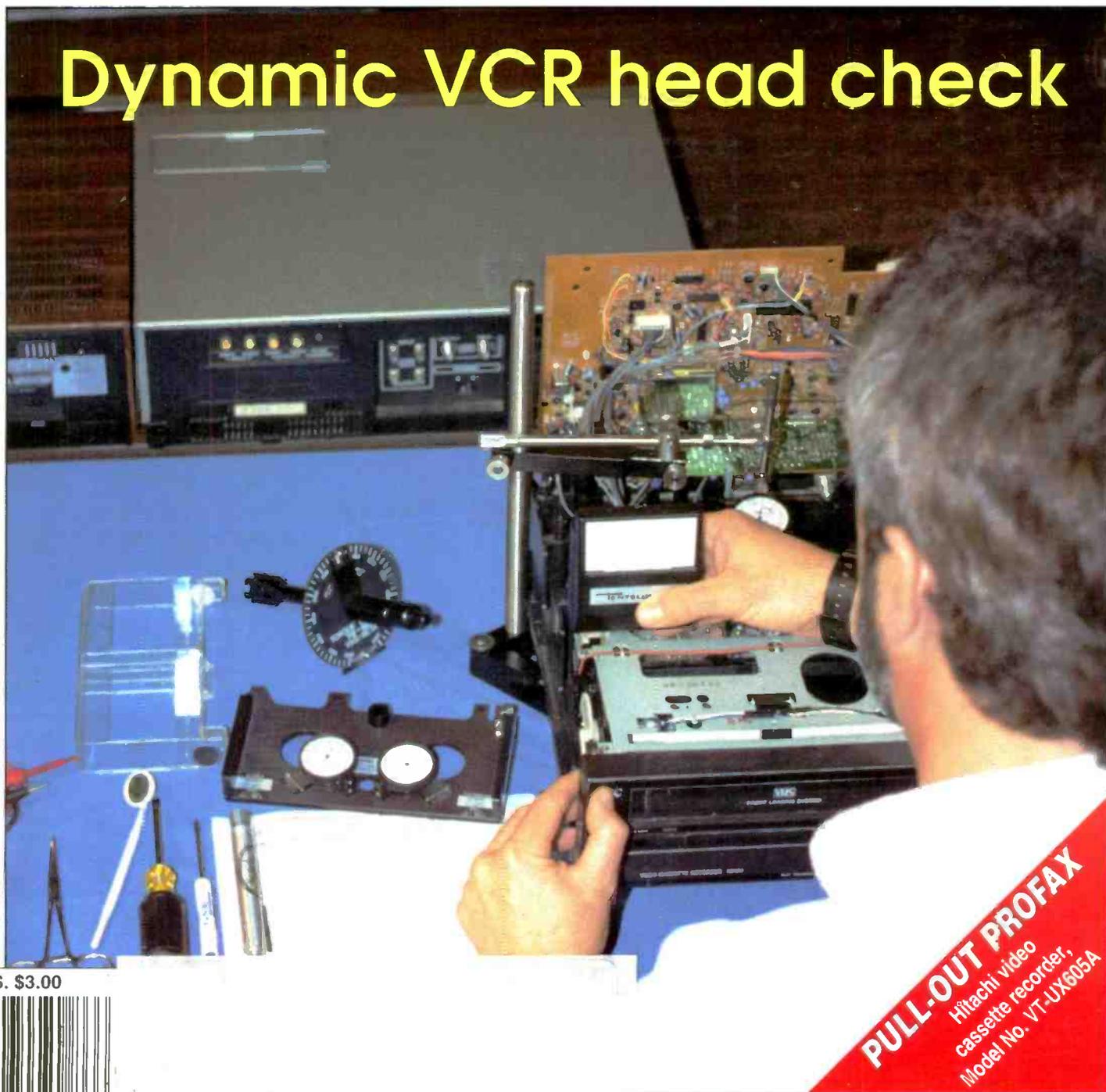
Servicing & Technology

February 1996

Troubleshooting color circuits without a schematic

Finding substitutes for passive components

Dynamic VCR head check

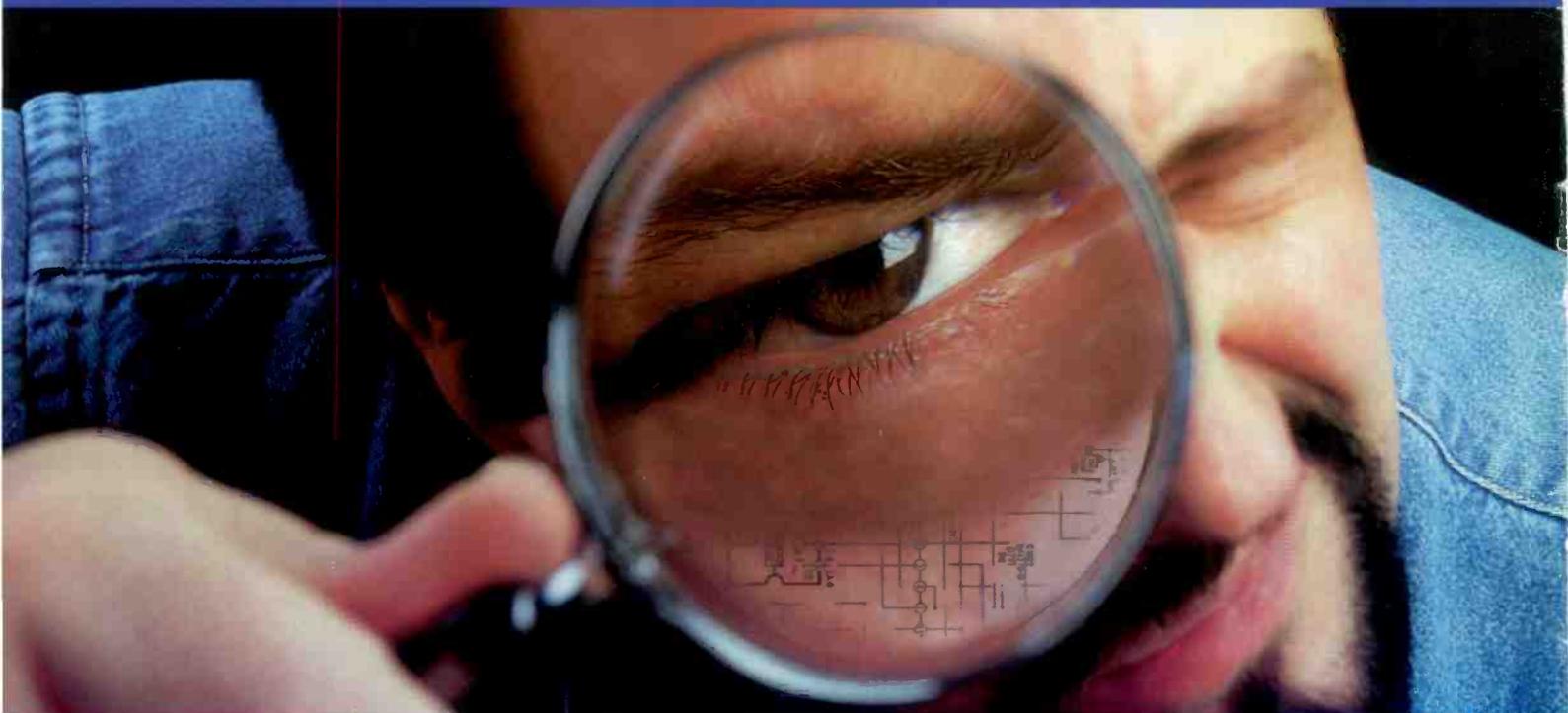


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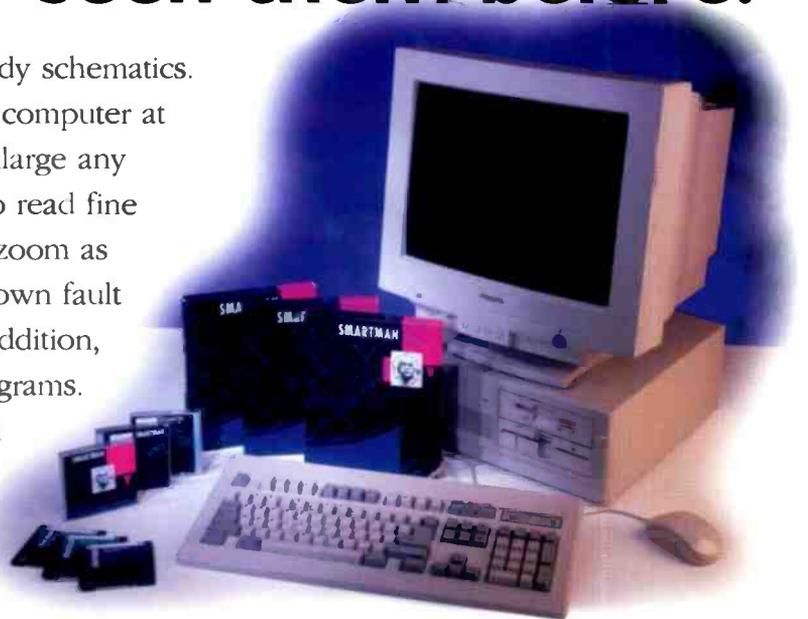


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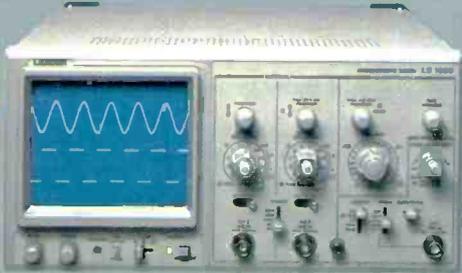
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ELECTRONIC

Servicing & Technology

Volume 16, No. 2 February 1996

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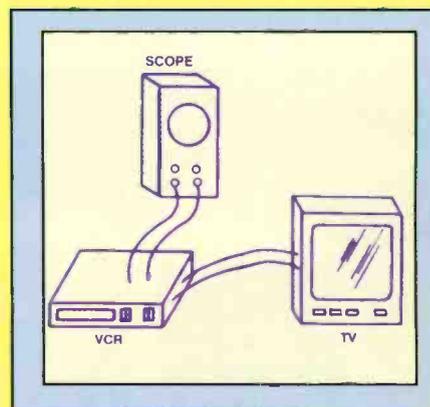
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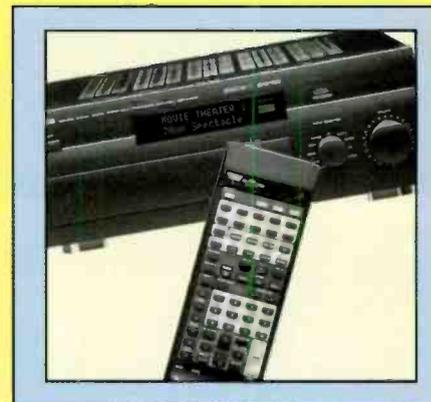
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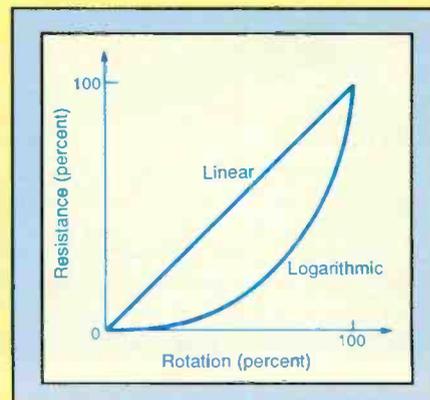
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VCRs are a combination of electromechanical and electronic systems. Proper diagnosis and repair of these complex products requires a understanding of both. (Photo courtesy Tentel)

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

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

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WAVETEK

Of electronics concepts and terminology

As I was thumbing through some of the returns from one of the Reader Surveys that we include in this magazine each month, I was taken somewhat aback by a comment on one of the cards. In fact the individual who sent it in had not checked any of the boxes or written in any of the comments solicited by the questions on the survey card. He simply included the comment "stop using the word 'leaky,' we are in the transistor age."

In fact, we use the word "leaky" frequently in this magazine. In most of Homer Davidson's articles dealing with television service, he suggests that readers measure voltages and resistances to determine if a semiconductor device is open or "leaky."

The correspondent who suggests that we stop using the term "leaky" because we are in the transistor age apparently associates the term with physical leakage of vacuum tubes. Back in the good old days of vacuum tubes, occasionally a tube would develop a leak and air would get into the tube, which was then said to be "gassy." Vacuum tube testers included a test that would let the technician know if the tube had become gassy.

As most of you know however, when we talk of leaky transistors or ICs we're talking about electrical leakage: leakage current. When a semiconductor device is operating normally in a circuit, but because of the desired circuit operation at the moment it is turned off, no current would flow through it (if it were an ideal device, that is). Semiconductors are not ideal components, however, so no matter how well the semiconductor is designed, or how well designed the circuit is in which it is used, when that circuit is operating, even when the semiconductor is not supposed to be conducting there will be some leakage current through it, howev-

er small. Unless it has been so damaged that it has become open. Take a look at the specifications for any semiconductor device; they include normal values of leakage current.

If the semiconductor device in a product becomes faulty, that leakage current may increase to the point that the product no longer functions properly. Excessive leakage current may even cause components that are connected to the leaky semiconductor to be damaged. This is actually what is meant by the term "leaky" in *ES&T*. All operating semiconductors leak current to some degree. When the semiconductor becomes faulty to the point where its leakage causes improper circuit operation, or even damage to connected components, it is said to be "leaky."

This is only one example of the many misconceptions and conceptual difficulties that those of us in the electronics field may fall prey to. In fact, they seem to be everywhere, even sometimes officially sanctioned. For example, for years voltage was called electromotive force, or EMF. Voltage is not a force. Voltage has the units of work.

As another example, most of us who have been around in electronics for a while were introduced to the concept of magnetism and electromagnetic induction in terms of "lines of magnetic force." If a conductor and a magnetic field were moved relative to one another, the conductor "cut" the magnetic lines of force and thus a voltage was induced.

In doing some research to verify some facts for a past article in this magazine, I found a much simpler explanation; one that doesn't require that we deal with the concept of "lines" of force. Quite simply, if the intensity of the magnetic field in which the conductor is placed

changes, increases or decreases, a voltage will be induced in the conductor that is proportional to the intensity of the magnetic field and to the rate of change of the field intensity.

Yet another example of a concept that seems to be forever just beyond the grasp of a lot of electronics specialists is that of "holes" in semiconductor material and flow of those "holes" producing current.

Most of the cause of our flawed understanding of these and many other electronics concepts is that we don't have a perfect understanding of electronics. Because we can't see electrons, voltages, currents, etc., but only their analogs on the face of a scope or the readout of a meter, we are forced to use analogies and models to grasp these concepts, and analogies and models only work up to a point. The best we can do is to continue to wrestle with these concepts, to read and study to try to find better explanations, and to avoid becoming tied to imperfect models that may have been used to help us understand electronics principles.

In the interests of helping to remove some of these obstacles to understanding, *ES&T* would like to serve as a forum for these concepts. If any readers have had difficulty with some of the concepts presented in their studies of electronics, or disagree with or have other problems with concepts as they are presented here, write in and let us know. We'll try to find an author who can explain it. Or if you feel that you have a good understanding of a concept and would like to share it with *ES&T*'s staff and other readers, write it up and send it to us. Let's all work together to clarify some of these crucial ideas.

Mike Conrad Penam

Philips Service Company teams with electronic industries association for training program

Philips Service Company (PSC), a division of Philips Consumer Electronics Company (PCEC), announces a stronger training partnership with the Electronic Industries Association (EIA). PSC will recognize EIA provided training for certification of authorized servicers in place of the generic Hands-On Training program provided by PSC's Tech Training.

"We chose EIA because of their commitment to quality and their reputation as an industry leader in 'hands-on' training," said Mike Johnston, Senior Vice President and General Manager, Philips Service Company.

Recognizing the continuing need for product specific training, Philips will begin providing free product specific training seminars via state and local electronic associations. Using normal monthly mailing, PSC will notify servicers of upcoming EIA training meetings and the new product training seminars.

Perry wins first-ever US Silver Medal at I.Y.S.C.

The Consumer Electronics Manufacturers Association (CEMA), a sector of the Electronic Industries Association (EIA), announced today that electronics student Tim Perry won a Silver Medal at the International Youth Skills Competitions (IYSC) in Lyon, France, October 12-15, 1995. Mr. Perry is the first American to ever achieve this level of success.

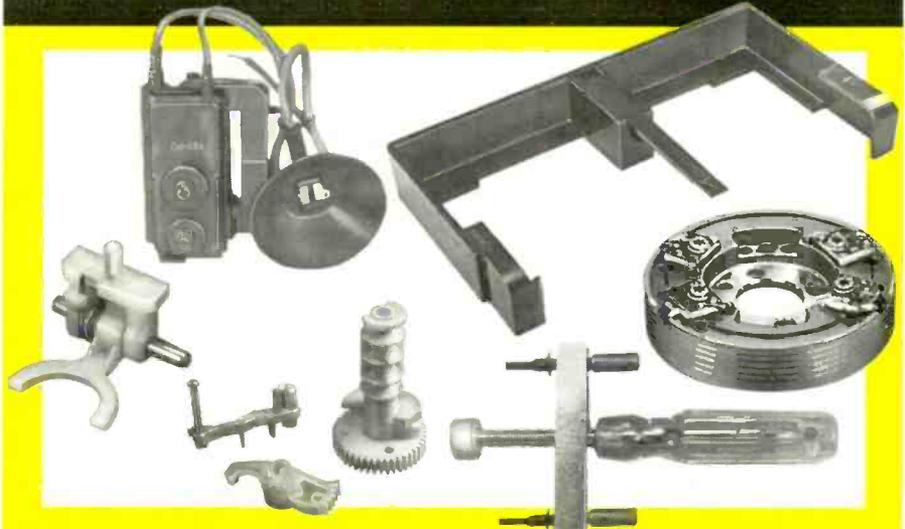
"This is the highest honor that anyone from the US has achieved in electronics product servicing," said Don Hatton, Vice President, CEMA Product Services. "It is a tremendous accomplishment for Tim and for the entire US consumer electronics industry."

Perry competed in several technical events: troubleshooting on computers, PC monitors, security equipment, and home office products; product assembly, testing, and calibration; and an extensive written theory exam.

Prior to his triumphant appearance at the IYSC, Mr. Perry won an impressive string of competitions on a local, regional, state, and national level—all sponsored by the Vocational Industrial Clubs of America (VICA). His next stop was the floor of CEMA's 1994 Summer Consum-

er Electronics Show (CES) in Chicago, where he beat out five other finalists to advance to a head-to-head competition for the US title. Perry was victorious in the final two-day competition, and with CEMA's support, he traveled to France
(Continued on page 65)

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Dynamic VCR head check

By WG

Testing to determine if a VCR video head is working may be difficult, inconclusive, or both. You can measure the static parameters of the head (inductance, resistance, etc.), and you can observe the picture produced on a TV screen by the VCR playing a known-good tape, but if there are playback problems that make you suspect a bad head there is no way to know if the head itself is functional unless you go to the time, trouble and expense of replacing the head with a new one.

Try this dynamic test

A simple and quick technique that you can use to check a head to see if it is actually working is by using a quickly-constructed, hand-made tool. Other equipment that is needed includes a VCR with known-good heads (for experimentation), an RF frequency generator (or a function generator) to generate a signal to be injected, and an oscilloscope and/or a TV to observe the resulting signal. I don't recommend using a TV alone, at least not until you master the technique. Even then, it's best if you have an oscilloscope.

The technique is simple signal injection, using a small inductor (i.e. coil) to radiate a generated signal into the revolving heads (Figure 1 and Figure 2). A two lead inductor is used to "broadcast" a signal from the signal source.

Setting up the equipment

Start by setting up the VCR with a tape that has something recorded on it (one that you don't care about because there is a possibility that it can get damaged), so you can do either or both of the following:

- monitor the FM envelope at the VCR signal with an oscilloscope,
- monitor the VCR output on a TV (i.e. watch the picture generated by a tape being played on a TV screen).

Turn on the signal generator to almost any frequency from around 0.5MHz to as high as 12MHz. Take any two-lead coil from your spare parts box and hook it up to the signal generator directly: one lead from generator ground to one leg of the

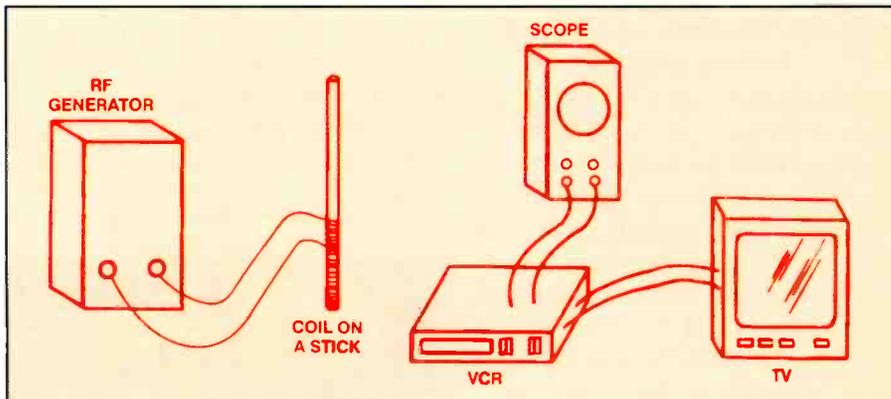


Figure 1. By using an inductor to couple a signal from the signal generator to the heads of a VCR while playing a tape, it is possible to determine if the heads are functional.

coil, and another lead from the signal output of the generator to the other leg of the coil. The type of signal is not critical, but sine waves give a good picture.

You can experiment with triangle waves, square waves, ramp waves, modulated waves, sweep generated waves, etc., but to describe the technique, this article will use sine waves.

Performing the check

With the generator on and the output at a medium to maximum setting, carefully place the coil behind the moving tape being played in the VCR, near the revolving heads (upper drum assembly).

Monitor the FM envelope and carefully move the coil closer and farther away from the revolving heads to get the best waveform on the oscilloscope. Try adjusting the RF frequencies anywhere in the range of 0.5MHz to around 2MHz (or even as high as 12MHz). Also adjust the RF generator output level and/or the scope vertical attenuation.

With very little experimentation you should easily get a "marker" blob on the FM envelope or a series of lines and/or washout on the TV screen, at the top, middle or bottom, depending upon the position of the coil relative to the VCR heads. If you try a coil and you get no waveform

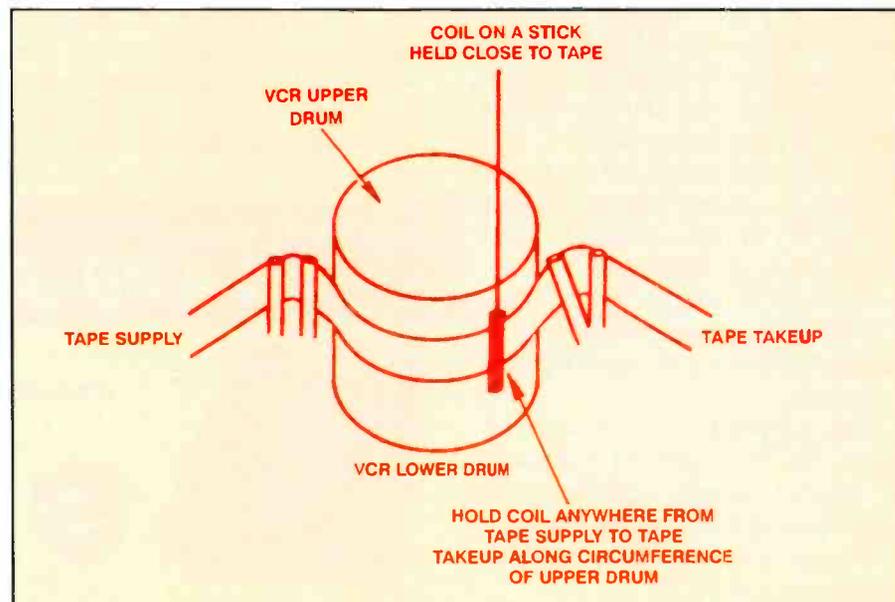


Figure 2. To check the VCR heads, connect the coil to the signal generator and hold it near the VCR heads while the VCR is playing a tape.

WG is an electronics enthusiast who does servicing as an avocation.

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on the oscilloscope, or indication on the TV screen, try a different one.

Most inductors should work

When I was initially developing this technique I tried several different inductors from my stock of reclaimed parts. Just about all of them worked to push an RF signal out of the coil, into the air, through the VCR tape and into the VCR heads where the signal was picked, processed/amplified and passed through the VCR circuits and on to the TV screen. Some of the types and styles of coil that worked are shown in Figure 3.

Take care in constructing and using the coil

Since there is a possibility of catching the coil on revolving parts and causing damage to the VCR, for my own self-made tool I chose a narrow diameter coil about 3/4 of an inch long encapsulated in a smooth, hard, slick coating. I hot-melt glued the coil onto a stick for a handle as shown in Figure 4. As stated before, almost any coil will broadcast enough to be useful when held close enough to, but never touching the tape.

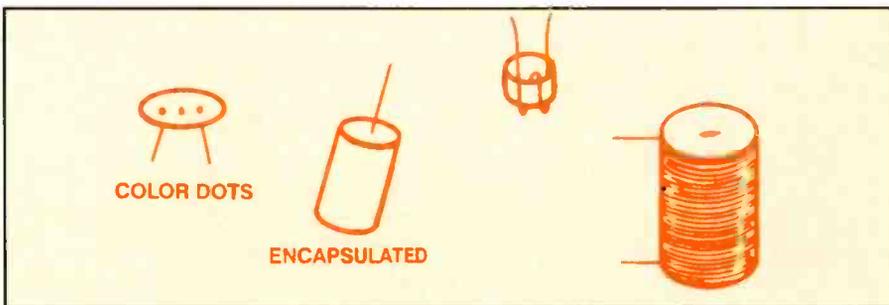


Figure 3. Almost any type of coil can be used to perform the dynamic head check.

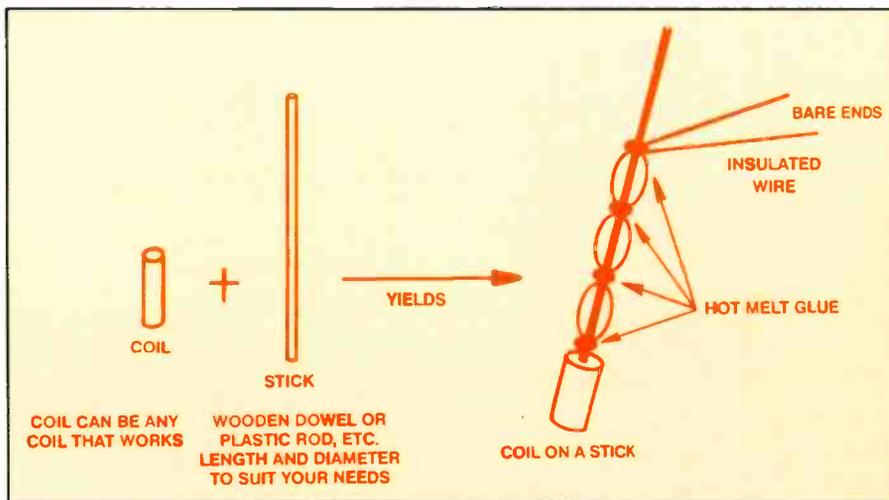


Figure 4. The VCR dynamic head tester can be constructed by gluing a coil to a wooden dowel, plastic rod, etc.

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To recapitulate, to check whether the actual heads of a VCR are truly working (assuming the rest of the VCR is functioning) take the cover of the VCR off, hook your "coil on a stick" (Figure 4) up to any RF signal generator or function generator, connect the VCR to a TV so that you can watch the output on the screen, and/or use an oscilloscope to monitor any appropriate VCR signal (the FM envelope is easy, quick and good).

By carefully positioning the coil near the revolving heads, between the moving tape and the tape cassette, you can observe the waveform on the oscilloscope or look for trash/washout/lines on the TV screen. That's it.

If the signal/marker shows up on the FM waveform, that means that the head is functioning. If snow/lines/trash shows up on the TV screen, that means that the heads are working (this is a little tricky at first to interpret, so I recommend using an oscilloscope until you become familiar with the particular TV pattern of your setup).

Comments

Although almost any inductor may be used, I would suggest a long smooth one. To work, the inductor has to be held right next to the head, a difficult and tricky task sometimes. Non-cylindrical coils could potentially be caught or grabbed or bind up more easily than a smooth cylindrical one. Moreover, a long inductor (around 5/8 to 1 inch in length) covers the entire width of the tape, ensuring at some point that the video head itself passes next to the inductor. Hold the inductor near, but not touching the tape, around 1/16 inch, depending on the strength of the RF signal, the scope vertical setting, and your particular coil. If you can't find a smooth coil, heat shrink a piece of heat-shrinkable tubing around a rough coil.

Use the coil to check all heads

The beauty of this technique is that it allows you to quickly check all heads of any VCR (2-head, 3-head, 7-head, etc.). Remember, some heads work only on certain speeds or in certain modes (i.e. fast forward, freeze frame, frame advance, etc.). All you have to do to check all of the heads is to play a tape that has been recorded at each of the speeds (SP, LP and

EP or SLP) on the VCR and at each speed use FF, freeze frame, etc. Then observe the FM envelope at each setting.

As an example, say that on one particular VCR setting, one of the heads (only two heads are used at a time) is bad, one of the A or B head waveforms will not show any coil marker (trash) on it (assuming the rest of the circuit is okay).

In another example, both of the heads are picking up the RF signal from the coil but the VCR tape picture on the TV

screen is full of speckles. Hence, this dynamic technique shows that both heads are functional for the RF signal, but only one head is properly playing on the TV screen. On the FM envelope, one head shows the FM envelope properly and the signal from the other head is almost a flat line (Figure 5). The greatest likelihood (since both heads pass the RF signal correctly) is that one head is excessively worn. You can confirm this with a head protrusion gauge.



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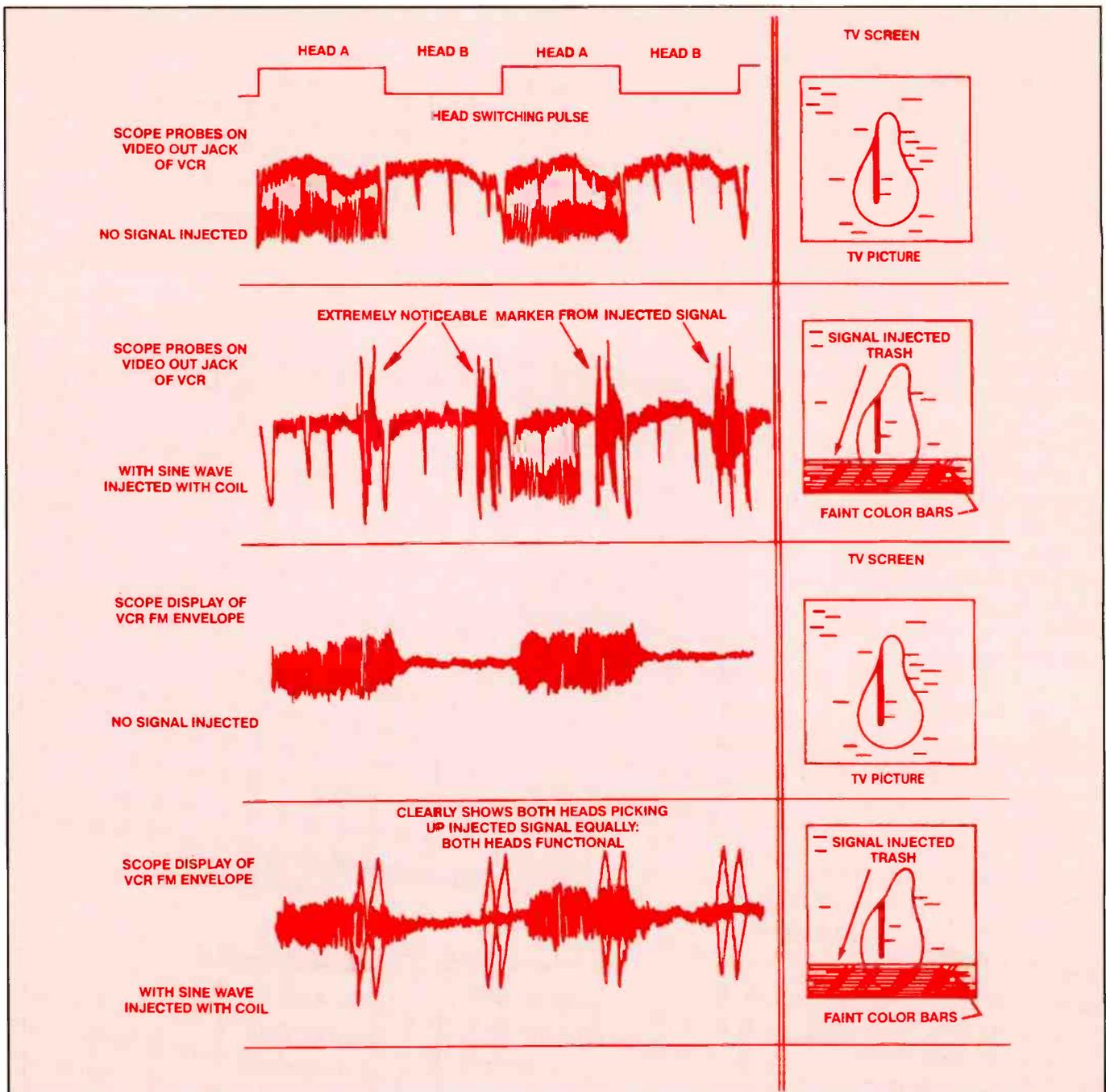


Figure 5. These sketches provide an idea of what a technician might expect to see when performing a dynamic check of the VCR heads. One of the heads is not producing a video signal even though it is picking up a signal from the coil. This suggests that the head is functional, but is so worn that it is not making proper contact with the tape.

Experiment with frequencies and positioning

By experimenting with various frequencies you can get horizontal and/or vertical and/or crosshatch bars/lines on the TV screen, or colored bands, etc. On the scope, watching the FM envelope at certain frequencies shows the familiar S curve of FM alignment.

I have also found that the angle at which you position the coil relative to the video head drum doesn't matter very

much. You're just trying for an easily generated, quick and dirty signal to enter the heads, not to maximize the efficiency with which the signal is coupled to the heads. In most cases you'll find that this RF signal doesn't even leave a trace on the tape when the tape is played back.

This is not a technique in this form or presentation of deriving meaningful waveforms, but simply the presence of an injected waveform at the output confirms that the VCR head is functioning. I suspect that with refinement and appropriate

equipment this technique would easily lend itself to checking much more.

The beauty of this technique is that it doesn't require any fancy or expensive instrumentation or even knowledge of where to hook up probes (or the sometimes exasperating mechanical difficulties in finding test points and/or attaching probes to them). You simply remove the cover of the VCR, insert a tape, play it and monitor the FM envelope and/or video out jack and/or TV screen while you inject a signal via your coil on a stick.

General software for service centers

By The ES&T Staff

The personal computer has come into its own as a desktop appliance that almost every home, business, and professional person will possess and use. Today's personal computers offer speed, power, ease of use, sound and graphics, and communications capabilities that allow an individual to accomplish a great deal more with the same amount of effort.

For example, with a word processor, the computer user can type a letter, and then print and address copies individually to any number of people with no further effort. To accomplish the same task using a typewriter would require that the individual type each letter separately.

Use of a database program allows the user to maintain a list of any kind, say a mailing list, and manipulate that list easily in any desired way. For example, say a service center wanted to identify its customers in a certain geographical area, it would only have to search for certain zip codes, and then print a list of the customers in those zip codes.

The computer in business

Every business of any size now owns at least one personal computer to maintain a database of customers, keep track of inventory, handle the accounting.

Fraternal and charitable organizations use the personal computer to accomplish many of the same types of functions as those performed by businesses.

Families are using their home computers to track their finances, store and retrieve recipes, play video games, and write term papers.

A general-purpose machine

The personal computer can do so many different things for different people because it is truly a general-purpose information processing machine. As long as the information that it processes can be reduced to a series of bits representing ones and zeros, the computer doesn't care if it's processing mathematics, graphics, words or music. Its ability to handle infor-

mation is limited only by the power of the processor, the size of both temporary and permanent memory, and the skill and imagination of the programmers who write the software.

In several past issues we have published articles about specific types of software. In one issue, for example, we talked about service center management software. In another issue we reported on diagnostic software.

The utility of the personal computer to the consumer electronics service business is not limited to those two types of software, however. There is a host of personal computer software, much of which was written without regard to the needs of electronics service, that nevertheless can be very useful in the service business.

This article will look at a few of those products. We'll briefly mention such software as word processing, database and spreadsheet, as well as products like electronics circuit diagnosis and design and computer-aided drafting (CAD).

The big three

Most individuals as well as businesses have a need to communicate on paper, to store and retrieve data, and to perform mathematical calculations. The personal computer is ideally suited to do all of these things, and programmers have designed many types of software to make it easy for computer users to do them.

The programs that are available to perform these functions are called word processing, database, and spread sheet programs, respectively. There are many companies that have huge resources dedicated to devising and improving these types of programs.

Word processing

The single most popular application of the personal computer is word processing. Word processing programs allow the user to type up letters and other correspondence on the computer and save them in memory until it's time to print them. It

also, of course, allows the individual to make corrections before the page is ever printed, so even the poorest typist can turn out perfect looking material.

But that's only part of what a word processor can do. Because the software manufacturers employ a wide variety of talent, many word processor software packages have a broad array of features, such as pre-formatted pages, graphics capability, and type available in a variety of sizes and styles. So the user can call up a certificate, design a letterhead, create a greeting card or format a newsletter.

Some of the more popular examples of word processor software are Word Perfect, Word Star, Word.

Spread sheet

Spread sheet programs, such as Lotus 123, Microsoft Excel and Quattro Pro, are extremely useful for anyone who needs to perform calculations in columnar fashion. The screen representation of the program consists of an array of horizontal rows and vertical columns. The intersection of a row and a column is called a "cell." You can enter numbers in cells, and then use the program's functions to operate on them.

For example, if you enter several numbers that you want to add together, such as household expenses, then you can enter a formula into another cell that will give the sum of those numbers. If you wanted to, you could also take the mean, the mode or the average of the numbers.

A spread sheet is especially useful for doing what accountants call "what if?" types of calculations. For example, let's say you work out a business plan for next year based on increasing your volume by some percentage, and assuming a particular inflation rate, you can then change those percentages and all of the calculations based on those rates will change.

Data base

Data base programs, such as dBase, Paradox, and Lotus Approach, allow the

user to store data and manipulate it in a number of different ways, depending on the experience and skill of the user. Actually, many database applications, such as service center software management programs, are based on one of these software packages.

Electronic circuit simulation

Some computer software programs allow the user to actually design a circuit on the computer screen and test it to see how it works. For example, one program, called Electronics Workbench by Interactive Image Technologies contains not only symbols for typical electronics components that can be hooked together, but it also has simulated test equipment on the monitor screen that can be connected to various points in the simulated circuit to read the parameter values.

To start building the circuit, the user moves the mouse over to the "parts" section of the screen, clicks on the part: resistor, capacitor, or whatever and drags it to the workspace on the screen, then drops it and runs "wires" to it. If the circuit gets too big for the screen, simply scroll and keep building. Because the wires are routed automatically, and a grid is available, even complex circuits are readable.

All commands can be issued from simple menus with a mouse, and common operations have keyboard shortcuts. You can cut, copy and paste groups of components, or put components into a subcircuit,

a kind of "black box." It's even possible to put one subcircuit inside another to simplify complex circuits. Subcircuits can be used simultaneously in many places in a circuit and stored for later use.

Other features of this program include an unlimited supply of all kinds of components, simulated test equipment that can be used to check circuit operation, and simulation of the circuit once the virtual "power" has been switched on and the virtual signal has been applied.

Educational features

A service center could use this type of software for educational purposes. For example, if one of the technicians should need training or a refresher on any type of circuitry, the service manager could set him up with a computer with this software on it and let him study on his own.

Another feature of the software, however, is that the individual who controls the computer, the instructor or service manager can introduce real world faults. For example, any component can be open-circuited or short-circuited, in a manner that's hidden from the student to give him some troubleshooting experience.

Drafting

Another type of software that may be of value to service centers is drafting software. Every service center uses schematic diagrams in one form or another, and from time to time may have a need to draw

partial diagrams of a TV or VCR or other consumer products.

Many times, such hand drawings do not very well convey the desired information because they're not clear and sharp. A drafting software package allows anyone who owns a personal computer to produce first class drawings, and not only of schematic diagrams, but of buildings, floor plans, and anything else that lends itself to drafting techniques.

On-line services and the Internet

If all of the other capabilities mentioned here weren't enough to make a personal computer all but indispensable to any business, the availability of on-line services with connection to the Internet makes it even more useful. There are a number of services: America On-line, CompuServe, GENie and Prodigy, to name a few.

Each of these on-line systems offers the user a broad mix of services. The mix of offerings from each on-line system is different, but many of the core services they offer are similar.

As examples, the user of an on-line service can read today's headlines, look at synopses of current magazine articles, check airline schedules, make reservations, look up the best places to dine in any city, check the weather anywhere in the world, access an encyclopedia, send messages to or chat with other members of the service, and more.

In addition, most on-line services offer access to the Internet so that users can send and receive messages to any other person who has access to the Internet, anywhere in the world. Today it's even possible to communicate by voice via the Internet.

Getting the most out of computers

Computers and computer software have had a profound effect on the way work gets done. They provide a number of features and functions that allow people to automate the work to be done and to look at the information they need to process in a variety of new ways.

Consumer electronics service centers have such a broad variety of information processing needs that software such as the ones mentioned here can make it much easier for owners, managers and technicians to do their difficult jobs. ■

Test Your Electronics Knowledge

Abbreviations and acronyms

By Sam Wilson

As you might expect, I have certain pet peeves. One such pet peeve is authors who use abbreviations and acronyms without defining them. They are saying: "I know something you don't know, so there!" They disregard the fact that there are newer young readers who are trying to get a foothold.

Here are a few examples of acronyms and abbreviations. Fill in their meaning and then check your answer.

1. ADC _____
2. ASIC _____
3. CAT _____
4. CPS _____
5. GPIB _____
6. MPU _____
7. OEM _____
8. PTC _____
9. SBS _____
10. UPS _____
11. VHSIC _____
12. ISO _____

(Continued on page 61)

Wilson is the electronics theory consultant for ES&T.

New technology

By The ES&T Staff

A home in one of the developed nations today may very possibly have a home theater with a large screen TV, surround sound, pictures and sound delivered from local broadcast stations, a cable TV system, a digital satellite system, a VCR or a laser disk; a personal computer with millions (or even billions) of bytes of disk storage and access to virtually limitless information via the internet; and cellular telephone communications.

Over the past several decades advances in technology have transformed consumer electronics. And, technological advances being made today are continuing to transform the world of consumer electronics. Here are some of the things that are going on right now that will, probably sooner than any of us expect, be affecting consumers and consumer electronics service.

Interactive multimedia via telephone/cable

In 1994, AT&T Network Systems and BroadBand Technologies, Inc. announced an agreement to jointly develop and market a new broadband access system which would allow telephone

and cable companies to offer interactive multimedia services (Figure 1).

The effort resulted in the SLC-2000 Access System with FLX switched digital video (SDV). This product integrates BroadBand Technologies Fiber Loop Access (FLX) switching and transport with AT&T's widely distributed SLC-2000 digital system, creating for network operators a powerful, cost-effective technology platform for new digital services.

Currently deployed by Southwestern Bell Telephone Co. in Richardson, TX, the new access platform is scheduled for first application delivery to customers in 1996. The system will be marketed, sold and serviced in the US and Canada by AT&T Network Systems, with full support from BroadBand Technologies which is the sole provider of the SDV capability for the SLC-2000 Access System. The new platform meets existing and emerging industry standards including SONET, TR303, MPEG2 and ATM.

The addition of the SLC-2000 Access System with FLX SDV complements AT&T's current HFC-2000 hybrid fiber-coax offer, allowing Network Systems to provide telephone and cable companies

with the broadest range of architectural choices to meet their service needs.

The HFC-2000 Broadband Access System is an integrated hybrid fiber-coax network. It delivers a mix of broadband and narrowband services, including telephony, analog cable television broadcasts and switched digital video services from a central office or headend to the home.

The SLC-2000 Access System with FLX SDV is the only second generation SDV technology available today. As AT&T and BroadBand Technologies continue to develop this platform, these features are being integrated:

- Direct delivery of ATM capability to subscribers' homes.
- Complete choice of initial deployment options from telephony to switched digital video and high-speed data services.
- It is the only system to utilize 16-CAP technology, which makes possible the transmission of video services over either coax or twisted pair drops and enables reuse of existing wiring in the home.
- It guarantees suppliers and service providers privacy through switched point-to-point digital services which delivers only one signal per subscriber.

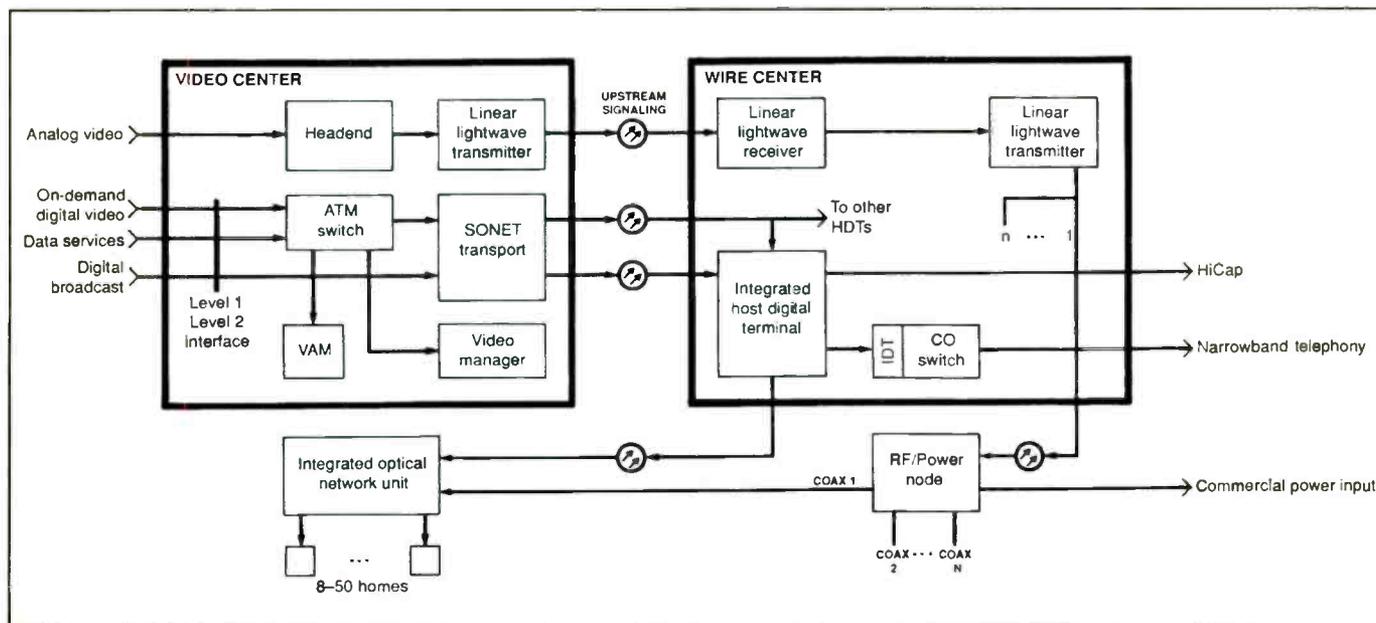


Figure 1. Telephone systems may soon be providing analog video, on-demand digital video, data services and digital broadcast, in addition to the telephone service that we currently expect from the telephone.

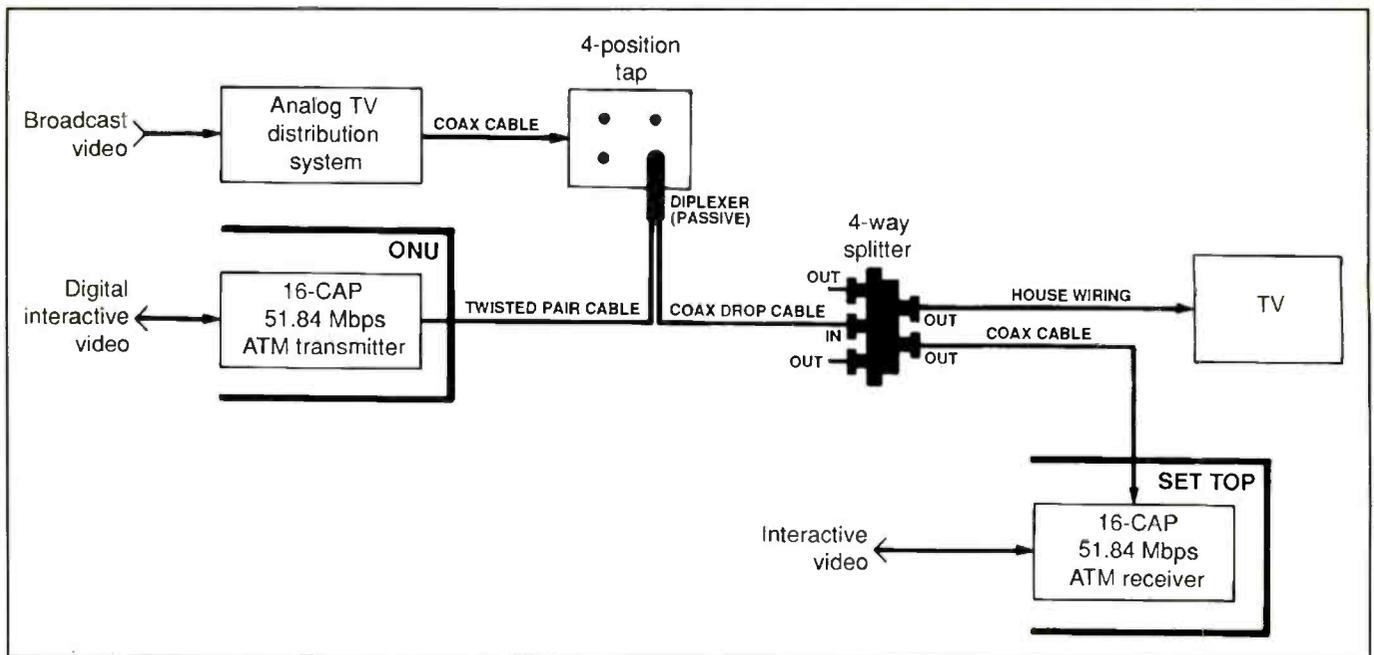


Figure 2. Technology called 16-CAP makes it possible to achieve a transmission rate of 51.84Mbit/sec, enabling video and other high bit rate signals to reach multimedia workstations and other desktop machines without requiring expensive upgrading of on-site cabling.

Digital light processing

Runco International, a manufacturer of high quality home theater video products, has announced an alliance with Texas Instruments to bring TI's digital light processing (DLP) to consumer projection video displays.

The new DLP projection technology provides many advantages over conventional LCD technology on the market. In addition to the benefits of size, weight, and portability, DLP technology delivers a better picture, longer illumination life, and semiconductor reliability.

The Texas Instruments DLP, a focused TI development since 1992, has already been selected by manufacturers in the professional and business products markets, and Runco plans to move DLP to the consumer. Runco is in the early phases of applying the technology to home theater video projectors. The company says that its current prototype delivers a very bright image with clarity, high contrast, and well-balanced color.

"We have always believed that image quality is our foundation," said company president Sam Runco. "DLP technology now offers an improved alternative to LCD, and holds the promise of making cathode ray tube systems obsolete in the future." Runco expects to have DLP-based models in the market by the third quarter of 1996.

TI's DLP projection technology is

based on its DMD (digital mirror device), a highly integrated semiconductor light switch. DLP technology combines a DMD with digital signal processing, memory, software, optical components, and an illumination source to create display systems. Runco is the first company to announce the use of the technology in home applications.

Home theater surround sound

Yamaha Electronics Corporation has introduced its first digital sound field

processor incorporating Dolby's latest surround sound home theater format, AC-3. The new model, designated DSP-A3090 (Figure 3), provides the 5.1 channels of AC-3 surround as well as the 7 channels of Yamaha's Cinema DSP surround settings for Dolby Pro Logic sources and five new modes that combine AC-3 with Yamaha DSP to deliver what Yamaha calls the most spectacular home theater experience possible today.

In order to provide the massive amount of program memory required to deliver

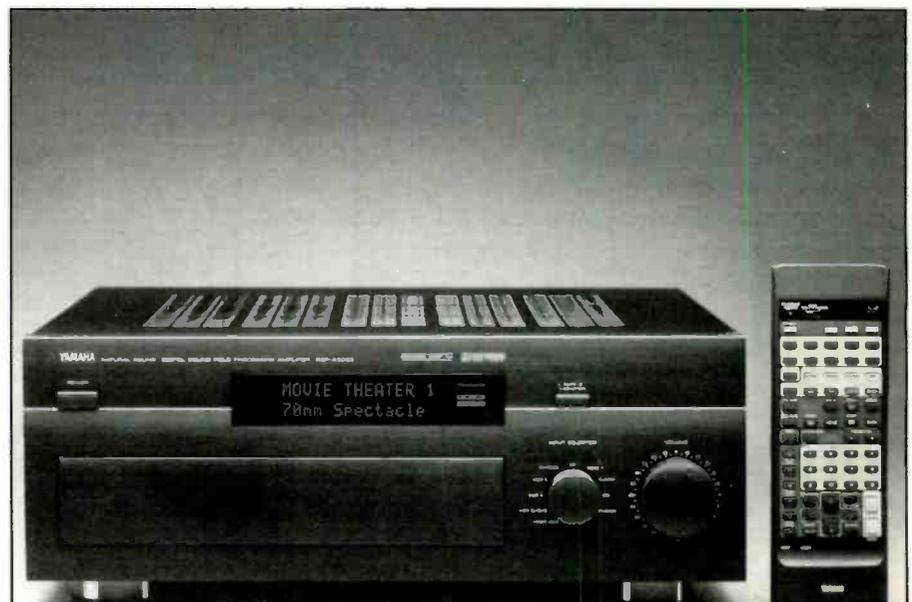


Figure 3. This digital sound field processing amplifier brings the latest in-theater sound to the home environment.

ATM

The ATM Forum, a leading networking industry body, has selected an AT&T concept as the preferred technology for two-way broadband transmission of ATM (asynchronous transfer mode) signals over ordinary telephone wires.

The concept is called 16-CAP technology (Figure 2) and it enables analog transmission of up to 51.84 megabits per second over 100 meters or more of ordinary unshielded copper pair wiring such as that used for telephone wires. The 16-CAP concept effectively triples the previous data transmission capacity of ordinary unshielded twisted-pair (UTP) wiring. "CAP" stands for Carrierless Amplitude-modulation Phase-modulation, a technology derived from existing concepts used in current high-speed modems; "16" stands for the number of different symbols that are used to achieve a transmission rate of 51.84Mbit/sec.

All 16 levels are used at the maximum transmission rate over voice grade pairs, coaxial cable or some fiber optic links. The same 16-CAP chip can back off to transmit at lower bit rates over longer distances or over standard wiring.

By greatly increasing the transmission capacity of existing twisted-pair wiring, the new technology enables video and other high bit rate signals to reach multimedia workstations and other desktop machines without requiring expensive upgrading of on-site cabling. The saving is expected to expedite the introduction of ATM into the proposed national information superhighway.

that kind of impact, Yamaha has designed and incorporated a sophisticated and powerful new VLSIC chip, the YSS-214. The new, very large scale integrated circuit supplies 33% more processing power than those used in the company's previous model, the DSP-A2070.

Building on a decade of sound field processing experience, begun with the DSP-1 in 1986, the new DSP-A3090 is

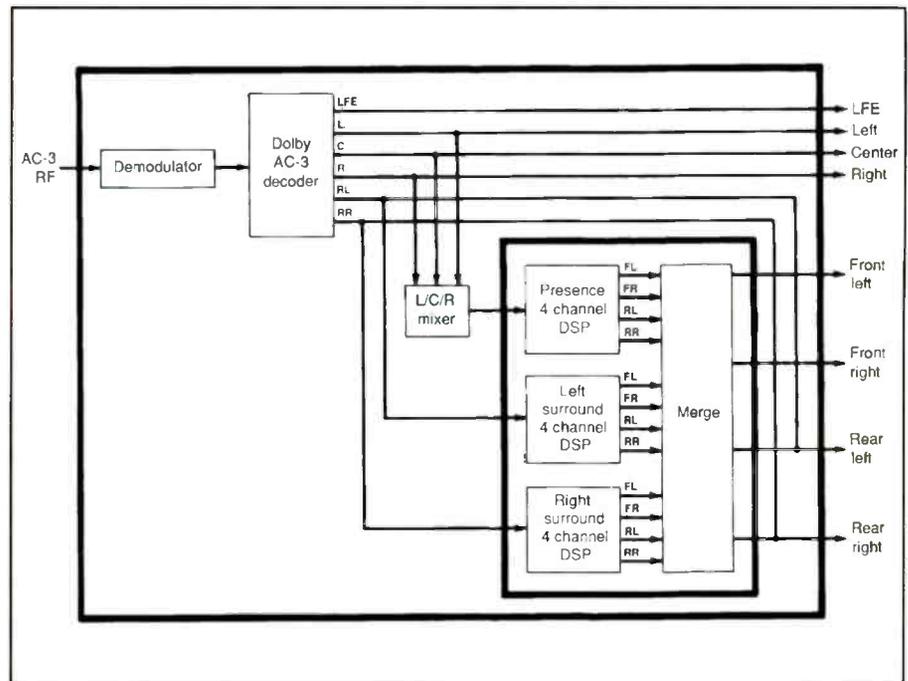


Figure 4. Block diagram of Dolby Surround AC-3 + DSP processing.

the fourth generation of the company's seven channel processor/amplifiers.

With 80 watts each to five channels and 25 apiece to the front effects channels, the unit provides more power than either of its predecessors. But power is not the only advance made by the new model. The unit incorporates a total of 30 different surround modes, the 24 built into the DSP-A2070, plus an additional six modes developed exclusively for AC-3.

A built-in test tone generator provides a sweep of the channels to establish proper balance. A subwoofer test tone generator provides a level for adjusting the subwoofer output so that a listener can match the room and the rest of the system.

Dolby surround digital

Dolby's new surround digital format, also known as AC-3, represents the next logical step in realistic and dramatic home theater (Figure 4). AC-3 is the home version of Dolby Digital found in movie theaters. For proper playback, AC-3 encoded discs require players and processors specifically designed to handle the new system. By the end of 1995, there will be more than 40 movies out on laserdisc in the AC-3 format, including such recent hits as "Forrest Gump," "The Lion King," "Outbreak," and "The Little Princess," as

well as new AC-3 mixes of classics, such as "Doctor Zhivago."

Dolby AC-3 has five discrete, full-bandwidth channels, plus a sixth subwoofer channel. The system creates a single composite digital data stream from which the discrete channels are later extracted. The advantage of the system is that its discrete full-range channels provide greater sound localization and simultaneous impact.

Servicing it

While all of this wonderful new technology improves the quality of life for consumers who are enjoying it, it also makes life more of a challenge for the service technician. Each one of the technologies mentioned here is one that technicians will no doubt face in the near future. What do you do when you're faced with a television set that's hooked up to the telephone system, or a TV or monitor that doesn't have a CRT, but instead a digital light processor?

We'll try to follow this introduction up with specific articles that address those challenges. But if we're not able to provide those articles before you need them, at least it won't be a complete surprise when you see some of these new technologies. ■

Troubleshooting color circuits without a schematic

By Homer L. Davidson

When you're servicing a color set that's having problems in the color circuits and the schematic diagram is not available, try a schematic of a set of the same make that may be similar. It is common that a set by the same manufacturer, or even one made by a different manufacturer, may have the same type of color circuits.

If you can't find a schematic of a similar set, you can try ordering the schematic for the set you're working on. You may find the schematic no longer exists, that it could take days or weeks for it to reach you, or that it may not come at all.

When you can't find a schematic for a given set, the only method that is left is to try to solve the no color symptom without the schematic. In modern sets the color circuits are located with the luminance and video circuits within one large IC. In the latest TV chassis you may find the IF/SIF/Video/Chroma/Vertical and horizontal deflection/and AFT circuits are in one large IC. In fact, you will frequently find a number of IC's and transistors in the color circuits.

Color symptoms

The most common problems caused by defects in the color circuits are the absence of color, intermittent color, poor color sync, washed out or weak color, or one color is missing.

Absence of color may be caused by just about any component within the color circuits. Intermittent color troubles are caused by internal IC breakdown, intermittent capacitors tied to the IC circuits, poor transistor and IC terminal contacts, 3.58MHz crystal, and poorly soldered connections. Weak and washed out color can result from a weak color stage, poor signal capacitors, improper resistance and the voltage source. Check the color output and demodulator IC output waveforms when one color is missing from the picture or raster.

Visual inspection

Many TV symptoms are caused by

Davidson is a TV servicing consultant for ES&T.

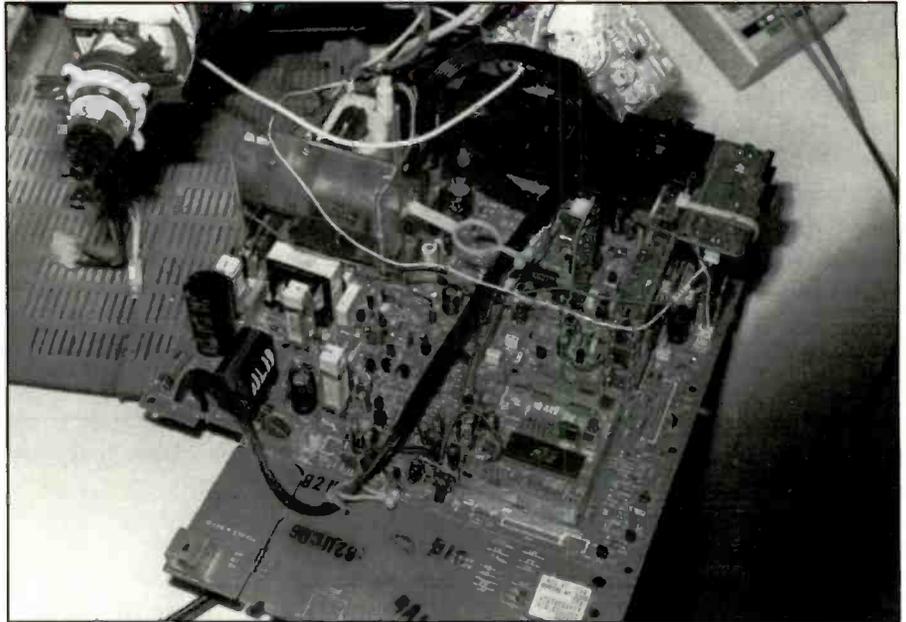


Figure 1. Examine the television circuits for burned and cracked components, loose leads and displaced parts.

burned or broken components. Unfortunately, these damaged components are often obscured because the TV chassis is literally covered with layers of dust and dirt hiding the small components (Figure 1). If the set you're working on fits this

description, blow out the chassis so you can see any damaged components. Flexing the chassis or prodding with a plastic tool can help locate an intermittent component or poorly soldered connection. Do not overlook small surface mount devices

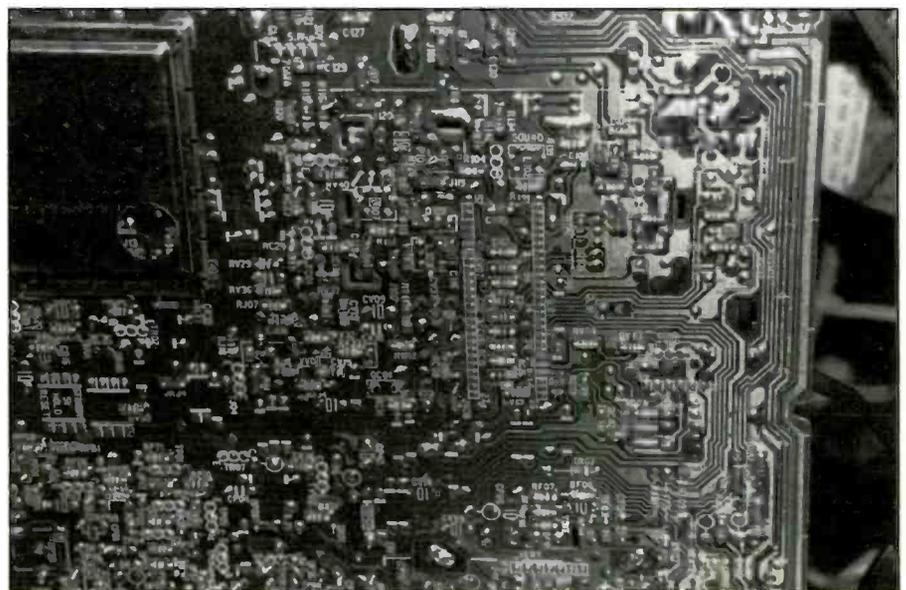


Figure 2. To locate the color circuits, find the 3.58MHz color crystal and trace the PC wiring from it to the correct color IC circuits.

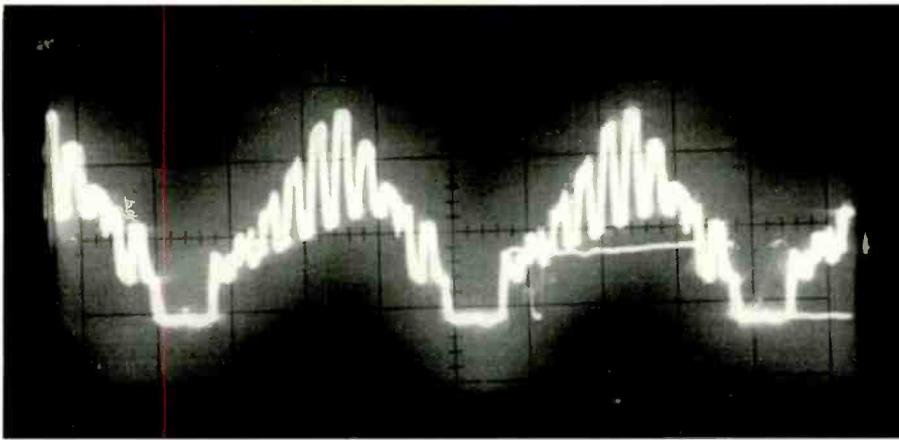


Figure 3. All three color output waveforms (B-Y, G-Y and R-Y) look somewhat alike and often the terminals are in rotation.

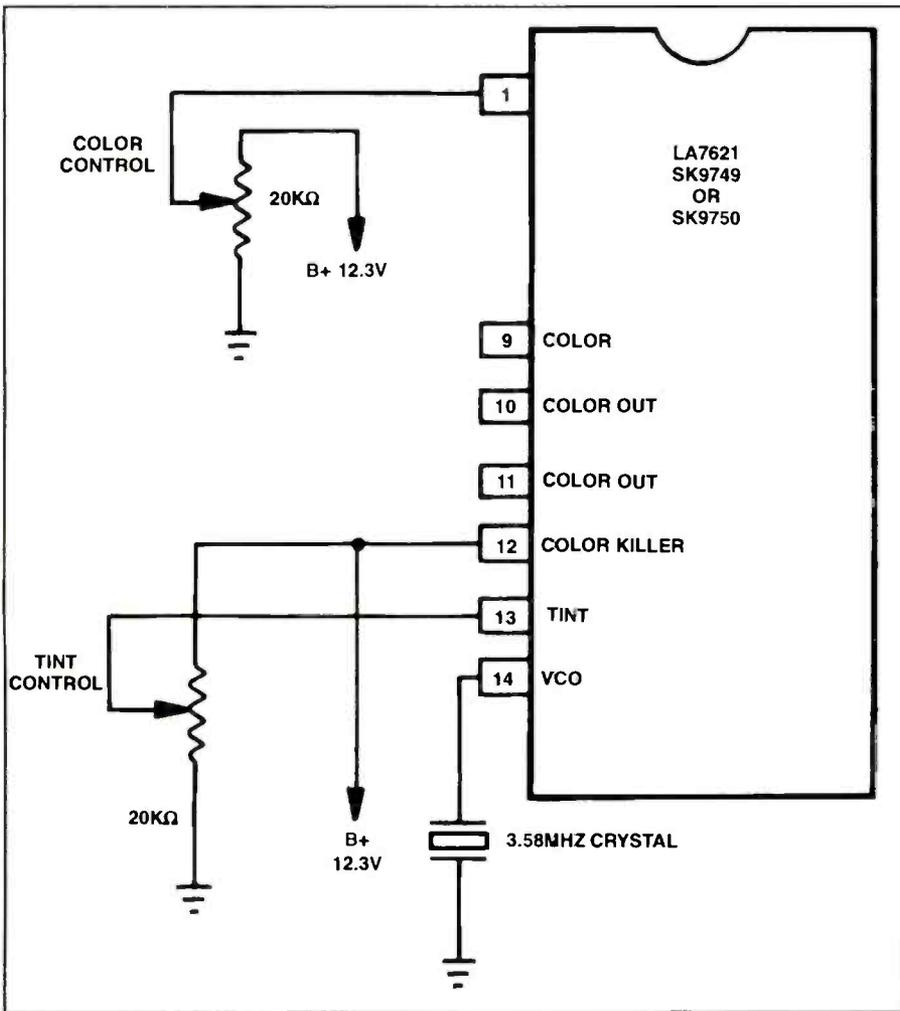


Figure 4. Look up the part number of the color IC in a universal semiconductor replacement manual to determine its pin assignments.

(SMD) or fold-over circuit connecting circuit wires.

Take a magnifying glass with a strong light and check the various components in the color circuits. You may be able to spot a resistor that has overheated or burned. Poorly soldered PC wiring con-

nections may be indicated by a dark ring or marks on the PC board around the component terminal lead.

Locating the color circuits

You can locate the color IC circuit section by locating the 3.58MHz crystal

mounted close to the color IC (Figure 2). Now trace the color oscillator circuit back to the IC terminals. Take the color or tint control leads and trace them back to the combination IC. Of course this takes more time, but you can locate the color IC in this manner. Remember, several different circuits may be fabricated as part of the large IC.

Another method is to locate the color IC output terminals that feed to the color output transistors and the CRT color gun assembly. These color output circuits are located on the CRT socket assembly. Trace the wiring back to the TV chassis and the correct demodulator IC terminals. Often these three color output terminals are located in a row. The color IC input terminal can be identified with a 4.5MHz ceramic filter or coupling capacitor.

You can observe these color output waveforms at the three output circuit terminals with the scope (Figure 3). Start at the color output transistors and work back toward the color demodulator IC terminals. Of course, one or all three waveforms can be weak, missing or distorted. This again takes time, but you can locate a defective color IC or color circuits. Make sure the black and white picture is normal before trying to troubleshoot the color circuits.

IC color circuits

After you locate the chroma IC, you may find it difficult to determine which IC terminals correspond to the color circuits. One way to determine the circuitry that's in the chroma IC is to look up the IC number located on top of the IC in the semiconductor replacement manual. Most IC's have a number stamped on the top flat side of the IC. Simply look this number up in the semiconductor manual.

For instance, the chroma circuits in a Sanyo AVM 255 chassis are located in an LA7621 IC, which includes color video, chroma, vertical and horizontal deflection circuits. This IC can be replaced with an RCA SK-9749 replacement IC. When the original IC part is not available, universal replacement IC's function well in the color circuits.

Besides allowing you to locate a universal replacement, the information in the semiconductor manual will tell you which terminals tie to the various color circuits (Figure 4). In this case, the color control connects to terminal 1. Terminal

13 connects to the tint control. The color demodulator output terminals are 9, 10, and 11. A VCO crystal oscillator circuit is connected to pin 14 with the color killer circuit tied to pin 12 of the universal replacement SK-9749 IC.

Scope and voltage tests

Once you have determined the functions of the chroma IC terminals, use the oscilloscope to observe waveforms at each color terminal. A color waveform at the color output terminals will indicate if the color circuits are normal. A distorted color waveform or the absence of a waveform can indicate a defective chroma IC, incorrect IC source voltage, or a defective part within the color circuits. Check the waveform at the VCO 3.58MHz crystal to see if the circuit is oscillating. Do not overlook a sandcastle or flyback waveform tied to the color circuits.

Measure voltages and resistances to common ground from each IC terminal. Measure from the terminal pin to ground. You may locate a leaky or shorted component. A low resistance measurement indicates a leaky component or a chassis ground connection. Of course, without documentation you don't know what the voltages on each terminal should be, but the highest voltage at any one terminal should be the voltage supply terminal (Vcc). The IC supply voltage is found in the semiconductor manual.

The voltage at the color and tint IC terminals should vary when either control is rotated. Usually, one side of the control is grounded and the other ties into the low voltage source. If a similar schematic has the same type of circuit, use these voltage sources as reference.

Starting with the oscilloscope

Some technicians prefer observing waveforms with the oscilloscope and then measuring voltages. After locating the correct color IC, observe scope waveforms at each terminal until you have located a waveform that has the shape of a color waveform.

If you find three waveforms alike, you have located the color output terminals. If you observe a waveform when scoping the color oscillator stage, you know the oscillator circuits are functioning (Figure 5). If you do not know what the appearance of the color waveforms should be,

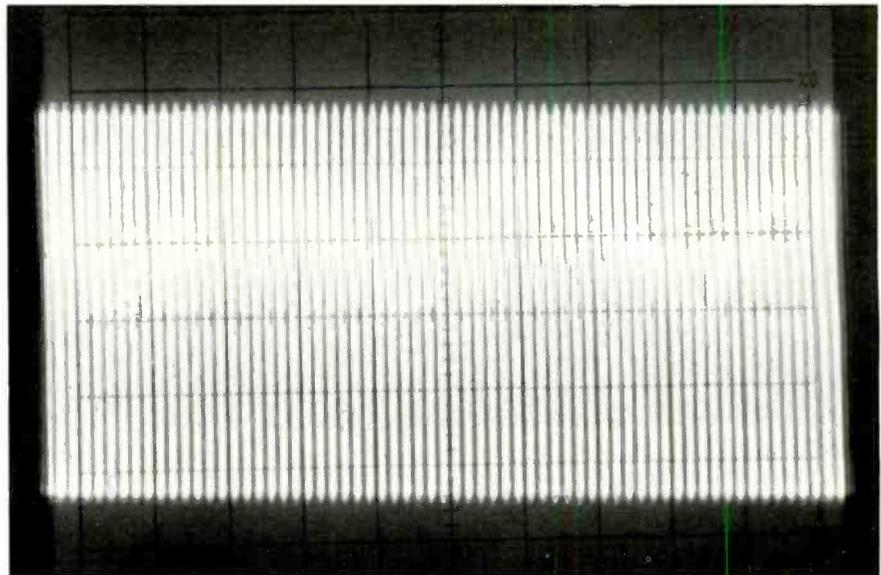


Figure 5. Connect the oscilloscope to the 3.58MHz color oscillator terminal to determine if the circuit is oscillating.

check the waveforms of color circuits on a known schematic. After you have finished checking the waveforms, measure the voltages.

Only black and white

If the symptom is absence of color, the defective component should be easy to locate. Start by locating the IC containing the color circuits. Observe waveforms at the color oscillator and color output terminals. If you don't know what terminals the color circuits are connected to, scope each IC terminal.

Sometimes the top markings on certain IC's do not indicate the part number, so you cannot look them up in the semiconductor manual. In other foreign chassis, you may not see any recognizable part numbers. Check with the schematic of a similar chassis.

The no-color symptom can be caused by the color IC, a defective 3.58MHz crystal, or an improper voltage source. Most color problems are caused by a leaky or shorted color IC.

Usually, if no color is found in the picture, you may find a defective part connected to the IC terminal. Often voltage and resistance tests will uncover a defective connecting component.

The color dot-bar or NTSC color generator is required in setting up and troubleshooting color circuits. The output of the color generator is connected to the antenna terminals. In fact, the color sig-

nal from the generator is the signal source used by Howard W. Sams in generating the color waveforms printed in Photofact folders. Although a color broadcast signal can be used as a signal source in troubleshooting color circuits, it is best if you use a crystal-controlled generator to match the manufacturer's waveforms. In addition to color tests, the color dot-bar generator can be used to check vertical and horizontal linearity, level the yoke assembly, and correct color bars and pin cushion circuits.

Color absent - Goldstar CMT-2612

The picture on the screen of a Goldstar CMT-2612 chassis had no color. The black and white picture was normal. Without a correct schematic, the color IC was isolated by locating the 3.58MHz crystal next to it. Observation with the oscilloscope revealed that there was no color oscillator or output waveforms. I immediately measured critical voltages and recorded the measured values.

Voltages at all terminals of the color IC, LA7629, were low. I checked IC LA7629 in the universal semiconductor manual and found that it can be replaced with an NTE-7008 universal replacement (Figure 6). The input terminal of this IC was pin 30, the crystal oscillator output terminal was pin 14, color output terminals were 9, 10, and 11, and the supply voltage source (Vcc) was connected to pin 16. The voltage at pin 16 was very low

(0.91V). The manual indicated that the color IC voltage source should measure around 12V.

I then measured the resistance from pin 16 to ground and it read less 0.15Ω. I disconnected pin 16 from the PC wiring using a desoldering braid and made another measurement. The supply voltage was now above 12V, indicating that IC501 was leaky. When I replaced IC501 with an NTE-7008 universal replacement, the set returned to normal operation.

Color pops in and out

Intermittent color is perhaps the most difficult problem to locate in the color circuits. After an hour or two, the color would disappear in an RCA CTC145 chassis. The black and white picture was normal. The best method of troubleshooting this condition is to monitor the color IC terminals at the 3.58MHz crystal and the color output and input terminals. You can locate the color IC by locating the 3.58MHz crystal.

In this RCA chassis, one large IC contains the IF/SIF/chroma/vertical and horizontal/AFT circuits. There are three

large IC's in this chassis. The IC next to the crystal is the color IC. Observation of waveforms in the crystal oscillator circuits and output terminals confirmed that this was the color IC (A23-1101-01A). In cases where the schematic diagram is not available, measure waveforms at the IC terminals and mark the IC input and output terminals and 3.58MHz crystal pins. You may note that the IC color circuits used in this set are also used in several of the latest RCA circuits.

I monitored the color circuits with the scope lead connected to the 3.58MHz oscillator terminal, pin 6, and the DMM at Vcc voltage supply pin 16 (Figure 7). The voltage at this pin should be the highest voltage at any of the IC terminals when the color circuits are normal. When the color dropped out, the supply voltage changed very little and the 3.58MHz waveform was still normal.

Next I connected the scope to pin 9 of the IC. This time when the color disappeared there was no color signal at the output color terminal. I measured critical voltages while the set was in the intermittent mode and checked them against

those readings that I recorded when the set was in the normal state.

Some voltages were off only a fraction of a volt. If you're servicing TV color circuits and find that the voltages at the IC terminals don't change when the video, luminance or color waveform is missing, suspect a defective IC or capacitor connected to the IC terminals. When a resistor changes value, the voltage measurement at the IC terminal to which it is connected will also change.

In this case, I suspected the color IC or a capacitor connected to the color circuits. When I sprayed C2810 with coolant and then prodded it, the color would come and go. This capacitor turned out to be the source of the problem. Always check all components tied to the IC pin terminals before removing the suspected IC.

Unusual color problem

In an Emerson MS250R model, there was a no. color symptom. I located the color IC by locating the 3.58MHz crystal. Observation of waveforms at the IC terminals indicated that there was no

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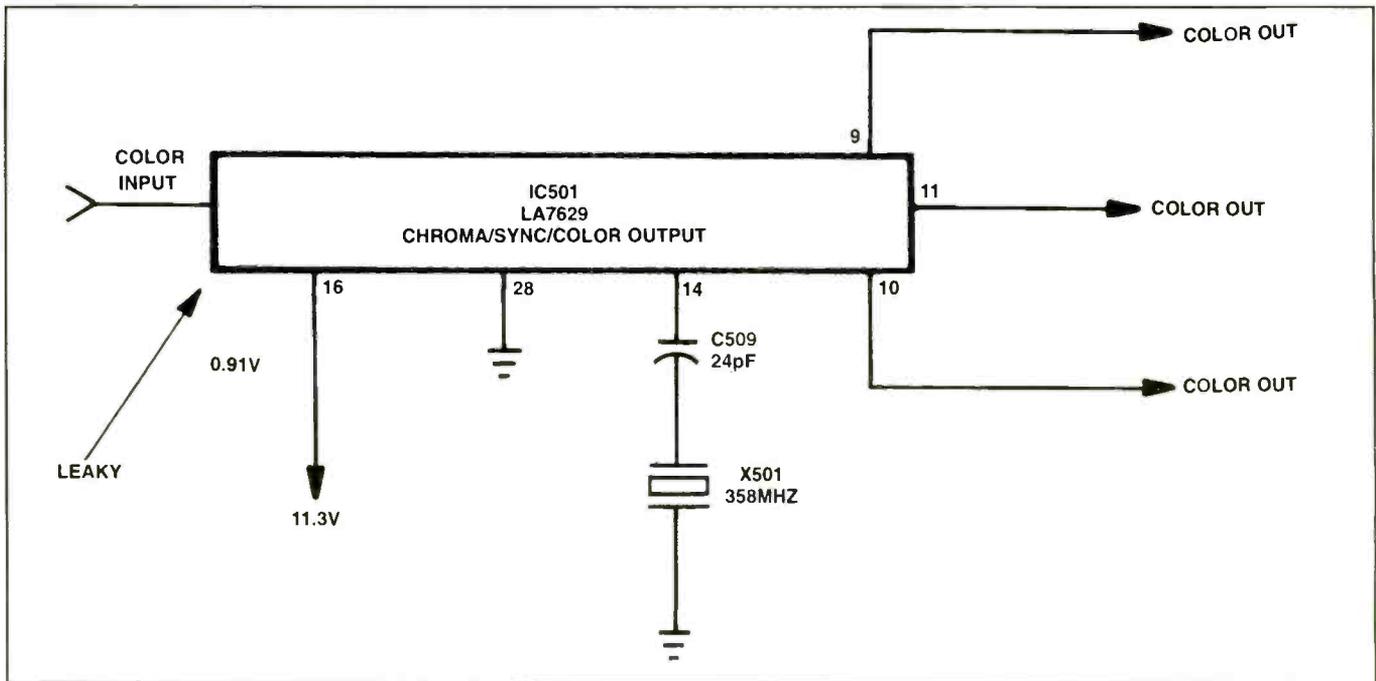


Figure 6. A leaky IC501 caused the no color symptom and low voltage supply source (Vcc) in a Goldstar CMT-2612 chassis.

color waveform. I traced the color crystal circuits to pins 16 and 17 with the crystal and small trimmer capacitor in between (Figure 8).

I then connected the oscilloscope to

pins 16 and 17, but there were no waveforms at those points either. I located the color circuit terminals by checking the drawing of IC201 (TA7644BP) in the semiconductor manual.

Next, I measured the voltage at each IC terminal. The supply voltage at pin 3 was normal at 14.9V, pins 17 and 18 measured 4.3V and pin 16 measured 7.4V. Since the supply voltage was normal, I suspected

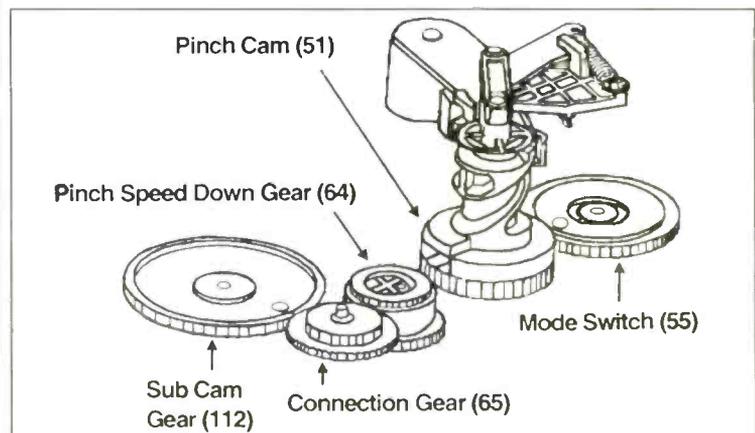
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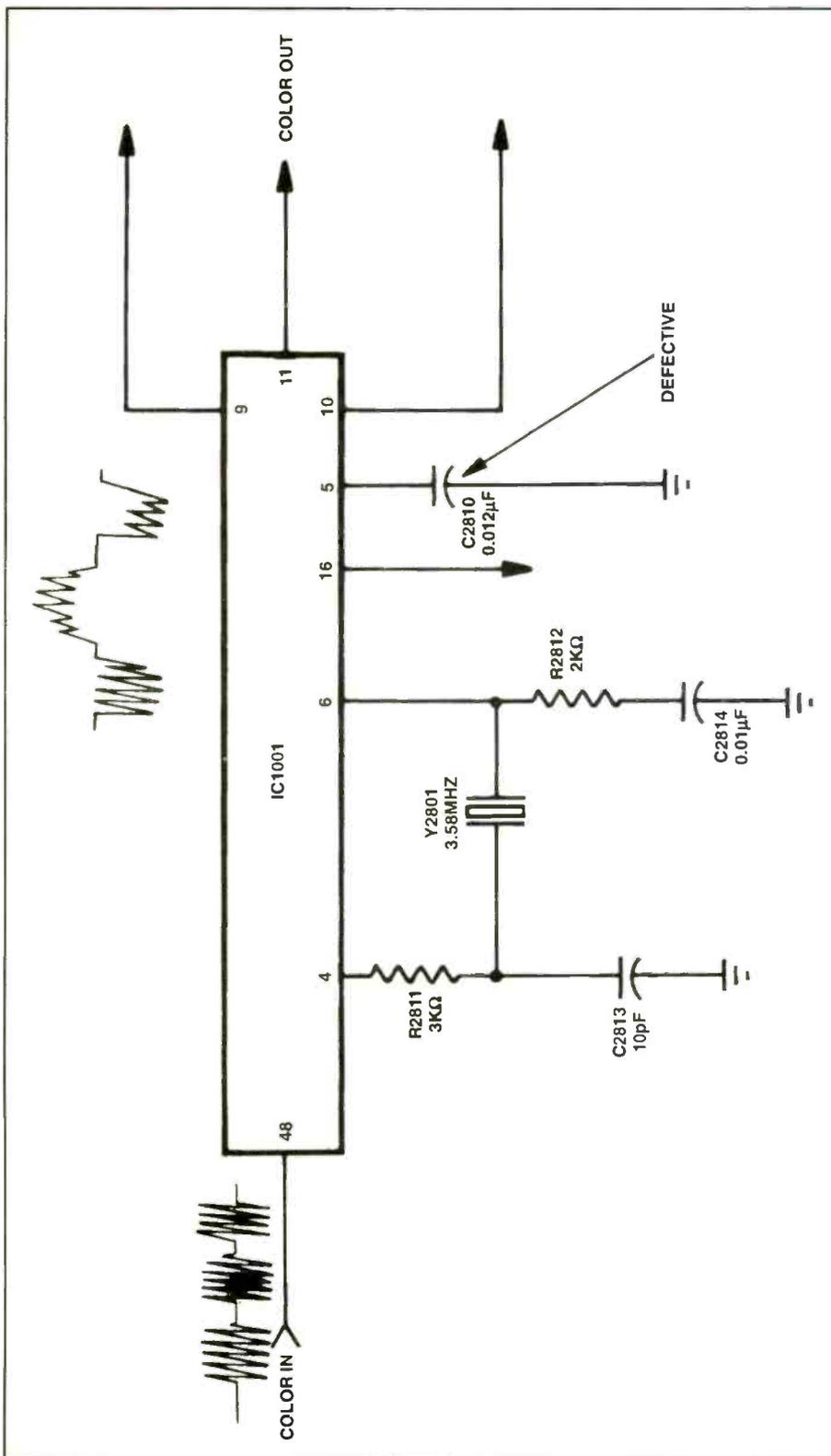


Figure 7. Capacitor C2820 caused the color in an RCA CTC145 chassis to be intermittent.

that the IC, the 3.58MHz crystal or one or more connecting components must be normal as well. A resistance measurement from each pin to common ground indicated no leakage. All resistor values were fairly normal.

I decided to replace suspected compo-

nents in order of increasing difficulty. The easiest component to replace was the 3.58MHz crystal, so I replaced it, but there were still no oscillator or output waveforms. Next, I replaced IC201 with an NTE-1547 universal replacement. The results were the same. When I prodded

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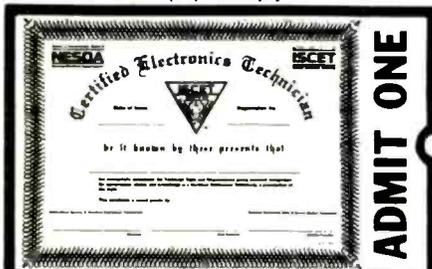


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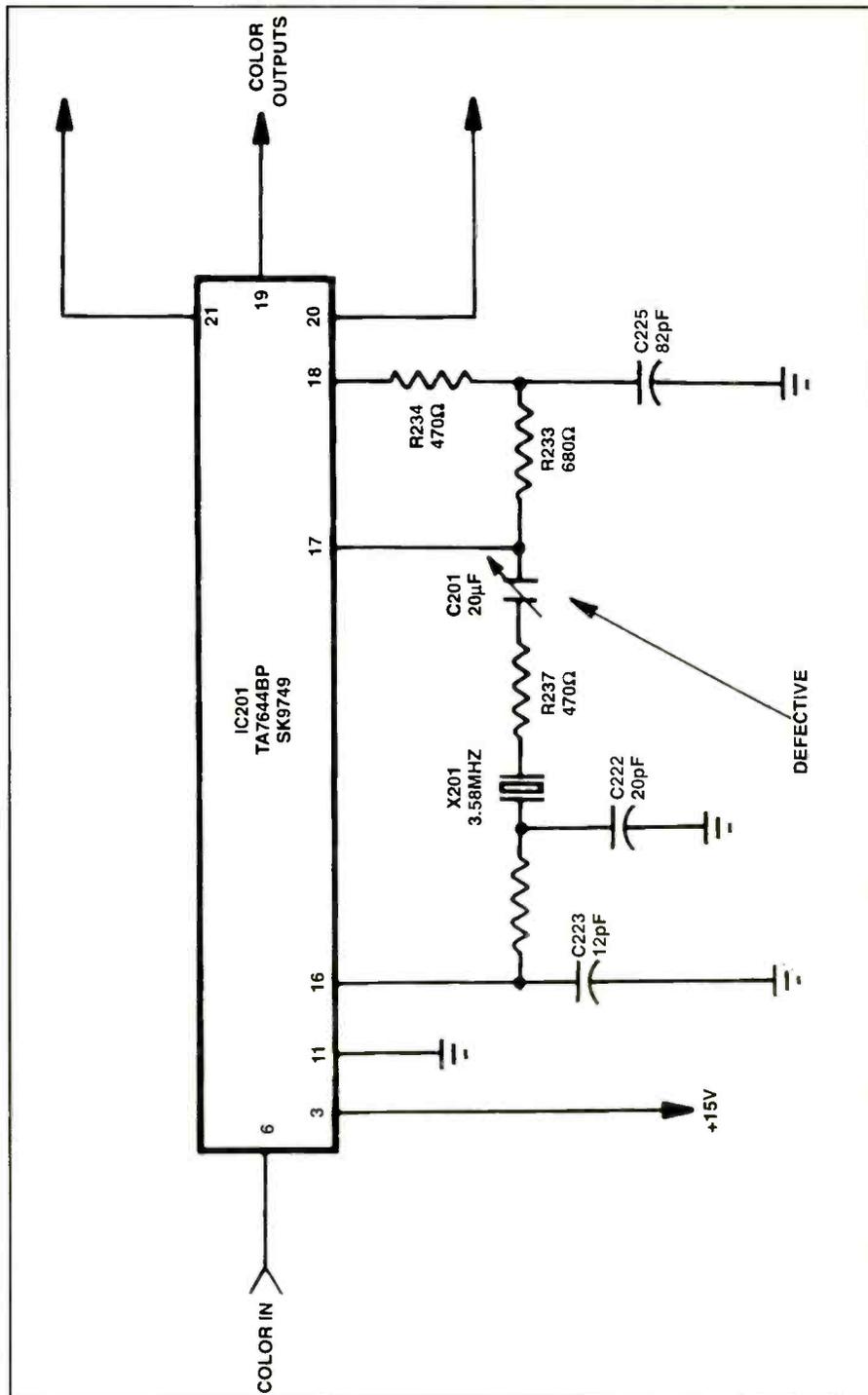


Figure 8. A small color trimmer capacitor (20pF) caused unusual trouble in Emerson MS250R television set.

and pushed trimmer capacitor VC-201 with an insulated tool, the color reappeared briefly. Sometimes these small trimmer capacitors can cause color sync problems. Replacing this trimmer capacitor restored the set to normal operation.

Once again

When a schematic is not available for a certain color TV chassis, try to use the schematic diagram of a similar chassis of the same manufacturer. In the absence of

any schematic, to select a replacement IC and determine the chroma IC pin connections, find the part number stamped on the IC and look up its specifications in a universal semiconductor manual. Observe color output terminal waveforms and the 3.58MHz crystal oscillator waveform to determine what color circuit is not functioning. Measure voltages and resistances at the IC terminals to locate a leaky IC, or a defective component tied to one of the color IC terminals. ■

***Troubleshooting and Repairing Digital Video Systems*, By Robert L. Goodman, McGraw-Hill, Inc., 400 pages, 300 illustrations, \$40.00 paperback**

An Integral component in virtually every type of consumer electronic system, including those involving digital video, the microprocessor represents exceptional opportunities for electronics repair technicians.

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***Electronic Circuits*, By Norbert R. Malik, Prentice Hall Inc., \$80.00 hardcover**

This text is primarily intended for a two-semester electronics sequence for majors in electrical engineering. The text organization also serves the special needs of computer engineers by allowing readers to advance rapidly to digital topics, omitting many details of linear applications.

The chapter sequence begins with instrumentation-oriented topics such as operational amplifiers and waveshaping, an ordering that gives readers an early return on their study investment and facilitates a concurrent laboratory where interesting concepts and simple designs

can immediately be explored. Early emphasis on operational amplifiers also promotes top-down design by encouraging students, from the very beginning, to visualize electronic circuits in terms of functional modules.

Beginning in Chapter 1, the book emphasizes the interrelationships between graphical, mathematical, and circuit representations of devices. In the author's experience such emphasis, continued throughout the text, helps students better integrate and retain the material. Chapter 1 also sets the stage for using computer simulation to support the study of electronics as well as its application.

SPICE modeling is fully integrated into the text, not relegated to an appendix. This integration establishes a learning in which students take for granted the powerful numerical capabilities of computers as they learn the subject. The text continually focuses students' attention on the importance of using algebraic hand analysis and simple models to develop understanding and then emphasizes, by carefully selected examples, how to use SPICE to extend this understanding beyond the limits of the simple models. This approach enables meaningful treatment of important topics that are traditionally omitted or covered only superficially because of their mathematical difficulty.

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and information from battery manufacturers about the performance characteristics of the batteries they supply.

The Battery Reference Book ends with a number of useful appendices, including a glossary, bibliography, and details on battery standards. This book gathers together a considerable body of information that has never been published in this form before. As such, it will appeal to a wide market including those who use batteries in their work.

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***Practical Electronic Fault-Finding and Troubleshooting*, By Robin Pain, Butterworth Heinemann, 240 pages, \$32.95**

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Finding substitutes for passive components

By Tom S. Jones

Troubleshooting an electronic system to pinpoint the fault is considered by technicians to be the most interesting phase of the servicing process. Discovering the problem is a culmination of experience and knowledge using the process of deduction to reveal the defective assembly, card, and component.

The next step, after isolating the defective component, is to order an exact replacement or some sort of substitute. This may often become more challenging and time consuming than troubleshooting.

Sometimes, with a good understanding of substitution principles, the repair can be completed by using a substitute from the service center parts bin. The final validation of any repair is a hot check on the equipment to detect any possible overheating or circuit instability.

Some universal guidelines to consider when selecting resistor, inductor or capacitor substitutes are discussed below.

Ratings

No matter which type of component is replaced, there are certain absolute limits to always consider. Do not exceed the voltage, current, power, and heat dissipation properties of the device. Although capacitors and coils are often considered "wattless" components, they actually have internal impedance and physical properties that contribute to heat generation and subsequent internal failure.

Radio frequency circuits

Substituting components in radio frequency (RF) equipment can lead to some interesting circuit behavior. Straight wires become inductors, the separation between wires or parts of components develop capacitances, and the combination of the two form resonant circuits.

All components behave differently at RF as opposed to dc conditions due to in-

herent device capacitance and inductance. These characteristics are exaggerated as the frequency of operation increases.

The watchword in RF component substitution is to keep everything physically the same. For example, keep the lead length, component orientation, size and type as near to the original component specification as possible. A component specified at 10pF will not necessarily have an effective value of 10pF when operated past the VHF(30MHz to 300MHz) region. The designer may have simply calculated that a 10pF capacitor will meet the requirement of the circuit at that particular frequency. In other words, all device values are frequency dependent.

Resistors

Three common types of fixed resistors are carbon composition, carbon and metal film, and wire wound. Carbon composition type resistors are rarely used and for good reasons: high noise levels from random movement of charge, value change due to soldering, and sensitivity to hot and humid environmental conditions. A carbon composition resistor stored in a garage parts bin in the humid southern United States for two years may change in value more than 15 percent.

Substituting resistors is not always as clear cut as one might think. Upgrading a pure carbon resistor to a carbon film or metal film may be circuit dependent. Pure carbon composition resistors decrease in value much faster than film types in RF circuits, therefore if you replace carbon composition with a film type, in some RF circuitry there may be a change in circuit operation.

For instance, a 100K Ω carbon composition resistor might drop to a 50K Ω effective resistance value, due to capacitance between carbon granules, when used at 100MHz versus dc. The original circuit would have been optimized taking into account the characteristics of carbon composition resistors.

Film resistors are basically constructed of a carbon or metal oxide deposited on a solid ceramic rod and spiral trimmed to obtain final resistance value. The end caps are fitted by compression or silver solder and the component is encapsulated in an insulative lacquer. Effective resistance values of film types remains fairly stable from dc through 150MHz.

Metal film resistors are good candidates for general replacement purposes in most electronic equipment. These resistors possess low noise and excellent thermal and aging characteristics.

Precision resistors should always be replaced with similar resistors. As with most electronic circuitry, the designer selected costly precision units for a reason.

Wire wound type resistors are extremely stable over time and can usually dissipate quite a bit of power. Although some wire wound resistors are wound in a manner to cancel magnetic fields, they are really best for use below 50KHz. The inductance and capacitance of the windings make them unsuitable for RF work. Modern precision film resistors are often used to replace wire wound resistors in low heat dissipation applications.

In terms of resistance tolerance, shelf life, temperature stability, and noise, the following ranking may be used as a substitution guide in modern equipment. Carbon composition is least desirable.

1. Wire wound (temperature stability slightly worse than metal film).
2. Metal film
3. Carbon film
4. Carbon composition

In low frequency applications you can usually replace a surface mount device with a regular axial lead resistor if space permits. However, there are some surface mount resistor types that are specially designed for RF use (low inductance and capacitance film resistors), and therefore a classic axial lead resistor may not be the best choice.

(Continued on page 41)

Jones is chief of technical services in the Engineering and Sustainment Division at Andrews Air Force Base.

Substitution formula

Often, an exact substitute resistor is not available in the service center. Use the following formula to create a parallel combination that will work.

$$R_{\text{UNK}} = \frac{R_{\text{REQ}} \times R_{\text{LARGER}}}{R_{\text{LARGER}} - R_{\text{REQ}}}$$

The defective resistor was 12KΩ, (R_{REQ}, or the resistance you need). Select a resistor you have on hand that is larger than the resistance you require (R_{LARGER}) from the resistor bin (22KΩ), and determine the unknown value (R_{UNK}) that you need to place in parallel with the 22KΩ to produce the required 12KΩ.

$$26.4\text{K}\Omega = \frac{12\text{K}\Omega \times 22\text{K}\Omega}{22\text{K}\Omega - 12\text{K}\Omega}$$

Most technicians will just use series resistor combinations to accomplish this, with the benefit of an overall voltage rating of the sum of the individual resistor voltage ratings. A parallel combination may be necessary due to wattage considerations. Caution: although the overall resistance is correct, the power dissipation of each of the two parallel resistors varies inversely to its value.

Substitutions for variable resistors

The same general resistor substitution

considerations apply to rheostats, potentiometers (pots), trimmers, etc. Replace carbon pots with cermet types for similar reliability, and with conductive plastic types if you need significantly increased reliability. Often, defective trimmers are simply replaced with a fixed resistor which is representative of the optimum value of the trimmer.

One area of concern is the law, or taper, of pots/rheostats. The taper or law is the nature of the resistance change as you vary the control. A logarithmic variable resistor will have a non-linear change in resistance near one end of the range and a more linear change at the other end of

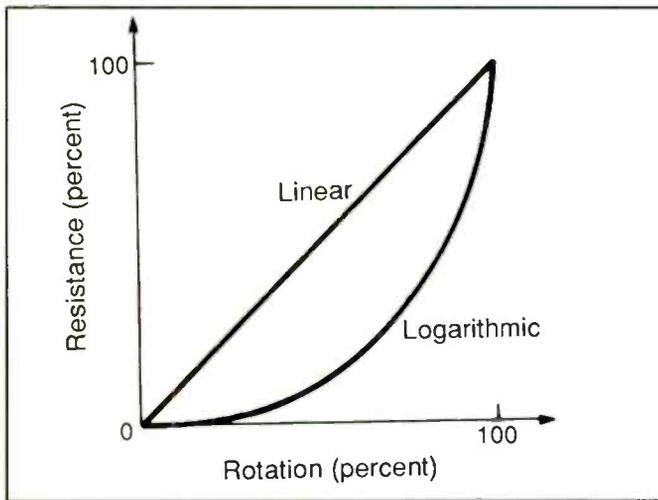
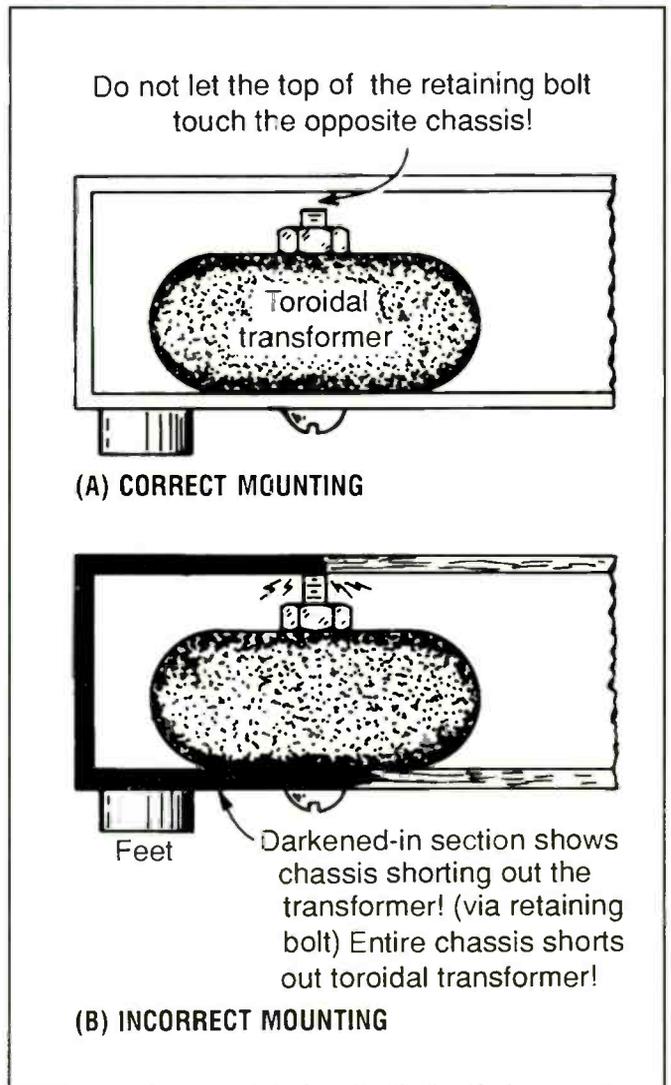
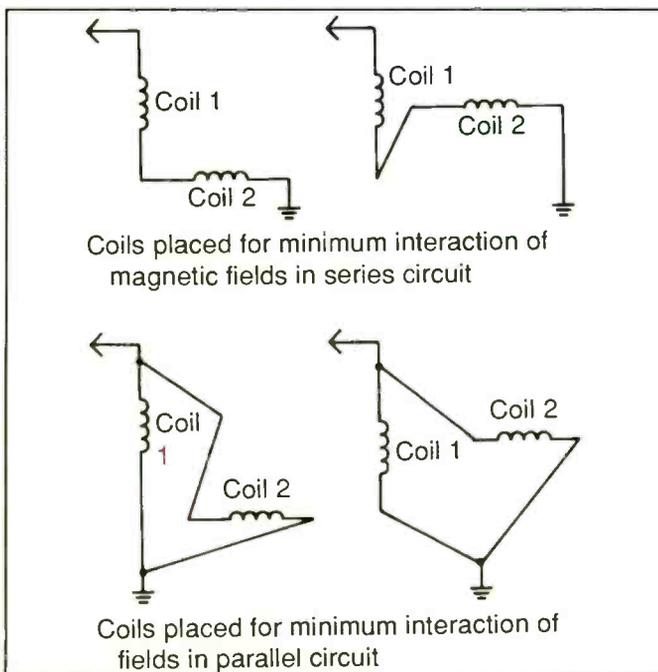


Figure 1. When installing a substitute for a potentiometer, make sure that the replacement has the same "taper" as the original. These curves show the graph of resistance vs. rotation of the two types of pot.



▲ Figure 3. Be careful when substituting a toroidal transformer that you don't cause any short circuits.

◀ Figure 2. When substituting two coils for a single coil, be sure to arrange them physically for the least interaction of magnetic fields.

the range per degree of control rotation. The volume control is usually a logarithmic taper type (Figure 1).

There may be temptation to replace, say, a 10K linear pot with a 50K linear pot. This is possible if the load is a high impedance, e.g., the load is a MOSFET gate or is isolated by a high value resistor. However, if the load draws a current, the result would be that most of the current/voltage change would occur near the end of travel of the pot and thus severely limit the usefulness of the control. In one instance, a 50K pot had to be rotated past 80% of its range to match the original 10K pot with the wiper arm at mid range.

Most trimmers are linear and so the ohmic value will change an equal amount per degree of rotation. Trimmers are assumed to be linear in most catalogs.

Inductors

Inductors include tuning coils and transformers for RF use, chokes for filtering, and supply filters. RF transformers and coils are used in tuned circuits, oscillators, etc., and are somewhat critical components. Chokes, on the other hand, are used in ac filtering, RF and signal blocking, the power supply and loading applications, which are not as critical when considering substitution.

RF coils and transformers

Adjustable RF coils and transformers may normally be adjusted plus or minus about 5 to 20 percent from their nominal value. This broadens the substitution range for coils to include components immediately above and below the exact replacement value. However, the "Q" and temperature characteristics may drift somewhat in critical applications when the tuning core is adjusted to either maximum of its range.

Generally, if the main concern is the inductance value, there should be no ill effects operating the replacement coil or transformer at maximum adjustment. The winding spacing on molded types should also be considered when substituting, because this affects the smoothness of the tuning as the core is adjusted.

You can replace open air/molded types with shielded can units. Shielded can types are often color coded for their use in the circuit, e.g., IF, antenna input, de-

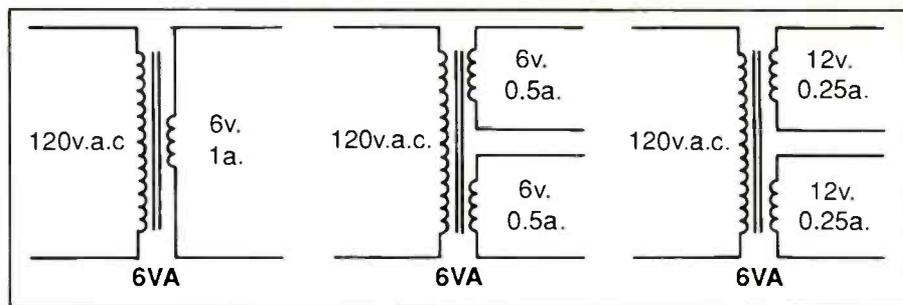


Figure 4. The volt-ampere (VA) rating for a multiple secondary transformer is for the total secondary load.

tor, filter matching, etc. Unfortunately, the manufacturers do not use the same color codes. The shield or can is normally grounded and used for electrostatic shielding, while the design of the core aids in magnetic shielding.

Another area of concern with iron oxide (or other core material used) is the possibility of too much current saturating or overheating the core, resulting in inductance changes which may or may not be permanent. In RF transformers, the lower frequencies are predominantly coupled through the core material and this causes a heating of the ferrite or powdered iron core. A core and the wire wrapped around it may appear physically sound, and yet the core may have been magnetically altered due to heat. A visual inspection and continuity check does not necessarily indicate a usable component. Any time you see one wire on top of another, or inside a cylinder in an RF circuit, you can assume it is some type of transformer or signal divider/combiner.

Many RF coils and chokes consist of turns of wire around a resistor (parasitic suppression) or perhaps just two or three turns of coiled wire without a form of any type, i.e., "air wound". If one of these is defective, just wind the same gauge enamel covered magnet wire in a similar pattern to replace the defective coil and the circuit should work fine.

In high powered equipment, silver coated wire or tubing may be used to decrease "skin effect" losses. A simple piece of similar gauge wire may not work in that circumstance. Tune by simply closing or opening the distance between turns to increase or decrease inductance, respectively. These self supporting air wound coils are common in transmitter equipment and receiver circuits. Above about 500MHz, coils and capacitors are often

implemented in a distributed manner using microstrip transmission line or tuned cavity technology instead of lumped constant elements.

RF chokes and supply filters

Ferrite and powdered iron materials are popular for dc inductors, as in power supplies, and RF chokes. These variously shaped devices, including toroidal cores, are often painted to identify frequency range. Sometimes the cores get cracked. Replace these devices only with the same color or equivalent mix/permeability.

Sometimes the original wire can be reused to wind a new ferrite device. Wind with wire that has high insulation sleeving to prevent possible arcing to the core. Toroid type cores have minimal magnetic field leakage and being careful about physical positioning is less of a concern than with the classic style coil.

Coil substitution (lumped types)

A single coil may be replaced with two coils of smaller inductance connected in series *electrically*. You add their values together to obtain a new value that is the sum of the two inductances. A smaller overall value inductor may be created using two inductors by connecting them in parallel *electrically*. Use the same formula as you did for parallel resistors.

Notice that the emphasis is placed on electrical versus physical connection. In order for the substitution to work, coil magnetic fields cannot interact with one another. Try to place coils at right angles to one another and on the same plane. Of course, this problem is minimized by shielded and toroidal type devices.

Obviously, if there is room in the equipment, you may reduce coupling by increasing physical distance between the substitute coils. Wire size must be care-

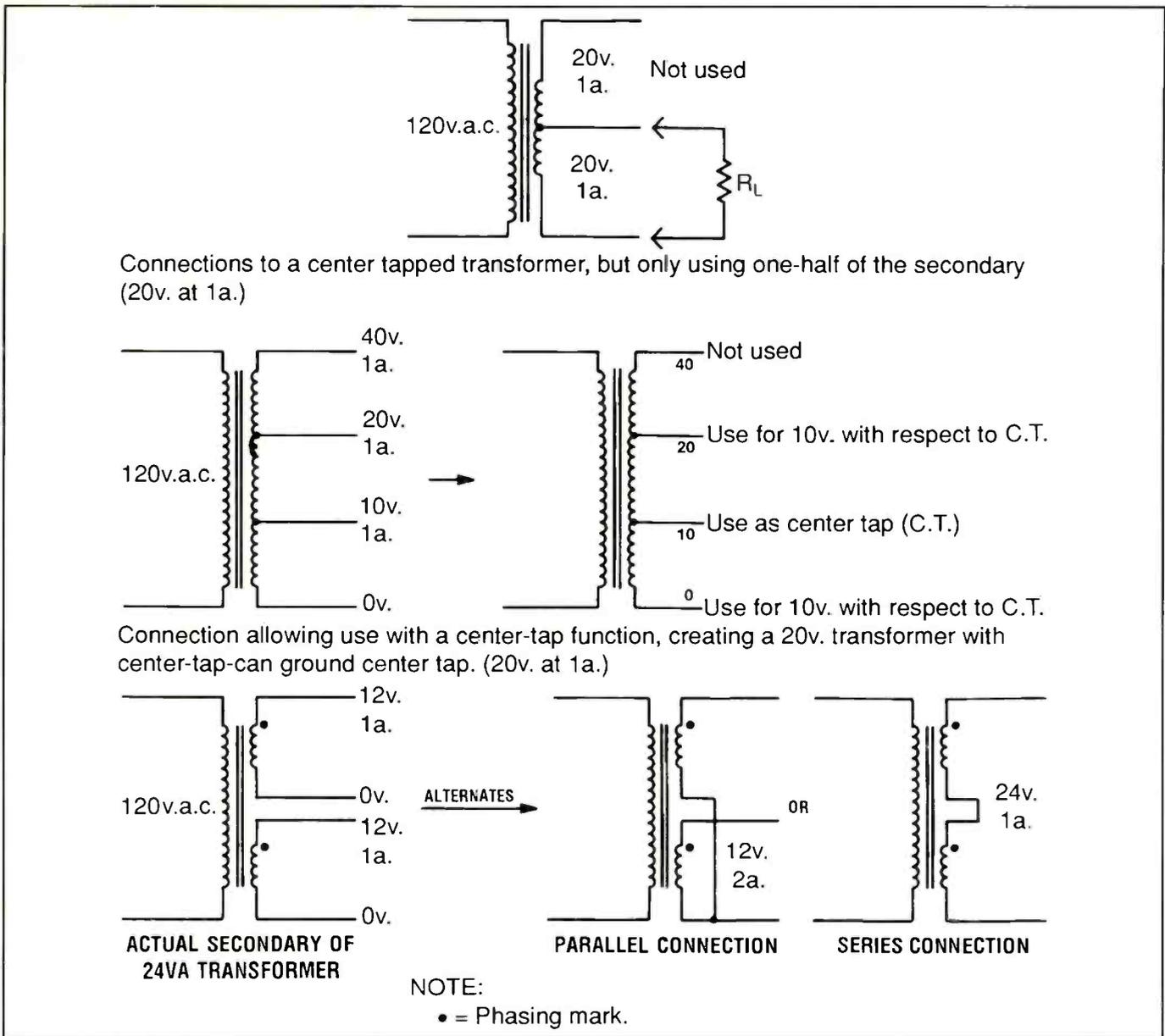


Figure 5. A little creativity can make it easier to locate a substitute for a transformer.

fully considered when substituting inductors to preserve current handling capability. Ensure the same wire size that is present on the substitute as used on the original defective component (Figure 2).

Power transformers

Power transformers are double wound type mains transformers. An autotransformer does not provide isolation and should not be substituted for a double wound or isolation type.

The following information also applies to toroidal type mains transformers, with the following exceptions; toroidal transformers draw a larger initial inrush current at turn-on. Your existing fuse

might blow if you substitute a toroidal type for a dual wound unit.

Care must be taken to ensure that a "shorted turn" is not created around the toroidal transformer when mounting. Moreover, the audible hum and magnetic fields are significantly reduced with these devices. They are quieter because there are no laminations held together with bolts which vibrate as the magnetic energy field sets up powerful, attractive forces in the component (Figure 3).

Transformer rating

The key rating for transformer substitution is the VA (volt-ampere) rating for the secondary winding(s). A transformer delivers the required current and voltage

to the load and this capability is indicated by the VA rating.

For example, a transformer with one secondary rated at 6VA will deliver 6V at 1A. If the unit had two identical secondary windings, then each could be rated at 6V at 0.5A and still the unit would be rated 6VA. A transformer with two 12V secondaries each rated at 250mA will also be a 6VA unit: 12V x 0.25A equals 3VA plus the other identical secondary 12V x 0.25A equals 3VA with a total of 3VA plus 3VA equals 6VA. The VA rating is the total secondary load (Figure 4.)

Interconnecting secondaries

To select the proper substitute transformer determine the secondary wind-

<u>TYPE</u>	<u>APPLICATIONS</u>	<u>POSSIBLE REPLACEMENT</u>
PAPER	RARE IN MODERN PRODUCTS	POLYESTER POLYSTYRENE
OIL	HIGH VOLTAGE, POWER FILTERS	ELECTROLYTIC
CERAMIC DISC	LOW-K, FOR HF COUPLING, DECOUPLING, TUNED MICA CIRCUITS, FILTERS THROUGH 500 MHZ TEMPERATURE COMPENSATION USE HIGH-K, FOR USE WHERE CAP. STABILITY IS NOT CRITICAL, RF COUPLING, DECOUPLING	POLYSTYRENE
POLYCARBONATE	HIGH FREQUENCY (HF) COUPLING, DECOUPLING NEAR LINEAR CAP. CHANGE WITH TEMPERATURE	
POLYPROPYLENE	HIGH FIDELITY, CIRCUITS WITH LOW LEAKAGE AUDIO, COUPLING, FAST RISE TIME PULSES, HF	
POLYSTYRENE	TUNED CIRCUITS, OSCILLATORS, OUTSTANDING STABILITY OVER TIME, CLOSE TOLERANCE	LOW-K CERAMIC
POLYESTER	"MYLAR", GOOD GENERAL PURPOSE, WIDELY USED, COUPLING, DECOUPLING, PULSE	POLYCARBONATE
MICA	TUNED CIRCUITS, PULSED FILTERS, EXCELLENT TEMP. STABILITY, RF TO 500MHZ	LOW-K CERAMIC POLYSTYRENE
ELECTROLYTIC	POLARIZED, FILTERS, AUDIO COUPLING, DECOUPLING, BYPASSING, SWITCH MODE AND SMOOTHING TANTALUM	
GLASS	MOST RESISTANT TO HUMIDITY AND MOISTURE	
TANTALUM	POLARIZED, COUPLING, DECOUPLING, GENERAL APPLICATIONS	

"Poly" types are considered film capacitors. Metallized "poly" types replace "poly," but generally handle less current and voltage. They also tend to recover from minor internal failures in the film during operation (self healing).

Figure 6. Use these general guidelines when looking for a substitute capacitor.

ing(s) voltage and current ratings. These may or may not be indicated on the unit somewhere. Parts catalogs list the voltage/current specifications. The substitute unit will be nearly the same physical size and type. The laws of physics are universal across brands. More VA requires more iron and copper.

If the voltage and current of the defective transformer secondary winding is known, a substitute transformer may be used which has a different secondary but will still meet requirements. Basically, parallel windings increase current., and connecting in series increases voltage. However, what is gained in current is lost

in voltage and vice versa.

Another point of interest is that transformers are phase sensitive. If windings are connected in a reverse phase situation, the net result is algebraic addition of the voltages. For example, separate windings, one of 10V and the other of 20V, connected in series and out of phase, will produce a resultant 10V output across the total secondary winding.

Volt-ampere (VA) ratings by manufacturers assume resistive loads. Most of the loads encountered in electronics equipment are not resistive loads, they are reactive. Capacitor input filters draw current differently than a resistive load. Use

a transformer that supplies about twice the current required by the load when designing a capacitive input power supply.

A possible problem with multiple-secondary transformers is that only one of the secondaries is defective (no output) and is not causing overheating or other problems. It is often difficult to find sources for odd-voltage multiple-secondary types. In this case, simply add a substitute transformer to provide the missing voltage if there is room in the cabinet to mount another transformer. Moreover, half of a center-tapped secondary winding of a substitute transformer might be used to get the job done (Figure 5).

Capacitors

After semiconductors, capacitors have the highest failure rate in most equipment. The type of capacitor that has a very high failure rate is the electrolytic. An electrolytic, by chemical design, will deteriorate over time, even when not in use.

Characteristics to be careful of when substituting capacitors include: working voltage, maximum peak voltage, dc and ripple temperature range, operating range of capacitor temperature coefficient, capacitance change with temperature tolerance, and acceptable variation in value from published value.

Because there is a vast range of capacitors available, the surest technique for successfully substituting capacitors is to replace them with the same type. Replace electrolytics with electrolytics, micas with micas, etc.

For example, suppose you find a defective 0.01 μ F capacitor in an RF circuit and replace it with one that you happen to have in the service center, also rated at 0.01 μ F. After turning on the equipment you find the new capacitor overheating, even though it was "similar" looking and of equal voltage rating. It's possible that the series resonant frequency of the replacement was near the equipment operating frequency and it overheated due to excessive current flow.

Lead length is also critical in some RF circuits. The self-resonant frequency of a

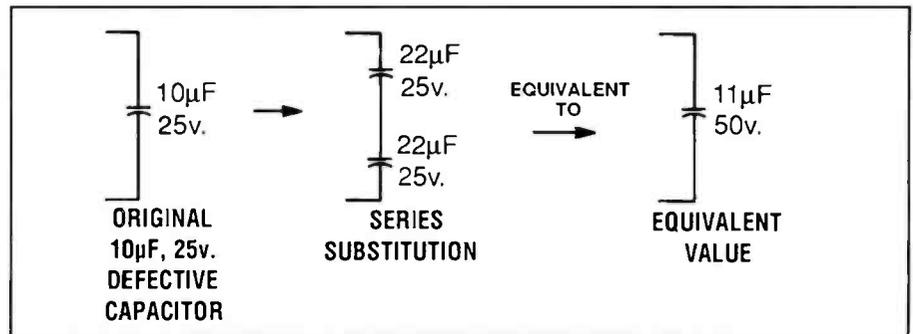


Figure 7. It is possible to use either a series or parallel combination to create a replacement for a capacitor that has failed. It is important to take care, if using a series combination, not to exceed the voltage rating of either capacitor.

300pF ceramic disc capacitor can change by more than 15MHz just by lengthening the leads one-tenth of an inch at 100MHz. Electrolytics have very low frequency capabilities when compared to micas, ceramics, etc., although they pack a lot of capacitance in a small area.

If the electrolytic has a lot of current flowing through it or fast rise time current pulses, a high ripple or low ESR type at the frequency in question should be considered for substitution purposes. The wrong type of capacitor will soon fail due to internal heating.

Capacitor substitution

Here are some general factors to keep in mind when you're going to use a substitute for a failed capacitor.

- At higher RF frequencies, or in high current pulse circuits, overspecify substi-

tute capacitor parameters (not capacitance value) by 50 percent to decrease internal heating.

- Electrolytics used for coupling and decoupling can usually be replaced by the next standard capacitance value, up or down, as long as the voltage rating remains the same.

- Air variable types are normally used in RF tuned circuits. Incidentally, there are "laws" for these devices just as for variable resistors. Straight line law is produced when both sets of plates are semicircular. In logarithmic law capacitors, the moving (rotor) set of plates is semicircular and the stationary (stator) plates have a tapered shape. There are a few other variations.

- It is accepted practice to replace a given capacitor type with one of a higher voltage rating.

- The size or shape of a wire lead capac-

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itor will usually not be a significant factor in substitution, unless the circuit is very sensitive, i.e., in some RF circuits or when in the presence of strong fields which may couple into the capacitor. Above 300MHz, leadless "chip" capacitors are becoming the predominant type in modern equipment. Leadless chip capacitors are used above 1 GHz.

- A substitute capacitor should have roughly the same size diameter leads when used as a replacement in high current (ac or dc) applications.

- Some of the "poly" capacitors have a band painted on one end. This indicates the outer foil, which is generally connected to the ground or low impedance side of the circuit to reduce coupling from external stray fields (Figure 6).

Substitution formulas

To create a new capacitor value by substituting in a series arrangement, use the formula below:

$$C_{\text{UNK}} = \frac{C_{\text{REQ}} \times C_{\text{LARGER}}}{C_{\text{LARGER}} - C_{\text{REQ}}}$$

Let's say, for example, that you encountered a defective capacitor with specifications of 10 μ F, 25V, and you have a 22 μ F capacitor in the parts bin. In this case, 22 μ F is C_{LARGER} , and you have to solve for the unknown capacitor, C_{UNK} to place in series with the 22 μ F to give a total of 10 μ F.

$$18.3\mu\text{F} = \frac{10\mu\text{F} \times 22\mu\text{F}}{22\mu\text{F} - 10\mu\text{F}}$$

Since there are no standard value 18 μ F capacitors, plug in the nearest standard value, another 22 μ F, use the product over sum formula, and find the answer to be 11 μ F. This is close enough when dealing with wide tolerance electrolytics.

For two capacitors in series, the equivalent capacitance is:

$$C_{\text{REQ}} = \frac{C1 \times C2}{C1 + C2}$$

It is best to use equal values of capacitance in series because the voltage drop varies inversely with the capacitance. The smallest value capacitor will need the largest voltage rating. Although we could use two 22 μ F, 16V replacement capacitors in our above example, equivalent to one 32V cap, it is best to use the next high-

er voltage rating. The internal reactance of each 22 μ F cap may not be the same; tolerances can be wide and so can variations from device to device, so one may drop more of the applied voltage than the other (Figure 7).

Whenever possible, it is probably best to use capacitors in parallel to reach a substitution goal. By paralleling, the overall impedance is decreased, there is no concern about unequal voltage across the components, and the formula is easier. The formula is the same as resistors in series. So, to replace a 100 μ F, 25V capacitor, use any combination of 25V capacitors that add up to nearly 100 μ F. One possibility would be two 47 μ F 25V caps, and if tolerance is really important, one additional 4.7 μ F, 25V capacitor.

Reforming electrolytics

During manufacture, a voltage is applied to the capacitor to "form" the insulating film. If the correct polarity voltage is not regularly applied, the film will lose form, capacitance decreases, and over the period of a year or two, may lose its insulating properties. I have not noticed a significant problem in this area, but you never know how old that replacement capacitor may be.

To "re-form" unused electrolytic capacitors, place the capacitor in circuit, except for the positive lead, then place a 1K Ω 2W, resistor in series with the circuit potential and the positive capacitor lead and turn on the equipment for about one minute. Then, turn off the equipment and let the 1K Ω resistor discharge the capacitor. The idea is to select a resistor value that will cause a slow rise in voltage across the capacitor to allow the "re-formation" to gradually take place.

Use caution

There is always an element of risk when substituting components. We do not have the benefit of full technical specifications on the components or the time to search for the very best fit and function. Keeping the general concepts in mind for replacing components will help restore the equipment much earlier than if we had to wait for the exact part. Often, component substitution is the only recourse to use when returning older, logistically insupportable equipment to service. ■

LITERATURE

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Circle (80) on Reply Card

Capacitor data book

ASC Capacitors has released a new Data Book summarizing its product offerings and providing useful information for anyone interested in capacitors. A key part of the data book provides more general information about specifying the correct capacitor type and value.

Topics range from the basic, "What are Capacitors?," to the more advanced, such as "How Close is a *Close Tolerance* Capacitor?," "Capacitance vs. Temperature," "Insulation Resistance and Leakage Current," and "Dielectric Absorption." For further reading, the book lists appropriate technical papers, also available from the company.

The data book incorporates a section on application-specific, or custom solutions. Increasingly, capacitor customers are asking for "value added" assemblies and

features to be added to a capacitor package to lessen inventory costs and product development cycle time.

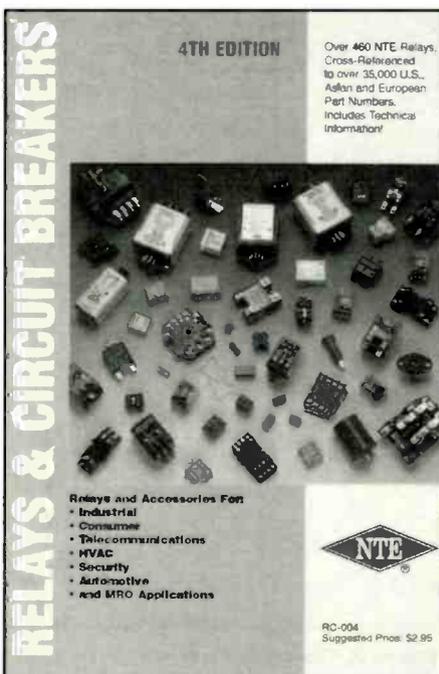
The section discusses which capacitor parameters can be altered to produce solutions that are unavailable in standard configurations. Among the many solutions mentioned are extremely high voltage or very low E.S.R. capacitors, custom ac and dc-based film formulation to enhance dielectric performance, or completed capacitor subassemblies to reduce manufacturing cycle time and inventory costs.

The data books also catalog the company's more than 40 standard capacitor lines. The publication enumerates physical and electrical characteristics, and includes drawings to clearly illustrate specifications. Types of capacitors described include those using polypropylene, polycarbonate, polyester, and polystyrene dielectrics, as well as polyester RC snubber networks.

Circle (81) on Reply Card

Relay catalog

NTE Electronics has released the fourth edition of its relay catalog. Fully updated, the new catalog lists replacements for more than 36,000 industry part numbers from over 486 suppliers.



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The catalog details all of the company's existing relays and accessories, along with ten recently introduced series of relays, five expanded series of relays, and several new sockets. The new offerings include multifunctional programmable timers/counters, I/O modules in slim-line sizes, PC-mountable relays for 5 mm grid patterns, and PC-mountable relays for appliances, HVAC, and industrial equipment. The new brochure also contains information on ac and dc relays for HVAC, appliances and office equipment, thermal circuit breakers, and subminiature PC-mountable relays for telecommunications, computers, and test and measurement equipment.

Circle (82) on Reply Card

Machine tool and magnification task lighting catalog

Waldmann Lighting features over 100 machine and magnification task lighting products and accessories in their new 36-page catalog.

Waldmann offers task lighting solutions for almost any type of machine tool application and environment.

Other products featured include the "Focus" Series magnification lights for inspection, quality control and ESD-safe applications, and hand-held "UV" task lights for close-up detail work that requires more illumination.

Circle (83) on Reply Card

Hand tool catalog

Willi Hahn Corp. has published a newly updated four-color catalog. This 32-page catalog details the Wiha line of over 700 hand tools manufactured in Germany.

The catalog specially features the company's most popular lines of screwdrivers and products such as microfinish (non-slip) handle screwdrivers, insulated screwdrivers (all rated to 1,000 V ac), newly designed T-handle screwdrivers, the Topra handle with its 6mm blade program, and precision screwdrivers.

Also featured is a line of Torx products ranging in sizes from T5 to T60.

Circle (84) on Reply Card

What Do You Know About Electronics?

Antennas and communication systems

By Sam Wilson, WA8RMS

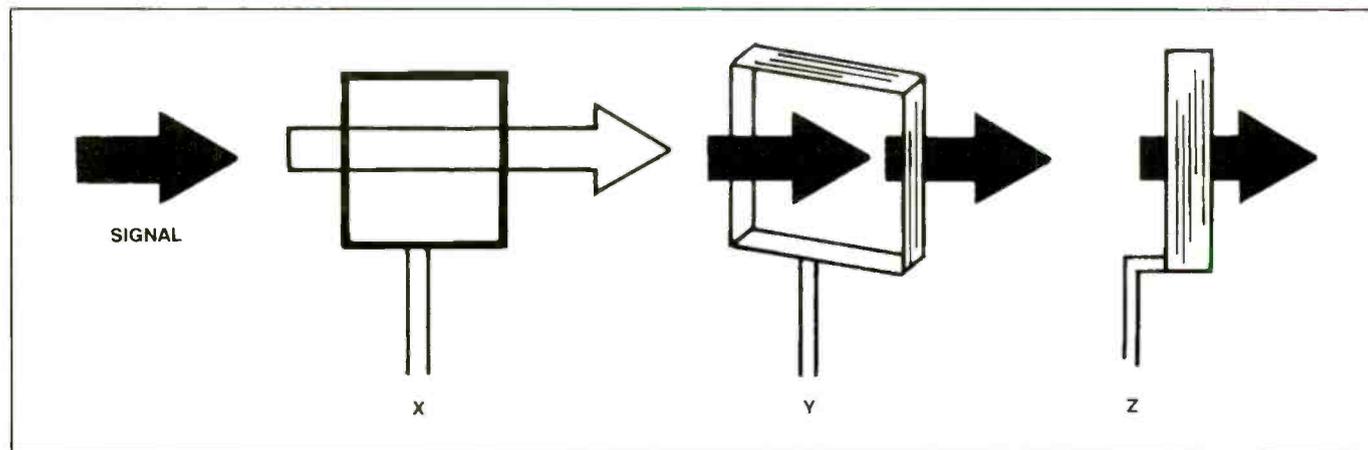


Figure 1. Reception of this loop antenna will be maximum when the signal that strikes is in the direction shown in X, Y or Z.

Before you read this article, take the following quiz on antennas. If you answer all of the questions correctly, write and tell me. I'll send you a highly coveted certificate that says: "(Your name) has successfully answered all of the questions in the WDYKAE? Antenna Quiz. (signed) SAM WILSON"

Now, if you don't think those certificates are hard to get, try to find someone who has one!

Antenna quiz

1. A piece of solid copper wire is lying on the top of a table. Although there are no connections to the wire there are electric currents flowing through it. Name two sources of the currents.

2. Refer to the loop antenna in Figure 1. The direction of maximum reception is marked with

- A. X.
- B. Y.
- C. Z.

3. Which signal causes interference on loop antenna reception?

- A. CW transmissions.
- B. Downward signals.

Wilson is the electronics theory consultant for ES&T.

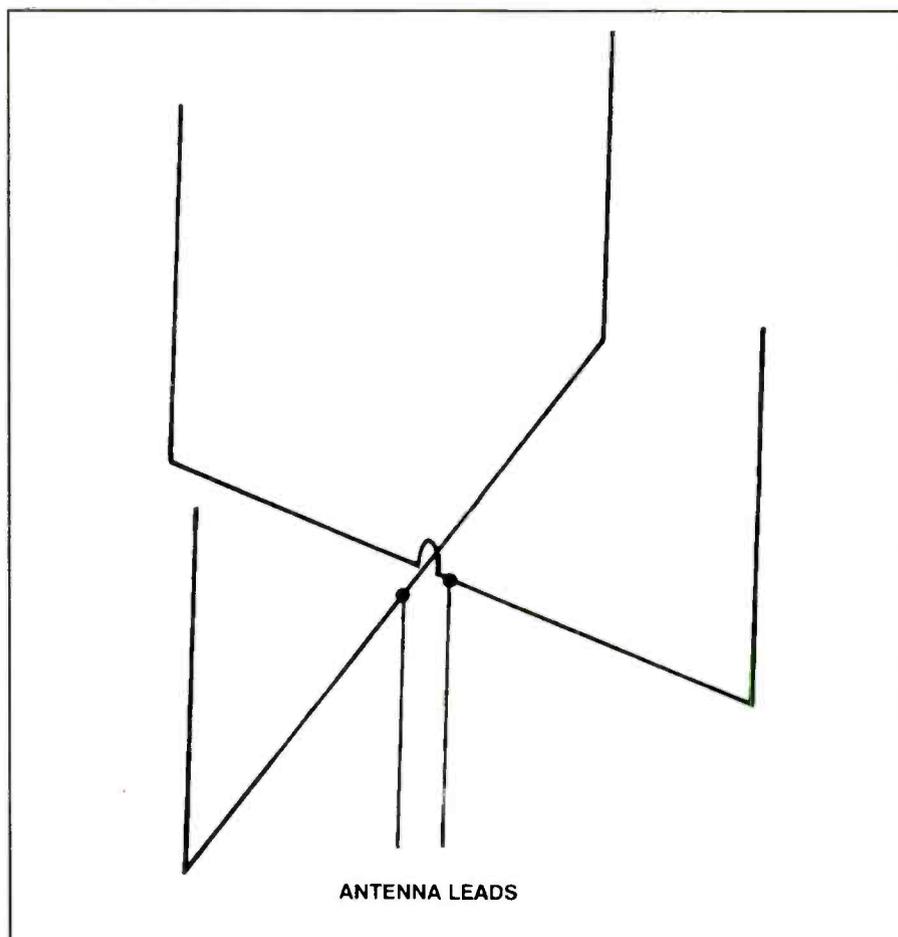


Figure 2. The Adcock antenna, constructed as shown here, reduces interference from downward signals because they are approaching the ends of the vertical rods.

ES&T Calendar

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February
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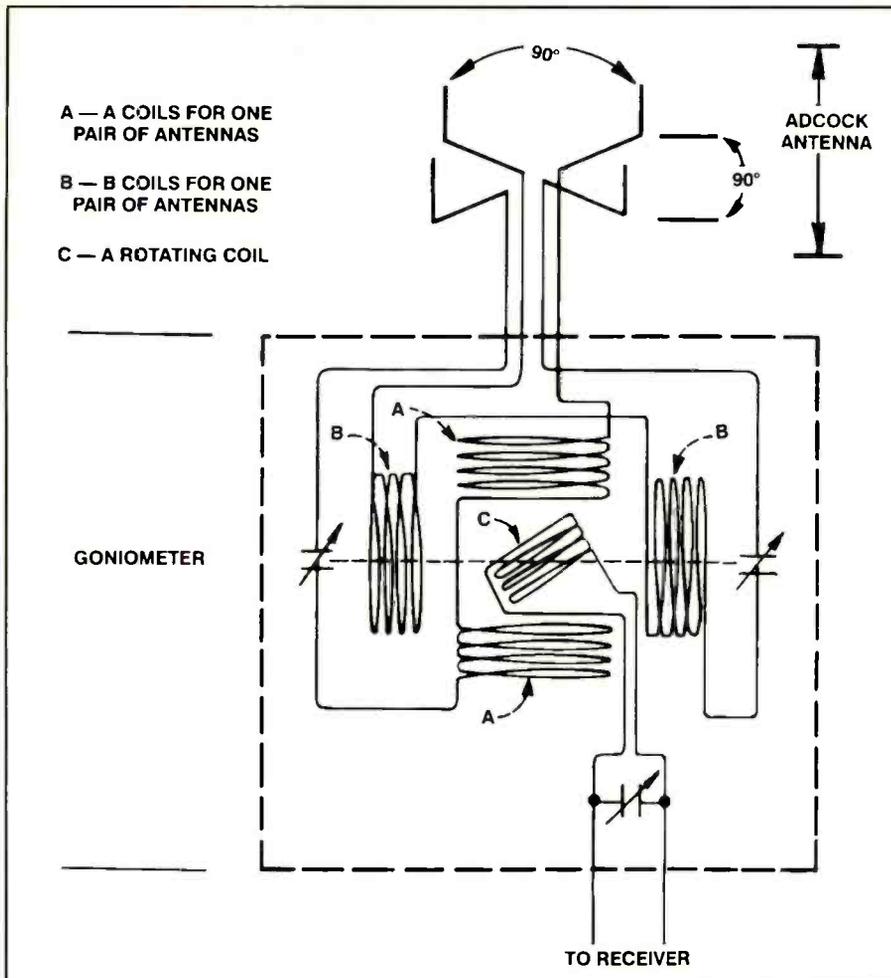


Figure 3. This shows how a goniometer is used with an Adcock antenna.

4. What type of direction-finding antenna is used to avoid the problem described in question 3?

5. What is a goniometer used for in conjunction with the antenna described in question 4?

6. The high antennas you see at AM radio broadcast stations are examples of Marconi antennas. A Marconi antenna is an example of a

- A. half-wave antenna.
- B. quarter-wave antenna.
- C. quarter-wave and half-wave antenna.

Answers to the antenna quiz

1. Answer: electromagnetic wave induction and intrinsic current. One source of current is electromagnetic radio waves and other sources of electromagnetic energy. Unless the antenna is in a shielded screen room it is exposed to a lot of electromagnetic energy.

There are some very intelligent people

who are concerned about the amount of electromagnetic energy humans are being exposed to—including the energy from power lines. Some studies have linked that exposure to cancer.

To understand the second cause of current in the wire, we need to go back to the concept of molecular motion and free electrons. At room temperature there is motion of atoms and/or molecules inside a material. Some electrons gain enough energy to escape into the material. Those electrons have a short life, and their random motion is called intrinsic current.

In an instant the number of electrons flowing in one direction in the wire can be greater than the number flowing in the opposite direction. That intrinsic current creates a noise voltage across the wire. Although that noise voltage has a low amplitude it will be amplified by an rf amplifier in the signal input stage. The overall result is that whenever you connect an antenna to a receiver you intro-

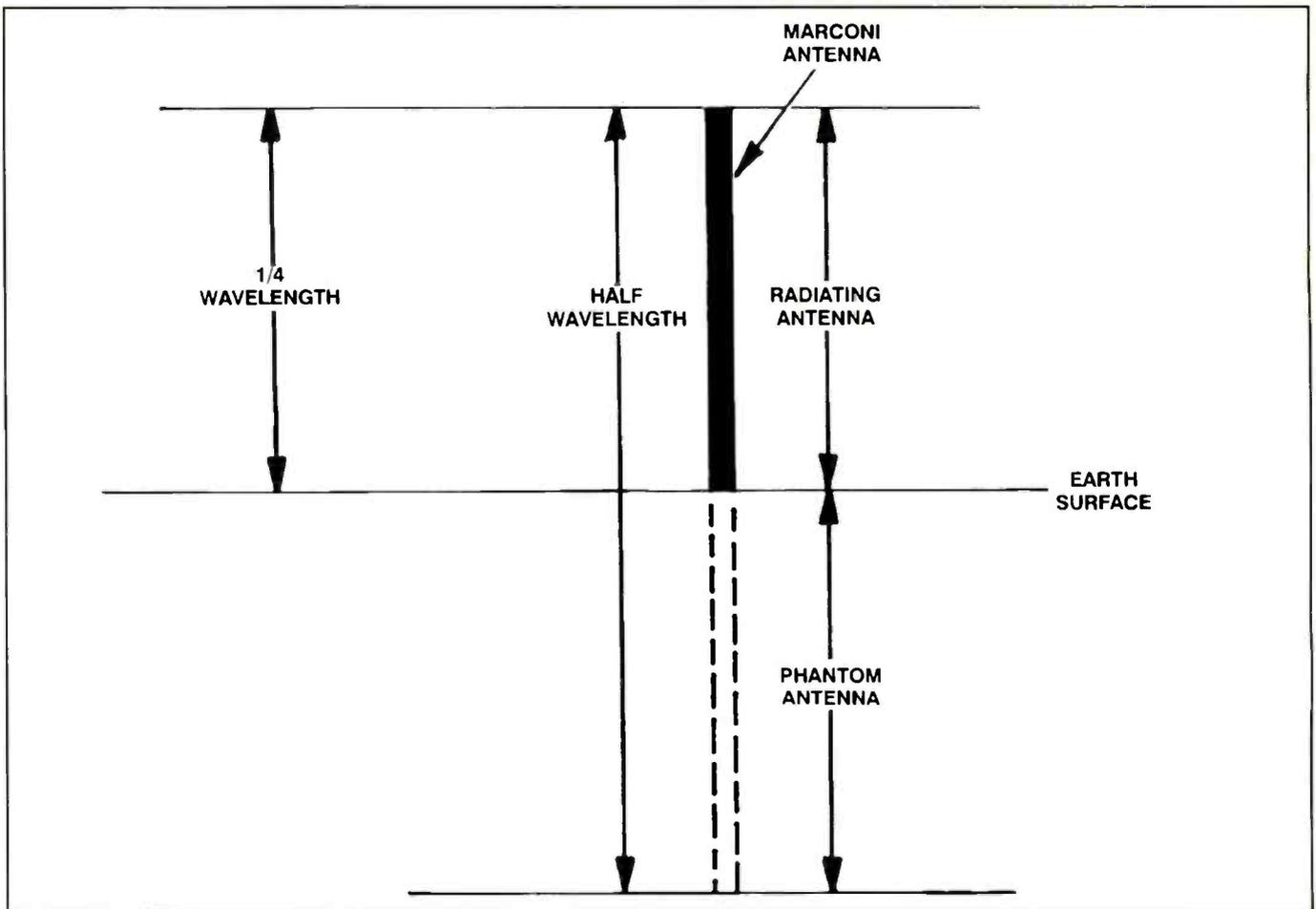


Figure 4. This is a Marconi antenna.

duce a noise voltage into the receiver.

2. *Answer: A.* The fact that a loop antenna is the least sensitive to broadside signals makes it useful direction-finding equipment. The antenna is rotated for a null in the received signal.

One disadvantage is that the loop antenna has its minimum sensitivity in *two* directions. So when you rotate the antenna for minimum reception the station being tuned can be in either of two directions. For that reason two readings are

needed to pinpoint the direction of the station.

A strongly-directional antenna (like the Yagi) can be used to narrow it down to one direction. However, that would not pinpoint the location because you still would not know the distance.

3. *Answer: B.* Downward signals are radio waves reflected from the ion region above the earth. Since those signals travel farther than direct waves, they arrive out of phase with the direct wave. That,

in turn, reduces the sensitivity of the antenna. Some improvement is obtained by using a circular loop rather than the square loop of Figure 1.

It is interesting to note that a highly-directional Yagi antenna increases the strength of a signal at the driven element. That increases the signal-to-noise ratio of the antenna, and explains why Yagi antennas are used in some types of direction-finding equipment. However, even circular loop antennas have some downward signal interference.

4. *Answer: the Adcock antenna.* Figure 2 shows the construction of an Adcock antenna. It reduces interference from downward signals because they are approaching the ends of the vertical rods.

5. *Answer: the goniometer is used to select the strongest signal.* Figure 3 shows how a goniometer is used with an Adcock antenna. The inner coil is rotated to receive the strongest signal. That has the same effect as rotating the antenna for the strongest signal.

You can think of the Adcock antenna



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as being two rectangular loops mounted at right angles and having the tops and bottoms of the loops cut off.

6. *Answer: C.* The above-ground part of the Marconi antenna (Figure 4) radiates a signal. That part plus the quarter-wave phantom antenna below ground is one-half wavelength.

In cases where the ground is not a good electrical conductor a counterpoise (made with underground or above-ground conductors) is used to complete the antenna. On smaller antennas the counterpoise is called a "ground plane."

The need for communication

When I was a young sport I did consulting work for a company called Grand Central Aircraft. They customized DC-3 planes that were used by generals and high mucky mucks. Across the landing strip from the company was a flying school where I took lessons.

One day I was up in the control tower working on a receiver and I saw something I never thought I'd see. A DC-3 was coming in for a landing—at the same time a private pilot was preparing to take off. There were no radios in the school planes,

so the tower control man flashed a red light. The pilot did not respond. The tower operator might just as well have flashed a black light.

The pilot started down the runway and the control operator shot a flare across the front of the plane. Then, another flare. Then, he shot the flares at the plane. He hit the tail twice and even though the plane zigzagged the pilot didn't notice.

The faster DC-3 caught up with the plane on the ground. Just in time the plane left the ground and the DC-3 went under it, no crash (they gave the control tower man a gift certificate for his heroic effort to shoot down the plane).

Installing a communications system

The military didn't see the humor in that. Grand Central gave me a contract to install an ARC-27 transceiver in the tower so that the tower could talk to the DC-3s. With a little research I found a surplus store that had an ARC-27 that operated off the power lines. That would eliminate most of my job and save the company a lot of money.

But, the big scary boss said, "If we wanted to buy something we wouldn't

have called you." He took me outside where there were about 20 garage-like buildings stuffed with old, used equipment, and said: "I want you to use our ARC-27 and this stuff." He gave me three technicians to search through that junk.

I built a dc power supply for them. It could have staggered a moose. In the last step of the installation I needed a ground plane for the antenna. I sent my helpers into the garages and told them to cut a circular ground plane for the antenna, and gave them dimensions. After three days they came back with one they had cut out of magnesium.

I was just as certain as you are that a magnesium ground plane wouldn't work. However, I had my helpers paint it with lead paint. Without the ground plane I could call the control tower in San Diego from Glendale, but I couldn't call a DC-3 at the end of the field. The ground plane worked well for approaching planes and planes on the field.

The cost to Grand Central Aircraft? About 7 times what it would have cost them to take my advice. I went back five years later and the installation was still being used, but, I still felt that someday it would go up in flames. ■

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Circle (63) on Reply Card

Administering service contracts

By Charles Varble, Jr.

The desire and need for service contracts was discussed in detail in the article "Professional service contracts are good for everyone." In ES&T's January 1996 newsletter, *Strictly Business* the early years of television they were promoted vigorously by department store and large service companies and they produced a large share of the business and a significant portion of the profit for the firms that sold them.

Consumers were happy that now when their television set broke down they would have it serviced promptly and at no charge to them since they had the foresight to carry a service contract. Pricing is a very important part of the service contract from both the seller's and the purchaser's viewpoint. In the past almost all service contracts were sold on a yearly basis and the customer paid in advance for the entire period. One disadvantage of this contract was that if the company went out of business the customer had already paid for service that he would not receive.

The department stores charged them on the credit card and if the customer chose to pay less than the full amount it was fine, because the store charged interest on the revolving amount. This article will discuss a different way to pay for a service contract that is easy for the customer and does not charge interest on much smaller payments.

Third-party contracts

Customers prefer to have a service contract that protects their electronic products but the large annual cost usually does not fit well into their budgets. The large annual cost also emphasizes the total cost and discourages many people from purchasing them. Most people are used to monthly payments and will purchase a service contract that only requires a small monthly payment.

Service companies must collect enough for the contract to provide all of

the service that is needed or requested and still make a profit on the sale of the contract. Many have tried, or are working, with third party administrators and have found that the payments are both slow and below the amount that they would have collected for the ordinary COD work.

Moreover, the service company usually has to get authorization from the third party company before making the service call, while also getting additional authorization before completing a major repair. The phone lines of the third party administrator are frequently busy and on occasion they say they will call you back with an authorization. This is not a good situation for the service company or the customer. When the service company sells and supplies the service then it is an ideal situation because they can give prompt service and they are paid their normal charges for both the parts and the service.

Monthly service contracts

Monthly service contracts are the answer for both the consumer and the service company. The payments are small and the customer does not pay any interest on them. They receive a coupon to send in each month with the remittance and they put these with their other monthly bills to pay.

The service contracts provide the service company with a guaranteed customer base. The company pays itself the full amount for both parts and service each time service is provided. The contracts help smooth out the variations in work load and the service company can keep its technicians busy and employed during the slower times of your business cycle.

Pricing the service contract

The price of the service contract should be determined by your current normal charges, expenses and the cost of doing business in your location. We have used

a charge of \$10.00 a month, plus \$1.50 a month if the set is remote control or has electronic tuning, for a total of \$11.50 a month for most sets. This is for in-home service and includes sets up to 27 inches.

The large screen or projection sets are considerably higher and our charge on these was \$25.00 a month. If you start off at a price that you think that you can provide service for, you can adjust it upward or downward as you compile the actual cost of providing the contract. We have a computer program, that I have written, that automatically adjusts the price at renewal time if a change is justified. We will discuss this in more detail later.

Sell the contract when the set is new

A new set purchase is the ideal time to sell the contract. If you sell the contract at that time you will find that you can sell it for considerably less because the parts are generally warranted for a longer time and the picture tube might be warranted for two years.

Our experience showed us that when we sold a contract on or at the time of the purchase, we could sell the contract for 60% of the cost of that on an older set. This broke down to \$6.00 for a regular set and \$7.00 for a set with remote control for the balance of the first year, or until the parts were out of warranty.

After the parts were no longer in warranty, we increased the rate to 80% of the normal contract price while the picture tube was still covered by warranty. This was \$8.00 for a regular set and \$9.00 for a set with remote control. The first contract was written for a period of nine months and the computer automatically adjusted the price when it sent out the renewal contract.

Sell the contract after the product is serviced

Another time that we offered a service contract was after we provided normal



Chart TV & Electronic Service

10812 ST. CHARLES ROCK ROAD
ST. ANN. MISSOURI 63074
PHONE (314) 291-2550

Never Pay Another TV Repair Bill

TV Service Costs too much! And it is going to cost even more.

Your Color TV is the major source of entertainment for most members of your family and it is used many hours each day. This is without a doubt the most complicated piece of equipment that you own and it contains over 1000 **parts** that must work together to give you the top quality picture and sound that you enjoy today.

Your Color TV is getting **older** and you can expect it to need more parts and service than in the past. Parts and service are going even higher and it costs a lot to maintain you set in peak operating condition.

We are offering you a **FULL** Service Contract that will provide your family with excellent picture and sound at all times.

Advantages of Our Service Contract

- * **All Parts are covered**
- * **Picture Tube is covered**
- * **Service Calls are covered**
- * **Shop Service is covered**
- * **All adjustments are covered**
- * **Never any charge for service**

Cost & Benefits to You

- * **\$10.00 a month**
- * **Add \$1.50 for Remote or Electronic Tuning**
- * **Charge on Master Charge or VISA**
- * **No automatic annual increase**
- * **Contract guaranteed renewable**
- * **Never any unexpected repair bills**

Fill out this coupon and mail it with your check today. The contract will be sent to you by return mail. If after examining the contract you decide you do not want it, you may return it for a full refund. We must receive your payment **within 10 days** to take advantage of this offer.

cut & mail to Chart TV

Make _____ Model _____ Serial _____

Name _____ Address _____

City _____ Zip _____ Phone _____

Contract will be for 1 year period and will remain in force as long as the monthly payment is received by Chart TV by the due date and will automatically be renewed unless canceled by you.

Contract begins* _____ approved by _____

Enclosed is \$10.00 (\$11.50 for remote or Electronic Tuning) please send my contract by return mail. Amount will be the same each month and will be due on the *date listed above.

Figure 1. This is a copy of a service contract after a normal COD service was provided.

COD service on a set and we had determined the condition of the set and the picture tube. A copy of the offer, which begins, "Never pay another TV repair bill," is shown in Figure 1. This offer was gen-

erally mailed to the customer or in some cases handed to them immediately after regular COD service was rendered.

The consumer is particularly receptive at this time as he knows the set will need

service and the cost is much more than a monthly contract would cost. We provided a self-addressed envelope with the offer, and required that they respond within ten days to take advantage of the offer.



If the customer waited longer than ten days and desired the contract, we would require that they pay for an inspection before we would issue the contract. This provision of the offer allowed us to determine that the set was still in contract condition, and would encourage the customer to make a quick decision rather than waiting several months before beginning the contract. Remote controls are covered including replacing the hand held unit. The customers only obligation was to replace the battery.

Under the terms of the contract, if the customer called and said that the remote control did not work we would request that they bring in the remote unit to the shop where we would check it while they waited. If a battery was all that was needed we would replace the battery and charge them for it. If the remote was bad we would repair it or replace it with a new unit. We found that customers were very happy that their remote was covered. Many of them reported that their neighbors had a service contract but the remote control was not covered.

List exclusions on the contract

Exclusions to the service contract were listed on the contract if something was not covered. For example, sometimes the set had a weak picture tube. In this case, we would still sell the contract but would exclude the picture tube. The contract covered the service to install a new picture tube, however. If the customer had the picture tube replaced at a later date they would pay the price of the picture tube only and we would install it. After that the picture tube would be included in the contract.

Some customers chose not to have the remote covered, or had a combination and did not wish that covered. This exclusion was listed on the contract. A copy of a contract that excludes the remote control is shown in Figure 2. Note that the computer prints out the small coupons that the customer is to send in with each payment.

The coupons are printed out in reverse order. The customer cuts the lower bottom coupon out and sends it in with the first payment. A contract that includes the

```

* Arco TV 12345 Ma-In Street St. Charles IL 66274 Phone 555-2550 *
#####
01/07/96
                SERVICE CONTRACT FROM 01/07/96 to 01/07/97

1200CMH Zenith J2517W
John R. Williams (708) 555-1212
4317 Lindsey Lane $10.00
St. Charles IL Ser. 391-12345678
60626 Exp. 01/07/97

                * Includes the Following *
                * Shop Service * Picture Tube
                * All Parts * All Adjustments
                * All Service Calls

Contract Will Remain in Force as Long as Payments are Received by Due Date.

Authorized By:

*****
* DUE BY 12/07/96 *      * DUE BY 11/07/96 *      * DUE BY 10/07/96 *
* AMOUNT $10.00 *      * AMOUNT $10.00 *      * AMOUNT $10.00 *
* CONTRACT 1200CMH *    * CONTRACT 1200CMH *    * CONTRACT 1200CMH *
* John R. Williams *    * John R. Williams *    * John R. Williams *
*****

*****
* DUE BY 09/07/96 *      * DUE BY 08/07/96 *      * DUE BY 07/07/96 *
* AMOUNT $10.00 *      * AMOUNT $10.00 *      * AMOUNT $10.00 *
* CONTRACT 1200CMH *    * CONTRACT 1200CMH *    * CONTRACT 1200CMH *
* John R. Williams *    * John R. Williams *    * John R. Williams *
*****

*****
* DUE BY 06/07/96 *      * DUE BY 05/07/96 *      * DUE BY 04/07/96 *
* AMOUNT $10.00 *      * AMOUNT $10.00 *      * AMOUNT $10.00 *
* CONTRACT 1200CMH *    * CONTRACT 1200CMH *    * CONTRACT 1200CMH *
* John R. Williams *    * John R. Williams *    * John R. Williams *
*****

*****
* DUE BY 03/07/96 *      * DUE BY 02/07/96 *      * DUE BY 01/07/96 *
* AMOUNT $10.00 *      * AMOUNT $10.00 *      * AMOUNT $10.00 *
* CONTRACT 1200CMH *    * CONTRACT 1200CMH *    * CONTRACT 1200CMH *
* John R. Williams *    * John R. Williams *    * John R. Williams *
*****

```

Figure 2. This is a copy of a contract that excludes the remote control.

remote control is shown in Figure 3. Note that the remote control transmitter is listed in the "includes the following" section of the service contract.

Fire or lightning damage was, of course, not covered. However, if we were called

on by the customer to service a fire or lightning damaged set, if there was no cosmetic damage to the set we told the customer to file his claim with the insurance company and we accepted the amount the insurance company paid after the de-



ductible. We did not require that the customer pay the deductible amount. Internally we charged only the unpaid amount against the contract as an expense.

Contract numbers

Our contract numbering includes a four-digit number followed by three letters. Figure 2 shows contract number 1200CMH. Figure 3 shows contract number 1247RMH, which is for a remote control model. The numbers started at 1000 and the three letters described the type of service contract.

A letter "C" in the first position stands for a regular color set, "R" stands for a remote control set, and "P" stands for a projection or large screen set over 27 inches. In the second position, the letter "M" indicates a monthly contract and "Y" indicates a yearly contract. In the third position, the letter "H" indicates a home service contract and a "C" indicates that it is a carry-in type of contract.

The coupons indicated the customers name, but we actually posted them only by the four-digit number, as they were all unique to a customer. If a customer dropped his contract the computer would mark it as deleted and would reissue that number when it was needed for a new service contract in the future.

Payments

Payments were generally very prompt and our experience was that many customers would pay two or three months at one time. If the customer wanted to pay the entire year at one time we would only charge them for eleven payments and they would receive the twelfth payment free. We charged a delinquent charge of \$2.00 a payment if the payment not received on time and usually this was when the customer forgot to make a payment. If they had mailed the coupon and we received it a couple of days late we usually waived the delinquent charge.

Contract usage

Usage will vary but most of your customers will only call when service is really needed. We did find that a small percentage of contract customers would call

```

* Arco TV 12345 Main Street St. Charles IL 66274 Phone 555-2550 *
#####
01/07/96

                SERVICE CONTRACT FROM 12/27/95 to 12/27/96

1247RMH RCA 25" ARY670
Marion McWorter (312) 555-4309
23 Booker St. Apt. #2 $11.50
Chicago IL Ser. 54321-8894
60613 Exp. 12/27/96

                * Includes the Following *
                * Shop Service * Picture Tube
                * All Parts * All Adjustments
                * Includes Remote Control
                * All Service Calls

Contract Will Remain in Force as Long as Payments are Received by Due Date.

Authorized By:

*****
* DUE BY 11/27/96 *      * DUE BY 10/27/96 *      * DUE BY 09/27/96 *
* AMOUNT $11.50 *      * AMOUNT $11.50 *      * AMOUNT $11.50 *
* CONTRACT 1247RMH *    * CONTRACT 1247RMH *    * CONTRACT 1247RMH *
* Marion McWorter *    * Marion McWorter *    * Marion McWorter *
*****

*****
* DUE BY 08/27/96 *      * DUE BY 07/27/96 *      * DUE BY 06/27/96 *
* AMOUNT $11.50 *      * AMOUNT $11.50 *      * AMOUNT $11.50 *
* CONTRACT 1247RMH *    * CONTRACT 1247RMH *    * CONTRACT 1247RMH *
* Marion McWorter *    * Marion McWorter *    * Marion McWorter *
*****

*****
* DUE BY 05/27/96 *      * DUE BY 04/27/96 *      * DUE BY 03/27/96 *
* AMOUNT $11.50 *      * AMOUNT $11.50 *      * AMOUNT $11.50 *
* CONTRACT 1247RMH *    * CONTRACT 1247RMH *    * CONTRACT 1247RMH *
* Marion McWorter *    * Marion McWorter *    * Marion McWorter *
*****

*****
* DUE BY 02/27/96 *      * DUE BY 01/27/96 *      * DUE BY 12/27/96 *
* AMOUNT $11.50 *      * AMOUNT $11.50 *      * AMOUNT $11.50 *
* CONTRACT 1247RMH *    * CONTRACT 1247RMH *    * CONTRACT 1247RMH *
* Marion McWorter *    * Marion McWorter *    * Marion McWorter *
*****

```

Figure 3. This contract numbered as 1247RMH, is one that is used to cover a remote control model TV set.

and report a minor problem or request an adjustment shortly after they bought the contract, just to see if we would really respond promptly.

Another small percentage of customers would call and report a minor problem, such as a black margin at the top or bottom of the screen, and state that they

would wait until they had a "real problem."

Some customers would call when they had accidentally pushed the parental control code, or when they had changed the setting from cable TV to regular TV, or they had the VCR set in the VCR position but were not using it. We processed these occurrences at no charge but we



explained to the customer that this was not covered by the service contract.

Handling the funds

The funds collected can be handled in a number of ways. We put the total income collected in a separate account. On a monthly basis, this account paid the company for the service that was rendered at the regular rates for both parts and service. Some companies just put the amounts in their regular account and do the processing with the computer.

It would best for any company that was thinking about selling service contracts to check with the state and local authorities to see if they are required to post a bond or have the funds in a separate escrow account. Many states do not require this because the period covered for each payment is actually only a month.

Posting only takes about thirty minutes a week and all of it is completed without writing a single invoice or manually writing it down on paper. The computer keeps track of the contracts and automatically generates a letter if a customer is past due. This notice is mailed in a window envelope, so it does not require separate addressing of the envelope.

When the last payment is made, the computer automatically checks the pricing and adjusts it if necessary and sends out the new contract, also in a window envelope. If the previous contract was the first year and was a "C9H" contract then the computer automatically changes it to a "CMH" or to "RMH" if it was a "R9H" contract and changes the price to reflect the fact that the parts are no longer covered by the manufacturers warranty.

Adjusting the rates

Rates were automatically adjusted by the computer if an adjustment was in order. The rate adjustment formula is complicated. The rate is not allowed to raise or lower the price unless the current year and the historic transactions (all of the cumulative years except the current year) resulted in a loss or a surplus to date. Then it would adjust the rate upward for the new year and would check it again at

* Enter as Requested *	
#####	
Print all Contract Customers	1
Print Selective Contract Customers	2
Print out Labels	3
Current Financial Report	4
Print Contract Renewal Notices	5
Print Selected Renewal Notices	6
Print Dates Contract Paid to	7
Print Delinquent Contract Numbers	8
Print Monthly Income Repotr	9
Print Monthly Expense Report	10
Print YTD Expense Report	11
Print out Contract Price List	12
Enter your Selection?	

Figure 4. Here is an example of the kind of reports that can be generated by a computer.

renewal time to see if a rate adjustment was needed.

If that rate had previously been increased and now the ratios were less than 100 then the rate was reduced for the following year. It could also be increased or decreased the following year if the computer calculated that an adjustment was needed. This automatic adjustment allows you to keep the basic rate low for customers who do not require excessive service while also allowing you to make a profit on the contracts where excessive service is needed or requested.

We had several customers who would call us if the cable went off, or if they had the VCR set for VCR operation and were trying to use the TV directly. We cheerfully provided service without charging them, but later the cost of the contract was increased because the cost of providing the service increased. This is a wonderful feature that allows you to provide service without saying "you have to pay for the service because the set did not fail." We did, however, inform the customer that the service requested was not really covered by the service contract.

Renewals, reports and tracking

Renewals are automatic and we rarely had a customer decline to renew the contract when a new one was mailed. We do

include preaddressed envelopes, twelve of them, with the contract, and we would regularly have customers call us to tell us that they had extra envelopes and did not need any because they mailed several payments at a time. The contract goes into a number 9 window envelope and the name and address on the contract shows through the window for mailing.

Reports are generated by the computer. An example of reports that can be generated is listed in Figure 4. The computer can also give you a printout of all of the contracts in effect and the dates that they expire. We printed out a monthly income and expense report that showed the activity during that month.

Tracking of the contracts is kept in a 5-1/2" by 8-1/2" envelope and these are listed in numerical order in a file. When the computer prints out a new, or a renewal contract, it also marks the file so that when labels are printed out it will print out two of them. One of these labels is placed on a Rolodex rotary file and the other label is placed on the envelope mentioned above. A sample of these labels is listed in Figure 5.

All of the coupons are put in the envelopes and the label has the complete data including the contract number (that includes the type) name, address, phone number, contract number, model and ser-



ial number and the expiration date of the service contract.

Handling a request for service

When service is requested, the person taking the information refers to the rotary file and verifies the expiration date and also the model and serial number of the set. This data goes on the service invoice and the technician providing the service checks the model and serial number against the one on the service invoice to insure that the set is covered by a service contract. We put a copy of the invoice in the contract envelope and also posted the file copy as we would a normal repair.

If reservice is needed we handled it the same as we would a reservice on a COD call; if any charges were needed they would be posted against the contract. When the technician provides the service, he prices the parts and service as he normally would for a COD call but instead of marking it paid he marks "contract" on the invoice. The copy that went into the envelope was posted once a week when the income was posted and then it was inserted into the envelope.

Dealing with obsolete parts

Obsolete parts were rarely a problem, but if we could not obtain needed parts we would offer the customer all of the money back that he had paid on the current contract, or more frequently would convert it to a new contract on a new set the customer purchased and he would not have to make any payments until the credit ran out. We did not cancel any contract because of age, even though many sets are over ten years old.

Conversions were made if a customer decided to purchase a new set and a new contract was issued at the lower price on a new set. Usually the customer was glad to have the coverage on the new set and rarely did they not take the conversion and request a refund.

Senior citizens especially enjoy and appreciate the advantages of a good service contract and many times this relieved a son or daughter from making a decision to get a set repaired or purchase a new one. Older people generally watch their sets more but they are also more gentle with them and our experience showed

that a service contract was profitable for both the service center and the customers.

Advantages of service contracts

Service contracts are good for several reasons. For one thing, they give you income up front and you can predict how much service will be needed. They will even out your work load and help you to keep your good technicians employed during slow times. The customers rarely complain when they do not have to pay for the service. Customers who ordinarily might replace a faulty set without even obtaining an estimate, call you because they have your contract.

Word of mouth advertising is very helpful and when a neighbor complains about the high cost of service, your contract customer will boast that they are not bothered with that problem because they have a contract with you. You are offering a service that most of your competition does not.

Your competitors will tell you, as mine did, that a customer would take the contract and then as soon as they had a major

repair, or picture tube replaced, would cancel the contract. This certainly was not our experience and your customer knows that he made a correct decision because he would have had to pay for the repair if he did not have the contract.

Service contracts provide additional business

Additional business is yours if you decide that this makes sense to you. If you try it for a year, you will certainly see the value of it. I had a friend who had a large service business and after I explained how the monthly service contracts worked he converted all of his to monthly contracts. This servicer no longer even offers annual contracts. He does send a bill each month, as opposed to the coupons that we send out, but he said that this procedure works well for him.

Make a change for the better and offer service contracts to your customers. You will be glad that you did and your customers will be happy with the comfort and security that it provides them. ■

Improve Your Form.

3/5 Part

A continuous feed form used for customer COD service, parts/accessory sales receipts, and warranty billing. Includes technician hard copy and set tag. Available in 3-part (N3CS) and 5-part (N5CS) format.

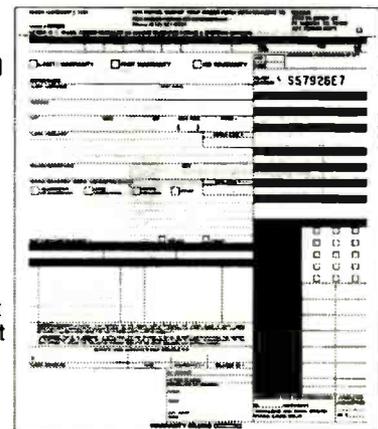
5 Part

A continuous feed 5-part (N5CN) form for warranty billing that does not include a set tag.

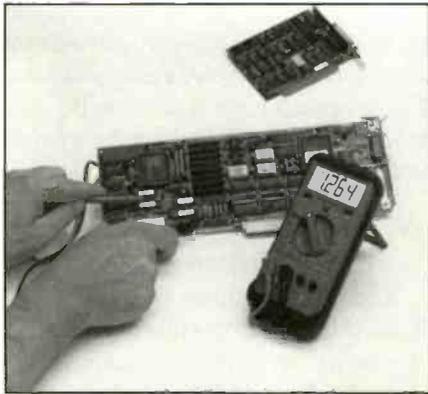
Discounts Carbonless NESDA Forms are available to NESDA members at additional savings. For pricing information and samples, contact Moore Business Products at the number below.

The NESDA Form

Moore Business Products
(800) 433-5557



PRODUCTS



Digital multimeter/component tester

Wavetek Corporation announces the release of a new high function digital multimeter (DMM), the DM16XL. In addition to core DMM functions of volts, ohms, and amps, this meter also features measuring modes for frequency, capacitance, logic test, transistor test, as well as continuity and diode test.

The meter adds user preferred features such as data hold (which freezes the reading on the display for later evaluation) and a large LCD display which offers 0.7 inch high numerals. Measuring functions include ac and dcV to 600V and current to 10A, resistance ranges from 200Ω to 20MΩ, capacitance to 20μF, frequency counter (to 15MHz), a transistor gain and CMOS and TTL logic test.

The meter's safety test leads are shrouded with plastic to eliminate the possibility of shock. Incorrect test lead placement will cause the DMM to issue a warning beep. The unit also features a fused 10A current jack. The meter is designed to IEC 1010-1 and UL3111 standards.

Circle (31) on Reply Card

Magnification light

Waldmann Lighting presents the Focus 7-118 magnification light which offers 40 percent more light output than other standard industry magnifiers. The light is intended for applications where higher levels of illumination is needed.

The light, which is part of the company's "Focus Series" magnifiers including the standard Focus 7 Plus and "ESD safe" version, features a "new generation" 18 watt compact fluorescent lamp which provides 12,000 hours of lamp life.



The unit includes all the features of the standard products including a large 3-diopter stadium shaped lens which tilts independently of the head. This lens provides an undistorted, broad field-of-view which reduces eyestrain and increases productivity.

The product is available with three optional "ADD-X" lenses that increase the magnification up to 7, 15, or 16 diopters. When used with the 13d "ADD-X" lens, the light meets the MIL-STD 2000, DOD-2000 and WS6536E. A spring-loaded base helps make luminaire adjustment easy.

Circle (32) on Reply Card

Industrial analog multimeter

Amprobe Instrument announces the release of the new industrial analog multimeter model AM-6B. The AM-6B will



supersede the AM-6A, while providing additional functions and extended range capabilities such as: 1.5V battery test scale, dB scale; for telecommunication applications, higher input impedance (4KΩ/Volt), fuse and diode protected for misapplication up to 250V, 5μA to 300mA dc current measurement capability, 10mV to 600Vdc voltage measurement capability, dual resistance scale up to 1MΩ, and a larger mirrored display.

Circle (43) on Reply Card

Service center software

CN Software announces the release of ROMS v4.1 (Repair Organization Management System).

The new version includes powerful automated workflow processing of service orders. The automated workflow process automatically moves units throughout the repair process based on information inputted into the system.

This new automatic workflow allows management to review possible bottlenecks through a special Status Code report that summarizes at which repair stage all of the models/items are in-house. Second, items sent in for repair cannot get lost in the flow due to human error.

Depending on which stage of repair the items are at, the unit will receive a user-defineable status code. Items are grouped into appropriate queues based on the status code. The software automatically changes the status of the service order so the company does not have to rely on manual input from the technicians for the following status: manufacturer warranty, estimate required, estimate approved, estimate denied, requires parts, parts on order, parts arrived, shipped, or billed.

The software comes with a default status code table that can be modified to accommodate the user's organizational requirements. For example, with the default codes supplied when parts that have been ordered arrive or an item returns from being routed to a third party for repair, the unit defaults to Working On.

Circle (33) on Reply Card

Software for electrical waveforms

Fluke Corporation has released a soft-

ware package called FlukeView, which gives users of the company's ScopeMeter test tool or the new ScopeMeter Series II handheld test tools a customized interface for managing measurement data on a personal computer.

After using a test tool to collect and store signal waveforms from a circuit board or other unit under observation, the user can instruct the software to upload the waveforms and associated data to a DOS-based or Windows-based PC. The program operates with the test tools to store not only waveforms but also test tool setups and complete screen images that are vital for reports and documentation. Simple menu-driven procedures enable users to quickly analyze, archive, or print the captured data.

The stored data can even be used to recreate the exact measurement conditions of a troubleshooting session at a later date—an aid when the test tool is used to frequently perform a series of tests, or when troubleshooting requires exact duplication of previous test conditions.

Circle (34) on Reply Card

Task-specific aerosol chemicals

A new selection of ozone-friendly, job-specific aerosol solvents, cleaners and degreasers is now available from *Micro Care Corp.* of Bristol, CT. These are all



replacements for ozone-depleting CFCs which will be phased out, as determined by the Montreal Protocol.

The "Specialist Series" of aerosol cleaners consists of five products, each with highly informative labels spelling out instructions for proper and safe use. Technical data and recommendations for the use with collateral products such as brushes, wipes and dryers are also furnished. Packaged in bulk containers as

well as aerosol cans, the new series consists of a defluxer, a degreaser, a head cleaner, a non-flammable contact cleaner as well as a label and adhesive remover.

Circle (35) on Reply Card

Fiber optic products

3M Electronic Specialty Markets (ESM) is now offering a variety of fiber optic connectors and accessories, splices, and test equipment used in the installation and maintenance of computer networks.

The line of fiber optic products includes: Fibrok 2529 Universal Optical Fiber Splice for splicing any combination of coated fibers, Photodyne 17XTA, XTF and 18 XTA Hand-Held Fiber Optic Power Meters for measuring fiber optic power signals, Photodyne XE Series Light Sources, a portable, handheld device for testing and measuring signals in fiber optic networks, Photodyne 8000XGA Fiber Identifier for identifying and testing traffic on fiber optic lines without cutting the fiber or interrupting service, connectors and accessories, the company's complete line of fiber optic connectors and related products for LAN applications; including the 6100 Series Hot Melt Fiber Optic Connector, an easy-to-install adhesive-based multimode connector, polishing machine for polishing the ferrule of hot melt connectors.

Circle (36) on Reply Card

Portable video generator

B&K Precision has introduced Model 1211D video pattern generator, designed for TV service operations that need durable economical video generators for testing NTSC televisions. The generator produces most of the useful color and convergence test patterns.

Patterns include color bars, full field color rasters with adjustable hue, a blank (black) raster, 7X11 cross hatch, and 7x11 dots. Chroma phase and level, RF output can be on channels 3 or 4. A modulated 1kHz audio tone is switch-selectable with any video pattern.

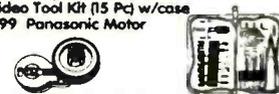
Circle (37) on Reply Card

Precision tool set

Willi Hahn Corporation introduces new compact precision interchangeable tool

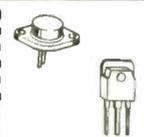
VCR REPLACEMENT PARTS

VXPO521 Panasonic Idler Orig.	\$2.99ea (10 min)
164113 RCA Idler Original	\$2.99ea (10 min)
NPLY0111GEZZ Idler Original	\$8.95ea
613-022-2534 Sanyo/Fisher Gear	\$2.99ea (10 min)
199347 RCA Replacement Belt Kit	\$1.99ea
VTK-1 Video Tool Kit (15 Pcs) w/case	\$39.95ea
VEM50099 Panasonic Motor	\$8.95ea



POPULAR SEMICONDUCTORS

2SD1427	\$1.89ea (10 min)
2SD1555	\$1.99ea
SDA-3202-3	\$5.95ea
25C4664	\$3.50ea 10/up \$2.95ea
STK563F	\$8.95ea 5/up \$8.50ea
STK4273	\$9.95ea 5/up \$8.95ea
STR0130	\$2.95ea Any Quantity!
STR0135	\$2.95ea Any Quantity!



POPULAR REPLACEMENT FLYBACKS

2434391	Hitachi	\$24.95ea
1-437-357-11	Sony	\$24.95ea
FO014	Sharp	\$19.95ea
FO075	Sharp	\$19.95ea
FO076	Sharp	\$19.95ea
FT588	Sharp	\$27.95ea
TLF14401F	Panasonic	\$29.95ea
TLF14423F	Panasonic	\$29.95ea
TLF14530	Panasonic	\$24.95ea



POPULAR REPLACEMENT PARTS

NCS-1	NINTENDO GAME SOCKET	\$7.95ea
340313-5	NAP TUNER	\$34.95ea
4835-1539-7006	NAP SAW FILTER	\$4.95ea
1-22E-482-00	SONY FOCUS RESISTOR	\$49.95ea
4835-1163-7005	NAP THERMISTOR	\$3.95ea
KSS-210A	ORIGINAL PICKUP HEAD	\$34.50ea



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Circle (59) on Reply Card

Test Your Electronics Knowledge

Answers to the quiz

(from page 14)

1. Analog to Digital Converter
2. Application Specific IC
3. Computer-Aided Test
4. Characters Per Second
5. General Purpose Interface Bus
6. MicroProcessor Unit
7. Original Equipment Manufacturer
8. Positive Temperature Coefficient
9. Silicon Bilateral Switch
10. Uninterruptible Power Supply
11. Very High Speed Integrated Circuit
12. International Standards Organization



sets to their popular line of high quality hand tools. The Compact Interchangeable Precision Tool sets come in a compact indexed storage box which folds out to neatly display the tools.

Four sets, each with different blade/tip combinations, contain the distinctive Wiha adjustable handle which allows you to vary the blade lengths from 6 inches to 3.75 inches. These comfortable, tapered handles provide added control with a finger tip rotation cup on the end of the handle. The interchangeable blades have two different tip styles on each blade. They are made of a special chrome-vanadium-molybdenum-steel which is hardened and chrome plated to the tip resulting in high quality, long life screwdrivers. The tip is left black to guarantee exact size.

The sets are a 5 Personal Computer Torx set, a 5 Personal Computer slotted/Phillips set, a 9 Personal Computer slotted/Phillips/Torx set, and a 9 Personal Computer metric nutdriver set.

Circle (38) on Reply Card

Digital oscilloscopes

Tektronix announces three new models of the TDS 300 series: 100 MHz TDS 340, 200 MHz TDS 360 and 400 MHz TDS 380.

The TDS 300 digital scopes are basic troubleshooting instruments targeted pri-



marily for the education, design, service and repair markets. With the TDS 340, 360 and 380 models, customers can now obtain the benefits of digital scopes at a price nearer analog scopes. With the digital capability of the series, users can store set-ups and waveforms and perform 21 different automatic measurements. They

also benefit from intuitive and simple interface.

All three scopes feature patented Digital Real-Time (DRT) oversampling technology, which reduces aliasing and enables single-shot waveform capture at the instrument's full bandwidth. The TDS 340's two channels digitize at a rate of 500 megasamples per second, the TDS 360 at a rate of 1 gigasample per second and the TDS 380 at a rate of 2 gigasamples per second.

For design and repair users, the 3 1/2-inch DOS compatible floppy disk drive built into the TDS 360 and 380 models is useful for storing reference waveforms, downloading waveforms and setups and importing and exporting waveform values into application programs.

Circle (39) on Reply Card

Alternative electrical cleaner and degreaser

CRC Industries announces the CRC Fast Dry Degreaser. This new alternative to traditional electrical cleaners and degreasers contains no CFCs, 1,1,1 trichloroethane, or other chlorinated solvents.

According to the manufacturer, the degreaser is excellent for use where rapid turn-around is necessary and low flash-point solvents can be used.

It is a non-conducting, non-corrosive compound, is designed to increase the life and efficiency of motors, parts, and other equipment by removing grease, oil, dirt, and sludge.

The degreaser, which quickly evaporates and leaves no residue, has a wide variety of industrial applications, including motors, pumps, generators, hoists, compressors, mechanical equipment, corroded machinery, air tools, brakes and clutches, chains and wire rope, dies, molds, and bearings.

Circle (40) on Reply Card

Electronics laboratory simulator

The New Global Specialties Protolab Complete release 3.2, is the combination of two computer simulated electronics laboratory programs combined into one small package.

The Protolab Complete has all of the functions and capabilities of the Protolab, release 3.0, IBM and the Protoware, 3-in-1 modules, IBM on one 3.5 inch disk with a 58-page instruction manual.

With this package the user can build experiments and test actual circuits, choose from an unlimited number of passive components, the world of transistors, diodes, special function linear circuits or play the electronic organ circuit. During operation the user can study and change component values and then with the use of a mouse analyze the circuit with the built-in battery, power supply, multimeter, oscilloscope, ammeter, wattmeter or signal generator.

Circle (41) on Reply Card



Mini-Fluxer and Mini-Cleaner products

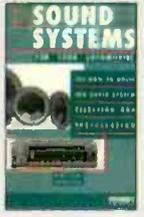
TopLine offers Mini-Fluxer and Mini-Cleaner controlled-release pen applicators which are useful for rework, repair and light assembly of TAB, surface mount and high density boards, as well as ceramic substrates.

These pens are a "user-friendly" method for pin-point application of flux or cleaning solvent on restricted or difficult-to-reach areas. These multicore pens are safe, quick, easy-to-use and cost effective. They are designed with a stainless steel spring-loaded applicator head which delivers a controlled amount of liquid to the work surface. All the user does is gently depress the chiseled tip against the work surface to start the flow. There is no waste and no handling problems. Running on vertical or inclined surfaces is eliminated.

Circle (42) on Reply Card



ES&T BOOK SHOP



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By Alvis J. Evans and Eric J. Evans
This book will show you how to plan your car stereo system, choose components and speakers and install and interconnect them to achieve the best sound quality possible. Order# 61046 \$16.95.



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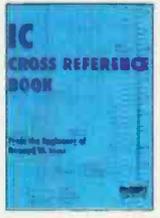


Semiconductor Cross Reference Book

By Howard W. Sams & Company
From the makers of Photofact service documentation, the Semiconductor Cross Reference Book is the most comprehensive guide to replacement data for all major types of semiconductors. This volume contains over 475,000 part numbers and other identifying numbers. Order# 61050 \$24.95.

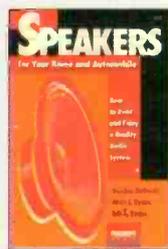
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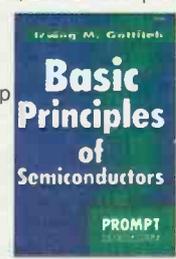
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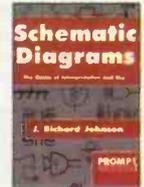
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SERVICE DATA & HARD TO FIND PARTS previously-owned SAMs, manufacturers data, books, FREE catalog. **AG Tannenbaum**, Box 386, Ambler, PA 19002, (215) 540-8055, fax (215) 540-8327.

FURTHER PRICE REDUCTION. Diehl Mark III \$49, Diehl Mark V Horizontal circuit tester \$169. New. Conductive coating for remote control keypads \$9.99 ppd. **WEEC**, 2411 Nob Hill Road, Madison, WI 53713. (608)-238-4629, (608)-273-8585.

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NEWS

(from page 7)

for the '95 IYSC.

Contestants, up to age 22, come to IYSC from all over the world to compete in a wide variety of occupational skills for gold, silver, and bronze medals. The CEMA Product Services staff conducts a biannual competition to select a US representative to compete in the Electronics Applications event at IYSC. IYSC is held in a different country every two years.

Perry, 22, resides in Salt Lake City, UT. He holds an associate degree in electronics from ITT Tech, where he will soon return to pursue a bachelor's degree.

The Consumer Electronics Manufacturers Association (CEMA) is a sector of the Electronic Industries Association (EIA), the Arlington, VA-based trade association representing all facets of electronics manufacturing. CEMA is the new name of EIA's Consumer Electronics Group (CEG). CEMA represents US manufacturers of audio, video, consumer information, accessories, mobile electronics and multimedia products. ■

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RCA 148034 flyback, RCA 158048 flyback, GE EP77X44 yoke, GE EP77X55 yoke (all new). Make offer. *Contact: Wieland TV/VCR, 237 Talbot Drive, Bedford, OH, 216-232-8653.*

VG91 and TVA 92 (less than six months in use). B&K VTVM model 177, B&K restorer and analyzer model 467, HV Probe HP 200 (new). Over 600 Sams, some tuners & modules (some new, some rebuilt), other misc. items. Will need a truck to haul off. All for \$4,500.00. *Contact: Davis TV & Radio, Claytie Davis, Sr., 1500 Stilwell Blvd., Port Arthur, TX 77640, 409-982-1572.*

Sencore VA62A universal video analyzer. All cables, manuals, and original boxes included. Excellent condition, \$1500.00. *Contact: Bruce, 603-878-2815.*

Sencore VA62 and VC63, \$1700.00. Marconi 2018 synthesized frequency generator 80KHz to 520MHz, \$2200.00. Tektronix 475 scope 200MHz with probes, \$950.00. Leader LCG396, NTSC generator, \$425.00. *Contact: Alex Torok, 814-337-2348.*

Sams from #1 to 1862. All in order and in filing cabinets. Make offer. *Contact: Rosenelyn Stipe, Box 429, LaVerkin, UT 84745, 801-635-2125.*

Fully-equipped service center for sale by owner. All test equipment manuals, microfiche, inventoried parts and cash register included. A "steal" at \$10,000. *Contact: John, 605-582-2716.*

WANTED

Sencore radio frequency switch #RFS205 or schematic copy; copy of manual for Conar model #214 transistor tester; 5W and/or 10W 27MHz. Bird 43 elements; NRI CB Radio or Radio Communications Course textbooks, etc. *Contact: Jordan Hillrich, 732 Queen Street, Regina, SK, Canada S4T 4A3.*

Sencore 3100 scope, Sencore LC-102 Z meter, Telematic 10J series test jig adapters. *Contact: Ron Walker, 1175 Waldo Way, Twinsburg, OH 44087, 216-425-9038 phone or fax.*

RGB tubes for Mitsubishi VS1200 projector or complete VS1250 data projector. *Contact: David, 310-924-2666.*

Service manuals for: Satellite America model SA-2000 satellite receiver and down converter, Heathkit oscilloscope 10-4105, Panasonic fax Panafax 260, etc. *Contact: Mr. Rejean Mathieu, 819-874-1049 (phone), 819-874-0704 (fax).*

B&K 1431, Midland 13-513, Redicom XF617, Genave Mobiline III, Sony ICF-6500W, Regence micro-com 21 and BTL-301, need schematics, copy is O.K. *Contact: C.W. Electronics, 40N Baily, Freeport, IL 61032, 815-233-0224, 815-233-1994 (fax).*

Transistor radios, "shirt pocket" sized. Also, older 4-pin tubes and antique radios, the older the better. *Contact: Don M. Maurer, 29 South 4th Street, Lebanon, PA 17042, 717-270-7037.*



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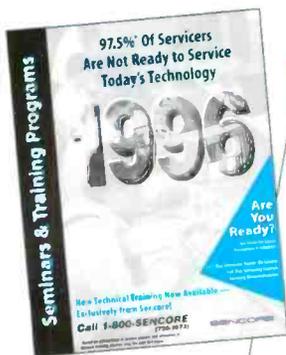
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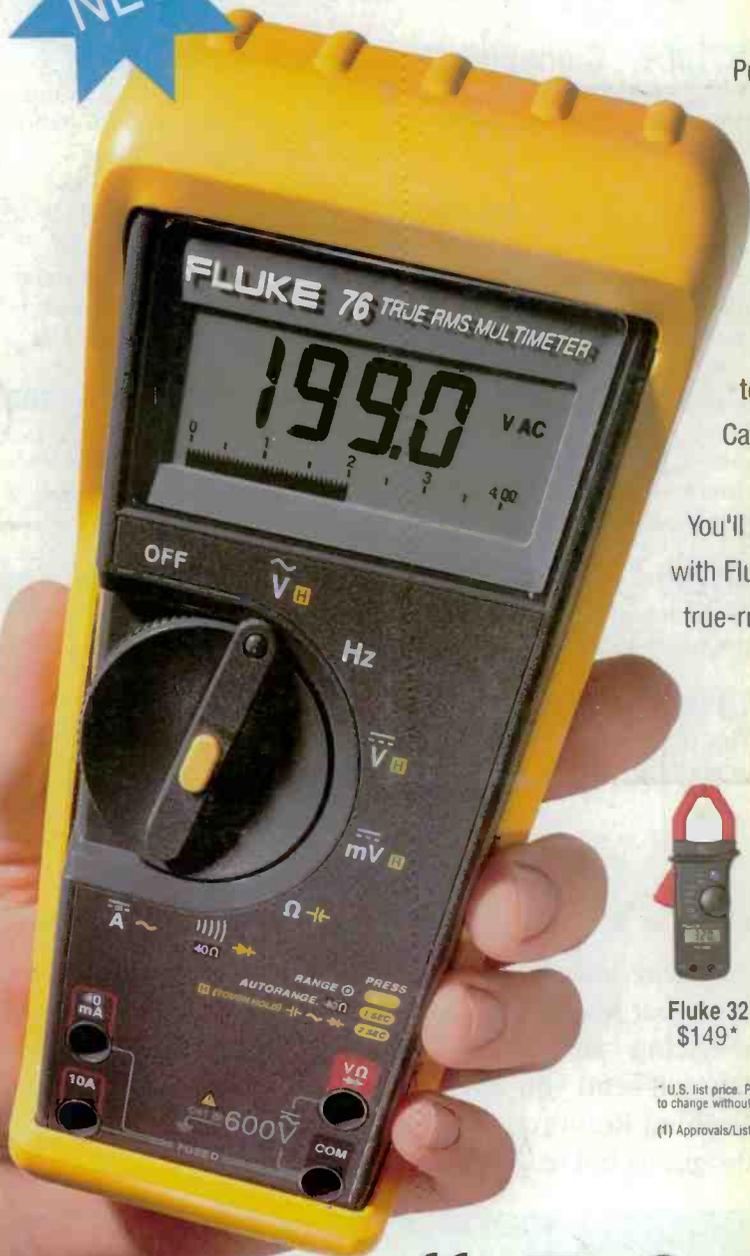
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