THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS

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VCR Servicing Special Report

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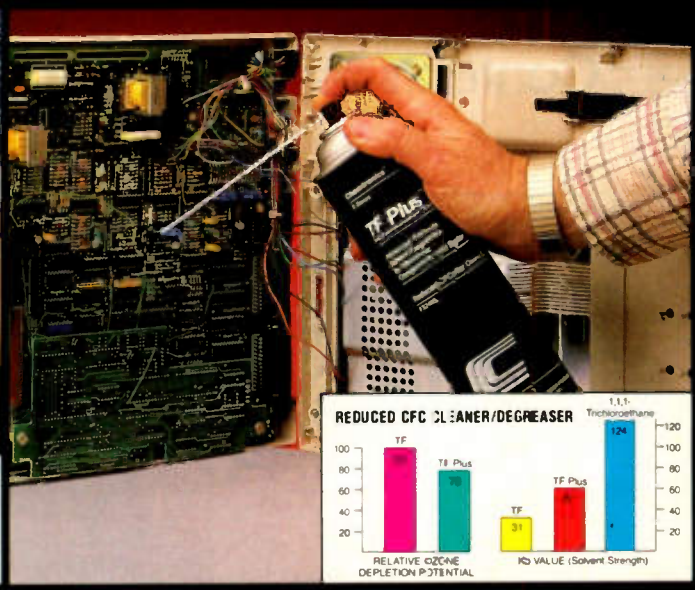

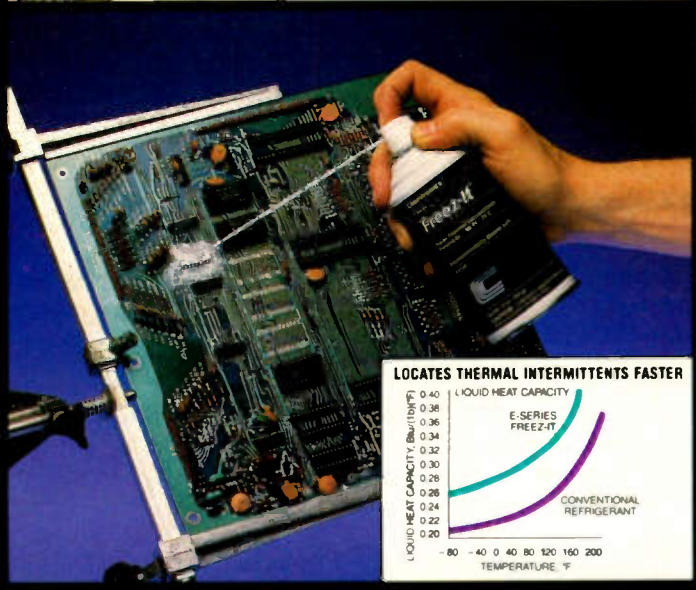

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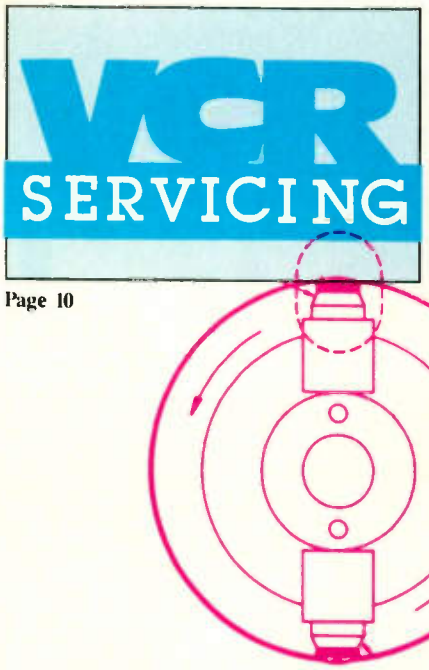
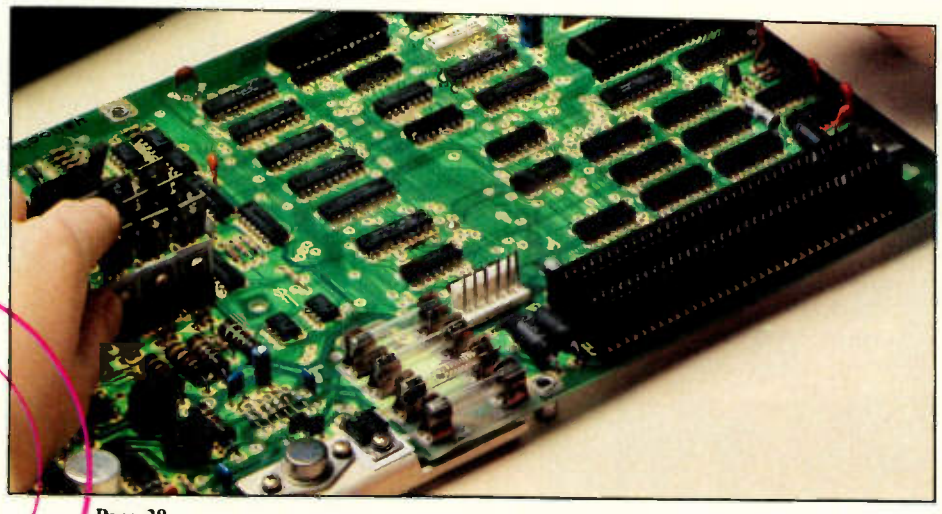
Contents

Volume 10, No. 2 February 1990



Page 10



Page 38

SPECIAL REPORT

VCR Servicing

THE MAGAZINE FOR CONSUMER ELECTRONICS SERVICING PROFESSIONALS
ELECTRONIC
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FEATURES

DEPARTMENTS

ON THE COVER

Servicing personal computers requires the use of some familiar equipment in some not-so-familiar troubleshooting methods. A good working knowledge of the PC from the user's standpoint can make a world of difference. *(Photo courtesy of HMC, Canton, MA.)*

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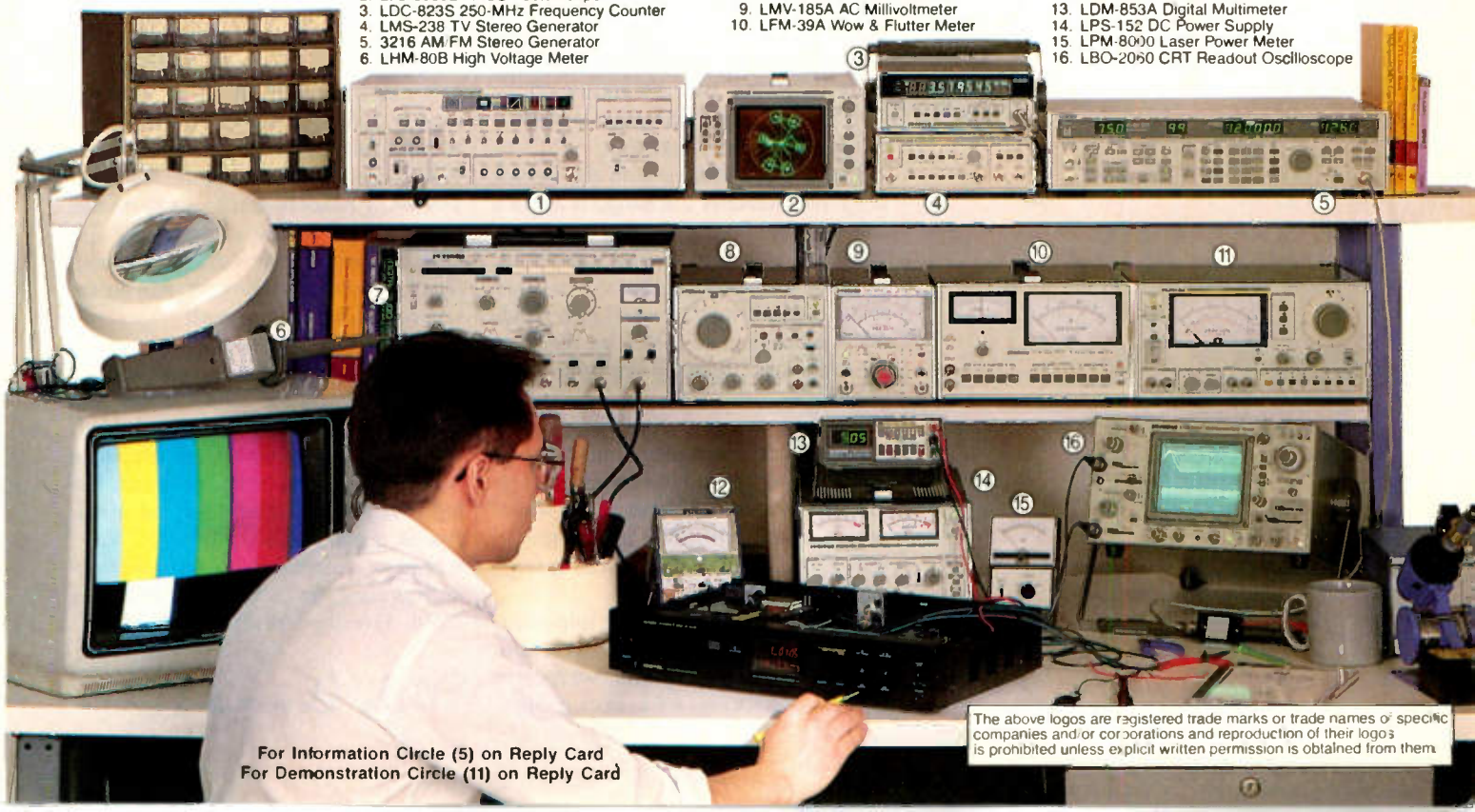
8. LAG-126S Audio Generator
9. LMV-185A AC Millivoltmeter
10. LFM-39A Wow & Flutter Meter
11. LDM-171 Distortion Meter
12. LTC-906 Transistor Checker
13. LDM-853A Digital Multimeter
14. LPS-152 DC Power Supply
15. LPM-8000 Laser Power Meter
16. LBO-2060 CRT Readout Oscilloscope



For Information Circle (5) on Reply Card
For Demonstration Circle (11) on Reply Card

It's back: free Readers' Exchange

A few months ago, we announced that we would begin charging our readers to place items in our Readers' Exchange department. Our decision to make this change was motivated by the best of intentions. We felt that a relative handful of our readers, the ones who placed the For Sale or Wanted items, were the primary beneficiaries. It also seemed to us that some of those individuals were taking unfair advantage of the department by asking us to place far more items in the department than the three that we limited it to.

We also felt that because these items constitute a kind of commercial venture, it was fair to ask the person placing the item to pay a small fee for the privilege. We also saw it as a way to make available space for more articles that would be of benefit to all readers.

The flood of letters we have received as a result of that change, and the paucity of paid Reader's Exchange items that have been submitted, tells us clearly that we made a mistake. Apparently, most readers don't really see Readers' Exchange as anything but useful editorial. Even a lot of people who seldom actually buy or sell read these pages with interest just to see what's being asked or offered, on the remote chance that they will find something that will be of interest to them. It also is, apparently, a good way for readers to exchange information that is really not worth paying to place in the magazine.

By charging to place this information in the magazine, we were cutting off the free flow of information that we really are interested in promoting.

Therefore, effective with the February issue, Readers Exchange is again a free service. So if you have something to sell, if you need to buy something, or if you just need a schematic or other servicing information, send in a Readers' Exchange item, following the rules set forth here. Space permitting, we'll publish it.

Here are the guidelines:

- All Readers Exchange items must be in some way related to consumer electronics servicing, and must not be something you are ordinarily in business to sell. Those items should be sold through paid ads.
- We will make every effort to publish all Readers' Exchange items in the first available issue of *ES&T* after we receive the item. However, we cannot guarantee that any Readers' Exchange item will ever be published. We reserve the right to refuse to publish any item in Readers' Exchange. If whatever you have to sell absolutely must be published, and in a specific issue, place a paid classified ad.
- Please limit your entry to no more than three items for sale and three items you want to buy, for a total of no more than six items. If you have more than that number, we suggest you include the words "Send self-addressed stamped envelope (SASE) for list." If you include more than three items, we will either publish the first three "For Sale" and "Wanted" items and ignore the rest, or we will discard the entry.
- Limit your descriptions to no more than 30 words, including your address. Even if you limit your entry to three items, detailed descriptions take up space that should be used for another reader's entry. If details are necessary, include your telephone number or ask those who respond to send an SASE for a detailed description. If you do leave in more than 30 words, we will be forced to either cut out all extraneous description or discard your entry. We simply don't have the manpower to edit each entry.
- Write legibly. Either type or print the entry, and explain any obscure abbreviations. We don't have the time or the resources to try to translate or to contact you for an interpretation. If we can't read your entry, we will discard it.
- A magazine such as *ES&T* works at least two months ahead. At the time of writing this editorial for the February 1990 issue, it's the middle of December 1989. Any Readers' Exchange items that are to appear in this issue would also have had to be in our hands by the middle of December. In general, aim for the second week of the month.
- Make sure to type or print your name, address and telephone number on your Readers' Exchange item; letters and envelopes frequently get separated. If you prefer not to have your telephone number published, let us know that. Using your peel-off label from the magazine is a good idea.
- Mail to: Readers' Exchange, Electronic Servicing & Technology, P.O. Box 12901, Overland Park, KS 66212.

Nils Conrad Persson

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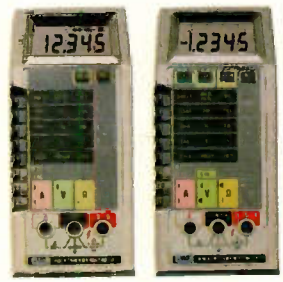

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VCR SERVICING

The salvation of your profit margin?

By Conrad Persson

Just a few years ago, VCRs were introduced as a consumer electronics product. In a remarkably short time, sales of VCRs skyrocketed, and now millions of them are in use in homes throughout the country. Because these units contain parts that get dirty, wear, stretch and break, VCRs have become a lucrative source of business for many electronics servicing technicians. In fact, VCRs have become so plentiful that many servicing concerns that once serviced TVs now specialize exclusively in cleaning and repairing VCRs.

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

Why this special report?

If the opportunities for servicing VCRs are great, so are the problems. For example, VCRs are complex systems, and an understanding of them requires a considerable amount of study. An attendant problem is the newness of the technology — it takes quite a leap in knowledge to become thoroughly comfortable with VCR servicing. Even worse, many (if not most) brands of VCRs are not actually manufactured by the organization name that appears on the product, making it difficult or impossible to determine where to go to find servicing literature or parts. If the name on the unit is the manufacturer, you're still not out of the woods — many of the VCR manufacturers are not familiar, and it's very difficult to find the company to obtain information and parts.

VCR manufacturers

ABC Int'l. Traders
216 South Oxford Ave.
Los Angeles, CA 90004-5195
Telephone: 213-380-4030
Fax: 213-380-4730

ALAKH, Div. of Hi-tech
25 Green St.
Hackensack, NJ 07601
Telephone: 201-343-2300
Fax: 201-343-7989
Brands: "Spartan" by Hi-Tech

Amco Group
3380 Livonia Ave.
Los Angeles, CA 90034
Telephone: 213-838-2626
Fax: 213-559-2600

Arrow Trading Co., Pierre Cardin Electronique
1115 Broadway
New York, NY 10010
Telephone: 212-255-7688

AV Distributors
2427 Bay Area Blvd.
Clear Lake City, TX 77058
Telephone: 713-486-3939
Fax: 713-486-8300

Canon USA, Video Div.
One Canon Plaza
Lake Success, NY 11042
Telephone: 516-488-6700
Brands: Canon, Canovision & Accu-Vision

CBM America, (Citizen Watch Co. Ltd., Electronics Group)
2020 Santa Monica Blvd., Suite 410
Santa Monica, CA 90404
Telephone: 213-828-8245
Brands: Citizen

Daewoo Electronics Corp. of America
100 Daewoo Place
Carlstadt, NJ 07072
Telephone: 201-935-8700
Brands: Portland, Daytron

Electro Star
1000 Stanford Ave.
Los Angeles, CA 90021
Telephone: 213-622-5290
Brands: Dynasty, Technidyne

Emerson Radio
One Emerson Lane
North Bergen, NJ 07047
Telephone: 201-854-6600

E&S Int'l. Enterprises
7849 Canoga Ave.
Canoga Park, CA 91303
Telephone: 818-887-0700
Fax: 818-708-2254
Brands: Stereo Sports, Giant

Getwin Trading
1225 Broadway, Suite 504
New York, NY 10001
Telephone: 212-685-6618
Fax: 212-889-4069

Goldstar Electronics Int'l.
1050 Wall St. W.
Lyndhurst, NJ 07071
Telephone: 201-460-8870
Brands: Goldstar

Grundig/Lextronix
3520 Haven Ave., Unit L
Redwood City, CA 94063
Telephone: 415-361-1611
Brands: Grundig

Hitachi Sales Corp. of America
401 W. Artesia Blvd.
Compton, CA 90220
Telephone: 213-537-8383
Brands: Hitachi

This special report is intended to provide some basic information to help readers who have chosen to specialize in VCR servicing. The article "A VCR Repair Notebook" explains some basic procedures to follow when you are faced with a malfunctioning machine. The other feature on VCRs, "Head Cleaning Tapes: Should You Recommend Them?" covers some of the basic facts about the interface between the VCR and the videotape, the reasons video heads get dirty, and some practical advice on how to (and how not to) clean them.

Another part of the special report is right here in this introduction: a list of all of the VCR manufacturers we are aware of, with addresses and phone numbers that might help you track down servicing literature.

If VCR servicing is an idea you've been considering, this special report might give you an idea of what you would be up against in this potentially lucrative new field. ■

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2951 S. Bayshore Drive, 8th Floor
Miami, FL 33133
Telephone: 305-448-7088
Brands: Image Translator, CaptionMaster

Japan America Electronics
2624 Wilshire Blvd.
Santa Monica, CA 90403
Telephone: 213-453-0440
Fax: 213-470-6176

Japanese Distributors
1641 E. Del Amo Blvd.
Carson, CA 90746
Telephone: 213-603-2600

JVC Co. of America
41 Slater Drive
Elmwood Park, NJ 07407
Telephone: 201-794-3900
Brands: JVC

Kenwood USA
2201 E. Dominguez
P.O. Box 22745
Long Beach, CA 90801-5745
Telephone: 213-639-9000
Fax: 213-604-4487
Brands: Kenwood

KLH—Wald Souhd
11131 Dora St.; P.O. Box 1085
Sun Valley, CA 91352
Telephone: 213-875-0480
Brands: KLH, Linear Dynamics, Maximus

Lloyd's Electronics, Div. of Dynascan
200 Clearview Road
Edison, NJ 08818
Telephone: 201-225-2030
Fax: 201-287-3060
Brands: Lloyds

Marantz
20525 Nordhoff St.
P.O. Box 2577
Chatsworth, CA 91313-2577
Telephone: 818-998-9333
Fax: 818-998-5475
Brands: Marantz

MGN Technology
9724 Kingston Pike, Suite 106
Knoxville, TN 37922
Telephone: 615-690-5755
Fax: 615-690 5756

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Panasonic, Matsushita Electric Corp. of America
One Panasonic Way
Secaucus, NJ 07094
Telephone: 201-348-7000
Brands: Panasonic, Technics

Philips/Philips Consumer Electronics
One Philips Drive
P.O. Box 14810
Knoxville, TN 37914-1810
Telephone: 615-521-4316
Brands: Philips

Quasar, Matsushita Electric Corp. of America
1325 Pratt Blvd.
Elk Grove Village, IL 60007
Telephone: 312-228-6366
Fax: 312-228-3767
Brands: Quasar

Randix Industries Ltd.
Granite Park
Milford, MA 01757
Telephone: 508-478-8989
Fax: 508-359-4896
Brands: Randix, Audiologic by Randix

Samsung Electronics America
301 Mayhill St.
Saddle Brook, NJ 07662
Telephone: 201-587-9600
Brands: Samsung

Sanyo Fisher (USA), Consumer Electronics Div.
21314 Lassen St.
Chatsworth, CA 91311
Telephone: 818-998-7322
Fax: 818-701-4170
Brands: Sanyo, Fisher

H.H. Scott
5601 Westside Ave.
North Bergen, NJ 07047
Telephone: 201-662-2000
Brands: Scott

Sharp Electronics
Sharp Plaza
Mahwah, NJ 07430-2135
Telephone: 201-529-8200
Brands: Sharp

Shintom West Corp. of America
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Torrance, CA 90501
Telephone: 213-328-7200
Fax: 213-328-4462
Brands: Shintom

S.R. Electronics
3840 N. Harlem
Chicago, IL 60634
Telephone: 312-625-5676
Fax: 312-625-5943

Symphonic
100 North St.
Teterboro, NJ 07608
Telephone: 201-288-2606
Brands: Symphonic, Funai, Avertura

Teknika Electronics Corp., Consumer Electronics
353 Route 46 W.
Fairfield, NJ 07006
Telephone: 800-TEK-NIKA
Brands: Teknika, Fujitsu, General, Janiel

Tele-Com Products
1075 Hamilton Road
Duarte, CA 91010
Telephone: 818-303-1183
Fax: 818-358-8485
Brands: Tele-Com

Thomas America
122 Tices Lane
East Brunswick, NJ 08816
Telephone: 201-238-6860
Parts and servicing information: 800-242-7158
Brands: Thomas, Crosley

Toshiba America Consumer Products
82 Totowa Road
Wayne, NJ 07470
Telephone: 201-628-8000

Tote Vision
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Brands: Tote Vision

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New York, NY 10010
Telephone: 212-255-5400
Brands: Unisonic, Compu Chron, Chronosonic, HEALTH WATCH

Vector Research
1230 Calle Suerte
Camarillo, CA 93010
Telephone: 805-987-1313
Fax: 805-987-1956
Brands: Vector Research, Carrera

Yamaha Electronics Corp. USA
6722 Orangethorpe Ave.
Buena Park, CA 90620
Telephone: 714-522-9105
Brands: Yamaha ■

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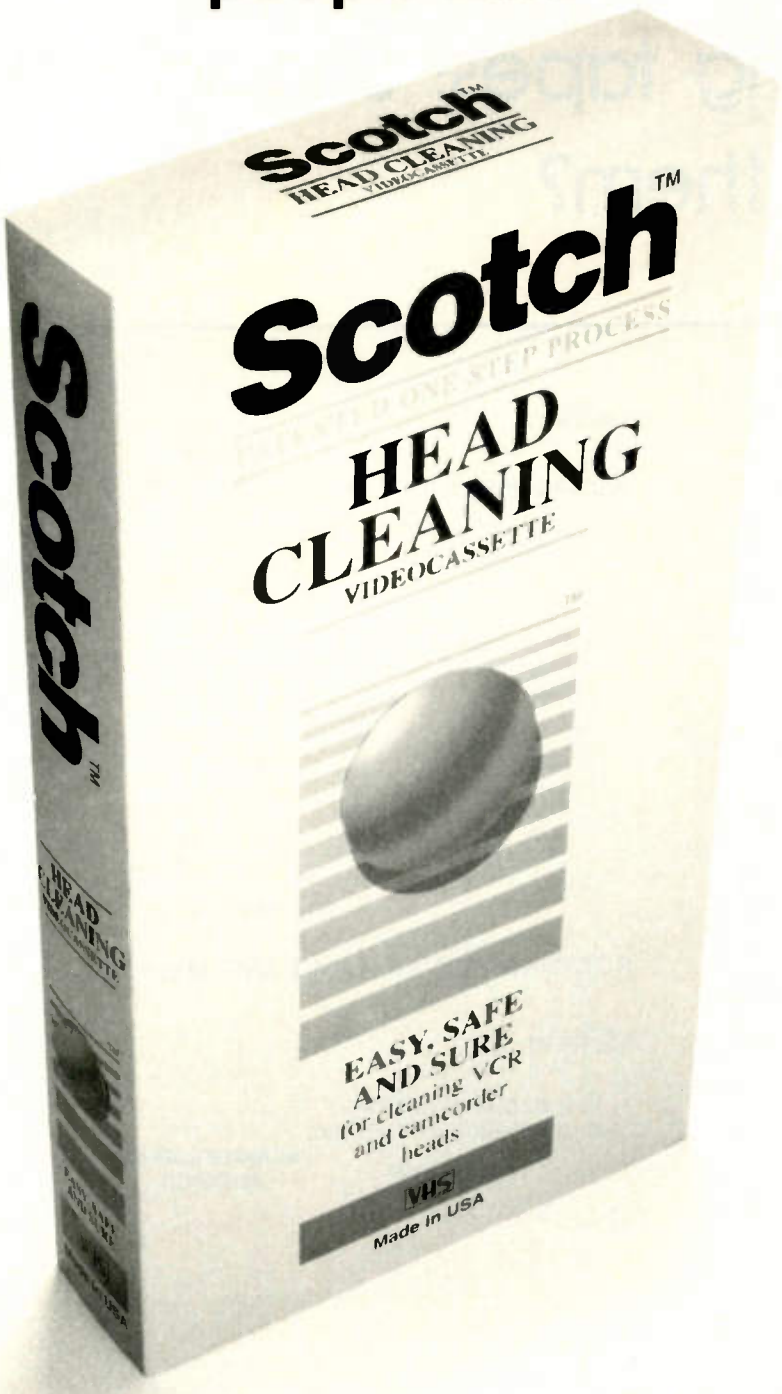

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Don Erwin, CSM, San Diego, CA

"Protects my customers' investment and my reputation."
Art Nelson, CET, Milwaukee, WI

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John Sperry, CET/CSM, Lincoln, NE

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VCR SERVICING

Head cleaning tapes: Should you recommend them?

Wear and tear causes problems in VCRs ranging from poor video and sound quality to inability to operate because the machine is dirty. As with any sophisticated home appliance, the VCR requires proper care and periodic maintenance to continue operating at maximum effectiveness.

According to manufacturers, as often as nine times out of 10, the primary cause of problems in VCRs returned for repair is simply a dirty machine in need of thorough cleaning. Of particular concern is the proper maintenance of the delicate record and playback heads in the machine.

In response, a number of different head-cleaning systems have been introduced for consumer use. Some use liquid solvents. Others use a dry abrasion method.

Each promises to do an effective job of keeping the VCR's record and playback heads clean and in proper operating condition. Unfortunately, not all deliver on that promise. Some, in fact, can cause more harm than good, as witnessed by widespread consumer complaints over head cleaning systems that may have caused damage and necessitated expensive repairs.

So serious has the problem become that the California Bureau of Electronic and Appliance Repair recently held hearings on a proposal to ban the marketing of video head-cleaning systems intended for home use.

The video recording process

Recording and playing back video information involves placing and sensing magnetic signals onto a thin polyester film coated with magnetic oxide particles suspended in a binder. To record the signals, a magnetic field is created in the VCR's recording heads. An ex-

Adapted from a paper compiled by 3M.

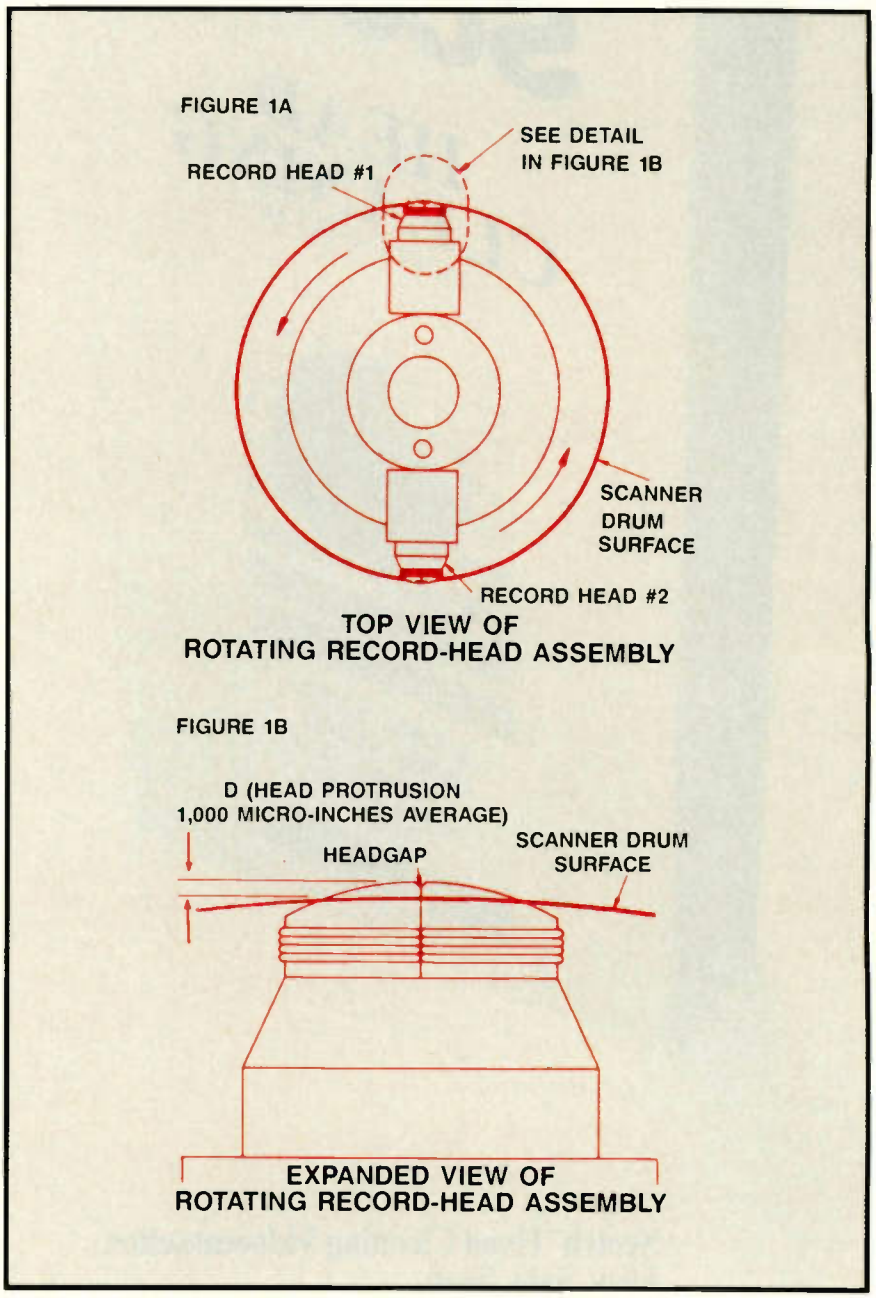


Figure 1. The video heads are mounted in a rotating drum assembly. The heads protrude slightly from the drum, which allows them to push into the tape coating. This design provides the extremely intimate contact between head and tape that is essential to record and resolve the high-frequency video information.

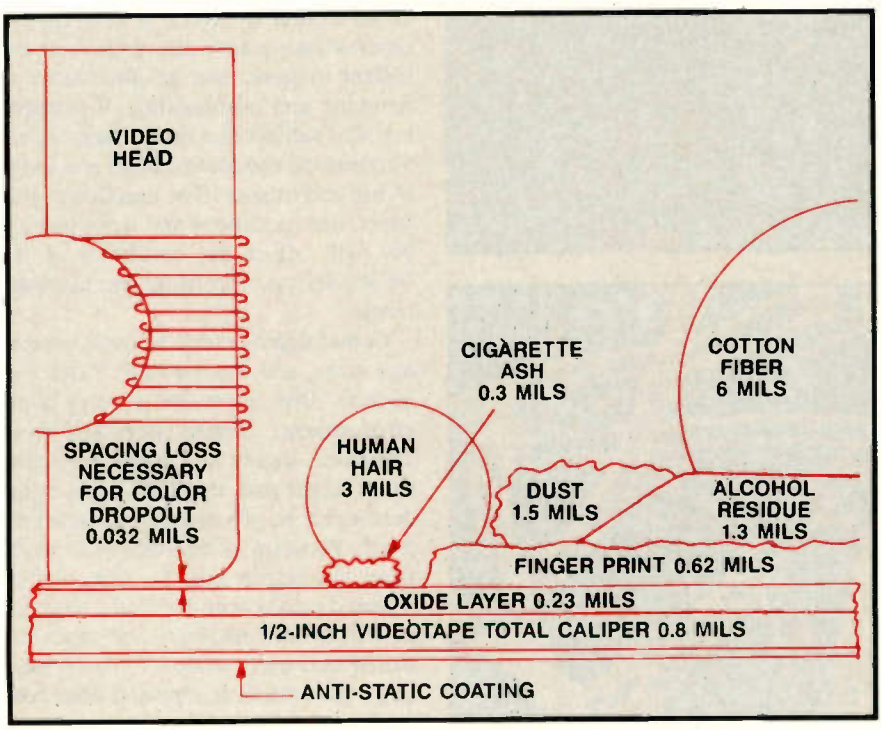


Figure 2. Contaminants as tiny as microscopic dust or airborne smoke particles can cause interference with magnetic signals and result in unacceptable video recordings or noisy playback images.

tremely small space, or *gap*, in each head provides a place where the magnetic signal can be transferred to the videotape as the tape is pulled past the head by the VCR's transport mechanism. In playback mode, the process is reversed, allowing the gaps in the playback heads to detect the magnetic signals and convert them back into the electronic signals that recreate the sound and picture information stored on the tape.

The video heads are mounted in a rotating drum assembly. The heads protrude slightly from the drum, which allows them to push into the tape coating. This design provides the extremely intimate contact between head and tape that is essential to recording and resolving the high-frequency video information. (See Figure 1.)

A video signal is much more complex than the audio-only signal carried on typical audiocassettes. For each second of taped video picture viewed on a TV monitor, the videotape carries 30 frames of magnetic information, each frame consisting of two lines — one line recorded in alternating sequence by each of the two heads. In addition, separate synchronization and audio tracks are also recorded on the tape as it passes over the rotating heads at the equivalent of up to 80mph.

So small are the distances and tolerances in video recording that the microscopic gap in the heads measures approximately one-half micron across. A human hair, by comparison, has a thickness of about 75 microns — 150 times the size of the head gap. It is also in this tiny gap that the magnetic flux lines, which are representations of the video images, are either generated or sensed. Any interference with the surface of these tiny record heads, or the even smaller head gap, will cause problems ranging from a noisy picture to complete loss of the video image. (See Figure 3A.)

Because of the complexity of this recording process, keeping the video heads, and particularly the head gaps, clean and free from contaminants is essential for proper video imaging. Contaminants as tiny as microscopic dust or airborne smoke particles can cause interference with magnetic signals and result in unacceptable video recordings or noisy playback images. (See Figure 2.)

In addition, it is very important to keep the entire path taken by the magnetic tape clean, and to properly maintain the VCR's tape-guiding mechanisms and tension adjustments, because these components can also adversely affect video performance.

Videotape quality

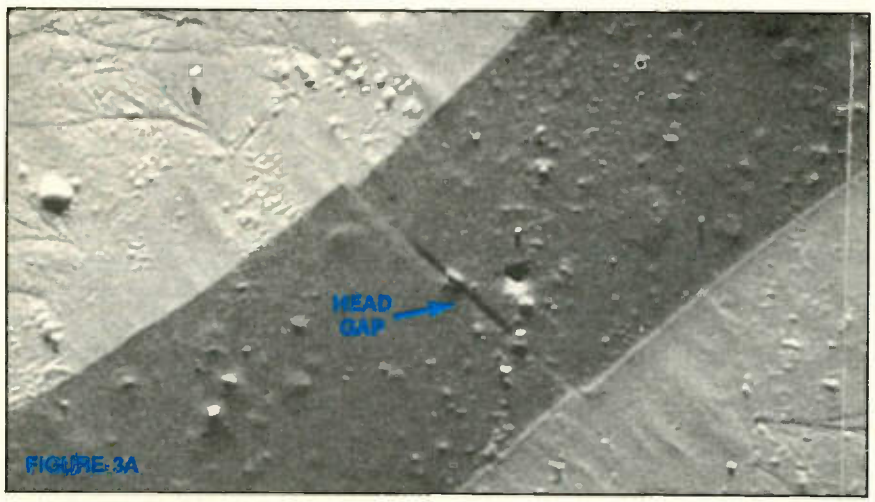
The tape that carries the picture and sound information is an important factor in proper VCR operation. Videotape consists of a thin, tough, flexible polyester film that is coated with microscopic particles of magnetic oxide suspended in a binder. There are three important components, each of which affects the quality of the tape's performance and ultimately the cleanliness of the VCR's heads.

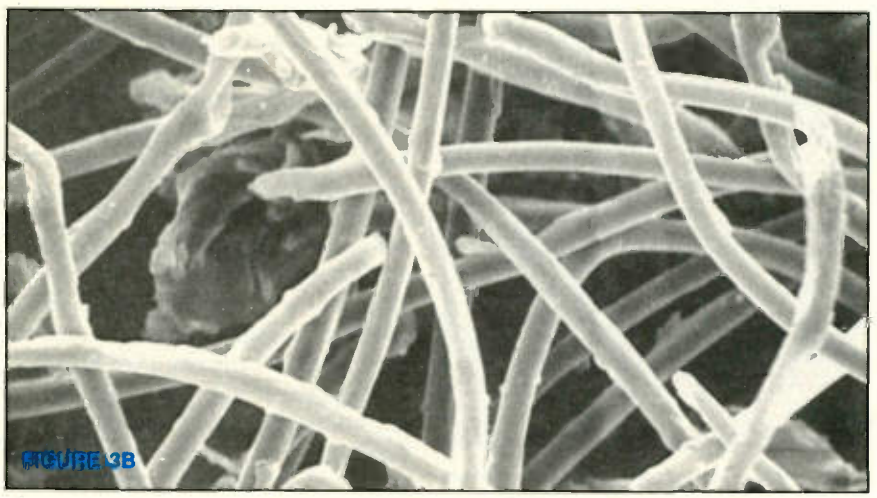
- The oxide particles are magnetically imprinted by the heads with the video, audio and synchronization signals. The greater the number and the more uniform the shape of the particles, the better the quality of the video image.

• The binder holds the microscopic magnetic oxide particles in suspension. The better the formulation quality of the binder, the better the oxide particles will remain in suspension against the backing.

• The tape backing must be strong, non-stretchable and environmentally stable. The weaker the backing, the more subject it will be to stretching and damage from continued use and environmental conditions such as heat.

Because of the physical nature of the recording process — involving the penetration of the recorder's heads into the tape itself during a stressful, high-speed operation — only high-quality, rugged, technologically advanced tapes can ensure reliable video recording.





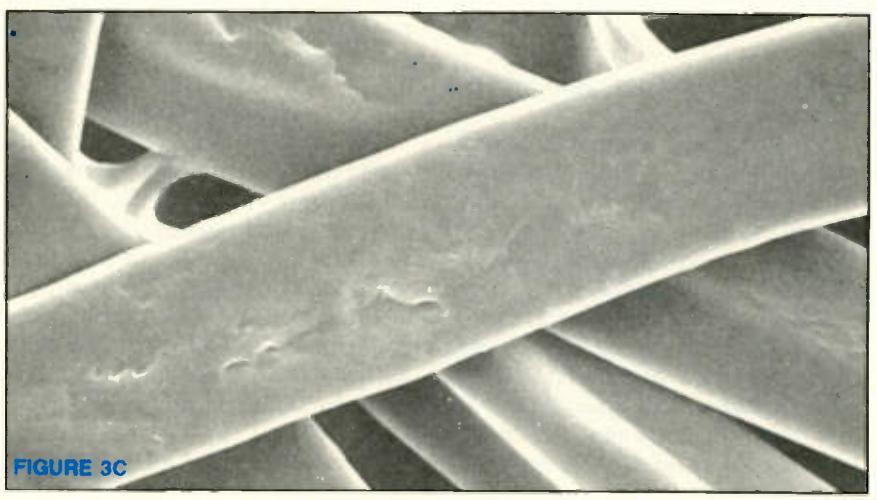


Figure 3. Compared to the small dimensions of the video heads and especially the microscopic gaps in those heads, the fiber materials used in many wet cleaning systems are relatively large. Figures 4B and 4C show two different brands. (Magnification: 1,000X.)

Sources of head contamination

VCRs are exposed to a wide variety of environmental conditions, a vast cross-section of users, a selection of tapes whose quality can range from excellent to poor, and an abundance of handling and mishandling. Videotapes are also subject to a broad range of environmental conditions, users and forms of use and misuse. The combination of users, use conditions and tapes inevitably will affect the condition of the VCR's delicate recording and playback heads.

Contaminants come in many shapes and sizes, and from a wide variety of sources. Dust is present in every home environment. Smoke particles from cigarettes, cigars and pipes are many times larger than the head gaps. Some debris may be generated by the machine itself. Particles of the magnetic oxide from videotapes may be worn off by repeated passes over the heads. The way in which both recorder and tapes are stored and used is also a key element in the generation of tape and head contaminants.

A major, often unappreciated source of head contamination is rented tapes. These cassettes are used by consumers of all ages and with varying levels of awareness of proper tape care and handling. They are played in a variety of machines, many of them not maintained in pristine condition, and critical adjustments to the tape-guiding mechanisms are rarely made. All of these factors can lead to undue wear, stress and damage to the thin, delicate magnetic tape and may increase the deposit of debris from the tape to the VCR's heads.

Another source of head contamination is the use of unlicensed and cheaper quality videotapes. The VHS format is a licensed product of JVC; Beta is licensed from Sony. Bargain tapes may not be produced to the standards specified in these formats, and there is an unavoidable trade-off between quality and price. The result can be a greater poten-

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tial for tape pigments and binders to be transferred from the tape to the recorder's heads, especially as the poorer quality cassette's performance deteriorates with repeated use.

Over time, contaminants from a combination of all these sources can build up on the heads and across the head gaps. The intrusion of these contaminants between the heads and the videotape impairs the heads' ability to properly record and play back signals. As the heads become progressively dirtier, picture quality deteriorates, leading ultimately to a complete clogging of the gap, at which point a complete loss of the video image occurs.

Preventive maintenance

Unofficial reports from some VCR manufacturers suggest that as many as 90% of the machines returned to them in need of repair are simply dirty. All they need to restore them to proper working condition is a thorough cleaning. Although recommendations for periodic machine maintenance and cleaning — with particular attention to head conditioning and removal of clogs — are now standard in most VCR owner manuals, that advice is generally ignored.

Basic VCR maintenance includes tape-path alignment, tension adjustment and general cleaning. Without proper maintenance and cleaning, performance quality can be expected to diminish over time, resulting not only in poorer video but also the possibility of damage to the videotapes played in the machine. This level of maintenance is not something that can or should be done by the consumer. A consumer's VCR should be periodically reconditioned by experienced service technicians to maintain machine and tape integrity. The frequency of maintenance is naturally dictated by the frequency and type of use.

Video-head cleaning

In addition to a regular schedule of professional machine maintenance, the video heads require regular attention to prevent deterioration or loss of the video signal.

It is important to note that recording tapes and video recorders are generally self-cleaning. The manufacturers of good- and premium-quality videotapes add trace amounts of cleaning agents to their oxide formulations to help prevent the buildup of debris on the VCR's heads. In addition, the recorder's own threading and tension adjustment mechanisms are designed to help keep debris build-up to a minimum.

Predictably, though, contaminants and other debris will accumulate on the video heads over time. This problem can be treated by the consumer. Head-cleaning videocassettes can provide an effective and inexpensive means of removing foreign matter from the VCR's heads and getting the equipment safely back into operation.

Three basic types of head-cleaning systems designed specifically for use on VCR heads are currently available to the consumer: wet systems, dry abrasive systems and a magnetic-tape-based system. This selection of VCR head-cleaning products is available in a marketplace characterized by conflicting claims, variations in product quality and aggressive pricing and marketing strategies.

Wet/fabric systems

Wet systems rely on a liquid solvent that is applied to a fabric material housed in a videocassette casing. The cassette is then played in the VCR, allowing the solvent to be transferred to the heads. This form of cleaning depends on the ability of the solvent to safely and effectively dissolve all the various types of debris from tapes and other sources present in the VCR. Furthermore, solvent-type cleaners cannot refurbish the ferrite surfaces of the video heads, which is a necessary part of restoring the VCR's performance and video signal.

Even when properly formulated, wet systems present a number of problems, not the least of which is the fact that the solutions used may damage plastic and rubber components inside a VCR. To effectively dissolve debris left on the heads, the wet system's fluid must be an aggressive solvent. Unfortunately, the process of transporting the solvent-soaked fabric past the VCR heads requires contact with other internal parts, which the solvent may also attack.

The primary danger is to the rubber pinch rollers of the VCR's tape-transport mechanism. These rollers are a vital part of the main tape-drive system, and even the least deterioration can cause failure, typically resulting in a tape being "eaten" by the machine.

The fabric media used as a carrier is also a potential danger to proper VCR operation. Video recording equipment is specifically designed and manufactured to safely and reliably handle an extremely thin, polished magnetic tape. The introduction of the thicker and relatively coarse fibrous materials employed by some wet cleaning systems can put unintended stress on the tape-transport mechanism and conceivably the fragile video heads themselves.

Compared to the small dimensions of the video heads (and especially the microscopic gaps in those heads), the fiber materials used in many wet cleaning systems are relatively large. (See Figure 3.) Given these relative sizes, it is easy to understand how physical damage can be sustained by the delicate recording heads.

Finally, professional-quality camcorders and most home VCRs have a dew sensor to detect the presence of excess moisture and shut off the machine when conditions are too moist for safe operation. In some older VCRs, the dew sensor must be manually reset by a service technician, but even in those that automatically reset, the introduction of unnecessary moisture is not recommended. Liquid cleaning solutions are best left to qualified service technicians.

Dry/abrasive systems

Dry/abrasive systems offer a second alternative to the consumer. These systems avoid the problems associated with the use of a wet solvent on a fabric and are not prone to attack the rubber pinch rollers or plastic internal parts of the VCR.

However, although many dry/abrasive systems are capable of doing an effective job of contaminant removal, they are often too aggressive and may cause premature video head wear. Some of the materials used in dry/abrasive cleaning systems are equivalent to very fine sandpapers. The cleaning effectiveness of abrasion is clear, but the abrasive nature of the system itself creates the danger of improper use or overuse.

In most typical dry/abrasive systems, there is no reliable way for the consumer to judge how much cleaning is needed or when the VCR's heads have been properly cleaned and conditioned. As a result, the consumer must make a best guess regarding how long to leave the dry/abrasive cassette in the VCR.

Magnetic-tape-based systems

The third consumer alternative is a magnetic-tape-based head-cleaning system. The chief advantage of such a system is that magnetic tape is the medi-

um for which the VCR has been designed. It will not cause damage or degradation of the VCR's delicate heads and internal mechanisms.

In a magnetic-tape-based video-head cleaning system, the level of cleaning agents in the tape formulation is increased to produce a head-cleaning cassette. Because the system is based on magnetic recording tape, the tape can include instructions for the user. As the system is played in the VCR and the heads become clean, a prerecorded video message tells the user when the recorder heads are clean and the machine should be stopped.

In tests conducted by 3M, testers found that with the magnetic-tape head cleaner, most cleaning can be accomplished within 30 seconds or less. On this basis, the consumer can expect 240 or more cleanings. If all 240 or more cleanings were made, head life would be reduced by an average of only 2.2% on clean heads.

Because new machines with clean heads were tested, the tape would appear to do less damage in everyday use because the tape is not in intimate contact with the record head until the head is clean, at which time the tape's prerecorded video message alerts the user to stop the machine.

As noted, good- and premium-quality recording tapes from most major manufacturers already contain trace amounts of head-cleaning agents in their formulations, along with lubricants and other necessary additives. This small amount of cleaning agent helps keep the video heads free of debris during operation and under normal conditions. Without it, the extremely small head gaps of the typical VCR would be subject to frequent clogging.

The user's responsibility

In a best-case scenario, a consumer using exclusively premium tapes in a clean, smoke-free home environment could expect a very low incidence of dirty or clogged heads. In reality, this is almost never the case. More typically, video recorders are used with a wide variety of recording tapes of vastly varying quality and condition, including tapes that may be rented, borrowed and of less than good quality.

Also, most home video equipment is not periodically adjusted or maintained in accordance with the manufacturer's recommendations. The result can be undue wear, stress and damage to the thin magnetic tapes used in the VCR and, almost inevitably, an occasional head clog that renders the video heads partially or totally inoperable.

The amount of cleaning agent in good- and premium-quality tape formulations does provide a basic form of preventive maintenance. It is not included in sufficient amount, however, to remove more than a small amount of contaminants under normal operating conditions because too much cleaning agent compromises the tapes' recording quality.

When problems occur, consumer head-cleaning tapes can help keep the VCR in operation. However, periodic cleaning and adjustment by an electronics servicer should be part of the preventive maintenance for all VCRs, and can prevent more costly damage. ■

VCR SERVICING

A VCR repair notebook

By Victor Meeldijk

Have you ever faced a VCR with a jittery picture and voices that sound as if the actors are gargling while speaking? Or have you wrestled with a top-loading VCR that doesn't latch closed? Or perhaps you've been stumped by an 8mm camcorder that seems to work fine when you defeat the sensors, but when a tape loads, it doesn't move. If you have, that's great — you're building a "repair notebook" for future reference. If you haven't built up that kind of experience, here are some VCR repair case histories that illustrate VCR problems you might run into some day.

Meeldijk is reliability/maintainability engineering manager at Diagnostic/Retrieval Systems, Oakland, NJ.

Fisher FVH-510 Problem: jitter

This Fisher FVH-510, which had had its idler tires replaced a few months earlier, now exhibited picture jitter in playback and the sound was slightly garbled (quivering). Audiocassette recordings exhibit similar problems when the tape warps, but the cassette used with the machine was not damaged or warped. A known-good tape also exhibited picture and sound jitter.

For a start, I closely watched the tape transport during play mode to see whether any of the tape-guide rollers or the pinch roller were sticking or moving erratically. I paid particular attention to the area near the audio/servo head. During this examination, I noted that a tape guide on the left side of the machine was vibrating. This vibration did not seem to be caused by the tape.

Closer examination revealed that the supply reel was moving slightly erratically. Figure 1 shows that this tape guide is part of the tension-arm assembly and is connected to the supply-reel band-brake assembly. After six years, the band brake had become worn and dirty, and movement of the supply reel during playback caused the band brake to vibrate. This vibration was transmitted to the tape guide and ultimately to the tape.

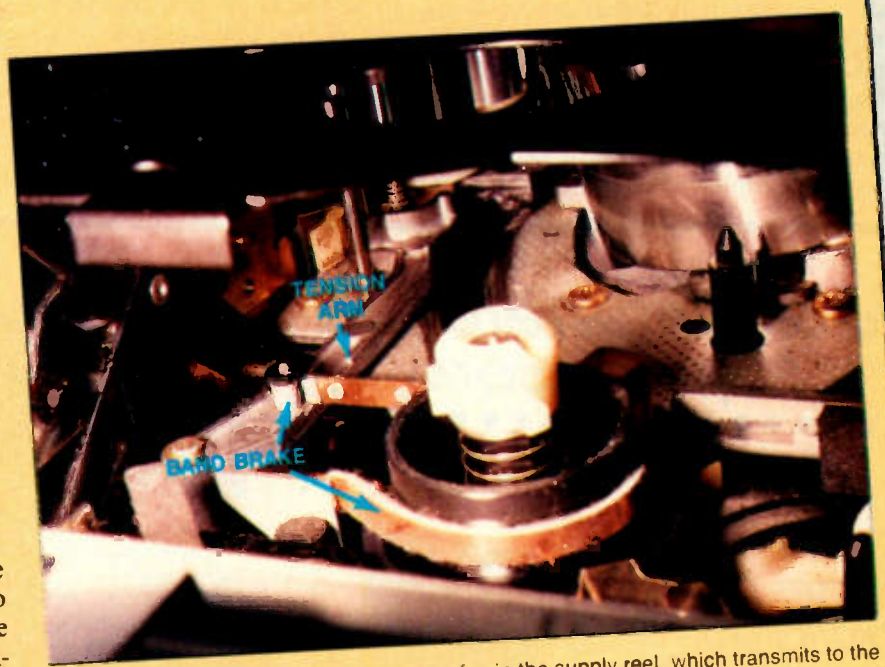


Figure 1. A worn band brake causes vibration in the supply reel, which transmits to the tape guide and the tape.

Replacement details for the band-brake assembly are explained in the sidebar, "VCR band brake replacement." To avoid tension misadjustments, I recorded the position of the old band brake by tracing an outline of it with a pencil. It was a simple matter to quickly adjust the new band brake by adjusting it to fit this outline. (If the tension adjustment is too low, the tape will not be pressed properly by the guide and will have minimal contact with the erase head. If the tension is too high, the supply reel movement will be impeded, and picture and sound distortion — jitter — will result.)

VCR band brake replacement

1. Remove the two tape-transport cover screws, press the cassette eject button, and lift off the tape-transport cover.
2. Press the tape-stage assembly down. Pry off and remove the fix washer for the band-brake assembly, visible through a hole in the tape-stage assembly (cassette holder tray). (See Figure 2.)
3. With the tape-stage mechanism up, lift the free end of the band-brake assembly and move it away from the supply reel. Push the tape stage back down.
4. Unplug the VCR and turn it upside down.
5. Remove the bottom cover. (Remember where each screw goes; they are not all the same length.)
6. ***CAUTION:*** *ICs on the printed circuit board mentioned next are sensitive to electrostatic discharge. You should wear a grounding wrist strap to perform the next operation. If you don't, be sure not to touch the circuit areas of the cards.*

Locate the eight hold-down screws on the circuit board (at the ends and center of the board; they are identified by arrows on the circuit board) and remove them. As noted before, keep track of where each one goes; they are not all the same length.

7. Gently push the circuit card assembly back. Using the center metal bar, lift the printed circuit assembly at the front; it will pivot at the rear end of the card. Prop the card up (a screwdriver can be used at the left side).
8. Locate the other side of the band-brake assembly (see Figure 3), and trace around it with a pencil to record its position.
9. Remove the screw, then lower the circuit board and hold it in place with one screw. Turn the VCR over, press the cassette eject button and remove the old band brake. Insert the new band brake and use the fix washer to hold it in place. Press the tape-stage assembly down and again turn the VCR upside down.
10. Lift and prop up the printed circuit board again. Screw the new band brake into position, within the outline traced in step 8.
11. Lower and temporarily secure the printed circuit board. Turn the VCR over. load a cassette and check the VCR operation. If necessary, adjust the band-brake tension. (See the text on page 16 for problems caused by too high or too low tension.) If the tension is properly set, reassemble the VCR.

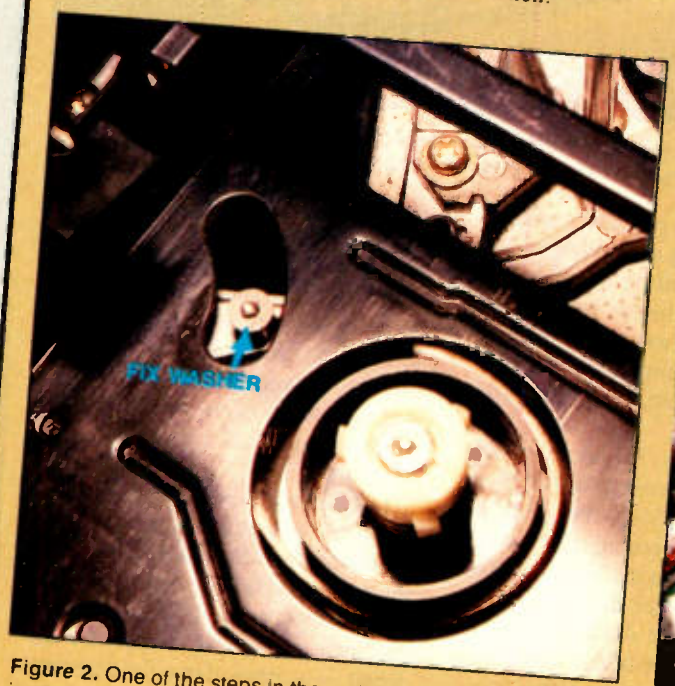


Figure 2. One of the steps in the replacement of the band brake is to remove the band-brake fix washer through this hole in the cassette stage assembly.

Figure 3. To make adjustment of the new band brake easier, trace the outline of the band-brake assembly on the VCR chassis. The new one can be adjusted to that outline.

Fisher model FVH-510 Problem: tape stage assembly won't latch

The same Fisher model FVH-510 also exhibited another problem: The stage would not always latch closed. Again, visual inspection revealed the simple cause of this problem: a loose screw. (See Figure 4.) The solution was easy — tighten the screw — but the execution wasn't so easy because the screw was impossible to reach without a lot more disassembly. To tighten a single screw, 18 others had to be removed (screws that secured the front of the VCR, the RF assembly and the transport mechanism itself). The complete transport assembly had to be lifted to reach this one screw. Total repair time was more than an hour. A simple problem, but tough to repair.

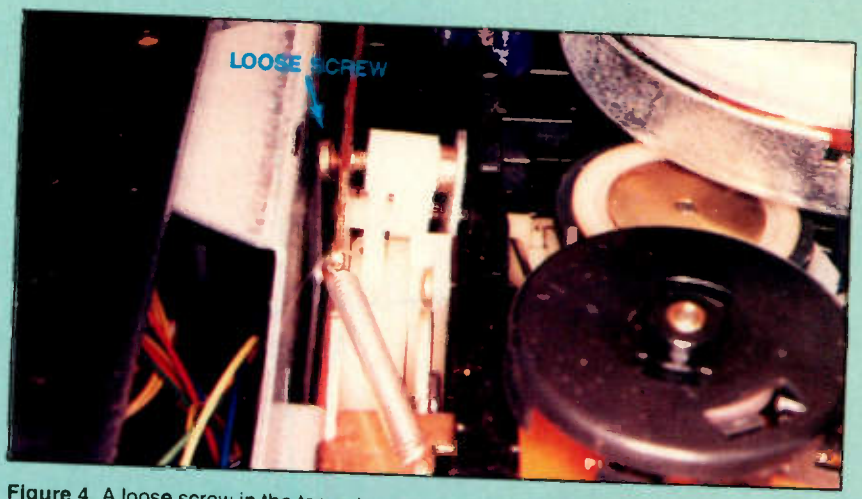


Figure 4. A loose screw in the tape-stage assembly kept the tray from latching properly.

Fisher FVH-525 Problem: Inoperable; never serviced or maintained.

A 6-year-old Fisher FVH-525 that had an estimated 15,000 EP-mode hours on it and had never needed repair before had completely stopped working. The owner reported that it was sluggish in fast forward/rewind modes before it stopped working.

An initial examination of the machine revealed signs of extensive use: the black finish was worn off of the cassette stage assembly and the take-up reel fix washer was missing. The machine was very dirty, with dust and magnetic tape particles on the tape heads. (See Figure 5.)

When I turned the machine over and removed the bottom cover, I found not only the reel fix washer, but a safety pin as well. Under the printed circuit board was a note that said, "Do not touch, please." How it managed to work itself deep inside the machine is a mystery. (The owner said later that it was originally on top of the VCR to warn people not to tamper with the machine while it was being used to make a recording.)

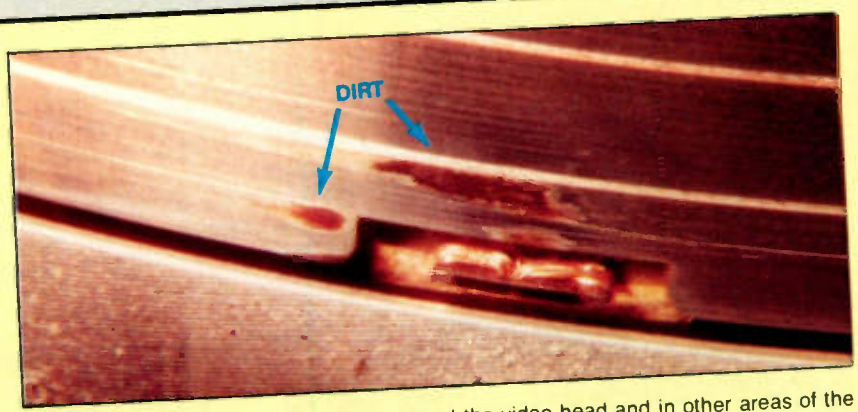


Figure 5. The dirt on the head drum around the video head and in other areas of the VCR suggests that the unit needs a good cleaning.

After making a physical examination and removing all foreign matter, I reviewed the failure symptoms:

- play — the cylinder rotated; the tape was not drawn out of the cassette, but the loading motor did run. The machine automatically went into stop mode.
- fast forward — I could hear the loading motor running, but nothing else happened. Stop mode didn't work, and depressing the power switch did not turn the VCR off. The cassette eject switch did work, however, and was not defeated.
- fast rewind — worked, but it was sluggish, with slipping noises.

The first thing I suspected in the failure of the tape-loading mechanism was the motor or the drive belt. The motor was running, and the belt was turning. However, that doesn't necessarily mean the worm gear and pulley are turning, so I checked them. Touching the pulley confirmed that it was stuck. Applying a slight force to the pulley caused it to start moving. It appeared that the tape-loading mechanism was stuck because of the lack of maintenance over the years.

Lubricating the machine (particularly the tape loading arm tracks), replacing the idler tires and checking and replacing the other belts and pinch roller, as well as cleaning the machine and heads, completed the repair — a repair that a little preventive maintenance could have prevented. (For information on replacing the idler tire, see "A VCR Repair Case History" in the February 1988 issue.)

Canon VM-E1 Canonvision 8 camcorder Problem: tape loads but doesn't move

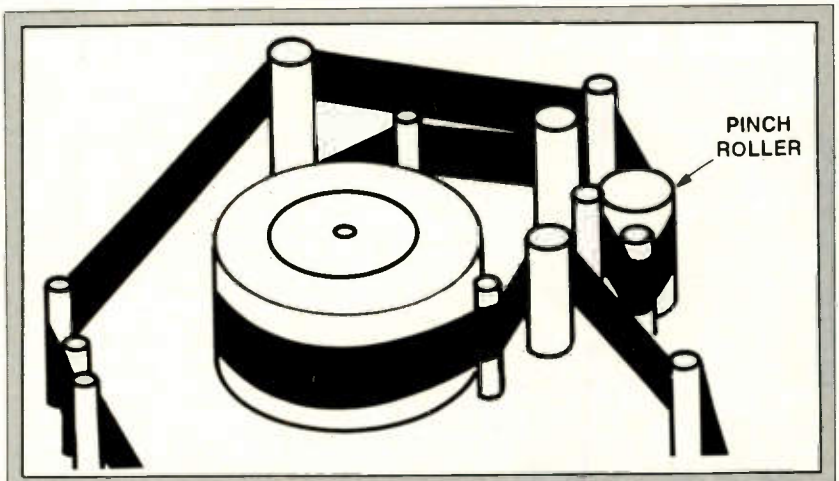


Figure 6. The tape in an 8mm camcorder is wrapped around the cylinder and engaged by the pinch roller.

8mm specifications

The specifications for the 8mm format were agreed upon by 127 electronics companies at a conference held in Tokyo in 1983. Camcorders were first marketed in 1984, and in 1985 more than a million pieces of equipment (more than 500,000 camcorders) were sold. (This format is called "8mm" because the tapes used are 8mm wide.) The other format — VHS-C — which rivals 8mm for small size, uses a length of VHS tape in a smaller cassette shell (the TC-20 is 20 minutes in SP mode and 60 minutes in EP mode); the format was introduced in the spring of 1986.

The 8mm wrap is similar to a reversed Beta tape wrap but has less twists and turns. Therefore, less strain is put on the tape. (See Figure 6). Metal oxide tapes are used to increase data packing density to make up for the smaller tape size. 8mm tapes are designated PX-Y. The P stands for metal particle tape; the X digit is either 5 for the PAL system or 6 for NTSC; the Y digit is the recording time in standard play mode.

This camcorder, a Canon VM-E1 Canonvision 8, was taken to Disney World in Florida, where it was hand-carried out of the plane and in and out of air-conditioned vehicles. On the day it was used, the temperature was 110°, and the tape became stuck to the rollers in the transport mechanism. The unit was repaired, but it was not checked or used for another six months, when it failed again after a few minutes of use. Only a still picture was observed in the viewfinder, and the tape did not move in any mode of operation.

The initial observations were as follows:

- A small spring was hanging from a plastic post opposite the tape sensor LED (as reported by the owner).
- The tape loaded when inserted into the camcorder.
- The tape did not move in any mode but would be pulled back into the cassette when the eject button was pressed.

I found that the dangling spring was supposed to provide tension for the reel brake. If this spring were disconnected, it would not stop the tape from moving but would result in the reel not braking when the stop button was pressed, according to the Canon Service Department.

I then suspected that perhaps a slipping belt might be involved, but there are no belts in this very compact unit; motors drive each reel. (An 8mm VCR is so compact that it has been coupled with a 3-inch LCD

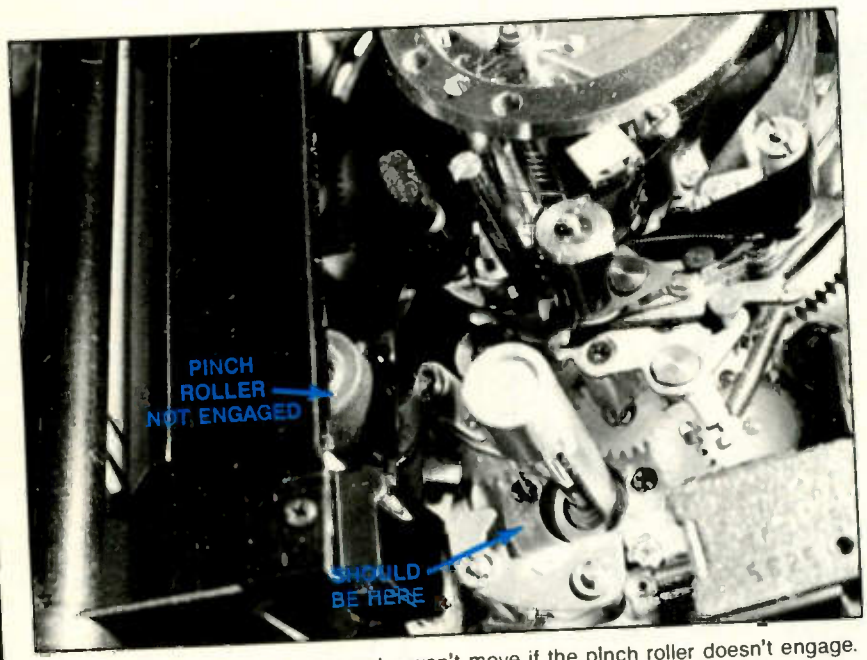


Figure 7. Tape in an 8mm camcorder won't move if the pinch roller doesn't engage.

Figure 8. The problem with this 8mm camcorder was ultimately traced to a semicircular metal gear that had disengaged from the plastic drive gear. The pinch roller, which is rotated by the gear, would not engage to load the tape properly.

screen color TV for a hand-held TV/VCR combination that is only 5"×2.5"×8" (W×D×H) and weighs only 2.5 pounds. This unit provides a nice contrast to an earlier model made for the industrial market in 1986. In that unit, the 8-inch color monitor and 8mm VCR combination weighed 18 pounds without the batteries.)

When the tape sensor was defeated (covered with a piece of black electrical tape), the reels turned in all modes with plenty of torque. (The cassette reel locking mechanism could not have caused the problem because the tape was drawn out of the cassette when the camcorder was loaded.)

Looking at the way the tape loaded, I found that the right side of the tape was not wrapped around the cylinder and that the pinch roller was not engaged. (See Figure 7.) The pinch roller is mounted on a metal semicircle gear. When the tape is loaded, the gear rotates the pinch roller into place, engaging the tape. In this case, the metal gear had disengaged from the plastic drive gear, and the improperly loaded tape was stalling the reel drive motors. (See Figure 8.)

Disassembling the transport mechanism to take out and realign the metal pinch roller gear would have been a lengthy task because the mechanism is fastened from under the top of the chassis. However, the gear is just flexible enough that the end of the gear can be lifted up and slipped over the drive gear to engage it. (This flexibility may have had something to do with the problem in the first place and may have disengaged if the recorder received a sudden shock.) Engaging the gear allowed the reel drive motors to pull the tape. ■

ETA announces convention dates

The Electronics Technicians Association (ETA) has set the 1990 Annual Technicians Convention for April 27-28 in Auburn, IN. The convention is cosponsored by the Indiana Satellite Dealers Association and the Indiana Electronics Service Association. The headquarters hotel will be the Country Hearth. Other activities will occur at locations in and around Auburn.

Technical seminars will cover a range of technician interests: VCR repair, CD servicing, microwave oven servicing, TV shutdown circuits, customer relations, terrestrial interference, private cable systems and the SAM school.

The SAM school, requested by the Indiana Professional Licensing Agency, will allow technicians to qualify for Indiana's mandatory license to install and service satellites, antennas and master antenna systems. The 2-day school will end with the Indiana License Exam or, for those out-of-state, the Certified Electronics Technicians Examination.

For more information, contact the ETA at 604 N. Jackson, Greencastle, IN 46135; 317-653-8262.

Conway acquires Beltron system

Conway Manufacturing has acquired the rights to manufacture the Beltron System picture-tube restorer product family from Edtron Instruments. The purchase involves all patents, copyrights, design and manufacturing rights. Two new models — an all-electronic manual model and a microprocessor-controlled automatic model — will be available from Conway. For more information, contact Conway at 8393 Capwell Drive, Oakland, CA 94621-2113; 415-568-5282.

NAE lists greatest engineering achievements

The National Academy of Engineering (NAE) has announced what it considers to be the ten greatest engineering achievements of the past 25 years. The achievements are: the moon landing, application satellites, the microprocessor, computer-aided design and manufacturing, the CAT scan, advanced composite materials, the jumbo jet, lasers, fiber-optic communication and genetically engineered products. The list is significant for those interested in electronics because six of the 10 are advances in electronics, and two others — the moon landing and the jumbo jet — would not have been possible without modern electronics.

"Taken together, these 10 outstanding engineering achievements demonstrate how completely new technologies have transformed our lives and improved human welfare in the last 25 years," said Robert M. White, NAE president. The NAE plans to mail 20,000 booklets to high school students and others to encourage young people to consider engineering as a career option.

Copies of *Engineering and the Advancement of Human Welfare: 10 Outstanding Achievements 1964-1989* are available for $8.95 each. Contact the NAE at 2101 Constitution Ave. N.W., Washington, DC 20418; 202-334-3313 or 800-624-6242. ■

Keeping in touch

By William J. Lynott

"I am compelled to regard the post office, next to Christianity, as the right arm of our civilization." So said the popular American orator, Edward Everett, many years ago.

I ran across that quote recently and couldn't help but think that Mr. Everett would likely be more restrained in his compliments if he were around today. The U.S. Postal Service as he knew it doesn't exist any more. Still, too many service dealers do not fully appreciate the business potential of the postal service — even with all of its faults.

The postal service that most of us take for granted today is actually a marvelous luxury that our early forefathers were denied. Direct person-to-person communications of the sort that are handled every day by modern postal facilities were, in fact, prohibited by law or imperial mandate in early civilizations. In those days, it was felt that free communications among ordinary citizens was unnecessary — even dangerous.

Uncle Sam's Postal Service now carries more than 150 billion letters and packages annually (more than 700 for every man, woman and child each year). Despite the occasional mishaps that we tend to magnify, the overwhelming majority of them reach their destinations quickly and safely.

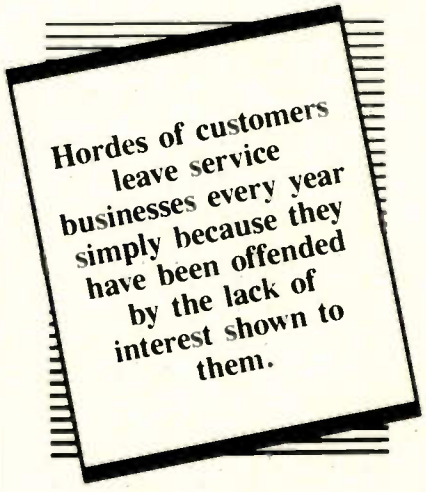
No, this isn't a plug for your neighborhood post office. It's my way of reminding you that direct mail is one of the least expensive and most effective ways of keeping in touch with your present customer base.

Over the years, I've had the opportunity to design, analyze and otherwise work with hundreds of direct mail promotions for many different service companies. During that time, I have come to feel strongly that direct mail is not a cost-effective way to bring *new* customers into a service firm. This is not to say that a professionally prepared mail promotion will not produce any new customers, only that the results will not justify the time and money invested in the project. In other words, that part of your budget intended to find new customers will be better spent elsewhere.

When it comes to staying in touch with present customers, however, there may be no better tool than direct mail. It's an effective way to let them know you appreciate them, that you want to keep their patronage, even that you have a special offer exclusively for them.

But why all the fuss over old customers? After all, they're already your customers.

The answer to that question is easy:



Industry studies show that finding a new customer for a business costs up to 20 times as much as keeping an old one. With that kind of arithmetic, it makes sense to do everything within reason to keep a customer comfortably in the fold once that customer has been found.

Although it's true that some of your customers will die or move away each year, it's also likely that some will leave you simply because they have been romanced away by a competitor. You can't do anything about the former, but if you let the latter happen, shame on you. You may be smart enough to love your customers dearly, but your affection may be wasted if you're not careful to communicate it clearly. The fact is that hordes of customers leave service businesses every year simply because they have been offended by the lack of interest shown to them.

So why not do the obvious? Why not spend a small amount of time and money to let your customers know you appreciate them enough to keep the flame alive?

Sound like a big job? Not at all. The U.S. Postal Service makes it easy and inexpensive.

Ordinarily, I would advise you against the use of post cards in a direct mail program — they're too small to carry a convincing sales message. However, when it comes to keeping in touch with existing customers, post cards can be a highly effective medium. Existing customers don't need to be given a lot of background on your company; they already know you. Therefore, the full space on a post card can be used to get right down to the business at hand.

I can still remember a post card I received from a local service company many years ago. It went something like this:

"Dear Customer:

Just a line to let you know that we here at XYZ Service Company appreciate having had the opportunity to serve you in the past. Our customers are very important to us, and we're anxious to stay in touch.

As a little token of our appreciation, we will accept this post card as $10 toward the cost of your next service call. It's good for up to one year from the postmark date. This offer is valid only to our present customers. It is not extended to anyone else."

How would you feel about a company that sent you a message like that? How I felt is evident from the fact that I still remember it after all those years. That's the way people are. A little interest goes a long way.

Your customer list is probably the most valuable asset in your company. Don't let it wither and die from lack of a little attention. ■

Lynott is president of W.J. Lynott, Associates, a management consulting firm specializing in profitable service management and customer satisfaction research.

50 Powerful Printed Circuit Board Projects; by Dave Prochnow; TAB Books; 210 pages; $15.60 paperback, $23.95 hardbound.

This book gives intermediate-to-advanced electronics hobbyists ready-to-prepare PCB templates for building 50 different digital projects. Each project includes a schematic diagram, parts list, and PCB template. Two appendices provide pinout diagrams and list manufacturers' addresses for obtaining the ICs and products described in the book.

TAB Books, Blue Ridge Summit, PA 17294-0850; 717-794-2191.

PHOTOFACT

Emerson

2713-1 . . . . . TC4253
2715-1 . . . . . TS4354

GE

2707-1 . . . . . 20GT309A01/311A01/311N01/420A01/420N01/421A01/421N01/423A01 (CH. CTC146B/C)

Magnavox

2706-1 . . . . . RJ5550AK01/2, RJ5552CH01/2, RJ5562CH01/2, RJ5563CH01,RJ5564CH01/2, RJ6050AK01/2, RJ6054HP01/2, RJ6056PE01/2,RJ6060AK01/2, RJ6066PE01/2, RJ7710AK01/2, TJ5552CH01/2 (CH.27H101/2/3/6, 31H101)

Philco

2708-1 . . . . . C5800TPE01/2/3/4, C5811TPN01, C5812TPE01, C6812TPE01/2(CH. 25C506)
2710-1 . . . . . C4920WWA01/2/3, C5800WPE01, C5802APC01, C5813WPN01,C5814WPE01, C5823APC01, C5824APC01, C6814WPE01 (CH.25C511/531/547/564)
2712-1 . . . . . R4930TWA01/2/3, R4940AWA01, R5852TPE01/TPE02/WPE01/WPE02, R5860WAK01, R5861AAC01, R5862APC01/WPE01, R5865TAK01/2/3/4, R5870TAK01/2/3/4, R5872TPE01, R5880WAK01/2/3/4, R5882WPE01/2/3/4, R5884WPE01, R6852TPE01/2, R6860WAK01, R6870TAK01/2/3/4, R6871TPN01, R6882TPE01/2/3/4, R7071TPE01/2 (CH. 25C503/20/25/34/35/36/37/46/52/56/62)

Quasar

2705-1 . . . . . TP1020DE/H/R, YTP1120DE/H
2714-1 . . . . . SL2744DW/46DD, TL9982CW/85CD/88CP, TT9901CE (CH.ALEDC148/GL7S)

RCA

2709-1 . . . . . F27100AKF01, F27101MMF01, F27107EGF01, F27110NGF01, F27122TNF01, F27123SBF01, F27150BHF01, F27155AKF01, G27130TNK01, G27140TNK01, G27143TNC01,

Continued on page 58.

Test your electronics knowledge

By Sam Wilson, CET

1. Which of the following is a measure of power?
A. ergs
B. joules
C. joules per second
D. erg-seconds^2

2. +3dB corresponds to doubling power. An increase of +6dB corresponds to
A. doubling the voltage.
B. increasing the voltage by 25%.
C. multiplying the voltage by four.
D. multiplying the power by eight.

3. The power dissipated by a certain 20Ω resistor is 4W. What voltage is across the resistor?
A. about 5V
B. about 9V
C. about 12V
D. about 27V

4. The two capacitors in the circuit shown in Figure 1 have voltage ratings of 100V each. Is there an excess voltage across each capacitor?

5. Refer to the crystal radio in Figure 2. The radio is tuned by the combination of L and C. In this circuit, L and C are in
A. series
B. parallel

6. The voltmeter in Figure 3 has a resistance of 10MΩ. The voltage reading should be about
A. 33.33V
B. 50V
C. 66.33V

7. In the circuit shown in Figure 4, what is the impedance seen by the generator?

8. The dc resistance of a transformer primary winding is measured with an ohmmeter. The value is 1.8Ω. The dc resistance of the secondary winding is measured the same way and is 0.9Ω. Can you determine the turns ratio of the transformer? (N_P/N_S = ?)

9. The physical length of a hertz antenna is about
A. 5% less than its electrical length.
B. 5% greater than its electrical length.

10. The period (T) or time for one cycle of a pure sine wave is 0.001 second. Can you find the second harmonic frequency of this waveform?

Answers are on page 37.

Wilson is the electronics theory consultant for ES&T.

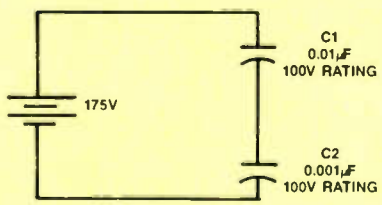


FIGURE 1

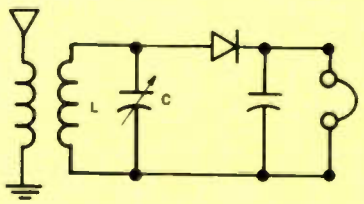


FIGURE 2

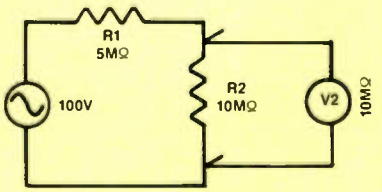


FIGURE 3

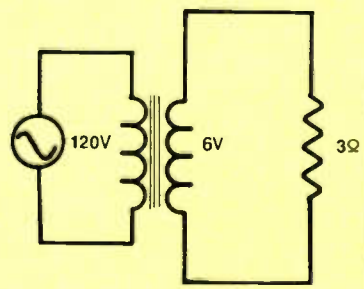


FIGURE 4

CM-139/B-1 (Y) COLOR TV RECEIVER
MAIN SCHEMATIC DIAGRAM

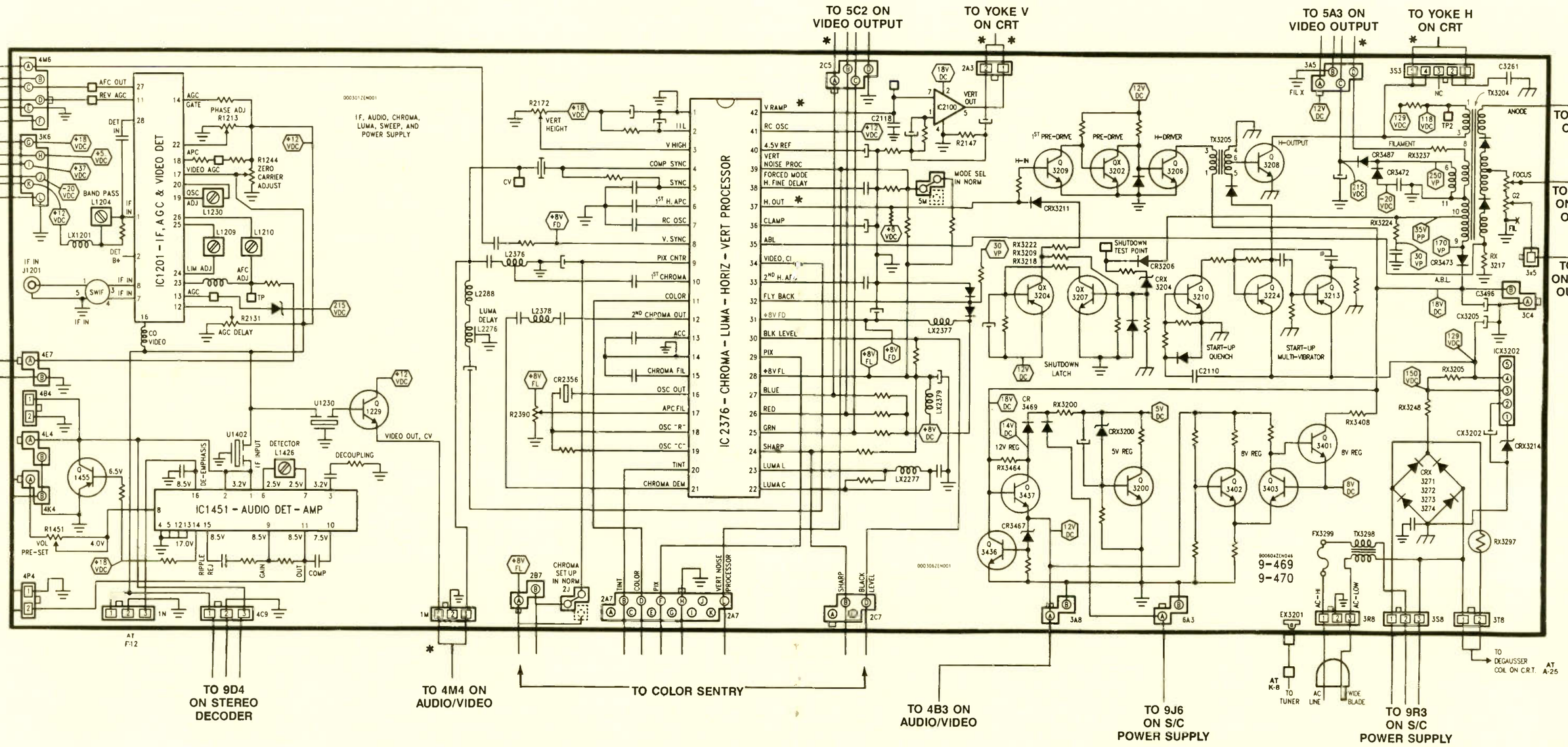
Manufacturers' schematics PROFAX
FEBRUARY 1990
3061
ZENITH
CM-139/B-1 (Y)
COLOR TV
RECEIVER

Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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

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

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



Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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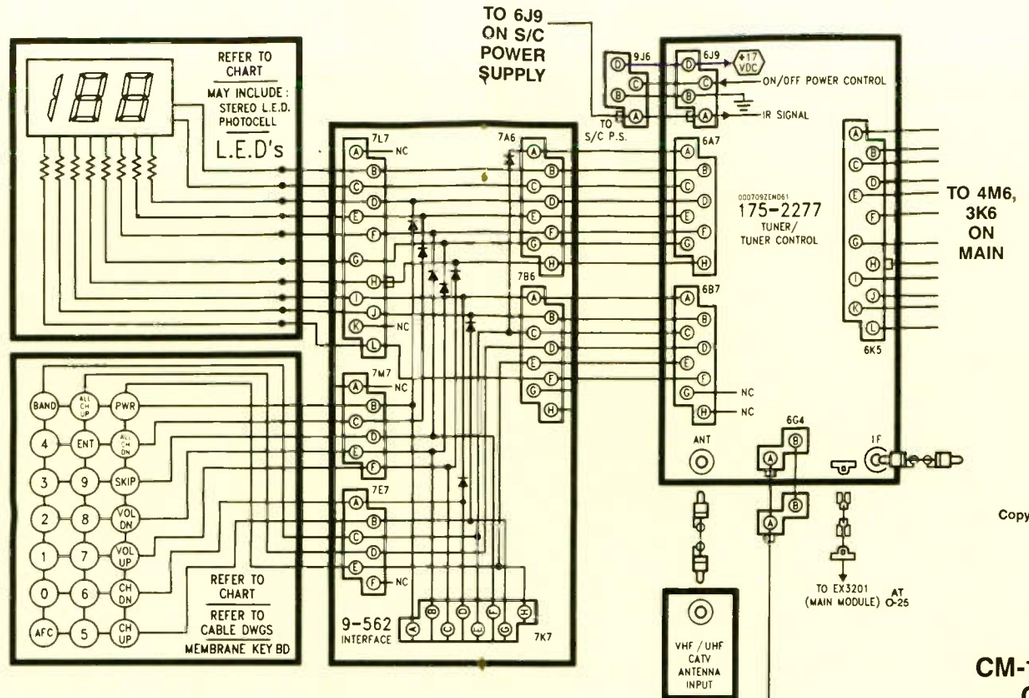
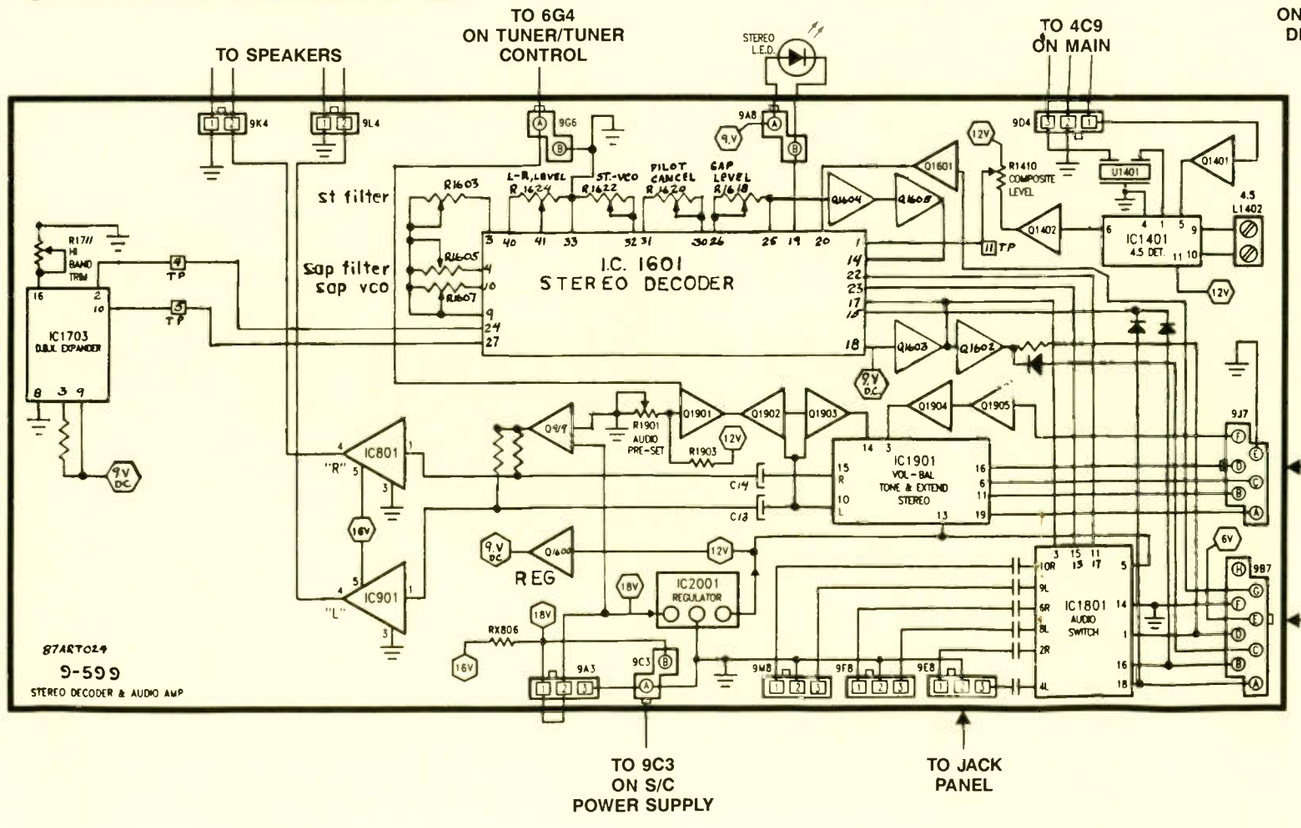
The other portions of this schematic may be found on other Profax pages.

CM-139/B-1 (Y) COLOR TV RECEIVER TUNER/TUNER CONTROL



CM-139/B-1 (Y) COLOR TV RECEIVER STEREO DECODER & AUDIO AMP



Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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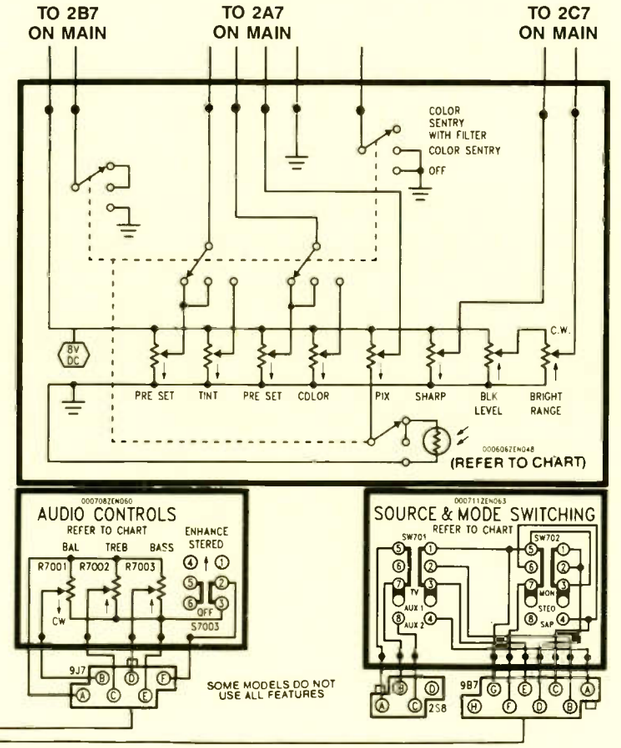
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

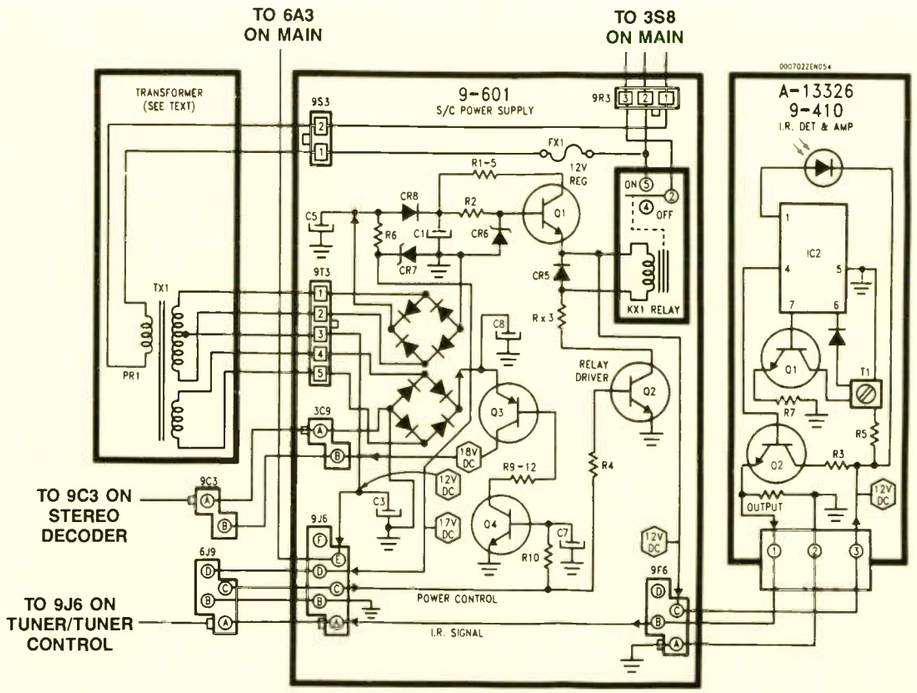
The other portions of this schematic may be found on other Profax pages.

Reprinted by permission of Zenith Video Tech Corporation
Copyright 1990, Electronic Servicing & Technology, P.O. Box 12901, Overland Park, KS 66212.

CM-139/B-1 (Y) COLOR TV RECEIVER COLOR SENTRY WITH FILTER



CM-139/B-1 (Y) COLOR TV RECEIVER S/C POWER SUPPLY



Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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

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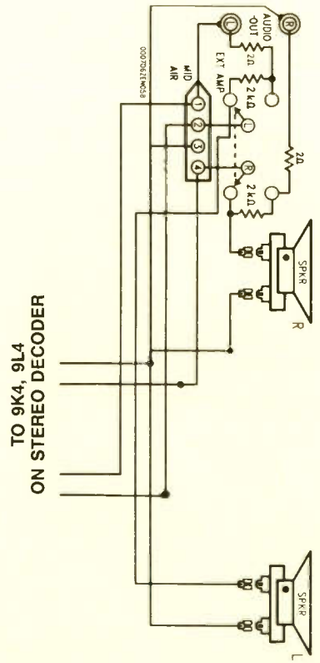
The other portions of this schematic may be found on other Profax pages.

CM-139/B-1 (Y) COLOR TV RECEIVER SPEAKERS



ES&T Manufacturers' schematics PROFAX

February 1990

Profax number

Zenith
CM-139/B-1 (Y) and (K) color TV receivers.....3061
Models SD2097S (Y) and SD1327W3, SD1327Y, SD1327Y3 (K).

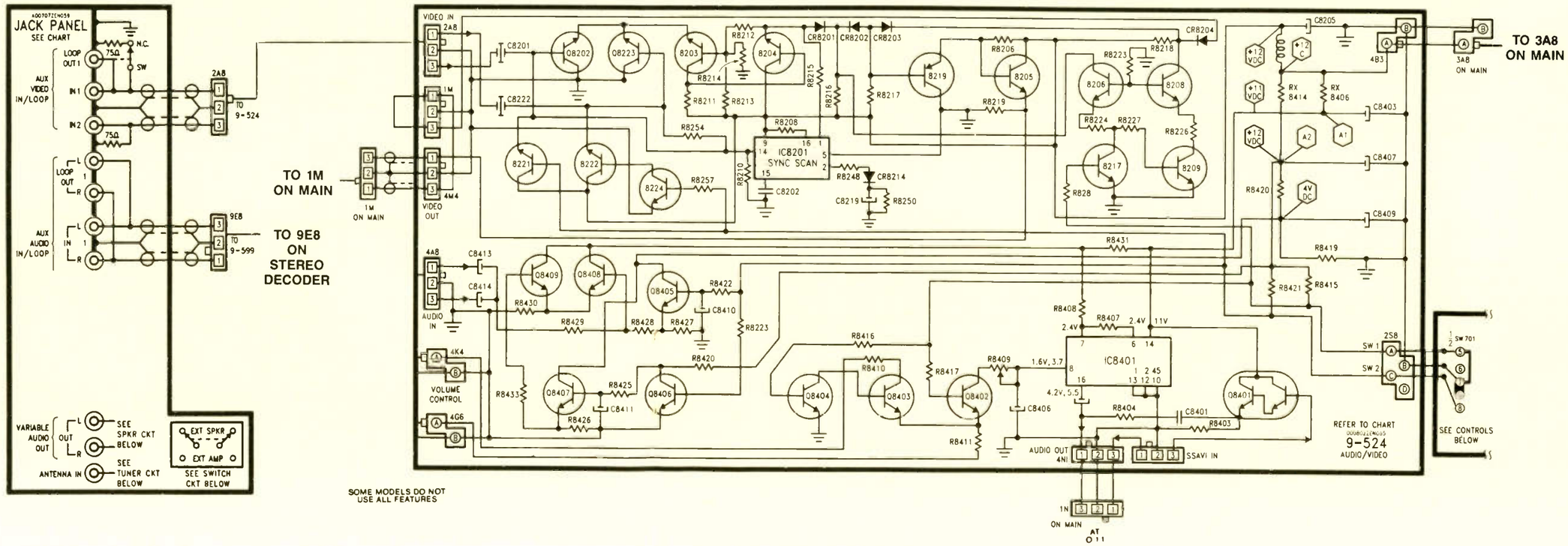
Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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

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

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

CM-139/B-1 (Y) COLOR TV RECEIVER AUDIO/VIDEO



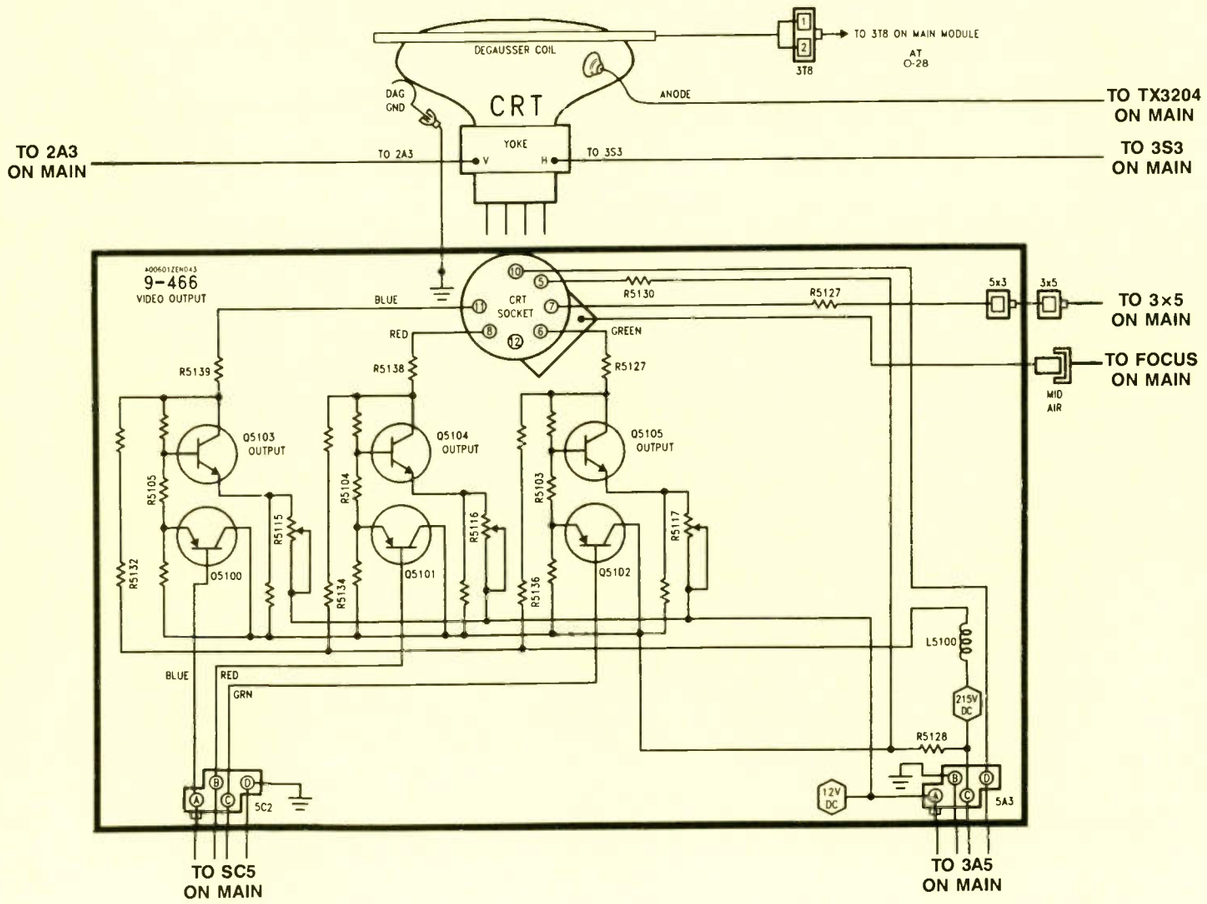
CM-139/B-1 (Y) COLOR TV RECEIVER
CRT/VIDEO OUTPUT

Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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

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

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



CM-139/B-1 (K) COLOR TV RECEIVER
S/C POWER SUPPLY*

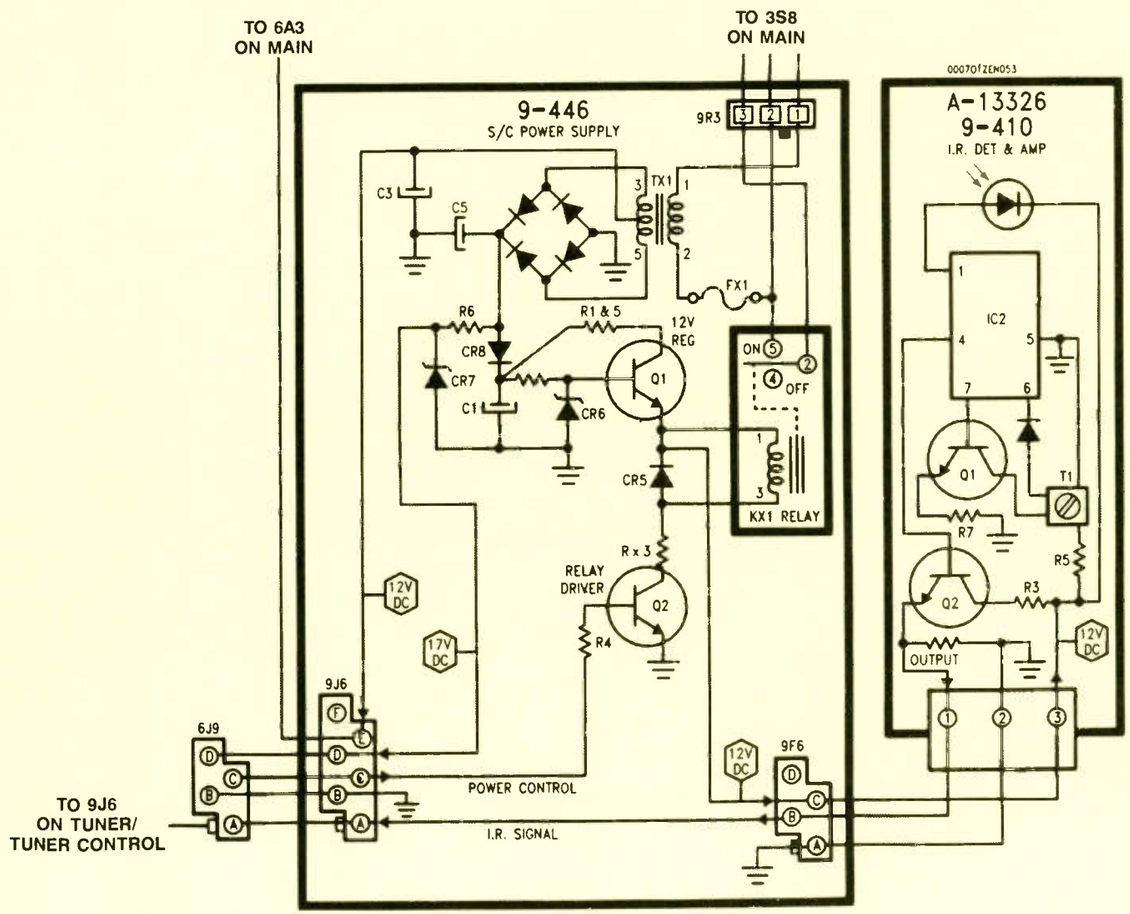
* The CM-139/B-1 (K) is similar to the CM-139/B-1 (Y). However, the (K) has a different S/C power supply (shown here) and lacks the audio/video board, the jack panel, the stereo decode and audio amp board, the audio controls and the source & mode switching. The color sentry is also part of the main board schematic.

Product safety should be considered when component replacement is made in any area of a receiver. Components marked with a ! designate sites where safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components. A lightning bolt designates the presence of uninsulated, dangerous voltage.

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

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

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



Answers to the quiz

Questions are on page 24.

1. C — Power is the rate of doing work or expending energy.

2. A — The 3dB power and 6dB voltage values are convenient ways of remembering decibel relationships.

3. B — $P=V^2/R$, so $V=\sqrt{PR} = \sqrt{(4)(20)} = \sqrt{80}$. The square root of 81 is 9, so the answer will be about 9V.

4. Yes. The higher voltage will be across the lower capacitance value:

$$V2=V1\times C1/(C1+C2)=$$
$$175\times 0.01/(0.01+0.001)=159V$$

That is greater than the voltage rating of the capacitor.

5. A — The voltage induced in L is in series with the windings. Another way of looking at it is that a series-tuned LC circuit passes one narrow range of frequencies and rejects all others. That is the purpose of the tuned circuit in the radio.

6. B — 50V. It is a simple series/parallel resistor circuit. You are finding the voltage across the meter. The parallel resistance of the resistance being measured and the meter's internal resistance is equal to R1, so half of the applied voltage will be across it.

7. 1,200Ω. The turns ratio (N1/N2) equals

$$V1/V2=120/6=20/1$$

$$Z1/Z2=N1^2/N2^2=(20)^2/(1)^2$$
$$Z1=Z2\times(20)^2=3\times(20)^2=1{,}200\Omega$$

8. No! The wire size of the primary is surely different than the wire size of the secondary winding. Therefore, the resistance ratio is not the same as the turns ratio.

9. A — less than. The equation is distance = rate × time. The distance in this case is the length of the antenna. However, the rate of wave travel is slower in the antenna metal than in air, so the physical antenna length will be less than the electrical length.

10. No! A pure sine wave has no harmonics.

Servicing Zenith microcomputers

Part VII: The video card

By John A. Ross

Most of us have made a living servicing and installing video products that range from TVs to satellite TV receivers. Because a microcomputer system includes a video display monitor and video output circuitry, this experience pays off when you are servicing microcomputers.

As with the other cards in the microcomputer, the floppy controller/video output card requires a bus interface. This article will only be concerned with the portions of the interface that directly affect video. These connections allow communication to take place between the central processing unit and the video card through the system input/output lines. In addition to the bus interface, the video portion of the card includes a CRT controller, with associated buffers and latches; video RAM

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

ICs and video RAM multiplexers; and data latches. Other circuitry on this card seems more familiar to the video-oriented technician: video timing and control circuitry, video enhancement and synchronization circuitry, and video output circuitry.

Figure 1 shows a diagram of the floppy controller/video output card. Shaded sections designate circuitry only used in the floppy disk controller portion of the card. As with the other cards in the Zenith system, the video card has a backplane edge connector that provides a connecting point for several different signals. Capacitors C362, C364 and C363 and inductor L301 filter and decouple the +5Vdc voltage from the system bus. This voltage becomes the operating supply voltage for the video output transistors and transistor-transistor logic devices located on the card.

U348 acts as a data transceiver and determines whether the data, found on lines D0 through D7, should go to the card from the system bus or from the video I/O channel bus, consisting of lines DB0 through DB7, to the system bus. A signal from pin 15 of U338, the PAL address decoder, establishes the direction in which the data should travel. When this signal, called the *XCVRD signal*, goes to a digital active low state, the data transfers from the card databus to the system databus. When the XCVRD signal goes to an active high, data transfers from the system databus to the video databus.

After the data flows onto the video databus, it arrives at the CRT controller IC, U325. Data signals are used by U325 to interface the controller with the system microprocessor, the video RAM, character generator logic and the monitor. Figure 2 shows a diagram of the CRT controller and the associated signals. Some of these signals — chip select, register select, read/write, enable, clock and reset — provide communication between the card and the system. Within the IC, 19 registers define the display and control parameters of the

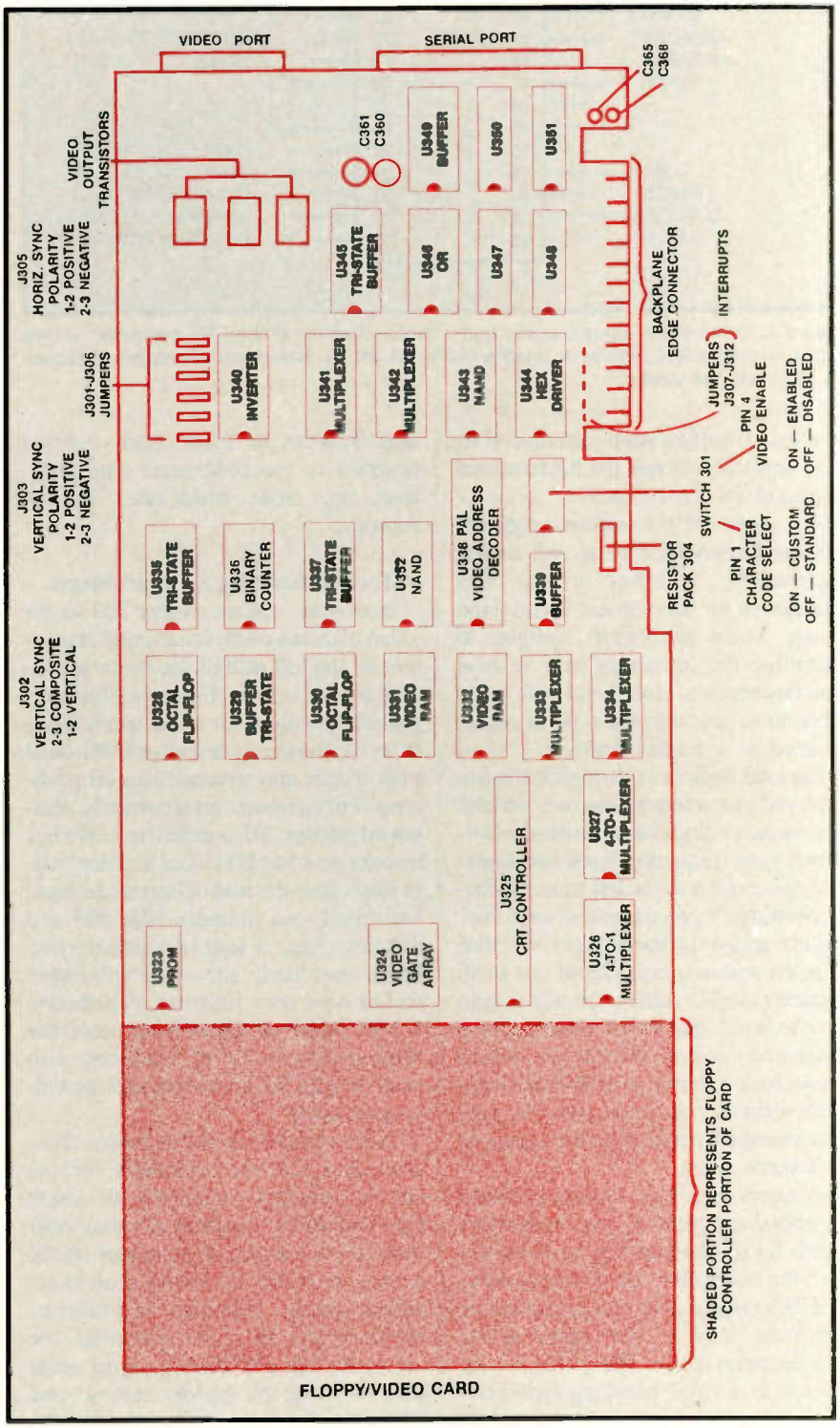


Figure 1. Shaded sections of this diagram of the floppy controller/video output card designate circuitry only used in the floppy disk controller portion of the card.

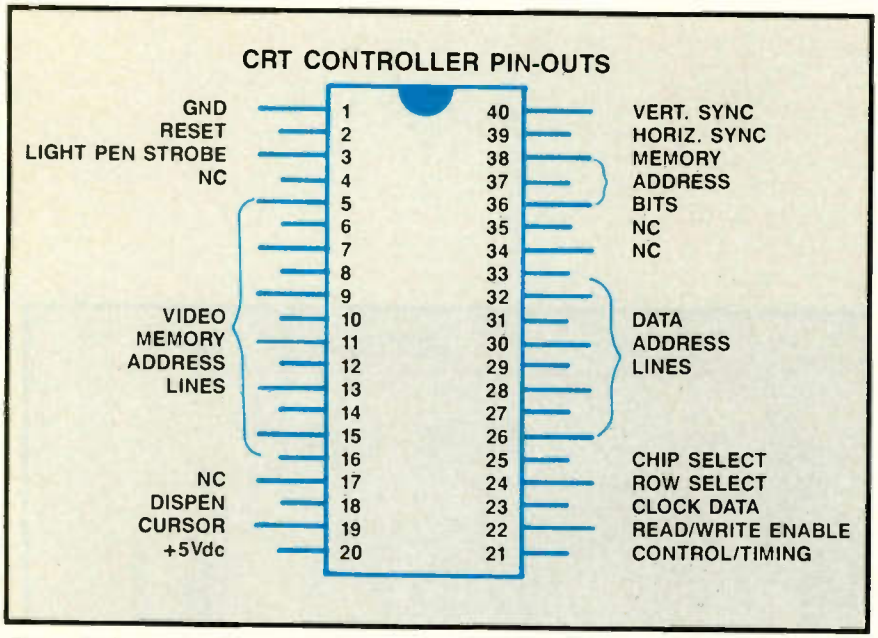


Figure 2. Some of the signals associated with this diagram of the CRT controller — chip select, register select, read/write, enable, clock and reset — provide communication between the card and the system.

monitor. Configuration through software applications sets the hexadecimal addresses for the registers.

One group of the internal registers sets the horizontal format and timing parameters. Another group sets parameters for the vertical format and timing. These parameters combine to determine the horizontal and vertical sync frequencies. Horizontal sync pulse duration varies with the type of monitor used as a display device.

The total number of displayed and undisplayed characters minus one, defined as a character clock, determines the horizontal sync frequency. Each horizontal sync pulse refers to the left-most character position displayed on the scan line. You can adjust the horizontal sync pulse duration within a range from one to 16 character clocks. Again, this adjustment sets the horizontal pulse duration for a designated monitor. Vertical sync pulses always have a duration of 16 scan lines. Each vertical sync pulse uses the top-most character position on the screen as a reference point.

Monitors, like TVs, require standard horizontal and vertical synchronization signals for display stability. Listed at pin 18 of the controller, the *display enable (DISPEN)* signal goes to a digital active high state when a video signal at the CRT becomes active. The DISPEN signal acts as a video blanking signal because it goes to an active low state during vertical and horizontal retrace. Even though the vertical and horizontal sync signals seem to come from internal registers of the controller, sync problems may arise from other trouble sources.

Troubleshooting sync problems

Incorrectly setting jumper 302 on the video card can cause the starting characters on the left side of the raster to display off the screen. Figure 1 illustrates possible positions for all jumpers. Aside from the jumper, a defective U341 quad multiplexer may produce similar problems. Furthermore, an incorrectly positioned jumper 305, a defective U340 hex inverter or a bad U349 hex inverter buffer may cause the loss of horizontal sync. Incorrectly set jumpers 302, 303 and 313 can cause a loss of vertical sync. More than likely, the video will either roll or have poor linearity. A defective U340, U341 or U349 can cause the same symptom. In all instances, also suspect the CRT controller and the video gate array.

Other registers establish cursor characteristics and the addresses for the screen memory. Changes of these registers allow scrolling of raster contents or positioning of the cursor on the screen. In addition, these registers establish whether the cursor will blink or move. At pin 56 of the controller, the *cursor-enable (PCURSOR)* signal exists as a result of the register settings and allows the definition of the cursor on the screen. Finally, one other set of registers, called the *top-of-page* registers, define the screen-memory address that contains the displayed first character of the top-left corner of the raster.

Screen memory and character generation require two sets of signals. Lines MA0 through MA13 serve as screen-memory address-output lines. These 14 lines let the controller address the 16kbytes of video memory. Lines RA0 through RA4 work as the raster-address signals for character generation logic. Character generator logic determines which scan line of a character row functions. Scan line counts range from zero to 31 per character row. Each scan line count becomes a part of the horizontal sync rate.

The video controller gate array

The video controller gate array controls many different tasks, such as video synchronization and control, multiplexing, decoding and timing. Figure 3 shows a block diagram that illustrates the various signal paths used during the gate array operation. Aside from showing the signal paths, the diagram also gives a good representation of how the entire video circuit works. Not surprisingly, when you troubleshoot the various fault symptoms associated with the video section of the card, the gate array usually becomes a likely culprit. The gate array works more efficiently and effectively than the standard ICs used in earlier video cards. Figure 4 illustrates the signals found at each pin of the gate array. Again, internal circuit actions define system parameters. Using data found on the system bus, the gate array configures the video I/O ports of the floppy/video card. This option essentially gives the user the choice between medium or high resolution, monochrome or color, enabling or disabling a video interface and the intensity of background colors.

Because some modes of operation provide 16 foreground and eight background colors, the user can also decide whether to define screen borders or enhance screen characters. Monochrome operation allows reverse video operation, blinking and highlighting of a defined character. Figure 5 lists the modes made available to the user by the video gate-array action. All of these options become possible as the internal databus of the gate array reads character and attribute bytes. However, several individual ICs may produce color-display problems.

Mismatched colors and lowered intensity defects can be caused by the dual 4-to-1 multiplexers, U327, U334, U333; the video RAMs; resistor pack RP306; the CRT controller; the tri-state buffer, U345; an octal flip-flop, U330; or the quad multiplexer, U342. Problems within U326, U327, U330, U333 and U334 may show up as incorrect background colors. Once again, there may be other causes of these symptoms, so also look at the CRT controller, the video gate array and the video RAM ICs. After multiplexing, the character output byte and the attribute byte are loaded into their respective character- and attribute-serialization registers.

Many possible symptoms are caused by this part of the video circuitry. A bad CRT controller may keep the cursor from blinking. In the graphics mode, defects in U326 and U327 (dual 4-to-1 multiplexers), U324 and U325 may cause the loss of video dots. Malfunctions in U330 (an octal flip-flop), the video RAM ICs and U334 (a dual 4-to-1 multiplexer) cause the display of the wrong data in the graphics mode. Other problems involve the display of random characters and attributes across the raster. Internal defects in U319 (an 8-bit latch), U323, U326, U327, U328, U330, U333, U334 and the video RAMs also will cause this problem. A white raster or a wrong font displayed points to switch 301 along with the same areas that may cause the random character symptom. Again, don't forget the major roles played by the CRT controller and the video gate array.

The video RAM

Another section of the floppy controller/video output card, the video RAM, stores the attribute and character bytes. Video RAM address bytes are derived from multiplexing signals on MA1 through MA10 from the controller and the T0, T1, VA11 and VA12 signals from the gate array with signals from the main address lines (A0 through A13). As the *NRFSH* or refresh signal at pin 18 of U335, an octal buffer, goes to a digital active low, the multiplexed output of U326, U327, U333 and U334 supply two bits of data to the video memory A0 through A7 address bus. Each video RAM latches onto an address byte when the row-address select signal at pin 20 of the gate array goes to an active low state. When the column-address select signal at pin 3 of U353 (a quad positive OR gate) becomes active, the video RAMs latch onto a second address byte from lines VMA1 through VMA6 of the video memory address bus. Character and attribute data bytes are stored at the addressed memory location.

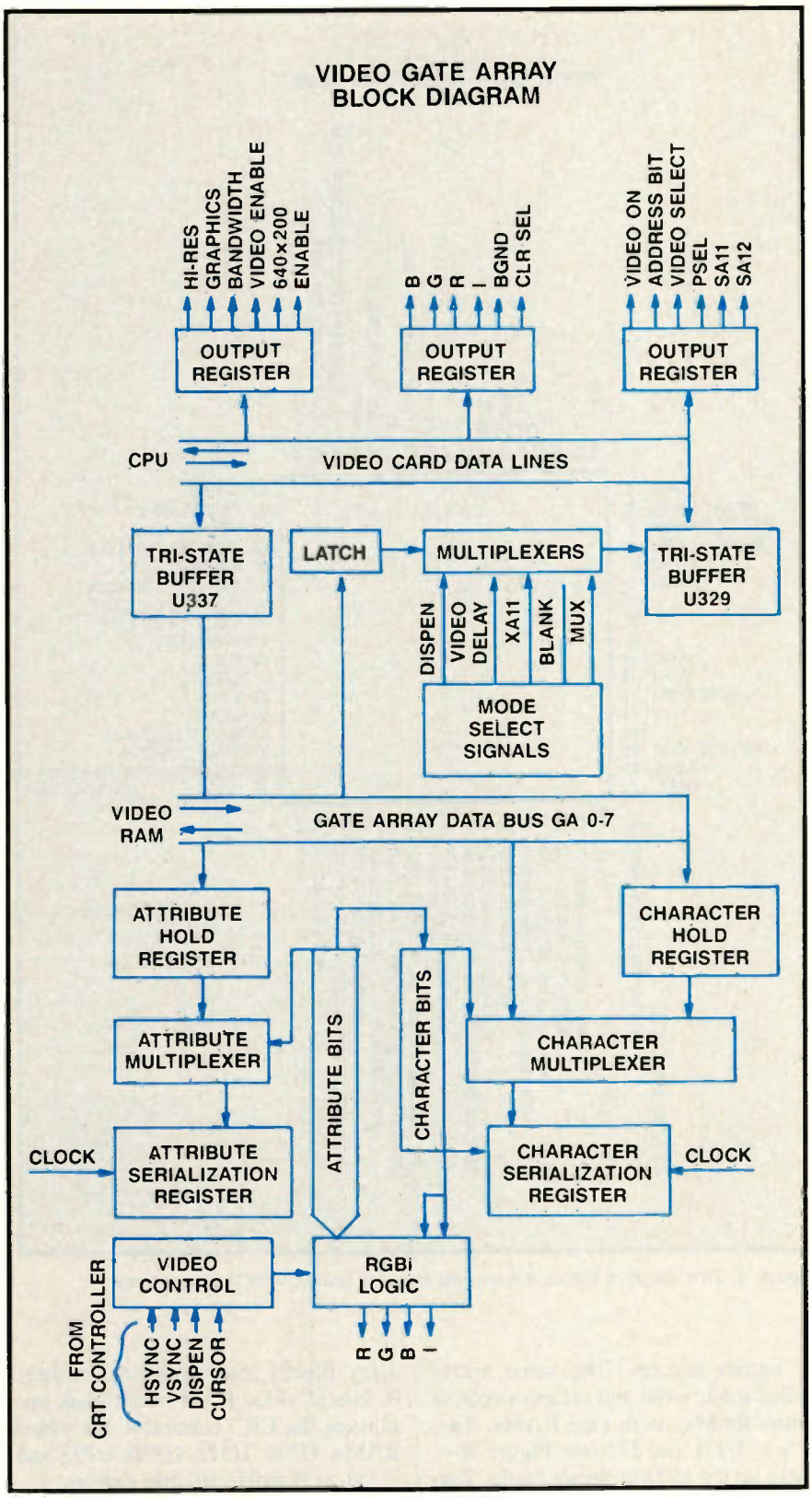


Figure 3. The video controller gate array controls many different tasks, such as video synchronization and control, multiplexing, decoding and timing. This block diagram shows the various signal paths used during the gate array operation.

The video data RAM devices work in a manner similar to the data RAMs seen

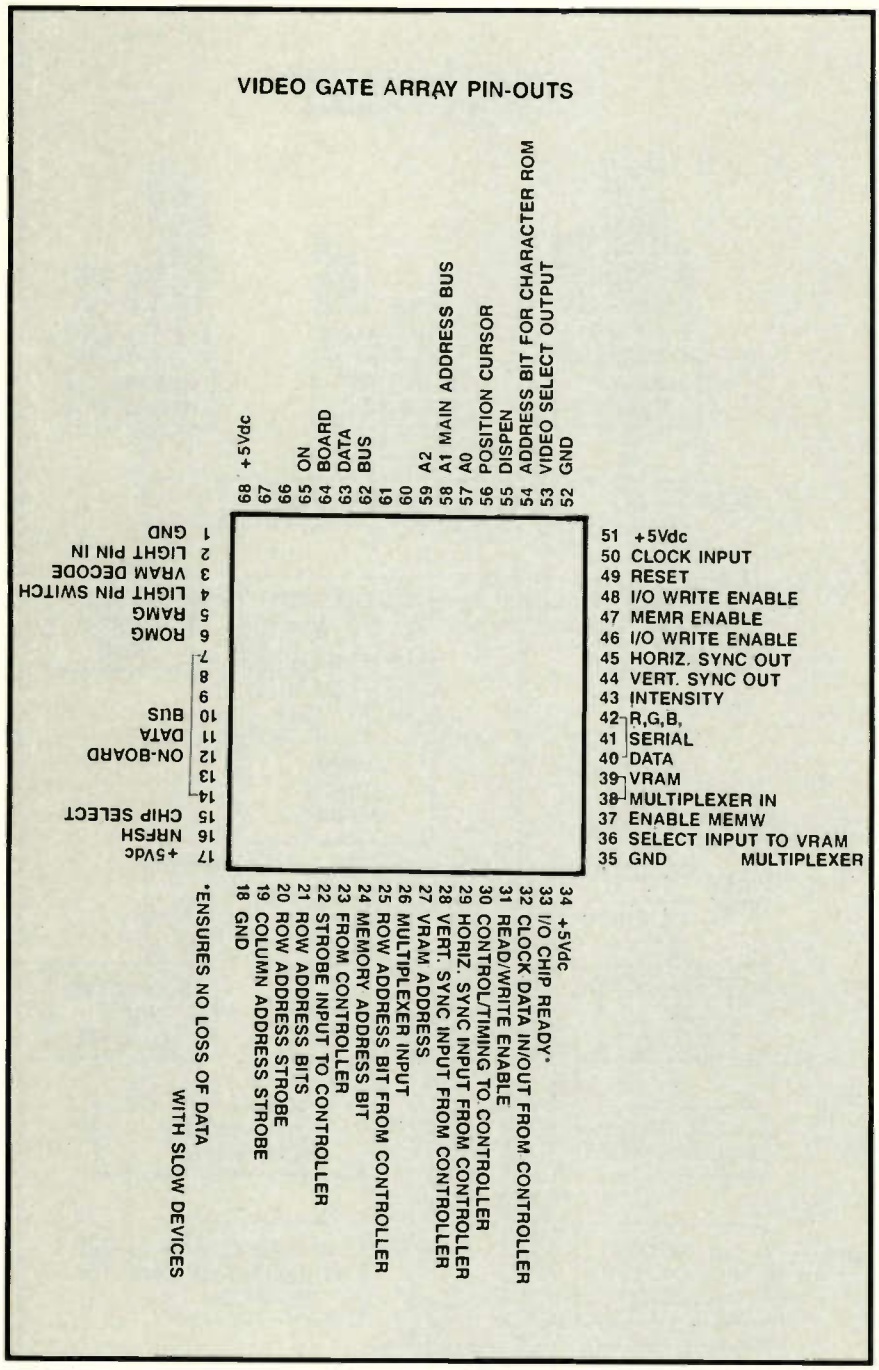


Figure 4. This diagram shows the signals found at each pin of the gate array.

in earlier articles. The same cycles called read, write and refresh occur in video RAMs, as in data RAMs. Two ICs — U331 and 332 (see Figure 1) — make up the 16kbyte storage banks. Two different video display modes, graphic and alphanumeric, cause the video RAM circuitry to function in different ways during the read cycle. A display of graphics causes the allocation of 16K of video RAM space. Because the gate array must decide whether a displayed pixel has turned either off or on, the gate array directly reads both bytes of data. A loss of video RAM output data implicates the CRT controller, the video RAMs, U326, U327, U330, U333 and U334 as possible trouble sources.

During the display of alphanumeric, 8K of RAM is available for attribute storage; 8K stays available for character storage. During the read cycle for alphanumeric data, both video RAMs alternately output two bytes of data. One byte acts as attribute data byte and is directly read by the gate array. This happens when the write-enable signal at pin 11 of U318, a quad NAND gate, goes to an active high state and the RAMG signal from pin 5 of the gate-array goes to an active low state. A digital active low RAMG signal causes the tri-state buffer, U330, to transfer data from the video RAM data lines to the gate array databus during the read cycle. When the ROMG signal becomes active, the other byte addresses the character generator read-only memory, which supplies a character data byte to the gate array.

Both the write and refresh cycles remain the same for either the alphanumeric or graphic mode of video display. With the memory-write signal at pin 2, U340 (a hex inverter) drives the signal at pin 11 of U318 (a quad NAND gate) to a digital low state. This action provides a write-enable signal for the video RAMs. The digital active low state at pin 18 of U318 turns on the tri-state buffer, U329. Data is transferred from the gate array databus to the video databus. Looking back at the data RAM articles, you will find that a refreshing of data stored in the memory locations prevents the loss of that data. NRFSH signal pulses from pin 16 of the gate array flow to pin 4 of U318 and to the video RAM multiplexers. A low NRFSH signal sends the signal at pin 6 of U318 high. With the resulting digital high level at pin 6, the binary counter, U336, supplies the tri-state buffer, U337, with a byte of data. All this means that a specific row within the video RAM has been addressed. The row-address strobe (RAS) signal at pin 20 of the gate array goes to an active low state and refreshes the designated row of data.

Any discussion of vertical and horizontal sync, character attributes and modes of video operation leads to the familiar-looking video output section. Once again, the gate array plays a major role. RGBi signals from pins 40, 41, 42 and 43 of the gate array feed data into a multiplexer found at U342. When the video-select signal (VSEL) at pin 53 goes to a digital active high state, the multiplexer outputs the RGBi signals. A digital high VSEL signal also causes the horizontal and vertical signals found at pins 45 and pin 44 of the gate array to output from U341, a multiplexer.

After U345 buffers and drives the RGBi signals to the monitor connector, a resistor pack designated as RP306 converts the signals to an analog level. Those signals, seen in different combinations by the base of Q301, change the

Alphanumeric text (monochrome or color)

40 characters per line by 25 lines per screen

80 characters per line by 25 lines per screen

Notes:
- In monochrome text mode, reverse video, blinking and highlighting are available.
- In color text mode, sixteen colors are available.
- The character generator can generate 256 different characters in 2 fonts.

Color graphics

Medium resolution (monochrome or color):
200 rows of 320 pixels defined
40 characters per line by 25 lines per screen

High resolution (monochrome only):
200 rows of 640 pixels defined
80 characters per line by 25 lines per screen

Notes:
- One pixel is one picture element, or one definable position on the video screen.
- Available colors:
  foreground: cyan, magenta, white, green, red, brown
  background: sixteen text colors (black, blue, green, cyan, red, magenta, brown, light gray, dark gray, light blue, light green, light cyan, light red, light magenta, yellow, white)

Figure 5. Some modes of operation provide 16 foreground and eight background colors. Monochrome operation allows reverse video operation, blinking and highlighting of a defined character.

bias voltage of the Q301 base. A change in the bias voltage produces video stepping voltages at the emitter of Q301. If no RGBi signals arrive from the multiplexer, pin 8 of U346 goes to an active low and cuts off transistor Q301. This action causes blanking of the video signal. Potentiometers R319 and R320 adjust the peak-to-peak voltage at the base of Q301 and vary the video contrast and black level.

U346 acts as an OR gate and sends the horizontal and vertical signals to U349, where the inverted signals become the composite horizontal/vertical signal. A composite signal adds synchronization between the horizontal and vertical retrace and the video output signals. During retrace, the composite signal becomes a part of the composite video signal. If the monitor displays no composite vertical or horizontal sync, look at jumpers 302, 303 and 305. Along with the possible jumper settings, consider a defective U341, U346 (a quad OR gate) and U349 as probable culprits. With no retrace action, the composite RGBi signal, seen at the emitter of Q301, is applied to the base of both Q302 and Q303. Output voltages at the emitters of Q302 and Q303 provide composite video signals to the monitor connector, P305.

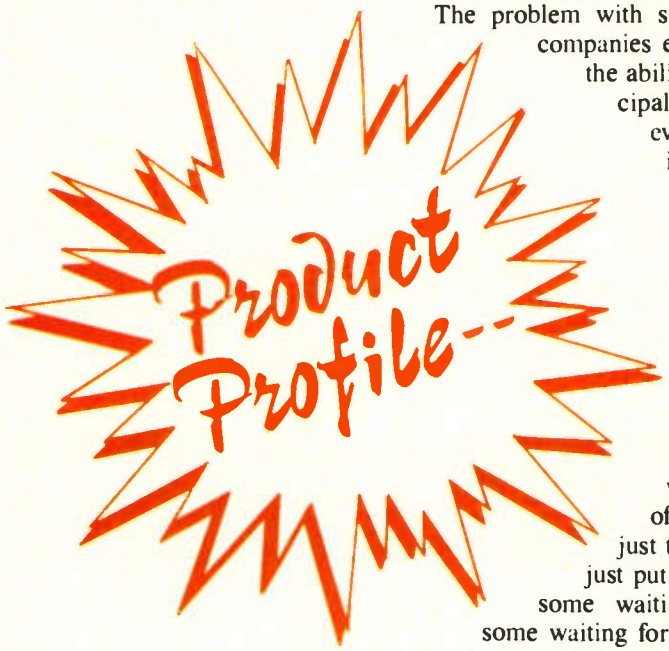
All the circuit operations combine to produce a display on the monitor. Coming from an earlier 150-series microcomputer, the display resolution has some limitations. Currently, the enhanced graphics adapter and video graphics adapter (both offer higher pixel resolution and increased color options) have replaced the color graphics adapter as a standard. Nevertheless, the floppy controller/video output card stands as a good model for microcomputer video circuitry. Nationwide, many CGA adapters remain in use. When we look at monitors, we will also take a more detailed look at the characteristics of the EGA and VGA cards. ■

Surviving success:

Software for managing your shop

By Conrad Persson

If your business takes off, are you prepared for more customers, more employees, more paperwork? Management software can help you stay on top of that mountain of paperwork.



Success. Everyone dreams about it; everyone wants it. The only problem is that when success comes in a small business, many of the people who dreamed about success are not ready for it. In fact, some companies never survive success. Sounds paradoxical, but in many cases it's true.

The problem with success is that companies expand beyond the ability of the principals to manage everything. Such is the case with consumer electronics servicing facilities. Success means there are dozens of defective products in the shop in various stages of repair: Some just taken in, some just put on the bench, some waiting for parts, some waiting for service information, some finished but on burn in. Now, when some impatient customer, who may be the source of a lot of business in the future, calls in to inquire about his set, what do you do? Do you try to find the records? Do you scour the shop to see where it is, only to find that the tech who's working on it is out to lunch or sick that day and you have no idea what the story is? Or do you have perfectly kept records that tell exactly where the set is, what condition it's in and when it should be ready to return to service?

Think about all of the paperwork that has been generated by those sets: customer order form, work order, order for parts. How do you keep track of it all?

Some service shops do it very well. Individuals who have good managerial and administrative skills set up elaborate tracking and recording systems and are able to stay on top of everything. Unfortunately, many servicing technicians who have become shop owners are great servicing technicians, but lousy managers and administrators. It's not something to be ashamed of; the world needs good technicians and not everyone is cut out to be a perfect manager. However, it could spell trouble for the management of the shop.

The computer as manager

As the world has become more complex, technology has developed products to help us handle that complexity. One of the most important tools of today is the personal computer. All kinds of businesses are finding that computers can help with the day-to-day administrative chores. Spread sheets were one of the first classes of programs to really make the computer a useful tool for the small business owner. The user can perform masses of calculations and perform "what if" comparisons.

Since that time, programmers have introduced a number of good word processor programs that reduce the chore of preparing correspondence and, in some cases, virtually automate the preparation and mailing of letters and other paperwork.

Another class of computer software that provides support for the servicing facility in just about every aspect of the business is service facility management

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

software. With one of these packages, you enter the customer's information and the nature of the problem with the product. If this is a repeat customer, you may just have to type in his phone number, and the rest of the information is brought up automatically from the computer database.

One of the companies that offers this type of software, Automated Systems, has an office just a few miles from the ES&T offices, so recently we paid the company a visit. Here's a rundown of the features of its software product. We assume that the features of any of the other software products listed in the accompanying list of companies will be generally similar to the features described here.

Our use of this particular software to describe features of service management software is not an endorsement of the product, merely an example with which we have become familiar. Because software such as this can vary considerably in its usefulness, depending on the particular needs and management style of the managers, we recommend that before you make a commitment to purchase such a system, compare the features and ease of operation of several packages.

Job tracking/scheduling

As the customer's job information is entered into the system, the computer automatically creates a job ticket and stores the information. The software helps the servicer in several areas:

- You can more easily handle customer telephone inquiries. You enter the customer's phone number or name and the job information appears on the screen.
- You can access a job's current status by supplying the appropriate code number. You have several options on how to access the information: by a customer's phone or I.D. number, or by a job, dealer or bill-to number.
- You can get detailed job-status information, such as which jobs are completed, which are in progress, what parts are on back order, the date back-ordered parts are received, and which jobs are waiting for approval of the estimate.
- You can maintain a history of each unit by serial number or by customer number.
- With bar-code technology, you can speed up service and minimize operator errors. If you need to add parts to a job or change the job status, you can scan the bar code printed on the job ticket.

When it's a field job, these features are added:

- Time increments defined by the user allow you to use 15-, 30- or 60-minute time increments on job-scheduling tables.
- A summary schedule lets you see the day's schedule.
- You can schedule by territory.
- A printout of technician routing sheets and a management summary sheet can be output.

Inventory management

The inventory program gives you the individual parts movement by the month, plus cross-reference data, prices, quantity and a re-order report. By checking the movement record, you can adjust quantities ordered to make sure you have adequate inventory of parts without being stuck with a large inventory of slow-moving parts. By coupling this information with manufacturer's shipping time, you can order replacement parts early enough to cut down on back orders.

This parts module allows you to put together detailed information on parts, such as the location and manufacturer of parts, the vendors you buy from, the number of parts on order, the last and average costs, quantities in stock, multiple price levels and generic part numbers. It also allows you to maintain a history of part usage and to charge out parts to jobs by entering the part number. When parts charged to jobs are not in stock, the system automatically creates or adds to purchase orders.

Invoicing

There is room for 576 repair descriptions for each type of product repaired. All repair descriptions and labor pricing are entered ahead of time. The information is then on record and can be pulled up and printed on invoices. For example, if a customer brings in a VCR for general maintenance, the user could make a number selection on the computer to print out a standard repair description of the work to be performed and the labor prices.

The software prints customer and standard NARDA invoices, and can automatically print post cards informing customers of the status of their units.

Warranty and service literature

The software can be used as an index to where service literature is stored in your shop. Once you describe where servicing literature for a particular model of product is stored (file cabinet A, drawer number 2, for example), that information will appear automatically on job orders for that model, so the technician who has been assigned the job doesn't have to search for it.

When service literature information

is entered, technicians can look up where to find manufacturer's literature or service tip literature. If the literature has been checked out, it lists the date and the name of the technician who checked it out

Once warranty information is entered, the program allows access to manufacturer warranty policies (such as warranty exclusions, warranty lengths and labor rates) and the manufacturer's address, telephone number and contact people.

Cash receipts

Cash, charge and received-on-account payments can all be handled from the front counter. With bar-code capability, you scan the invoice to bring the job on to the screen and enter the amount of payment. The computer does the rest, including figuring the balance due.

Codes and tables

User-defined codes and part-pricing tables let you customize your system and speed up data entry. The technician presses a special key to see the list of possible code entries. They include codes for unit types, brands, manufacturers, technicians, job status (such as "parts on order" or "estimate approved"), shipping (how a customer wants a unit returned), sales taxes, and vendors.

Forms and reports

A service management software system can save you time and money in several ways by doing much of the paperwork for you. First, a valuable technician will have to take less time away from repair work to do paperwork. Second, you only have to enter the customer data once. After that, the computer will automatically generate the information in the proper format to match your different forms. Finally, the various computer-generated reports allow you to see where your money is going and how fast. The following are some of the forms and reports available:

- Management reports, which can show you the daily work in process, work that is completed but not picked up, which units were worked on by a particular technician, and technician productivity.
- Job tracking/scheduling reports, including routing sheets and job tickets.
- Warranties and service literature location reports.
- Inventory management reports, including purchase orders, parts that need to be ordered and the total value of parts.
- Edit lists, such as customer name or inventory parts lists.

A caveat

A service management system won't make your business run any smoother all by itself, any more than an oscilloscope will diagnose a problem in a product. It's a tool. You have to learn how to use it and teach other people in your business how to use it. And you have to use it consistently and correctly.

These systems are probably not for every servicing facility. A low-end system — software only to run on your own PC — may cost several hundred to more than a thousand dollars. A high-end system for a large shop — software or software and hardware — may cost several thousand dollars. On the other hand, if a shop is large enough to use one of these systems, and the people who will use it are dedicated enough to make it work, the benefits may far outweigh the cost. ■

Service management software companies

Active Software
1208 Apollo Way, Suite 507
Sunnyvale, CA 94086
408-732-1740

America West C&E
311 Washburn Drive
Rock Springs, WY 82901
307-382-5663

Applied System Technologies
350 S. Main St.
Doylestown, PA 18901
215-345-1111

Automated Systems
P.O. Box 6142
4827 Pioneers Blvd., Suite 100
Lincoln, NE 68506
402-489-2717

C&L Computer Consultants
205 Regency Executive Park Drive, Suite 306
Charlotte, NC 28217
704-521-8113

Computer Transaction Systems
58 Lochmere Ave., P.O. Box 56
North Weymouth, MA 02191
617-331-6968

Core Software
26303 Oak Ridge Drive
Spring, TX 77380
713-292-2177

The Data Group
77 S. Bedford St.
Burlington, MA 01803
617-272-4100

Image Network
2001 Ruppman Plaza
Peoria, IL 61614
309-679-4233

Magic Solutions
610 Vermeulen Place
Franklin Lakes, NJ 07417
201-891-6383

Mini Computer Software Specialists
200 Executive Drive
Brookfield, WI 53005
800-543-2130

National Electronics Sales and Service Dealers Association
Service Control System II
2708 W. Berry St.
Fort Worth, TX 76109
817-921-9062

Ogment Group
P.O. Box 781
Lafayette, CA 94549
415-284-4142

Service Management System
931 Sunset Blvd.
W. Columbia, SC 29169
803-798-5860

Sidon Data Systems
18001 S. Mitchell
Irvine, CA 92714
714-553-1131

Soft-Serve
7042 Marco
Pontiac, MI 48054
313-334-8115; 800-458-6909

Products

Video sweep generator

Leader Instruments has introduced the model 430 video sweep and multiburst generator. The sweep and multiburst output can be continuously variable or preset. The sweep signal repeats at the field rate and sweeps from 100kHz to 10MHz. Five sets of dropout markers can be selected. The generator provides a 100% white reference pulse for multiburst operation at the beginning of each visible line.

Circle (73) on Reply Card

Analog/digital scopes

Two analog/digital storage oscilloscopes from *John Fluke Mfg.* offer real-time sampling speeds of up to 250MS/s, four 4K memories, post-trigger capability of up to 5,000 divisions, averaging, digitally delayed timebase, and an envelope mode. The 60MHz PM 3355 DSO and the 100MHz PM 3375 DSO also have cursors and autoset. The DSOs can store 64 front-panel settings.

Circle (74) on Reply Card

AM/FM stereo analyzer

Sencore has introduced an AM/FM stereo analyzer that generates modulated RF signals. The SG80 integrated-microprocessor-controlled, IEEE488 and RS-232 compatible analyzer produces RF, IF, C-QUAM, MPX, SCA, audio, and tunable sweep and marker generators. Tests include sensitivity, selectivity, separation and pilot threshold parameters.

Circle (75) on Reply Card

Power supplies

Beckman Industrial has introduced the MPS Series, a line of dc power supplies. The MPS60 and MPS100 feature full output power and digital metered displays for output voltage and current. Remote sensing on the MPS100 regulates the output voltage at the load to compensate for test-lead voltage loss. Dual output ratings are ± 15Vdc at 2.0A for the MPS60 and 30Vdc at 3.5A for the MPS100.

Circle (76) on Reply Card

Adapter kit

Pomona Electronics is offering the model 5514 SOIC clip adapter kit. The adapters are designed for high-density, surface-mount, small-outline ICs (SOICs). The kit includes one each 8-, 14-, 16-, 20-, 24- and 28-pin SOIC clips. Access pins are 0.025-inch square, gold-plated pins on 0.100 centers. SOIC contacts are also gold-plated.

Circle (77) on Reply Card

Magnetic sensing probe

The Lil Devil Mag-probe, available from *HMC*, detects residual magnetism and transient current pulses as fast as 10ms. It also identifies north and south poles in ac- and dc-powered solenoids, relays and other devices that use a coil. The LED in the probe's handle lights if the device under test is energized. Standard- and high-sensitivity models are available.

Circle (78) on Reply Card

Fax maintenance kit

The Fax Maintenance System from *PerfectData* cleans fax components, printheads and cabinets. The system includes PerfectDuster II with Ozone Guard, a cleaning solution with 10 double-ended flexible swabs, a case and cabinet solution, and 25 non-residual wipes.

Circle (79) on Reply Card

Miniature wire stripper

The PA 1115 Mini-Stripax miniature wire stripper from *Paladin Corporation* cuts 30- to 60-gauge solid and stranded wires in a single motion. The front-feed stripper removes the insulation from multiple conductors without touching or nicking the internal wires. The tool is insulated to 600V.

Circle (80) on Reply Card

Solder joint repair kit

The Dot-Maker kit from *ESP* contains tools and materials used for surface-mount and electronic solder joint repair. The Dot-Maker precision hand dispensing tool dispenses solder cream and paste flux from prefilled caplettes. The VAC tweezer, with interchangeable pad/tips, handles and places SMT components with a squeeze-bulb that reduces lead and board scratching.

Circle (82) on Reply Card

Liquid electrical tape

Star Brite liquid electrical tape is a liquid vinyl that seals out moisture and prevents corrosion of wires or terminal junctions. The liquid dries to form a flexible protective coating that also helps hold wires and terminals together.

Circle (83) on Reply Card ■

What do you know about electronics?

$2\pi f = \omega$

By Sam Wilson, CET

Let's look at the differences (and similarities) between linear motion and angular motion. Linear motion is motion on a flat surface. For all practical purposes, it is motion on the surface of the earth.

The rate of change of distance is called *speed*, often represented by $\bar{v}$. The overbar means average. A very basic equation for linear motion is:

$$\text{distance}=\text{rate}\times\text{time}$$

Distance is often represented by the letter s. Don't confuse it with speed ($\bar{v}$). Using symbols: $s=\bar{v}t$. Written as a function of speed:

$$\bar{v}=s/t$$

Angular motion is circular motion. It is expressed as revolutions per minute (rpm) by the celebrated man on the street. However, in science, the second is the basic unit of time. The symbol ω is used to represent angular velocity. Therefore, in science, ω is measured in revolutions per second.

If you take the radius of a circle (r) and lay it along the circumference, as shown in Figure 1, the angle marked is one radian. You can lay the radius along the circumference exactly 2π times. Therefore, circumference is equal to $2\pi r$.

It follows that when a circle turns through one complete revolution, a point on the circumference travels through 2π radians. Angular velocity is most often expressed in science as radians/second. If a wheel is turning at a rate of 10 revolutions per second, its angular velocity is the same. There are 360 degrees in each revolution. Therefore:

$$\omega=\left(\frac{10\text{ revolutions}}{\text{second}}\right)\left(\frac{360\text{ degrees}}{\text{revolution}}\right)$$

$$\omega=3{,}600\text{ degrees per second}$$

Note that after revolutions are cancelled, all you have left is degrees/second. In scientific work, you use 2π radians instead of 360 degrees. For the above example:

$$\omega=\left(\frac{10\text{ revolutions}}{\text{second}}\right)\left(\frac{2\pi\text{ radians}}{\text{revolution}}\right)$$

$$\omega=20\pi\text{ radians per second}$$

A sine wave is generated on a time axis by the tip of a phasor rotating counterclockwise. (See Figure 2.) Assuming that the phasor represents voltage, you can find the voltage at any instant from this simple equation:

$$v=V_m \sin \Theta$$

where theta (Θ) is the angle the phasor makes with the starting position.

This relationship is illustrated by the drawing in Figure 3. However, you may not know the value of Θ. Let's look again at the rotating phasor that produced the sine wave. Its angular velocity is:

$$\omega=2\pi\text{ radians/second}=$$
$$2\pi\text{ radians/time}=2\pi\text{ rad/T}$$

Because the phasor completes one cycle in the time represented by T, T is called the *period* of rotation. The equation can be written:

$$\omega=(2\pi\text{ radians})(1/T)$$

However, 1/T equals frequency. Substituting frequency (f) for 1/T:

$$\omega=2\pi f$$

So, ω is the rate at which the phasor is turning, and $2\pi f$ is a way of expressing the frequency of the signal.

The reactances of inductors and capa-

Wilson is the electronics theory consultant for ES&T.

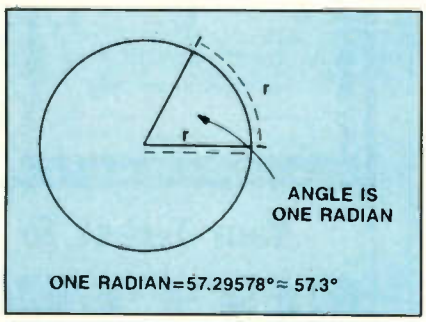


Figure 1. If you take the radius of a circle (r) and lay it along the circumference, the angle marked is one radian.

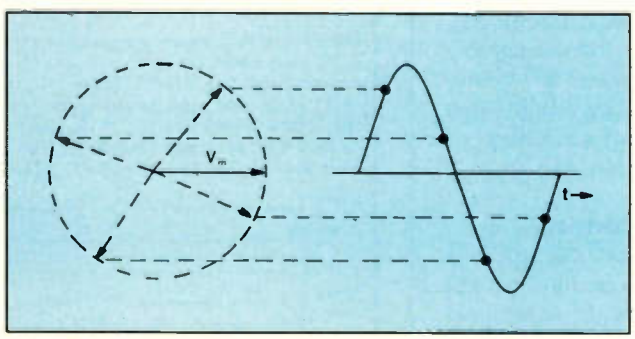


Figure 2. The phasor is marked V_m. As it rotates counterclockwise, it projects a sine wave onto the time axis. Four representative projections are shown. V_m, with a solid arrow, is in the starting position.

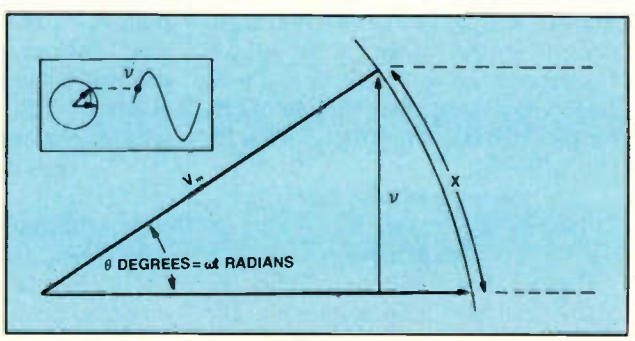


Figure 3. Assuming that the phasor represents voltage, you can find the voltage at any instant from the equation $\sin\theta=v/V_m$. Therefore, $v=V_m\sin\theta=V_m\sin\omega t$. Distance X equals the angular velocity multiplied by the time (distance=rate×time).

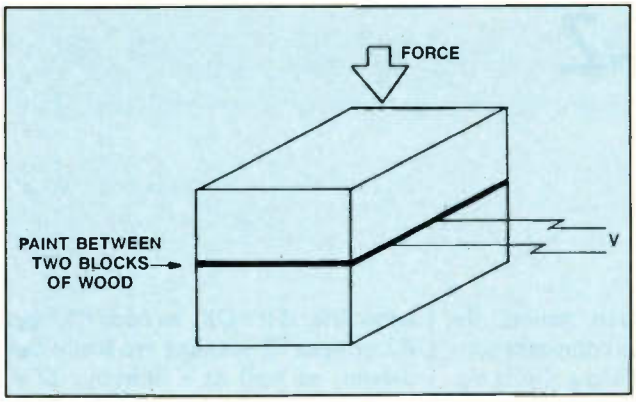


Figure 4. Some kinds of paints are also unconventional piezoelectric materials. Load cells, which measure force or weight, have been made by pressing two insulated, freshly painted surfaces together.

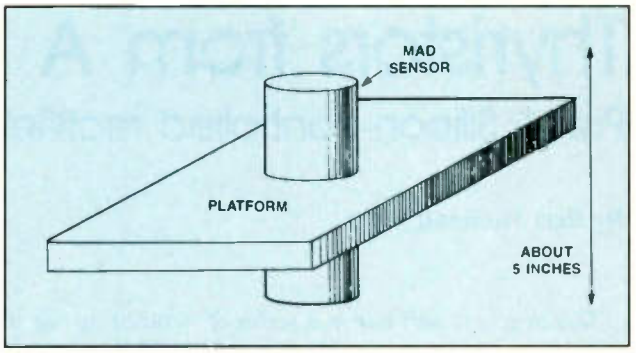


Figure 5. A magnetic anomaly detector (MAD) system can detect small changes in magnetic fields. Problems encountered with the MAD gear illustrate the prevalence of unnoticed magnetic fields, such as those found in wood and many types of plastic and those generated by the electric currents used in normal plane operation.

citors depend on the frequency of the ac signal. That is why you write:

$$X_L = 2\pi fL = \omega_L$$
and
$$X_C = \frac{1}{2}\pi fc = 1/\omega_C$$

Different materials

Over a period of time, I have run across some unusual materials used in electronics. Also, I have run across unusual applications of some basic components. From time to time, I like to share some of them with you.

• *Piezoelectric:* There are certain materials — such as barium titanate, quartz and tourmalene — that produce a voltage when under pressure. In addition to the materials mentioned, piezoelectricity is found in some unconventional places. For example, your bones are piezoelectric materials.

One theory is that the bones generate a voltage when strained, which may be perceived by the brain as a warning that the bone is in danger of breaking.

Some kinds of paints are also unconventional piezoelectric materials. Load cells, which measure force or weight, have been made by pressing two insulated, freshly painted surfaces together as shown in Figure 4. I'm not sure I understand why paint works, but I am going to experiment with that idea.

• *Electrostatics:* People have been experimenting with the use of electricity as a cure for diseases, aches and pains since the days of the Roman Empire.

There is a company (called Polarin) in West Germany that makes electrostatically charged bandages to hasten cures. The bandages are not highly successful for some types of wounds. However, they are supposed to work well on major burns. There are many testimonials regarding those cures.

One problem with electrostatic bandages is that they attract dust, pollen, spores and every other air impurity you can think of.

Electrostatic charges are easily stored in teflon. Also, that is a very good nonstick, neutral material for bandages. You might be surprised to learn that cotton can hold an electrostatic charge for as long as a day and a half. A company once hired me to design and build a machine that could put an electrostatic charge into a cotton bandage.

A lab was set up for me in Fort Collins, CO. I hired six students from Colorado State University and we got right down to it. After several failures, I finally got a machine to work. It put so much charge in the cotton that it glowed blue in the dark! (I used 300kV in the machine.)

Just as we finished the job, the owner of the company flew into town wearing a lot of anger. He accused us of fooling around and not really getting anywhere with our work. He was very nasty.

We charged a cotton bandage to full capacity and I told him: "If you don't think we are doing a good job, see if you can wash the charge out of this one." When he touched the cold water faucet, he became immediately convinced. I don't know if he ever got the feeling back in his arm, but that was the end of that project.

I never claimed to be smart about business.

• *Magnetics:* Magnetic materials come in three classes: ferromagnetic (materials that are strongly attracted to a magnetic field and offer an easy path to magnetic flux lines); paramagnetic (materials that, in theory, are not affected by magnetic flux lines); and diamagnetic (materials that move away from a magnetic field if free to do so).

Just as there is no such thing as a perfect resistor or conductor (at room temperature), there is also no perfect magnetic material.

The paramagnetic materials are of present interest. When the magnetic anomaly detector (MAD) was first designed for antisubmarine work, there were some basic problems that had to be overcome.

The MAD system can detect small changes in magnetic fields. For example, when an airplane, carrying the MAD gear, flies over the surface of the ocean, it can detect the way the earth's magnetic field is distorted by a submarine.

One problem encountered in the design was the electric currents used in normal plane operation. For example, currents for running lights, landing lights and instruments all have accompanying magnetic fields. These magnetic fields confused the MAD gear.

To solve that problem, the MAD gear is positioned on a boom in back of the plane to get it away from those fields.

A second problem was that the detector had to be mounted on a platform of non-magnetic material. (See Figure 5.) Materials that are normally paramagnetic turned out to be too magnetic for the detector. Would you have guessed that wood and many types of plastic are too magnetic?

They finally did find a material that worked, but they don't like to talk about it.

An example of an unusual magnetic material is hydrogen. There are also other magnetic gasses. They are considered to be paramagnetic under ordinary circumstances, but their magnetic properties are now being put to work in newer MAD equipment. ■

Thyristors from A to Z

Part I: Silicon-controlled rectifiers

By Bert Huneault, CET

This article is part one in a series of articles on thyristors. In this part, we will focus on SCRs. Part II will describe diacs and Shockley diodes.

Most consumer electronics technicians have encountered thyristor circuits such as the one shown in Figure 1, in which a silicon-controlled rectifier (SCR) is used as a simple switch. In this case, it turns the FM stereo lamp on or off, depending on whether or not a stereophonic station is tuned in. Today, the switching function is usually performed within a multiplex decoder IC and the stereo lamp is commonly replaced by an LED indicator. The simple discrete circuit in Figure 1 was chosen to introduce thyristors and illustrate the fact that they are basically switches — contactless solid-state switches.

In this example, when the receiver is tuned to an FM stereo station, the 19kHz pilot (part of the composite stereo signal) is converted into a 38kHz signal by a frequency doubler and boosted by tuned amplifier Q1. The 38kHz subcarrier is then coupled through C1 to the gate of the SCR. As long as the 38kHz pulses are present at the gate, the SCR is triggered on (switched into conduction) during each positive alternation of anode voltage supplied by power transformer T1. This causes the lamp to light up. When the receiver is tuned to a mono station or between stations, there is no pilot signal; hence no 38kHz subcarrier is applied to the gate of SCR1. In the absence of gate pulses, the SCR switches off even though 60Hz ac voltage continues to be applied to the anode. Thus, no current flows through the stereo lamp.

Troubleshooting this particular circuit should be quite simple. If the FM stereo lamp doesn't light up even though stereo reception is normal, suspect the lamp first. If it's OK, an open C1, open R2 or open T1 winding are likely candidates, as well as a defective SCR. What if the SCR becomes internally shorted, anode to cathode? The stereo lamp will be on permanently, of course.

Huneault is an electronics instructor and head of the REE department at St. Clair College of Applied Arts & Technology in Ontario, Canada.

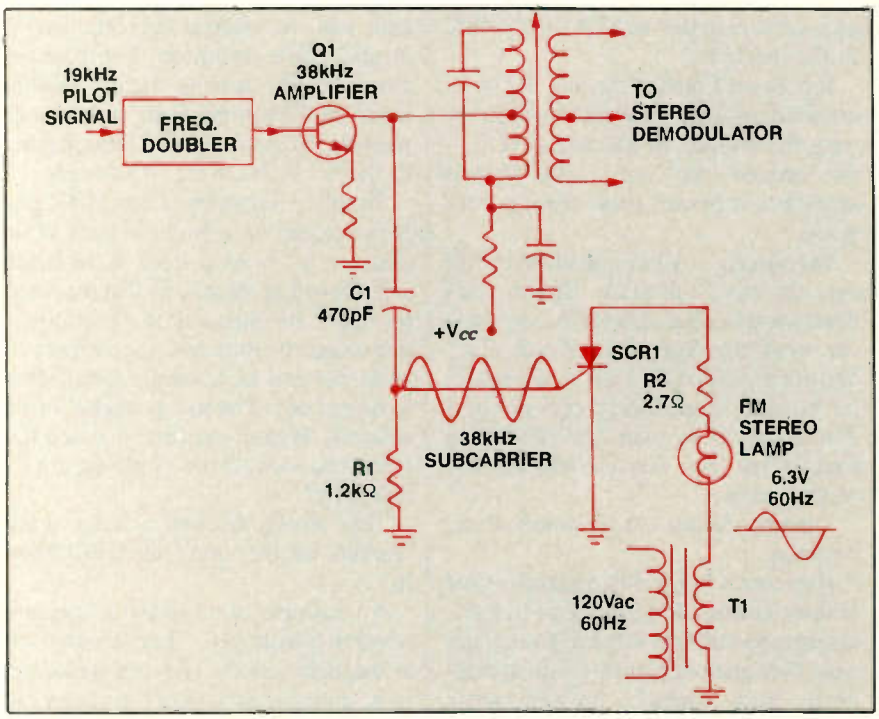


Figure 1. In thyristor circuits, an SCR can be used as a simple switch — in this case, to turn the FM stereo lamp on or off, depending on whether or not a stereophonic station is tuned in.

Thyristors galore

Welcome to the world of thyristors. The SCR discussed above is just one member of the large thyristor family, which also includes such devices as the triac, silicon-controlled switch (SCS), programmable unijunction transistor (PUT), gate turn-off switch (GTO), light-activated SCR (LASCR) and others. Often referred to as PNPN switches because of their multi-layered semiconductor construction, thyristors even include, in a generic way, 2-terminal trigger devices such as diacs and Shockley diodes.

In this and subsequent articles, we'll survey the field of thyristors, discuss their principles, characteristics and ratings, and illustrate each type with practical examples. We'll also mention testing methods and consider the effects of thyristor failures in specific circuits.

Thyristors defined

To get things going, we should perhaps ask one question: What is a thyristor? Essentially, it's a bi-stable switching device that features latch-on characteristics equivalent to those of its predecessor, the thyratron, from which the name thyristor was derived.

Old-timers undoubtedly remember the thyratron, a hot-cathode, gas-filled tube in which a control electrode (grid) determines the conditions for ionization of the gas. Thyratrons were widely used in industrial electronics before the advent of their solid-state counterpart, the SCR. Today thyristors are found everywhere: in radios, TV receivers, audio and videotape recorders, computers, electrical appliances, CD players, power tools, battery chargers, lamp dimmers, ignition systems, microwave ovens and more.

Technicians should not lose sight of

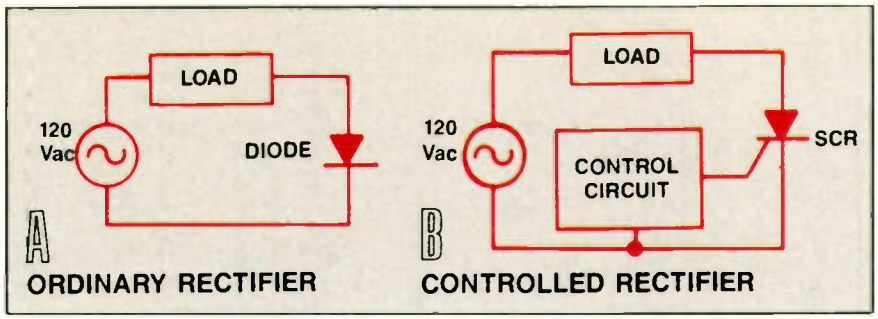


Figure 2. When used in an ac circuit, the silicon device is a rectifier, but unlike an ordinary diode, it is a controlled rectifier. In Figure 2A, which features a simple silicon diode rectifier, we have no control over the average current flowing through the load. In Figure 2B, however, the control circuit connected between gate and cathode of the SCR has the ability to vary the device's duty cycle and thus the average value of load current.

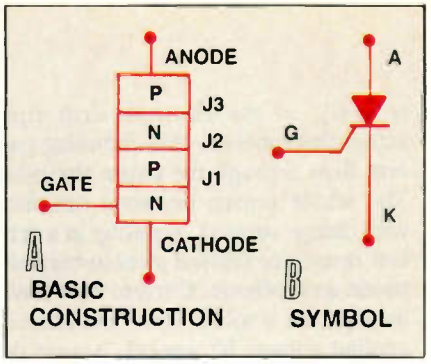


Figure 3. The SCR is a 4-layer, 3-terminal device featuring three semiconductor junctions (J1, J2, J3).

the fact that, whether they are used as rectifiers, relays, logic elements, oscillators, heat controllers, timing devices, protective elements, power-supply regulators or motor-speed controllers, thyristors are still essentially on-off switches. They have two stable states, acting as open circuits capable of blocking applied voltage until triggered. When triggered on, they become closed switches (very low impedance) and continue to conduct even after the trigger is removed (latching feature).

Although some thyristors have maximum current ratings of only milliamps, others can control whopping amounts of current, as high as a few thousand amperes. And they come in a variety of packages: small, medium, large and jumbo.

Before examining specific types, a brief comparison is in order. Thyristors differ from bipolar junction transistors in that the latter are variable resistance devices — the resistance between emitter and collector can be varied gradually by changing the amount of base current. Thyristors, on the other hand, are either completely off or fully on, with no in-betweens. That's why they are switches, not linear amplifiers.

SCRs: The thyristor family's grandpa

We'll begin our study of thyristor devices with the granddaddy of them all, the silicon-controlled rectifier (SCR). Although some sources credit Bell Telephone Laboratory engineers with having first introduced the SCR in 1956, others suggest that it was first produced by the General Electric Company in 1957. Regardless of its birthplace and age, the SCR ushered in a new era in control electronics and generated numerous offspring along the way.

Its name was well-chosen. When used in an ac circuit, the silicon device is indeed a rectifier, but unlike an ordinary diode, it is a controlled rectifier.

Figure 2 illustrates the concept. In Figure 2A, which features a simple silicon diode rectifier, we have no control over the average current flowing through the load; it's strictly determined by Ohm's law (I=V/R). In Figure 2B, however, the control circuit connected between gate and cathode of the SCR has the ability to vary the device's duty cycle (duration of conduction in each power-line cycle) and thus the average value of load current.

To understand just how this control is achieved, it's necessary to become familiar with the fundamentals of SCRs. We'll study this device in a fair amount of detail to gain a solid understanding of thyristor concepts. Subsequent types will be discussed much more briefly, because they're all based on practically the same principles.

SCR basics

Figure 3 shows that the SCR is a 4-layer, 3-terminal device featuring three semiconductor junctions (J1, J2, J3). The simplest way to illustrate the operation and characteristics of this PNPN device is to hook it up in dc circuitry, as shown in Figure 4.

With no voltage applied to the gate, it makes no difference whether we apply forward or reverse voltage between anode and cathode — the SCR remains in the blocking state (open switch) either way. We can see why by examining the polarity of junction voltages. In Figure 4A, the dc voltage applied across the device reverse-biases junction J2 (positive on the N-side and negative on the P-side of the junction). The reverse-biased junction naturally behaves like an open circuit; no current (other than a negligible amount of leakage) can flow through that gap. It should be noted in passing that if the anode voltage were increased sufficiently to exceed the device's forward breakover voltage rating, an avalanche condition would occur and the thyristor would conduct. However, this situation is normally avoided in SCR applications.

Reversing the polarity of applied voltage, as in Figure 4B, doesn't help because we then have two reverse-biased junctions (J1 and J3); obviously no current can flow. So, in both cases, the SCR remains in a non-conducting state, just like an open switch. Because no current flows, the load drops 0V. Thus the full applied voltage (100V) appears between the anode and cathode terminals of the SCR.

Now, let's get down to business. Figure 4C shows what we have to do to initiate conduction. With forward voltage still applied between anode (+) and cathode (−), a forward-bias voltage (V_g) is also applied across the gate-to-cathode junction (J1), resulting in gate current (I_g). R_g limits this gate current to a safe value. (Note: Arrows indicate electron flow.)

Foreigners get in on the act

To see how this action turns on the SCR, compare Figure 4A and Figure 4C. In Figure 4A, no conduction was possible because the majority carriers in the P-region below J2 are holes (positive charges), and these are repelled by the positive voltage above J2; thus no charge carriers cross the reverse-biased junction. But in Figure 4C, V_g tricks the majority carriers (electrons) from the cathode's N-region into crossing J1 into the P-type gate region. In other words, negative charges get injected into the gate, where they become foreigners in P-land! Although some electron-hole recombinations do occur and result in a certain amount of gate current, the gate quickly becomes overpopulated (saturated) with these foreigners. And here's the crux of the whole thing: The positive voltage (from V1) on the other side of J2 looks pretty good to those foreigners (grass is greener on the oth-

er side), so the electrons drift right across that junction, thus initiating current flow through the entire thyristor. The whole device becomes saturated with charge carriers, resulting in a very low resistance (closed switch) between anode and cathode. Current now flows through the whole circuit, and most of applied voltage V1 appears across the load. The voltage across the thyristor drops to a very low value, typically 1V or so.

Note that the SCR is not a perfect switch. Unlike the 0V normally measured across the closed contacts of a mechanical switch, the small voltage across the terminals of a conducting SCR represents power dissipation. A volt or so may not seem like much, but if the current is heavy, the power dissipation can be considerable. For example, 1,000A at 1.5V represents 1,500W of heat. For this reason, SCRs must be heat-sinked well in heavy current applications. In typical home entertainment equipment, current is likely to be only a few amps, so the heat-sink requirements are less severe but still important.

Finally, see Figure 4D. Here we note that even though gate current is now interrupted by S1, the thyristor continues to conduct; this figure demonstrates the latching property of SCRs. Although gate current was necessary to initiate cathode-to-anode conduction, once the SCR is turned on, the gate loses control just like the grid does in a thyratron.

This situation brings up a good question: How can the SCR be switched off? There are three simple methods: interrupting anode current by momentarily opening the load circuit; reversing the polarity of applied voltage V1; and reducing the anode current (for example, by lowering V1) below the minimum value necessary to maintain conduction. This latter value, called *holding current* (I_t) is typically a few milliamperes in low-power SCRs.

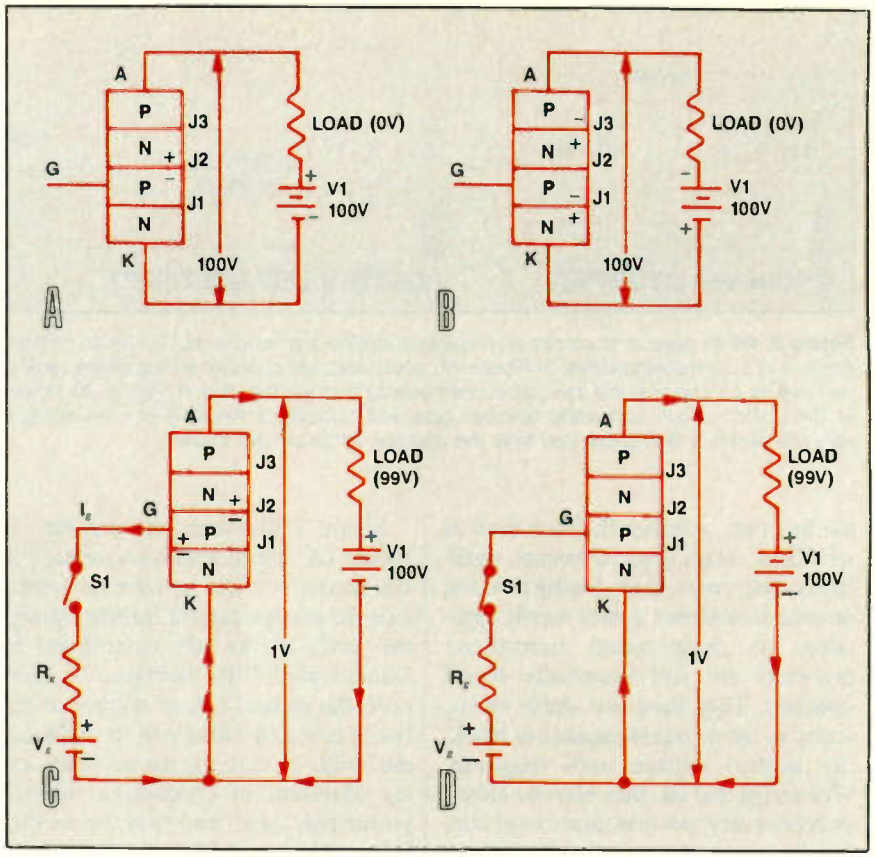


Figure 4. The simplest way to illustrate the operation and characteristics of this PNPN device is to hook it up in dc circuitry. In Figure 4A, we have forward A-K voltage and no gate voltage; the SCR is an open switch. In Figure 4B, we have reverse A-K voltage and the SCR is still open. In Figure 4C, forward-biasing the gate turns on the SCR. In Figure 4D, gate current is no longer needed once the SCR latches on.

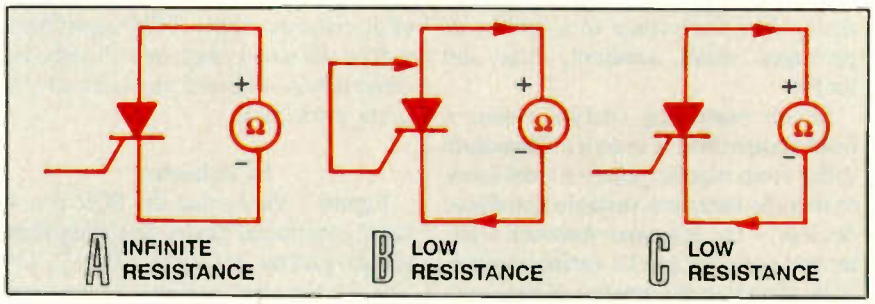


Figure 5. To illustrate a practical method of testing SCRs, connect an ohmmeter between the SCR's anode and cathode, with the polarity shown in Figure 5A. Note that the ohmmeter shows infinite resistance because, without the required initial gate current, the thyristor is essentially an open switch. If you touch the gate lead to the anode, as shown in Figure 5B, the ohmmeter shows low resistance. With positive voltage applied to the gate, the SCR fires. If you disconnect the gate as shown in Figure 5C, the ohmmeter continues to read low resistance, demonstrating the latching property of the SCR.

Testing an SCR

To reinforce and confirm the theory we just looked at and to illustrate a practical method of testing SCRs, a simple experiment is in order. All you need is a VOM and a low-power SCR rated at just a few amps — the kind most likely found around the shop. Switch the VOM to the R×1 range of the ohmmeter function, and ascertain the polarity of its leads. Remember that the red lead is not always the positive one.

Connect the ohmmeter between the SCR's anode and cathode, with the polarity shown in Figure 5A. Leave the gate terminal open. Note that the ohmmeter shows infinite resistance, confirming that without the required initial gate current, the thyristor is essentially an open switch. Actually, the SCR's internal resistance is not really infinite because of a small amount of leakage, but the leakage is so small that the ohmmeter virtually shows infinite resistance. If it reads low resistance, the SCR is either shorted or extremely leaky.

Next, keeping the ohmmeter leads where they are, touch the gate lead to the anode, as shown in Figure 5B. Note that the ohmmeter now shows low resistance, confirming that with positive voltage applied to the gate, the SCR fires (switches into conduction). If it doesn't turn on, throw it away.

Finally, disconnect the gate as shown in Figure 5C. The ohmmeter continues to read low resistance, demonstrating the latching property of the SCR. Incidentally, the gate doesn't have to be left connected for any length of time to initiate conduction because it takes only a microsecond or so for an SCR to switch on. That's why, in many practi-

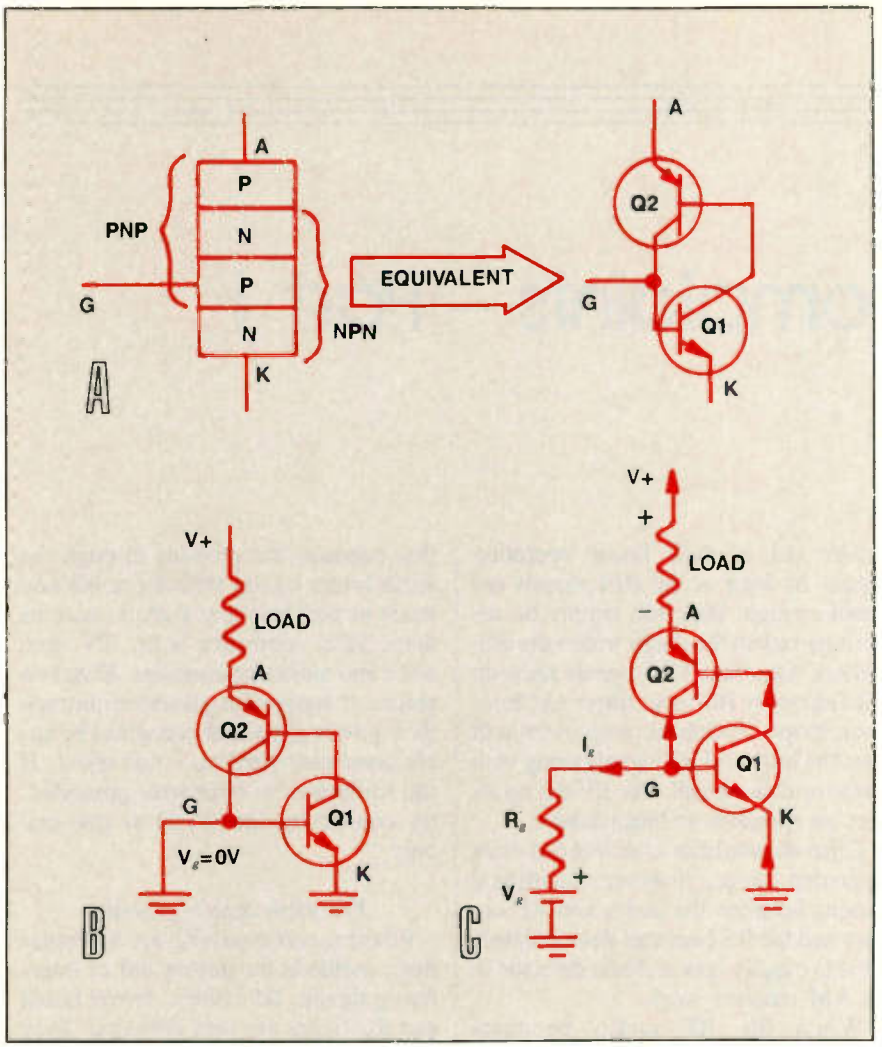


Figure 6. One way to visualize an SCR is as consisting of a pair of interconnected complementary transistors: a PNP (Q2) and an NPN (Q1), as shown in Figure 6A. Figure 6B shows that, with gate voltage, the SCR is off. In Figure 6C, the voltage applied by the V_g source initiates a rapid regenerative action, which latches the SCR on.

cal circuits, gate control is achieved by means of very brief triggering pulses. Maintaining gate current longer simply wastes energy.

Now, if you temporarily open the anode circuit and then connect the SCR as in Figure 5A again, it will be obvious that the thyristor has reverted back to its blocking state (infinite resistance) because the anode current was momentarily allowed to drop below the *holding current* value.

Note that although low-power SCRs will respond nicely to this testing method, high-power SCRs may not. Large SCRs with current ratings of tens or hundreds of amps may not stay latched on after the gate is disconnected because, in order to latch on, these SCRs need more current than the ohmmeter can supply. That's why we suggested switching the ohmmeter to its R×1 range: Higher ranges such as R×10,000 usually introduce so much series resistance that the latching current cannot be supplied.

Let's get a little more formal

If all that jazz about electrons becoming foreigners in P-land didn't exactly turn you on, perhaps we need to get a little more formal in our explanation of SCR action. An entirely different but helpful approach is to visualize the SCR as consisting of a pair of interconnected complementary transistors: a PNP (Q2) and an NPN (Q1), as shown in Figure 6A. The base of the PNP transistor is also the collector of the NPN; likewise, the base of the NPN (SCR gate) is also the collector of the PNP.

In Figure 6B we can see that with 0V applied to the gate terminal (equivalent to the gate being grounded) no base current flows in Q1; therefore, Q1 is off. No collector current through Q1 means no base current for Q2; therefore, Q2 is also off and no current flows through the load.

Now look at Figure 6C. The voltage applied by the V_g source causes base current to flow in Q1 and the NPN transistor turns on. Q1's collector current

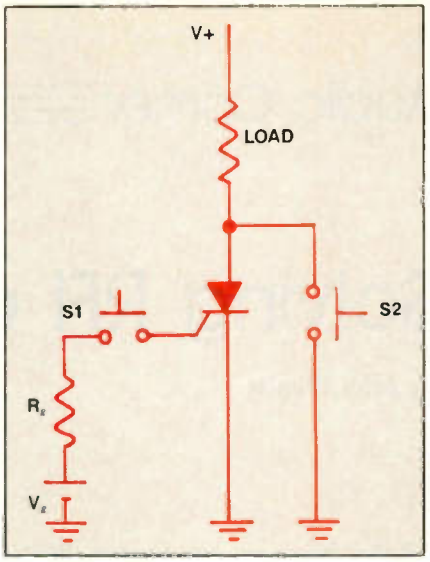


Figure 7. When S1 is closed momentarily, a pulse of gate current flows and the SCR latches into conduction. If S2 is then closed briefly, load current is shunted around the SCR, and anode current drops below the minimum I_H value, causing the thyristor to switch off.

flows into the base of the PNP transistor and is sufficient to turn it on. As Q2 turns on, its collector current results in increased base current in Q1. The result is more Q1 collector current and more base current for Q2, and so on. The net result is that when V_g is applied, the collector current increases in both transistors, and the cathode-to-anode impedance of the whole thyristor becomes very low (equivalent to a closed switch). The load is therefore energized.

Subsequent removal of V_g doesn't turn off the thyristor because of the regenerative feedback action just described. The regeneration will be sustained as long as the anode current is not allowed to drop below the I_H value.

Whether you understand this 2-transistor-equivalent explanation or prefer the foreigners-in-P-land analogy, we can sum it all up with Figure 7, which clearly illustrates simple on-off control of an SCR in a dc circuit.

When S1 is closed momentarily, a pulse of gate current flows and the SCR latches into conduction. If S2 is then closed briefly, load current gets shunted around the SCR, and anode current drops below the minimum I_H value, causing the thyristor to switch off. The circuit action just described is quite fast. It occurs even if the pushbuttons are tapped only briefly because it takes only one or two microseconds for the SCR to latch on and perhaps 25μs or so to turn off.

In a future article, we'll discuss SCRs in ac circuits where the thyristor can actually control the amount of load current, in addition to rectifying the ac.■

Solving RFI complaints – Part I

By John Shepler

Radio frequency interference (RFI) can be one of the biggest headaches you will encounter when you're servicing audio components. Equipment that works perfectly in the shop will suddenly glitch, distort or conjure up mysterious voices when installed. Worse, the problems seem to come and go.

RFI infects radios, TVs, guitar amplifiers, intercoms and church PA systems with extraneous noises. Even lamp dimmers, computers and industrial equipment can be affected. Any equipment in strong electromagnetic fields, such as radio or TV transmissions, is vulnerable. By understanding the causes and cures of RFI, you can make your present customers happy, plus pick up extra income solving these problems when others have given up.

What causes RFI?

A typical complaint is that the customer can hear weak voices in a home intercom or stereo system. Upon investigation, you find that the house is within two blocks of a radio station antenna. A few feet of wire connected to an oscilloscope input shows a signal strength of 1V to 10V.

Such a strong signal literally overwhelms the small signal amplifiers within the intercom. The power cord or multiconductor cable acts as an antenna to pick up the signal. If the intercom's case is not a complete metal box, even switch wiring or pc foil traces will act an antennae.

The same intercom in a house several blocks further from the station also picks up the signal. However, no interference is audible. Why?

The problem arises only when the op-amps or transistors in the intercom are driven out of their linear operating range. As long as the RFI signals are small enough, they will simply be superimposed on the audio within the amplifiers. Most small RF signals are soon filtered out by RC input filters and feedback loops. Wideband amplifiers will pass the low-level RF signals along with audio or data signals. The RF has no effect on speakers or headphones.

Once an amplifier is driven out of its operating range, however, non-linear mixing between the audio and RF occurs and the RF becomes demodulated. This is exactly how a diode detector in an AM receiver works.

When the RF audio becomes demodulated, it mixes with the intended audio, and it is impossible to separate the two. The only solution is to go back and attenuate the RF signal so that it no longer is strong enough to be detected.

Grounding and shielding

An easy and inexpensive solution is to get rid of the antenna effect by shielding and grounding the equipment. Sometimes you can just connect the ground wire from a turntable to an amplifier. For a problem in the intercom, a ground wire from the case to a cold-water pipe might do the trick.

Shielded cable with the braid grounded to the equipment prevents long runs of signal wire from picking up RF signals. Installing shielded cable makes more sense when the wiring is accessible than when replacement cables have to be pulled through walls.

One simple measure is to coil up unused wire or power cord. On some computer equipment, wrapping aluminum foil around the loose power cords is enough to stop data glitches.

Be especially careful of ground loops. A ground loop is created anytime both ends of a cable are grounded. The path that connects the grounds through the earth forms a loop with the cable and tends to pick up stray signals, such as hum, SCR controller buzz, TV sync noise and radio transmissions. Even two pieces of equipment grounded through their power plugs and connected by cable braid can experience this effect. If the equipment is otherwise grounded, try connecting the shield at one end only.

Filtering and bypassing

Filtering and bypassing are the brute-force methods for getting rid of interfering signals. RF chokes, ferrite beads and RC filters are very effective. They can be installed directly in the circuits or at the inputs and outputs of the equipment.

Many filters are available commercially. Most of these are inductor-capacitor filters that are specifically designed for telephone lines, power strips, coaxial or twin-lead TV cable, even phono inputs. Computer components are often called EMI (electromagnetic interference) rather than RFI filters. Check your distributors or catalogs for these.

The simplest filter is a common ceramic capacitor. For the intercom problem, you might get rid of the RF signal by installing some 100V, 0.001 μF ceramics from each screw terminal to the case or ground terminal. The capacitor value will vary. Smaller caps — 100pF or less — are useful for FM and TV interference. Larger caps — 0.001 μF to even 0.01 μF — are needed for AM signals. Make sure you use caps with high enough voltage ratings. A supply of 100V and 500V disks will cover most situations. Low-voltage disks are useful for speaker cables.

Next month, we'll talk about additional filtering you can try if the problem persists despite these corrections. ■

Shepler is an electronics engineering manager and broadcast consultant. He has more than 20 years of experience in all phases of electronics.

Those hexadecimal numbers

By Conrad Persson

One of the difficulties of servicing personal computers is that the servicing literature often refers to numbers in hexadecimal form rather than decimal or binary. There are actually very good reasons for using hexadecimal numbers. Binary is not a very good number system to use in any case because, by the time you get to the binary equivalent of the decimal number 16, you're up to four digits. By the time you get to the binary equivalent of 32, you've reached five digits. In fact, every time you double the decimal number again, you add another binary digit — 64 is six digits, 128 is seven digits, etc.

Decimal numbers can also be unwieldy. It's not really practical to give hexadecimal address locations, for instance, in decimal, because decimal numbers don't express the relationships of locations to each other as do hexadecimal numbers.

Here's a brief explanation of how hex and binary numbers relate to decimal, and a table of the decimal, binary and hex numbers through 64.

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

Binary numbers

Binary numbers use only numbers that comprise the digits 1 and 0. Binary numbers are used in computer calculations because digital electronics is based on two conditions of an electronic circuit: on or off. Any other system used to encode numbers would be subject to ambiguity because it would rely on a continuum of voltages rather than on two distinctly different states.

As in our decimal number system, the rightmost digit in a binary number is the smallest digit. Counting in the binary system proceeds as follows: 1, 10, 11, 100, 101, 110, 111. Note that because there is only one digit other than zero in the binary system, each place farther to the left that a digit (1) occupies causes its value to be doubled. Thus the binary number 1 is the same as the decimal number 1. The binary number 10 is the same as the decimal number 2. The binary number 100 is the same as the decimal number 4.

The binary number 111, therefore, consists of one 4, one 2, and one 1, and is therefore equivalent to the decimal number 7.

Hexadecimal numbers

Computers don't actually use hexadecimal numbers as some people suggest. They use only binary numbers. There is a neat correlation between hex numbers and binary numbers that makes it simpler for humans to handle such numbers in hex notation rather than in binary. Keep in mind that the binary equivalent of 255 is 11111111. You don't have to try to handle too many numbers like that to get confused. The hex equivalent of that same number is the neat FF.

Hexadecimal numbers (numbers to the base 16) count to 15 using a single digit: 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. Thus in the hex system, the number 10 is one greater than F, and is equivalent to 16 in decimal.

Try counting to the decimal equivalent of 15 in both binary and hex. You will find, if you do it right, that one digit in hex can be used to represent the same quantity as can be expressed by four digits in decimal.

Figure 1 lists the decimal numbers from 1 to 16, with both the binary and hexadecimal equivalents. ■

Number system equivalents

Decimal	Binary	Hexadecimal
1	00000001	01
2	00000010	02
3	00000011	03
4	00000100	04
5	00000101	05
6	00000110	06
7	00000111	07
8	00001000	08
9	00001001	09
10	00001010	0A
11	00001011	0B
12	00001100	0C
13	00001101	0D
14	00001110	0E
15	00001111	0F
16	00010000	10

Figure 1. This table shows the decimal numbers from one to 16 and the binary and hexadecimal equivalents. Note that in each case the rightmost four digits of the binary number is the exact equivalent of the rightmost digit of the corresponding hex number, and the leftmost four digits of the binary number is the exact equivalent of the leftmost digit of the corresponding hex number.

Video Corner

The amplifier as a troubleshooting aid

By Stephen J. Miller

Time-saving techniques can be real lifesavers in the service industry, especially if you, like me, are accustomed to eating regularly. This month, we will look at a simple amplifier that has saved me countless troubleshooting hours on many types of A-V equipment.

Buy or build?

This amplifier is available already assembled from Radio Shack (part number 277-1008C). A similar amplifier could be constructed from scratch, but because of the low price of the commercial item, a home-brewed device would probably be more expensive. However, don't let its low price fool you; it can be invaluable when properly used. It is battery-operated, so it can be safely connected to even hot ground circuits without an isolation transformer. This feature is extremely helpful when you are servicing out in the field.

Miller is a senior bench technician for a Lancaster, PA, repair company.

The amp's internal speaker allows you to listen to the amplifier input signal. An earphone jack permits the output signal to be coupled to either headphones or another device. This amp can be used to check the audio output on any type of equipment: phono cartridge outputs, tape deck outputs, FM tuner outputs or about any type of audio signal you can think of. However, don't think of it as just an audio amplifier. Rather, consider it an amplifier of all frequencies from 30Hz to 30kHz. With a slight modification, which will be discussed in detail later, this amplifier starts with a gain of 700 at 30Hz, rises to a gain of more than 800 at 8kHz, and still has a gain of 300 at 30kHz. This device can amplify any signal within this frequency range. The signal need not be an audio signal. In fact, it has been most useful to me in amplifying non-audio signals. An example will demonstrate its usefulness.

A frequency-selective pre-amp

A dog of a portable VCR was making the rounds at the shop. The GE model number of the miniature nightmare was ICVD 5021X. When the unit played an SP tape, it would alternate between a clear picture and total snow. On an EP tape, the unit would not speed-select properly — EP tapes would play at the SP speed with rapidly moving video and "chipmunk" audio. Several technicians had looked at the VCR, and everyone had agreed that the playback servo problems were due to a missing control track (CTL) pulse.

The control track pulse is a 30Hz signal, which is derived from the vertical sync signal and recorded on the bottom edge of the tape. During playback, these pulses are used to phase-control the capstan motor, thus producing a noise-free picture. Also, by monitoring the frequency of the CTL signal, the system-control circuit can select the correct playback speed (SP, LP or EP). Many units, including this GE, will default to the SP playback speed if no CTL pulse is present.

Figure 1 shows the control-pulse amplifier circuit. All dc voltages on IC2003 were correct. Likewise, all external components coupling the CTL signal into the IC were OK. Yet, even after IC2003 was replaced, no CTL signal was present at TP2008.

Could the CTL head be defective? It seemed that this head was the only remaining suspect. However, it did have continuity, and it did not have any leakage to ground. Furthermore, tapes recorded on this machine played fine on other VCRs. Therefore, the CTL head was capable of correctly recording pulses. Because the CTL head is part of an assembly, it is fairly expensive and we were reluctant to order a new one without proof that it was our culprit. The question was how to test the head.

I tried to scope the incoming signal

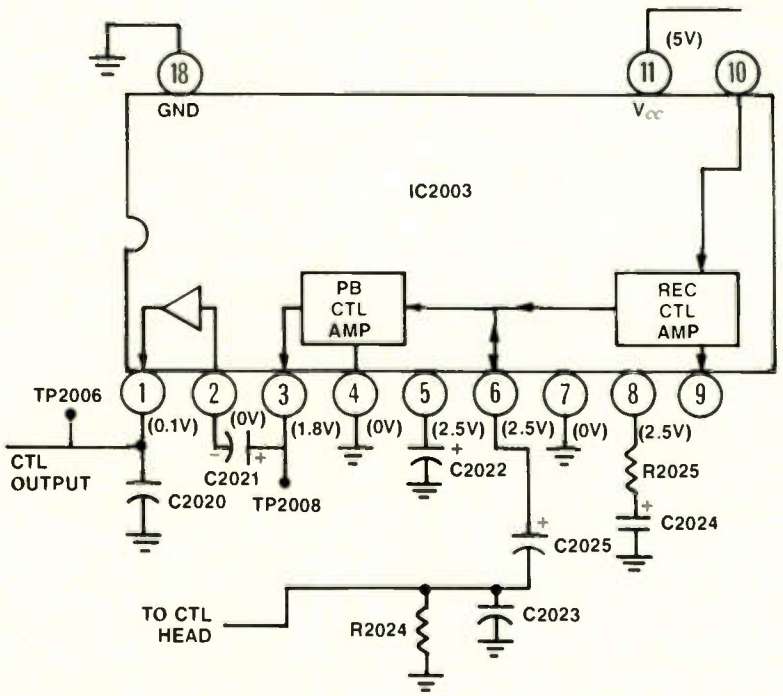


Figure 1. The CTL pulse is derived from the vertical sync signal and recorded on the bottom edge of the tape. During playback, these pulses phase-control the capstan motor, producing a noise-free picture. The frequency of the CTL signal tells the system-control circuit which playback speed to use.

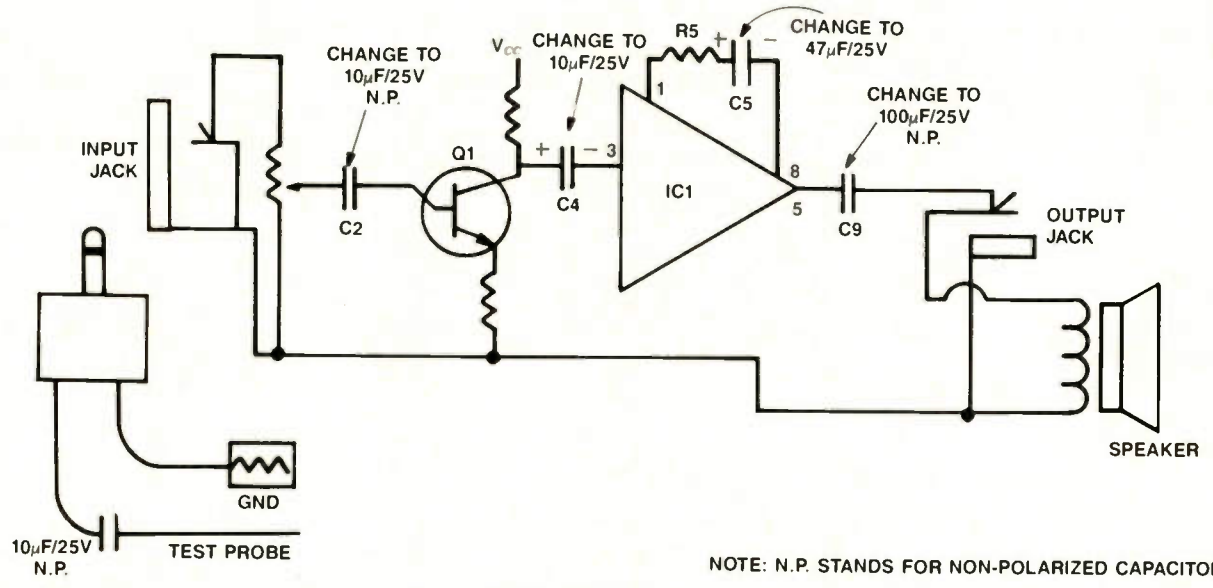


Figure 2. The low-frequency response of the Radio Shack 277-1008C mini-amp can be lowered by increasing the values of three capacitors.

from the CTL head, but even with the scope's gain cranked up, all I could see was a screen full of hash. It seemed the CTL head was acting as an antenna and coupling all types of RF noise into the scope. Because the scope is an extremely wide-band device, it amplified and displayed all this noise on its screen. What I needed was a frequency-selective pre-amp to amplify and clean up the signal before it was input into the scope. Such a scope accessory is available, but I didn't have one. Being frugal (all right, cheap), I began to look for a substitute pre-amp. Realizing that the CTL signal is only 30Hz, I thought of the Radio Shack mini-amp.

Altering the amplifier

Unfortunately, the manufacturer's quoted low-frequency response was 100Hz. I wondered if this frequency could be easily lowered. Looking at the schematic inside the unit's case, I realized that increasing the values of three capacitors would do the trick. (See Figure 2 for the modifications.) If R5 is not present in your unit, be sure to add it when you increase C5 to 47μF. The capacitor from the volume control to Q1 should be a non-polarized capacitor.

Likewise, if the mini-amp is to be used to drive another circuit, the output capacitor, C9, should be changed to a non-polarized type. With the original capacitor in the output circuit, you can use the mini-amp to drive another circuit as long as its input voltage is less than 4Vdc. If the input voltage is greater than 4Vdc, C9 will be reverse-polarized. By changing C9 to a non-polarized type, this restriction is removed. Several versions of this mini-amp have been marketed, so parts placement and component call-outs may vary. However, by following Figure 2, you can locate the correct components.

Troubleshooting with the amp

Having modified the mini-amp, I connected it across the CTL head and put the VCR into play with an SP tape. Much to my surprise, I heard a low-frequency tone, much like a cat's purr, coming from the amp's speaker. Connecting the output of the amp to the scope displayed a beautiful, perfectly normal CTL pulse. The mini amp helped me prove that the CTL head was OK, but I still didn't know what was wrong with this GE VCR.

After entering at pin 6 on IC2003, the CTL signal is amplified, exits on pin 3 and re-enters this IC on pin 2. Could I inject the mini-amp's output signal into pin 2? I thought it was worth a try. With the power off, I connected the amp's output between pin 2 and ground. Because the amp contains an internal blocking capacitor in the output circuit, no external coupling capacitor was needed.

Powering up both the amp and the VCR and adjusting the amp's volume control, I found that the VCR worked normally. Servo lock, speed select and tracking control functions all operated properly. Therefore, the problem had to be in the circuitry before pin 2 but after the CTL head input.

With renewed determination, I decided to recheck all the discrete components and the wiring interconnections around IC2003. About ten minutes later, I had the VCR repaired. After checking numerous components, I discovered a microscopic break in the foil between R2025 and pin 8 of IC2003. Although the IC's block diagram doesn't show that pin 8 is part of the playback CTL amp, it obviously is. Bridging this foil was all it took to complete the repair.

Using the mini-amp was a great help in troubleshooting this VCR. First, I verified that the CTL head was OK. Second, by injecting the amp's output back into the VCR, I verified that a large part of the machine was OK, narrowing down the possible problem areas. Without the amp's assistance in narrowing the search area, the problem would have been extremely difficult to find.

Next month, we will detail other uses for the mini-amp. In the meantime, give it a try. It can be extremely useful in amplifying all types of waveforms within the range of 30Hz to 30kHz. Just remember, although the mini-amp does have an internal dc blocking capacitor in its output, it does not have an internal input blocking capacitor. However, an external input blocking capacitor can be connected in series with the center conductor of the input cable. ■

Continued from page 23.

G27149TKC01, G27250CPC01, G27251TNC01, G27255NPC01, G27259HPC01, G27340CKC01, G27350CPC01, G27360GMC01 (CH. CTC140AD/AJ)

2715-2 ..... F20580WNN01, F20581EGN01, F20583MKN01, F20590HGN01, F20591EGF01, F20595BHN01, F20597AKN01 (CH. CTC148P)

Sears

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2712-2 ..... KV-27DS20/21/22/23/24 (CH. SCC-A81S-A/T-A/U-A/V-A/W-A)

Sylvania

2711-2 ..... CLH242PE01/246PE01, RLH342PE01/346PE01, RLH350AK01, RLH351AK01/AL01, RLH353HP01, RLH355PE01, RLH910AK01, RLH912PE01, RNH352AK01/354HP01/356PE01, RNH601WA01/611CH01, RNH921AK01/926AK01, RNH937PE01/938PE01 (CH. 25B104/106/107/110)

2713-2 ..... RNH372AK01/375HP01/378PE01/613CH01/957PE01/958AK01/980AK01/982PE01, RPH540AK01/542AK01/546PE01/590AK01/598PE01/713CH01/990AK01/995AK01 (CH. 26C902/904, 27C902/03/09/10)

2714-2 ..... CXH165WA01/2, RKH178WA01/2/3/4, RKH190WA01/2/3/4, RXH169WA01 (CH. 19B105/6, 20B103/5)

Toshiba

2705-2 ..... CF2655J/R, CX28409/519 (CH. TAC8910/13/15)

2706-2 ..... CF2628 (CH. TAC8811)

2707-2 ..... CF2033J, CX21319 (CH. TAC8901/7)

2708-2 ..... CX2657J, CX28579 (CH. TAC8912/17)

2709-2 ..... CF2041J, CF2044J, CX21419/49 (CH. TAC8900/05)

Zenith

2710-2 ..... D1920W, D3920W, D3930W, D3960W, SD1923W/W3, SD1925W, SD1995W/W3, SD3923W, SD3933W, SD3961Y, SD3961YH

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Magnavox picture tube 13VAKTC02, new or good used. *Devin Lynch, 423 N. White, Kansas City, MO 64123; 816-483-6281.*

Service manual for YORX model M2681 AM/FM stereo. Will purchase or copy and return. *Steve Beach, 1857 Carina Court, Rio Rancho, NM 87124; 505-892-8726.*

TUBES WANTED — receiving and transmitting tubes. Send your list for bid. New tubes in original boxes only. Also need radio IF XFMRS. *Antique Electronic Supply, 688 W. First St., Tempe, AZ 85281; 602-894-9503, Fax: 602-894-0124.*

Schematic and/or service manual for a Grundig model UC-440 car stereo with autoreverse cassette player and AM/FM/MPX radio. *John Phipps, 1412 Navaho Trail, St. Charles, MO 63303.*

Mitsubishi flyback, part number 334B07006, for model VS506U projection TV. *Charles Morgen, 646 Devon Drive, Nashville, TN 37220.*

Schematic — compt. ESP volt-syn-timer block, model 686-5067-00, manufactured by JCPenney, Japan. *WM. D. Browning, 311 Saipan, San Antonio, TX 78221; 512-923-7879.*

Part or source for 18-pin IC AM/FM frequency synthesizer, part number (SA)8X08N and (SA)8X18N (plastic DIP); or (SA)8X08F and (SA)8X18F (ceramic dip). Made by Signetics in late 70s to early '80s. Desperate! *Mike Kirk, 4502 Bluejay Court, Woodbridge, VA 22193; 202-822-2653 (work).*

New or used, discontinued Astatic model X-26 crystal cutting cartridge (recording head), need several. *Michael Ames, 7 Hyatt St., Cortland, NY 13045; 607-255-1941.*

Sams Photofacts — #2411-#2591. Will pay a reasonable price. *Jennings Hanson, 735 Clematis Road, Venice, FL 34293; 813-493-4159.*

Source for parts and schematics for OEM car stereos in Toyota, Nissan, Mazda and Honda automobiles. *Anthony Morganti, Amherst Electronics, 3243 Sheridan Drive, Amherst, NY 14226; 716-837-6601.*

Source for control-panel re-hab on Amana. Penneys microwave ovens and others not covered by known leaders in this business. *Charles M. Kelly, 3336 Chatham, Waukegan, IL 60087.*

B&K 747B tube checker; RCA/Zenith test jig; B&K 1248 color bar generator; waveform monitor; vectorscope; test equipment for A-V repairs. *Fax: 403-473-0931-11.*

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Sams Photofacts #1471-2039, $475; Eico 667 tube tester, $45. *Bruce McFarland, 220 Norman Ridge Drive, Bloomington, MN 55437; 612-835-3759.*

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Sams Books, all types, all numbers. *Loeb, 414 Chestnut Lane, East Meadow, NY 11554.*

Sencore VA62, 63, 64, EX231, $2,450; Tentel VHS gauge package. $1,250. *Bob Hendrickson, 5116 Hutchins St., Winston-Salem, NC 27106; 919-922-4571.*

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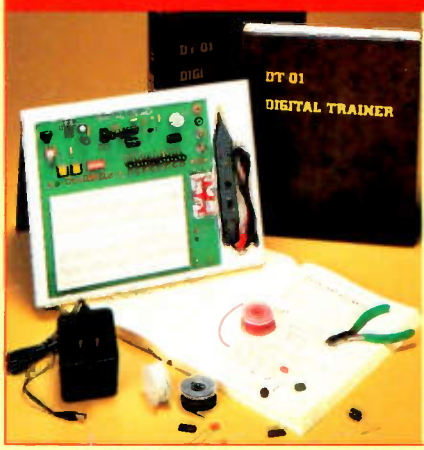

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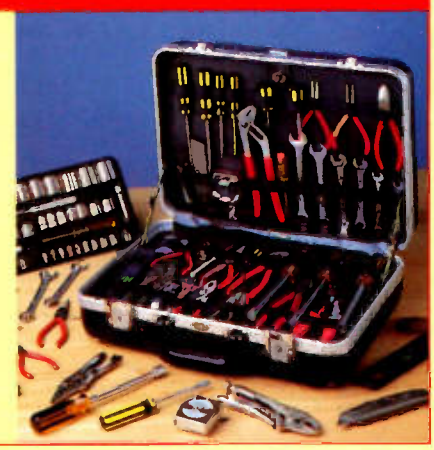

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