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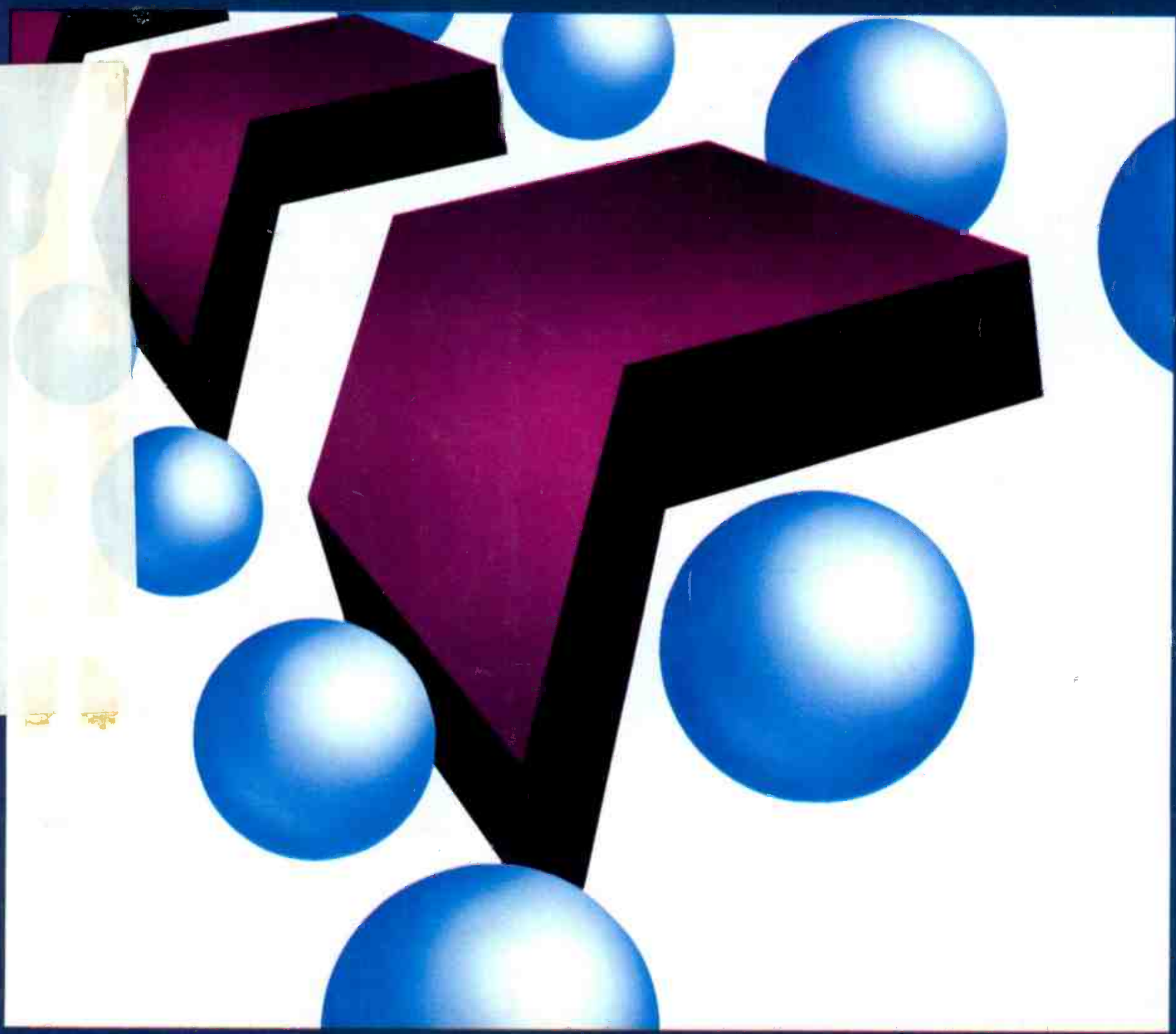

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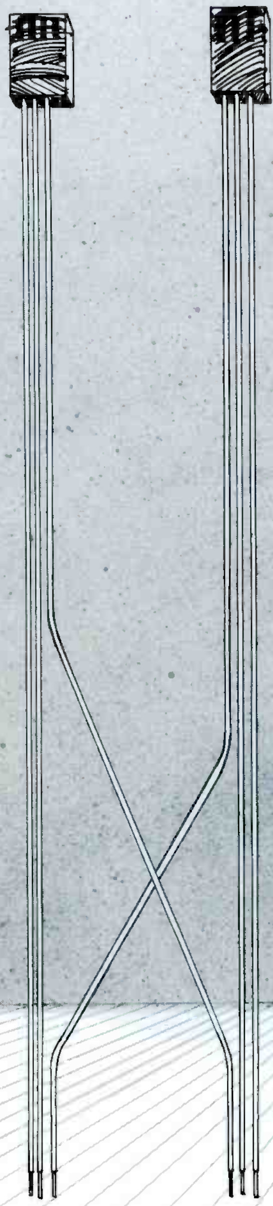

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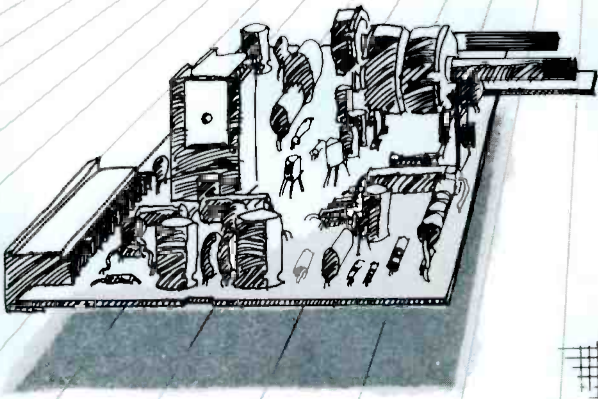

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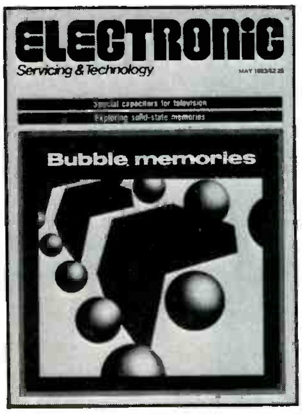
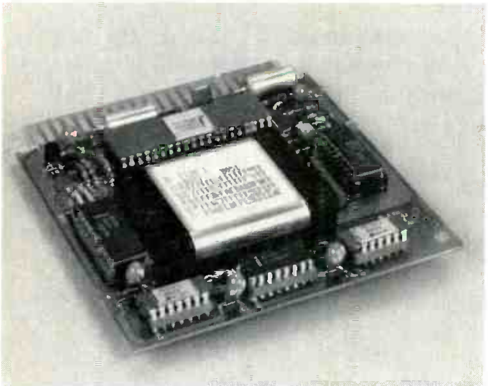
The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

May 1983
Volume 3, No. 3



Bubble memories may be the wave of the future in digital systems. They can sharply reduce size and weight, making a portable computer system practical, and they have increased memory capability, making the system more powerful and flexible. See article on page 10. (Illustration courtesy of Intel Corporation.)



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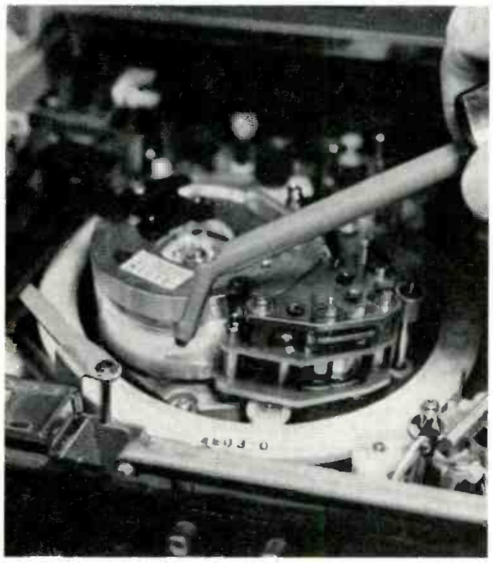

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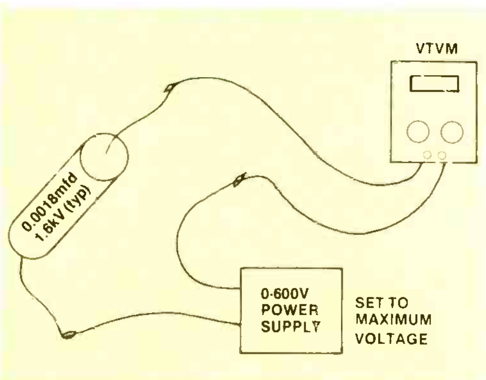

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Departments

Next month...

Video developments. Video has come a long way from the first small, monochrome televisions with limited programming. Today you can watch dozens of channels, 24 hours a day, on 40in projection TV screens, with stereo sound. But there is more on the horizon, as this article will explain.

Magnetic bubbles — a different kind of bubble

A bubble is a breath of air captured in a soap film. It floats lazily on a gentle summer breeze, turning the sunlight that falls on it into a rainbow of colors. It encounters a wall, a tree branch, a blade of grass and bursts, leaving only a wet mark and a memory.

A bubble is a tiny pinpoint of light that floats up through a glass of ginger ale, getting larger as it goes higher. When it reaches the surface, it pops, creating a spray of liquid that tickles your nose, and disappears without a trace.

The only thing that magnetic bubbles, as describes on page 10 in this issue, have in common with these more familiar kinds of bubbles is that viewed from one end, they have a circular cross section, so they resemble little bubbles of magnetism as they move along their tracks in a magnetic bubble memory.

They are different from the bubbles with which we are familiar in that they do not self destruct at random. In fact one of the useful characteristics of magnetic bubble memories is that they are non-volatile. That is, even if their souce of power is removed, every bit of information is retained.

But magnetic bubble memories have several other desirable characteristics. For one, they have no moving parts. This feature gives them extremely high reliability as compared to a magnetic tape or disc drive that has parts that can wear or break. They are also lightweight and consume relatively small amounts of power. Because of these characteristics, magnetic bubble memories are finding a natural niche in portable data terminals, particularly for use in newspaper work.

Magnetic bubbles are not entirely without shortcomings, however. One drawback is their relatively slow speed. Although they are competitive with floppy discs, they can't compete with random access memory. Another concern about these new memories is long term stability. Several conditions, such as extreme cold, magnetic pulses or static electricity can cause problems for bubble memory devices.

In spite of these problems, the advantages of bubble memories suggest that they will be showing up more and more in digitally based equipment. Keep your eyes open for them.

Your comments are welcome.

Your responses to questionnaires have been extremely helpful. Letters, notes and cards have come in suggesting that we publish articles on particular subjects. We have made notes of those, and we're taking action to fill those requests.

We're trying to make it easier for you to give us your comments. If you're going to be filling out a reader service card to request more information about any of the new products or literature presented in this issue, please note that the address side of the card contains a box marked "Editorial Comments." That's our invitation for you to share your thoughts about **ES&T** (and electronics in general) with us. Is there something about this issue, or an article in particular, that you like and would like to see more of? Please let us know. Is there something you don't like? Let us know that too.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

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Technology

Superchips provide power in small packages

Hewlett-Packard has announced the HP 9000 family of 32-bit computers. Intended primarily for computer-aided engineering applications, the HP 9000 family features models with up to three CPUs, Ethernet-compatible and HP networking, and a choice of UNIX* or BASIC operating systems. Individual 32-bit workstation prices range from $28,250 to $64,565.

The computer's power, small size and relatively low price were attained by a significant advance in VLSI circuit technology. A 5-chip set of ICs is the nucleus of each HP 9000. These "superchips" pack up to eight times more circuits into the same space as currently available ICs.

"This revolutionary technology has enabled us to make a dramatic breakthrough in the evolution of scientific computing," said Douglas C. Chance, HP vice president and general manager of HP's Technical Computer Group. "Our fundamental contribution is that we've made super-minicomputer power affordable enough that each scientist and engineer can have his or her own 32-bit computer.

"Our leading-edge customers and distinguished computer scientists have predicted that the future of scientific and engineering computation is going to be based on the concept of 'one engineer, one mainframe.' They universally agree that a network of these extremely powerful personal computers will solve technical problems far better than large, centralized machines shared by multiple users."

Chance said that programs are so large, complex and computation-intensive in today's scientific and engineering environment that the traditional approach of dividing the power of an expensive, centralized mainframe

Article and photos courtesy of Hewlett-Packard.

*UNIX is a trademark of Bell Laboratories.

The HP 900 family of 32-bit computers includes desktop-sized workstations priced so that Individuals can have their own mainframes.

The five superchips in the foreground are the nucleus of each model in the HP 9000 family. The chips are mounted on boards that fit into a lunchpail-size module, which in turn is the basic power package inside the computer.

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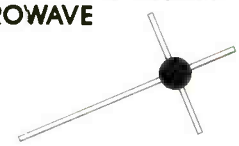

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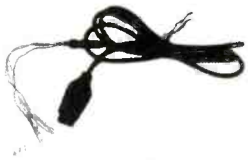

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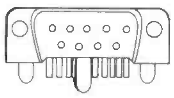

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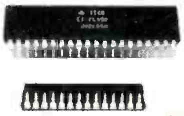

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among many users often isn't appropriate.

Compact but powerful

Occupying about as much desk-surface area as a daily newspaper page, an HP 9000 integrated workstation can include a monochromatic or a color-graphics CRT display, keyboard, built-in printer, built-in 10-megabyte Winchester disc drive, 256-kilobyte flexible-disc drive and up to 2.5 megabytes of error-correcting and self-healing main memory.

The HP 9000 features 55ns CPU microcycle time for one million instructions/second performance, and 6 megabytes/second I/O rate. Memory cycle time is 110ns.

The HP 9000's true 32-bit virtual-memory addressing capability enables technical users to deal easily with programs and data structures as large as 500 megabytes.

Two operating systems

HP 9000 users have a choice of two operating systems: HP-UX, a fully supported, extended-function HP version of UNIX, and a high-performance version of HP's Enhanced BASIC. UNIX, developed at Bell Laboratories for scientific and engineering applications, is becoming as popular in industry as it is in the academic community.

HP-UX adds such enhancements as virtual memory for both programs and data, improved file reliability, full HP documentation, database-management software, and 2- and 3-dimensional graphics.

The unit's BASIC-language operating system is more powerful than BASIC typically is considered to be. HP Enhanced BASIC was developed for Hewlett-Packard's desktop computers and includes many powerful features required by engineers, who are the primary users of Hewlett-Packard's large installed base of desktops.

A "run-time" compiled BASIC, a significant new capability, is available with the HP 9000. This advance in software technology provides the friendliness and ease of use common to interpretive BASIC, but adds a software innovation to achieve the faster final-execution speeds of a compiled language.

News

ISCET sponsors technical seminars this month

A series of technical seminars on digital electronics, computer operation and servicing, and TV servicing will be presented by Sam Wilson, CET, during May under the sponsorship of the International Society of Certified Electronics Technicians (ISCET). Each seminar will be hosted by the local or state association in that city.

The seminar schedule includes Spokane, WA, May 4; Seattle/Tacoma, WA, May 6; Portland, OR, May 7; Salem, OR, May 9; the Texas Electronics Association Technical Institute in Kerville, TX, May 13-15; and Denver, May 21-22.

Wilson, a full-time author and part-time lecturer, is test director for ISCET. His experience in electronics includes 12 years as a servicing technician and 20 years as an instructor in electronics schools.

For information, location and prices for any of the seminars, contact ISCET, 2708 West Berry, Fort Worth, TX 76109; 1-817-921-9101.

Department of Labor reports growth in service industry

The following statistics are from the U.S. Department of Labor, as cited in the May 17 issue of *U.S. News & World Report.*

In 1980, there were approximately 83,000 individuals engaged in the occupation of "TV, radio repairer." Over the decade from 1980 to 1990, this group is expected to grow by 28% or more.

If we adopt a conservative figure of 28%, this figures out as 23,240 new jobs. If the population of the United States is assumed to be (roughly) 300 million people by the year 1990, then this represents 77 new jobs per million Americans.

What these statistics do not say is that the narrow role of "TV, radio repairer" cannot meet their range of consumer electronics servicing demands that are emerging throughout the 1980s – especially videotape recorders, home computers, video games and the like. Clearly, the 77 new jobs per million Americans figure is too low.

Additionally, the "repairer" is finding himself less and less able to cope with the increasing complexity and diversity of consumer electronics products. A large fraction of the new jobs are – and will be – for those who view themselves as *technicians,* not repairers.

(Reprinted with permission of *METSDA.)*

Advanced electronics courses available for at-home study

Two new study-at-home courses, which provide information about the constantly changing subject of advanced electronics, are now available from Oklahoma State University.

The courses are designed for students who have a basic understanding of electronics, but go on to introduce students to theories needed to understand and implement specific applications using the technology.

The courses, "Digital Electronics" and "An Introduction to Linear Integrated Circuits" are each offered for three hours of university credit from OSU. Admission requirements apply only if students are working toward an OSU degree.

These "learn-by-doing" courses are offered for year-round enrollment, and each consists of 13-15 written assignments and two proctored exams. Students may go from enrollment to completion in their own hometowns – materials are sent by insured, return mail when the course applications are received. The exams may be proctored by an approved examiner in the student's area.

A special reduced tuition rate is available to persons who need the information in these courses, but do not want college credit. For more information on either of these courses, write Independent and Correspondence Study, 001 Classroom Building, OSU, Stillwater, OK 74078, or call 1-405-624-6390. Be sure to specify the course for which information is needed.

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We've got great news for people who've been holding out for a high quality, high performance DMM at a moderate price: Fluke's new nine-function model D 804 is now available at select electronics supply stores.

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Digital building blocks:

Bubble memories

By Bernard Daien

Almost all digital systems use some kind of memory. Unfortunately there is no "perfect" memory. Each kind of memory has advantages and disadvantages. Random Access Memory (RAM) can be changed, used and reused, but it is *volatile* (the contents are lost if there is a power outage). Read-Only Memory (ROM) is permanent, but it cannot be changed.

Magnetic disc and magnetic tape memories are non-volatile and can be used, reused or changed, but they require precision mechanisms and clean environments, suffer from wear-out and breakdown, and need periodic cleaning and maintenance.

Solid-state RAMs are usually limited to 64,000 bits of data, but bubble memories are now available with 4,000,000 bits. Larger storage capacity formerly demanded the use of magnetic disc or magnetic tape machines. The bubble memory is less expensive in both initial cost and maintenance cost than the magnetic mechanisms. Because bubble memory is a form of solid-state device, the downtime is also considerably less than with the magnetic mechanisms.

Obviously bubble memories offer considerable advantages over RAMs, ROMs and magnetic machines for many purposes. In the case of the popular microprocessor-based personal computers, bubble memory can sharply reduce size, weight and cost, while increasing reliability. The increased memory capability will make the system more powerful and flexible, and the reduced size and weight makes a portable computer system practical. The reduction in maintenance is desirable for small computers, whose maintenance costs can readily exceed the initial purchase price, because the purchase price is quite low.

Bubble memories may well be the wave of the future in digital systems. At least one major bubble-memory manufacturer has committed to full production, delivery and price schedules for memories up to four megabit size. The prices are realistic, but as has always been the case in electronics, sharp decreases in price are expected as mass production and volume sales have their influence.

Bubble-memory circuitry is somewhat different from other solid-state memories, so the technician facing a bubble memory system will require some prior knowledge of how this new technology works. This article explains the basics of bubble memories for the technician desiring *an introduction to bubbles.*

Some facts about bubble memories

For readers concerned about how the bubble fits into existing digital systems – they do fine. They are TTL-logic-family compatible (they fit right into TTL systems using 12V and 5V power supplies).

Bubble memories are manufactured with a form of semiconductor processing, but they use a garnet substrate on which a magnetic film is deposited, using conventional techniques, followed by such familiar IC processes as passivation and metallic deposited bonding pads. We can consider the magnetic bubble memory to be a new variation of semiconductor fabrication technology. The major differences are in the materials used and the fewer processing steps required.

Magnetic "bubbles" in the chip are created by a *bubble generator* and moved along the magnetic film by an external magnetic field. The bubbles are little magnetized islands in the material, called *domains.* These domains are de-

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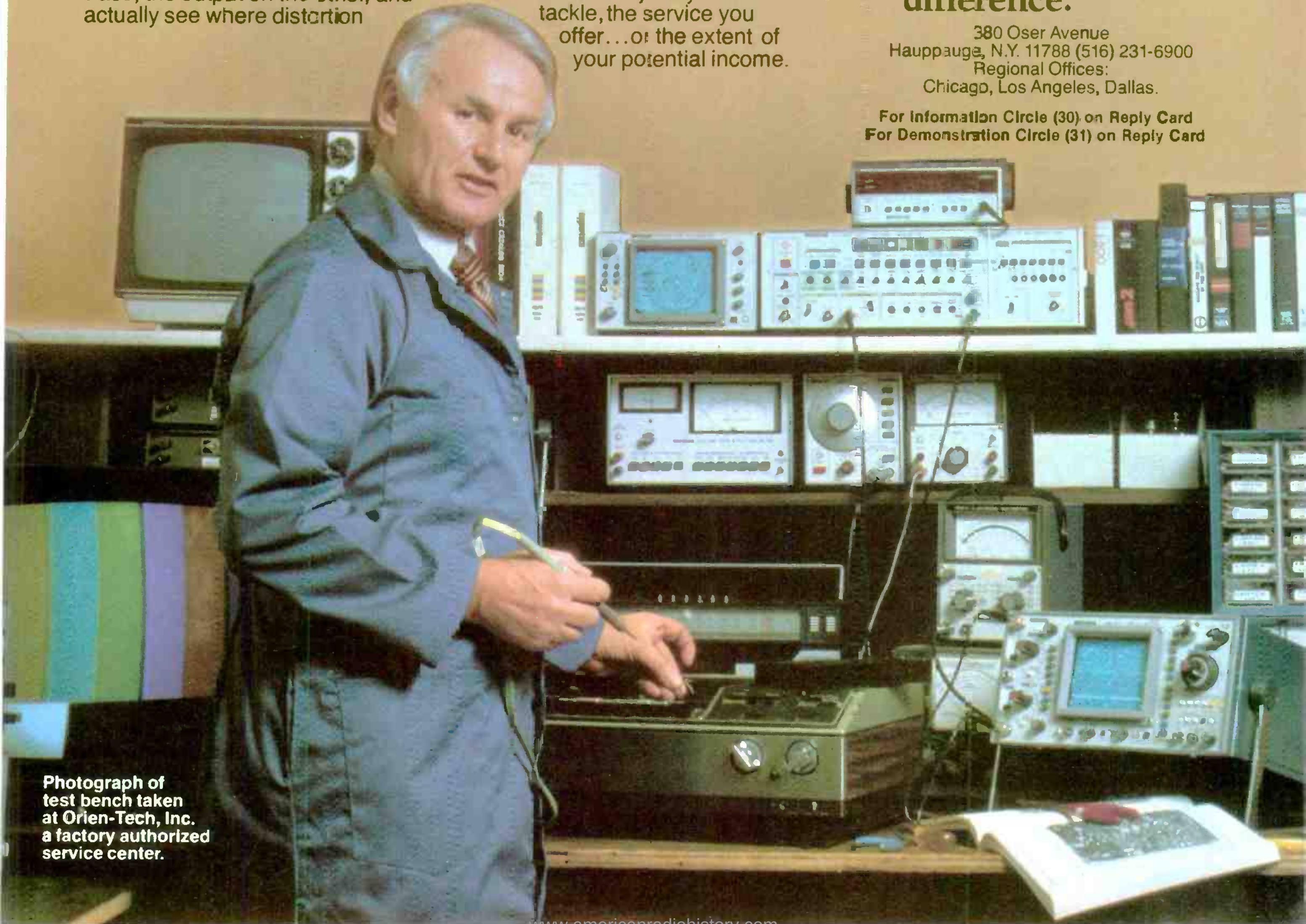


Photograph of test bench taken at Orien-Tech, Inc. a factory authorized service center.

tected by a *bubble detector* inside the chip. The detector output is an electrical signal, which is processed so that the output of the bubble memory circuitry is in TTL-signal-level format. The presence of a bubble is considered to be a *one* or *high* state, while the absence of a bubble is a *zero* or *low* state.

The bubbles move along in a thin magnetic film deposited upon the garnet substrate. Metallic patterns called *chevrons,* deposited on the magnetic film, direct the domains into the desired path of travel, finally passing the detector. Thus the bubble memory is a *serial* magnetic storage device, in some ways like magnetic tape, but with one important difference. In tape memories, the magnetic bits are stationary in the tape, and the tape moves past the recording/playback heads. In bubble memories, the chip is stationary, but the magnetic bits move past the recording and playback circuitry.

Bubble memories are high-density devices, with one chip now capable of storing 4,000,000 bits (512,000 bytes or words). The chip can therefore replace a double-density, double-sided, floppy-disc memory, along with the drive mechanism. It holds the equivalent of 260 double-spaced, typed pages.

Because the bubble memory is non-volatile, the need for a backup power source for the memory is eliminated. These backup supplies usually use a nickel-cadmium storage battery system, which is heavy, bulky and costly. Consequently the digital system can be made smaller, lighter and cheaper.

The elimination of motor-driven mechanisms greatly reduces the need for maintenance. Mechanical maintenance is a major cause of computer downtime at the present time.

The significance of all this is not being lost on users of digital systems. Coming from nowhere, as a new product, bubble memories sold $50 million worth of product in 1981, and are expected to sell more than $150 million worth of memory in 1983. Intel, a major manufacturer of bubble memories, first introduced their 1-million-bit memory in 1979. At that time, a memory kit consisting of the memory chip and supporting chips, sold for more than $2500 per kit. In 1982, the price for production quantities of the same kit had dropped to less than $300. Now the price is less than $250 in quantities of 10,000, with further price reductions to less than $200 in 1983.

As prices drop, more applications become practical, which increases sales and production and causes further price reductions—so the future looks very good for bubble memories. It is anticipated that a 4-million-bit bubble-memory system will be priced at $150 in 1986, at which time it is expected that 16-million-bit bubble memories will be introduced, with a $600 million market. Alternate source agreements have already been worked out between Intel and Motorola.

The impact of this new technology will have a profound effect on the small-computer market. Small computers will be able to do more, at a lower cost and with less maintenance. More important, from the technicians point of view, servicing emphasis will be shifted, with less service for mechanical reasons. This will result in more service being devoted to the re-

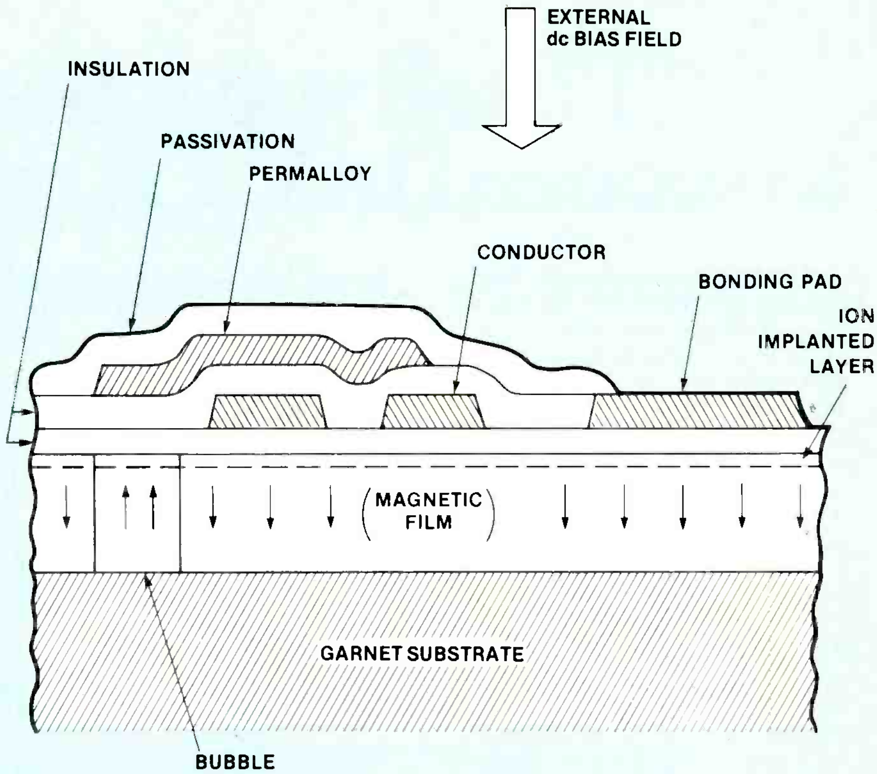
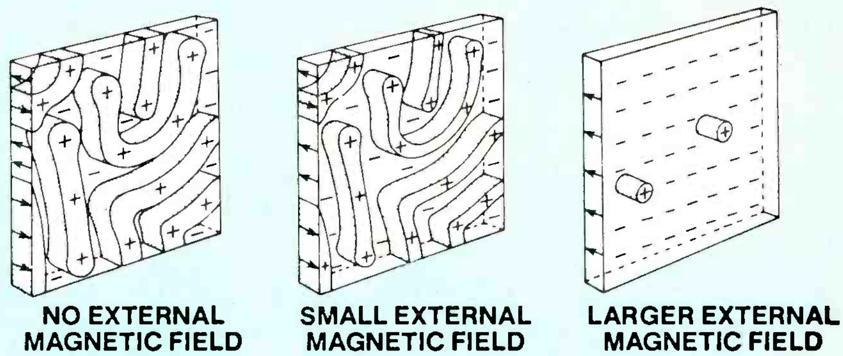


Figure 1. This cross section of a bubble memory chip shows the internal construction and external magnetic field. Illustrations courtesy of Intel Corporation.



Magnetic domains in thin film under increasing magnetic bias field.

Figure 2. The magnetic domains (bubbles) vary from snakelike forms, with no magnetic biasing field, to circular cross sections at optimum biasing. If the bias is further increased, the domains disappear completely.

maining parts of the system, which are predominantly electronic, solid-state devices. Although power supplies will be part of the service problems, memory systems are becoming larger and will inevitably have to assume their share of maintenance. The implication is plain: Bubble memories are here to stay, and it is the right time to get to know them.

What's inside the package?

Figure 1 is a bubble chip cross section, showing how it uses many of the processes involved in semiconductor fabrication. The passivation is silicon oxide (glass) in a grown layer, just as in silicon monolithic ICs. The bonding pads are metal depositions, also as in IC structures. The main difference is in the magnetic film deposited on top of the garnet substrate. This material is selected for its magnetic, rather than semiconductor property.

Magnetic domains are found in all magnetic materials. When such materials are in the unmagnetized state, the domains are oriented randomly in all three dimensions: length, width and depth of the host material. By magnetizing the material strongly so that it is saturated magnetically, all the domains are oriented in the same direction. If however, we use a thin film of magnetic material, the dimension of depth is eliminated, confining the domains to essentially 2-dimensional orientation, in snakelike configurations.

This is shown in Figure 2, in which the magnetic domains are formed under the influence of a steady, strong, magnetic field called a *bias field.* This field is the result of placing a strong, permanent magnet in close proximity to the thin film. The domains are about 0.0001 inch in diameter, and when viewed on end, appear as round shapes, or bubbles. If the strength of the bias field is increased further, the domains shrink and disappear as the entire film is magnetized uniformly. When the magnetic bias is removed, the domains return to their ribbon-like shapes. Thus the strength of the biasing field is held to an optimum value in order to form the desired uniformly shaped bubbles.

Actually, there are two permanent magnets, one immediately above and one immediately below the chip. This is shown in the assembly drawing in Figure 3, in exploded form.

The bubbles move along under the influence of two *deflection coils* wound at right angles to each other. The coils are driven by triangular current pulses. The vector addition of the magnetic fields, produced by the two coils, propels the bubbles along. The two deflection coils are also shown in Figure 3, as if they were slid off the chip. The entire assembly is then covered with a magnetic shield to prevent external magnetic fields from affecting the memory and to prevent radiating the deflection fields into nearby circuitry.

The deflection coils in the 4-megabit bubble memory are driven at a frequency of 50kHz, resulting in a data-transfer rate of 200,000 bits per second. For higher performance, the coil drivers operate at 100kHz, permitting data transfer at the rate of 400,000 bits per second.

How it works

The bubbles originate from a *seed bubble,* which is generated by a hairpin-shaped loop of conductive material, through which a pulse of current is passed. The field created reverses the bias field momentarily and creates a domain. This seed bubble remains as long as the external bias field exists. Because the bias field is created by permanent magnets, in normal use the seed bubble will exist for the life of the memory. This is the reason for the non-volatility of the bubble memory: the continuing presence of the biasing field produced by the permanent magnets, which do not depend on a power source.

The bubbles that move are split off of the seed bubble, much the same way as cells in living tissue grow by the process of dividing. The seed remains in place, and the bubble split off is mobile and moves away, repelled by the seed, which has the same polarity.

The mobile bubble is directed along a precise track, propelled by the deflection field and guided by the chevrons. The process of splitting off a bubble from the seed is accomplished by applying current pulses to the hairpin-shaped conductor. The bubble is a binary *one,* so we have generated a binary *one* with a current pulse. To generate a *zero,* no current pulse is applied and no bubble is generated. The bubbles pass along *loops* in orderly fashion, and after passing the bubble detector, they are destroyed, and new bubbles are generated at the beginning of the loop. The loop is capable of holding a number of moving bubbles, similar to a shift register, which holds many bits of digital data. (A shift register,

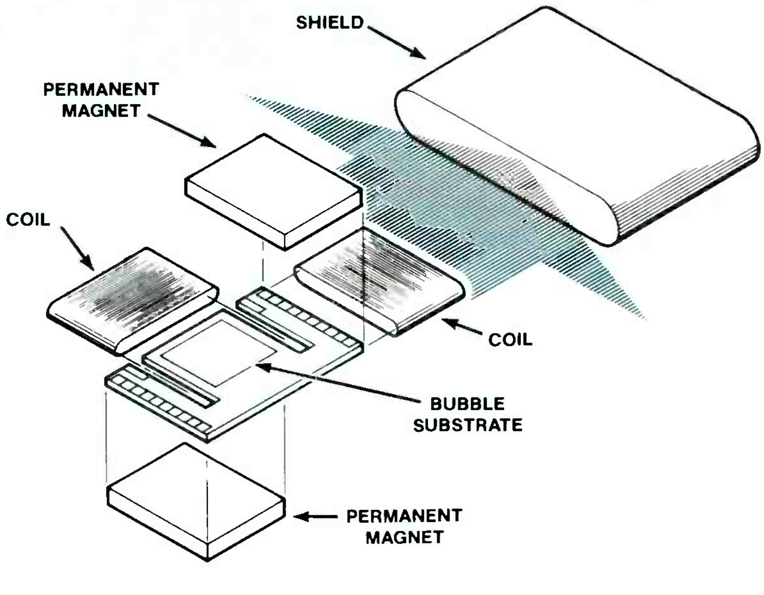


Figure 3. The permanent magnets, deflection coils and magnetic shield are shown as they would be placed before assembly. The two deflection coils are slid over the chip, then the two permanent magnets are placed on top and below the coils, and finally the magnetic shield is slid over the assembly.

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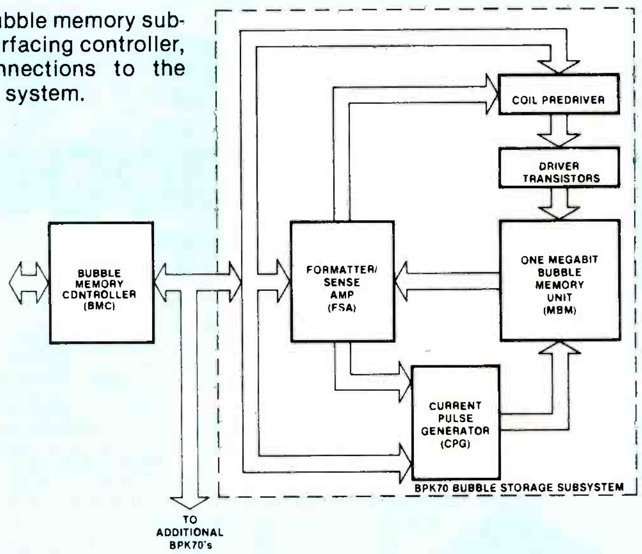
Figure 4. This basic bubble memory subsystem shows the interfacing controller, signal flow and connections to the microprocessor-based system.



similar to the bubble memory, also passes along the bits until the end of the register is reached, at which time the data is destroyed. Serial shift registers handle data in a manner roughly analogous to the operation of the bubble memory loop).

Actually a large bubble memory is organized into several internal loops, increasing the storage capability of the memory. A 1-megabit memory can be organized into 272 active loops, each with a capacity of 4096 bits.

Support circuitry

The bubble memory requires some supporting circuitry, made of ICs and discrete components. Usually the bubble memory and its required supporting circuitry is mounted on one PC board. These bubble systems are compact, with the 1-megabit system taking up only 16in^2 of board space. Power dissipation at a 100% duty factor is only 6W, and standby power is less than 1.5W.

The support circuits are as follows:

A *current pulse generator* (CPG) originates all signals needed, except for the rotating (deflection) fields. The current pulses that form new bubbles come from the CPG.

The *coil predriver* (CPD) forms the waveshapes needed for the fields that move the bubbles. The triangular waveforms then go to transistor drivers, which supply the required currents for coil driving. The CPD receives four digital signals, with appropriate durations and phasing to control the timing of the fields, from the *controller*. (It should be noted that the other magnetic memories, such as disc, tape and cassette, all require the use of a controller also.)

The *controller* is the interface between the memory and the rest of the computer system. It converts the digital system's parallel word format into serial format for use with the bubble memory, and the bubble memory's serial format into the parallel format required by the digital system. It generates the timing pulses required by the bubble memory and its support circuits. (The controller is not properly considered part of the memory/memory-support subsystem, but is included here in order to explain the workings of the entire memory system. Remember, most memory systems require some form of interface circuitry between the digital system and the memory: in short, a controller.)

The *formatter/sense amplifier* (FSA) keeps track of the loop operations in the bubble memory and shifts data to the bubble memory input tracks (writing into the memory) or from the bubble memory output (reading out of memory). It also amplifies the output signal from the bubble detector, which is inside the chip.

The arrangement and signal flow is shown in Figure 4, a block diagram of the bubble memory, along with the controller and interconnects to the microprocessor-based digital system.

Because the controller in this case controls a bubble memory, it is called a *bubble memory controller* (BMC). In the case of a floppy disc controller, it would be a FDC. This is merely routine to avoid confusion, because the word *controller* is really a general term, and we often need to be more specific.

Note that in Figure 4, the BMC output may also go to other bubble subsystems. This indicates that a large memory system may consist of several 1-megabit subsystems, or even 4-megabit subsystems. This is in accord with the common practice of assembling large memories out of several smaller memory chips, and is done routinely with solid-state memories other than bubbles.

Now that we have defined the support circuits in a general way, a few detailed comments are in order. The controller maintains the memory addressing information, and interprets and executes requests for data transferral.

The FSA also incorporates provisions for detection and correction of errors. The FSA is tied to the chip-select pins of the other support chips, so unneeded devices are in the power-down condition, conserving power and reducing dissipation. This information is essential to the servicing of bubble systems.

The coil predriver is required, because the current pulses needed by the coil system are larger than can be generated by ICs made with the usual processing steps. The output of the CPD is further amplified by the transistor coil drivers. The CPD is able to provide up to 200mA of drive current into the bases of bipolar power transistors.

Although the thin film of magnetic material grown on the substrate is epitaxially grown garnet, the substrate itself is actually a wafer of gadolinium-gallium-garnet, usually referred to as GGG.

As bubble memories grow in size, they necessarily become more complex, but the basics remain the same. It would be useful for readers to read some of the technical literature now available from manufacturers and sales sources. As time passes, these systems will grow larger and more complex. Now is the time to get to know bubbles! ES&T

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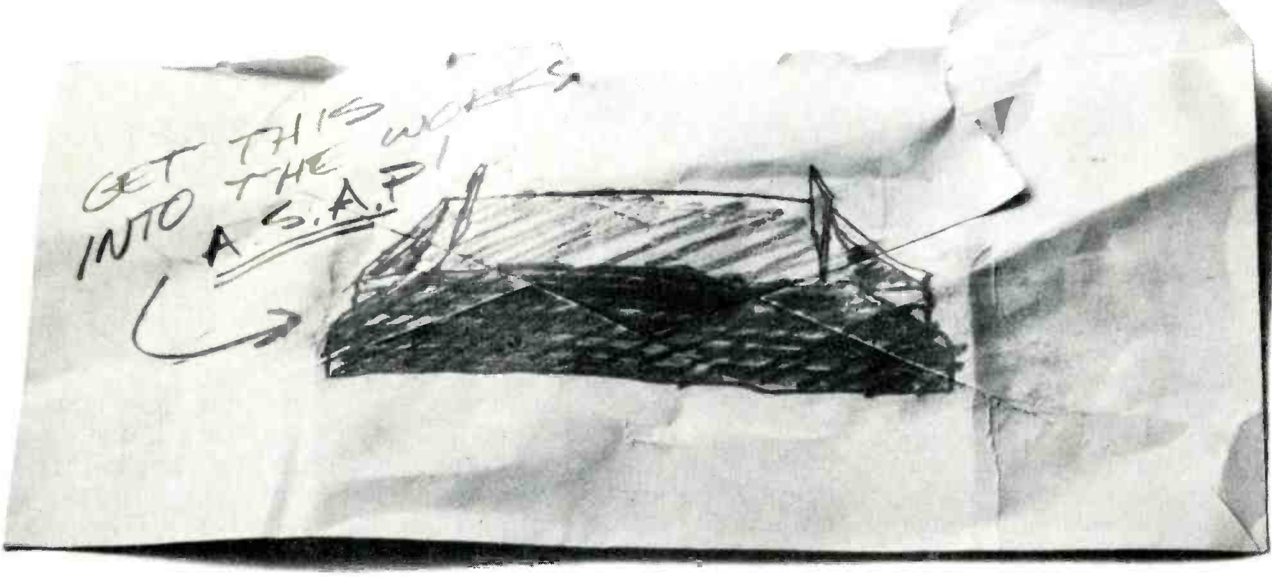

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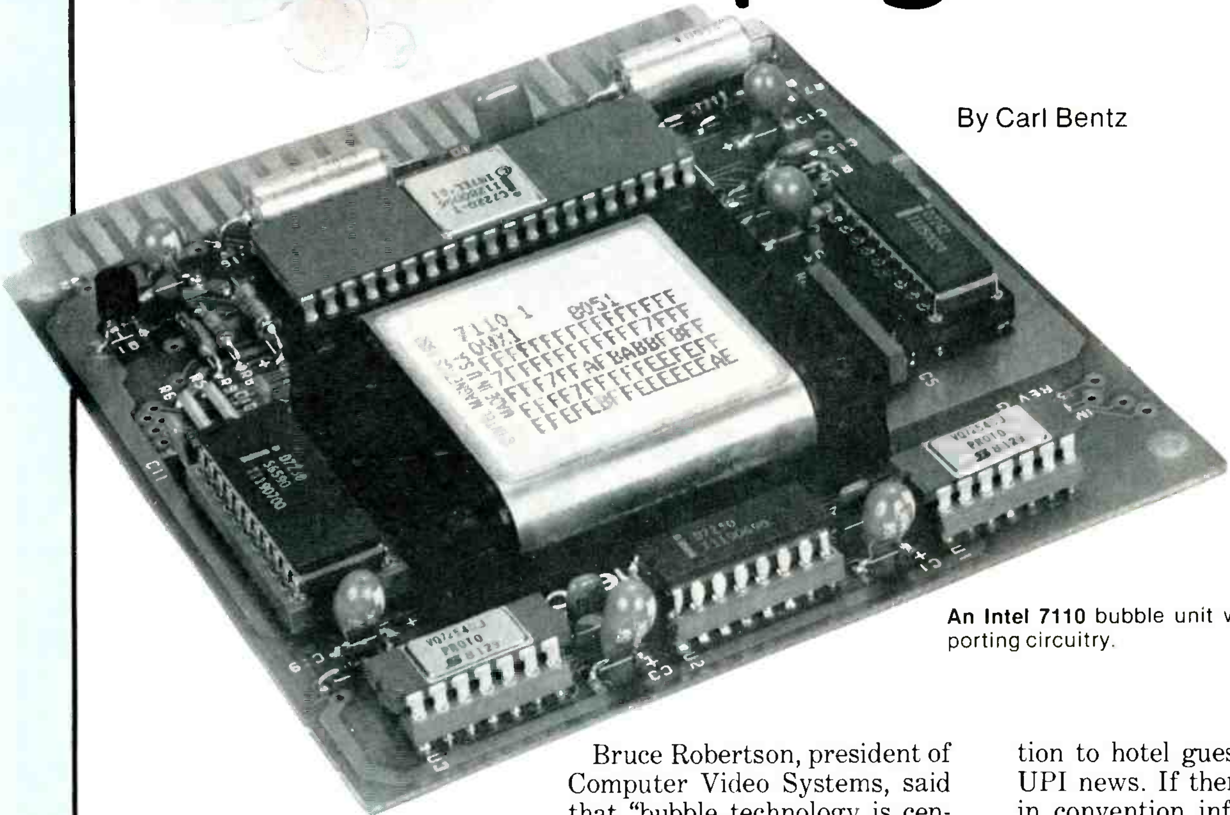
From data storage to programming

By Carl Bentz



An Intel 7110 bubble unit with the supporting circuitry.

Currently two applications of bubble memories in TV equipment have been developed. The applications are somewhat diverse: one for data storage and the other retaining instructions of a programming nature.

The use of bubbles for mass data storage is found in the Compuvid character generator for CATV information and news channel operations. The system, built by Computer Video Systems of Salt Lake City, provides a 32-character, 8-line display format on the TV screen. The first 27 pages of memory are implemented with standard random access memory (RAM) semiconductor ICs. Data storage is incremented by 417 pages of display with the bubble memory option, offering additional program instruction memory as well.

Bruce Robertson, president of Computer Video Systems, said that "bubble technology is central to our products. It cannot be outperformed by any other data storage medium."

The bubble units in Compuvid equipment use Intel 7110 devices. By late 1981, more than 100 users of some 1200 installed Compuvid systems have augmented the memories with the bubble units. Because of preferences, Robertson's organization has made other options available to his users, including a 160-page RAM memory (which requires external fail-safe protection), a 2000-page floppy disc drive and a 20,000-page Winchester rigid disc drive.

One Compuvid system of interest is operated by a company named Vegas in two hotels in Las Vegas. Bubble memories store 200 pages of color display data. The system provides tourist and convention information to hotel guests, as well as UPI news. If there is a change in convention information, the equipment allows a quick change of memory, usually requiring less than a minute.

Another Compuvid innovation is the CPA public access system. Viewers may select subject categories of their interest, dial up the CATV headend access telephone number and order up to 10 different categories in a desired order by pressing 2-digit codes into their telephone dial. Then, on their CATV-connected TV set, the information will be presented in the order requested. No special hardware is required in the subscriber's home. Multiple bubble systems make the CPA system possible.

For TV studio production and post-production, another unique application of bubble memories is available as a special option to the NEC E-Flex DVE digital video effects system. ES&T

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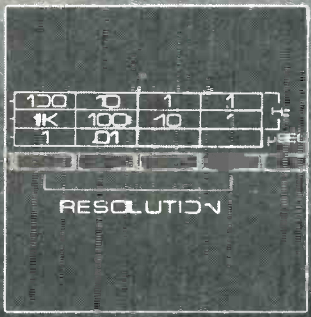

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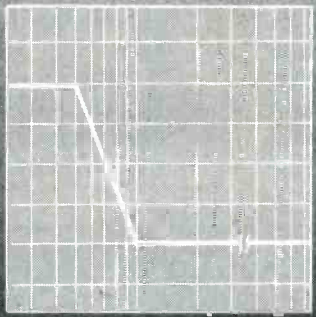

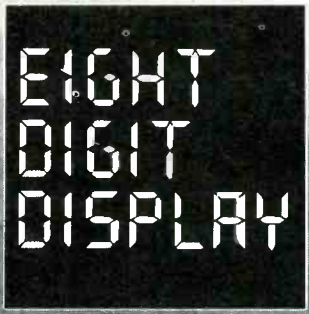

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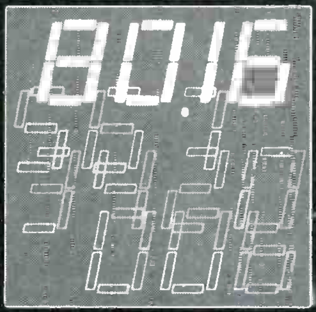

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Circle (11) on Reply Card

Has this ever happened to you? You find an open transistor in the IF section of a stereo, look up the replacement in the ECG book, and discover that you don't have it in stock. The next step, of course, is to look in other books to see if there is an RCA, GE, HEP or some other replacement in stock. If you find no suitable replacement in stock, the only recourse is to order one.

You can make this a less frequent occurrence by organizing your present stock and understanding some things about universal-type replacement transistors.

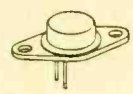
How to select & organize replacement transistors

By William T. Stough, Tower Electronics

Numbering systems

Vacuum tubes have only one identification number. A 6GH8 is a 6GH8, regardless of who made it. Each manufacturer of universal replacement transistors, however, had its own numbering system. I say *had* because some other manufacturers are now adopting the Sylvania (NAP) ECG numbering system. Many manufacturers are putting both the old and the new numbering sytems on the transistor bag. I recommend that you adopt this new standard system unless you use only one brand of transistors. The way to do this is to cross all transistors over to a single numbering system, then put them all in numerical order on a peg board or in some other organized way instead of having two, three or more areas for transistors. Mix the brands of universals and have a single organized system.

If this new system is not already marked on your older stock, look up those transistors in the ECG book and find the corresponding

Breakdown Voltage		Type			Collector Current	Collector Diss.	Current Gain	Freq in MHz	Package	
BV_{CBO}	(BV_{CEO})	NPN	PNP	Application	I_C (A)	P_D (W)	h_{FE}	f_t	Fig. No.	Case
90	(80)	.....	ECG218	Gen Purp, Pwr Amp	3	25	20 min	3 min	T25	TO-66 
200	(110)	ECG175	.....	Gen Purp, Pwr Amp	3	40	80 typ	15		
300	(300)	ECG124	.....	HV Gen Purp	0.150	20	100 typ	30		
300	(250)	ECG286	.....	Horiz Switch	2	25	100 min	8		
375	(350)	ECG384	.....	Hi-Speed Sw. Amp, $t_f = 0.3\mu s$	7	45	20 min	1 min		
800	(400)	ECG369	.....	Gen Purp Linear	3 peak	40	30 min	7		
1600	(700)	ECG321	.....	Horiz Switch	1.5	15 at TC70°C	1.5 min	.....		

Universal replacement transistors can frequently be used in servicing electronic equipment. A selector guide such as this will help in selecting a suitable replacement when an exact replacement is not available.

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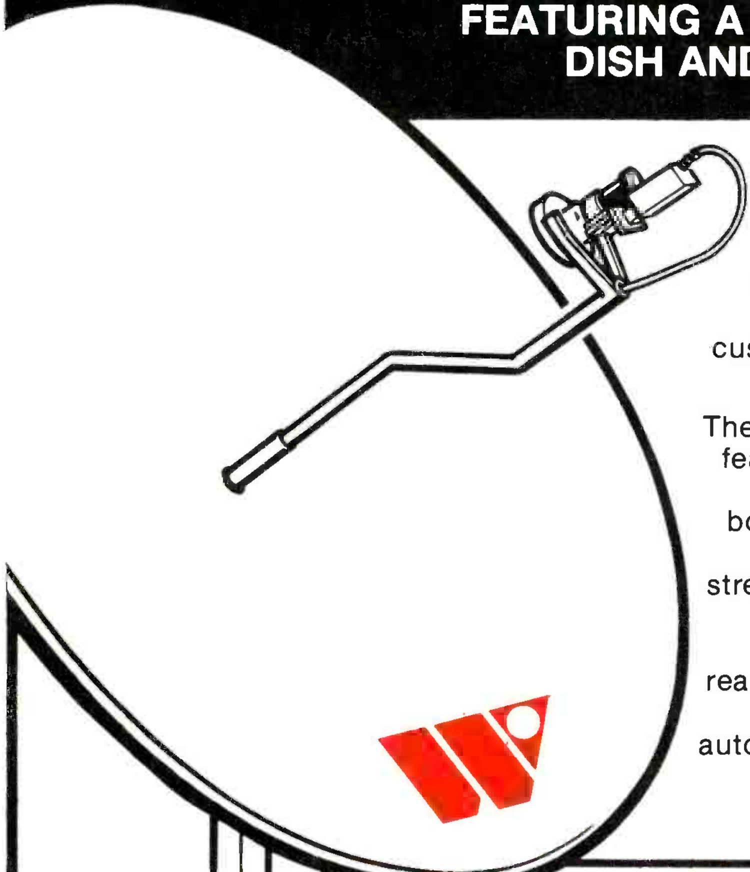

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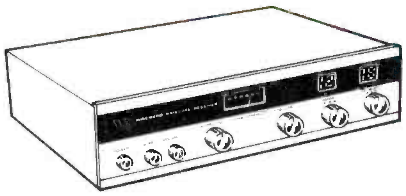

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number. For example, a GE 20 crosses to an ECG 123A. Write that number on the bag and file it accordingly. The index of some replacement books will also lead you to a section that cross references the separate numbering systems. By going to one system only, you will save time in finding transistors.

Exact replacement vs. universal

Can we get away with using universals to replace the original transistors? Consider this: In most circuits, the design engineer had to allow a great deal of leeway for variations in transistor characteristics. Transistors cannot be manufactured to the exact characteristics possible with tubes. Put five transistors of the same number on a curve tracer and they'll all be different. The designer usually has to allow for these variations by designing the related circuits to accommodate them. There are circuits however, in which only an exact replacement will work.

Keep this in mind if the replacement gives you strange results. For example, do *not* use universal SCR replacements in RCA trace and retrace circuits. There *are* times when you *must* use nothing but the exact, original number replacements. I have also encountered this in high-frequency tuned circuits, but this is not usually the case. A replacement will ordinarily operate satisfactorily, provided that the specifications that vary from those of the original are better. Many shops, such as ours, must use universal types because they don't specialize in one brand. Furthermore, because we do TV, stereo and other types of electronic servicing, we would need a warehouse if we stocked original numbers for all brands, or we would always be ordering, paying minimum order fees, and tying up jobs if we didn't rely on universals. We have used them with great success in televisions, stereos, industrial devices and other types of equipment.

Not in stock?

How many times have you looked up a replacement only to find that you did not have it; and then been forced to discontinue the repair until the replacement arrived? It is always more efficient if you can complete the job once it's started, and it builds better customer relations.

But, if you don't have it, you don't have it–right? Well, maybe. To take maximum advantage of your stock, you need to do more than look up the original number, see what universal it crosses to, and see if you have that replacement.

Suppose the replacement crosses to an ECG 124, and you don't have that transistor. Look up the characteristics of that transistor in the appropriate section of the book. It is an NPN silicon, rated at 300V, 0.150A, and 20W. Next, find the section of your book called "transistor selection guide." (Most replacement books have this feature.)

In this guide, transistors are arranged according to their case style, and within that section, the transistors are arranged in ascending order of the voltage rating of each. In the ECG book, as an example, locate the entry for the ECG-124 previously mentioned and note its voltage, current and wattage ratings. All NPN transistors below this entry that have equal or greater current and wattage ratings can also be used because they have the same case style, and greater voltage rating.

Note the cut-off frequency. This may be a critical factor in high-frequency circuits, but in audio, IF or other lower frequency circuits, most of these transistors are more than adequate. Also note the current gain (Beta or hfe).

The value of hfe might seem to be an important item, but I can think of only a few cases from my experience in which the hfe of the replacement had any effect on the circuit operation, and in those cases, we ended up going to an exact replacement. It seems the effect of hfe is one of those items that the engineers "designed out of the circuit" via external parts. So, unless it is a darlington, hfe will be of little concern to you. You are primarily concerned with voltage, current and wattage ratings–and sometimes with case style.

In the example of the ECG 124, an ECG-286, ECG-384 and ECG-369 all are equal to or rated higher than the ECG-124, and all have the same case style. I have on several occasions used a -286 rather than a -124 with perfect results.

If case style is not important (for example, when a heat sink is not used) other transistors may also be used. But be *sure* you install them properly because the emitter, base and collector leads may be in different positions. An example is an ECG-233. You may be able, if you are careful, to also use any of a number of other transistors as replacement.

Become familiar with all of your replacement books, not just the area that crosses the original equipment number with the replacement number.

Higher rating needed

We have encountered cases in which the required replacement did not hold up, but we cured the problem by going to a higher rated item. For example, a vertical output transistor failed in a Japanese-made TV. The replacement transistors called for were ECG-152 and ECG-153. (Always replace both if one transistor in an output pair fails.) These only held up for a few weeks. So we went to ECG-331 and ECG-332, using the selection guide that I have described, and they held up.

Photofact numbers

Some caution should be exercised when considering the use of replacement transistors listed in older Sams Photofacts. The selection of replacements is much greater now, so it is likely that a closer match can be obtained. After all, using the numbers shown in a 10-year-old Photofact is equivalent to using a 10-year-old crossover list. The safest action is to look up the replacement in the latest cross-reference guide.

It pays to build your stock if you frequently replace transistors. Be sure to replenish those that you use before they're needed next time.

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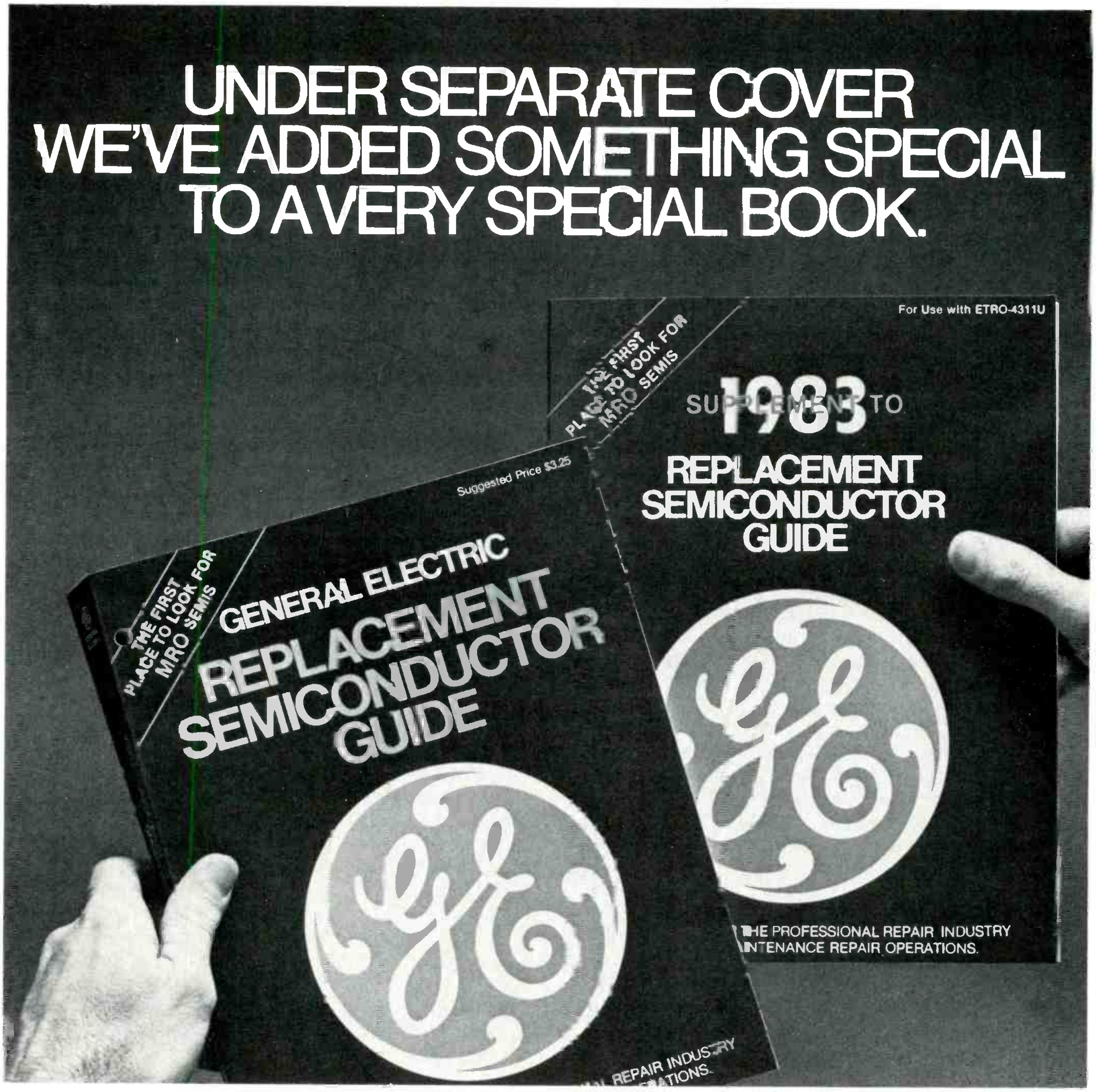

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An ounce of prevention

Many VCR problems can be prevented by routine maintenance

By Robert Goodman

For several fundamental reasons, VCRs require considerably more routine maintenance at shorter intervals than audio-only tape recorders. The recording of video waveforms demands a much wider bandwidth (30Hz to about 4.5MHz vs. 30Hz to 16kHz for audio), and this in turn calls for a higher video-head-to-tape speed that makes the head-to-tape contact much more critical. These higher speeds also cause greater wear on heads and mechanical parts, along with increased deterioration of the tape coating. Even a thin coating of tape oxide on the video head can prevent proper contact between tape and head, and this degrades the picture quality.

Another major factor is that picture defects, such as high-frequency attenuation, noise and minor drop-outs, are easily seen by all viewers, while the same defects in an audio program might be overlooked. Periodic cleaning, for example, is not a luxury; it is essential.

VCR basics

VCRs have fixed-position heads for audio, control-track signals and erasing. The tape moves slowly past these motionless heads in exactly the same way as in audiocassette machines. To achieve the much faster tape-to-video-head speed, the tape is wrapped around a head drum with the entering tape higher or lower (from the baseplate) than the exiting tape. Therefore, the tape moves at an angle as it travels around the head drum. This head drum contains video heads that rotate rapidly, projecting slightly from an opening in the head drum. Consequently, the recorded track on the tape crosses the tape at an angle, (each individual track is long compared to the tape's width). This type of recording is called *helical* or *slant-track*.

Both VHS and Beta machines operate with these basic principles, but the tape is contained in a cassette that allows easy handling and automatic loading.

Magnetized heads

The best VCR picture quality with minimum noise requires that all playing/recording and erase heads must be completely free from steady magnetic flux.

Every ferrous part of a VCR that touches the tape will become weakly magnetized over a period of time. The heads are most susceptible because they are subjected to current surges each time the ac power is turned on or off. Other causes of magnetized heads include the use of magnetized tools near the heads, a defective bias oscillator that distorts the bias-current waveform, and using an ohmmeter to test continuity of the heads.

A magnetized *audio* head (or other magnetized metal parts) will remove some of the high frequencies and also greatly increase the tape noise of pre-recorded tapes. Magnetization of the *video* head can weaken or eliminate the color and partially erase the video signal from a previously recorded tape.

Fortunately it is easy to remove unwanted magnetic flux. For tape guides and other ferrous parts, apply power to the demagnetizing tool before it is brought near the VCR, then bring the tool near the magnetized area, slowly moving it around near the part before it is removed three (or more) feet away and the power turned off. If the power is turned off when the demagnetizer is near any ferrous material, the collapsing field will apply a strong permanent flux that can be removed only by subsequent demagnetization.

Heads are demagnetized in the same way, except more care must be taken with *video* heads. Only an approved VCR-head demagnetizer should be used with video heads, because a strong field can shatter video-head chips. *The video head should not be touched by the demagnetizer or human fingers.* Figure 1 shows a Nortronics VCR-205 head demagnetizer.

Why VCRs need cleaning

Video heads penetrate slightly in-

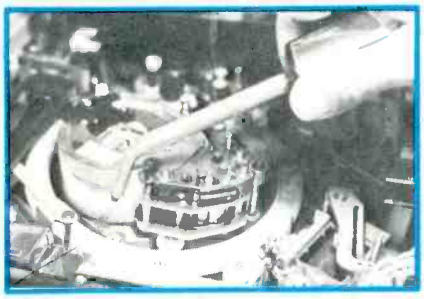


Figure 1. Typical operation of a video-head demagnetizer.

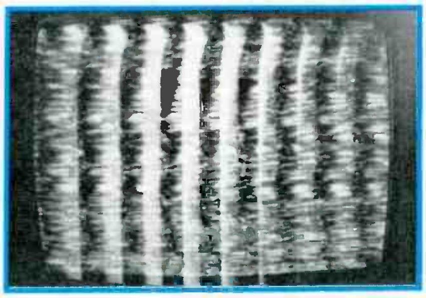


Figure 2. Oxide buildup on the video head caused unstable tearing of recorded color bars.

Figure 3. Drop-outs remove the video from one or several horizontal scanning lines on the TV receiver screen.

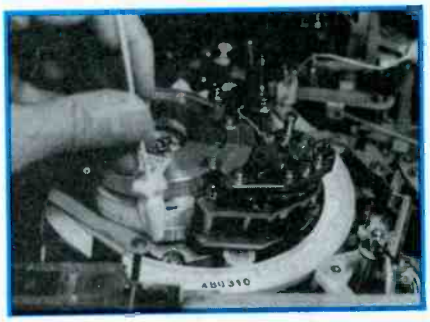


Figure 4. For cleaning video heads, use a special cleaning pad, such as a chamois leather cloth or cellular-foam swab.

Figure 5. An old toothbrush can be used to loosen stubborn accumulations on and around video heads. Work carefully; video heads are delicate and easily damaged.

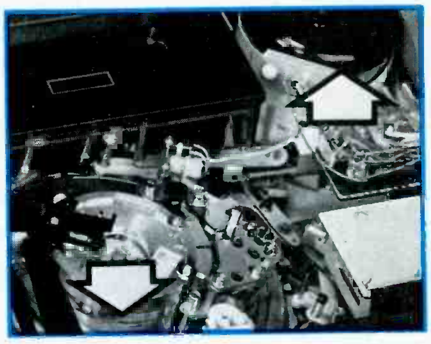


Figure 6. The lower arrow points to one video head in a Beta VCR. Rotation of the blower (black plastic attached to motor shaft in front of top arrow) can be used to position each video head for cleaning. *(Photo courtesy of Nortronics.)*

to the tape oxide when recording or playing tapes, producing some shedding of oxide that gathers on heads and guides.

An accumulation of oxide, tape-binder, dust and smoke particles can form a hard layer on some areas of the head surfaces. Such unwanted coatings force the tape away from the head, and the increased spacing greatly weakens the amplitude of signal recorded on or played from the tape.

Normal spacing between tape and head is 0.00002in (compared to 0.004in for the thickness of a human hair), so only a small thickness of particles on a video head can cause a large loss of video quality, such as a smeared picture, loss of color or a snowy picture (Figure 2).

Oxide build-up that is ignored for a long time can become large and ragged enough to scratch or tear tapes or vary the tape speed (and tape speed is extremely important in video recording.) Oxide accumulations can grow on rollers, guides and other parts of the tape path. All these must be removed without scratching any of the surfaces.

Maintenance cleaning at regular intervals is the only way to prevent oxide buildup and other mechanical problems in VCRs. It is strongly recommended that home-type VCRs should be cleaned and the heads demagnetized after every 100 hours of operation, or two to four times per year.

Incidentally Quasar model VR1000 VCR records and plays the video signal on the back side of the tape where there is no oxide.

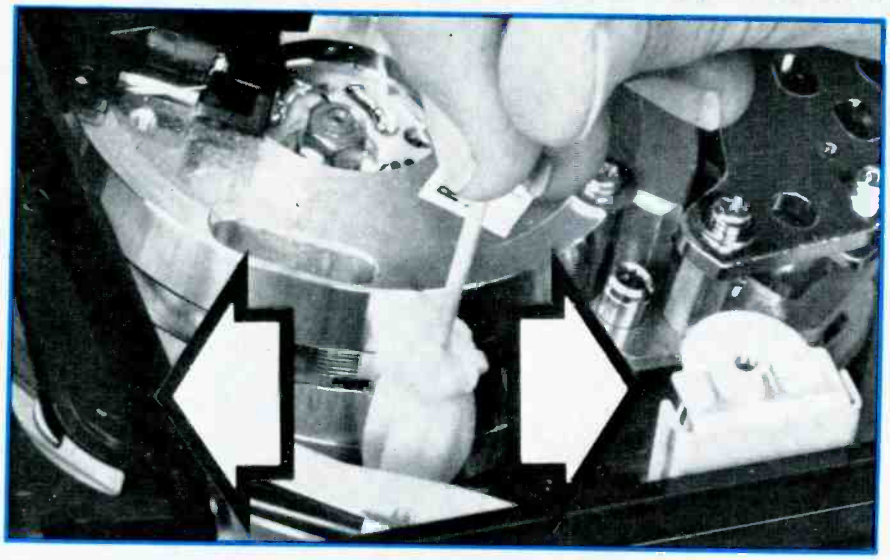


Figure 7. Two arrows show the correct side-to-side motion of the cleaning swab used to clean Beta video heads. *(Photo courtesy of Nortronics.)*

This method minimizes tape and head wear, but the tradeoffs are not acceptable.

Another problem that is easily confused with a dirty head is called *drop-outs*. Drop-outs appear as one or more missing horizontal scanning lines in the picture (Figure 3), and they are caused by a missing speck of oxide on the tape. Drop-outs are common with badly worn or defective tapes.

Use a special cleaning pad, such as a chamois leather cloth or cellular-foam swabs, to clean dirty heads. If these recommended materials are not available, lintless muslin or other cloth can be used. *Do not use cotton-tipped swabs, because the cotton strands can catch on edges of the video head and perhaps pull away the ferrite chip from its mounting, thus ruining the head.* (Cotton swabs soaked in alcohol or other cleaning fluid *can* be used for cleaning tape guides, and other heads for audio, control track and erase functions.) Methanol or surgical isopropyl alcohol is adequate.

When cleaning a video head, the chamois or cellular-foam pad should be soaked liberally in cleaning fluid, then rubbed firmly but carefully across the head horizontally (Figure 4). Never rub a video head up and down because the head might become damaged. Clean the entire head using side-to-side motions, clean all guides or other places where the tape touches. Do not touch any of these parts with your fingers, because the skin oil will attract dust and dirt.

While you clean a video head, it is a good idea to hold the head so it doesn't move from the force exerted against the head. Hold a drive motor or drive belt that prevents rotation of the head assembly.

A head that is unusually dirty requires additional cleaning. First, soak the head chip with alcohol or other approved liquid or spray cleaner two or three times, or until the debris begins to dissolve. Next, gently scrub around the head chip using an old toothbrush soaked in liquid cleaner (Figure 5). Do this carefully, or the head can be ruined. Of course, the head must be replaced anyway if it cannot be properly cleaned, so nothing of value is destroyed if the head cannot be cleaned and is destroyed in the attempt. Shortening the toothbrush bristles might provide better cleaning.

Cleaning a Beta-format VCR

The following steps apply to the cleaning of Beta VCRs.

- Disconnect the ac power cable.
- Remove all screws that hold the top cover in place. These usually are Phillips screws, so be careful not to damage the slots. If this is an older Zenith or Sony Betamax, remove the *tracking* knob from the lower left corner by grasping it and pulling the knob up and off its shaft.
- Press the *eject* button to raise the cassette-carrier platform, lift off the top cover and then push down the cassette carrier.
- Locate the black fan/blower on the motor (top arrow in Figure 6). Rotate this blower to move one of the video heads to a position shown by the lower arrow of Figure 8. If the head is difficult to see, use an inspection mirror. Do not touch the video head face with your fingers.
- First saturate a cellular-foam cleaning swab with a good tape-head cleaner solution and clean that head by side-to-side movements (Figure 7). One way to ensure horizontal motions is to hold the swab stationary while rotating the blower slightly forward and backward. Never clean a video head by moving the swab up and down; these heads are easily damaged.
- Rotate the head ring by moving the blower so that the second head is exposed, and clean it by the same method.
- Clean the control-track and audio heads (Figure 8) by using a sideward motion of the swab.
- Clean the erase head, which is located behind the swab shown in Figure 9.

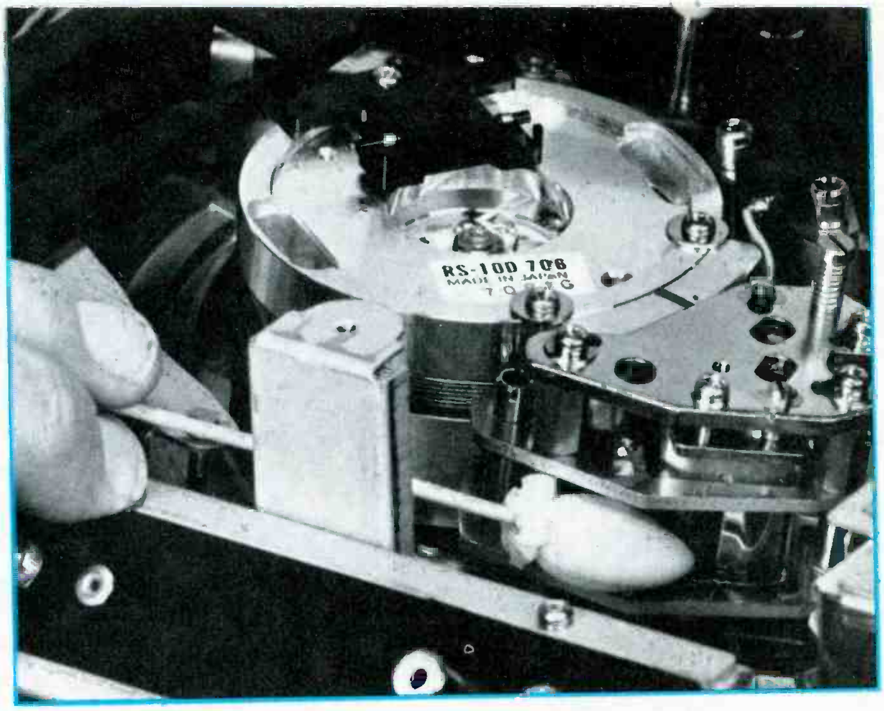


Figure 8. Audio and control-track heads are cleaned by the same side-to-side motion of a cleaning swab. *(Photo courtesy of Nortronics.)*

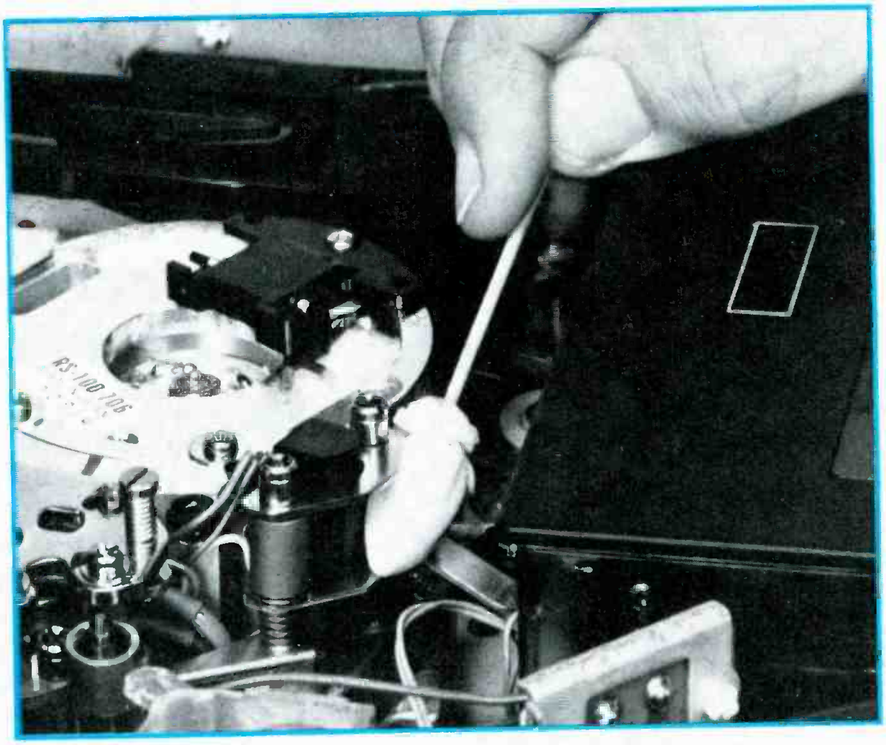


Figure 9. In Beta machines, the erase head is located away from the other fixed audio and control heads, but is cleaned by the same method. *(Photo courtesy of Nortronics.)*

- After all heads have been cleaned, use a swab and cleaning liquid to remove accumulations of dirt and ferric material from all parts touched by the tape during operation. These include rollers and guides.
- Push the *eject* button to raise the cassette carrier. Reassemble the unit by placing the top cover in position and re-installing all cover screws. Replace the tracking-control knob (if the machine has one), and wipe clean with an anti-static dust cloth.

Cleaning a VHS VCR

Again, make certain the power cable is disconnected to remove all voltages, and follow these steps.

- Remove the screws holding the machine's top cover and remove the cover.
- In Figure 10, a large arrow iden-

tifies one video head in the rotating head disc. The other head is at the other side of the disc. Gently rotate the wheel disc, bringing one head where it can be cleaned conveniently. An inspection mirror will allow a better view of the head. Clean the head with side-to-side motions of a cellular swab that has been soaked in an approved head-cleaner liquid (Figure 11). A safer method is to hold the swab motionless and rotate the head wheel slightly. Clean the second head by the same method.

- Locate the control-track and audio heads (at the swab's tip in Figure 12) and clean them by the same general method, using side-to-side brushing movements. Also clean the erase head, which is at the opposite side of the head wheel.
- Using swabs and head-cleaning fluid, clean all parts of the machine that touch the tape.
- Replace the top cover, installing all screws and tightening them. Wipe the machine with an anti-static cloth.

Remember these two precautions: do not use cotton swabs or others that can produce lint, and make certain cleaning fluid on the tape heads is totally dry before a cassette is loaded into the machine. Wet guides and heads might jam the machine or cause improper threading.

Tape tension

Correct tape tension is vital in the proper operation of any VCR. Excessive tension causes increased wear of heads and tape guides. Also it can stretch the tape, causing tracking and timing errors.

Insufficient tension might allow the tape to fall out of the path, thus failing to make correct contact with the heads and misaligning the tracks.

Tape tension should be tested (and corrected when needed) on a regular basis, *before* problems arise.

Belts and drive wheels

While the machine is opened for cleaning, all drive belts and wheels should be examined. Check for loose drive belts and worn rubber drive wheels. (Improper fast forward and rewind can be caused by worn drive wheels). Use isopropyl alcohol for cleaning these components. If new belts are installed, verify that they operate with the proper tension.

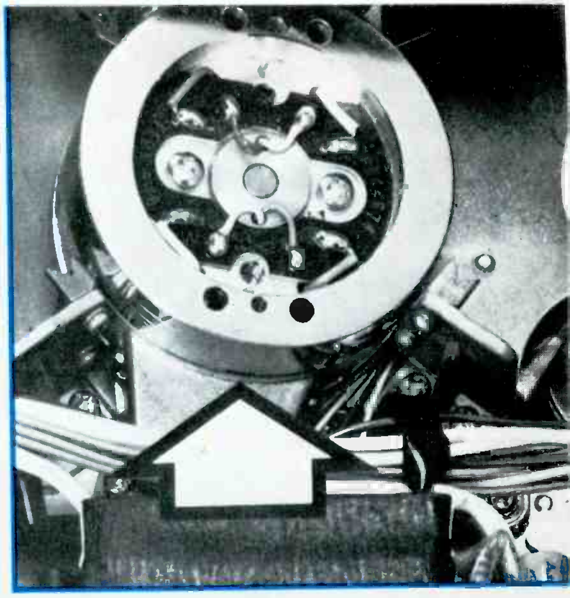


Figure 10. The large arrow identifies one video head in a VHS-type machine. *(Photo courtesy of Nortronics.)*

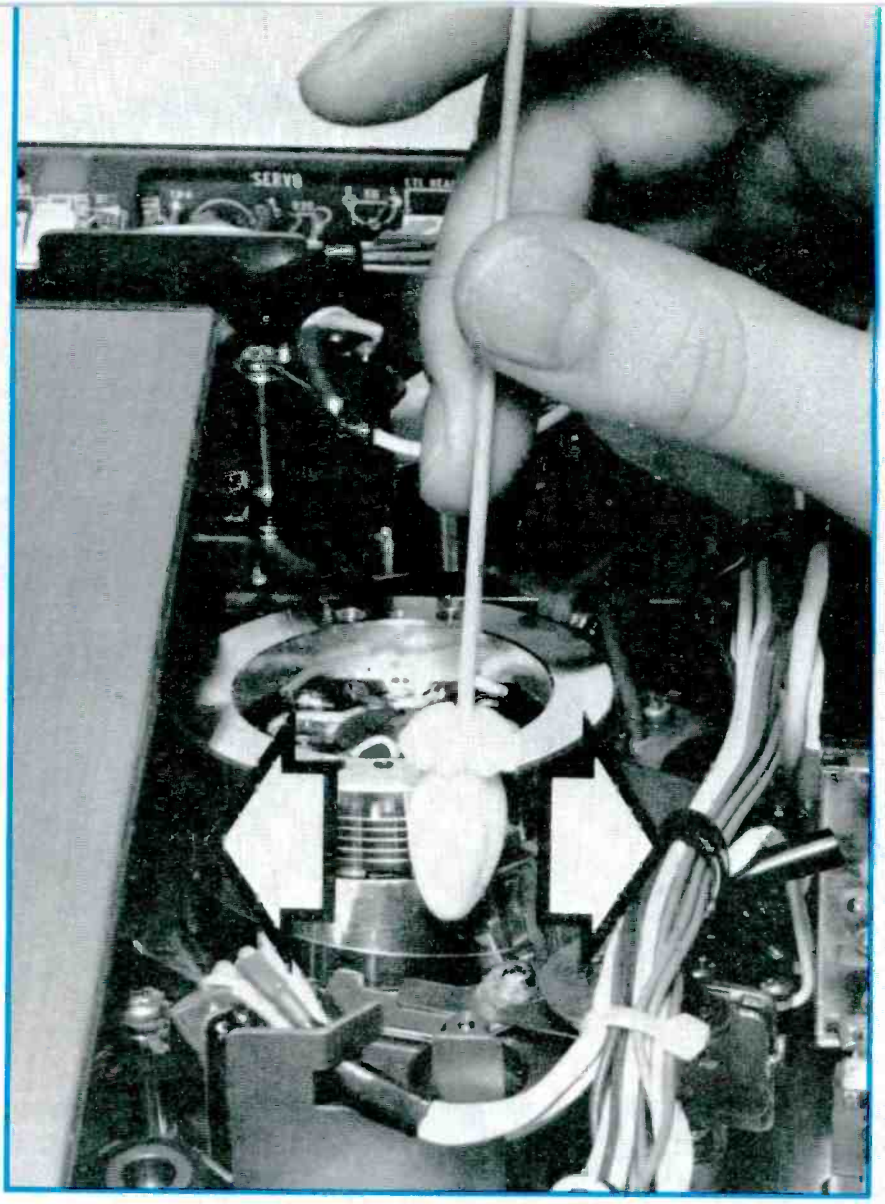


Figure 11. Video heads in VHS machines are cleaned by the same side-to-side motion of a cleaning swab soaked in head-cleaner liquid. *(Photo courtesy of Nortronics.)*

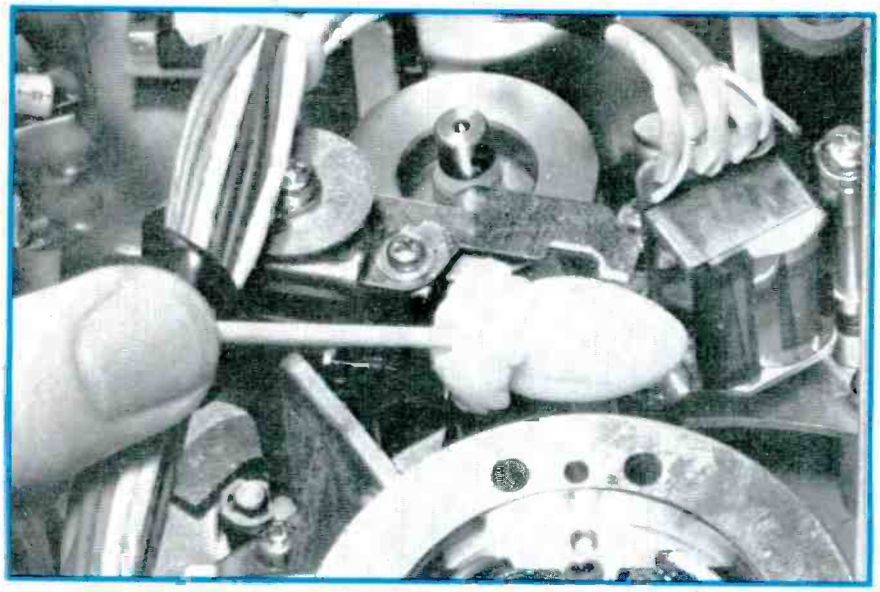


Figure 12. Audio and control track heads in VHS machines are located in front of the swab tip. *(Photo courtesy of Nortronics.)*

Many VCR mechanical alignments and parts replacements require special jigs, gauges and fixtures. Without them, much time can be wasted, and the chances of producing correct operation are small. Learn how to use them.

Video head stiction

The word *stiction* comes from sticking and friction. Stiction describes a condition of the video-head drum assembly that causes the tape to stop moving during recording or playing. If stiction occurs and the machine is not shut off immediately, severe clogging of the video heads can occur, with consequent damage to both tape and heads.

Loss of air cushion between the tape and the drum head is the usual cause of stiction. Friction of the tape during normal operation polishes the drum surface to a smooth finish. When the drum becomes too smooth, the air cushion cannot exist, and the tape adheres to the drum. Replacement of the head drum is the ultimate solution, but a costly one.

The following method is recommended as a last resort before the video-head disc is changed because of stiction. Do not use sandpaper, emery cloth or similar abrasives during this repair, and use extreme caution around the video heads, because they can be damaged easily. The procedure requires a Zenith SC-21179 brush tool that can be obtained from area Zenith distributors.

- Remove the cassette lift assembly and threading-arm guides (in Sony and Zenith machines).
- Remove the arm-lock bracket and the tape-retainer spring assembly.
- Remove the rear-panel assembly and perform the threading operation.
- Fold a calling card as shown in Figure 13 and insert it between the drum and the head-bracket assembly.
- Position the video heads as specified for dihedral adjustments and then lock them in place with partially inserted dihedral screws. (If dihedral screws are not available, hold the rotating disc firmly with thumb and forefinger, taking care not to touch the heads.)
- Use the special brushing tool

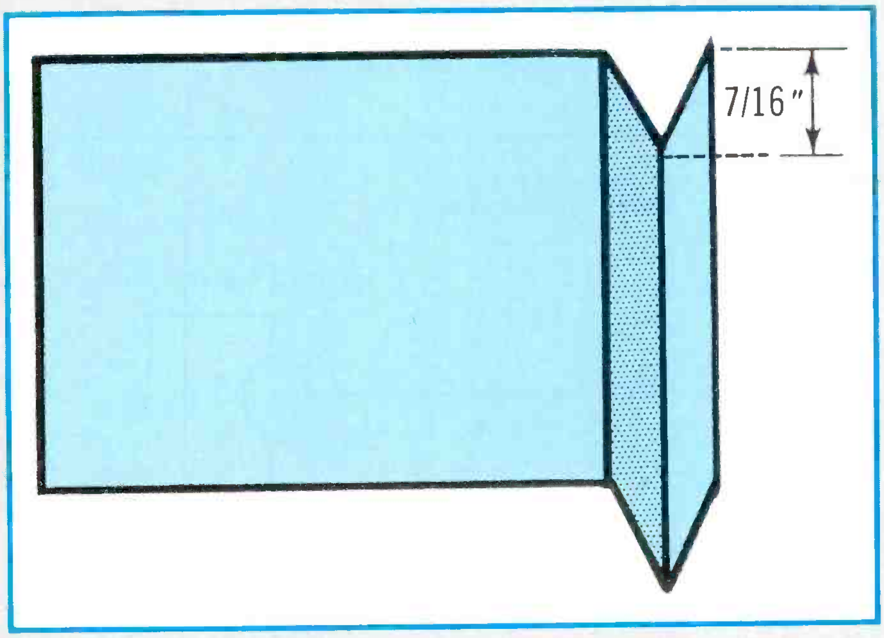


Figure 13. When burrishing head drums to eliminate stiction, construct this simple shield from a calling card.

(with its bristles set to approximately ⅛in) to brush horizontally across the upper (stationary) head disc. Then also across the rotating center head disc, and finally the stationary lower head disc. Do not approach closer than about ⅜in to the head-disc coil.

- Continue in this way from the front of the head-disc assembly to within ⅜in of the coil at the rear. Then rotate the video head disc clockwise until the rear coil is in line with the rewind-sensing coil.
- Hold the rotating disc in place and continue brushing toward the rear of the head-disc assembly. When the tape path around the drum has been brushed to a dull finish, blow all remaining aluminum particles out the VCR's rear by using compressed air or the canned air found in some VCR head-cleaning kits.

Careful performance of this procedure should eliminate the stiction, giving many more hours of satisfactory performance.

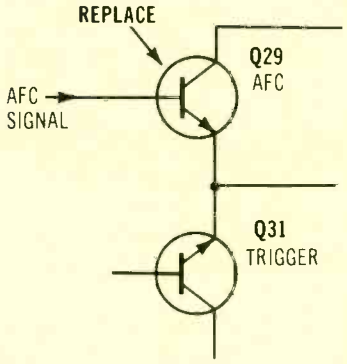
Comments

Cleaning of all VCRs should be performed regularly before operating problems begin. Many VCR troubles will disappear after these cleaning and head-demagnetization procedures are performed, so we recommend they be done after the symptoms have been verified but before other repairs are attempted. ES&T

Symcure

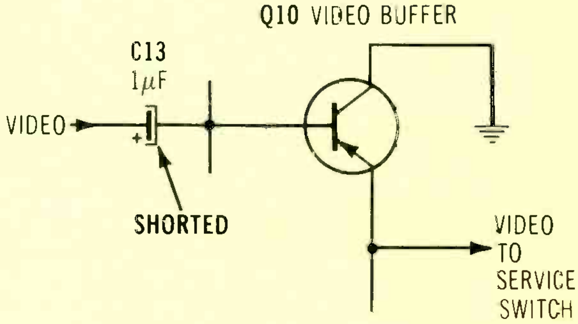
Symptoms and cures compiled from field reports of recurring troubles

Chassis – RCA CTC88 1
PHOTOFACT – 1787-1



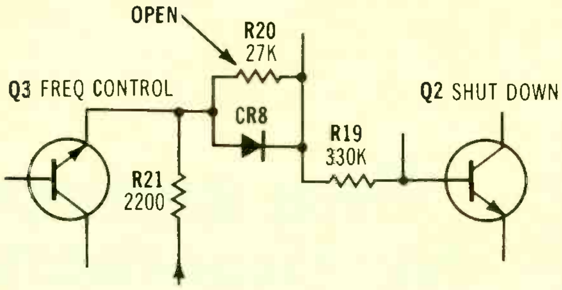
SYMPTOM – Incorrect horizontal frequency; cannot be corrected by hold control
Cure – Replace AFC transistor Q29 as a test

Chassis – RCA CTC97 2
PHOTOFACT – 1931-2



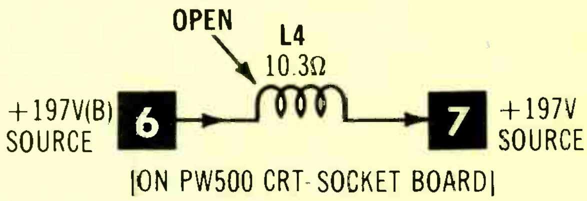
Symptom – Excessive brightness with retrace lines
Cure – Check capacitor C13 and replace it if shorted

Chassis – RCA CTC97 3
PHOTOFACT – 1931-2



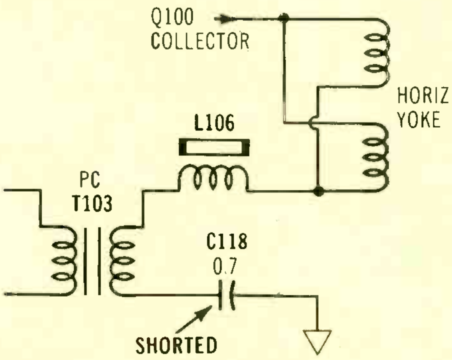
Symptom – Erratic shutdown, similar to overcurrent
Cure – Check resistor R20 (in regulation circuit) and replace it if open

Chasis – RCA CTC101 4
PHOTOFACT – 1896-2



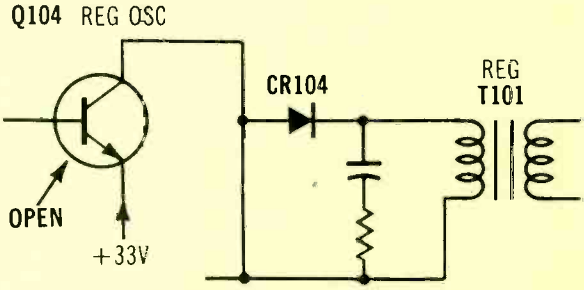
Symptom – Excessive brightness with retrace lines, shutdown in a few seconds
Cure – Check L4 (on CRT-socket board) and replace it if open

Chassis – RCA CTC101 5
PHOTOFACT – 1896-2



Symptom – No sound or raster; receiver in shutdown without high-voltage
Cure – Check yoke-coupling capacitor C118 and replace it if shorted

Chassis – RCA CTC108 6
PHOTOFACT – 2030-2



Symptom – No sound or picture; no tic-tic from regulator
Cure – Check regulator oscillator transistor Q104 and replace it if open

Photofact

These Photofact folders for TV receivers have been released by Howard W. Sams & Co. since the last report in ES&T.

EMERSON
BT-121 2153-1

JCPENNEY
685-2018-60 2152-1
685-1028G,-30 2153-2
685-1037G, -20/38G,-20 2157-1
685-2004-20 2158-1

MAGNAVOX
Chassis 09C201 2152-2

PHILCO
Chassis E34-7/9 2153-3

QUASAR
Chassis AM/AQ/ASQ/ASR/P/
SR/YAM/YAQ/YASQ/YASRDTS-980 2156-1
Chassis N/PTS-989 2157-2

SEARS
401.50301150 2154-1
564.44151250/4201250/4221250/
4241250 2158-2

SONY
Chassis SCC-265Z-A 2155-1

WARDS
GEN-11282A 2152-3
GGV-12974A,B,C 2154-2
GEN-12324A 2155-2
GNB-16333A 2156-2

Coming in ES&T

CRT problems or circuit defects? These defects can often cause the same symptoms, so a technician must learn to determine which element to service. This article offers help in analyzing the symptoms and locating the problem.

Recommended audio test equipment. For someone interested in servicing audio equipment, it may be difficult to decide on what equipment to buy. It is tough to decide what is needed right away and what can be bought later, but this list of basic test equipment outlines what you will need from day one.

Readers' Exchange

Needed: Would like to copy service manuals and/or schematics for Sencore SS137 sweep circuit analyzer, Power Designs model 5015S, and Sylvania CK 3000 test jig. *Dennis Hoey, 707 Whitpain Hills, Center Square, PA 19422.*

Needed: CRT checker restorer/analyzer (B&K models 467, 470 or similar). Also Sony picture tube #140CB4 (#73110510). *Ed Herbert, 410 N. Third St., Minersville, PA 17954.*

Needed: Schematic and source of pulleys for Standard Radio Corporation PRO 3000 cassette deck, model SR-T18OD-KU. Unable to locate manufacturer's address. *Bert Kuschner, 3340 Turtlemound Road, Melbourne, FL 32935.*

Needed: Service manual for Dynaco stereo amp, model #SCA-35. Will buy a photocopy. *Rubadub Recording Company, 3411 Wellington Ave., Parma, OH 44134.*

Needed: Schematic for Sears CB, model 3810. Call collect or write. *J.A. David, 3740 Stone Haven Drive, Charlotte, NC 28215; 1-704-537-7624.*

Needed: Record-playback head for Kirting Constellation 66 4-track, reel-to-reel tape recorder. *Harrison's Radio & TV, Carnduff, Saskatchewan, Canada S0C 0S0.*

For sale: Heathkit model 10-4540 scope; 5MHz triggered sweep with flyback ringer built in; factory wired and calibrated; like-new condition. Sencore portable digital voltmeter, model DVM-35; like new; still in box with warranty. Bell & Howell Schools (Heathkit) digital multimeter, model 1MD-1210-2; like new. All are in excellent condition and supplied with manuals and leads; guaranteed. Best offer for one or all; am open for trades. *Rod Wells, 4528 N. Dearing St., Fresno, CA 93726; 1-209-291-5071.*

For sale: Knight RF sweep generator/crystal oscillator with cables and manual, excellent condition; Knight VTVM with hi-volt probe and manuals; Eico signal generator, model 324, with cable and manual. All instruments for $90 plus UPS shipping. *Ron Kolasa, 4942 E. Flower Ave., Mesa, AZ 85206.*

For sale: Eico model 368 TV-FM sweep and marker generator, $50; model TV50 Genometer by Moss Electronics, $30; model 76 CR bridge and signal tracer by Superior Instruments, $30. All with manuals. Send for list for more equipment. *Lloyd E. O'Brien, Radio & TV Service, P.O. Box 105, Springfield, WA 26763.*

For sale: Tektronix equipment – two type-162 waveform generators, one type-163 pulse generator and one type-160A power supply. Best offer or consider trade for TV test equipment. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235; 1-412-242-4701.*

For sale: Retiree wishes to dispose of excess radio and TV tubes (300 plus) to highest bidder. Will itemize upon request. *Graham Pickles, 3834 Calle De Soto, Tucson, AZ 85716.*

For sale: Conar solid-state oscilloscope, trigger sweep, model 255; four probes included; $150 plus postage. Heathkit regulated high-voltage power supply, model IP-17; 400Vdc, –100Vdc, 6.3Vac, 12.6Vac; $70 plus postage. Heathkit stereo sweep generator, model IG-37; center frequency 100MHz, pilot frequency 19KHz; % crystal controlled markers; $50 plus postage. Manuals, schematics and cables included. Send for list of more equipment. *Henry H. Perry, 37 Grand View Ave., Lynn, MA 01904; 1-617-595-2855.*

For sale: B&K model 415 sweep/marker generator, $300; Simpson model 465 autoranging digital multimeter, $200; B&K model 290 solid-state electronic multimeter plus PR-32 demodulator and PR-28 high-voltage probes, $175; and more. All equipment like new with accessories and manuals. Send for complete listing. *Clarence C. McKee, 9516 Zion Road, Rives Junction, MI 49277; 1-517-569-3139.*

For sale: Parts, equipment, etc., from pre-'70s radio-television, appliance service (shop close-out). Best offer; send SASE for list. *Otmer Basham, 214 S. Craig Ave., Covington, VA 24426.*

For sale: Riders radio and TV servicing schematics, complete. Radio volumes I through XXIII, TV volumes 1-18, complete with index catalog; $250 plus postage. *William Krieger, Bill's Television Service, 153 W. Baseline Road, Glendora, CA 91740.*

For sale: B&K equipment – scope 1472CP (usable to 30MHz) TVOM #290, CRT analyzer #467 (includes 10 adapters), NLS DMM #3.4A and other excellent pieces of slightly used equipment. Write for list and prices; package deal under $2100. *Leonard Elgart, 3510 Avenue H, Brooklyn, NY 11210.*

For sale: 1924 Fada 5-tube radio, restored, works well; three 1902 books entitled *The Library of Electric Science* (1358 pages). *George Robinson, 7155 Walden Road, Newburgh, IN 47630.*

For sale: B&K solid-state sweep/marker generator, $195 plus shipping, *W. Hagel, 8400 Old Melones Dam Road #80, Jamestown, CA 95327; 1-209-984-3711.*

SWD-1 VIDEO CONVERTER

FOR CABLE TV

The SWD-1 Video Converter is utilized on cable TV systems to remove the KHz's signal from a distorted video (channel 3 in/out) and also pass thru the normal undistorted/detected audio signal. Rocker switch selects operating mode to remove KHz's distortion from the video or pass all other channels normally. Simple to assemble—less than 30 minutes. Pre-tuned. Input/output Channel 3. Impedance 75 ohms. 117VAC.

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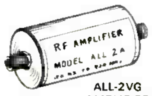
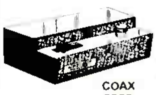


ALL-2VG AMPLIFIER



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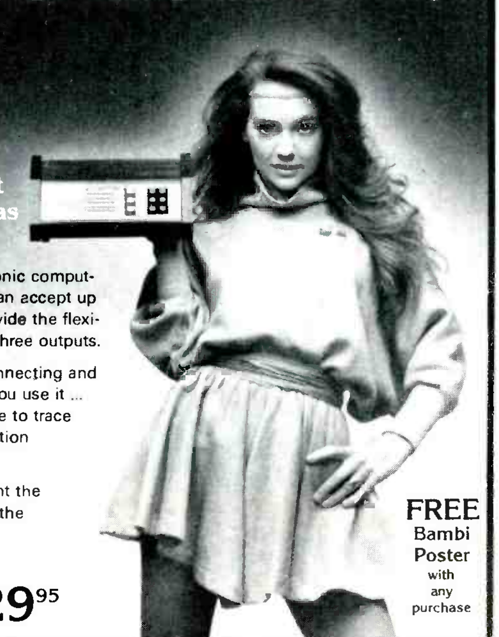

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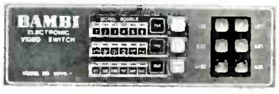

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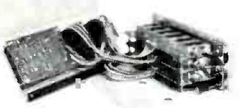

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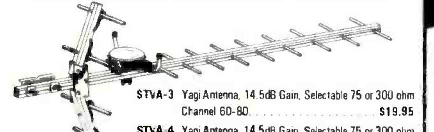

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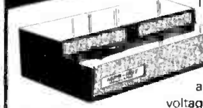

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Needed: Schematic for Fairchild TC175 CCTV camera; schematic/book for U.S. Navy signal generator, model TS-418 A/U 400MHz-to-1GHz; schematic for General Radio 1021-P1 generator, 250-920MHz. *Joseph Silver, A&B Electric Co., 1883 E. Main St., Rochester, NY; 1-716-288-1520.*

Needed: Back copies of **Electronic Servicing** from 1977 to 1980. *Walter Walsh, 7940 Jefferson Highway, #220, Baton Rouge, LA 70809.*

Needed: New or used flyback transformer for a B&K TV analyst, model 1075. Give price plus shipping charges to Puerto Rico. *Rivera's Radio & TV Service, 3462 Ma. Sta., Mayaguez, Puerto Rico, 00708.*

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Needed: Schematic and/or manual on Radio City Products, model 123 flybacker; schematic and/or service manual for Systron Donner or Fairchild 6200A (the machine was made by two different companies over a period of years). *Bob Goddard, 72 Grove St., Plainsville, MA 02762; 1-617-699-7454, after 5 p.m. EST).*

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Needed: Service manual and schematic for an RCA Rider Chanalyst, type 162C. Will pay for same or copy and return. *William A. Thoma, 762 Silverleaf Drive, Dayton, OH 45431.*

Needed: Supreme Most-Often-Needed TV Manuals, #TV-6, 7, 9 and 21. Also Sams Photofact #TR-82. *C.T. Huth, 146 Schonhardt St., Tiffin, OH 44883.*

Needed: Sencore LC-53 Z meter, Sencore DVM-56A Microranger, and Sencore UPS-164 universal power supply, or comparable equipment. Will pay cash or will trade my Sencore, B&K, Eico and Heathkit equipment via UPS. *Rod Wells, 4528 N. Dearing St., Fresno, CA 93726; 1-209-291-5071.*

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Needed: The complete tuner system mounting bracket and connecting system and tuners for Zenith color TV chassis #25DC56. *Jiranek TV, Farmington, IA 52626.*

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Needed: Sams Photofacts #1000 and up. Also need a B&K model 467 CRT tester or equivalent. *Tom Craven, 204 Maple Grove, Springfield, IL 62707; 1-217-529-6123.*

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Special capacitors for television

By C. A. Honey

Illustrations courtesy of Sencore.

Most TV servicemen who have been servicing for several years are aware of many changes in the design philosophy of components, particularly capacitors. In the old vacuum-tube days, the main filters were wet electrolytics with open vent holes in their tops. If you turned a set on its side, electrolyte would run over the service bench and capacitors would have to be replaced.

In the late '40s and early '50s, electrolytic capacitors with a paste electrolyte appeared on the scene. The spill problem ended but we still had the problem of shelf life. Even today we need to apply voltage to new filters to "form" them and condition them for low in-circuit leakage on turn-on.

With the advent of solid-state design, several new types of capacitors appeared on the scene. For the first time, we encountered several types of electrolytic capacitors. We found that our old solar capacitor analyzer or the older type bridges of other makes would destroy many of the low-voltage units we now encountered. Analyzers with 30V to 70V bridge voltages could not be used to measure a filter rated at 3V, 6V or 25V.

New terms appeared in parts lists: *solid tantalum, wet slug, aluminum electrolytic.*

To help those new to this industry and refresh the memory of old-timers, I'll briefly summarize some of the characteristics of modern filters and other capacitors marked with only a part number and the word "special."

Electrolytic capacitors

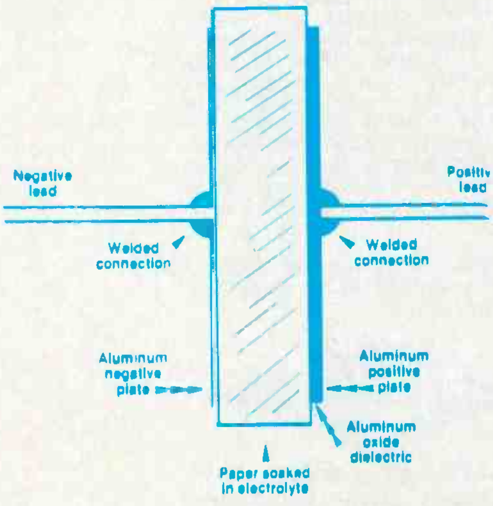
Electrolytic capacitors, as compared to other electronic components, might be considered perishable. They deteriorate comparatively quickly when stored on stockroom shelves. They actually wear out with use, some rapidly if applied improperly in a circuit. Their proper operation depends upon several factors: working voltage, surge voltage, temperature of operation, leakage at rated working voltage, amount of ac actually being filtered, mass (larger mass holds more internal heat), and power and dissipation factors.

Perfect capacitors do not exist in practice. In addition to capacitance, they exhibit internal series inductance (ESL), parallel leakage resistance (IR) and equivalent series resistance (ESR). All of these factors combine to cause problems during normal operation. These losses appear as heat and must be kept to a minimum if long capacitor life is to be attained.

Most small, low-voltage capacitors for modern sets are aluminum electrolytics. If designed for PC-board mounting, they take up little space and usually have stable capacitance, ESR and leakage characteristics. Many are designed for up to 85°C operation. A typical example of this type is the Sprague Verti-lytic series used for replacement purposes by many TV shops.

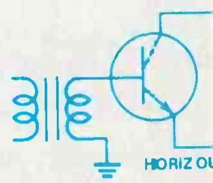
Tantalum capacitors

Tantalums are more expensive and harder to obtain than ordinary electrolytic capacitors, so they do not often appear in designs for consumer electronics. In some special cases, the extra cost is justified. In the computer field, for example, many are used because of their higher reliability. They are noted for having few or no catastrophic failures, even after more than 10 million unit-hours of life and environmental tests.



An aluminum electrolytic capacitor consists of two aluminum plates with an electrolyte-soaked material between them.

In addition to the failure modes shown in this illustration, capacitors may also open or short out.



They also have a reverse voltage capability of up to 3V and will function with a higher ripple-current-carrying capability than regular electrolytics. If you replace a tantalum in a set, do not use a regular-type electrolytic. If the cheaper type could have been used successfully in the circuit, the manufacturer would have used it.

Electrolytics perform a valuable function, but there are many applications where they simply will not work. Most technicians are aware of this, but many do not know the reasons why certain special types are required in certain areas of consumer electronics. I would like to list a few of these special types, give their characteristics, and show their application.

This information will help you to analyze a TV circuit and determine which type capacitor should be installed when failed units must be replaced. Unfortunately, most manufacturer's service data does not give much more than a part number and notes that "For safety's sake, you should replace *only* with an exact replacement." Few shops want to wait until they order a special part only to find they had a suitable replacement type in stock which they could have used. On the other hand, you do not want to replace a special capacitor with a part that will soon overheat and fail.

Electrostatic capacitors

Non-electrolytic capacitors fall into a category we commonly call *electrostatic*. They are used in circuits as bypass capacitors, as couplers of signals and in circuits with complex voltage or current waveforms. Several types are manufactured, and each type is designed for a specific application. This article is written mainly to describe those types of capacitors that *must* be used in the pulse circuits of modern TV sets. Just as special rectifier diodes must be used for scan rectifier circuits, special capacitors must be used as well.

Capacitors that do not have special construction will not work at the horizontal frequency or pulse level without severe internal heating. I have had sets that repeatedly failed in the same area. When you touched the retrace capacitors you could almost burn your fingers. Investigation showed that the dealer who had previously tried to repair the set had been using a regular 1.6kV capacitor in the retrace circuit, and as a result, it was shorting out at regular intervals. The one he used was a high-quality part in perfect condition, but it was not designed for that application.

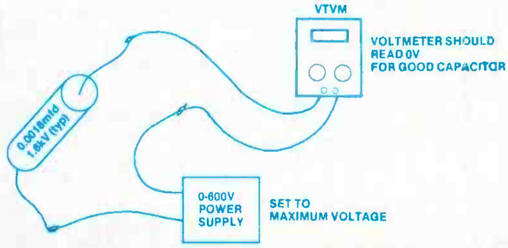
SCR capacitors

Capacitors designed to handle the fast rise and fall pulses in the modern TV set are often called SCR capacitors. A more common term would be a *retrace* capacitor, because this is the term used in transistorized horizontal output stages, as well as SCR sweep-type sets.

Special 4-legged capacitors

These capacitors are made similar to the SCR capacitors and the following statements apply to both. They are defined by several terms, but are similar in physical material and construction. The April 1982 issue of **ES&T** (page 48) discusses the retrace capacitor used in Admiral sets. Many other makes use it also. Various values are used but the purpose is the same: These capacitors complete the yoke and flyback resonant circuit during retrace time.

During this retrace time, high pulse currents flow through the capacitor. These pulses have fast rise and fall times and cause severe problems in conventional capacitors. The severest of these is internal heating brought about by ESL-IR-ESR losses within the body of the capacitor.

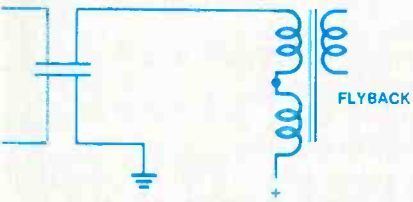


If a capacitor analyzer is not available, you can check a capacitor with a power supply and a VTVM. After an initial surge of the meter, it should drop back to zero.

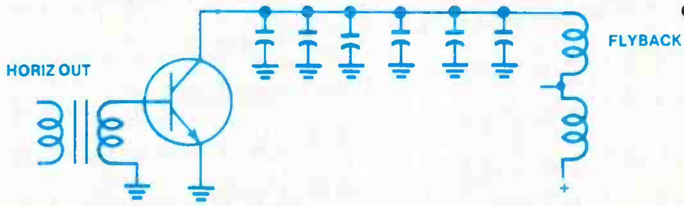
I prefer the separate capacitors instead of one large one for retrace use. Zenith, for example, has as many as six or seven "special" capacitors in the retrace circuit of some sets. These may be found in two styles. One style, white in color, experiences a high failure rate. The other, a Sprague type PP, has an orange body. Both types are marked with the part number 22-5001 and may or may not be marked with the capacitance and voltage rating. Incidentally, that part number is a 0.0018mfd at 1.6kV; it cannot be replaced with a conventional part. Any retrace capacitors in the white case, regardless of the make of set, should be replaced with the PP type as preventive maintenance.

In the average Zenith with separate capacitors, I have had from two to three of these open without the owner noticing any trouble. Of course the high voltage would be higher than normal and each time a capacitor opened it would jump 2kV or 3kV. Eventually catastrophic problems would occur, as documented by Zenith.

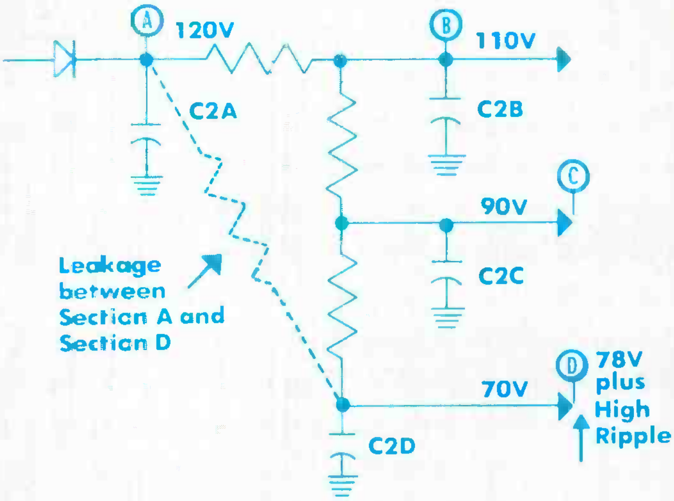
I do not normally replace the 22-5001 capacitors with a 4-legged one, even though Zenith has a mod kit for this application. I replace the original part, usually a white capacitor with only the part number on it, with a better quality replacement. I have never had a recurring failure. The reasons I prefer separate capacitors are simple. First, one large capacitor



A 4-lead capacitor completes the yoke and flyback resonant circuit during retrace time.

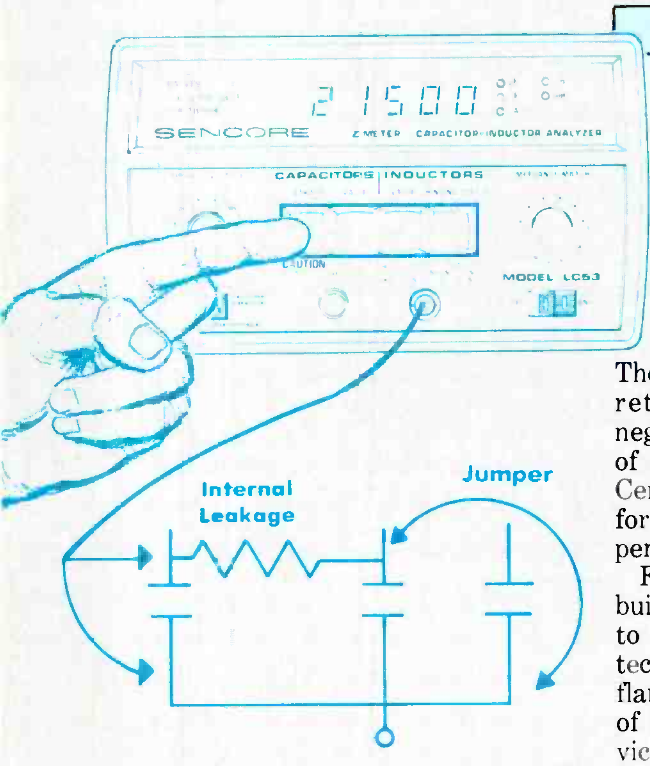


Some TVs use six or seven separate specially manufactured capacitors in the retrace circuit rather than a single 4-legged unit. Advantages are improved heat dissipation and limited high-voltage change when a capacitor opens.



Leakage between sections of a multi-section electrolytic capacitor changes voltages, couples signals and creates odd symptoms in the circuit.

(4-legged or not) holds more heat internally and can accelerate failure. Second, when failure does occur in the separate capacitors, it is usually an open. With several in parallel, all that happens is the high voltage may increase 5% or so. On the other hand, a 4-legged capacitor, though it is not supposed to, sometimes opens capacitance-wise without opening the collector or emitter circuit. The higher voltage goes to extreme levels and catastrophic failure results.



Leakage between sections of a multi-section electrolytic capacitor is indicated by an increase in leakage current when testing one section and a short is connected across another section.

What makes a capacitor *"special"*?

The secret to the proper type of retrace or SCR capacitor may be found in its construction or design. As mentioned before, internal heating is the most frequent cause of failure. In TV sets, this has been solved by using special capacitors for extraordinary requirements. These may be broadly categorized by dielectric material into polypropylene, polycarbonate, polyester and polystyrene.

Polypropylene capacitors

Polypropylene capacitors are probably the best type to be found for use in SCR sweep circuits and as trace capacitors in other type sweep systems. They will handle high ac current or voltage waveforms of pulse or complex nature with minimal internal heating. Those specifically designed for TV retrace applications have a negative temperature coefficient of approximately 180 ppm per Centigrade degree, which allows for high circuit stability and compensation.

For these applications, they are built to a 5% tolerance and rated to 105°C. To provide further protection, they are coated with a flame-retardant epoxy. This is one of the main reasons we have service notes saying "For safety's sake use only an original equipment replacement part." Obviously if we know the design characteristics of the original part, we can replace it with equal or better parts that may be much easier to obtain than the original.

Regular film-type capacitors, while suitable for pulse applications, still have drawbacks, and proper circuit design and application are important. By derating the case temperature or applied voltage, the life of a polypropylene capacitor may be extended many hours.

Each 8°C decrease in case temperature will usually extend the life of these capacitors by at least 100%. It is feasible that their life could be extended beyond 100,000 hours, with a survival rate of about 95%, by use of proper derating of temperature and voltage. Forced cooling or increasing the retrace capacitor surface area can accomplish this. Using several capacitors in place of one large, 4-legged type is one method of increasing surface area.

Polycarbonate capacitors

This is also a type of film capacitor, generally described as a "metallized polycarbonate film." It operates easily at frequencies up to 40kHz with a dissipation factor in the order of 0.3 to 0.5% over extreme temperature ranges. Because of these low losses, it works extremely well in pulse circuits. Polycarbonate capacitors are not used as much in TV sets as they once were, due to higher cost. They have generally been replaced by other film types, especially polypropylene, which are even better suited for small current pulse widths. Another disadvantage to use of polycarbonates in television is that they must be derated much more than polypropylene types if used in circuits with pulse widths below 30μs.

The width of the pulses in horizontal output circuits can be as short as 10 or 12μs, depending on how well the circuit is tuned. At a width of 25μs for example, a polycarbonate must be derated about 40% to keep its voltampere losses (heat) down to an acceptable value. A polypropylene, on the other hand, used in the same application, must be derated only 5%. Polycarbonates really come into their own when used with pulse widths above 200μs, where no derating is required.

Polycarbonate capacitors have a typical capacitance change of about 0.5% at 125°C, compared to more than 10% for polyester. From room temperature to 85°C, the typical change is 0.3%, compared to 0.7% for a polyester capacitor. It has a low dielectric absorption, typically running about 0.4%. Other characteristics are quite similar to those of a good polystyrene capacitor except that a polycarbonate will operate at much higher temperatures.

Polyester film capacitors

These capacitors are made with thin foil and special impregnated dielectric material. They are available in voltage ratings up to 1600V, but special precautions must be observed in their use. At 105°C you must derate the voltage by 25%. At 125°C you must derate 50%. They are useful for dc applications but have limits as to how much ripple they can handle.

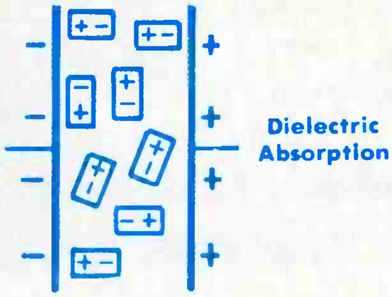
Maximum ac for a 1600V unit is 500V from 10Hz to 60Hz. Further derating to 400V is necessary at 120Hz. Polyester film capacitors are not used in pulse circuits and should be avoided when replacing retrace capacitors.

They do have some good points, however. Their dissipation factor is approximately 1%, and normal design operating temperatures are from −55° to 85°C.

Exceptions to the above specifications are found when we examine the construction of high-voltage doublers or triplers. Special polyester capacitors are usually used because of their small size and because they work well when immersed in potting compound. Polyester humidity characteristics are excellent; they are stable with time, temperature and voltage. As long as high peak-current ratings are not exceeded, they have a long lifetime when sealed within the epoxy blocks.

Polystyrene capacitors

Polystyrene capacitors have special characteristics all their own and for their intended applications cannot be outperformed. Tolerances may run from 0.1% up to 20%. Because tight tolerances are easy to achieve, you will find them used in critical applications



Dielectric absorption is a phenomenon caused when some of the dipoles in the dielectric fail to release their energy when the capacitor is discharged.

in analog and digital computers, in precision timing circuits, or in high-Q tuned circuits. Most laboratory capacitor standards will be polystyrene.

They have low dielectric absorption and an insulation resistance so high that it is almost impossible to directly measure it. Their temperature coefficient is approximately linear over a temperature range of −55°C to 85°C. Perhaps one of the biggest advantages is that the capacitance is for all practical purposes independent of frequency.

Practical service hints

If a set comes in with a shorted horizontal output transistor, remove one end of each retrace capacitor (both leads on one end of the 4-legged capacitor), and check it for value and leakage. With multiple retrace capacitors, you will usually find one or more open. Because of the way they are designed, they usually open instead of shorting. The result is a rise of high voltage, and a duty cycle change that results in overheating of the output transistor.

Sometimes the open retrace may be found to exist by merely measuring the high voltage. If the set is of modern design, it probably has no high-voltage adjustment and high-voltage measurement will indicate if capacitors are open. With multiple retrace capacitors, you can assume a voltage increase of about 5% for each open capacitor.

When finishing up a solid-state service job, run the set for about 10 minutes and then shut it off and feel the case of the horizontal output transistor. If the proper retrace capacitor values are present, resulting in proper tuning of the resonant flyback circuit, the case temperature will be relatively cool. A hot case means you have the wrong value (total) from the collector to ground of the output transistor.

How to check retrace capacitors

Because these capacitors are rated from 1200V to 1600V, depending upon the set, conventional methods may fail to detect problems. An ohmmeter check will show only a short or an open between the two leads at one end of the 4-legged capacitor. A capacitor that breaks down under load will not show a problem with a 1.5V ohmmeter check.

A much better way to test one of these high-voltage capacitors is to use a good capacitor analyzer that had a leakage check to at least 600Vdc. If you do not have such an analyzer, then the dc power supply from an auxiliary source may be used, as follows: Remove the retrace capacitor from the set and connect one end to one lead of the power supply. Connect the other end to one lead of a VTVM. Connect the remaining lead of the VTVM to the open lead of the power supply. With all three connected in series in this way, turn the power supply on and set it to maximum voltage. After an initial surge on the VTVM, it should drop to 0V if the capacitor is good.

Because 0V on the VTVM means no leakage is present, an open capacitor will also pass this test. Because the tolerance is required to be within 5% of rated value, open capacitors are found when the capacitance is measured. In making any measurements in TV service, it is necessary to have an instrument at least four times more accurate than the desired measurement. With 5% parts, you need a capacitor measurement to 1.25% accuracy. I use a Sencore LC53 for all my testing because it measures leakage to 600V, as well as making a 1% value test. A professional will always have good state-of-the-art test equipment. The days of the screwdriver probe and wet fingertip are over. ES&T

Practical stereo repair

By William H. Stough, Tower Electronics

One of the most common defects in stereo systems is a dead channel. Usually the output transistors are open or shorted, and there are a number of ways to cure the problem. Some technicians replace the outputs, apply power and hope for the best, but it is not uncommon for new outputs to be instantly destroyed.

Another approach is to unsolder every transistor in the dead audio channel and check them all for leakage. This takes time, but some technicians feel that it works better and saves new transistors – at least most of the time.

A better approach

A common item found in a dusty corner of most shops is a variable-voltage transformer. This is a tranformer that can vary its output from zero to approximately 140V, and it has many good uses, including dead-channel stereo repair. For this procedure, replace the bad outputs and hook up the stereo (speakers and all), but do not apply power. Instead, plug the stereo into the variable transformer with the transformer set at 0V. (Note: Some variable transformers are *auto transformers* and do not perform the same safety function as an isolation transformer. If the stereo does not have an internal transformer, plug the variable transformer into an isolation transformer rather than into the ac line directly. See Figure 1.)

Now run the transformer up to 10V and compare the voltages on the good channel outputs with those of the repaired channel. Record those voltages on a chart. Do not trust them to memory; you will have too many to compare for that. (See Figure 2). The voltages at this point will not be proper for normal operation. You are only concerned with *comparing* the left and right channels. At 10Vac instead of 120V, you will not blow the new transistors if there are other shorts, and if all is well you save yourself the trouble of unsoldering many audio transistors. If the voltages are nearly identical, go to 20V and record again. If they are still the same, go to 40V and measure again. Then increase to 70V.

Somewhere around this point, you will usually hear a lot of hum or buzz in both channels. But if the voltages match, do a gutsy thing and run it up more – until the buzz stops. Now pause for a few seconds, remove power, and put your finger on *all* of the outputs. None should be running hot. Beware if one transistor is quite warm when all others are cool. Further testing is then required. If all the voltages have checked the same, you will usually not blow the new outputs.

If the repaired channel has exhibited a radical deviation from the known-good channel at any time, stop there and *go no higher*. By 40Vac, shorted drivers and amplifiers will almost always show up. In these cases, you will have to test the remaining transistors and diodes (if any) in the bad channel, but you will not have blown the new outputs.

Comparative voltage tests of left and right channels at low ac voltages can also be used to find shorted and leaky transistors in the drivers and amps. But regardless of the methods used, *all* transistors with direct coupling to the outputs must be checked. A short in an audio amplifier five transistors away from the outputs can blow the new outputs. *All* bad parts must be found before the repair can be considered complete. Look very carefully for burned resistors. The excess current from the shorts burns emitter and other resistors. It has been my procedure at this point to remove from the circuit every driver and amp with direct coupling and check them out of circuit on a tran-

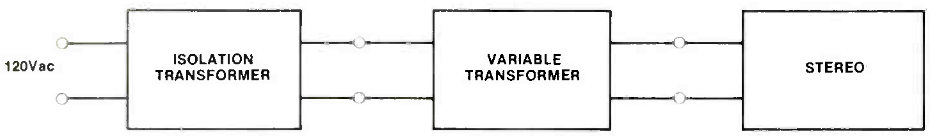


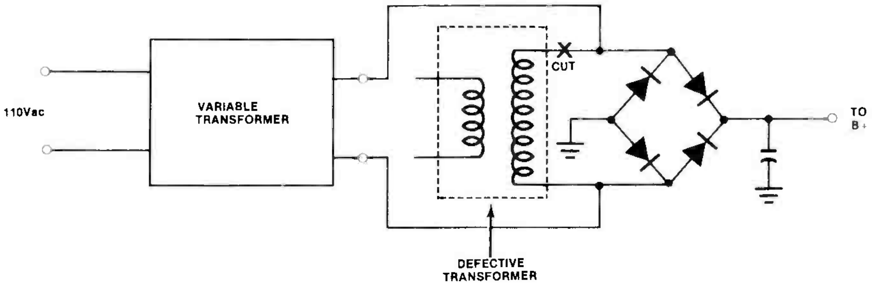
Figure 1. A variable transformer may be used as a valuable servicing aid in stereo repair. If it is not an isolation-type unit, an isolation transformer should be used in conjunction with it.

	Channel under repair						Good channel					
	Q7 NPN			Q8 PNP			Q9 NPN			Q10 PNP		
Vac	E	B	C	E	B	C	E	B	C	E	B	C
10	1.1	1.2	5.4	– 1.0	– 1.0	– 5.4	1.1	1.2	5.4	– 1.1	– 1.2	– 5.4
20	2.5	**3.1**	10.2	– 1.2	– 1.7	– 10.2	1.3	**1.8**	10.2	– 1.3	– 1.8	– 10.2
40	9.8	**10.5**	20.5	– 2.2	– 2.9	– 20.5	3.0	**3.6**	20.5	– 3.0	– 3.6	– 20.5
70	STOP											

Figure 2. Voltage checks of replacement output transistor against known good channel as supply voltage is increased, will reveal problems without damaging components. Here, checks of Q7 (replacement transistor) against Q9 at 20V and 40V supply voltage shows that Q7 is turned on too hard because of other defects in that channel's circuitry.

sistor tester that tests for leakage. Reject any with above normal leakage. (But before doing this, I call the customer with an estimate, described below).

Be careful when putting a voltmeter probe on transistors: One slip may cause a short that destroys a dozen transistors. I once sneezed suddenly while holding a probe in a solid-state television and blew five transistors!



A variable transformer may be used to determine the required specifications of a replacement power transformer when the original unit is defective and no replacement information is available (see text).

An estimate

Coming up with an estimate on a repair job *before* replacing parts is what every customer requests, but how can we do that?

In the case discussed here, in which the new outputs cured the whole problem, you have your estimate. Check all functions of the AM, FM, 8-track or cassette for operation before preparing an estimate.

Where the outputs did not cure the problem, assume at least half of the drivers and amps are bad and allow some leeway. Figure the cost of the parts and labor, then give the customer the estimate. Some stereos aren't worth enough to repair at this point, so it would be a waste of time unsoldering all these transistors only to have the repair job rejected. The transformer method will have saved you much time if this happens.

Bad power transformer

An open power transformer in a TV set is as rare as snow on the Fourth of July, but in stereos,it is not at all unusual. With some makes, you can buy a replacement. Sometimes though, the company that made the unit went out of business, or does not concern itself with repairs. The schematics, if available, may give no voltages. What then?

First, check diodes for shorts. If OK there, check the B+ for shorts. (The filter capacitor the diodes feed is the point you want.) If there are shorts, you must cure the problem before going further.

This can be a good point to call the customer with an estimate – because cheaper stereos are the ones with the most bad transformers. Assuming the job is still on, you now will substitute a new transformer. You guessed it – the variable transformer again!

If the secondary of the set's power transformer had no center tap, hook the variable transformer up to where the secondary of the old transformer went (Figure 3). Fuse it there at about 1 to 2A. *Slowly* run the voltage up until the stereo begins to operate properly. Try it at high volume, checking for distortion. Take the voltage just a little higher and measure – that is the voltage of the replacement transformer you want. Measure the current draw and be sure the replacement will deliver at least 2 to 3 times that. *Fuse* the replacement's primary, check its current draw and install a fast-blow fuse with about 2½ to 3 times that current draw.

A similar process is used when there was a center tap on the original. You use a dc power supply substitute at the B+ source and slowly run the voltage up. Then you calculate the ac required to produce that dc. This varies depending on how the transformer was wired. Remember, in many cases, you can modify how the diodes are connected if necessary. You are primarily interested in obtaining the proper B+ supplies.

ES&T

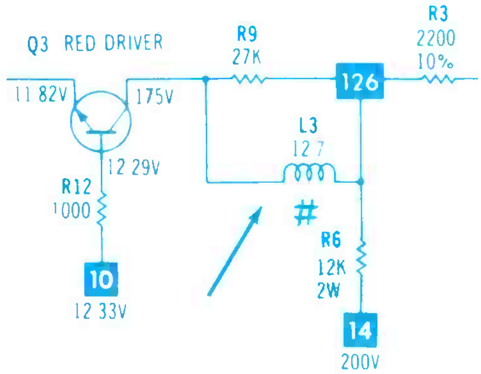
Troubleshooting Tips

Incorrect colors
RCA CTC99
(Photofact 1975-2)

The symptoms of this RCA problem were a severe smear in the red areas, reduced color saturation, incorrect hues and poor gray-scale tracking. Unfortunately, I had not done any troubleshooting in pre-CRT matrixing color receivers previously, and my inexperience resulted in much wasted time.

I decided that the problem was in the low-level demodulation and matrixing circuits prior to the color-output power transistors, so I scoped everything and became more confused. I expected the same waveforms as were obtained in tube-equipped receivers, but they were different. For a time, I wondered if the waveforms were correct or not, indicating normal operation or a defect. Finally, I concluded these waveforms were correct, but they were different from those in older receivers because of vertical and horizontal blanking pulses added to the composite video or perhaps because of the matrixing of luminance and chrominance signals.

The situation became worse when I scoped the red, blue and green matrixing transistors that had –Y chroma signals at each base and Y luminance waveforms at each emitter. The collector signals did not appear to be valid additions of luminance and chrominance signals. Worst of all was the discovery



that some matrixed waveforms were present at the bases of Q1, Q2 and Q3, the three color-output transistors that drive the CRT cathodes. That surprise was explained when I remembered that some signal must be transferred from emitters to bases because of the constant current during operation.

Finally, I found a radically different waveform at the Q3 red-transistor collector, while the Q1 and Q2 waveforms were similar. Ohmmeter tests proved peaking coil L3 was open. The open coil increased the collector load to 39K rather than the usual 12K, and the 27K resistance of R9 blurred the red picture while decreasing the red present in the raster. Replacement of L3 cured the picture symptoms and gave a better waveform at the Q3 collector.

Although some time was lost in exploring these various waveforms, it was worth the cost because I learned what to expect in pre-matrixing circuits.

Glen H. Bryant
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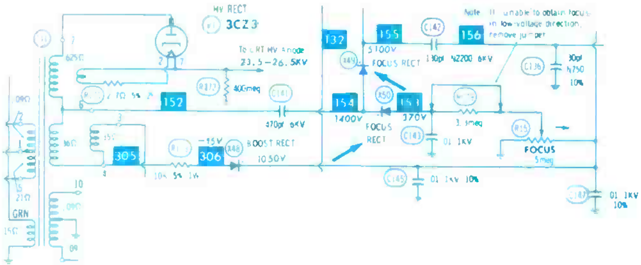
Snivet lines in picture
RCA CTC40
(Photofact 1030-2, etc.)

Only one symptom was noticed, when the CTC40 receiver was first tested on the bench. Unstable vertical black lines could be seen on several channels. With solid-state receivers, these lines are called snivets, and they originate during the same time of each horizontal scanning line. Therefore, the source is somewhere in the horizontal-output stage or the high-voltage system.

Conventional tests of these components will not reveal the one causing the snivets. Perhaps an internal arc radiates noise pulses that are then mixed with the incoming station signal. Or the cause might be a parasitic oscillation that is triggered by the horizontal pulses. In any event, the offending component often must be identified by an absence of the symptom when the part is replaced as a test.



We began by replacing the trace and retrace SCRs, switching diodes in the trace and retrace areas of the horizontal-output stage and the high-voltage rectifier tube. No improvement was noted until the two focus diodes (X49 and X50) were replaced. All snivets were eliminated by the two new diodes.

Incidentally, I have not been successful when using ECG116 replacements in this circuit. Original-replacement RCA diodes are recommended here.

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ES&T

Exploring solid-state memories part 2

By Bernard Daien

The words *memory* or *memory bank* usually mean a rather large capacity memory on one or more circuit board assemblies. These assemblies are made up of several IC RAMs or ROMs, with the necessary wiring interconnects. The reason for such large memory capacity is that microprocessors by themselves are useless, and even smaller systems based on microprocessors (MPUs) need quite a bit of memory in order to store programs. Because the memory is used with some sort of computer, specifications of the memory are determined by the computer system into which it is connected. In the case of most MPUs today, a 16-wire address bus is used in order to give the system an addressing capability of more than 65,000 addresses.

At this point, we need to clear up a little confusion that exists in digital literature. When speaking of a memory, it is common to find a RAM described or referred to in several different ways. For example a 4K-by-8 RAM might be termed a 4K RAM, meaning that it has 4096* different addresses, but the word length is not defined, and the writer assumes that the word length in the system being used is known to the reader. Again, the same RAM might be referred to as a 32K RAM, meaning that the RAM has a total storage capacity of more than 32,000 bits. Sometimes in this context, the author will be a bit more specific and refer to the RAM as a 32 Kilobit RAM, which is more accurate. Still more confusing, when speaking of an MPU system, including the RAM, 4K means that the system has a 4096-address capability. So you see, RAMs and their systems can be defined in terms of addresses, words or bits, and the reader must be careful to determine which is being used.

*Editor's note: In a digital system, one K refers not to 1000, but to 1024 (2^{10}, or two times itself 10 times). This is the power of two that is closest to 1000, so it is called one K.

Memory Banks

It is now apparent that in order to build a memory for use with a modern MPU, we must incorporate the ability to work on an address bus of 16 wires, (a 16-bit address bus). As an example, we are going to look at a memory of 4096 8-bit words (a 4K-by-8 RAM). To be more specific, we are going to make it a high-speed, N-channel MOS, static RAM, with tri-state outputs, using type 2102, 1K-by-1 RAM ICs. These chips were selected because of their low cost and good performance. Figure 1 shows the chip pin-outs, and Figure 2 shows a simplified internal diagram of the chip. It is arranged in 32 rows and 32 columns, with internal row and column decoders, which decode a total of 10 binary lines for address purposes. Because this is a 1K-by-1 chip, there is only one input pin for data and one output pin. The usual *read/write* and *chip enable (chip select)* inputs are on the chip, so this memory is similar to the one we discussed earlier.

We are now going to examine some practical problems relating to the use of this chip in a larger memory system: the *organization* of a memory bank. First we must connect the chip's address inputs to the address bus. Notice that the chip has 10 address inputs, but the address bus has a 16-wire system. Each chip has only one data input and one data output because we are dealing with a RAM holding only one bit at each memory address. These 1-bit data input and output pins must be connected to the 8-wire input data bus, and the 8-wire data output bus because we are dealing with an MPU that uses 8-bit words.

The *chip enable* pin also controls tri-state output buffers inside the chips, so that the enabled chips and the disabled chips do not interfere with each other.

Finally, we need 32 of these 2102 RAMs to achieve 32K bits (4K 8-bit words). Therefore we must organize 32 of these chips in such a way as to construct our memory bank. For simplicity we have shown the system with separate data input and output buses, but with suitable tri-state input and output buffers (as is commonly done) this memory can operate from a bi-directional 8-wire data bus. Because such buffering can always be simply added, it is not included now. It would have been just as easy to organize the 4K-by-8 memory using 1K-by-8 RAM chips. That would require only four chips. There are many other possible ways of doing the same thing; some ways cost more, some require more interconnections and some result in faster operation. The choice, based on trading off such factors, is up to the memory designer.

Figure 3 is a block diagram of the complete memory. Note that on-board, fixed voltage regulators are used, as is customary with most digital systems of modern design. These regulators protect the memory from transients, and by providing effective decoupling, reduce the need for large capacitors formerly used for that purpose.

The memory board is set up in four banks of eight 2102 RAMs each. Together, the eight RAMs in each bank provide eight bits of output or eight inputs (i.e., the required 8-bit word). Because we have 1024 addresses per RAM, each bank is able to store 1024

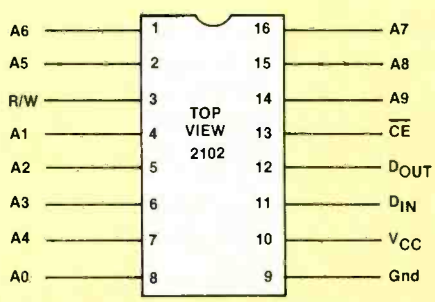


Figure 1. Pin-outs for the type-2102 1K-by-1 static MOS RAM. *A* is an address bit pin, *D* is a data pin, *R/W* is a read/write control pin and *CE* is a chip enable pin. The bar over CE indicates that the active state occurs when the chip enable is 0 (low).

8-bit words. Further, we have four identical banks, thereby providing a total of 4096 8-bit words. This leads to the need for a *bank decoder*, which is able to select any one of the four banks of chips for addressing purposes. We need to select one bank out of four, so the decoder must have four outputs. Two binary-coded input lines provide four input combinations, which defines this bank decoder as a 2-binary input, 1-out-of-4-lines-out decoder. (We will refer to this decoder as the *bank selector* hereafter.)

Remember that the row and column decoders in each 2102 require a total of only 10 lines. Because all the chips are addressed in parallel, 10 lines are sufficient for the address inputs of all 32 chips. Also, we used two address bus lines for inputs to the *bank selector*. The *bank selector* (decoder) output drives the *chip select* input, on each chip in the desired row of eight chips; thus we are using *chip select* as part of the addressing system. This makes a total of 12 lines used for addressing, out of the 16 lines in the address bus. We would use the other four lines if we expanded the system to a 64K memory, which would require 16 of the 4K boards we are describing here.

Bigger memories

By using 16 boards, plus a decoder for selecting the desired board, a 64K memory could be implemented and the needed decoder would then have four binary input address lines, and a 1-out-of-16-line output. Then we would be using the full 16 lines in the address bus in order to achieve the full addressing capability of the 16 lines: 64K addresses.

Putting it another way, we are only using 12 lines because that is all that is needed for 4K of RAM. That leaves room for expansion of our memory system as we desire; in which case we may need all of the 16 wires in the address bus. Now you can see that the 4K RAM tells the entire story. Duplicate this board 16 times, add another decoder (a *board select* decoder), and you have a full 64K memory system: Obviously it would have been difficult to show the diagram for a full 64K system in this article, but the 4K system can serve as a model for not only the concept, but also the working diagram of such a full system.

How it works

Address bits A0 through A4 on the address bus are fed through the board terminals into address inputs A0 through A4 on all the RAM chips. This goes into the row decoders on each chip, and thus selects one of the 32 rows in the matrix in every chip.

Address bits A5 through A9 are similarly fed through the board terminals, but go through the column decoders and select one of the 32 columns in each chip.

The result is that one of the more than 1000 locations in each chip matrix is selected (addressed). That location holds only one bit in the 2102 RAM chip. Having selected the desired location in each chip, using 10 of the address bits in the address line, it is also necessary to select eight chips out of the 32, because we need to input and output one bit for each of eight separate chips, in order to generate an 8-bit word. We accomplish this by organizing this memory board into four banks of eight chips each, therefore we must select one of the four banks. Address bits A10 and A11 are used for this purpose. They are fed through a decoder, but this decoder is not part of the 2102 RAM chip; it is external and we must add it on the board. It is a 2-binary input, to 1-out-of-4 decoder, and is the *bank selector* we have discussed earlier. The outputs of this decoder are connected to all the *chip enable* pins on the RAMs in one of the four banks of eight chips. It should be noted that the *chip enable* inputs also control the high-impedance (open circuit) state of the tri-state data output buffers inside the RAM chips. This effectively controls the outputting of data to the output data bus. (When the RAM chips are not in the *enabled* condition, they are precluded from placing data on the data bus.) When the RAM chips are *enabled*, they output the memory data in the form of one's or zero's.

All eight data inputs, DI 0, through DI 7, are fed into the inputs of the eight chips comprising each bank, through the board terminals. These are used when writing into the memory. Data

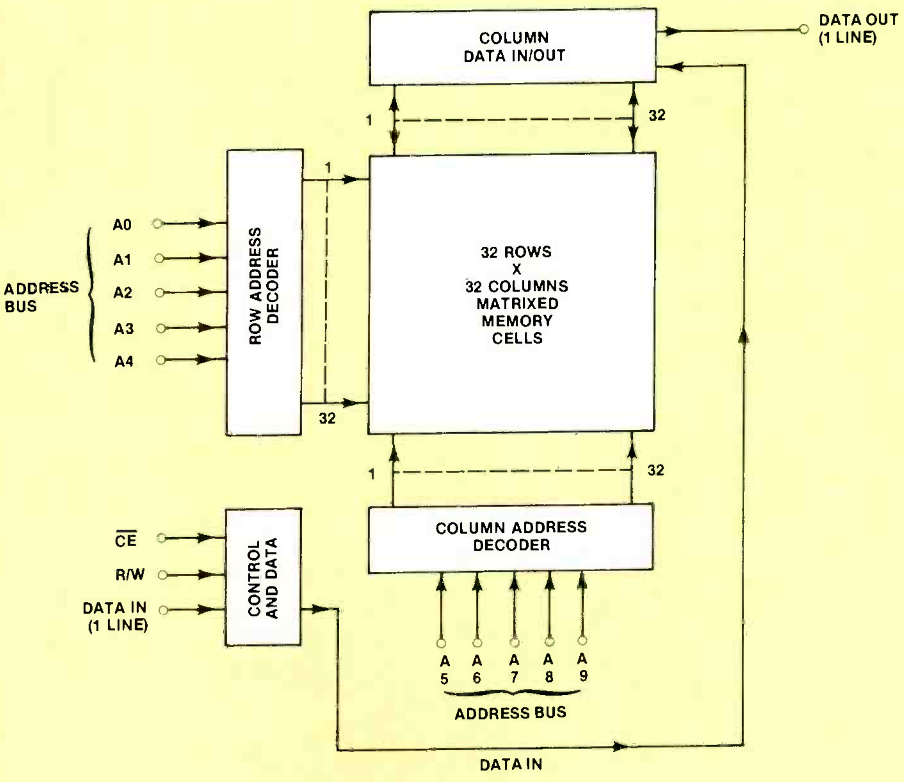


Figure 2. A simplified internal diagram of a type-2102 static MOS 1K-by-1 RAM. Note that inside the data in/out block is a tri-state output data buffer.

outputs are fed into the output data bus, through the board terminals. (But remember, there are tri-state buffers on the data outputs, inside the 2102 RAM chips.) In order to write into or read out of the memory, a control signal from the control bus is fed into the *read/write* pin of all 32 chips via the board terminal, *read/write.*

When a *Write* signal is inputted, the tri-state output buffer is put into the high-impedance state, because we are not going to read out the RAM contents at the addressed location.

Buses and buffers

We previously mentioned that most MPUs now use a bi-directional data bus, yet we have shown a data input bus and a data output bus in Figure 3, and this needs explaining. In the memory board used as an illustration, we have stopped at the board limits. Additional tri-state elements, such as buffers and inverters, are often used to interface into a bi-directional bus. This is done for several reasons. Sometimes the memory does not have sufficient drive capability to handle everything on the data bus, or inversion of the signal may be needed to meet the requirements of the system. Often these buffers are put on the board, in which case the board has only one data bus set of connections into the bi-directional data bus.

Some types of RAM chips have internal logic that does it all, in which case the RAM chip has only one set of data connects, which tie directly into the bi-directional data bus. In such variations, there are no *data input* and *data output* labels; there is only a *data* label.

There is a good reason why we have stopped at the board limits. To go further would have gotten us into another subject, buses. This opens a big can of worms, because buses are not standardized. The bus is essentially a transmission line, handling radio frequency signals (1MHz, maybe higher), so capacitance, inductance, terminations, etc., all are significant. Even the ac power wall plug is standardized, but the connectors on the ends of buses are not yet fully agreed upon, with major computer manufacturers using different configurations. Buses could be the subject of a separate article, but the subject of this article is memories. At this point it is necessary only to know that there are several ways to interface RAM chips with a bi-directional bus. What we're concentrating on is what happens in memories themselves.

We showed a waveform and timing diagram in part one of this article; now we will emphasize the timing part. On some RAMs, it is necessary to wait awhile after addressing, before applying the *read/write* signal. This is done in order to allow time for address decoding and to make sure that addressing is completed, so that the data will be in the correct address in the RAM. Thus, it is important that the applied signals to the chip are in correct sequence, with the required overlaps in time. If a signal is unduly delayed or distorted in the system, problems in operation of the RAM can arise, even though the RAM itself is good.

Because these various waveforms and their timing come from the microprocessor system, it is necessary to make sure that the MPU and the memory are compatible. Usually it is possible to modify signals in such a way as to accommodate the needs of both the memory and the MPU. Signals can be inverted through inverting buffers. They can be delayed by transferring signals to a register, holding them momentarily, then transferring them out of the register at the proper time, etc. Such manipulation is common practice, because the logic elements required are inexpensive ICs and are readily available.

Figure 4 is a "mode" table for the type-2102 RAM chips, showing required inputs for reading, writing and disabling. Notice that when the *read/write* input is at write (low), the output is disabled. When

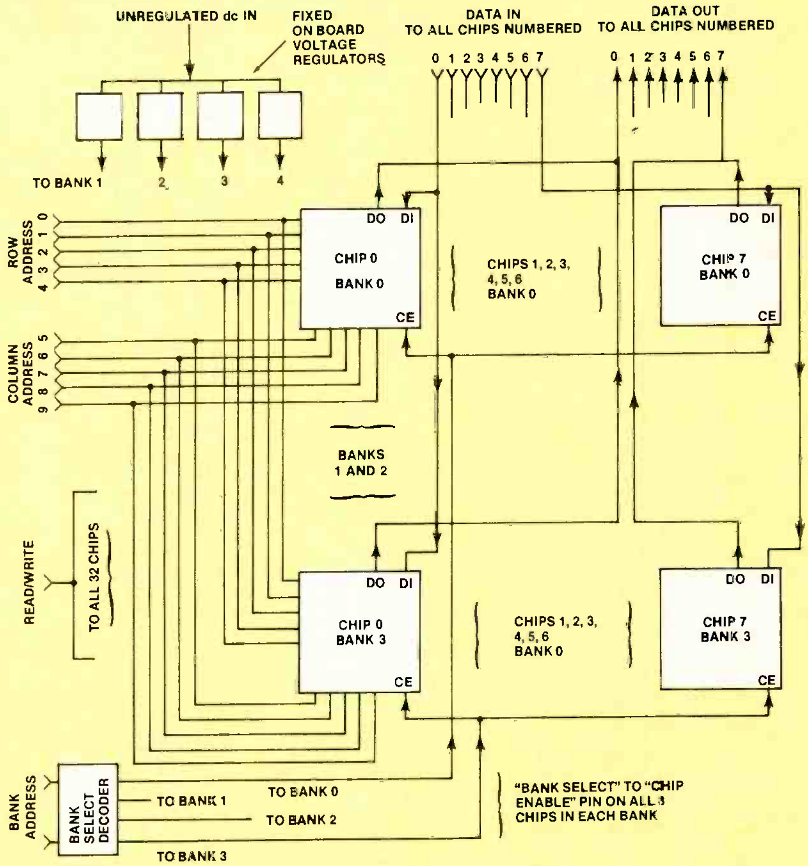


Figure 3. A 4K-by-8 memory organized with 32 1K-by-1 static RAM chips. Chips 1 through 6 in each bank are not shown, and banks 1 and 2 are not shown. *Data in* and *data out* pins on all similarly numbered chips are in parallel. *Chip enable* pins on all eight chips in each bank are in parallel and are used for *bank select* purposes. *Read/write* pins on all 32 chips are in parallel.

MODE OF OPERATION	INPUTS		DATA OUTPUT
	READ/ WRITE	CHIP SELECT	
READ	1	0	ADDRESS CONTENTS
WRITE	0	0	HIGH Z (DISABLED)
STANDBY (DISABLE)	X	1	HIGH Z (DISABLED)

Both the "Read/Write" and the "chip select" inputs control the state of the tri-state output buffer stage

Figure 4. Operational modes for type-2102 RAM. A *1* = 3.5 to 5.0V for a 5V power source, and a *0* = 0V to 1.5V for a 5V power source. An *X* means any voltage between 0V and 5V and a *High Z* (disabled) output indicates the tri-state output stage is in the high-impedance state.

the *chip select* is not selected (high), the output is disabled. This prevents an output during writing or when the chip is not selected.

One thing has thus far been omitted: protection against loss of power, which results in destruction of the memory's contents. This is usually accomplished with a rechargeable nickel-cadmium battery used as a standby power source, and is therefore considered part of the power supply. It is not mounted on the memory board itself, and thus is omitted here.

Occasionally, buffers are included between the MPU and the memory because the MPU cannot supply sufficient drive for all the loads imposed by the system. A good example of this is the *read/write* board input on our memory board (notice we are driving the *read/write* inputs of 32 RAM chips in parallel.)

RAM interchangeability

Like many other kinds of semiconductors, RAMs are made by several different manufacturers. Identical products often have totally different identifying numbers – again a lack of standardization which is so common in the semiconductor and computer industries. As a good example, the type-2102 RAM chip (a 1K-by-1 static MOS RAM) is made by RCA as a type-CDP 1821, by Intel as a 2102, by AMI as an S6508, by MOSTEK as an M4102, etc. These type numbers do not follow any kind of organized system and do not even remotely resemble each other. You just have to search through cross-reference guides until you find a suitable equivalent.

Unfortunately this situation exists not only in the memory part of computing systems but also pervades the entire computing industry. Considering the fact that modern computer science is a relatively recent development, there is no reason for ambiguity, lack of standardization and lack of cooperation in the business. Imagine what it would be like if a pair of shoes was sold on a non-standardized size basis and each manufacturer had his own sizes.

Of course there are many different kinds of RAMS, in a wide variety of packages and pin-outs.

This gives the memory builder great flexibility in design. Fortunately most MOS RAMs are now using supply voltages compatible with TTL logic, so that power supply voltages and logic signal levels are not major problems. The fixed voltage regulators for on-board use are supplied in compatible output voltage ratings, simplifying things greatly. In the few cases where logic signal levels are not compatible, there are logic level *translators* (ICs) that do the job efficiently and inexpensively. This all adds up to the fact that you can expand the memory on most MPUs with a few evenings of work, because most MPUs have a greater addressing capability than is utilized with the limited amount of memory supplied with many systems. As a matter of fact a visit to your local computer store will often provide you with a current magazine listing PC boards for memory expansion, saving you much of the trouble of wiring the system.

As an alternative, you can buy perforated board on 1/10-inch centers, push the IC pins through the holes, and with a hand wire-wrapping tool, wire the board. This eliminates sockets, soldering and lots of time. You save money and learn a great deal in the process. This is practical because 48K of memory is the minimum for the serious technician, and the full 64K is desirable. The alternative is the use of a floppy-disk machine with mechanical drives.

When using perforated board and wire wrapping, be sure to buy your ICs with wire-wrap pins (square cross section). Your local electronics distributor should be able to apply inexpensive hand tools for wire wrapping and unwrapping, the necessary wire, and wire stripper. The use of perforated board and wire wrapping eliminates the need for PC board construction and soldering in very close quarters.

Advanced MPU users usually have at least 48K of fast solid-state memory, backed up with a floppy disk. The disk provides fairly permanent storage (until erased), but is quite slow compared to the solid-state memory. The solid-state memory uses part of its capacity for utilizing the floppy disk.

ES&T

Troubleshooting cable-related problems

By Carl Bentz

In the October, 1982 issue of **Electronic Servicing & Technology**, we published an article, *Is It the TV or Is It the Cable.* The purpose of the article was, as the name inplies, to help TV servicing technicians who encounter certain problems on cable-equipped televisions to determine if the problem is caused by the set or by the cable company.

One reader had experienced two problems that were not addressed in the article. These were answered by a letter from the article's author to the reader. We thought that many other readers might benefit from this information, so it is presented here.

"First, I have serviced, from time to time, TV receivers on a local cable network that have had a similar problem in that the tuner was being over-driven by the signal coming from the cable. The only solution that was suggested to me was to place attenuators on the cable line into the set. One particular set required 9 to 12dB attenuation for normal operation. My question is: Whose fault is it, the cable signal or the TV receiver?

The second problem I have run into on the same cable network is when characters are superimposed on the picture (such as a phone number to call on an advertisement, or the 'Five-day Weather Forecast' on the news), there is a loud buzzing sound until the characters disappear. What causes that?"

Carl Bentz's answer

According to FCC regulations, the signal level measured at the subscriber outlet should be at least 0dBmV (1mV into 75Ω). Most cable system operators use a rule-of-thumb that says to keep the signal level in a range of 0 to +10dBmV. Some even limit that to 0 to +5dBmV. If the levels were all controllable on a level-per-channel basis at the subscriber outlet, then there would be no problems. However, the CATV system includes miles of coaxial cable, many amplifiers and a number of different passive devices, each of which has a frequency response curve. As a result, some channels could easily fall below the 0 level and some rise over even the +10dBmV figure. Further FCC rules regarding levels across the CATV spectrum call for adjacent channel visual carrier levels to be within 3dB of each other. For non-adjacent visual carrier levels, the variation should be within 12dB.

If the signal at the subscriber outlet is above the +10dBmV figure, the fault is that of the CATV operator. Generally, the system technicians will carry in-line attenuators with them for installation on cases of over-driven sets. Such an attenuator should be used by the technician as an immediate fix while the real cause of the over-drive situation is researched. In the majority of cases, when the system is operating properly, the attenuator should not be needed.

Several things may result in excessive signal levels at the subscriber's outlet. They should all be considered before assuming that an attenuator should be left permanently in line at the over-driven television. To look at these problems, a couple of operational concepts of the CATV system need to be pointed out.

Coax cable attenuates the signal passing through it. Generally the losses at Channel 13 are approximately twice those at Channel 2, in terms of dB. Several types of line amplifiers are used in the CATV system to recover those losses. In fact the systems are designed to place an amplifier on the line after losses of 10dB for Channel 2 and 20dB for Channel 13 have occured (which should occur at the same distance along the cable – in theory). The amplifiers are designed and adjusted to recover only the losses (an amplifier has a gain of 10dB at 56MHz, with increasing capabilities to 20dB at 212MHz). In between these two extremes, the gain figure should closely approximate a straight line.

For the newer wideband systems with sub-, mid- and superband capability, the gain figure for a particular part of the spectrum should also lie somewhere along that gain line. Most of the manufacturers include a minimum of equalizer controls within the amplifier modules to allow the CATV technicians to adjust the gains of a particular module to fall within the extremes. In theory, then, perfection is possible.

Some extraneous problems detract from ideal operation, however. First is temperature variation of the environment. As temperature increases, so does the attenuation of the coax cable. Hot days cause signals to drop to levels that may cause snowy pictures. Cold winter days may cause the signals to rise to levels that will cause over-drive. A compensating AGC module is built into the CATV amplifier to counteract the level change. By comparing a pilot carrier (or two), the circuitry automatically adjusts the gain of the amplifier to maintain the signal levels within a desired range.

A second problem is discontinuities along the cable. If for any reason, the center conductor of the cable should be closer to the shield, a change in the basic impedance of the coax (75Ω) may occur. Imperfections of the dielectric of the coax may cause a similar impedance change. Connections at the amplifiers, at splices, splitters, power inserters and the directional taps (where the subscriber's line attaches to the distribution system) may not be perfect. As the environment changes (moisture and temperature are the primary factors), those connections may also change in their integrity, resulting in alteration of the characteristic 75Ω impedance.

Whatever the original cause, when the impedance varies, reflections (ghosting) or suck-outs (added attenuation) may occur. To the subscriber, these mean reduced quality of a channel or the entire spectrum of channels. Often such discontinuities are intermittent in nature, and the CATV technician is obliged to spend time locating the offending cable or component to repair the problem.

A third deviation from the ideal is the receiver. Given three "identical" receivers, one may work well in the 0 to 5dBmV range, one may require a negative dBmV figure and the third could easily need more than +10dBmV for clean picture operation. With different brands of receivers involved, the problem becomes even more pronounced.

The fourth consideration involves the design of the cable system and the subscriber location. The directional tap to which a subscriber is attached exhibits a given amount of attenuation to the signal from the distribution line.

A particular tap value is chosen by the system designer in terms of subscriber distance from the tap (or by how much RG-59 cable attenuation will occur between the tap and the subscriber's television) and the distance in terms of signal level from the last amplifier in the CATV system. If each subscriber outlet will be approximately the same distance from a tap location, then the tap value may be easily chosen. If one subscriber's dropline will be much longer than others, the tap will have to be chosen to deal with that added loss. Then subscribers who are closer to the tap will have higher levels, perhaps excessively higher. In-line attentuators must be used on those *closer* sets in order to alleviate the problem if over-drive occurs.

An additional condition causing overdrive is easily fixed. It is entirely possible that when a technician last adjusted the level controls of an amplifier, he misread his meter or perhaps it was not operating properly. Obviously if that was the case, a high level out of an amplifier may be turned down. At the same time, a particular amplifier module in the CATV line amp could have developed a problem of excessive amplification. As the technician checks his system for proper level adjustments, he can determine such a module failure and replace the faulty unit.

Generally, then, when overdrive occurs at the subscriber's outlet, the CATV people will be the ones to find and fix the problem. It is their duty to do so. Of course the receiver AGC may come into play for a given situation, but should be adjusted only as a last resort.

Getting rid of the buzz

Titling of pictures on television introduces a condition to the TV system not usually found during typical picture presentation. Titling inserts high speed (fast rise-time or fall-time) transitions into the signal. These changes in signal level may go from black (0IRE units) to peak white (100IRE units). Such changes, just as square waves in digital signals, result in a variety of harmonic frequencies introduced into a signal. If the harmonics lie outside the various passbands of different sections of the TV receiver, they will create no problems. Some, however, do not. Often critical fine tuning will eliminate the difficulty. Occasionally a misadjustment of the IF tuning within the television will be found and its correction will remove the buzz problem.

Another reason for an audible buzz during titling is the result of a clamping instability within the television. At the TV station, great care is taken in circuit design to clamp black levels to a given dc voltage. Receiver manufacturers may not be as careful in their designs. If a clamp is not operating totally up to snuff, a white portion of the picture may upset the clamp voltage, effectively pulling the signal dc level in such a way as to bring sync information to a higher dc level as well. As the sync information begins to be detected, the buzz occurs in the sound. Although some less expensive receivers may not include all the proper clamp circuitry, the more expensive receivers may include adjustments. Also, a sharp technician may locate a circuit component failure.

If the originators of the program material are cognizant of the problem, they can reduce the possibilities of buzz when they produce the program. Every production type character generator made today includes controls for the luminance levels of the title characters. Adjustments will allow "blacker-than-black" as well as "whiter-than-white" characters to be placed into the video signal. In both cases, problems will occur.

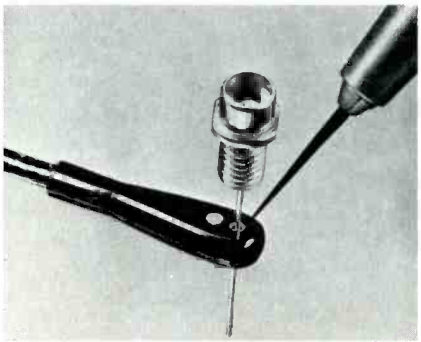
Too black may tell the TV receiver that there are some extra pieces of information in the signal that may be sync information. The TV becomes confused as to what is really sync, and the picture tears horizontally wherever titling characters occur. *Too white* generally causes the buzz to occur in the sound. Careful adjustment of the character generator will limit the fast signal excursions of the titling information to the common blanking level, (normal picture black and maximum character white to less than peak picture white). Within those limits, the majority of TV receivers will not produce a buzz.

In the past several years, a great deal of attention has been given to a characteristic of the TV signal known as *incidental phase modulation.* As rapid black/white transitions occur within the signal, as in a stairstep signal or in titling, momentary changes in carrier phase may occur. This little-understood signal characteristic results in a buzz in the sound. Unfortunately it may occur within the transmitting end of the TV system as well as in the receiver. The engineering department of the TV station attempts to maintain a minimum of the unwanted modulation within the transmitter. In receivers, little can be done about it, except making certain that IF alignment is proper. Filtering circuits involved in pickoff of both the visual and sound information are involved, however. Newer receivers that use surface acoustic wave filters (SAW filters) are less likely to have the problem.

Products

Miniature wideband current probe

The model 71 miniature wideband current probe, from *American Laser Systems,* measures wideband current or pulses without loading the circuit being tested. It induces no appreciable capacitive nor inductive effects on circuitry, so the signal under measurement does not change. It requires no additional lead length for insertion



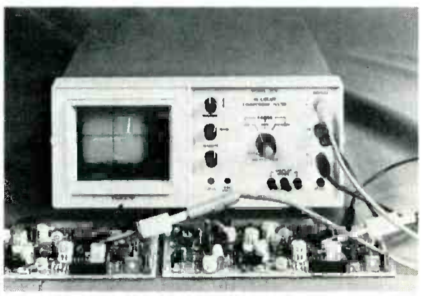
and therefore does not alter circuit performance. The 711 exhibits only 0.02Ω shunted by 4μh insertion impedance.

Circle (79) on Reply Card

In-circuit component tester

Vu-Data Corporation has introduced an inexpensive way to detect defective components in-circuit or out-of-circuit, and without the need for circuit power. The model 3110 in-circuit component tester provides all the capability required for even the most inexperienced user to determine good or bad components.

A CRT X-Y display presents the E/I characteristic curve of the particular component or circuit under

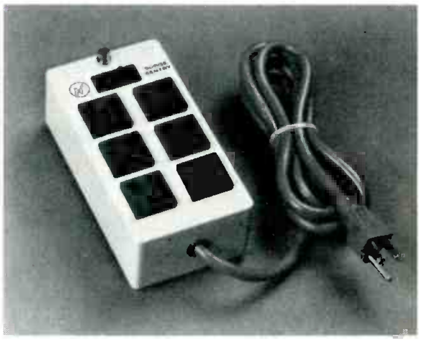


test, and a *compare* mode allows the operator to easily detect the difference between good and bad circuit elements by switching the CRT display at a 1Hz rate.

Circle (80) on Reply Card

Power surge protection

Designed for high-speed, wide-range protection against equipment malfunctions and data losses caused by power line surges, the Surge Sentry model SS-120-MS



from *RKS Industries* features a built-in on/off master switch for activating the unit's six receptacles.

Responding to surges within picoseconds, the unit has rated dissipation of 1,000,000W at 100μs. It also has the ability to clamp any voltage rise of more than 15% above peak nominal.

Circle (81) on Reply Card

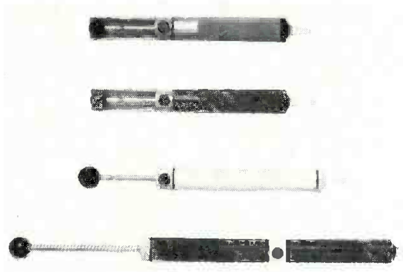
Epoxy system

Isochem has announced a new system of flexible epoxy potting with its Isochem 411X. Inexpensive fillers can be used in-house to considerably lower the cost of the finished product. These include sand, glass bubbles, aluminum balls, aluminum hydrite, silica, mica or talc. Typical uses include automotive regulators, automotive ignition coils and TV multipliers.

Circle (85) on Reply Card

Desoldering tools

Wahl Clipper has introduced four new precision-built desoldering tools with metal barrels and suction washers. Model SR2 has a non-recoil spring, model SR3A has guarded recoil action and is designed for use on tightly grouped or difficult-to-reach components, model SR3A/Micro is made for use on very closely grouped components, and the short piston throw on model



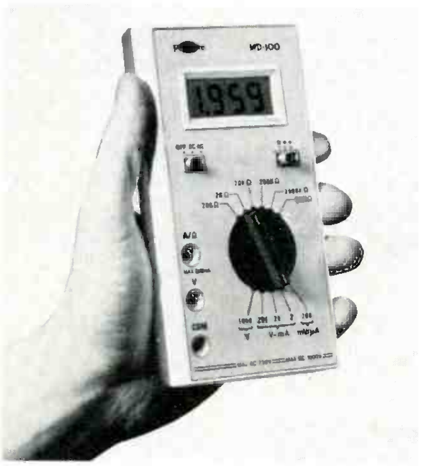
SR3A/S allows ommission of the guard to permit versatile loading.

Circle (83) on Reply Card

Rotary switch DMM

A 3½-digit LCD readout, rotary switch DMM with auto polarity and auto zero is among eight new multitesters marketed by *Philmetric.*

The model MD 100 offers 24 operating ranges and slide switch select for all functions, has dc voltage accuracy of ±0.8% and an ac



voltage accuracy of ±1.2%. It features a color-coded face plate for easy function identification.

Circle (84) on Reply Card

Low-static desoldering tool

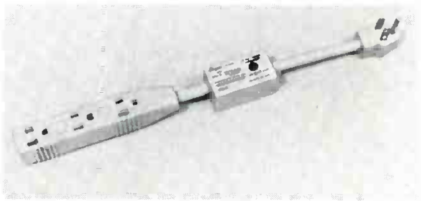
The SS011 low static potential Successor, from *Soldaput,* is equipped with a detachable release lever that allows for either palm-grip plunger release or finger-touch release. The travel length of the plunger is adjustable to suit

the reach of the technician. A metal barrel, static-conductive Teflon tip and metal tip collar provide static protection for sensitive MOS-LSI devices.

Circle (82) on Reply Card

Surge suppressor

Dymarc Industries has added a new 3-input portable plug unit to its Clipper line of transient surge suppressors. The model C-120Q, designed for direct installation by an end-user, is a parallel protection device, which means that the normal amperage sustained by the



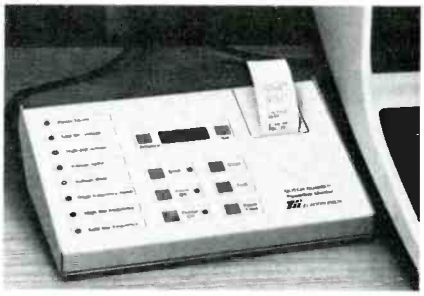
critical load being protected can vary depending on equipment type with no loss in suppression performance. The Clipper C-120Q is listed and tested under UL 1449, the specification developed to update suppressor requirements in view of the susceptibility of sensitive equipment to transients and their damaging effects.

Circle (86) on Reply Card

Computer power monitor

TII Industries (ASE Symbol TI) has introduced a new computer protection technology named the Computer Diagnostic Power Monitor, model GPM-P.

Errors arising out of electrical glitches, power failure, voltage spikes, high and low line frequency



and other electrical aberrations have become common problems. TII's GPM-P enables the user to identify all such problems by monitoring power lines that feed microprocessors, dynamic RAMs, Winchester discs and similar sensitive electronic equipment.

Circle (87) on Reply Card ES&T

Marketplace

Literature

A comprehensive calendar of 1983 electronic industry events, arranged in full-year worksheet format, with large, open date squares for personal notations, is being offered by the **Electronic Representatives Association** (ERA).

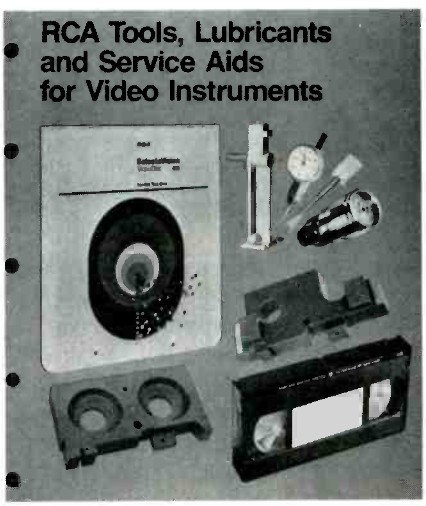
The calendar is designed for quick recognition of all major industry show and conference dates, including special-market events. When available, city and state locations for events are shown, as well as telephone numbers to call for more information on individual events.

Circle (103) on Reply Card

Hamtronics has announced publication of a new 1983 catalog of equipment for the VHF/UHF/OSCAR enthusiast and 2-way shops. The 36-page catalog features many new products, including FM repeaters, new VHF and UHF FM receivers, helical resonator preamps and filters, low noise receiver preamps and a UHF receiver to listen to the space shuttle. Also included are the popular FM transmitters and power amplifiers, VHF and UHF receiving and transmitting converters and VHF transceivers.

Circle (105) on Reply Card

The RCA directory, *Replacement Parts for RCA Video Cassette*



Recorder Instruments, Cross Reference from Manufacturer's Identification Numbers to RCA Stock Numbers, has been extensively updated and is now available from **RCA Parts Distributors.** This cross reference, form number 1F6627 Rev. 10/82, includes 28 pages of parts listings for RCA VCRs. Some of these parts are also used in certain models of Magnavox, Quasar, Panasonic, Sylvania and other makes of VCRs.

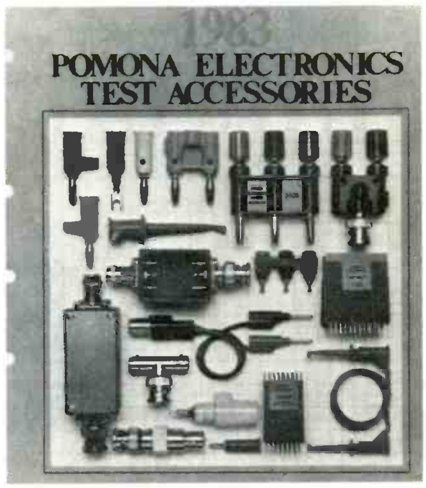
Circle (104) on Reply Card

A new group of digital and analog multimeters, multitesters and test accessories are featured in **Philmore Manufacturing's** new short form catalog.

The catalog includes features, details and specifications on the company's new MD 150 side-positioned push-button DMM with 26 ranges; a highly functional rotary-switch model MD 100, 3½-digit, LCD-readout DMM with auto polarity and auto zero; a color coded 20,000Ω multitester, model PNH 205; a companion model PNH 206, a 20,000Ω/V dc multitester; and a 10-range 1000Ω/V pocket size multitester.

Circle (106) on Reply Card

ITT Pomona Electronics has published a 115-page catalog of test accessories for use in elec-



tronic equipment. The catalog includes more than 500 photographs and 30 drawings of such test accessories as banana plugs, jacks and patch cords; phone tip jacks, plugs and connecting cords; test clips; probes and holders, binding posts, black boxes and sockets.

Circle (107) on Reply Card

Books

Editor's note: Periodically ***Electronic Servicing & Technology*** *features books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given for each book, rather than to us.*

How to Buy and Convert Surplus Electronic Equipment, by Mark S. Starin; Tab Books; 490 pages; $23.95.

Every year, the government dumps millions of dollars worth of surplus equipment at a fraction of its original cost, and while most hobbyists find this gear fascinating, few can figure out how to use it. Now, this comprehensive handbook provides everything needed to find, buy, adapt and use surplus radios and other electronic devices, even when equipment comes without manuals or schematics.

Compiled by a veteran surplus sleuth and converter, this volume takes a practical, hands-on approach. Beginning with an overview of the equipment that's most readily available, it shows how to identify various items, including how and where to obtain manuals and lists of retail surplus outlets. Next, readers delve more deeply into the theory of operation of each of these devices and learn the basics of troubleshooting them.

Published by Tab Books, Blue Ridge Summit, PA 17214

Computer Peripherals That You Can Build, by Gordon W. Wolfe; Tab Books; 272 pages; $19.95 hardbound, $13.95 paperback.

This extraordinary handbook includes step-by-step instructions for building a variety of exciting and functional computer peripheral devices, and most can be built for under $50. It also shows how to build a standard bus that allows easy interfacing of those peripherals to any model personal computer.

No specialized knowledge is needed to build this bus, or the peripherals included here. Anyone who's familiar with the fundamentals of programming and who can read a schematic diagram, identify common electronic parts, and find the address, data and control buses in a computer, can build any peripheral and the standard bus.

There are directions for building A/D and D/A converters, cassette interfaces, keyboards, light pens, disk drivers, ac and dc control mechanisms, real-time clocks, music boards and a variety of other peripheral devices that can save computing time, simplify various tasks and enhance the overall usefulness of your computer unit.

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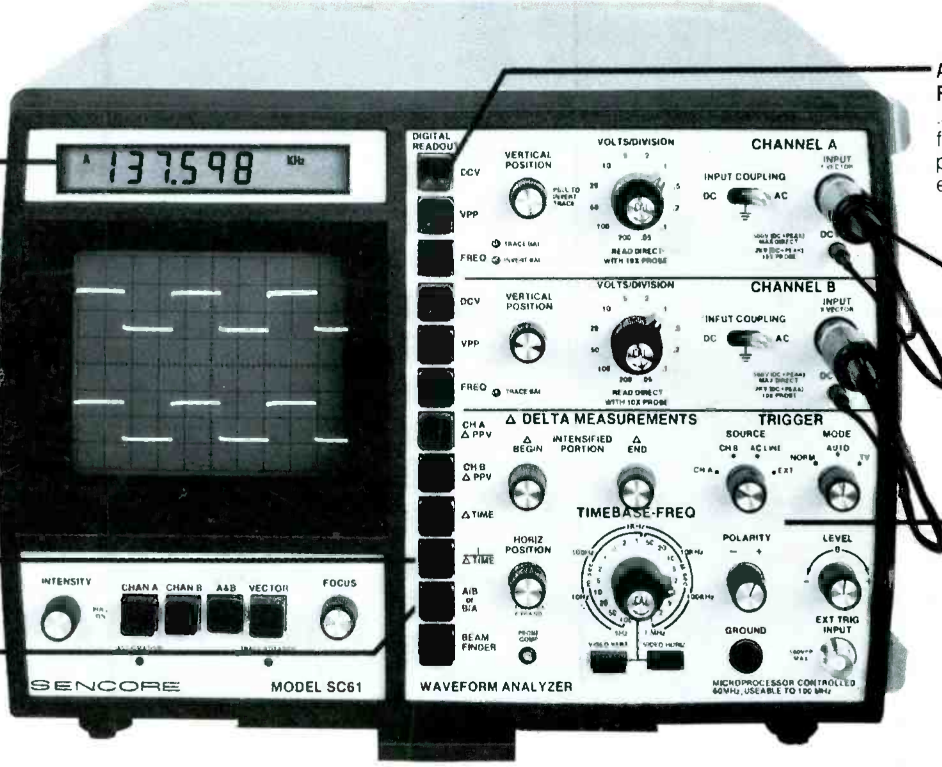

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The first scope with push button digital readout. If you use general purpose oscilloscopes for troubleshooting or testing, we can double your present productivity with the SC61 Waveform Analyzer, the first instrument to turn every conventional scope measurement into an automatic digital readout.

No more graticule counting. Connect only one probe to view any waveform to 100 MHz. Then, just push a button to read DCV, PPV, frequency and time — automatically!

There are no graticules to count or calculations to make, which speeds every measurement.

The digital readout is from 10 to 10,000 times more accurate as well.

Plus you have everything you want to know about a test point, at the push of a button, which speeds troubleshooting tremendously.

A special Delta function even lets you intensify parts of a waveform and digitally measure the PPV, time or frequency for just that waveform section.

And it's neat. No more tangled leads, piles of probes or dangling cords. The SC61 is an entire test station in one unit.

The one and only. There are other scopes with digital readout, but none of them completely automate every conventional scope measurement so you can automatically analyze any waveform without counting one single graticule. Totally automatic waveform analyzing at the push of a button. It will make all the difference in your productivity.

Double your productivity. When we say the SC61 will double your productivity, we're being conservative. We've seen cases of three, four, even ten time increases in productivity with this first-of-its-kind, automated oscilloscope. Every situation is different, however, so try the SC61 and judge for yourself. Here's our offer.

Money back guarantee. If the SC61 does not at least double your productivity during the first thirty days, you may return it for a full refund, including freight both ways.

Call today. Get the entire SC61 Waveform Analyzer story. Call toll-free today, and ask for our eight page color brochure. It could be the most productive call you make this year!

Phone Toll-Free
1-800-843-3338
Alaska, Hawaii, Canada and South Dakota call collect (605) 339-0100

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