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Service & Technology

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Maintenance and cleaning of VCRs • The knob-repair nightmare

Using a small transformer to get special ac voltages

Desoldering components



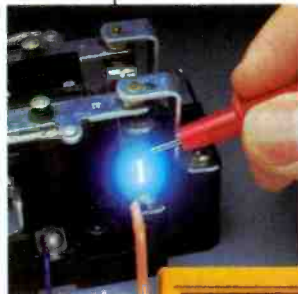
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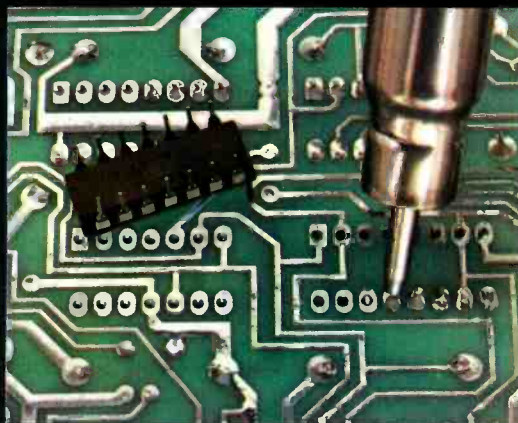
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Desoldering components

By James K. Bausell

On today's high-density PCBs, desoldering a faulty component must be accomplished in 3s or less.

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Test your electronics knowledge

By Sam Wilson

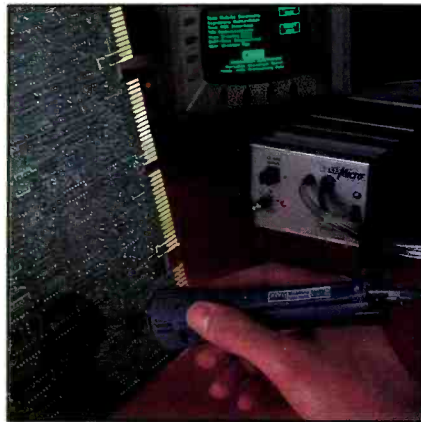
The author presents eight types of resistors for readers to identify. "Experienced technicians won't be fooled."

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VCRs maintenance and cleaning

By Victor Meeldijk

Guidelines are given for maintaining commercial-type VCRs that require frequent head cleaning in order to remain operational: every 200 hours.



page 12

Removing a failed component without damaging the PCB requires skill.

(Photo, courtesy PACE, Inc.)



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This VCR head had not been cleaned in more than two years.

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Using a small transformer to get special ac voltages

By Arthur G. Hansen, PE

The buck/boost transformer is smaller, cheaper and easier to select—a rough estimate of requirements will do.

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What do you know about electronics?—More on infrared remote controls

By Sam Wilson

Basics of infrared reception are discussed, with emphasis on preferred wide- and narrow-pulsed data transmission.

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The nightmare of knob repair

By Larry Critchlow,
the "Old Timer"

Watch for more time-saving tips from this author.

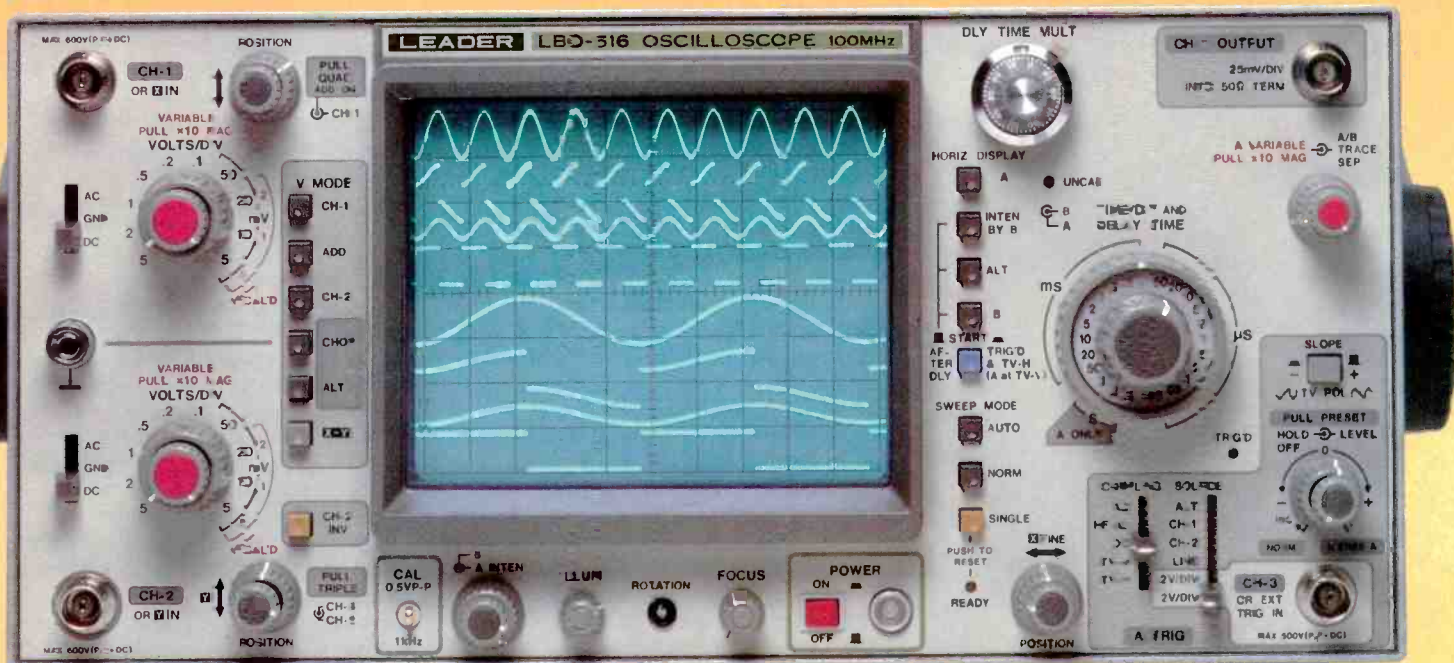
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Electronics: concrete results from abstract concepts

Whether you have ever thought about it or not, technicians and others working in electronics have made a commitment to deal in the abstract. Think about it. You deal in volts, amps, ohms, amplification, bandwidth, frequency. What are those things? How many volts to a pound? How many amps would fill a teacup?

Electricity/electronics is a discipline in which, at least in my experience, it's very difficult to grasp the fundamental units. By contrast, take the basic units of the physical world. You can pick up something that weighs a pound and feel what a pound is. You can look at a ruler and see how big a foot or an inch is.

When it comes to electricity, though, you have no such evidence of the senses. For someone who's just starting in electronics it takes a while to get a *feel* for what the units mean. For example, is a volt a very large potential? Ten volts? 100? And how about current? Is one amp very large? Ten?

As all of you who have been involved with electronics know, the answer is "that all depends..." Are we talking about an LCD watch or a washing machine? Still, after a while we get a feel for the correct values, so that if someone talks about a phono cartridge putting out a few microvolts, it sounds about right. And capacitors come in microfarads or smaller, and resistors come in a few ohms, a few hundred ohms or thousands or millions of ohms.

Armed with that feel, then, if someone starts talking in terms of farads, milliohms or megamps it doesn't sound right. That doesn't mean that values in those ranges can't exist, but they don't *sound* right and, properly, raise concerns.

Another difficulty in dealing with electrical units is that they tend to be defined in terms of one another—Ohm's Law and all that. What's an amp? Well, if you place a resistance of one ohm across a potential of one volt, the resulting current is one amp.

OK then, what's a volt? Well, if you run a current of one amp through a resistance of one ohm, the resulting potential drop will be one volt.

What's an ohm, then? If you place a potential of one volt across a resistance and the resulting current is one amp....Enough!

As it turns out, there actually is a definition of one of these parameters that relates it to the physical world. According to an article "Volts and amps are not what they used to be" in the March 1987 issue of *IEEE Spectrum*, a monthly technical magazine published by the Institute of Electrical and Electronic Engineers, The International Committee on Weights and Measures has adopted the following definition for an ampere: That constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed one meter apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newtons per meter of length.

OK, so 2×10^{-7} newtons per meter doesn't really give you a feel for what an ampere is, especially as it's pretty hard to visualize an infinite length of infinitesimally thin conductors in a vacuum. Still, this definition of an ampere does connect the electrical world with the physical world and gives you a concrete value on which to base the concepts of volt and ohm.

Converted into the English system of measurement, that force between conductors carrying one amp is equal to about four and one-half millionths of a pound.

Although that force seems small indeed, if you give those wires a little more heft, wrap many turns close together and run several amps through them instead of just one, you have an electric motor capable of generating a lot of force.

As it turns out, these abstract concepts dealt with every day by electronics technicians produce some very concrete results. It's reassuring every once in a while to find a definition, such as the definition for ampere give above, that demonstrates the connection between that abstract world and the real world.

Nils Conrad Persson

"I thought a DSO that did all that would cost a fortune..."



"Isn't that the new B&K-PRECISION 2520 digital storage oscilloscope?"

"Right, Jim... It's quite a performer, with dual-channel real-time and digital operations, 2 megasample per second sampling and 1024 x 3 bit per channel storage. It's even got an analog output for a plotter."

"Those specs sound pretty good, Bob, but why a DSO? Won't your analog scope do the job?"

"This DSO really opens new doors... For instance..."

Let's say I need to look at a non-repetitive waveform..."



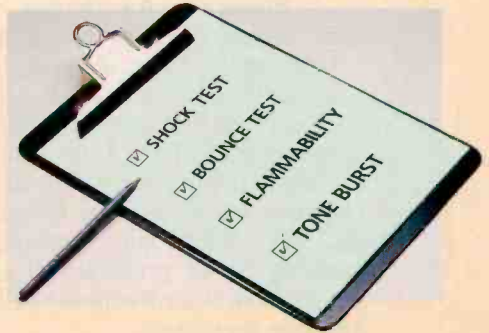
"Like our mechanical stress tests?"

"Exactly... or a one-shot pulse, or even a power line glitch... Looking at those on a regular scope is darn near impossible, even with a camera. On the 2520, I can pretrigger at 0%, 25%, 75%, or 100%. When the event pops, it's frozen on the screen. I can also compare test results from one event to the next."



"I see, Bob. Freeze one event on one channel, look at the new events on the second channel, and zoom in for a closer look. What other jobs will it simplify?"

"Here are just a few ideas: Shock testing — without trigger cata loss; Bounce testing on switches and breakers; capturing a PCM tone burst; and flammability tests using two thermocouples... Our bio lab can even use it for



nerve response tests... Best of all the 2520 costs just \$1990."

"\$1990? I thought a DSO that did all that would cost a fortune. Where do I get mine?"

You can get your own 2520 from your local B&K-PRECISION distributor. Also ask about the new 2521 with automatic time and voltage measurements and optional 2502 waveform processor. For complete details and a free list of DSO applications contact:



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Preparing for change

1987 Technician convention theme

Convention dates: June 24 to 27

According to Dick Glass, president of the Electronics Technicians Association, International, the 1987 Convention will be held at Depauw University in Greencastle, IN. Electronics technicians working in all professional areas are invited, both members of ETA and non-members.

Workshops begin Thursday, June 25. Two tech-seminar types will be held simultaneously at the university's Science & Math Center. The Electronics Workshops will address such topics as computer servicing; electronics components; TV service; communications radio and electronics instructor methods. The second seminar is the ninth in a series of SAM (Satellite-Antenna-Master Antenna) schools. SAM schools are geared to helping TVRO techs move into roof-top and master antennas, as a supplement to the somewhat depressed satellite business. This 16-hour, 2-day school ends with the opportunity for at-

tendees to qualify for a CET (Certified Electronics Technician) rating, by passing ETA-I's written examination.

Through special arrangement with the State Professional Licensing Agency of Indiana, area technicians can qualify for required technician licensing for satellites and antennas by taking the state examination at the conclusion of the SAM school.

Other events occurring at the 9th Annual Technicians Convention include a hog roast; ladies and childrens tours; Technician-of-the-Year award and banquet. Also election of officers of ETA Divisions: Shopowners, Educators, Canadian, Certified Technicians, Communications and Satellite Technicians.

For registration and ETA information:

ETA-I
604 N. Jackson
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317-653-5541

Novice hams now vocal

Ham radio operators with Novice licenses now can communicate by voice instead of being

limited to the traditional Morse code. The Federal Communications Commission has expanded entry-level privileges that, previously, required passing a more difficult examination.

For more information on amateur radio and how to obtain a Novice license, contact the American Radio Relay League, Dept. NE, 225 Main St., Newington, CT 06111.

Extended hours, call toll-free

Matsushita Services has extended evening hours for its call-in consumer information and assistance service through its Consumer Affairs Department. Consumers with inquiries concerning Panasonic or Technics consumer products may call 201-392-4767 or 4768 weekdays between 9 a.m. and 8 p.m. (Eastern Standard Time).

The company also has expanded the operational hours of its Panasonic telephone products assistance hotline. Consumers requesting operational assistance, on telephone products, only, may call toll-free, 1-800-922-0028, weekdays between 9 a.m. and 8 p.m. (EST).

The how-to magazine of electronics

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Servicing & Technology

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Feedback

Is there a solution?

I am writing in an effort to find out what is happening in the electronics industry—in particular, consumer electronics. I own an independent repair shop and can no longer make a living in this business because of these obstacles:

- Retail stores in our area are charging ridiculously low prices for televisions, video machines, and stereos. For example, a 13-inch color television is \$99, a 19-inch set is \$129 and VCRs, as low as \$199.

- Then there are the repair problems with the few sets that do come in. For instance, VCR service manuals are vague and expensive. Also, when I have called Technical Assistance for some companies, I could hardly understand the technician because he could not speak English clearly; at other times these technicians either did not know or would not help me.

- Training on VCRs is almost non-existent.

....I don't understand how large companies such as RCA, Sony, Zenith, and Sylvania can compete with the cheap sets manufactured by Korean firms. Why isn't anything being done to prevent these sets from coming into our country? And if that is not possible, the prices should be raised so that small stores like mine can make something on the repairs.

These low prices not only affect large companies and independent shops but distributors as well. Remember, we can't order parts, modules, test equipment, or service manuals if there are no sets to repair.

Wayne Sherman
Bergenfield, NJ

The problems you describe in your letter of January 9 are very real, and I sympathize with the difficulties you and other servicers are facing.

I'm not an expert on international economics, but I believe the U.S.

government's experts when they say that tariffs and import restrictions don't work.

You mentioned VCRs, but state that servicing those units presents some problems like lack of training and vague servicing manuals. I wouldn't be surprised. In spite of that, many servicing technicians are learning about VCRs.

There are a number of things you might explore. VCR manufacturers, EIA, book publishers.

Another possibility would be the associations: ETA and NESDA.

There is a wealth of information available, although it may not always be easy to find.

Conrad Persson
Editor

Continued on page 19

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May 1987 *Electronic Servicing & Technology* 9

**From one year
by hand,**

Advanced CAD reduces design time to 3 days



Dr. Richard I. Hartley (left) and Dr. Sharbel E. Noujaim, two members of the GE team that developed the silicon compiler, an advanced chip design tool, examine a computer-generated plot of one chip fabricated by this method. (Photo courtesy of GE.)

Computer aided design has dramatically reduced the length of time needed to bring an integrated circuit from concept to production. Recently a team from the General Electric Research and Development Center developed an advanced silicon compiler that's reducing the time it takes to design custom integrated circuit chips for the company's internal product needs.

Three working days vs. six-eight months

The first two working chips to result from the computerized tool completed the design cycle (went from algorithm description to layout) in just three working days. These were 1.25 μ CMOS devices containing 35,000 transistors in one case and 15,000 in the other.

It is estimated that the process

would have taken six to eight months if these very-large-scale-integration (VLSI) chips had been designed with the low-level compilers, or assemblers, now commercially available and well over a year if designed "by hand."

The two chips, to be employed in a high-performance graphics computation application, contain some 1,500 transistors per square millimeter, giving them what is believed to be the highest layout density achieved to date for compiled, non-memory circuits at this feature size. Interconnection wires occupy only 10% of their total area, and less than 1% of the chips' area is wasted.

IC performance based on algorithm description

With GE's advanced silicon compiler, the chip design is generated

directly from the specifier's high-level language description of the algorithm the circuit will execute. Rather than detail *how* the circuit should operate (a task that requires an IC design specialist and hundreds of hours of design time), this description simply spells out *what* the circuit is to do.

The GE compiler language (resembling "C") is both easy to master (the user need not be a programming or chip-design specialist) and extremely efficient. The more complex of the two chips described (the one containing 35,000 transistors) was fully specified with only 100 lines of code.

Simulation mirrors results

Once the chip is specified, the compiler first does a simulation to test the algorithm it has been supplied. This simulation produces data that mirror the output of the eventual chip, enabling the designer to see how closely his algorithm achieves the hoped-for results.

After the algorithm description is adjusted (if necessary) and certain "housekeeping" chores (such as defining the chip's aspect ratio) are completed, the design tool is *turned loose* to perform the actual chip compilation. This is fully automatic. The system creates the specialized cells it needs to do the job from its library of basic *building blocks* such as adders, subtractors and delay. It then figures out how to lay out and interconnect them following tried and proven design rules. It has built-in optimization routines that serve to maximize layout density and minimize wire length.

As the final step in the process, the computerized description of the chip produced by the compiler is run through a Calma workstation that *details* the cells (*draws in* the required transistors and other basic circuit elements). The file that results from this process is then sent to the vendor who employs it to produce the mask set needed for fabricating the chip.

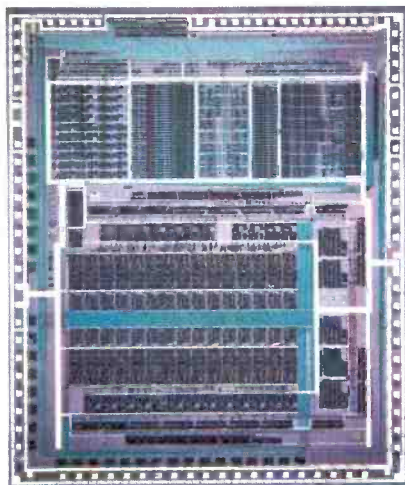
As currently configured, the GE compilation tool is designed for generating circuits using a bit-serial architecture. This accommodates many digital signal proc-

essing applications required by GE's internal product operations. The design tool is fully functional at the GE Research and Development Center and is in transition to several company locations.

Device performs to produce unit vector

The first of the compiled chips is called the *Normalizer*. This 35,000-transistor device performs the normalization of 2- or 3- dimensional vectors to produce a unit vector. With unnormalized vector coordinates as inputs, the chip performs a reciprocal of square root algorithm and normalization of numbers to determine the coordinates of the unit vector.

The Normalizer contains 13 12-bit x 12-bit multipliers and an equivalent number of adders and subtractors, plus registers for constant storage. It measures 184 mils x 206 mils, has a room temperature (25°C) clock speed of 30MHz, and dissipates 400mW of power at 30MHz.



This closeup shows the plot for a chip designed for use in a high-speed GE graphics processor. Implemented in 1.2μ double-level-metal CMOS technology, this multiply/accumulate chip measures 7.2mm x 8.0mm and contains 56,000 transistors. Its 24-bit x 24-bit multiplier is pictured at the bottom, its exponent and mantissa data paths, at the top. (Photo courtesy of General Electric R&D.)

Interpolator has 36MHz clock speed

The other compiled chip is known as the *Interpolator* and serves to calculate the interpolated value at a point from values of up to eight vertices. Smaller in size,

this chip measures 121 mils x 128 mils and consists of seven 12-bit x 12-bit multipliers and a like number of adders and subtractors. It has a clock speed of 36MHz and dissipates 150mW. Only 15 lines of high-level-language compiler code were required to specify it.

The architecture of the two chips is bit-serial with 12-bit fixed point twos' complement arithmetic. All operations are carried out on a bit-by-bit basis synchronous with the chip clocks.

The silicon compiler automatically performed data synchronization between the chips' operators, a key problem in circuits with pipelined bit-serial architecture. This eliminated the tedious job of manually translating the system algorithm into a bit-serial architecture.

Prototype quantities of the Normalizer and Interpolator chips have been fabricated at the GE Research and Development Center employing its 1.25μ double-metal CMOS process. Both types were fully functional at first silicon. **ES&T**

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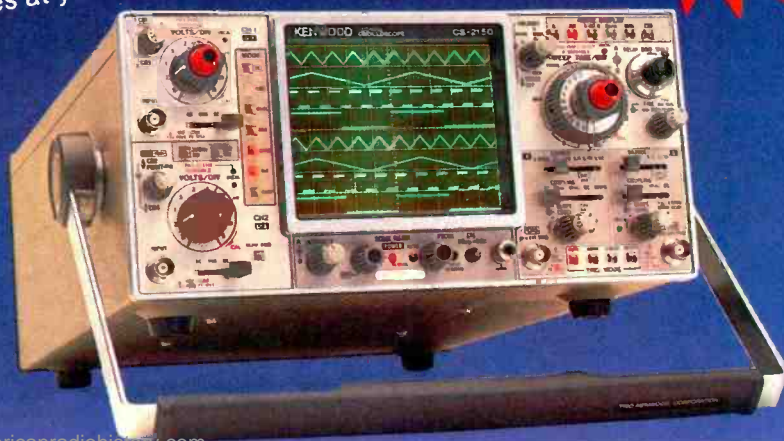
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Desoldering components, Using continuous vacuum solder extraction

By James K. Bausell

The most common problem involving circuit board rework or repair is the removal and replacement of a component from the board. Beyond the diagnostic or troubleshooting stage, the greatest problems arise in trying to remove a failed component without damage to the board. High density circuit boards now incorporate very tight lead-hole spacing so that the lead fits tightly into the plated-through hole. In addition, there are often large ground buses located on the surface of these boards that tie in to several leads on each component, adding additional thermal mass that must be overcome during desoldering.

To overcome these problems, it is almost mandatory that the technician now must consider the thermal mass properties of each solder joint before desoldering. It also is still important that heat applied to each joint continues to be limited to a maximum dwell time – normally two to three seconds.

Because most components associated with printed circuit assemblies have been soldered in place, heating is one of the key factors in component removal. The circuitry can be ruined completely if you apply excessive heat.

On semiconductor devices, the desoldering operations must be performed rapidly, in no more than three seconds per solder joint as a rule. Similarly, the circuitry itself is highly susceptible to heat damage. Because controlled pressure and heat were used to bond the circuitry to the base material in manufacturing, when these same forces are applied during desoldering operations, delamination can occur.

At temperatures necessary to melt solder, the bond strength of

circuit traces can be reduced to approximately 20% of their cold strength in just a few seconds. If excessive pressure from a soldering or desoldering tool is applied, it can easily delaminate the circuit pads or runs.

Thermal considerations

A primary factor to consider before attempting to desolder any joint is the joint's metallic volume. In general, the greater the mass, the more heat is required. The mass of any particular joint may vary over a wide range. If you're working on only a single pad on a single-sided circuit board, there's relatively little mass involved, so the pad heats up quickly.

In a vacuum desoldering system, the tip performs four basic functions:

1. It is the primary means of transferring heat to melt the solder joint.
2. It is the beginning of the path through which the molten solder will flow.
3. It pulls ambient air through the joint to cool the joint and to prevent resweating.
4. It is used to manipulate the lead during the entire desoldering sequence.

Thermal considerations when desoldering

1. Joint metallic volume.
2. Surface condition of joint to be desoldered.
3. Area of contact between the heat source and the solder joint.

But if it's a double-sided board with plated-through holes, there's more than double the mass, and that's before the mass of any component lead is taken into consideration. The lead mass itself can vary greatly, since some leads are thicker and longer than others.

Additionally, the circuit runs to each joint may vary in size and number, and some joints may have large metal surface planes or buses connected to them. There may be stand-off terminals mounted at the joint, with one or more connecting wires attached to the terminal.

Each joint has its own particular volume; how this joint mass compares with the mass of the heat source (soldering iron tip, desoldering tip, etc.) determines the rate of temperature rise of the work.

Surface condition

A second factor of importance is the surface condition on the joint at the area of contact between the heat source and the joint. If oxides, coatings or other contaminants cover the solder joint, there will be a barrier to the flow of heat. Then, even though the heat source is the right size and temperature, it may not be able to supply enough heat to the joint to melt the solder in an acceptable time period.

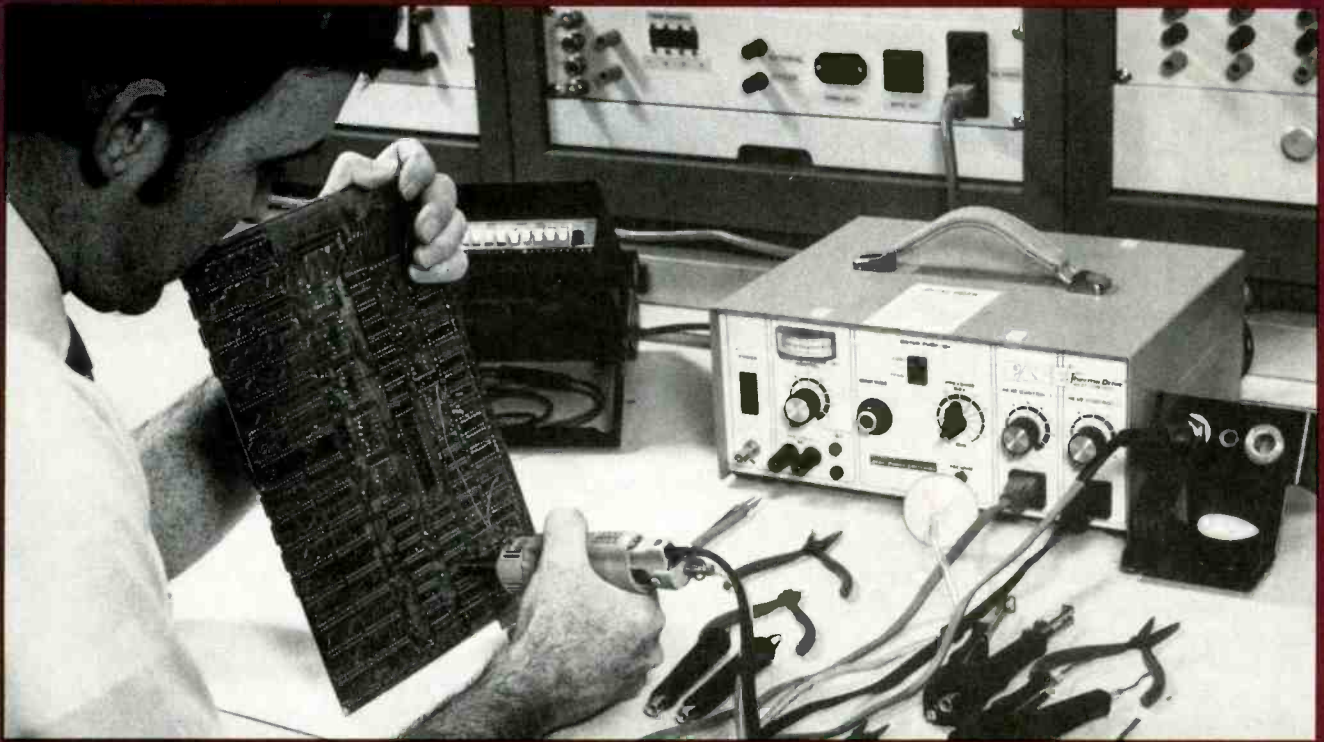
Thermal connection

A third factor to consider is area of thermal contact. This is the area of contact between the heat source and the solder joint. In desoldering for component removal operation, thermal contact is made between the tip of a desoldering tool and the solder joint itself.

Heat rate indication

For desoldering, the primary workpiece indicator is observing how fast heat is flowing into the

James K. Bausell is corporate sales manager for PACE, Inc., Laurel, MD.



A solder extraction desoldering unit consists of a handpiece with a hollow tip, a source of vacuum to extract the molten solder from the joint, a waste solder collection chamber, and a control unit to control desoldering tip temperature and vacuum.

solder joint. In practice, this means observing the rate at which the entire solder mass melts, which should be within one to three seconds for desoldering.

Any component removal procedure must control the amount of heat and pressure applied to the solder joint, and the amount of time for which they are applied. To achieve effective soldering with minimal risk of damage, consider the best means to achieve efficient heat transfer from the heat source to the solder joint. The prime pipeline for quick, efficient heat transfer (flow) through a solder joint is via the solder mass itself.

The secondary means is via the component lead. Ideally, optimum heat transfer should be through a combination of these two media. Application of heat directly to a circuit pad itself, with heat transfer through the plating in the hole, should be avoided. These are low mass elements that are easily damaged by excessive heat.

Prior to any desoldering operation, the solder joint should be in-

spected to ensure that there is sufficient surface solder fillet to work with. If not, then additional solder fillet should be added to the joint prior to desoldering.

Desoldering system selection

There are many types of solder removal methods. Continuous vacuum solder extraction system is well suited for desoldering components from high-density PCBs. An ideal solder extraction system consists of a straight in-line handpiece having a hollow tip, a heating element, and a solder receiving chamber that collects and solidifies the waste solder (and in some systems, clipped leads as well).

The solder extraction handpiece normally is provided along with a power source that controls the vacuum (and in some cases, pressure), and the necessary electrical voltage to the desoldering unit heater.

The advantage of this type of system is that it can provide full control of both heat and vacuum. In some systems, a power source

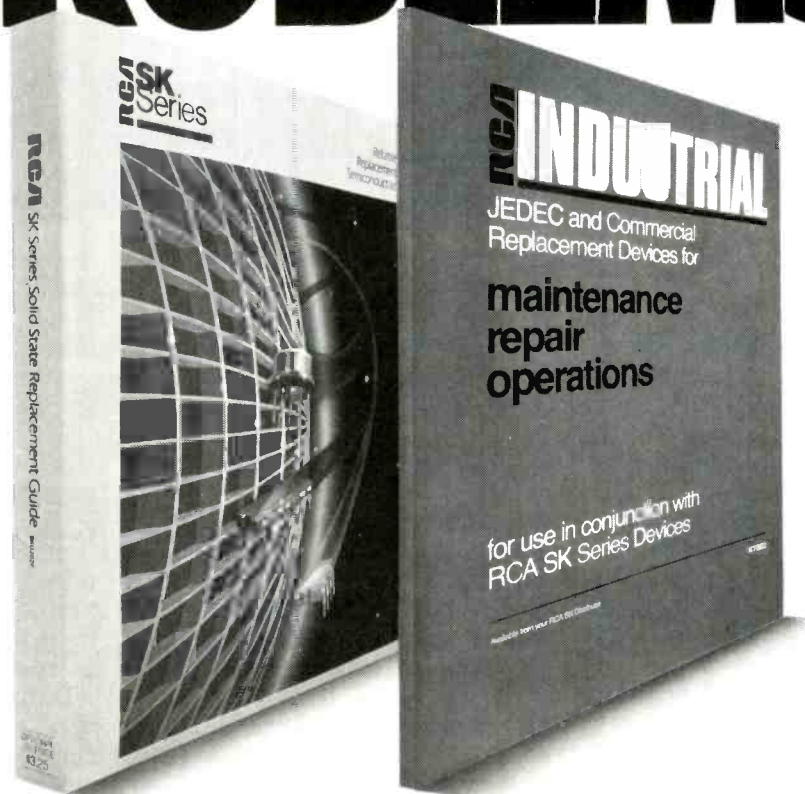
also can provide variable control of the temperature level at the heated tubular tip. This permits more precise operating on different boards, plated-through holes, solder masses, and heat sinking configurations.

For solder extraction, the heated tip is applied to the solder joint (not the pad). When the solder is melted, the vacuum is activated, causing the solder to be withdrawn from the joint and deposited into a collection chamber.

To overcome the critical problem of the lead resweating to the side walls of a plated-through hole, the lead always should be oscillated with the tip, prior to and during vacuum application. This permits cool air to flow into and around the lead and plated-through hole side walls, causing them to cool down, thereby preventing lead resweating.

Solder extraction with continuous vacuum is a consistent method for overcoming this resweat problem for either dual or multileaded components, terminating into

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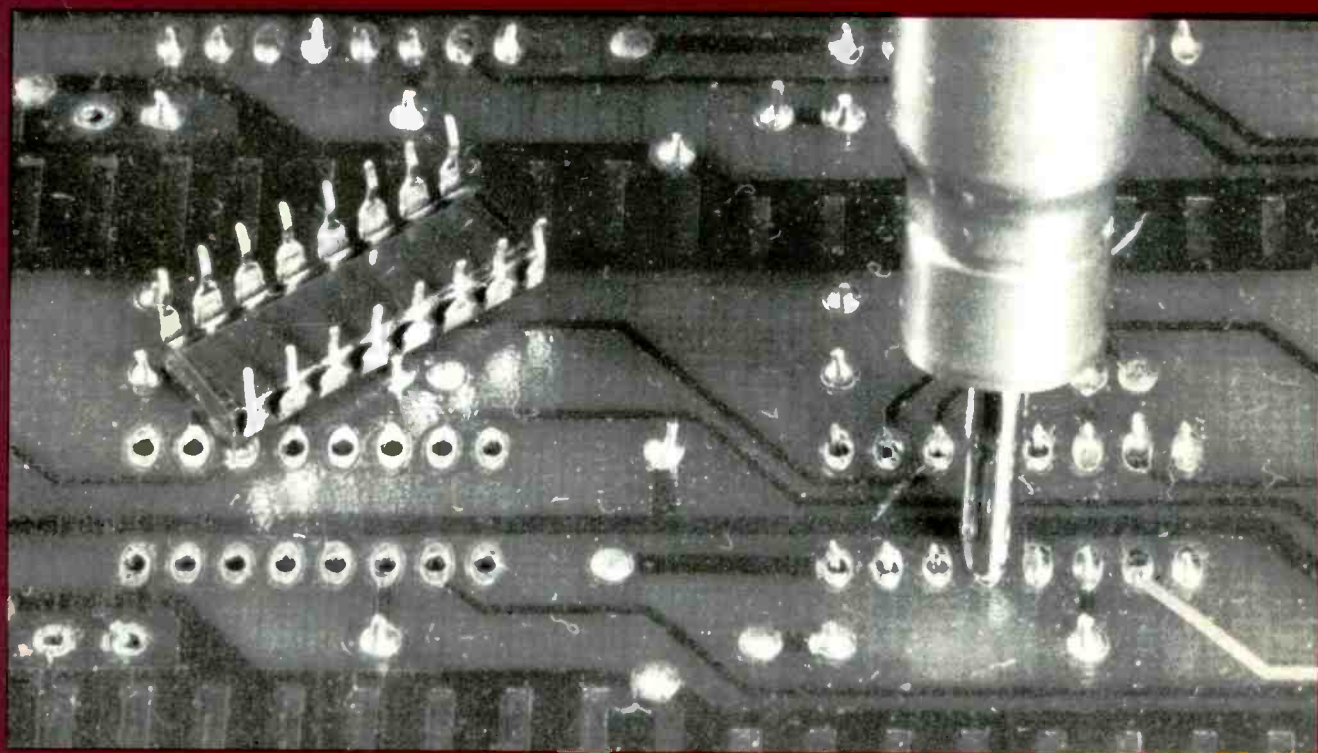
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The hollow tip of the handpiece slips over the lead to be desoldered.

plated-through hole solder joints in double-sided boards.

Desoldering tip selection

A solder extraction handpiece is normally provided with various sizes of tubular tips. In operation, the tip performs four basic functions.

1. It is the primary means of transferring heat to melt the solder joint.
2. It is the beginning of the path through which the molten solder will flow.
3. It pulls ambient air through the joint to cool the joint and to prevent lead-to-surface resweating.
4. It is used to manipulate the lead during the entire desoldering sequence.

The right tip size has an opening that will fit over the lead or pin for maximum heat transfer, yet allowing sufficient clearance around the lead to permit molten solder and air passage through it.

The maximum outside diameter (OD) of the tip selected should not cover the pad completely or touch

the circuit board base material itself, nor extend over the figure of an eyelet or funnelet. For desoldering terminals, the tip OD is selected to permit entry into the desired area.

The desoldering operation

When desoldering with a solder extraction system, the operation is performed one lead at a time. This permits controlled desoldering based on the individual thermal mass properties of the joint, while limiting heat build-up over a large area. It is best to first examine how the component is mounted to the board in terms of thermal mass of each joint, on both sides of the board. Typically, some joints will be connected to one or more circuit tracks, some to surface ground planes, buses or large solder masses, and some will be totally unconnected (pads/terminals only).

Then determine the amount of solder mass at each joint. Each should have an adequate solder fillet to ensure positive heat transfer

through the joint. In cases where the fillet contains insufficient solder, it is best to add solder to the joint to build up the fillet, thereby ensuring good heat transfer characteristics for desoldering.

It is best to hold the desoldering handpiece like a pencil or soldering iron for maximum comfort and control. The tip should be placed over the lead so that is approximately at a right angle to the board. Your arm should be positioned comfortably so that there is no strain.

During any desoldering operation, it is necessary that circuit pads or adjacent circuitry be protected from lifting or damage, and that measling does not occur on the adjacent base material. Two elements that can cause problems are *excessive heat and pressure*.

To prevent any of the above problems, only a light touch should be used when desoldering, essentially allowing the desoldering tip to touch the pad just lightly. Also, dwell time on the joint should be kept to a minimum—normally

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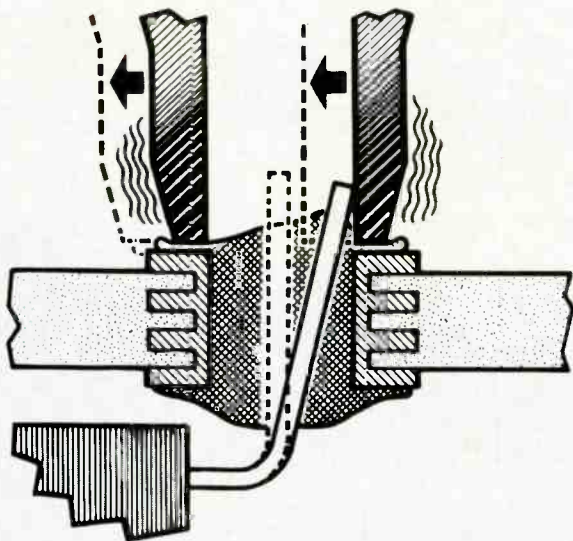
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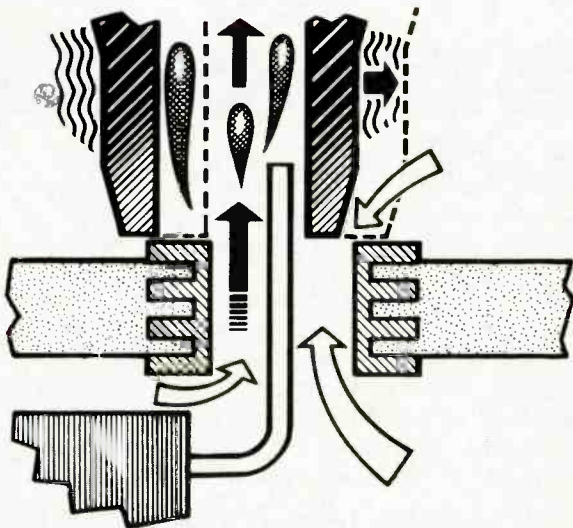
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Wiggling the lead with the desoldering tip lets you know when the solder has melted.



Once the solder has melted, apply the vacuum while continuing to wiggle the lead. This removes almost all of the molten solder and cools the lead, the through-hole plating and the pad to prevent resweating.

about two to three seconds maximum after the initial solder fillet melt.

The tip should be held tightly against the solder joint with no more pressure than a pencil balanced lightly on its tip. The solder should be permitted to melt.

Once the melting action starts, and the tip comes down over the lead, the top should be used to wiggle the lead until the lead swings freely and easily, indicating full solder melt through the joint.

When desoldering round leads, use the desoldering tip to move the lead in a circular motion. When desoldering flat leads, such as on dual-in-line packs, the tip should move the lead back and forth along the flat plane of the lead. Once the lead moves freely, indicating full solder melt through the joint, the motion is maintained while the vacuum is applied. Then, with the vacuum still applied, the tip is removed, and the vacuum is turned off.

When desoldering multileaded dual in-line (DIL) components, avoid working on adjacent leads in sequence to prevent localized heat buildup. A good procedure is to do the corners first, then skip over every other lead on the first pass, going back for a second pass to desolder the alternate leads.

A good rule to follow for most double-sided boards is to apply heat at a tip temperature of 575°F to 600°F (302°C to 316°C), for approximately two seconds following initial solder fillet melt on the lead side. Then, apply vacuum (with the lead kept moving) for at least one second to two seconds. This will permit ambient air to be drawn up through the hole, causing cool-down of the hole and the lead, and preventing lead resweating.

If, after desoldering all the leads on a component, it is found that sweat joints still occur, or that the solder joint was not completely desoldered, do not attempt to apply more heat to the joint. Allow the joint to cool down; resolder the joint and desolder it once again.

ES&T

Feedback

Continued from page 9

Letter to Sam Wilson

I have two questions regarding "Test Your Electronic Knowledge," January 1987 issue.

1. Question No. 7: The track on a compact disc is about ????. You gave the correct answer as choice "D. None of these choices is correct."

In the December 1986 issue, page 54 under heading *Technology required to produce a compact disc*, the second paragraph states that there are approximately 2½ miles of spiral track on a compact disc. This was given (in January, question 7) as choice C. My question: How long is the track on a compact disc?

2. Question No. 8: What is the name of the block marked X in the phase-locked loop in Figure 4? You

gave the answer as "Divide-by-three circuit." Can this also be called *Prescaler*?

ES&T is a great magazine!...

**Joe Sanfilippo
Woodruff, WI**

In reply to your first question, the answer in the magazine was incorrectly marked. The correct answer to question #7 is C. As you pointed out, 2½ miles is an average value for compact discs. In reality the length of the track is determined by how much information has been recorded, so that is why we always say about 2½ miles.

*In reply to your second question, the answer is yes you can call the block a **prescaler**. However, the word *prescaler* doesn't describe*

what it does in the phase-locked loop, so I prefer the use of the term "divide by 3 (or divide by any number)."

Thanks for your comments on the magazine. Your correspondence is very important to us.

Sam Wilson

Do you have a comment, a gripe, or some valuable information that you'd like to share with the editors and/or readers of *ES&T*. Please address your comments to *ES&T*, care of the "Feedback" department. If they're of general enough interest and we have the room, your comments might be published here in the "Feedback" column.

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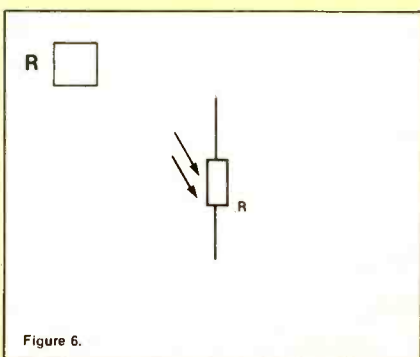
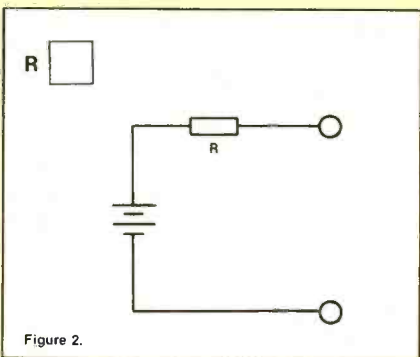
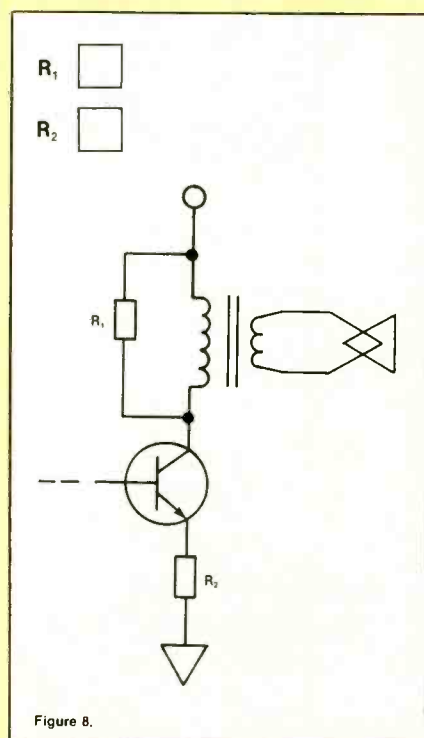
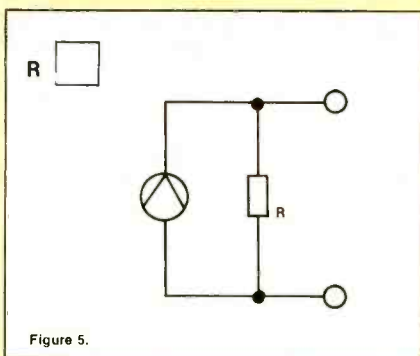
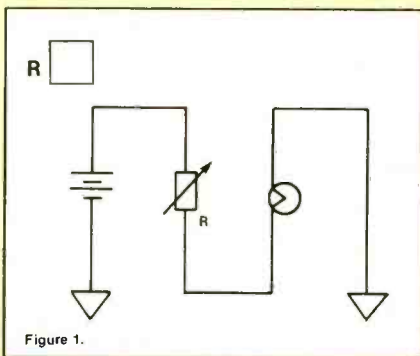
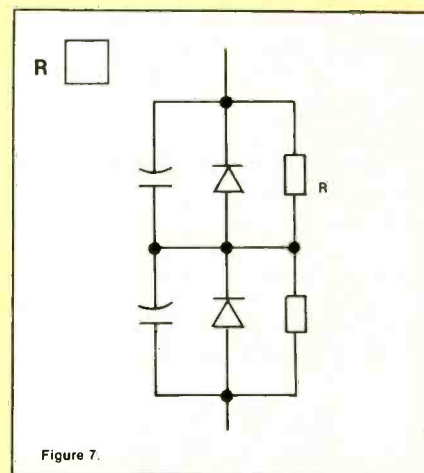
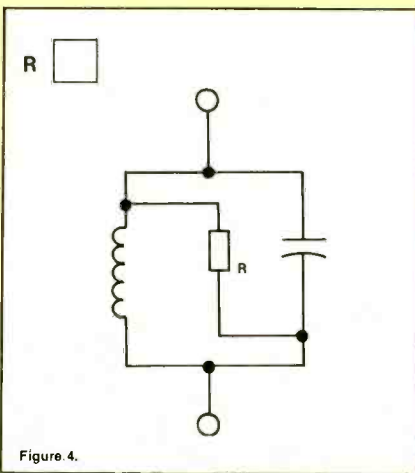
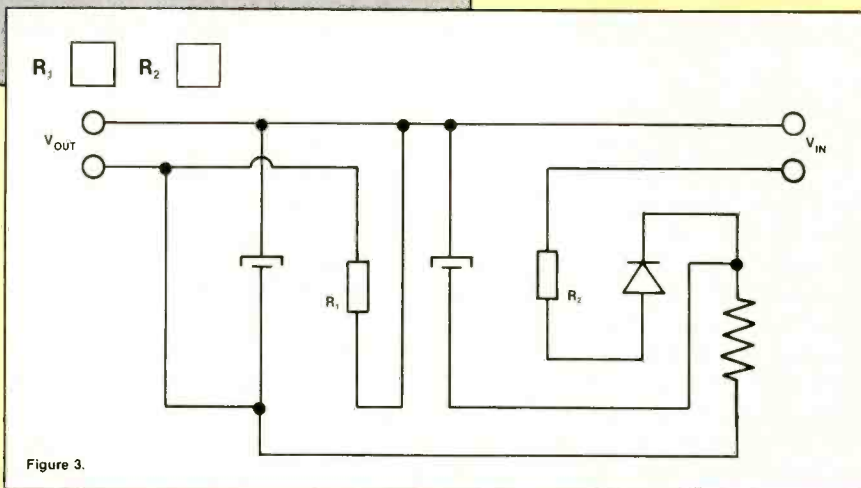
Test your electronics knowledge

By Sam Wilson

What could be easier than a quiz on resistors? To make it a little bit more challenging, the circuits are drawn differently, but the connections are correct. Also, the symbols have been changed in some cases. Those things won't fool an experienced technician. Try for 100% on this quiz.

Here are the names of the resistors. Enter the letters on the drawings:

- A. Thevenin resistor
- B. VDR
- C. Equalizing resistor
- D. Swamping resistor
- E. Norton resistor
- F. LDR
- G. Rheostat
- H. Surge limiting resistor
- I. Temperature compensating resistor
- J. Bleeder resistor
- K. Potentiometer
- L. Bias resistor



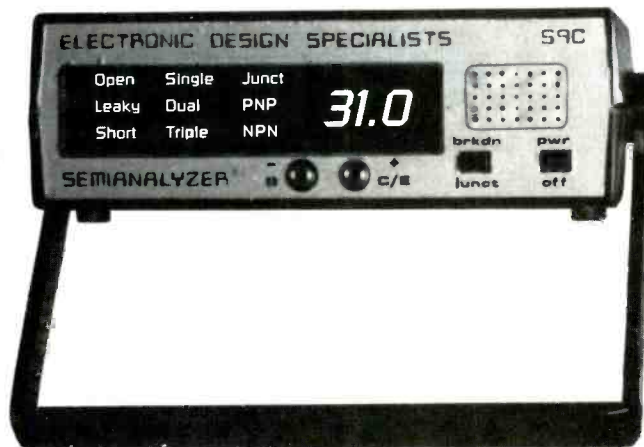
Answers are on page 53.

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Maintenance and cleaning of VCRs

Grime collects on VCRs neglected, as was this, for more than two years. Note dirt on swab.

By Victor Meeldijk

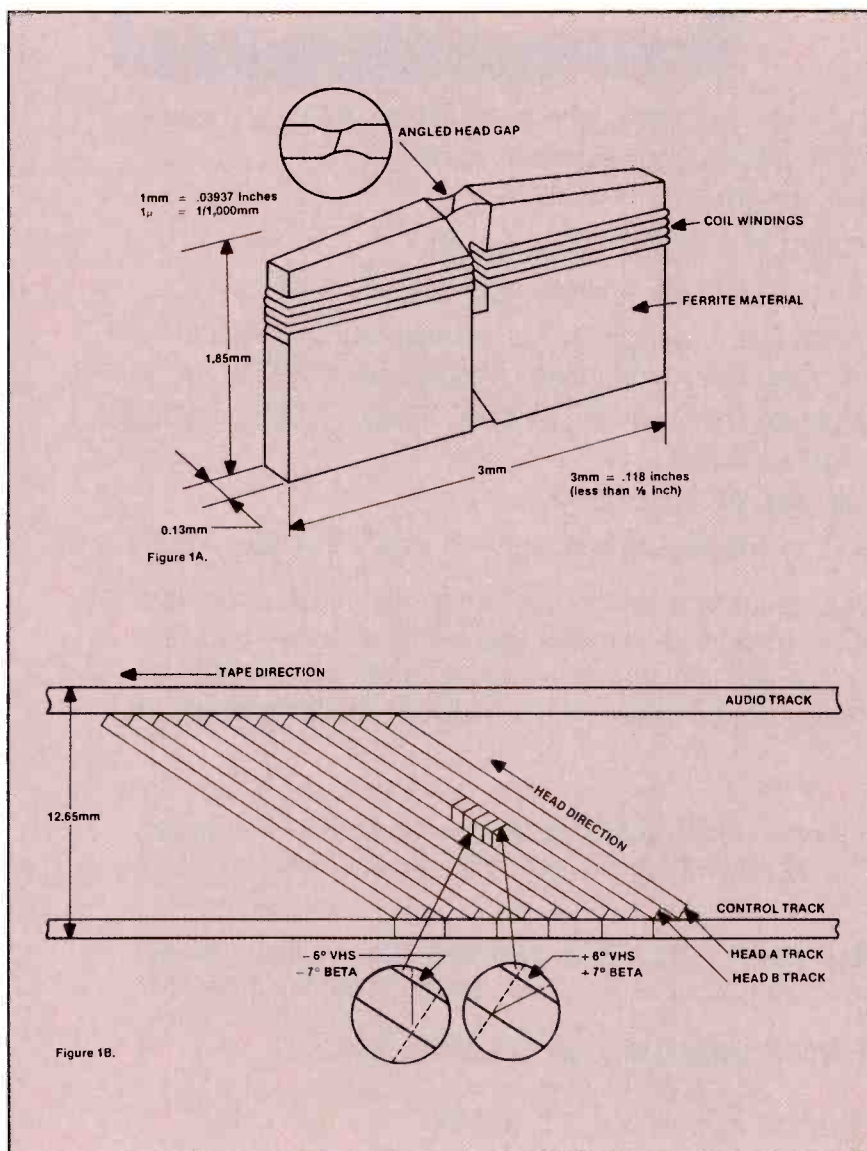


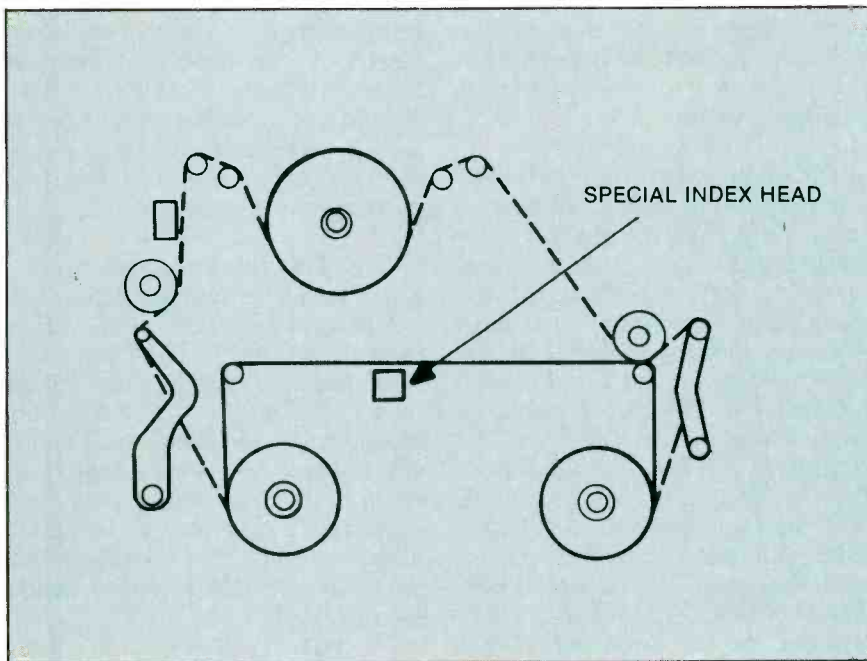
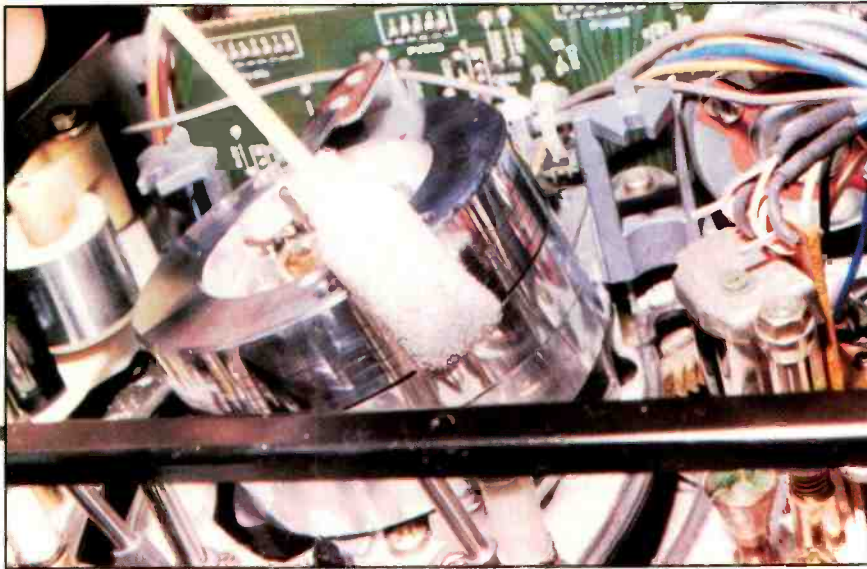
Figure 1. A: Atypical video head is made up of two pieces of ferrite material and coil windings of wire 1/1,000 inch in diameter. B: The azimuth method of recording minimizes crosstalk between adjacent video tracks. See page 24.

Although videotape recording was pioneered by Ampex in 1956, and the industry standard U-matic cassette recorder became available in the late 1960s, home recording did not really start until 1976 with a 1-hour record/playback machine. This was the Betamax SL-7200, developed by the Sony Corporation, according to Akio Morita, chairman of the Sony Corporation. In the book "Made In Japan," the term *Betamax* was coined because in Japanese there is a word pronounced "beta" that refers to a rich and full brushstroke in calligraphy—without skips or white spots. VCR azimuth recording (which is explained later) does not need guardbands or blank tape areas between tracks.

Home recording grew with the SL-8200, which offered up to three hours of record time, and expanded even more in late 1979 with the Beta III, which had a five hour record capability.

The competing VHS format, sometimes called Video Home System, was introduced by JVC after the appearance of the Beta machine in 1975. The Matsushita Corporation, better known in the United States as Panasonic, expanded the capability of the VHS machine to four hours. The 1985 expiration of the 10-year JVC patent on the VHS format has resulted in the recent emergence of Korean manufactured recorders.

Meeldijk is reliability maintainability engineering manager, Diagnostic/Retrieval Systems, Inc.



Other early home recorder designs, now obsolete, included the VX format, marketed as the Great Time Machine by Quasar Electronics (a division of Matsushita) and the V-Cord system developed by Sanyo. The latter, while using two video heads for full field recording, stretched the machine capability to two hours by using 1-head helical scanning and skip-field recording.

Total VCR sales to dealers, ac-

cording to the Electronic Industries Association, were 252,981 units the week of Sept. 13 to Sept. 19, 1986. This was a 3.7% increase compared with the sales for the same week in 1985. Of this number, 231,765 were VCR decks and 21,216 were camcorders (in 1985 516,698 camcorders were sold, with 1,168,768 sold to dealers in 1986, a 23% increase). It was projected that 13.8 million recorders

All recorders—including VHS, Beta, 8mm, and VHS-C—have the same elements.

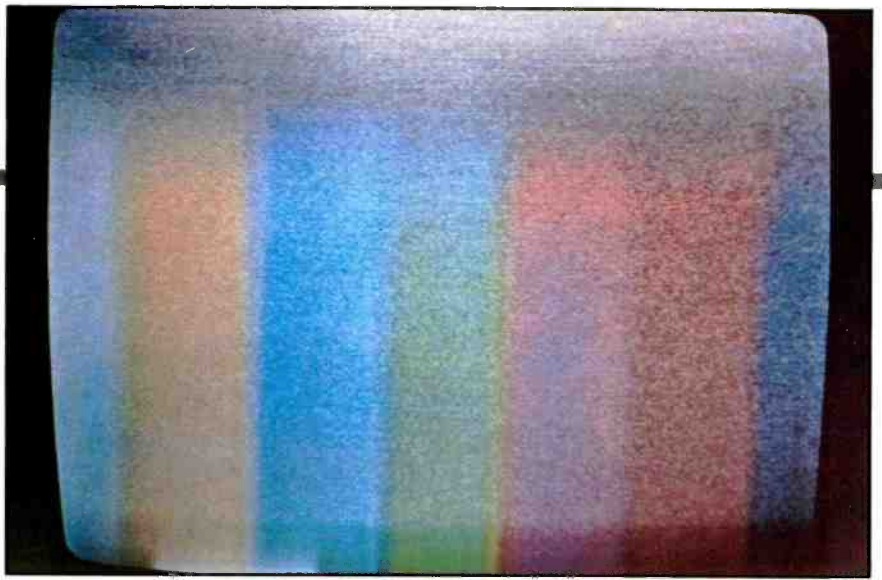


Figure 2. If one video head becomes inoperative, the effect is a combination of a bad image and lots of snow. See page 25.

There is much controversy as to when, and if, periodic head cleaning for VCRs is necessary.

would be sold to dealers in 1986 (7.6 million were sold in 1984 and 11.8 million in 1985) and that a projected 14 million households were expected to have VCRs (34.4 million VCRs.) The projections were close: nearly 13.2 million VCRs were sold to dealers in 1986. Forty percent of the households now have VCRs.

VCR maintenance percentages

An Electronic Industries Association study of VCR owners who indicated that they had required servicing, 32% reported that the reason for servicing was head cleaning, 15% for repair of the rewind mechanism and 11% for head replacement. If 11% of machines require service (as noted in the January 1987 issue of *Consumer Reports*, from a survey of readers with machines purchased between 1982 and 1985), then 21.2 million recorders (from the figures given above) times 11% (of recorders brought in for servicing) times 32% (recorder service for head cleaning) equates to more than 746,000 recorders requiring cleaning in early 1987 alone.

It is expected that these percentages will increase with the use of camcorders, which are exposed to harsher environments than experienced in the home (mechanical shocks, dust, sand, moisture and excessive heat). VCR damage also can be a result of cassette tape damage. In tests done by the U.S. Naval Avionics Center, and by manufacturers using recorders in military applications, it has been

found that the magnetic tape will stretch. The tape may be permanently damaged when used at temperatures in excess of 60°C, and the videocassette case may warp when subjected to an 85°C storage temperature. When the tape stretches, the oxide particles will flake off into the VCR mechanism. Should the cassette warp excessively it may become jammed inside the recorder, which will then require service to remove.

The videocassette recorder mechanism

All recorders, including VHS, Beta, 8mm and VHS-C, have the same basic elements: tape guide rods, cylinder (or drum or scanner) assembly, record heads (audio/video), control (or servo) head and erase heads. The audio, servo and erase heads resemble those heads found on audiotape recorders but the video (and hi-fi audio) heads are different.

The typical video head is a tiny electromagnet made up of two pieces of ferrite material and ultra fine (1/1,000 inch) magnet wire (Figure 1, page 22, shows the construction of a typical video head). Early machines have only two video heads, as do currently offered inexpensive VCRs. Some of the new machines have as many as five heads: two for the 2-hour mode, 2 for the 4/6-hour modes and one for still-field playback. Other machines have four video heads and two heads for hi-fi audio recording. The index head, used to find tape segments in fast forward

or rewind, is not located on the video drum and is located in the tape path for tape fast forward/rewind where no video playback is necessary.

Video heads are located on the video drum and two heads, diametrically opposite each other, are used at one time (for a given tape mode) to record a program. The head gap on a VHS machine is ± 60 from perpendicular, and ± 70 from the perpendicular for Beta format units.

This recording scheme, called azimuth recording, makes it possible to eliminate spaces or guard bands

between tracks because a head cannot pick up a signal from the differently angled pattern made by its counterpart head. Should one head become clogged with magnetic oxide particles, filling the head gap and shorting out the video signal, the effect is a combination of a bad image and lots of snow (see figure 2, page 24).

The video heads (and hi-fi heads if present) rotate at 1,800rpm. In the SP (or 2-hour mode) the tape is drawn at a linear tape speed of 1.33 inches per second, which results in a relative head-to-tape speed of over 220 inches per sec-

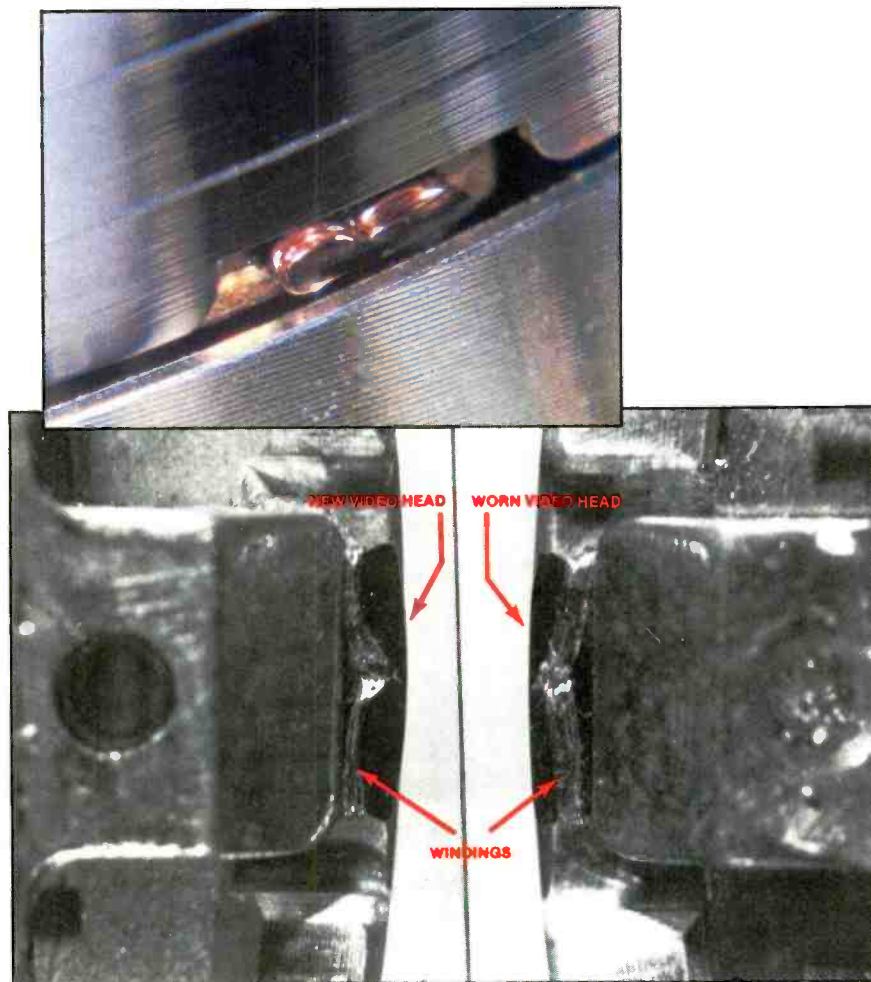
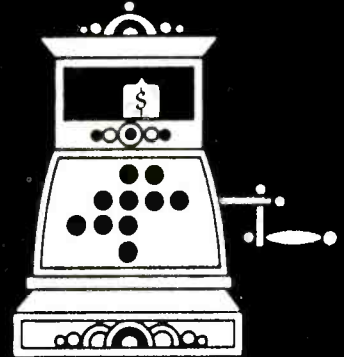


Figure 3. This photo shows a magnified image comparing a new video head (left) with a worn head (right). The new head protrudes 0.0019 inches beyond the head drum, while the worn one only protrudes 0.0005 inches. The line between the two, 0.002 inches wide, will give some idea of the magnitudes being shown. The color inset is a closeup of the video head that will give some idea of the angle from which the head wear photos were taken. See page 26.

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ond (for Beta machines with different cylinder, or drum, size the relative speed is 273.2 inches per second). For each hour of recording time, each head travels the equivalent distance of seven miles.

Video heads have a life of between 1,000 and 3,000 hours. The 1,000-hour figure is based upon the use of non-name brand or unlicensed tapes that may be more abrasive than high quality tape, and which may even damage the VCR heads, according to a *Consumer Reports* video tape report, November 1986.

It is difficult to judge head wear with the naked eye because the head protrusion between a worn head, which could fail anytime, is 0.0004 inches and the head protrusion of a new head is 0.0020 inches. Figure 3, page 25, shows two video heads, one worn and one new. The line between the heads is 0.002 inches thick, or the thickness difference between a worn and new head. To further illustrate the small measurements involved, Figure 4 shows a video head vs. a 1-cent piece. It is easy to see why special tools such as a head protrusion gauge should be used to adequately measure head wear (Figure 5).

VCR cleaning/maintenance intervals

There is a great deal of controversy as to when, and if, periodic head cleaning for VCRs is necessary. Some manufacturers recommend that no cleaning be done unless video degradation occurs. Cleaning intervals between 200 hours to 500 hours have been recommended by some service texts, and makers of head cleaners recommend anywhere from 6-, 20-, 40- or 100-hour intervals.

The following guidelines are given for recorders used for business or commercial purposes where it is critical that they work when they are needed. Cleaning interval is 200 hours, when there is no control over the quality of tape used or the environment the machine is exposed to. Before any maintenance or cleaning is at-

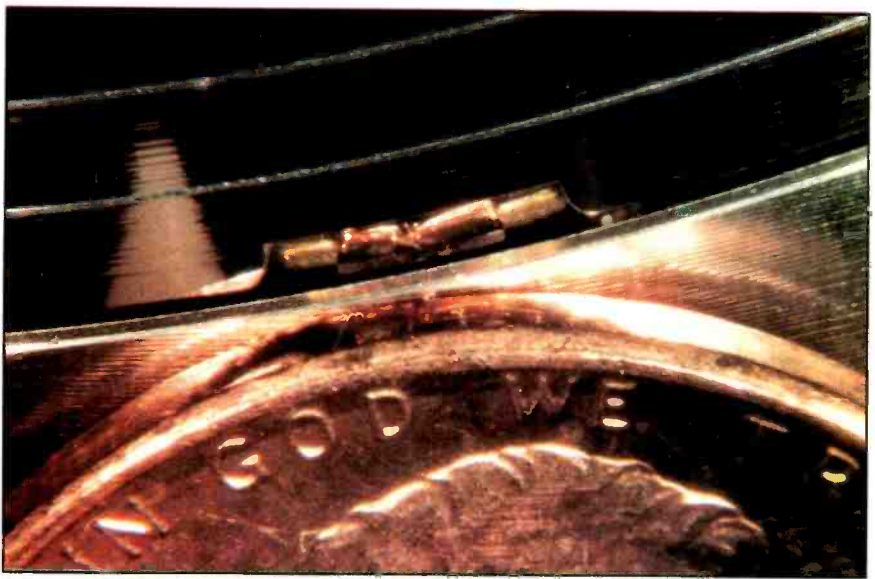


Figure 4. The size of this video head compared to the size of this penny's lettering gives a pretty good idea of how small the head is, and why special tools are required.

VCR cleaning methods

There are a few distinct categories of cleaning methods:

- Dry cassette tape cleaners that use unpolished or partially polished recording tape, or employ a wiping action
- Wet cassette-type cleaners that use a soft synthetic, or chamois, cleaning ribbon in a cassette housing which is moistened by a cleaning solution
- Chemical, cleaning aerosol sprays
- Lint-free swabs (such as foam) and a cleaning solution. The pinch rollers, heads and other parts of the tape transport mechanism are individually cleaned using a moistened swab.

Only the last method is recommended as this is the only way to thoroughly clean the VCR mechanism. Unpolished tape is abrasive and leads to additional head wear. The wet-cleaning cassette may leave fibers on the video heads from the cleaning ribbon and Freon aerosol sprays may create a rapid temperature change of the head resulting in head damage from the different temperature characteristics of the epoxy, ferrite, brass and copper materials used in the head. Epoxy failure will allow the ferrite to crack or the head gap to open, either of which results in a head failure.

VCR cleaning procedure

To clean a VCR follow these steps:

- Make sure the machine is turned *off* and does not have a cassette in it. Unplug the unit from ac power.
- Remove the top cover of the machine to gain access to the tape transport mechanism.
- Moisten a lintless (foam or chamois) cleaning swab with a cleaning solu-

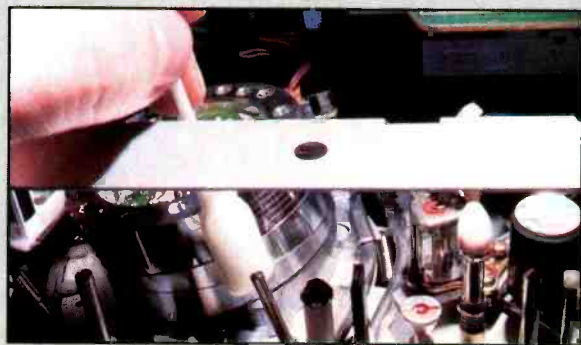


Figure 6. Use a lintless swab and the recommended solvent to clean video heads. Rub the heads only in the direction of tape movement. Use of up-and-down motions may damage the fragile heads.

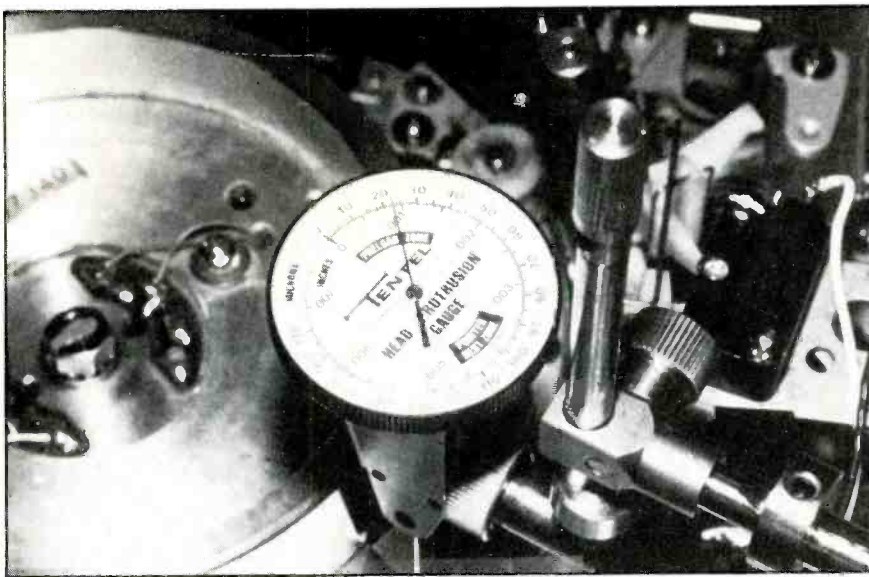


Figure 5. A head protrusion gauge such as the Tental HPG-1 accurately measures head wear and lets you know when a head needs to be replaced.

tion. (Methyl alcohol does the best job but can be a health hazard. Other solvents are isopropyl alcohol, DuPont Freon TF or trichlorotrifluoroethane and alcohol).

- Clean the video heads by applying five or six strokes of gentle back-and-forth motion in the tape path direction. Rotate the head drum assembly by hand. Touch the top and not the sides of the upper drum to do this, to expose the total surface to be cleaned (See Figure 6).
- Clean the rest of the tape path (Figure 7 shows a typical VHS tape path) in a similar manner. Be sure to clean the audio/servo head, erase head, tape guides, pinch roller, capstan shaft assembly and the index head (if used).

Do not

- use a cotton swab, as it may leave lint particles.

Do not

- apply vertical cleaning strokes. Motion in other than that of normal tape path motion can damage the very fragile heads.

Do not

- use acetone, MEK or other strong solvents. They may dissolve the varnish insulation from the head magnet wire coils.

Do not

- use Freon aerosol sprays that can create a rapid temperature change of the head assembly which can result in head damage.

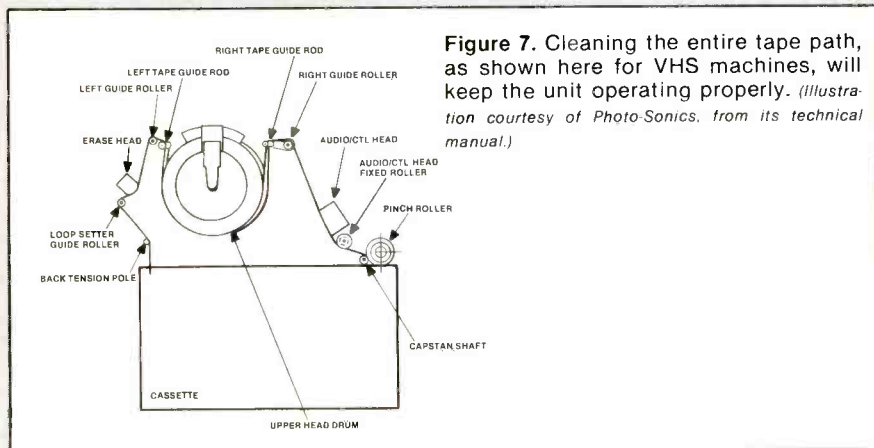
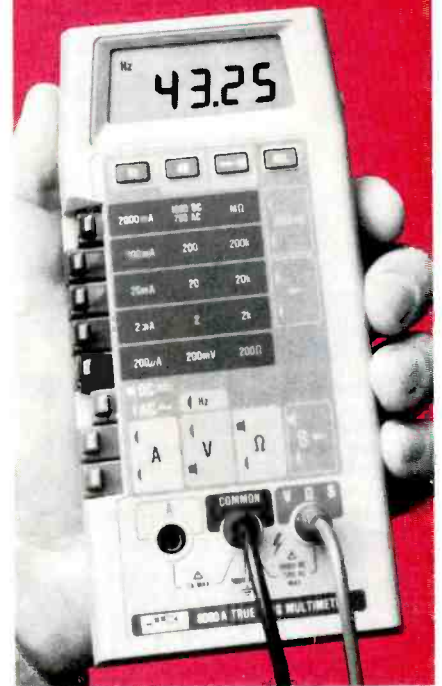


Figure 7. Cleaning the entire tape path, as shown here for VHS machines, will keep the unit operating properly. (Illustration courtesy of Photo-Sonics, from its technical manual.)

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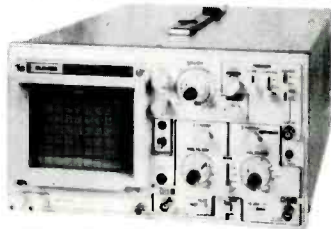
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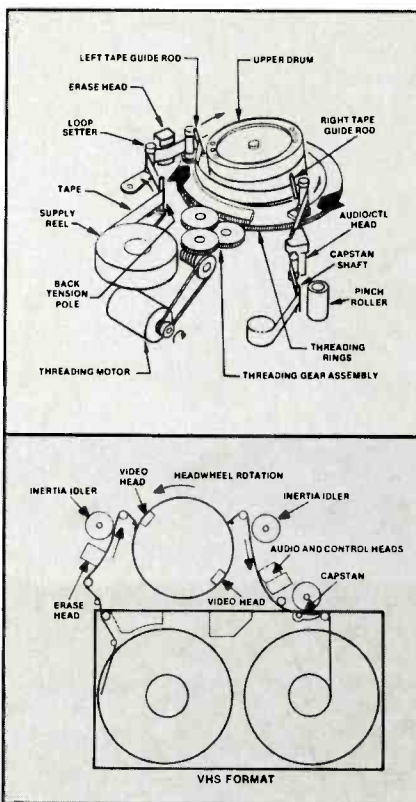


Figure 8. Moving parts should be lubricated only as recommended by the manufacturer with the lubricant recommended. Be sure to follow instructions carefully. (Illustration courtesy of Photo-Sonics, from its technical manual.)

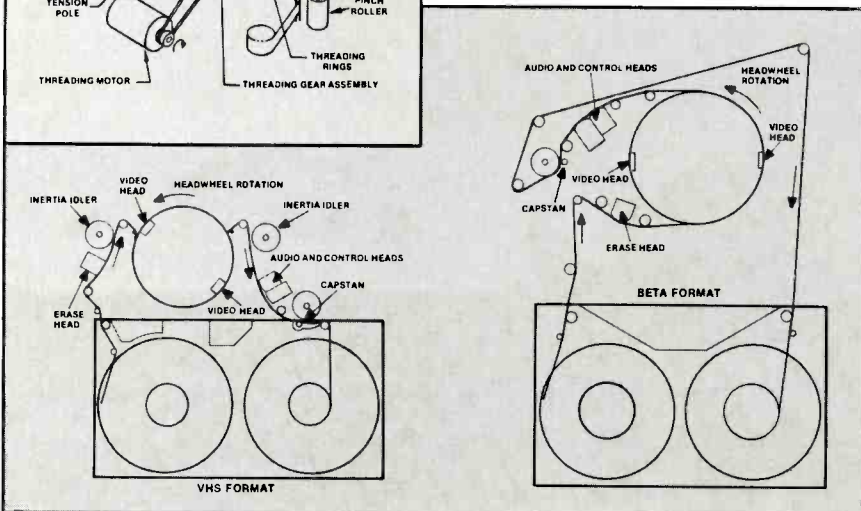


Figure 9. This illustration contrasts the tape configuration in a Beta VCR with that of a VHS VCR. Note that because of the shape of the tape path, the Beta configuration is called omega (Ω) wrap and the VHS configuration is called inverted M, or W wrap.

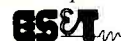
tempted, however, the manufacturer service manual should be checked. Do not lubricate or clean any part unless it is recommended by the manufacturer (sealed bearings, for example, do not require any lubrication).

Video head replacement is at 1,000-hour intervals, audio/servo and erase heads at 4,000-hour intervals. (According to a *Consumer Reports* survey in January 1987, only 2% of machines purchased from 1982 to 1985 have had the heads either repaired or replaced.) Lubrication of the tape guides (using a 90-weight graphite grease type MX90, or the manufacturer recommendation) should be performed when the heads are replaced. Belts are replaced at 2,000-hour intervals (or during each head replacement for critical applications). This is for rubber and not special film belts made of Kapton, Mylar or similar materials. Pinch rollers should be inspected every 500 hours and are replaced every 4,000 hours. Pulley bearings, made of brass/bronze materials, wear out faster than other parts of the recorder and are replaced every second head replacement (1,500 hours to 2,000 hours).

Head degaussing for the video or hi-fi heads is not necessary as these heads are made of ferrite materials. Although head degaussing of the other heads and tape guides often is not mentioned in service manuals, it should be part of the maintenance done when the video heads are replaced. Degaussing is rarely necessary; it is considered necessary when there is a consistent loss of several lines of video.

These fairly short maintenance intervals, when compared to a 500-hour cleaning and 3,000-hour head life ensure that the recorder is operational when needed for critical recording situations.

Following the guidelines presented in this article will assist in keeping any VCR in peak operation condition.



The author would like to acknowledge the assistance of Mr. Wayne Graham, of the Tentel Corporation, Campbell, CA, and Mr. Philip Kiel of Photo-Sonics Inc., Burbank, CA, for supplying some of the information used in this article.

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This simplified TV servicing guide developed by *Sencore* is for everyone with questions about increasing their servicing productivity and capabilities. Titled "VA62 Simplified Operating Guide," it takes a step-by-step process to teach signal injection, a quick, profitable method of servicing.

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The VA62 Simplified Operating Guide is valued at \$20 but is being offered during the introductory period at no charge.

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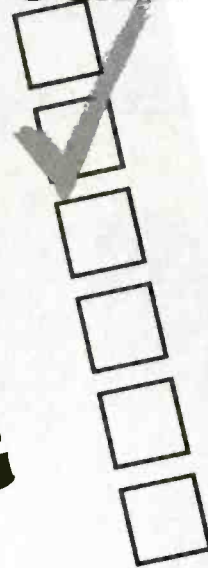
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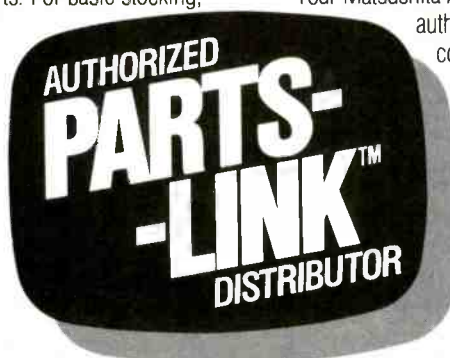
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Using a small transformer to get special ac voltages

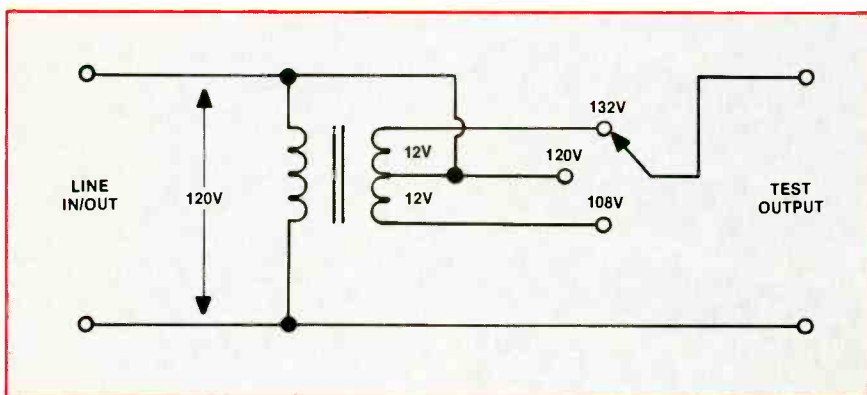
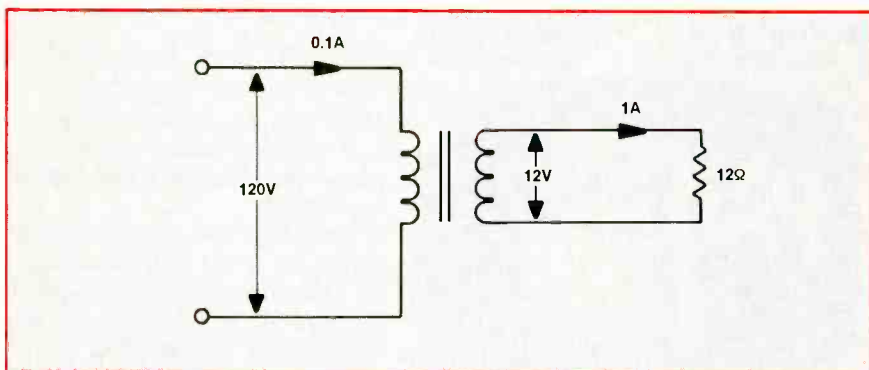


Figure 1. Connecting a small transformer like this will allow you to increase or decrease incoming line voltage by the transformer's output voltage (120V in this case) to test equipment response to undervoltage/overvoltage conditions. If you would use a unit such as this frequently, it would be best to build it into a case and add a double-pole *on/off* switch, and a line fuse and indicator light. Add a duplex receptacle as output and you have a handy, versatile unit. Connect it to the incoming line via a 1:1 isolation transformer for safety.



THE LOW-VOLTAGE TRANSFORMER

	Primary	Secondary
Volts	120.00	12.00
Amps	.10	1.00
Volts x Amps	12.00	12.00

Figure 2 table.

Figure 2. In a transformer, the power consumed in the load is equal to the power measured in the primary, less transformer losses. The voltage step-down ratio equals the current step-up ratio.

By Arthur G. Hansen, P.E.

When an equipment test requires a special ac line voltage, you can save time and money if you know how to connect a small rectifier transformer or control transformer to do the job. Here's how.

Using special ac voltages

Almost every technician or experimenter needs a non-standard ac line voltage from time to time. To check a unit's performance at low and high line voltages, or to operate a piece of equipment from a supply voltage different from the nameplate value, it helps to know a simple, inexpensive way to get special ac line voltages. While special transformers or adjustable autotransformers will do the job, they can be expensive or just not available. Instead, you can use a low-power rectifier or control transformer. With its low voltage secondary winding connected to aid or oppose the line voltage, it can provide a simple, low-cost solution.

The buck-boost transformer

To get an ac line voltage that is more than or less than the standard value, you can just connect the secondary winding of a transformer so that its voltage adds to (boosts) or subtracts from (bucks) the ac line voltage. The buck/boost transformer will be smaller than a regular line-to-line isolation transformer, and cheaper than an adjustable autotransformer.

A setup that can change the 120V ac line by plus or minus 10% is good enough for many equipment tests. A schematic for a voltage changer is shown in Figure 1.

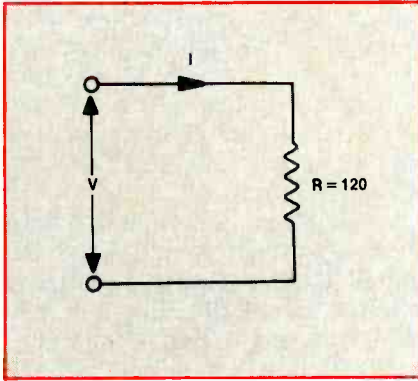


Figure 3. If the load were a pure linear resistance, bucking/boosting the input voltage by 10% would result in the change in output current and power shown in the table.

R = 120 OHMS

Condition	Volts	Current Power = V/R Amp	= VxI Watt
Normal	120.00	1.00	120.00
Ten percent low	108.00	.90	97.20
Ten percent high	132.00	1.10	145.20

Figure 3 table.

This circuit uses a transformer with a primary winding rated at 120V ac and a center-tapped secondary winding of 24V. A switch connects the load device to one of the following:

1. Directly to the input ac line voltage
2. The line voltage *boosted* by one 12V side of the transformer secondary (one-half)
3. The line voltage *bucked* by the other 12V half of the secondary.

With 120V input, the switch selects 120V, 132V (120+12), or 108V (120-12).

The buck/boost transformer supplies only a fraction of the total output power, so most of the power to the load comes directly from the ac line. In comparison to a full transformer, the buck/boost transformer is not only smaller and cheaper, but easier to select.

The method has two limitations:

1. There is no electrical isolation between input and load. For safety reasons you should use a 1:1 isolation transformer and connect the buck/boost system to its output.
2. The output voltage changes in steps, and is interrupted every time the selector switch setting is changed.

If your application can tolerate this, then a buck/boost transformer probably can do the job.

How it works

To see how the arrangement works, let's first review some basic principles of transformers. The first rule is:

Input power equals output power.

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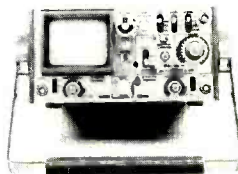
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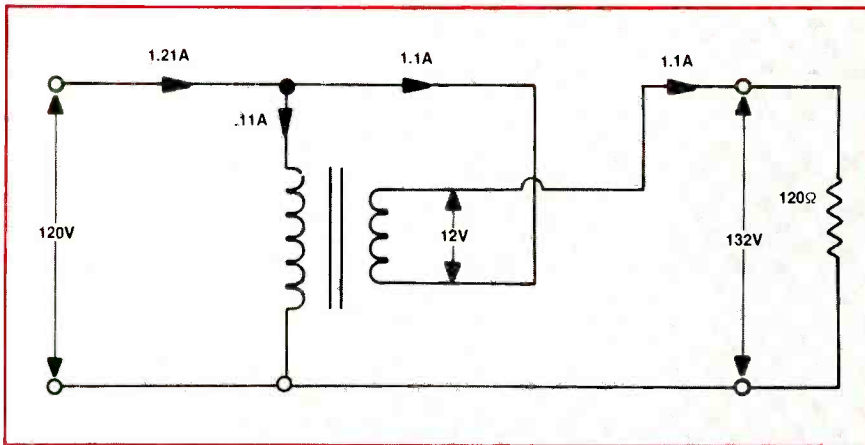
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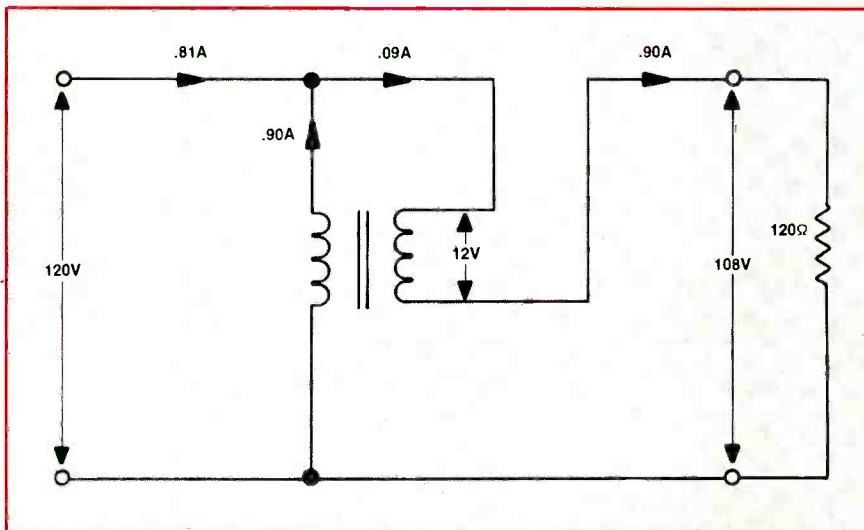
Circle (18) on Reply Card



BOOST ARRANGEMENT

		Transformer			
	Load	Secondary	Primary	Total	
V	132.00	12.00	120.00	120.00	
I	1.10	1.10	.11	1.21	
V x I	145.20	13.20	13.20	145.20	

Figure 4A table.



BUCK ARRANGEMENT

		Transformer			
	Load	Secondary	Primary	Total	
V	108.00	12.00	120.00	120.00	
I	.90	.90	.90	.81	
V x I	97.20	10.80	10.80	97.20	

Figure 4B table.

Figure 4. When the transformer is connected to boost the line voltage (A), the load draws more current. When the transformer is connected to buck the line voltage, the load draws less current. In both cases, the transformer rule, output power equals input power, is obeyed.

This is because we are just transforming the input power from the transformer primary to the secondary. Except for small losses in the transformer, all of the primary input power appears on the secondary output.

The input and output powers are just the products of volts and amps. Figure 2 shows a transformer with a 120V primary and a 12V secondary. The table shows the primary and secondary voltages and currents when the secondary is connected across a 12Ω load.

Because the volt-ampere products of primary and secondary must be equal, we now have the second rule for transformers:

The voltage step-down ratio equals the current step-up ratio.

Suppose, for example, that you have a device that normally draws a current of 1A from the 120Vac line. You want to test this unit at line voltages that are approximately 10% higher and 10% lower than normal. Because the device draws 1A from 120Vac, you can represent it as a 120Ω resistor. Under normal, low and high line voltage conditions, the table in Figure 3 shows what you would measure if you took current and power readings in the circuit of Figure 3.

To test the unit, connect the low voltage secondary winding of our 12V transformer in a boost (voltage-adding) and a buck (voltage-subtracting) arrangement.

Increasing the output voltage

Suppose that the transformer of Figure 2 is connected as in Figure 4(A). Notice that the load resistor of 120Ω, which would draw 1A from 120V draws more current when the voltage it is connected to is boosted. Note the voltage, current and power values in the Figure 4A table.

The table of numbers illustrates the basic transformer rule:

Transformer output power equals transformer input power.

Because the voltage ratio is 10:1 (120:12), the current ratio is 1:10 (0.11:1.1).

With this arrangement the load is operating at 132V, supplied from a 120Vac line.

Decreasing the output voltage

You can reduce the 120V to 108V for low voltage testing by connecting the secondary winding of the transformer so as to buck, or oppose, the input voltage. This is shown in Figure 4B.

With this arrangement, you'd get the measurements shown in the table of Figure 4B.

Here again, the basic transformer rules are obeyed. The main difference from the "boosting" arrangement is that the transformer current flowing in the 120V winding subtracts from, rather than adds to, the total input current.

NOTE: You have to find out experimentally how to hook up the secondary winding. To do this, first identify and mark the primary and secondary connection points. Then, connect one lead of the secondary winding to the primary and measure the combined output voltage. If it is greater than the input, you've found the boost connection; the buck connection is just the reverse.

Practical considerations in transformer selection

Selecting a transformer for a boost/buck arrangement is not critical. Even a rough estimate of your requirements is good enough as long as the low-voltage winding of the transformer has approximately the right voltage, and that it has enough current capacity to handle the load current. For these examples, almost any transformer with a 12V, 1A secondary will work.

See how this might work in a practical case. You need to run a quick, one-time buck/boost test. You've determined that you need a transformer with these characteristics:

Primary voltage	120V
Secondary Voltage	12V
Secondary Current	1A

Going through your collection of old salvaged transformers, you find one that has a 10V, 1.5A secondary. The current rating is adequate, but here is how you would check the voltage:

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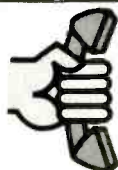
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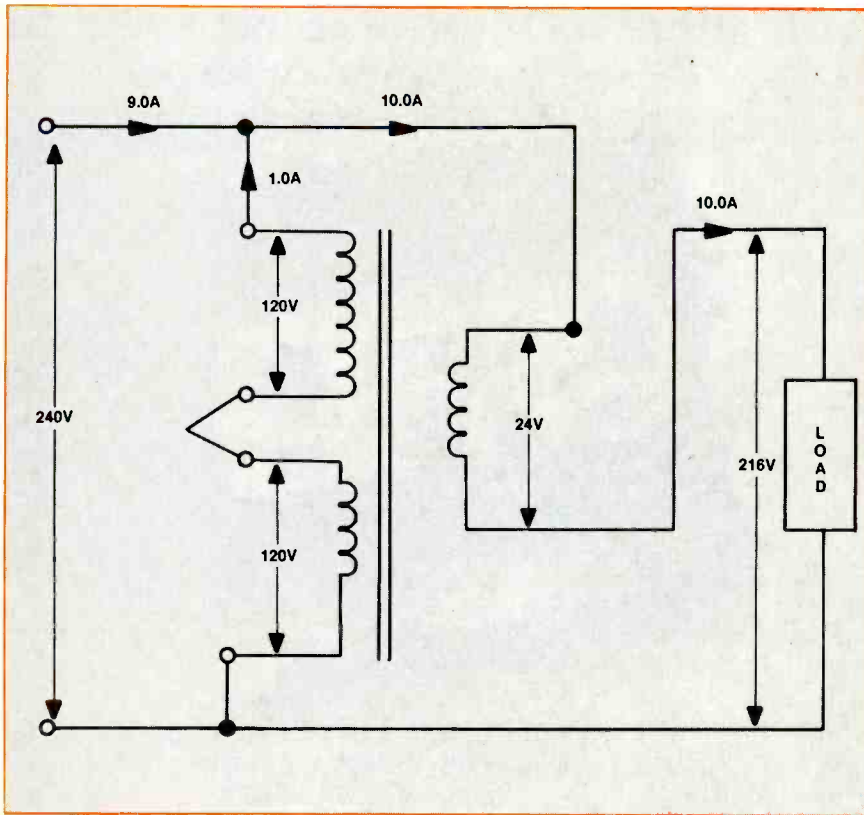
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	Input	Transformer		Output
		Primary	Secondary	
Volts	240.00	240.00	24.00	216.00
Amperes	9.00	1.00	10.00	10.00
Volt-Amps	2,160.00	240.00	240.00	2,160.00

Figure 5 table.

Figure 5. A dual 120V primary transformer can be connected to buck or boost a 240V line to test 240V equipment.

Voltages	Ideal	Actual	%Error
Secondary	12.00	10.00	—
Input	120.00	120.00	—
Boosted	132.00	130.00	1.54
Bucked	108.00	110.00	1.85

The transformer secondary voltage of 10V is 20% less than your ideal value of 20V. However, the error in the total bucked and boosted voltages is less than 2%. You can use the 10V unit. Generally, a transformer that is about right is good enough.

Saving money

Because the bucking or boosting transformer only handles a fraction of the total power, it is much smaller and cheaper than a con-

ventional transformer. Consider another practical case, where you want to test an ac equipment rated at 10A at 208V. You have a 240V line, and you want to reduce this to 208V. To get exactly 208V from a 240V line, you would need a bucking transformer with a 240V primary and a 32V secondary, rated at 10A.

Suppose that it's a Friday afternoon and you want to finish the test before the weekend. You call a local supplier, but all that he has in stock is an industrial control transformer with a 10A 24V secondary and a dual 120V primary (the dual primary means that the transformer has two 120V windings). These can be connected in parallel for 120V or in series for 240V. If you connected this transformer according to Figure 5, you'd get the values of voltage, current and power shown in the table.

The total output voltage is 216V rather than 208. You note, however, that the error is only 8V in 208, or about 4%. You decide that this is close enough and, after a quick trip to the supply house, you're ready for the test.

Notice that the bucking transformer has a volt-ampere product that is one-ninth of the full transformer you would need.

There is an additional plus to consider: A small transformer dissipates heat better than a larger one. Because of this, the size, weight and cost of the 240VA unit will be even less than one-ninth that of the 2,160VA unit. Also, the small buck/boost transformer not only saves money, but is easier to connect and mount.

Buck/boost: inexpensive, simple

When you need a special ac voltage for testing or operating a piece of equipment, consider ways to use a transformer with a low voltage secondary winding connected to boost or buck the primary voltage. This will be cheaper and simpler than using a transformer rated for the full load. Selection of the buck or boost transformer is generally not critical. For many applications, a suitable unit may be right there in the shop or readily available as a surplus unit.

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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, rather than to us.

Electronic Test Instruments: A User's Sourcebook, by Robert Witte; Howard W. Sams, \$14.95, 272 pages, paperback.

From simple meters to spectrum analyzers, the author covers practical techniques and shortcuts for using the latest digital instruments involved with understanding designing and troubleshooting electronic circuits and systems. Technicians, hobbyists and ham radio operators will find it a useful tutorial and reference book.

Request book No. 22483.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 317-298-5400.

It's YOUR Business, By William J. Lynott; Lynco Publications, 101 pages, \$14.95, paperback.

This is a collection of 49 of the most popular columns from the series of the same name that appears monthly in *Appliance Service News*. The author is publisher of the Service Dealer's Newsletter.

"It's YOUR Business" is concerned with the nuts and bolts of a profitable servicing business.

Pennsylvania residents, please add 90 cents sales tax.

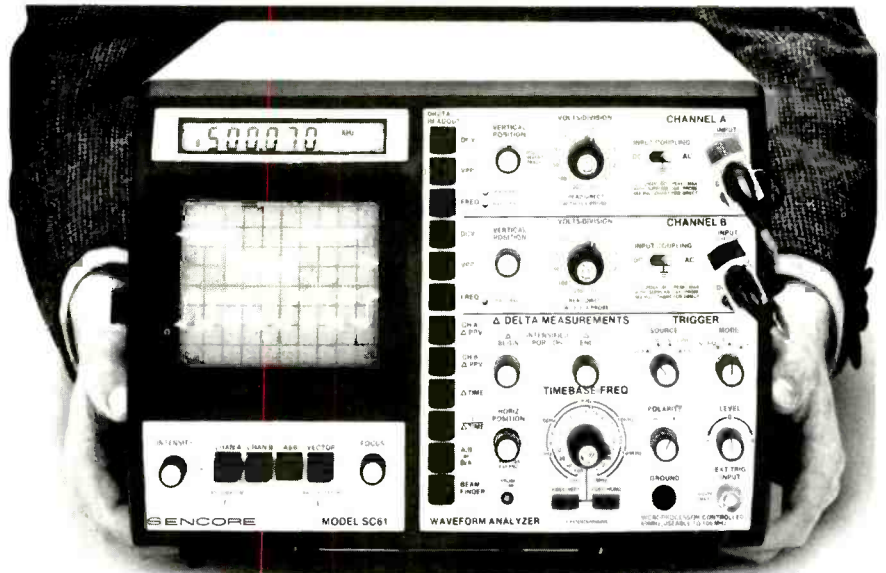
Published by Lynco Publications, 614 N. Easton Road, Suite 200, Glenside, PA 19038; 215-886-3646.

RS-232 Manual and Interfacing Guide, by Datatran, \$5, 55 pages, softbound.

A comprehensive manual for RS-232 interfacing and troubleshooting has been produced for use by Datatracker users, but the wealth of information provided would be valuable to any technician or training personnel. The 55-page manual includes chapters on RS-232 Background Information, and RS-232 Troubleshooting and Interfacing Techniques.

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May 1987 *Electronic Servicing & Technology* 45

What do you know about electronics?

More on the basics of infrared remote controls

By Sam Wilson

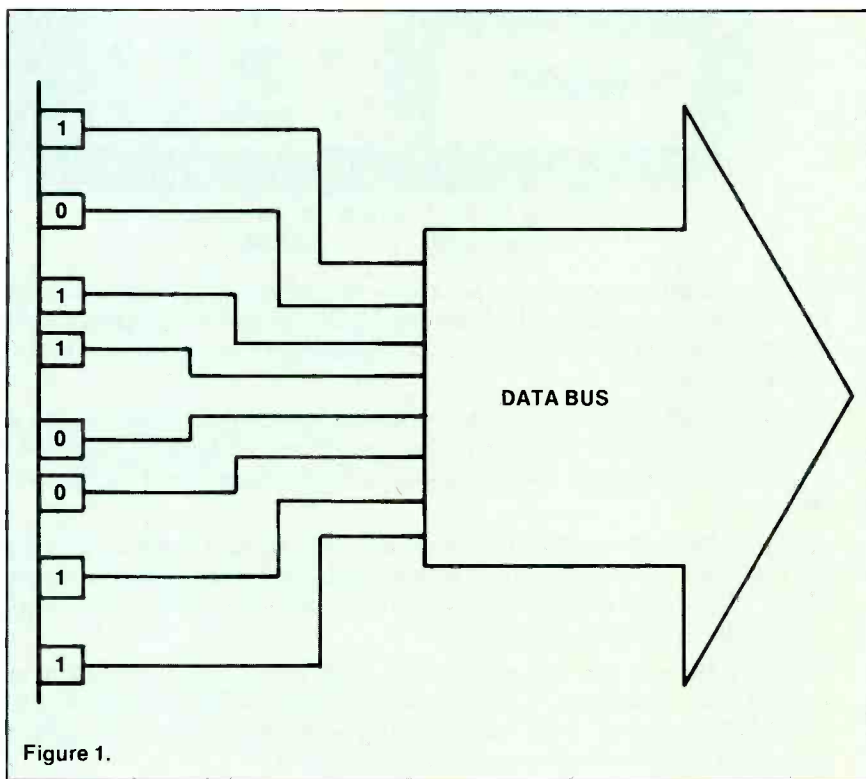


Figure 1.

Figure 1. In parallel data transmission, all bits of a data word are sent at the same time over a data bus consisting of one path per bit.

The basic idea of remote control is that a *transmitter* in the viewer's hand is used to send coded signals to the *receiver* (inside the TV set). The coded signals are used to turn the TV set *on* and *off*, change the sound volume and adjust the set in a number of other ways from the remote position.

In the previous issue, I discussed the infrared diode and the pin diode. The infrared diode is used in the transmitter to convert coded electrical signals into coded infrared radiation. The pin diode is used to receive the infrared signal and deliver it to the waveshaping and decoding sections in the remote controller-receiver.

In the previous article, we discussed, in block diagram form, the transmitter and receiver sections. In this article, we will look at some additional features of the coded signal, and a simple method of decoding signals in preparation for operating the TV controls.

Transmission of data

There are two basic ways in which data can be transmitted from one point to the other. For the parallel method shown in Figure 1, the individual lines are used to carry a coded signal. For the case shown, there are eight lines, so the data transmitted will consist of eight individual combinations of ones and zeroes, all sent at the same time.

Parallel transmission is the fastest method of transmitting data from one point to another. However, there are cases where it cannot be used; for example,

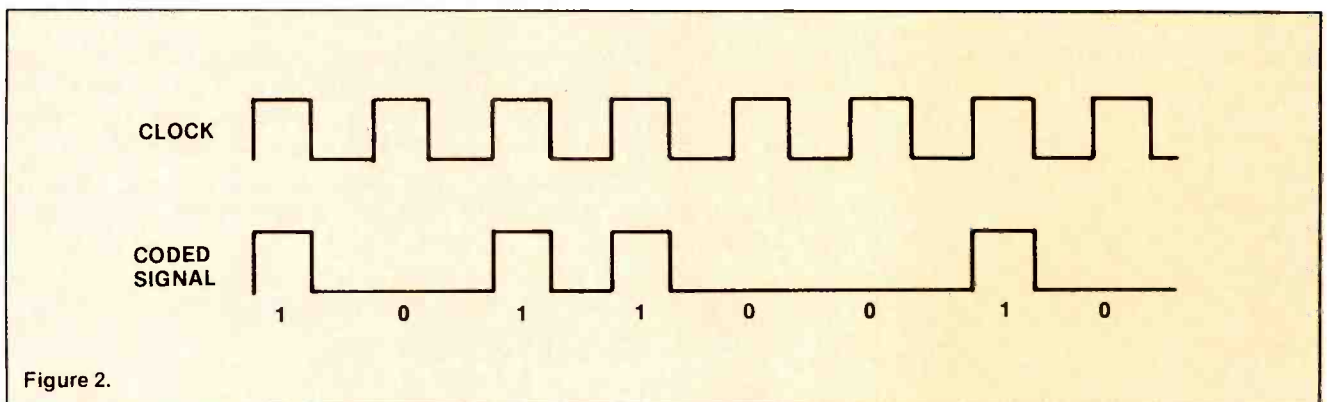


Figure 2.

Figure 2. In a serial data transmission, bits are sent one at a time via a single path and assembled into a word at the receiving end. Presence of a pulse represents a logic 0.

when transmitting data over a telephone line. It would be necessary to have eight individual telephone lines to accomplish the parallel data transmission shown in Figure 1.

Serial data transmission is accomplished by sending one individual digit of a code at a time. This is illustrated in Figure 2. The clock is used to time the signals and move the data. In this case, the data consists of pulses that represent a logic 1, and absence of pulses that represent logic 0.

A disadvantage of data transmission shown in Figure 2 is that it is not possible to tell whether the pulse is missing because it was not sent or because the transmitter/receiver combination was not able to convey the pulse from one point to another.

Another way of sending data is shown in Figure 3. Here, a wide pulse is used to represent a logic 1 and a narrow pulse is used to represent the logic 0. In this case there is always a pulse present even though the digit 0 is being transmitted.

There are many methods of sending data in serial form. In the previous issue we talked about pulse-code modulation. In that case, a binary code is used to represent various amplitudes of a signal for compact disc operation. The same technique can be used to represent and transmit data with a pulse code.

The method shown in Figure 3 is the one often used for infrared remote controls.

Serial-to-parallel conversion in the receiver

The first thing that must be done in the receiver is to take the received pulses and shape them. That is necessary because the transmission system rounds the pulses and makes them useless for operating digital circuitry. So, the receiver amplifies the signal and shapes the pulses. These steps are not illustrated in this article.

After the pulses have been shaped, they are converted into a parallel data word for convenient decoding. One method used to do this is to deliver the pulses into a *shift register*.

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Figure 3. This scheme of data transmission differs from that of Figure 2 in that, here, a wide pulse represents a logic 1 and a narrow pulse represents a logic 0.

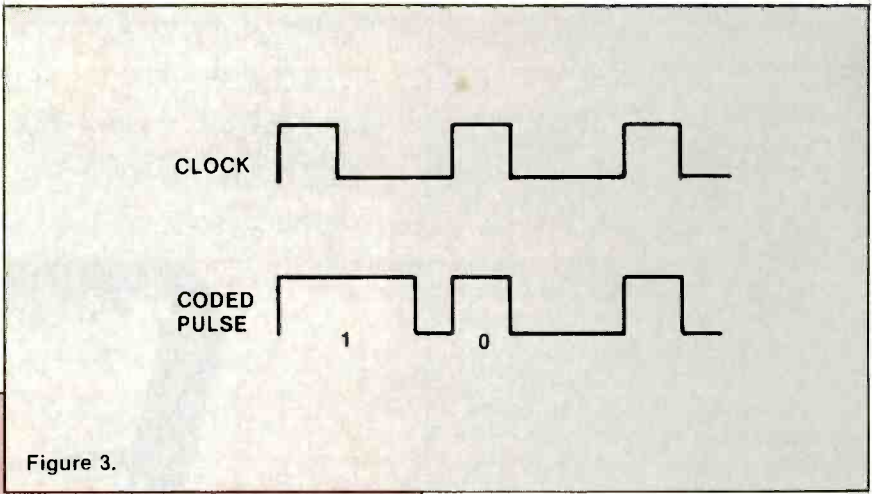


Figure 3.

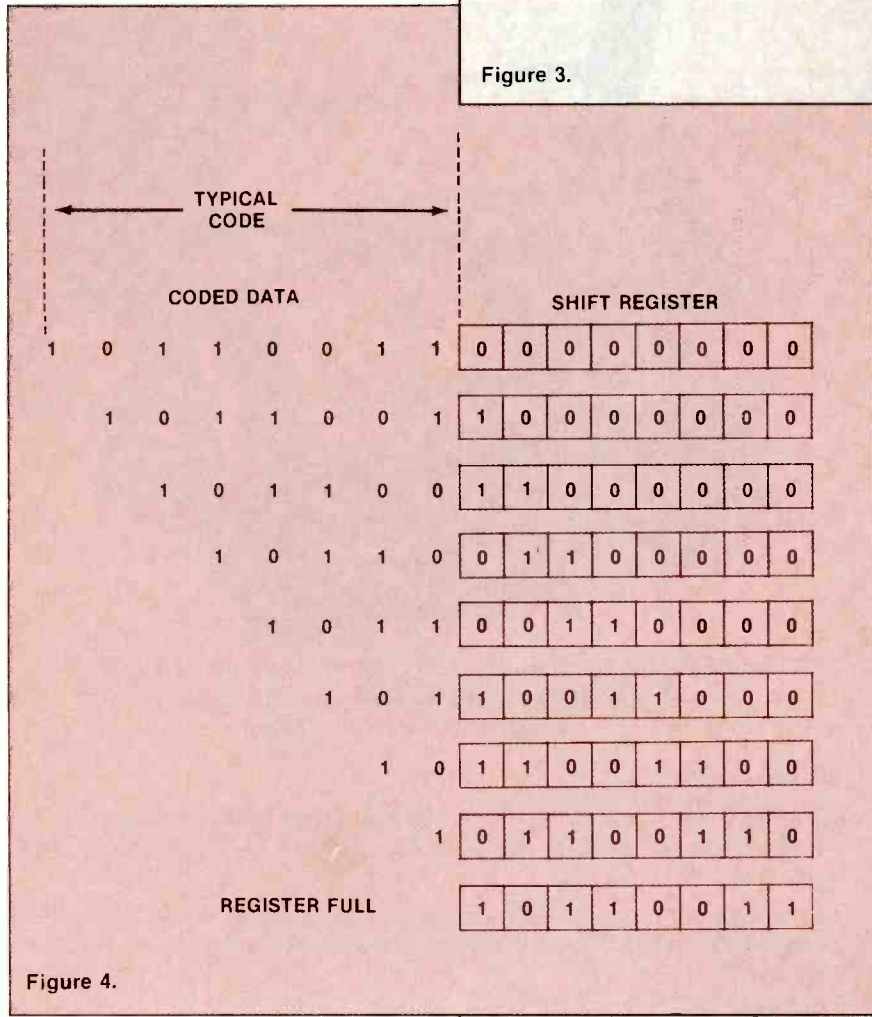


Figure 4.

Figure 4. A shift register accepts serial data one bit at a time and converts it into a parallel data word.

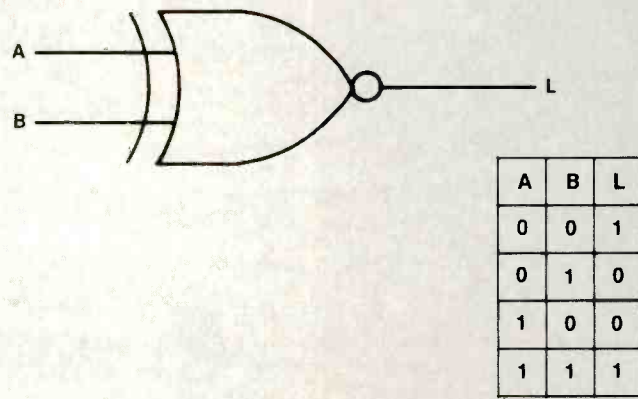


Figure 5. An EXCLUSIVE NOR gate has a logic output of 1 only if both inputs are the same (1 or 0). If the inputs are different the output of the gate is 0.

Figure 5.

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Shift registers are made with flip flops. The actual circuitry will be discussed in another session at another time. The theory of the shift register is shown in Figure 4. In order to understand this illustration, you must know that a clock pulse is delivered to the flip flops in the shift register. Each time a clock pulse is delivered the data is moved one block to the right. (The clock pulse is not shown in Figure 4.)

In Figure 4, the flip flops are shown as boxes in the shift register. The same shift register is shown nine times to illustrate the flow of serial data into the flip flops.

In the first illustration, the shift register has all zeroes in the flip flops and the coded data has not started to enter. At the first clock pulse the right-hand digit (logic 1) of the coded data has entered the shift register in the first flip flop position. The last zero in the previous step has been discarded.

In the next step the second digit (logic 1) is entered into the shift register. That moves the first digit to the right, and another zero has been discarded.

The next illustration shows a zero entered into the shift register and another zero discarded.

If you will study this illustration carefully, you will see that the data is stepped into the shift register one bit at a time until all of the digits have been entered. At that time the register is full.

This type of shift register is sometimes referred to as *serial in/parallel out* because the data in the register is used as an 8-bit parallel code in the receiver.

In many of the modern systems there are more than eight digits. For example, in the Fisher REM-885 there are 12 bits of data for each individual coded signal.

The identifying code and decoder

Part of the signal coming from the transmitter is used for an identifying code. In the Fisher system, there are three digits used for this purpose. This code assures that the transmitter being used is the one intended for the receiver. It also assures that it is a legitimate signal coming from a transmitter and not from some extraneous



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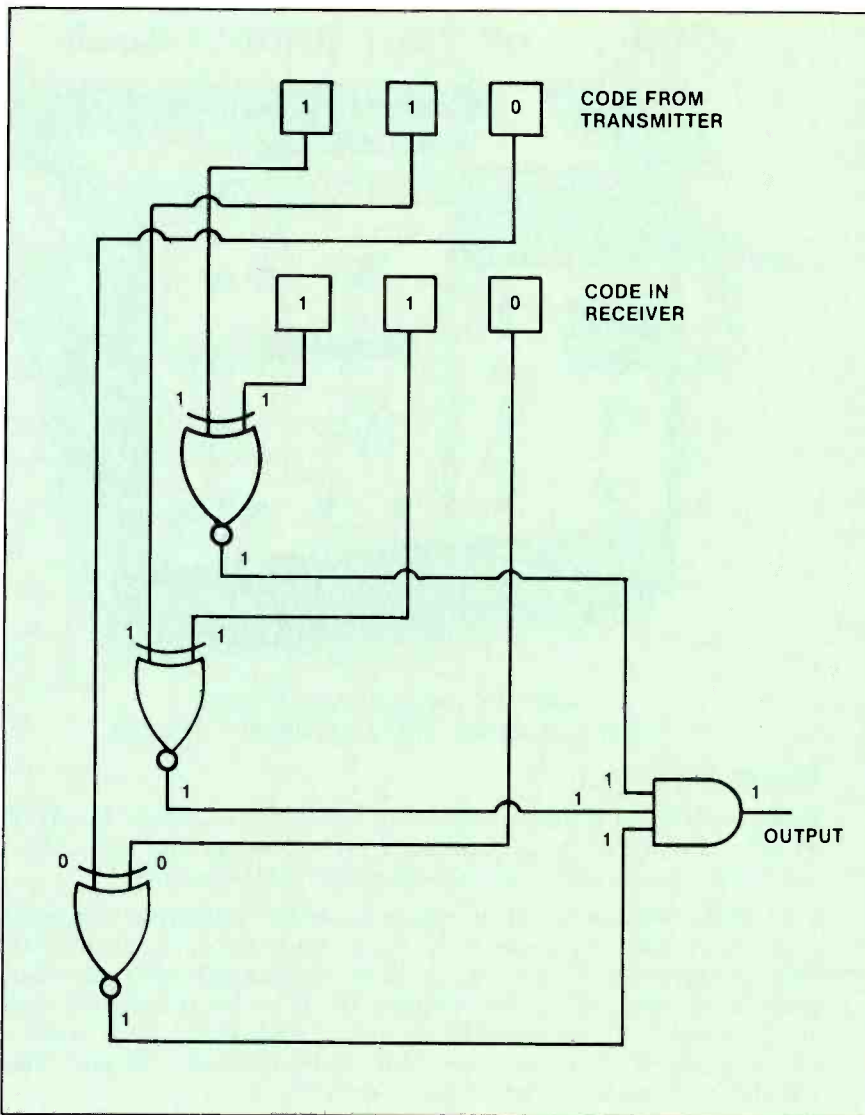


Figure 6. In this decoding system, if the code from the infrared transmitter matches the code in the receiver, a signal is generated, enabling the receiver to decode the command signal from the infrared transmitter to change channel, adjust volume, etc.

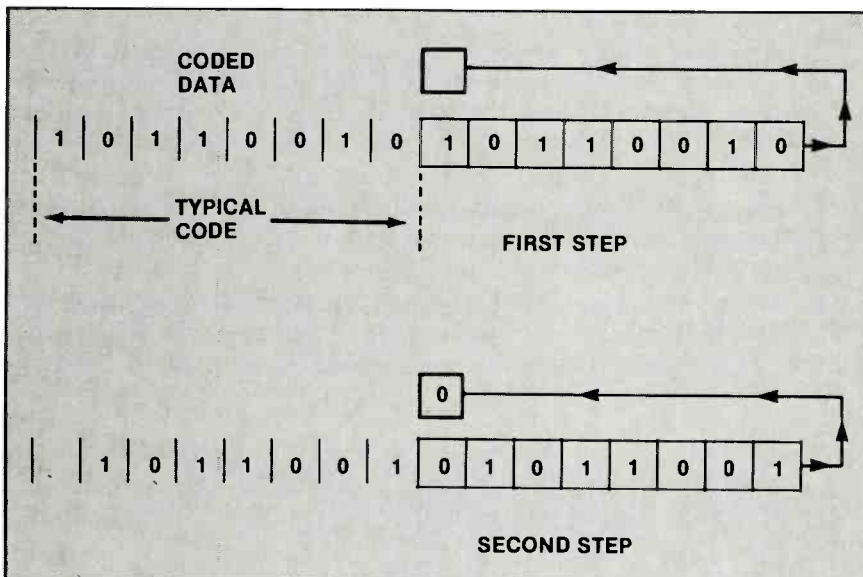


Figure 7. In this decoding system, comparison of bits transmitted at different times by the transmitter allows the decoder to determine if the command signal is valid.

noise pick up.

There are many ways in which a 3-digit code can be used to identify the signal as being proper. We will discuss one of the possible methods to show how simple the procedure actually is.

The operation of this decoder depends on the use of the EXCLUSIVE NOR gate illustrated in Figure 5. The symbol is shown along with the Truth Table that illustrates the fact that *the only way you can get a logic 1 out of this EXCLUSIVE NOR is if the two inputs are identical*. In other words, there will be an output signal if the input data can be both zeroes or both ones. If there is a difference between the two input signals the output is a logic 0.

Consider the simple decoding system shown in Figure 6. The upper blocks represent three flip flops in a shift register. A coded signal has been received from the transmitter, putting these flip flops in the 110 condition. The lower three blocks represent three permanent logic levels in the receiver. They represent the code for this particular system.

In the illustration, the code from the transmitter matches the code in the receiver. When this happens there will be an output that tells the remaining receiver circuitry to "go ahead and decode the message." Note that each pair of signals is delivered through an EXCLUSIVE NOR gate. In each case the pair of inputs to the EXCLUSIVE NORs are identical, so a logic 1 is delivered by an EXCLUSIVE NOR to the AND gate.

With three inputs into the AND gate the output is a logic 1. That output is used to give the receiver an OK to decode the rest of the bits in the transmitted code.

Remember that this is only one of the many possible ways of determining whether an input coded message (signal) is proper for operating the receiver.

Figure 7 shows another way of assuring that a received code is legitimate. To understand how this system operates, review again the condition for loading a shift register illustrated in Figure 4. Remember that the data is stepped in from the left to the right, and

each time a new digit is entered into this shift register, the one on the right is discarded in this simple application.

For the system in Figure 7, instead of discarding the right-hand digit it is returned to a block where it is compared with the last digit that was stepped in.

To start the operation, the register in the receiver is first filled with the code being transmitted. The transmitter repeats the code, and the first step of the illustration shows the second received code in a position to be moved into the shift register.

In the second step, the zero has been entered into the shift register. At the same time, the last zero from the previous step is moved out and back into the block where it is compared with the input digit. Of course, the last digit from the first code received and the last digit from the second code must be identical. When these two are compared by a logic comparator, they will produce a logic 1 output.

The coded data is stepped in one digit at a time. Each time, the last digit from the previous code is returned for comparison.

The theory here is that if the code is a random combination of ones and zeroes it would not be possible to compare every single digit favorably.

If at any time the digits do not match, there will be a logic 0 out from the EXCLUSIVE NOR that is used to compare the digits. The system will then shut down.

To summarize, the receiver has safeguards against receiving a false input. If the signal is legitimate, it is decoded. The decoded signal is used to perform the various functions in the receiver.

Unusual theories

Over the years I have accumulated a box of unusual letters from readers, acquaintances, companies and other sources. This particular box is marked *strange*. The letters contain pet theories of the letter writers. They are totally out of step with what is generally regarded as being facts.

Strange as these theories are, I am unable to totally disregard them. For one thing, the writers usually are qualified professional people. Another reason is that I am not sure if I have all of the facts straight myself.

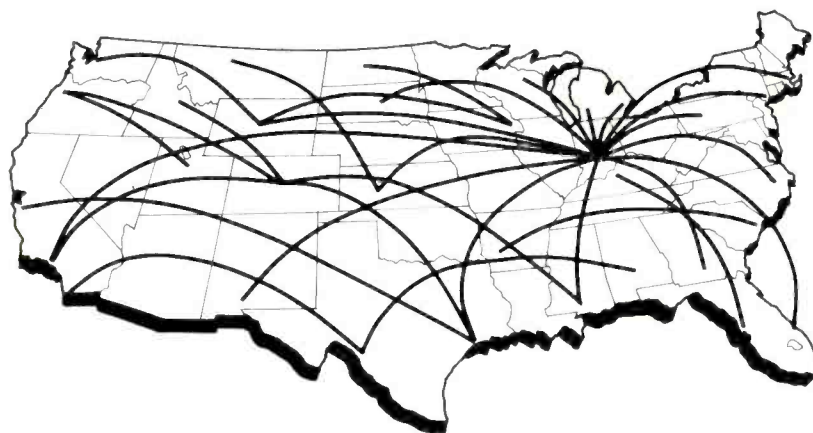
From time to time I would like to share some of these theories with you. The one I want to tell you about in this issue came from a col-

lege professor with a doctorate. He teaches at a highly respected university in Texas. His letter contained this unusual (strange?) theory:

"A battery cannot produce voltage at any time unless current is being drawn from that battery."

I have never heard this from any other source so I keep it in a box!

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May 1987 *Electronic Servicing & Technology* 51

Knob-repair nightmare

By Larry Critchlow, "the Old Timer"

Have you noticed that some TV manufacturers reinforce their plastic knobs with an outer metal sleeve? You probably never replaced one of these knobs. How many times has this happened? Someone brings you a small portable television. God only knows what brand or vintage. He hands you the cracked channel selector knob and says, "The Tee Vee is fine. I just need a new channel selector, which the kids broke. Can't change the channels." You look through your stock of new knobs and then through your stock of used knobs. The only one you can find that might work has the numbers all in the wrong places. Maybe you can order a new one? It'll take three weeks to know for sure. If you *do* get it, it costs \$5 or more plus phone calls. Or you could assemble one from a universal kit (this is costly and will break sooner than the old knob did).

This may only happen once a week, but that's 50 aggravations a year you can avoid. Here's how to do it.

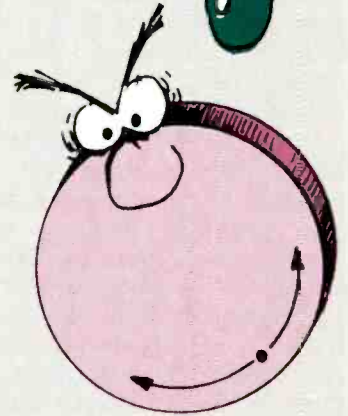
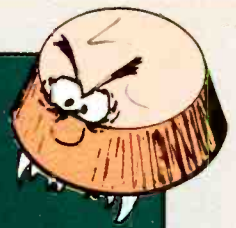
Visit your local hobby shop. Ask to see the K&S display. This Chicago-based firm supplies brass and aluminum rods, sheets, tubing, etc. They have 20 sizes of thin-wall, brass tubing (in 1-foot lengths) from 1/16 inch to 21/32 inch. More sizes than you will ever need! While you are there, pick up a hobbyist's back saw (XACTO). These have very fine teeth, screw-on handles and replacement blades. Very neat.

Now back to paragraph one, the part about knobs that don't fail, and paragraph two, the TV viewer who can't change channels. Select one of the brass tubes that fits snugly over the broken part of the knob. Saw off a length (3/8 inch or so usually does it), assemble the whole works with some 5-minute epoxy. It's done. When you get good at it, you can do five knobs an hour.

What about the tough case? "This knob is worn, smashed, and I don't even have all the pieces." From your drawer of old knobs, select a similar one and saw off whatever plastic you need to fill out the missing portions. Get an old tuner shaft and file a few thousandths off the flat. Smear a little oil on the shaft. Assemble the pieces (reinforcing sleeve, spring and lots of epoxy) right on the shaft. The oil allows removal after hardening, and the filing assures that the repaired knob will fit tight.

I have repaired hundreds this way, including fine tuners, push-pull volume and little clock-radio knobs, and never had a call back. Can't say that about the rest of this business...

the Old Timer



Answers to the Quiz

1. G—A rheostat is a 2-terminal variable resistor used to control current. (The term *potentiometer* was not used.)

2. A—The Thevenin circuit shown can be used to represent any 2-terminal active dc circuit. A resistor across the original circuit will draw the same amount of current as when it is placed across the Thevenin circuit.

3. R_1 —J, R_2 —H
The circuit is for a $\frac{1}{2}$ -wave rectifier with a pi filter. It is drawn upside-down and backwards.

4. D—The purpose of the swamp resistor is to lower the circuit Q. That, in turn, gives it a greater bandwidth.

5. E—The Norton generator shown, like the Thevenin generator, can be used to represent any 2-terminal active dc network.

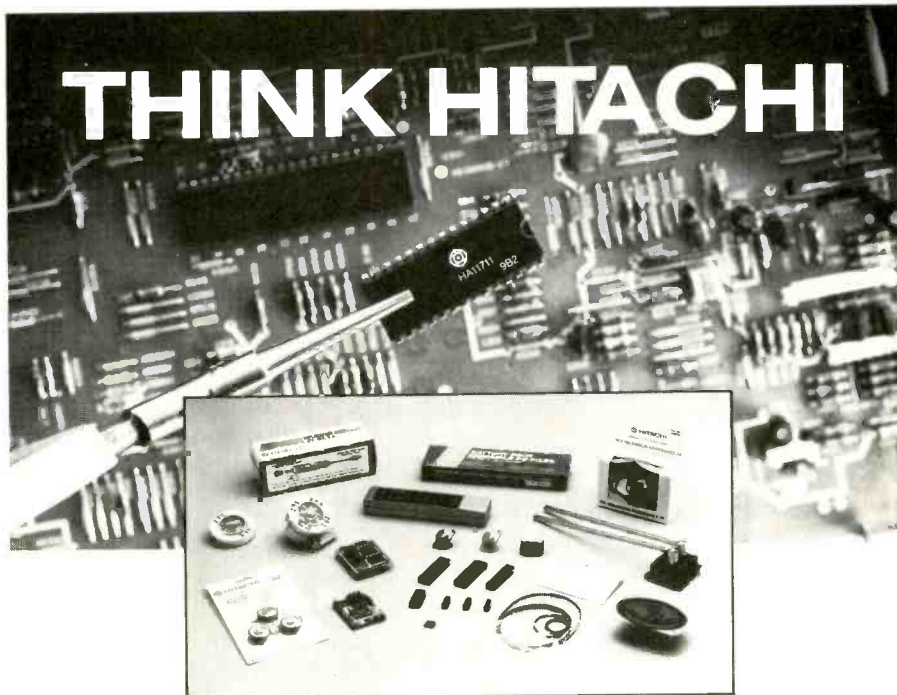
6. F—The arrows pointing to the resistor symbol mean that it is a light-dependent resistor.

7. C—The resistors assure that a reverse voltage across the diodes will be evenly distributed. The equalizing resistors have a high value of resistance.

8. R_1 —B, R_2 —I
The voltage dependent resistor protects the transistor from inductive kickback. The emitter resistor stabilizes the amplifier against temperature changes. (The term bias resistor was not used.)

Questions on page 52.

By Sam Wilson



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Circle (24) on Reply Card

May 1987 *Electronic Servicing & Technology* 53

Products

Test and measurement training package

A training system that operates as a source of a wide variety of electronic signals for students learning to use test and measurement equipment is now available from *Tektronix*. This is the CRS 101 Basic Training Lab that includes the CRS 10 Power Unit, CRS 30 General Purpose Board and instruction manual.

Tektronix's CRS 10 Power Unit and CRS Signal Boards are training tools suitable for teaching students about concepts including rise time, pulse width and frequency, as well as lessons in digital troubleshooting and making video measurements. Several other signal boards can be plugged into the power unit for specific training applications.

The CRS 10 is a power/clock board driven by an external transformer that provides 24V ac centertapped—below levels considered hazardous by the Underwriters Laboratory.

Circle (75) on Reply Card

Low-cost current probe

John Fluke Manufacturing announces a clamp-on current probe that provides accurate measurements of both dc and ac currents up to 400A. The Fluke 80i-410 dc/ac current probe is a battery-powered, Hall-effect probe compatible with a wide range of voltmeters, multimeters and other voltage measuring instruments.

The jaws of the 80i-410 are designed to fit around a conductor without breaking the circuit. The output signal is $\ln V$ per amp, dc or ac. The large jaws will fit over a single conductor up to 30mm (1.18 inch) in diameter, or over two conductors 25mm (0.98 inch) in diameter, making it easy to read the sum or difference of two currents.

Circle (76) on Reply Card

Cordless, triple-use tool

The Weller Pyropen, a cordless LP-gas catalytic soldering iron, torch and hot air gun, has been in-

troduced by *The Cooper Group*. This multipurpose tool is especially useful for field and service jobs and in the electrical and communications industries when electricity is not available. It can be used as a heat gun to shrink tubing, connect vinyl chloride pipes and dry glues, as a soldering iron, and as a torch to braze copper and other metals.

The handle of the 9 $\frac{3}{8}$ -inch tool serves as the gas container and holds enough LP gas for about a 3-hour operation. Refill the container in seconds.

Circle (77) on Reply Card

Capacitance meter

A.W. Sperry Instruments announces the model CM-200 digital capacitance meter.

The CM-200 will allow the accurate measurement of almost any capacitor. It is a handy and useful tool for use in the laboratory, manufacturing plant or in the field. Its features include 0.5% basic accuracy, large, easy-to-read 3 $\frac{1}{2}$ digit LCD display, separate test socket for close connection of capacitors, built-in tilt stand and fuse protection.

Ranges are 200pf/2nf/20nf/200nf/2 μ f/20 μ f/2,000 μ f/20mf; maximum resolution is 0.1pf and the maximum test voltage, 3.2V.

Circle (78) on Reply Card

Two stereo TV analyzers

Sencore Electronics has two new stereo TV analyzers: the ST65 Video Analyzer Stereo TV Adder and the ST66 Stereo TV Analyzer. Reportedly with just one connection, the technician can check the stereo circuits in seconds with 100% accuracy and confidence. Both instruments are complete analyzers with all the following signals:

1. RF audio carrier
2. RF video carrier
3. 45.75MHz IF carrier
4. 4.5MHz IF carrier
5. MTS Composite Signals
 - a. L+R
 - c. Pilot
 - b. L-R
 - d. SAP
6. Normal and compressed audio (300Hz, 1kHz, 8kHz)

These signals allow testing the

complete operation of the stereo circuits including separation, crosstalk, dBx (R) noise reduction, audio beat in the video and pilot threshold tests.

Circle (79) on Reply Card

Lightweight soldering iron

Added to the collection of soldering irons supplied by *Oryx* is the Oryx 15W lightweight iron. This 115V low-cost iron is designed for light industrial application and is precision-engineered to a high quality.

The unit is supplied with an iron plated soldering tip for long life. Its operating temperature is a nominal 700°F.

Circle (80) on Reply Card

The secret is out

The Secret is *TEC—Total Electronics Cleaner*, an improved formula containing a cleaning product that has been used by professional service technicians for years, and is now available to the general public. A two- to three-second spray is all it takes, according to the manufacturer.

TEC is a non-conductive, non-toxic, residue free, anti-static, rapid drying electronics grade solvent, that removes dust, dirt, oil, and oxides. It is safe for use on computer, video audio, telephone, and business electronics equipment in homes or offices.

Circle (81) on Reply Card

Thermal balance

Davle Tech has introduced the Electer 200GX series of soldering irons. Three models are available: 20W, 25W and 30W. Some features of these soldering irons are:

- The *nichrome* element wire is precision wound at the end of the stainless steel barrel to ensure maximum temperature as close to the working surface of the tip as possible for rapid heat-up and instant heat recovery.

- Electer's new thermally balanced heating element increases the efficiency of the iron, while reducing power consumption to almost half that of most soldering irons.

- A newly developed ventilated neoprene finger grip.
- Heat-up time to the working temperature is attained in about 90 seconds.
- A selection of long lasting, iron plated tips is available for the iron.

Circle (82) on Reply Card

Desoldering tool

Sibex has released its model S-1 desoldering tool. This device is designed for the engineer or technician who performs electronic repair work or modification.

Designated the "low-priced desoldering tool with the high-priced features" model S-1 incorporates a silent, electrically powered vacuum pump controlled by a switch located in the handpiece. The unit may be cleaned while in use. Designed for static-free operation, it is suited for PC board repair work.

Circle (83) on Reply Card

Has 24V heating element

Model EX-501 solder extractor has a self-contained diaphragm pump that provides PSI air pressure and delivers 18 inches to 24 inches of Hg. It is safe for use with static-sensitive components and an operator ground is provided. Included with model EX-501 is model EX-1000 desoldering handpiece and separate solder iron that feature temperature controlled 24V

heating elements for operator convenience and safety. Assorted tips and cleaning brushes are also provided. An *Automated Production Equipment* product.

Circle (84) on Reply Card

Soldering tool for SMD components

A Tweez-SM soldering station is available from *Hexacon Electric*. Tweez-SM soldering irons will safely remove or replace most SMD components on the market today. Two standard tip sizes will solder or desolder more than 90% of current surface-mounted components. Interchangeable custom tips are available for other special sizes and shapes.

Tweez-SM uses a tweezer action to fit snugly around all sizes and shapes of SMD components. It is lightweight and has excellent maneuverability for the delicate positioning required on SMD boards.

Circle (85) on Reply Card

Crimping tool used in video/broadcast work

The *Xcelite* MAC-8281 crimping tool, introduced by *CooperTools*, works on Belden 8281 cable as well as most brands of dual crimp BNC/TNC coaxial connectors. The quality tool is designed specifically for video and broadcast applications.

Among the features of the tool

are its small handle spread, for greater user comfort, and dies that may be interchanged with *Xcelite* MAC-2210 and MAC-NI-8281.

Circle (86) on Reply Card

Desolder braid in new reel

Solder Absorbing Technology announces that 3S-Wick is now available in 50-foot lengths. The cost per length on this new package has been reduced compared to the standard, still available, 5-foot dispenser reel. 3S-Wick is characterized by its high heat conductive woven pattern of pure copper fibers and its patented coating. The heat conductivity of the weave is needed to draw off quickly any excess heat from soldering tips in order to limit the rate of temperature increase and peak temperature levels.

Circle (87) on Reply Card

Stores, dispenses tubing

The *Shrinkcrack*, from the firm of the same name, is designed to handle shrink-tube storage dispensing. Made of high-impact plastic, the wall-mountable dispenser will accommodate two full 2"x2"x4' boxes and one full 4"x4"x4' box of heat-shrinkable tubing. Short lengths of tubing (less than four feet) fall to the bottom where they may be retrieved for smaller jobs.

Circle (88) on Reply Card

ES&T

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Troubleshooting Tips

Sound but no raster RCA CTC71AB

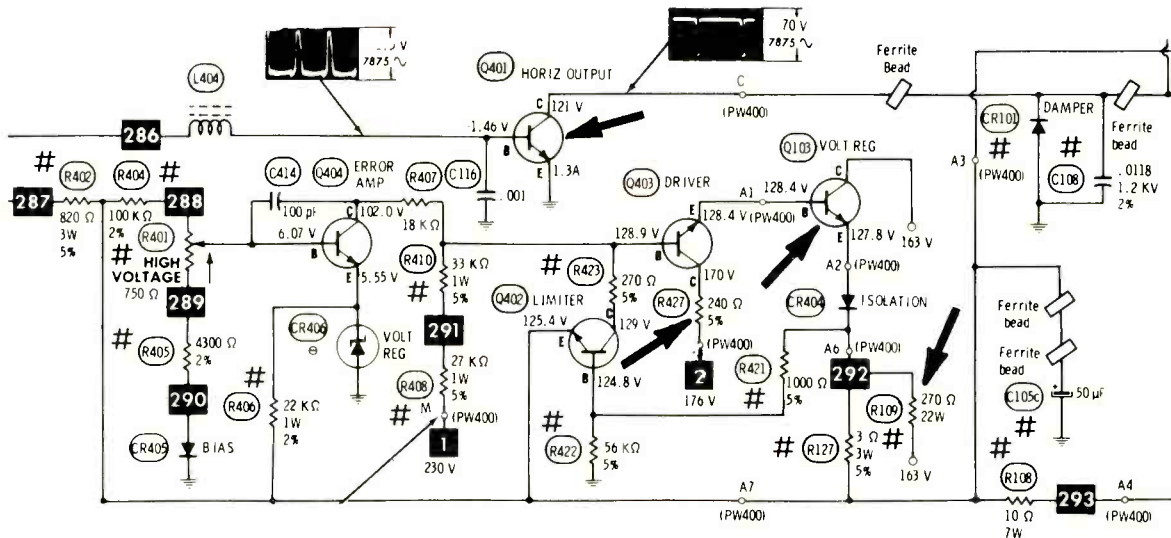
(Photofact 1435-3)

Although the RCA CTC71AB showed no picture or even a raster, there was some sound. After a few seconds of operation, the circuit breaker tripped, evidently from an overload.

Major components of the low-voltage power supplies were tested, revealing that Q103 was shorted and R109 had been overloaded so severely that it was ready to disintegrate.

picture was not wide enough to fill the screen horizontally and turning up the brightness gave a very narrow picture with very bad vertical linearity. At the same time the high-voltage reading dropped to 11kV. From all the symptoms, the problem appeared to be in the HV-regulation circuitry.

My first step was to check the small regulator transistors (Q402, Q403 and Q404). They apparently had no large defects, so I decided to check all critical components, which in this case were resistors. My plan was to check in-circuit the first time through



For those technicians who have not analyzed this regulator circuit, Q103 is operated as a variable resistance in series between +163V at the Q103 collector and the regulated +127V at the emitter. The 270Ω 22W R109 is added in parallel between Q103's collector and its emitter (through isolation diode CR404). When the +127V output current is large, both transistor and resistor contribute. When the demand for current is very low (and the +127V rises), the transistor is near cut-off and only the resistor passes very much current. Thus by variations of current, the regulation of the B+ is accomplished. Transistors Q404, Q403 and Q402 monitor the +125.4V supply and correct it by changing the bias (and therefore the internal C/E resistance) of Q103. When the *high voltage* control is adjusted properly, regulation of the output B+ source is very good.

Now back to the real world. Thermistor RT101 (120Vac surge resistor) was replaced because it appeared to be very brittle and, in fact, broke when examined. When ac power was applied, the circuit breaker did not trip, but there was no high voltage.

Next, major components of the horizontal deflection system were tested. Both the Q401 horizontal-output transistor and the STM101 tripler were shorted. After they were replaced, the high voltage was a constant 24kV that could not be adjusted, the

and not remove any resistors unless the readings were unreliable because of other components. I started with resistors regulator Q103 and worked back toward the front of the control circuit.

However, only a few tests were required to discover that 240Ω R427 was open. Because R427 is rated at 5% tolerance, the local distributor does not stock it and the local distributor had to order it from the factory. Installation of the correct 5% R527 and several minor adjustments restored the CRC71 RCA to normal working conditions.

George M. Marechek
Cheverly, Maryland

Picture only 4" tall Wards GGV1293A

(Photofact 2138-2)

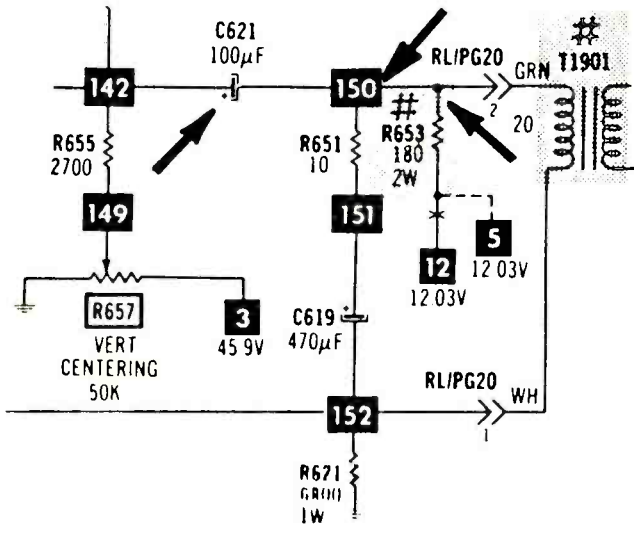
During a home service call, I found the picture on the Wards color receiver was about 4 inches high with a 1-inch foldover at the bottom. Of course, similar symptoms usually require extensive testing, so I brought the receiver to our shop.

First, the vertical-hold, centering and height controls functioned but had minimal effect on the vertical deflection; the short picture remained.

Primary suspects were Q601 and Q603, the



vertical-output transistors, but they tested good without leakage, shorts or opens. Voltages at the base, emitter and collector of Q601 were within specifications, as were those at the base and collector of Q603.



I performed a careful visual inspection of top and bottom of the circuit board for any obvious damage to components and wiring. Any faults located would simplify the search for defects.

The foil side of the board was badly charred at the junction of R651 and R653, and the leads were loose in the pad. Although the resistors were changed and the leads resoldered, there was no change in the picture. Lesson: the obvious is not always the offender.

Drawing on my past experiences that an open electrolytic capacitor can cause foldover and loss of height, I began paralleling the most-suspected capacitors, which were C603, C615, C619 and C621.

When C621 was bridged, the picture returned to full height. A first glance at a schematic doesn't show any important function for C621 until you look just slightly further and find that the positive terminal of C621 is connected to the cold end of the vertical-yoke coil. There is no other path to ground, so the only continuity for the vertical yoke is through C621, through 100Ω R653 and to the +12V supply that is bypassed to ground by two 470µF capacitors. Other wiring in that area is for pin-cushioning and other functions.

A new C621 was installed, the vertical controls were adjusted and the receiver was operated for 24 hours, proving its stamina.

Myron H. Freedman
Tucson, AZ



June 26, 1986

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Circle (26) on Reply Card

Audio equalizers

It seems we spend so much time working with CDs, digital audio recorders, PCM machines, microcontrollers, and other equipment with a minimum of actual audio circuitry, that we forget about basics. Remember that sound is actually analog in nature, and that some audio equipment, amazingly, has no digital circuitry. Take the audio equalizer, for example. It's one of the most useful, and least understood, of devices, so let's take a look at it.

First, think about how sound actually transfers to our ears from a stereo. No matter how flat the electronics are, by the time the music reaches you, the nonlinearities of the speakers and room have combined to muck things up substantially. Take my listening room for example. It's small, so it has standing waves at about 100Hz. This means that a single cycle of 100Hz is just the right size to fit exactly into the length of the room. When this happens, subsequent cycles at the standing wave frequency are reinforced by a sort of positive acoustic feedback. The audible result is a severe boominess to the sound, because the 100Hz material ends up much louder than it was intended to be. The equalizer is well suited to attenuating a small part of the frequency band like this.

What it is

An audio equalizer is really just an elaborate set of tone controls. But instead of having an effect over broad ranges, such as bass and treble, the equalizer divides the audio spectrum into a large number of bands, normally ten or so.

Tone controls usually correct for things such as recording errors and personal taste, so may be changed often. An equalizer is generally used to compensate for room and speaker characteristics, so one needs to adjust it less often. This takes some of the sting out of having to remember the settings of 20 or so pots.

Almost any equalizer worth having will offer separate control over left and right channels. The left and right speakers in the typical listening room seldom see the same acoustic *load* and must be separately adjusted.

So far I have been referring specifically to the *graphic* equalizer, the terminology referring to the fact that the setting of its controls affords a rough visual representation of the frequency response curve. Another, less common device is the parametric equalizer, so called because it allows you to vary *parameters* such as filter center frequency, *Q* (bandwidth), and, like its graphic cousin, amplitude. Parametrics are great for the most common room equalization tasks. Most handle only a couple of bands at once, which is usually all you need. But, because they don't have as many knobs as a graphic, they aren't as appealing to the mass market.

Connections

Figure 1 shows a typical installation. The equalizer is inserted into the signal path at a point ahead of the volume and tone controls. This means the tape monitor loop, or a special external processor loop (EPL). The signal level here remains within a relatively constant amplitude range, regardless of volume setting. To compensate for the loss of a monitor loop, most equalizers come with their own to replace it.

Equalizing a room

In addition to an equalizer, you'll need a source of *pink noise*, a calibrated microphone and an audio spectrum analyzer. The latter is not to be confused with its far more expensive RF cousins. An audio analyzer covers the band from roughly 20Hz to 20kHz, and usually costs less than \$500. Sometimes it is even built into the equalizer, along with a pink-noise source, dramatically reducing cost.

Types of noise

When speaking of noise in this context, we mean a signal that contains all possible frequencies within a given spectrum. Use of noise allows us to check a system's simultaneous response to all frequencies, closely simulating music. There are two flavors, pink and white. Pink noise contains equal energy per octave. That means the frequency band from, say 1kHz to 2kHz will contain the same energy as the one from 8kHz to 16kHz.

By comparison, white noise has equal energy per Hertz (cycle), which means that each succeeding octave contains more energy than the previous one. We use pink noise because an audio spectrum analyzer uses percentage-of-bandwidth filters. For example, 10% of the 1kHz to 2kHz band is 100Hz, while the same percentage of the 8kHz to 16kHz spectrum is 800Hz. If we used equal energy per frequency noise (white), instead of equal energy per octave (pink), the analyzer would show a rising frequency response instead of the flat one we want. Figure 2 shows a simple white/pink noise generator circuit.

Calibrated microphones are not cheap or easy to acquire, but most audio spectrum analyzers come with an adequate one. Also, because adjustment is most frequently done at the bass end, any good quality mike will get you pretty close. We begin by connecting the pink noise generator to one channel of the amp. The other channel remains *off*. Put the microphone at the listening position, turn up volume high enough to get a good reading of the analyzer. Tone controls should be flat, and any filters *off*. Adjust the equalizer until you get a reasonably flat response on the analyzer. Don't worry much about the very bottom (under 30Hz) or top (over 15kHz). Repeat for the other channel. Keep a record of the equalizer settings.

You're finished. Now, you can use the tone controls on the amp or receiver to compensate for program material and personal taste. If you have speakers in more than one room, repeat the adjustment procedure and keep track of settings for each room.

Strange notions

I'm reminded of an interesting anecdote that demonstrates how a concept can be warped into nonsense while passing as unquestioned dogma from one person to another. A friend of mine and I had spent the better part of four hours equalizing his listening room. It was an unusually tough instance, because we were using Magneplanar electrostatic speakers in a large, acoustically complex room. The equalizer's knobs were all over the place.

When I came back the next day, I noticed they had all been set flat. Puzzled, I inquired what had happened. Apparently a stereo salesman acquaintance of his had come over the night before and had been appalled at the way the

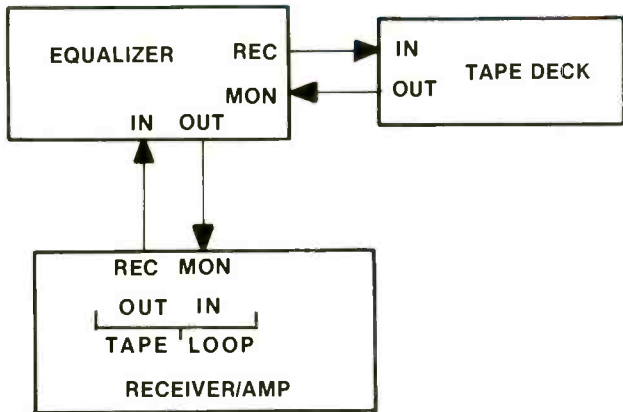


Figure 1. The basic equalizer hookup.

eq was set. He promptly chided my friend and explained to him that, like tone controls, equalizer pots should always be set flat, so as to produce "uncolored" sound! Of course, if that were true, why have an equalizer at all?

Another question that comes up often goes something like this. "I have a 50W stereo receiver and want to add more power. What kind of equalizer should I use?" Of course, from an experienced audio technician's viewpoint,

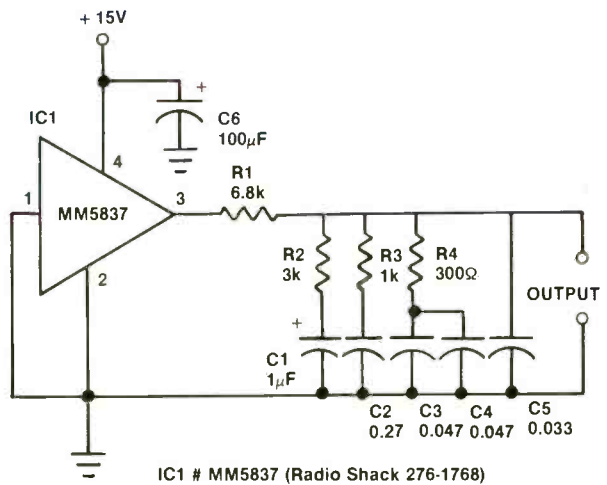



Figure 2. A simple pink noise generator.

this query belies the adage that there is no such thing as a dumb question. Still, the typical user may not understand that no amount of line level processing is going to increase an amp's maximum power. Some of the confusion probably arises from the fact that equalizers built for the automotive market often come with their own power amp.

Well, that's it for this time. Happily listening!

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Circle (27) on Reply Card

Common ailments of the Commodore 64

This month, we'll talk about typical failure symptom analysis on the Commodore 64. This computer was chosen because there are so many of them out there, and so relatively few technicians capable of repairing them.

Troubleshooting a computer is no different than troubleshooting any other electronic system.

Troubleshooting a computer is no different than troubleshooting any other electronic system, like a stereo receiver or a television. There is a recommended procedure to follow, and if you follow it, you will find the problem fast.

1. Observe the symptom.
2. List the functional blocks of the computer likely to cause the symptom.
3. Troubleshooting the blocks in order of failure likelihood
4. Localize the symptom to a defective component.
5. Replace the component and test for overall proper operation.

Once you understand what you are doing, and have assembled your workbench in an organized manner, you can perform most computer repairs in a relatively short time. For example, most C-64 repairs can be performed in two hours or less.

In C-64s, the component most likely to fail is the PLA.

Not having much of a background in them, I talked to Daniel Tolvtvar, a local computer consultant who has been performing computer repairs on everything from mainframes to micros over the past eight years. According to Dan, in C-64s, the component most likely to fail is the PLA (program logic array). This results in a variety of different symptoms, depending upon how the unit fails. Sometimes you'll get a blank screen, sometimes you'll get changing colors on the border of the display. The PLA is probably the toughest chip to analyze because it controls other chips. Depending upon how it fails, it could cause other chips to turn *on* and stay *on*, or turn *off* and stay *off*, which could cause just about any symptom. The machine may or may not load a program, depending upon the failure mode.

Another common failure is memory chip(s) failure. The typical symptom here is blank screen, and the machine will not load.

One of the most common failures of the C-64, especially in the older ones, is power supply failure. The power sup-

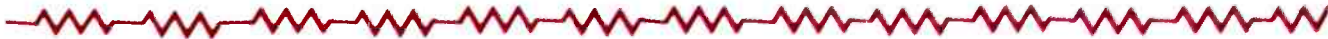
ply (a separate unit from the computer itself) is encased in resin, to avoid tampering presumably. Unfortunately, this also eliminates the possibility of repair in many cases. If a power supply has failed you can take one apart and chip away at the resin until you know where the fuse is located, then measure its continuity. If the fuse is blown, replace it and hope for the best. If the fuse is good, or if the replacement fuse also blows, a new power supply must be ordered. Sometimes, due to stress and strain, an open occurs in one or more of the wires connecting the power supply to the main unit, so taking the power supply apart is not always a futile activity. If you are efficient, and have the correct plug and wire in stock, you can make these minor repairs for less than the cost of a replacement power supply.

Be sure to test the power supplies under load, either a resistive load or hooked to your substitute computer. Sometimes the power supplies will test normal under open-circuit conditions but will fail under load. Likewise, when the power supplies fail, they often will take out part of the components on the main board, so be careful. The custom chips average in cost about \$30 apiece, so if more than two are blown, you can usually figure that the cost to repair will be more than most people would be willing to pay. Because Commodore has recently brought out a new C-64 for close to \$200, that means that an owner will, on average, be willing to spend about \$100 or so on a repair. Schematics for the C-64, by the way, are available from SAMS.

Use your senses and observation skills before getting out the test equipment.

When you are examining the memory bank you may or may not need the scope. As in the case of audio/video repair, you should always use your senses and observation skills before getting out the test equipment. Being careful to observe precautions against electrostatic discharge damage, put a finger next to, then touch each memory chip. (In fact, it would be a good idea at this point to touch all the chips.) If you encounter one or more that is significantly warmer than the others, chances are almost 100% that you have encountered a shorted chip. Carefully spray that chip, and only that chip, with coolant spray and watch for any symptom change. If you get a symptom change you have certainly isolated the problem. If not, change it anyway. Usually you need do nothing other than to replace it (them) in order to restore normal operation. In other words, most of the time chip failure is a cause not an effect. This is true assuming you have previously checked the power supply for normal operation.

Often, memory chips will open rather than short. In this case, all you need to do is to piggyback a known good IC right over the suspected memory chips, one by one. If only one chip has failed, when you piggyback the good one over the bad one, normal operation will be restored. Never do this or make any other changes in the circuit while the power is applied, of course! To piggyback an IC, just lay



the chip on its side and then rock the chip, bending the leads toward the center of the chip. Do this on both sides. Then the chip can be "clipped" to the chip in the circuit by friction only.

Upon occasion, you will encounter multiple memory chip failure. In this case, piggybacking one by one just won't get it. Now you will have to drag out the scope and/or a logic probe, and take a look at things. Check the power supply input to each chip. Next, check the processor clock, and then check each address line to see that there are pulses coming out. If one is stuck, either high or low, this should lead you to a problem. Also check the enable lines on the major chips (such as the PLA); see if they start out low at reset, then go high as indicated on the schematic. Check the reset line on the processor. If you have not by now discovered anything, it is time to start investigating the memory.

Look at the data-out lines from each memory chip. Look for a stuck bit (line not toggling). Again, this is after you have piggybacked each one. Experience indicates that about 75% of the time, the memory chip will fail open rather than short.

When you have to use the scope, you will be looking for a nice clean square wave on all the data-out lines. Even bad

chips may produce square waves, so you must already know what a normal waveform looks like. It should be nice and sharp both on the leading and trailing edges. If the trailing edge is not crisp, that is often the sign of a bad chip. Mark those as suspicious.

When you have checked all the chips, then go back and spray each one individually and watch the waveform that was your clue. If it straightens out or dramatically improves, you have located a problem. Don't stop short; be sure to do this for each of your suspected chips. Dan says that he found one this way that had four bad memory chips. It isn't likely, but it does occur.

Finally, after the freeze spray test, go back and piggyback each of those suspected chips (all at the same time). That should cure the memory problem, and also should restore proper operation, unless you missed something in the prior tests.

The C-64 uses 4164 chips that are readily available off the shelf.

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Some terms and what they mean

The introduction of VCRs was accompanied by an introduction of an entirely new vocabulary of terms to describe their components and operation. Here is a glossary of terms, reprinted from GE servicing literature, courtesy of the General Electric Company, that define the concepts discussed in VCR servicing books and articles. The remainder of this glossary will be published in next month's Video Corner.

Glossary

ACC

Automatic color control, used to maintain an overall constant color signal level in the color circuits.

ACK

Automatic color killer.

Adjacent Track

This is the name of the video track to the immediate left or right of the track of concern.

AFC

Automatic frequency control used to phase-lock the color circuits to either the recording or playback color signal, in order to achieve a stable color signal.

AFT

Automatic fine tuning is a special circuit found in most recent TV sets that makes the local oscillator of the TV tuner follow the channel of concern in order to produce a stable IF frequency. In other words, if for any reason the TV station being received changes frequency, the AFT circuit will automatically compensate so that no interference will be seen on the screen. No manual fine tuning is necessary.

AGC

Automatic gain control, used to maintain an overall constant picture level in the luminance circuits.

APC

Automatic phase control, used to help phase-lock the color circuits either to the recording or playback color signal in order to achieve a stable color signal.

Azimuth

A term used to describe the left-to-right tilt of the gap of a recording head, if it could be viewed straight on.

Balanced Modulator

A circuit designed to give as an output the frequency sum or frequency difference of its two input signals. Any special characteristics of one of the input signals will be present in the output signal.

Beats

A term used to describe the unwanted signals produced when two original signals are allowed to be mixed together.

Bipolar PG

Pulse generator signals that have both positive and negative excursions.

Burst

A short time occurrence (eight cycles to 10 cycles) of the 3.58MHz subcarrier signal, appearing right after horizontal sync but centered on the blanking portion of the video waveform. Burst is used to keep the color oscillator of a TV receiver locked to the broadcast station.

C signal

The color portion of a video signal.

Capstan

A small rotating metal dowel that drives the recording tape to assure positive tape movement.

Chroma

The color portion of a video signal.

Chrominance

The color portion of a video signal.

Clamp

The process of giving an ac signal a specific dc level.

Control Signal

A special signal recorded onto the videotape at the same time video signal is recorded; used during playback as a reference for the servo circuits.

Converted Subcarrier

This is the process of frequency shifting the color 3.58MHz subcarrier and its sidebands down to 629kHz.

Crosstalk

The name given to the unwanted signals obtained when a video head picks up information from an adjacent track.

CUE

To scan the playback picture at a faster than normal speed in the Forward direction.

DL

Delay Line.

DDC

Direct drive cylinder. As used in VHS, this means that the video heads are driven by a self-contained brushless dc motor using no belts or gears. DD cylinders produce pictures with better stability.

Dark Clip

After emphasis, the negative-going spikes (undershoot) of a video signal may be too large in amplitude for safe FM modulation. A dark clip circuit is used to cut off these spikes at an adjustable level.

Delta Factor (Δf)

A term used to indicate that a playback signal off the video tape has some jitter or *wow and flutter*. Δf , or a *change in frequency*, means that the color signal off the tape is not a stable frequency of 629kHz, but rather a signal whose frequency at any instant is some small amount above or below 629kHz.

Deviation

A term used to describe how far the FM carrier swings when it is modulated. In VHS the upper limit is 4.4MHz.

Dew Detector

A variable resistor whose resistance value depends upon the ambient humidity.

Dihedral

A term used to describe the relative position between the two video heads as they are mounted in the head cylinder. Perfect dihedral means that the tips of the heads are exactly 180° apart.

Dropout

A momentary absence of FM or color signal off the tape, whether due to uneven oxide or a coating of dust on the tape or video heads.

Duty Cycle

In describing a rectangular waveform, the "duty" refers to the percentage of *off* time and *on* time for one complete cycle. 50-50 means that there are equal periods of

off time and on time for one cycle and this would be a square wave.

E-E

Electronics to Electronics. This is the picture viewed on the TV set when a recording is being made. This picture goes through some but not all of the recorder's circuits and is used to test the operation of said circuits.

EQ

Shortened form of *Equalization*, used in the audio circuits.

Emphasis

The process of boosting the level of the high frequency portions of the video signal.

FG

Frequency generator used in the servo circuits.

FL

Filter.

FM Signal

The luminance portion of the video signal is used to control the frequency of a stable multivibrator. The output of this multivibrator is a frequency modulated (FM) signal shifting from 3.4MHz to 4.4MHz (pulse sidebands).

Field

One-half of a television picture. A field consists of 262.5

horizontal scanning lines across the picture tube. Two fields are necessary to complete a fully scanned TV picture (frame). First, one field is *sprayed* on the picture tube, starting at the top of the tube with Line 1, and ending at the bottom with Line 262.5. Then, the next field begins at the top of the tube again with Line 262.5 and ends at the bottom with Line 525. The lines of the second field lie in between the lines of the first field. This property of falling in between lines is called *interlacing*. The two sweeps of the picture tube, or two fields make up one complete TV picture or *frame*. Frame repetition is 30Hz; field repetition is 60Hz.

Flagwaving

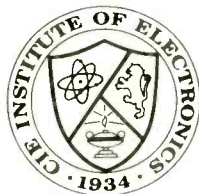
This is the term used to describe a TV set's ability to accept unstable playback pictures from a videotape recorder. All home VTRs have some degree of playback instability. A TV set with a long horizontal AFC time constant may not recover from the VTR's instability before the active picture is being scanned. This can cause a bending or flapping from side to side of the top inch or so of the screen. This movement is called *flagwaving*.

To be continued



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Remote control add-ons: prefer Teknika 6401, dead or alive! *JFD Technical Services, 62 Main St., Leroy, NY 14482; 716-768-2800.*

Admiral on-off volume control, part No. 75A203-14, new or used. State price. *Syverson's, Inc., Box 98, Wanamingo, MN 55983.*

Supremes manuals TV-1, 2 and 11, and R-1; volume control with switch for Sony KV-1210U television No. 1-222-235. *Charles T. Huth, 229 Melmore St., Tiffin, OH 44883.*

Instruction manual for Tektronix type 531 oscilloscope. Will buy, or copy and return. *Louis Jones, 4382 Valley Drive, Santa Maria, CA 93455.*

Filter chokes (used OK), 10 Ω to 100 Ω , 2 $\frac{3}{8}$ -inch mtg. centers; 1 through 4 section filter (can) capacitors, 20mFD through 80mFD, all 450V; twist prong installation tool. *Jim Farago, P.O. Box 65701, St. Paul, MN 55165.*

Hickok generator, CTV, model 661; Hickok generator, model 660; Hickok generator, model 662; Precision generator, model E-310. *Jim Shoemaker, Color TV Sales and Service, 600 First St., Leechburg, PA 15656.*

Tektronix, Hewlett-Packard, Fluke and other test equipment. Also want manuals for the same. *Roger Briggs, 983 Ponderosa Ave., No. D, Sunnyvale, CA 94086; 408-730-4573.*

Schematic for Sears color set, model 564-41692803. Not available in Sams Photofact catalogues. Will forward a check immediately for any expense. *Robert Faeth, 6D Cardinal Cedar Glen, West Lakehurst, NJ 08733.*

Any early radio-TV literature or ads, etc., for high school student making a study of radio pioneers. *D. Mark Maurer, 2352 Grace Ave., Lebanon, PA 17042.*

Service manuals or schematics (or both) for two R.J. MacDonald products—AM/FM radio/record player, model M-9040; portable stereo radio/cassette, model No. code 06-33-67. Will gladly pay for original manuals or copies. *J.L. Wingfield, P.O. Box 685, Cedaredge, CO 81413; 303-856-6341.*

Stumped! Need to touch base with someone who has built a *working* telephone tester that was described in November 1985 issue of *ES&T*. *Murray's Repair Service, 8842 Grange Hill Road, Sauquoit, NY 13456; 315-737-7192.*

Krohn Hite model UF-101A power amplifier: schematic for Advent model 300 receiver. Will pay copying and postage. *Stephen Ford, 3166 West Road, R.R. No. 3, Nanaimo, British Columbia, V9R 5K3, Canada.*

Theory of operation, troubleshooting procedures and schematic diagram for the TOCOM 5503A converter/decoder. Will exchange service literature for the OAK sine wave system models M-27, M35B and V-26 multicode; Zenith service manual 923-1000 for the SSAVI system. Also have schematic diagrams for OAK N-12, Selectra model 603 and M/A-COM Linkabit VC-2000E. Will exchange copies of any above, or will purchase TOCOM literature. *Donald G. Seibel, 6201 35th St., Lubbock, TX 79407.*

IC chip, Plessey PLW 6B SL1640C balanced detector for Royce CB, model 1-632 (IC No. 2); schematic for Knight R-55A receiver. Will copy and return. Internal information on Plessey chip would help, if available. *James K. Koelling, 4709 NW 19th, Oklahoma City, OK 73127.*

Power-amp module and schematic for Kenwood TK140X stereo receiver. *Joe Sanfilippo, P.O. Box 347, Woodruff, WI 54568; 715-356-6004, or 715-356-7564.*

Technical manuals for the following: Contact Chatter Tester by AECO; model EPC-10026; B&K Nos. 1000 and 1076; Hickok No. 760 scanners and any (fly. spot) scanner equipment. *D. Test, Box 9064, Newark, NJ 07104.*

Schematic/service information for Crumer electronic piano, model PRF. Will pay for copies. *Arthur Vickers, P.O. Box 742, Torrington, CT 06790.*

For Sale:

Text books, service manuals: A.B. Dick mimeograph machine with service manual, \$35 plus shipping; 800 new, standard brand tubes, 85% off list price. Send large s.a.s.e. for list. *M. Seligsohn, 1455-55th St., Brooklyn, NY 11219.*

B&K digital color generator, model 1246; TF166 Sencore transistor analyzer; each, \$50. Mark IV tuner subber, \$25. Postage not included. *George Otto, 1045 Magnolia Ave., Benumont, TX 77701; 409-835-1286.*

Sencore LC53 Z-meter, manual and leads, new condition, \$600; Heathkit lin/log sweep generator, IG-1275, like new, \$150; Heathkit transistor FET tester, IT-3120, tried and true, \$50. *Greg Nesbo, d.b.a. ComputeK, 643 Hill St., Shelby, MT 59474; 406-434-5854.*

Hitachi NTSC waveform monitor, model V-099, \$600; B&K model 466 CRT tester rejuvenator, \$75; Heathkit IT-18 transistor tester, \$25. *Robert Cahill, 91 Main St., Kingston, NH 03848; 603-642-4292, days.*

EICO model 330 RF generator, \$100; Heathkit IG-5282 AF generator, \$40; Sencore model SS137 sweep circuit analyzer, \$50; Leader LCG 388 color-bar generator, \$100; Sylvania CK3000 color test jig with adapters, \$350; Heathkit IM-5210 HV probe, \$25; B&K model 467 CRT restorer/analyzer with adapters, \$450; Thordarson model 19-2000 degaussing coil, \$25. Will sell separately, or \$1,000 for all. *Dennis Hoey, 634 Walnut St., Lansdale, PA 19446.*

Owner's manual and schematic for Johnson Invader Viking transmitter, type A, catalogue 240-302, serial No. 10086; audio output transformer fed by 2-626 taps Com-4816-10V line; schematic for Coronado radio 458-45A-86-860. Quote price for information. *Lew Wollaston, Wollaston Radio & TV, 1504 Big Horn, Alliance, NE 69301.*

Tektronix 453 (50MHz) and 432 (25MHz) scopes; Hewlett-Packard 1741A (100MHz) storage scope; Fluke 8024B multimeters; Hewlett-Packard model 3300A function generator (0.01kHz to 100kHz). Other test equipment. Please send \$1 for list and prices. *Roger Briggs, 983D Ponderosa Ave., Sunnyvale, CA 94086; 408-730-4573.*

PTS model 8001 component analyzer, vertical and horizontal hookup to scope, like new, with manual, \$45, shipping included. *Calvin S. Loyue Jr., 17J Washington Lane, Westminster, MD 21157.*

Sams Photofact folders, 65, Nos. 936 to 1683, \$1.50 each; 200, Nos. 1715 to 2320, \$3 each; 3,000 tubes, in boxes, new, used, old, antique, etc., \$300. *Paul's TV, 6564 S. Federal Highway, Stuart, FL 33497.*

B&K equipment—model 470 CRT tester/rejuvenator, model 415 TV sweep analyst, model 1077-B TV analyst, \$150 each; model 801 capacitor analyst, \$40. Heathkit EU-205-11 strip chart recorder, \$50; Simpson VTVM model 312, with carrying case, \$100; Hallicrafters S53A receiver, 540kC to 54.5MC, \$50. All with manuals except EU-205-11. Add postage. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235; 412-242-4701.*

Sencore models CR70, VA62, VC63, NT64, HP200 and PR57, \$3,950 plus shipping. *Keith Peyton, 2424 Graham Ave., Evansville, IN 47714; 812-476-0103, after 6 p.m.*

B&K 1076 analyst, \$100; EICO sweep/marker generator, model 368, \$25; EICO dynamic tube tester, model 666, no charts, \$35; EICO audio generator, model 378, \$25; Lafayette signal generator, model 99-5015, \$25; Lafayette audio/square/sine wave generator, model 99-5014, \$35; Accurate Instruments geonameter, M156, \$25. All prices plus shipping. Many other items too numerous to mention: Send s.a.s.e. for list. *Stanley Chalker, 1176 Smithsonian Ave., Youngstown, OH 44505.*

All *Electronic Servicing & Technology* publications from June 1974 to October 1985, excellent condition. Make offer and include shipping charges. *Michael Costello, 40 Whiteway St., St. John's, Newfoundland, Canada A1B 1K2.*

Micronta model 22-025 VTVM, \$15; Sencore model BE156 bias supply, \$15. Both include manuals and leads. Heathkit model IP-17 power supply, \$85, with manual, shipping extra; Mark IV-C tuner/subber, \$35; Mercury 1400 capacitor/tester, \$25; B&K model 466 CRT tester/rejuvenator, \$70. All include manuals and leads. *Dennis Dillon, 1616 S. 94th, West Allis, WI 53214; 414-774-2255.*

Sencore VA62 video analyzer, NT64 pattern generator, VC63 VCR test accessory, complete with manuals and cables, never used, \$2,800 for all. *Jack Ambrose, P.O. Box 536, 11156 North Road, Leavenworth, WA 98826.*

Navy signal generator, small, AN/USM27B, \$50 or best offer; government tech manuals, \$10 each—what are you looking for? *D. Test, Box 9064, Newark, NJ 07104.*

B&K 1077B analyst, original box, \$175; Leader LTC-906 TX tester, \$70; EICO 150 signal tracer (old) and manual, \$30; Sencore FC51. 1GHz counter with wideband amplifier, \$350; B&K 1640 12V power supply, \$75; Optoelectronics 8010 1GHz counter with power pack, \$175; Heathkit SM-4180 FM deviation meter, \$100 and SM-4190 wattmeter (100MHz to 1GHz), \$10; B&K E-2000 RF generator, new but broken, no manual, \$40; All devices new or like-new, with schematics, manuals and accessories except where noted. Supreme radio manuals, send s.a.s.e. for list. *Henry W. Porter, 2548 Phyllis St., Jacksonville, FL 32204; 904-387-0182.*

Assorted modules, assorted tubes, assorted semi-conductors. Send s.a.s.e. for complete list. *Bill Messina, 53 Railroad Ave., Norwood, MA 02062.*

EICO battery eliminator and charger, model 1050, Vdc 0-20, Adc 0-20, \$25. *T.W. Benson, 204 Riverside Ave., Tallahassee, AL 36078; 205-283-4266.*

Pioneer car-stereo display, never used, \$100; ADM-3 CRT terminal, \$75; B&K 1401 scope, \$125; Telequipment D-61 dual trace, \$325; Sencore SG-165, \$595. *Bob Ursdevencz, NSE, 3921 Farnam, Omaha, NE 68131; 402-346-7744.*

B&K 1470 dual-trace scope with two probes, \$250; B&K 162 transistor/FET, in-circuit tester, \$80; B&K 1801 frequency counter/probe, \$125; B&K 470 CRT tester and rejuvenator with 19 sockets, \$225; 42 Sams Photofact folders between No. 600 and 800, \$42. All items complete with manual, schematic and in first-class condition. *Long's TV Service, 720 Goshen St., Salt Lake City, Utah 84104; 801-595-8442.*

"Million" old-time tubes for older radios, amplifiers, televisions, auto radios, etc. Many yokes and flybacks. *Harry's TV Corner, 1120 Cottman Ave., Philadelphia, PA 19111; 215-745-2060.*

New Beckman HD110-T with temperature thermocouple, warranty card, used only once, \$150; FE-20 Hi-Lo Sencore with 7P212 probe, factory calibrated December 1986, \$125 or best offer. Add shipping. *Hi Tech Service, 72 Mary Stafford Lane, Flint, MI 48507.*

Sencore VA48, \$750, and DVM56, \$400. *Bill Bechtold, 7429 Frederick, Omaha, NE 68124; 402-397-2461.*

Sencore field-strength meter, model FS-134, \$150; Sencore CR31 super mack CRT tester, \$375; EICO model 944 flyback yoke tester, new, \$100; B&K TV analyst, model 1075, \$85; Commander CRT tester and rejuvenator, model 857, \$40; Heathkit capacitance checker, model IT-28, \$35. *E.R. Beard, Route 1, Box 366, Bruceon Mills, WV 26255; 304-379-9344.*

Diehl Mark III scanner, \$325; Diehl Mark V scanner, \$525. Both with warranty and manuals. *McCormick TV, 824 Woodrow, Denton, TX 76205; 817-566-0774.*

TV tubes, all types; Sams AR, CB, M hi-fi, TV manuals to 1200 series, \$1 each, plus postage. Send s.a.s.e. for items of interest. *Carl's Electronics, 417 S. 6th St., Sunnyside, WA 98944.*

Heathkit 10-14 5-inch scope, schematic and all manuals, looks and operates like new, \$175; Conar 311 resistor/capacitor tester, with manual, good, \$25; Sencore DVM37 digital multimeter, with manual, original carton, perfect, \$175; B&K TV analyst, model 1077B, all leads and manual, original carton, like new, \$325; Sencore LC53 Z-meter, used very little, complete in original carton, mint condition, \$600. *Paul Cecil, Paul's TV, 260 Main Cross, Charlestown, IN 47111; 812-256-3119.*

Montgomery Ward Airline radio (mid- to late-'40s) model 62-197, 16-tube, 4-band, with two 12-inch chrome speakers and chrome transformer; Zenith Super Transoceanic model H500, CH 5H40 with owner's manual, working and in excellent condition. Make offer. *R. Embrey, 65 S. Florida St., Buchannon, WV 26201; 304-472-1614.*

Must sell, retiring - tubes; yokes; modules; Sams Photofact folders (1100 up) \$2.75 each, 10 for \$25; transistors; ICs; test equipment. S.a.s.e. for free list. *Unied Electronics, P.O. Box 6292, Raritan Station, Edison, NJ 08837; 201-248-1176.*

Integrated Computer Systems Software and Hardware Course 525A and Interfacing Applications Course 526A, includes workbooks and carrying case, cost \$1,685, sell \$800, including shipping and insurance; Atari 800/400 Personal Computer Operating System user's manual and hardware manual, \$20, including shipping. *Roman Olearczuk, 1055 E. Harvard Road, Burbank, CA 91501; 818-843-7264.*

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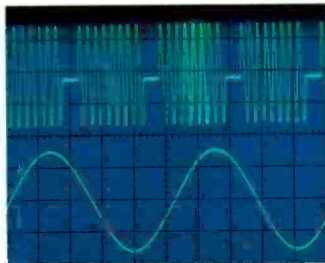
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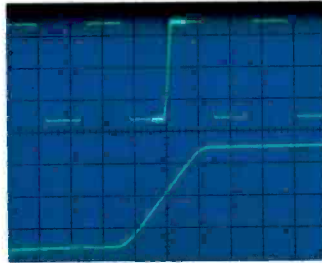
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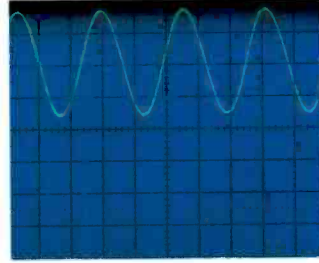
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Bandwidth	100 MHz
No of Channels	2 + Trig. View
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Digital Readout Features	Direct Ch 1 Voltage Meas. 0.5% DC; 2.0% AC RMS Resistance: 01 Ω to 200 Meg Ω Continuity/Temp: Audible/C $^{\circ}$ or F $^{\circ}$ Totalizing Counter: —1 counts to 8,000,000 Direct Freq. Meas: 100 MHz to 0.001% acc. Period, Width Meas: 10 ns with 10 ps max. resolution
Timing Meas. Accuracy	.001% (delay and Δ -time with readout)
Trigger Modes	P-P Auto, Norm, TV Field, TV Line, Single Sweep
Weight	7.3 kg (16.2 lb)
Price	\$2650
Warranty	3-year including CRT (plus optional service plans to 5 years)

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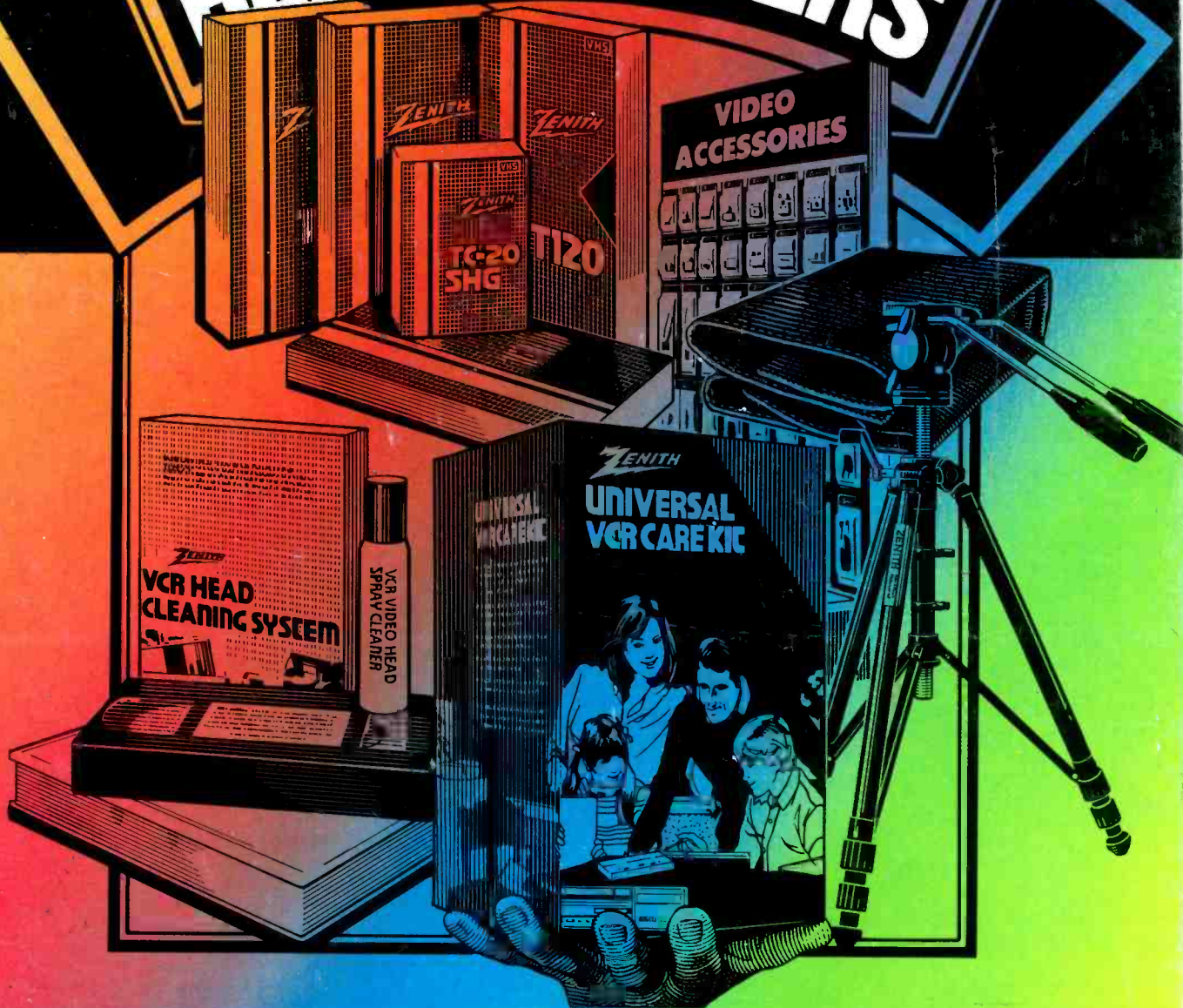
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