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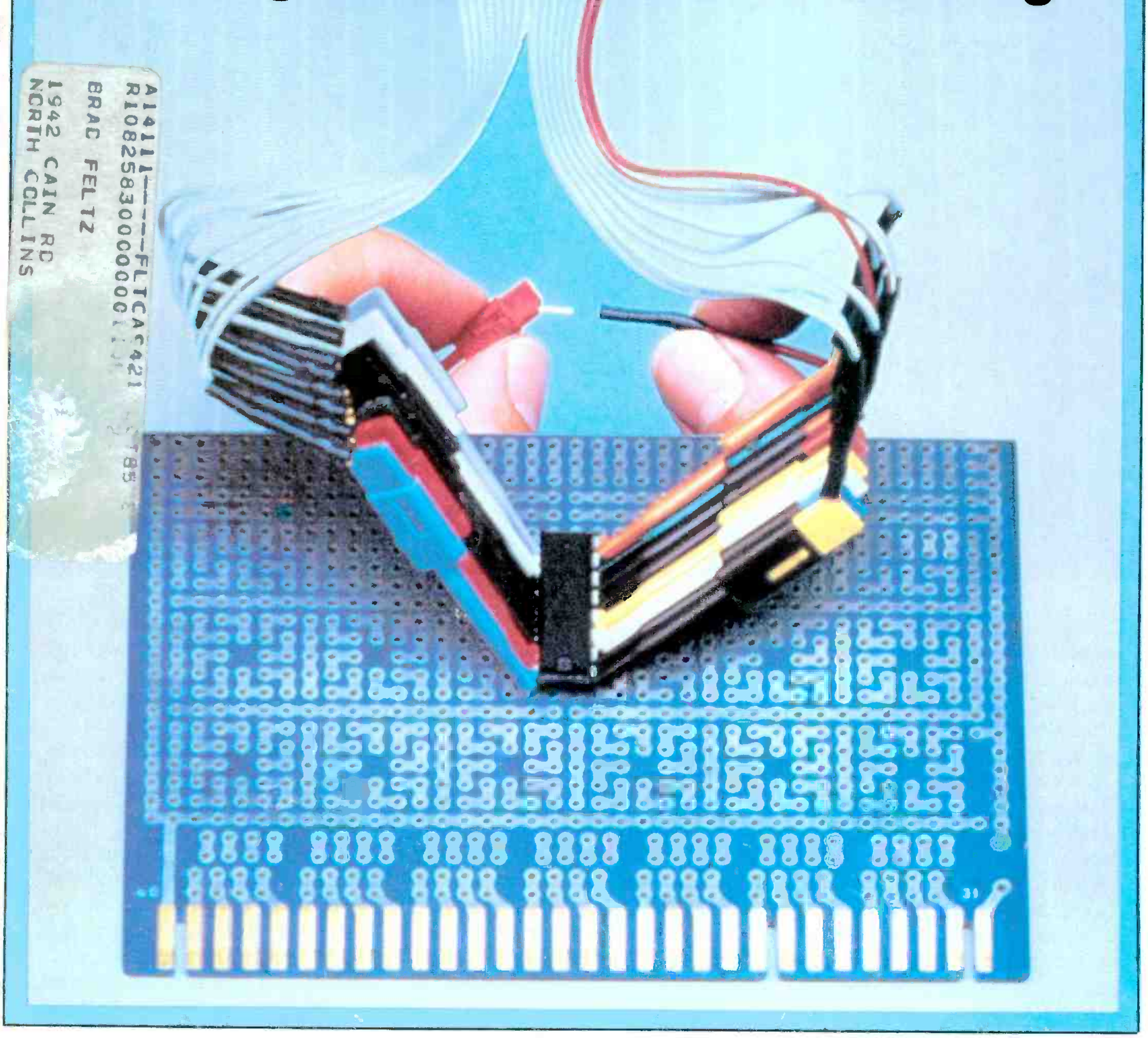
Servicing & Technology

AUGUST 1985/$2.25

Servicing E30-series NAP color televisions

Some new circuits • VCR maintenance

Meeting the measurement challenge



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Circle (4) on Reply Card

The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

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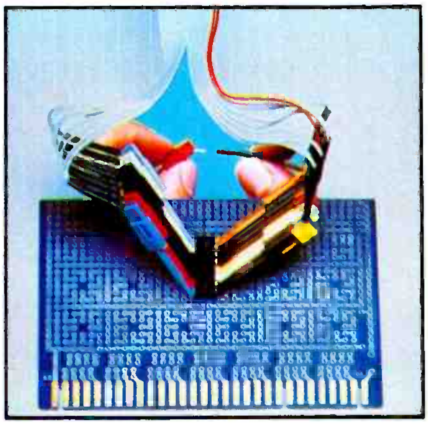

For testing, even when contact access is exceedingly narrow and where delicate wires could be damaged easily, there is technologically advanced equipment, that also assures signal accuracy to infinitesimal margins. Yet *in*accuracy must always exist. Why? See page 24. *(Photo courtesy of E-Z-Hook, Division of Tektest.)*

A new computer interface provides household convenience without limitations imposed by similar, earlier peripherals. Page 6.

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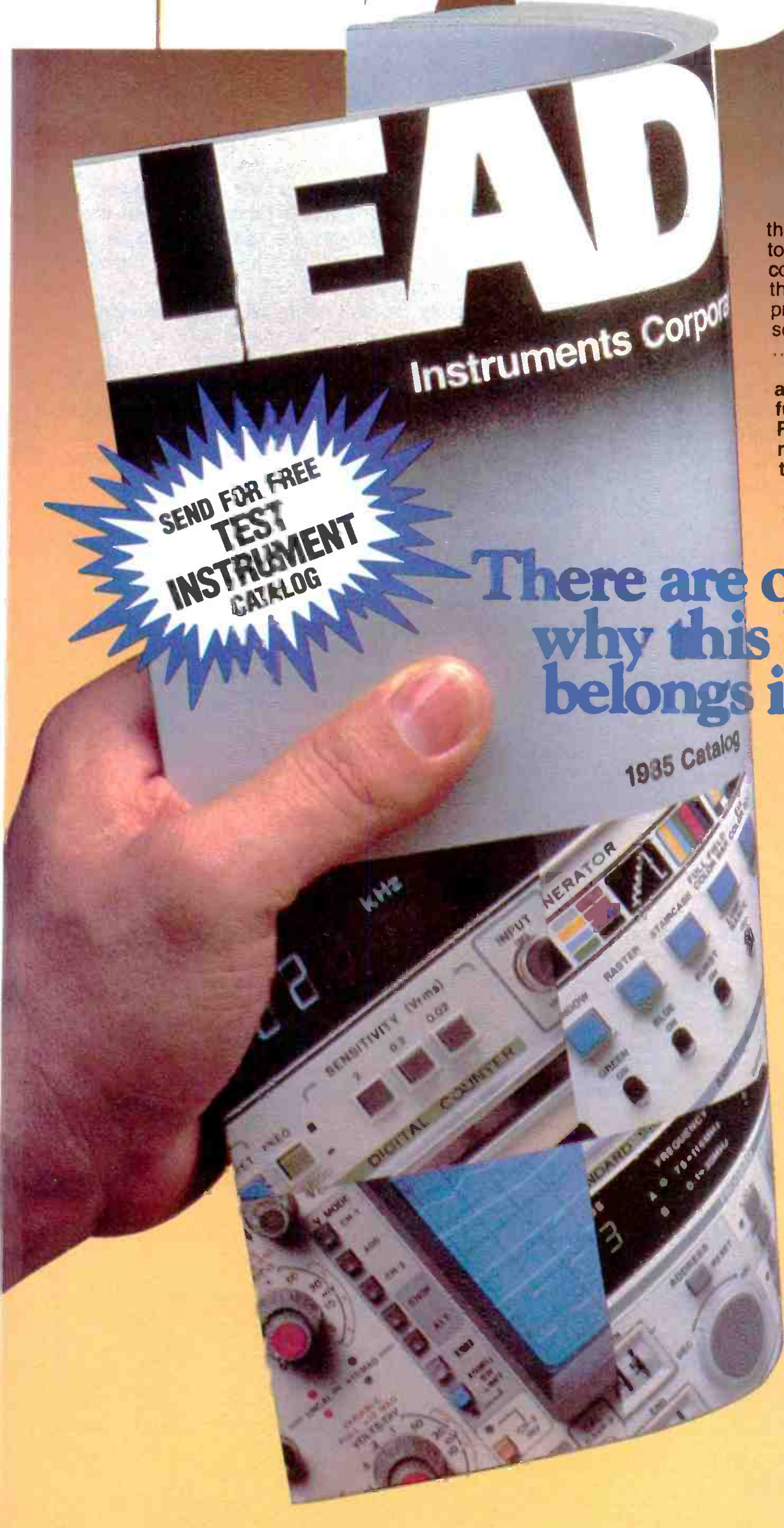

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Editorial

Models, analogies and simplifications

This world we live in is incredibly complex, and the more we study it and try to comprehend it, the more complex it seems. No matter what aspect of this world we study: physical, biological, social, *any* study beyond a mere surface look reveals complexities that elude our grasp.

Humankind's answer to this difficulty is to construct intellectual models; idealized little worlds where we can limit the number of elements and formulate precise rules for their actions and interactions. In this manner, physicists have constructed an atomic model, with protons and neutrons in the nucleus and electrons whirling about in precisely defined orbits. Every so often, studies reveal some hitherto unknown, teeny particle contained in the nucleus: mesons, gluons, quarks and more. And their place in the model has to be assessed.

The study of electronics, also complex and influenced by a large number of factors, likewise is understood by using models. For example, all lengths of wire and most components, such as vacuum tubes, transistors and diodes exhibit some amount of inductance, capacitance and resistance. Unless these extraneous values affect circuit performance significantly, they are ignored when the circuits are analyzed mathematically.

Components often are represented by models. A transistor, for example, may be represented by an ideal current source with associated ideal resistors and diodes. A complex digital circuit may be represented by an assemblage of little compartments, each of which may represent either a one or a zero.

All of these models help us grasp difficult concepts that otherwise would be so complex that they would be almost impossible for ordinary humans to understand. The danger is that we might forget that we're dealing with a model and begin to believe that the real world works that way; or we forget the limitations of the model, sometimes with results that can be somewhere between ludicrous and disastrous. We're all familiar with the analogy between electricity and a system containing water. Pressure represents voltage, volume of water flow represents current, and larger or smaller pipes represent varying degrees of resistance. An analogy such as this provides an intuitive feel for what's going on in an electrical system.

Unfortunately, some people take the analogy too far. When it breaks down, as it will sooner or later, they decide that they've been misled, or that the analogy is in fact totally worthless. Or that everything they've been taught about the subject is now suspect!

No one ever has seen an atom. Atoms behave as though they consist of electrons orbiting a nucleus. The atomic model that we see so often works well, but it is just that: a model. The electricity/water analogy helps us visualize how electricity works, but it is an analogy. Simplifying electronic circuits works very well, for the most part. But we always must keep in mind that these are models, analogies and idealizations. If actual observations appear to differ from what was calculated or expected, it is likely that the model, analogy or idealization either was not sufficiently realistic, or that we tried to use the model outside of the limitations for which it is valid.

Nils Conrad Persson

ELECTRONIC Servicing & Technology

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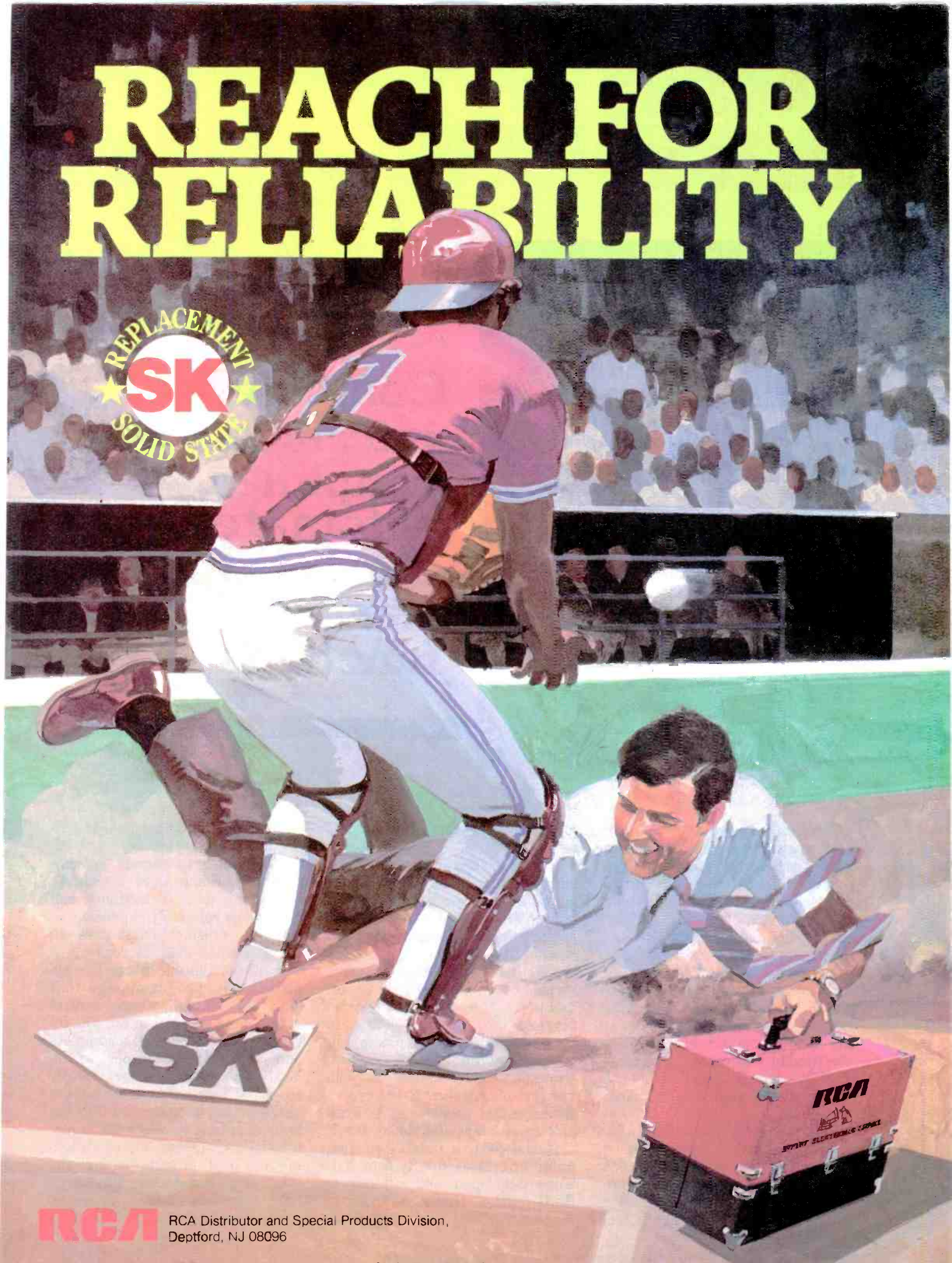

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Computer interface simplifies, automates control of home electrical functions.

A recently unveiled computer interface enables popular home computers such as the Apple and Commodore 64 to automatically control most electrical devices in a home, store or office.

The company, X-10 (USA), claims that the interface gives computers its first truly useful application in the typical home by making possible the automatic control of lights, appliances, heating and air conditioning and other electrically operated apparatus. This is a special benefit to households where someone is handicapped.

"The home computer finally has a practical role," said Peter A. Lesser, X-10's president. "We now can help anyone achieve automated security, safety, energy savings, overall convenience, and other benefits–and do it simply," he said.

The interface is a small peripheral that is actually a self-contained microcomputer with its own microprocessor, and memory backed up by a battery that can sustain it without ac power for more than 100 hours. It sends signals over the ac wiring to control up to 72 lights and appliances plugged into System X-10 modules, which in turn are plugged into convenient 120V outlets throughout the house. A wide variety of plug-in X-10 control modules and accessories is available from Sears and Radio Shack.

In the past, a number of computer interfaces for System X-10 were developed and offered by third parties. However, these interfaces often had significant limitations such as permanent connection to the computer, requiring the computer to remain *on* continuously. Some were limited to controlling only 16 modules, and most were relatively expensive.

X-10's interface overcomes all these limitations. Moreover, it uses a color-graphic interactive approach to programming that makes programming home control both simple and fun to do. The interface is supplied with a complete home control software package on disk. The software graphically steps the user through each room in the house, in color, and tells the individual how to select the lights, televisions, stereos, air conditioning and heating systems, and any other electrical devices the household wishes to control. Program, even, light brightness levels.

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More functions, more flexibility in Teleport 9 radiotelephones.

Talking to one another, exchanging information and data–regardless of the location–are both taken for granted and necessities in many walks of present-day life. Radio communications paved the way to these technological possibilities.

The breakthrough toward extensive application of such advances was achieved with the adoption of transistor technology, that permitted materialization of handy portable radio sets. AEG-Telefunken, which was among the pioneers of radiotelephone technology, recently developed a new phase in this technology with the new hand-held radiotelephone, Teleport 9.

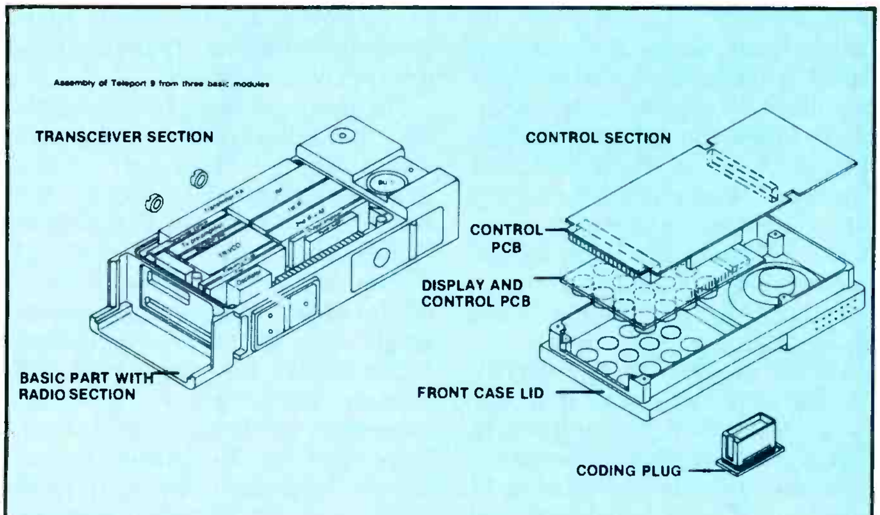

Figure 1.

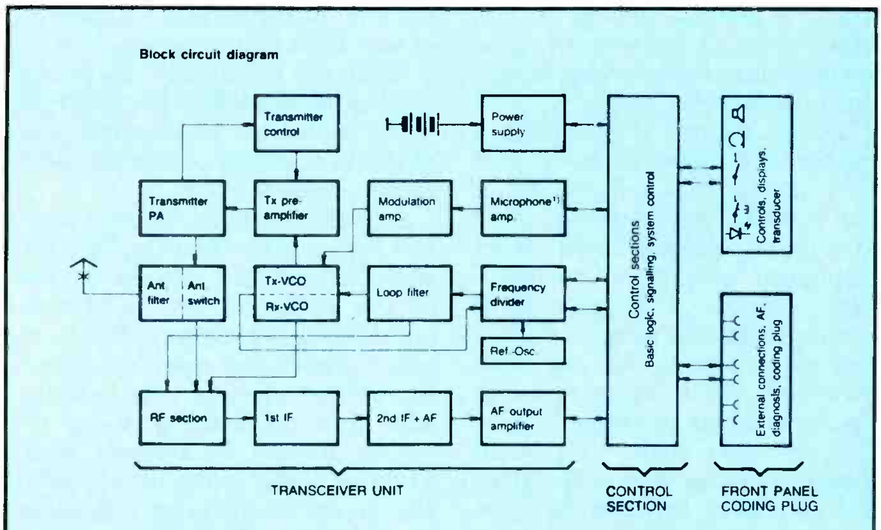

Figure 2.

Modern component technologies and modular design were combined with compact packaging and miniaturization to allow more functions than before in the hand-held set. The radiotelephone features a microprocessor control, offering the user more flexibility than in earlier sets without any hardware modifications.

The Teleport 9 equipment family ranges from the genuine hand-held set to the portable system component for use in complex networks such as with through-dialing facilities or closed network character. In a closed network (such as airports), different users have access to a group of frequencies.

Because of differing requirements throughout the world, a number of special versions are produced, using modular design.

Construction of the set (Figure 1) allows assembling all the versions required from three basic modules; the radio section contains the transmitter, receiver and frequency synthesizer. The control section contains a microprocessor for the variable programming of all control functions, the selective call generator and decoder; displays and controls also are included. A removable coding plug contains a PROM (programmed read-only memory) in which all the service-specific set characteristics are fixed. ES&T

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News

RCA reduces orders for VCRs

Concerned by escalating industry production of VCRs, RCA said it has taken steps to reduce its orders for VCRs in the second half of the year.

Jack K. Sauter, RCA group vice president, said recent monthly shipments of VCRs to the United States market are "staggering and totally out of line with consumer purchase rates." Industry sales so far this year are running some 30 percent ahead of 1984's record sales, "but production figures by Far Eastern suppliers indicate that some 122 percent more VCRs are being shipped into the United States compared with last year," he said.

RCA's first step in heading off an oversupply of VCRs in the second half is the delaying of nearly $50 million worth of VCRs that had been scheduled for shipment to RCA this summer.

All VCRs sold in the United States are primarily manufactured in Japan, with Korea a new source of the recorders beginning this year. RCA holds the leading market share in VCR sales in the United States.

Sauter said the VCR industry had been enjoying an excellent sales year to date with industry sales in the United States projected to be 11.5 million units including camcorders in 1985, a 51 percent increase over last year, with VCR shipments from the Far East running at a *15 million* annual rate.

"The current excessive buildup of VCR inventory could endanger the long-term growth of this still dynamic industry. As the approximately 70 VCR brands now participating in the U.S. market are pressured to seek additional retail outlets, consumers could very well become confused at finding a relatively complex electronic product at their local supermarket.

"If established TV and video dealers also lose interest in VCRs, a $7 billion-plus industry covering both hardware and software will soon be endangered. And the public quickly could turn its attention to other consumer products once it realizes supermarkets can't service VCRs," Sauter said.

He said a specific concern is the possibility that dealers will "take the path of least resistance and concentrate their selling efforts on VCR models with limited features and low selling prices. If this were to happen, new products such as hi-fi models and camcorders may never get established as viable new products for the industry."

Color TV replacement cycle examined in EIA/CEG report

One-half of the color TV sets bought 15 years ago are still in use, and four out of five are still in-use 10 years after purchase, according to a study released by the Electronic Industries Association's Consumer Electronics Group.

The report was prepared by Market Facts, under the direction of CEG's marketing services video committee. A representative sample of 17,000 households, nationwide, received questionnaires, and 74 percent responded. The survey was conducted between January 10 and February 10, 1985, following the holiday buying season.

Among the other findings were the following:

- Almost 46 percent of color-TV households have more than one color television. Twelve percent have three or more color sets.
- Portable models represented 74 percent of color televisions sold in 1984, up from 48 percent in 1970. In 1984, monitors represent 2 percent and projection televisions, 1 percent of color televisions purchased by American households.
- Remote control is becoming a common feature of color televisions. In 1984, 58 percent of all consoles and 37 percent of all portable models sold were equipped with remote control.
- In 1984, about 40 percent of color televisions were purchased as replacements for sets that went out of use; 38 percent were purchased as additional televisions, and some 10 percent were upgrades. The proportions of additional and upgrade purchases have been increasing over the past 15 years.
- Screen sizes of 21 inches and over dominate console sales. Most portable televisions have 19-inch screens, although 13-inch portables are increasingly popular.
- Households with electronic peripherals such as VCRs, home computers, video games or cable TV are much more likely to own two or more color sets.
- Digital television was seen as a likely purchase by 49 percent of TV households. Stereo television was considered a likely purchase by 30 percent of color-TV households. Both systems involve additional expense, however there is considerable interest among consumers in these new video technologies.

Students complete course for consumer electronics technicians

Twenty-five young people have been awarded certificates in the first phase of the Consumer Electronics Technician Training Program in Washington, DC.

The program is sponsored jointly by the Electronic Industries Association's Consumer Electronics Group (EIA/CEG), the Electronic Industries Foundation (EIF) and the District of Columbia's private industry council. Its objective is to improve skill levels and enhance employment opportunities for young men and women interested in pursuing careers as electronics technicians. Developed by the consumer electronics industry through EIA/CEG and its product services department, the course of study was taught by an industry instructor who in turn will train District of Columbia instructors.

While the pilot phase involved a total of 25 students, the program is scheduled to train some 120 students annually during the next three academic years.

According to CEG Product Services Director Don Hatton, "We are extremely pleased with the success of the pilot and are fully committed to this program. This joint effort proves how much can be accomplished when private industry and local government work together toward a common goal. Training these young people to be electronics technicians advances the interests of our industry and the community." ES&T

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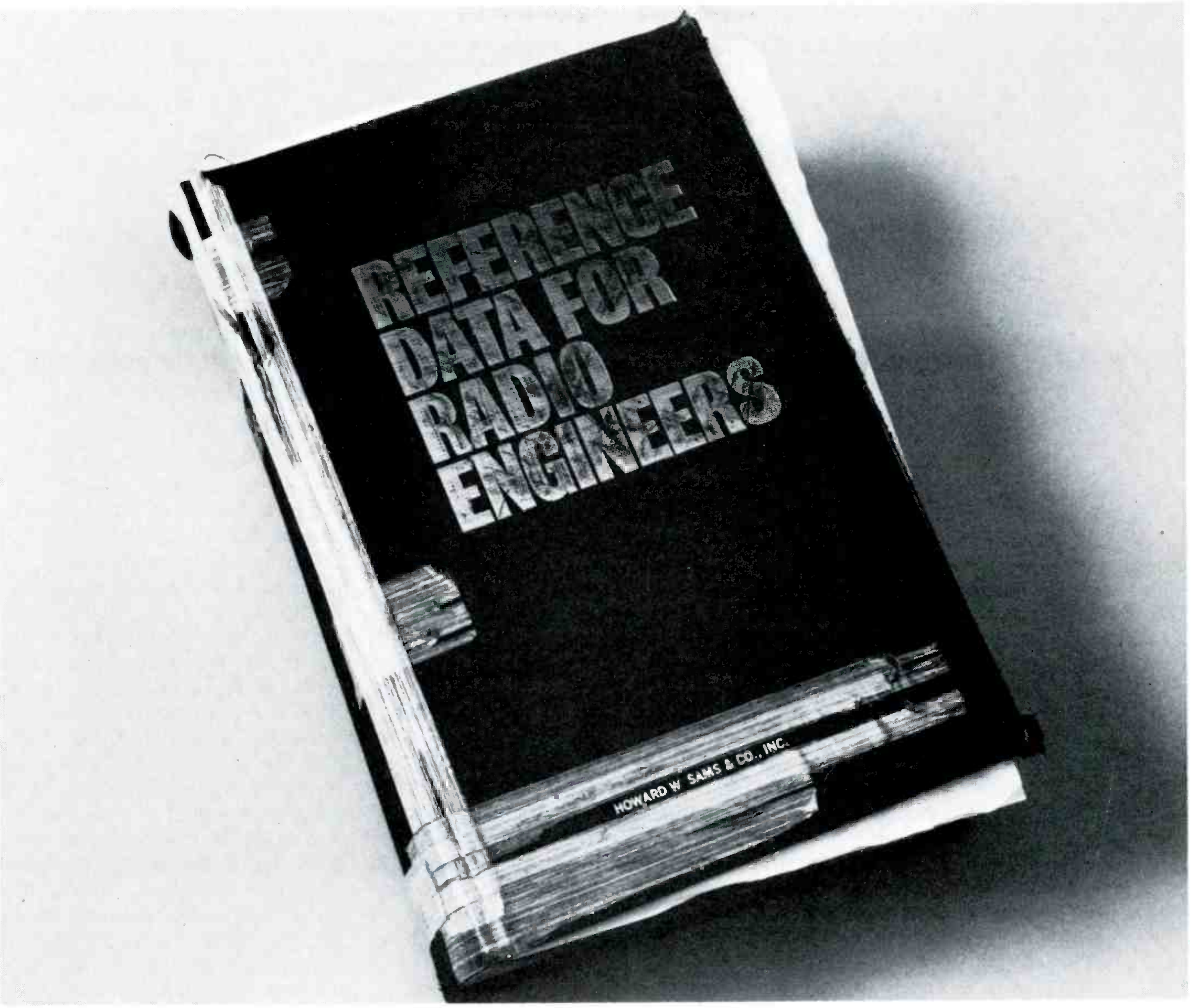

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Servicing E30-series NAP color televisions

Efficient troubleshooting of color-TV receivers requires a knowledge of all unusual circuits plus a list of the most common component failures. These servicing tools are provided for the E32 Magnavox specifically, and for all E30-series NAP color receivers in general.

By Stan Vittetoe

E30-series chassis are manufactured by N.A.P. Consumer Electronics Corporation and used in all three of its color-TV lines (Magnavox, Philco and Sylvania). The same basic chassis appears in 13-inch models (designated E21) in 19-inch models (designated E32) and 25-inch models where the chassis number is E34. Two-digit suffixes indicate variations of tuning systems and other minor differences. Also, some changes are required in the horizontal-deflection system to accommodate the various picture-tube sizes.

Therefore, after you become familiar with the basic chassis, the troubleshooting of all E30-series color receivers will be easy. The Figure-1 photograph shows internal boards and major components of a Magnavox E32 (Photofact 2086-2). Circuits and servicing of the E32 chassis are subjects of this article.

SCR switching regulation

A conventional 4-diode bridge rectifier (fed by line voltage) and C518A (Figure 2) produce nearly +160V of filtered but unregulated dc voltage. The principal regulator action is the integration of dc-power pulses. SCR513 is forced to conduct the +160V supply to 22μF C518B for varying amounts of time, according to the line voltage and the load on the regulated supply. When the +112V regulated supply drops, the circuit lengthens the conduction time of SCR513 to permit additional current to flow into C518B and thus raise the dc voltage. (For more information on integration of dc pulses, see our May 1985 issue, page 16. The SCR conduction was illustrated on pages 18 and 19 of the same issue. Notice that the E34 SCR driving circuit is different from the one on page 19, but the SCR operation is identical.)

Two things should be understood about the Figure 2 regulator. Even when SCR513 is conducting, the SCR current does not increase to maximum instantly. Think of R529 plus the inductance of the pin-24-to-pin-22 flyback winding as the resistance leg of a low-pass filter with C518B used as the capacitance leg. According to the theory of filter operation, the SCR513 anode current cannot change rapidly. This is proved by scope waveforms that show the anode current having a sawtooth shape with gradual increase and gradual decrease.

Secondly, there is an increase of regulated voltage because the SCR rectifies part of the pulse-and-base-line waveform at the anode (coming from the flyback winding). This is a separate action from the primary SCR switching *on* and *off* of the dc-supply voltage. Because there are two SCR513 actions, rather than one, and both contribute to the output dc voltage, the SCR conduction time is much shorter than it would be without the rectification mode. (See page 10 of the May 1985 **ES&T** article.)

Briefly, SCR513 is gated into anode/cathode conduction by a pulse at its gate, produced by the 3-transistor circuit in Figure 2. Current begins to increase gradually, so if the conduction was permanent, eventually the +112V source has accepted enough current to increase its voltage about 1V, a negative-going horizontal

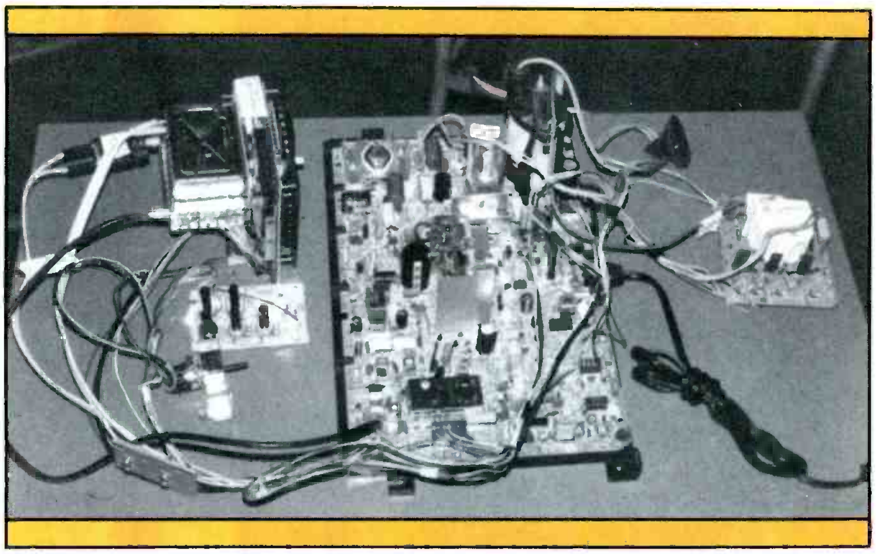

Figure 1. All major circuit boards and the tuner assembly of a Magnavox E32-chassis 19" color receiver are shown in this photograph.

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pulse from the flyback reaches the SCR513 anode and turns off the conduction. Current drain of the horizontal-output transistor causes the C518B voltage to decrease about 1V before the next gate pulse starts the SCR513 conduction again. That is slightly more than one cycle stated in the most simple steps.

The +112V source is monitored by the Q500 base voltage (see Figure 2), via the R518/R521/R524 voltage divider. Then R542 and the Q500 collector form a voltage divider between the +25V source and +6.5V at the Q500 emitter, which has its dc voltage stabilized by zener SC521. R545 feeds the Q500 collector dc voltage, which varies inversely with the +112V source, to the Q504 base. To trigger Q502 and SCR513, the Q504 base dc voltage must rise rapidly to the critical point. The rapid rise of Q504 base voltage comes from the sawtooth voltage there. R548 brings in a sample of negative-going horizontal pulses that are integrated by C534 into horizontal-rate sawteeth.

At the Q504 base, the critical voltage is +7.3V (6.2V from SC521, 0.5V for SC524 and 0.6V drop across the Q504 B/E junction). When the Figure-3 sawtooth rises up to that triggering level, Q504 conducts suddenly with the collector current (through R539) reducing the base-to-ground voltage of PNP Q502, thus forcing it into maximum saturation conduction. Current from the +25V supply passes through Q502 from emitter to collector, passes through diode SC519 (now forward biased) and through R533 to ground. The sudden voltage drop across R533 is coupled through C531 to the SCR513 gate, thus gating SCR513 into conduction. This SCR conduction current, which increases the C518B voltage, continues until the next negative horizontal pulse reaches the SCR513 anode and stops it. At the same time, another negative-going pulse is producing the sawtooth at C534. Therefore, the two circuit actions are synchronized.

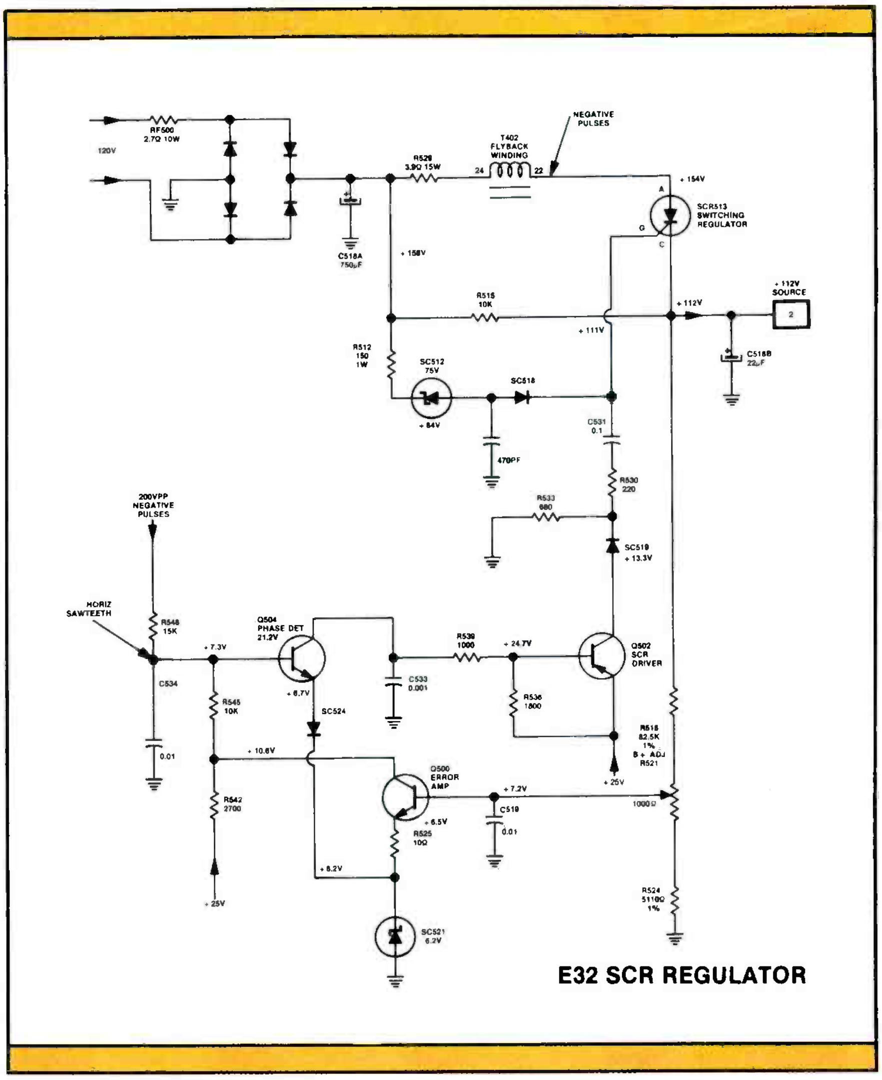

Figure 2. A 4-diode bridge rectifier with C518A produces almost +160V that is the input source for the SCR regulator. SCR513 is turned on for varying amounts of time so the +160V source can be fed in slow-buildup dc-current pulses that charge C518B, producing a dc voltage that supplies the horizontal-output transistor. A negative pulse at the SCR513 anode (during retrace time) stops all SCR current at the same time in each horizontal cycle. The three-transistor circuit monitors the +112V source and adjusts the time during each horizontal cycle that SCR513 is gated-on (by a positive pulse through C531). Early gating raises the regulated voltage by allowing current flow for a longer time. Also, positive sections of the pulse waveform at the SCR513 anode are rectified. This produces dc voltage that is stored in C518B, making the regulation more efficient.

Slightly low +112V regulated supply

When the +112V source has decreased because of a heavier current or a reduction of line voltage, the following sequence takes place very rapidly:

- The Q500 base becomes less positive, thus causing its collector to become more positive.
- Of course, the more-positive Q504 base voltage raises the C534 sawtooth to a higher dc-voltage level. Therefore, the triggering level is reached earlier on the C534 sawtooth and earlier in the horizontal cycle.
- In turn, SCR513 is gated into conduction earlier in the horizontal cycle. And because the conduction is stopped (by an anode negative pulse) at the same time during each cycle, the conduction time is extended, additional current enters C518B and thus the regulated voltage is increased to the original value.

Slightly high +112V regulated source

When the +112V source increases because of a smaller current drain or an increase of line voltage, the following sequence takes place very rapidly:

- The Q500 base becomes slightly more positive, forcing its collector voltage to become less positive.

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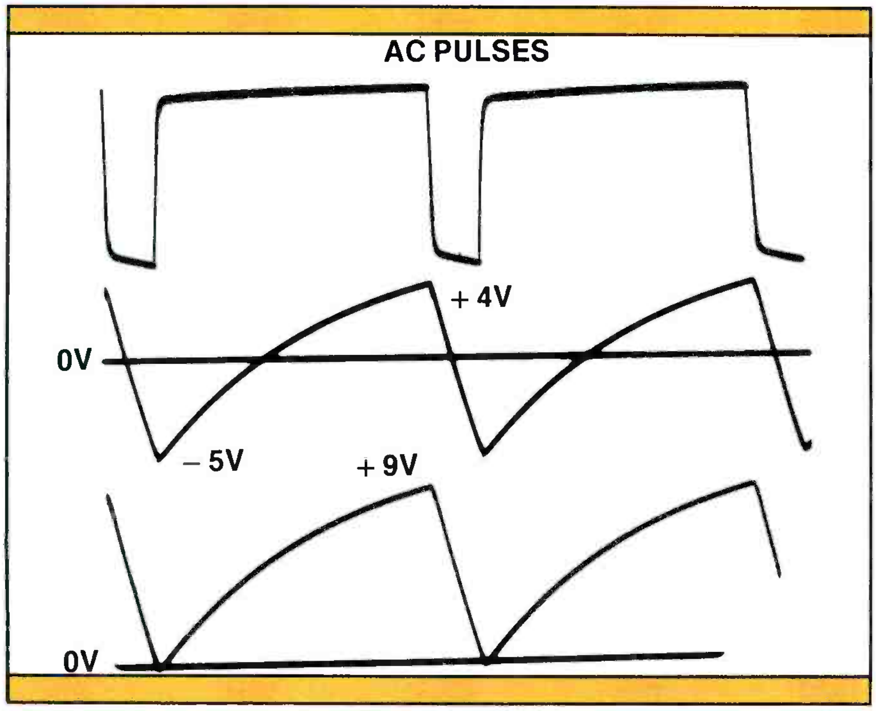

Figure 3. These waveforms illustrate how the C534 sawtooth (of Figure 2 schematic) and a dc control voltage from the Q500 collector can determine where in the horizontal cycle that SCR513 is gated-on by the circuit. The top waveform shows ac pulses from a generator. After integration (center waveform) the zero-voltage line is near the vertical center of the resulting sawteeth. Photofact 2086-2 shows 9VPP for the sawteeth at C534 in an E32 chassis. Using a sawtooth amplitude of 9VPP has the sawtooth extending from −5V through zero and up to +4V *when no dc voltage is added to the circuit.* That voltage swing would not trigger the E32 circuit, because slightly more than +7V is needed (see text). If +5V is added by the circuit from the Q500 collector (see Figure 2), the voltage swing of the sawtooth, as shown by the bottom waveform, is from zero to +9V. If more than +5V is added, the zero line drops below the waveform. For example, Figure 2 calls for slightly over +7V. If +7V is added the zero line moves 2V below the sawtooth, and the sawtooth extends from +2V to +11V, which with proper adjustment of R521, the B+ adjustment control, should produce good regulation at +112V.

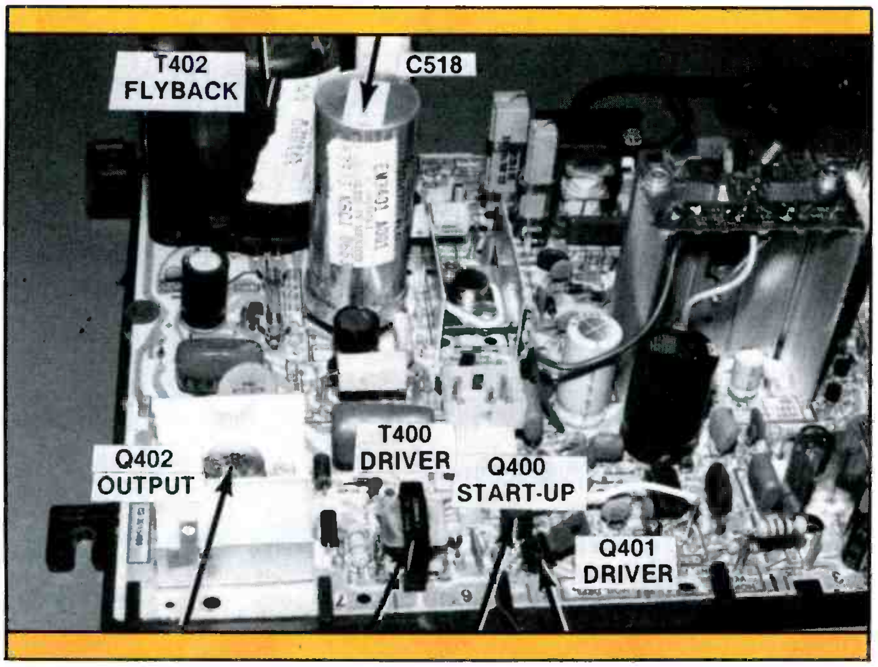

Figure 4. Arrows point out locations of several important horizontal-deflection components on the E32 chassis.

- Because of R545, the Q504 base voltage and C534 also become less positive, and the triggering level is reached later on the sawtooth.
- Therefore, the later triggering level gates SCR513 into conduction later in the horizontal cycle, which decreases the conduction time and reduces the total amount of current entering 518B, thus the regulated voltage is decreased to normal.

Start-up circuitry

The +112V regulator circuit cannot operate at switch-on unless it is supplied with the proper temporary start-up voltage. Start-up for the +112V supply is produced by a gating pulse that is applied to SCR513 (Figure 2). When power first is switched on, the cathode of zener diode SC512 has about +160V, while its anode has 0V. Because SC512 is a 75V zener, it will conduct through forward-biased SC518 diode to the gate of SCR513 where this positive voltage forces SCR513 into full conduction current that raises the C518B voltage from zero to an increasing voltage (+160V, if the conduction is permanent). But as the voltage nears the proper +112V, the horizontal-deflection system, which has been producing a start-up of its own during the same time, begins to operate. Horizontal operation gives power to the sources produced by rectification of flyback pulses, so the 3-transistor control circuit for the SCR now has dc power, and the regulator output rapidly stabilizes at +112V.

After start-up is over and normal operation of the regulator has been achieved, zener SC512 has only about 47V across the 75V barrier so SC512 cannot operate or interfere with the synchronized gating of SCR513.

Now back to the horizontal just before start-up. There are three stages in the horizontal-deflection system that must have dc voltage. The driver and horizontal-output transistors have sufficient voltage to start operation as the +112V supply is rising (after SCR513 is gated-on) because they are supplied directly from that source. However, the horizontal oscillator must have a start-up temporary

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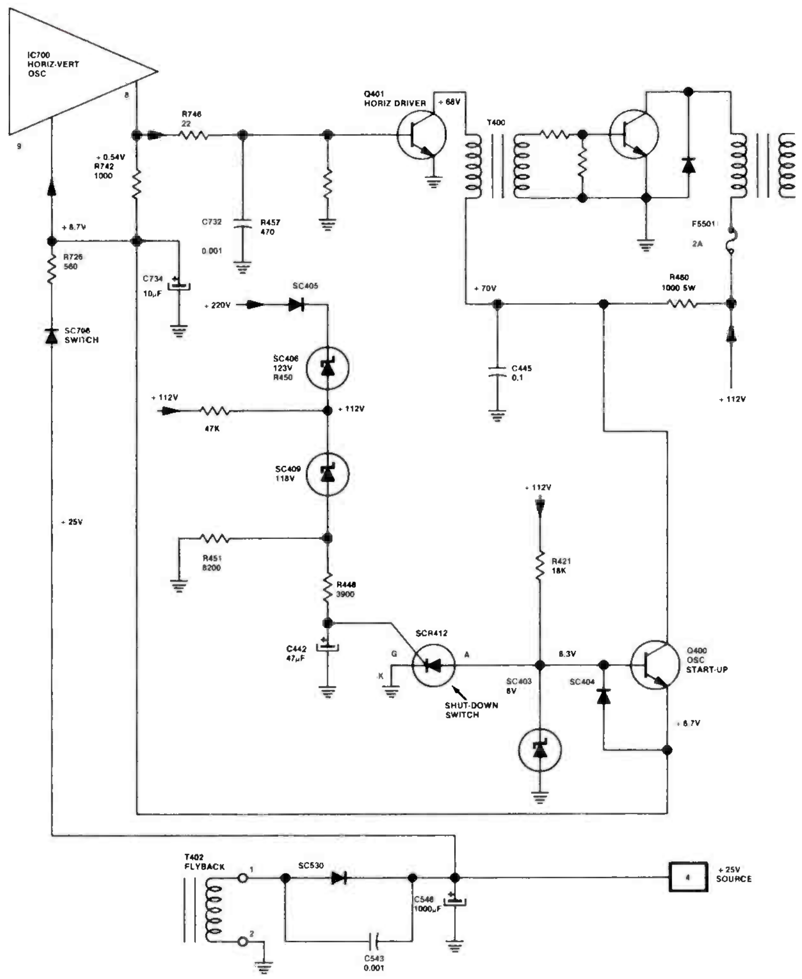
voltage, because it is operated after start-up from the +25V source, produced by rectification of horizontal pulses.

Figure 5 shows the oscillator start-up circuit with Q400. Current from the +112V source is limited by R421 and applied to zener SC403 that furnishes a fixed voltage of +8.3V to the Q400 base. The Q400 collector obtains +70V from the driver supply, while the emitter circuit is connected to IC700. Under these conditions, a transistor will attempt to draw sufficient C/E current to raise its emitter voltage about 0.7V below the base dc voltage. So, during start-up, about +7.6V is supplied to C734 and the horizontal oscillator. The oscillator works and the remainder of the horizontal-deflection system operates normally.

When the horizontal-deflection begins to operate, those dc sources produced from horizontal power rise to rated voltages. Notice that the +25V source is connected to C734 through SC706 (forward biased when +25V is present) and R726. Therefore, the horizontal oscillator and C734 have about +8.7V, which is normal for the circuit. But notice that the +8.7V also in applied to the Q400 emitter. Because the base voltage remains clamped to +8.3V, the B/E junction is reverse biased, so NPN Q400 is cut off and cannot interfere with the horizontal-oscillator supply voltage.



START-UP AND SHUT-DOWN

Figure 5. IC 700 has a count-down circuit that produces both horizontal and vertical deflection frequencies from one stable oscillator. Excessive dc voltage from either of two scan-rectified supplies will trigger shut-down. After the cause of overvoltage has been repaired, the receiver can be turned off for the crucial capacitors to discharge and then back on, followed by start-up and normal operation.

Shut-down mode

Excessive dc voltage from either of two scan-rectified supplies will trigger shut-down. This explanation begins with the circuit that stops horizontal sweep, and then describes how the supply voltages are monitored.

SCR412 is used as the SCR shut-down switch (Figure 5). Assume a sufficiently positive signal, or series of pulses stored in C442, is received at the SCR412 gate. SCR412 is triggered, becoming a short circuit between anode and ground. The SCR412 anode is connected to the Q400 base, so the base voltage becomes zero. But that is not the desired result, because Q400 is cut off already. A path is needed to ground the Q400 emitter voltage that is the B+ supply for the oscillator. The polarity of Q400 base and emitter does not permit current flow from emitter to base. Diode SC404 is connected between base and emitter, but with opposite polarity. Therefore, when SCR412 is triggered, its conduction grounds the SC403 voltage and, through the SC404, conduction also grounds the C734 voltage that operates the horizontal oscillator. For a split second, there is an overload from the low resistance of SC706 plus R726 shorted from the +25V source to ground. But, simultaneously, the horizontal oscillator stops working and the whole horizontal-deflection system goes dead. *The receiver is in shut-down mode.* After the cause of overvoltage has been repaired, the receiver can be turned off for the crucial capacitors to discharge and then back on, followed by start-up and normal operation.

Shut-down triggers

As shown in Figure 5, both the +220V and +112V supplies are

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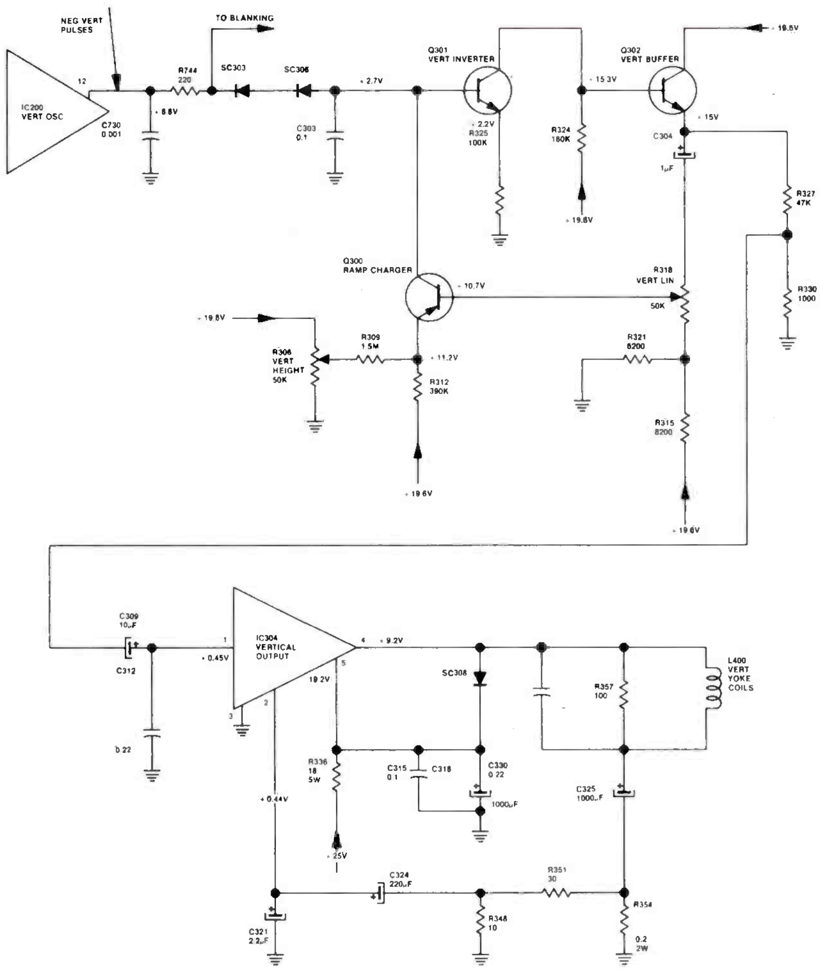

E32 VERTICAL

Figure 6. E32 vertical sweep has several different circuits. Q300 is used as a resistor that feeds the height-control dc voltage to charge C303, while Q300's C/E resistance is varied by dc voltage from R315 and varied dynamically by a vertical signal coming from C304. Therefore, both height and vertical-linearity functions are combined. An integrated circuit (IC304, that operates very warm) contains the vertical-output stage. Some 25-inch models have a power transistor added to supplement IC304.

monitored, and a substantial increase of either will trigger shutdown. The +220V source is monitored because it varies up and down similar to the high voltage. But the +112V supply also is monitored because leakage in SCR513 (or some other defect) might force the voltage far above the nominal value and ruin many components.

The +112V source is connected to the zener SC409 cathode and the zener anode is connected through R448 to the SCR412 gate. SC409 is a 118V zener, so an increase above +118V places a positive voltage at the SCR412 gate. A sufficiently positive gate voltage triggers SCR412, producing shut-down.

That part of the circuit plus SC406 is used to monitor the +220V source. SC406 is a 123V zener, so with a normal +112V at the SC406 anode, an SC406 cathode voltage of +245V or higher will cause conduction in SC406. In turn, the SC406 conduction forces SC409 to conduct and produce shut-down.

Shut-down produces a dead receiver with no sound or raster, but the +160V supply with its bridge rectifier continues to function and the regulated supply might have any voltage from zero to +160V at the C518B output. If the receiver's ac power is removed long enough for the regulated source to drop to nearly zero and the C442 SCR412 gate capacitor voltage to become zero, then power can be applied again, causing start-up and continuous normal operation if the cause of the shut-down has been eliminated.

Vertical deflection

Figure 6 shows the complete vertical-deflection system. A 503.468kHz crystal-controlled oscillator inside IC700 has its output signal divided by 16, producing 31,468Hz that is divided by two to produce the horizontal oscillator 15,734.4Hz frequency. Also, the same 31,468Hz is divided internally by 525 to produce the approximately 60Hz vertical frequency that exits IC700 at pin 12.

C303 is the linear sawtooth capacitor that is charged by current through Q300, the ramp-charger transistor. The amount of C303 charge is determined for dc by the Q300 emitter voltage, adjusted by R306, the height control, and dynamically by the Q300 base voltage that has a blend of vertical-drive waveform (through C304) and dc voltage from R315 which is determined by the vertical-linearity adjustment. Then the negative-going pulses at IC200 pin 12 discharge C303 through SC303, SC306 and R744.

Q301 is an inverter/amplifier of the sawtooth signal, Q302 is an emitter-follower buffer that drives the linearity circuit as well as a voltage divider supplying the input of IC304, the vertical-output integrated circuit. IC304 pin 4 drives the vertical yoke coil directly, while C325 is the coupling capaci-

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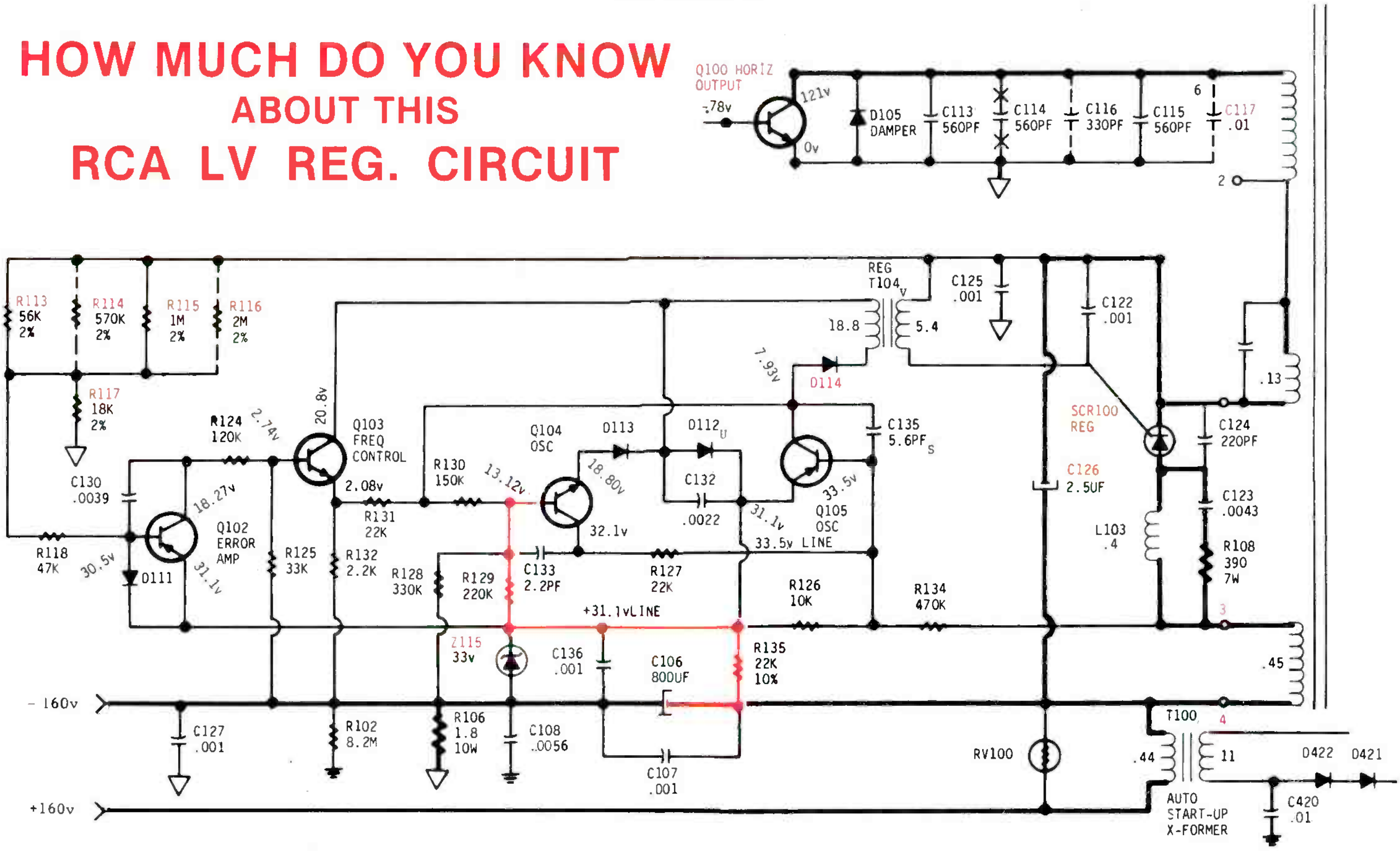
HOW MUCH DO YOU KNOW ABOUT THIS RCA LV REG. CIRCUIT



Typical of RCA CTC 85 thru 108 LV Regulator Circuits

Schematic by Diehl Engineering

How many of these questions can you answer ?

(1) Every circuit has a beginning and an ending. Where does this circuit begin ?

(2) Specifically, what is the purpose of this circuit ?

(3) What turns it on ? What turns it off, or does it ever really turn off ?

(4) Does this circuit have a shut down feature ? If so, which components are involved ?

(5) What would happen if Q103 were to become shorted E to C ?

(6) What purpose does Z115 serve ?

(7) What would happen if D114 became shorted ?

(8) What purpose does C126 serve ? What will happen if C126 becomes open ?

(9) Is the winding between terminals 3 and 4 of the flyback a primary or a secondary winding ?

(10) What purpose does C117 serve ? Exactly what does it do, and exactly how does it do it ?

(11) Exactly what do resistors R113, 114, 115, 116, and 117 do ? What happens if they change value ?

(12) What occurs that causes this circuit to produce an initial start up pulse ?

(13) Why does this entire circuit become shorted and begin to destroy horiz output transistors if the regulator SCR becomes shorted ?

(14) There is exactly one safe and practical method of circumventing this LV regulator circuit for test purposes. This technique does not involve a variac. Instead, you must disconnect one wire then connect a jumper wire from terminal #4 directly to .... Which wire do you disconnect and where do you connect the other end of your jumper wire ?

(15) If SCR100 is shorted, this circuit will still "eat" horiz output transistors even if you are using a variac. Why ?

(16) Why does this circuit use a floating ground ?

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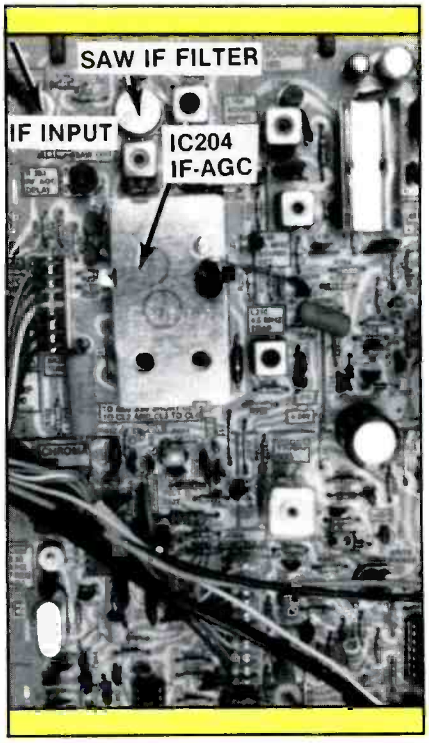

Figure 7. Arrows show several important IF components.

tor at the cold end of the yoke. Notice that C325 is not grounded directly, but through R354. The voltage drop from the R354 current is filtered and applied to IC304 pin 2 as negative feedback to reduce the distortion and nonlinearity. SC308 clips off most of the positive-going pulse that is produced by the collapsing field of the yoke coil's inductance. This reduction of the pulse amplitude minimizes the danger of the excessive pulse amplitude shorting IC304.

No hold controls are needed or supplied for vertical or horizontal deflection circuits due to the countdown from a common oscillator.

Color-output amplifiers

On a small circuit board that includes the picture-tube socket are three TO-220-type power transistors that amplify the red, blue and green color signals and apply them to the corresponding CRT cathodes. Wiring of the red-output stage is shown in Figure 8; however, all three are identical except for component identification numbers. The R-Y, B-Y or G-Y demodulated chroma signal is fed to the output-transistor base, while the Y luminance signal is brought to each emitter through an adjustable-drive control.

One area of the circuit is different. Many other brands and models have a variable control for each color stage that changes the Y luminance amplitude and as a side effect also varies the collector dc voltage. Because the collector is direct-coupled to a CRT cathode, this also affects the gray-scale tracking. In the E30-series machines, the collector-supply voltage of each output transistor is determined by a transistor called a *drive regulator*. For the red stage, red-bias control R960 determines the Q906 base voltage. Of course, the Q906 emitter voltage follows along just about 0.7V less positive, and this emitter voltage is the supply voltage for R957 and Q905. An increased Q906 emitter voltage also increases the Q905 collector voltage and the red CRT cathode that reduces the brightness. Also, the video drive is reduced because the Q906 C/E resistance is lower (the C/E resistance is added to R957 to obtain the total Q905 collector load resistance). Of course, a decreased Q906 emitter voltage decreases the red CRT cathode, increasing the brightness and increasing the color amplitude at the CRT cathode.

As part of the gray-scale-tracking procedure, the individual Q905, Q907 and Q909 collector-supply voltages are adjusted, with one left at maximum.

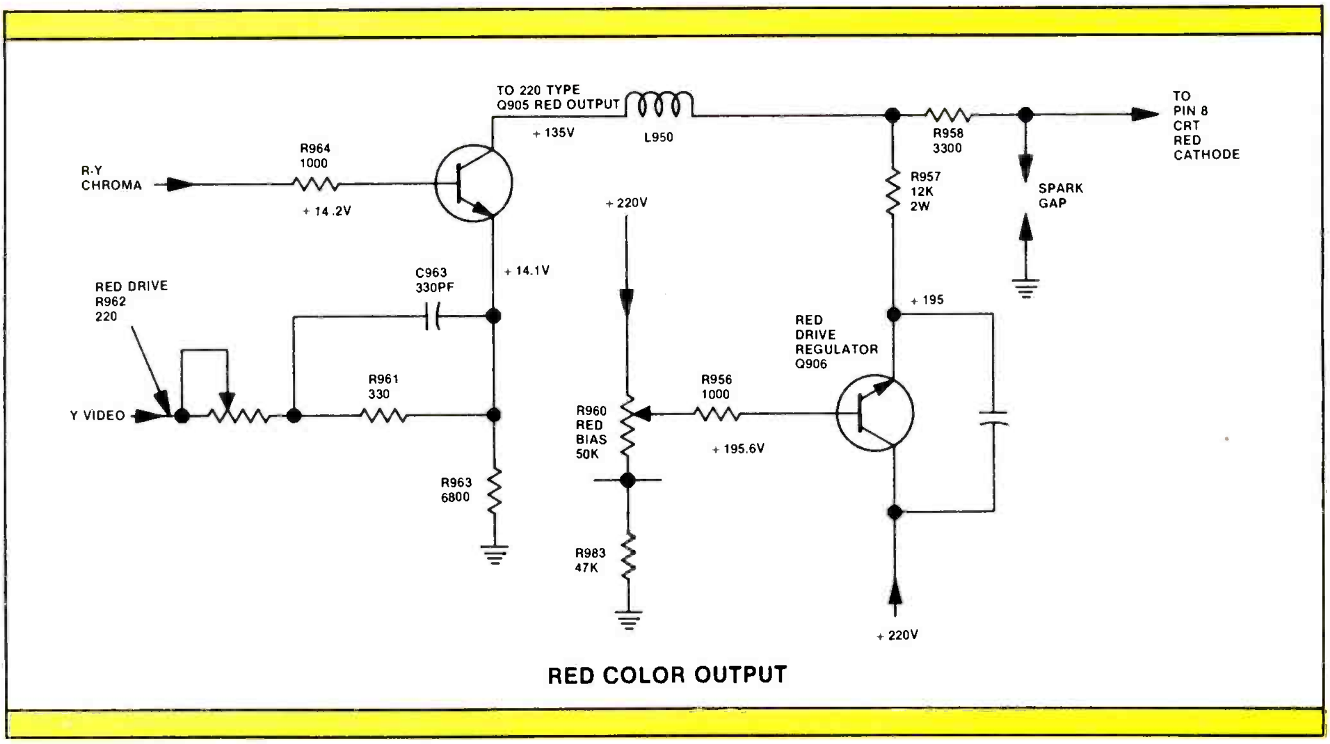

Figure 8. As shown here only for the red channel, −Y demodulated chroma is supplied to the bases of three power transistors on the CRT-socket board, and the Y luminance is applied to the emitters through drive controls (used during gray-scale-tracking adjustments at high brightness). Dc voltages of the CRT cathodes (plus some change of output transistor gain) are adjusted by controls called *drive regulators*.

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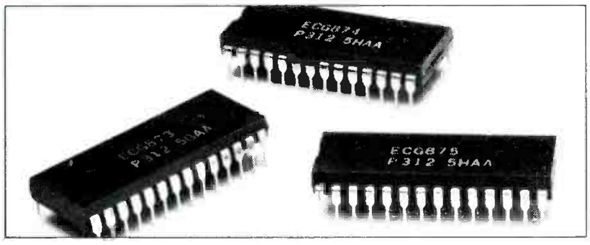

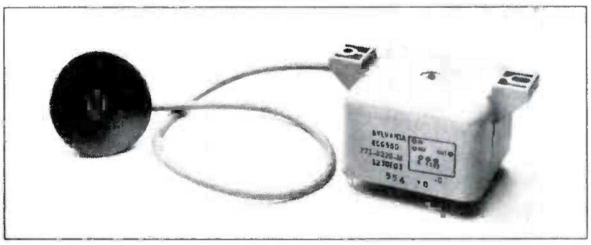

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ECG® Bipolar Transistors

Philips ECG replacement leadership is obvious again. The ECG 29, bipolar transistor, used as a replacement in the fan motor control system of Cadillacs, has been added to the Philips ECG line. (The ECG29 replaces Delco part numbers 139DDF and 7391-BT). There are 322 other bipolar transistors in the Philips ECG line that replace thousands of other domestic and foreign transistor types.

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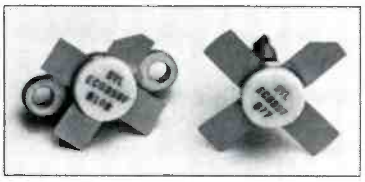

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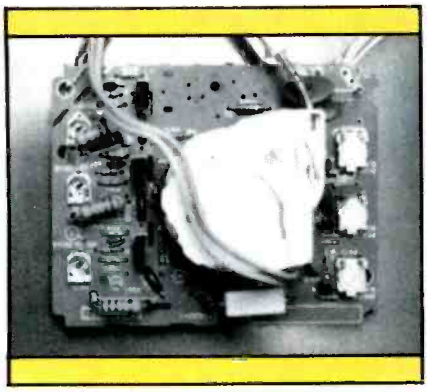

Figure 9. Three color-output transistors, six adjustable controls and other essential components of the final color-amplifier stages are on a smaller circuit board that includes the picture-tube socket.

Typical defects and repairs

Negative-going pulses from the flyback must be applied to the SCR513 anode during horizontal-retrace time to stop SCR513's conduction. Therefore, if a total loss of horizontal deflection occurs while SCR513 is conducting, the regulated supply voltage will increase up to the maximum of +160V. If the horizontal deflection stops while SCR513 is not conducting, the +112V source will decrease, perhaps to zero. However, 10kΩ R515 is connected between the +160V raw supply and the +112V source, so the exact output voltage will depend on the defect and the current drain on the +112V source.

For either condition, the proper test condition is to clip a jumper lead across the SCR513 regulator between anode and cathode. Using a variable-voltage transformer, slowly increase the input line voltage until +112V is measured at the SCR513 cathode. Usually, Q400 will supply sufficient B+ to operate the horizontal oscillator, so the receiver should operate when the defect is repaired. Use a scope and DMM to find the defective stage in the horizontal system. After the defect has been found and repaired (with picture and sound as proof), remove the jumper and test the tool operation including regulation.

An open R512 (Figure 2) produces a dead receiver because SCR513 cannot be gated on to power the horizontal-sweep system. A shorted SC512 zener allows the receiver to operate with about +118V from the regulated source, but with horizontal tearing of the picture because there was no starting pulse to gate-on SCR513.

Alternate current paths through R515 and R512 can produce some strange symptoms. If R529 opens, the SCR513 anode circuit is opened, but the receiver operates and will continue to operate as long as R512 does not open. R512 will operate extremely hot because the +112V-source current flows through R512, SC512, SC518 and the gate-to-cathode junction of SCR513 to C518B.

If switching-regulator SCR513 shorts between anode and cathode during operation, the regulated B+ begins to rise until it reaches +123V where the shut-down circuit operates to eliminate the horizontal-deflection and with it the sound, picture and raster.

A common failure of the +112V regulator is loss of the SCR513 gating pulse. This will produce a raster resembling one made from multiple small keystone patterns stacked vertically. The most likely gating failures are caused by a defective Q502 SCR-driver transistor, Q504 phase detector transistor and C534 (the capacitor that produces sawteeth from pulses).

Filter capacitor C518 (including A and B sections) is a common source of problems. Intermittent start-up can result from a decreased value of C518A, or if it has a bad soldered joint. Intermittent shut-down can be caused by changed values in R518 and R524 (near the B+ adjustment control R521). Other cases of intermittent operation were produced by bad connections of the B+ interlock at yoke plug PL300.

Insufficient height can be caused by any of the following: a leaky C/E junction in Q301 or Q302; a changed value of R327 or R330; a defective R336; a bad C309; and a defect inside IC304.

Many horizontal-frequency problems can be traced to XT700, a ceramic resonator in the oscillator circuit. Of course, many problems that appear to be horizontal-frequency problems actually are malfunctions in the sync-separator circuit. Horizontal tearing, picture pulling and weak locking often can be caused by a C/E leakage in Q701, a leaky SC702, a shorted SC704, or a change in the value of R708. An open Q400 (the horizontal oscillator start-up transistor) can eliminate all horizontal signals. Or a leaky Q400 might produce insufficient high voltage and overheating of Q402 output transistor.

Repeated failure of Q402, the horizontal-output transistor, has been traced to an intermittent connection of C457 (the 0.0095μF retrace-tuning capacitor) and by C456 (470pF) touching the output transistor's heat sink.

Excessive CRT-beam current can cause recurrent failures of Q402, output transistor. Use the following procedure to obtain correct beam current:

- Tune in an active channel.
- Turn down color control. Turn brightness and picture controls completely clockwise.
- Adjust the brightness-range control until the blackest parts of the picture are barely illuminated. Turn up the color and make minor adjustments, if necessary, to the brightness and picture controls.

Symptoms of high voltage with audible squealing but no raster can occur from bad solder connections at C475 (0.47μF coupling capacitor to the horizontal-yoke coil). Increased brightness with retrace lines, erratic shut-down, shading on left side of the screen and a low +220V source indicate an open (or partially open) C540 (50μF). R992, which connects the master-screen control to the +220V source, can become open and increase the brightness with erratic shut-down, poor focus with retrace lines or arcing in the CRT-socket spark gaps. ES&T

These discussions of circuit theories and the listings of recurrent problems and component failures should help you in future repairs of E30-series Maganvox, Sylvania and Philco color-TV receivers.

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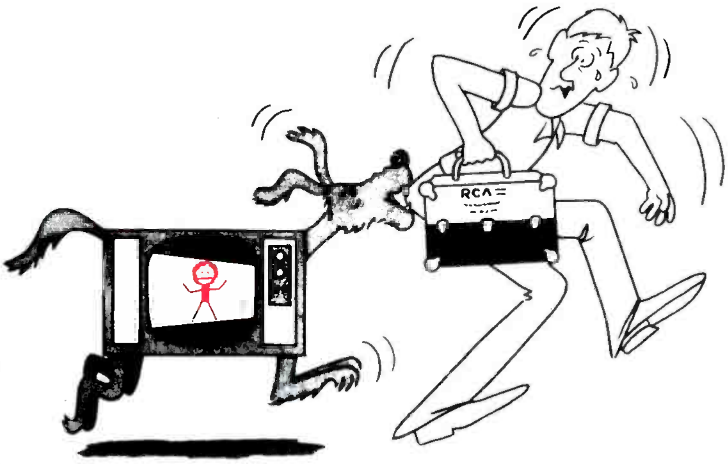
How Many Times
Do You Intend To Let
"THE SAME DOG"
Bite You ?



★ How many times have you worked all day long trying to diagnose the hi-voltage / LV regulator circuit of a set that is in shut down only to eventually find that a **shorted** video, color, vertical, tuner, AGC, or matrix circuit was causing the set to shut down and, to find that the hi-voltage / LV regulator circuit was working flawlessly all the time?

★ How many times have you spent the day looking for a **short** that was causing the set to shut down, only to eventually find that an **open** vertical, video, matrix circuit or, an **open** HV multiplier was to blame?

★ How many times have you worked all day on the same TV set, only to find out that the set's flyback transformer was defective?

★ How many flyback transformers have you replaced only to find that the original flyback was **not** defective?

★ How many horiz output transistors and Sony SG 613 **SCRs** have you destroyed while simply trying to figure out whether the flyback was good or bad?

★ How many times have you been deceived by your flyback "ringer"? Can you even count the number of hours that your "ringer" has caused you to waste?

★ How many times have you condemned a flyback, only to find that a shorted scan derived B+ source was causing the flyback to "appear" as though it were defective?

★ How many hours have you wasted, working on a TV set, only to find that the CRT had a dynamically shorted 2nd anode (to primary element)?

★ How many new sweep transformers have you unknowingly destroyed because a short existed in one of the scan derived B+ sources?

★ How many times have you said to yourself, "I could fix this - - - -thing if I could only get it to fire up long enough to lite the screen? - - - without blowing an output transistor or a fuse."

★ How many additional bench jobs could you have gotten, had you been able to give an accurate, "on the spot" estimate on sets that were either in shut down or, not capable of coming on long enough for you to analyze them?

If you had been using our all new Super Tech HV circuit scanner, you would have had an accurate evaluation concerning all of the above in about one minute, at the push of **just one** single button.

It's true! Push just one test button and our HV circuit scanner will (1) Accurately prove or disprove the flyback, (2) Check for any possible shorts in any circuit that utilizes scan derived B+, (3) Check the scan derived power supplies themselves for shorted diodes and / or electrolytic capacitors, (4) Check for primary B+ collector voltage and, (5) Check the horiz output stage for defects.

Our HV circuit scanner works equally well on sets with integrated or outboard HV multipliers. It will diagnose any brand, any age, solid state TV set including Sony. The only exceptions are sets which use an SCR for trace and, another for retrace (i.e., RCA CTC 40 etc.). Our scanner will not work on these sets.

In plain English, our HV circuit scanner is even easier to operate than a "plain vanilla" voltmeter.

First off, when you're using a scanner, you **do not** remove the flyback in order to check it. In fact, you don't even unhook any of the wires that are connected to the flyback! All you do is:

(1) Remove the set's horiz output device, plug in the scanner's interface plug, then make one single ground connection. That's all you do to hook it up.

(2) If the primary LV supply is functional and, assuming that the emitter circuit of the horiz output stage has continuity, the scanner will tell you that it is ready to "scan" by illuminating the "ready" light, which is the white button on the test / run switch.

(3) Press the spring loaded (test) side of the test / run switch and the scanner will "look" for any type of a **short** that might exist anywhere on the secondary side of the flyback, including the HV multiplier, any circuit that relies on flyback generated B+ and, including the flyback itself (both primary and all secondary windings). It will simultaneously check for a shorted LV regulator device HV multiplier, or an open or "partially" open safety capacitor.

If a short or, an "excessive load" exists on one secondary winding, all other secondary windings will have "normal" output voltage in spite of the short. Only the shorted winding itself will have zero volts on it. This makes shorted scan derived B+ sources incredibly easy to isolate. During this test, the 2nd anode voltage is being limited to approx 5 kv by the scanner.

If a short is present, the red "flyback" light will either lite, or flash (at various speeds), depending on which type of a short exists. If no shorts exist, the "flyback" light will be green.

Assuming that the "flyback" light is green, no **shorts** exist and, it is now time (and safe), to begin looking for **open** circuits which might be causing the set to shut down due to flyback run-a-way. It only stands to reason that if no shorted conditions exist, then one (or more) circuits will have to be open, otherwise, the TV set would be working!

(4) Now that you know that no **shorts** exists, push the "run" side of the test / run switch (the side that latches). Provided all of the other circuits in the TV set are functional, the scanner will now put a picture on the set's CRT screen that has full vertical and horiz deflection, normal audio, video and color.

Keep in mind that during this test, your scanner is:

(1) Circumventing all horiz osc/driver related shut down circuits,

(2) Limiting the set's 2nd anode voltage to approx 20-25 kv,

(3) Substituting the set's horiz osc/driver circuit and, as a result, eliminating any need that the set might have for an initial start up or B+ resupply circuit for the osc/driver.

Wait about 15 seconds for its filaments to warm up, then look at the CRT. Any circuits that are **"open"** will now produce an obvious symptom on the screen. Because the scanner has circumvented all of the set's shut down features, you can now use your old reliable "symptom to circuit analysis" technique to troubleshoot the problem, i.e., if the picture has no blue in it - - - repair the blue video or blue matrix circuit. If the picture has only partial vertical deflection - - - repair the vertical circuit, and so on. The scanner has effectively removed all of the stumbling blocks that would normally prevent you from diagnosing the problem. i.e., start up and shut down features, and allowed you to repair the TV set by using conventional techniques.

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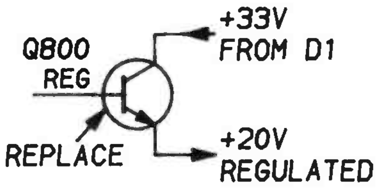
Symcure

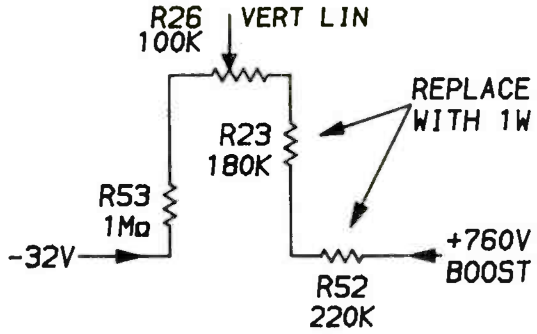
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Quasar TS-929 1
PHOTOFACT—1476-1



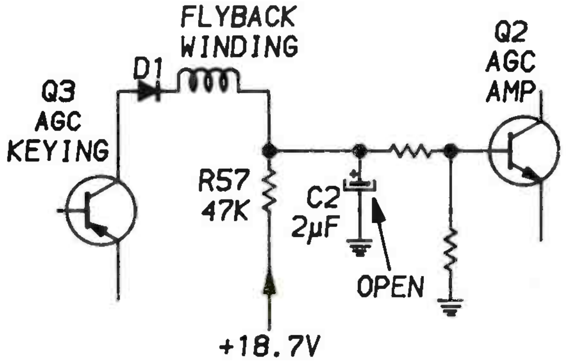
Symptom—Picture blooms intermittently with drive line on left side.
Cure—As a test, replace the Q800 regulator output transistor (near ZA panel).

Chassis—Quasar TS-929 2
PHOTOFACT—1476-1



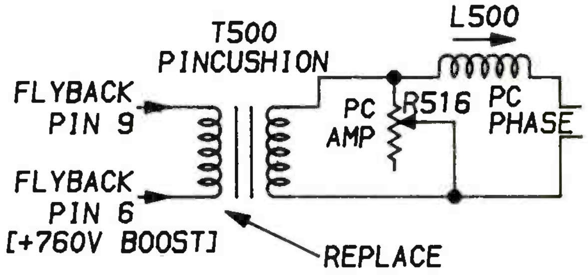
Symptom—Insufficient height with poor linearity.
Cure—Check R23 and R52, and replace them with 1W rating if out of tolerance.

Chassis—Quasar TS931 3
PHOTOFACT—1479-3 (similar)



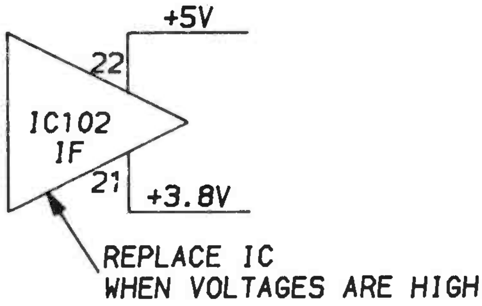
Symptom—Horizontal pulling, erratic vertical rolling.
Cure—Check AGC capacitor C2, and replace it if open.

Chassis—Quasar TS929 4
PHOTOFACT—1476-1



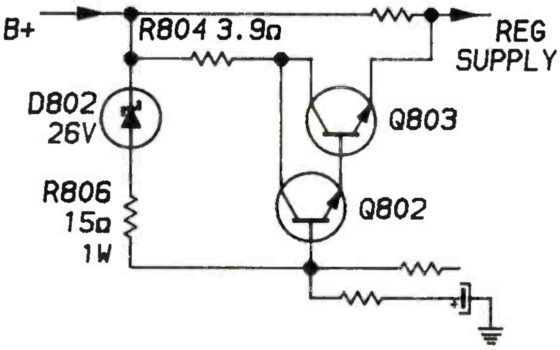
Symptom—6CH3 damper becomes red, breaker trips.
Cure—As a test, disconnect T500 from the flyback. If the short is gone, replace T500.

Chassis—Quasar TS953 5
PHOTOFACT—1575-1



Symptom—The picture overloads on strong signals.
Cure—Check dc voltages at IC102, and replace IC102 if the pin 21 voltage is higher than +5V.

Chassis—Quasar TS953 6
PHOTOFACT—1575-1



Symptom—Insufficient width, and picture flashes when brightness is increased.
Cure—Check all identified components, and replace all that are defective.

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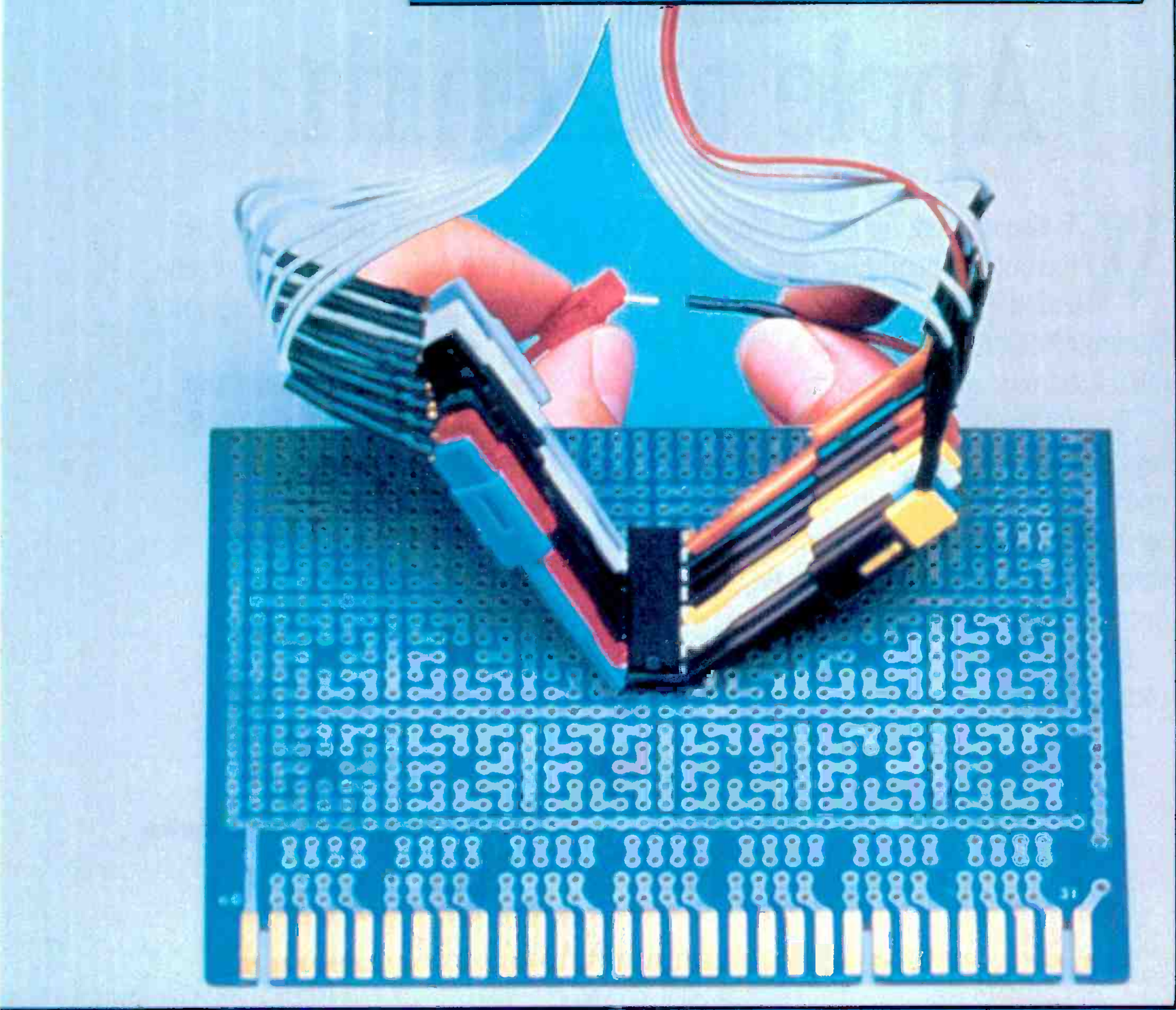
Meeting the measurement challenge

By Sam Wilson



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Measurement is one of the important jobs of a technician. In a standard troubleshooting procedure, the technician makes a measurement and compares the measured value with a value that is expected to be obtained at that location. If the measured value and the expected value are the same, then it is a logical conclusion that the source of the trouble has not been located. The technician moves on to the next possibility and, sometimes, the next and the next....

In this article, I have put together some random thoughts on measurement challenges.

The uncertain electron

One of the strangest characteristics of an electron is that two of its parameters defy simultaneous measurement. The *velocity* of an electron and its *position* never can be known at the same time. This is called the *Heisenberg Uncertainty Principle.* Anything you do to measure its velocity would change its position and anything you do to measure its position would change its velocity.

This is not something that is waiting for better measurement techniques.

The uncertainty principle has been related to measurements in electronic circuits and many other fields of science. Carried to its ultimate statement: *You actually can't measure anything with unquestionable accuracy because anything you do to make the measurement changes the situation.*

As a technician, you are already familiar with some manifestations of this principle. They are shown in Figure 1.

In Figure 1(a) a voltmeter is shown to be measuring the voltage drop across the 10MΩ resistor. The internal resistance of the voltmeter will shunt the resistance and reduce the actual voltage across R1. The voltage measurement, therefore, will not coincide with the actual value of voltage without the voltmeter.

In Figure 1(b), you see an ammeter being used to measure the current in a simple dc circuit. Inserting the ammeter into the circuit changes the resistance–and the current–very slightly. Therefore, the measurement is not exact.

Because it is impossible to make an exact measurement, the best you can do is to be aware of the changes that your measurement will make in the circuit, and work toward minimizing those changes.

In Figure 1(c), a voltmeter is being used to measure the voltage across a charged capacitor. The instant the voltmeter is connected across the capacitor, it begins to discharge. Because of the meter's inertia, it doesn't even begin to display a voltage value before the capacitor has started to discharge.

Meeting the challenge of measurement

The circuit of Figure 2 has been discussed earlier in this column and you should know that the voltage between *a* and *b* is 100V. If the capacitor is not charged, there is no voltage across it. Therefore, the output voltage has to be the same as the battery voltage.

The problem is in trying to prove this in the lab. The instant you connect a voltmeter from Terminal *a* to *b*, the capacitor begins to charge and the output voltage begins to decrease rapidly. If C has a low capacitance, it will charge before the indicator on the voltmeter gets a chance to move.

Over the years, technicians have sent me some clever methods of determining the voltage without changing its values. I would like to pass two of those along to you.

One suggestion is to use an electrostatic voltmeter to measure the voltage. An electrostatic voltmeter does not draw current for its measurement and, therefore, should not disturb the capacitance charge.

Figure 3 shows the principle of operation for an electrostatic voltmeter. It is nothing more than a capacitor with one movable plate.

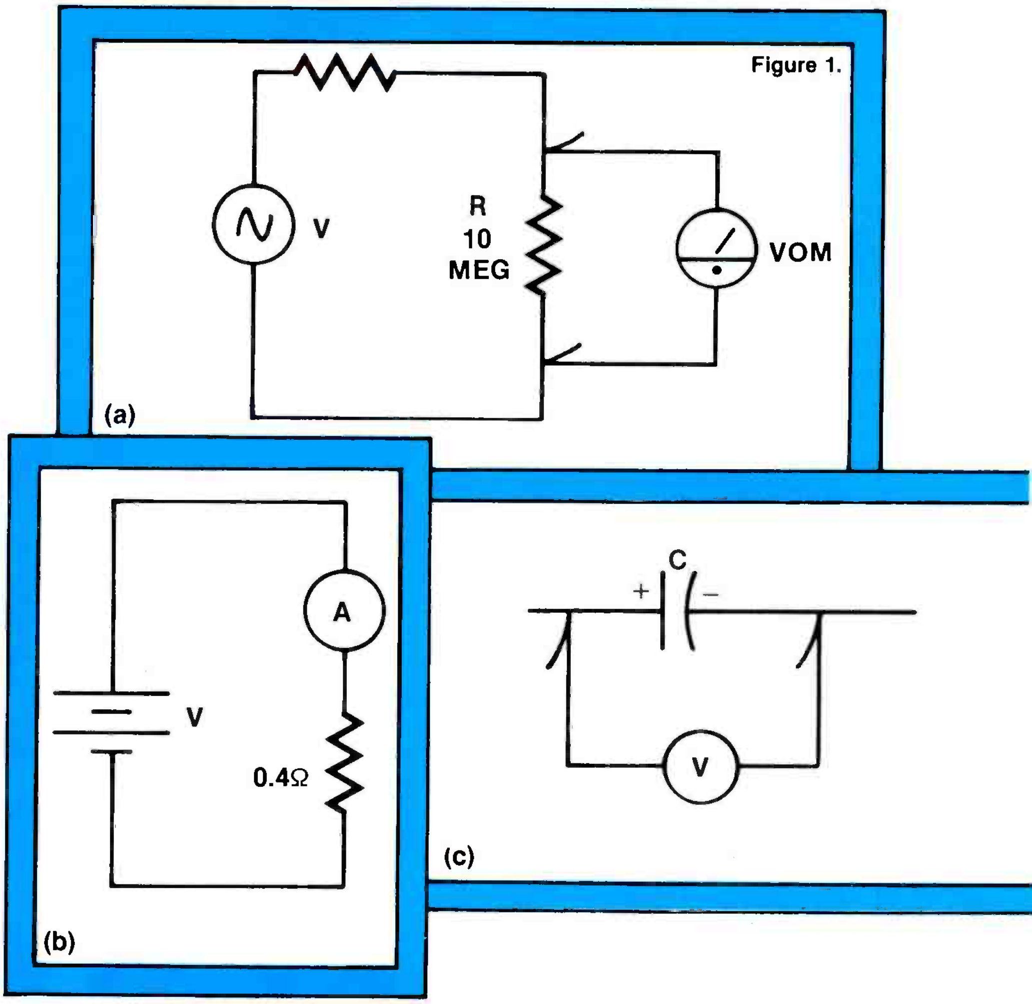

Figure 1.

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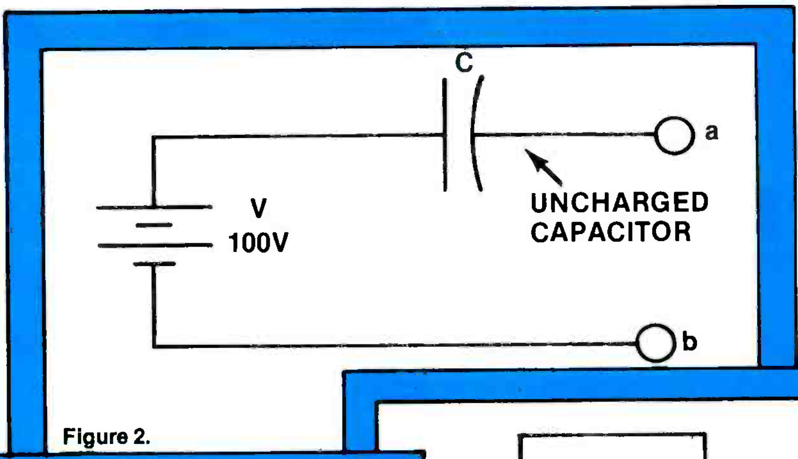

Figure 2.

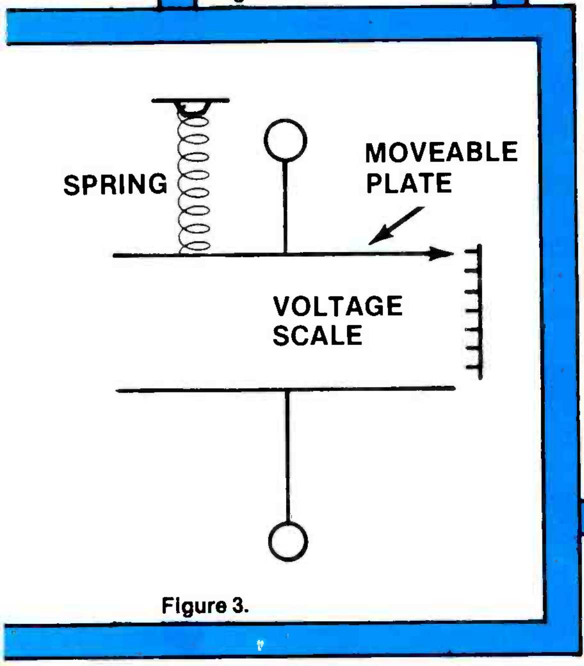

Figure 3.

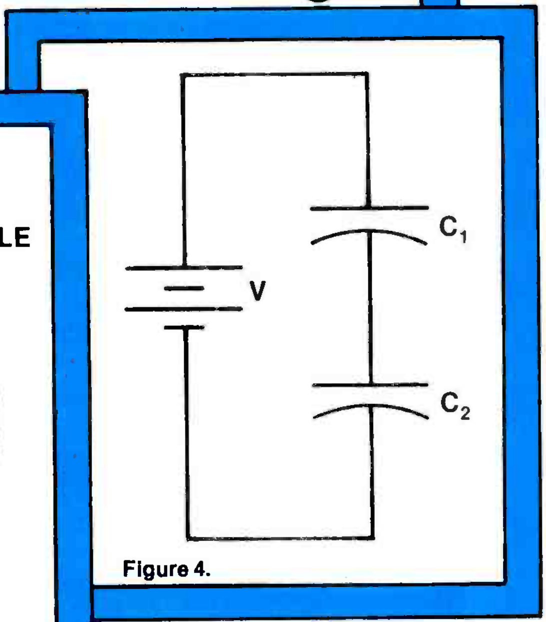

Figure 4.

When the capacitor is charged, the plates are attracted physically because unlike charges attract. The greater the charge, the greater the attraction. There is no current flow in this meter so it would seem to be the answer to the measurement problem stated for Figure 2.

Electrostatic voltmeters are usually designed for measuring voltage above 500V. That is no problem here because the same circuit can be made with a much higher voltage source replacing the battery.

Figure 4 shows why the test won't work. In this illustration, C1 represents the original capacitor of Figure 2 and C2 represents the electrostatic voltmeter. You will remember that whenever two different capacitance values are connected across a dc source, the greater voltage is across the smaller capacitor (C2). There is a redistribution of charges when the second capacitor is connected in the circuit and that changes the actual voltage measurement.

One of the most astonishing letters I ever received was related to the circuit of Figure 2. This letter came from a college professor in Texas who claimed that the voltage between points *a* and *b* must be 0V. His explanation was that *a battery cannot produce voltage unless it is delivering current.* He had a lot of letters after his name, and an impressive job, so I took his explanation to the Physics Department at the university where I was teaching.

Much to my surprise they defended his viewpoint. The idea is based on the fact that voltage is produced in six different ways, and all of them require a movement of electrons. That, by definition, is a current.

The letter from the professor concluded by saying that unless you can prove there is a voltage across the battery without current, then Vab = 0.

Having failed to get the college professors to jump in and disprove his statement, I decided to appeal to the supreme authority: the technicians. I put the contents of the letter in a magazine article and appealed to technicians to come up with a way to prove that there is voltage across a battery even though it is not delivering current.

Technicians, of course, knew the answer right away and I got so much mail on it that the mailman made a suggestion that I move out of his territory. The method of measurement is shown in Figure 5. Here, an accurately calibrated voltage source in series with a microammeter is used for the test equipment. The voltage source is set precisely to equal the battery voltage.

If the microammeter shows no current, then it follows that the battery must be producing voltage to offset the calibrated voltage. Furthermore, the battery voltage is generated without producing a current flow.

This same setup can be used in proving that the voltage across *a* and *b* in the circuit of Figure 2 actually is equal to 100V.

At first it seems as though the circuit of Figure 5 eliminates all of the possible inaccuracies of measurement. It does come close, but there are still some measurement problems. First, the current could be so small that the microammeter – no matter how sensitive – can't measure it. Second, how do you accurately calibrate the voltage source? Short of using a national standard, there will always be some slight inaccuracy in the voltage setting of that source.

Finally, the voltage of a battery is at best known to a few decimal places. So, it is impossible to make an exact setting of the calibrated source.

Regardless of these sources of possible error, the measurement of Figure 5 is a clever method of *proving* that there are 100V across the circuit output of Figure 2.

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A clever current measurement

A few years ago, I was teaching a course in "CET Review" to a group of experienced technicians. The subject of measurement uncertainty came up, and many of the technicians expressed disbelief in the idea that it was impossible to make a precise measurement. So I challenged them to make a measurement of dc current flowing in a wire without disturbing any aspect of that current.

Figure 6 shows how they (almost) solved the problem. They took the current-carrying wire and looped it around an ordinary compass. The direct current flowing through the wire caused the compass to deflect an angle from north. That angle was measured accurately. Using some rather simple algebra, they were able to calculate the strength of the magnetic field due to the current. Therefore, they accurately could determine the current itself. This instrument is a *tangent galvanometer*. In the early days of making measurements, it was *the* method of measuring current because ammeters were not available.

Although it is true that the measurement is accurate, it is not true that this method does not introduce error. Unfortunately, the magnetized needle in the compass, and to some extent, the compass itself, changes the magnetic field pattern of the current loop and, therefore, introduces some inaccuracies in the measurement.

The statistical approach

It is always a good idea to keep in the back of your mind the fact that the measurements that you are making will in some way affect the quantity you are trying to measure. The best you can do is to make sure that your measurement technique has a minimum effect on the results. One way to do that is to understand your test equipment and how it works.

If you are thinking of getting into an argument with someone, and you are going to argue that it is possible to make a truly precise measurement, with zero error, be prepared to lose. If there's a bet, take the *other* side.

Measuring non-linear distortion

From what has been said so far about making measurements, it should be apparent that any attempt to *measure* non-linear distortion in an amplifier also will *cause* non-linear distortion in that amplifier.

A simple explanation of non-linear distortion is that it occurs as a result of operating a tube, transistor or FET in the non-linear region of its characteristic curve.

Because none of these devices has a perfectly linear region on its characteristic curve, it follows that they all introduce some non-linear distortion. The trick is to reduce this distortion to a minimum value.

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you should get a pure sine wave output. Because there are no harmonics in a sine wave, there should be no harmonics in the output.

If the amplifier is not linear, then the sine wave will be distorted and there will be harmonic frequencies present in the amplifier output. One method of checking an amplifier for non-linear distortion is to check its output for harmonic content when the input is a sine wave signal.

The method just described is very good but it can be expensive. A quicker, cheaper way to do it is to use a lissajous pattern. As you might expect, this procedure will not expose a slightly non-linear distortion condition, but it is suitable for a quick check.

The test setup is shown in Figure 7. A sine wave generator delivers the signal to the amplifier and oscilloscope. The output signal goes to the load resistance, and also to the scope horizontal amplifier. (The internal sweep of the scope is not used. In other words, the scope is in an X-Y mode.)

The vertical amplifier of the scope is adjusted to a convenient height – say, six centimeters.

The horizontal amplifier is also adjusted for the same width (6cm in this case). The X and Y adjustments are best made without the other input: The X width is adjusted with Y *off*, and the Y height is adusted with the X *off*.

You should get a straight line on the scope with this test. It will lay to the left because of the 180 degree phase shift unless you are testing a non-inverting amplifier.

Figure 8 shows a few displays for the more obvious causes of non-linear distortion.

The longer the display line, the better you will be able to identify non-linearity. Of course, the amplifier in the scope could be non-linear, so you should run the test without the external amplifier to see how it looks on the scope.

As I said before, this isn't the best way, but it is probably the easiest and cheapest way to check for amplifier linearity. ES&T

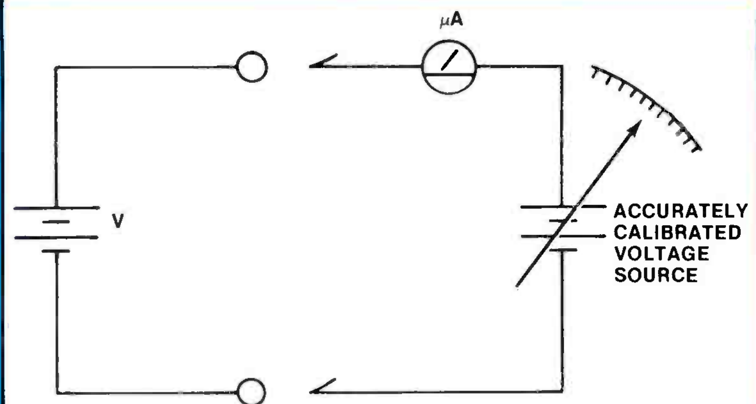

Figure 5.

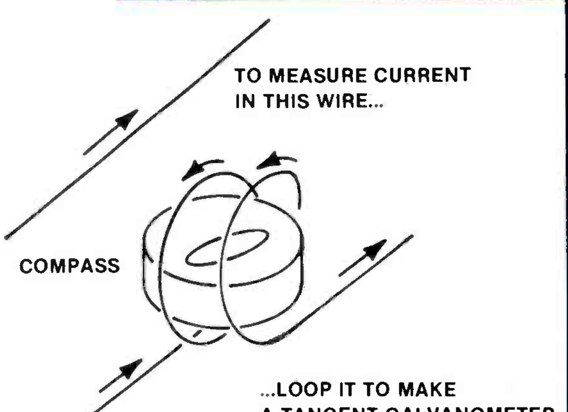

Figure 6.

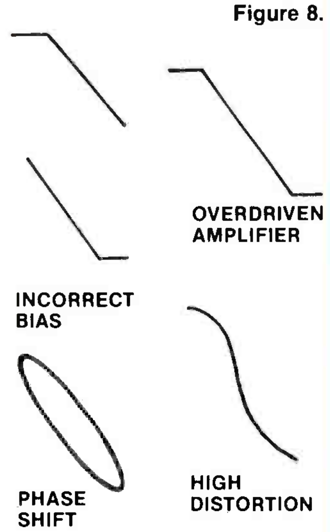

Figure 8.

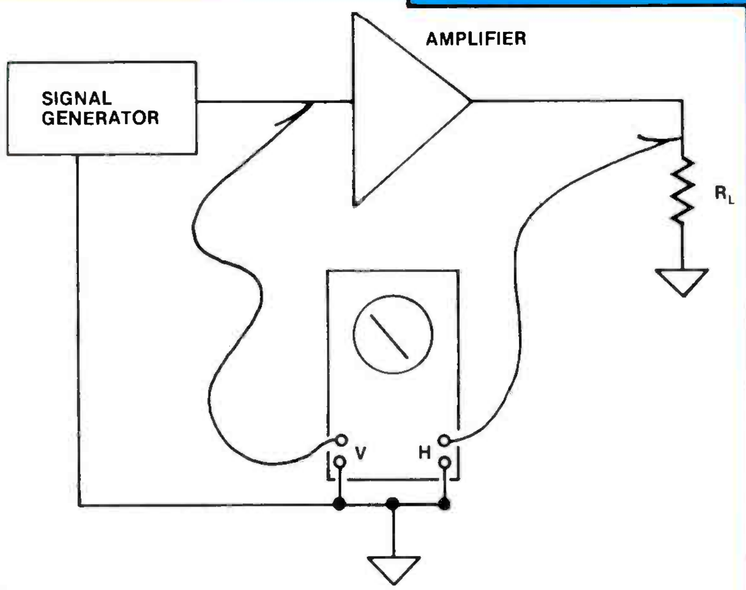

Figure 7.

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Some new circuits
The IC op-amp

By Joseph J. Carr, MSEE, CET

Editor's note: Electronic circuits and signals seem to lend themselves to infinite variations, permutations and innovations. One example is in audio technology where tape at one time provided pretty good sound. Then came Dolby noise reduction, followed by Dolby B and Dolby C that made it better. In television, SAW (surface acoustic wave) filters, comb filters and phase-locked loops eliminated the need for adjustments, improved picture performance and made tuning easier and more precise. In every facet of electronics, the introduction of ICs has simplified circuit design and enhanced reliability.

Presented here are two examples of recent circuit developments that anyone interested in understanding and servicing electronic products should be aware of. One is the realization of a classical circuit, the instrumentation amplifier, in IC form, described in an article written by Joe Carr. The other is a new noise reduction system for FM stereo, described in an article adapted from a press release from Nakamichi.

The IC operational amplifier revolutionized analog circuit design about two decades ago, even though early models were not well-suited to general use in most circuits and also were expensive. In the mid '60s when the 741 IC operational amplifier was developed, it became possible to use this wonderful low cost part for a wide range of applications where, before, it had been inconceivable. But if you thought that the operational amplifier (op-amp) was impressive, then you will be thrilled over the new generation of IC instrumentation amplifiers (ICIA).

This article will deal with IC versions of the classical instrumentation amplifier (IA) circuit. The IA provides an extremely high input impedance (similar to the non-inverting follower circuits), a high possible gain and easy design. The gain equation for this circuit is shown in Figure 1.

The IA circuit shown in Figure 1 consists of two sections: A1-A2 and A3. Amplifier A3 forms a simple dc differential amplifier, and obeys the same rules. The A1-A2 amplifier is a differential non-inverting input with differential output stage. Cascading these two forms of amplifier yields the in-

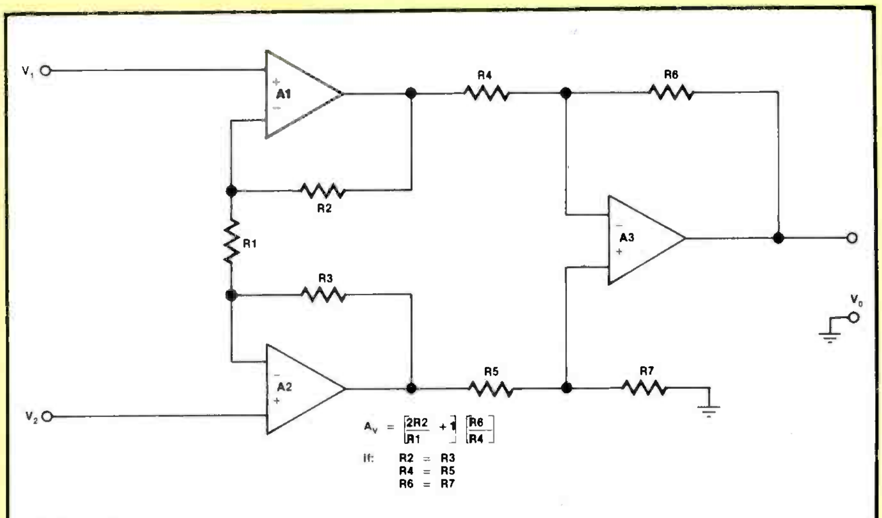

Figure 1.

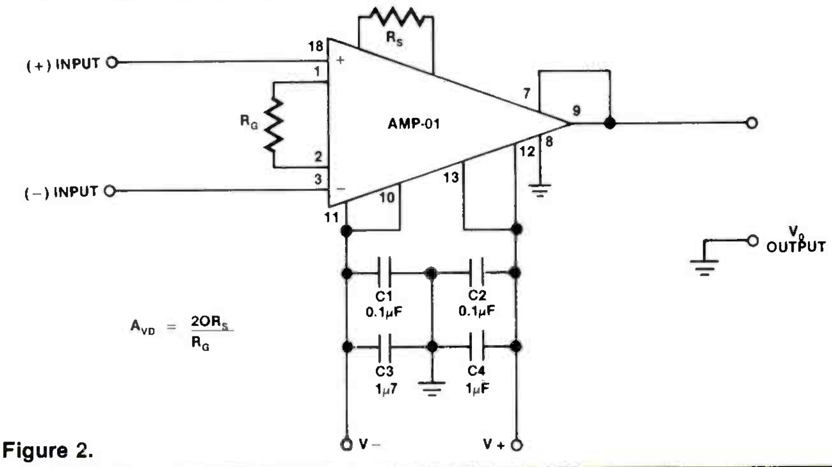

Figure 2.

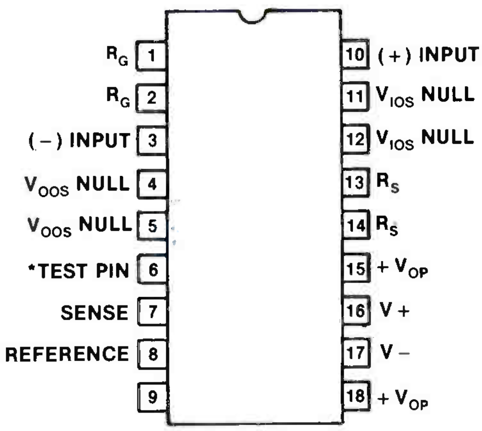

Figure 3.

*DO NOT USE PIN 6

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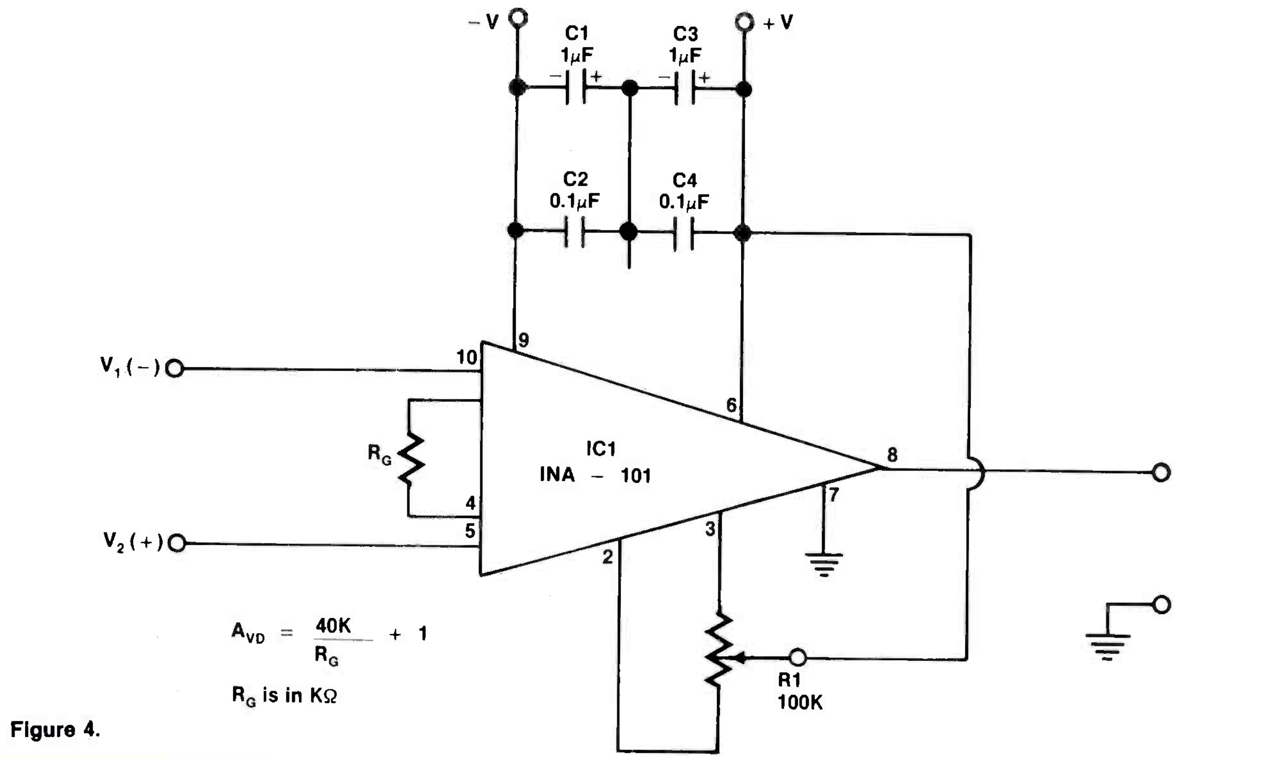

Figure 4.

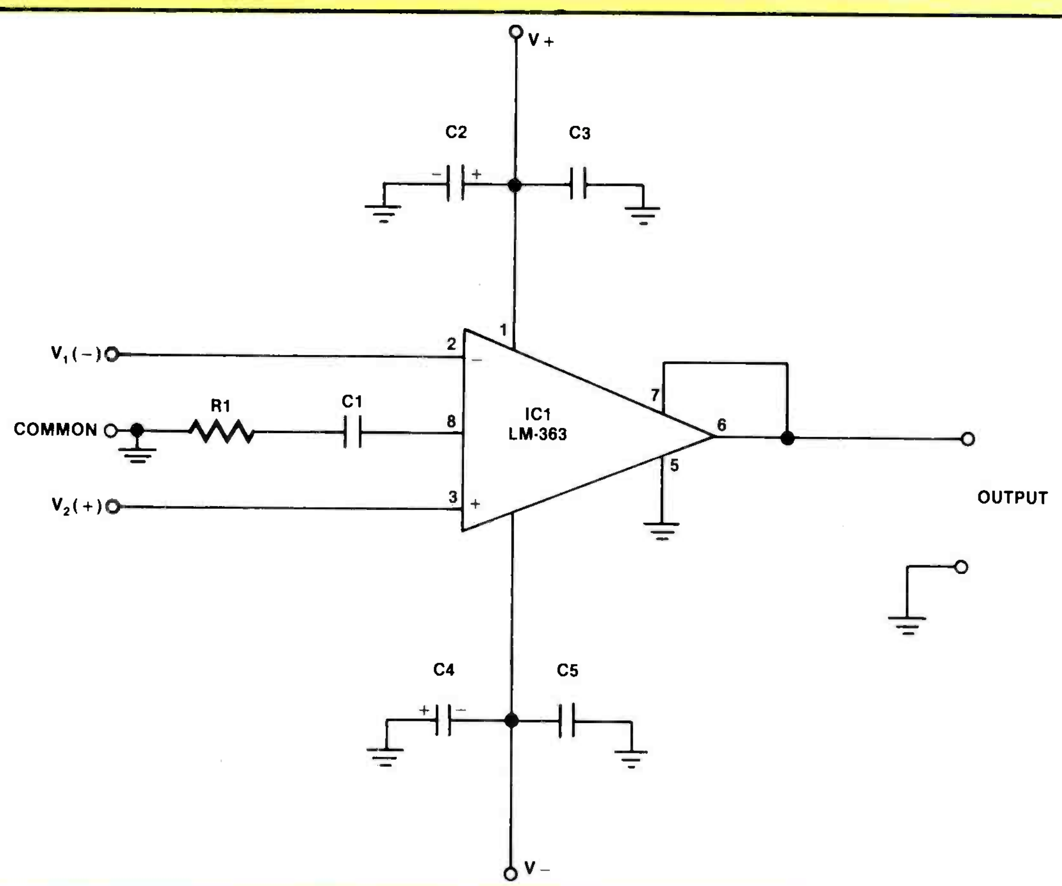

Figure 5.

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strumentation amplifier.

In many cases, where variable or adjustable gain is required, all resistors are fixed except R1. Care must be exercised, however, because R1 appears in the denominator of the equation in Figure 1. This location means that the gain can get very large when the resistance of R1 drops close to zero. In some cases, the designer will place a small-value fixed resistor in series with a variable resistor (potentiometer) to adjust gain, but limit it to a maximum.

IC instrumentation amplifiers

The operational amplifier revolutionized analog circuit design, then for a long time after, the only additional advances were that op-amps became better and better (they became nearer the ideal op-amp of textbooks). Although that's exciting, such devices are not really new. The next big breakthrough came when the analog device designers made an IC version of Figure 1–the ICIA. Today, the manufacturers are offering better and better ICIA devices.

One popular ICIA is the *Precision Monolithics* AMP-01 device. The basic circuit for the AMP-01 is shown in Figure 2. Notice how simple the circuit is. There are few connections: differential inputs, dc power supplies (V– and V+), output, ground and two gain-setting resistors. The voltage gain of this circuit is given by:

$$A_{vd} = 20\ R_s/R_g$$

Suppose you want to make a differential voltage amplifier with a gain of X1000: Simply establish a resistor ratio of 1000/20, or 50:1. Thus, if R_s is set to 100Ω, and R_g is 2kΩ, you will have the required gain of 1000. The permissible gain range is 0.1 to 10,000.

The dc power supply voltages are up to ±18Vdc. Notice in Figure 2 that the dc power supply lines are heavily bypassed. The 0.1μF units are used to bypass high frequencies; the 1μ F units are for low frequencies. The 0.1μF units must be mounted as close as possible to the body of the amplifier.

The maximum operating frequency depends upon the gain. At a gain of one, the maximum small-signal input frequency is 570kHz, while at a gain of 1000 it reduces to 26kHz.

Figure 3 shows the AMP-01 as it is housed in an 18-pin DIP.

The Burr-Brown INA-101 is another popular ICIA device. This amplifier is similarly simple to connect. There are only dc power connections, differential input connections, offset adjust connections,

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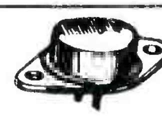

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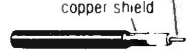

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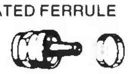

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ground and an output. The gain of the circuit is set by:

$$A_{vd} = (40\ k/R_g) + 1$$

The INA-101 is basically a low-noise, low input bias current IC version of the IA of Figure 1. The resistors labeled R2 and R3 in Figure 2 are 20kΩ, hence the *40 k* term in Figure 4.

Potentiometer R1 in Figure 4 is used to null the offset voltages appearing at the output. An offset voltage is a voltage that exists on the output at a time when it should be zero (i.e. when V1 = V2, so that V1 – V2 = 0). The offset voltage might be internal to the amplifier, or it might be a component of the input signal. Dc offsets in signals are common, especially in biopotentials amplifiers such as ECG and EEG.

A typical circuit using the LM-363 ICIA is shown in Figure 5. The miniDIP version of the LM-363 device is shown in Figure 7 (an 8-pin metal can also is available). The LM-363 device is a fixed gain ICIA. There are three versions: the LM-363-10, the LM-363-100 and the LM-363-500, with gains of 10, 100 and 500, respectively.

The LM-363-xx is useful in places where one of the standard gains is required and there is minimum space available. A circuit designer could use the LM-363-xx as a transducer pre-amplifier, for example, especially in noisy signal areas; the LM-363-xx can be built onto (or into) the transducer to build up its signal before sending it to the main instrument or signal acquisition computer.

A typical circuit using the LM-363AD device is shown in Figure 6. A selectable gain version of this LM-363AD device – the 16-pin DIP version – is shown in Figure 8. The type number of this device, LM-363AD, distinguishes it from the LM-363-xx ICIA. The gain can be X10, X100 or X1000 depending upon the programming of the gain setting pins (2, 3 and 4).

Switch S1 in Figure 6 is the *gain select* switch. This switch should be mounted close to the IC device, but is flexible in mechanical form. The switch also could be made from a combination of CMOS electronic switches (e.g. 4066).

The dc power supply terminals. are treated in a manner similar to the other amplifiers. Again, the 0.1μF capacitors need to be mounted as close as possible to the body of the LM-353AD.

Pins 8 and 9 are guard shield outputs. These pins are a feature that makes the LM-363AD more useful for many instrumentation problems than other models. By outputting a signal sample back to the shield of the input lines, the

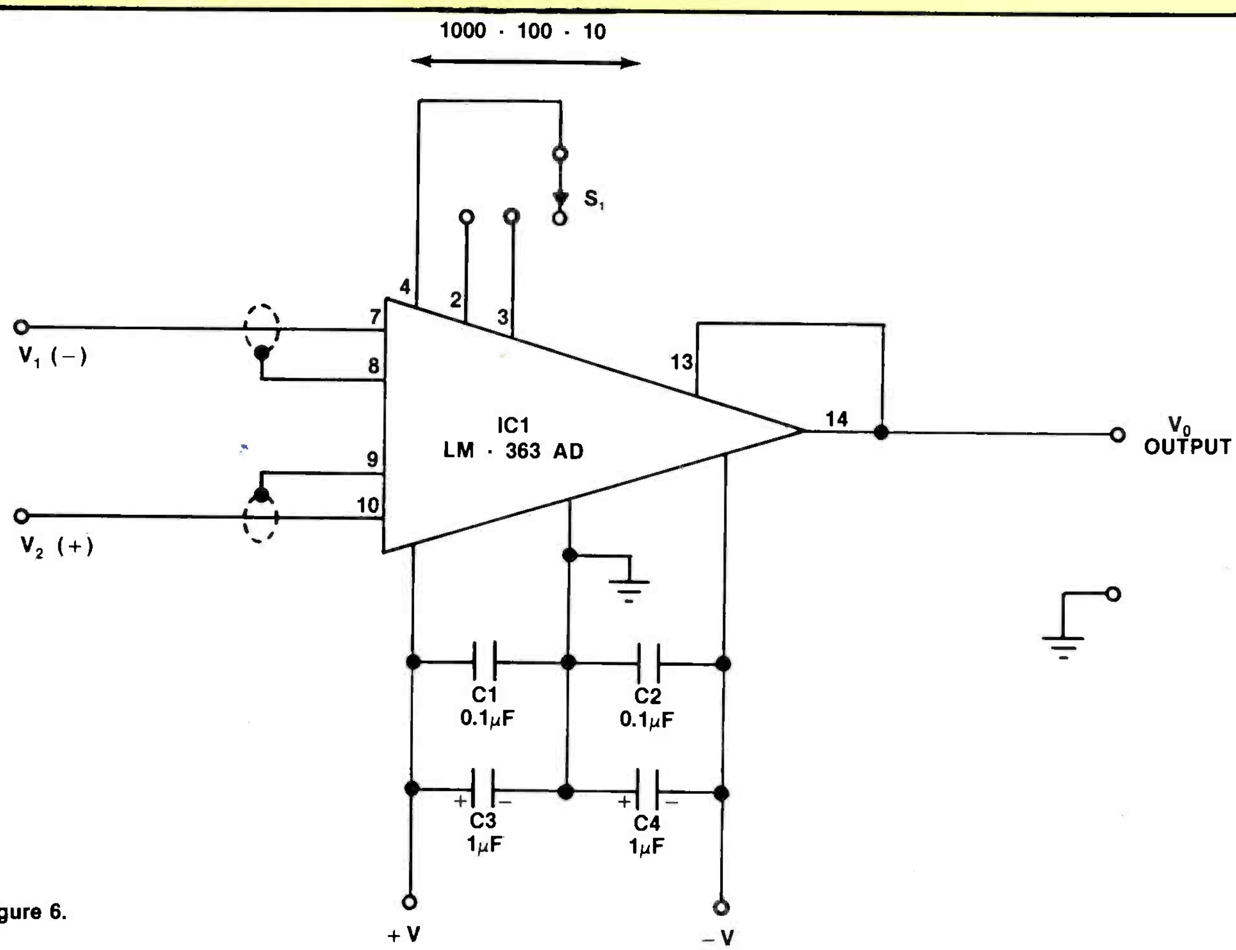

Figure 6.

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common-mode rejection ratio can be increased. This feature often is used in bi-potentials amplifiers and in other applications where a low-level signal must pass through a strong interference (high noise) environment.

The LM-363 devices all operate with dc supply voltages of ±5V to ±18Vdc, with a common mode rejection ratio (CMRR) of 130dB. The 7nV/SqR(Hz) noise figure makes the device useful for low noise applications (a 0.5nV model is available at premium cost).

Bright future for the ICIA

The ICIA device is the device of choice for a wide range of applications, including broadcasting/audio, scientific instrumentation, industrial electronics (data acquisition) and biomedical electronics. I predict that the ICIA will increasingly replace normal IC op-amps in many electronic circuits.

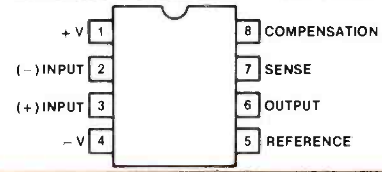
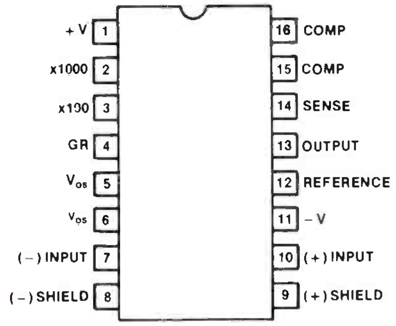


Figure 7.



PROGRAMMING	GAIN	JUMPER PINS
	x10	(All open)
	x100	3 & 4
	x1000	2 & 4

Figure 8.

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123AP	.13	.09	163A	2.35	1.99	199	.18	.12
128	.38	.33	171	.49	.39	234	.19	.13
129	.38	.33	184	.38	.30	287	.29	.22
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Schotz Noise Reduction

Many have bemoaned the fact that the FCC adopted the FM stereo system that it did. Theory dictates that the output noise of an FM detector increases with frequency at the rate of 6dB/octave. In mono reception, and for the mono content of a stereo broadcast, this is partially mitigated by pre-emphasizing the audio before transmission and de-emphasizing the highs in a compensatory manner in the receiver. The net result is a flattening of the noise spectrum above 2122Hz, the *break point* of the 75μs pre-emphasis used in the United States.

In a stereo broadcast, the mono content, the sum of the left and right channels (L+R), directly modulates the transmitter to preserve compatibility with mono receivers. The difference signal (L−R) modulates a 38kHz ultrasonic carrier that then is added to the sum signal and the 19kHz *pilot* needed to demodulate the stereo, and the composite frequency modulates the RF carrier. The difference information is conveyed by a modulation technique called double-sideband suppressed-carrier amplitude modulation (DSSCAM). After modulation, the difference signal occupies the portion of the spectrum between 23kHz and 53kHz (23kHz ± 15kHz), so, for proper demodulation, the FM detector must respond linearly from 20Hz to 53kHz.

The noise spectrum at the output of an FM detector increases with frequency, so there is much more noise in the 23kHz to 53kHz band than in the entire audio band. When the 38kHz subcarrier is demodulated, this noise is translated down to the audio band and contaminates the L−R signal. When the noise laden L−R signal is *matrixed* with (added to and subtracted from) the sum signal to separate left and right channels, its noise appears in both.

For these reasons, stereo reception tends to be *noisier* than mono reception, as any fringe-area listener can readily testify. In fact, it takes at least 100 times more signal power to reach 50dB quieting in stereo than it does in mono, thus forcing many listeners to forego stereo reception of their favorite stations.

Early noise reduction schemes

Early attempts at solving the FM stereo noise problem involved using fixed *high-blend.* Because FM noise increases with frequency, blending the treble portion of the left and right channels, thus returning them to mono, results in cancellation of much of the noise. The technique is quite effective but doesn't make much sense: With fixed blend, stereo separation is sacrificed even when there is no need to do so.

A somewhat more sophisticated approach to high blend senses the RF signal level and adjusts the blend ratio accordingly. On weak signals, which presumably have a greater noise content, the left/right blend increases to reduce the noise. On strong signals, the blend decreases to maximize the stereo effect.

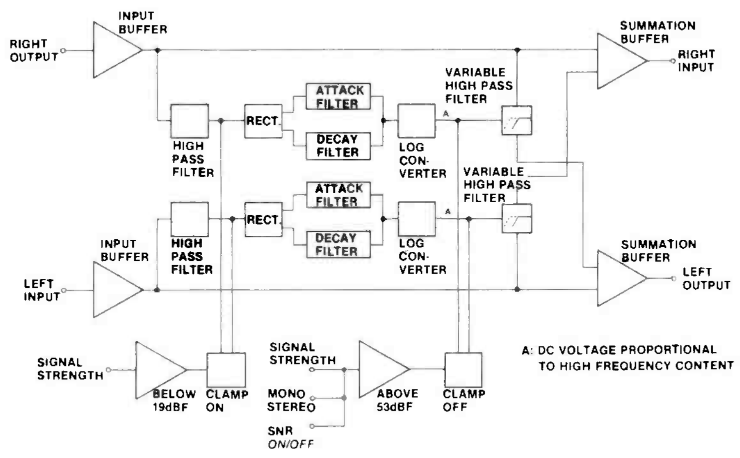
A third technique blends the left and right channels until they are essentially returned to mono—eliminating the noise—and then tries to reconstruct a stereo image synthetically. Although this technique can produce a dramatic improvement in signal-to-noise ratio, the stereo image that is recreated often is unrealistic.

Schotz Noise Reduction

Schotz Noise Reduction (SNR) is a new technique for which patents are pending in the United States and abroad. It affords a 6dB improvement in effective stereo sensitivity and thus quadruples the effective stereo listening area of every station while preserving the true stereo image to the greatest extent possible.

Schotz Noise Reduction takes advantage of the so-called *masking* effect. This well-known law of psychoacoustics states that program material will mask noise in the same portion of the audible spectrum provided that the program material is louder than the noise. Stated another way, whenever the treble content in the program outweighs the high-frequency noise, you don't hear the noise. Only when the program does not contain high-frequency energy, will the noise be perceived.

Essentially, Schotz Noise Reduction is a highly *intelligent,* adaptive high blend. The blend ratio varies not only with RF signal strength, an indirect but accurate



SCHOTZ NOISE REDUCTION BLOCK DIAGRAM

(Diagram courtesy of Nakamichi USA Corporation.)

Figure 1.

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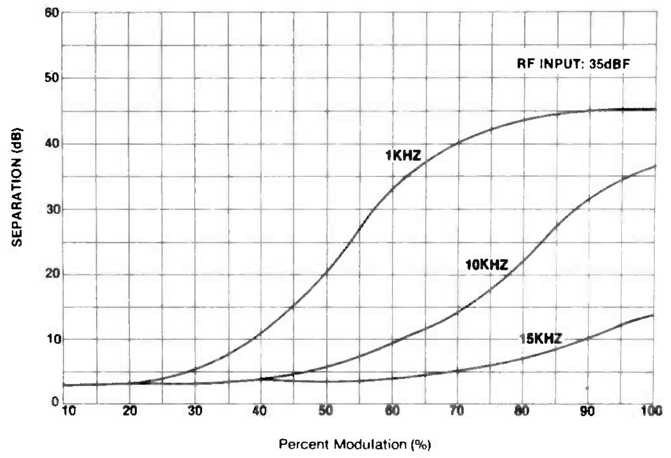
measure of the noise level, but with the high-frequency content of the program. When the program contains sufficient high-frequency energy to mask the noise, channel separation widens to create an accurate stereo image; when the program has insufficient high-frequency energy to mask the noise, the channels are partially blended to reduce the noise. Although this would seem to imply that the stereo image would be degraded in a way similar to a conventional high blend, in a practical sense, this is not the case. Blending occurs only when there is too little high-frequency energy to create a stereo image in the first place. Thus, Schotz Noise Reduction produces a meaningful improvement in stereo signal-to-noise ratio without degrading the stereo image.

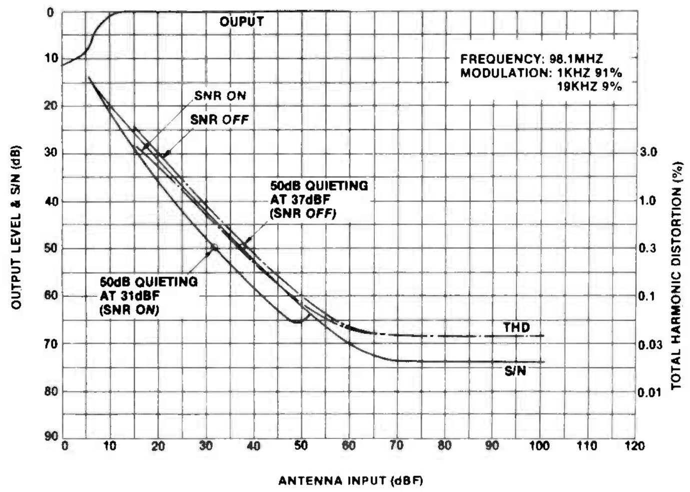
Figure 1 is a block diagram of the SNR system. After stereo demultiplexing (not shown), the left and right signals pass through separate input buffers. These drive a set of high-pass filters (shown between the main audio signal lines) that extract the high-frequency energy of the left and right channels separately. Full-wave rectifiers convert the high-frequency energy into dc voltages. These voltages pass through attack and decay filters that determine how quickly the system responds to changes in high-frequency content. The signals now pass through log converters, the outputs being dc voltages proportional to the logarithm of the high-frequency energy in each channel, that is, voltages proportional to the treble loudness of the program in each channel. These two signals, designated *A* in the diagram, control the cutoff frequencies of two variable high-pass filters that selectively pass more or less of the left-channel audio into the right channel (and right-channel audio into the left channel) depending upon the treble energy in each channel. The actual blending occurs in the output summation buffers.

On mono signals, and on stereo signals of sufficient strength to ensure quiet reception, the Schotz Noise Reduction system turns



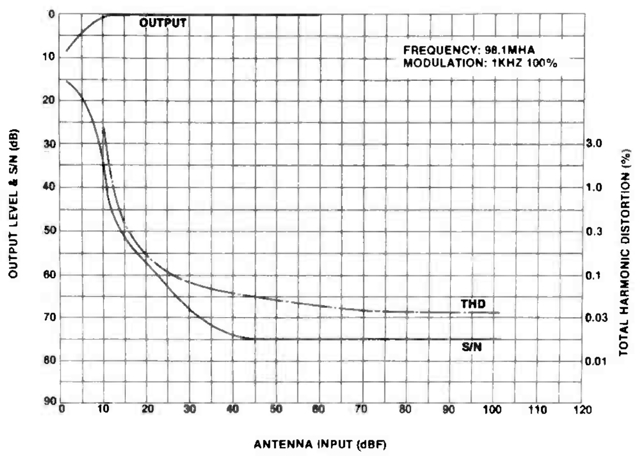
SEPARATION VS. PERCENT MODULATION
(Graph courtesy of Nakamichi USA Corporation.)

Figure 2.



OUTPUT LEVEL, S/N & THD VS. ANTENNA INPUT (STEREO MODE)
(Graph courtesy Nakamichi USA Corporation)

Figure 3.



Output Level, S/N & THD vs. Antenna Input (Mono Mode)
(Graph courtesy Nakamichi USA Corporation)

Figure 4.

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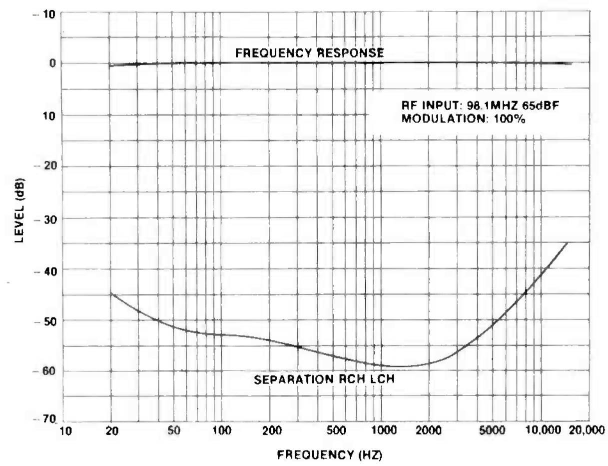
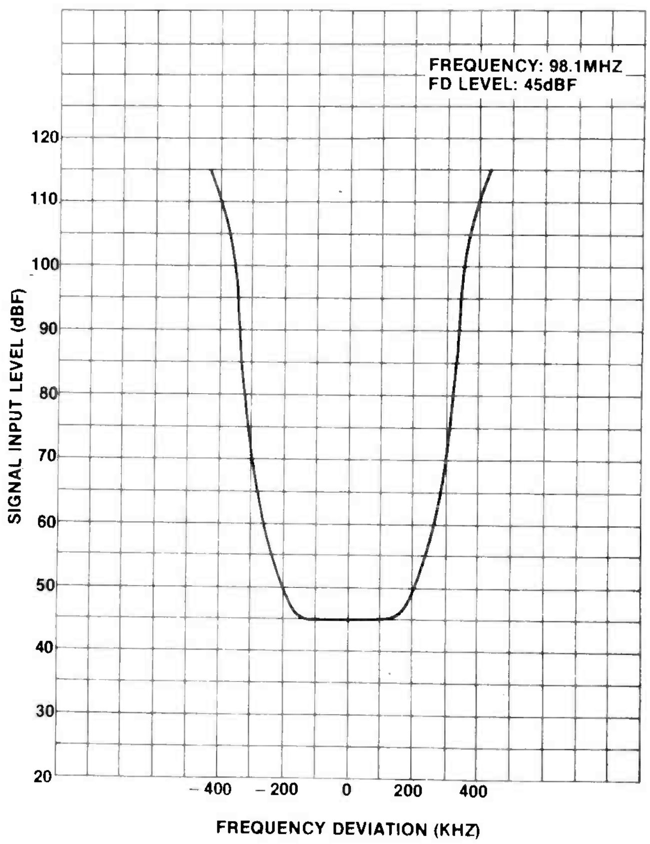
itself off. The system also can be defeated by a front-panel switch. Three inputs – signal strength, mono/stereo, and *on/off* – feed logic circuitry (designated *above 53dBf* and *clamp off* in the diagram) that prevents the variable high-pass filters from crossfeeding information between the two channels. On weak stations, it's also desirable to defeat the dynamically variable high blend to avoid any possibility of *noise pumping* on a weak (and usually fading) signal. Thus, when the RF signal level falls below 19dBf, the system converts to a conventional high blend. The circuitry necessary to accomplish this is designated *below 19dBf* and *clamp on* in the diagram.



FREQUENCY RESPONSE & STEREO SEPARATION

(Graph courtesy Nakamichi USA Corporation)

Figure 5.



SELECTIVITY CURVE

(Graph courtesy Nakamichi USA Corporation)

Figure 6.

Figure 2 depicts the performance of the Schotz Noise Reduction system at an RF input level of 35dBf – a signal strength at which conventional tuners would have inadequate stereo quieting. The figure plots channel separation vs percent modulation at three frequencies (1kHz, 10kHz, and 15kHz). As can be seen, at very low modulation levels, separation is reduced at all three frequencies to eliminate noise. However, with 40 percent 1kHz modulation, channel separation at that frequency is more than 10dB, which provides adequate stereo. At 10kHz and 15khz, where the FM noise density is greater, the left/right blending continues to higher modulation levels.

Figure 3 depicts the output level, noise level and distortion of the Nakamichi ST-7 AM/FM stereo tuner with and without* Schotz Noise Reduction. As you can see, 50dB quieting is achieved at a remarkably low 31dBf, 6dB less signal than is required for equal stereo quieting without SNR. Figure 4 illustrates the same data in the mono mode. Because Schotz Noise Reduction functions to reduce stereo noise, a single set of curves suffices for the mono condition. Figure 5 details the frequency response and channel separation of the ST-7 at the *standard* 65dBf test level. As you can observe, SNR has no adverse effect on strong-signal reception. Finally, Figure 6 illustrates the selectivity of the ST-7. Note the uniform response throughout the normal deviation range (± 75kHz) and the smooth symmetrical *sides*. These two desiderata, often mutually exclusive, ensure excellent selectivity and minimum distortion. ES&T

*Schotz Noise Reduction is manufactured under license from L.S. Research. U.S. and foreign patents pending.

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Servicing videocassette recorders
Part 1

By Neil R. Heller

The advent of consumer video equipment has brought the greatest challenge to the repair technician. Various manufacturers producing recorders and cameras, each more complex than the next, have created the need for the service center to keep pace with changing technology.

This is the first of a series of articles based on the fact that the basic theory of either the videotape recorder (VTR), or the color camera, is centered on similar principles regardless of the type or manufacturer of equipment. By relating to the generic nature of equipment design, these articles can enable you to interpret problems, locate key test points, read waveforms and effect repairs.

Unlike other types of technical material, these articles will concentrate on circuit theory only to the extent to which it provides an understanding of how to repair the product. The aim will be to provide practical procedures for troubleshooting and repairing based on principles of design.

Before attempting to service any type of equipment, it is important to understand how it functions. Peculiar problems sometimes result from a product's normal operation. Next, make sure you have the proper test equipment. This includes both standard test equipment and those special test fixtures recommended by the manufacturer. When dealing with test equipment, it is important to know what it does and how to use it.

Finally, for maximum effectiveness, refer to the manufacturer's specific service manual for the product under repair.

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VTRs operate on a complex interrelationship between electronics and the mechanism that is electronically driven. Regardless of the type of recorder, its electronic function is to place a signal on the tape during the recording process, and to recover the recorded signal during playback. The recorder mechanism is responsible for moving the tape past the heads and maintaining the timing of the system.

The operation of VTR electronics and related mechanism is different from the principles used in audiotape recorders mainly in the degree of accuracy required. Minor changes in audiotape speed usually result in a loss of frequency response. In VTRs, the same minor changes can result in a totally unusable picture. For this reason, the transport mechanism of a VTR is more vulnerable to breakdown than is the electronics assembly, and requires periodic preventive maintenance. Understanding the needs and problems of these precision mechanical assemblies derives from an understanding of how the tape travels around the transport system, and how the signal is placed on the tape.

Overview of videotape

In most videotape recordings, the standard TV signal, which consists of a wide band of frequencies between 0MHz and 6MHz, cannot be recorded directly on the tape. The limited amount of acceptable bandwidth requires that these frequencies be translated to a higher set of frequencies so that the ratio of higher frequency to lower frequency is greatly reduced. To accomplish this, the TV signal is modulated and the resulting RF is recorded on the tape. Besides the recorded video information, two other signals are recorded. The first is the audio signal and the second is known as the control track pulse or CTL, which is read in the playback mode to determine the speed of tape movement.

These signals are laid down during the recording process and read during the playback process by a series of contact points along the tape path. These contact points are referred to as heads.

The tape path

During recording, videotape is fed from the supply reel and first contacts the full erase head, which is responsible for erasing any previously recorded information before receiving the process information from the various signal heads.

Next the tape is moved across the video heads. Many of today's VTRs can be found in 2-, 3-, 4-, and 5-head configurations. Regardless of the number of video heads, only two at a time are used for the recording process. During a single rotation of the heads, sometimes referred to as the upper drum cylinder, the two video heads intersect the tape once, each recording one video field consisting of 262.5 horizontal lines. The combination of two video fields is called a frame. The rotation of the video heads must be maintained at precisely 1800 rpm in order for the recorder to produce an NTSC signal, which is the TV standard for the United States. The resulting signal is produced by a combination of *A* and *B* video head recordings. The duration between each field will be 1/60th of a second. The duration between each frame will be 1/30th of a second.

The method of recording individual fields and frames is the same as the TV scanning process. After the beam has completely traced one TV field, it is blanked out and returns to the top of the screen to start scanning the next field. The rotating video heads use the period of vertical blanking to overlap each other. As a new field is beginning, one video head is at its starting contact point with the tape and the other is at its last contact point.

During recording, RF is constantly applied to the video heads. During playback, each video head can be on only when it is in contact with the tape, otherwise the playback circuits would amplify snow and the result would be noise. To prevent this condition, the playback video head amplifier is electronically switched *on* and *off* during this overlap period when both heads are in contact with the tape. Because the video heads are mounted on the upper drum cylinder exactly 180 degrees apart, the videotape is wrapped around the cylinder for an angle greater than 180 degrees in order to allow for the overlap period.

After the video tracks are written, the tape passes to the audio/CTL head where the audio and control track pulses are recorded on the tape. Because the video heads are positioned 180 degrees apart, a control track is required only for alternate recorded fields in order to let the system know that the tape speed is correct. For this reason, control pulses are re-

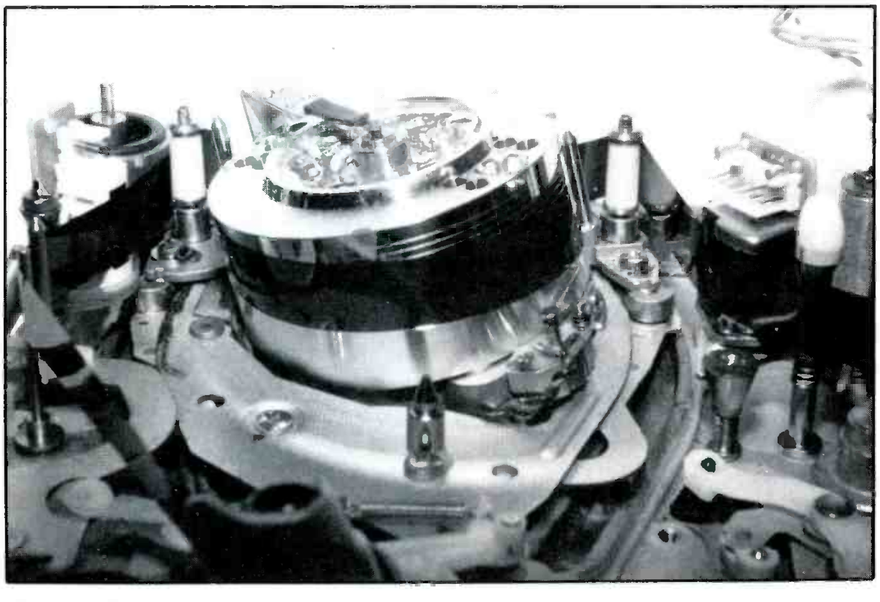

Figure 1. The path of a videocassette tape is long and tortuous, taking it past erase heads, video heads, audio heads and a control signal head.

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Servicing videocassette recorders

corded at a frame rate of 30Hz.

At each point along the tape path, the tape must be positioned so it can have maximum physical contact with the various heads. This is the function of a group of guide posts and idlers. One of each usually can be found for the erase head, the video head entrance and video head exit points, and the audio and control track heads. Finally, the tape is received by the take-up reel and the journey is complete.

Regardless of the type of unit, the sequence of events from the supply to the take-up reel will be the same. For example, VHS and Beta units have the position of their supply and take-up reels reversed but the tape of both units first contacts the full erase head and ends by receiving the audio/CTL signals.

Separating the video tracks

Prior to the advent of home video recorders, the U-matic format, which used ¾-inch tape, was the standard type of industrial-grade recording. This system used two video heads mounted on the same azimuth. The term azimuth describes the left-to-right tilt of the head gap when viewing the video head's gap straight on. For example the U-matic's heads are both mounted perpendicular to the tape path. The azimuth in this case is zero. Because the video RF from each head was recorded at the same angle, but contains different information, any crossover of signals between the recorded tracks will result in a degraded playback picture. It became necessary to separate the recorded video tracks. This area of separation, which involves moving the tape fast enough to assure that there is physical spacing on the tape between the recorded tracks, is known as *guard band*.

The design of the ¾-inch U-matic recorder required that the video tracks be separated by a

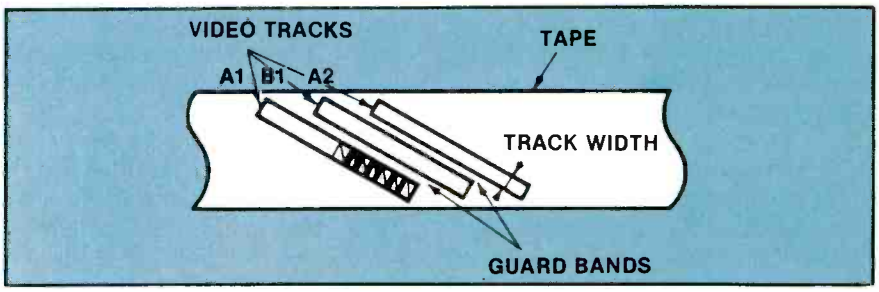

Figure 2. On a VHS video recorder, the video tracks are recorded slantwise on the tape. The distance between the tracks is the guard band.

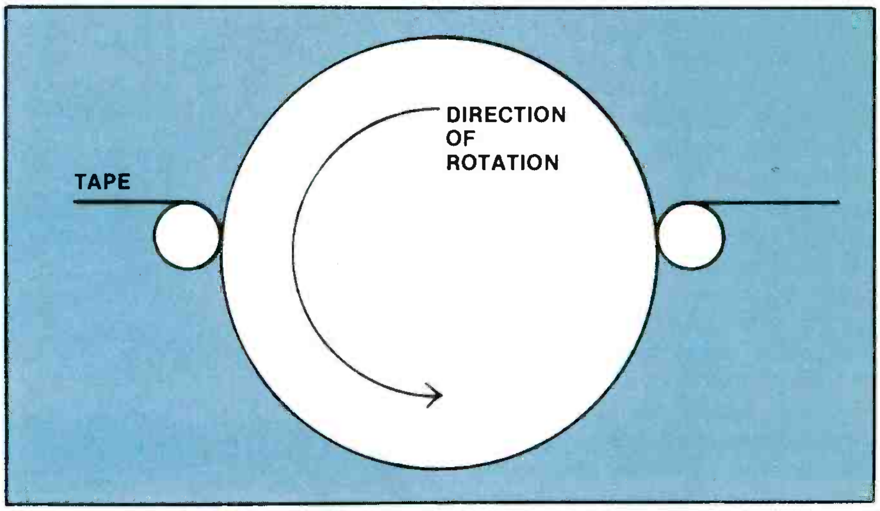

Figure 3. Video tracks must "overlap" during the vertical blanking interval, so the tape must be wrapped around the cylinder for an angle greater than 180 degrees.

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guard band of 59μm. This required a fast tape speed that permitted only the use of a 1-hour length of tape. Although this presented no problem to industrial users, whose production needs never exceeded one hour, it was unacceptable to the consumer desiring to record movies and sporting events. Increasing recording time while still maintaining manageable tape loads meant reducing both videohead and guard-band size as well as tape speed. Each one of these recording-time assists has its limitation. For example, reductions in tape speed are limited to the point where the loss of frequency response will result in a loss of picture quality. The same is true of the reduction in video-head size. Smaller video heads offer less area to work with in order to transfer the signal between video head and tape.

As a compromise to tape speed and head width, it was necessary to design consumer tape recorders

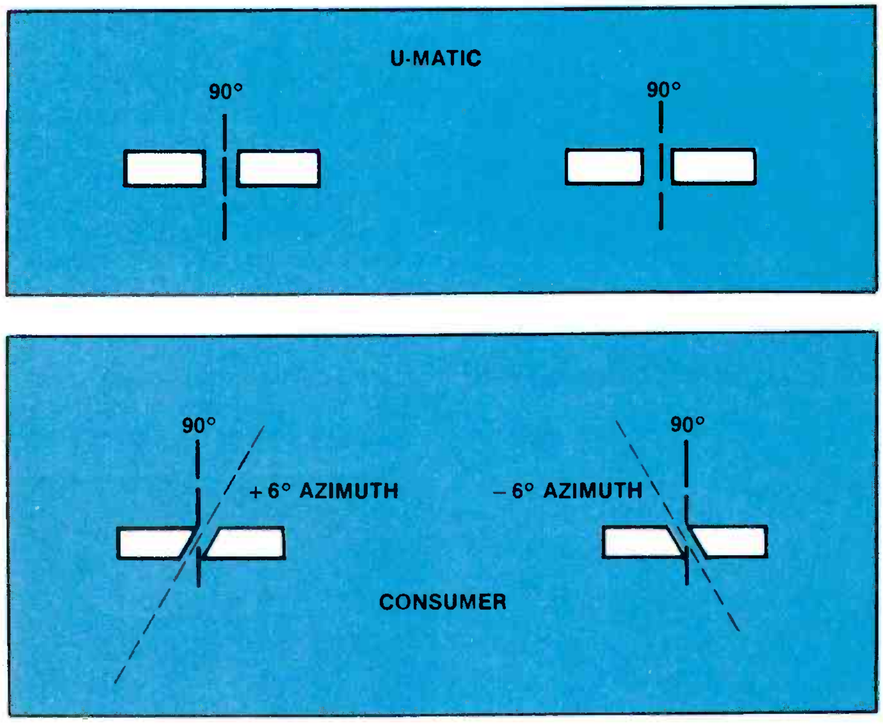

Figure 4. In the U-matic format, the azimuth for both heads is 90 degrees. This necessitates a large physical guard band that reduces playing time. Use of ±6 degree azimuth on VHS heads minimizes crosstalk between adjacent tracks, and gives longer playing time.

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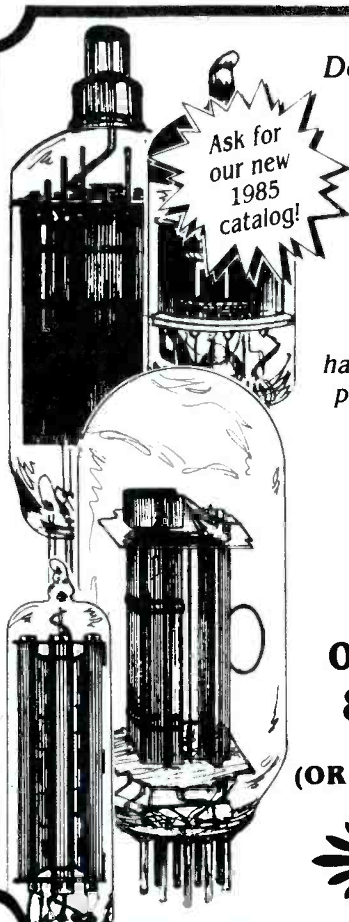

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with no actual guard band. In order to eliminate adjacent track interference, it was necessary to tilt the video head gap in equal and opposite azimuths. By offsetting the physical azimuth, signals produced by a video head playing back a track recorded by the opposite head would be greatly reduced. This ensured that a particular video head would not pick up any crosstalk from an adjacent track. VHS units use a ±6-degree azimuth offset whereas Beta units use a ±7-degrees.

The result will be a guard band equal to the adjacent track width. Many multiple speed, 2-head consumer recorders take advantage of both physical guard bands and azimuth recording. For example, a 2-head, 2-, 4-, 6-hour VHS has a physical head width of 29μ. In the

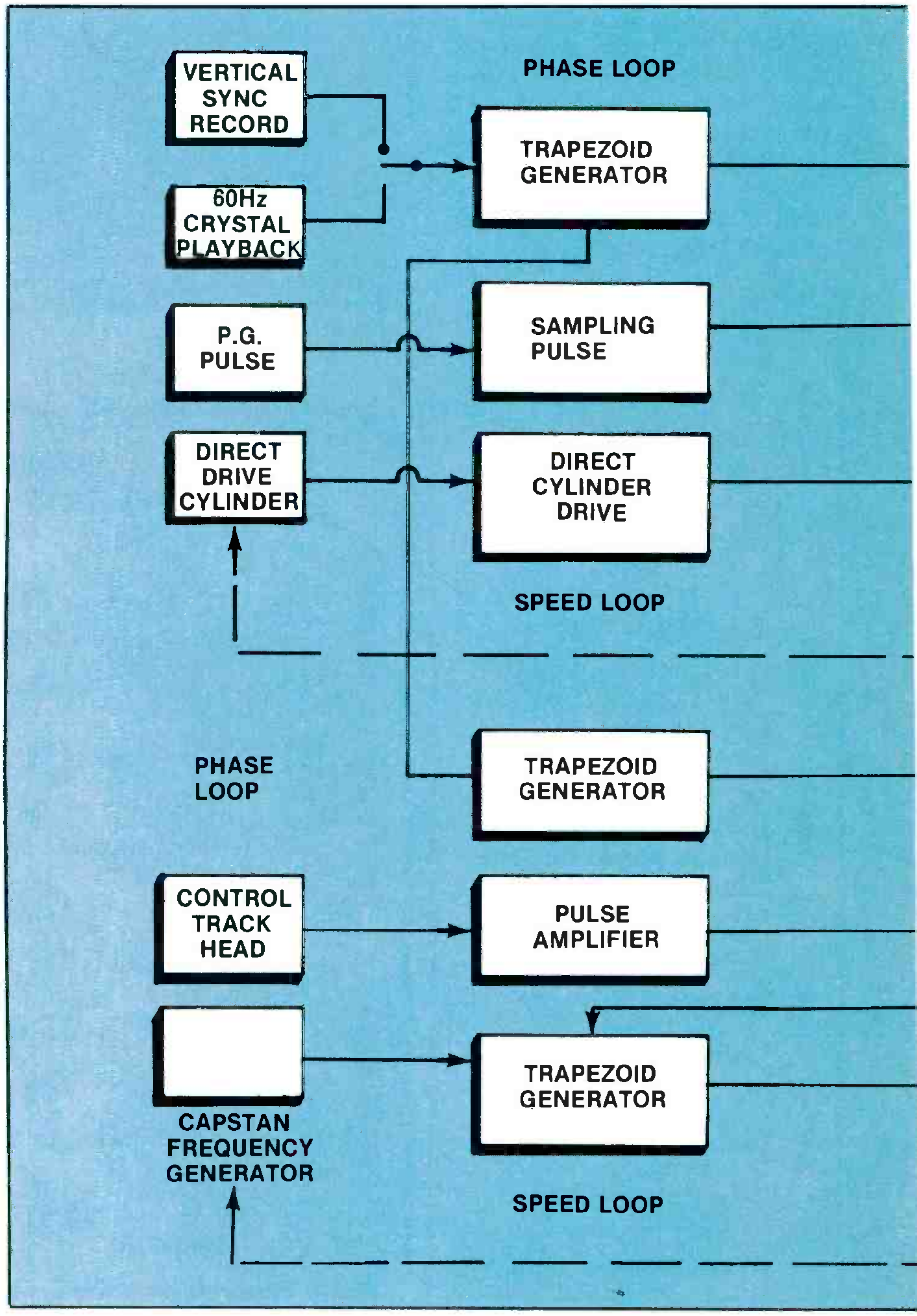

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Figure 5. Use of ±6 degree azimuth on VHS heads yields alternate tracks that are at angles to one another. Guard bands may therefore be reduced or eliminated.

Figure 6. The servo system in a VCR contains both a speed loop and a phase loop to keep the head cylinder and capstan motors operating at the correct speed and in proper phase with each other. The relationship of the two loops and various components is shown here in diagram form.

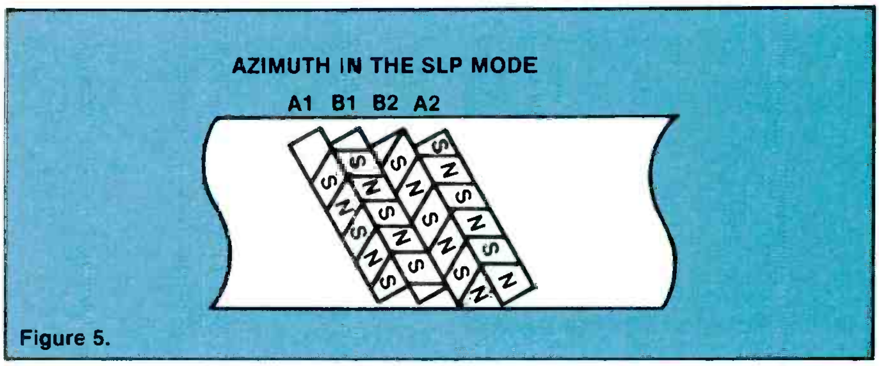
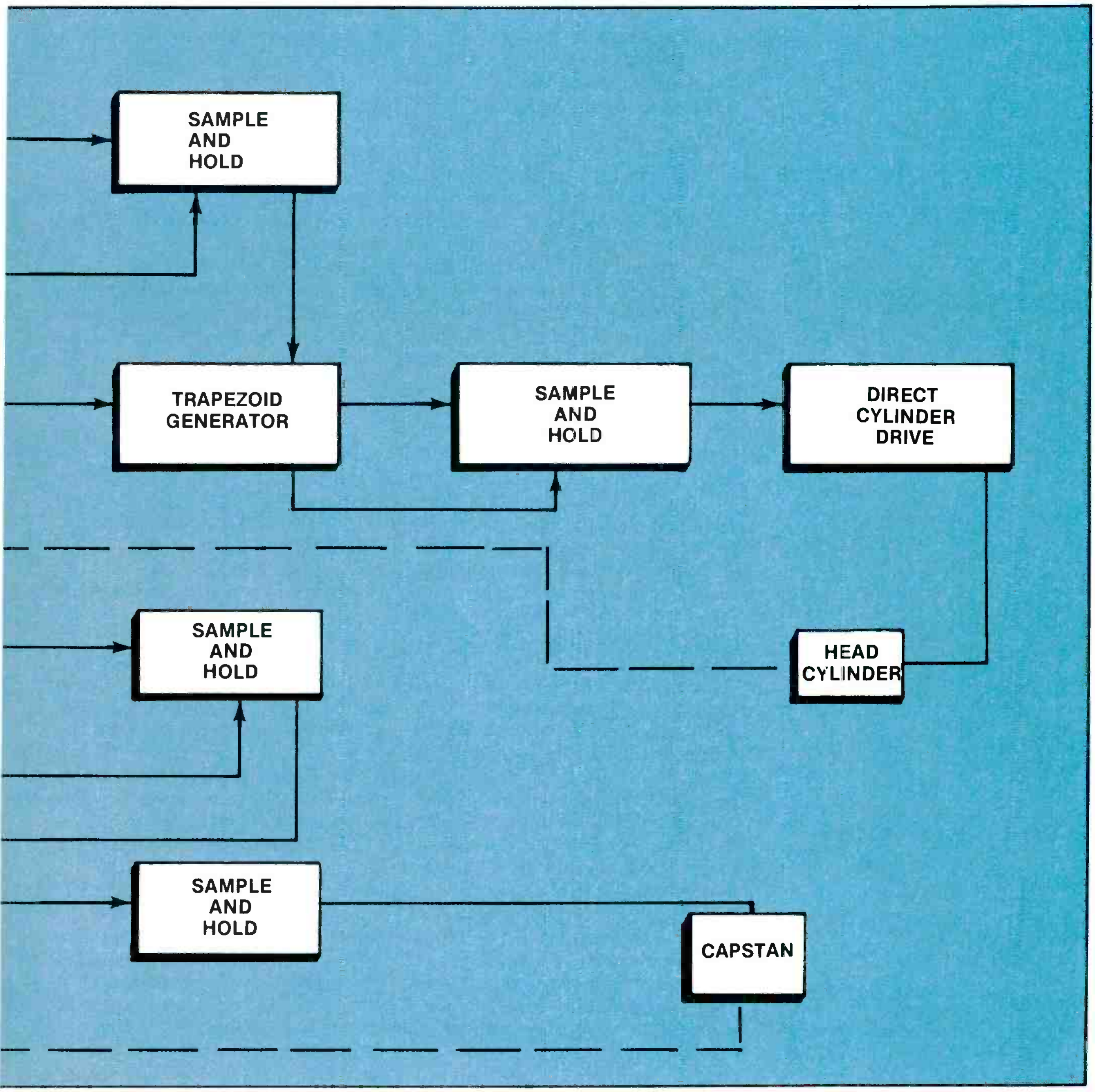


Figure 5.



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2-hour mode, the tape speed of 33.3mm/s creates an effective track width of 59μ of which 30μ represents guard band. At the slowest speed, the guard band is reduced to zero and the head azimuth difference is completely responsible for maintaining track separation.

Multiple head units make use of the faster speeds by using a set of wider heads for the 2-hour mode and switching to the smaller heads for 6-hour recordings. This results in a better 2-hour recording and playback.

The servo system

The physical layout of a VTR is designed to enable the tape to receive maximum signal transfer from the various heads. The recorder's servo system maintains control over the system. Assuming the transport is properly adjusted, timing is everything. Constant speeds must be maintained in order to achieve proper writing and reading of the RF signal. Furthermore, motor speed is not solely based upon the individual head or capstan (tape) but rather is dependent upon the relationship between the two.

By design, a servo system is one that compares two references, one fixed and the other variable and automatically adjusts when there is a difference between them. The signal output of the servo is designed to maintain the variable as close to the fixed as possible.

Individual VCR servo circuits consist of two parts, speed and phase. The speed section provides the power to drive the motor and the phase section is responsible for speeding up or slowing down the motor to more closely match the fixed reference. In any motor system, the uncontrolled or free-run speed of the motor is always its fastest speed. The function of the servo is usually to brake the motor to its controlled speed.

In the record mode, the servo reference is taken from the incoming signal's vertical sync. The vertical signal is separated from the composite video and passed through an integrator network to extract only the sync pulse. The output toggles a flip-flop that divides and shapes the signal into a 30Hz square wave. This pulse is then compared with the variable reference. In the case of the head cylinder, the variable reference is generated by two magnets located on the lower stationary part of the drum cylinder. As the upper part of the cylinder rotates, it cuts the magnetic field and generates a pulse. This PG pulse is then waveshaped and used to key a section of the trapezoidal waveform. The voltage generated by these two pulses is used to control the speed servo.

The capstan servo uses the same waveshaped vertical sync as the cylinder servo. The variable reference is taken from the capstan pulse generator that detects motor speed. Regardless of the selected motor speed, the pulses from the capstan generator are counted down to 30Hz in order to be keyed at the same rate as the fixed reference.

In addition to providing the fixed reference to both the cylinder and capstan servos, vertical sync also is used to generate the control track pulse, which is used to reference the capstan servo during playback.

Playback servo mode

In the playback mode, there is no video signal's incoming vertical sync to use as a reference. Because stable playback cannot rely on vertical sync, the unit switches its reference to a 60Hz pulse that is created by counting down the signal produced by a 3.58MHz crystal. This 60Hz signal is then processed in the same way as vertical sync. The rest of the cylinder servo system processes signals in the same manner as in the record mode. This internal 60Hz reference also serves as the fixed reference for the capstan servo.

The capstan variable playback reference depends upon the recorded control track signal. Regardless of how perfect are the control track pulses recorded during recording, tape stretch can cause the positioning of the CTL pulses to change. To guarantee interchangeability from tape to tape and from recorder to recorder, the CTL pulse is passed

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through a variable positioning circuit before being compared to the fixed reference. The CTL's position then can be adjusted via the recorder's tracking control in order to obtain the best range of servo control and playback picture.

The key to understanding servo operation is to recognize that all system timing is locked to vertical sync, or its substitute 60Hz pulse in the case of playback. Remember, because the video heads are set 180 degrees apart, the sampling rate need be only every other vertical pulse or 30Hz.

The sum of the variable and fixed references is the error voltage. In our example, we will assume that the error voltage is a braking voltage. If either the capstan motor or the cylinder motor are turning too quickly, the duration of the generated pulses will become shorter as the frequency becomes higher. When this occurs, the voltage generated by the sample-and-hold circuit will increase and, in turn, generate a higher braking voltage, thus slowing the motor down.

If either the capstan motor or cylinder motor is turning too slowly, the duration between the generated pulses will increase as the frequency decreases. The pulse from the frequency generator will ride on the lower section of the trapezoidal ramp and the braking voltage from the sample-and-hold circuit will decrease allowing the motor to speed up.

Normally a stable position for the sample-and-hold circuit will consist of the pulse riding on the middle section of the ramp. Minor movements to and from the midpoint position will occur as a result of physical capstan instabilities.

This article has presented the basic foundation for understanding VTR problems. The next article will apply this basic theory of operations to practical adjustments and troubleshooting.

ES&T

Answers to the Quiz

See questions, page 54

1. B
2. C
3. D
4. C
5. D
6. C
7. A
8. B
9. A
10. D

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Test your electronic knowledge

By Sam Wilson

All of the questions in this quiz are based on articles that appeared in **Electronic Servicing and Technology.**

1. Induction cooking uses frequencies in the range of:
A) 1000Hz to 5000Hz.
B) 25kHz to 35kHz.
C) 1000kHz to 5000kHz.
D) 25MHz to 35MHz.

"Cooking on Cool Surfaces" – August 1984

2. A voltage doubler is used to rectify the line voltage. Its output should be about:
A) 220V to 250V.
B) 270V to 290V.
C) 300V to 340V.
D) 440V to 460V.

"Servicing NAP C3 TV Chassis" – August 1984

3. The reciprocal of reactance is:
A) replescense.
B) endurance.
C) elastance.
D) susceptance.

"Test Your Electronic Knowledge" – January 1985

4. Which of the following statements is true regarding desoldering braid?
A) The primary purpose of fluxes used with desoldering braid is to make it easier to hold the braid against the terminal being desoldered.
B) Flux is never supplied with these braids.
C) The primary purpose of flux on this braid is to prevent oxidation of the braid wire.
D) These braids are always supplied with flux.

"Desoldering Today's Circuit Components" – October 1984

5. An antenna pre-amp is mounted on the antenna mast. Which of the following is true?
A) It is powered by the signal
B) It gets its operating power from the sun.
C) It does not require power.
D) It is permanently powered from an outlet in the home.

"The Video Connection" – April 1985

6. Which of the following is a new thyristor that simplifies and reduces the cost of control circuits?
A) MAT
B) MBT
C) MCT
D) MDT

"New Thyristor Expected to Simplify, Lower Cost of Consumer-Product Control" – March 1985

7. A small physical area on a floppy disk that is occupied by one binary digit is called a:
A) Bit cell.
B) Pixel.
C) hard sector.
D) soft sector.

"Understanding the Floppy Disk" – April 1985

8. For a telephone line simulator, you can use:
A) 12V stiffly regulated.
B) 48V fed through a 1.5K resistor.
C) 24V through a 600Ω resistor.
D) a well-grounded wire.

"Troubleshooting Telephones" – March 1985

9. Which of the following is an example of a crowbar device?
A) Gas tube
B) Fuse
C) Circuit breaker
D) None of these choices is correct.

"Don't Let Power Line Disturbances Damage Your Electronic Equipment" – March 1985

10. Compact-disk technology has been used to make high-capacity read-only memories. The memory potential of a compact disk is:
A) equal to one-half of a floppy disk.
B) equal to one floppy disk.
C) equal to 50 to 100 conventional floppy disks.
D) equal to 500 to 1000 conventional floppy disks.

"Computer Drive Memory Uses Compact Disk Format" – January 1985

Answers on page 53

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Coming in...

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Diagnosing VCR head problems—Merely putting your finger on the difficulty may result in a "repaired" VCR with heads that soon will need to be replaced or, conversely, it may cause you to replace a good head that still has many hours of potential service. In this forthcoming article, Wayne B. Graham discusses how misdiagnoses may be avoided.

VCR servicing, part 2—As an electronics technician about to troubleshoot an ailing VCR, you naturally start by testing its electronic components, right? "Wrongo!" says Neil Heller, author, who walks readers through correct VCR servicing procedure that begins by checking out, item-by-item, the transport mechanism. Second of a 3-part series.

The Video Connection, part 4—After a 2-month interruption, this series continues, with part 5 slated for October. Martin Clifford simplifies connecting video units, whether multiple TV sets or a complexity of add-ons is involved.

What do you know about electronic circuits?—Blowing misconceptions about fuses. Sam Wilson debunks some commonly held precepts about fuses and how they blow. Also, he initiates a serial discussion of the three kinds of noise signals that are characteristic of all amplifying devices.

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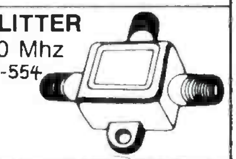

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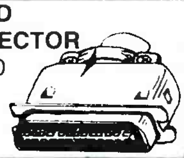

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Books

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104 Weekend Electronic Projects, by Joseph J. Carr, Tab Books, $10.95 paperback.

More than 100 electronics projects that can be built in a single weekend per project, using standard parts and components, are detailed by the author. Each project includes step-by-step instructions reinforced by show-how diagrams, drawings and schematics.

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Transistor Circuit Design—with Experiments, by Delton T. Horn, Tab Books, $14.45 paperback.

The author covers all the basic building block circuits and shows how the three transistor types—common-emitter, common-base and common-collector—are used in their construction. Once these simple circuits are mastered, readers will determine that the most complex of transistor circuits are combinations of these units. Step-by-step project plans encourage the hands-on experience to design a practical amplifier, a Colpitts oscillator and multiple frequency Colpitts oscillator, and to work with different types of waveform generators such as triangle wave, sawtooth wave and unusual waveform generators. The focus of the book is on the bipolar transistor.

Tab Books, Blue Ridge Summit, PA 17214

AM/FM Stereo System Troubleshooting, By Robert L. Goodman, Tab Books, $13.95 paperback.

Following an explanation of how AM/FM and stereo amplifiers operate, readers will review solid-state electronic theory that covers transistors, diodes and IC logic. Equipped with this knowledge, they then can move into analysis of stereo multiplex circuitry and troubleshooting diagnosis that includes tuning and aligning, and the use of typical stereo decoders and detectors. Besides the use-it-now information on parts and procedures, there is practical advice on maintaining, cleaning and adjusting 8-track tape machines. Maintenance, troubleshooting and repair data are provided for tape players, recorders, record players and turntables. A full glossary of hi-fi, stereo and audio terms helps even beginning audiophiles grasp the details.

Tab Books, Blue Ridge Summit, PA 17214

Interfacing Test Circuits with Single-Board Computers, by Robert H. Luetzow, Tab Books, $12.95 paperback.

The author, who is a manufacturing systems engineer currently specializing in automated manufacturing equipment and production test systems, provides quantities of detailed data on the construction of interface circuitry. Readers also learn how to build simple test circuits efficiently and economically to make a variety of electrical measurements. There are complete schematics, parts lists and building instructions.

Directions for connecting computers to the Heathkit IB5281 RCL bridge (a single test unit that can measure resistance, capacitance and inductance) are covered, as well as how single-board computers can be used to control electric motors, including a stepper motor system. Analog-to-digital and digital-to-analog converter circuits and programs are fully discussed, and there is practical advice given on expansion of a single-board computer for advanced test systems.

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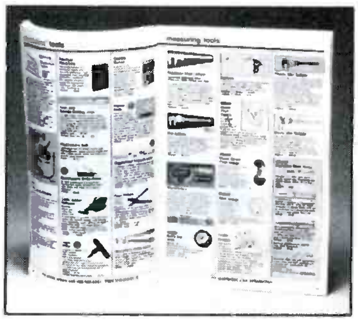

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Products

High speed logic probe

Beckman Industrial Corporation, Instrumentation Products Division, is adding the LP25 logic probe to its Circuitmate product line. According to the manufacturer, this will provide users with high speed logic troubleshooting capability for less than traditional 10MHz probe prices. The LP25 digital logic probe measures TTL, DTL, RTL, CMOS, NMOS and MOS logic levels at speeds up to 25MHz. It will detect pulses of 30ns duration, with a pulse memory feature to capture single occurrence pulses for visible indication. A LED/tone indication enables the user to be aware of the logic level without continually observing the LEDs. Among the other features: It is TTL/CMOS switchable; the input is protected to 200V, ac or dc.

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Continuity/short indicator

Teaco introduces the model 2171 Cabl-Simpl-Chekr designed to test a variety of ribbon cables for continuity vs. short. Simple to use, it

provides the lab or field technician with a quick-check method of determining whether a particular cable is basically good, possibly eliminating the need for troubleshooting a complete system.

A variety of adaptor boards is available with male header shrouded contacts, IC sockets with zero insertion force, card edge connectors, or *D* connectors, plug or socket.

Circle (76) on Reply Card

SMD-capable repair station

From *Automated Production Equipment Corporation* comes the model-2000 complete repair station that features a precision solder paste dispensing system to aid in the reattachment of SMDs. Also featured is a surface-mount placement tool with three tip pairs, which allows fast removal and replacement of SMDs. There are provisions for repairing conventional thru-hole components.

Circle (77) on Reply Card

Contact enhancer

Tweek by *Sumiko* is a fluid created to increase contact reliability by filling in microscopic gaps in metal-to-metal connections. Treated as directed, connections behave as if either the conductivity of the adjacent metal surfaces has increased, or the contact area has been multiplied by a significant factor. When highly magnified, smooth metal surfaces show gaps and peaks that provide only a few contact points–continuity in the signal path suffers momentary interruptions. In the case of digital circuits, transmission interruption can result in the loss of essential data.

Tweek is not a cleaner, grease or antioxidant: It becomes conductive when compressed between two mating contact surfaces. It is used in a variety of applications where hard-to-identify intermittent problems are caused by very brief interruptions in signal transmission.

Circle (78) on Reply Card

Temperature-controlled soldering

A miniature soldering iron with fingertip control to within ±2 percent of temperature is available from *M.M. Newman Corporation.* The Antex TSCU-1 temperature controlled soldering station and CTC miniature iron feature positive tip-temperature feedback combined with a sliding potentiometer in the station for precise soldering in the 140° to 815°F range. The device is equipped with a ground wire to superearth and a sponge tray, providing 0V to eliminate RF interference and magnetic fields. The balanced iron weighs 3/4-ounce and heats in 30 seconds.

Circle (79) on Reply Card

Locking DMM leads

TPI has addressed the nuisance of having test leads disconnect accidentally from the meter. The new LTL 1000–recommended for low voltage and resistance measurements–has a thumb screw

that expands the banana plug inside the meter jack for a tight connection. Banana plugs are rubber-shielded for maximum safety. To minimize thermal EMF and contact resistance, contacts are silver plated. Ratings are 1000Vrms and 10A continuous current.

Circle (80) on Reply Card

Terrestrial interference notch filters

Conifer Corporation is introducing the CNF Series TI notch filters, which are designed to be an easy and economical way to eliminate terrestrial interference. The CNF Series filters are engineered to trap out microwave transmissions that create interfering carriers 10MHz above and below the center frequency of a satellite transponder channel transmitted within the 3.7 to 4.2GHz band.

These filters connect in series with the IF cable of any satellite receiver using a 70MHz-, 130MHz-, or 134MHz-IF. They may be installed singularly or in cascade depending on the particular requirements needed.

Circle (81) on Reply Card

Continued on page 60

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Literature

BBC-Metrawatt Goerz has issued a pocket-size booklet describing applications for its model M 2050 digital scope multimeter. The M 2050 combines a flat-panel 50kHz oscilloscope, a 3½-digit multimeter and a transient recorder into a lightweight, portable package. The brochure describes four applications that the M 2050 performs faster and more easily than separate scopes, multimeters and transient recorders.

Applications described in detail include: capturing and measuring motor start-up currents, characterizing circuit designs, servicing a plastics molding machine and testing an elevator's control circuitry. More than 20 other uses in design engineering, plant maintenance and field service also are listed.

Circle (125) on Reply Card

A P Products has published a catalog featuring its entire line of bread-boarding, interconnection and testing devices.

Whereas in the past products were published in two separate catalogs, this 30-page manual provides a single source for engineers, technicans, hobbyists, educators and students seeking IC testing products.

The publication has been organized by product category with large photographs, specifications and concise product descriptions.

Included are the company's most recent contributions to IC technology: the surface-mount test clip, the Low Profile Logical Connection and the ACE Board-100 series.

Circle (126) on Reply Card

United States Instrument Rentals has published a 288-page guide describing its complete inventory of test and measurement equipment available for rent, lease or purchase. The guide includes thousands of products from most of the major manufacturers. A 1-source document that gives product models, descriptions and specifications, this publication also explains the benefits of renting equipment and the optional financial plans available.

Circle (127) on Reply Card

Topaz announces the availability of its Power Conditioning Selection Guide, a short-form catalog with complete specifications on all Topaz products. This informative catalog explains how power problems create computer problems, and offers effective solutions. The catalog guides readers through the alternative solutions and directs them to the most appropriate and practical choice of power conditioning products.

Ultra-Isolator noise suppressors, Vac regulators, Line 2 power conditioners and uninterruptible power systems are discussed in detail. The information provided should enable the reader to make an informed buying decision.

Circle (128) on Reply Card

The 66-page catalog from **Vector Electronic** describes 705 electronic-packaging, bread-boarding and prototyping items. Special sections are devoted to circuit boards, racks and cages with motherboards, connectors, terminals, accessories, tools and breadboarding equipment.

An 8-page section covers microcomputer prototyping boards for VME-bus, S-100, STD, Multibus, IBM-PC, IBM-AT Exorcisor, Apple II, DEC and TI980 systems.

Another section describes 151 card racks and cases in a wide variety of sizes and configurations. The connector section includes Euroconnectors for VME systems, IDC connectors, D-subminiature connectors and card-cage connectors. The section also contains information on DIP sockets, wrap-posts and terminals.

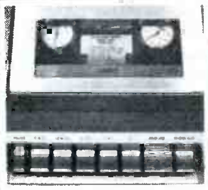
All products are indexed both by generic name and part numbers. A complete price list and list of authorized Vector distributors accompanies the catalog.

Circle (129) on Reply Card

Multiplex Technology is offering an illustrated, 4-page brochure describing how Channelplus adds new convenience to the use of video sources such as VCRs, satellite receivers, cable services, TV cameras and videodisc players.

Circle (130) on Reply Card

Video Recorder Maintenance

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Continued from page 58

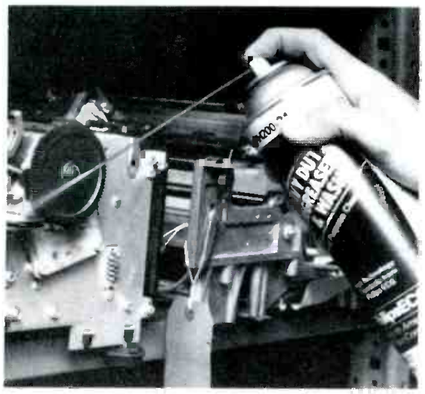
3½-digit DMM

A.W. Sperry Instruments announces the introduction of the 3½-digit, rotary-switch, digital multimeter, DM-3000. Features that are comparable to more expensive DMMs, include: pocket-size, overload protection, 10Aac/dc current readings, large 0.5-inch digit, easy-to-read LCD and 200 hour battery life. The DM-3000 incorporates nine functions on 28 ranges; DCV, ACV, DCA, ACA, OHM, diode test, battery test, HFE test and continuity buzzer.

Circle (82) on Reply Card

High technology cleaner

Shown with the extender tube in place for pin-point application is type PH200 heavy-duty Degreaser & Wash, an industrial cleaner by *Philips ECG, North American Philips,* that penetrates and dissolves grease, oil, oxidation, encrusted dirt and other contaminants from machinery and operating equipment.



The complete line of high technology chemicals from Philips ECG includes a variety of aerosol cleaning, shielding, testing and lubricating agents for electronic and industrial usage.

Circle (83) on Reply Card

Glossary, microelectronic terms

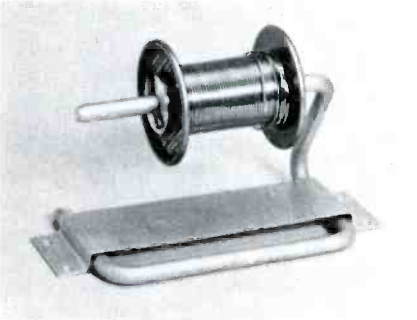
The Electronic Industries Association announces the availability of JEDEC Standard No. 99, "Glossary of Microelectronic Terms, Definitions and Symbols." This standard replaces JEDEC Publication No. 99, published July 1977.

JESD-99 will be useful to users, manufacturers, educators, technical writers and others interested in the characterization, nomenclature and classification of microelectronic devices. It lists and defines more than 400 of the most common physical and electrical terms applicable to these devices, and shows the industry-standard symbols and abbreviations that have been established for such terms.

Circle (84) on Reply Card

Spool holder

Rush Wire Strippers' model SA-1 accommodates a standard 5-pound reel of solder, and simplifies solder dispensing, thus



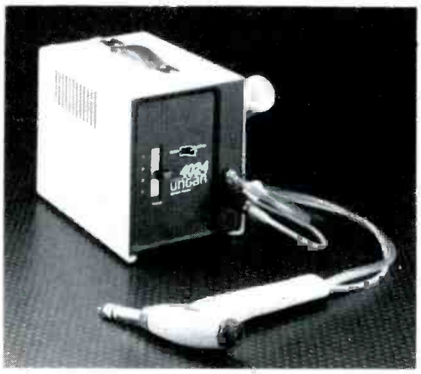
avoiding waste. The unit also can hold small reels of wire used in assembly operations.

The base unit of this spool holder is attached to the work surface with four screws, and the reel holder slides easily in and out of the base to facilitate replenishing of material or location changes. Overall, it measures 6" x 3" x 2¾", and weighs 3 ounces. It will hold reels up to a maximum width of 3 inches and maximum diameter of 4 inches, with a minimum arbor-hole diameter of ¼ inch.

Circle (85) on Reply Card

Soldering service center

A service center that provides



electronically controlled, variable-temperature for either soldering or desoldering is presented by the *Ungar Division of Eldon Industries.* Plug-in soldering and desoldering handles give the user the options of soldering or desoldering. Temperature can be set on a sliding scale from 450° to 850° F. In the soldering mode, either a micro-sized or macro-sized soldering iron can be used; twelve standard Ungar tips are available for each.

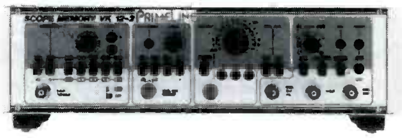
Eight standard Ungar tips will fit the desoldering handle.

Circle (86) on Reply Card

Digital waveform recorder

Soltec Distribution announces the PrimeLine model VK12-2 signal event recorder, digital memory unit. The VK12-2 converts any oscilloscope, strip chart recorder or XY recorder into a high performance storage instrument.

The VK12-2 digitizes and stores periodic and/or transient events in a 2000-byte (8-bit words) memory with 8-bit resolution. A 2MHz data sampling rate (clock rate) allows accurate reconstruction of the recorded analog signal, dc to 300kHz. The signal can be viewed



on a standard analog oscilloscope or reproduced on XY recorder or strip chart recorder by using the slow speed analog recorder output. Users who wish to employ the VK12-2 as a high speed analog memory for digital computers may order the bidirectional IEEE bus interface options.

Circle (87) on Reply Card

Versatile DMM

Triplett's model 4750 digital multimeter provides versatility and true RMS measurements. The multimeter's functions include: dc/ac voltage, dc/ac current, resistance, frequency, dBm, diode check, continuity check and temperature. Also data hold, peak hold, relative display, 3½-digit optional display and autoranging are provided, with a 0.04 percent basic

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Vdc accuracy. The unit employs a custom LSI chip plus CPU to provide a 25,000-count resolution. The unit may be operated from its internal 9V battery or with an optional ac adapter.

Circle (88) on Reply Card

Solid-state replacement guide

A new edition of *RCA's* SK series "Guide to Reliable Replacement Semiconductors" has been published. The 616-page guide contains more than 2500 SK and KH types that replace more than 206,000 industry types. Included among the 214 new SK types in this edition are 40 optoelectronic devices, seven microprocessor types, 13 bipolar transistors, two Darlington transistors, 10 CMOS ICs, 29 linear ICs, 10 power FETs and two Sanyo/Sears high voltage blocks.

Circle (89) on Reply Card

150MHz oscilloscope

A quad input, dual independent time base 150MHz oscilloscope featuring ±2 percent vertical accuracy, 500µV/div vertical sensitivity and 20kV accelerating potential has been introduced by

B&K-Precision, Industrial Electronic Products Group of Dynascan Corporation.

Designated model 1596, the instrument's low profile design and lightweight (16.28 pounds) fill field service as well as on-the-bench R&D applications. Model 1596 features 500µV/div sensitivity to 70MHz (cascade channel 1 to channel 2), 1mV/div sensitivity to 100MHz and 5m/div sensitivity to 150MHz. Waveforms are viewed on an 8 div x 10 div (1 div = 1 cm) rectangular CRT with internal graticule, scale illumination and 20kV accelerating voltage. Model 1596 also features a *dual* model whereby the *A* sweep and *B* sweep operate independently of each other. Two signals can be viewed in different sweep times in the dual mode.

Circle (90) on Reply Card

Power conditioner

Topaz introduces Line 1 power conditioners designed specifically to protect microcomputers against electrical noise and high or low voltage.

Line 1 power conditioners feature exceptionally low output impedance, enabling them to protect microcomputers against powerline disturbances while also meeting the *peak-current* power demands of internal switched-mode power supplies. They attenuate electrical noise over a broad frequency spectrum of 400Hz to 25MHz.

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Wanted: Bird thruline wattmeter. *Ray W. Mackie, 810 Rezanof No. 2, Kodiak, AK 99615; 907-486-5334.*

For Sale or Trade: Sams AR-17 through AR-327 (308 volumes), eight assorted MHF series, 38 assorted TR series, $5 each or will trade all or part for Sencore test equipment or other video service manuals. *Frank Eichler, Hap's Video Plus, 515 Walnut St., Red Bluff, CA 96080; 916-527-2535.*

For Sale: Sams Photofacts folders, 75 assorted 286 to 1731, $2 each or $100 for all, plus shipping. Send s.a.s.e. for list. *Norman Wescott, RR2, Box 307, Tilton, NH 03276.*

Wanted: Manual and schemetic for Tektronix oscilloscope model 535A; B&K 1076 analyst, transistor radio analyst model 960. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

Wanted: Stepping relay for Heath TV (295) remote control. *Donald O'Bryan, 9308 Annetta Ave., South Gate, CA 90280; 213-569-5147.*

For Sale: Sencore SG165 stereo analyzer with leads and manual, used very little, $500, including shipping. *Jim Leonard, Leonard's TV and Radio, 1431 Colorado Ave., Lorain, OH 44052; 216-288-3252.*

Wanted: Heathkit EAC-1 auto electrical systems course, all four parts complete; schematic for Collins KWM2/A. Will pay postage, copy and return. *Cecil Phelps, K0HHI, P.O. Box 154, Delco, NC 28436.*

For Sale: Sencore SG165, new, still in original carton. All cables and manual. Cost $1295, will sell for $895. *Al Nikora Sr., 5298 Argyle Court, Sterling Heights, MI 48078; 313-268-6938.*

Wanted: Sprague model TO-6A capacitor analyzer. Please state condition and price. *Eodice TV, 5056 Lincrest Place, Huber Heights, OH 45424.*

For Sale: Heathkit microprocessor trainer accessory ET-3400A, with 3K memory chips and modification for trainer, $95, including shipping. Electronic books, most hardbound classroom-type current material on television, digital, computers, basic electronics, etc. Send for complete list. *Calvin S. Logue Jr., 17 J Washington Lane, Westminister, MD 21157.*

Wanted: GR resistance; GR model 1650 impedance bridge; B&K FET meter model 290; B&K lab DMM model 2830. **For sale or trade:** six each, both series and parallel filaments, TV tuners for old-type television. The long shaft can be cut to fit. *Jack E. Smith, 215 College St., Montezuma, AZ 31063.*

For Sale: Supreme radio manuals, volumes 1 through 24. Tekfax volumes 103 through 115, $10 per volume. Sams Photofact folders, assortment of 102 complete sets. Send for list. *Elmer J. Alderman, RFD 2, Box 139, Madison, NC 27025.*

Wanted: Sencore VA62 video analyzer. Working condition and fair price. *David Muratore, 27 Clarkview Drive, New Windsor, NY 12550; 914-562-2805.*

For Sale: B&K 415 sweep generator and B&K 1077B TV analyst, both with full manuals and in excellent condition (oscillator used less than 20 hours), $300 each, $500 for both. *Burl A. Dixon, Route 8, Box 444, Muncie, IN 47302; 317-289-6272.*

Needed: Flyback transformer for Sears TV model 528-40721400, part No. 80-164-3G. Please state price. *George Saylor, 2319 Parrish St., Philadelphia, PA 19130.*

Needed: Supremes manuals TV-1, -2, -11, -12, -27 and R-1. **Wanted:** Schematics for Sherwood S-800 IV stereo FM-MX receiver, Lafayette LA 125T transistor stereo amplifier. Heathkit WA-P1 pre-amplifier. *Marlon Soudatt, 10108 Flatlands Ave., Brooklyn, NY 11236.*

Wanted: 321A or 321 Tektronix scope badly needed. Please call or write: *Marv Loftness, 115 W. 20th, Olympia, WA 98501; 206-357-8336.*

Needed: Sams TR-82 Photofact; Knight 83YX137 AF generator and RF generator, with manuals. *C.T. Huth, 130 Hunter St., Tiffin, OH 44883.*

Wanted: Schematic and operating instructions for Heathkit color bar and dot generator, model IG-28. Will purchase or copy and return. *William A. Thoma, 762 Silverleaf Drive, Dayton, OH 45431.*

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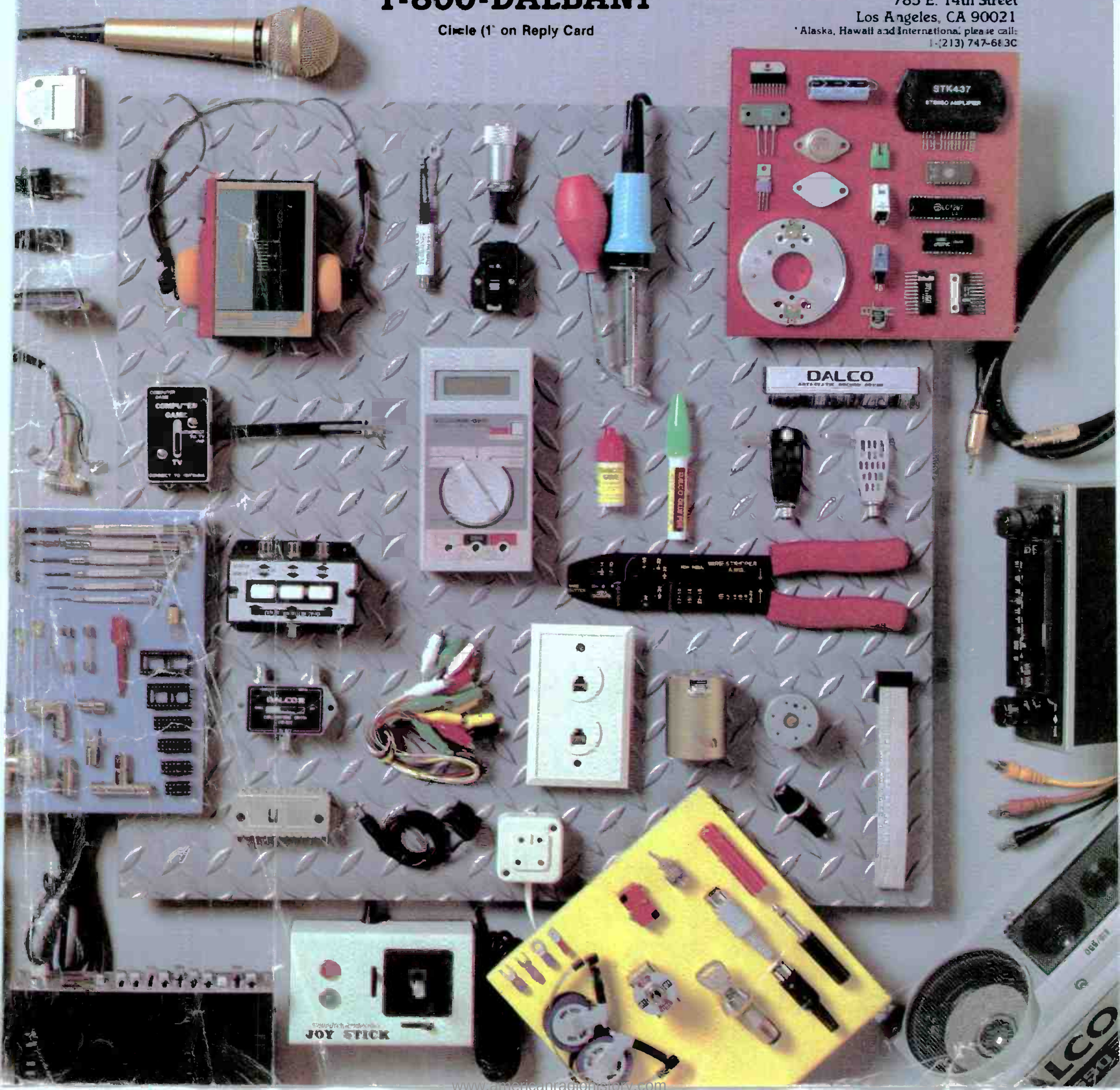

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