The how-to magazine of electronics...

ELECTRONIC™

Servicing & Technology

APRIL 1987/$2.25

Oscilloscope: the eyes of the technician

Test lab: LCR meter • Troubleshooting horizontal ICs, Part 2

Another first: the experimental 4Mb CMOS DRAM

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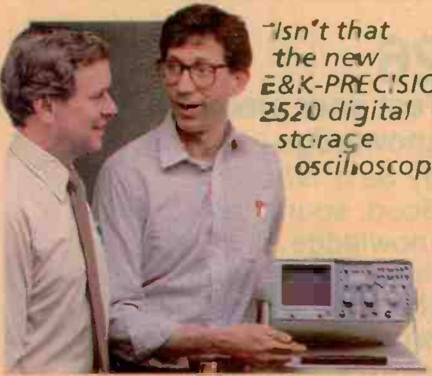
Circle (1) on Reply Card

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



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

"Right, Jim . . . It's quite a performer, with dual-channel real-time and digital operations, 2 megasample per second sampling and 1024 x 8 bit per channel storage. It's even got an analog output for a plotter."

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

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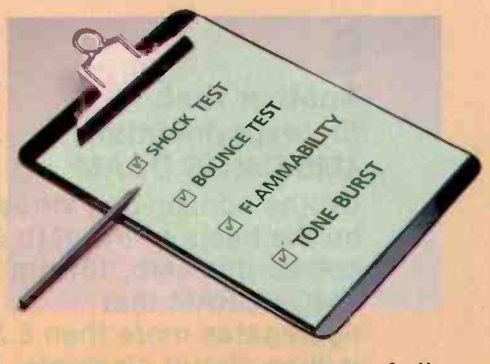

"$1990? I thought a DSO that did all that would cost a fortune. Where do I get mine?"

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

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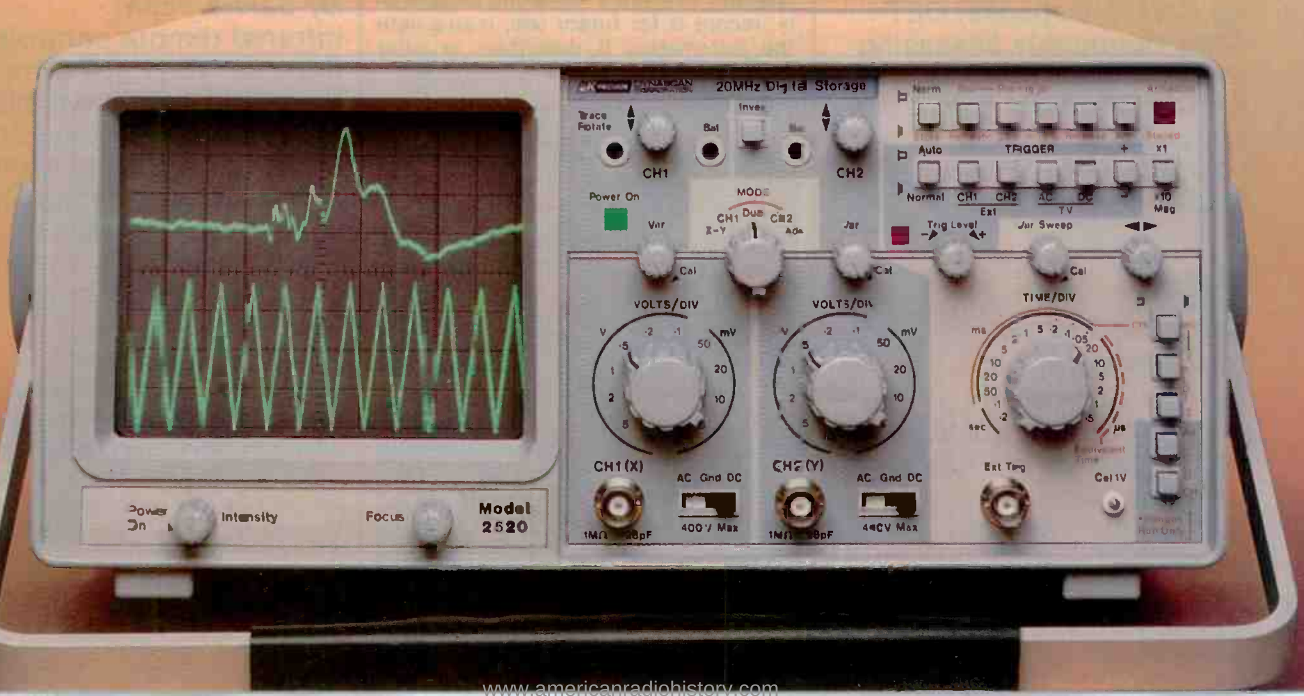

The how-to magazine of electronics...

ELECTRONIC Servicing & Technology

Volume 7, No. 4 April 1987

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Another first: the experimental 4Mb CMOS DRAM

On the horizon and virtually on the heels of the 1Mb chip comes this 4Mb, 137mm² CMOS DRAM that aggregates more than 8.7 million circuit elements. A Technology article.

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Oscilloscope: the eyes of the technician

By Conrad Persson

"See" into circuits as far as your oscilloscope will allow. Late-model scopes permit increased visual perception even though the scope, itself, may be smaller, lighter weight, even battery powered.

16
From the test bench: model AR-460-D LCR meter

By Carl H. Babcoke, CET

After thoroughly assessing the various features of this small, hand-held meter, the author reports that it is a valuable adjunct to other test equipment.

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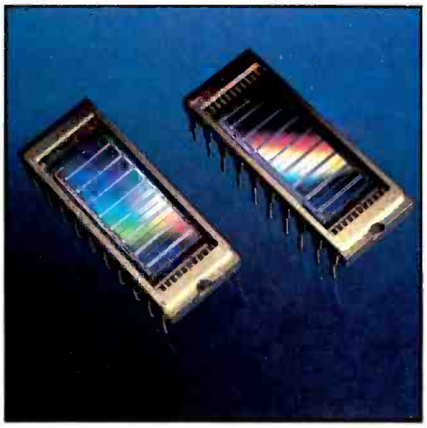
Learning from a tough dog repair

By Max Goodstein

Taming tough dogs leads to knowledge for the future because the lessons were learned the hard way.



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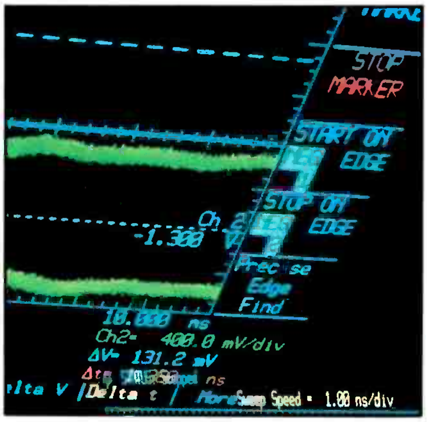
In less than two years since the 1Mb chip was introduced, these experimental 4Mb chips have been developed, promising four times as much dynamic access memory. *(Photo courtesy Toshiba Corporation)*



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A digital storage oscilloscope allows the operator to store a waveform indefinitely, record it for future use, manipulate the information it describes, or print paper copy. *(Photo courtesy Hewlett-Packard)*

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Test your electronics knowledge

By Sam Wilson

Good, sound background knowledge should pull you through this month's quiz. The questions represent the variety of electronics information that a technician may need, unexpectedly, at any time.

43
Troubleshooting horizontal ICs, Part 2

By Homer L. Davidson

Concluding an article that began in the February issue of ***ES&T***, the troubleshooting case histories detailed on these pages provide specifics that also should be useful in generalized applications.

50
What do you know about electronics? – Infrared remote controls

By Sam Wilson

Infrared remote controls have so much going for them that they are expected to replace both wired and ultrasonic controls ASAP. Best part: whereas jangling keys, for instance, can trigger ultrasonic, not even other infrared sources can fool infrared!

(Please note: to prevent duplication of effort, the author has decided to withdraw his promised serial presentation of CD circuits, theory and practice, leaving future discussions to Kirk Vistain's Audio Corner.)

Sometimes it's hard to go back for a scope!

LBO-325 CRT is shown actual size.

60-MHz full-function field-service Attache Case Oscilloscope is so light and small it will be taken everywhere, every time.

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For information Circle (4) on Reply Card

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For Demonstration Circle (5) on Reply Card

Editorial

Simplify

About 100 years ago, Henry David Thoreau left the life of society and went to dwell in the woods near Walden Pond in Concord, MA. "I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach..."

His exhortation to the readers of Walden is "Simplicity, simplicity, simplicity! I say let your affairs be as two or three, and not a hundred or a thousand: Instead of a million count half a dozen, and keep your accounts on your thumbnail."

What would Thoreau think if he could see the world today? Far from becoming simplified since that time, life in general has become increasingly complex. Why, the technology of electronics alone has gotten so burdensome that we have to rely on acronyms and abbreviations just to communicate economically. Unfortunately, the proliferation of acronyms and abbreviations lends itself not only to economy but to confusion.

Take *pc,* for example. If you're going to be talking a lot about printed circuits, it helps to abbreviate it in speech or writing. Unfortunately, if you're not quite explicit, someone might get the idea that you're talking about a personal computer or a programmable calculator. And let's say you were in fact talking about a personal computer, how is the listener to know if you're talking about a pc in general or IBM's PC.

But that's just for starters. TVs and scopes have CRTs. And digital readouts are based on LEDs and LCDs. And modern circuits may be based on MOSFETS: PMOS, NMOS or CMOS. A rolling stone gathers no MOS, so they say.

But hold on. There's more. Lots more. And part of the problem is that these abbreviations and acronyms get into the lingo but almost no one knows or remembers how, or precisely where they came from or what they mean. For example, many months ago we asked readers where the term "aquadag" (the conductive coating on a CRT) comes from. For those of you who missed it, we learned that it's a water-based (hence the "aqua" part) solution of Deflocculated Acheson Graphite. Aquadag was, and perhaps still is, a trademark of the Acheson Graphite Company.

And the unfamiliar and sometimes unintelligible acronyms and abbreviations continue to flow from the pens and tongues of the scientists and engineers, often to the increased confusion of us mere mortals. And we at ***ES&T*** have been as guilty as anyone.

Here's a modest suggestion. Any time you hear a term or abbreviation you're not familiar with (wait until LCDs get more popular and people begin tossing around beauts like "smectic" and "cholesteric"), don't be afraid to ask what it means and where it came from. And if you catch us bandying such terms about, let us know. And by all means, if you have a favorite abbreviation, acronym or obscure electronics term that you are familiar with, write and let us know. If you have a favorite whose meaning you're *not* familiar with, write and we'll try to find out what it means.

While Thoreau's idea of going back to the woods to simplify and live life in its elemental form won't work for most of us, at least we can make a stab at simplifying by clearing away some of the clutter in our working vocabulary.

Nils Conrad Persson

Feedback

Mechanics also are technicians

I must take exception to Mr. Gus Robino's use of the phrase "...either reckless or auto mechanics" in his letter to July's Feedback. I am fortunate enough to have a friend who not only serves as the chief technician of a large multisystem cable TV operation, but who is also a highly competent mechanic. After watching him accomplish in an hour repairs which would have taken me a full weekend (and cost a crunched knuckle or two!), I've developed a healthy respect for qualified automotive technicians.

I doubt if Mr. Robino intended to belittle anyone, but my point is this: If we in the electronics servicing industry can put down so unthinkingly a profession whose contributions to our technological society are at least as vital as our own, what right do we have to take offense when someone ignorant of electronics wrinkles his/her nose at the mention of "TV repairmen?"

Michael W. Moran, CET
Waupun, WI

***ES&T* is glad to be of service**

Just wanted to express appreciation for the Reader's Exchange column. I have purchased several items from advertisers in this column. Thank you also for dividing the ads into the two categories: Wanted and For Sale. That was a significant improvement!

Garth Fisher
Assistant Professor Electronics
Walla Walla College
College Place, WA

This reader says "Go for it!"

...About the letter to Wallace Harrison from Robert J. Horsley (February 1987 ***ES&T***): In considering a business in electronics, I would jump in and do it; the opportunities are there. Sure, the product is getting cheaper, but the technology is changing and service methods are, too.

I do agree that just repairing televisions, solely, would be devastating, so diversify and service televisions, stereos, VCRs, CDs, to name a few. And what about industrial servicing of items such as alarms, closed circuit camera systems and 2-way communications. The service is out there; all you have to do is market your skills.

I have a business servicing (*the above equipment)* and also electrical wiring, and it looks better than anything I ever have thought of doing before....

A person could find another shop to purchase to acquire an already established clientele and foothold. To start from scratch, a person could do it for $6,000 to $8,000, easily, plus good contacts.

Because I felt that those letters in the February issue were so discouraging, I feel compelled to write my opinion.

Mike Shelton Sr.
Burlington, NC

News

Car audio installation tape now available from EIA/CEG

A videocassette training tape, "Basic Car Audio Installation," has been prepared by EIA's Consumer Electronics Group (CEG) and is now available through its product services department.

This 30-minute videotape introduces you, the electronics technician, to the increasingly complex subject of car audio installation. It guides you in the correct layout and design of a car stereo installation facility, covering basic as well as specialized tools needed for the installation.

Among key topics covered in this training tape are safety in the shop; how to treat the car, from pre-installation checkout to demonstrating the completed job; the technical resources available for information about specific types of vehicles, dashboard dismantling, speaker sizes and antenna locations; and types of speaker wiring found in the automobile.

For additional information on this videocassette, which is priced at $30, contact the CEG Product Services Department, Electronic Industries Association, 2001 Eye Street NW, Washington, DC 20006 (202-457-8782).

Permanent injunction prohibits Certification scheme

In December 1986, Stan Haring of Olympia, WA, agreed to a permanent injunction by the state of Washington that prohibits him from offering a certification program under the auspices of an organization he called the American Assocition of Certified Electronics Technicians (AACET).

In a consent decree signed by both parties, Haring, who has been an instructor at Olympia's Puget Sound Community College, agreed to pay a civil penalty to the state of Washington and to desist from any future violation of state law.

The office of the International Society of Certified Electronics Technicians (ISCET) became aware of AACET when some industry people mistook AACET's policies for those of ISCET. ISCET members and certification administrators advised ISCET of the AACET plan to offer certification for a fee without qualifying examinations to instructors, military and other technicians working in the industry.

The test offered by Haring, was reviewed by both ISCET and Don Hatton, the Director of Product Services for the Consumer Electronics Group of the Electronics Industries Association (EIA/CEG). In the opinion of both, it was in no way an adequate measurement of the complexities of professional servicing.

ISCET made the initial inquiry to the Washington Attorney General and cooperated fully in the ongoing investigation. Jim Parks CET, ISCET Chairman from Winter Springs, FL, points out that, "ISCET recognizes the right of other organization to offer certification programs. . . .However, they have an obligation to ensure that their testing procedures are meaningful and that the designation instills public assurance of a minimum level of technical competence."

ISCET, a non-profit society headquartered in Fort Worth, TX, has certified more than 21,000 technicians as ISCET Certified Electronics Technicians since the program's inception in 1965. ES&T

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INTERTEC PUBLISHING CORPORATION

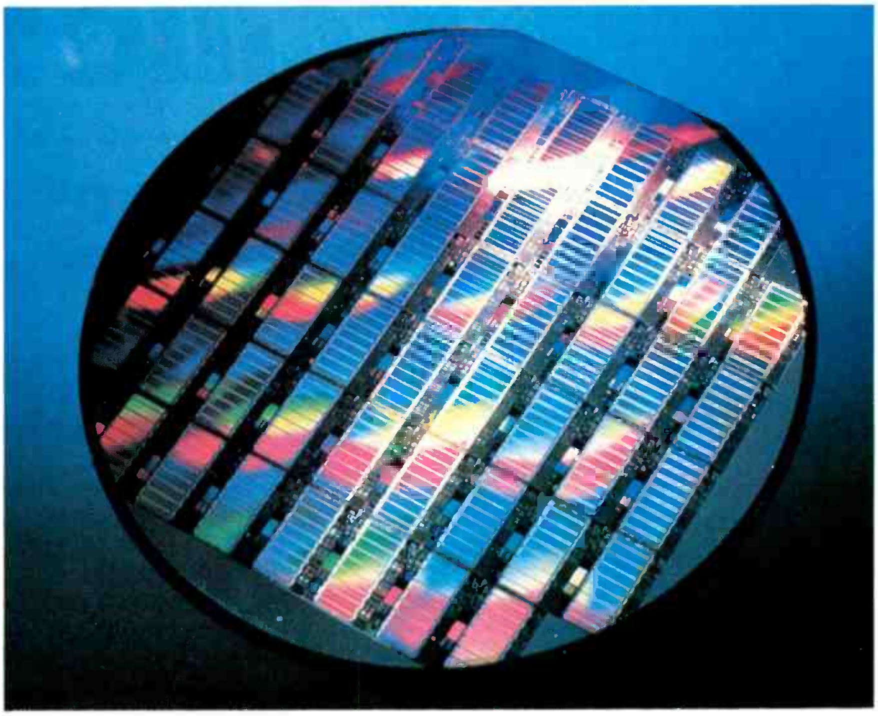
Technology

Another first: the experimental 4Mb CMOS DRAM

Make way for the 4-megabit CMOS dynamic random access memory.

Just 21 months ago (July 1985 issue) ***Electronic Servicing & Technology*** brought you news of the then-awesome 1Mb chip developed by Toshiba. In May, 1986, ***ES&T*** reported that the access time for this semiconductor chip–previously headlined as "Faster than a speeding bullet..."–had been accelerated further by Toshiba integrating refresh operation circuits directly on the chip. Now this.

Toshiba's 4Mb DRAM incorporates more than 8.7 million circuit elements on a 137mm² chip. A single chip can hold information equivalent to approximately 16 pages of a metropolitan newspaper, a volume that would require 16 256K DRAMS currently in use. Such high integration makes it possible to make microcomputers, personal computers and office automation devices even more compact than they are today.



There are approximately 50 4-megabit DRAMs fabricated on this silicon wafer—more than 435 million circuit elements. *(Photos courtesy Toshiba Corporation)*

The 4Mb DRAM features low power consumption, high speed and enhanced reliability. Power consumption is only 300mW during operation, and 2.5mW in standby mode, despite the fast access time of 80ns.

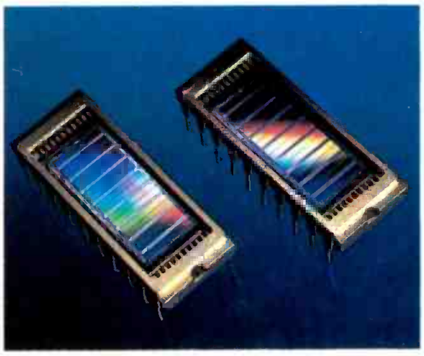
Formidable hurdles were overcome to make this chip a reality. First, microlithography must achieve 1.0μm minimum feature size (minimum feature sizes used for the 256K DRAM and 1Mb DRAM were 1.8μm and 1.2μm, respectively).

Next, the chip's basic capacitor had to be minimized, but reliability is jeopardized when the quantity of charge that can be stored in a capacitor is reduced. Toshiba solved this problem by digging a groove into the silicon substrate and turning the side wall of the groove into a capacitor, making it possible to store sufficient electric charge in the small memory-cell area.

To make this possible, however, a new technique had to be developed using arsenic glass in order to evenly disperse impurities at a high density and suitable depth into the groove side walls.

Another problem associated with such large-scale memories is "soft errors" that can alter the information: alpha particles coming from radioactive contaminants in the packaging material and in the chip, itself, that cause fluctuation in the amount of charge stored in the capacitator. This was solved by altering the impurity concentration in the substrate.

The CMOS structure was chosen to permit low power consumption and high operating speed. Power consumption was reduced even further by engineering a method of activating only one-fourth of the circuitry, instead of the entire chip.



Four-megabit dynamic RAM (DRAM) can hold the equivalent of 16 newspaper pages of information.

***Editor's Note**: The devices and technological advances that* **ES&T** *reports in this department may take months, even years to reach the servicing bench as part of consumers' improved or more compact electronic equipment. (Some may prove impractical to manufacture or to market and, therefore, will never be a servicing concern.) We believe, however, that our readers, with their technical orientation, are interested in all the exciting developments that may ultimately impact the electronics industry.*

ES&T

Oscilloscope: the eyes of the technician

By Conrad Persson

The oscilloscope is the servicing technician's electronic "eyes." You can't directly observe what's going on in a circuit, but you can attach the probes of the oscilloscope and look at the screen and observe just exactly what's going on.

The ability of a technician to use an oscilloscope to *see* what's going on in a circuit is limited by the limitations of the oscilloscope, its ease of use, and the skill of the technician in using the oscilloscope.

Improvements in modern scopes

All of the electronics technological innovations that are being developed are being incorporated into today's oscilloscopes. Integrated circuits are cramming so much into such small packages that instrument manufacturers are able to increase the sophistication and capabilities of their scopes while at the same time reducing their overall size. The reduced power consumption of these units makes battery-operated portable oscilloscopes practical. Digital circuitry makes possible digital storage oscilloscopes that can capture and hold waveforms indefinitely. Microcomputer control simplifies setup and operation.

Some other improvements in scope sophistication that have been introduced in recent years are such things as oscilloscopes with LCD readout, which are so small that you can almost put them in your pocket. Yet another development is the addition of a digital readout on the front of the scope (or sometimes to the screen itself). With this, you can read the value of amplitude or period directly in digital numbers so you don't have to count graticule markings, check the knob settings and calculate these values.

Digital storage oscilloscopes

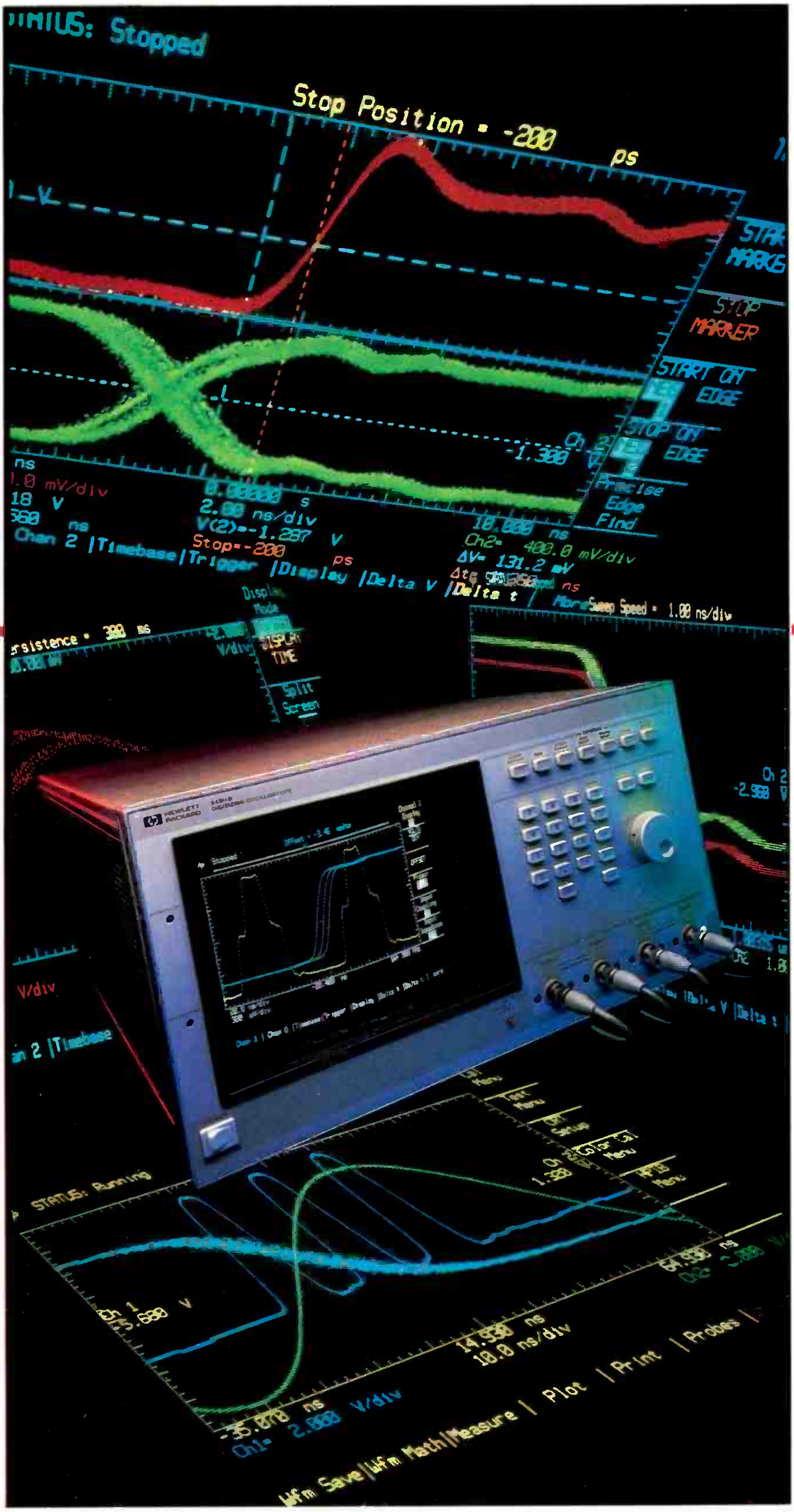
One of the most exciting developments in oscilloscopes in recent years is the digital storage oscilloscope (DSO). It offers a number of significant advantages beyond the capabilities of analog oscilloscopes.

One of the primary advantages of digital storage oscilloscopes is their ability to store the signal being observed. In fact, this one capability results in *several* advantages. For one thing, the capability to record a waveform makes it possible to capture a waveform, store it and compare the stored image to the same waveform from the same point in another unit.

Manipulating the information

Many digital storage oscilloscopes have other capabilities that can help simplify the troubleshooting task. Some DSOs, for example, have a printout capability so that you can print out any portion of the waveform you've captured and take it with you to examine at your leisure, or to make marks on or write your comments on. Sometimes this kind of activity with the thinking process it encourages helps you figure out what the problem is.

Still another capability that some DSOs offer is interface connections. If you have a personal computer, depending on the kind of computer it is, you can transfer the recorded information to the computer to record the waveform permanently on floppy disk, or to manipulate the information in any



number of ways, again stimulating the troubleshooting thinking process. Just think: If you were ever working on the same unit, or a similar unit with a similar problem, you'd have a record of what you discovered the first time you ran into the problem.

Multichannels make it easier

Most DSOs have more than one channel available. Just think of the implications of that. Let's say you're monitoring an intermittent problem as discussed previously, but you have a strong suspicion that it's related to or caused by another condition, say a sag of the 120V line voltage. With a multichannel DSO, you can put one set of probes on the testpoint of the unit under test and another set on the incoming power line and record both signals. Then when the intermittent occurs, you can look at both waveforms at the same time and compare them.

If the waveform at the test point starts doing funny things at about the same time as the power line voltage drops, you have a strong reason to suspect that the low

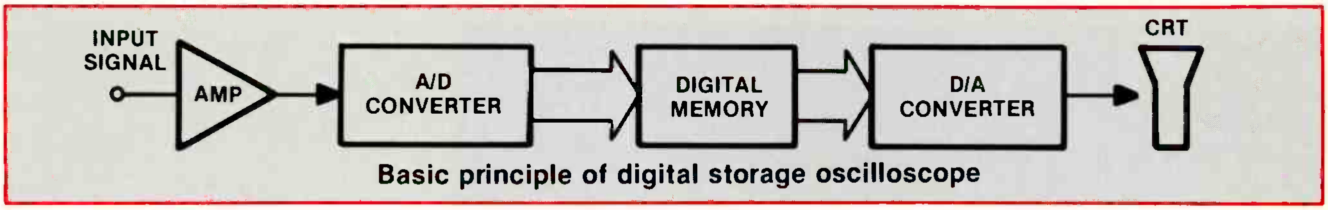


Figure 1. Simplified diagram of digital storage oscilloscope.

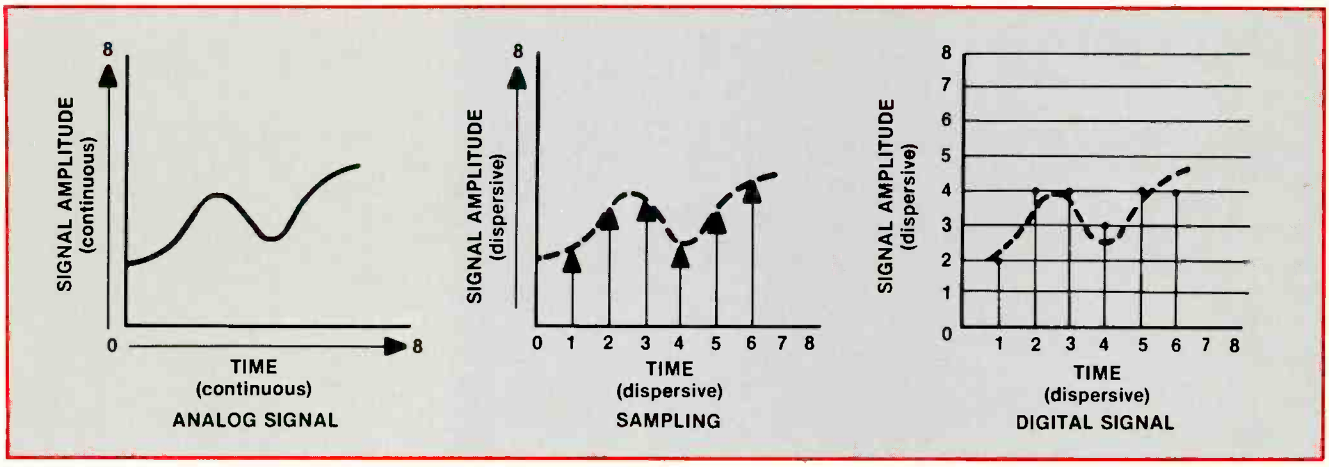


Figure 2. Each sampled analog signal is quantitized to digital.

TIME	1	2	3	4	5	6
DATA	2	4	4	3	4	4

Table 1. Signals quantized into digital are stored in memory.

voltage is the cause, and you can take corrective measures.

DSO operating principles

Until the introduction of the DSO, the term *storage oscilloscope* was applied to an oscilloscope that uses a storage CRT. This type of oscilloscope stores the displayed waveform as a trace on the scopeface.

The digital storage oscilloscope makes possible the storage of waveforms as bits in a digital memory circuit. Take a look at Figure 1, a simplified block diagram of a DSO. Instead of being amplified and applied directly to the deflection plates of the CRT, the waveform in a DSO is first converted into its original equivalent and stored in memory. To reproduce the waveform on the CRT, the data stored in the memory is sequentially read and converted back into an analog signal.

The A/D (analog to digital) converter converts the analog signal into a sequence of digital bits, in which form it is stored in memory. The amplitude of the analog signal varies continuously in time. In order to be converted into a digital signal, the analog signal is sampled at intervals. The analog value of the signal at each sample point is converted into a binary number (quantized) and stored. See Figure 2 for an idea of how the A/D process proceeds.

In order to be displayed as an analog signal on the scopeface, the digital data representing the signal must be converted back to an analog signal. This is accomplished through a digital to analog (D/A) converter.

DSO circuit structure

The circuit structure of one DSO, the DSS 5040 manufactured by Kikusui, is shown in the block diagram in Figure 3. Its features are largely typical of digital storage oscilloscopes. The major blocks are the vertical deflection circuit, the horizontal deflection circuit, the data acquisition and processing circuit, the CRT circuit, the CAL circuit and the power supply circuit.

Vertical deflection circuit

The purpose of the vertical deflection circuit is to provide the voltage signal that deflects the beam spot vertically on the CRT screen. The input signal is impedence-matched and amplified by the CH1 or CH2 pre-amplifier to a level suitable for driving the subsequent stage of the circuit. Under the control of the oscilloscope's microcomputer the channel selector chooses the channel to

IN THE FUTURE...

TECHNICIANS WILL HAVE TEST EQUIPMENT YOU MAY DREAM ABOUT TODAY...

A Technician may probe with just two test leads, an amplifier, TV, or cellular telephone, and his test equipment may read out:

"LEAKY SINGLE JUNCTION NPN TRANSISTOR,
BREAKING DOWN AT 15.3 VDC"

Imagine, if you will, that even an average technician would be able to locate, IN SECONDS, defective components in a blown amplifier, a lightning-damaged TV, anything with transistors, diodes or capacitors;

EVEN MAJOR DISASTERS WITH MULTIPLE DEFECTIVE COMPONENTS...

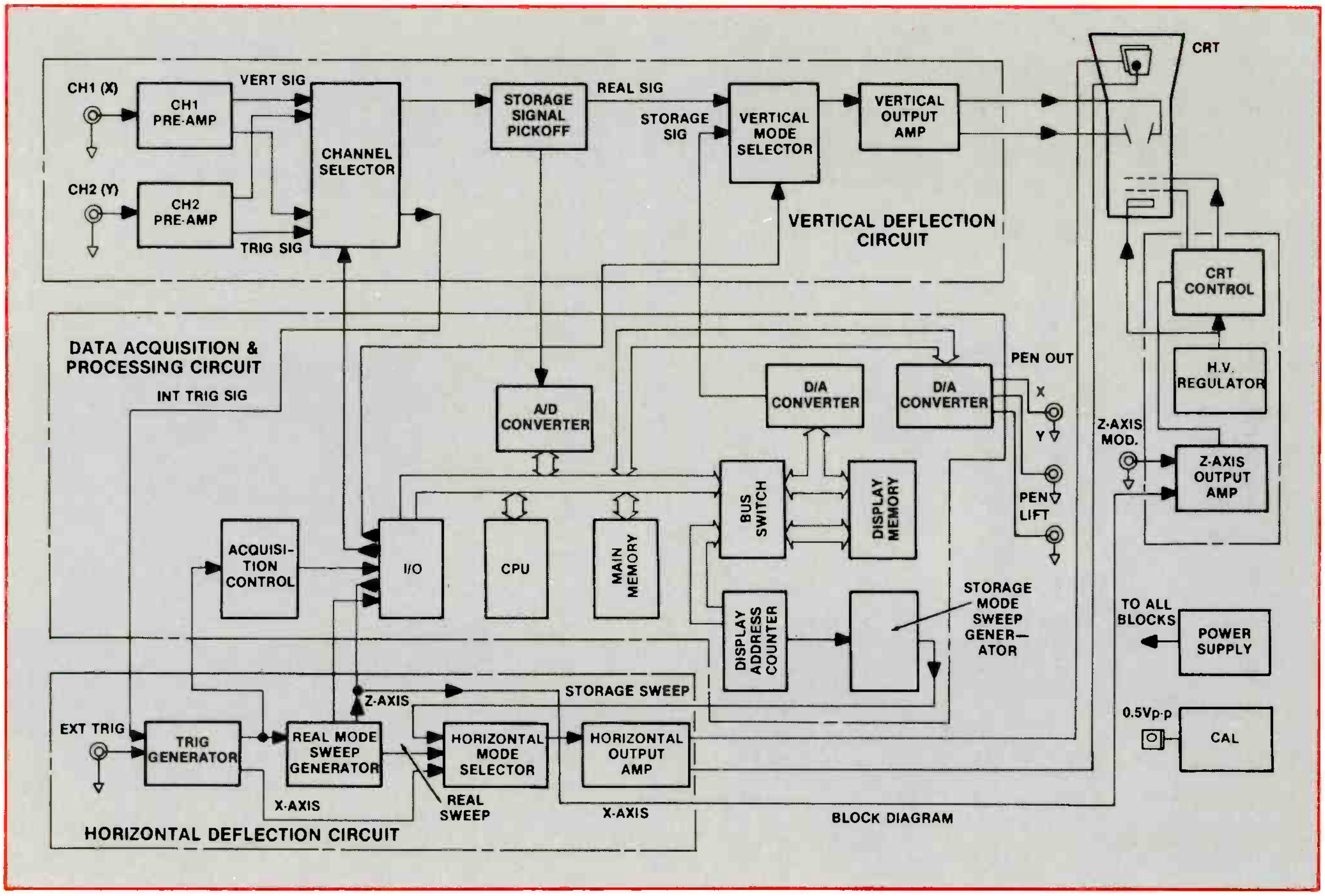


Figure 3. This complete block diagram traces signals' I/O, conversion, memory and reconversion process.

be used. Then the signal is fed to the STORAGE SIGNAL PICKOFF circuit. The signal picked off is fed to the A/D converter. The vertical mode selector picks either the storage signal or the real signal. The selected signal is fed to the vertical output amplifier that amplifies the signal to a sufficient level for vertically deflecting the CRT beam.

Horizontal deflection circuit

The purpose of the horizontal deflection circuit is to provide the voltage signal that deflects the beam spot horizontally on the screen. The circuit includes a trigger circuit and a sweep circuit. It also acts as an X-axis deflection circuit for X-Y operation.

The trigger generator selects either the signal fed from the channel selector or the EXT TRIG signal, and generates a triggering signal for sweep and an AUTO signal to indicate the presence or absence of the triggering signal.

When in the X-Y mode or EXT HOR mode, the circuit operates as an X-axis amplifier.

The real mode sweep generator, which is synchronized with the triggering signal, generates a sweep signal for operation in the real mode.

The horizontal mode selector selects the storage mode sweep signal, the real mode sweep signal, or the X-axis signal. The selected signal is amplified by the horizontal output amplifier to a sufficient level for horizontally driving the CRT beam.

Data acquisition and processing circuit

This circuit converts the analog input signal into a digital signal for storage, and provides interpolation on the stored data for reproduction of the analog signal on the CRT screen. The various data items fed through the I/O port are read by the CPU, which provides the control signals for the various circuits. The waveform data fed from the A/D converter is stored in the main memory. The CPU provides interpolation and other processing on the data. The processed data is transferred to the display memory. Except during the transfer periods, the contents of the display memory are constantly sent to the D/A converter and displayed on the CRT.

The CRT circuit

The CRT circuit provides the high voltages for the CRT and controls the Z-axis of the CRT. The Z-axis amplifier amplifies the Z-axis signal to a sufficient level for controlling the brightness of the CRT beam spot. The HV regulator provides a high voltage for the CRT. The voltage is controlled by the CRT control circuit via the Z-axis output amplifier, to control the CRT beam spot intensity and focus.

The CAL circuit and the power supply circuit

The CAL circuit provides a reference signal for calibration of the probe and for operation of the amplifiers in the non-calibrated state. The reference signal is a square wave of 0.5Vp-p, with voltage accuracy better than 2%.

The power supply circuit provides supply voltages (145V, 12V, –12V, and 5V) for the various circuits of the oscilloscope. ES&T

Circle (7) on Reply Card

Report from the test lab

Model AR-460-D hand-held LCR meter

Model AR-460-D from American Reliance is a small, hand-held digital LCR meter that can test resistances, inductances and their dissipations as well as capacitances and their dissipations. A large center knob selects any of five inductance ranges providing full-scale readings between 200μF and 2H, any of seven capacitance ranges allowing full-scale measurements between 200pF and 200μF, or any of six resistance ranges providing 200Ω to 20MΩ full-scale readings.

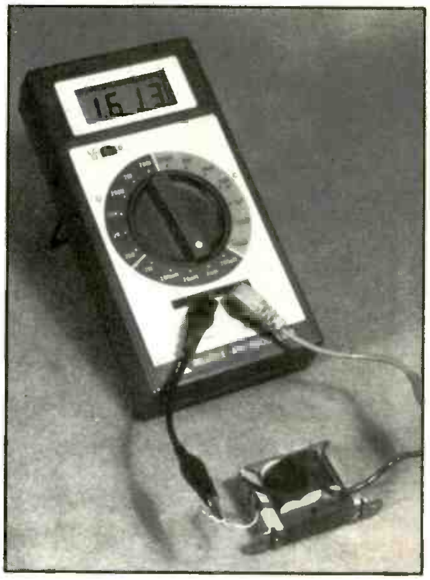
The 3½-digit readout has sharp ½-inch LCD black-on-white numbers with automatically placed decimal, automatic minus sign and *LO BAT* battery-condition annunciators. LO BAT is displayed during the last 5% of the battery life. An alkaline 9V battery is needed, but is not supplied with the meter. Operating life of the 9V battery is estimated at 100 hours of operation. Or, an external ac-to-9Vdc adapter (not supplied with the meter) can be plugged in for acline operation. A spare 2A fuse is provided. The test leads are only about five inches long, because excessive lead length can produce incorrect inductance and capacitance readings. Sampling time is fast, about 0.4s, or more than two per second.

Model AR-460-D is small, officially measuring 17.2x8.7x3.4cm and weighing 350 grams (approximately 6⅞"x3½"x1½" with a weight of less than a pound with battery and probes.)

Overrange for any function or range is indicated by a single, nonflashing *1* at the left when none of the other digits is showing.

A feature in the AR-460-D that was new to me is a switch position for *D* or dissipation of inductors

Model AR-460-D from American Reliance is a small meter for hand-held or bench use. It tests resistances, inductances and dissipations, also capacitances and dissipations.



Model AR-460-D indicates the filter choke has a 1.613mH inductance. This choke has a core made of laminated iron. The LCR/D switch is in the LCR (left) position.

and capacitors during their tests. The dissipation reading is said to be an indication of the *Q* of the inductance or capacitance. For example, a dissipation reading of 0.01 divided into 1 (the reciprocal of the number) equals a Q of 100. A dissipation of 0.10 divided into 1 shows a Q of 10, and a poor dissipation (D) reading of 0.50 divided into 1 calculates to a Q of only 2; a very low reading. This example probably is not accurate, but it serves as an illustration.

Also, the manufacturer states the D factor for out-of-circuit inductors and capacitors is based on the internal parallel leakage of capacitors and the internal series resistance of inductors.

Dissipation appears on the readout up to 19.99 before overrange begins. However, I have not been able to find out if the dissipation reading is displaying voltage, current, resistance or something else. It is not a simple thing to produce a high dissipation reading by using series or paralleling resistances. This complex subject will be discussed later.

Measuring inductances

To test inductances, you only have to connect two test leads, select an appropriate range, and read the meter for inductance and dissipation.

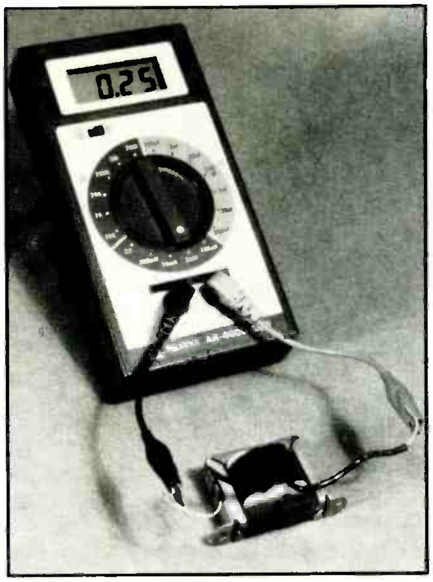
To include in-circuit tests and establish good safety habits, you should follow a few preliminary steps that have nothing to do with inductance tests. First, unplug the ac power to the unit under test and short the B+ dc voltage to ground for a few seconds. Next, make cer-

EFFECTS OF FLYBACK SHORTED TURNS

The AR-460-D's 5-inch test leads alone were connected to flyback pins 3 and 9 during the following tests, which were performed out-of-circuit.

Defect	Inductive value	Dissipation
No defect; Normal	108.7mH	0.00
Rect filament shorted	106.6mH	0.07
4 turns shorted	51.9mH	0.82
AGC winding shorted	67.9mH	0.11
HV winding shorted	17.3mH	0.38
1 turn of solder shorted	104.6mH	0.17
pin 3 shorted to pin 4	04.5mH	2.82

Table 1. When the AR-460-D was connected to the *primary* of an old TV flyback and several windings were shorted in sequence, the primary inductance changed in unpredictable ways, as explained in the text.



The same filter choke is being tested again, but now the LCR/D switch has been moved (to the right) to the D or dissipation position, showing a readout of 0.25.

tain the ac and dc loads across the inductance are not too low (refer to later discussion) for valid readings. Finally, use a test lead to short across the inductance to be sure no dc voltage is stored there in the associated circuit.

Now attach the two AR-460-D test leads to the inductor. (Use only the two short test leads, if possible. If not possible, use the shortest that will reach). Turn *on* meter power with the side-mounted sliding switch. Starting with the 2H range, rotate the large knob toward lower inductances until a usable reading with several digits is obtained. For this, the panel sliding switch should be in the LC position. Slide the LC-Ω/D to the right or D position for dissipation reading. A low reading around 0.01 is best, but it probably will be much higher in-circuit because of circuit loading. If the inductor is a television flyback, write the reading at the edge of the schematic for future use. Remember, of course, that the flyback primary will measure much lower (usually) in-circuit vs. the out-of-circuit inductance. Both readings should be recorded for future use.

Dissipation – No doubt you are wondering if the dissipation reading can indicate shorted turns or an excessive load on a transformer. The specific answer depends on the type of transformer. The general answer is *yes*, usually. Table 1 shows the primary inductance of an old-type flyback along with the dissipation readings for various simulated, massive shorts.

Shorted turns in some windings affect the primary inductance and dissipation very little, while others produce large changes. Of course, a flyback (especially an old type) does not have the same tight magnetic coupling to every turn in every coil from the source winding. In a theoretically perfect transformer, a short across *one* turn in any winding would reduce the inductance of all windings to zero. Late-production flybacks more nearly approach the ideal than the one used as example, but the old one is better for some measurements.

Flyback analysis – Some of the readings in Table 1 make sense to me; others do not. For example, the HV rectifier-tube filament winding (I told you it was old!) consists of two turns of highly insulated wire loosely looped around the flyback's insulated core. It seems rather obvious that shorting it out should make little difference in the primary inductance, and that was true. I was surprised that one turn of solder around the core

EFFECTS OF SHORTS IN A POWER TRANSFORMER

Defect	Inductive value	Dissipation
Normal; No defect	1.099H	0.18
6Vac winding shorted	.047H	2.60
Either B+ winding shorted	.024H	1.23
Both B+ windings shorted	.016H	1.76

Table 2. With a small power transformer connected, a short across any secondary winding reduced the primary inductance to almost zero. That is evidence of tight magnetic coupling.

near the windings reduced the inductive value so little. I experimented with several locations and could not find one that reduced the first reading very much. Perhaps the *doughnut* covering over the coils was too large or not shaped right, preventing the solder *wire* from being near the original windings.

Although I can't explain why some of the shorts gave the inductance and dissipation readings that are recorded, there is a good explanation for the very low inductance and very high dissipation when pin 4 was shorted to pin 3. This winding has pins 9 and 3 at the ends, with pin 4 at a tap and pin 8 (not tested) as another tap. Shorted turns anywhere in the 9/8/4/3 pins' total winding produces a very low inductance with a very high dissipation reading. This might not be true of other windings because they are not located with the 9/3-pin winding, either physically or magnetically.

Power-transformer analysis– Table 2 shows the inductance and dissipation readings of a 60Hz laminated-core small power transformer. All secondary loads have been disconnected to simulate out-of-circuit operation.

Notice in Table 2 that any shorted winding reduces the primary inductance virtually to zero as it increases the dissipation reading far above normal. Evidently all windings have tight magnetic coupling with all other windings, which explains why a shorted secondary winding (or a shorted secondary load) can cause the primary winding of a power transformer to overheat and possibly burn out.

Conclusion: With 120Vac 60Hz transformers, the inductance and dissipation readings made by model AR-460-D are accurate and dependable.

Other tests– A variety of chokes and transformers were checked for inductance, with good results. One indicator, evidently intended for use in a speaker crossover network, tested 1.908mH with a dissipation of 0.03. With opportunities for in-circuit tests limited, other tests were made to simulate in-circuit loading problems.

Paralleling errors– Table 3 shows the changes of inductance when the same flyback was paralleled by various values of capacitors and resistors. Values of the loading resistors and capacitors were not tested precisely; high accuracy was not needed here.

One conclusion from the *paralleling* of various *capacitors* across an inductance is that they *increase* the reading, with even a 0.005µF producing a noticeable increase. Stray capacitance of the wiring and most small ceramic capacitors can be tolerated in-circuit without increasing the reading sufficiently to produce significant errors.

The meter is more tolerant of *paralleling resistances*, showing virtually no change down to 10kΩ. Below 10kΩ, each step of decrease reduced the inductance reading. *Resistors reduce the reading.*

Therefore, the in-circuit recommendations for paralleling an inductor are for less than 0.001µF and more than 10kΩ. Larger capacitances and lower resistances will produce incorrect readings of inacceptable magnitude. Remember, these figures apply only to inductances in the range near 100mH. Possibly lower inductances can tolerate larger paralleling capacitances and lower resistances; the combinations are endless.

Series errors– Table 4 shows similar readings of the inductance when capacitors and resistors of various values were connected *in series* with the inductor. No value of capacitor could be found that gave a correct reading when connected in series. Values of 0.22µF and smaller produced near-zero

THE EFFECTS OF PARALLEL CAPACITANCE AND RESISTANCE ON INDUCTANCE READINGS.

Inductance in parallel with:	Resulting inductance	Dissipation
0.00	108.9mH	0.00
0.005µF	112.1mH	0.00
0.01µF	114.9mH	0.01
0.025µF	120.9mH	0.01
0.05µF	144.0mH	0.01
0.10µF	192.6mH	0.01
0.15µF	347.4mH	0.07
0.22µF	OVERRANGE	0.63

Inductance in parallel with:	Resulting inductance	Dissipation
OPEN	108.9mH	0.00
50kΩ	108.7mH	0.01
10kΩ	108.1mH	0.07
5kΩ	106.1mH	0.14
2.5kΩ	98.0mH	0.32
1100Ω	72.8mH	0.68
470Ω	23.1mH	1.43
220Ω	2.4mH	5.29

Table 3. The first table shows the effects on the inductance of the test flyback's primary winding when capacitances of increasing values are paralleled. Notice that larger capacitances increase the inductance *readings*. In the second table, resistors are paralleled across the primary winding. Low-value resistances reduce the reading excessively. In summary, best accuracy of in-circuit inductance readings can be obtained when the combined loads are 0.001µF (or smaller) and 10kΩ (or larger).

THE EFFECTS OF SERIES CAPACITANCE AND RESISTANCE ON INDUCTANCE READINGS

Inductance in series with:	Resulting inductance	Dissipation
A SHORT	108.9mH	0.00
0.22μF	0.35mH	OVERLOAD
0.15μF	49.2mH	OVERLOAD
0.10μF	139.3mH	OVERLOAD
0.068μF	352mH	OVERLOAD

ANY VALUE CAPACITOR IN SERIES WITH AN INDUCTOR PRODUCES A WILDLY INACCURATE READING. A SERIES CAPACITOR IS ***NOT*** *RECOMMENDED.*

Inductance in series with:	Resulting inductance	Dissipation
A SHORT	108.9mH	0.00
33Ω	108.2mH	0.06
100Ω	108.1mH	0.18
470Ω	107.6mH	0.69
4.7K	102.1mH	7.40
10K	90.2mH	17.86

SMALL VALUES OF RESISTANCE IN SERIES WITH AN INDUCTOR DO NOT AFFECT THE INDUCTANCE GREATLY.

Table 4. *Listing one* shows the results when capacitors of various values are placed in *series* with the test yoke's primary winding. Some of the readings that resulted were higher, some were lower, but none was correct. During your tests, therefore, make certain there are no coupling capacitors between the inductance and the meter. *Listing two* shows the gradual decrease in reading according to an increase of resistance *in series* with the primary winding. In summary: There should *never* be a capacitor in series with an inductor during inductance tests; and do not allow more than 100Ω in series with the inductance during these tests.

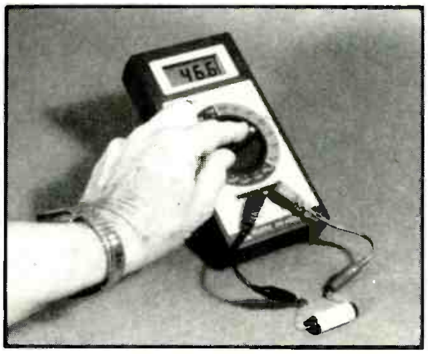
readings, while progressively larger capacitances gave increasingly larger readings (some far above the correct one). But most important: *all values produced dissipation overrange.* Do not knowingly connect *any* capacitor in series with an inductor being tested by the AR-460-D.

It is strongly suggested that any inductance being measured should be direct coupled (no series capacitor) *to the meter and have 100Ω or less of resistance in series with the inductance.*

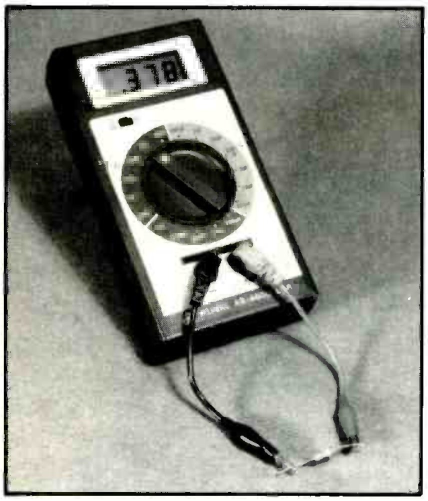
Specifications – Full-scale accuracies of the five inductance ranges are specified as ±2%+1 digit for the 200μH range, ±1%+1 digit for the 2mH, 20mH and 200mH ranges, and ±2%+1 digit for the 2H range. These accuracies apply only when the dissipation is lower than two.

Measuring capacitances

Capacitor measurements are just as easy as inductor measurements. For in-circuit tests, unplug all ac power from the unit being tested and make certain the paral-



On the 200nF range, the capacitor tests 46.6nF (or 0.0466μF) with a dissipation of 0.01. The small size of the instrument is shown in comparison to an operator's hand.



As shown, a resistor measured 0.378MΩ (or 378kΩ) on the 2MΩ range of resistance. Resistors do not have dissipation factors, and the correct resistance reading is obtained on both settings of the LCR/D switch.

lel ac and dc loads across the suspected capacitor are not too low in value, and no ac or dc components are in series with the capacitor. Use a test lead to short across the capacitor for a couple of seconds to drain all voltage that might be stored in the capacitor or in the associated circuits.

Attach the AR-460-D's two short test leads to the capacitor. If these are not long enough, use the shortest leads that will reach. Begin with the front panel switch moved to the left in the LC position. Rotate the bar knob to the capacitance sector and to a range believed to be higher than needed. When a reading is obtained, turn to a lower range to obtain more active digits (three or four preferred) on the readout, and then slide the front-panel switch to the D or dissipation position. Evaluate the condition of the capacitor from these two readings. If the readings raise questions, disconnect one end of the capacitor from the circuit and repeat the tests. Out-of-circuit tests usually are more accurate.

Dissipation (D) readings will identify capacitors that have excessive internal leakage. Most small capacitors should read no higher than 0.02. Many tested 0.00. Electrolytics produce much higher readings. One 12μF read 0.20, and a 38μF gave a reading of 0.24. Experience soon will show you what is acceptable with these as starting points.

Load resistances across capacitances – When a capacitance is being measured by the AR-460-D, *paralleling* a resistor across the capacitance reduces the meter reading. *The amount of* meter-reading *error depends on the capacitance value vs. the resistance value.* In a sense, therefore, it is impossible to assign a single resistance and call it a minimum in-circuit load resistance if accurate capacitor readings are essential.

In Table 5, for example, three capacitors of decaded values were subjected to a series of decreasing resistances. From the mass of data, three examples were chosen for each capacitor value. The largest value shows the highest resistance that reduced the capacitance reading perhaps 2% to 5% (enough accuracy for many uses) with increased dissipation. The next lower resistance value provides for a comparison, while the lowest resistance value reduced the capacitance reading too much, thus producing unacceptable readings with very high dissipations. These show the limits for in-circuit capacitance tests.

As you probably have guessed, larger capacitance values can tolerate lower resistance values. Two examples showed such limited effects that they were not placed on a table. Here is number one: A 12.36μF electrolytic capacitor had a dissipation of 0.06. With a 40Ω load resistor, it measured 12.31μF with 0.38 dissipation.

Number two: Similarly, a 38.6μF electrolytic capacitor having a dissipation of 0.20 was paralleled by a 40Ω resistor, changing the readout to 38.5μF with a dissipation of 0.31. The answer is clear. If the circuit and capacitor are properly discharged first, it should be possible to test most power-supply capacitors in-circuit. There are always some reservations according to the specific circuits.

Measuring resistances

Resistances are measured in six decaded ranges exactly as is usual with digital multimeters. Be certain the probes are not connected to any circuit with ac or dc voltages.

Five of the resistance ranges (200Ω, 2kΩ, 20kΩ, 200kΩ, and 2MΩ) are rated at accuracies of ±0.5% plus one digit. The 20MΩ range is rated at ±1% plus one digit.

All ranges are the low-power type. Only 3.13V was measured across the open test leads. However, any reading that does not produce overrange measures only slightly above 0.2V, which is not sufficient to cause conduction in solid-state junctions (except perhaps some germanium).

In the absence of any Bureau of Standards test resistors, the AR-460-D and a digital multimeter were used almost simultaneously to measure many resistances, with both showing almost identical readings, which implied that the AR-460-D's accuracy was good. Of course, there is no dissipation factor when resistors are tested.

Miscellaneous facts and comments

Perhaps some technicians are not familiar with the prefix *nano* as used to identify three capacitance ranges on the AR-460-D. (By using nano, the capacitance ranges can be decaded easily.) Remember, nano is located between micro and pico in the complete sequence: UNITS, MILLI, MICRO, NANO and PICO.

There are simple rules for converting a reading in one prefix to another. For example:

• Change the reading in nano to micro by moving the decimal *three places to the left.*

RESISTANCES PARALLELED ACROSS CAPACITORS SIMULATE IN-CIRCUIT LOADING

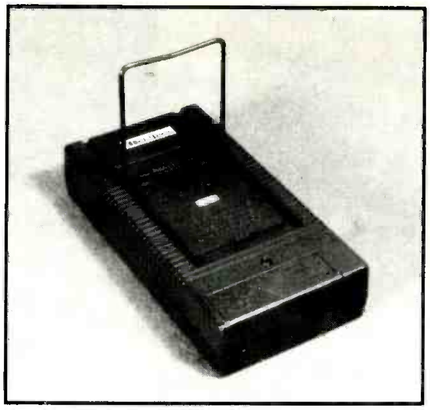
Parallel defect	Capacitance reading	Dissipation factor
	NOMINALLY 0.001μF	
NONE	0.00124μF	0.02
100kΩ	0.00122μF	1.18
15kΩ	0.00104μF	9.31
10kΩ	0.00095μF	14.67
	NOMINALLY 0.01μF	
NONE	0.011μF	0.01
10kΩ	0.010μF	1.32
2.3kΩ	0.0097μF	6.84
1,000Ω	0.008μF	17.13
	NOMINALLY 0.10μF	
NONE	0.094μF	0.01
1,000Ω	0.0921μF	1.63
700Ω	0.090μF	2.07
100Ω	0.076μF	17.26

Table 5. Extensive experiments showed that paralleling a resistance across a capacitor reduced the capacitance reading and increased the dissipation factor. However, the amount of capacitance decrease depended on the capacitance-value vs. the resistance-value. Study these three examples. Notice that lower resistances can be used when the capacitances are larger.

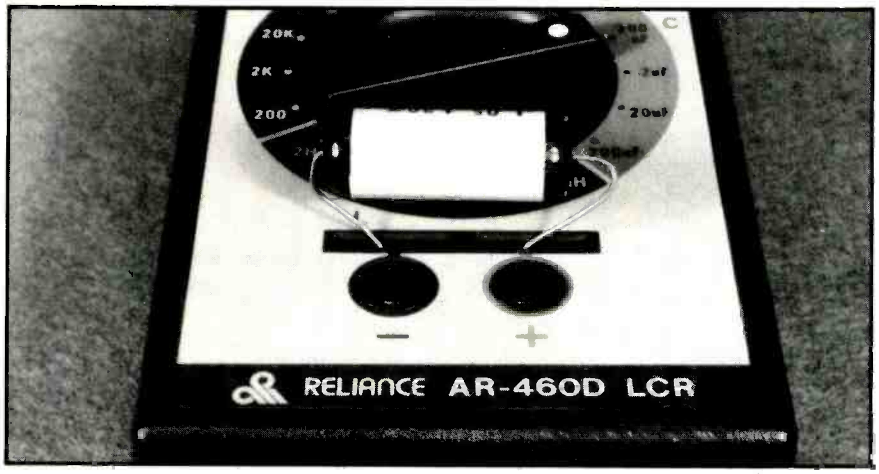
- Change the reading in nano to pico by moving the decimal *three places to the right*.
- Change the reading in pico to micro by moving the decimal *six places to the left*.

A complete listing of all the combinations for all five prefixes is extensive, and probably would cover an entire page. Basically, remember that all adjacent prefixes are separated by three decimal places. The biggest problem is remembering whether the decimal is moved to the left or to the right. Incidentally, between units and pico there are 12 decimal places.

Color coding is used on the AR-460-D's front panel. Around the large black selector knob are three areas where the ranges are marked. A black sector with light gray lettering identifies the five inductance ranges. Higher at the left, a brown segment with light gray lettering identifies the six resistance ranges, and at the right of the large



The multipurpose wire on the meter's back can be used as a tilt stand, as a carrying bail or as a hanging point for suspension. The latter two uses are performed with the wire bail in the holes nearer the top; while the lower holes are used when the bail functions as a tilt stand or for storage and transportation. In the photograph, the bail is extended to form the tilt stand.



One spring-loaded slit-type connector is located above each input jack, and they are connected to the input jacks. Lightweight components with short leads can be plugged into the slit connectors during tests. A capacitor is shown here being checked, but small chokes or resistors can be connected the same way.

knob is a red segment with black lettering and the seven capacitance ranges marked.

Another feature causing model AR-460-D to closely resemble many small digital multimeters is the two input jacks for banana plugs. In addition, these input jacks are connected to two long narrow spring clips inside the meter just above the two jacks, thus allowing an out-of-circuit capacitor, for example, to be plugged into the two clips for testing. For components that can be connected that way, the tests are much faster.

Another useful feature is the loop of heavy wire on the back side that can be stored in a groove of the plastic cabinet and secured by a plastic catch. When desired, the wire can be extended from the meter body and used as a stand. It can be used to hang the meter from above as a carrying bail.

It is important that technicians who operate the AR-460-D understand the normal readouts for inductance, capacitance and resistance when the test leads are shorted and open. For example:

- *Inductance* – With test leads shorted together, the readout showed almost zero inductance with excessive dissipation. In fact, the 200μH and 2H range dissipations overranged. With the test leads open, overrange is indicated for all ranges with very low dissipation readings of approximately 0.01 to 0.02.
- *Capacitance* – With the test leads shorted together, the 200pF, 20μF and 200μF ranges indicated overrange with excessive dissipation and varying readings, while the remaining ranges indicated near zero with varying dissipation. With an open circuit at the test leads, the capacitance ranges read 0.00 but the dissipation readings jumped constantly high or low erratically. The operation manual states this is normal.
- *Resistance* – When the test leads were shorted together during resistance tests, the readout indicated near zero for all ranges. With the test leads open, all ranges activated the overrange readout. These resistance functions are the same as those in digital multimeters.

What is a dissipation factor

In the American Reliance model AR-460-D, circuit operation of the dissipation factor is a mystery to me. Neither the literature nor the operation manual gives the basic principle of operation or states what is being measured or how.

The instruction sheet says the D factor evaluates the internal leakage of capacitors or the internal series resistance of inductors, but it does not explain why the primary inductance of a *power* transformer is reduced to near zero when one of the secondary windings is shorted.

The operation manual says a 1,000Hz signal is used for capacitance and inductance measurements. Oscilloscope tests showed 1,000Hz sine waves continuously at the test probes when capacitance and inductance tests are selected.

Many experiments were tried in efforts to discover how the dissipation factor was measured. For example, when the meter range was not changed but a capacitance box produced capacitances from very small to 0.22μF, the ac current certainly increased with each increase of capacitance. Problem: The current change did not track with the dissipation readings made simultaneously. Many other tables were made involving other parameters, but none pointed to a reasonable explanation.

Comments

In just a few weeks, American Reliance Model AR-460-D has become a valued part of my bench test equipment. Of course, it does not replace a digital multimeter, but an AR-460-D and a good DMM work very well together.

Model AR-460-D sells for $199.95. Therefore, in many shops, each bench man can have one permanently without sharing it with several technicians. It is a meter that in the first few months will save more than the meter's cost in time saved. ES&T

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Circle (12) on Reply Card

Learning from a TOUGH DOG TV repair

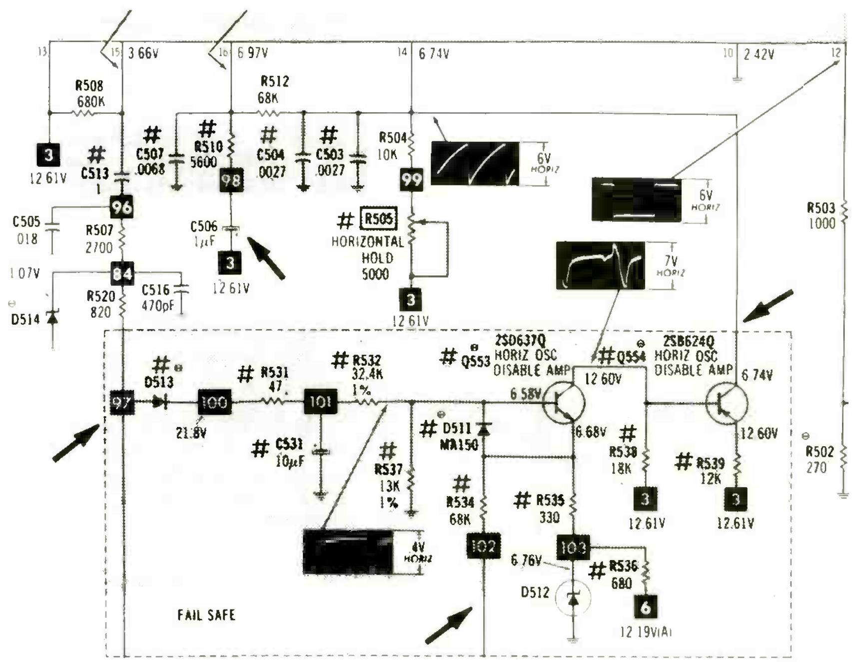
By Max Goodstein

In every technician's life, one difficult troubleshooting incident makes him wish he had chosen another profession! For me, the problem television was a Panasonic CT9000 (Photofact 2046-1).

The television receiver lost horizontal hold after 30 minutes. By spraying the horizontal-oscillator components with a cooling spray, I hoped to identify the heat-sensitive one. Cooling IC401, the horizontal-oscillator integrated circuit, appeared to help, so I replaced it. The problem was unchanged.

All components of the horizontal oscillator were tested in-circuit and a few tested out-of-circuit, but no defects were found. Then I noticed transistors Q554 and Q553 in a system called horizontal-oscillator disable circuit, with a direct connection to the horizontal oscillator in IC401 at pin 14. When the HV current, or the HV amplitude or both become excessive, the circuit operates to force the oscillator far out of frequency where the hold control cannot achieve locking.

Evidently, the disable circuit was being triggered. But the question remains: Was the high voltage actually excessive, or was the



In the fail-safe horizontal-oscillator *disable* circuit, excessive amplitude of flyback pulses at D513 produces dc voltages at the Q553 base that exceed the emitter voltage, which is stabilized with a zener. The resulting Q553 collector current lowers the Q554 positive base-to-ground voltage. This is forward bias for PNP Q554, which saturates Q554, causing nearly zero volts E/C. Therefore, the +12.6V source is connected through 12kΩ R539 direct to the oscillator pin 14 in IC401, forcing the oscillator far out of frequency. The same action occurs when a less-positive voltage from the low end of the HV winding reduces the Q553 emitter voltage, thus producing C/E current in Q553 that in turn triggers Q554, etc. Horizontal frequency problems also can be caused by components in the *frequency-control* section. C503, C504 or C507 might produce loss of locking if it had heat-sensitive leakage. C506, an electrolytic, might cause picture instability if open, or locking problems if leaky or shorted. Don't forget these are part of the oscillator circuit, also.

disable circuit defective? At B+ fuse F002, the voltage was higher than the required +123V, and the base voltage of Q801 was about +150V when +124V was called for. Evidently the excessive low-voltage supply was increasing the flyback pulse's amplitude, in turn triggering the disable circuit.

Ohmmeter tests of resistors, capacitors and diodes in the low-voltage power supply around Q801 soon located a shorted D802.

Diode D802 was replaced, but the horizontal hold still could not be locked. I removed the Q801 regulator transistor from its mounting to check the forward and reverse resistances with my VOM. There seemed to be base/emitter leakage in the 2SD692 Q801 transistor. The ECG substitution manual suggested an ECG243 as replacement for the 2SD692, which is a Darlington type. Because I didn't have an ECG243 in stock, I substituted an ECG284 NPN type with disappointing results. The picture showed a 60Hz weave, and the audio had hum. *Installation of the proper ECG243 cured the horizontal-hold problem.* Incidentally, the schematics show Q801 as a conventional bipolar type, but the one removed and the new replacement both were Darlingtons.

More problems

About a week later, the customer called me. The repaired receiver had stopped all operations except for a periodic loud thumping sound from the speaker.

Back at the shop, I found the voltage at B+ fuse F002 varying from 50V to 55V in step with the slow motorboating sound. When fuse F002 was removed, the voltage rose to about +120V. I removed the horizontal-output transistor (Q551) and checked it for leakage. There was no leakage, but I replaced it for a test anyway. The condition did not change.

Next, I scoped Q501 horizontal-driver transistor's base for horizontal pulses from IC401. Nothing but *hash* could be seen, even with maximum scope gain. The IC401 horizontal oscillator IC and Q801 regulator were replaced (for the second time), but the problems were unchanged.

Then I realized that the +123V supply (through R455) powers the horizontal and vertical oscillator sections of IC401, and because of the very low B+, the IC401 horizontal oscillator would not function. With the receiver power unplugged, I connected an external 12V supply to pin 13 and ground, and was rewarded with beautiful horizontal square waves at pin 12.

But now I'm confused. What is causing the low B+ voltage? Is it leakage? The resistance of the B+ 12V supply as measured from the Q552 emitter to ground was about 380Ω. According to the schematic, the +12V source returns to ground through 680Ω R751 and a winding of T751, the pincushion transformer. Where is the additional load? I substituted +12V (from my modified old CRT checker) to the +12V source at Q552's emitter, but the voltage dropped to +8V.

Continued on page 57

Test your electronics knowledge

By Sam Wilson

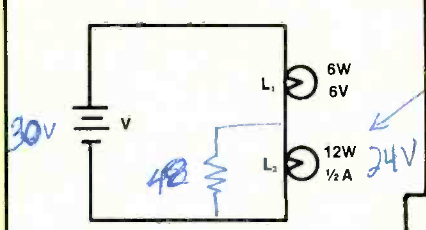


Figure 1.

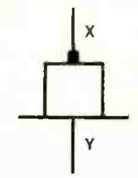


Figure 2.

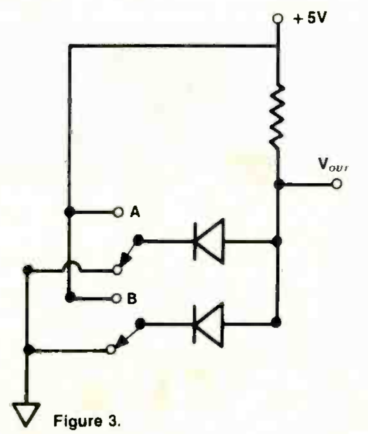


Figure 3.

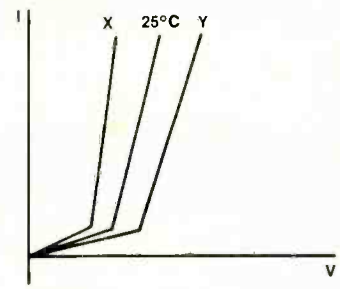


Figure 4.

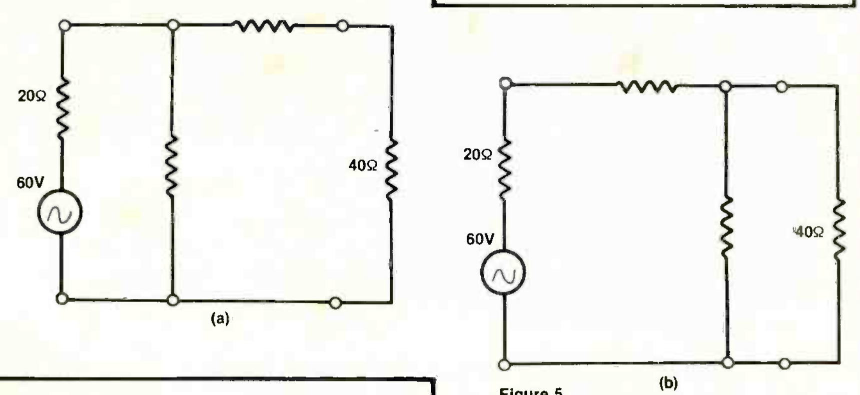


Figure 5.

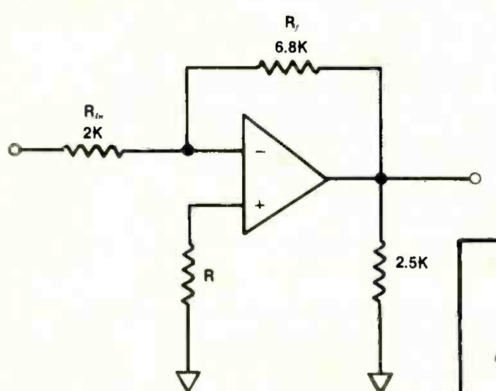


Figure 6.

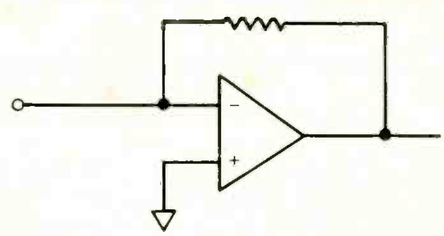


Figure 7.

1. Show how you connect one resistor in the circuit of Figure 1 so that the rated current can flow through each filament. What is the resistance of the resistor?

2. What battery voltage is required for the circuit of Figure 1?

3. Which end of the diode in Figure 2 is the cathode?
A.) The one marked X.
B.) The one marked Y.

4. Assume that +5V represents logic 1 and 0V represents logic 0. (Disregard any voltage drop across the diodes.) The circuit of Figure 3 operates as
A.) an AND.
B.) a NAND.
C.) an OR.
D.) a NOR.

5. Which of the following is NOT a requirement for an operational amplifier?
A.) Differential input
B.) Zero volts input and output (with no signal)
C.) Linear rolloff
D.) A positive and negative (long-tail) power supply voltage

6.) Comparing 3-layer diodes and 4-layer diodes, which is unilateral?
A.) 3-layer diode
B.) 4-layer diode

7.) Which of the diode characteristic curves in Figure 4 is for temperature above 25°C?
A.) The curve marked with an X.
B.) The curve marked with a Y.

8.) Which of the circuits in Figure 5 is correct for a minimum loss pad?
A.) The one shown in (a).
B.) The one shown in (b).

9.) For the inverting operational amplifier of Figure 6, the value of R should be slightly over ________.

10.) The circuit of Figure 7 is
A.) useless.
B.) an inverting voltage amplifier.
C.) a current-to-voltage converter.
D.) a differentiating amplifier.

Answers are on page 61

TROUBLESHOOTING Horizontal ICs

By Homer L. Davidson

PART 2

This is Part 2 of a 2-part article. "Troubleshooting horizontal ICs" began in the February 1987 issue of *ES&T*.

No vertical or horizontal locking

The picture on a Sharp 13D38 (Photofact 1934-2) was moving horizontally and vertically. It could not be locked with the vertical-hold control or the horizontal-hold control. I checked the dc voltages of all IC501 pins, comparing the readings against the schematic. Pin 10 (vertical hold) and pin 2 (horizontal hold) measured slightly less than called for by the schematic – not enough for concern.

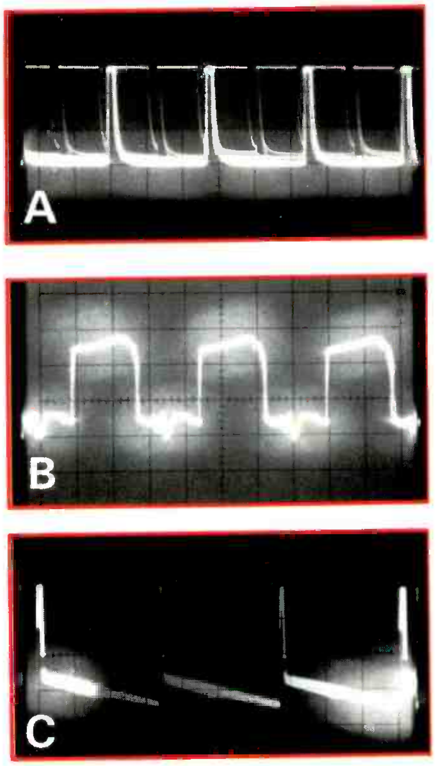
Normal horizontal-sync pulses were scoped at pin 16. A 470µF 25V electrolytic capacitor was paralleled across the +11.9V supply because hash from poor filtering has been known to cause erratic sync in some previous repairs. The parallel capacitor did not change the unstable picture.

Finally, we replaced IC501 (with SK3921) and the problems were solved; both vertical and horizontal then could be locked correctly.

Circuit analysis – Figure 3 shows very little except those four voltages and waveforms that are so important for IC oscillator troubleshooting. Incoming horizontal sync at pin 16, +9.9V supply at pin 15 and horizontal near-square waves from pin 4 for the horizontal-driver transistor are all self explanatory. The sawteeth (ramps) needed for pin 1 are formed from flyback horizontal pulses by series resistance R602 and paralleling capacitor C601 (nearby components do not change the basic sawtooth shape).

Pin 2 obviously can be called the oscillator pin because it has the hold control. Not so obvious are the factors that determine the unlocked horizontal frequency. Capacitors and resistors make up an RC time constant. R608 plus R606 vs. C604 plus R607 form the basic time constant. However, there is one more important factor determining frequency: the dc voltage present. This is the element that is varied to accomplish locking; the dc voltage is varied in two ways. Variable voltage from R608 hold control is the most obvious. But there is another source not shown in Figure 3. In reality, R604 connects to R603 with fast and slow time constant filters between the junction and ground. If the horizontal attempts to drift, the correction voltage from pin 1 is filtered and applied to the oscillator pin 2 where it corrects the frequency. Pin 1 appears to be the only entrance for phase-comparison sawteeth, meanwhile doing double duty as exit for the dc error-correction voltage. The horizontal sync pulses entering at pin 16 comprise the other signal for the phase-comparison circuit.

The quality of C604, C607 and R606 must be excellent, especially regarding performance when heated. Substituting ordinary ceramics for C604 and C607 is almost certain to cause horizontal-frequency drift problems.



These waveform photographs are typical of those found in many of the solid-state color TV receivers. (A) Horizontal sync pulses typically have faint lines in between the pulses. They are caused by interlaced scanning. (B) Horizontal pulses (almost square waves) at the IC output pin might have this appearance, although not all look the same. (C) This is the waveform from the IC vertical-output pin in one model. Again, not all receivers have the same waveform.

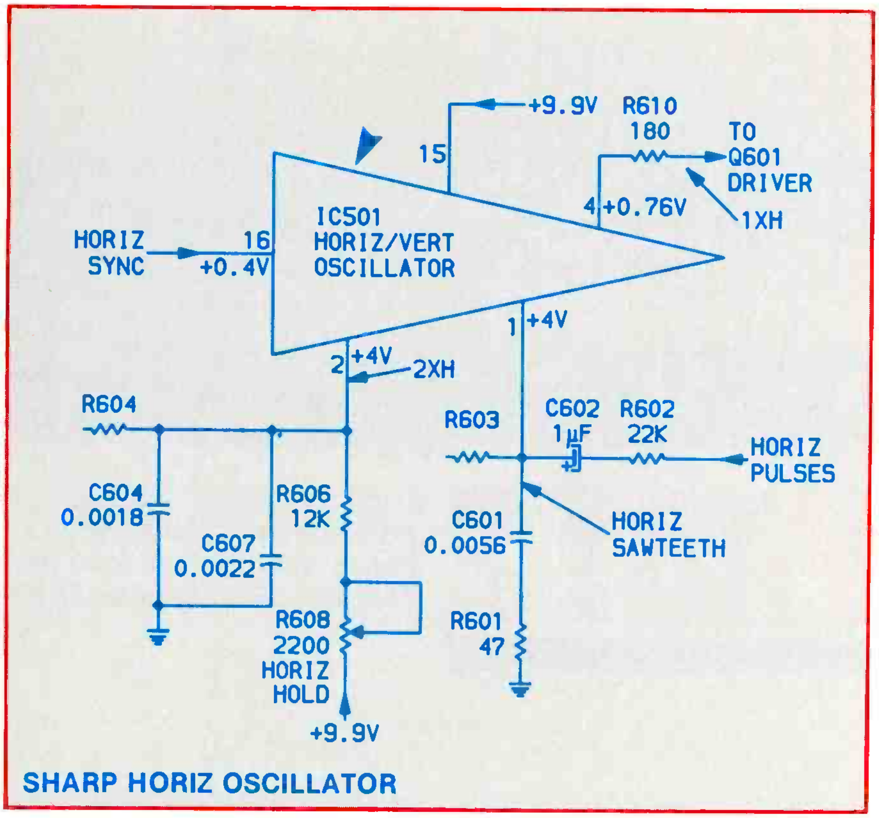


Figure 3. The horizontal oscillator of this Sharp 13D38 (Photofact 1934-2) is typical of many from Japan, except for details. The oscillator output, sync input, horizontal pulses and sawteeth input and the B+ supply are all identified. One thing is different from some: The oscillator operates at double horizontal (31,468H) and a single divider provides the essential 15,734Hz where the signal emerges at pin 4. Critical components here are C604, C607 and R606.

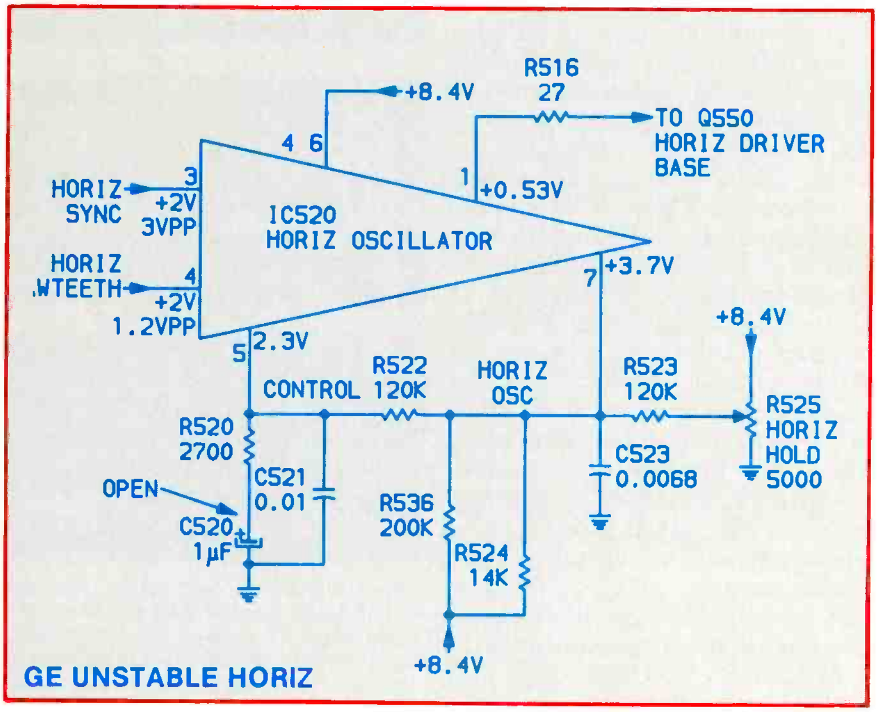


Figure 4. Again the three important waveforms and the B+ voltage are identified in the General Electric 10AA-A receiver (Photofact 1757-1). R524 (14K) and 0.0068µF C523 are critical for thermal drift in this model. Also, R523 and C520 can present problems at times. All are in the oscillator circuit, except C250 that is in the frequency-control circuit (where sync and sawteeth are compared). In this case, C520 was open and erratic.

One other thing about the circuit is unusual: IC501 has a divider internally, so the oscillator operates at 31,468Hz and the divider provides the required 15,734Hz for the driver transistor.

Erratic horizontal locking

After a General Electric 10AA9406 (Photofact 1757-1) was operated for a few minutes, the horizontal frequency would drift. Resetting the hold control restored the locking for a time. But after about half an hour the maximum horizontal-hold adjustment could not bring the picture into lock.

Because the oscillator pin 7 (Figure 4) changed only from +3.83V when locked to +3.88V when out-of-lock, we decided the IC might be at fault, and replaced IC520. Unfortunately, the performance was not improved. The next suspects with drift problems are resistors or capacitors that change from the heat of operation. And, of course, electrolytics cause more problems than do those that are wound in plastic. The only electrolytic in the oscillator circuit is the 1µF C520. When tested with a digital-readout capacitance meter, it showed only 0.07µF.

Replacing C520 with a good-quality 1µF capacitor stopped all the horizontal-frequency drifting and brought stability to the R525 horizontal-hold adjustments.

No sound or picture; one resistor hot

While testing dc voltages in a JC Penney 685-2069 color receiver, I measured +158V at the collector of the Q551 horizontal-output transistor and a complete loss of horizontal sweep. Scope waveforms showed no drive signal at the Q551 base.

When tests were made around horizontal-driver transistor Q502, the most obvious symptom was the smoking heat of 1,200Ω resistor R516 (Figure 5). Except for such rare problems as an errant solder splatter or a winding-to-core short in the driver transformer, the only component that can draw excessive current through R516 is Q502. Two defects involving Q502 can cause excessive collector current through R516. The transistor can be leaky, or Q502 might be getting too much positive base voltage from IC401 pin 1. The +2.5V collector voltage could indicate either.

However, when the Q502 base was grounded, R516 ran hot no longer, and the collector voltage was very high, indicating good transistor action without any serious collector leakage. The base ground was removed, and the tests moved to IC401. Pin 1 had no horizontal pulses. More important, pin 11 voltage checked only about +1V where +12V is normal. The resistance from pin 11 to ground was tested and the reading was very low. Pin 11 was unsoldered from the circuit board and checked again. Now it measured 87Ω to ground. There could be no question: IC401 was defective.

An IC401 HA11235 (obtained from JC Penney or Goldstar) was installed and *normal operation was restored*. To prevent a delayed failure, resistor R516 (that had been overloaded so much) was replaced and the receiver given a long heat run.

Intermittent raster

After a Sylvania with a E05-1 chassis (Photofact 1420-2) was operated for about two hours, the raster would collapse. I suspected some component was breaking down from heat. But the question was: which component?

An excellent first step in troubleshooting is to connect a dc voltmeter to the low-voltage B+ power supply and a scope to the horizontal-output pin of the oscillator IC. Then after the raster leaves, read the meter and observe the scope waveform and amplitude. Very often the changed voltage or waveform will indicate the problem area, or show where the next tests should be done.

There was one result from using that method with the Sylvania: the +24.5V supply source was lowered severely when the blackout

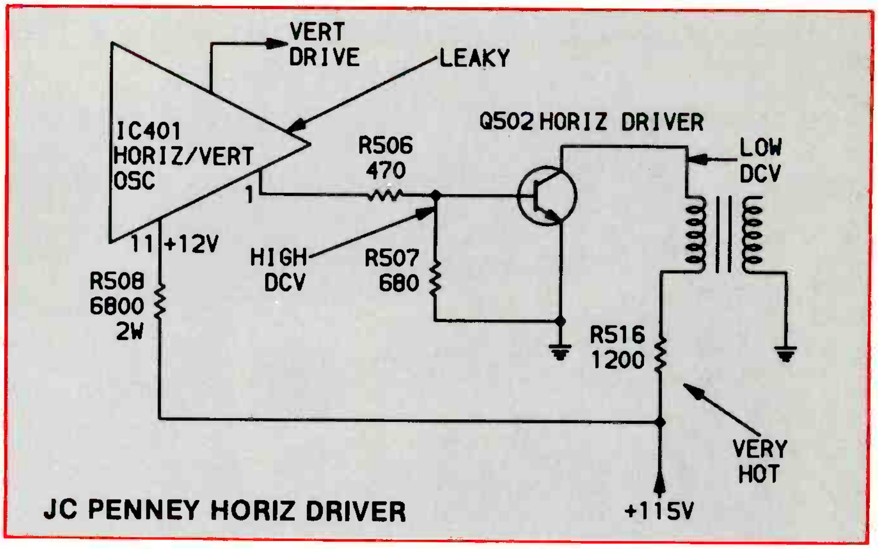


Figure 5. With model 685-2069 JC Penney television (Photofact 2239-1), the burning heat of R516 was the most prominent symptom. Q502's collector voltage was almost zero (which accounted for the R516 heat), although its base voltage was too positive, as was IC401 pin 1. However, pin 11 measured a very low resistance to ground. Therefore, IC401 was replaced. Horizontal deflection and HV were restored.

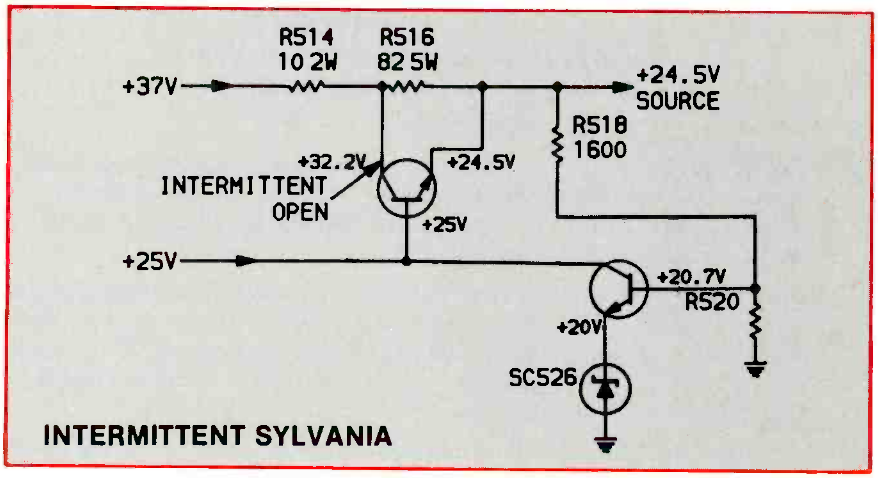


Figure 6. After the EO5-1 chassis Sylvania (Photofact 1420-2) was operated for two hours or more, the raster would disappear. After electronic, visual and mechanical tests, the problem was discovered to be a bad joint at the collector terminal of regulator transistor Q502.

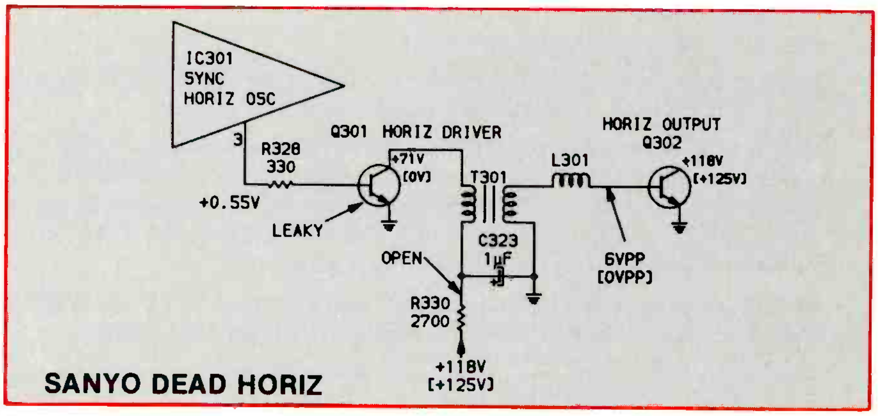


Figure 7. Schematic dc voltages in Sanyo chassis 91C610 (Photofact 2170-1) are shown in the usual way, but the voltages actually measured are shown in brackets. And the dc voltages at R330 input and the Q301 collector indicate that R330 is open. R330 had all the appearances of being too hot, so Q301 must have had excessive collector current. Q301 was tested and found to have high leakage. Replacement of Q301 and R330 brought normal operation; the IC301 pin 3 signal also was normal.

occurred. That clue led to a more detailed examination of the complete low-voltage supply. By moving the circuit board downward, the blackout occurred more often. A combined mechanical and visual series of tests finally located a bad soldered connection at the collector terminal of regulator transistor Q502 (Figure 6).

Removal of the old solder and application of new solder (being certain all areas were tinned properly) stopped the intermittent loss of raster.

No raster—no sound

Many technicians say a dead receiver is easier to repair than an intermittent one. Certainly that was true of the previous intermittent Sylvania vs. the next case, a model 91C610 Sanyo (A2V-61000 chassis in Photofact 2170-1). Nothing worked on the Sanyo. At the Q302 horizontal-output, the collector was measured about +125V without pulses instead of +118V with pulses. Q302 also had no base signal. Pin 3 of IC301 (Figure 7) had a very low amplitude signal when scoped. But most important, zero voltage was measured at the collector of Q301 horizontal-driver transistor, although about +125Vdc was at the other end of resistor R330 where +118V is normal. Of course, R330 was open and Q301 tested very leaky, which, with the usual +70V applied to it, would probably have become a dead short. The excessive transistor current ruined R330.

Q301 was replaced by a universal ECG399, and a new 2,700Ω R330 was installed, bringing normal operation.

Problems! Problems! Problems!

After a leaky Q100 horizontal-output transistor was replaced in an RCA CTC99E chassis (Photofact 1895-1), we heard a continuous arcing sound in the flyback transformer (Figure 8). Immediately, the circuit went into shutdown. After the ac power was *off*, we found that the new Q100 was leaky and ruined.

It was obvious now that the receiver must be operated on reduced line voltage until the problems are solved.

The defective T102 flyback output transformer was replaced with a 154493, and another Q100 part number 146823 output transistor was installed. Resistors 1.2Ω R104 and 0.18Ω R109 showed signs of overheating, and they were replaced also.

A variable-voltage transformer was connected to supply the receiver's ac, and operation was started at about 40Vac with slow increases to about 80Vac without any indication of overload or high voltage. Remember, the CRT heaters are operated from the flyback, so even if a television does operate at low line voltage it is difficult to see a picture.

With an ac input of 80Vac, the Q100 collector voltage was about +140V. This indicated either a total lack of Q100 drive signal or a shorted SCR regulator that had forced the horizontal into shutdown. SCR100 was checked and replaced but those conditions did not change. Evidently the main problem was the loss of Q100 drive.

Then I remembered that the RCA CTC99 has a pulse-type of start-up. That brought another important thought to mind: An inductance in series with the 120Vac line can reduce the amplitude of the starting rush of current and cause intermittent start-up in some receivers that have pulsed-B+ start-up. And a variable-voltage transformer for obtaining any line voltage between zero and 120Vac certainly has considerable inductance when adjusted to about half rotation. Also, the C106 charging current is lower when the line voltage is reduced, and that contributes to the start-up failures.

Therefore, start-up usually will not occur when the receiver has line voltage lower than about 90Vac.

However, there is a solution. With proper precautions and an external power supply, the CTC99

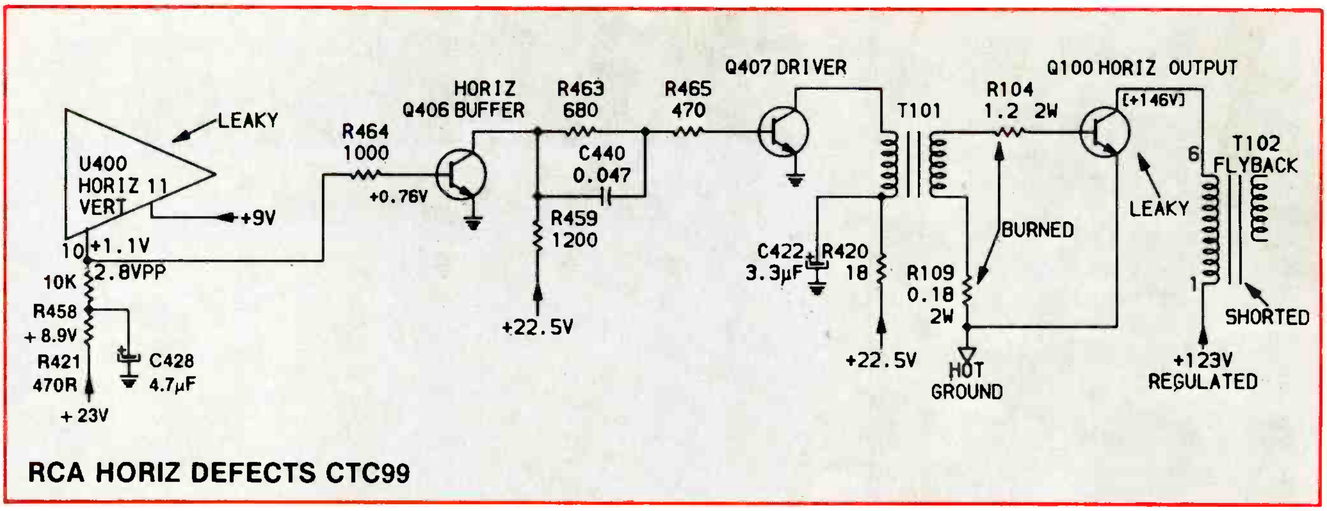


Figure 8. Only the last four horizontal-deflection stages are shown here in simplified form for the RCA CTC99 (Photofact 1895-1). Notice the *hot* and *cold* grounds. For some tests, both can be connected together. But be careful; *all grounds are hot* and become a shock and damage hazard when you try to connect test equipment (that has the third-wire ground) to *any* receiver ground. Sparks probably will fly. Use an isolation transformer on the CTC99. All details of this repair are given in the text plus an 8-point method of using an external voltage supply for the oscillator so the remainder of the chassis can be operated at about 35Vac when a higher voltage would cause damage to transistors or other components.

horizontal system can be made to operate with low power when the line voltage is reduced to only about 35Vac. This ability is particularly valuable in a receiver that does not produce HV or pass all of the sequential waveform tests (to be described) because the horizontal-sweep system has serious defects that could cause extensive and expensive damage if operated at 120Vac.

Operating an RCA CTC99 from lower line voltage must be done carefully. These are the steps I use:

1. With ac plug removed, connect the rear chassis rail (cold ground) to the C106 negative terminal (hot ground). Operate the receiver from an isolation transformer to prevent shocks and shorts.

2. Connect a regulated 200mA, +20V external power supply to TP-13 and cold ground. TP-13 also is at the CR422 cathode and the CR421 anode. Voltages down to about +9V work, but not so well. A +16V to +21V range of steady voltage is satisfactory. Higher voltages produce better waveforms.

3. Adjust the variable-voltage transformer (variac) for about 30Vac, and then fine-tune the line voltage by adjusting for +40V across C106 (near Q100).

4. Apply dc and ac power to the receiver, then turn on the receiver. It is not necessary to disable the SCR regulator.

5. Check the waveform and frequency (repetition rate) of the oscillator at pin 12. Expect almost-sawteeth of about 31,468Hz frequency at about 2Vp-p amplitude. Look for near-square waves at the Q407 collector (metal mounting tab) at about 80Vp-p and 15,734Hz. Finally, the Q100 output-transistor collector should have flyback pulses of perhaps 350Vp-p to 400Vp-p. These pulses should be normal in appearance.

6. Examine the Q100 collector pulses for incorrect waveshapes. Look for narrow ringing on the pulses or an extra-wide pulse midway or so between the normal pulses. The ringing on pulses and a high peak-to-peak reading might indicate an open C117. Broad extra pulses between the normal ones indicate a heavy load on the flyback.

7. If the waveforms stop in the center of the horizontal path, the problem is likely to be in the next one following the last stage having a correct waveform. Perform the usual tests, particularly the B+ voltages and the various signals, keeping in mind that only the oscillator, buffer, driver and output stages have voltage. The IF, chroma, video, sound, sync and all the rest are without B+. When repairs and replacements have provided normal clean 380Vp-p 15,734Hz flyback pulses at the Q100 collector, without sharp ringing or extra pulses, it is safe to unplug the ac power cable and remove the jumper wire between cold and hot grounds. Also, disconnect the external dc-voltage supply.

8. While watching the horizontal section, apply normal 120Vac to the receiver. If all defects have been found and all repairs properly made, the receiver should work normally. Finally, test the safety shutdown operation by connecting XT to XT1. The receiver should go into shutdown. If it doesn't, you must repair the X-ray latch and detector circuits.

When first turned *on* with the 120Vac power, if the receiver operates but not correctly, it is necessary to do more troubleshooting. But do not connect the external jump-start power supply unless necessary to substitute for a start-up circuit that is not working at all, or (as detailed previously), to permit operation of the Q100 stage with very-low dc voltage.

Meanwhile, at the CTC99– When the 8-step testing sequence was applied to the CTC99, all went well until step 5. No 31,468Hz sawteeth were scoped at pin 12 and no 15,734Hz square waves for the buffer were scoped at pin 10. Several more tests indicated U400 was defective, therefore, we replaced the U400 oscillator/count-down IC with a part number 145803. Afterward, strong horizontal-drive broad pulses came from pin 10 to Q406 base. Sufficient amplitude horizontal pulses without ringing or other smaller pulses were scoped at Q100's collector, so we assumed the receiver was ready for higher voltage. Q100's collector at that time measured +40V.

The external dcV supply was removed and the line voltage increased to 90Vac for a trial run. Sound and picture started just as they should. When the line voltage was increased to the rated 120Vac, performance was excellent. When terminals XT and XT1 were shorted together, the receiver instantly went into shutdown, as it should. Reset of shutdown for full operation occurs when the receiver is turned *off* for a short time (or longer) and then switched back *on*. The reason for the short delay is that C106 must completely discharge before its next charging current can supply sufficient voltage for dependable start-up operation.

Some of the components mentioned here are not part of Figure 8, but can be found in Photofact 1895-1. For example, C106 is the large metal-can filter capacitor mounted vertically near the horizontal-output transistor. We suggest you use the Photofact during troubleshooting, along with the 8-step sequence.

Finally, the CTC99 operated correctly, and I breathed a sigh of relief. Few color receivers require so much intricate testing and such an unusual number of replacement components. Therefore, I operated it for several extra hours on the time-test bench before delivery.

Comments

Although these are genuine case histories, they were chosen primarily for the opportunities they offered for discussing general troubleshooting methods. We sincerely hope this approach has been helpful to our technician readers. ES&T

What do you know about electronics?

Infrared Remote Controls

By Sam Wilson

To avoid the possibility of duplication of information between this column and Audio Corner, which has recently been discussing digital audio, I will now leave the subject of compact discs in Kirk Vistain's capable hands and proceed with other subjects.

In this issue, I will discuss some of the basic components and circuits used in infrared remote controls.

Infrared remote controls

I wish to thank the Fisher Corporation for much of the information that follows.

I have been informed that wired remote controls still are being used for air conditioners and VTRs, but those units will soon be using infrared remote controls.

Ultrasonic remote units require a tuned circuit for each function. This limits the number of functions that can be included in their design. Too many functions result in an overweight and oversized unit.

Another problem with the ultrasonic controls is that they can be fooled by jangling keys and other high-pitched noises.

Infrared remote controls are the logical answer to the problems of the other types. They are portable and lightweight. They use coded signals that cannot be fooled by other infrared sources (such as a hot fireplace).

The wavelength of the most efficient infrared diodes is 940nM. (A nanometer is 10^{-9} meter.) Figure 1 shows the relationship between various wavelengths and the optimum infrared frequency for remote controls.

Figure 2 shows a simplified block diagram of the remote control system.

The viewer's hand-held transmitter is battery operated. This requires special attention because of the high current demanded by the infrared LED.

A pulse modulator is used to chop the LED current (and light output) into pulse combinations that represent binary digits. A different code is used for each function controlled.

The PIN diode in the receiver converts the received infrared pulses into electric impulses. These pulses are amplified and shaped before being decoded.

Depending upon the code received, the output of the decoder circuitry controls the appropriate function in the receiver.

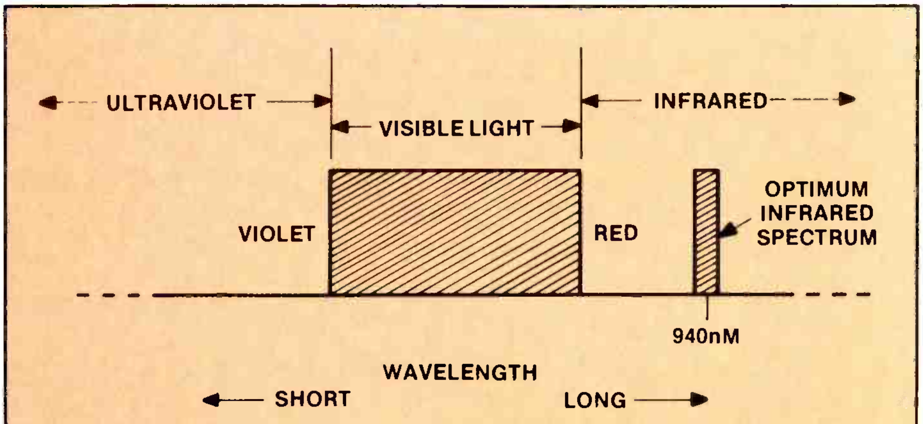


Figure 1.

The infrared LED

The infrared LED works like any ordinary LED. You will remember from a previous article that the energy level of electrons can be raised or lowered. One way to do this is to supply an electric field that attracts the electrons.

In the case of the LED, the applied electric field is used to get the electrons across the junction. This is illustrated in Figure 3. The positive field supplies enough energy to electrons to get them across the depletion region.

After the electron gets across the junction depletion region, it gives up the extra energy in the form of light energy. That light is delivered to the outside world through a very small window.

The thing that makes the infrared diode different from other LEDs is the type of materials used for its construction. Ordinarily, an infrared diode requires between 300mA and 500mA for a continuous emission. That would seriously limit the battery life of the remote control. However, in this application the LED is pulsed so that the current drain is less than 10% of the continuous emission value. This gives a very satisfactory battery life.

The result is a sufficiently average light power (about 5mW) to operate the receiver from a distance of 7M to 10M.

The pin diode

At the receiver, the received signal produces a signal of about 50μVp-p.

The receiver PIN diode gets its name from the fact that it is made with *P*-type material, *I*ntrinsic material and *N*-type material. The intrinsic material is a very lightly doped section between the N and P materials.

To understand the PIN diode operation, refer to the model shown in Figure 4. Observe that the diode is reverse biased. Ordinarily, this would mean that no current is flowing. This is especially true because of the intrinsic layer

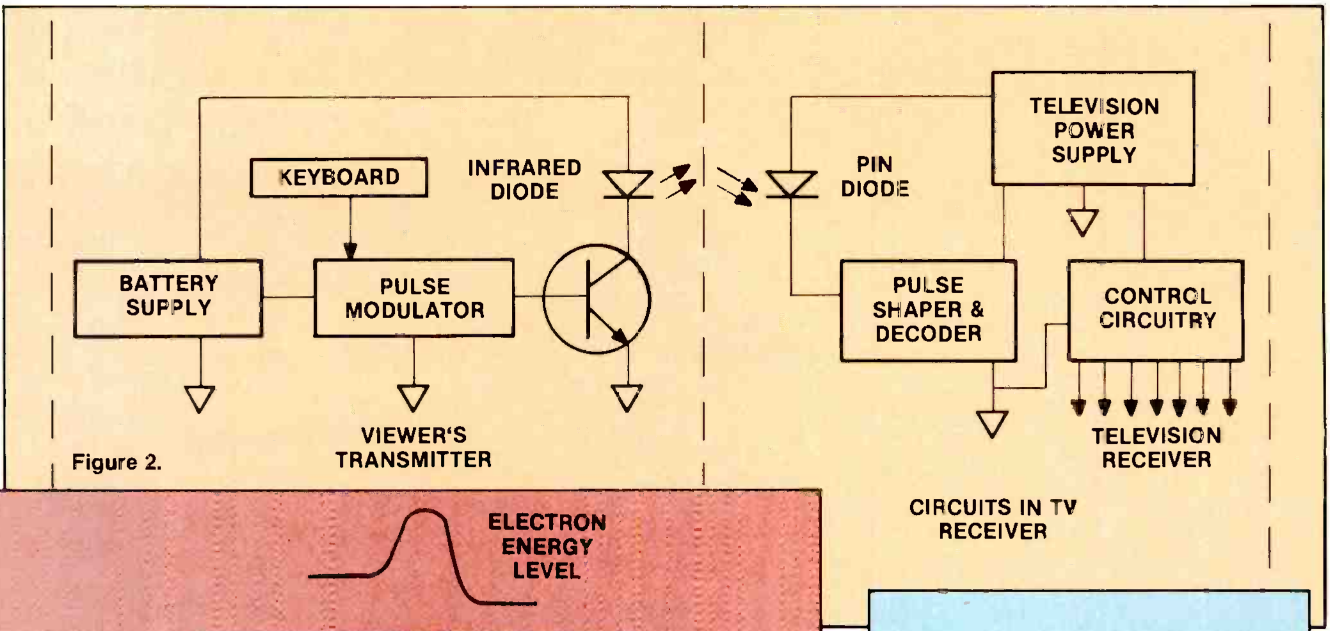


Figure 2.

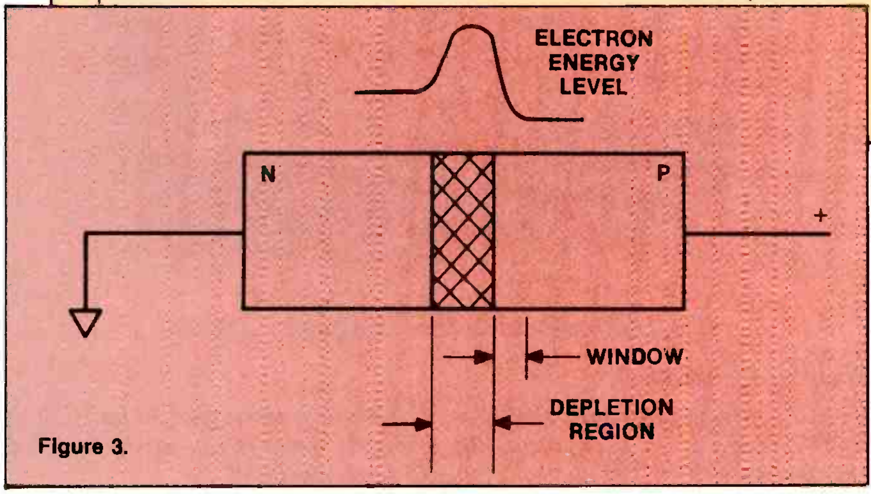


Figure 3.

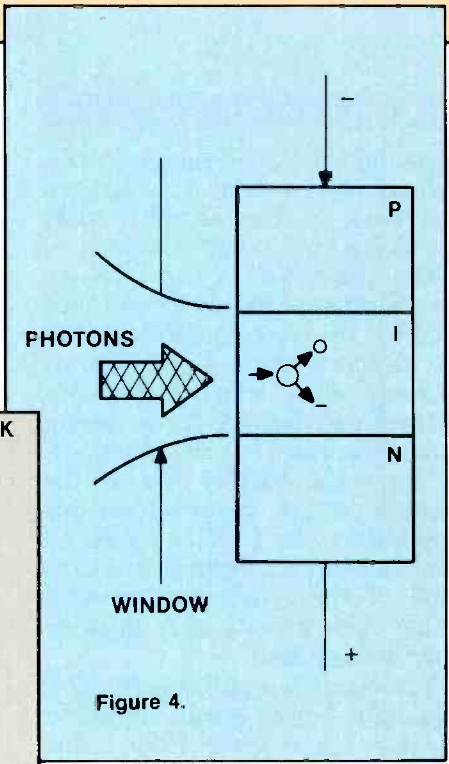


Figure 4.

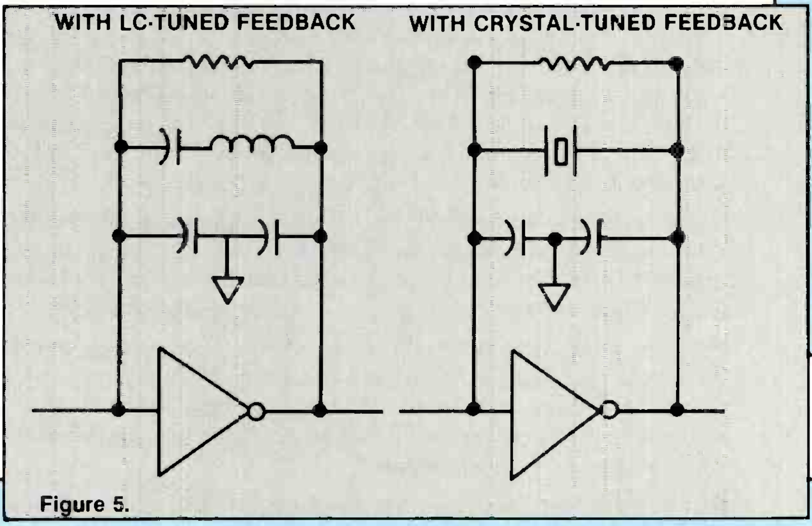


Figure 5.

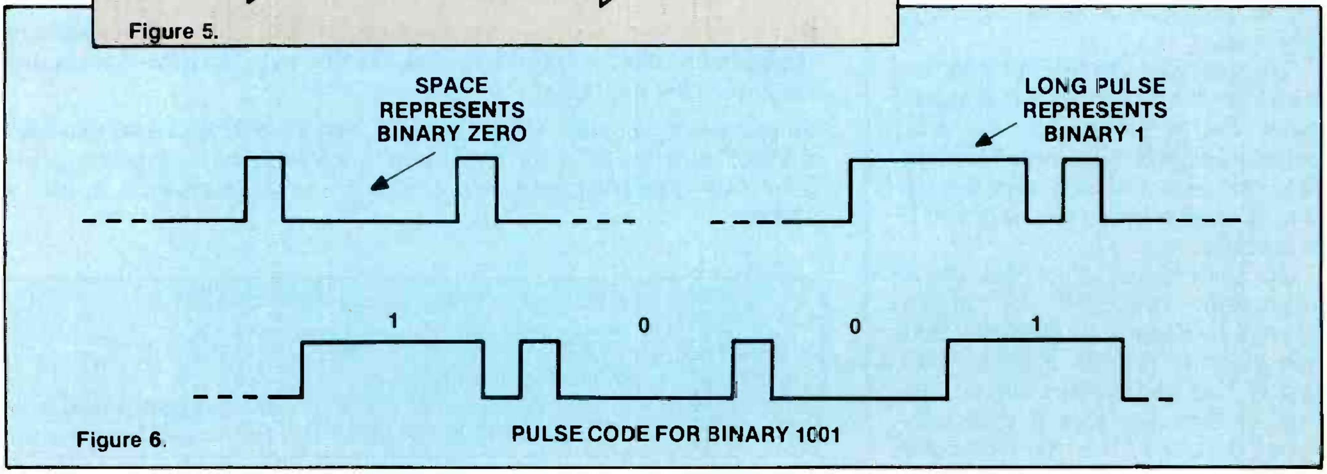


Figure 6.

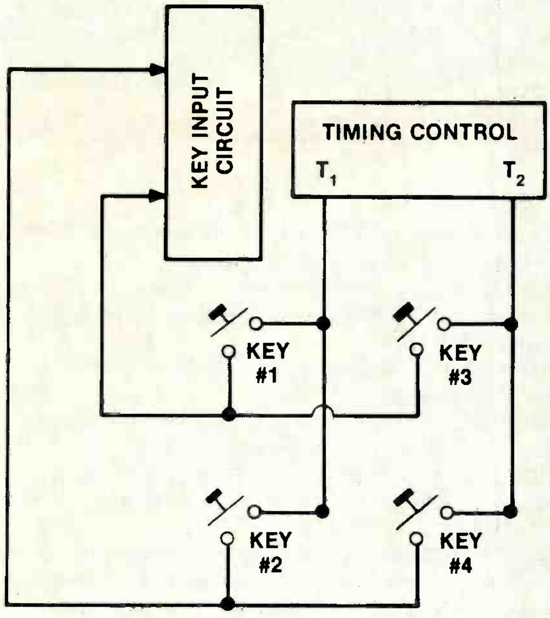


Figure 7.

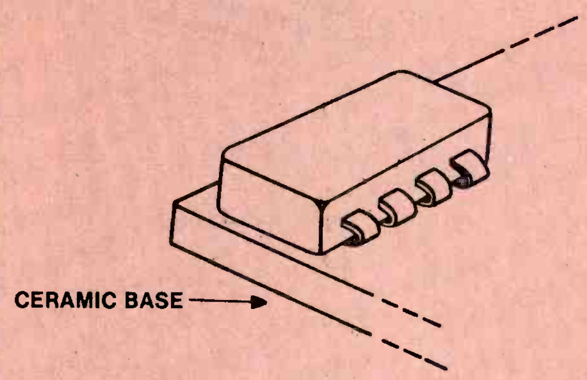


Figure 8.

that is much like an insulator.

When the infrared light strikes the intrinsic layer, the photons strike the atoms and release electron-hole pairs. This converts the intrinsic layer into a conductor, and reverse current flows through the diode.

PIN diodes have other applications in microwave systems, but the action just described explains how they work as infrared sensors.

The oscillator

An oscillator is used in the transmitter. It is needed for pulsing the infrared LED, and also for providing pulses to the modulator.

The oscillator can be made with an inverter as shown in Figure 5. A common cathode, emitter or source amplifier has an output that is 180° out of phase with the input. So, any of those amplifiers can be used as an inverter.

The simplest inverter oscillator is made with an inverter as shown in Figure 5. As with all oscillators, it is an amplifier with tuned regenerative feedback. The tuned circuit may be either an L-C type or a crystal.

An example of a pulse code

There are many different ways to use pulses for representing the binary numbers 1 and 0. The method shown here is for the Fisher REM-885.

As shown in Figure 6, a wide space represents logic 0, and a wide pulse represents logic 1.

In this unit there are two ways to send signals. A *single-burst signal* contains only two cycles of coded information and then stops. An application might be using the remote to turn the controlled system *on* and *off*. You wouldn't want the system to turn *on* and *off* repeatedly, so, a single burst signal would be used.

A *hold signal* repeats the coded transmission over and over—as long as the key is depressed. That would be useful for increasing or decreasing the sound volume of the controlled system. You continue to depress the volume key (using the *up* or *down* position) until the sound is at the desired level.

The keys on the remote unit determine whether the transmitter output is a single-burst or a hold signal. Figure 7 shows how this is done for four keys.

Keys 1 and 2 complete the pulse control circuit to T_1. That is a single-burst connection.

Keys 3 and 4 complete the pulse control circuit to T_2. That is a continuous output (hold) connection.

In the next issue, I will continue the discussion of infrared remote controls.

More on surface mounts

You can learn a lot by studying how manufacturers of surface-mount circuits work with their products.

Figure 8 shows a surface-mount component mounted on a ceramic base. To solder the component in place, first attach it to the ceramic with a paste. The complete unit then is heated to the point where the paste turns to melted solder. Cooling is the final step.

To remove the component, the board again is heated to a temperature just below the melting point of the solder. Then, a hot air stream is directed to a point directly below the component to be removed.

The additional heat melts the solder making it easy to remove the component. ES&T

Azimuth recording: the way to eliminate crosstalk between VCR video tracks

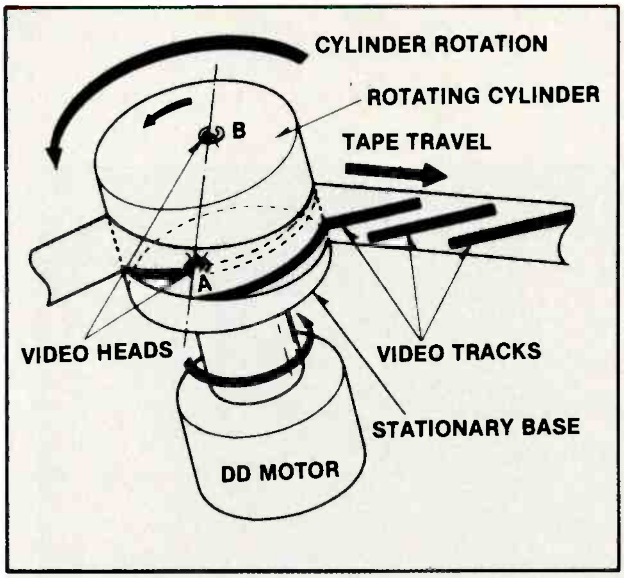


Figure 1. The video heads of a VHS VCR are moved across the tape, while the tape is moved past the head cylinder.

The designers of VHS VCRs for use in the home were faced with a nice set of requirements:

- First of all, of course, a home VCR had to have picture and sound quality at least as good as, if not better than, broadcast television.
- It had to be small enough to fit into the average living room unobtrusively.
- It had to be capable of playing back a tape that was long enough to hold an average-length movie.

This, of course, is far from a complete set of requirements, but it gives an idea of what the designers were up against.

One consequence of the size requirement was reduction of the size of the head cylinder compared to those found in existing professional and broadcast video recorders. And, in order to pack enough program material onto a reasonably sized cassette tape, it was necessary to make the recorded tracks narrow and close together. All of these things taken together resulted in a VCR with extremely small heads, having narrow gaps ($0.3x10^{-6}$ meters). That's three-tenths of a micron or 12 millionths of an inch. Just by way of comparison, a typical human hair is three thousandths of an inch thick or about 250 times the dimension of a VHS VCR head gap.

Even though the recorded tracks are narrow, when you're recording in SLP mode the tracks are not just close together, they're overlapping slightly. If some steps were not taken to avoid it, the consequence would be crosstalk – that is each frame of the TV picture would contain some of the information from the previous frame and from the next frame. This crosstalk is avoided by using a technique called azimuth recording.

The term *azimuth* can be traced back to its Arabic and

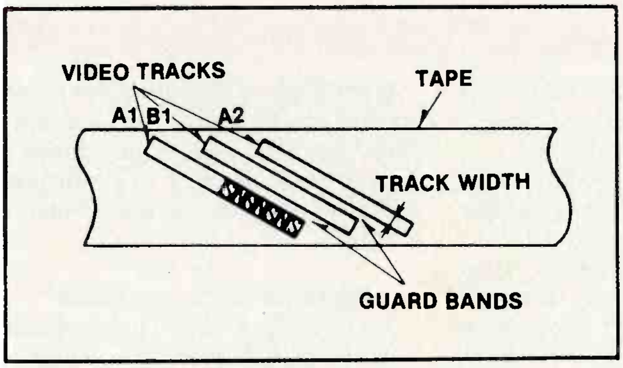


Figure 2. Because of the heads' motion relative to the tape motion, the video tracks are laid down on the tape as a series of slanted bands with unrecorded areas (guard bands) in between. In SLP mode, because the tape moves slowly past the heads, the guard bands disappear; the video tracks overlap.

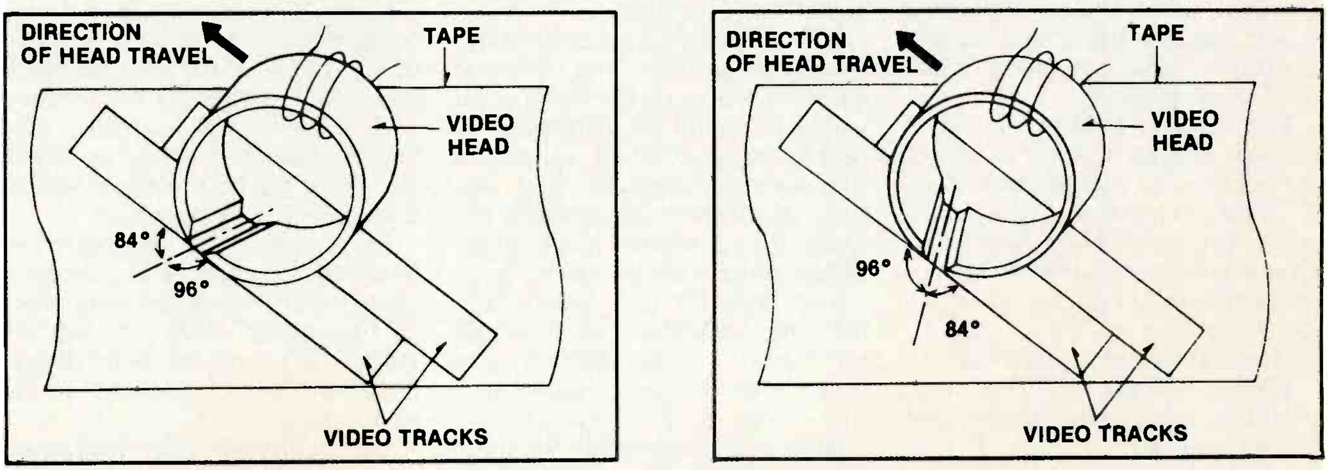


Figure 3. In azimuth recording, the video heads are set at an angle of 12° relative to each other (one head is at +6° to the perpendicular, one is at −6° to the perpendicular). With this system, even though alternate tracks overlap, there is no crosstalk.

The term *azimuth* can be traced back to its Arabic and Latin origins in words meaning, more or less, "the way."

Latin origins in words meaning, more or less, "the way." In ordinary speech it means an angular distance from a fixed point, usually due south. The term was borrowed by audio engineers to describe the angular deviation of an audiotape recorder head gap from the perpendicular, that is, any deviation from a right angle to the direction of tape motion. That usage of the word azimuth has been extended to video heads.

If a recorded track is laid down with the head at one azimuth angle and played with the head at another azimuth angle, the reproduced signal is attenuated. Depending upon the magnitude of the angle, the frequency of the recording and other considerations, the signal will be attenuated to a greater or lesser degree.

This characteristic is used to advantage in VHS VCRs by installing one video head at an azimuth of +6° and the other video head at −6°. By doing this, alternate tracks are recorded at an angle of −12° to each other. Therefore, in the SLP mode, even though the head that is actively playing back a track also is traveling across the portions of the two adjacent tracks that overlap it, little signal is generated by the overlapping tracks because they are at the wrong azimuth angle.

This article is adapted from, and the illustrations taken from, the GE Videocassette Recorder Service Manual for the model 1CVP2020X VHS VCR.

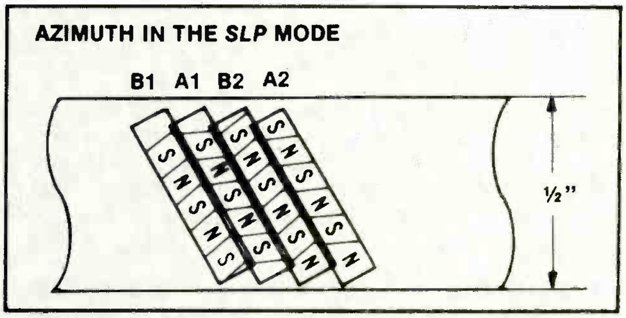


Figure 4. This representation of the video tracks in SLP mode shows the overlap of the tracks. Note, however, that the alternating north and south magnetic poles are at an angle to those of alternate tracks. This is the result of azimuth recording, and eliminates crosstalk from track to track.

Computer Corner

By Bud Izen CET/CSM

More about getting started in computer repair

TIPS

- **Major brands are easy to service.**
- **Needed: schematics, diagnostic software.**
- **Smartest to work on brands sold locally.**
- **Get friendly/closest authorized dealer.**

The last installment of *Computer Corner* covered some of the aspects of getting started in microcomputer repair. This installment completes that task. One thing that is nice about servicing the major brands of computers is that most are easy to service. For example, the top of the Tandy line, the 3000 series (HD and HL), come apart by removing only three identical Phillips head screws off the back. Inside, one size Phillips head screw is used for all purposes, both holding peripheral cards in place and for holding sub-chassis to the main chassis. As far as I am concerned, that rates an A+ for serviceability!

One thing that is nice about servicing the major brands of computers is that most are *easy to service.*

Computers are made to be serviceable, but you will still need schematics and, more often than not, diagnostic software. Schematics, in many cases, can be obtained from either Sams or the manufacturer. Diagnostic software can be obtained from many sources, including the manufacturer, computer users' groups, and independent sources like Norton Utilities. I will be devoting a future column or two to using disk-based utilities.

Some computer manufacturers have gone out of their way to help the service technician.

Some computer manufacturers have gone out of their way to help the service technician. Zenith Data Systems, for example, has "burned" diagnostic routines, both high and low level, right into their monitor ROM. By changing one jumper on the circuit board in some models, all these utilities become available. This, too, will be covered in a future article.

Regardless of the size town or city you live in, there is probably a computer retailer somewhere near you. If you are smart, you will start out by confining your labors to working on brands that are sold locally. There is one very crucial reason for this: parts availability.

As in all types of repair work, doing the diagnosis is not much good if you can't replace the defective parts afterwards. Now, depending upon the type of computer as well as the specific part needed, parts procurement varies from easy to impossible. For example, with regard to most IBM "clones," which are machines functionally equivalent to a specific IBM counterpart such as the PC, XT, or AT, just about every part is a standard one, available "off the shelf" from any digital parts mail order or wholesale house. On the other hand, if you are working on a Commodore 64, just about everything except the memory chips is going to be a special IC, available to my knowledge, from nowhere other than a Commodore authorized dealer.

I am sure you are a bit ahead of me at this point. Your best bet is to get friendly with the closest authorized sales dealer for the computer or computers you want to repair. This arrangement can be mutually profitable. Most individual dealers neither have the inclination or the know-how to run a profitable service department. If you can meet with the owner and figure out an arrangement, that person can act for you with the manufacturer to obtain parts and service literature. Then, the dealer can give *you* the repair work, either by referral or (more likely) by accepting the work directly and giving it to you on an independent contractor basis. That way, you can make money efficiently and the dealer can resell your repairs, making something as well.

Meet with the owner (of a sales dealership) and figure out an arrangement.

What happens if you cannot get cooperation from your local computer dealers, as sometimes happens? Well, what I would do then is to do what one of my associates did. He called around the region until he found an out-of-town dealer who did not feel threatened by a repair dealership over 30 miles away, and now my associate gets his parts through the mail. Slower service is still better than no service.

...don't be afraid to tackle IBM personal computers. They work the same way all the rest do, using mostly standard parts.

By the way, don't be afraid to tackle IBM personal computers. They work the same way all the rest do, using mostly standard parts. The only exception is the ROM, available from IBM only, although again you may be able to find an authorized IBM sales dealer or even a service dealer to sell you one on some type of exchange basis.

Next time, I'll be talking about basic repairs to Commodore 64s, and the following month on disk drive diagnosis on IBM PC-compatible machines. In between now and next month, I'm giving you a homework assignment: Go out and find at least one source of generic computer parts and ICs, and at least one dealer, preferably Commodore, who will sell you parts.

COMING

- **May—basic repairs to Commodore 64s**
- **June—disk-drive diagnosis for the IBM PC compatible machines**

Continued from page 25

I started disconnecting all jumper links on the +12V source and found that many ICs were connected to it, each having a resistance of around 1,000Ω. The R751 pincushion resistor paralleled with all the ICs combined to give the low reading of 380Ω.

I called the Panasonic information line and asked one of the engineers if this was normal. After checking his notes, he said that the +12V source resistance can show as low as 200Ω.

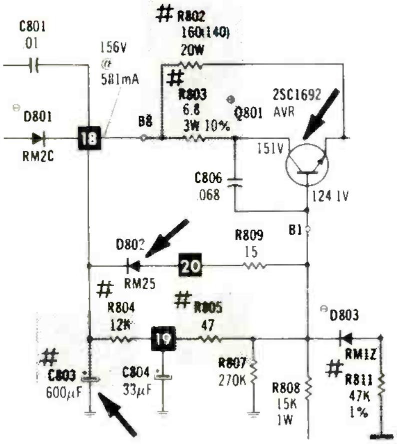
Then I disconnected pin 4 of the flyback from the circuit and the low voltage increased to about 85V with some pulsing. When the vertical output transistors (Q451 and Q452) were disconnected from the circuit board, the low voltage increased to about +110V without the *motorboating*. I concluded that the flyback probably was defective. The symptoms were the same.

Finally, I concluded that I had been troubleshooting the wrong end; the problem must be in the power supply. After a few other things were tried without improvement, I paralleled an electrolytic capacitor across C803 in the power supply, causing the B+ to skyrocket. Suddenly there was high voltage with audio but without motorboating. (C803 is the peak-reading capacitor for the +156V source, and it is the *only* +156V filter capacitor.)

Measuring the B+ fuse voltage confirmed that the voltage now was the required +123V at the lowest setting of R812, the regulator control. What confused me was the tremendous drop in voltage from +123V to +55V; a 125% change in voltage.

Thinking back on my procedure, I realized if I had started by connecting a 100W bulb across the open fuse terminal, I would have seen the bulb barely lit, proving there wasn't a short or severe leakage. Therefore, the power supply would have been indicated. Sometimes the things we learn the hard way are valuable to us in the future.

ES&T



D801 is the ac line-voltage rectifier and C803 is the peak-reading filter capacitor for the +156V supply that is the input for the Q801 voltage regulator which produces +123V for the horizontal-output transistor. In the first repair, a shorted D802 is applied +156V to Q801's base, attempting to raise the +123V to +156V. Of course, Q801 became shorted and ruined. In the second repair, an open C803 produced a low B+ voltage and a pulsing or motorboating symptom.

CD player servicing: testing RF amp and optics

Every time a new type of product arrives on the scene, we're shelling out more money on some jig, test appliance or generator. It seems the folks who are responsible for all this new technology are seldom familiar with field repair, working as they do, in the rarefied atmosphere of an engineering lab. A telling example of this occurs in the adjustment manual for a name-brand VCR. The recommended method for adjusting the FM modulator requires a spectrum analyzer. All to align a $300 VCR! It's just not practical. Change is great, but we all need help learning how to use the few grand worth of test equipment that's already depreciating on the bench.

The RF amp section gives pause to many techs, so that's where I started. Typically the RF amp is tested by observing the waveforms at test points, while the disc is playing. The problem occurs when the player is so messed up it won't play a disc to begin with. With many CD players, the microprocessor shuts the unit down when almost any failure occurs, making it difficult to isolate the cause. Some manufacturers provide a test mode, which disables shutdown, but implementations vary widely, and sometimes you still can't get an *eye* pattern or other waveform to monitor. So we need a method that allows us to check quickly the front end, even if the player is in shutdown or standby mode.

RF amp & optics

For the purpose of testing gain, all you need is a sine wave. A precise simulation of the complex RF waveform (eye pattern) is unnecessary. Figure 1 shows a simple bench setup. The resistor in series with the signal source serves to decouple generator impedence from the amp and eliminate it as a gain deteminant. Without it, you'll get different gain readings depending on the generator. I used a Leader LAV-192, which has a top frequency of 1MHz. Although well below the nominal 4.3218MHz of the CD signal, I found it generally adequate.

Figure 2 is a simplified RF amplifier section. In some, this is in one IC; in others, several are used.

A quick way to avoid setting up the test rig is to *buzz* the circuit with your finger. Actually, pins on the prevalent surfact-mount devices are rather small, so a sharp-pointed metal probe would be better. Buzzing the AC or BD input should produce clipping at the RFO (RF output) or FERR (focus error) test point. This proves the RF amp is live. Likewise, check the EF (tracking) amp; observe the output at the TERR (tracking error) test point.

If you want numbers, feed a 2mV, 1kHz sine wave into the input to be tested. Figures derived from one particular unit are outlined in the following table. Machines will differ somewhat, so keep that in mind when reviewing the figures. You will probably want to keep test results for the types of CD players you usually service.

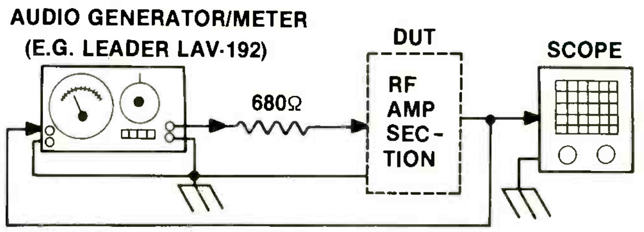


Figure 1. Test rig for RF amp gain check

Testing the optical block

Typical output level for AC, BD, E, or F detectors is roughly 2mV to 4mV p-p. Ironically, this is similar to the signal level produced by the *old-fashioned* phono cartridge that the laser replaces.

The low output amplitude of the photodetectors makes it difficult to measure without a scope having a 1mV vertical sensitivity. Even then, close attention must be paid to grounding for best results. Those of you whose scopes are equipped to subtract channel B from A usually can eliminate 60Hz noise from the waveform with a little trick. (By the way, most oscilloscopes that I've used accomplish subtraction by offering an Add mode and an inversion switch on one or the other channel, usually B. Adding an inverted signal is equivalent to subtraction.) Connect channel A to the test point, channel B to a source of 60Hz that is in phase with the noise on the desired signal. This usually is available on the power transformer secondary. With the mode switch set to Add, invert channel B and adjust vertical gain until the 60Hz noise on A is minimized, and all you have is the desired signal.

You can test for proper alignment of EF detectors with the scope set for an X-Y display. One channel of the scope is connected to RF amp, pin 9, the other to pin 10. At these points, the E and F signals already have gone through one stage of amplification, so are easily displayed. Adjust scope gain for equal amplitude on both channels and switch to X-Y. You should see an out-of-phase Lissajous display: a flattened oval with the top end about 45° to the left of vertical.

Disabling shutdown circuits

As I mentioned before, most CDPs have circuitry that shuts them down if they don't get the proper data from the disc. Sometimes disabling them is a simple matter of grounding a test pin on the microprocessor, but sometimes you need to get creative, and *force* certain flags, such as FOK (focus OK), LDON (laser diode *on*), or GFS (guarded frame sync) to their normal level in order to perform tests. This procedure varies greatly from unit to unit, and the only answer is a thorough understanding of the particular machines you service. There are other parts of the servo that can be broken and tested. Maybe we'll cover that in a future column.

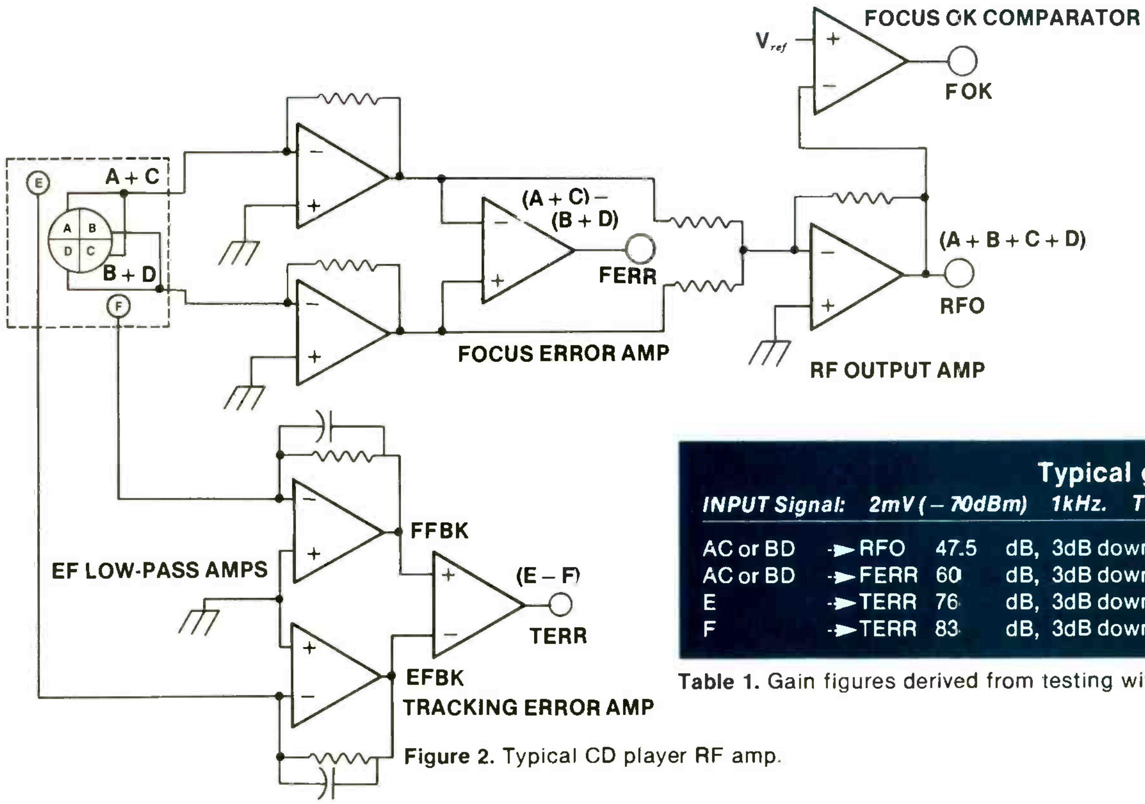


Figure 2. Typical CD player RF amp.

Typical gain figures

INPUT Signal: 2mV (−70dBm) 1kHz. Typical RF amp.

AC or BD	→ RFO	47.5	dB, 3dB down @	300kHz
AC or BD	→ FERR	60	dB, 3dB down @	14kHz
E	→ TERR	76	dB, 3dB down @	7kHz
F	→ TERR	83	dB, 3dB down @	2.5kHz

Table 1. Gain figures derived from testing with a sine wave.

ES&T

Literature

Source book, technical supplies

Contact East's comprehensive product guide for 1987 features a full line of tools and instruments, including many new products. Highlighted are static-control devices, an expanded tool kit line, state-of-the-art fiber-optic equipment, test instruments (DMM s, oscilloscopes, counters, power line monitors, disk drive testers, for example), hand tools such as screwdrivers, pliers, wrenches and crimpers, and soldering supplies. All products are described in detail with price specifications and color photos.

Circle (125) on Reply Card

Repairing Atari products?

Replacement parts for Atari products are described in the *Best Electronics* catalog. According to Best, the once-dwindling Atari repair business again is lucrative. Along with a full stock of the most common replacement parts, Best offers repair/technical information to service centers confronted with an Atari-related, hard-to-solve problem.

Circle (126) on Reply Card

Full-line mail order

Global Specialties, an *Interplex Electronics* company, has announced establishment of a mail order division to market the company's complete line of electronic testing and prototyping equipment. A full-line catalog, including ordering instructions, an order form, and a postage-paid return envelope has been mailed to a selected list of potential end-users throughout the country. An 800 number for direct telephone orders also is featured.

Circle (127) on Reply Card

New or reconditioned equipment

A 20-page electronic test equipment catalog and price list from *Accutest Instruments* features thousands of off-the-shelf items, both new and custom-reconditioned, at up to 70% off original list prices. All custom-reconditioned equipment is checked and precision-calibrated by trained technicians for performance that is recommended by the company as both accurate and reliable.

Circle (128) on Reply Card

MTS Simplified Guide

Sencore Electronics announces the MTS Simplified Guide that is intended to give the reader the background needed to analyze stereo televisions quickly and accurately. The MTS Simplified Guide will teach many aspects of TV stereo, and show you many tips to use in servicing MTS chassis. An extensive, yet simplified theory section is included.

There are a number of servicing aids including a simplified block diagram, trouble tree, and many quick test procedures. ES&T

Circle (129) on Reply Card

Books

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

Electronic Connections, *Home and Car Entertainment Systems*, by Martin Clifford, Prentice-Hall, 414 pages, $24.95, hardbound.

Electronic connections have reassumed their importance in the servicing industry. In the recent past, each consumer electronics product was designed as an independent entity neatly packaged in its own cabinet, with only a power cord and/or download exposed. Came stereo components, sound amplifiers, multiple televisions in many households, VCRs, and computers and their peripherals: The once-integrated (now-fragmented) units became only as good as their cables, ports, jacks, adapters and other connections. This book covers the subject thoroughly, with many easy-to-follow schematics, diagrams and other illustrations. Order No. 250498.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 1-800-223-2336.

VCR Troubleshooting & Repair Guide, by Robert C. Brenner and Gregory R. Capelo; Howard W. Sams, 256 pages, $19.95, paperback.

A preventive maintenance and troubleshooting reference for VCRs, this guide may be used by electronics enthusiasts with limited experience. The servicing technician will appreciate the more sophisticated service and repair functions that also are included. Among the topics covered:

- Introduction to VCR maintenance
- Basic troubleshooting
- Routine preventive maintenance
- Specific troubleshooting and repair
- Magnetic recording theory
- VCR operating theory
- Advanced troubleshooting

When ordering, specify No. 22507.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 1-800-428-SAMS.

Electronics Math, by R. Jesse Phagan; Tab Books, 256 pages, $15.45, paperback, $22.95 hardbound.

This guide to electronics math comes right to the point in showing how to use mathematics as a practical electronics tool. The author avoids the overly theoretical approach in favor of leading readers logically from the basics of scientific notation through the principles of ac and dc circuit math and on into transformers, inductive and capacitive reactance. Within this framework, the reader is introduced to using the oscilloscope for measuring phase shift, the theory and applications of time constants used in R-L circuits, and a short course in understanding power supplies: how to measure them and make any necessary modifications. These subjects and more are fully illustrated.

Published by Tab Books Inc., Blue Ridge Summit, PA 17214; 717-794-2191. ES&T

ANSWERS to the QUIZ

By Sam Wilson

Questions are on page 26

1. 48Ω. Figure A shows the connection for the resistor. Current through first lamp:

$$I = \frac{P}{V} = \frac{6W}{6V} = 1A$$

Because the second lamp only can conduct ½A (given), it follows that the resistor must provide a path for the remaining ½A.

Voltage across second lamp:

$$V = \frac{P}{I} = \frac{12}{1/2} = 24V$$

$$R = \frac{V}{I} = \frac{24}{1/2} = 48\Omega$$

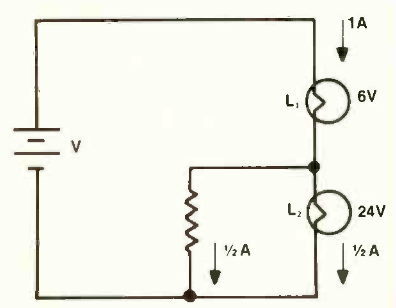


Figure A.

2. 30V. The voltages across the lamps are 6V and 24V. The battery must supply the total voltage drop, or,

$$6 + 24 = 30V$$

3. A. The cathode of the diode is always marked in some way. Note the thick section on the cathode lead.

4. A. If either or both inputs (switches) are grounded (logic 0) the output is zero. Only when the two switches are in the logic 1 position (+5V) will the output be +5V. The truth table looks like this:

A	B	Vout
0	0	0
0	1	0
1	0	0
1	1	1

The truth table shows that the circuit is an AND

5. D. Operational amplifiers that require only a positive supply voltage are in use.

6. B. Both are breakover diodes. The diac will conduct in either direction if a sufficiently high voltage is connected across it. The 4-layer diode conducts readily in one direction but not in the other.

7. A. The curve marked with an X shows a higher current for a given voltage. That occurs when the temperature is higher.

8. A. A minimum loss pad is designed like a T pad. However, the T resistor closest to the lower resistance being matched is removed.

9. 1.5Ω. The resistance value is calculated by the equation:

$$R = \frac{R_f \times R_{in}}{R_f + R_{in}}$$

10. C. The op-amp connection of Figure 7 is a well-known current-to-voltage circuit.

Readers' Exchange

Wanted:

Good, used CRT 510ZEB22 (not 510ZB22), original is from MGA/Mitsubishi model CS1971; Rider's radio manuals No. 2, 4, 5, 7 and 8. *Mike's Repair Service, M. Danish, P.O. Box 217, Aberdeen Proving Ground, MD 21005; 301-272-4984, evenings.*

Sams Scanner service manuals, SD-1, SD-4, SD-5, SD-7, SD-8, SD-9 and SD-10; service information on Luxman stereo R-1120. *Billy Stewart, P.O. Box 2076, Hickory, NC 28603-2076.*

VHF and UHF mobile radio, prefer two channel, needs PL or provision for PL board; base radio; UHF and VHF Handy Talkies; battery packs or whole, broken redecom/Cook's XF617 radio; deviation meter; 1COM O2AT and O4AT; any type of laser items; repair manual and/or not-working Hallicrafter's 2-meter radio model H2M 1000; UHF repeater, with or without duplexer, any condition, need not work. *Gary Bernard, P.O. Box 5523, Merritt Island, FL 32954.*

Telefunken , Becker and Ampex tube audio equipment and reel-to-reel tape machines; schematics for above. Interested in prewar Telefunken pre-amp tuners, the Becker tube radio for autos and the Ampex 351-2 or MR-70 tube tape recorders; help in finding units or schematics will be appreciated. *Mike Milbert, 18 Warrior Brook Court, Germantown, MD 20874.*

Signal-strength meter for CATV levels. *John Russo, 1057 Big Pine Drive, Santa Maria, CA 93454; 805-925-2173, evenings, 805-925-8773, days.*

Knight RF generator and signal tracer (83Y135) with manuals; Sams TR-82 Photofact; Tekfax manuals 100, 102, 117. *Charles T. Huth, 229 Melmore St., Tiffin, OH 44883.*

Schematic for Heathkit regulated power supply model IP-32. Will buy or copy and return. *William A. Thoma, 762 Silverleaf Drive, Dayton, OH 45431.*

Owner/operating manual for Crusader 300 amateur bilinear amplifier, or the name and address of the manufacturer. *John Lykins, 404-H Glascock Drive, Flemingsburg, KY 41041; 606-849-8681.*

Service information and owner's manual for TEAC reel-to-reel tape recorder, model A4010S. Will copy and return, or will buy outright. *Tri-City TV, Route No. 3, Birch Tree, MO 65438.*

Service literature for Sony 4-203W (Sams 774-3 or Sony S.M.). Help appreciated. Will pay. *Larry's Island TV; 813-472-4100.*

Dual-trace, dual-time-base scope, 60MHz to 100MHz; sweep/function generator with lin/log sweep; bencher paddle. All with manuals, and at low price. *John Waskowitz, 580 83rd St., Brooklyn, NY 11209.*

Sams CB Radio manuals – volumes 148-154, 166, 167, 169-177, 179-207, 281, 282, 284-293. *Larry Jackson, Route 2, Box 299J, Hamptonville, NC 27020.*

Sencore VA62 VCR test accessory, and NTSC accessory. *Al's TV, P.O. Box 115, Anita, IA 50020; 712-762-4210.*

Radio Electronics, June 1971, or any parts, information, board or layout for RF pre-amp article. *Merimack, Attn: Hilary, 986 Monroe Ave., Rochester, NY 14620.*

Sencore Powerite No. PR57 in good working condition. Send price. *Ron Grega, 107 Ridgeview Drive, Dunmore, PA 18512; 717-347-6842.*

Any 2-way radios, HTs, CBs, scanners. Need not work. Cheap color computer with one disk drive, can be obsolete model, working or not. Deviation meter and frequency counter. Any lasers and related items. Also, Yeasu FT727RA, 1COMO2AT, ICOM 04At. *P.O. 5523, Merritt Island, FL 32954.*

Tube, type 812A. Manual and schematic for Precision signal generator E-200-C. Will buy or copy and return. *John Zuba, 23 Patton St., High Bridge, NJ 08829; 201-638-8370.*

EICO model 232, working or not. *P.S. Martinez, P.O. Box 20972, Phoenix, AZ 85036.*

Keypad tuner switch No. 56D33-1 for Admiral chassis 28M55. *Dave Morning, 24370 Hedgewood Ave., Westlake; OH 44145.*

Schematic for Panasonic AM-FM phono-stereo combination, model SE 1160. Out-of-print with Panasonic, no Sams folder or book. Copy appreciated, or will copy and return at my expense. *R.H. Muller, 1201 Aloha Lane, Clearwater, FL 33515.*

Pantek No. KR85, 4-digit, 16-pin display, originally used in Litton microwave, model 420. *Robert E. Seibert, R.D. No. 1, Box 248, Lambertville, NJ 08530.*

NRI TV course or similar instruction; Sencore VA48. *Alan Weinber, 1742 Avenida Sirio, Tucson, AZ 85710; 602-747-5299.*

Manual and/or schematic for Fairchild dual-trace oscilloscope, model 776H. Will buy or copy and return. *A. Szalay, 3838 N. Whittier Place, Indianapolis, IN 46226.*

Service manuals for Advent projection televisions, model 1000A and VB761. *Fred Jones Jr., Fred's Electronic Service, 1203 Corlies Ave., Neptune, NJ 07753; 201-988-8841.*

Horizontal flyback transformer for Quasar color TV receiver, model WP3422QW. Transformer part number is 25-9033A 82, TLF-6032F. *E. Patrick Harrigan, 5165 South Magellan Drive, New Berlin, WI 53151; 414-425-6184.*

Voltage regulator STR459 as used in TV receiver auto-voltage sets. Prepared to pay cost. *Ivan Hamilton, P.O. Box 423, St. Kitts, West Indies; 809-465-8500.*

Schematic and information for Precision model E-200 RF signal generator. *Doug Heimstead, 1349 Hillcrest Drive, Fridley, MN 55432.*

Picture tube No. 330WB22, Sony part No. 873970205, working condition. Send purchase requirements. *Snow, R.R. No. 2, Box 596, Yarmouth, ME 04096.*

Setup chart for checking old 4-pin tubes (45, 27, etc.) in EICO model 666 tube tester. Will copy and return or pay for copy. *Don Maurer TV, 29 S. 4th St., Lebanon, PA 17042.*

Schematic for Ross radio, RE8000. Will buy or copy and return. *Rivera TV, 9235 Telegraph Road, P100, Rivera, CA 99660; 213-949-2161.*

Horizontal output transformer No. AC-145629 for Crosley model 9-419M1 television, or substitute part Stancor A-8128/1 or Merit HVO-3. *Myron H. Freedman, Mickey's TV Service, 8915 E. Bellevue St., Tucson, AZ 85715.*

Bearcat 210 scanner custom 8-pin chip; Motorola SC74012P, or cross-reference and copy of the schematic. Will buy or copy and return. *Larry Bivins, 309 Burton Court, Thousand Oaks, CA 91360.*

Transformers rewound (someone in the industry who has the know-how and equipment); power and audio outputs. *Kenneth L. Mixon, 401 E. San Pedro Ave., Perry, FL 32347; 904-584-2116.*

Service manuals and schematics for CPI frequency counter FC-70 and frequency converter FA-70. Will buy or copy and return. *Black Mountain Electronics, 186 E. May St., Heppner, OR 97836; 503-676-5560.*

Power transformer for Heathkit oscilloscope, model IO-18, part No. 54-103-24, transformer no longer available from Heath; B&W picture tube No. 440 ANB4 for Panasonic television No. TR-216. *Joseph S. Grishin, 976 Ray Road, Wantagh, NY 11793; 516-785-8298.*

Magnavox flyback transformer, Fly 360, part No. 361308-1/c Thordarson, for Magnavox B&W portable television. *J. Kapral, 101 Newberry Circle, Oak Ridge, TN 37830; 615-482-1482, call collect.*

Copy of manual or schematic for EICO model 369 solid-state version, TV sweep-marker generator. *Jack Lionel, Jalisa Techs, P.O. Box 604, Bloomfield, NJ 07003.*

Schematic or service manual for Electronics Relays GR Power Chopper (power factor corrector). Company is out of business. *Leo Unger, 4066 Inglewood Blvd., Los Angeles, CA 90066.*

Glass dial scales for Radiola model 76Z-12, and for Telefunken Caprice 5051W. *Paul M. Williams, 2364 Beaver Valley Pike, New Providence, PA 17560.*

HV tripler part no. 561BO26-1 for MGA color television, model CS196. Please send price. *Augustine's TV and Radio Service, 530 N. 9th St., Reading, PA 19604; 215-372-5438.*

NTSC generator, state price, model and condition. *J. Konney, 2519 N. Austin, Chicago, IL 60639; 312-237-7845.*

Continued on page 64

Products

SK solid-state replacement guide

A new edition of the *RCA* "SK Guide to Reliable Replacement Semiconductors" has been introduced by *RCA's Distributor and Special Products Division.*

This edition contains 2,900 SK and KH types that replace more than 214,000 industry types. Included for the first time are QMOS logic devices and an extensive line of RF devices.

Circle (75) on Reply Card

TV-RF signal analyzer

Sencore Electronics has completed development of the FS73 Channelizer Jr. The instrument is accurate within 1dB for each channel. Sencore reports that the FS73 has a fully auto-ranging meter, performs tests not found elsewhere and is fully portable.

The FS73 reportedly provides an exclusive all channel microprocessor-controled tuner for checking every standard and cable channel RF level with FCC accuracy. Exclusive 1-touch frequency offset allows the customer to select either normal, HRC, or ICC carrier shift. Dial in the channel, then read the level on the fully auto-ranging meter. This same method is used to measure the RF audio and FM sound (broadcast) through the same input.

Circle (76) on Reply Card

Low-cost transmission test set

A full transmission test set has been introduced by *Triplett* Corporation for the communications market.

Compact and lightweight, this basic transmission test set was designed for use both indoors and outdoors by service technicians, telephone installers, repairmen and anyone else involved in testing communications equipment.

The test set performs the following functions: circuit loss (with an accuracy of ± 0.2dB); circuit noise (accuracy of ± 0.2dB at 1,000 Hz); power influence (accuracy of ± 0.4dB at 1,000 Hz); and line current (accuracy of ± 2%).

A standard volt meter is also included for measuring ac and dc volts, plus there's a special ohmmeter for conducting 8455 tests.

Circle (77) on Reply Card

Clean, control static-generated dust

Chemtronics' Screen Prep provides a convenient method for cleaning smudges and stains that result from equipment handling prior to or during service calls. It also effectively removes CRT screen contaminants that inhibit and distort vision, thereby reducing eye strain and improving operator efficiency.

Circle (78) on Reply Card ES&T

Continued from page 62

Sencore VA48, still in original carton; Conar 255 solid-state trigger scope, ESR capacitor analyst; EICO 667 dynamic tube tester. Make offer, all most be sold. *R.M. Hoffmeyer, 1170 Pino Solo Drive, Santa Maria, CA 93455; 805-937-4073.*

Telequipment oscilloscope, type 52; F.S. meter for television; Hickok VTVM with large meter face. *Jim Shoemaker, 600 First St., Leechburg, PA 15656; 412-842-8321.*

Old B&K scopes, models 1431, 1460, 1435, any condition. *Mike Shelton, 2708 May Drive, Burlington, NC 27215.*

Used Panasonic telephone answering machine model KX-T1625 or KX-T1730, need not be working, but must be complete and include ac adapter (if required). Please indicate model, condition and asking price. *Dave, P.O. Box 151, Poway, CA 92064.*

Micronta DMM, model 22-200 (by Radio Shack); Robyn CB radio, model T240D; Lectrotech TO-60, TO-55 or TO-50 scope; Hallicrafters short wave radio S-120 or any other models. All, working or not. Also, a copy of tube setup chart for Hickok 53 tube tester. *Stanley Chalker, 1176 Smithsonian Ave., Youngstown, OH 44505.*

Odyssey video game cartridges. *Donald Lewis, Route 1, Box 308, Central City, NE 68826.*

By high school class to repair donated video equipment, schematics for the following – Sony ac power adapter, AC-3400; Sony camera adapter, CMA-1 and CMA-2; Sony monitor, PVM400; Sony camera, AVE-3450; Sony reel-to-reel recorder, AV-3400 and Panasonic monitor, TN63. Will purchase or copy and return. *Jerry St. Jacques, Manchester Technical Center, 4420 Manchester Road, Middletown, OH 45042; 513-422-6446.*

For Sale:

Leader sine/square wave generator, model 120A, make offer; numerous electronics books and parts, s.a.s.e. for list. *Mike Shelton, 2708 May Drive, Burlington, NC 27215.*

TEK 545B scope, $300 or best offer; Heath condenser checker, Systron-Donner DMM, mini digit DPM, two boxes assorted tubes, gates, limiters. Everything must sell. *Tim's Audio Service, P.O. Box 2461, Augusta, ME 04330.*

Sams Photofact folders: 67 to 625 plus 33 others. $300 plus shipping. *Lyle D. Kinney, R.D. No. 4, Box 235, Bath, NY 14810; 607-776-9234.*

Sams Photofact folders No. 1500 to No. 1955, a total of 445 issues, new, unopened, $3 each as a package, no singles. Same for Ar 19 to 79 and TR15 to 64, $2 per issue. *Stanley Chalker, 1176 Smithsonian Ave., Youngstown, OH 44505.*

Hitachi 20MHz dual-trace oscilloscope, model V-212 with probes. Bought new, never used, $300 plus shipping. *Victor M. Ortiz, Ortiz TV Service, Avenue Ferrocarril, Isabela, Puerto Rico 09662.*

Sony AVC-1400 B&W video camera and power unit with two lens, telefoto and wide angle, like new, $125; ALCO mini toggle switches; many SPDT 6A, 125V, new, $1 each or two for $1.50. *Rygwalski, 2100 S. Beech Road, West Palm Beach, FL 33409; 305-683-2472, evenings.*

Sencore model CG141 color generator, $40; Sencore model TF166 transistor and FET tester, $60, both include manuals and leads; Heathkit model IP-17 power supply, $100 with manual, no reasonable offers refused. *Dennis Dillon, 1616 S. 94th St., West Allis, WI 53214; 414-774-2255.*

Tubes, new and used, $1 up. Used tubes, untested and unsorted, $35 per hundred, special. Send $1 (deductible from order) with list of your needs and prices. Shipping charges are extra. *Ed Barlow, P.O. Box 29, Tweed, Ontario, Canada K0K 3J0.*

Modules – two MAE001A, three MAE001B, $5 each; three MAL001B, one MAL001A, $6 each; three MAG001B, $7 each; seven PM200, $3 each; one MAK001, one MLK002, $10 each; one MAN002A, six MAD001A, $4 each. All, $145 plus shipping. *M.E. Andrews Jr., Box 91, Exeter, RI 02822.*

Radar Range scope, early 1940s, by Dumont, weighs approximately 90 lbs, several G's shock resistant; Webcor hi-fi, reel-to-reel, tube-type tape recorder, model TP2718-1, weighs approximately 40 lbs. Make offers on each. *Shannon O. Sellers, 7308 Franklin Drive, Bessemer, AL 35023.*

More than 100 TV tubes, $20; pilot bulbs and fuses. *Al Crispo, 3225 Chipmunk Drive, New Port Richey, FL 33552.*

Tentelometer and spindle-height gauges, $495. *J. Gilbart, 4049 N. Newhall St., Milwaukee, WI 53211; 414-962-0974.*

B&K electronics multimeter, model 290; B&K transistor tester with case, model 510; Diehl SuperTech model IV; Viz WP 29 monitor, 150Vac; all, $600. Will ship UPS or c.o.d. *John Cooper, Route 3, Box 925, Kountze, TX 77625.*

Parts for following color sets – Quasar T915, 919; GGY16227A Ward's E22 chassis; CE8181W Ward's E21-32 chassis; 25EC58 Zenith; M25 Admiral; T-995 Magnavox; RCA CTC48, 58, 86, 88, 91. B&W sets – Sears 528.51330, RCA KCS 183E, 195B. Many other chassis on hand. *D.J. Aijala, 50 Fir Circle, Babbitt, MN 55706.*

Sencore SG165 stereo analyzer, $250. *Ray LaFrance, P.O. Box 1279, Medford, OR 97501; 503-779-4329 or 503-772-2141.*

B&K model 1570A 80 MHZ scope, quad trace with probe case and three probes (10x, 10:1/direct, RF det.), has scope cover, $1,000; B&K universal counter, model 1822, 175MHz, $350. Both, mint condition, used only few times. *Ron Grega, 107 Ridgeview Drive, Dunmore, PA 18512; 717-347-6842.*

B&K model 707 tube tester, $120; Amphenol model 860 color generator, $100; Telemetric model 730 tuner-subber, $80; degaussing coil, $20; many modules and parts. Retiring. Prices include shipping. *Kaz Glista, 274 Newington Road, West Hartford, CT 06110; 203-666-6007.*

Sencore – VA48 video analyzer, SG165 stereo analyzer, CR70 CRT tester and rejuvenator, LC75 Z-meter, TF46 transistor tester, CT25 color-bar generator; B&K 667 tube tester. All new condition, complete with accessories and literature. Sams Photofact folders, complete, between No. 2229 and 2361, plus miscellaneous between No. 897 and 2132. Manufacturers' service manuals. Must sell; no reasonable offers refused. *Michael Schmaeling, Route 2, Box 1002, Irvington, AL 36544; 205-957-2892.*

B&K 1827 6-digit autoranging frequency counter with SA-27 antenna, BC-27 ac adapter-charger and manual, asking $68; 300 new receiving tubes, mostly for color television, each tube boxed, asking $325. Send s.a.s.e. for tube list – prefer pickup on tubes. Thordarson flyback No. 308, never used, $15. Shipping and c.o.d. extra. *Ronald Kolasa, 4942 E. Flower Ave., Mesa, AZ 85206.*

Sams manuals – TSM No. 1 through 11, plus Nos. 13, 27, 30, 35, 42, 48, 49, 50, 52 through 62, 68, 73. AR 4, 8, 9, 10, 12, 19, 21, 23, 25, 28, 35, 45; MHF 177. Any book, $3.50 postpaid, or make offer on any five or more. Need Sams CB207 manual; will give any three of above, or purchase. *Don Nash, 1444 Pulaski St., Port Charlotte, FL 33952.*

RCA repair parts for XL-100 TV CTC-70 series; 95% of parts in original boxes, net cost approximately $500, will take $50 plus postage. Send s.a.s.e. for list. *John Gorman, 210 Sprague Ave., South Plainfield, NJ 07080.*

Sams Photofact folders, 376 total between Nos. 63 through 1460. Make offer on one or all, send s.a.s.e. for list. *Donald Lewis, Route 1, Box 308, Central City, NE 68826.*

Jackson tube tester, model 658-1, $75; EMC tube tester model 213, $30, both check new tubes; B&K 283 DMM, like new, in original box, $75. All prices plus shipping. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235; 412-242-4701.*

Sencore VA48 with TR219, AT218, excellent condition, factory-refurbished one year ago, $600. *Fred's TV Service, 3901 Rosewood Drive, Midwest City, OK 73110.*

Sencore VA62 with VC63, NT64, $2800; Tentel HP6-1 head protrusion and eccentricity gauge, $400; Tentel TSH-V4 spindle-height and elevator gauge, $300; JVC VHS torque meter, $250; JVC torque gauge, $150. *Jim Bullington, P.O. Box 61, Thomaston, GA 30286; 404-647-2718.*

Tubes, transistors, magazines, diagrams, Sams Photofact folders, test equipment, radio parts, speakers; tube and parts location, send s.a.s.e. *Florian Rogowski, 25103 Cunningham, Warren, MI 48091.*

B&K 467 CRT restorer/analyzer with many adapters, $225; B&K 520 transistor tester, $85; B&K 1076 television analyst, $95; B&K 707 tube tester, $35; Sencore CA 122B color-circuit analyzer, $35. All in excellent condition. *Frank Manera, 137 Lynch St., Providence, RI 02908; 401-831-7156.*

Sencore VA48 video analyzer, complete with box, books and cables, $600, includes shipping, UPS, c.o.d. or cash. B&K 1076, best offer. *Charles TV, Route 210 and Poplar Lane, Indian Head, MD 20640; 301-743-7777.*

Sharp flyback-triplers, Nos. RTRNF0003PE22, RTRNF1133CE22, RTRNF1139CE22, RTRNF0001PE22 and deflection yoke No. RC1LH0007ME22, all for $200 plus shipping. *Globe TV, 3407 Arlington Ave., Riverside, CA 92506; 714-684-9393.*

Photofact

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

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ATTENTION: Sylvania remote control motor for hospital televisions no. 23-99-383 for sale. With exchange $39.00, without exchange $47.00. Kinirral Electronics, 68-26 64th Place, Glendale, N.Y. 11385. Tel. (718) 366-3859. 1-86-4t

SENCORE VA-48 VCR-TV ANALYZER. Excellent condition, $500.00. Larry Colman, 28 Spring St., #20, Norwalk, CT 06854, 203-838-4284. 4-87-1t

PHOTOFACTS: Individual folders #1 to #1400 $3.00. Above #1400 $5.00. Sent same day first-class postpaid. Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 4-87-6t

3000 COLOR TV REPAIR TIPS, 31 Brands 116 Page Manual. Send $21.00 to A. Fernandex, Box 546110, Surfside, Florida 33154. 4-87-3t

PORTABLE TV STATION transmits VCR, camera or test generagor signals 150 feet on UHF channnel 15. Excellent for shops, schools, businesses and hobbyists. $120 complete. SOLAS PRODUCTS, Box 665, Springhouse, PA 19477, (215) 723-4597. 4-87-1t

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TV TOUGH DOGS 200 symptoms and cures. Send $6.95 to DAVIS TV, 11772 Old Fashion Way, Garden Grove, CA 92640. 4-87-3t

HELP WANTED

CAMERA-VIDEO Technicians needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer and/or industrial cameras and VCR's. Training by manufacturers such as Sony, Hitachi, Panasonic, etc., are necessary for job experience. Come to sunny Florida and enjoy your work & leisure time. Write or call ATLANTIC ELECTRONICS INC., 1232 NE 26th St., Ft. Lauderdale, FL 33305. (305) 564-8274 10 AM to 6:30 PM. Ask for Dave or Joe. 8-85-tfn

VIDEO/AUDIO technician needed. Top pay and benefits for well trained and experienced technicians who are expert with consumer TV and audio equipment. Training by manufacturers such as: Sony, Hitachi, RCA, Panasonic, etc. are necessary for job experience. Write or call: Atlantic Electronics, Inc., 1881 NE 26th St., Ft. Lauderdale, FL 33305, 305-564-8274 (10 AM 6:30 PM). Ask for Dave or Joe. 06-86-tfn

MANAGER/TECHNICIAN needed to run electronics shop in Southwest Florida. We are looking for the best person possible to operate our electronics repair shop. Salary starts at $32,000.00 per year or better, depending upon qualifications. Partnership of the company is also available. Please send resume to: M.C.R., INC., c/o Steven W. Vergo, 418 S. Barfield Drive, Marco Island, FL 33937. 4-87-1t

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TV REPAIR SHOP. Complete stock parts, literature, test and office equipment. Large hotel contacts. Middle of Silicon Valley, San Jose, California. 408-986-8232. Look first-make offer. 4-87-1t

Bus. Opportunity (Cont.)

JACKSONVILLE, FLORIDA: TV sales and service. Two businesses with long histories have owners retiring. Have proven gross sales of $55,000 and $171,000. Both offering training and owner financing. Land with one. VR business brokers. (904) 264-2164. 4-87-1t

INDUSTRIAL ELECTRONICS SERVICE COMPANY. Come live & work in sunny Florida. Earn $45.00/hr. Established accounts. Owner moving overseas. Asking $40,000, (813) 923-8016. 4-87-1t

TV/VCR SALES/SERVICE business for sale, well established (15 years) excellent location. Assume low rent lease option. (Family health problems force sale.) Great "MONEY MAKER", $49,000.00 min. 50% down all (negotiable). T.V. Laboratories, Forest Avenue, Staten Island, New York 718-720-6825. 4-87-1t

Educ.-Instruction

CABLE TV TRAINING—Training in Cable Television Technology. Learn construction, installation, and maintenance. Cable Correspondence Courses, Inc., P.O. Box 1319, St. Charles, MO 63302. 2-87-3t

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Electronic Design Specialists, Inc.	13,15	7	800/544-4150
Electronic Specialists, Inc.	39-40		800/225-4876
ETA	63		
Fluke, John Mfg. Co., Inc.	7	6	800/227-3800
Fordham Radio Supply Co.	55	18	800/645-9518
ISCET	63		817/921-9101
Jensen Tools Inc.	30A-30B		602/968-6231
Leader Instrument Corp.	5	4,5	514/337-9500
MCM Electronics	21	11	800/543-4330
Microwave Filter Co.	38A-38B		800/448-1666
NARDA	57	19	312/953-8950
National Technical Schools	29-30		800/BBE-TTER
NESDA	59,61		817/921-9061
NRI Schools-Electronics Division	27-28		202/244-1600
NTE Electronics, Inc.	39-40		800/631-1250
OK Industries, Inc.	19	8	800/523-0667
OK Industries, Inc.	29-30,38A-38B		800/523-0667
Philips ECG	23	12	800/225-8326
Prentice-Hall Inc.	30A-30B		
Projector Recorder Belt Corp.	66	23	800/558-9572
RCA Distributor and Special Products	27-28		609/853-2441
Sencore, Inc.	45,47	14,15	800/843-3338
Sencore, Inc.	49,51	16,17	800/843-3338
Simpson Electric Co.	25	10	312/687-2265
Sperry Tech, Inc.	66	24	800/228-4338
Tektronix, Inc.	IBC	2	800/433-2323
Tentel	27-28		800/538-6894
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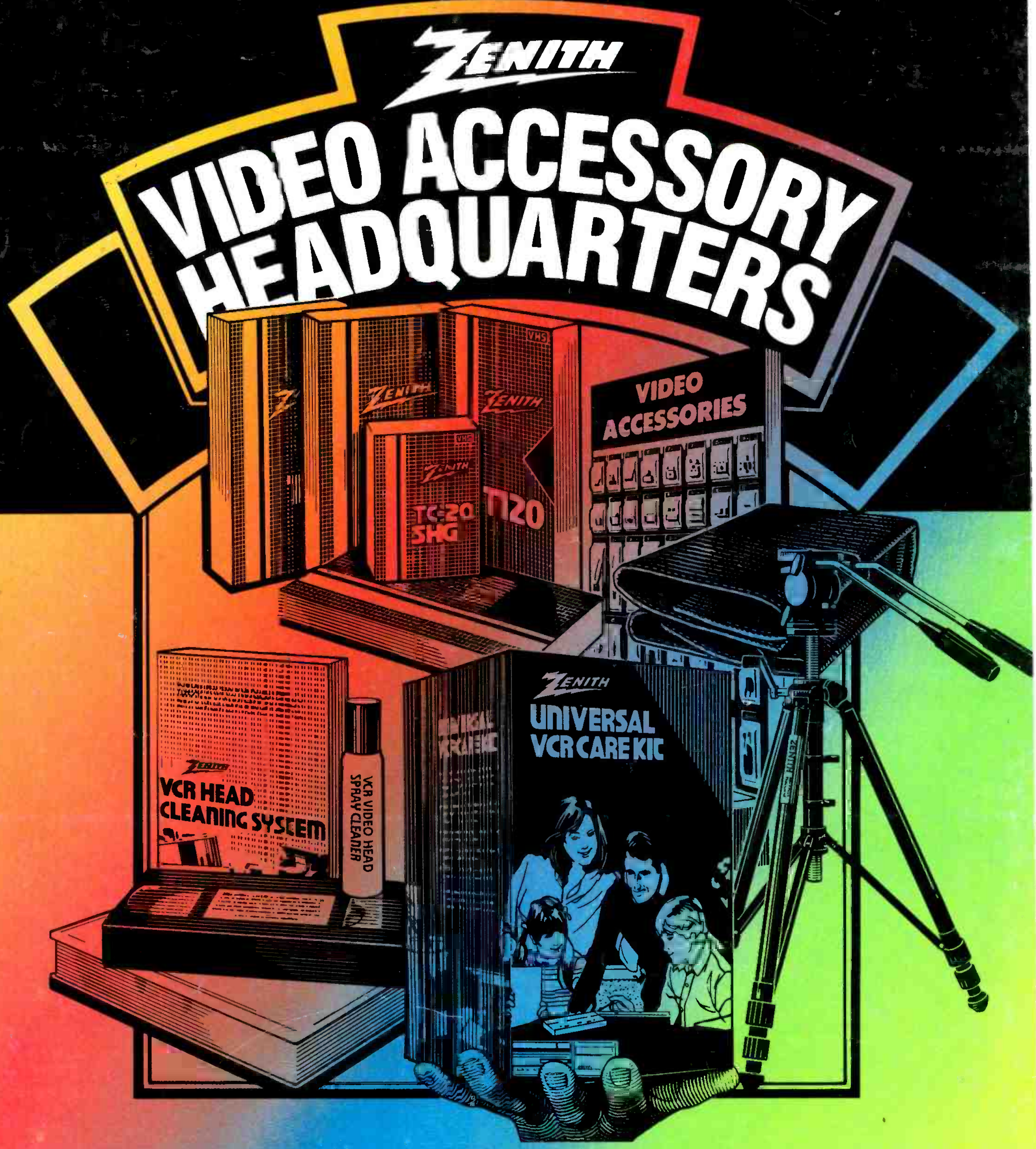

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