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Electronic Servicing

Scope Tips

Filter Problems

Basics of Microprocessors

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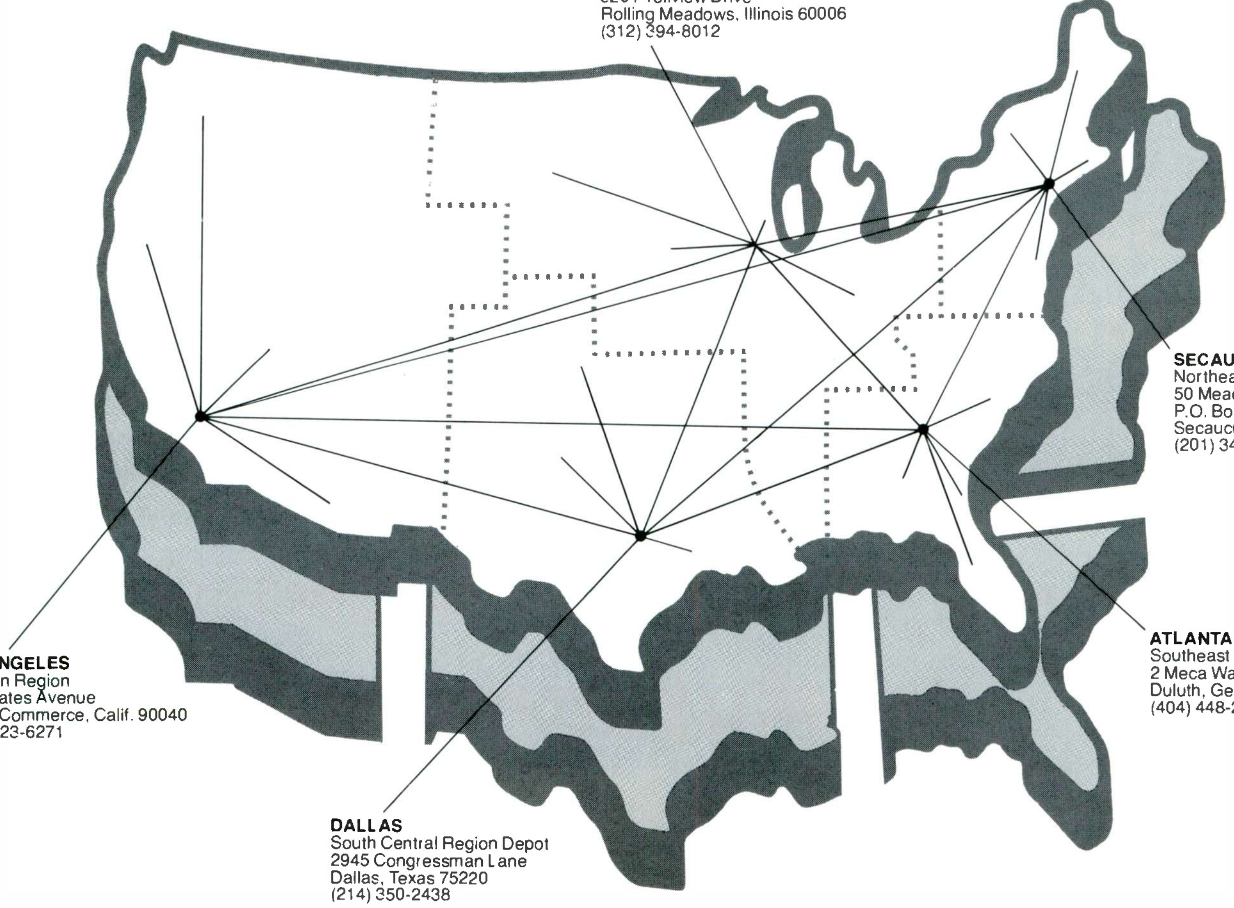

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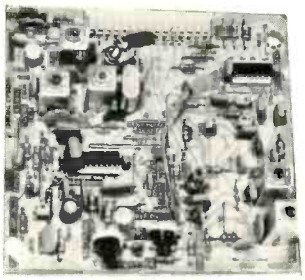

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If you want to branch out into the TV Tuner Repair Business write to the Bloomington Headquarters about a franchise.

Circle (3) on Reply Card

April, 1979
Volume 29, No. 4

Electronic Servicing

Departments

About The Cover Microprocessor photos were furnished by *Intel* and *Zilog*, with graphic design by *Linda Franzblau*.

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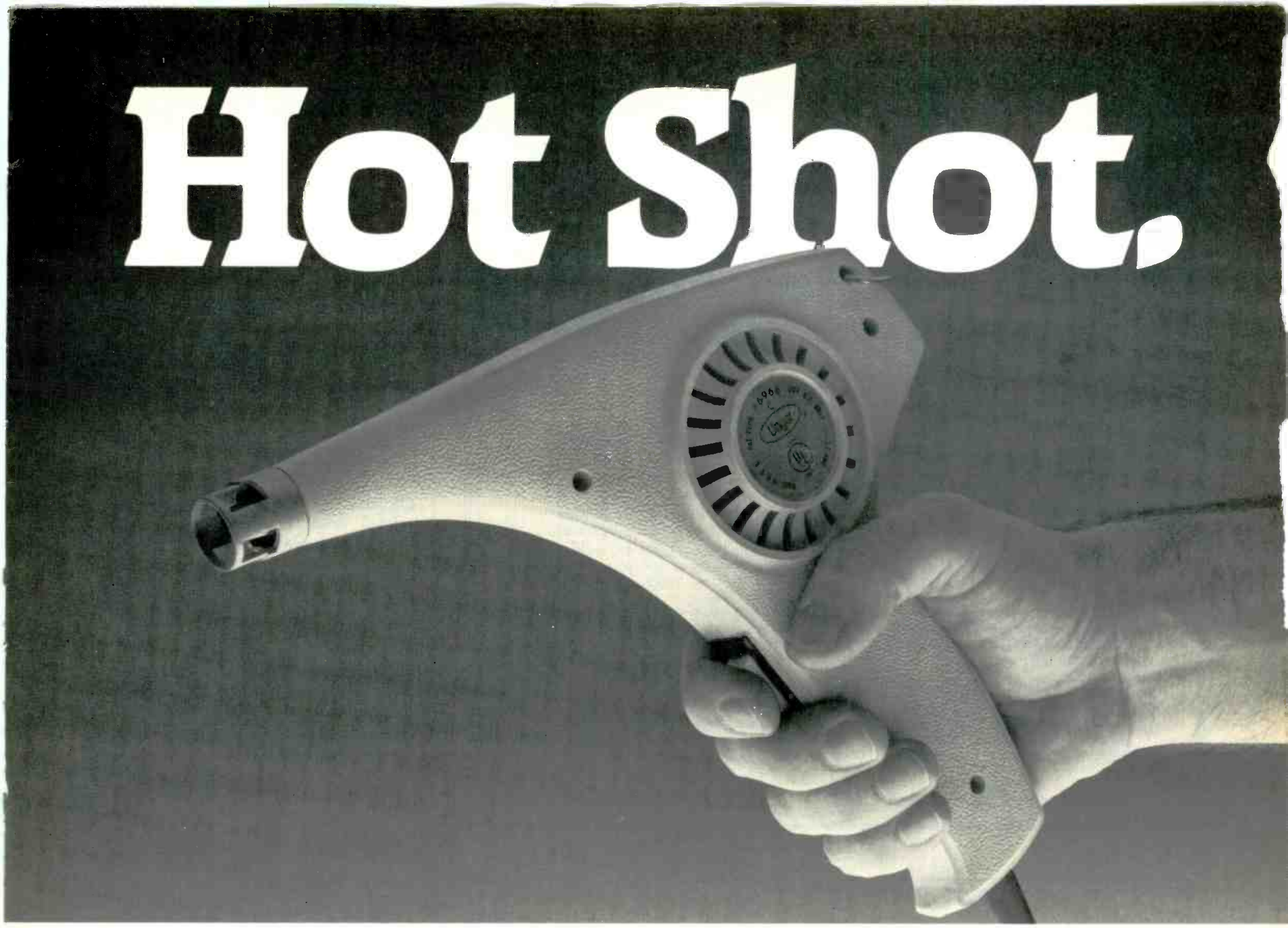
Hot Shot.



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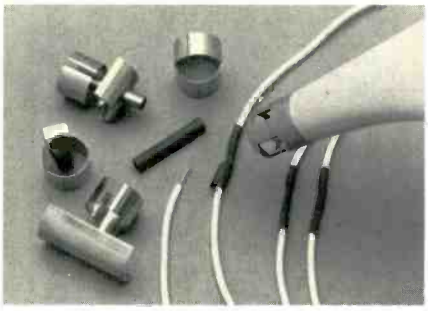

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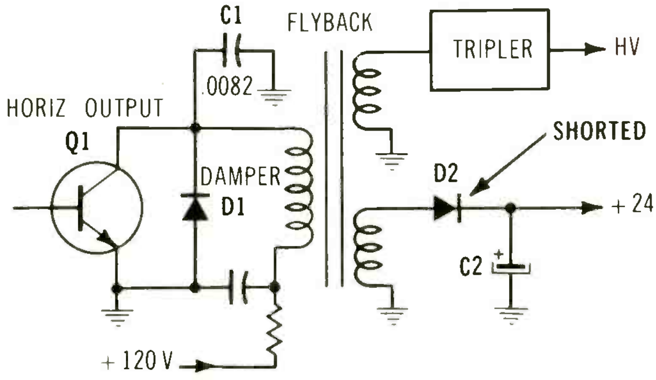
Circle (4) on Reply Card

#5

QUICK-QUIZ

By Wayne Lemons



After a shorted D2 is replaced, the TV works okay for several seconds before D2 shorts again.

WHICH PART IS BAD?

ANSWER ON PAGE 51

Electronic Servicing

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GENERAL ELECTRIC

electronicscanner

news of the industry

At the recent Detroit conference of the Society of Automotive Engineers [SAE], the most popular sessions were those conducted by the microprocessor manufacturers. Tighter government standards of automobile emissions are inspiring serious research into closed-loop servo electronic methods of regulating fuel mixtures and other parameters important to minimum emissions. Many of the automotive engineers were familiar with 4-bit, 8-bit and 12-bit microprocessors and the peripheral circuitry. It seems likely that 4-bit microprocessors having around 20 input/output lines will be sufficient for these operations.

Motorola is expected to offer a single-chip microcomputer with internal A/D and D/A converters for direct interface with analog signals. IC 6805 is an 8-bit unit intended for large volume applications, such as automotive controls.

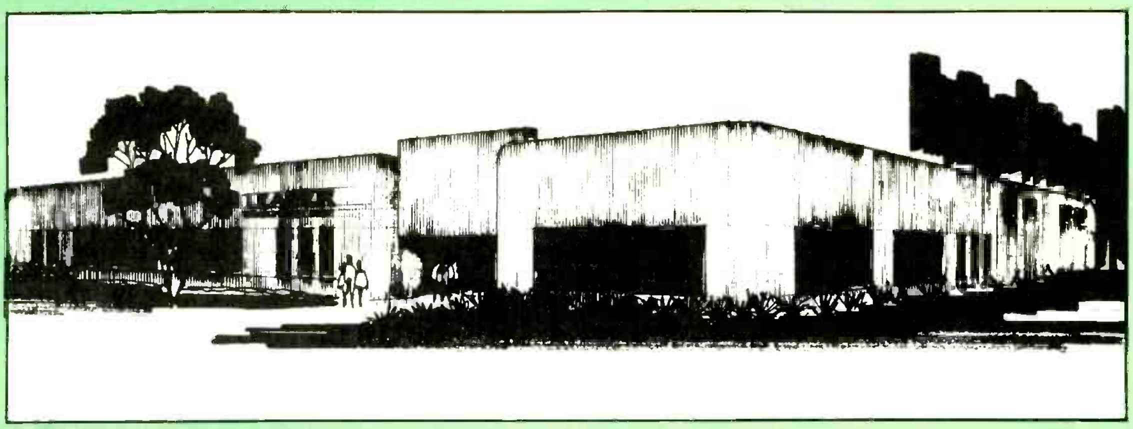
High-performance microprocessors now are packaged in 64-pin quad-in-line [QUIP] cases. Some of these devices have the equivalent of 50,000 to 100,000 transistors on one chip. Previously, larger ICs were manufactured in Dual Inline Package (DIP) cases having 16 pins, 24 pins, or 40 pins. Another variation is 68 pins in a square. Such a large number of pins brings problems of installing and removing ICs without damaging them. One solution is zero-insertion-force sockets which can be opened manually for insertion or removal of ICs.

For the first 8 weeks of 1979, sales of monochrome TVs were up 13.5%, color sales were 0.9% higher and sales of videocassette recorders increased by 97.1%, compared to the same period of 1978. Also, the highest unit color TV sales in history were in 1978, showing an increase of 12.4% over 1977, according to the EIA.

Both Zenith and the consumer-products division of RCA announced increased profits for 1978 compared to those of 1977.

Digital readouts using green fluorescent or liquid-crystal displays are expected to replace radio dials in auto stereos. This will allow the use of digital speedometers and digital clocks. Microprocessors probably will control many functions. Examples are accurate automatic tuning of more radio stations with information stored in the Read-Only Memory (ROM) section of the microprocessor. Also possible are displays of miles-per-gallon (MPG) auto operation, the amount of fuel remaining, the time to reach a certain destination or the speed which provides the highest MPG. In fact, a new $200 add-on system gives most of the auto readouts, time with alarm plus electronic speed control with memory.

Leader Instrument Corporation is running well ahead of the planned expansion rate for the third year, according to William Brydia, corporate vice president of leader. Part of the growth occurred from sales of oscilloscopes, which almost doubled. Other milestones are eight new products that supplement the more than 50 in the Leader line. Only two products were increased in price for the new list, as Leader endeavors to "hold the line" on prices.



Leader Instruments expects by June 1 to occupy this 10,000 square-foot administrative and warehouse facility in Hauppauge, NY. The building replaces one destroyed last year by a tornado.

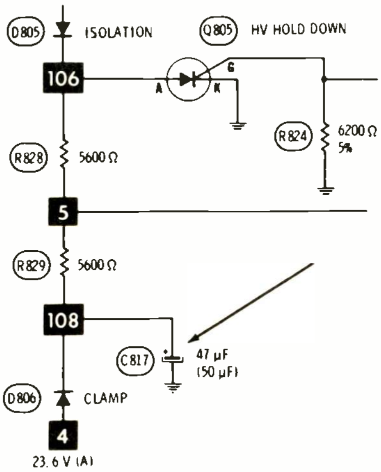
troubleshooting tips

Pulsating audio and picture
Admiral 4M10
(Photofact 1504-1)

Symptoms of the defect alternated between a hum bar in the picture and a strong pulsation of both sound and picture.

This seemed to point toward a power supply problem. However, paralleling each filter capacitor in turn didn't improve the performance. All power-supply semiconductors checked okay, also.

My Symcure file gave some supply failures, but none helped. All supply dc voltages were within tolerance, except for the 235-V supply which went down to about 150 V when the picture pulsated. Also, these supplies had excessive ripple.



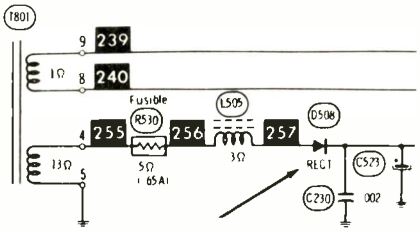
A check of the dc voltages in the horizontal section disclosed 40 V instead of the normal 22 V at the anode of the Q805 HV-hold-down SCR. When the VOM probe was touched to the anode, the pulsations would stop. I began shunting other electrolytics, and a test capacitor bridged across C817 eliminated all the symptoms.

After the capacitor was replaced, the ripple on the main power supplies was nominal.

Robert Holvorson
Junction City, KS

Intermittent height
Sony SCC-17A&B
(Photofact 1309-2)

The reduction to about half height occurred only at the beginning of operation. After the internal heat increased, the intermittent was gone.



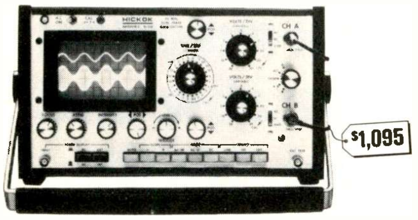
Since the vertical-output transistors operate from the +129-V supply, it was the first suspect. However, both the ripple and the dc voltage were okay and did not change significantly during the height reduction. Most of the waveforms of the vertical-deflection circuit had reduced amplitude during the intermittent.

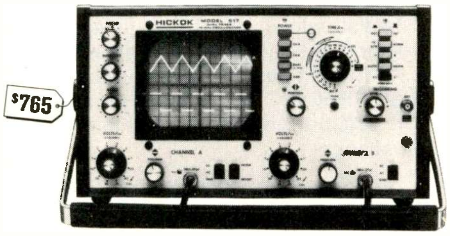
Q506 tested good, however the collector voltage was low during the problem. This focused attention on the 18.2-V supply, which was found to measure only about 13 V when the height was affected. After all the load was disconnected, the voltage remained low. When I warmed diode D-508, the voltage jumped up to the normal value.

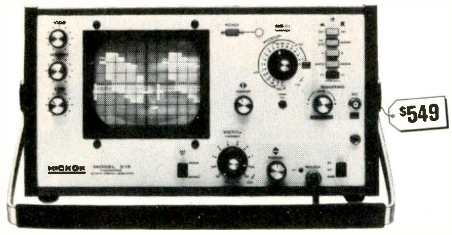
Heat-sensitive diodes are rare, so I alternately cooled and heated it, finding low voltage with cooling and normal voltage with heating.

Replacement of D-508 with the proper fast-recovery diode solved the height problem and also the flashing that occurred with each voltage change. Evidently, the diode had high internal resistance when it was cool.

Ron Schmitz
Miamisburg, OH





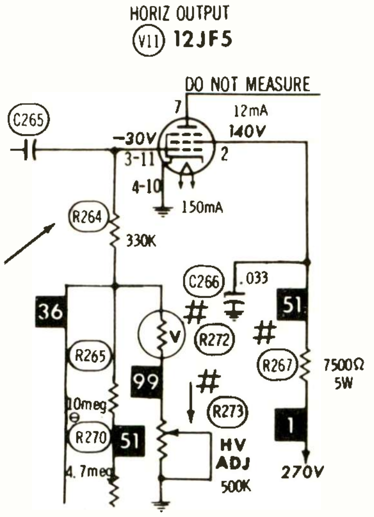


Troubleshooting tips

Stripes in the color GE CH-10HE

(Photofact 1384-1)

Horizontal stripes or streaks could be seen where the colors changed to a different hue. New chroma tubes made no change. Scope waveforms showed erratic and weak burst, which could cause an intermittent 3.58-MHz carrier, since it is generated by ringing a crystal with burst.



Also, the scope showed improper coincidence (phase) between the burst-gating pulse and the burst in the chroma signal. Of course, this can cause weak burst. But why were they not phased properly?

All components at the grid of the 8BU11 burst separator were tested, but they were not defective. And the gating pulse had the right amplitude and waveshape.

In desperation, I scoped the horizontal drive at the grid of the 12JF5 horizontal-output tube, finding it slightly distorted and with a slight ringing at the bottom of the falling edge. More tests revealed that R264 (330K) had decreased to about 20K, and replacing it removed the streaks in the color. Evidently, the distorted drive signal caused the horizontal to fire at a wrong time. In turn, this caused the burst-gating pulse to arrive at the wrong phase.

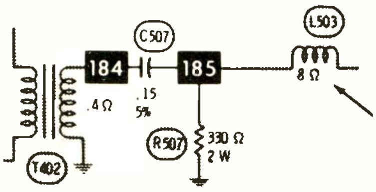
John Augustine
Reading, PA

Foldover and no locking RCA CTC81P

(Photofact 1615-2)

The symptoms were no horizontal locking, dim raster, reduced width and horizontal foldover at the left of center. Adjustments of the horizontal-hold control could not bring the sweep to correct frequency or lock it.

Although the high voltage was only about 5 KV, the Q501 protective transistor was not responsible since it was biased into nonconduction. B+ voltages in the sweep circuit were about right, except for the main terminal of the trace-switch ITR. It should have had about +63 V, but measured about +120 V. Also, the gate of ITR401 had 0.1 VPP and zero volts dc, although 5 VPP and -5 V were called for.



Circuitrace 185 had about 10 VPP. Therefore, L503 *must* be open. A hot soldering iron applied to the L503 terminals didn't help.

A new L503 peaking coil restored a normal locked-in picture with full high voltage. Thanks to previous articles in **Electronic Servicing** about SCR sweep, I was able to find this problem rapidly.

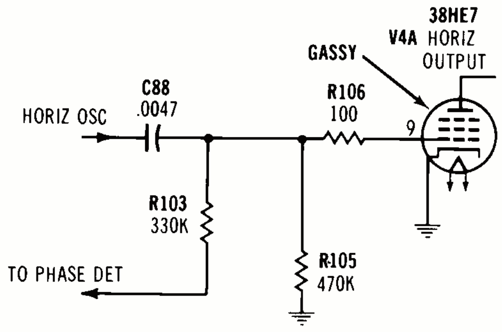
Bob Clutter
Independence, MO

☐

symcure

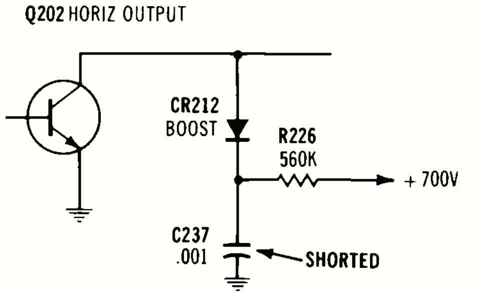
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Zenith 16DB12X
PHOTOFACT—1265-3



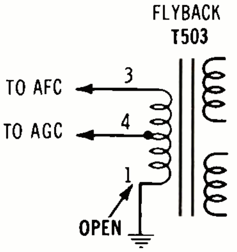
Symptom—Loses horiz lock after warmup
Cure—Replace 38HE7 output tube as a test for gas and positive grid

Chassis—Zenith 25FC45
PHOTOFACT—1453-3



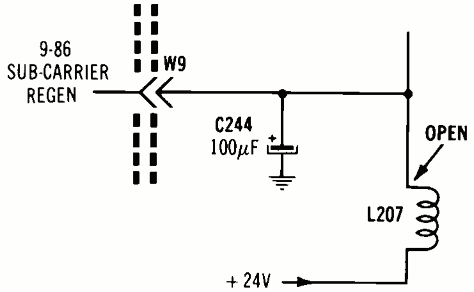
Symptom—No set-up horiz line; dim picture
Cure—Check C237, and replace it if shorted

Chassis—Zenith 9HB1X
PHOTOFACT—1611-2



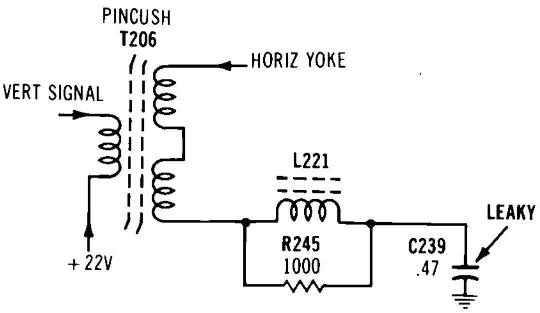
Symptom—Loss of contrast and locking
Cure—Check flyback, and replace if winding is open

Chassis—Zenith 25FC45
PHOTOFACT—1453-3



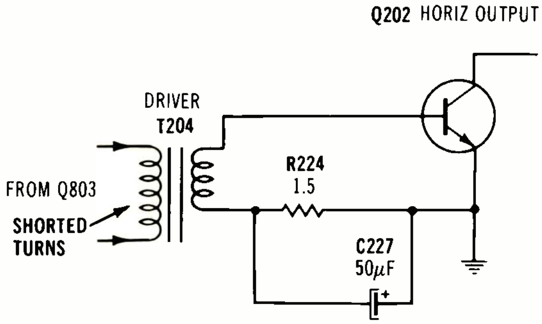
Symptom—Dim picture without color; video-output bases had less than normal positive voltage
Cure—Check L207, and replace it if open

Chassis—Zenith 13HC10
PHOTOFACT—1634-2



Symptom—No HV, RX234 open and Q204 shorted
Cure—Check C239, and replace it if shorted

Chassis—Zenith 19ED45
PHOTOFACT—1377-3



Symptom—Intermittent horiz foldover at right edge
Cure—Check T204, and replace if primary has erratic low ohms reading

reader's exchange

There is no charge for a listing in *Reader's Exchange*, but we reserve the right to edit all copy. If you can help with a request, write directly to the reader, not to **Electronic Servicing.**

For Sale: Heath model IO-18 5-inch lab scope, like new, $75; Heath TV alignment generator model TS-4A, $25. Both with manuals and probes. Also, Heath vectorscope, $25. *George Campbell, 44445 13th Street East, Lancaster, CA 93534.*

Needed: Miscellaneous test equipment for a new TV shop, reasonably priced, in working condition and with manuals. Send description and prices. *Walt's TV Service, 26 Zophar Mills Road, Wading River, NY 11792.*

Needed: Single copies of all *PF Reporter* issues, and back issues of **Electronic Servicing** up through 1972. State best price for part or all. These are needed for our shop library. *Frank Bouldin, 605 Candlewood Road, Fort Worth, TX 76103.*

For Sale: Original Rider's Troubleshooters radio manuals volumes 1 through 14, in excellent condition, sell as a set only for best offer; 1957 RCA Orthophonic AM/FM receiver with cherry cabinet, plays good, $35. Also, many old radio tubes. *Dave Haman, Box 580, R.O. #6, Greensburg, PA 15601.*

Needed: Schematic and deflection yoke for model 5P108 Amcrest TV. *Lube Service Company, 17 East Mountain Road, Sparta, NJ 17871.*

For Sale: B&K-Precision model 1471B 10-MHz, dual-trace triggered scope, $300; Heathkit model IG-72 audio generator, $30; Heathkit IG-102 RF signal generator, $30; Heathkit model IT-121 solid-state tester, $30. All in new condition with probes and manuals. Also, Collins 10-80 meter radio, plays good, $100. *Dennis Gignac, 56 Westside Avenue, North Attleboro, MA 02760.*

Needed: Sylvania CK3000 test jig with adapters. *Ken Ausperk, RR4, Box 13, Logansport, IN 46947.*

For Sale: Hickok model 440 semiconductor curve tracer with manual, like new, $60. You pay freight. *Roosevelt TV, 263 Nassau Road, Roosevelt, NY 11575.*

For Sale: Rider's television manuals, 26 volumes for $50 plus shipping. *Don Guadini, 555 North Wilson Road, Radcliff, KY 40160.*

Needed: Schematic or power transformer for chassis 85 Atwater Kent radio superheterodyne. Will buy or copy schematic and return. *Tom Kovich, 1532 El Prado, Torrance, CA 90501.*

Needed: Videocassette tapes for model N1481 Philips/Norelco color video recorder. *John Najvar, Route 3, Box 3-B, Shiner, TX 77984.*

Needed Urgently: Schematic or service manual for model ST-5A GE marker generator and model ST-4A sweep generator. Will buy, or copy and return. *Robert Altomare, Northern Virginia Community College, Woodbridge Campus, Electronics Department, 15200 Smoketown Road, Woodbridge, VA 22191.*

Needed: Volume R-17 of "Most Often Needed Radio Diagrams of 1957" by Beitman. Also, an operating manual for a model IO-12 Precision tube tester. *Ronald Lettieri, 433 East Drinker, Dunmore, PA 18512.*

Needed: Schematic and service information for model 555N Data Instruments scope. Will buy, or copy and return. *Casimer Zukowski, 2920 West Golden Lane, Phoenix, AZ 85021.*

Needed: Transformer C32-M-9162 for a model 37-116 Philco radio. Either new or good used. *Action Radio & TV, 540 West Highway 434 Unit 8, Altamonte Springs, FL 32701.*

For Sale: B&K-Precision model 415 sweep-marker, with carton, manuals and probes, used once, $350; Conar triggered-sweep scope with probes, $75; Conar color generator with manual, $50. *Leonard Elgart, 3510 Avenue H, Brooklyn, NY 11210.*

Needed: Catalog and prices of surplus electronic organ parts and subassemblies. *N. Young, 214 E. Robertson, Brandon, FL 33511.*

For Sale: Sencore PS-148 scope with 39G3 low-cap and demodulator probe, hardly used, $150; Heathkit TV post-marker/sweep-generator model IG-57A with attenuator and cables, factory calibrated, used twice, in excellent condition, $75. *Paul Ciarelli, 17 Pebble Lane, Levittown, NY 11756.*

Needed: Alignment tape for Wallensak model 1980 open-reel tape recorder. Will use and return the tape. *Elmer Mosley, 720 Poplar, Kenova, WV 25530.*

Trade: Early, out-of-print Photofacts to trade for others or for Rider's manuals. *Lawrence Beitman, P.O. Box 46, Highland Park, IL 60035.*

For Sale: New Heatkit remote-control kit for GR900 color TV, $50. *Robert Bowman, 1273 Meadow Lane, Youngstown, OH 44514.*

For Sale: Hickok model 230 tube tester with case for carrying eight receiving tubes, $150; Sencore MU150 continental tube tester, $300. Both in warranty and mint condition. Consider DVM or counter as partial trade. *Kenneth Miller, 10027 Calvin, Pittsburgh, PA 15235.*

For Sale: Sylvania CK-3000 hybrid color-TV test jig with cables for all major brands, $200; B&K-Precision model 280 digital multimeter with power adapter, $50; B&K model 1248 color-generator/analyzer, $95; B&K

model 467 CRT restorer/tester, $160; EICO model 944 flyback/yoke tester, $35; Castle Mark IV-A tuner subber with power supply, $25; RCA model SM-5440 UHF/VHF indoor rotating antenna with 100 ft. of cable, $60. All items shipped FOB. *Ralph Roode, 4401 Bermuda Circle, Irvine, CA 92714.*

For Sale: One RCA vertical-output transformer, part 130092, new in carton, $15 plus shipping; one GE B&W yoke part ET76X41, good condition, $5 plus shipping. *Frank Randolph, 6123 Main, Lanham, MD 20801.*

Needed: Service and operation manual for model LA-545 scope by Lavoie Laboratories (seems to be exact copy of Tektronix 545). Also, need address of Lavoie Lab. *Rejean Mathieu, 660 13th Avenue, Senneterre, Quebec, Canada 10Y 2MO.*

Needed: Copies of **Electronic Servicing** from November 1974 to April 1978. *Rejean Mathieu, 660 13th Avenue, Senneterre, Quebec, Canada 10Y 2MO.*

For Sale: Test equipment manuals for B&K-Precision, Sencore, RCA, Hickok, Heath, Tektronix, H-P, Simpson, and Triplett. Send stamped addressed envelope with list of your needs. *Ron Jordan, 5277 Larchwood Drive, San Jose, CA 95118.*

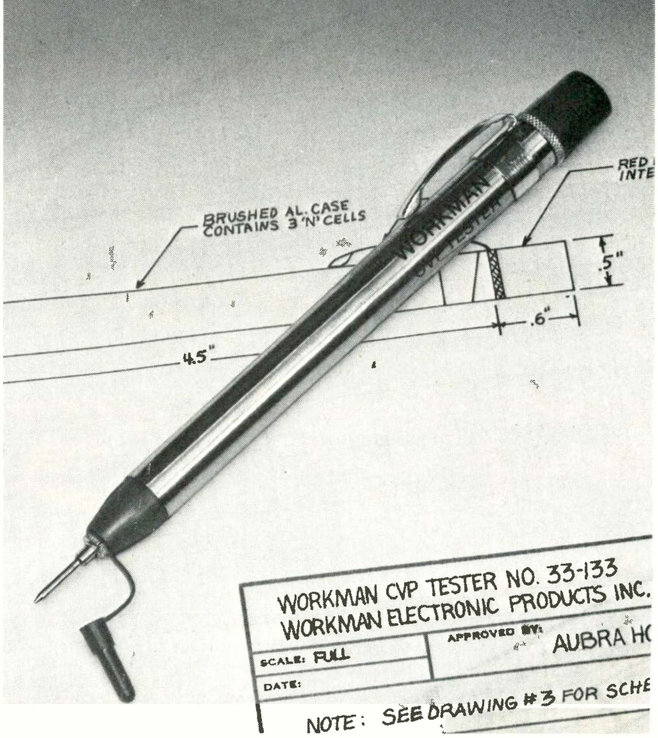
For Sale: Three unused RCA electric signs, $5 each; 101 radio and TV tubes, one to three of each type, $35; 100 dial lamps, $4; 36 issues of **Electronic Servicing** to December, 1977, $18; and 32 issues of CDE Capacitor, tips and information, $3. All for $60. All prices are less shipping. *Otmer Basham, 214 South Craig, Covington, VA 22426.*

For Sale or Trade: Early Rider's manuals and out-of-print Photofacts. *Lawrence Beitman, Box 46, Highland Park, IL 60035.*

For Sale: RCA 535A scope, $280; B&K-Precision 520B transistor tester, $135; new B&K 1077B Analyst; and B&K 415 sweep/marker. Might trade for Sencore VA-48 video analyzer. *Ralph Dorough, 600 Colonel Drive, Garland, TX 75043.*

For Sale: Fathometer chart paper for Raytheon model DE-729 (also fits DE-112, 116, 701, 705, 707 and 725, but different calibration lines). List price is $9 per roll, but I will ship 10 (or all) COD for $1 per roll; 32 rolls are available. *Edwin Pitsinger, 2409 Avenue N, Galveston, TX 77550.*

For Sale: Direct-burial type of jacketed and silicone-sealed coax CATV cable, spool of 3,085 feet, $530 value for $400 plus shipping; Leader LTC965 curve tracer; EICO 1030 dc bias supply; EICO 955 capacitor tester; B&K-Precision radio Analyst; Sencore TF17A transistor tester; Sprague TC5 capacitor tester; SECO



HC8 cathode-current tester; Pomona 2900 HV probe (converted to 40 KV); EICO 465 scope; Sencore FE14 TVOM; Sencore SM152 sweep/marker; make offers. *Richard Dugo, 29 Mill, Dansville, NY 14437.*

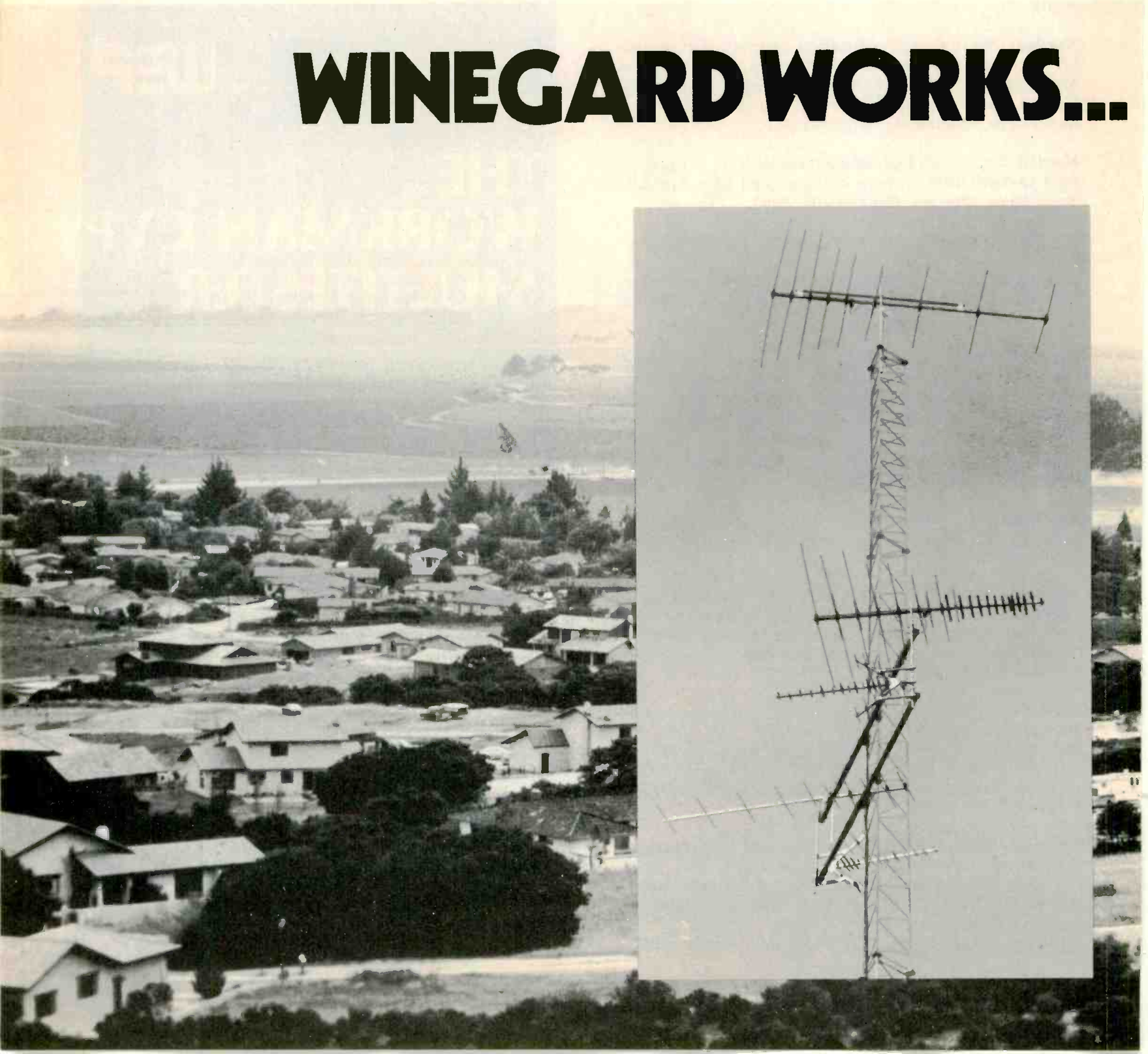
For Sale: Tektronix 531A dual-trace scope with CA dual-trace plug-in, D-type differential amplifier, current probe and scope cart; RCA WC528B curve tracer; VOX-70 Record-A-Call answering machine with extra tapes; 130 most-used (new) tubes in caddy. All have manuals and cables, and are in excellent condition. Make offer; or consider trade for a microcomputer system. *Mike Murphy, 40512 Regency Drive, Sterling Heights, MI 48078.*

Needed: Source of parts (including heads, preamps, motors and others) for Bell tape deck, manufactured by TRW. Need service manuals for models T-347, T202 and T201. *George Barnes, 38 Woodmere Road, Framingham, MA 01701.*

For Sale: B&K-Precision model 1077B TV Analyst, about year old, used little, $375; and Olson TE-197 VOM, 50,000 ohms-per-volt, $40. Or best offers. *William David, 209 Fir, Montgomery, MN 56069.*

For Sale: Like-new Sencore model TF166 transistor/FET analyzer, $100; Tektronix model 514AC scope, $100. *J. E. Johnson, Route 6, Box 245A, Thomasville, GA 31792.*

For Sale or Trade: B&K-Precision model 415 sweep/marker, with manual and leads, excellent condition, $250 prepaid. Or, trade for a Sencore SM152 with



manual and accessories, in good condition. *Earl Triplett, Box 165, Avant, OK 74001.*

Needed: Horizontal-output transformer part number D80-49-3 for a Silvertone B&W TV. Sears does not stock. *Ludlow TV Service, 4035 South Richmond, Tulsa, OK 74135.*

Needed: Lectrotech BG120 color-bar generator; Sencore SG165 stereo analyzer; Sencore PS148 scope. Accept equivalent instruments. *Thomas Burns, 9 Allegheny Terrace, Pittsburgh, PA 15207.*

For Sale: Bell & Howell home-entertainment electronics course, $75; CIE FCC first-class license course, $60; Heathkit HW101 with mic, $400; Lafayette HA-146 2-meter fig with antenna, 11 sets of crystals and touch-tone pad, $240. *Larry Hall, Route 3 Box 3462, Selah, WA 98942.*

Needed: Horizontal and/or vertical sweep tester for transistorized circuits; a color test jig; a good scope; and one color TV correspondence course. *Kenneth Miller, 10027 Calvin, Pittsburgh, PA 15235.*

Needed: Schematic and service data for model AM-100 Viso-Analyzer by Commercial Trades Institute. Will buy, or copy and return. *William Ott, Route 2, Box 119C, Hinesville, GA 31313.*

Needed: Riders volume 23, also HQ-180. *Anthony Kray Main Street, Putney, VT 05346.* ☐

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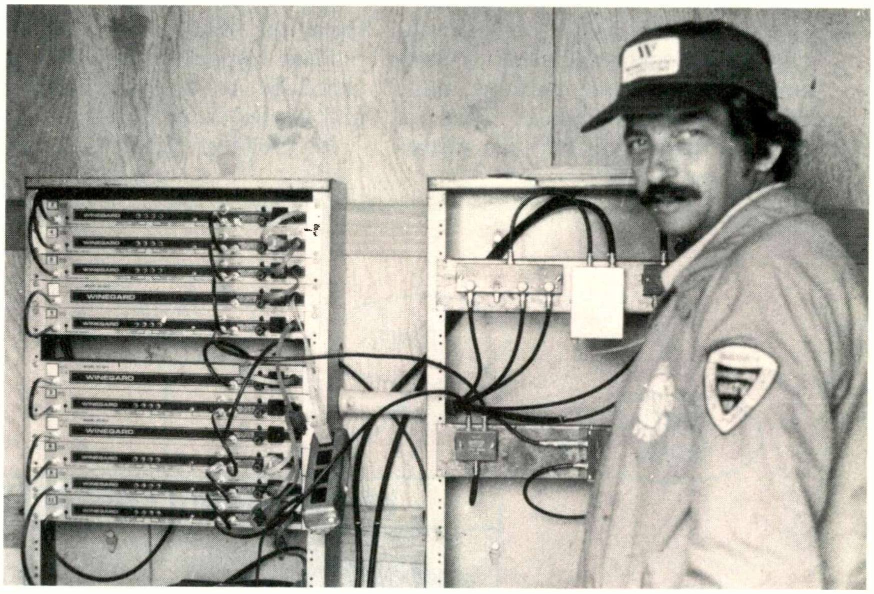
for an entire community.



Dave Marsh, owner of AA Antenna Systems in San Jose, California, shows off the Winegard MATV headend he installed to service 155 homes in the Indian Springs housing development. Reception is reported to be excellent although this is a very difficult signal area.

Indian Springs, California, 85 miles from San Francisco, is a great place to live, but not for getting much television.

To help sell their 155-home development, the Jules Duc Construction Company planned a community MATV system. Dave Marsh, who had left a good telephone company job to go on his own as a TV antenna installer, got the chance to bid on the job. He got a set of blueprints of the site and designed a Winegard CLA system. "Then," Marsh recalls, "I sent the plan to Winegard where some improvements were made. I priced it out, submitted the bid, and got the job."

To get TV signals from San Francisco, a 70-foot self-supporting tower was put on the side of the highest hill in Indian Springs. Because of the inaccessability of the location and the time requirement, Marsh hired a helicopter. The job that would've taken six men three days to complete was done by four men in two hours. Marsh installed five Winegard antennas on the tower: CH-2026 for channels 2, 4, and 5, CH-9055 for channel 81, CH-2008 for 8, CH-7082 for 11-36, and a CH-9055 for channel 46. Other equipment used included: AC-0926 preamp; ME-26 tuned for channels 2, 4, and 5; DX-0302, DX-0303, DX-0304, DX-0305, DX-0306, DX-0308, DX-0309, and DX-0311 strip amplifiers; Three VC-4213's; CL-22 and CLA-121 line amplifiers; CT-1001, CT-1002, CT-1004 droptaps; AF-0500, IP-6, IP-12, IVB voltage block and CL-2800 cable.

"As the homes would go up I'd pre-wire them," Marsh said. "I'd go in right after the electrician and just before the drywaller. Each house received three outlets." Without the Winegard system only two stations, channels 8 and 46, would've been available to the homeowners. As a result of the system each homeowner now receives channels 2, 4, 5, 8, 9, 11, 36, 46 and 81. Marsh credits the assistance he received from his Winegard distributor, and the Winegard District Manager, in helping him establish his business. "Everytime I had a problem I'd call on Winegard and they spent the time to get things straightened out," Marsh stated.

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Circle (7) on Reply Card

What are Microprocessors?

By Carl Babcoke, Editor

This brief overview of microprocessors is presented as an introduction to the new series that begins this month in *Electronic Servicing*. These articles will bridge the gap between the theory of these complex circuits and practical field servicing.

Microprocessors defined

Microprocessors have been a major factor in the digital electronics revolution. And yet they remain something of a mystery.

Defining a microprocessor is complicated by a lack of standardization caused by rapid growth. Microprocessors are linked to computers, yet they can perform many complex programs alone. There is no clear distinction between microprocessors and microcomputers or minicomputers.

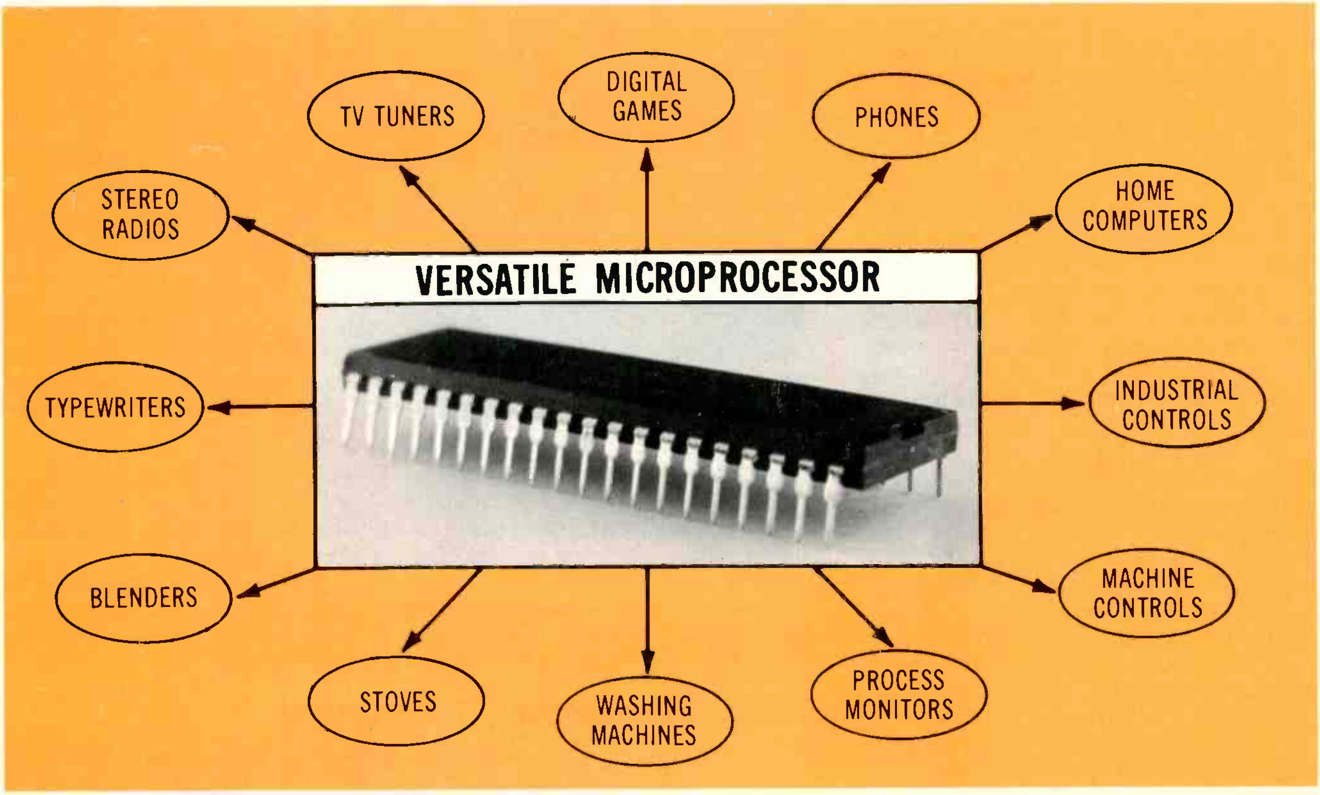
According to one simple definition, a microprocessor is a single integrated curcuit (IC) which can perform about 75% of the operations usually done by a small computer. What's more, most small modern computers include a microprocessor to do the mathematics and control functions.

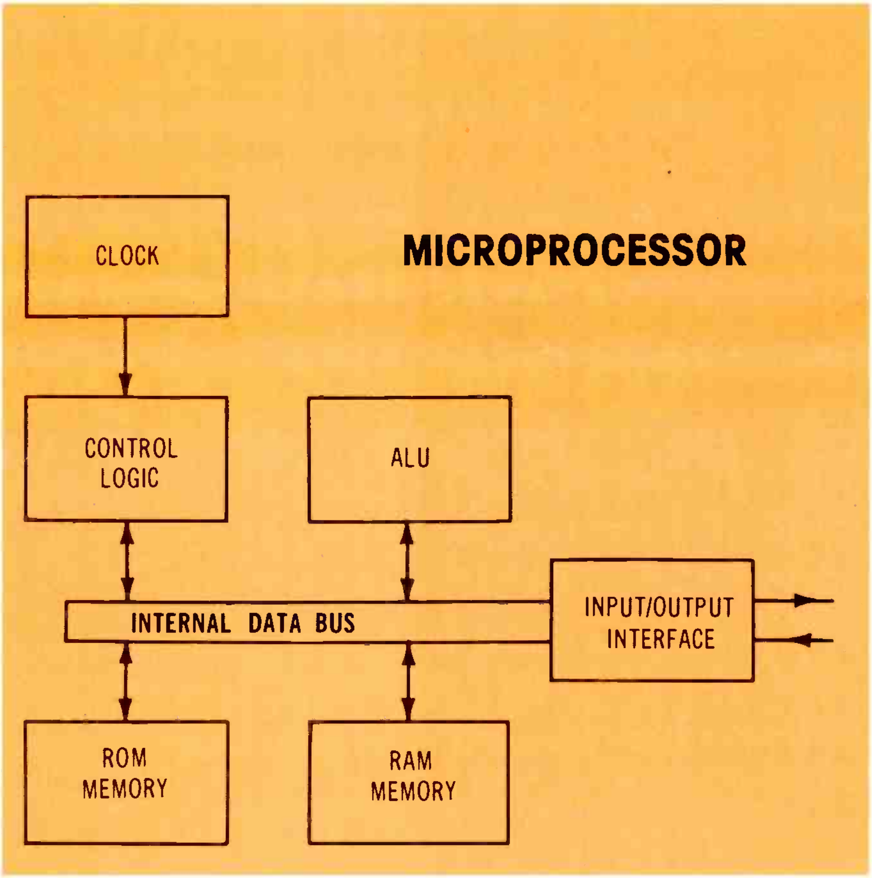
In broadest terms, microprocessors are programmable devices which control sequential processes and whole machines by the manipulation of digital signals.

Basic functions

Late-model microprocessors contain (usually inside one IC) these four basic sections:

- an arithmetic-logic unit (ALU) which sometimes is called a processor;





- control logic with a timing clock;
- two kinds of memory; and
- input-output devices (which by multiplexing can be the same unit with two functions).

Together the ALU and the control-logic circuits often are referred to as a Central Processing Unit (CPU). A CPU is comparable to a digital calculator, since it takes care of the mathematical functions, among others. Also, the CPU acts as a speedy delivery service, taking data between memories (they cannot communicate directly with each other) and obeying commands from the Read Only Memory (ROM) or (through an encoder) from an operator.

A CPU has two kinds of inputs and outputs that operate on the signal busses. Address lines always are outputs, while data lines can handle either input or output data, depending on the timing.

On command, the CPU assigns data to certain sections of Random-Access Memory (RAM) and ROM memories. Then it checks to be certain the data corresponds to those particular address locations.

RAMs are the temporary storehouses for data that will be needed later, including the program that controls the microprocessor.

ROMs are brains that are manufactured with permanently stored information. When asked, each ROM tells the CPU what it should do, how to accomplish the action, when to do it, and where to place the data afterwards.

Notice that the CPU never operates alone. It is a good servant that works rapidly and accurately at whatever it's instructed to do. That's why most new-type microprocessors have some ROM, RAM and input-output capability provided inside the same IC package.

Additional memories of both kinds can be added externally and connected into the signal busses where the CPU can carry their data too.

Classic 8080

One of the first popular microprocessors is the 8080 which has been manufactured by many companies. Large-Scale Integration (LSI) technique was used to pack a complete microprocessor into one 40-pin DIP case. IC 8080 has 16 address lines, 8 data lines, 10 control lines, 4 power pins and 2 pins for clock input. It is an 8-bit microprocessor that can address up to 65,536 8-bit words. Therefore, it is said to have a 64K memory.

In this microprocessor, a bit is a binary 0 or 1, while a byte is 8 contiguous bits found in a single memory location. A word is 16 contiguous bits that occupy two successive memory locations.

These specifications indicate that the 8080 has a fair amount of computer capabilities, in addition to a large potential for controlling many complex operations. While newer microprocessors have even more capabilities, they lack the wealth of software that's available for the 8080.

Typical uses

A complete list of all the jobs a microprocessor can perform would fill many magazines. However, they can be lumped into three basic categories:

- programmable controllers;
- arithmetic units; and
- sequencers.

Not all applications use the full capabilities of microprocessors, which are available in 4-bit, 8-bit and 16-bit versions. For example, microprocessors used in home appliances, business machines, videotape editors or audiotape recorders probably are selected mostly for the control functions.

Microprocessor is the most popular term for a new feature of many new products in a multitude of fields. A few microprocessor-controlled TV tuners are in production now, and every TV line is expected to have a version by next year.

Every technician should learn enough about microprocessors to permit analyzing and servicing any systems that contain them. This recommendation is for all kinds of electronics, because microprocessors now are (or soon will be) found in all branches.

The new series about microprocessor circuit operations (which begins elsewhere in this issue) will help fill the gap between engineers complex information and practical field servicing of the equipment. ☐

An introduction to microprocessors

By Jack Webster

Internally, microprocessor ICs are very complicated. Some contain the equivalent of several thousand transistors. And many details of construction and operation are hidden in proprietary secrecy. Therefore, a study of these commercial ICs is of little value. Instead, this series will concentrate on general operations of various sections in an IC and the typical functions and performances of microprocessors. Experiments showing the simplified operation of memories and other microprocessor circuits will be given later.

Basic concepts & definitions

People who work in a specialized field usually develop their own vocabulary or jargon that helps them communicate with each other.

A good starting point for a study of microprocessors is to learn the jargon used by digital engineers, manufacturers and service technicians. These various terms will be included at appropriate points.

And because microprocessors are essential parts of computers, some computer terms will be explained also. However, microprocessors have many more uses than just in computers. They are versatile and are capable of doing many things according to how they are programmed.

Human vs. machine language

Suppose a math problem involves multiplying eighteen by twelve. That's stated in English words; so for a human who understands English, the first step is to change it into a mathematical form, such as:

$$\begin{array}{r} 18 \\ \underline{x12} \end{array}$$

In other words, the problem must be changed to a *language* that the problem-solver can utilize.

Therefore, if the same problem is to be solved by a computer, the various elements must be changed to a form (language) that the computer can identify and manipulate.

Microprocessors recognize only binary language. Every message into or out of a microprocessor must be in the form of digital ones and zeros (highs and lows). The numbers 18 and 12 are decimal types, which can't be used directly by computers or microprocessors.

Because a microprocessor can't recognize 18 and 12, they must be converted to these binary equivalents:

$$\begin{array}{r} 10010 \\ \underline{x\ 1100} \end{array}$$

The numbers now are in binary language, but a difficulty remains. Both numbers can be recognized by the computer, but it doesn't understand the multiplication sign. A binary code is needed for the multiplication sign.

Such binary codes are programmed into the IC during manufacturing. Assume that the binary number 0111000 was assigned to the function of multiplication. After this change, the problem becomes the all-digital (1100) (0111000) (10010). It is properly stated in computer language and the microprocessor section of the computer can perform the calculation.

Notice, however, that translation of decimal numbers into computer data has produced digital numbers that are not readily understood by most humans. Imagine trying to operate a calculator that forces the operator to change every decimal number into binary code before it is fed into the calculator! A readout in binary also is not acceptable.

An automatic interpreter is needed; one that converts Arabic decimal numbers to binary. Thus for example, 1, 2 and 3 become 0001, 0010 and 0011.

ICs that make such conversions are called *encoders.* A keyboard-type encoder converts to binary code any decimal numbers or math operators (+, -, X and ÷) that are typed on it.

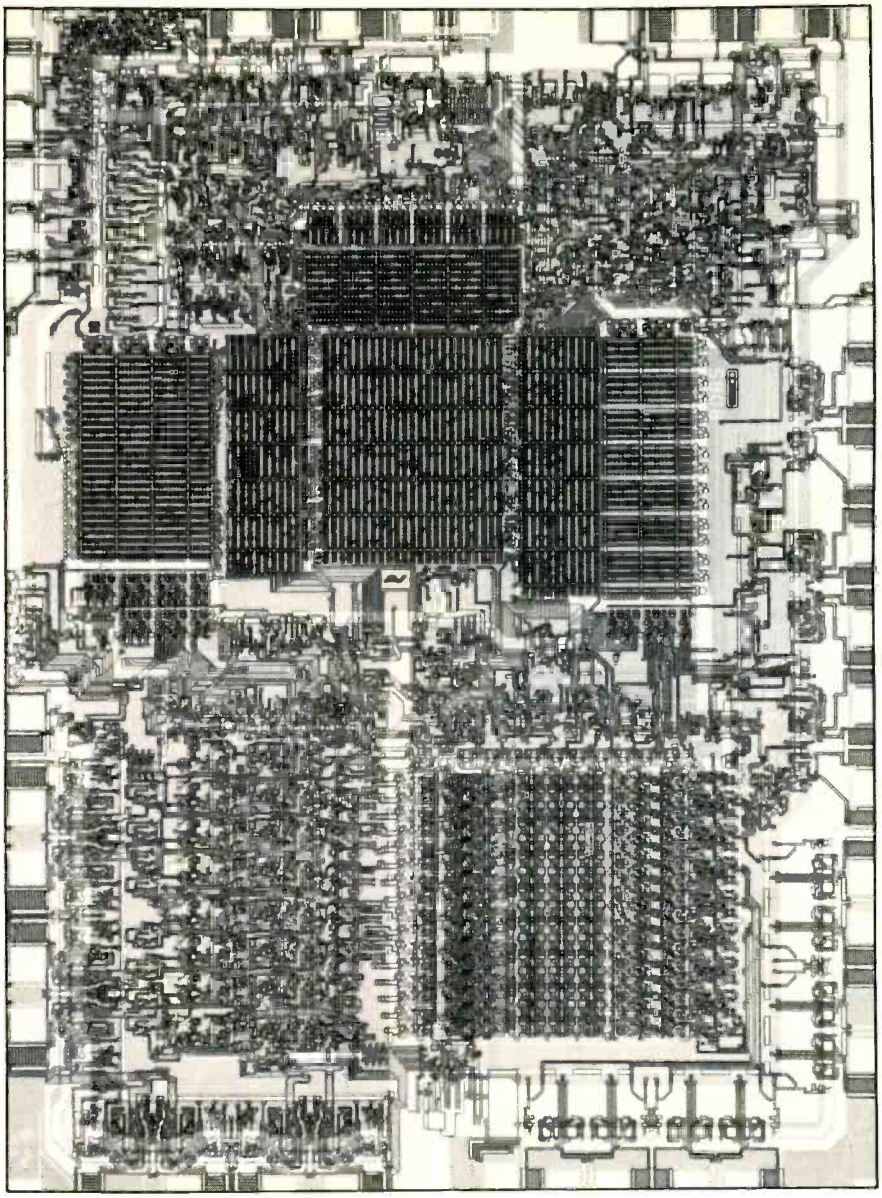
After the microprocessor solves the math problem, it sends the answer to the output. Unfortunately, this answer is in binary form that's not acceptable to the operator.

A *decoder* is necessary for converting the output binary numbers to Arabic decimal numbers which then are displayed on an LED or LCD display, a TV-type screen or other kind of numerical display.

Both the numbers and multiplication commands are encoded into binary language and then fed to the microprocessor. The keyboard and its encoder act as an *interface* that permits a human operator to send the microprocessor a valid message. This is the *input* section.

Similarly, the output decoder and readout display act as an interface to allow the microprocessor's answer to be understood by the human. This is the *output* section.

All computers and microprocessor-controlled devices have combined input and output sections, commonly written as *I/O*.



The 8085 microprocessor chip is very complicated because it is less than a half-inch square. (*Courtesy of Intel*)

ALU calculator

A calculator can be made by adding input and output devices to the type of Arithmetic-Logic Unit (ALU) that is part of each microprocessor. This simple calculator (Figure 1) is capable of performing logic functions (such as AND and OR), comparing data, multiplication, division, addition and subtraction. Data is moved in and out on the *bus* lines.

Other functions can be performed, but only under the constant control and supervision of a human operator. The system is limited in both speed and accuracy because of the manual control.

Control & timing

These many intricate steps can be handled better electronically by the addition of a *control and timing unit* (Figure 2). Usually the Arithmetic Logic Unit (ALU) and the control unit are different sections inside the same microprocessor IC. However, in a large computer, they might be in two separate ICs.

Working together, the ALU performs arithmetic manipulations and logic functions, while the control unit moves the signals to and from the proper locations.

A clock is added in Figure 2 to operate the stepping of various signals into and out of the system, and to time the various operations. This clock function is similar to that of a clock in synchronous counters.

So far, no provision has been made for any kind of memory. And memory is essential for any program that operates sequentially.

RAM & ROM memories

RAM is the acronym for Random Access Memory, and it is a system that accepts binary bits (ones and zeros) for storage (usually temporary). By an input of the proper signals, those binary bits can be retrieved and used at any time and

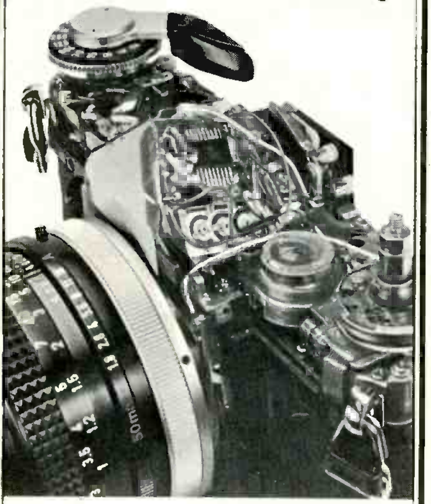


Figure 1 The Arithmetic-Logic Unit (ALU) of a microprocessor with suitable encoders and decoders can perform many mathematical calculations and logic functions. However, the human operator must manually control each step.

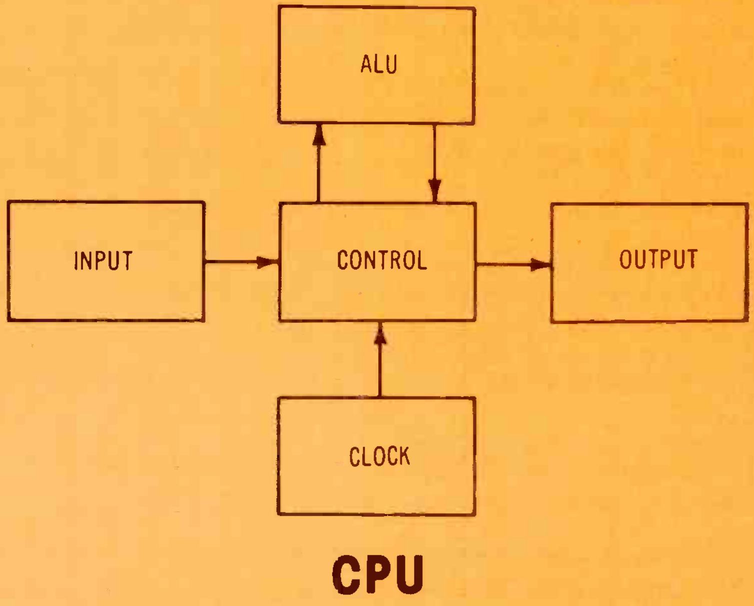


Figure 2 The Central Processing Unit (CPU) is made up of the Arithmetic-Logic Unit (ALU) and the control and timing (clock) unit. Except for memory, this comprises a basic microprocessor.

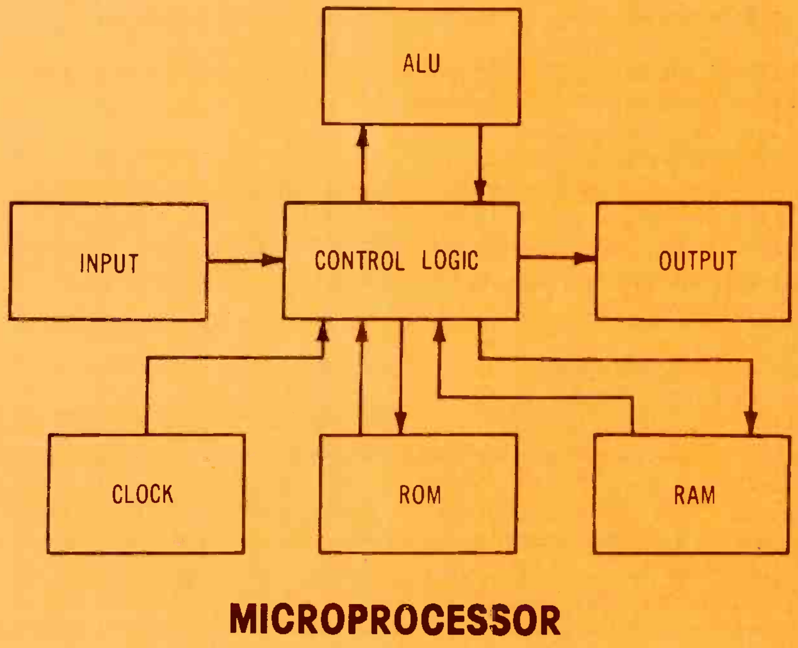


Figure 3 A functional microprocessor has these sections.

from any internal location regardless of sequence. Any number can be stored and retrieved, or a new number can be inserted at any time by use of the proper code. RAM memory usually is lost when the dc power is removed.

ROM means Read Only Memory. It too is a memory system, but one that stores the data permanently. The IC is programmed when it's manufactured, and most types cannot be changed after that. For example, the binary value of Pi (3.14159265 in decimal) can be stored in the ROM when it's built. Addressing the ROM with the proper code allows this precise figure to be retrieved at any time for an unlimited number of times. The computer operator cannot change the value or erase the number. ROM memories remain intact whether or not any dc power is applied.

Figure 3 shows the system of Figure 2 with RAM and ROM memories added. If more memory is needed, additional memory ICs can be connected externally and operated from the microprocessor.

Static & dynamic

RAMS are available in either static or dynamic types. A *static* RAM is made from flip flops (which retain the last state), so no further attention is required after the data is read into it. This binary data is retained (as long as the dc power is not turned off) until it is superceded by new data.

A *dynamic* RAM memorizes binary states by storing electric charges, which would soon dissipate if not refreshed periodically. Static RAMs usually are specified for smaller systems while larger systems use dynamic RAMs and provide the circuits for the refresh mode.

Volatile & non-volatile

The word *volatile* describes digital memory circuits that are erased (all stored data is lost) when the dc supply voltage is removed. *Non-volatile* memories retain the stored data regardless of the presence or absence of supply voltage.

Other types of memories are included in many microprocessors, and they will be discussed in a later article. ☐

MICROPROCESSOR QUIZ
Can you define these terms?

ALU
BINARY
BUS
CLOCK
COMPUTER
CONTROL & TIMING
CPU
DECODER
DYNAMIC
ENCODER
HARDWARE
INPUT
INTERFACE
I/O
KEYBOARD
MEMORY
NON-VOLATILE
OUTPUT
RAM
ROM
STATIC
STEPPING
SOFT WARE
VOLATILE

Figure 4 These words were mentioned in the article. Can you define them in computer and microprocessor terminology?

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2SA 497	1.20	2SC 711	.25
2SA 509	.35	2SC 712	.25
2SA 562	.30	2SC 717	.40
2SA 564A	.34	2SC 730	3.30
2SA 634	.40	2SC 732	.25
2SA 643	.35	2SC 733	.25
2SA 673	.40	2SC 734	.25
2SA 678	.50	2SC 735	.25
2SA 683	.50	2SC 756	1.90
2SA 684	.50	2SC 756A	2.15
2SA 695	.50	2SC 778	3.25
2SA 699A	.60	2SC 781	2.40
2SA 706	1.00	2SC 784	.35
2SA 720	.35	2SC 789	.90
2SA 733	.25	2SC 793	2.40
2SA 747	4.80	2SC 799	2.40
2SB 22	.50	2SC 828	.25
2SB 54	.35	2SC 829	.25
2SB 77	.40	2SC 839	.35
2SB 175	.40	2SC 867A	4.45
2SB 186	.25	2SC 900	.25
2SB 187	.25	2SC 930	.25
2SB 324	.35	2SC 945	.25
2SB 367	1.30	2SC 1000BL	.40
2SB 405	.30	2SC 1013	.60
2SB 407	.90	2SC 1014	.60
2SB 463	1.10	2SC 1018	.80
2SB 474	.85	2SC 1030	2.30
2SB 507	.85	2SC 1060	.80
2SB 511	.80	2SC 1061	.85
2SB 557	2.70	2SC 1096	.50
2SC 183	.50	2SC 1114	3.75
2SC 184	.50	2SC 1116A	3.75
2SC 372	.25	2SC 1124	.90
2SC 373	.25	2SC 1127	.90
2SC 380	.25	2SC 1162	.80
2SC 382	.40	2SC 1166	.35
2SC 387A	.40	2SC 1172B	3.80
2SC 394	.30	2SC 1173	.65
2SC 458	.25	2SC 1209	.35
2SC 460	.50	2SC 1226	.65
2SC 481	1.40	2SC 1226A	.65
2SC 482	1.40	2SC 1237	2.10
2SC 485	1.40	2SC 1239	2.80
2SC 495	.55	2SC 1306	1.80
2SC 509	.40	2SC 1307	2.80
2SC 517	3.20	2SC 1318	.40
2SC 535	.35	2SC 1364	.40

TYPE	1-9	TYPE	1-9	TYPE	1-9
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2SC 1384	.40	2SD 427	2.15	STK 439	8.75
2SC 1448A	1.15	2SD 525	1.10	TA 7045M	2.40
2SC 1475	.90	2SD 526	.75	TA 7055P	2.40
2SC 1509	.60	2SK 19	.50	TA 7060P	1.10
2SC 1567A	.70	2SK 23	1.00	TA 7061P	1.10
2SC 1675	.30	2SK 30	.45	TA 7062P	1.30
2SC 1678	1.50	2SK 33	.70	TA 7063P	1.45
2SC 1687	.45	2SK 34	.55	TA 7074P	3.95
2SC 1728	.95	2SK 41	.55	TA 7089P	2.40
2SC 1760	1.05	2SK 55	.70	TA 7120P	1.80
2SC 1775	.35	3SK 22Y	1.75	TA 7203P	2.80
2SC 1816	1.90	3SK 35	1.45	TA 7204P	2.40
2SC 1908	.35	3SK 37	2.25	TA 7205P	1.90
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2SC 1969	4.25	3SK 48	3.65	TC 5081P	3.25
2SC 1973	.65	3SK 49	1.50	TC 5082P	3.75
2SC 1974	1.80	AN 214Q	1.80	UHIC 001	5.55
2SC 1975	1.80	AN 239	4.75	UHIC 002	5.55
2SC 2028	.60	AN 247P	2.85	UHIC 003	5.55
2SC 2029	1.90	AN 274	1.85	UHIC 004	5.55
2SC 2076	.60	AN 313	4.55	UHIC 005	5.55
2SC 2091	1.10	AN 315	2.15	UPC 20C	2.65
2SC 2092	2.15	BA 511A	2.10	UPC 554C	1.75
2SC 2098	3.40	BA 521	2.30	UPC 555H	1.75
2SD 72	.60	HA 1151	1.80	UPC 575C2	1.50
2SD 91	1.50	HA 1156W	1.90	UPC 576	2.30
2SD 92	1.70	HA 1306W	2.35	UPC 592HZ	.90
2SD 180	1.90	HA 1322	2.85	UPC 1001HZ	2.30
2SD 187	.40	HA 1339	2.90	UPC 1008C	5.70
2SD 218	3.40	HA 1339A	2.90	UPC 1020H	2.30
2SD 234	.75	LA 4031P	2.15	UPC 1025H	2.30
2SD 235	.75	LA 4032P	2.15	UPC 1156H	2.30
2SD 261	.35	LA 4400	2.30	UPD 857C	9.35
2SD 287	2.80	M 51513L	2.40	UPD 858C	7.15
2SD 291	2.70	PLL 01A	4.50	UPD 861C	9.05
2SD 313	.65	PLL 02A	5.75	C-3001	1.60
2SD 315	.75	PLL 03A	8.65	2SC F8	2.90
2SD 325	.70	SG 613	5.80	4004	2.40
2SD 330	.84	STK 011	4.30	4005	2.50
2SD 356	.75	STK 013	8.75	78L05	1.10
2SD 358	.85	STK 015	4.75	MPS U31	1.90
				SN 7400	.19

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Bad filters cause elusive problems

Hum bars and small pictures are not the only symptoms of open filter capacitors. Filters that bypass the common voltage supply of several basic circuits can allow (if they become open) a mixing of these signals. The unusual symptoms that are produced can be eliminated by following the tests described here.

By Homer L. Davidson

Conventional or unusual symptoms

Symptoms of defective filter capacitors range from the usual hum bars and audible hum to others that seem to have no connection with power-supply problems.

In previous years, most technicians tested for bad filters by paralleling the suspected capacitor with a new one of the correct value. Of course, this test cannot identify leaky capacitors. Another limitation is the temporary healing of some capacitors because of the severe voltage surges produced by shunting while the power is on. Despite these restrictions, the paralleling test generally was satisfactory in previous years. But components have changed to types having less tolerance for overloads, so modifications of the test are necessary.

One good method is to turn off the power before a test capacitor is connected to the circuit. Following the test, the power should be turned off before the capacitor is disconnected. An elegant solution is to use one of the capacitor-substitution boxes that permit charging the capacitor before it is switched in direct.

Unusual symptoms—One old-timer in the TV-servicing field once said, "I always shunt the filter capacitors in the low-voltage supply when unusual symptoms appear on the screen. I find that it solves about 60% of my service problems."

Dangers to solid-state components from voltage surges have been mentioned already, and precautions must be taken. However, the old-timer's reasons for using this test to locate those hard-to-explain symptoms remain valid for modern equipment.

Many different sections of each TV obtain dc power from the same source. When a capacitor opens, the signal impedance of that supply no longer is near zero. Waveforms of hum, audio, vertical or horizontal signals appear on the B+lines and are brought into other sections. Therefore, the symptoms of a defect appear in a section that does not have a problem except from the signals fed through the power supply.

Analyze waveforms—A better test method than shunting is to scope the waveforms at the various branches of the B+ supply. This is particularly valuable where the B+ circuit is not readily accessible but the signal wiring can be reached easily.

In most cases, no detailed analysis is needed. If the schematic calls for about 1 VPP of 120-Hz ripple, but horizontal pulses of 100 VPP are there, don't analyze the pulses but eliminate them by finding the bad capacitor. When a new capacitor has removed the hash and pulses, the original problem probably will be gone also.

Notice, however, that the excessive amplitude of a wrong waveshape has located the supply line which is not properly filtered.

Test equipment—No unusual test equipment is required to find which filter is defective. Most good shops have everything that's needed. These items of test equipment are recommended:

- a meter for measuring dc and ac voltages plus resistances (many problems reduce the B+ voltage);
- a scope calibrated to read peak-to-peak ac voltages (it can show foreign waveforms and the total amplitude); and
- a generator of crosshatch patterns (better for showing bending).

In addition, a capacitor substitution box covering the larger values needed for solid-state merchandise is an excellent time-saver. A model that reduces surges is highly recommended.

Another optional instrument for solving difficult cases of borderline performance is a capacitance meter. Some new models have a direct-reading digital display.

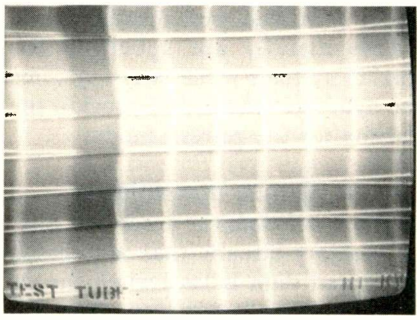


Figure 1 Three classic symptoms of an open power-supply filter are two rounded black horizontal bars in the picture, horizontal displacement at the bars and a smaller picture size. With crosshatch, the bars are stationary; while on station signal they move slowly up through the picture.

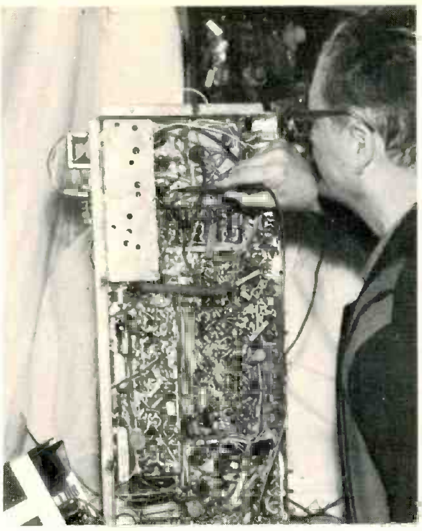
Typical symptoms

Dark horizontal hum bars that move slowly up through a narrow picture (Figure 1) are one classic symptom of bad filter capacitors. (Of course, bad tubes can cause the same hum bars in sets that have tubes.) These dark bars sometimes are accompanied by bending of vertical lines as the hum moves up the screen. Audible hum might or might not be heard in the speaker. Incidentally, an *erratic* bending of vertical lines (but without hum bars) can be caused by high power factor in the filter that bypasses the supply to the horizontal-sweep circuit.

However, many other symptoms (some very unusual) can be produced by filter capacitor defects in some TV models. Some of these are explained in the case histories that follow.

Previous repair

The complaint against an old Sears color receiver was a kink in the picture that travelled upward. Obviously, the flyback transformer and two filter capacitors had been replaced by another shop. In fact, the cans had not been replaced, but instead the two separate capacitors were hanging by their leads under the old ones (see Figure 2).

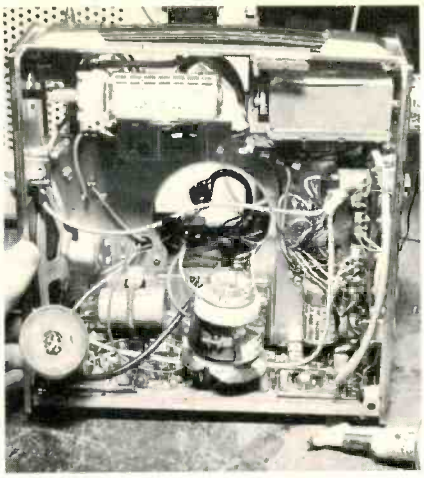


The author checks filter capacitor voltages in an older color TV.

Both capacitors checked above the rated values and the dc voltage at the output of the power supply was about correct. However, the scope indicated excessive ripple at the second filter capacitor (the one downstream from the filter choke). Shunting another 100 µF capacitor across it made little difference.

When measuring the dc voltage at each side of the choke, there was only slightly more than 1V difference between the readings. Since the drop should have been higher, the choke winding was checked and found to be less than 1Ω. Insulation paper around the winding was brown from excessive heat.

The original C2 probably had shorted or become leaky, damaging the choke. And the shorted turns reduced the filtering, causing hum in the picture.



The method of finding open capacitors by scoping the B+ supplies is especially helpful when the filters are not accessible.

Quite often, one shorted section of a multiple can is followed soon by failure of another section. Therefore, the choke and all complete filter cans were replaced at the same time, solving the hum problem.

Poor horizontal locking

The picture on this Olympic CTC31-chassis television would lose horizontal locking when channels were changed or during a videotape problem. In addition, the horizontal locking was very loose.

All dc voltage measurements, resistance tests and waveforms showed nothing wrong in the AFPC and horizontal-oscillator stages. However, when a similar value was paralleled across C2 (Figure 3), the

Figure 2 Paralleling new capacitors across the old ones if not recommended. Failure of a second section often follows the original failure. These capacitors are too near the hot resistors, and their size further restricts the air flow.

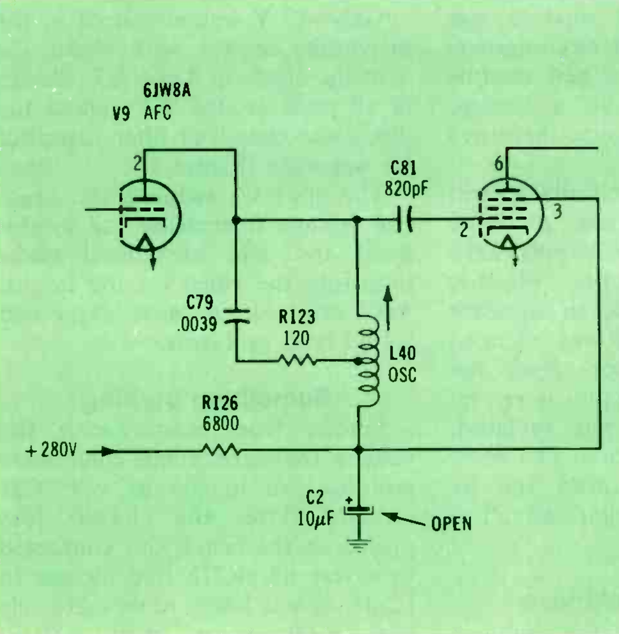


Figure 3 An unstable horizontal oscillator was caused by an open in C2.

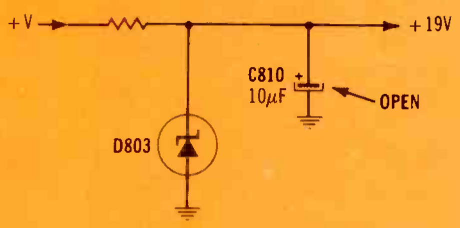


Figure 4 Picture pulling (and no other symptoms) resulted from an open C810. Zener D803 regulated the dc voltage, but did not eliminate enough of the ripple.

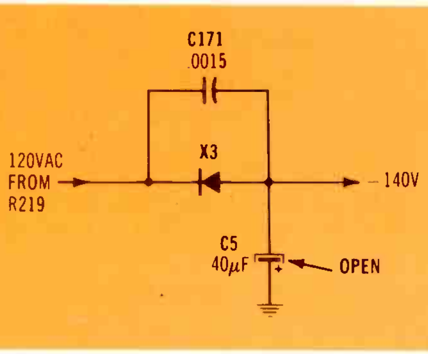


Figure 5 Lower voltage and higher ripple because of an open filter capacitor can cause both increased brightness and video hum, when the supply furnishes negative voltage to the brightness control.

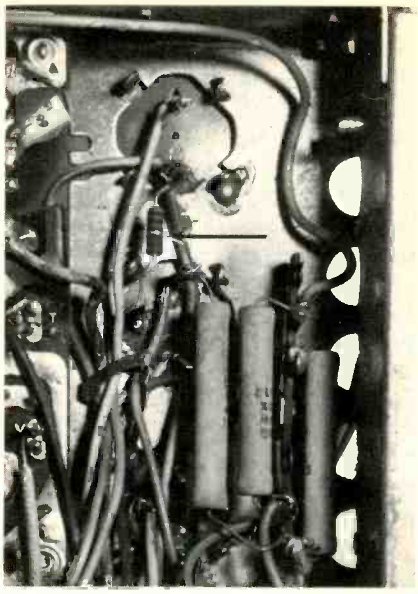


Figure 6 Resistor R226 is cool during normal operation. If it becomes very hot, either C2A is open or there is a short in the load.

Bad filters

locking was normal. Replacement of C2 produced solid locking.

Picture pulling

Picture *pulling* was the problem of a M25-chassis Admiral. Some sideways movement of certain picture elements was minimized by careful adjustment of the horizontal-oscillator coil. But this borderline adjustment brought on an intermittent loss of horizontal locking. It was clear that defective components were to blame and not adjustments.

A new horizontal module was installed, but without any improvement. Occasionally, a new module will be defective, so a second module was tried. Again, there was no change.

Voltages in the horizontal circuit were within tolerance. A scope check of the +19-V supply indicated excessive ripple. Module M800 was not in stock, so capacitor C810 (see Figure 4) was shunted with a test capacitor. Both the pulling and the ripple were reduced. After C810 was replaced, performance was normal. The zener diode (D803) regulated the dc voltage but did not eliminate all of the ripple.

Excessive brightness

When brought to the shop, a Penncrest model 4828 had 60-Hz hum in the picture and excessive brightness that could not be reduced enough by the brightness control.

At first, it was believed that two defects (one video and one filter) were causing those symptoms. However, scoping the +260 V supply and shunting its capacitors gave no improvement.

Brightness problems often originate in the video stages, and hum sometimes does too. During a search of the schematic, it was noticed that -140 V was applied to one end of the brightness control through a limiting resistor.

Only -17 V was measured at the brightness control, with about -70 V at the anode of diode X3. Checks of all parts around X3 showed the diode was okay, but filter capacitor C5 was open (Figure 5).

The open C5 reduced the negative voltage (increasing the brightness) and also introduced 60-hz hum into the video via the brightness control. A new capacitor solved both problems.

Something burning

Smoke from underneath the chassis indicated some component was too hot in the RCA CTC31 chassis. After the chassis was placed on the bench and connected to a test jig, R226 (see picture in Figure 6) was found to be extremely hot. R226 is a small 680-Ω decoupling resistor in the +350-V supply (Figure 7), so it seemed certain that some kind of short or overload in this supply was causing excessive current.

All wires and the resistor lead were removed from the lug of C3A. The capacitor was checked for leakage, but the leakage was normal. Neither were any shorts discovered at any of the other leads that had been connected to the lug.

A new resistor was installed and all wires reconnected to the capacitor lug. When the power was turned on, the new resistor began to heat excessively and smoke.

After several frustrating hours of hunting for a short circuit, a broken terminal lug at C2A was found which gave the effect of an open capacitor. At first, it seemed impossible for this capacitor to cause heating in the *other* branch of the supply. However, the installation of a new resistor and a new C2A capacitor restored correct operation.

By now, there could be no doubt; an open C2A had been the culprit.

Further study of the schematic revealed the reason. C2A bypasses the horizontal pulses that back up from the sweep. When C2A was open, the other filter (C3A) tried to bypass those pulses. However, the current from the filtering of the pulses had to pass through R226. So, the unusual current of C3A was causing R226 to burn up.

Arcing sounds

When the Zenith model B4030W was turned on and the tubes heated enough to operate, a loud arcing sound could be heard. The sound was similar to arcing in the tripler, but the flyback was buzzing and the whistle from the sweep circuit was heard at too low a frequency. In addition, the horizontal-output tube was running a red plate.

Replacement of the oscillator and output tubes eliminated the overheating of the output tube. But the raster showed white erratic lines and the stripes of wrong horizontal frequency. Adjustments of the horizontal oscillator helped very little.

Scoping the +270-V source revealed excessive hash and horizontal pulses at C1B. And the source measured only about +190 V. Shunting another capacitor across C1B restored the horizontal locking and stopped the arcing noises. For a permanent repair, the whole C1 can was replaced.

Frying sounds

Frying noises in the speaker and erratic arcing lines in the raster along with a height of about 5 ins were the symptoms of the RCA CTC74 color TV.

Rotation of the horizontal-hold control either made the condition worse or caused the breaker to trip. Varying the brightness made no change. Squeals could be heard from the flyback transformer.

This receiver had been brought in from another shop. Many of the diodes, small capacitors, both SCRs and other components had been

Continued on page 28

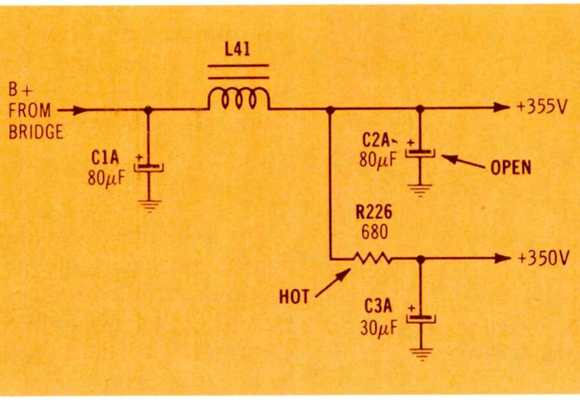
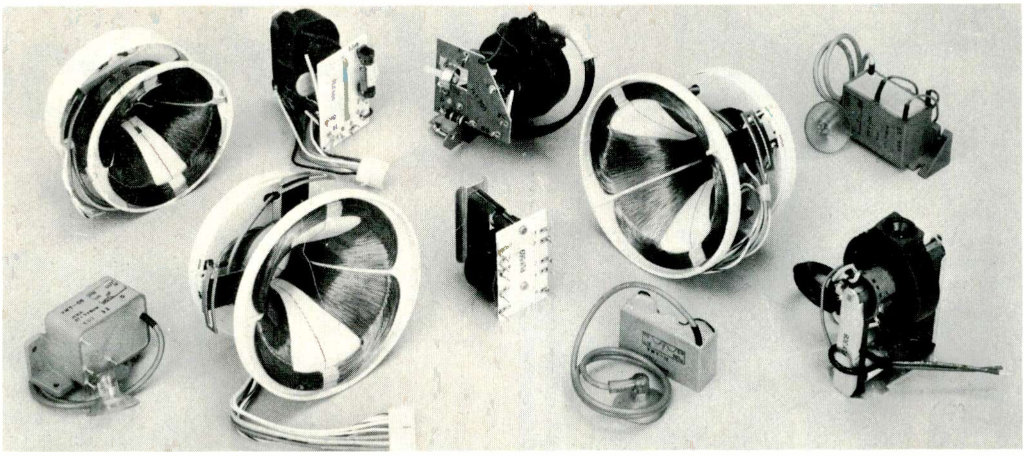


Figure 7 When C2A is open, R226 runs too hot and often fails. Without the capacitance of C2A, excessive amplitudes of horizontal pulses and ripple are produced there. However, C3A is a low-impedance path for such signals and it is separated from C2A only by R226 which has a low resistance. The full amplitude of pulses and ripple therefore is placed across R226. This strong capacitor current is sufficient to ruin R226.



people in the news

James Farrell, regional sales manager for B&K-Precision, explains features of the test equipment to John Hughes (center) and Howard Crowner (right) of Datatrol Corporation. (*Courtesy of B&K-Precision*)

B&K-Precision has begun making test equipment product presentations at offices or plants of industrial companies. After the presentation, a question and answer period is provided, followed with operation of the test equipment by the industrial engineers and technicians. These "on-site" programs are conducted by field engineers Stephen Brow and Paul Nielsen along with Jim Farrell, B&K-Precision regional sales manager.

Dr. William L. Bowden has been named president of the Cleveland Institute of Electronics (CIE). Dr. Gerald O. Allen has been moved to chairman of the board, and the former chairman, John D. Drinko,

becomes chairman of the executive committee, a new post.

Named to the post of staff vice president of the RCA videodisc programming operation is Gordon W. Bricker, formerly manager of the RCA consumer electronics division.

Paul Jones, general manager of PTS-Seattle, has been named PTS "Man of the Month." Jones joined PTS four years ago after several years working with sonar gear in the US Navy and 18 months with another tuner service company. Last year, he received an award certificate from PTS for zero complaints. His branch also has been cited for outstanding service by the National Electronic Service Dealers Association (NESDA).

Paul Jones (right) receives the PTS "Man of the Month" award from John Rollison. (*Courtesy of PTS*)

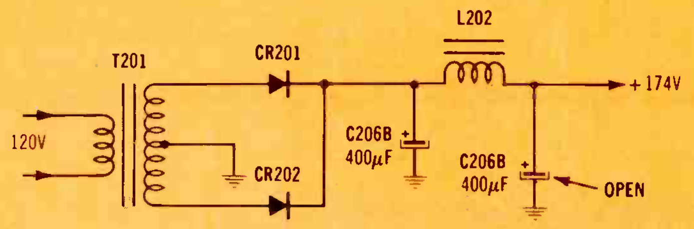


Figure 8 Frying noises and unstable double-triggering raster lines were the symptoms when the SCR horizontal-sweep filter (C206B) was open.

Bad filters

Continued from page 25

replaced. In fact, about the only part not replaced was the flyback.

First, the horizontal module was replaced, but that cured only the horizontal squeal. There was a tip in the tech-note file about this model, and a visual examination showed a loose terminal inside C206B (see Figure 8). C206B is the main bypass of the supply to the horizontal-output stages. A new one solved the problem.

If the tech-note had not been handy, the bad capacitor could have been located by scoping the +174-V supply and finding horizontal pulses.

Seasick picture

Watching the wavering picture on this 3M20 Admiral could have made a viewer seasick. At times it resembled the commercial of the man who ate too much, except that hum bars could be seen also.

All filters were scoped immediately, but no unusual waveforms were found. To make sure the power supply was not the source, each filter was shunted in turn (with the power turned off during each connection or disconnection). Again, no discrepancies were found.

A study of the schematic revealed that the +25.8-V source supplies the IFs, video, color stages and the video output. The scope showed more ripple and hash than should be present at that point.

However, that same supply had been shunted without the trouble being cured. Noticing the 4000 μF value of C103A in Figure 9, brought to mind that the test capacitor had been one of 100 μF. Of course, this size is much too small for that circuit.

When a 4000 μF capacitor was connected temporarily, the queazy picture quieted to the usual stability, and the previous ripple-plus-hash waveform (Figure 10) changed to a straight line.

A new C103 metal-can capacitor completed the repair.

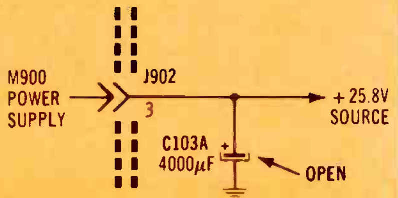


Figure 9 An open C103A caused extreme picture pulling. A test capacitor of lower value will not remove the symptoms.

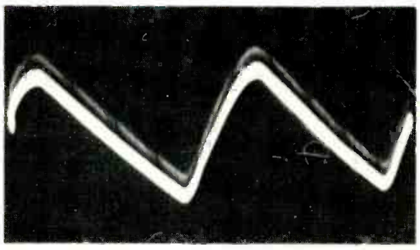


Figure 10 This is the waveform at C103A (see Figure 9) when it was open. After a new one was installed, the waveform was a straight line.

Bad filters?

The model 6A1-1762A Montgomery Ward TV receiver had a narrow picture with hum bars in it. These are common symptoms of an open filter.

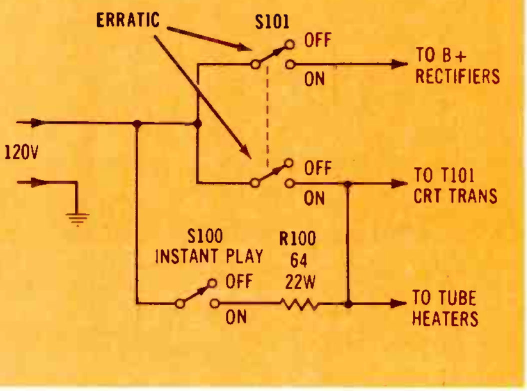
However, when the main on/off switch was left in the on position, the vacation switch could turn on and off all the power. These symptoms were intermittent.

Then it was noted that the CRT heater voltage was only about 4 V, and all other tube heaters were abnormally dim. In addition, the B+ measured only +210 V. All of these symptoms indicated a low line voltage, but no reason could be seen.

When the on/off switch was bumped accidentally, the picture became full sized, the tubes were brightly lit and there was no hum. Apparently, an open was occurring between the line voltage and the common side of S101 (Figure 11). With this open circuit, both heater voltages and the ac for the rectifiers were supplied through R100, which dropped the voltage and upset the peak-reading action of the filter system.

This freakish defect gave all the usual symptoms of open filters, and the case should serve as a warning

Figure 11 When an intermittent switch interrupted the 120 volts at the common lug of S101, the power evidently traveled through R100 and supplied both the CRT transformers and the B+ rectifiers with reduced voltage. However, the symptoms were similar to those of bad filters: hum bars and a narrow picture.



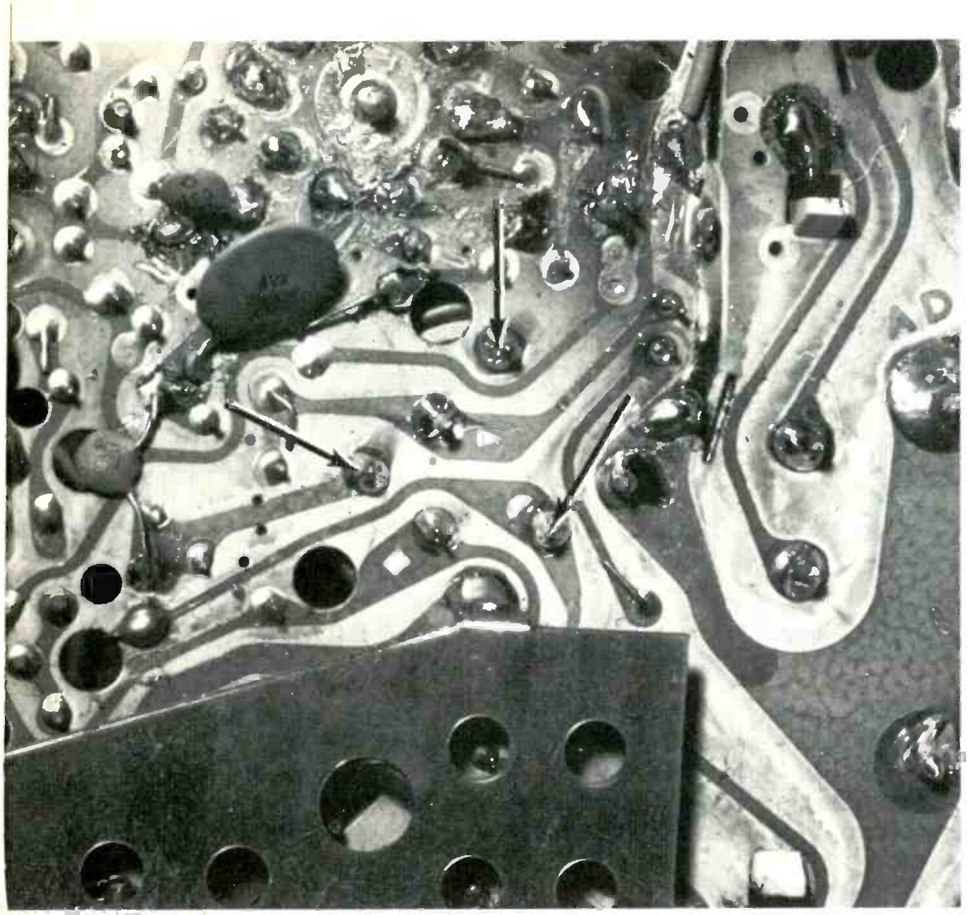


Figure 12 Arrows point to the ground lugs of the 2-section filter capacitor. Normally, the ground circuit is completed through these lugs and the metal case of the capacitor. When a misguided technician installed two separate capacitors, the ground circuit was opened and the TV was dead. Watch for this in other receivers.

to not replace filters before other tests *prove* them to be defective.

Two equals one?

After it was opened in the shop, the monochrome 6H4-1A Admiral was found to have two tubular filter capacitors mounted on top of the circuit board to replace a two-section can. These capacitors were of the correct ratings and were soldered into holes used by the original can.

There was one mistake. Part of the original wiring had entered at one common lug of the can and had left by way of another lug of the can. The technician who installed the two separate replacements had not connected these two points together. Therefore, the ground circuit was open. Installation of the correct 2-section can capacitor brought the TV to life (Figure 12).

Comments

When filter capacitors open, several distinctive symptoms are produced. And the exact symptom often indicates which capacitor is open.

An open first filter capacitor (the one nearest the rectifier) reduces the supply voltage and greatly increases the ripple.

An open second filter capacitor (the one after the choke) has little effect on the supply voltage. It might increase the sound or picture hum slightly. But it's more likely to cause some weird symptom. Picture pulling or double triggering of the horizontal are two common problems.

Shorts or leakage between sections of capacitors that are in the same multiple-section case are rare (fortunately). They are difficult to find, since the usual paralleling or shunting will not be an effective test.

Open filters beyond the two mentioned first usually do not add hum to either picture or sound. And the symptoms can *seem* to indicate defects in almost any other section of a receiver. Scoping or shunting are recommended to find open capacitors in those cases. ☐

Tips for using scopes Part 2

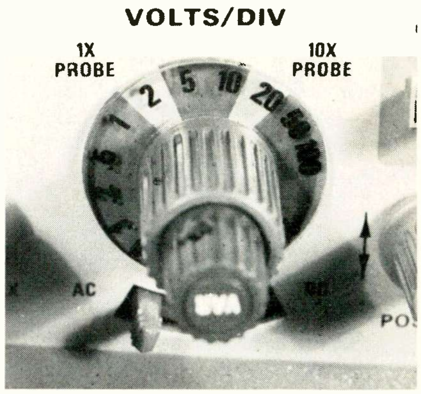


Figure 1 Vertical gain that determines the waveform height is controlled by a calibrated switch and an uncalibrated knob. For accurate measurements, set the variable control to the calibrate position.

Calibration of vertical gain and sweep-time controls is a valuable feature of all triggered scopes. Peak-to-peak voltages can be checked directly. And the repetition rate of a signal can be obtained by measuring the time of one cycle and doing a simple calculation. Other subjects for discussion include delayed and expanded sweep, measuring signal delay and rise times, how dual-trace operation works and how to measure dc volts.

By Gill Grieshaber, CET

Vertical gain

A similar arrangement of calibrated switch positions and uncalibrated variable controls is used in the vertical deflection circuit. The switch is calibrated in "volts/cm" or "volts/div." Usually the calibration is correct when the concentric variable-gain knob is turned clockwise until the switch clicks.

For accurate measurements of either ac peak-to-peak or dc voltages, the control *must* be in the calibrate position.

One Sencore scope has vertical calibrations only for an X10 probe. Tektronix has a double calibration system (Figure 1). Two transparent areas of the knob expose the calibration for an X1 direct probe (left side of knob) and another calibration for an X10 probe (right side). It's advisable for an X10 low-capacitance probe to be used for all measurements, and these direct calibrations help prevent mistakes.

Figure 2 shows the effect (beginning at the top trace) of 5 V, 2 V, 1 V and 0.5 V sensitivity. With the variable gain control, any intermediate vertical height can be obtained.

Newer color TV receivers (that have ICs in the chroma section) operate typically with very low signal levels, perhaps only 0.1 VPP or even lower. An X10 low-capacitance probe *always* should be used with chroma. Therefore, assuming a chroma signal of 0.1 VPP and a probe loss of 10 times, the scope maximum sensitivity must be 0.01 V (10 mV) for a height of only one division. This is a minimum, for more height is desirable, and future equipment might have even lower signal levels. Therefore, it's advisable for a new scope to have a maximum sensitivity of 5 mV or better.

At the other end of the voltage range, most scopes should not have more than about 600 V peak (or peak ac plus dc) at the input connection to prevent internal damage. Of course, an X10 probe increases the maximum allowable. Measurements of sweep pulses up to almost 1,000 V are necessary for solid-state TVs. Therefore, a scope for TV work should have minimum range of 10 V/div. Multiplication by the X10 probe over the typical 8 graticule divisions allows maximum measurements up to 800 VPP.

Signal delay line

When a conventional triggered scope is called on to display pulses or square waves, the leading (or trailing) edge which triggered the sweep is not seen. The edge reached the triggering circuit at the same time as it arrived at the vertical circuit. But the small amount of time necessary for the sweep to begin allowed the triggering edge to be finished before the sweep started.

Because the triggering cannot occur *before* the triggering voltage arrives, the opposite action must be taken: the arrival time of the signal must be delayed in the vertical amplifier.

In scopes that have the feature, the vertical signal time delay is accomplished by a delay line, which operates by the same basic principle as that of color TV delay lines, although the delay time is shorter.

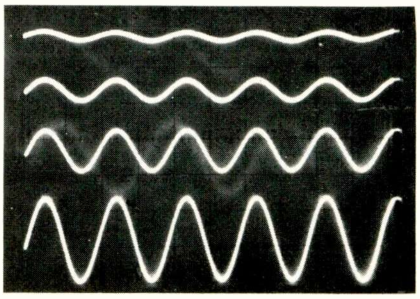


Figure 2 These are the waveform height changes at volts/div settings of 5 V (top trace), 2 V, 1 V and 0.5 V. The variable control plus these switch positions can produce any desired height.

Waveforms from a scope without a signal-delay line and another with a delay are shown in Figure 3.

Some scopes that do not have a delay line *appear* to show the triggering edge, because the beam starts at zero and moves up (or down) to the flat peak before starting the normal sweep. Thus at long-sweep times and low-rep-rate square waves, the initial edge *seems* to be there. However, a fast rep-rate signal (100 kHz used in Figure 3) shows definitely that part of the first peak is missing.

The A picture of Figure 3 shows the second square wave has a center width of 2.4 divisions, while the first one has only 1.6 divisions because lack of a delay removed the edge and part of the peak. Figure 3B is the same signal when reproduced on a scope that has a signal-delay line. Both the first and second square waves have the same width across the center, proving that none of the waveform is missing.

Incidentally, the two pictures also illustrate a fraction of the waveform differences between a 10 MHz scope (waveform A) and one rated at 35 MHz. The rise time is better and the corners are sharper in the B waveform. Actually, the difference should be greater, but the generator is the limiting factor here.

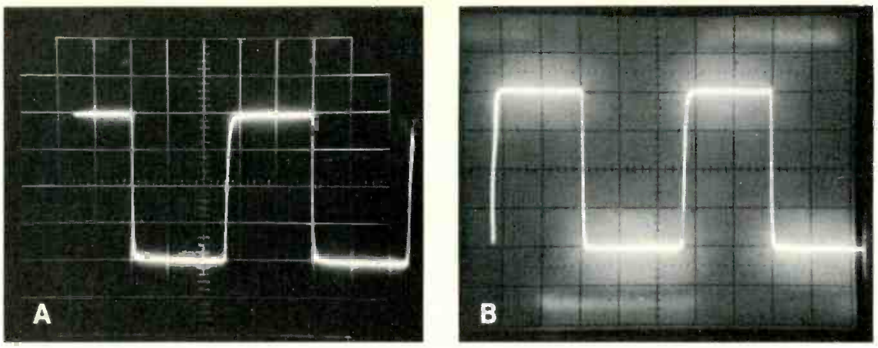


Figure 3 Scopes without a signal-delay can't display the initial triggering edges of fast-repetition pulses or square waves (see picture A). The same signal but from the CRT screen of a scope that has a signal-delay line is shown in picture B. All of the leading edge is visible.

Makeup of pulses

The terminology and makeup of pulses and square waves are shown in the drawing of Figure 4.

Sine waves can be described adequately by stating the amplitude in either RMS or PP voltages plus the frequency in Hertz (cycles per second), because all sine waves have the same shape. However, pulses and square waves must be described in more detail. The number of pulses that occur during each time period is the repetition rate. Also, a scope can be used to measure the time of one cycle between identical points of two successive cycles. Usually, the measurement is taken between leading edges (Figure 4).

A full pulse specification would list the pulse width (the *on* time) in addition to the *off* time and the repetition rate in Hz or time. In fact, present practice is to list all specs in terms of time (except amplitude, of course). For example, the pulse in VIR systems that corresponds to video line 19 is called a 63.7 μs pulse that occurs once every 0.0167 s (or 16.7 ms). (In video terminology, this is one horizontal line having a vertical-field repetition rate.)

Important probes

Unshielded test leads *never* should be used with sensitive scopes, Without proper shielding, the desired waveform probably will have a mixture of hum, CB and other radio carriers plus horizontal pulses from TV sweeps. More of these interferences exist now, and the signal levels in typical equipment are lower than ever.

Even when the shielded lead and probe that come with the scope are used, two other precautions should be observed. For pulses and complex waveforms, use the ground provided *at the scope probe*. Ringing and other waveform distortions can occur if the only ground is a lead connected between scope ground and circuit ground.

Also, connect the scope-probe ground to the common ground of the stage where the waveform measurement is being made. This is especially important where the signal amplitude is small and the interference level is high.

If the interference has a widely different frequency, it might be visible as "fat" horizontal lines on the waveforms (see Figure 5).

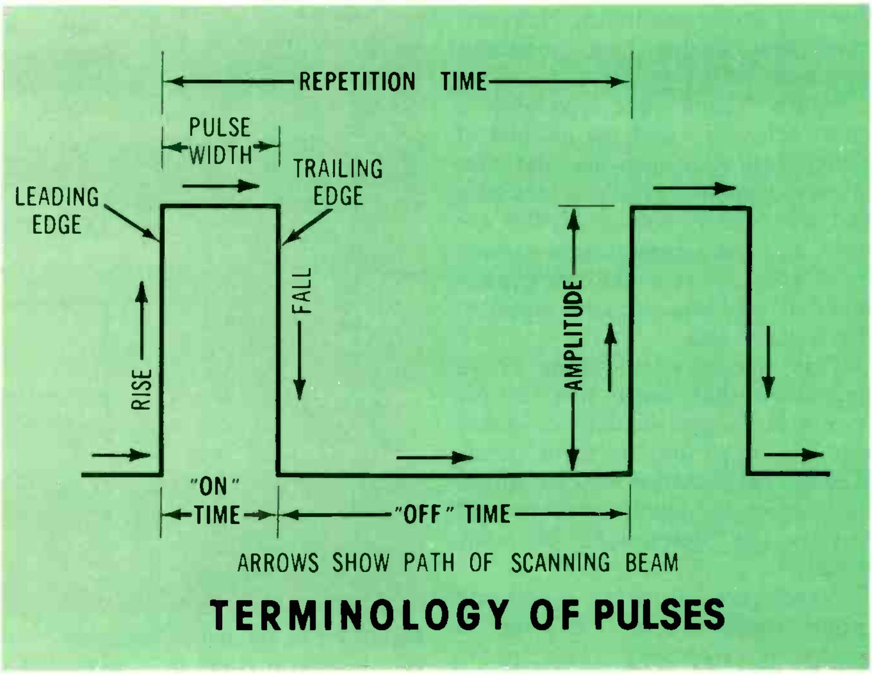


Figure 4 Pulses and square waves must be described by more specs than are necessary for sine waves. Arrows show the path of the beam that traces the waveform.

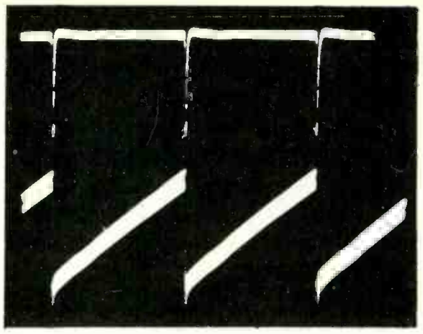


Figure 5 Waveforms with thick horizontal or base lines usually have other frequencies mixed with the desired signal. Horizontal pulses produced these fat lines on the vertical waveforms.

Scope tips

Another example is horizontal-sweep pulses that appear erratically mixed with chroma signals in color receivers.

Proper probes and probe grounds plus a wise choice of grounding point on a circuit board will provide dependable waveforms and prevent wasted time from wrong diagnosis.

Low-capacitance probes—The twin benefits of X10 low-capacitance probes (Figure 6) are higher impedance and reduced capacitance at the probe tip. These reduce circuit loading while permitting the cable to be shielded. The only trade-off is the 10-times loss of signal at the scope input. However, most new scopes have sufficient gain even with this loss.

Figure 7 shows one type of X10 probe schematic and the method of compensation to provide flat frequency response. Both a resistive and a capacitive voltage divider are used, and the compensation capacitor is adjusted to make the capacitance divider loss precisely equal to the resistive loss.

This probe adjustment is so important that most new scopes have a test signal (usually a square wave) available on the front panel. Wrong compensation causes amplitude errors at high frequencies and distorts the waveshapes of many signals.

Waveforms of under, over and proper compensation are given in Figure 8. However, some probe adjustments change the waveform only near the edges (narrower preshoot and postshoot).

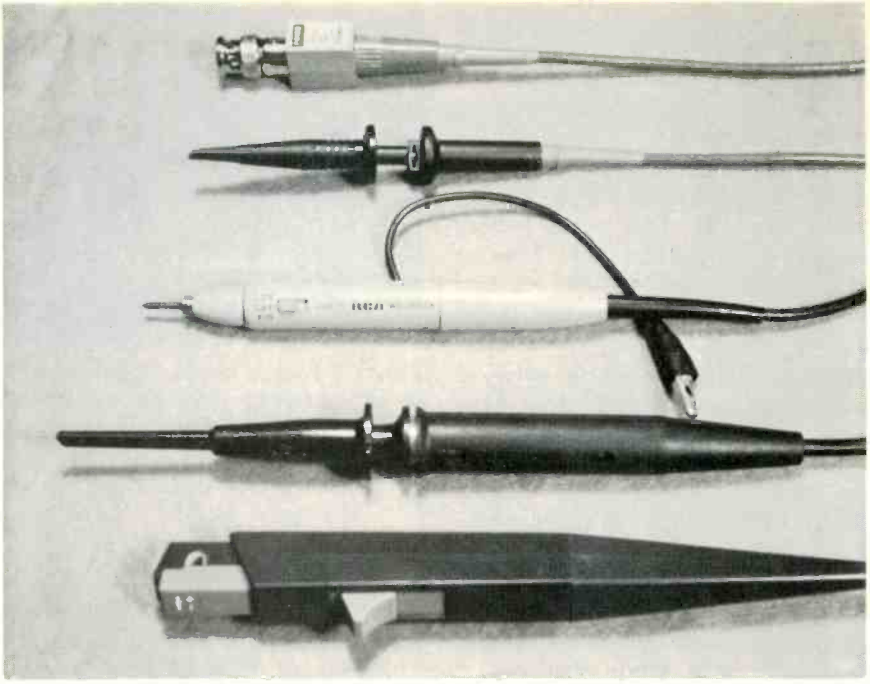


Figure 6 The correct kind of compensated probe is vital for complex waveforms. At the top are the two ends of a Tektronix probe. An X1-X10 RCA probe is in the center. Below it is a B&K-Precision probe which can be changed rapidly for either X1 or X10 operation. At the bottom is one end of a Tektronix current probe. One jaw is slid back, thus allowing a wire to be placed between the two halves. A matching network is at the scope end. Current waveforms are very important in many cases.

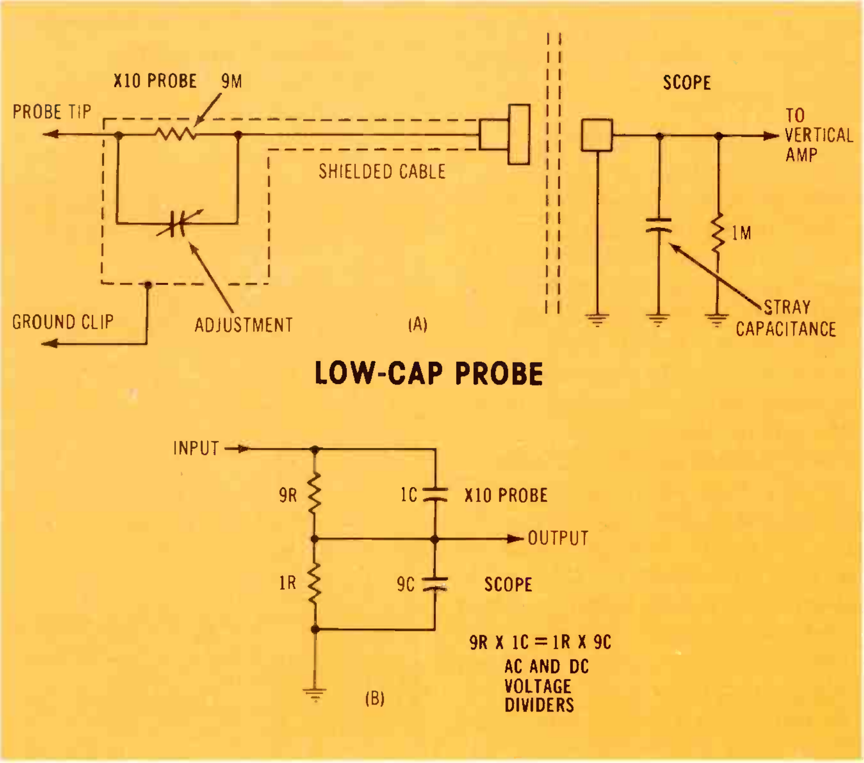


Figure 7 Flat frequency response from dc to high frequencies is possible with an X10 scope probe only when the dc and ac voltage dividers are perfectly matched. (A) This is the schematic of most X10 probes. The variable capacitor in the probe is adjusted for flat response. (B) When the circuit is simplified, the two voltage dividers can be seen clearly.

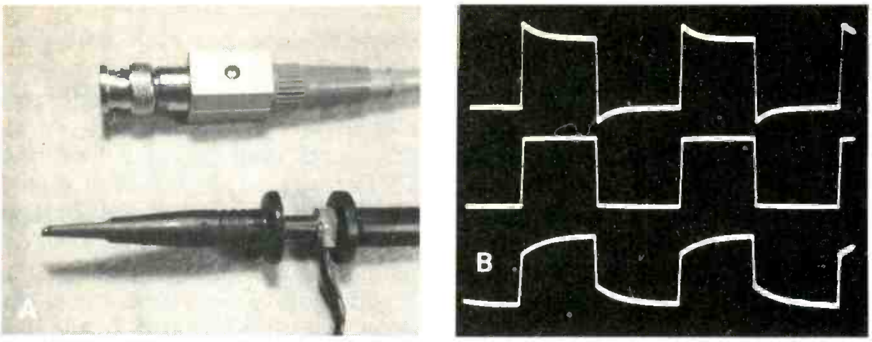


Figure 8 (A) Some X10 scope probes (such as this one from Tektronix) have a different circuit. The scope capacitance (not probe capacitance) is varied by a trimmer placed in the box at the scope end of the cable. (B) Top trace shows the calibration waveform when the compensation is excessive. Correct compensation is shown by the level tops and bottoms of the center trace. Under-compensation is indicated by the rounded corners of the bottom trace.

Which probe?—Several readers have asked which probe should be used in video, sound IF and vertical-sweep circuits. *Use the low-capacitance probe for all of these.* RF/IF/chroma detector probes are available for use with alignment or for demodulation during signal tracing of those signals that are above the response of the scope or which need detection. These probes are valuable when they're needed. But, they are not for everyday troubleshooting.

Use an X10 probe (or keep an X1-X10 probe set at the X10 position) for *all* measurements. If the amplitude is too small, then change to the X1 direct probe.

Measuring signal frequencies

Last month, the sweep time/division switch was discussed only regarding the number of waveform cycles it provided. However, trig-

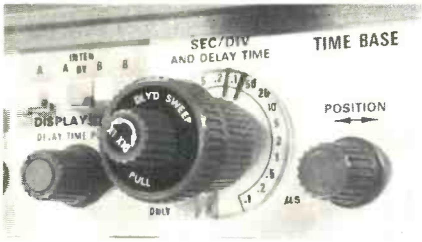


Figure 9 Shortest sweep time of the Tektronix T935 is 0.1 μS, which can be extended to 0.01 μS by adjustment of the X10 variable sweep-width control.

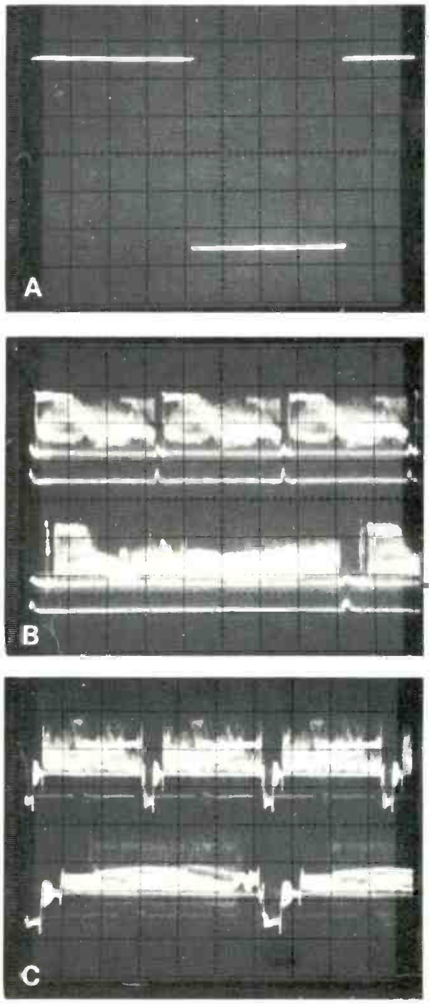
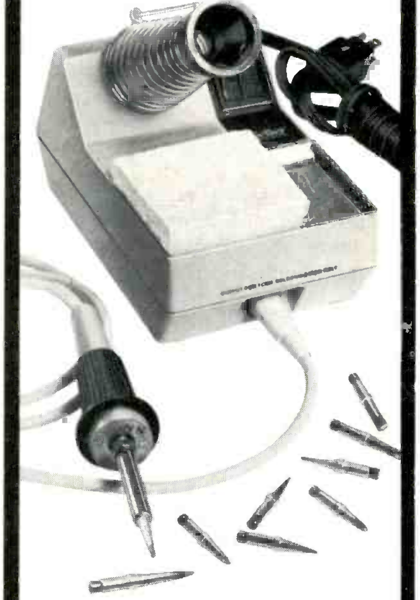


Figure 10 The signal frequency can be measured by a combination of the calibrated horizontal sweep and the graticule markings. (A) One cycle of square wave covered 8.25 divisions when the sweep time was 2 mS/div. Therefore, the repetition frequency was 60 Hz. (Multiply divisions by the sweep time and divide the answer into 1 to obtain the frequency.) (B) The video waveform was shown at 5 mS/div (top) and 2 mS/div (bottom). Time of 1 cycle was about 16.6 mS, giving 60.2 Hz as the vertical frequency. (C) For top trace, the sweep time was 20 μS/div; and 10 divisions enclosed slightly more than three cycles. At 10 μS/div (lower trace), one cycle covered 6.33 divisions for a total of 63.3 μS or about 15,797 Hz for the horizontal frequency. The frequency accuracy is sufficient for most tests.



gered scopes have calibrated sweep times that can be used to measure the repetition rate of many waveforms. The accuracy of these readings can be good, since the sweep times are rated between ±2% and ±5% plus any parallax or reading errors.

The Tektronix scope of Figure 9 has 21 ranges of calibrated sweep times between 0.5 s and 0.1 μs plus a variable giving up to X10. The B&K-Precision that I use most of the time has 16 ranges from 100 ms to 1 μs plus a fixed X5 magnifier.

The sweep time/div multiplied by the number of graticule divisions used for one cycle gives the total time of one cycle of signal. And the reciprocal of this time of one cycle is the signal repetition frequency. (The reciprocal is 1 divided by the time figure; a math function that's easy to do by using a small calculator.)

Three examples of measuring frequencies with a calibrated scope are given in Figure 10. Study them carefully. All are very easy to do and require virtually no time. Of course, if the frequency is known, it's also easy to find the scope sweep time required to display that frequency.

Table 1 gives typical examples of often-used frequencies versus the time/div settings that produce 10 cycles, 2 cycles or 1 cycle of waveform over the whole CRT screen.

Table 1 Many of the often-used frequencies are listed with the scope sweep times required to show 10 cycles, 2 cycles or 1 cycle across the whole screen. Also included are the formulas for changing sweep time to frequency and frequency to scope sweep time.

Frequency		Seconds	For 1 cycle per div, set sweep for:		For 2 cycles per screen, set sweep for:		For 1 cycle per screen, set sweep for:	
20	Hz	.05	50	ms	10	ms	5	ms
50	Hz	.02	20	ms	4	ms	2	ms
60	Hz	.0166	16.6	ms	3.32	ms	1.66	ms
100	Hz	.01	10	ms	2	ms	1	ms
120	Hz	.0083	8.33	ms	1.66	ms	.83	ms
400	Hz	.0025	2.5	ms	.5	ms	.25	ms
1,000	Hz	.001	1	ms	.2	ms	.1	ms
5,000	Hz	.0002	.2	ms	40	μS	20	μS
10,000	Hz	.0001	.1	ms	20	μS	10	μS
15,734	Hz	.0000636	63.6	μS	12.8	μS	6.4	μS
100	kHz	.00001	10	μS	2	μS	1	μS
3.58	MHz	.00000028	.279	μS	.056	μS	.028	μS

Reciprocal formulas for
sweep time versus repetition frequency
1 ÷ TIME (in seconds) = FREQ (in Hz)
1 ÷ TIME (in milliseconds) = FREQ (in kHz)
1 ÷ TIME (in microseconds) = FREQ (in MHz)

1 ÷ FREQ (in Hz) = TIME (in seconds)
1 ÷ FREQ (in kHz) = TIME (in milliseconds)
1 ÷ FREQ (in MHz) = TIME (in microseconds)

Also given are the formulas for changing time per cycle to repetition frequency or frequency to time.

Accuracy of these frequency measurements depends partially on the visual measurements from the CRT screen, as illustrated in Figure 11. The brighter top and bottom peaks of pulses and square waves tend to make the spot enlarge. So it's difficult to be certain where the exact corner is located, while the fast rise and fall edges are nearly invisible.

Therefore, improved accuracy can be obtained when fewer than 10 cycles are viewed on the screen.

Figure 11A shows the basic condition of one cycle per division, where the frequency is equal to the reciprocal of the time value set by the time/div switch. However, maximum accuracy is possible when only 1 cycle (Figure 11B) is covering the whole screen. Of course, the time/div setting must be multiplied by 10 divisions to give the total time of one cycle.

Dual-trace operation

Many of the new scopes can show two waveforms simultaneously by the dual-trace method. The mode switch shown in Figure 12 offers a choice of Channel A, Channel B, or both in either chopped or alternate mode. Also, provision is made for adding or subtracting the two waveforms, which is valuable for showing distortion and for minimizing common-mode hum or noise.

The differences between alternate and chopped modes of dual-trace operation are illustrated in Figure 13. For alternate, a complete Channel 1 waveform is traced, followed by a complete Channel 2 waveform, and so on. Flicker is very noticeable

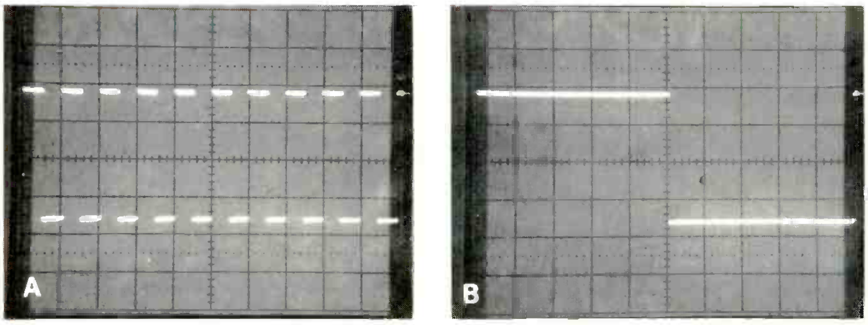


Figure 11 Accuracy of frequency measurement is better when fewer cycles are on the CRT screen. (A) 1 mS sweep time shows 10 cycles of a 1000 Hz square-wave signal. (B) A change of 0.1 mS reduces the display to one cycle and allows better accuracy of measurement.

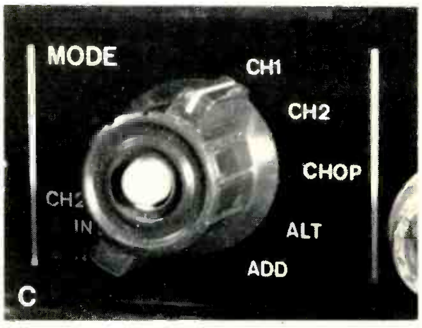


Figure 12 Five variations of single-trace or dual-trace operation can be selected by the mode switch of this B&K-Precision scope.

at slow sweep speeds. Therefore, alternate mode is recommended only for short sweep times and high-frequency signals.

Chopped operation slices both waveforms into small segments (Figure 13C) by a sampling circuit operating above 100 kHz. When the signal frequency is low and not harmonically related to the sampling frequency, the tiny segments form complete waveforms. High signal frequencies often display interference patterns. Chopped mode should be used only with long sweep times and low-frequency signals.

Measuring rise time

Rise time of a pulse or square wave is defined as the amount of time required for the leading or falling edge to trace between 10% and 90% of the total amplitude.

Many square waves appear to have perfectly perpendicular edges, but that's only because those edges are not expanded enough by the scope. Figure 14 gives the details of measuring two square waves. One was a probe-calibration waveform; the other was from a sine/square generator. Evidently the calibration waveform was obtained from a clipped sine wave, for the fall time in Figure 14A was a long 12,000 ns. By contrast, the generator waveform fall time measured 60 ns. Of course, this included the fast rise time of the scope. But it can be disregarded when it is much less than the measurement.

Expanding waveforms

Another operation that recurrent scopes can't do is to magnify waveforms. Triggered scopes have three ways of expanding the waveforms. Two methods often are used together for maximum expansion.

Two functions that can be done by almost all triggered scopes were used to produce the waveforms in Figure 15. The signal source was the *bar sweep* pattern (five bursts of different frequencies) from the Sencore VA-48 Video Analyzer.

The waveform was locked at 5 mS sweep and showed three vertical fields. Then, without any additional locking (triggering), the waveform was expanded by using shorter sweep times. At 50 µs, about 8 horizontal video lines could be seen. This was reduced to less than 1 video line at 5 µs.

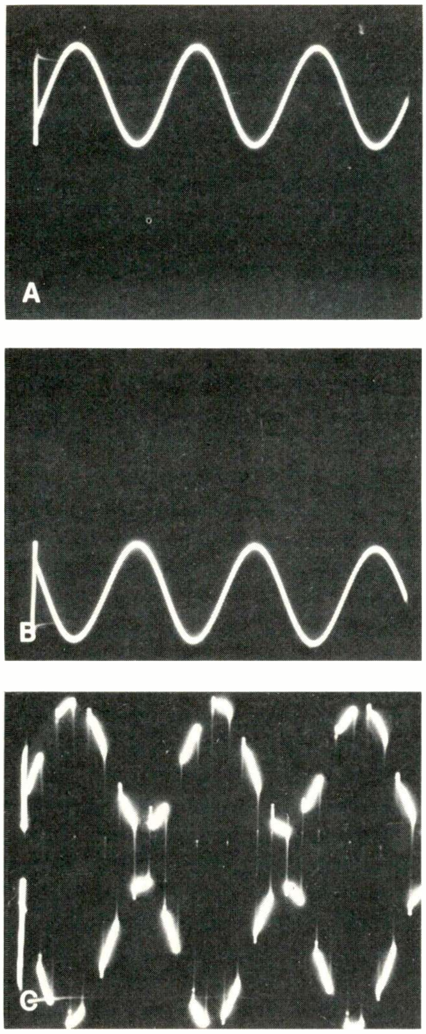


Figure 13 Two types of dual-trace operation are illustrated by these waveforms. During alternate mode, the scope traces one waveform (A) completely, then it traces the other complete waveform (B). But with chopped mode, a small segment of the upper waveform is displayed, then a tiny segment of the lower waveform is traced while the first is blanked (C), and so on until all parts of both waveforms are displayed. These chopped segments appear to be a continuous waveform when the signal frequency is much lower than the sampling frequency. Incidentally, it's difficult to show the C waveform. This sine wave was about 15 kHz, which was varied carefully until the segments were motionless.

More expansion of the waveform's right area was needed. However, a shorter sweep time would expand the left side while driving the right edge off the screen. Since this was the area of interest, no shorter sweep time could be used. If the high-frequency bursts were to be magnified any more, another method was essential.

That other method was an in-

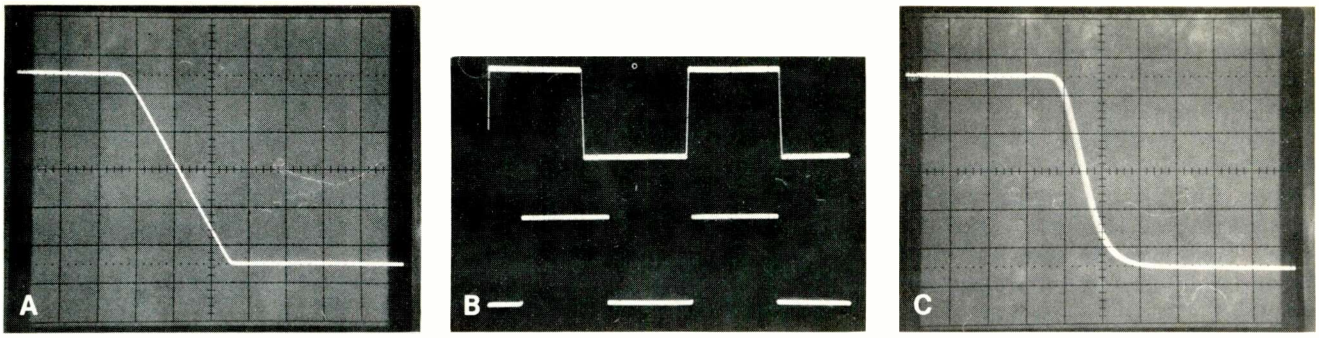


Figure 14 Rise time can be checked easily with a triggered scope. Rise time is the time required to trace between the 10% and 90% points of a rising or falling edge. (A) The 10-to-90 part of the waveform used 2.5 divisions at 5 μS/div, so the rise time was 12,500 ns. (B) Top trace is a normal display of the A waveform, while the C waveform is shown by the lower trace which has a faster rise time. (C) This rising edge used 1.2 divisions at 0.05μS/div, for a rise time of 60 nS.

Scope tips

crease of sweep width (which gives some benefits of a shorter sweep time). Although most scopes have a fixed X5 width expansion, the one of Figure 15C was variable with an X10 maximum. Notice that the sweep contained the same less-than-one video line as before (Figure 15B), but 90% was off the screen and invisible. The remaining 10% was stretched to cover the entire screen width. Then, by operation of the horizontal-positioning control, the waveform was moved sideways to show the 3.06-MHz portion (Figure 15C center trace) and finally the 3.56-MHz section (bottom trace).

About 20 cycles of the 3.56-MHz burst occupied the whole screen width, and they were revealed as having near-square waveshape. A scope of narrower bandwidth would show them as sine waves.

Delayed sweep—A few scopes (see last month's chart) have another method of expanding *selected* parts of waveforms. The feature is called *delayed sweep* and it requires a second time-base generator.

Some scopes have separate primary and secondary time-base controls and calibrations. Others combine the two. As shown in Figure 16, the T935 Tektronix has a large knob which usually rotates the plastic skirt that has two black lines (indicating the primary sweep time). When delayed sweep is selected by the display mode buttons (at the left), the large knob is pulled outward and rotated separately clockwise (while the skirt with the lines does not move). The two black lines on the skirt show the main time-base time, and the white line on the large knob points toward the sweep time of the delayed sweep. In the picture, the main time is 2 ms, and the delayed time is 0.2 ms.

VITS by delayed sweep—Typical operation of delayed sweep is illustrated by obtaining expanded waveforms of the VITS and VIR in TV video signals (Figure 17). The first dual-trace waveforms were obtained at a main sweep time of 0.1 ms. Remember, the scope *must* be triggered from vertical sync taken from this same video either by the scope's sync separator or externally from the TV-receiver sync separator. (Also, external triggering can be taken [with less stability] from the TV vertical-sweep signal.)

The complete procedure is detailed in Figure 17 and will not be repeated here. Delayed sweep is not mandatory for TV servicing, but it is valuable for work with digital word trains.

Incidentally, the VITS and VIR signals can be displayed on most triggered scopes. Lock the scope to the vertical sync (as explained before) and then select 0.1 ms sweep time, which shows an expanded view of the vertical retrace area that is similar to A in Figure

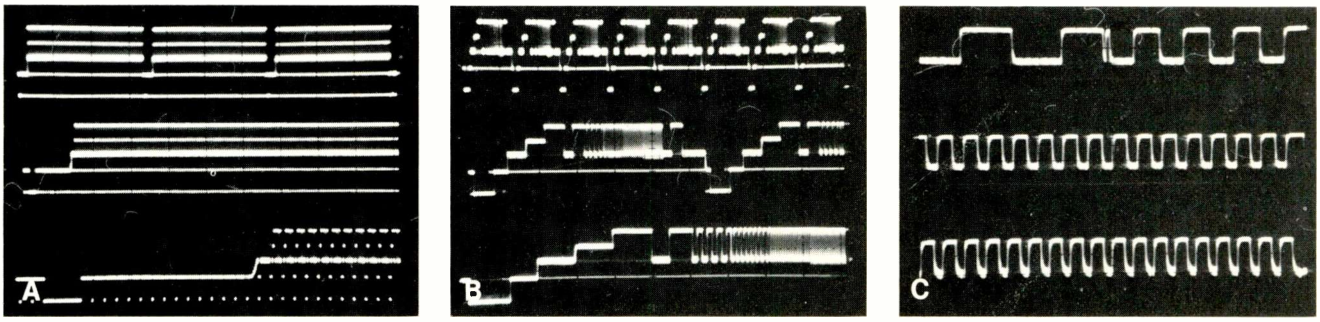


Figure 15 Video waveforms can be expanded enormously by a triggered scope, as shown by this generator signal. (A) Three vertical fields are shown at 5 mS/div time (top trace). Changing to 1 mS/div (center trace) allows display of less than 1 field. A sweep time of 0.1 mS/div shows only slightly more than the vertical interval (bottom trace). (B) When triggered properly at 50 μS, about 8 horizontal lines of video are shown (top trace). A time of 10 μS shows less than two lines (center trace), and 5 μS restricts the waveform to less than one line (trace at bottom). That's as far as this method should be used, since the bursts at the right are to be examined. (C) The same 5 μS and X10 trace expansion plus positioning reveals part of the 0.75 MHz and 1.51 MHz bursts (top trace). Moving the waveform to the left allowed the 3.02 MHz burst to be seen (center), and more positioning to the left shows the 3.56-MHz burst.

Figure 16 The seconds/division switch assembly of the T935 Tektronix has three functions. The position of the large knob determines the primary sweep time. When it is pulled out and turned to the right, the sweep time of the delayed sweep is selected. The small knob at the outside is a variable width control with calibrated X1 and X10 positions at the stops. Also, the three buttons and knob at the left are used with the delayed sweep. This delayed sweep can greatly expand small areas of a waveform.

17. Next, switch on the X5 expander and move the trace to the left until the VITS and VIR are on the screen. Alternate mode of dual-trace operation allows the different waveforms of the two vertical fields to be separated, while single-trace scopes show both waveforms together.

Checking delay lines—Actual delay produced by the delay line in a color-TV receiver can be measured by using either the delayed sweep or the expanded sweep methods previously described.

Figure 18 shows the input (top trace) and the output (bottom trace) of the delay line in a solid-state color receiver. Measure by eye how many divisions or fractions separate the *same* point of both waveforms, and multiply this figure by the time base. The delay here was about 0.08 to 0.09 µs. Some error is inherent since the delay line distorts the waveform slightly, thus causing difficulty in knowing the exact corresponding point of the output waveform.

Measuring dc voltages

Modern scopes permit easy tests of dc voltages, both with and without signal ac voltages. Some experienced technicians say they seldom use a dc meter. Instead they

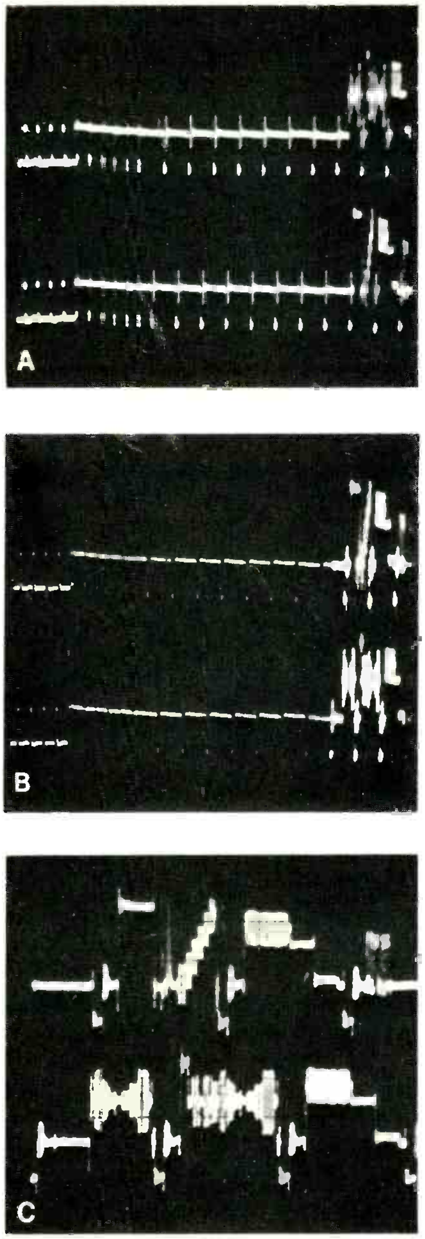


Figure 17 The method of displaying VITS and VIR signals by delayed sweep is shown by this sequence. (A) At a 0.1 mS/div sweep time, the two vertical intervals (field 1 and field 2) are shown. (B) After the "A intensified by B" button is pushed (see Figure 16), part of the waveform is brighter. (Pulling out on the main time/div knob and rotating it to the right allows the main sweep time to be undisturbed while the delayed time is adjusted.) The delayed time/div knob setting determines the width of this brighter section, and the "delay-time position" knob adjustment moves the brighter section from side to side. These two should be adjusted alternately until only the desired area (of the VITS and VIR signals in this case) is brighter. (C) When the "B" display mode button is pushed, the screen shows only the area that previously was brighter, but it is expanded to full screen width.

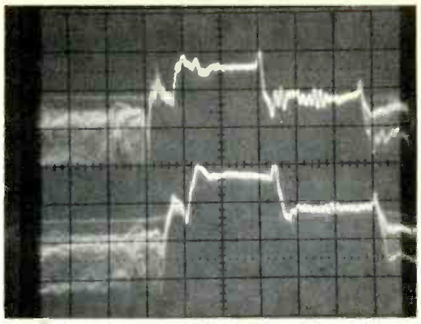


Figure 18 Dual-trace operation at 10 μS main sweep and 2 μS delayed sweep showed a 0.08 μS delay produced by one color-TV delay line.

Scope tips

use the dc function of their triggered scope.

Three methods of reading dc levels are shown in Figure 19. In the A picture, video is displayed at the bottom when the vertical input switch, Figure 20, is in the ac position. Then when the switch was slid to the dc position, the entire waveform moved up four divisions. Multiply the movement (4) by the volts/div rating (1 V/div) to obtain the dc voltage (+4 Vdc) that is mixed with the video waveform.

Downward movement would have indicated a negative voltage, as is found at many video detectors.

Of course, a large dc voltage and a small ac voltage might move the dc waveform off the screen. A higher V/div setting must be used then.

Figure 19B illustrates how to measure dc voltages that do not have ac mixed with them. The procedure is similar to the previous one. Select a range that does not move either line off the screen. Notice how many divisions the line moves when the switch is moved from dc to ac (or ac to dc) and multiply this by the vertical switch setting.

One typical test is measuring a power-supply voltage. For this, leave the input switch at the dc position. After the scope is grounded to the circuit, touch the *hot* scope probe to ground while noticing the line position. Then touch it to the B+ or B- circuit and measure the number of divisions the line moves. Multiply this by the switch setting.

Always preset the variable vertical sensitivity control to the "calibrate" position and include the effects of the X10 probe (if used). These probes multiply the reading for dc exactly the same as they do for ac waveforms.

For varying dc voltages or for instruction purposes, dual-trace waveforms provide the ultimate in ac/dc measurements. In the C picture, both channel switches were adjusted to the "ground" position of the vertical-input switch. This disconnects the probe from the scope input and grounds the scope input (which is handy and useful for many tests). Then the horizontal lines of both traces were positioned together (in this case, where the line is shown in Figure 19C), and the Channel 1 switch changed from "ground" to "dc" position. The video waveform appeared near the top with its center about 4 divisions above the zero (bottom) line. Of course, the reading is not accurate at this point, because the average point of a waveform is not necessarily at the vertical center.

Digital and transistor waveforms often make sense only after the dc level or the position of the average voltage line is known. **Electronic Servicing** has been using such waveforms for several years, for they are excellent educational tools that clearly reveal the details of many circuit operations that probably would be misunderstood without them.

These concepts and measurements are so important that they will be discussed in a separate article later.

Comments or questions?

If you have comments or questions about any aspect of scope operation, please write to the editor:

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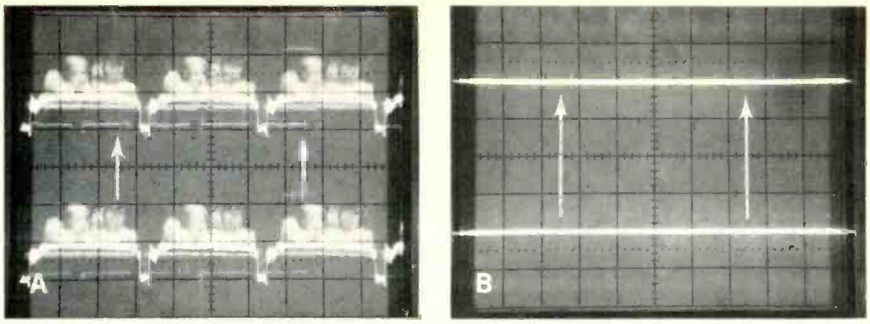

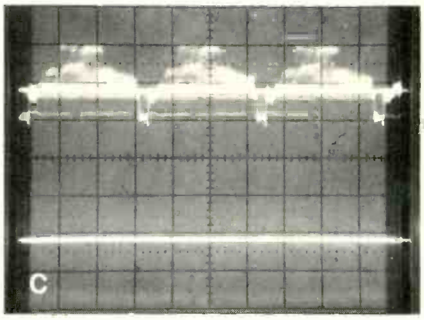

Figure 19 Three methods of measuring dc voltage are shown. (A) Notice how many divisions the waveform moves when the switch is changed from ac to dc. (B) Voltages without waveforms can be measured in the same way. Just notice how many divisions the horizontal line moves when the probe is changed from ground to the point with the voltage. (C) Dual-trace operation permits a graph-like display of better accuracy, and it requires little additional time. The waveform is shown in proper relationship to the line which represents ground (zero volts).

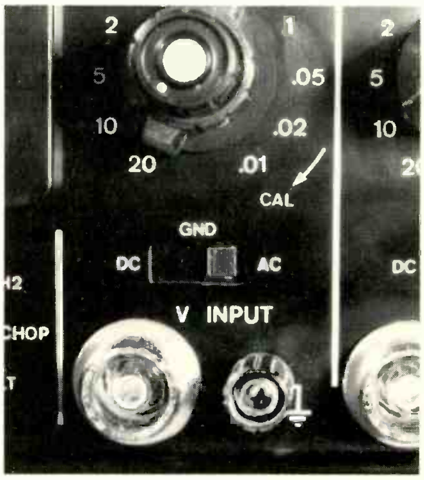

Figure 20 All new triggered scopes have some kind of three-position switch (one B&K-Precision switch is shown) that changes the scope vertical response to either ac or dc. The third position disconnects the probe from the scope input and grounds the scope input. This saves time and is convenient.

Sam Wilson's Technical Notebook

SYNCHRONOUS COUNTERS

By J. A. "Sam" Wilson, CET

No "Royal Road"

Euclid was a teacher, among other things. Once he was asked to teach the rules of geometry to a member of the aristocracy which governed the country. The ruler was impatient, however, and didn't want to follow the slow-moving traditional methods of learning. He asked Euclid for a special approach that would make the subject easier and faster. Euclid replied, "There is no royal road to geometry."

"How can I become a top-rated electronic technician?" Many readers ask this question in their letters. The phrases vary, but the meaning always is the same: each man sincerely wants to be the very best kind of technician, and not merely an average one.

Unlike Euclid's royal student, the men writing to me don't seem to be searching for an easy way out. *They just want to make sure the time spent in study will produce the best possible results.*

Your comments or questions are welcome. Please give us permission to quote from your letters. Write to Sam at:

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P.O. Box 12901
Overland Park, Kansas 66212

Unfortunately, there is no single method that is best for everyone. Some people can learn a large amount from a correspondence school. Others don't like to read about the subjects, and they need a classroom personal approach. One man I knew in California reached a very high technical level by making effective use of the local public library and the many good books there.

Now, I want to make clear that I'm not qualified in any way to advise the best and most-effective way of studying. I'm not even qualified to make educated guesses.

However, as an experienced teacher, I have noticed some methods that appear to work well for most people. They are listed here.

Develop an interest—It is *easier* to study any subject that holds interest. Monday-morning-quarterbacks are not required to memorize the scores and performance records of their favorite football teams or players. No, they learn all that information because they're *interested* in the subject and want to know it completely.

Likewise, my best students are those who have an active genuine interest in electronics.

Start a schedule—Study or read some technical topic each day or evening. Don't wait until *forced* to learn about a subject in order to survive, and then go on a crash program.

One good example is digital electronics, especially microprocessors. The time is coming soon when technicians won't be able to understand television receivers, industrial controls, communications and many other products unless they have a working understanding of microprocessors.

By coincidence, a new series about the internal workings of microprocessors will begin in **Electronic Servicing** this March or April. Make a monthly habit of spending sufficient time in studying these vital facts.

Perform experiments—During 1978, my industrial electronics series gave details of experiments to be performed with digital components. Refer to those articles and work the experiments. Merely reading about a subject is so easy that most is forgotten rapidly. More information is retained by actually doing the work or the experiment.

Learn electronic history—Beginning technicians often have difficulty in obtaining an overall comprehension of electronics because they are starting in the middle of the subject. New circuits are easier to understand when compared to those developed in the past.

Encyclopedias and the biographies of electronic pioneers are helpful by showing the evolution of electronics. This is the approach that worked best for me.

If there is a method I haven't covered here, please write the

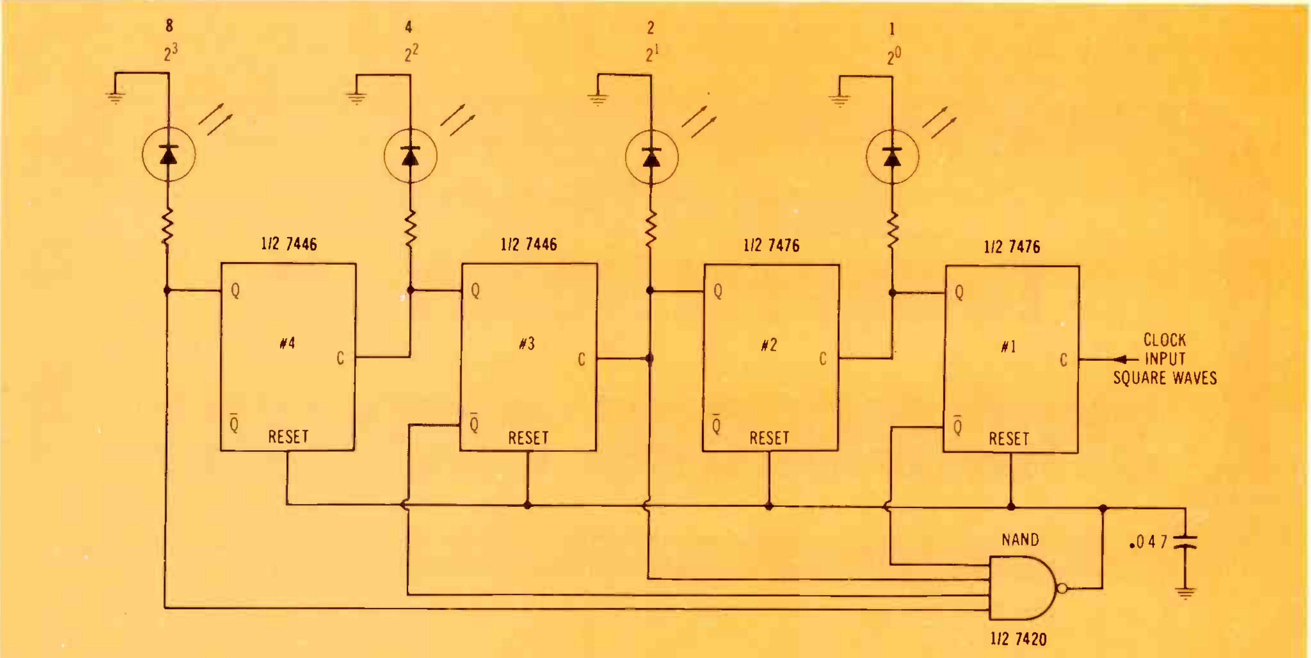


Figure 1 This ripple counter displays consecutive counts up to decimal 9, then it resets to zero and counts up again. Each flip flop toggles the next, so they operate in sequence and therefore require time for all flip flops to finish toggling. With some ICs, the time delay is sufficient to cause a false NAND output (glitch) which resets the counter prematurely. The capacitor prevents the false resetting when the counter is operating with a slow clock speed. However, a capacitor can't be used for fast speeds. One solution is to change to a synchronous type of counter.

Synchronous counters

details and send them to me in care of the magazine.

Delay problems in counters

Ripple counters of the type described previously in the industrial series have an inherent time delay during normal operation. A brief review of ripple counters should clarify the reasons why this time delay is produced and how it can cause trouble.

Ripple-counter operation—The counter shown in Figure 1 works by a series of four frequency dividers. Two clock pulses to flip flop 1 (FF1) produce one pulse at the output. When delivered to the clock input of FF2, two output pulses from FF1 produce one output pulse from FF2. And so on until each flip flop has been triggered in sequence by the one before it.

A logic 1 (high) at the output of a flip flop lights its LED, so an unlighted LED indicates a logic 0. Each LED is assigned a different decimal value. Starting at the left, those values are 8, 4, 2 and 1. Therefore, a binary readout of 1100 is 8 + 4 + 0 + 0 = 12 decimal. Maximum binary count from four flip flop dividers is 1111 or decimal 15. A counter without the programming NAND begins at 0000 readout and increases to 1111 before starting over again at 0000.

In Figure 1, the ripple counter is programmed by the NAND to display all counts from zero to 9. Then at the beginning of the 10 count (binary 1010), all NAND inputs have highs, and the NAND delivers a low (logic 0) to all flip flop reset terminals. This resets all flip flops to zero for a 0000 binary count. From zero, the counter again counts up to 9 and resets at the beginning of the 10 count. The sequence repeats over and over.

Although the resetting occurs so rapidly that no blink of the 1010 display on the LEDs can be seen, it is not instantaneous. A larger time delay occurs in the arrival of the highs at the NAND inputs.

This brief explanation shows the reason for the terms "ripple" and "ripple through" that are applied to the counter. The triggering ripples from one flip flop to another, in a way very similar to the domino effect where one falling domino makes the next one fall, until all have been toppled. The flip flops are operated in *sequence*, and time is required.

Fast operation—At high clock frequencies, it is possible for a following clock pulse to arrive at the input of the first flip flop before the last flip flop has received its command signal. The result is a "race" condition, and the displayed count is completely false.

NAND programming—The problem of wrong counts and premature resets can occur with counters that are programmed with a 4-input NAND (as most were in the industrial articles).

In the Figure 1 counter, for example, highs must be at all NAND inputs simultaneously (see Figure 2). Unfortunately, the time delay between output highs from the first and fourth flip flops can be sufficient to prevent the fourth flip flop high from arriving at the NAND before a high from a previous flip flop has begun to drop toward zero volts (low). This causes a narrow glitch which resets the counter too soon.

One solution for the delay problem is to use fewer NAND inputs and have them separated by no more than one flip flop.

In Figure 2, examine the column of binary states. The resetting binary condition is 1010; therefore, try to find two that do not occur in any count previous to 10. Of course, the NAND inputs can come from the NOT-Q outputs, if desired. Six different pairs of NAND inputs are possible from the four binary digits.

After you choose a pair to be tested, begin at the 1010 binary count and move up the column to see if the same logic levels appear at any previous count. If so, that pair cannot be used. Two examples follow.

If the NAND inputs are taken from the Q output of FF4 and the inverted FF3 output at its NOT-Q, the NAND will be triggered at the 10 count all right. However, it also would be triggered by 9 and 8 as well.

Next, take the NAND inputs from the NOT-Q outputs of both FF3 and FF1. The NAND will be triggered at the 10 count. Unfortunately, it also will trigger at 8, 2 and zero.

Neither of these two examples will program the counter properly. (The remaining three wrong combinations are omitted to avoid wasted time.)

Now select two NAND inputs from the Q outputs of FF4 and FF2. Check the binary count column for a previous identical listing. There is none. Therefore, the counter will operate properly with those two NAND inputs.

Two-input NAND—Figure 3 shows the ripple counter after programming by a two-input NAND gate. The first and third digits of the

DECIMAL COUNT	BINARY COUNT	NAND INPUT
0	0000	0101
1	0001	0100
2	0010	0111
3	0011	0110
4	0100	0001
5	0101	0000
6	0110	0011
7	0111	0010
8	1000	1101
9	1001	1100
10	1010	$\boxed{1111}$
	INVERTED FOR NAND	RESETS TO ZERO

A COUNT FOR FIGURE 1

DECIMAL COUNT	BINARY COUNT	NAND INPUT
0	0000	00
1	0001	00
2	0010	01
3	0011	01
4	0100	00
5	0101	00
6	0110	01
7	0111	01
8	1000	10
9	1001	10
10	1010	$\boxed{11}$
	USED FOR NAND INPUTS	RESETS TO ZERO

B COUNT FOR FIGURE 3

Figure 2 (A) The 4-input NAND column is for Figure 1, and it proves the counter will reset at the beginning of decimal 10 count. (B) Outputs from FF4 and FF2 were selected for the 2-input NAND of Figure 3. Use the binary count column to verify this choice.

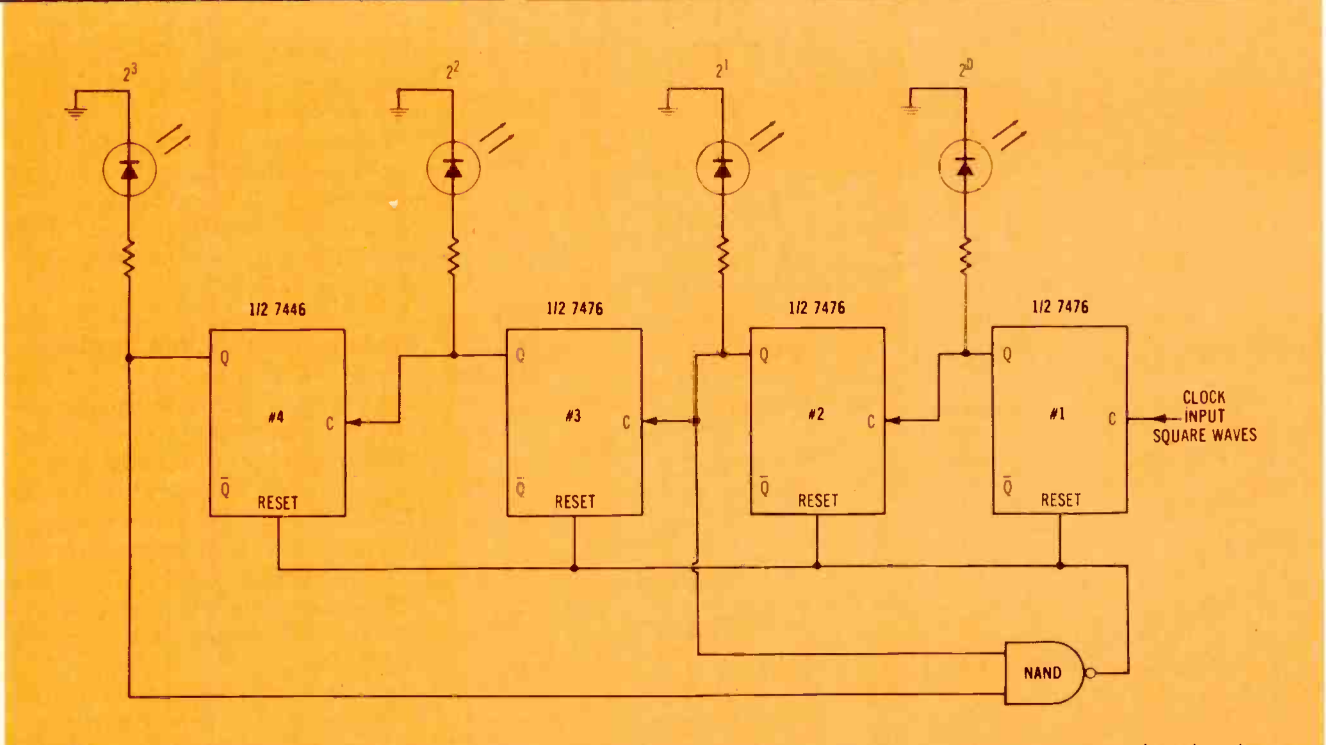


Figure 3 No glitches are produced by this simplified ripple counter. Only one flip flop separates the signals that are applied to the two inputs of the NAND. Therefore, the time delay is shortened. With only two inputs, the programming must be selected with greater care.

1010 binary (decimal 10) count will force the output of the NAND to go low and reset the counter.

This circuit will operate exactly the same as the one of Figure 1 does, except glitches are eliminated. The different programming from two flip flops that are separated by only one other flip flop has reduced greatly the time delay between the NAND inputs.

Also, the circuit simplification allows a reduction in the number of connecting wires, and this is important when printed-circuit boards are used.

Synchronous counters

Another method of eliminating glitches is to use a *synchronous* type of counter which forces all of the flip flops to change at the *same* time. A synchronous counter with two flip flops is diagrammed in Figure 4.

Two conditions are necessary before a TTL flip flop will toggle. Both J and K terminals have logic 1 highs, and the clock signal switches from high to low. (CMOS types toggle when the clock signal switches from low to high.)

In Figure 4, notice that the clock signal is connected to the clock terminals of *both* flip flops. The first one has permanent highs at the J and K terminals, so it is free to toggle continuously from the clock signal. However, the J and K terminals of FF2 are connected to the Q output of FF1. So FF2 can toggle *only* when FF1 is high.

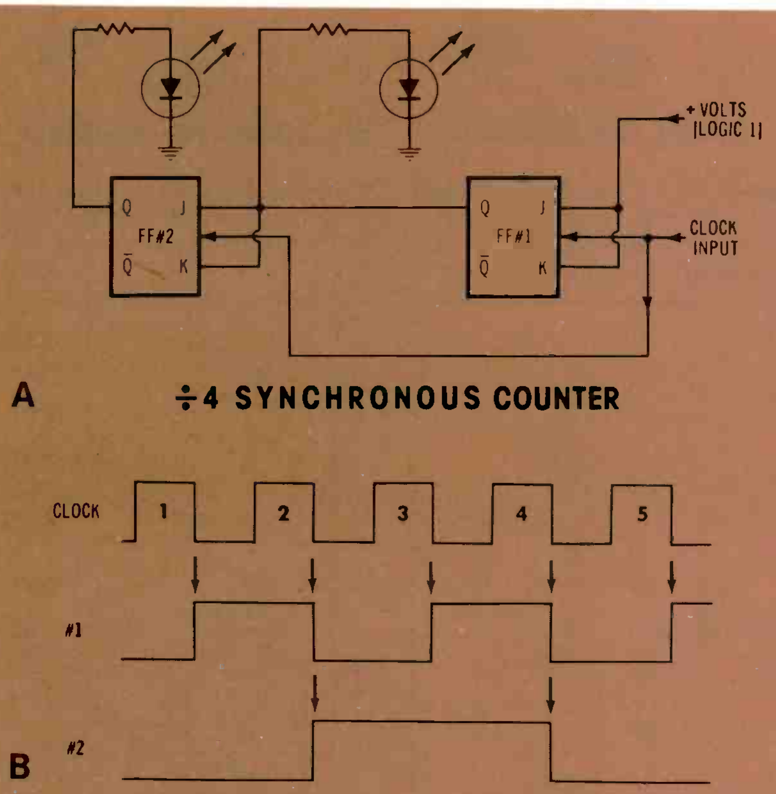


Figure 4 Glitches are prevented by the design of synchronous counters. (A) The schematic shows one with two flip flops. All toggling occurs at the trailing edge of the clock signal, and not from a previous flip flop. Therefore, all flip flops (that otherwise are ready for toggling) will change state at the same time. (B) Typical waveforms show that FF1 is toggled by the trailing edge of pulse 1. But FF2 can't toggle then because the J and K terminals are not high. Pulse 2 toggles both flip flops because the FF2 J and K terminals now have a high from FF1. And so on through the following pulses. The trailing edge of pulse 4 restores both flip flops to the starting condition, and the counter continues.

Follow the operation for a few clock pulses. Assume that both flip flops are in the low condition at turn-on. At the first high-to-low transition of the clock signal (that is, the first trailing edge), the input FF1 flip flop will change to the high condition.

Although the FF2 flip flop also is supplied with the same clock pulses, it can't toggle on this first trailing edge because the J and K terminals have lows. A high doesn't reach them until after the first flip flop toggles, and the clock pulse by then is low. FF2 ignores the first clock pulse.

After the first trailing edge, FF1 has a high output which is applied to the J and K terminals of FF2. This high remains until the next trailing edge which toggles FF1 to low output and toggles FF2 to high output (for the first time). FF2 now has lows at its J and K terminals, therefore it remains without change during the next trailing edge of the clock signal that toggles FF1 to the high condition again. The FF1 output high arms FF2 so it and FF1 both go low at the *next* trailing edge.

Although this explanation is correct, it is a bit tedious to follow. Refer to the waveforms and the pulse-versus-state table in Figure 4 if problems arise.

Notice that the table shows a repetitive pattern through counts of decimal 0, 1, 2, 3 and back to zero for another identical count. This proves the circuit is performing a binary count.

Advantages and disadvantages

When a comparison is made between ripple (asynchronous) and synchronous counters, the advantages are not all on one side.

Synchronous counters are better because the flip flops all change at the same time, thus preventing any race problem or glitches.

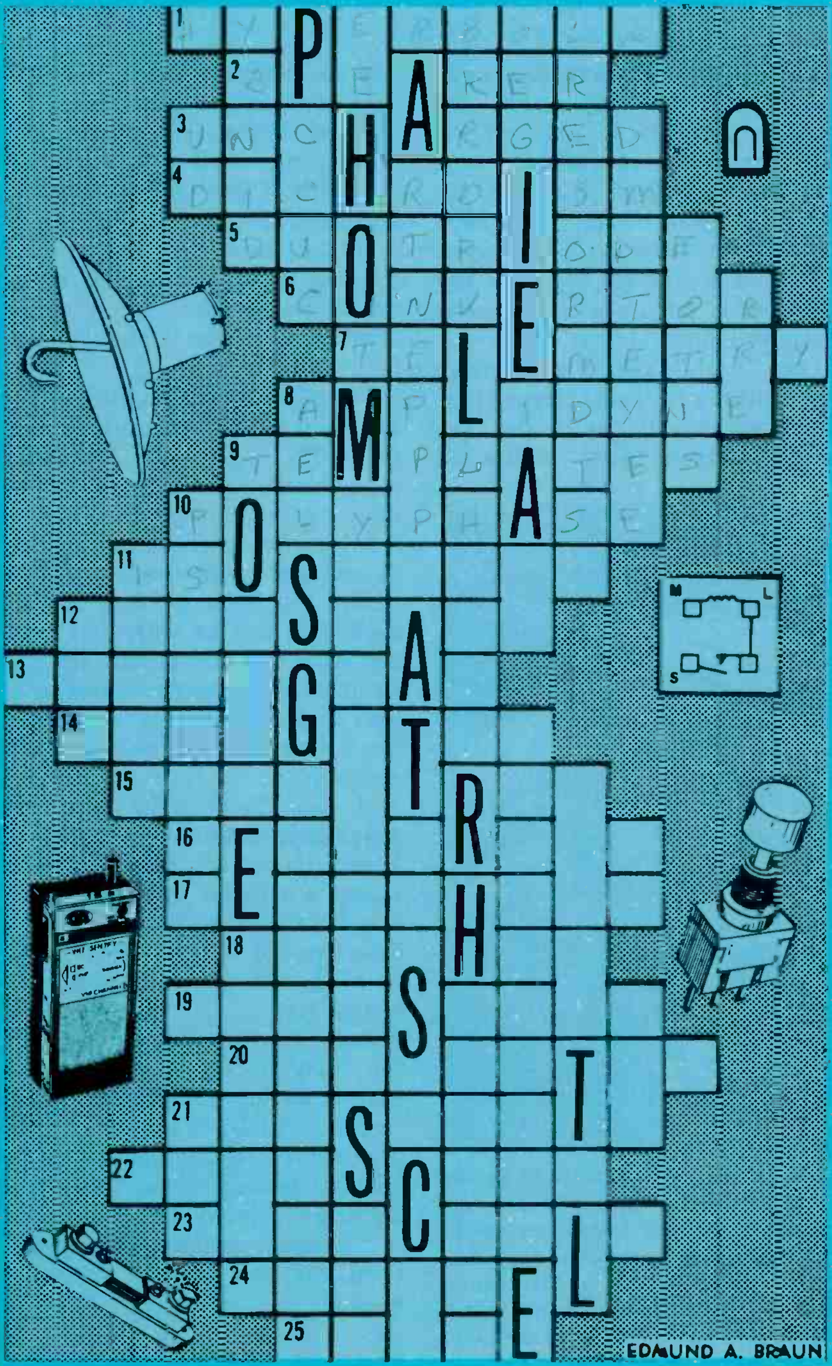
However, synchronous counters require increased current from the power supply. Also, for counts above decimal 3 (logic 0011), additional gates must be used. These are not needed for ripple counters.

Circuits for higher-count synchronous counters will be presented next month. ☐

Can you steal OHM?

by Edmund A. Braun

Time to relax and have fun solving this Just-across-word Puzzle based on Electronics. Each word is connected to the word above and below by one or more letters but only one is usually shown as a clue. Each correct answer is worth 4 points; a perfect score is 100. It should be fairly simple to get a high rating except perhaps for someone who thinks "Hertzian wave" is a hair style, or that "binding post" held Joan of Arc when she was executed! If you're a novice and miss some, don't fret because you'll have added to your electronic vocabulary. Ready? Then, GO!



1 A curve that's the focus of points having a constant difference of distance from two fixed points.
2 Device for converting audio frequency current into sound waves.
3 Not having electrical energy stored in a capacitor or battery.
4 Showing different colors when object is viewed from several directions.
5 Having two triodes in same tube envelope.
6 Device for changing electrical energy from one form to another as ac to dc.
7 Sends readings of gauges, meters, etc., to distant points via radio.
8 Special dc generator used extensively in servo systems as a power amplifier.
9 Patterns used as a guide for drilling holes, etc.
10 This type circuit usually involves three alternating voltages.
11 High resistance separator or support for conductors.
12 A graph of a wave as a function of time and distance.
13 Pertaining to a remnant or remaining part.
14 Refers to a type of spring clip with long, metal, meshing jaws.
15 A triode with an anode that can be moved or vibrated by an external force.
16 Restoring to a sound condition; fixing.
17 Transmission of speech current over wires enabling two persons to converse.
18 Pieces of conductive material which ride on a motor's commutator.
19 To interchange the relative position of conductors in an open wire line.
20 A major, essential, functional part of an organized whole.
21 In microelectronics, the material on which a circuit is fabricated.
22 Process of stopping a multi-programmed system by rejection of new jobs.
23 Obsolete term for the present preferred term gigahertz.
24 Unit used to express loudness or volume of sound.
25 Slang term for electric current.

You'll find the solution on page 50.

Reports from the test lab

Each report about an item of electronic test equipment is based on examination and operation of the device in the **ELECTRONIC SERVICING** laboratory. Personal observations about the performance, and details of new and useful features are spotlighted along with tips about using the equipment for best results.

By Carl Babcoke

Transistor tester

Leader Instruments model LTC-906 (Figure 1) tests transistors, diodes, FETs, UJTs and SCRs either in-circuit or out-of-circuit. The in-circuit good/bad and base identification tests can be made rapidly since the readout is by LEDs. Out-of-circuit tests measure transistor beta, B/E dc voltage (identifies material) and collector-to-emitter leakage. Results of these tests are displayed on the mirrored-scale meter.

In-circuit tests

During an in-circuit good/bad test of transistors, the internal circuitry evidently tries every combination of the three leads. Therefore, it is not necessary to connect the three test leads to any certain elements of the transistor. If the transistor is a PNP type that has some gain in the circuit, an LED marked "PNP" and "good" flashes on and off continuously. In addition, two or three LEDs at the right of the transistor socket (Figure 2) flash on and off in time with the "good" LED. These LEDs are part of the six that identify the base and the two transistor leads that connect to collector or emitter. If only two of the six LEDs flash, the one in the left vertical row indicates the lead that connects to the base. And the one in the right column identifies the collector. By elimination, the one remaining is the emitter.

However, many transistors light three LEDs. In such cases, an out-of-circuit test is required to determine which is collector and which is the emitter. However, for most in-circuit tests, it is not necessary to know collector from emitter. It is enough to know the transistor is not open and that it does give gain.

The "high" and "low" drive switch has two uses. Some low-impedance circuits require the high setting before a "good" indication can be obtained. When two LEDs light in the collector column, reducing the setting to the low-drive position might allow only one LED to light. Thus, the collector is positively identified.

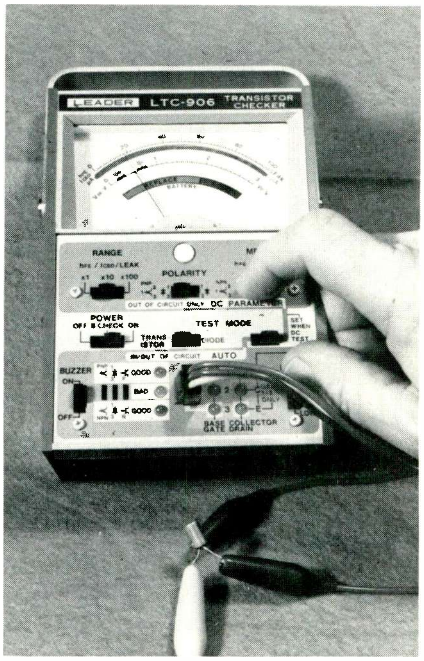


Figure 1 LEDs on the panel of Leader model LTC-906 transistor checker show good or bad transistors in-circuit. Additional parameters are read on the meter during out-of-circuit tests. No variable controls are used; all test set-ups are made by switches for fast operation.

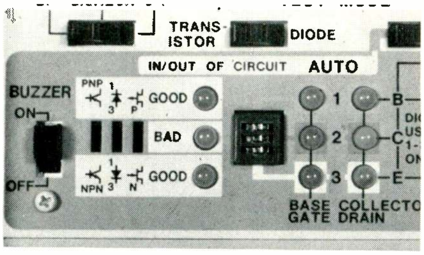


Figure 2 Socket and controls for in-circuit transistor tests are located on the lower-left section of the panel.

If the base is open to either collector or emitter (or the transistor has no gain for any reason), the "bad" LED at the left of the socket lights steadily.

For NPN transistors, the tests are the same except a good one causes the "NPN" "good" LED to flash.

In-circuit tests because of their nature cannot be precise or totally reliable. Low resistances or high capacitances of the circuit can nullify any in-circuit test. Even so, such tests can be extremely valuable. Most circuits permit the transistor to have some gain during the test, and this usually is sufficient for a satisfactory preliminary evaluation.

If the "bad" LED lights, the schematic should be examined. Where no low resistances or reactances are found in the stage, it's certain the transistor actually is defective. Of course, such transistors should be removed for a second test.

Buzzer—Located just to the left of the "bad" LED is a buzzer which sounds during each flash of either "good" LED. This allows the operator to watch the circuit connections instead of the tester while hearing the decision of the checker. A "buzzer" switch is provided to turn off the buzzer when not wanted.

Tests—In summary, the in-circuit

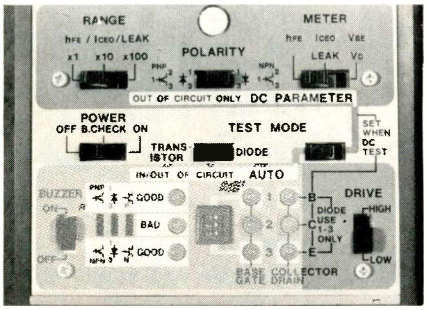


Figure 3 Switches on the upper and right sections of the panel are operated during out-of-circuit tests of beta, C/E leakage and B/E voltage drop.

tests identify PNP versus NPN types and indicate if the transistor is good or bad. In most cases, all three leads are identified, regardless of how the tester is connected to them.

Out-of-circuit checks

Each transistor must be plugged in or connected correctly during all out-of-circuit tests. Usually base, emitter and collector will be known from the in-circuit tests. Any question about a reversal of collector and emitter can be resolved with the "polarity" switch later.

Seven switches control the out-of-circuit dc parameter tests (Figure 3). Of course, the "power" switch is used also for in-circuit tests. It has a position for reading the internal 9-V battery condition.

One switch selects tests for a transistor or a diode. The other test mode switch allows either in-circuit dynamic checks or out-of-circuit dc tests.

Bias—Voltage drop across the base/emitter junction is measured on the mirrored-scale meter (Figure 4). Calibrations are in volts, with a maximum of 3 V. Green sections centered around 0.3 V for germanium and 0.7 V for silicon show the material of the transistor that's under test.

If the B/E junction is open or the leads are reversed, the meter reads slightly more than full scale.

Iceo leakage—Collector-to-emitter leakage from 2 μA to 10 mA are measured in three ranges. (Iceo means: current between collector and emitter with base open.) Tests with known defective transistors indicated these ranges are sufficient.

Hfe—Beta from 2 to 10,000 also can be measured in three decaded ranges. Tests with transistors (that previously had been checked by five other testers) showed good accuracy, except for a tendency to show higher readings for transistors of high beta. Of course, no two methods of measuring beta seem to give identical results. It is important for a beta tester to provide repeatable readings (which the LTC-906 does) so comparisons can be made.

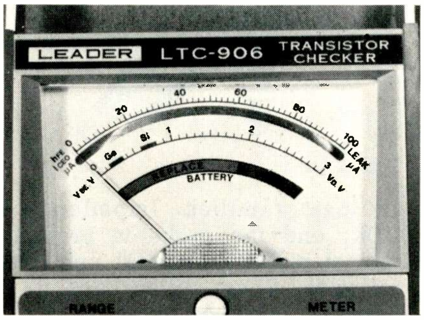


Figure 4 The meter has three scales. At the bottom is the "replace/good" battery test. Base-to-emitter voltage (with green areas showing the tolerance of silicon and germanium types) is displayed on the center scale. Beta and collector-to-emitter leakage are shown by calibrations of the scale at the top of the meter face.

Polarity—Correct setting of the "polarity" switch is necessary during leakage and beta tests. Usually the leakage will appear to be excessive if the polarity is reversed.

If there is any question about the collector and emitter being reversed, the correct connections and polarity are the ones giving highest beta. (Many transistors have some gain even with the collector and emitter interchanged.) Just slide the polarity switch from PNP to NPN and back again. Leave it at the position that shows the highest beta reading.

Comments

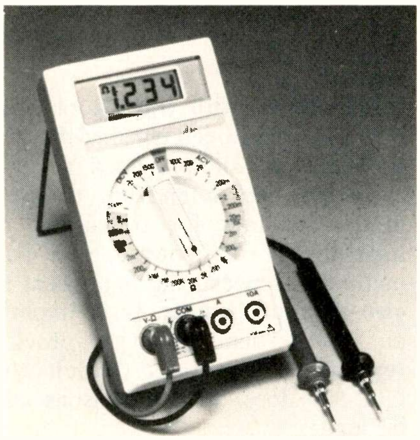
The model LTC-906 transistor checker fulfilled the promises of providing rapid and accurate transistor tests. A test cable consisting of a 3-prong plug with three color-coded wires and clips allows either in-circuit or out-of-circuit transistors to be connected. Transistors with wire leads (either flat or round) can be plugged directly into the socket on the front panel. A plug on the top of the case allows the use of an external voltage supply. ☐

Circle (30) on Reply Card

test equipment

Digital multimeters

Beckman Instruments has entered the digital meter field with a line of three multimeters. These three instruments are 3½-digit meters that operate for about 2000 hrs from one 9-V battery. All inputs are protected against overloads, and the resistance ranges employ low power.



Model 3010 features a dc voltage accuracy of 0.25% and a 22 MΩ input resistance. It sells for $130. Model 3020 is similar to model 3010 but the dc accuracy is 0.1% and the price is $170. Model 3030 is priced at $190 with true RMS capability and 0.1% dc accuracy. A full line of accessories is available.

Circle (31) on Reply Card

Auto-tracking power supply

Model 1650 from **B&K-Precision** offers one 5-V 5-A output and two separate 25 Vdc outputs at 0.5 A. An automatic tracking circuit allows the second 25-V supply to track with any voltage changes of the first supply. All outputs are isolated. For example, the two variable 25-V supplies can be connected with one supplying positive and the other negative voltage.

Short-circuit protection and automatic current limiting are possible. A meter can be switched to read voltage or current of any supply.

Model 1650 is priced at $275.

Circle (32) on Reply Card

Component tester

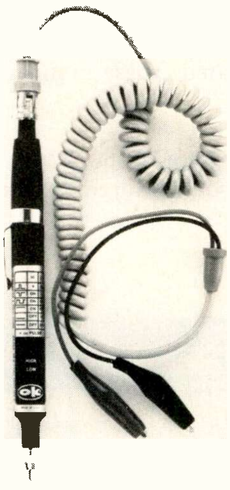
PTS Electronics has introduced model 8001 which works with any standard scope to test discrete solid-state components. A three-range switch matches the impedance of the component.

Model 8001 operates either in-circuit or out-of-circuit, and sells for $54.95.

Circle (33) on Reply Card

Logic probe

A logic probe that detects pulses of 10 ns or more is announced by **OK Machine And Tool.** Model PRB-1 probe is said to be compatible with all logic families. Impedance is 120K, and the probe is protected against polarity reversal and overvoltages. Short pulses are automatically stretched to 50 ns.



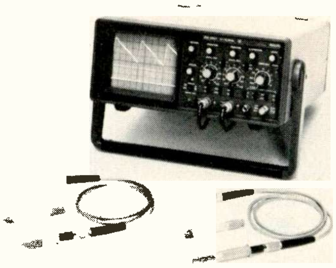
PRB-1 sells for $36.95.

Circle (34) on Reply Card

Portable scope

A choice of display modes and automatic triggering are features of model PM-3207, a 15-MHz portable scope from **Philips.**

Dual-trace and X/Y operation with switchable inversion of the B channel plus automatic triggering-level setting according to the amplitude of the input signal are additional features. Facilities for automatic triggering of TV video are built in.

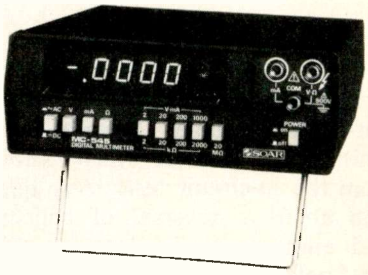


Model PM-3207 is priced at $795. Many accessories are available.

Circle (35) on Reply Card

High-accuracy DMM

Model MC-545 **Soar Corporation** digital multimeter is a five-function bench-type instrument that features 4½ digit accuracy. Zero adjustment and polarity indication are automatic, and the modes are visible in the display.



One option is a digital BCD output for digital recorders or microprocessors.

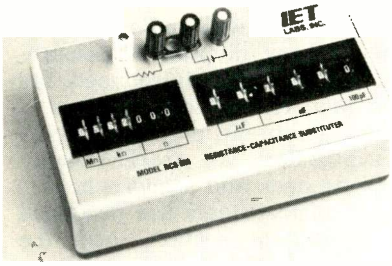
Model MC-545 sells for $289.95.

Circle (36) on Reply Card

R/C substituter

Features of the previous resistor and capacitor substitution boxes have been combined in the **IET Labs** model RCS-500 R/C box.

Two sets of side-by-side thumbwheels dial in the desired combination of resistance and capacitance. The value is direct reading from the switch numbers, so no calculations are required. The box uses 1% 0.5-W resistors and 4% 100-V capacitors.

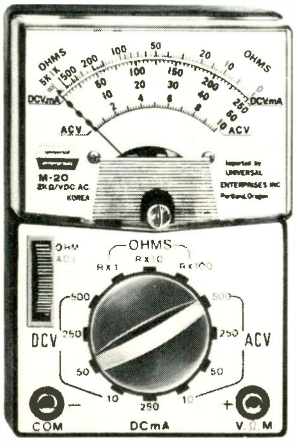


IET Labs model RCS-500 sells for $185.95.

Circle (37) on Reply Card

VOM

A new VOM multitester is available from **Universal Enterprises.** The meter movement is diode protected, and a fuse protects the ohmmeter function.



Model M20 has 12 ranges, is rated at 2,000 Ω/V and sells for $12.95.

Circle (38) on Reply Card

Full-function DMM

All range and function switches of the **Data Precision** model 935 digital multimeter are the sliding pushbutton type that allow one-hand operation. Model 935 has 29 ranges, including a choice of high-power or low-power ohms, dc and ac volts, dc and ac current.

Basic dc accuracy is said to be ±0.% ±1 digit. Polarity sign, zeroing, decimal points and a low-battery-voltage indicator are automatic. All ranges are protected against specified overloads. For example, all dc voltage ranges can safely withstand 5 kV pulses for 1 µs, or 1000 V for an unlimited time. The 3-½ digit display has 0.5-inch LCD digits.

Price of the model 935 is $149 in single quantities, complete with test leads, battery and instruction manual. Many optional accessories are available.

Circle (39) on Reply Card

Pulse generator

Two features of the Continental Specialties model 4001 pulse generator are independently-variable pulse widths and pulse spacing. The duty cycle is variable from 0.5 Hz to 5 MHz, and jitter is said to be less than 0.1% + 50 ps.

The six modes (selected by switches) are; run, trigger, gate, single-shot, square wave and complement. In the trigger mode, external signals between dc and 10 MHz can trigger the pulses. One output pulse is obtained with each press of the one-shot button. Square waves up to 2.5 MHz can be obtained. The polarity of the output signal can be inverted by the complement switch. The generator is compatible with TTL circuits.

Circle (40) on Reply Card ☐

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2SA 484	1.95
2SA 495	.40
2SA 497	1.30
2SA 509	.40
2SA 561	.40
2SA 562	.40
2SA 564A	.30
2SA 634	.50
2SA 643	.45
2SA 673	.45
2SA 678	.45
2SA 682	1.00
2SA 683	.40
2SA 684	.45
2SA 695	.59
2SA 699A	.70
2SA 706	1.10
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2SA 720	.40
2SA 733	.30
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2SB 324	.40
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2SB 407	1.00
2SB 434	1.00
2SB 435	1.20
2SB 463	1.20
2SB 473	1.00
2SB 474	.90
2SB 492	.80
2SB 507	1.00
2SB 528D	.90
2SB 595	1.50
2SB 596	1.50
2SC	
2SC 281	.40
2SC 372	.30
2SC 373	.30
2SC 380	.30
2SC 394	.30
2SC 458	.30
2SC 495	.60
2SC 509	.45
2SC 515A	1.00
2SC 517	3.00
2SC 535	.40
2SC 634A	.45
2SC 696	1.30
2SC 710	.30
2SC 711	.30
2SC 730	3.40
2SC 732	.30
2SC 735	.30
2SC 756	2.00
2SC 756A	2.00
2SC 781	2.40
2SC 784	.40
2SC 799	2.50
2SC 828	.30
2SC 839	.40
2SC 867	3.70
2SC 867A	3.70
2SC 897	2.50
2SC 930	.30
2SC 945	.30
2SC 983	.70
2SC 959	1.30
2SC 1000BL	.45
2SC 1014	.70
2SC 1018	.80
2SC 1030C	2.40
2SC 1061	.90
2SC 1079	3.90
2SC 1096	.60
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2SC 1124	1.00
2SC 1172B	3.95
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2SC 1239	2.90
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2SC 2166	1.80
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2SD 72	.70
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2SD 235	.80
2SD 261	.45
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2SD 427	2.25
2SD 525	1.20
2SD 526	.80
FET	
2SK 19BL	.60
2SK 23	.90
2SK 30	.50
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2SK 55	.80
3SK 22Y	1.80
3SK 39	1.20
3SK 40	1.20
3SK 41	1.60
3SK 45	1.60
3SK 48	3.90
3SK 49	1.60
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BA 521	2.40
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HA 1366WR	2.90
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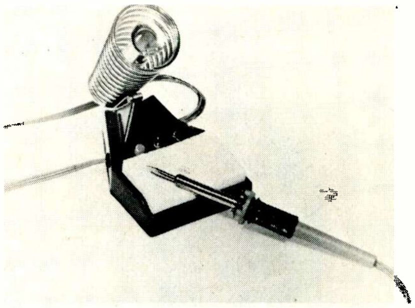
productreport

Soldering station

Stedi-Heat soldering station from **Hexacon Electric** provides idling at low temperature when the iron is resting in the holder and then an automatic increase of temperature when the iron is brought to the work.

Because of the Posi-Ground construction, any electrical voltage leakage is below the point of damage to solid-state components.



Model 4422 is intended for light duty or small components, and model 4423 is designed for larger production soldering.

Circle (41) on Reply Card

Wide-range speaker

Designed for applications where an attractive wood-grain cabinet is desired, the **Shure** model SR112W also provides high efficiency operation and hi-fi frequency response.

Two heavy-duty 8-inch bass speakers with front-ported bass-reflex cabinet and a high-frequency horn tweeter are said to provide virtually flat response from 45 Hz to 16,000 Hz.

Price of model SR112W speaker system is $350 to the user.

Circle (42) on Reply Card

Flux cleaner

Multicore Solders has introduced PC-85, a water-soluble, biodegradeable solution formulated to remove rosin soldering-flux residues from printed circuit boards. It will not remove component markings or inks, and is compatible with materials used in the manufacture of PC boards and their components. PC-85 is furnished as a concentrate, and it can be diluted up to 95% with tap water.

Circle (43) on Reply Card

New jackets

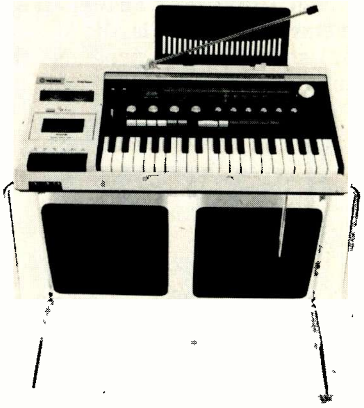
Jackets with "RCA Antennas" emblems are available from **RCA** antenna distributors. The jackets are made in three styles and four colors for RCA antenna installers and dealer personnel.

Circle (44) on Reply Card

Organ with radio

The **Webcor** division of **Leisurecraft Products** has introduced the Music Machine, which combines a 3-octave electronic organ with rhythm synthesizer, an AM/FM radio, a cassette deck and a microphone.

Eight musical beats are produced by the rhythm section, and the tempo can be adjusted. Music of the organ/synthesizer and the microphone can be recorded together on the cassette tape recorder. The twin speakers can be removed and placed elsewhere in the room for best stereo effect.



The Music Machine retails for $500.

Circle (45) on Reply Card

UHF-to-VHF Converter

Winegard's Model VC-4213 single-channel crystal-controlled UHF to VHF converter replaces four previous Winegard converters.

Model VC-4213 has a UHF preamplifier and a two-stage VHF final amplifier. Four diodes are used in a doubly-balanced converter, which gives less interference and cross-modulation distortion.

Conversion gain from UHF to VHF

is 24 dB, and the input selectivity is improved by a triple-tuned bandpass circuit.

Model VC-4213 lists for $405.50, and is designed to be used with Winegard's 3-volt and 7-volt DX-series of strip amplifiers.

Circle (46) on Reply Card

Noise-cancelling telephone

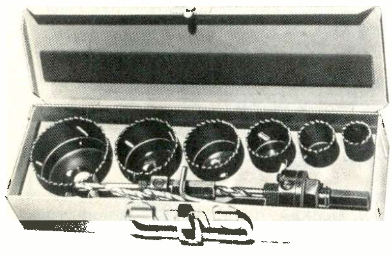
The **Roanwell** replacement noise-cancelling telephone transmitter (microphone) is said to eliminate more than 75% of the total background noise.

Installation can be made without tools. The "Confidencer" is screwed into any standard telephone, after the original transmitter is removed. It is available in many colors to match the telephone.

Circle (47) on Reply Card

Hole-saw kit

Klein Tools offers a new model high-speed hole-saw kit that includes six saws (from 7/8-inch to 2-½-inch), two arbors, two spare pilot bits, an Allen wrench and a red metal case. Each saw has slots in the sides to expedite removal of cores.



Circle (48) on Reply Card

Tuner parts directory

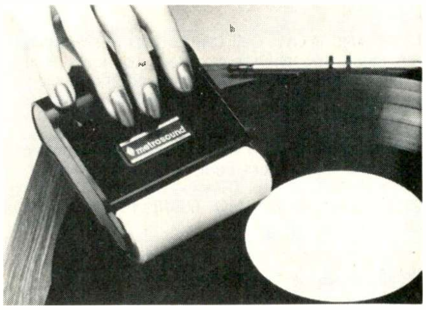
PTS Electronics 1979 Tuner Replacement Guide & Parts Directory has 182 pages of technical information about TV tuners and modules, in addition to descriptions of PTS products and services.

The new catalog sells for $5. It contains 83 pages of schematic and layout blowups of VHF and UHF tuners.

Circle (49) on Reply Card

Record cleaner

A roller made of ultra-soft polymer is the phonograph record cleaner introduced by **Metrosound Audio.**



When the stickiness is reduced by dust from many records, it can be restored after the roller is removed from the handle and washed.

Model M96 Super Cling Rotary Cleaner has a retail price of $16.99.

Circle (50) on Reply Card

Unusual metal shears

The **Jilson** QuikSnip shears cuts aluminum, brass and copper sheets up to 15 gauge or mild steel to 18 gauge. These shears are said to operate without bending or distorting the metal. A ¼-inch guide hole drilled in the center of sheet metal allows the beginning of a cut.

Circle (51) on Reply Card

CB Antennas

Channel Master has introduced nine mobile, base-loaded CB antennas. Five antennas incorporate a Quick-Lock bayonet-mount feature for quick removal or installation.

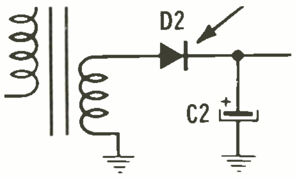
The antennas feature a high-performance coil, a constant diameter whip, and a heavy-duty shock spring. Maximum SWR is 1.3:1.

Circle (52) on Reply Card

#5

QUICK QUIZ

ANSWER:



Rectifiers for high frequencies (such as horizontal sweep) MUST be "pulse" or fast-recovery types. Do NOT use conventional 60-Hz rectifiers, they will overheat and fail rapidly. **Replacement D2 is the wrong type of rectifier.**

REFER TO PAGE 4

the marketplace

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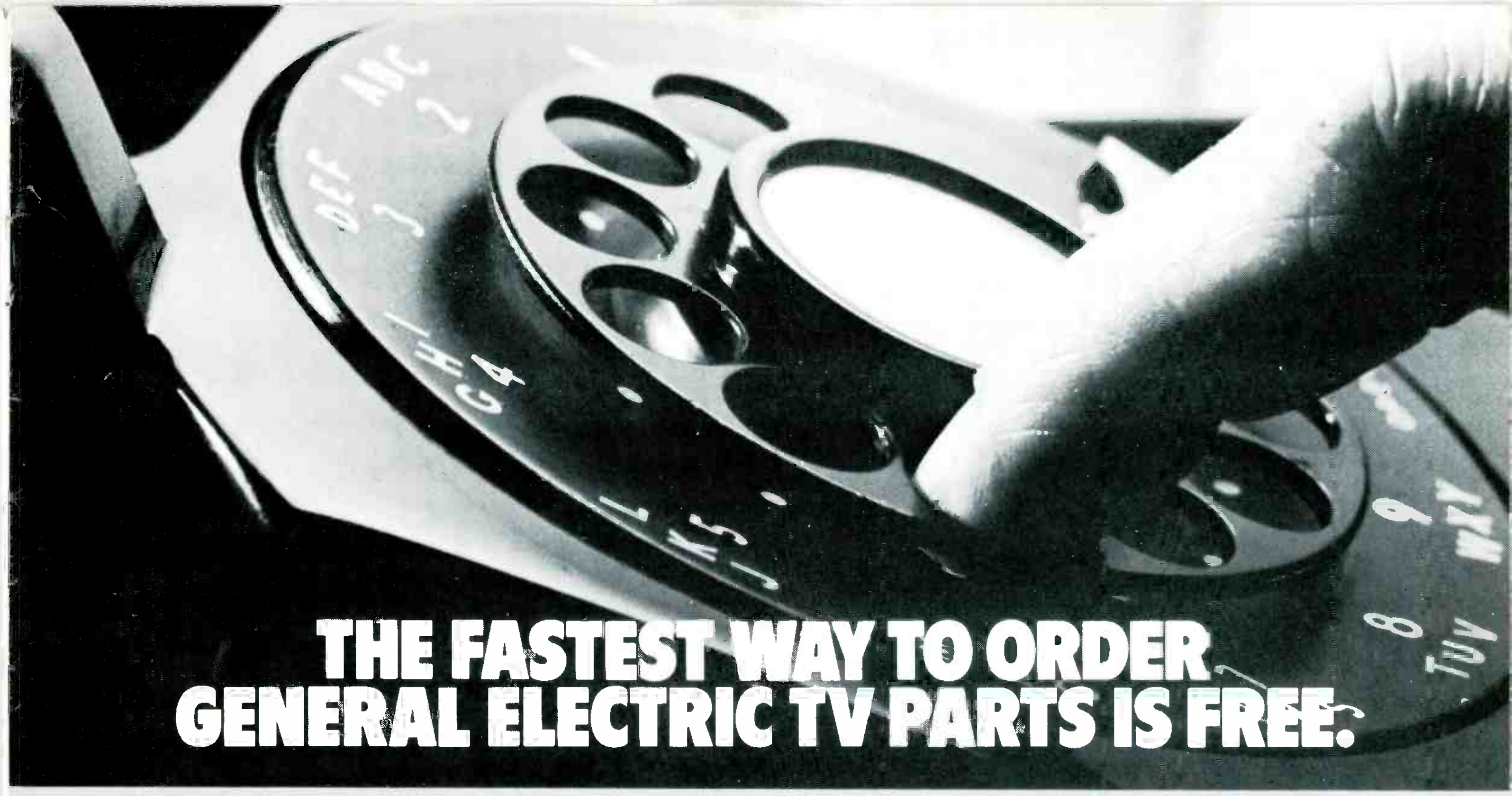

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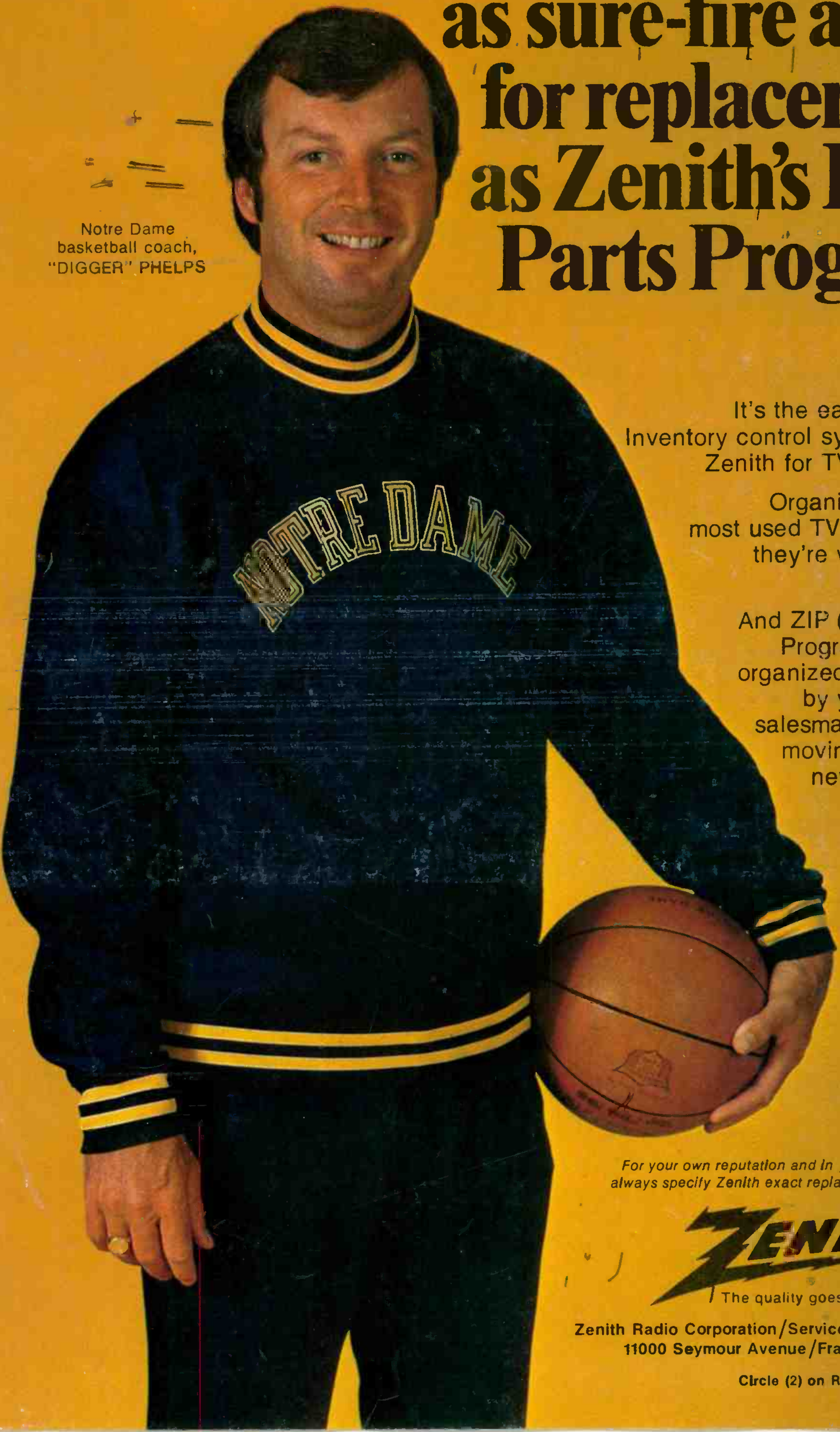

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