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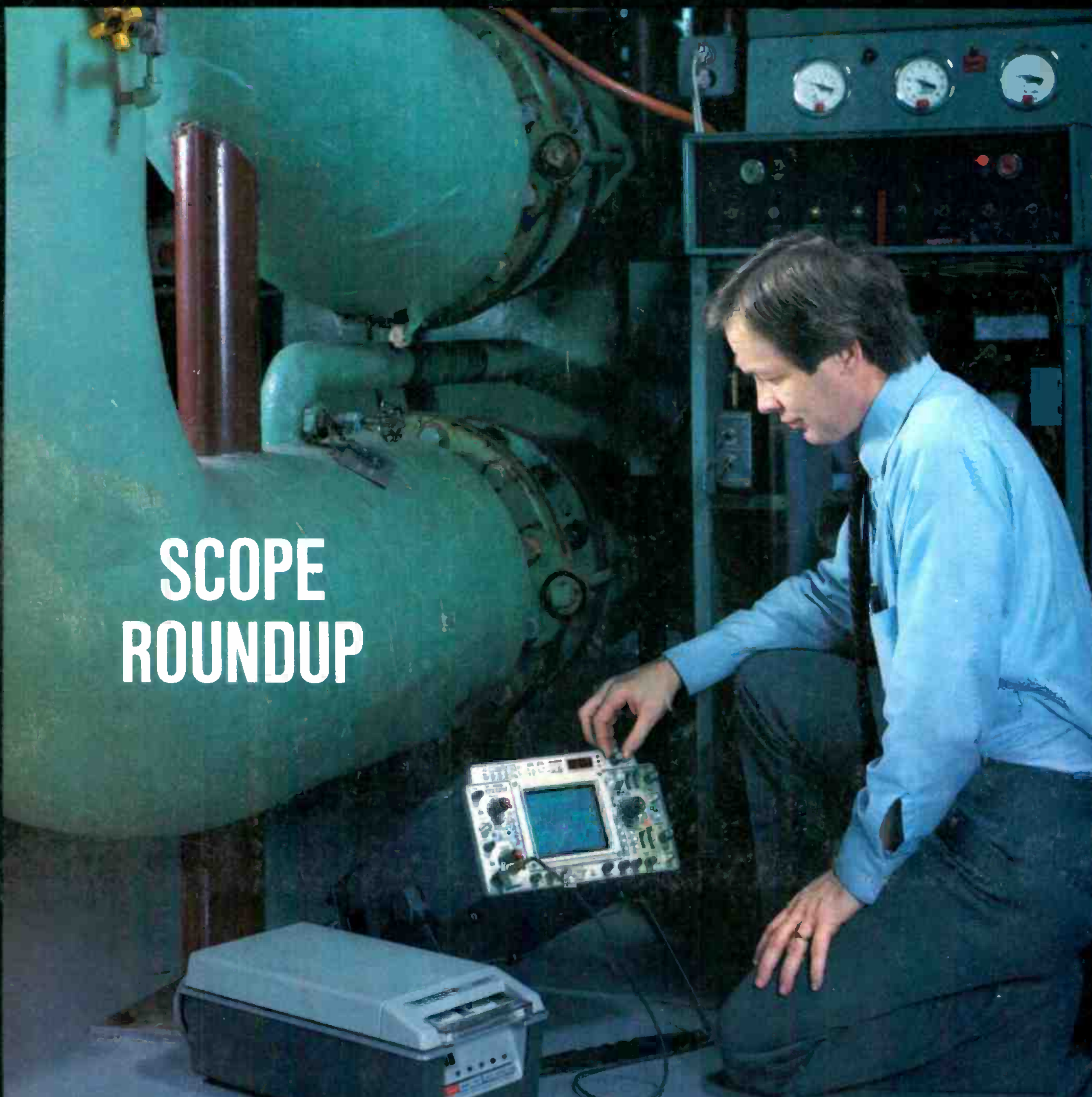

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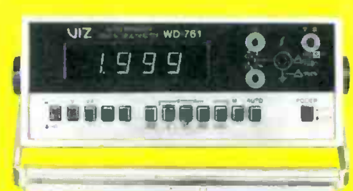

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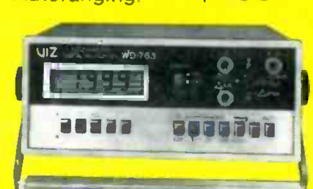

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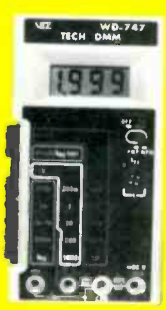

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Next month in

Electronic Servicing®

- The well-equipped audio test bench
- Planning the complete industrial maintenance shop
- Repairing audio recorders
- 1980 Index of articles
- Applications of digital scopes

For industrial maintenance and consumer servicing professionals

Electronic Servicing®

April 1981 ☐ Volume 31, No. 4

About the cover

A technician takes measurements from transducers in an industrial air conditioning unit using a Tektronix model 468 oscilloscope. The Tektronix 4924 digital cartridge tape drive to the left is used to record the measurements. For information on current scopes, see the Scope Roundup on page 18.

Photo courtesy of Tektronix Inc., Beaverton, OR.

electronic scanner

news of the industry

NEDA adds conference to EDS '81

The National Electronic Distributors Association has added an extra feature to its Management/Marketing Conference at EDS '81, May 4-7, in Atlanta. A mid-afternoon session on "Semiconductor Distribution." A Scenario For The Future," will be held Wednesday, May 6, from 3:00 p.m. to 5 p.m. in the ballroom of the Atlanta Hilton.

An authoritative panel headed by Frank Castle, new president and chief executive officer of Components Corporation of America, comprises: Walter Blanchard, the Page Group, consultants to NEDA; Paul Carroll, president, Semiconductor Specialists; Jack Darcy, president, Kierulff Electronics; Harold Mumma, national sales manager, Fairchild Semiconductor; Jerry Wasserman, senior consultant, Arthur D. Little, Inc.

The results of NEDA's recent 1980 Delphi Survey of the semiconductor distribution industry's next 10 years will be presented and analyzed for the first time. Semis now represent about one-half of total distributor sales with much of that done by the leading 25 companies.

The new NEDA Semiconductor Distribution program will cover such diverse subjects as Delphi survey methodology, industry growth, distributor share of market, distributor growth—capabilities and limitations, second-tier distribution, the Japanese approach and supplier policies.

Who cashes in on this scenario, how is it planned for, and will the smaller distributors fit, are just a few of the many angles to be explored at this May 6 session. Registration fee is $50 to be sent to: National Electronic Distributors Association, 1480 Renaissance Drive, Park Ridge, IL 60068.

Pre-'81 conference on distribution outlook

The National Electronic Distributors Association (NEDA) is sponsoring an all-day Distribution Outlook Conference in Atlanta on May 4th, the day before EDS '81 opens.

Organized and conducted by Alberto Socolovsky, publisher of Electronic Business, the conference will examine in depth and focus on growth and competition for the U.S. electronics industry, expected to be the fastest growing industry of the decade.

Beginning at 9 a.m. in the Atlanta Hilton Hotel Ballroom, the distribution outlook meeting will open with a review of past industry growth performance by Socolovsky. Bill Meserve, senior consultant in distribution at Arthur D. Little Company, will follow with a forecast of distribution industry growth and direction. Clark Walser, an electronic distribution specialist at Bacon, Whipple & Co., will discuss the relationship of capital, profitability and growth. The industry speaker at lunch will be David Shaw, executive vice president of Time Electronics, whose subject will be "The Challenges of High Technology to Distribution." Following lunch, Jamie Kirk, distribution sales manager, Intel Corporation, will make a presentation on the demands of leading edge technology products. Concluding the conference will be a discussion of distribution's participation in the booming military market by John Doyle, manager of procurement administration, Westinghouse Defense Group. Questions from the audience will be taken at the conclusion of each session during the program. The conference is expected to end by 4:30 p.m.

Registration fee for "Distribution Outlook—Growth and Competition in the 1980's" is $60, including lunch. Reservations and check should be sent directly to National Electronic Distributors Association, 1480 Renaissance Drive, Suite 214, Park Ridge, IL 60068.

EDS announces international programs

The growing international tone of the Electronic Distribution Show in Atlanta will be heightened by a special program, covering several aspects of international electronics trade, to be held May 5 from 9AM to 10AM, immediately after the 1981 EDS opening ribbon cutting ceremonies.

The program on international electronics marketing, to be presented in collaboration with the U.S. Department of Commerce, will have three components: highlighting for international buyers the manner in which electronic parts and equipment are distributed in the United States, and the role of the EDS Show in creating a marketplace; the ways in which U.S. vendors can sell their products overseas; an explanation to foreign buyers of problems possibly to be encountered when purchasing electronics goods on the domestic market.

NATESA convention scheduled in August

As announced by Frank J. Moch, executive director, the annual NATESA convention is planned for August 19th through 23rd, 1981, at Indian Lakes Resort, Bloomingdale, IL. Transportation from O'Hare airport will be available.

Subjects to be covered include: computers in service; billing for service; set leasing; direct mail advertising; diversification; telephone techniques; total service; and videodisc technology. A variety of tours will be available.

The annual NATESA golf tourney will take place Thursday morning, August 20th. The all-inclusive golf fee of $15 is payable in advance.

Registration fees will be $50 for the first person from each member company, $40 for each spouse and $20 for each child under 12 years old, with a bonus promised those who register early.

Florida latest state to join NESDA

The Florida Electronic Service Association voted to affiliate with NESDA, the National Electronic Service Dealers Association, at the state board meeting in Orlando, February 8. Florida becomes the 29th state to affiliate officially with NESDA. At a joint meeting of the previously affiliated state associations of Washington and Oregon, at Hood River, OR, February 8, the Washington state directors voted unanimously to become 100% affiliated as of March 1, and the Oregon state association as of February 1. Under the 100% affiliation plan members receive reduced national dues based on the size of the state association.

Arizona State Electronics Association had previously selected 100% membership to begin as of February 1, and Texas became the first state to go in under the new plan January 1. Wisconsin, Arkansas, and Colorado, previously 100% affiliated, are also eligible for the reduced membership rate plan.

NESDA is a federation of professional state electronic service associations and is the nation's largest association of service dealers. For further information about the association or the new state membership plans, or for an individual membership application, persons may contact NESDA 2708 West Berry St., Ft. Worth, Texas 76109; (817) 921-9061.

EIA supports economic recovery

The Board of Governors of the Electronic Industries Association recently strongly endorsed the economic recovery program that President Reagan proposed to the House of Representatives and the Senate, in joint session, on February 18, 1981.

The Association also backed the proposed methodical scrutiny of regulatory constraints which, like taxation, have become cost factors in the determination of price. EIA further endorsed the ongoing nature of planning for economic recovery, recommending that a specific tax incentive for R&D and specific tax relief for Americans working abroad be included in the second phase of the President's program.

Recognizing the urgent need for remedial action, the Association pointed out that the President's program is "one skillfully stripped for action and tailored for impact." EIA today communicated its support of the President's fiscal '82 program to each member of Congress, urging them to expedite its passage.

Dynascan increases 1980 earnings

Dynascan Corporation recently announced higher earnings on lower sales for the year and fourth quarter ended Dec. 31, 1980.

For the year, earnings were up 256 percent to $1,905,000 or 56 cents a share compared with $535,000 or 16 cents a share a year earlier. Sales declined by 9 percent to $51,168,000 from $56,055,000.

For the fourth quarter, earnings increased to $791,000 or 23 cents a share, compared with nominal net income of $15,000 a year earlier. Sales in the final quarter increased 13 percent to $14,877,000 from $13,138,000.

Canadian conference has been expanded

Because of the increased demand for exhibit space, the 1981 International Electrical, Electronics Conference and Exposition, scheduled for Exhibition Place, October 5-7, has been expanded more than 6,000 square feet, an increase of 15% additional exhibit space.

The conference and exposition is sponsored by the Canadian region of the Institute of Electrical and Electronic Engineers. The conference hotel headquarters is the Royal York Hotel. Pre-registration is free for qualified industry personnel; the student rate is $2.00 and non-members $10.00. Send inquiries to Southex Exhibitions, 1450 Don Mills Rd., Don Mills, Ontario, Canada, M3B 2X7. Telephone: 416-445-6641; Telex: 06 966612. □

people in the news

Tronics 2000 Corp. has announced entry into the Dallas market. Development of the two territories which cover Dallas County will be headed by **Kenneth B. Leathers** and **Kevin T. Connors.**

Seven vice presidents have been appointed to the marketing organization of the newly formed N.A.P. Consumer Electronics Corporation. N.A.P., a new subsidiary formed when North American Phillips acquired GTE Entertainment Products Group, manufactures and markets audio-video products under the Maganvox, Philco and Sylvania brands.

The new vice presidents are: **David M. Arganbright,** vice president of marketing services; **James A. Egan,** vice president and general manager of special markets operations; **Robert T. McCarthy,** vice president of marketing planning; **Enrico R. Policicchio,** vice president and general manager of Philco operations; **Ron R. Stoltenberg,** vice president and general manager of Sylvania operations; **Paul J. Terhaar,** vice president and general manager of product services; and **Kenneth C. Thomson,** vice president and general manager of Magnavox operations.

William A. Enser has been appointed director of planning.

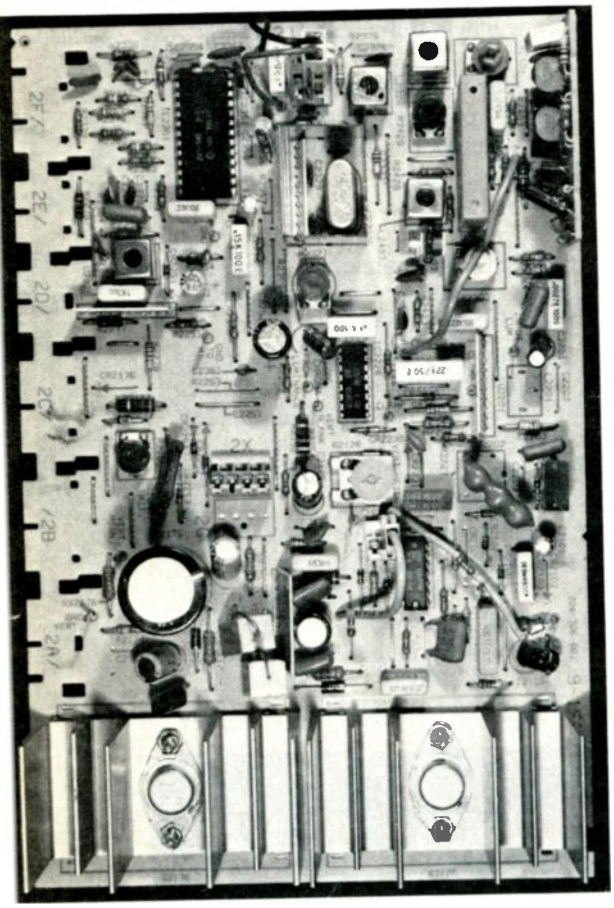
Thomas R. Shepherd, formerly senior vice president of GTE Entertainment Products Group, has been appointed president of N.A.P. Commercial Electronics. Shepherd began his career with GTE in industrial relations in 1956 and rose successively through general management and marketing positions.

Shure Brothers Inc. has announced the promotion of **Tom Tichy** to department manager, electroacoustical development, with responsibilities for all loudspeaker component and system research and development activities. Tichy's most recent position was section manager. He joined Shure in 1971.

Arthur E. Kowitz has been named director of management information systems for Simpson Electric Company.

Varian Associates has appointed **George Hoberg** as general manager of its EIMAC Division.

Hoberg had been assistant to the president, Electron Device Group, and for a year was assistant general manager of the Palo Alto Microwave Tube Division. Before joining Varian in 1979 he had been president of a small company specializing in digital image processing. Earlier he was an engineer and engineering manager in the data communications and digital computer fields, and served as an officer in the United States Navy. □



Zenith comb filter and luminance circuits

The most important of the Zenith video improvements is the comb filter (called Peak Resolution Picture). Comb filters reduce interference beats between luminance and chrominance signals while giving a wider bandwidth for a sharper picture. The waveforms and explanations will help technicians understand the phase-relationships and the scoping of composite-video signals.

In the Zenith SM1973P, the M2 module is only about 6x9 inches but it contains most of the luminance (video) stages, many of the chroma stages, the vertical countdown and the complete vertical-sweep system. With a comb filter, the M2 number is 9-152-01.

By Gill Grieshaber, CET
Gill's Color TV
St. Joseph, MO

Mounted back-to-back with the M1 tuner module (described last month) is the M2 module (Figure 1), containing several video and luminance stages, a comb filter, the chroma system (minus only the matrixing and color amplifier stages), and the complete vertical-countdown and vertical-deflection systems.

Conventional video and luminance stages are required to amplify the signal while providing the needed frequency response. Color receivers without comb filters must have the video response narrowed to minimize video/chroma interference. Zenith model SM1973P has a comb filter (Figure 2) that decreases the interferences and widens the luminance frequency response to give sharper pictures.

Background of comb filters

It is helpful to know the origin of the term *comb filter*. Sidebands of the chrominance signal extend from 1.5MHz below the 3.579545MHz color-carrier frequency to 0.5MHz above. Luminance sidebands occur at 15,734.4Hz intervals. Both luminance and chrominance sidebands occupy the area around 3.58MHz; each chrominance sideband is midway between successive luminance sidebands. Each bundle of chroma sidebands is 7,867.2Mz from the luminance sidebands on both sides. The luminance and chroma signals are *interleaved,* which is necessary under the NTSC system of color television.

A filter system to remove the chrominance sidebands without weakening the adjacent luminance sidebands (or vice versa) might be built theoretically by using many rejection filters with each tuned sharply to an undesired frequency. *The frequency response of such a filter would resemble the teeth of a comb.* Systems that *appear* to have this filtering action are called comb filters.

Of course, a filter system of this type is impractical. Consider the operation of only three filters to eliminate the 3.5638MHz lower sideband, the 3.5795MHz color carrier and the 3.5953MHz upper sideband of the color signal without attenuating the two interleaved luminance sidebands at 3.5717MHz and 3.5874MHz. Filters of such sharpness are almost impossible to construct, and if built they would ring excessively, rendering them useless. Also, about 31 of these expensive filters would be required to cover the conventional 500kHz

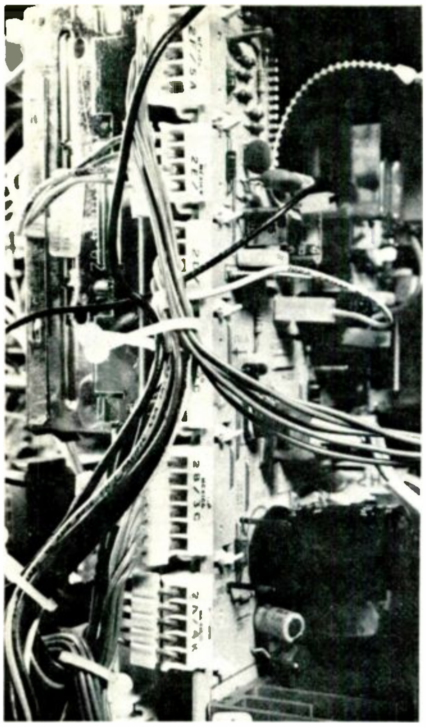


Figure 1 The M2 module at right is back-to-back with the tuner module.

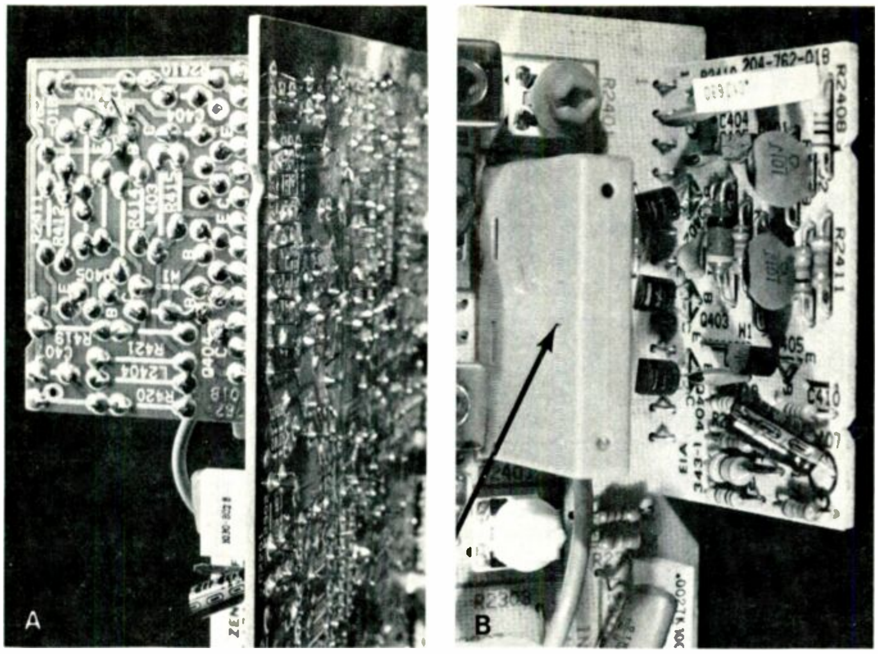


Figure 2 The transistors plus some resistors and capacitors for the comb filter are on a daughter board connected by 13 pins to the mother board. (A) The wiring sides of mother and daughter boards are shown. The pins between the boards can be convenient test points. (B) Five comb-filter transistors are on the daughter board. An arrow points to the glass delay device on the M2 mother board.

chroma bandwidth.

So-called comb filters in current use do **not** have a comb-like frequency response or sharply tuned resonant circuits of any type. They are much less complicated than a true comb filter would be. Separation of luminance from chrominance (or chrominance from luminance) is accomplished by phase cancellation, not by filtering.

In the NTSC system of color TV, each horizontal line of composite video has *chroma* signals of opposite (180°) phase; alternate lines have burst and chroma sidebands of identical phase, and adjacent lines of video have opposite phase. Of course, the sync and blanking pulses are identical for all horizontal lines of video, and there are only insignificant differences between the luminance waveforms of consecutive lines. If two consecutive lines of identical amplitude composite video could be combined, the chroma burst and sidebands would cancel, leaving double amplitude of luminance without chroma or burst. If one of those consecutive lines having identical amplitude is phase-inverted before they are combined, the luminance signals cancel, leaving only a double amplitude of chrominance signals (burst and sidebands).

Unfortunately, there is a major problem. *Only one line of video is present at any time,* and this line never is present in its entirety. Compared against time, each line of composite video moves continuously, requiring approximately 63.55μs for one line. There is no convenient and easy method of comparing consecutive lines of video, although inversion of the phase is simple.

Several products have been developed to delay video signals by precisely one line (about 63.5μs). A glass-type delay device can provide the needed time delay, but the frequency response is not wide enough to accommodate the entire composite video (about 10Hz to 4.1MHz). Color receivers with glass-type acoustic delay devices can delay only the 3MHz to 4MHz range, which is the range of chroma signals in modern color receivers.

The Zenith comb-filter circuit includes such an acoustic delay device.

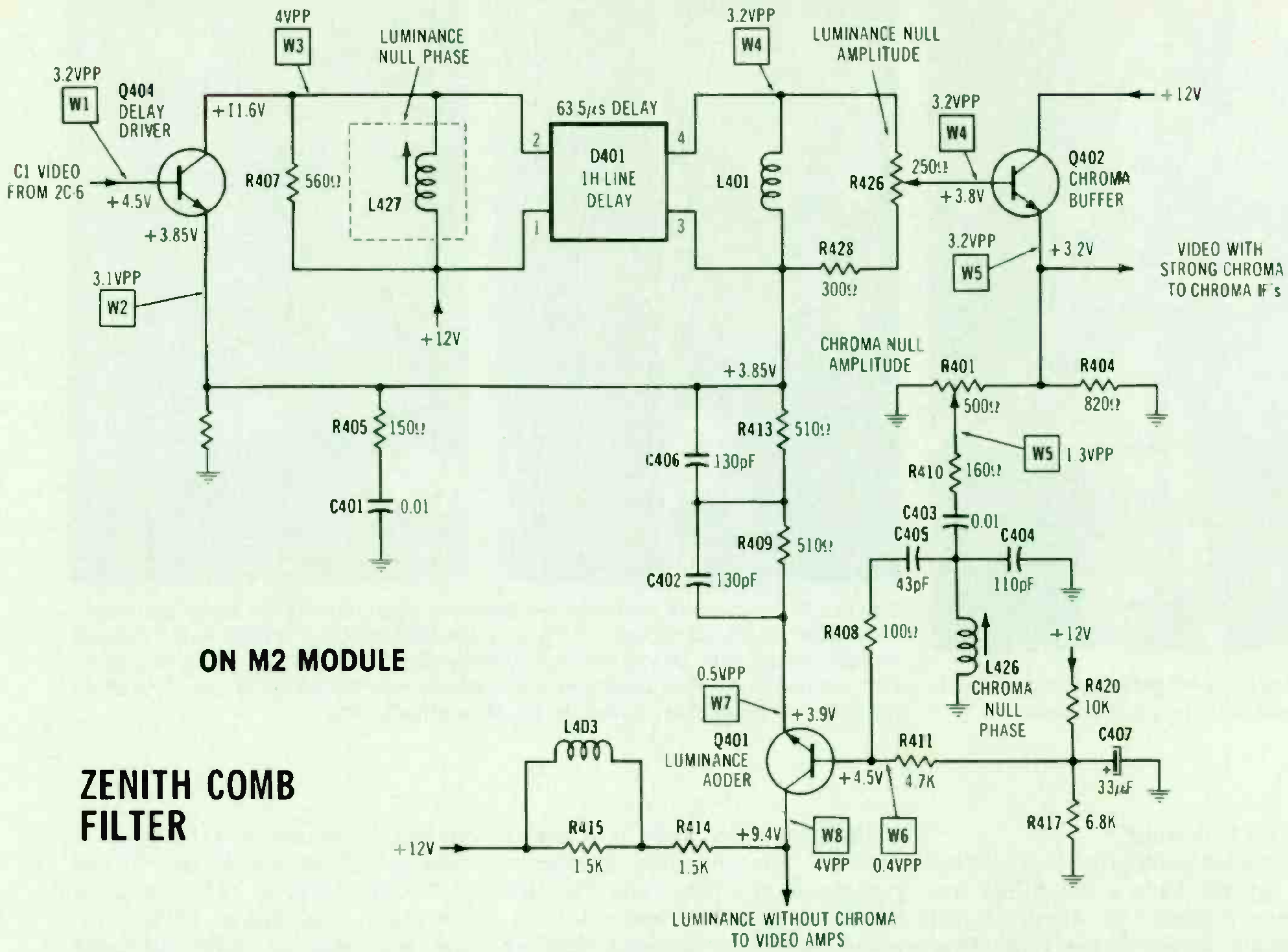
Zenith comb-filter operation

Figure 3 shows a schematic of the Zenith comb filter with typical voltages and waveforms measured in the sample SM1973P receiver. Composite C1 video is applied to the Q404 base. Emitter resistor R406 has only a small amount of bypassing (R405 and C401); the emitter waveform is virtually identical to the base signal (see W1 and W2 waveforms). This emitter waveform is applied to: D401 pin 3; the low end of R426 (through R428); and the Q401 emitter (through a low-pass filter). These connections are explained later.

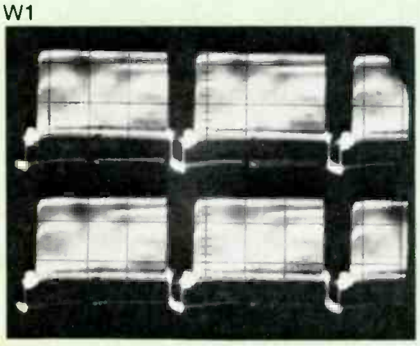
The D401 delay device is driven by the Q404 collector. L427 and R407 restrict the collector signal to the 3-4MHz chroma band; L401 removes any stray low frequencies from the D401 output at pins 3 and 4. The output signal is applied across the R428/R426 combination, which adjusts the ratio of direct video (from Q404 emitter and D401 pin 3) to the pin-4 chroma signal that has been delayed by the time of one horizontal line. Because L401 is a near short to the low-frequency section of the luminance signal, the luminance signal appears at pins 3 and 4, and at both ends of R426. Therefore, R426 adjustment varies the amount of delayed chroma that is mixed with the undelayed composite video and then applied to the Q402 base.

Output of Q402 at the emitter has the normal amplitude of luminance with more than twice the usual burst amplitude (Figure 3, waveform W5). Although the luminance has not been canceled, the increase of

ZENITH COMB FILTER

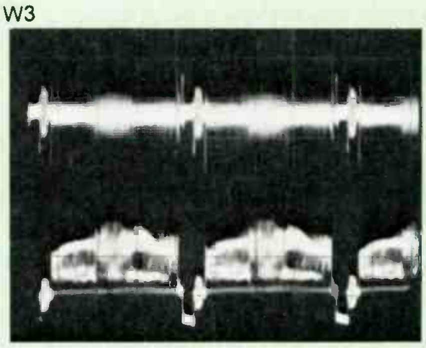


W1



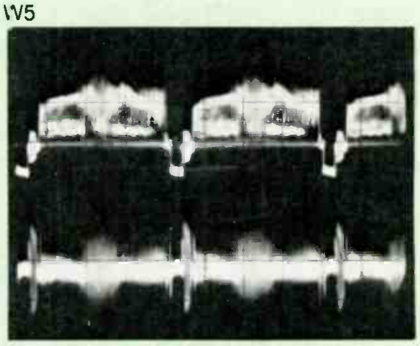
W2

W3



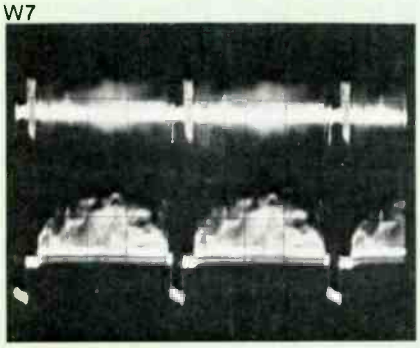
W4

W5



W6

W7



W8

Figure 3 Three transistors make up the comb filter. Composite video from the Q404 emitter is connected to pin 3 of D401 and, through R428, to the low end of R426 control. Because of a phase inversion at the Q404 collector and another in D401, the burst at pin 4 (from the delayed line of video) has the same phase as the undelayed burst at pin 2. The two add, producing a very large burst in the composite video at the Q402 emitter. Part of this signal serves as input to the chroma take-off coil. Composite video from the Q402 emitter is sent to the Q401 emitter through high-pass filters R413/C406 and R409/C402. These filters pass strong chroma (and luminance harmonics) and weak low-frequency luminance. (This is the input source for the luminance at the collector.) Also, a sample of video with strong burst and chroma is amplitude-adjusted by R401 and has all low-frequency video removed by the C403/L426/C404 filter, leaving the strong delayed chroma. The base of Q401 has burst and chroma delayed by one horizontal line while the emitter has an equal amplitude of undelayed burst and chroma (plus low-amplitude luminance). The two chroma signals cancel, producing luminance without chroma at the Q401 collector. Waveforms and dc voltages were recorded during operation on a TV signal of moderate level. Incidentally, all components on the M2 module have a figure 2 following the first letter. For example, the first comb transistor is Q2404 (not Q404) and resistor R2407 is shown here as R407. Zenith uses the condensed version on the daughter board and the full numbers on the M2 module.

chroma amplitude gives the same effect as if the luminance of composite video had been decreased to less than 50% amplitude. After the luminance is removed by the C334/C332/L327 chroma-peaking circuit (shown with the chroma schematic), the chroma signal has decreased luminance contamination compared with operation without a comb filter.

Scoping chroma phases

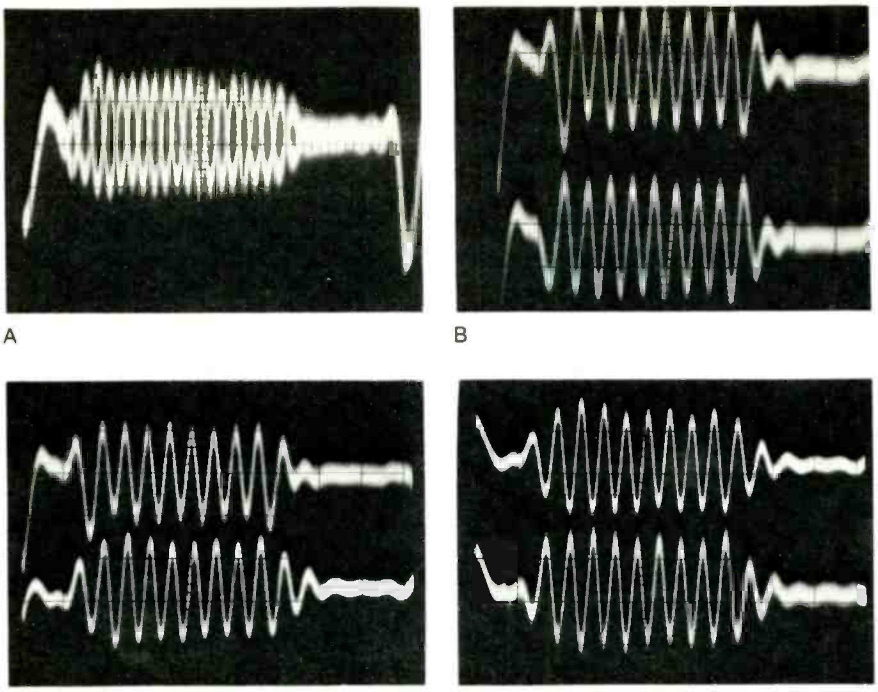
Figure 4 uses scope waveforms to explain how cancellation or addition of 3.58MHz burst or chroma sidebands can occur. A single-trace scope mode (waveform A) shows the opposite-phase burst when odd and even video lines are combined.

Complicating the phase analysis are the effects of alternate scope traces. For example, when channel one (top trace usually) shows line one of composite video, the channel two (lower trace) shows the next, or line two, of video. The following top trace shows line three, followed by line four displayed by the lower trace, and so on. With continuous sweeps, the odd lines are displayed by the top trace and the even video lines are shown by the lower trace. The luminance part of composite video has the *same* phase for all video lines as viewed on both scope traces. However, *the chroma sidebands and burst of the odd video lines are reversed or inverted in phase from those of the even video lines.* This is illustrated by waveform B of Figure 4. (Burst is a constant, so it is used to represent all chroma signals in these waveforms.) Notice that the two bursts are out-of-phase, as specified for interleaved chroma and luminance. Both bursts *appear* to be on the CRT screen constantly, although they actually exist alternately. The human eye and CRT-screen phosphors both have persistance which allows alternate traces to apparently be visible at all times.

It is normal for the burst and chroma phases to be reversed on consecutive horizontal lines of video. Often this *apparent* phase reversal is combined with an actual phase inversion in the circuit. To minimize the confusion, refer to the Figure 5 table, which lists the correct phase relationships at various points as viewed by a dual-trace scope in the alternate-sweep mode.

Minimizing luminance in the chroma

Waveform C in Figure 4 shows bursts at the pin-2 input of delay device D401 (top trace) and the



A B C D

Figure 4 These waveforms are expanded to show the burst phases as they are revealed by a dual-trace scope. (A) When the burst of all composite-video lines are shown on a single trace, the reversed phases overlap, making analysis difficult. (B) With dual-trace mode, the burst of odd lines is shown by one trace, and the burst of even-numbered video lines is shown by the other trace. These bursts represent the reversed phase of alternate lines when both scope channels show the same input signal. The luminance has identical phase; it is not inverted. (C) Top trace is D401 pin 2, the input of the delay device; the lower trace is the D401 pin 4 output waveform. Notice that they are in-phase, which proves a phase inversion inside D401, because in-phase burst is shown by alternate scope traces as out-of-phase. (D) These bursts were scoped at the base and emitter of Q401. They are out-of-phase when scanned alternately by the scope. In real time the base and emitter burst and chroma signals are in-phase, so they cancel when adjusted for identical amplitudes. The only true input signal (base-to-emitter) is a low-amplitude luminance waveform that appears amplified and without phase change at the Q401 collector. The scope was fed external sync from the receiver composite sync at R131, and the scope sweep time was 0.5μS/division. This is the best method of obtaining a stable display for these difficult-to-scope waveforms.

pin-4 output (lower trace). Sine waves of the two bursts are in-phase. This might appear to be a transformer with in-phase signals at primary and secondary. But D401 is not a transformer or a conventional delay line. Instead, it is an acoustic delay device that bounces the 3.58MHz acoustic signal from one wall of the device to another until the signal at the output port has been delayed by the time of one horizontal line. There is no inductance, resistance or capacitance *coupling* between input and output.

There are two reasons why the pin-2 and pin-4 terminals have in-phase chroma and burst. First, a strong signal from the Q404 emitter (Figure 3) is connected to the cold end of D401 and L401; *pin 4 will have nearly normal composite video, even if the delay line is disconnected or defective.* As an experiment, the base and emitter of Q404 were connected, and the change of Q402 emitter waveform was photographed. As expected, the video amplitude was reduced and the percentage of burst amplitude decreased to normal (Figure 6).

Burst phase in interlaced video as viewed on dual-trace scopes

Waveforms compared	**Relative phase of bursts**	**Comments**
input video to both	traces show reversed phase	*normal for dual-trace
Q404 base & emitter	traces show reversed phase	normal; no B/E inversion
Q404 base & collector	traces show same phase	normal; B/C has inversion
Q404 base & D401 #4	traces show reversed phase	**double inversion
D404 base & Q402 base	traces show reversed phase	**double inversion
Q404 base & Q402 emitter	traces show reversed phase	***double inversion
Q404 base & Q401 base	traces show reversed phase	****see note
Q404 base & Q401 emitter	traces show reversed phase	****see note

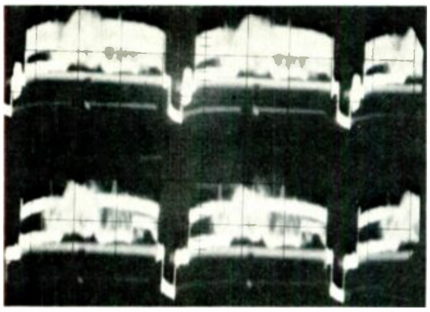
* *normal for dual-trace operation with NTSC video. The scope displays alternate lines of video, and the chroma phase changes with each line.*

** *Q404 inverts between base and collector, and D401 inverts between #2 and #4; therefore, the overall phase is unchanged.*

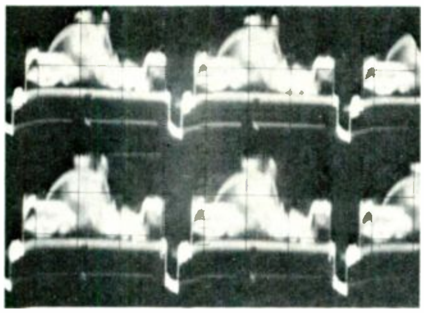
*** *Q404 inverts and D401 inverts while Q402 B/E does not invert.*

**** *Neither L426/C404 nor R413/C406-plus-R409/C402 changes the signal phase obtained from the Q402 emitter. Therefore, the same phase of chroma and burst signals is applied to both base and emitter of Q401. When the amplitudes are equal (adjusted by R401), these signals cancel, leaving only the weak luminance at the emitter.*

Figure 5 As shown in Figure 4, the sine waves of burst and chorma sidebands always are out-of-phase when viewed on a dual-trace scope that shows odd-number lines of video or burst on one trace and even-number lines on the other trace. The burst or chroma sidebands *appear* to have a phase reversal, even when the same signal is sent to both scope channels. This can cause confusion during analysis of comb filters where both circuit-action phase inversions and NTSC-chroma phase inversions are present. Study the table and compare its statements with the waveforms in Figure 4.



A



B

Figure 6 To verify this analysis of comb operation, the signal input to the D401 delay device was removed by shorting between terminals #1 and #2. (A) These are normal waveforms. Upper trace is the Q402 emitter and the lower trace shows luminance only at the Q401 collector. (B) Upper trace is the Q402 emitter and the lower trace is the Q401 collector waveform when D401 was disabled. Notice that the burst amplitude is the same in both traces, proving the chroma cancellation has been defeated.

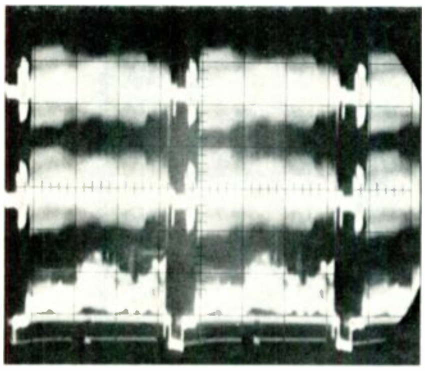


Figure 7 The top trace is the burst and chroma signal without any luminance at the Q401 base; the emitter signal has strong chroma and weak luminance (center trace). The only clue to the emitter luminance is a slight downward displacement in the blanking area of the center trace. Collector luminance without any burst or chroma sidebands is shown by the bottom trace (not photographed simultaneously with the two dual-trace waveforms). The R401 and L426 adjustments that phase-out the burst and chroma are critical and precise, requiring test instruments.

Second, there are *two* phase inversions between the Q404 base and D401 pin 4. One inversion is between base and collector of Q404, and the second is provided by the D401 pin connections. These two phase inversions restore the original phase, and the Q404 base (and emitter) phase is identical to the D401 phase at pin 4, where it adds to the pin 3 chroma and luminance coming from the Q404 emitter. The top end of R426 has luminance and double or triple amplitude of burst and chroma sidebands (waveform W5 in Figure 3).

As stated before, the composite video signal with enhanced chroma amplitude is sent from the Q402 emitter to the chroma take-off and peaking circuit (C334/C332/L327) and on to the chroma IFs and demodulators. The effect of the increased chroma amplitude is to reduce the luminance contamination in the chroma by increasing the chroma-to-luminance ratio.

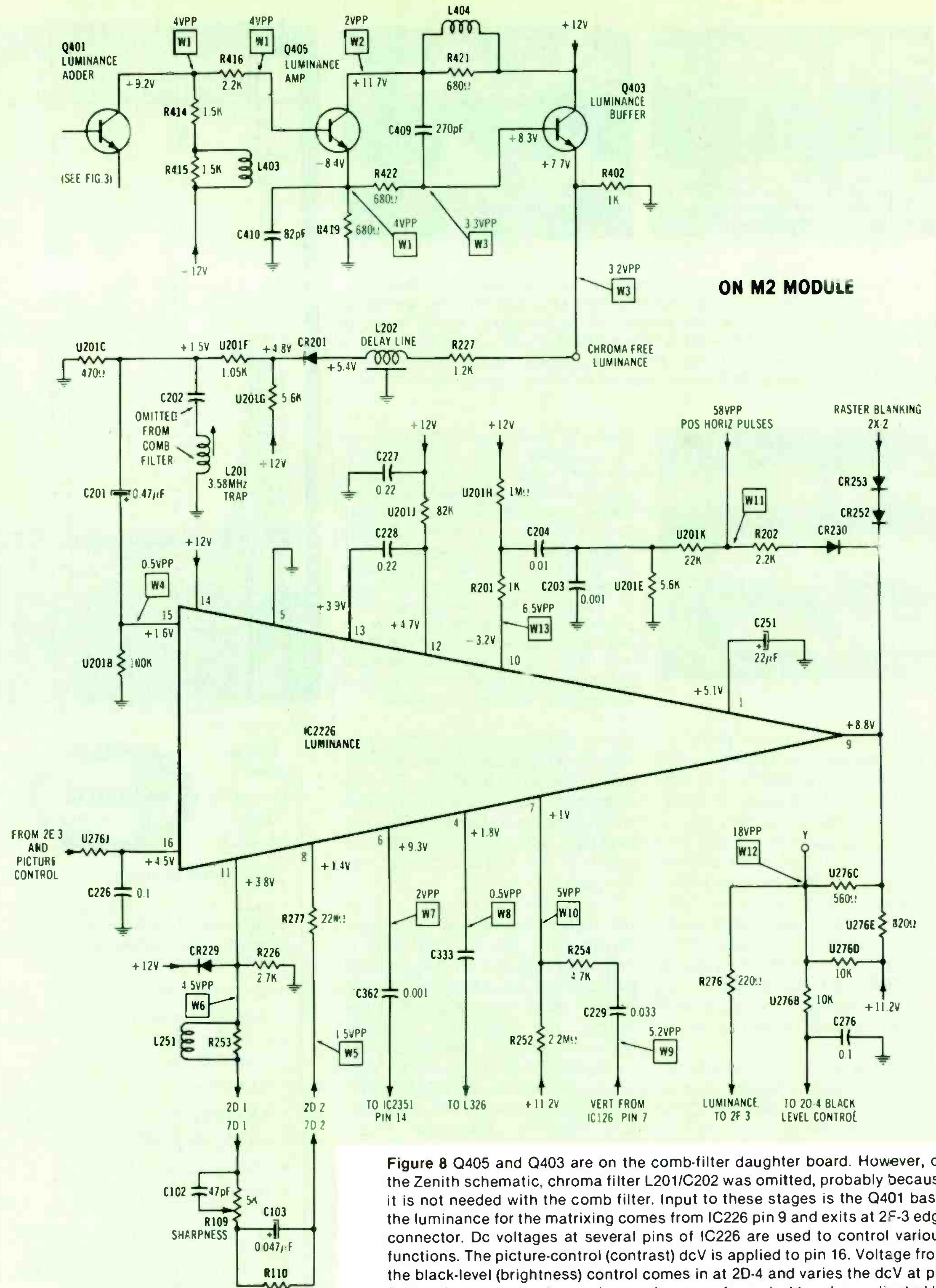
Canceling chroma in the luminance

Signals applied to the base and emitter of Q401 (Figure 3) provide strong luminance with almost zero chroma amplitude at the collector (see waveforms in Figure 7). The luminance can have a wider bandwidth because no low-pass filters or peaking roll-offs are needed to remove the chroma from the luminance.

Composite video having chroma of higher-than-normal amplitude (from the Q402 emitter) is amplitude-adjusted by R401 control and then has the luminance removed by the C403/C404/L426/C405 filter before the resulting chroma-without-luminance signal is applied to the B401 base (Figure 7A). Composite video from the Q404 emitter also passes through two high-pass low-frequency-attenuation filters (R413/C406 and R409/C402) that allow strong chroma signals and reduced-amplitude luminance signals to reach the Q401 emitter (Figure 7B).

Although both the base and emitter waveforms appear to be identical, they are not. The base signal has no luminance; the emitter signal has some.

The chroma signals at base and emitter have the same phase (see

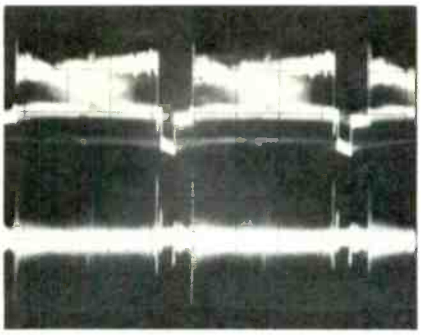


ZENITH LUMINANCE

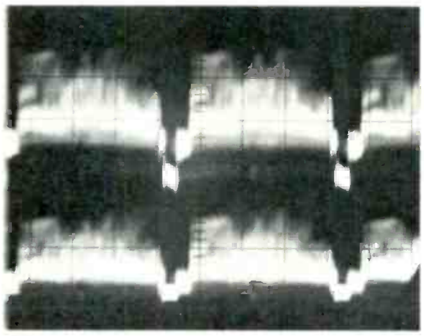
Figure 8 Q405 and Q403 are on the comb-filter daughter board. However, on the Zenith schematic, chroma filter L201/C202 was omitted, probably because it is not needed with the comb filter. Input to these stages is the Q401 base; the luminance for the matrixing comes from IC226 pin 9 and exits at 2F-3 edge connector. Dc voltages at several pins of IC226 are used to control various functions. The picture-control (contrast) dcV is applied to pin 16. Voltage from the black-level (brightness) control comes in at 2D-4 and varies the dcV at pin 9. High-frequency luminance harmonics come from pin 11 and are adjusted by R109 before reaching pin 8 to perform picture-sharpness variations. Horizontal pulses for blanking enters at pin 10 and, through CR230, to pin 9. Vertical sweep for vertical blanking enters at pin 7. Pins 4 and 6 are connected to chroma IC351, but the reason is not apparent. Probably it sends luminance blanking pulses to blank the chroma, also. Refer to waveforms 5, 6, 7, 8, 9 and 10 that are repeated with vertical-rate scope sweeps following the horizontal-rate waveforms.

Waveforms for Figure 8.

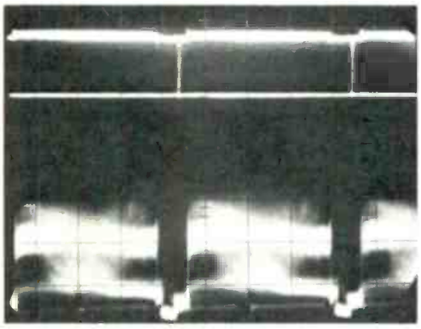
W1



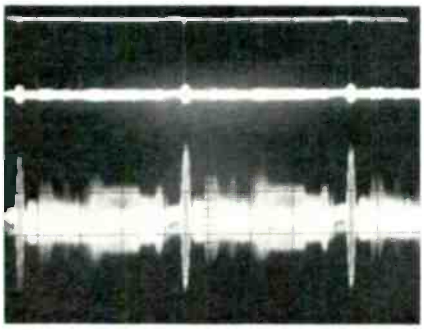
W3



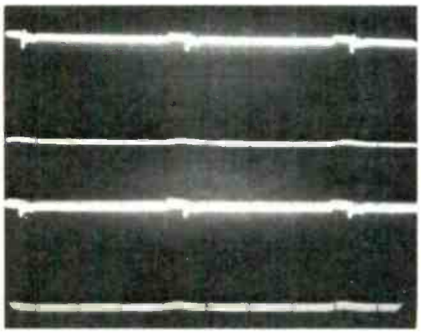
W2
W5



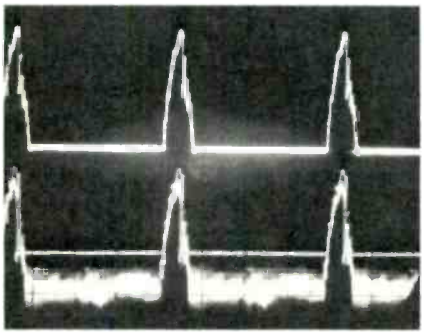
W4
W7



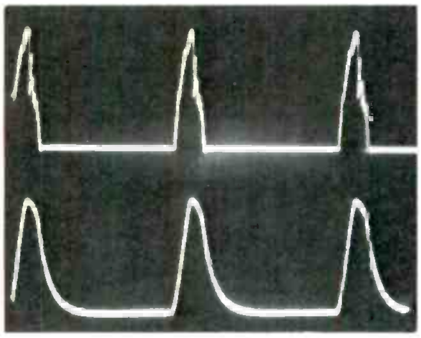
W6
W9



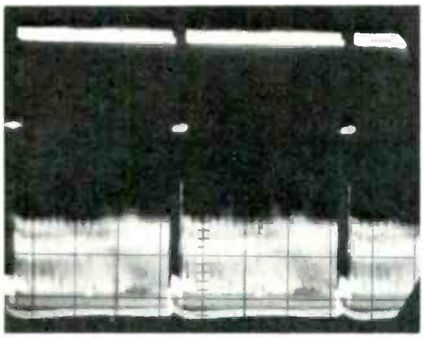
W8
W11



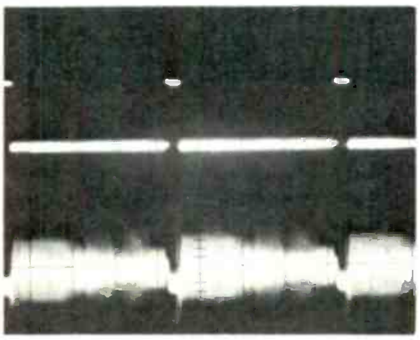
W10
W11



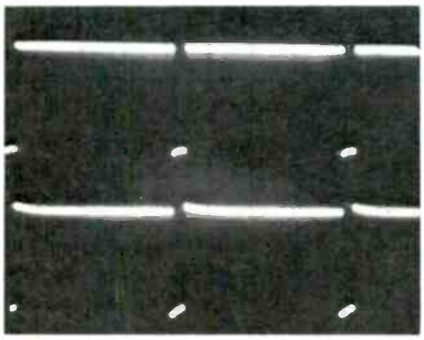
W12
W5V



W13
W7V



W6V
W9V



W8V

W10V

proved when the trace height is in-

vertical sweep. □

Industrial MRO & Consumer Servicing

SCOPE ROUNDUP

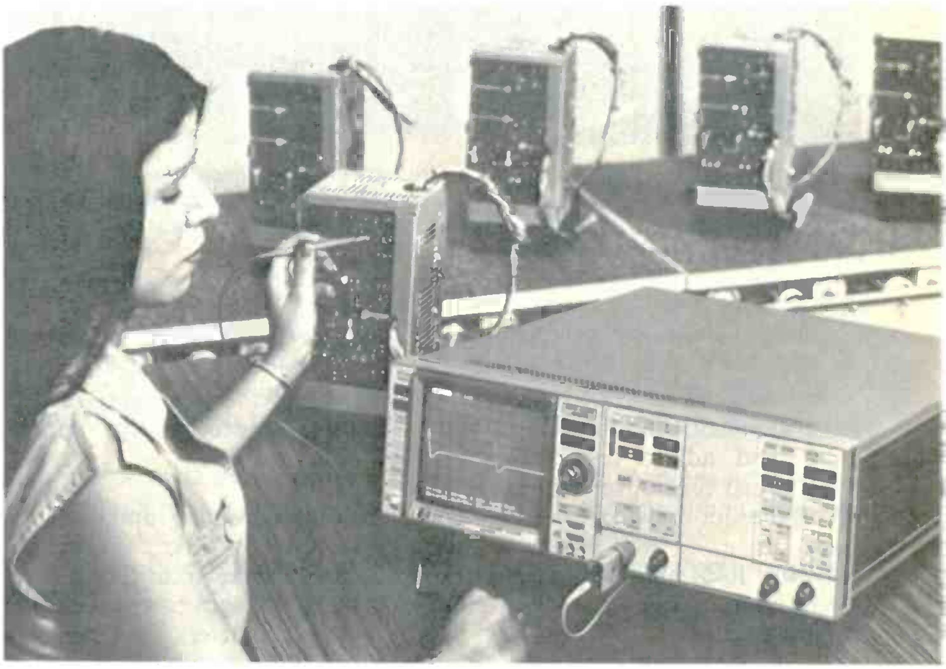
Oscilloscopes have always had great value for displaying waveshapes, but they now are becoming essential as new electronic products of higher sophistication are developed by the industry. Fortunately, scope improvements have advanced in step with the new technology so that today's scopes represent new peaks in performance, convenience and features.

Many new scopes are designed for specialized applications or have unique features: battery-operated portable operation; inexpensive narrow-bandwidth models for factory alignment and adjustments; waveform storage by digital or CRT memory; operation with alternate time bases and up to four waveforms (two dual-trace and two triggers); remote-controlled waveform analyzer and recorder; and large models that can communicate with computers and test their own performance accuracies.

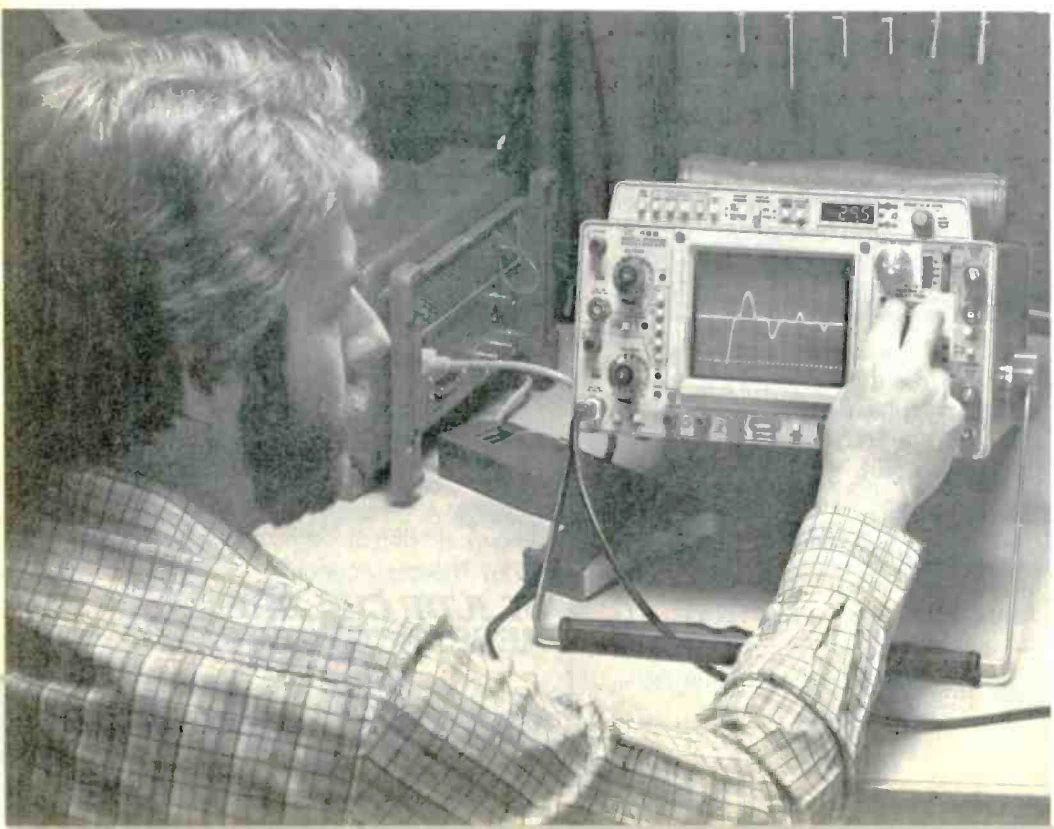
Use the charts of scope brands and models to find those features valuable for special needs.

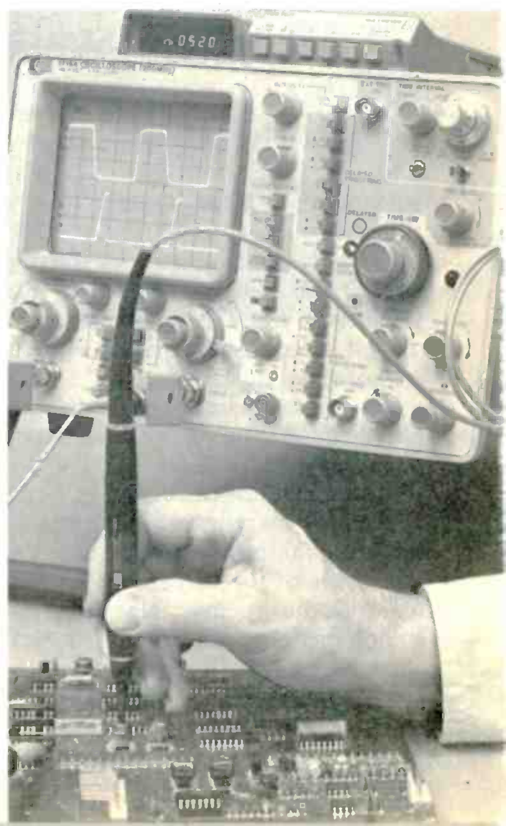
Importance of scope specifications

The importance of some scope features and specifications is not always clear. Some buyers might think that *more* or *higher* is better. This is not necessarily the case.



Photos courtesy of: right, Hewlett-Packard (model 1980 Oscilloscope measurement system); bottom left, Tektronix (model 468 digital storage oscilloscope); bottom right, Hewlett-Packard (1715A oscilloscope).





However, the general trend in electronics is to need and demand expanded capabilities. The following information should help buyers select the most appropriate features.

• *Triggered vs. recurrent*—The former battle between triggered and recurrent sweep is over. Few recurrent models are offered now, and those are intended for beginners or production lines. Recurrent scopes have constant horizontal deflection without gaps whether or not the vertical channel has a signal; and locking is achieved by injecting a sync signal (obtained from the vertical amplifier) into the sweep oscillator so it is held to a sub-multiple repetition frequency.

Triggered-sweep scopes do not require a mathematical relationship between deflection and signal frequencies. A CRT screen might show a thousand cycles or one-tenth cycle, and this expansion or compression of waveforms is one important value of triggered scopes. Triggering (starting of the deflection) occurs when the input signal first produces a specific voltage level, previously selected by the scope operator. Then the deflection continues for a specific time selected by the operator. Following this deflection, the beam retraces and waits until deflection is triggered again. Without an input signal (or an auto feature), there is no deflection. Locking is achieved when triggering occurs regularly, producing a motionless waveform on the CRT screen.

There are many advantages of triggered sweep, including the possibility of expanding the left edge or a selected center section for detailed analysis, an almost total lack of locking drift and excellent stability.

The accompanying charts no longer identify recurrent or triggered scopes. If the **Horizontal-sweep time/division** column lists time (1μs-5s per div, for example), the model definitely has triggered sweep. If frequencies are listed (2-30kHz, for example), the model has recurrent sweep.

• *Vertical sensitivity*—The maximum height of small-amplitude signals is limited by the sensitivity of scope vertical channels. This is rated by a certain voltage per graticule division. A scope rated at 1V per division would need an input of 8V to produce a full height of eight divisions (or three divisions for 3V).

Modern troubleshooting techniques demand the use of low-capacitance scope probes that reduce the scope's effective sensitivity by a factor of 10. Vertical sensitivity should be 10 times the minimum actually needed. Many waveforms in newer color TVs have 0.1VPP or lower amplitudes. When a 10X probe is connected to a 0.1VPP waveform, the scope sensitivity must be 0.01VPP (10mV peak-to-peak) to produce a waveform height of only one graticule division. And the scope sensitivity must be 0.002VPP (2mV) per division to show five divisions of height.

It is necessary that the maximum sensitivity minus the X10 probe loss produce at least two vertical divisions of the weakest signal to be examined or measured. For TV servicing, a maximum sensitivity of 2mV or 5mV is sufficient. Industrial and digital servicing also require about the same sensitivity, not so much for the signals but for power-supply ripples and transients. Always use probes that are matched to the scope.

Another essential for the vertical channels is an ac/ground/dc switch that blocks or passes the dc components of the signal. However, all triggered scopes have the switch as standard equipment, so this does not affect the selection of a proper model.

• *Scope bandwidth*—Vertical-channel frequency response is perhaps the most important scope specification. With vertical bandwidth, wider is always better. This is true for several reasons. A scope user seldom knows the exact high-frequency response that is needed, and often does not know when the waveforms are degraded. Second, a wider response usually provides less phase shift and ringing in the higher frequencies. Also the trend is toward equipment circuits that demand scopes of wider frequency response; it is wise to specify bandwidth of double the amount needed now.

The rise time of scopes is related to bandwidth. In fact, it is usually computed from the measured bandwidth, rather than being measured separately. A shorter rise time indicates wider frequency response, and vice versa.

• *Dual-trace operation*—Most technicians who are experienced and competent with scopes prefer the dual-trace option. The advantages are too numerous to list.

• *Signal delay*—Some scopes have two or more types of delay, thus causing confusion in the specifications. Technicians often ask about delayed sweep when they really need vertical-signal delay. These delays are completely different.

Assume the scope operator is trying to *lock* the sweep on the leading edge of a pulse. The short rise time of the pulse usually triggers the sweep very solidly. However, the triggering action requires a short time, and another short time interval is necessary to start the horizontal-deflection trace. Therefore, the rising edge and part of the pulse peak has passed before the trace begins, and will not be seen on the screen. With 100kHz repetition pulses, about a third of the first pulse is missing.

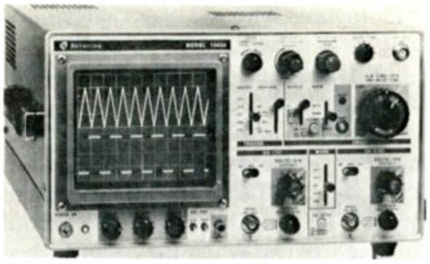
The solution is to trigger the sweep by a sample of the vertical-channel signal, then between this point and the CRT, add a signal-delay line. When the signal dalay equals the natural delay in starting the horizontal deflection, all of the rising edge and the first peak are visible.

Addition of the signal-delay line (or two for dual-trace) is not prohibitively expensive, but it is essential only for viewing of pulses.

• *Horizontal-sweep times*—Different signal-repetition frequencies require a corresponding change of scope-sweep times to show a standard number of signal cycles on the screen. Additionally, the operator might want to show less than one signal cycle (shorter sweep times) or many signal cycles (longer sweep times).

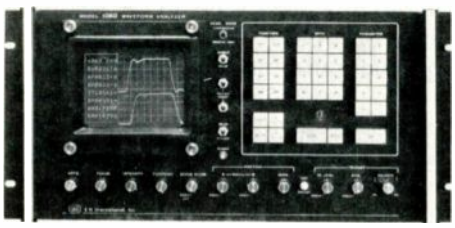
A wide selection of sweep times can be needed. Most manufacturers solve the problem by providing many long sweep times (in fact, too long for any applications except medical). *The specification to check is the shortest sweep time.* Each buyer must determine this from the signal frequencies to be viewed.

Remember that a comparatively long sweep time of 12.8μs/div shows two cycles of 15,734.4Hz (horizontal-rate sweep or video). Probably all new triggered scopes achieve this condition easily. However, displaying two cycles of a 2MHz carrier requires a 0.1μs



Ballantine Laboratories, Inc. Model 1042A

E-H International Model 1060



Scope roundup

sweep. Switching in the X5 expansion gives the equivalent of a 0.02μs/div sweep, showing two cycles of a 10MHz carrier. Of course, there is **some** value (usually less) in viewing more than two cycles.

Many scopes have an approximate match between sweep time and vertical-channel frequency response. For example, a shortest sweep time of 0.1μs often is paired with a vertical-frequency rating of 30MHz to 35MHz. Or, a shortest sweep of 0.5μs might accompany a 5MHz to 10MHz vertical bandwidth.

For an occasional emergency, the X5 or X10 sweep expansion can substitute for a shorter sweep time. However, this often results in excessive jitter and trace instability. It is advisable, therefore, for the normal sweep time to accommodate all customary conditions.

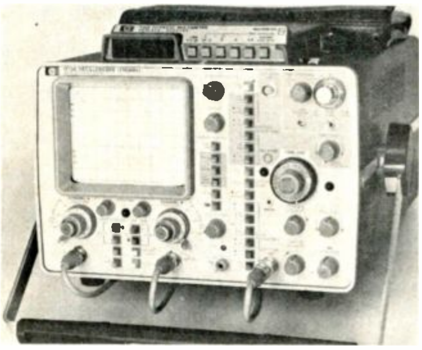
• *Horizontal bandwidth*—Some models allow the internal amplifier of the horizontal sweep to handle a signal from the outside. With single-trace scopes, this provides a method of showing vector patterns. However, many dual-trace scopes use the vertical channels for X/Y operation, giving the advantages of identical frequency and phase response of the two channels plus calibrated attenuation controls. Models offering X/Y operation

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Sync	Calibrated Waveform	Special Features
B&K-Precision Circle (40) on Reply Card													
1405	10mV/div	5MHz					10Hz-110kHz	dc-250kHz					Recurrent sweep
1432	2mV/div	15MHz	24ns or less		X		-5μs-.5s per div	dc-1MHz	X5		X	X	Battery option Ch. 2 polarity invert
1466	10mV/cm	10MHz	35ns or less				1μs-.5s per div	dc-1MHz	X5		X	X	Auto level – displays base-line with no input signal
1476	10mV/cm	10MHz	35ns or less		X		1μs-.5s per div	dc-1MHz	X5		X	X	Differential inputs Auto-level
1477	10mV/cm	15MHz	24ns or less		X		.5μs-.5s per div	dc-1MHz	X		X	X	Differential inputs
1479A	5mV/cm	30MHz	11.7ns or less	X	X		.2μs-.5s per div	dc-2MHz	X5		X	X	Ch. 2 polarity invert Differential inputs AM detector
1520	5mV/cm	20MHz	17.5ns or less		X		.5μs-.5s per div	dc-2MHz	X10		X	X	Independent selection of chop or alternate display Ch. 2 invert
1530	2mV/div	30MHz	11.7ns or less	X	X		.2μs-.5s per div	dc-2MHz	X5	X	X	X	Ch. 2 polarity invert Single-sweep hold-off
1535	2mV/cm	35MHz		X	X		.1μs-.5s per div	dc-2MHz	X5		X	X	Ch. 2 polarity invert Uncal. condition LEDs Single sweep Norm/chop sweep select
1420	10mV/cm	20MHz	17.5ns		X		1μs-.5s	dc-1MHz	X10		X	X	Mini-scope Battery option
1500	5mV/div and 1mV/div	100MHz	3.5ns	X	4-trace		Time base "A" 20ns-.5s Time base "B" 20ns-50ms per div	dc-5MHz	X	X	X	X	Dual independent time bases 50 and 1M inputs Alternate time base operations Ch. 1, A gate, B gate outputs
Ballantine Laboratories, Inc. Circle (41) on Reply Card													
1022A	5mV/div	15MHz	28ns		X		1μs-100ms		100ns		X	1kHz, sq. wave	5 lb. DMM size
1021A	5mV/div	15MHz	28ns				1μs-100ms		100ns		X	1kHz, sq. wave	5 lb. DMM size

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Sync	Calibrated Waveform	Special Features
1032A	5mV/div	25MHz	14ns		X		1μs-1.25s	1MHz	100ns		X	square wave	Independent dual triggering
1031A	5mV/div	25MHz	14ns				1μs-1.2s	1MHz	100ns		X	square wave	Independent dual triggering
1042A	1mV/div	40MHz	8.7ns	>90/ ns	X		200ns-1.25s	1MHz	20ns	2μs-5s	X	square wave	Trigger holdoff Independent dual triggering
Caywood Electronics Circle (42) on Reply Card													
Millen 90942	No amplifier 90928 amplifier available 39V, peak to peak per cm	No amplifier					No sweep	No amplifier 90928 amplifier available					2-inch module scope
Millen 90912	No amplifier 90928 amplifier available 22½V p-p per cm						No sweep						2-inch module scope
Millen 90913	No amplifier 90928 amplifier available 5.7V p-p per cm						No sweep						1½x3-inch module scope
Millen 90902	No amplifier 90928 amplifier available 39V p-p per cm						60Hz line sweep						3½x19-inch rack mount scope
Millen 90905-B	No amplifier 90928 amplifier available 12V p-p per cm						60Hz line sweep						5-inch rack mount scope
Millen 90925	0.16V peak to peak per cm	dc to 550kHz					2-30 kHz						2⅝x4⅝-inch scope on 3½x19-inch rack panel
EH International Circle (43) on Reply Card													
1060	2mV/div-10V/div	w/961 probe 1GHz bandwidth w/960 probe 350MHz bandwidth	350ps		X		0.2ns/div. 100ms/ div			X			Waveform analyzer digitizer Digital readout sampling scope Programmable
Gould Inc., Instruments Division Circle (44) on Reply Card													
OS255	2mV/cm to 10mV/cm	15MHz	23ns		X		500ns-0.2s/cm	3dB at 1MHz. <3° at 50kHz	X5 (100ns) cm		X	1V pk/pk, 1kHz nominal sq. wave	Sum & difference X-Y display Dc trigger Z-modulation
OS260	2mV/cm to 20V/cm	15MHz	23ns			X	500ns-0.2s/cm	3dB a: 1.5MHz, <3° at 200kHz	X10 (50ns/ cm)			1V pk/pk 1kHz nominal sq. wave	True dual beam Single sweep X-Y-Y display Dc trigger Z-modulation

Hameg, Inc. Model Hm 512

Hewlett–Packard Model 1715 A



Scope roundup

with two vertical channels have no need to publish frequency-response specifications for the horizontal amplifier.

• *Expanded sweep*—Expansion or magnification of a waveform horizontally usually is accomplished by one of two methods. In the specification charts, the expanded sweep refers to the X5 or X10 sweep-magnification switch. Almost all triggered scopes have such a switch, usually combined with a centering control or other control. Activation of the X5 switch, for example, increases the horizontal-sweep width five times. Rotation of the centering control allows any fifth of the trace to be examined.

The expanded trace is darker because it is seen only one-fifth of the time. Also, any trace jitter is magnified by five.

A few more-expensive scopes have another type of expanded horizontal sweep. An adjustable window of the waveform is selected by the operator and then this section is expanded to full-screen width. The actual trace width is normal, but the trace brightness is dimmed because only a fraction of the originating waveform is displayed. Magnification can be much greater by this second time-base method and jitter often is minimized relative to the amount produced by X5 trace expansion.

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Sync	Calibrated Waveform	Special Features
Gould Inc., Instruments Division, continued													
OS1200	2mV/cm to 10V/cm	25MHz	14ns	X	X		200ns/cm -1s/cm	3dB at 500kHz <3° at 250kHz	X10 (20ns/ cm)			1V pk/pk 1kHz nominal sq. wave	Sum & difference X-Y display 6kV accelerating V Dc trigger Z-modulation
OS-1100A	1mV/cm to 10V/cm	30MHz	12ns	X	X		200ns/cm -2s/cm	3dB at 1MHz, <3° at 500kHz	X10 (20ns/ cm)	X		1V pk/pk, 1kHz nominal sq. wave	Sweep delay Single sweep 10kV accelerating V Dc trigger Z-modulation
OS3500	2mV/cm to 5V/cm	60MHz	<6ns	X	X		50ns/cm -0.5s/cm	3dB at 1.5MHz, <3° at 500kHz	X10 (5ns/ cm)	X		1V pk/pk, 1kHz nominal sq. wave	Trigger view 4-trace alternate Trigger hold-off Dc trigger Z-modulation
OS3600	2mV/cm to 5V/cm	100MHz	3.5ns	X	X		50ns/cm -0.5s/cm	3dB at 1.5MHz, < 3° at 500kHz	X10 (5ns/ cm)	X		1V pk/pk, 1kHz nominal sq. wave	X-Y-Y display Δtime w/DMM optional signal amplitude w/probe
OS3350	1mV/cm to 20V/cm	40MHz	9ns	X	X		100ns/cm -1s/cm	3dB at 2MHz, <3° at 500kHz	X5 (20ns/ cm)	X	X	1V pk/pk, 1kHz nominal sq. wave	Special TV waveform & raster monitor Digital line callup for PAL or NTSC Teletext compatible LED display of line number Also functions as conventional 40MHz dual trace scope
DSO 4000	5mV/cm to 20V/cm	10MHz conventional 450kHz digital storage	35ns 1.8MHz sample rate	X	X		1μs/cm -20s/cm		X10 (100 ns/cm)	Digital delay		1V pk/pk 1kHz nominal sq. wave	Digital storage plus 10MHz real time Transient capture Nonfade digital display Waveform generation Bus output Selectable pretrigger viewing X-Y, T-Y outputs

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Sync	Calibrated Waveform	Special Features
Gould Inc., Instruments Division, continued													
DSO 4100	100µV/cm to 5V/cm	250kHz digital storage	1MHz sample rate	X	X		100µs/cm -50s/cm	250kHz	X10 (10µs/ cm)	Digital delay			Digital storage in T-Y & X-Y modes Bipolar trigger Transient capture Waveform generation Y-Y & T-Y outputs
DSO 4020	5mV/cm to 20V/cm	10MHz conventional 500kHz digital storage	35ns 2MHz sample rate	X	X		1µs/cm -20s/cm		X10 (100 ns/cm	Digital delay		1V pk/pk 1kHz nominal sq. wave	Features of DSO4000 plus: 4k byte memory X40 sweep expansion External clocking Digital I/O capability Babysit mode
DSO 4040	1mV/cm to 5V/cm	25MHz conventional 2.5MHz digital storage	14ns 10MHz sample rate	X to 4-trace	X		200ns/cm -5s/cm		to X20 calibrated	Digital delay		1V pk/pk 1kHz nominal sq. wave	5k byte memory "Glitch" mode Babysit mode Roll mode Sum & difference mode 4-trace display Digital I/O
DSO 4200	100µV/cm to 5V/cm	200kHz digital storage	0.8MHz sample rate	X	X		100µs/cm -50s/cm	200kHz	X10 (10µs/ cm)	Digital delay		1V pk/pk 1kHz nominal sq. wave	Features of DSO4100 plus: 4k byte memory X40 sweep expansion Y-shift/expand after storage 10-bit vertical resolution Babysit mode Digital I/O
Hameg, Inc. Circle (45) on Reply Card													
Hm307	5mV	10MHz	35ns				.2µs/cm- .2s/cm	1MHz	X2.5			X	Component tester
Hm312	5mV	20MHz	17.5ns		X		40ns/cm- .2s/cm	2.3MHz	X5		X	X	X-Y via channel II
Hm412	2mV	20MHz	17.4ns	X	X		40ns/cm 2s/cm	2.3MHz	X5	X	X	X	X-Y via channel II LED overscan
Hm512	5mV	50MHz	7ns	X	X		20ns/cm- 5s/cm	4MHz	X5	X		X	X-Y via channel II LED overscan
Hm812	5mV	50MHz	7ns	X	X		20ns/cm- 5s/cm	4MHz	X5	X		X	Storage scope
Hewlett-Packard Circle (46) on Reply Card													
1200A	.1mV to 20V/div	dc-500kHz	.7µs		X		1µs- 5s/div	dc-300kHz	X			1V line frequency	100dB CMR
1201A	.1mV to 20V/div	dc-500kHz	.7µs		X		1µs- 5s/div	dc-300kHz	X			1V line frequency	Variable persistance storage 100dB CMR
1205A	5mV to 20V/div	dc-500kHz	.7µs		X		1µs- 5s/div	dc-300kHz	X			1V line frequency	50dB CMR
1220A	2mV to 10V/div	dc-.5MHz	23ns		X		20ns- .5s/div	dc-1MHz	X		X	.5V 1kHz	
1222A	2mV to 10V/div	dc-15MHz	23ns	X	X		10ns- .5s/div	dc-1MHz	X		X	.5V 1kHz	
1715A	5mV to 5V/div	dc-200MHz	1.75ns	X	X		1ns- .5s/div	dc-1MHz	X	X		3V 1kHz	Delta time, optional DMM counter
1722B	10mV to 5V/div	dc-275MHz	1.3ns	X	X		1ns- .5s/div	dc-1MHz	X	X		3V 1kHz	Delta time and voltage microprocessor
1725A	10mV to 5V/div	dc-275MHz	1.3ns	X	X		1ns- .5s/div	dc-1MHz	X	X		3V 1kHz	Delta time, optional DMM counter

Hickok Model 515

Leader Instruments Corp. Model LBO-801

Scope roundup

This second-time-base type of horizontal expansion is called *delayed sweep* because its second sweep is triggered from and later than the main sweep. Delayed sweep should not be confused with signal delay (discussed previously).

• *TV sync*—Video waveforms in TV receivers, videocassette recorders or videodisc players are difficult to lock on any scope unless it is equipped with an internal sync separator. Of course, locking the scope through the external-sync jack sometimes is possible with television receivers by connecting to its sync signal or using a sample of a deflection waveform as external sync. TV sync or an internal sync separator is a *very* useful feature for displaying any kind of video.

• *Calibration waveform*—All service-type triggered scopes now have a square-wave calibration waveform available on the front panel. This signal allows a rough check on the amplitude calibrations, and it permits adjustments of X10 low-capacitance probes for flat frequency response.

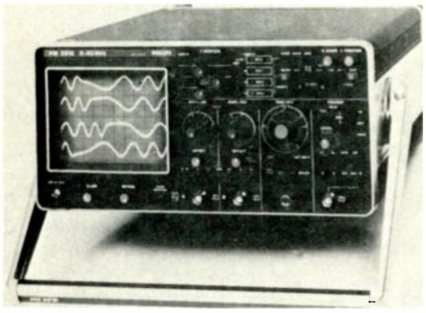
• *Trigger holdoff*—Digital waveforms do not always have a regularly recurring pattern to the pulses; difficulty can be experienced with extraneous pulses. Sometimes these unwanted pulses can be eliminated by a careful adjustment of the time/div variable control, but

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Sync	Calibrated Waveform	Special Features
Hewlett-Packard, continued													
1727A	10mV to 5V/div	dc-275MHz	1.3ns	X	X		1ns-.5s/div	dc-1MHz	X	X		3V 1kHz	Delta time, optional DMM counter Variable persistance storage 2000cm/µs
1740A	1mV to 20V/div	dc-100MHz	3.5ns	X	X		5ns-2s/div	dc-5MHz	X	X	op-tional	1V 1.4kHz	Optional DMM counter
1741A	1mV to 20V/div	dc-100MHz	3.5ns	X	X		5ns-2s/div	dc-5MHz	X	X	op-tional	1V 1.4kHz	Variable persistance storage Optional triggered XY and DMM counter 200cm/µs
1742A	1mV to 20V/div	dc-100MHz	3.5ns	X	X		5ns-2s/div	dc-5MHz	X	X	op-tional	1V 1.4kHz	Delta time, optional DMM counter
1743A	1mV to 20V/div	dc-100MHz	3.5ns	X	X		5ns-2s/div	dc-5MHz	X	X		1V 1.4kHz	Crystal referenced delta time 0.002% accuracy
1744A	1mV to 20V/div	dc-100MHz	3.5ns	X	X		5ns-2s/dif	dc-5MHz	X	X		1V 1.4kHz	Variable persistance storage 1800cm/µs
1980 A/B	2mV to 10V/div	dc-100MHz	3.5ns	X	X		5ns-1s/div	dc-4MHz	not needed	inde-pen-dent		10,1, 200mV 100mV 20mV 1.86 kHz	Fully programmable IEEE 488 Automatic signal requisition
Hickok Circle (47) on Reply Card													
515	5mV	15MHz	24ns				0.2s/div to +0.1µs/div	1MHz	X5		X	X	
517	5mV	15MHz	24ns		X		0.2s/div to 0.1µs/div	1MHz	X5		X	X	
Hitachi Circle (48) on Reply Card													
V-151B	1X:5mV/div 5X:1mV/div	15MHz 5MHz	24ns 72ns				0.2µs/div	500kHz	100ns/div (10X)		X	1kHz square	
V-152B	1X:5mV/div 5X:1mV/div	15MHz 5MHz	24ns 72ns		X		0.2µs/div	500kHz	100 s/div (10X)		X	1kHz square	
V-202	1X:5mV/div 5X:1mV/div	20MHz 7MHz	17.5ns 50ns		X		0.2us/div	500kHz	100ns/div (10X)		X	1kHz square	Square CRT Low drift

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Synd	Calibrated Waveform	Special Features
Hitachi, continued													
V-301	1X:5mV/div 5X:1mV/div	30MHz 5MHz	24ns 72ns	X			0.2μs/div	500kHz	100ns/ div (10X)		X	1kHz square	
V-302B	1X:5mV/div 5X:1mV/div	30MHz 5MHz	24ns 72ns	X	X		0.2μs/div	500kHz	100ns/ div (10X)		X	1kHz square	
V-352	1X:5mV/div 5X:1mV/div	35MHz 7MHz	17.5ns 50ns	X	X		0.2μs/div	500kHz	20ns (10X)		X	1kHz square	Square CRT Low drift
V-550B	1X:5mV/div 5X:1mV/div	50MHz 10MHz	7ns 36ns	X	X		50ns/div	500kHz	5ns/ div (10X)	X	X	1kHz square	Trigger view Auto focus Variable holdoff
V-059B	1X: 50mV/div 5X: 10mV/div	7MHz 2MHz	50ns 175ns				10μs/div	10kHz	1μs/ div		X	Gate signal square	Small size Lightweight Ac, dc or battery powered TV waveform monitor
V-1050	1X:5mV/div 10X:05mV/ div	100MHz	3.5ns	X	X		20ns/div	2MHz	2ns/ div (10X)	X	X	1kHz square	0.5mV sensitivity Alternate time base 2% accuracy 20MHz bandwidth limiter Trigger view on A & B channel
Kikusui Electronics Circle (49) on Reply Card													
5650	1mV-5V	dc-50MHz	7ns	X	X		.1μs-.5s	dc-2MHz	10X	X	X	X	Portable Triggered delayed sweep 500kHz chop frequency Auto-trigger level Auto-focus Variable holdoff
5630	1mV-5V	dc-35MHz	10ns	X	X		.1μs-5s	dc-2MHz	10X	X	X	X	Portable Triggered delayed sweep 500kHz chop frequency Auto-trigger level Auto-focus Variable holdoff
5531	1mV-5V	dc-35MHz	10ns	X	X			dc-2MHz	5X	X	X	X	Triggered delayed sweep Variable holdoff Portable
5530	1mV-5V	dc-35MHz	10ns	X	X		.2μs-.5s	dc-2MHz	5X			X	Portable Single sweep
5520	1mV-5V	dc-20MHz	17ns		X		.2μs-.5s	ac-1MHz	5X		X	X	One touch X-Y Single sweep ac or dc triggering Bench unit
5513	1mV-5V	dc-10MHz	35ns		X		.1μs-.1s	dc-1MHz	5X		X	X	Bench unit
Leader Instruments Corp. Circle (50) on Reply Card													
LBO- 515B	5mV	30MHz	11.5ns	120ns	X		.2μs/div -.5s/div	1MHz	X	X X10	X	X	Calibrated delayed time base
LBO- 520A	5mV	35MHz	10ns	120ns	X		0.2μs/div -0.5-5/cm	1MHz	X X10		X	X	Internal graticule Rectangular CRT
LBO- 507A	10mV	20MHz	17.5ns				0.5μs/cm -200ms/cm	250kHz	X X5		X	X	
LBO- 508A	10mV	20MHz	17.5ns		X		0.5μs/cm -200ms/cm	800kHz	X X5		X	X	
LBO- 513	1mV	10MHz	35ns				0.5μs/cm -200ms/cm	250kHz	X X5		X	X	High sensitivity
LBO- 514	1mV	10MHz	35ns		X		0.5μs/cm -200ms/cm	800kHz	X X5		X	X	
LBO- 308S	2mv	20MHz	17.5ns		X		0.5μs/cm 0.2s/cm	1MHz	X X5		X	X	Portable, battery operable (10 lbs.)
LBO- 517	1mV	50MHz	7ns	120ns	X		0.05μs/cm 0.5s/cm	1MHz	X X10	X X10	X	X	3rd & 4th cha. trig. view Alternate triggering Alternate time base display

Non-Linear Systems Model MS-15

Philips Model PM3310



Scope roundup

at the expense of uncalibrated sweep time.

Another solution is a *holdoff control* that delays the beginning of each trace. This feature and the signal-delay line are recommended for digital measurements.

• *CRT high voltage*—Anode voltage in scopes might be any value from 2kV to 20kV. Higher anode voltages produce a brighter trace and better focus at high brightness. Lower priced scopes usually have about 2kV, satisfactory for continuous sine or square waves when no horizontal expansion is employed, because all three methods of expansion can decrease the trace brightness. X5 expansion allows a visible trace for only a fifth of the time. X10 expansion shows a trace for a tenth of the time. Delayed sweep also has a visible trace for a fraction of the total time.

Bright operation under these dimmer expanded conditions requires a huge reserve of brightness over the amount that is satisfactory for continuous sweeps. If sweep expansion is needed often, it is wise to select a model with 6kV, 10kV, 12kV or even 20kV of anode voltage.

• *Internal graticule*—The graticule lines of many scope screens are engraved in plastic that is mounted in front of the CRT. Illumination by tiny bulbs is easy, but parallax can be a problem.

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Sync	Calibrated Waveform	Special Features
Leader Instruments Corp., continued													
LBO-801	200µV	300kHz					20mV/div 20V/div	300kHz				X	X-Y alignment scope for swept frequency measurements High sensitivity
LBO-802	200µV	300kHz			X		20mV/div 20V/div	300kHz				X	Reversible polarity for X & Y inputs Dc clamping (int/ext)
LBO-5810P	10mV	20MHz	17.5ns		X		0.5µs/div -200ms/div	800kHz	X X5		X	X	Programmable LED lamps indicate selected control position Capable of 32 preset tests controlled by TTL logic
LBO-308PL	2mV	20MHz	17.5ns	120ns	X		0.5µs/div -0.2s/div	1MHz	X X5	X	X	X	10kV accelerating potential for sharp display High sensitivity Calibrated delayed time base
Non-Linear Systems Circle (51) on Reply Card													
MS-15	10mV/div	-3dB at 8MHz and -6dB at 15MHz	23ns				.5s/div-.1µs/div	-3dB 200kHz				1V square wave	Small size Portable Battery-powered Lightweight
MS-215	10mV/div	-3dB at 8MHz and -6dB at 15MHz	23ns		X		.5s/div. .1µs/div	-3dB 200kHz				1V square wave	Small size Portable Battery-powered Lightweight
MS-230	10mV/div	-3dB at 30MHz	10ns		X		.1s/div-.05µs/div	-3dB 200kHz				1V square wave	Small size Portable Battery-powered Lightweight
Philips Test & Measuring Instruments Circle (52) on Reply Card													
PM 3207	5mV-10mV	0-15MHz	23ns		X		.2s/div 500ns/div	0-2MHz	X5 100ns		X	X	Chan B. invert Add mode Double insulated
PM 3212	2mV-10V	0-25MHz	14ns	X	X		.5s-200ns	0-1MHz	X10 20ns		X	X	Composite triggering Double insulated 10kV CRT
PM 3214	2mV-10V	0-25MHz	14ns	X	X		.5s-200ns	0-1MHz	X10 20ns	X	X	X	Comp. trig. 10kV CRT Double insulated Alternating timebase display

Philips Test & Measuring Instruments, continued

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Synd	Calibrated Waveform	Special Features
PM 3216	2mV-10V	0-35MHZ	10ns	X	X		.5s- 100ns	0-1MHz	X10 10ns		X	X	Comp. trig. 10kV CRT Double insulated Trigger holdoff
PM 3218	2mV-10V	0-35MHz	10ns	X	X		.5s- 100ns	0-1MHz	X10	X	X	X	Comp. trig. 10kV vert. Trigger holdoff Alternating timebase
PM 3226	2mV-10V	0-15MHz	23ns		X		.2s- 500ns	0-500kHz	X5 100ns		X	X	Compact size
PM 3233	2mV-10V	0-10MHz	35ns	X		X	.5s- 200ns	0-1MHz	X5 40ns		X	X	10kV dual-beam CRT
PM 3234	2mV-10V	0-10MHz	35ns	X		X	.5s- 200ns	0-1MHz	X5 40ns		X	X	Variable resistance storage
PM 3244	5mV-2V	0.50MHz	7ns	X	4 ch.		.5s-50ns	0-1MHz	X5 10ns	X		X	4-channel scope
PM 3262	2mV (35MHz) -5V	0- 100MHz	3.5ns	X	X		1s-50ns	0-2MHz	X10 5ns	X		X	Composite trig. Trigger holdoff Trigger view 3rd ch. Alternating time-base
PM 3263	2mV (35MHz) -5V	0- 100MHz	3.5ns	X	X		1s-50ns	0-2MHz	X10 5ns	X		X	Comp. trig. Trig. holdoff Trig. view 3rd ch. Alternating time-base Microprocessor controlled timing
PM 3264	2mV (35MHz) -5V	0- 100MHz	3.5ns	X	4 ch.		1s-50ns	0-2MHz	X10 5ns	X		X	Four channel Trig. holdoff Trig. view 5th channel Comp. trig. - alt. TB
PM 3266	2mV-5V	0- 100MHz	3.5ns	X	X		1s-50ns	0-2MHz	X10	X		X	Variable resistance storage Comp. trigger Trigger holdoff Trig. view Alternating time-base
PM 3310	10mV	60MHz	6ns	X	X		5ns/div up to 60 min/div	60MHz	X5		X	X	

Sencore Circle (53) on Reply Card

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Synd	Calibrated Waveform	Special Features
SC60	5mV/div to 200V/div	-3dB 60MHz -12dB 100MHz	6ns	X	X		100ms through .1µs 19 steps	5MHz less than 3° phase shift 10MHz usable	10X		X	1VP-P 2kHz square wave	2kV probes TVV & TVH preset buttons Timebase switch calibtrated in time and frequency

Simpson Circle (54) on Reply Card

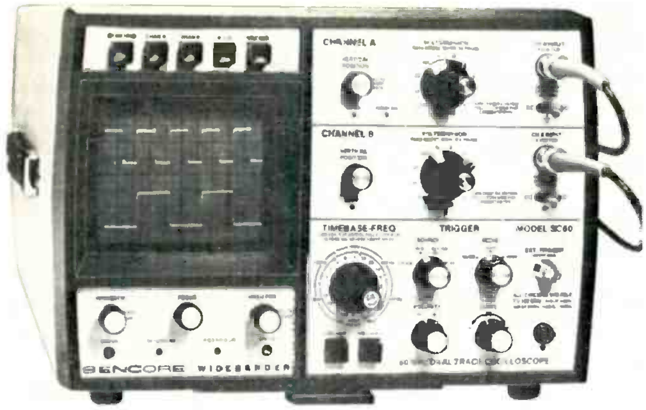
Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Synd	Calibrated Waveform	Special Features
452	5mV/cm	dc to 15MHz	24ns		X		0.2µs/cm to 0.5s/cm		X5		X	X	
454	5mV/div	dc to 15MHz	24ns		X		0.5µs/div to 0.5s/div		X5		X	X	

Soltec Corp. Circle (55) on Reply Card

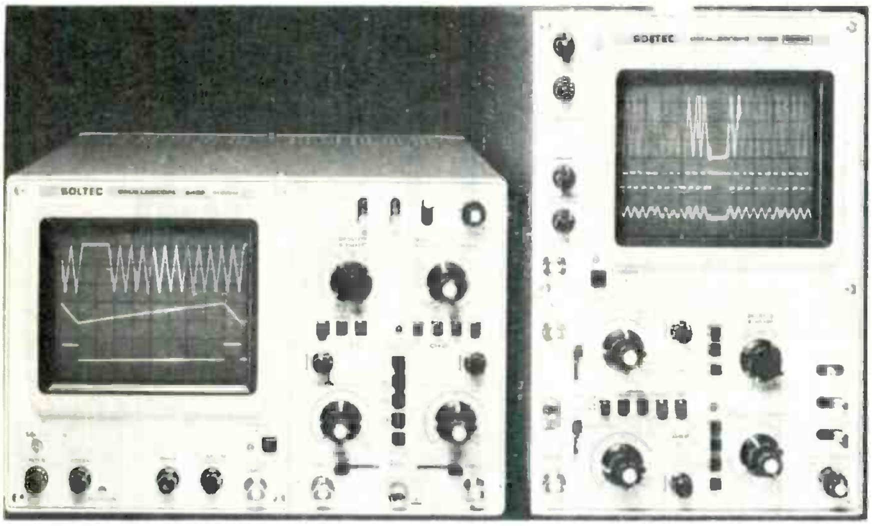
Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Synd	Calibrated Waveform	Special Features
512-1	10mv-5V	12MHz	29ns				.1µs-.1s				X	X	Domed mesh CRT Compact & light
512-2	10mV-5V	12MHz	29ns				.1µs-.1s		X		X	X	Domed mesh CRT Compact & light
540P	2mV-10V	40MHz	8.7ns	20ns	Triple trace		20ns-.5s		X	X	X	X	Domed mesh CRT Alternate trigger Triple trace Data readout option
540D	2mV-10V	40MHz	8.7ns	20ns	Triple trace		20ns-.5s		X	X	X	X	Domed mesh CRT Alternate trigger Triple trace Data readout option

Model	Vertical Sensitivity	Vertical Response	Rise Time	Signal Delay	Dual Trace	Dual Beam	Horiz. Sweep Time/Div.	Horiz. Amp Bandwidth	Expanded Sweep	Delayed Sweep	TV Synd	Calibrated Waveform	Special Features
Soltec Corp., continued													
540M	2mV-10V	40MHz	8.7ns	20ns	Triple trace		20ns-.5s		X	X	X	X	Built-in digital multi-tester Domed mesh CRT Alternate trigger Triple trace Data readout option
540C	2mV-10V	40MHz*	8.7ns	20ns	Triple trace		20ns-.5s		X	X	X	X	Built-in counter timer *Counter/timer section usable to 100Mhz Domed mesh CRT Alternate trigger Triple trace Data readout option
560	2mV-5V	60MHz	5.8ns	20ns	Triple trace		10ns-.5s		X	X	X	X	Domed mesh CRT Chopped or alternate trigger Triple trace Data readout option
Tektronix Circle (56) on Reply Card													
T921	2mV/div	dc-15MHz	23ns or less	X			0.2µs/div		X10	X	X	X	
T922R	2mV/div	dc-15MHz	23ns or less	X	X		0.2µs/div		X10	X	X	X	Dual-trace Rack mount available
T932A	2mV/div	dc-35MHz	10ns or less	X	X		0.1µs/div		X10	X	X	X	Delayed sweep and differential
T935A	2mV/div	dc-35MHz	35ns or less	X	X		0.1µs/div		X10	X	X	X	Variable trigger holdoff and differential
314	1mV/div	dc-10MHz	36ns		X		0.1µs/div			X			Battery-operated Weighs 10.5 lbs.
335	1mV/div	dc-35MHz	10ns		X		0.02µs/div			X			Battery-operated Weighs 10.5 lbs.
434	10mV/div	dc-25MHz	14ns		X		0.02µs/div						Split-screen storage
455	5mV/div	dc-50MHz	7ns		X		0.05µs/div			X			Cost-effective for 50MHz bandwidth
465B	5mV/div	dc-100MHz	3.5ns		X								
VIZ Circle (57) on Reply Card													
WO-527A	10mV/cm	dc-15MHz	23ns				0.5µs/cm to 0.5s/cm	dc-1MHz	X10		X	X	TV line selector trigger polarity indicator
WO-555	10mV/cm to 20V/cm	dc-15MHz	23ns	X			0.5µs/cm to 0.5s/cm	dc-1MHz	X10	X	X	X	TV line selector trigger polarity indicator
Vu-data Corporation Circle (58) on Reply Card													
2521	5mV/div	25MHz	14ns	X	X		100ns	200kHz	20ns/div			4V 1kHz	Optional DMM-counter
PS-950A	5mV/div	50MHz	7ns	X	X		100ns	200kHz	10ns/div			4V 1kHz	Optional DMM-counter
PS-935A	5mV/div	35MHz	10ns	X	X		100ns	200kHz	10ns/civ			4V 1kHz	Optional DMM-counter
2522	5mV/div	25MHz	14ns	X	X		100ns	200kHz	20ns/div	X		4V 1kHz	Digital delayed sweep and event count
Wavetek Circle (59) on Reply Card													
1901C	1mV/div	dc to15kHz						dc to 1.5kHz					12-inch CRT
1903	150mV/div	dc to 15kHz						dc to 15kHz					12-inch CRT
1910	1mV/div	dc to 15kHz						dc to 1.5kHz					12-inch CRT
1951	<1.5 to >150V	dc to 15kHz											Open frame OEM scope 12-inch CRT
1955	<1.5 to >150V	dc to 15kHz											Open frame OEM scope 9-inch CRT

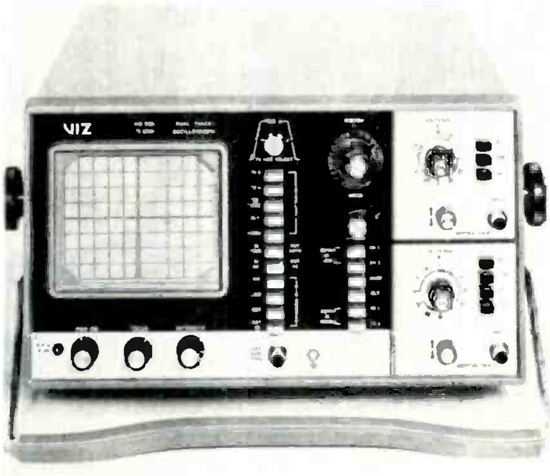
Scope roundup



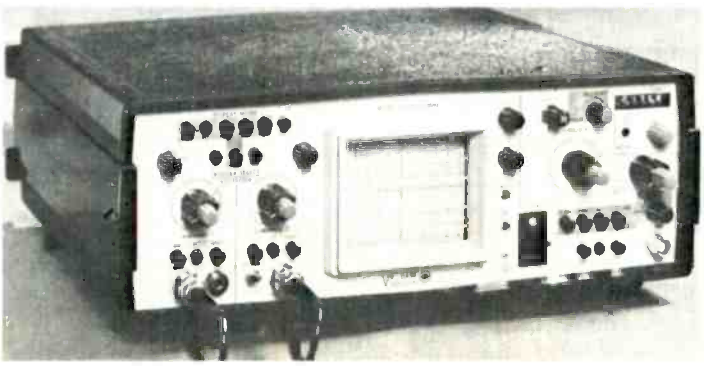
Sencore Model SC60



Soltec Models 540P and 540D



VIZ Model WO-555



Vu-data Corporation Model 2522

Internal graticule lines eliminate all parallax but sometimes bring other problems in properly illuminating the graticule. Buyers should consider the importance of precise peak-to-peak measurements vs. the ease of controlling the illumination of external graticules.

• *Single sweep*—A few models have provision for individual single sweeps. The scope is prepared for operation and the single-sweep function activated. Then, the proper button is pressed (or whatever provision is made) to produce one sweep across the screen.

Single sweeps are useful for showing transients (the transient triggers the sweep) or for producing stable ultra-low-frequency waveforms.

• *Storage scopes*—Three basic methods are available for retaining a waveform after the signal is over. Some retain the waveform for a time in the CRT by special meshes or unique screen coatings. The newest method is digital storage, in which the digital equivalent is kept in a digital memory and released as needed. Special CRTs are not required for digital storage. A few models have digital-storage response up to 10MHz and nonstorage operation to 100MHz.

• *Other features*—Other unique features of some scopes include operation from line power or rechargeable batteries, beam locators, attached digital multimeters and microprocessor-controlled timing circuits.

Look ahead

After all the specifications and features have been decided on during selection of a new scope, estimate any future needs. The trend is toward wider bandwidths and shorter sweep times, as well as other specifications needed for digital measurements. It is wise to choose a scope model that exceeds present-day needs. □

NOTE: *Information on scopes from Telequipment arrived too late for inclusion in this roundup. To receive information on the company's products, circle (60) on the reader service card.*

horizontally and the device current is displayed vertically. An open across the test leads produces a straight horizontal line; a short produces a straight vertical line. Capacitors create ovals, resistors form slanted lines and solid-state junctions (in diodes and bipolar transitors) cause one or two right-angle corners, as shown in Figure 4.

Comments

Performance of the Hameg HM-307 scope was much better than the averge portable scope. There are no industry standards for trace drift, convenience of operation or efficient arrangement of controls. In this test, these items were judged to be very good. Although no precise frequency response was measured, the scope was compared with a 35MHz large model when waveforms of composite video, sinewaves, high rep rate pulses and squarewaves, and other waveforms were examined. Model HM-307 produced excellent waveforms of good stability without any hint of ringing or overshoot.

A few conventional features or functions have been eliminated, probably as a concession to the small size, and they were noted previously. Because of magnetic fields in the testing area, the base line had a slight tilt, but the amount was not sufficient to degrade portable measurements. When the scope is used in a permanent location, the scope tube can be rotated to correct the tilt.

The component-testing feature was found to be a valuable addition, especially for in-circuit checks. No quantitative figures are obtained from these tests; they are indications, not measurements.

A 45° tilt of the line was obtained by a resistance of about 400Ω; this is the most-sensitive range for resistance tests. Some tilt can be seen down to below 22 Ω or above 5600Ω, but without any accuracy. The oval trace of a 0.22µF capacitor barely showed a separation of the two sides; 1.5µF produced an oval 5cm wide and 2cm high. A 10µF electrolytic produced a tall oval. Values higher than about 500µF give a single vertical line.

Testing of diodes and transistor junctions was more productive. Power-supply diodes gave sharp single corners out-of-circuit but vertical lines (from the large capacitances) in-circuit.

Zeners or silicon B/E junctions exhibit a second corner from the zener effect. These solid-state junction tests can be very helpful where extreme accuracy is not required.

For operator convenience, it is not necessary to disconnect the usual scope probe during component tests. Also, it is not necessary to disconnect the component-testing probes from the jacks. Incidentally, the left jack is ground; a vertical line with a single heavier horizontal line indicates a ground in European schematics.

The Hameg model HM-307 performed excellently and above expectations. It should operate successfully for all portable functions in both consumer service and industrial fields. □

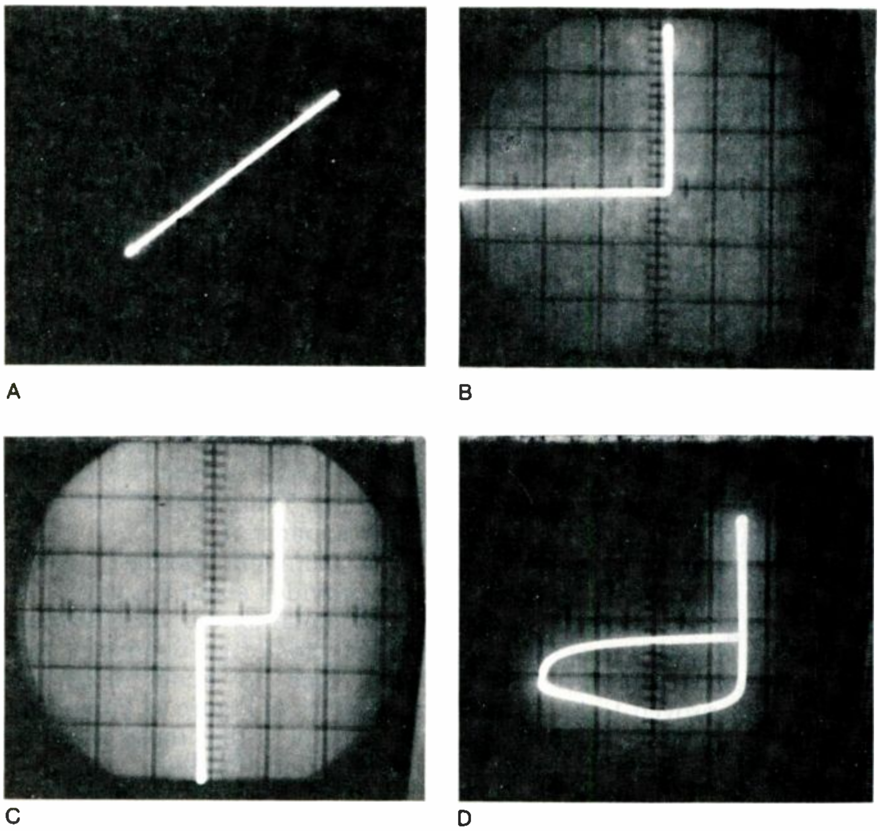
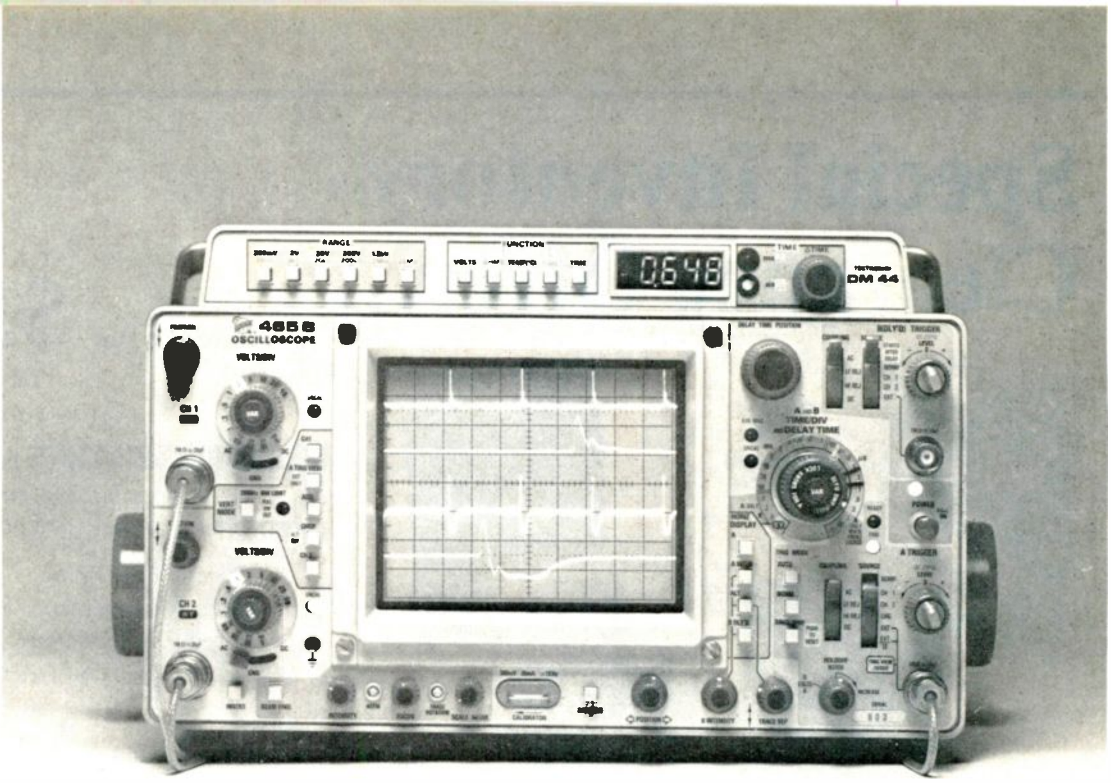


Figure 4 These are typical waveforms obtained during an evaluation of the component-testing feature. (A) A 470Ω resistor tilted at the line about 40°. (B) A power-supply-type diode produced this right angle when the cathode was connected to the ground lead (left CT jack) and the anode was connected to the right-hand CT jack. If the leads are reversed, the angle moves to the lower-right quadrant. Note: the left half of the screen represents negative voltage, while the right half is positive current. Therefore, this diode drew no current during the negative (left) voltage arc, but passed maximum positive current when positive voltage was applied. (C) Zener diodes and silicon B/E junctions have a normal diode angle and a second (less sharp) angle at the zener voltage. (D) Reversed test leads to a diode that was paralleled by a 1.5µF capacitor produced this waveform that resembles a musical half-note.



Industrial servicing applications for portable scopes

By Pat Adamosky and Jack Doub, Tektronix Inc., Beaverton, OR

A critical part of the service technician's job in maintaining industrial control systems is checking and diagnosing low-voltage, high-technology devices in hard-to-reach places. Both operator safety and routine and emergency troubleshooting can depend on the most accurate, convenient equipment available. And among the compact and portable instruments needed for industrial troubleshooting is the high-performance, portable oscilloscope.

Virtually all areas of heavy industry use equipment and machinery that is controlled by digital micro-electronics. Effective troubleshooting is a must to ensure operator safety, to schedule necessary repairs and to avoid unforeseen hazards.

Control and sensor LEDs (Light Emitting Diodes) at the computer input board of computer-controlled systems indicate only when signals are or are not present. They cannot indicate when the signals are faulty, and they cannot monitor for evidences of equipment stress or breakdown.

Another troubleshooting difficulty arises because most industrial control circuits are working just a few millivolts above the noise level. Without an adequate test and measurement tool, the service technician can have problems interpreting, or even finding, signals during maintenance checks, and may overlook areas that need attention.

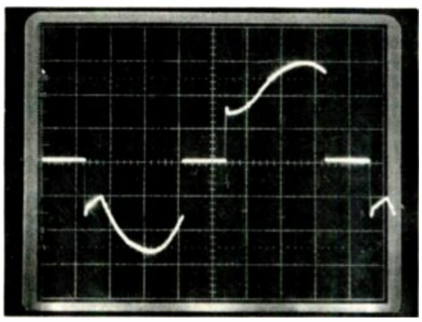
The modern oscilloscope is a convenient tool that can help service technicians handle the sophisticated electronics found in modern industry. The following brief examples describe just a few of the ways portable oscilloscopes help make accurate and efficient troubleshooting easy. The result: equipment that operates properly and increased safety for operators.

Troubleshooting SCRs

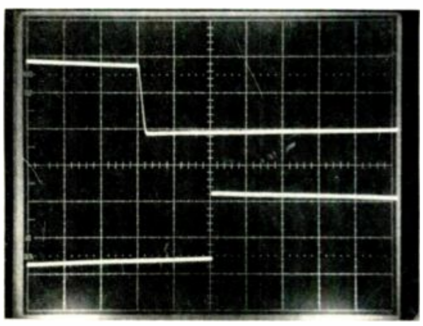
Portable scopes are frequently used to troubleshoot the motor control circuitry on forklift trucks. In most of today's forklifts, battery power has replaced fossil fuel. Microprocessor-driven silicon controlled rectifiers (SCRs) handle the switching of the large voltages required to operate the forklift.

A faulty SCR could cause a deep or quick discharge which could result in an electrical fire or other serious damage to the equipment. With a portable scope, the technician can view the switching waveform of the SCR and verify that the device is switching at the right level by checking the rise time and amplitude of the signal.

Another important part of routine troubleshooting is verifying that the correct pulse signals are coming from the microprocessor control circuit. On the oscilloscope CRT screen, logic pulses appear as a string of dashes and spaces, making it easy for the technician to assess their accuracy.



Waveform of SCR firing in a switching regulator application.



Upper Trace—safety sensor; lower trace—pulse that shuts off machinery. The traces show time relationship between sensor and machinery shutdown in milliseconds.

Sea trials

The crew taking a new ship out for sea trials carries along a portable oscilloscope to make testing easier. Using acoustic transducers, the shakedown crew can assess sound levels in bunk space that could make sleeping difficult and watch for vibration in structural members of the hull which could eventually damage the craft if not rectified.

Using a portable scope to work near the transducers, the crew can make adjustments while the ship is underway, and then immediately check results. The checkout crew can quickly see where potential problems lie without having to wire in and constantly refer to the larger lab scope that may be up on deck or on the bridge.

R/C shipyard cranes

Another shipyard application, shipyard crane maintenance, is also easier and more efficient with a portable oscilloscope. The huge modern cranes now in use in many shipyards are radio-controlled (R/C) from the ground, and are operated by means of a more sophisticated version of the joystick controls used to operate an R/C model airplane. These digital controls are more accurate than those of older cranes, and the operator is much safer on the ground than controlling the crane from above. But unless the R/C system is well-maintained, the crane may be difficult to control, endangering both the machinery and the ships under construction or repair.

Operating at 70MHz, the radio links digital coding equipment at both the operator and the crane end. Using a good digitizing portable scope, maintenance crews can quickly check for a signal and verify the amplitude. Signals are radioed to the scope and displayed as a series of pulses. The scope can also display the pulse width and timing, allowing the maintenance crew to check for code accuracy.

Sewage treatment plants

Automated sewage treatment plants operate from a central computer. The computer receives input from remote sensors throughout the plant, monitoring such parameters as pump flow and temperature, and then uses this data in controlling waste processing. Inaccurate input from these sensors can lead to expensive consequences, both in damage to the equipment and in improper waste processing and the resulting environmental pollution.

Maintenance technicians carry portable scopes to check sensor input at the computer, and to trace problems back down the line to the remote sensors when necessary.

Food processing

To protect industrial workers, effective safety-control equipment is required on most heavy industrial machinery. In a food packing plant, for example, where employees on a processing line are working near hazardous machinery that could cut off a hand or an arm, safety bars and sensors are in place to keep the operator's hands away from danger. Should a worker inadvertantly stumble or reach into the machinery, sensors shut down the machinery within just a few milliseconds.

Those sensors must be checked regularly. Using a storage oscilloscope set up to trigger on a single-shot event, the engineer can trip a sensor. The storage scope captures the trace, verifying the time it takes to stop the machinery once the sensor has been tripped. Data gathered this way not only protects the workers by verifying that safety equipment is working properly, it also satisfies the timing verification requirements for OSHA.

Laser scanners in sawmills

In the forest products industry, laser scanners measure the width, thickness and length of logs before milling. Acting on input from the scanners, a microcomputer controls the cuts, maximizing the yield from each log bolt. In a plywood veneer milling lathe operation, the scanner determines the pivotal center of a log as well as its diameter. The equipment under computer control then peels the log in a thin sheet which is used to make up the individual laminations in a sheet of plywood.

In both of these operations, a detector "reads" the laser energy reflected from the log, and converts that energy to electrical signals for the computer. In troubleshooting laser scan detectors, an oscilloscope can verify correct operation by showing both the level of signal return and the change of electrical current vs. time. The critical point of the adjustment is to get as close to the ambient noise as possible to maximize signal return—a measurement that can be done only with an oscilloscope.

Conveying system controls

Most industrial conveying systems, whether on the automobile assembly line or in the food packing plant, use encoders to position or track workpieces. Most systems use either *absolute* or *incremental encoders.* Both types of devices convert mechanical position into digital electronic signals, which are then processed by a computer.

An *absolute encoder* senses the position of a workpiece in terms of binary code, and the controlling computer receiving this information can then precisely position the piece before directing work on it.

An *incremental encoder* uses a scribed ceramic "chopper disk" that allows light to pass through notches from a lamp to a photocell. The incremental encoder is used to track a piece after it has been classified by parameters such as height or weight. The computer relies upon the encoder signals of so many pulses per inch of travel to know where the piece is on the line, and where to divert it for more work or release it for sorting.

An oscilloscope is essential for checking out both types of encoders. It can give the service technician a clear look at the digital code being sent by an absolute encoder, and it is the only instrument that will permit effective troubleshooting of an incremental encoder.

The most common fault of an incremental encoder is a *missing segment.* The term applies literally to a segment of the fine encoding notches on the scribed ceramic chopper disk, which may have been fractured or polluted with foreign material. The LED on an input card at the computer will tell when the encoder is running—that is, whether a signal is present—but it will offer no clue about whether a segment is missing.

Because a missing segment can cause inaccurate sorting by sending the computer an erroneous code, the service technician must detect it as quickly as possible. The oscilloscope is the only instrument available that can help spot the breaks in code that indicate a missing segment. □

reader's exchange

Needed: 10W exciter or transmitter, 4-bay antenna, tower, coaxial cable and studio equipment for religious station. Donation tax deductible. *Rev. Charles Sivley, Rt. 11, Box 381, Keavy, KY 40737.*

Needed: Rabbit ear antenna for Weltron (out of business) AM/FM 8-track stereo, model 2001. *M. B. Danish, Box 217, Aberdeen Proving Ground, MD 21005.*

Needed: KRK TV tuner 167 and 168, RCA model EP404W. *M. Hardecker, 805 Stiles Ave., Maple Shade, NJ 08052.*

Needed: IF, video, sync, AGC board for Magnavox chassis T921-01AA. Will buy entire set to obtain good board. *Kaye W. Hamilton, Route 1, Box 108, Friendly, WV 26146.*

Needed: Schematic and charts for Supreme Dynamic mutual conductance tube tester, model I-177B. *Sam H. Jansen, 305 California Ave., Arcata, CA 95521.*

Needed: Picture tube rebuilding equipment. *Fuhr TV, 1052 Sandusky Plaza, Sandusky, OH 44870*

Needed: Schematic for Kaiser short wave AM/FM radio model No. W835. Will pay for original or will copy. *Orlando J. Ortiz, 4029 Eagle St., Los Angeles, CA 90063.*

Needed: Service information for Allied AM/FM stereo receiver model 2690. Sams MHF-8 covers it. Will buy, or copy and return. *Jensen Radio-TV, 833 Jacobson St., Marinette, WI 54143.*

Needed: Sams or equivalent of Elgin RM-4301 stereo unit out of print at Elgin, and JVC or MHF29. *G. Newman, 1230 N St., Box 1105, Sacramento, CA 95814.*

Needed: Service literature including schematic and parts list for Fender model No. 5E3 guitar amplifier. This amplifier used five tubes: 12AY7, 12AX7, 5Y3, and two each, 6V6. *A-Earl's TV and Appliance, 1211 Houston, Levelland, TX 79336.*

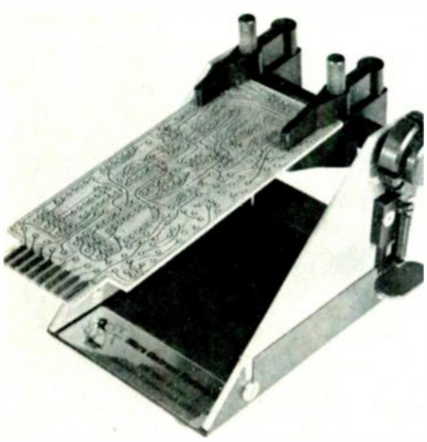
Needed: No. 30043 power transformer for RCA institutes model 54-45 or any cross reference information that will lead to a substitute. *Sunrise TV, 408-A N. Caldwell St., Brevard, NC 28712.* □

both resistive and reactive current flow at their rated power, frequency and voltages.

Circle (20) on Reply Card

Mini PCB holder

Micro Electronic Systems announces a new PCB holder, for small boards. Collapsible for service kits, the PCB is held by two small vice-like grippers. The shaft can be



rotated to flip over the board. It is designated part number 1521. The price is $41.40.

Circle (21) on Reply Card

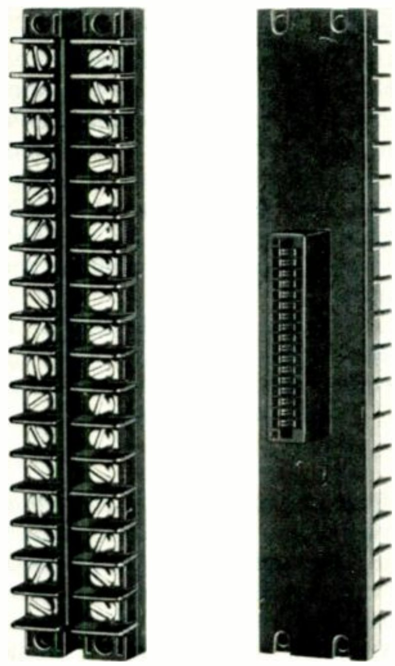
Portable desoldering

Ungar's Hot Vac 4000 desoldering system contains a built-in vacuum pump allowing it to be used at any location in a factory, repair center or field location where normal ac power is available. The solder is melted by the heated long-life tip, and the vacuum is actuated by a switch on the biomechanically designed handle. The solder which is removed is retained in the built-in solder reservoir which may be emptied, even when the heater is hot. Tip temperature is adjustable from approximately 500-1000 degrees F. The Hot Vac 4000 includes a built-in handle holder and handle.

Circle (22) on Reply Card

Interface devices

Two Mag-Master interface devices have been designed by **Magnum Electric** to effect interconnect of field wiring with electrical and electromechanical circuits, equipment and systems. Type 10 and type 12 Mag-Master devices



have two rows of terminals strips on one side and an edge card connector on the other, connected directly through. Mag-Master features a variety of circuits and quickly plugs into mating edge card terminations.

Circle (23) on Reply Card

All-purpose cases

Platt Luggage, Inc. introduces their all-purpose case line made from aluminum covered veneer, with heavy duty hardware. In two sizes: 18¼x13x5-inches and 18¼x13x7½-inches, each with five adjustable, rubber covered dividers and polyfoam interior.

Also new from Platt: injection molded tool cases made of high impact polypropylene combined with patented, molded polyurethane

pallets. Two sizes: 800T, 18x13½x6, with two pallets; 805T, 18x13½x5, with one pallet.

Completing the line, their compact 10x13-inches, two-pound zipper tool case of padded, expanded vinyl, has 29 pockets and heavy-duty, nylon zipper.

Circle (24) on Reply Card

New mounting kit

The semiconductor division of **Westinghouse Electric** has introduced a new power semiconductor mounting kit for attaching semiconductor devices to heat sinks. The kit is packaged for use either on a production line or at on-site locations. Each kit contains three kinds of thermal interface compound, enough to mount several thousand devices. Also contained in each kit are a specially designed template featuring both universal torque seals for mounting stud devices and a force indicator for disc packages; an application data sheet on mounting power semiconductors which gives mounting, maintenance and repair information; a plastic-laminated step-by-step instruction card; a tube of NeverSeez compound for lubricating clamp threads; compound applicators and cleaning supplies; and a power semiconductor user's manual and data book.

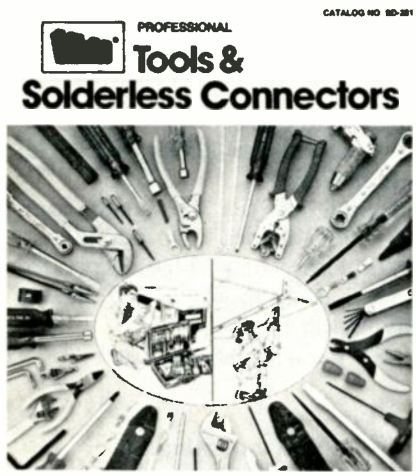
A power semiconductor user's manual and data book also is included ☐

Circle (25) on Reply Card

catalogs literature

An expanded product catalog, SD-281, has been introduced by **Vaco Products.** Included are complete descriptions and illustrations on their product line of hand tools, solderless connectors, fastening devices and application tools. The catalog includes a new section that provides simplified technical information to assist in selecting tools that are job-specific.

Circle (26) on Reply Card



Catalog No. 124 is a reference manual of more than 2400 products available from **Klein Tools.** The 112

page catalog describes a selection of pliers, screwdrivers, hammers, measuring tapes, knives, levels, tool pouches, wrenches, chisels, saws, cable cutters, fish tapes, work gloves, padlocks, tool boxes, tool chests, roller cabinets, contractor's storage boxes, truck boxes and a full line of occupational protective equipment. OSHA and ANSI editorial treatment on the use of tools and protective equipment such as belts and harnesses is included.

Circle (27) on Reply Card

The Electronic Industries Association has published the 1981 edition of its *Trade Directory and Membership List.* The annual publication is the authoritative listing of association member companies and affiliates, showing corporate division locations, phone numbers, top-level management personnel, products manufactured, trade names, EIA's Board of Governors, the association committee organization, and officers of EIA's divisions, departments, councils and panels.

The EIA Trade Directory is available at a cost of $20 for members and $40 for non-members.

Circle (28) on Reply Card

The 1981 edition of the *Electronic Service Industry Yearbook* has been sent to members of the **National Electronics Service Dealers Association,** many of the affiliated state associations and the International Society of Certified Electronics Technicians. The 100-page book contains updated addresses and personnel for nearly 100 electronics and test equipment manufacturers, 800 numbers of hundreds of companies, names and addresses of state and national officers, CET Certification Administrators in each state, and pages of information about the associations, the industry and electronics.

Circle (29) on Reply Card

The *Computech Computer Assisted Television Repair System Manual* from **State Electronics** is designed to be an organized, accessible source of solutions to many service problems. About 6500 symptoms and solutions are indexed numerically by Sams numbers and listed alphabetically. The manual is updated monthly and contains step-by-step procedures and troubleshooting techniques.

The Computech system is available at a subscription price of $20 a month.

Circle (30) on Reply Card

RCA has published the *1981 SK Top of the Line Solid State Replacement Guide* listing more than 1300 solid state replacement devices that replace more than 170,000 domestic and foreign types. The (SPG-2022) SK Guide lists the SK stock number

along with the stock number of the numbering system used by ECG, REN and TM. The guide includes information on RCA's line of replacement transistors, rectifiers, thyristors, ICs and high voltage triplers including many MRO replacements. An index and comprehensive data section with listings grouped according to type of device are also included.

Circle (31) on Reply Card

Shape Magnetronics Inc. is offering a cross reference of line voltage regulating transformers. It lists comparable Shape and Sola constant voltage regulator models, covering approximately 70 Line Tamer models, categorically divided by application.

Circle (32) on Reply Card □

test equipment report

Versatile pulse generator

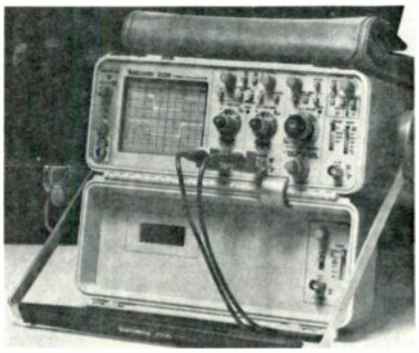
Tektronix' new PG 507 50 MHz pulse generator is designed specifically for logic design applications with the key logic families. It features simultaneous, normal or complementary dual pulse outputs with a maximum amplitude of 15V peak-to-peak in a ± 15V window. Each output has an independent normal/complement switch, allowing up to four output modes. The Output High Level and Low Level voltage controls track between channels. A 3-state trigger/gate light, selectable 1 Megohm/50 ohm trigger/gate input impedance, variable trigger-level control, control-error warning light to indicate incompatible control settings, and special custom timing position on the period, duration and delay controls are other features.

The PG 507 is priced at $1,650 (U.S. base price).

Circle (33) on Reply Card

New scope series

The **Tektronix** 2300 Series, (2335, 2336 and 2337) are all 100 MHz, dual trace with delayed sweep, 5 ns/div maximum sweep speed and 5 mv/div vertical sensitivity. An improved triggering circuit offers the user stable and dependable triggering capability beyond the scopes' rated bandwidth, and a newly designed CRT provides a sharp, crisp trace and a nearly 2:1 improvement in spot size over other currently available portable oscilloscopes. U.S. base prices range from $2,775 to $3,350.



The 2300 Series, available in May, meets the service measurement needs of TTL- and CMOS-based equipment and will be used in computer, telecommunications, control apparatus, harsh field service applications and applications where EMI is a problem.

Circle (34) on Reply Card

High energy SPGs

The release of two high energy spike generators, Model SPG-310 and SPG-320, has been announced by **Power-Science Inc.** The new models generate high energy line voltage disturbances such as normal mode and common mode spikes in selectable amplitudes from 50 V and 1200 V. The spikes can be selected from two source impedances of 1 and 4 ohm.

Circle (35) on Reply Card

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19CTB 1980-1

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the marketplace

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MIRROR IN THE LID, and other PRE-1946 Television sets wanted for substantial cash. Also interested in 12AP4, MW-31-3 Pre-War picture tubes, parts, literature on Pre-War Television, Arnold Chase, 9 Rushleigh Road. West Hartford, Conn. 06117 (203) 521-5280 2-81-4t

McADAM ELECTRONICS Model 2000 Digital Audio Analyzer. Measures Power, THD, IMD, volts. Built-in scope. $800. (602) 273-1310. 4-81-1t

SAMS AR MANUALS (113) 4 thru 188 at $5.00 each; B&K 707 Tube Tester, 970 Equipment Analyst at $300 each; Sencore TF17 Transistor Tester, FE20 Multimeter at $80 each; A1 condition, negotiable. Bill Perry, 1001 West Picacho, Las Cruces, NM 88001. 4-81-1t

TUBES FOR TV AND RADIO—35¢ ea. Washington TV Service, 1330 E. Florence Ave., Los Angeles, CA 90001. 3-81-9t

DESPERATELY NEED: Information on "Telicon" projection TVs from 1947, RCA "Test Lamp" for 1940's projection TVs. Arnold Chase, 9 Rushleigh Road. West Hartford, Conn. 06117 (203) 521-5280. 2-81-4t

FORMER TV TECH liquidating tubes, parts, equipment, etc. in one cheap lot. Jim Hurd, 56 St., Timothy Court, Danville, CA 94526. 4-81-1t

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FOR SALE: TV and small appliance repair shop close to good fishing. Dans TV, P.O. Box 42, Osakis, MN 56360, Phone 612-859-2851. Asking $10,000. Bldg. can be rented or bought, 6000 square feet. 4-81-1t

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