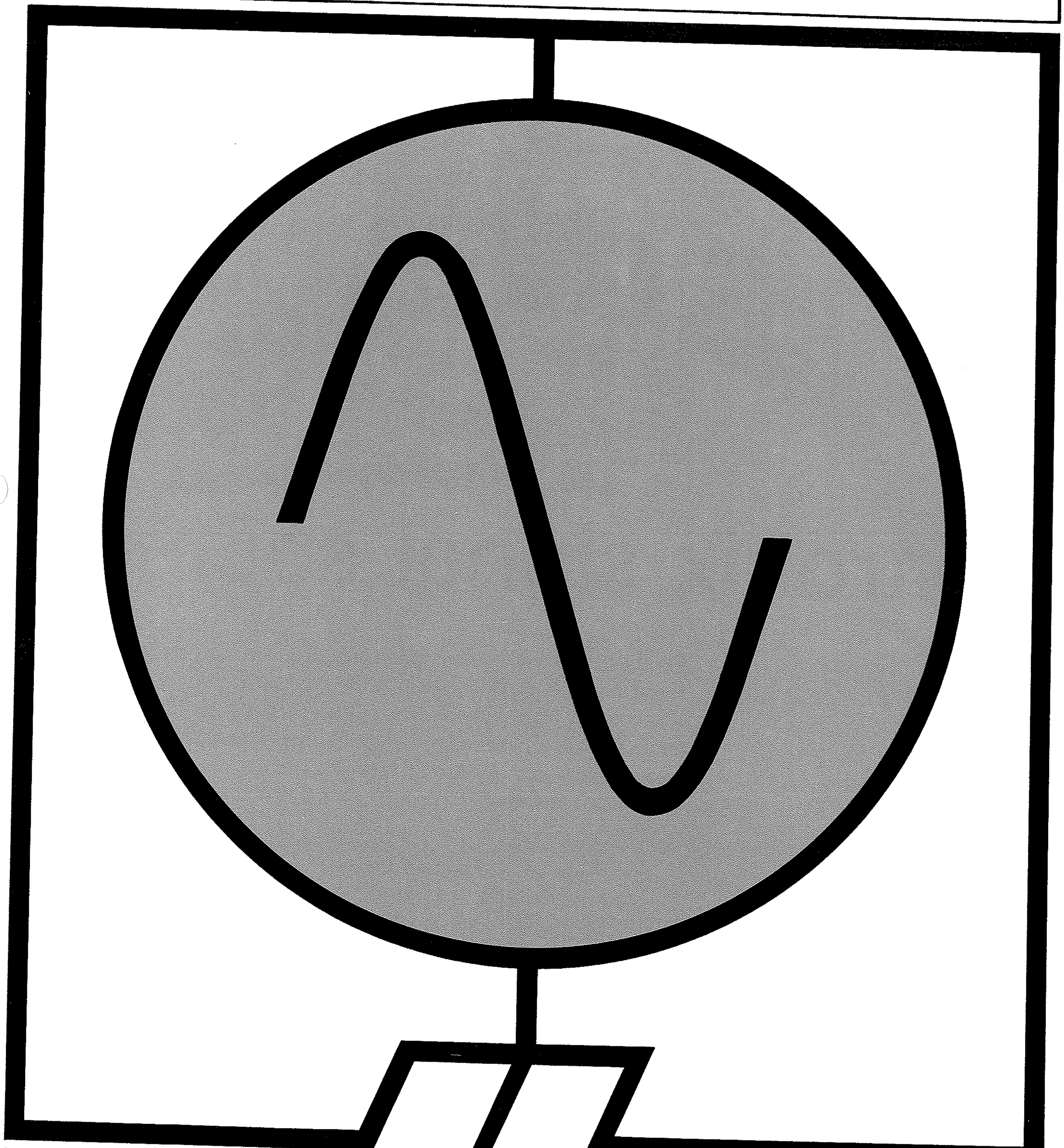
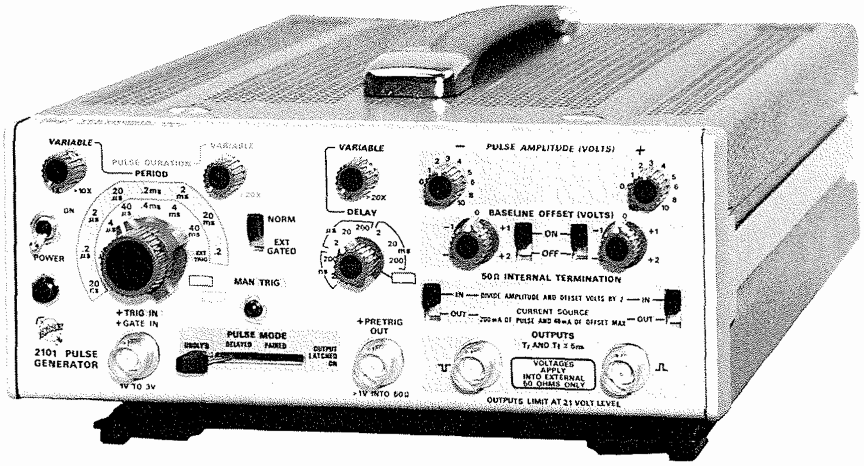
TEKSCOPE

JUNE 1970





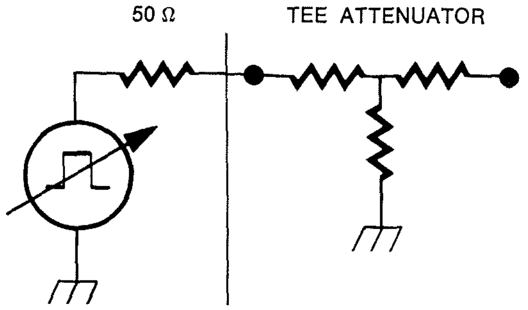
tektronix signal sources

Oscilloscopes and pulse generators are very closely associated. Pulse generators are essential in calibrating the oscilloscope. Pulses are formed in many oscilloscope circuits. The measurement of pulse parameters is the primary purpose of the time base oscilloscope. Tektronix has long been engaged in the design and manufacture of pulse and other signal sources.

A new general purpose pulse generator, the Tektronix 2101, has recently been announced. This instrument is easy to operate and yet will produce a wide variety of pulses. This article will look at 2101 performance and some aspects of pulse source application.

The 2101 may be divided into two major operating sections: Gated Power Output and Gate Timing. This two section approach follows a concept of pulse generation by gating DC power supplies. The 2101, of course, has an AC powered internal DC supply. This supply is the ultimate source of output power. It should not be confused with the output power sources mentioned hereafter.

COVER—Do you see a symbolic CRO or a Signal Source symbol? If you see both, the activities of Tektronix in two separate, but closely related, instrumentation fields are symbolically joined.



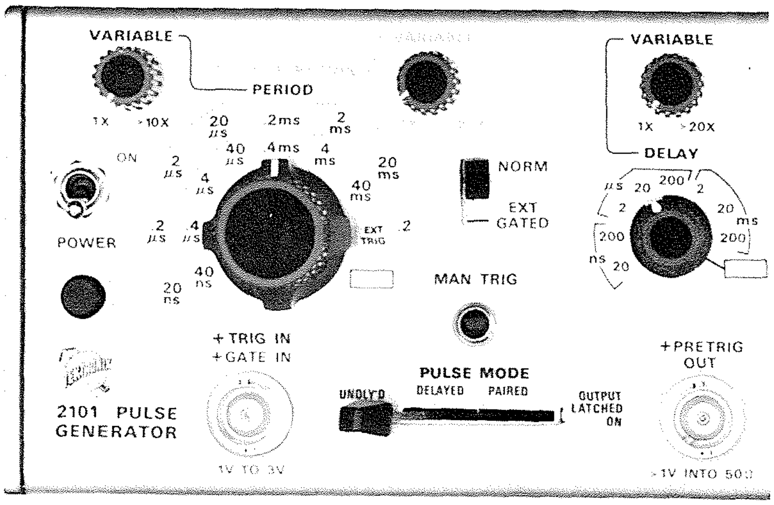
When using most pulse generators, it is good practice to use higher amplitude outputs with external attenuation whenever minimum aberrations at very low amplitudes are needed.

The 2101 has two power output connectors. A pair of variable amplitude current sources are operated in parallel to each output connector. In each pair, one supply contributes plus or minus 40 mA for **offsetting** the pulse starting level or baseline. The other supply controls **pulse amplitude** by adding up to 200 mA to the **offset current.** Each output has an identical offset supply, but the pulse amplitude supply is of positive polarity in one pair, negative in the other. When the 2101 is operated LATCHED ON, the pulse supply is turned on and "pulse" duration is long. So long that until the Mode is changed, the 2101 is actually a direct current power supply.

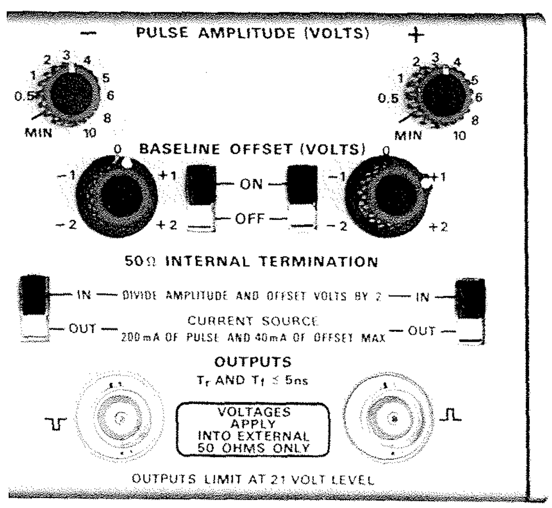
Pulse risetime, falltime, overshoot, droop, and other aberrations are primarily caused by the output supply circuits. A gated transistor actually controls the amplitude of the output pulse current. This device is optimized to produce minimum aberrations at 50% amplitude. These aberrations are less than 3% at full output amplitude in the 2101. Since all pulse generators tend to produce larger relative aberrations at low variable amplitude settings, the user should know how to minimize aberrations. Whenever low amplitude, clean pulses are needed, it is good practice to use high amplitude settings and external attenuators for best results.

GATE TIMING

Period, Duration, and Delay are all gate timing functions. In the 2101 all three functions are internally generated. External sources of these functions may be used in combinations with internal timing signals to provide additional control of gate timing. The 2101, with external control, can produce bursts of pulses and pulse periods locked to an external time reference.



"GATING"

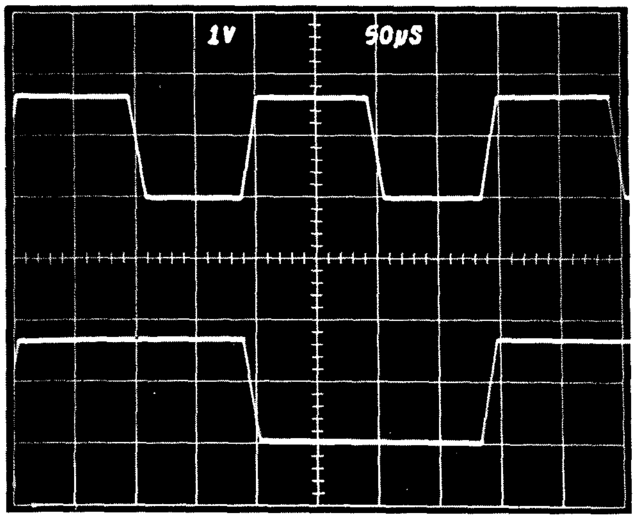


"POWER SUPPLY"

The latest Tektronix Pulse Source can be divided into two operating sections. With OUTPUT LATCHED ON the "power supply" outputs direct current. In all other modes the "power supply" is "gated" to produce pulses.

PROTECTION AGAINST ERRORS

The DURATION and PERIOD controls of the 2101 interlock to prevent improper duty factor combinations. Duty factor is the ratio of duration to period. Duration must always be less than period. The DURATION and PERIOD controls rotate independently in any less than one duty factor control set up. If either control sets up a duty factor condition approaching one, the two controls lock and rotate together.



Duration can change period. This double exposure shows the inadvertent doubling of period by misuse of a duration control. Both traces are produced with period set to 100 µs. The lower trace has "doubled" period as duration (width) was rotated beyond 100 µs. Protection against inadvertent period doubling is a feature of the 2101.

Pulse generator output circuit destruction can occur if protection is not built in. The 2101 protects itself from shorting loads by being designed as a current source. Over voltage protection from inductive kicks and other load developed excess voltages is furnished by diode protection. Because it is protected, the 2101 can be safely coupled to any passive load.

2901 TIME MARK GENERATOR

The new 2901 is one of the most convenient sources of accurate timing signals. Twenty time signals are available from 2 nanoseconds through 5 seconds, all based on a 10 MHz ± 20 ppm crystal controlled oscillator. Push buttons select individual time marks or combinations of time marks over a 0.1 microsecond through 5 second range. All timing signals are conveniently available at amplitudes of at least 0.3 volts into 50 Ω. For Z axis and other applications where large amplitudes are needed 25 volt into 1 kΩ markers of either polarity can be produced. These large markers can be used individually or in combination over the 1 microsecond through 5 second range.

A novel feature allows the 2901 to count down from external reference signals. Custom markers for radar or time signals for other purposes can be easily produced. Any two volt signal from 50 kHz to 10 MHz will provide the sufficient reference drive. Time reference signals lower than 50 kHz reference may be used if the rate of rise is >1 volt per microsecond for two volts. The 2901 extends the external reference time period up to 50,000,000 times.

In addition to pulse time marks; 2, 5, 10 and 50 ns period sine waves are generated. Frequency multiplication of the 10 MHz internal reference signal assures the time accuracy of this group of timing signals. In addition to the regular time mark and sine wave outputs a set of eight positive pulses is available for triggering or other uses. These pulses are selected in decade steps from 0.1 microseconds to 1 second. The trigger output amplitudes are at least 0.5 volts into 50 ohms or one volt into 1 megohm. This compact, bench or field instrument is a useful secondary standard wherever ac power is available. Extensive use of integrated digital circuits in the 2901 Time Mark Generator minimize the possibility of miscount and simplify maintenance and reduce calibration time.

This precision time or period source produces sixteen timing pulses by digital countdown. Maximum countdown ratio is 5 x 10^{+7} from an internal precision source. The 2901 will also accurately countdown external signals.

OTHER SIGNAL SOURCES

114, 115, and R116

Tektronix manufactures **20** signal sources in addition to the 2101 Pulse Generator and the 2901 Time Mark Generator. Two of the instruments, the 114 and 115, can be classified as general purpose pulse generators.

The economical **114** is designed for laboratory and production test applications. The broad operating range of this instrument makes it well suited for those use areas where economy and versatility are paramount.

Independently variable rise and fall times allow the **115** to meet many transition time test requirements. Rise or fall is adjustable from a fast 10 nanosecond up to a slow 100 microseconds. Delay functions include paired pulses and externally triggered bursts. Compactness plus very useful performance features enable the 115 to be used as stimulus in IC and other logic testing.

The programmable **R116** is similar to the 115 in specifications. This rackmounted pulse generator is the unit selected for use in the Tektronix **S3130** and **S3150** Automated Test Systems. The R116 may be operated manually from conventional front panel controls.

R116 PROGRAMMABLE PULSE CHARACTERISTICS

Risetime	10 ns to 100 μs
Falltime	10 ns to 100 μs
Period	100 ns to 110 ms
Duration (width)	50 ns to 550 μs
Delay	50 ns to 550 μs
Burst Time	50 ns to 550 μs
Amplitude (50 Ω)	0.4 volts to 10 volts
DC Offset	—5 volts to +5 volts
Polarity	Positive or negative

CALIBRATION SOURCES WITH OTHER USES

A group of Tektronix generators were designed to meet the exacting requirements of oscilloscope calibration. The precise performance of these units make them well suited in other applications where similar qualities are required.

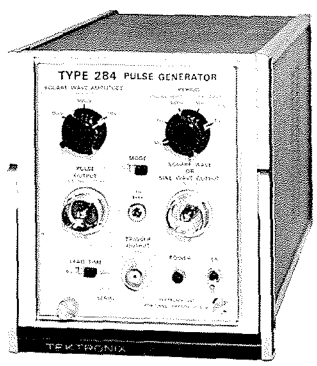
In addition, when you need results to be close to or better than instrument specifications, a calibration instrument available for daily use can be insurance against errors and wasted efforts. The 106, 191, and 184 are calibration instruments often used outside the calibration laboratory.

The **106** provides simultaneous positive and negative-going output transitions with ≥1 ns risetime into 50 Ω. Minimum aberrations make 106 waveforms ideal for verifying oscilloscope transient response. This instrument is also useful in diode recovery, core testing, digital, analog design and other applications.

Type **191** is a variable-frequency sine wave generator whose output maintains constant-amplitude over the entire frequency range of 350 kHz to 100 MHz. Amplitude is held constant during frequency variations by continuous sampling of the output voltage. Both output amplitude and frequency are calibrated.

The Type **284** Pulse Generator is very useful for verifying the performance of sampling oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the risetime, vertical deflection factors, and horizontal sweep rates. A pre-trigger is provided for non-delay line systems.

In addition to checking the transient response of sampling oscilloscopes, the 70 picosecond, pulse output is an excellent 50 Ω signal source for TDR measurements. The Type 284 is available in a cabinet version, or modified for rack-mounting in standard 19-inch rack.



Television Test Signals

If you have ever had your television picture roll, you probably have seen a VITS. In that dark area between pictures, a horizontal line or two may have a set of dots, a series of various levels of grey, or a series of luminance changes. These are VITS or VERTICAL INTERVAL TEST SIGNALS. Vertical Interval Test Signals are one of a group of test signals used by broadcasters and networks to verify system quality.

The composite television signal is an extremely complex, analog signal requiring fidelity in every stage from camera to home receiver. Without attention, each of the many processing and transmission stages will take a little information out of the signal. The cumulative effect through many stages can be significant. Since small degradations are difficult to analyze subjectively on picture monitors, the broadcast industry uses test waveforms and oscilloscopes instead. These test waveforms are based on the special character of the camera signal, the bandwidth limitations of the TV channel and the problems of interaction of color and black and white signals.

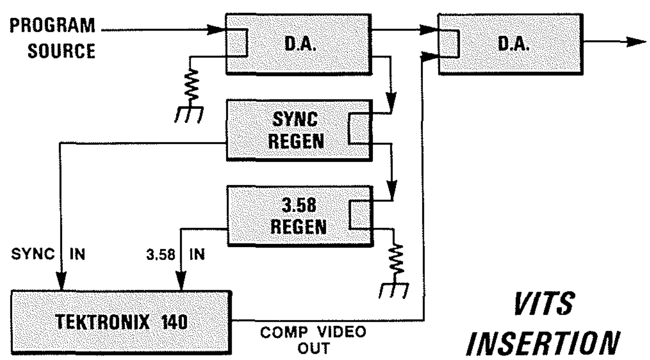
The Tektronix 140 NTSC Signal Generator is a source of several precise test waveforms for measuring chrominance and luminance interactions. These interactions are one of the major problems that occur when nonlinearities exist anywhere in a TV system. The 140 generates three test signals for measuring the effects of these nonlinearities. One waveform is the **Modulated Stairstep;** five equal steps of luminance modulated with 3.58 MHz chrominance. The chrominance amplitude is equal to the luminance riser amplitude. In TV systems Chrominance Phase and Gain can **differ** with luminance level. The measurements made with **Modulated Stairstep** are called **Differential Gain** and **Differential Phase.** Variations on these measurements include inserting the modulated stairstep on every fifth line with the other four lines held at a variable level of luminance. These levels are changed to simulate varying average picture level (APL) conditions.

Another effect that can be measured with a 140 is called **Luminance Cross Modulation.** This is the effect of various chrominance levels on luminance. For some years the phase of chrominance was considered to be the only critical parameter for true hue reproduction. The color signal, however, does have a luminance component. If the luminance component is changed (distorted) in amplitude, the viewed effect is often subjectively judged to be a phase (hue) distortion. To test for **Luminance Cross Modulation,** the 140 provides a second waveform, a variable luminance level modulated by three levels of chrominance. The luminance, after demodulation, is measured on a waveform monitor for distortions of level caused by chrominance.

Color bars are widely used for a quick check of picture quality. A trained observer who sees minor color differences on a picture monitor display of color bars can make measurements with a vectorscope. With a vector display he can quickly measure errors of amplitude and phase for each color bar. Eight bars are generated; white, six colors, and black. Each color bar is generated in the order of its luminance value.

Color Bars and Modulated Stairstep signals are normally used in off-the-air testing. When program material is being broadcast, the two signals can be used as VITS. Since the Vertical Interval Test Signal occurs during the time used for vertical blanking, it does not conflict with any picture being transmitted. The VITS is a quantitative signal that can be analyzed at any point from camera to receiver. All interested parties use the VITS to verify the quality of what he is receiving and what his system is adding to or subtracting from the transmitted picture.

The 140 can add color bars or modulated stairstep to program material. For VITS Insertion the 140 can serve as the MASTER SYNC source or can be slaved to program sync. If program composite sync and subcarrier are not separately available, we recommend the set up below.



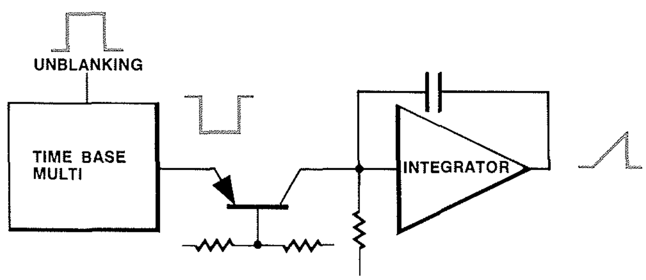
140 VITS insertion with program material.

CONCEPT BOOKS

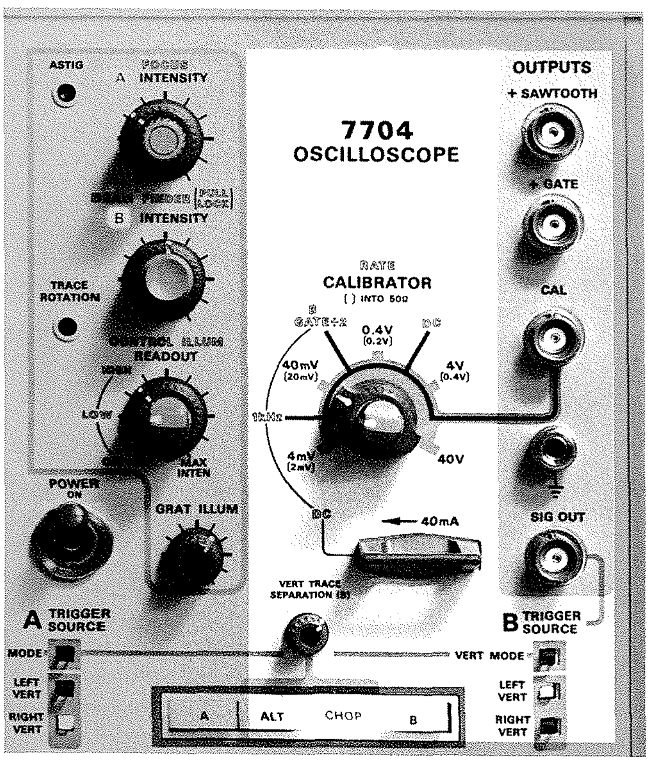
Tektronix has published two paper bound books in the CONCEPT SERIES containing television information. These are available at nominal cost from Tektronix. TELEVISION SYSTEMS MEASUREMENTS by Gerald Eastman discusses measurement techniques used in the television broadcast studio. TV SYSTEM MEASUREMENTS can be ordered using part number 062-1064-00. TELEVISION WAVEFORM PROCESSING CIRCUITS, part number 062-0955-00, by the same author, describes the circuit concepts of Tektronix wavefrom monitors and vectorscopes.

the 7000-series oscilloscopes as signal sources

A substantial portion of an oscilloscope is often available as signal sources. These sources are outputs of vertical amplifiers, time base generators and the calibrator. These outputs are normally thought of as *auxiliary* to most scope applications. Knowledge of how they work and their characteristics extend the usefulness of your scope beyond routine work.



This is how a time base produces the gate for unblanking and the sweep sawtooth. The same gate and sweep sawtooth can drive, gate or control devices external to the scope.

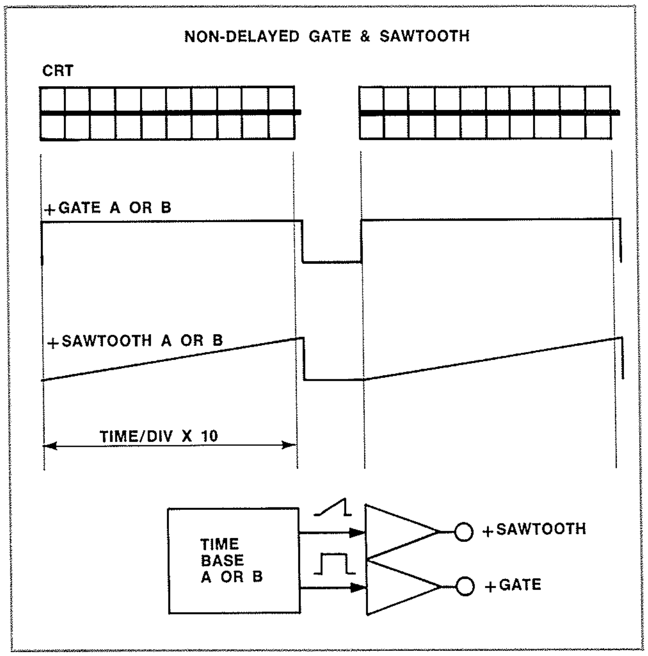


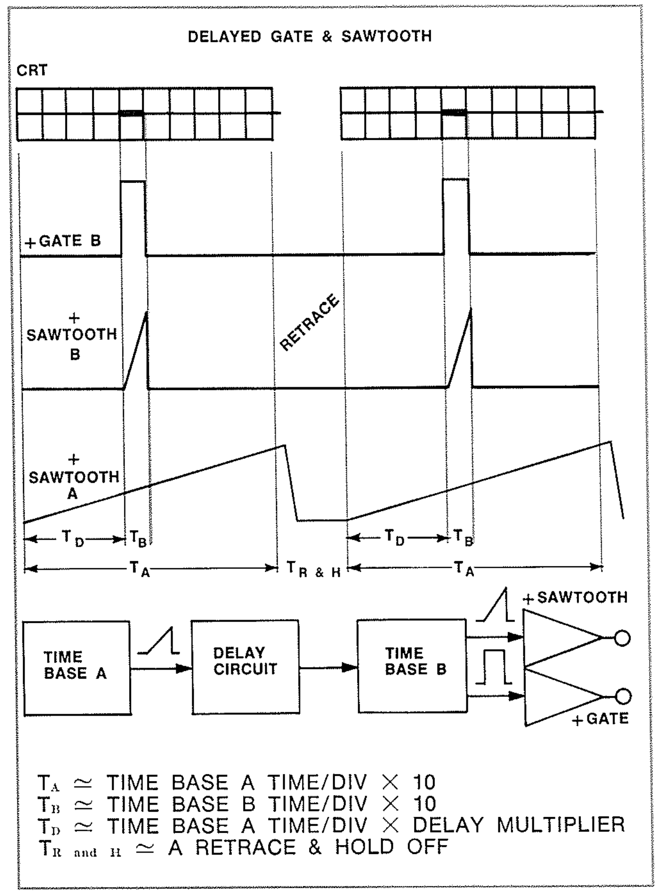
The panel area of a 7704 has four signal source outputs from seven generators and amplifiers.

The 7704, 7504, and the new 7503 have four signal outputs: SAWTOOTH, + GATE, CALIBRATOR, and VERTICAL SIGNAL OUT. The SAWTOOTH and + GATE each originate in time base circuitry; the CALIBRATOR independently produces squarewaves but may be driven by a time base gate. The VERTICAL SIGNAL OUT is derived from the vertical amplifier. An examination of each source in detail follows.

SAWTOOTH AND + GATE

Both gate and sawtooth are produced by time base generators for unblanking the CRT and sweeping the deflection system. A multivibrator produces the gate. This





multivibrator may be triggered or internally caused to free run producing a gate that is integrated, generating a sawtooth for time base deflection. A portion of the sawtooth separately resets the multivibrator. The duration of all time base waveforms is determined by sawtooth rate of change and the reset voltage level of the multivibrator. Duration of gate and sawtooth is therefore directly controlled by the TIME PER DIVISION control. Duration and sweep length in time are, for practical purposes, identical. TIME PER DIVISION times ten divisions approximately equals duration of the + GATE and + SAWTOOTH.

Period of both sawtooth and gate will be duration plus retrace and hold off time. Hold off is a built in interval before the next waveform cycle can occur. It is very significant at fast sweep rates, but becomes inconsequential for medium to slow sweeps. In most cases, the user may use 10 X TM/DIV as an approximation period. It is well worth while to use a second oscilloscope to fully understand the full effects of the *source scope's* controls on its own outputs.

In the 7704, 7504 and 7503 the + GATE can be set as a delayed gate. This is a gate initiated at a selectable time after a delay time base starts. In the 7704 and 7504 a delayed sawtooth can also be produced. The duration of the delayed waveform is determined by the delayed time base TIME PER DIVISION control.

Gates and sawtooths have controllable time relationships with the display and can be used to initiate externally generated events, control swept systems, and provide versatile waveforms for other applications. An example of how the sawtooth may be used is shown on page 13 of this issue.

CALIBRATOR

The 7000-Series Calibrator has the following purposes:

1. Verification of deflection factor accuracy for both voltage and current.
2. Response compensation signal for both voltage and current probes.
3. Verification of mid-range time base accuracy.

Voltage probes have a required compensation adjustment in the range of 500 microseconds. For this reason, the Calibrator in the 7000-Series has a one kilohertz squarewave output. Current probes require longer duration waveforms for adjusting compensation. The 7000 Calibrator provides such signals by using the period of Time Base B divided by two to generate gate periods beyond four minutes. This long period provides a useful waveform for measuring long time constant effects in other circuits. For example: Long duration step waveforms are useful in detection of low frequency bandwidth problems.

7000-SERIES OUTPUT CHARACTERISTICS

+SAWTOOTH OUTPUT

LOAD	RATE OF RISE	PEAK
50 Ohm	50 mV/Div	≥500 mV
1 Megohm	1 V/Div	≥10 V
Short	≥1 mA/Div	≥10 mA

Output Source Impedance 950 Ω ± 2%

+GATE

LOAD	OUTPUT VOLTS	RISETIME
50 Ohm	0.5 V ± 10%	≤20 ns
1 Megohm	10 V ± 10%	—

VERTICAL SIGNAL OUTPUT

LOAD	OUTPUT VOLTS
50 Ohm	25 mV/Vertical Div ± 10%
1 Megohm	0.5 V/Vertical Div ± 10%

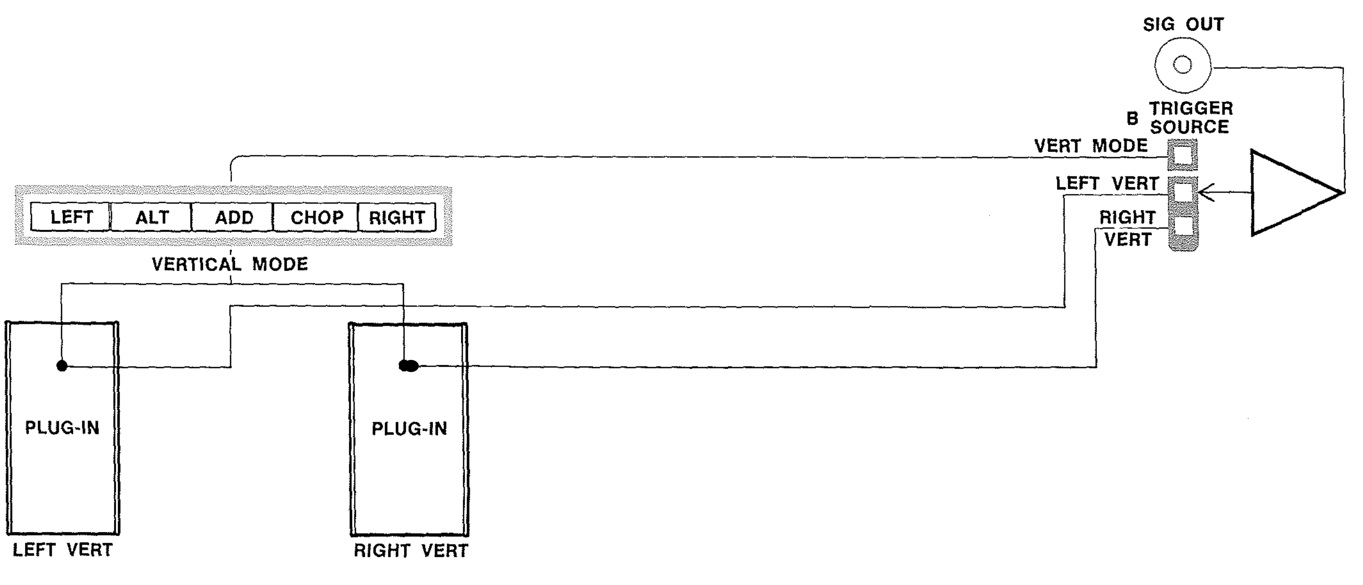
Source Impedance 950 Ω ± 2%

VERTICAL SIGNAL OUTPUT

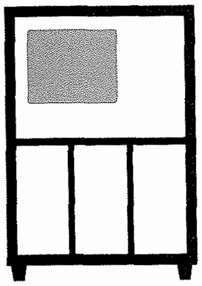
A wide variety of amplified and/or mixed signals may be produced by the SIG OUT circuitry. To fully utilize all possibilities, you must understand the relationship of vertical controls and vertical time sharing to the composite waveform produced.

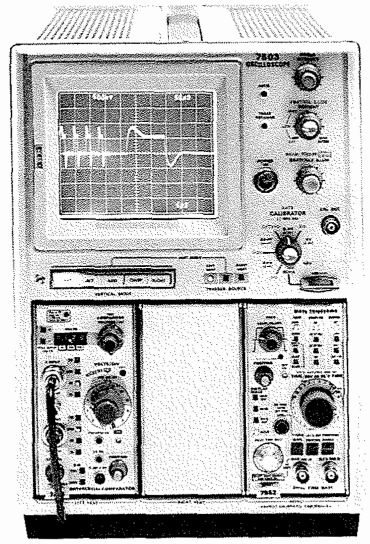
The vertical amplifier signal selected by the **B TRIGGER SOURCE** switch is the signal available at the SIG OUT connector. The character of that signal is affected by several factors. The dc level is directly affected by vertical positioning controls. A measurement should be made of the output level to determine what vertical position should be used if the output dc level is important. Absolute signal voltage out is determined by the vertical deflection factor. For example, the output at 10 millivolts per division deflection factor will be twice that at 20 millivolts per division. Any signal causing off-screen deflection may produce amplitude distortion. Any time shared output will lose information during the switching time. Time sharing, algebraic addition, deflection factor and vertical position all affect the character of the signal out.

The SIG OUT may be used to drive auxiliary devices such as counters, provide composites of two or more signal inputs, or selectively gate a signal on and off.



These 7000-Series push button selectors determine which plug-in signal is amplified and available at the SIG OUT connector. The same "Time Shared" signals driving the CRT are available at the output when B Trigger Source is in VERT MODE. The LEFT VERT or RIGHT VERT buttons of the B Trigger Source switch selects one of the two plug-ins as the output signal source.





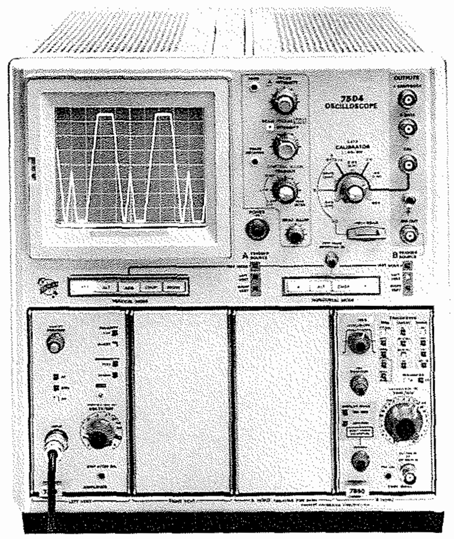
turning easily from one thing to another

Oscilloscope Versatility By Addition

Versatile is a much used word. Repetition of the word has reduced its meaning, but it is still the best one word description of a general purpose instrument. The title of this article, taken from Webster's, is the meaning of versatile that fits the Tektronix 7000-Series. The 7000-Series has new ways to meet your future measurement needs.

The ability to turn easily from one performance characteristic to another has long been associated with plug-in substitution. Since substitution is so firmly established, it is easy to overlook the possibility that plug-in substitution **only** is a limited concept. Limited, if all that is possible is a change from one performance feature to another.

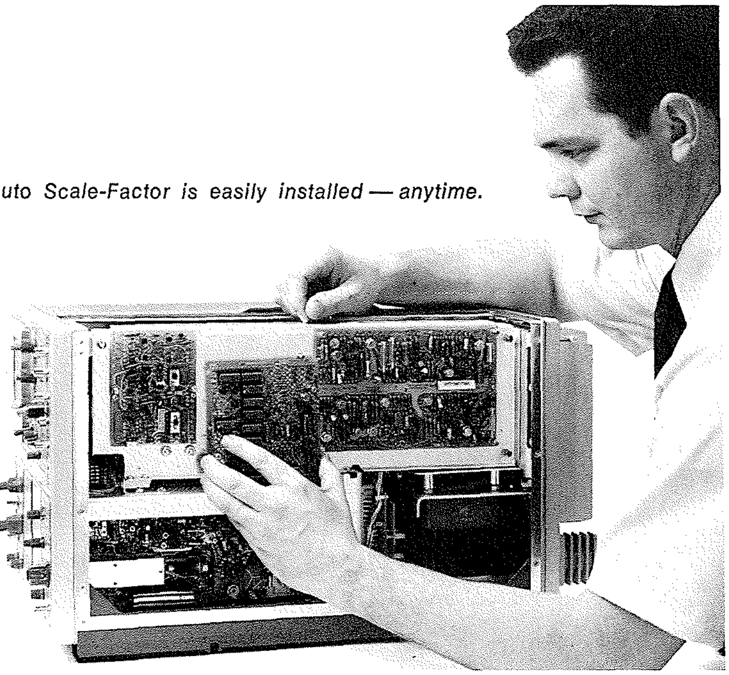
Change of oscilloscope vertical amplifier characteristics was featured in the Tektronix 112 external amplifier 20 years ago. This "outboard" amplifier converted the 10 MHz, 30 millivolt per division, 514 oscilloscope to something else: A 5 millivolt per division, differential input instrument. The outboard approach was soon overshadowed by plug-in methods of substitution. That innovation was introduced by the Tektronix 530/540 Series. Plug-ins were a major contribution in the early 50's. Easy substitution of state of the art, high performance features protected the future value of the plug-in oscilloscope. Substitution was simple and could be done any time. The value of easy substitution by plug-in change immediately became a sought after oscilloscope feature. Performance change by plug-in substitution was extended to horizontal systems with the introduction of the 536, 561, and 647.



Selection of a general purpose oscilloscope is a long term commitment and the instrument selected must serve your needs for many years. It is certain that more features will be required, but precisely what features will be needed is uncertain. Since plug-ins are a proven way to substitute features, when adapting to new measurement needs a plug-in scope is certain to be considered. To meet future needs more completely, the 7000-Series allows the **ADDITION** as well as the substitution of features.

The ability to **ADD** features is built into the 7000-Series oscilloscope. For example: The mainframe circuits will function without plug-ins. Addition of a plug-in time base and plug-in amplifier will create a fully functional oscilloscope. Even when the other one or two plug-in compartments are empty!

Auto Scale-Factor is easily installed — anytime.



Since the present three 7000-Series scopes are fully functional with only two plug-ins you can have a complete single or dual trace, delaying sweep instrument by using just two plug-ins. Plug-in capacity is reserved for future **additional** performance. When it is needed, performance can be easily added to the plug-in features already in use. Attractive blank panels are available to use in the plug-in compartment reserved for future needs.

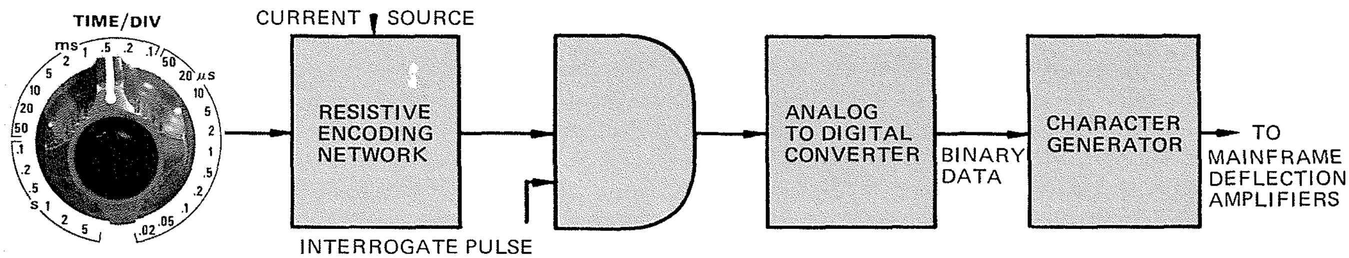
There are currently three oscilloscopes in the 7000-Series family: The four plug-in compartment 7704 with DC to 150 MHz performance, the four plug-in compartment 7504 with DC to 90 MHz performance, and the new 7503 featuring three plug-in compartments and DC to 90 MHz performance.

AUTO SCALE-FACTOR READOUT

The Tektronix Auto Scale-Factor Readout process, very much simplified, involves an analog encoding of plug-in control settings, pulse interrogation of that analog information, A to D conversion, and character generation controlled by the converted data, time shared into the scope's output amplifier. The logic used in the process of Auto Scale-Factor Readout is located either on the plug-in or the plug on character generator board. Because the mainframe does not have the Auto Scale-Factor circuitry hard wired in, a scope user can readily reserve capacity for its future addition. Two or three plug-ins in an Option 1 7000-Series mainframe* is a high performance scope today and an excellent investment in the future. This starter approach, without Auto Scale-Factor Readout, allows advanced scope performance today at minimum cost. Option 1 reserves capacity for future AUTO SCALE-FACTOR READOUT with no cost penalty.

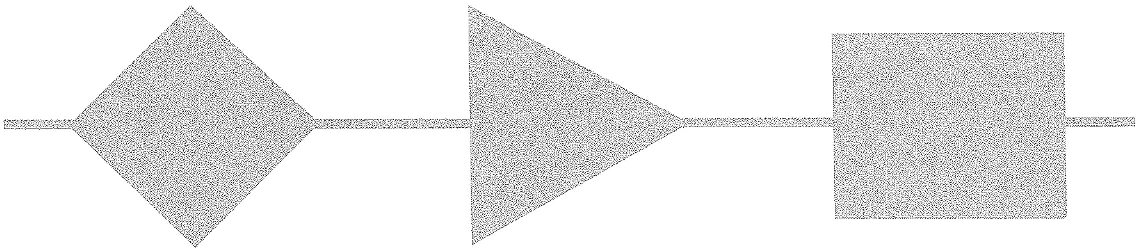
The 7000-Series Readout includes 50 characters. The CRT display can include up to 8 words of 10 characters each. Two words are controlled by each plug-in in use. Complete sets of Scale Factors for voltage, current and time plus symbols and words for polarities, greater than and identify are generated as appropriate.

*Listed in the 1970 Catalog on page 34 as OPTION 1.



SIMPLIFIED AUTO SCALE-FACTOR READOUT

SERVICE SCOPE



TROUBLESHOOTING SAMPLING SYSTEMS PART II

By Charles Phillips

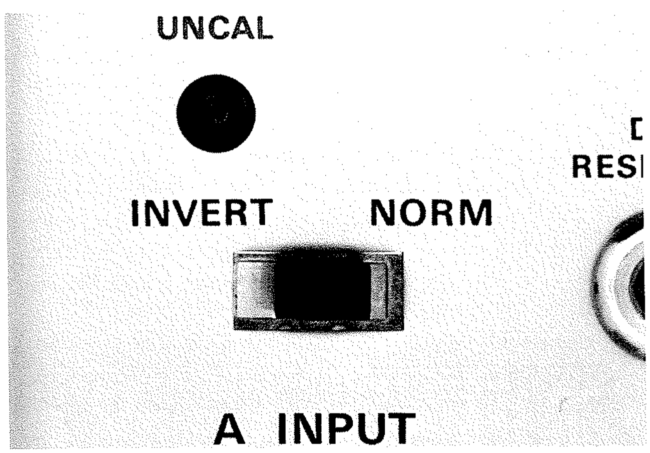
Product Service Technician, Factory Service Center

In the last issue, we covered the vertical circuitry of a "composite" Tektronix Sampling Oscilloscope. This issue discusses troubleshooting the typical horizontal system of that scope.

A spot or trace on screen is very useful in analyzing and finding problems in any scope. To eliminate the effects of most vertical problems, slip the NORM/INVERT switch to its center. A trace or spot will be centered vertically except when the vertical output circuits are defective. Use the horizontal position control to verify that the horizontal deflection amplifier is functioning.

In the absence of a trace, rotate the trigger sensitivity control. If no time base appears, switch to a manual scan mode. In manual scan, a variable DC voltage is substituted for the staircase equivalent time base. The manual scan should plot a horizontal line.

After you have established that the horizontal amplifier and staircase circuitry are operating, set the NORM/INVERT switch to NORM. Now let's proceed to the trigger circuitry. Regenerated trigger pulses should appear at the front panel trigger output connector or at the input to the fast ramp stage if the trigger circuit is operative. Use the trigger sensitivity control over its full range until trigger waveforms appear.



Slide switches of this type "break before make". This allows the troubleshooter to select a mid-range break position that opens the input to the output amplifier.

We now proceed to the fast ramp and comparator. With the regenerated trigger operational, a timing ramp of short duration should be generated. At the input to the comparator, a slewing ramp waveform should appear on a test scope. This slewing waveform verifies operation of the fast ramp and comparator. When the staircase is not functioning, the manual scan may be substituted for the staircase to analyze the fast ramp and comparator.

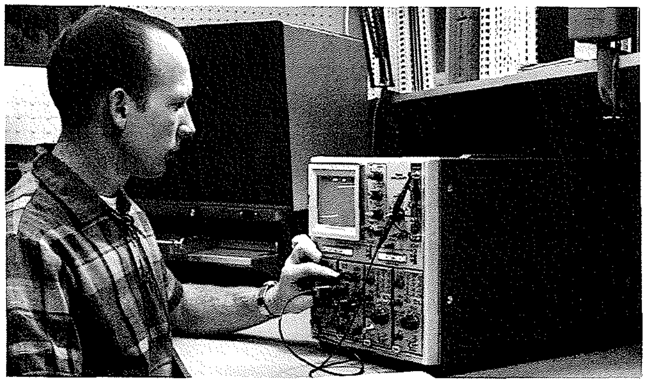
GENERAL TROUBLESHOOTING TECHNIQUES

The techniques used in troubleshooting sampling circuits are generally the same as for any other circuit. You should know the function of front panel controls and how the circuits work. In any malfunctioning circuit, transistors and tunnel diodes are the most suspect components. Here are some of the techniques that we have found helpful in locating defective components.

If you have a unit that is intermittent or drifts, routine checks may reveal no problem. Use a small, portable hair dryer to apply heat to the area where a problem is suspected. Then cool that area with spray-type, circuit cooler. The quick change in temperature will normally cause a defective component to malfunction severely. In many cases, the component will open or short. Locating the defective part should then be easy.

Elusive intermittents are often nailed by using circuit cooler and a hair dryer.

Some tunnel diode troubles are hard to detect. For example, the sampling system may operate, but the operation is not "normal". Triggering insensitivity, display jitter, balky time base operation all may be caused by a sluggish tunnel diode. A Tektronix 576 or 575 Curve Tracer is a very valuable instrument for identifying marginal tunnel diodes and transistors. A sluggish tunnel diode develops excessive voltage before switching. A slower "turn on"



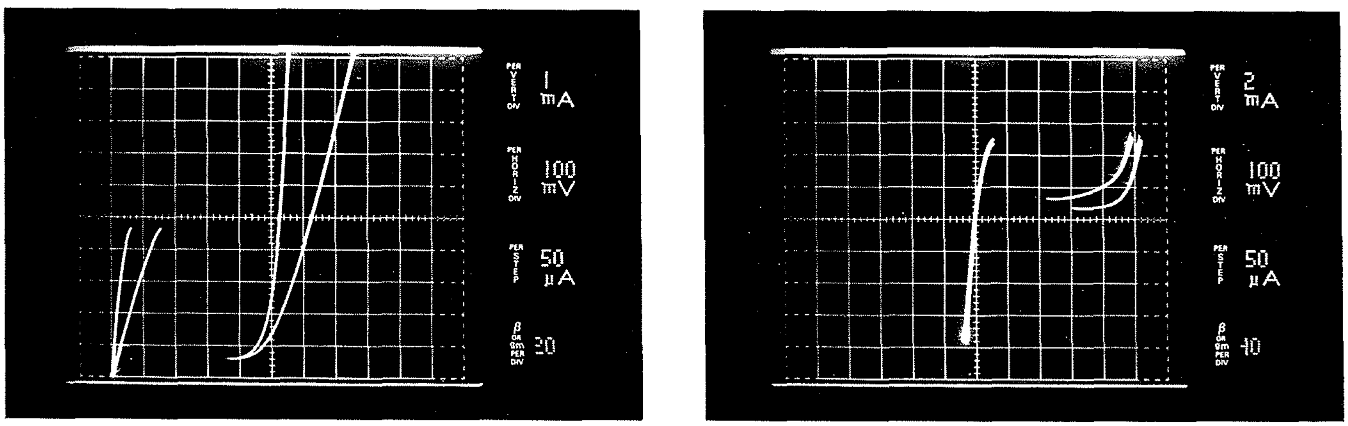
Chuck Phillips uses the 7504 Oscilloscope Sawtooth to verify correct TD performance.

voltage than normal results. A good tunnel diode will switch at about 100 mV. A sluggish tunnel diode can develop 200 mV or more before switching.

Other methods of testing tunnel diodes are helpful where no curve tracer is available. The sawtooth output from a scope may be used to drive the tunnel diode to determine its switching point.

The sawtooth on a 7000-Series scope is a handy tunnel diode test signal. 10 mA or less TD's may be checked by placing them across a probe from ground lead to tip. The tip is then touched to the sawtooth output. The resulting display will show the voltage across the TD in the vertical axis. Each horizontal division will represent approximately one milliampere. A good 4.7 mA device will switch between the fourth and fifth horizontal division and develop about 500 mV. Caution: Some other scope sawtooth outputs are not current limited; a limiting resistor must be used.

Go, No/Go tests may be made with the multimeter. With power on, an in circuit voltage measurement across a tunnel diode should read 200 to 600 millivolts. A reading of 0 volts or substantially greater than 600 millivolts is a good indication of a shorted or open tunnel diode.



Marginal Tunnel Diodes are quickly detected with Tektronix 576 Curve Tracer. In the left photo, the "good" TD switches at 4.7 mA and 60 mV. The "poor" unit develops 160 mV before switching at 4.7 mA. The right photo shows "acceptable" waveforms made with the AC position of the 576. The AC Mode is a full sinewave sweep mode useful in making quick diode checks. It eliminates the need to observe diode polarities. (Photos are double exposed.)

PROBLEMS & CHECKS

Horizontal Amplifier

Problem: Position control will not move trace or positioning range is not normal.

Check: A. Sweep centering adjustment for proper centering.
B. Output stage for unbalance.

Problem: Display compression or expansion.

Check: A. Output stage.

Staircase Generator

Problem: Sweep starts at a different point on screen than it does in the manual scan position.

Check: A. Staircase DC level adjustment.
B. Output stage tube, nuvistor, or transistor.

Problem: No single sweep operation when in the single sweep mode.

Check: A. Tunnel diode stage in staircase circuitry.

Fast Ramp

Problem: Sweep nonlinearity at beginning of trace.

Check: A. For proper adjustment of the comparator.
B. Comparator tunnel diode.

Problem: Slashing between dots or other indications of improper blanking or unblanking.

Check: A. Transistors in the staircase inverter circuit.

Problem: Time base calibration changes with different values of trigger sensitivity.

Check: A. Transistor at input of the fast ramp where the regenerated trigger signal is applied.

Problem: Center of time base is nonlinear.

Check: A. Nuvistor or transistor in sweep calibration adjustment stage.

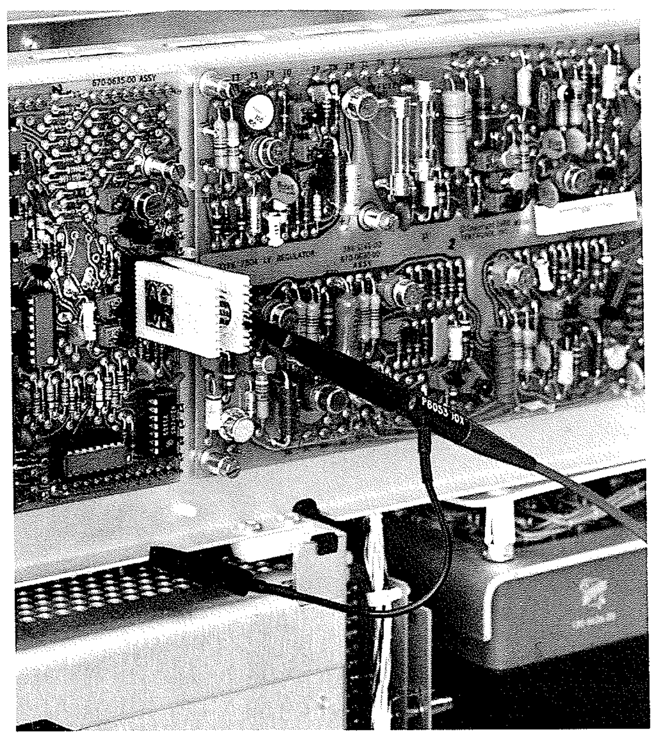
USEFUL IC TOOLS

Integrated circuits are showing up everywhere. Here are several handy IC handling tools available through your *local suppliers.*

The first item is particularly useful in removing TO5 case devices. This tool, manufactured by The Ephrata Tool Co., has tips that grip the TO5 case securely for pulling out of sockets or boards. This tool also has a handy set up for trimming TO5 leads neatly and easily.

Integrated Circuit Test Clip manufactured by AP Incorporated snaps over a 16 pin line like a clothes pin. It provides accessible test points and can help you pull suspect IC out of sockets and boards. Two sizes are available: 0.3 inch #923700 and 0.5 inch #923702.

Trimming individual leads on integrated circuits and transistors is a nuisance. This Ephrata cutter does the job with less effort.

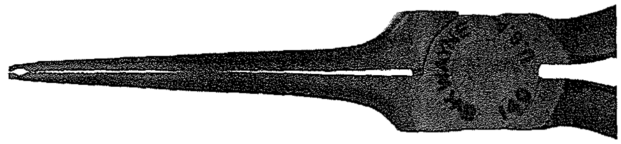


Dual in-line integrated circuits often lack convenient probe test points. The AP, Inc. test clip simplifies the probing job.

MODIFIED AND DO IT YOURSELF TOOLS

From time to time, we mention tools that are commercially *available through local suppliers.* These tools are mentioned as a service to people who are concerned with the responsibility of insuring instrument quality.

We occasionally mention standard tools modified to ease a particular job. These tools will also be readily available from your local suppliers and you can make the modification.



Sampling gate diode characteristics are critical to sampling system performance. It is generally best, for that reason, not to touch the body of the diode while performing any checks or replacements. If you do touch them, don't be overly concerned; they probably will be still okay.

A long-nose pliers may be easily modified to facilitate insertion and removal of gate diodes without touching them with your fingers. Grind out a groove on each jaw near the tip and you will have a handy device to use in tight spaces. The long-nose pliers that you modify should be of a type that does not normally develop high, crushing pressures at the tip. A type with jaws almost as long as the handles is good.

Occasionally, you will find an adjustment in a spot where a long, flexible screwdriver would be handy. A simple and easy to make tool has been used to advantage by some of our people. Take a 12 inch length of number 14 buss wire, flatten the end and slip a piece of spaghetti over all but the ends. Take a small knob (of a type used on small shafts) and fasten to round end of the "screwdriver" shaft. You now have an insulated tool to use in recessed narrow areas for low-torque adjustments.

INSTRUMENTS FOR SALE

3S1, 3T77A $1700. William McPerson, Powers Wire Products, 10180 E. Valley Blvd., El Monte, California 91731. (213) 283-0321.

531 with 53/B Plug-In. $500. Chuck Frederickson, Univac Fed. Systems Division, 475 No. Prior Avenue, St. Paul, Minnesota 55104. (612) 645-8511, Ext. 3308.

525. $550. Mr. L. R. Roche, Dyna Technology, Inc., Sioux City, Iowa 51102. (712) 252-1821.

547, 1A1. Scope-Mobile Cart. $1950. George Payne, 806 Third Avenue, Sweet Home, Orgeon 97386. (503) 753-8482.

517A. Henry Thomas, Electronics Department, McAllen High School, 2021 LaVista, McAllen, Texas 78501.

310A. $600. Tom Fisher, Standard Communications, 620 E. 219th Street, Torrance, California 90502. (213) 775-6284.

107. Price open. Mike Brady, Instrumentation Services, 957 Winnetka Avenue North, Minneapolis, Minnesota 55427. (612) 545-8916.

517. $1000. 514D. $100. Dennis R. Menges, FMC Corporation, 220 South Belmont Avenue, Indianapolis, Indiana 46206. (317) 632-5411.

547, 1A1, 1S1. All for $3000 or individually. Palmer Agnew, 314 Front Street, Owego, New York 13827.

3B4. $300. Mr. Moss, Eastwood Industries, 1101-11 West Armitage Avenue, Chicago, Illinois 60614. (312) 472-8662.

190B. $275. Bob Lightner, Audio Supply, 81 North Atlantic, Cocoa Beach, Florida. (305) 783-3062.

545S6. $900. Mr. M. Stephanski, Deltron, Inc., Wissahickon Avenue, North Wales, Pennsylvania 19454. (215) 699-9261.

575, Mod 122C. $900. Jack Fields, Carrier Corp., Carrier Parkway, Syracuse, New York 13201. (315) 463-8411, Ext. 3365 or 3366.

547, 1A1, 111. Mr. Tibol, Semi-Elements, Inc., Saxonburg Blvd., Saxonburg, Pennsylvania 16056. (412) 265-1581.

661, 4S2, 5T1A, $2000. John McAlpine, Linear Accelerator Lab., University of Saskatchewan, Saskatoon, Saskatchewan. (306) 343-4511.

545 with plug-ins 53/54C, 53/54L, M. $750. D. K. McDonald, Electronic Systems, P.O. Box 20391, Denver, Colorado 80220.

454 with extras. $2200. Hull Industries, Santa Monica, California (213) 451-2215.

LC130, 317, 503, 515, several 530/540 Scopes with plug-ins. Henry Posner, Pacific Combustion Engineering Co., 5272 E. Valley Blvd., L.A., California 90032.

561B, 3S2, 3T2, Two — S2 heads. Wilmar Electronics, 2103 Border Avenue, Torrance, California 90501. (213) 320-6565. Price for all units — $2250.

3T77. $325. 3S3. $750. Al Nelson. (303) 733-0421.

180 Time Mark Generator $150. Plug-In Units, 53C $95, 53/54K $75, "S" $50, 545 $850. Jim McKim, 5601 Del Cerro Blvd., San Diego, California 92120. (714) 583-4076.

561, Plug-Ins 2A61, 2B67, $650. Paul F. Fitts, Innovatek Enterprise, Smithfield Road, Millerton, New York 12546. (914) 373-9122.

INSTRUMENTS WANTED

555. Henry Thomas, Electronics Department, McAllen High School, 2021 LaVista, McAllen, Texas 78501.

570. Chris McIntyre, 13 Laurel Village, Beaufort, South Carolina 29902.

422. George Rademacher, Jr., Georges Mfg. Corp., 9915 Pacific Avenue, Franklin Park, Illinois 60131. (312) 625-5868.

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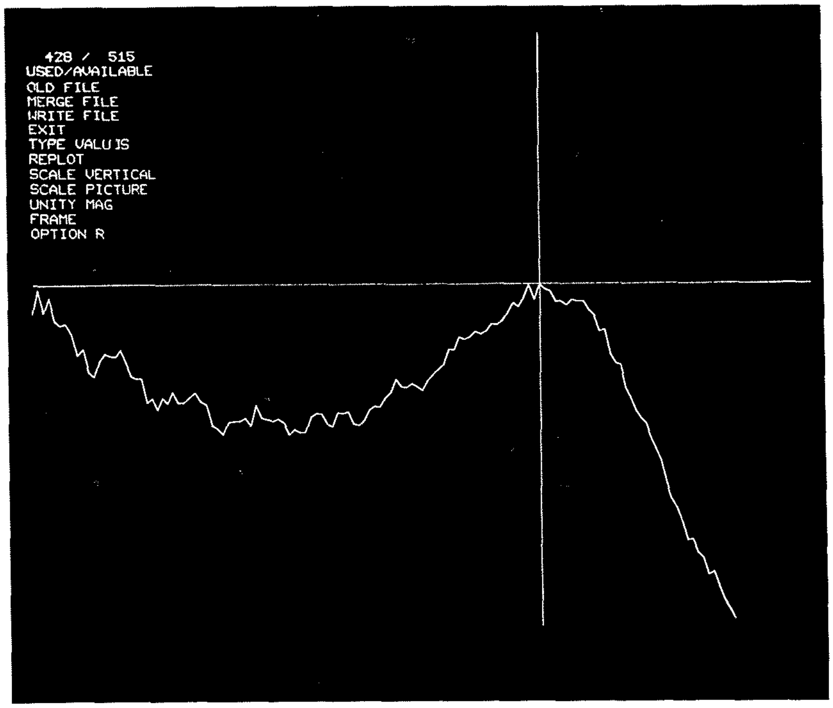

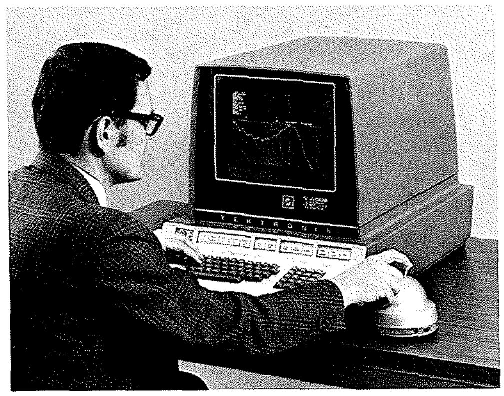

Interactive Graphics

It is easier to point to a location than to describe it. That is a fundamental concept in Tektronix Interactive Graphics. Interactive Graphics is the operation of pointing when a man talks to machine about a graphic display.

Pointing in communications between people is a mechanical action, visually interpreted. Pointing in communications between man and computer is a mechanical action by the man, electronically interpreted by the computer through a computer terminal.

The CRT in graphic terminals is a one-way device. It displays, but *it does not see.* It has no electrical characteristics that are easily used for seeing information from the man. You **cannot point** anything at the display CRT and have the CRT see the point.

There are ways to point to locations on CRT's and have the computer terminal "see" that location. On a refreshed CRT, any point on the CRT face is scanned repeatedly with a process similar to that used in television. Scanning is a precisely timed process. If a photosensitive device is pointed at a CRT, an electrical pulse is developed each time that location is scanned. This pulse has a *time* relationship in the scan sequence that can be processed and communicated to a computer. The photosensitive device is generally called a LIGHT PEN.

LIGHT PENS are commonly used with refreshed CRT's, but they cannot be precisely placed on the location pointed to. Mechanical parallax results from the separation of the display and the CRT surface. Other parallax problems are caused by electronic dissimilarity between separate write and read circuitry.

The Tektronix T4002 Graphic Computer Terminal uses a **pointer** that is unique, accurate, and simple. This pointer uses the write-through function of the Tektronix Bistable Storage Tube to eliminate mechanical parallax. A cross-hair cursor (pointer) is written through the stored graphic display. The terminal operator points by *positioning* the cross-hair cursor on the graphic display. On command, A to D conversion precisely *defines the location in* digital form. This data is sent to the computer. Now, the computer can see the operator's point within one least significant location bit.

The pointing device used by the operator can be a mouse, scratch pad or the Tektronix Joystick. The Joystick is an accessory to the 4901 Interactive Graphic Unit. The 4901 can communicate location precisely on the T4002 Graphic Computer Terminal because the voltages developed by the Joystick, or any similar device are **seen** by the same circuitry used to plot the *original, computer-generated* display.

The Tektronix T4002 Graphic Computer Terminal with the unique **4901 INTERACTIVE GRAPHIC UNIT** achieves no parallax, two-way graphic communications.