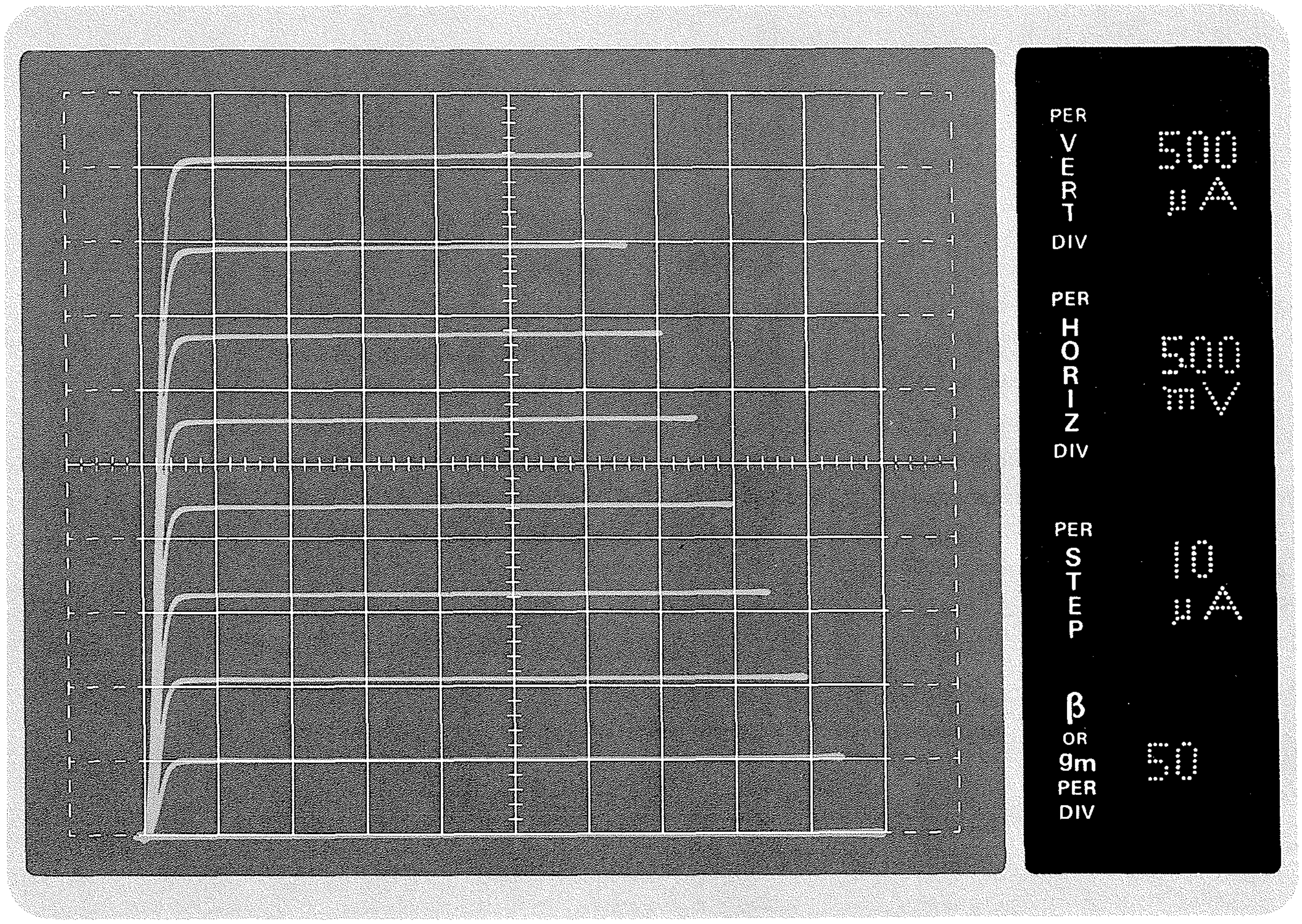
TEKSCOPE

FEBRUARY 1969



A NEW DIMENSION IN CURVE TRACING . . . readout and other advanced features provide new measurement capabilities . . . page 3 SERVICE SCOPE . . . beginning, a guide for localizing instrument problems . . . page 8 AN EXTENDED VALUE . . . 2 new oscilloscopes and 25 plug-ins offer a wide spectrum of performance . . . page 12

TO OUR READERS

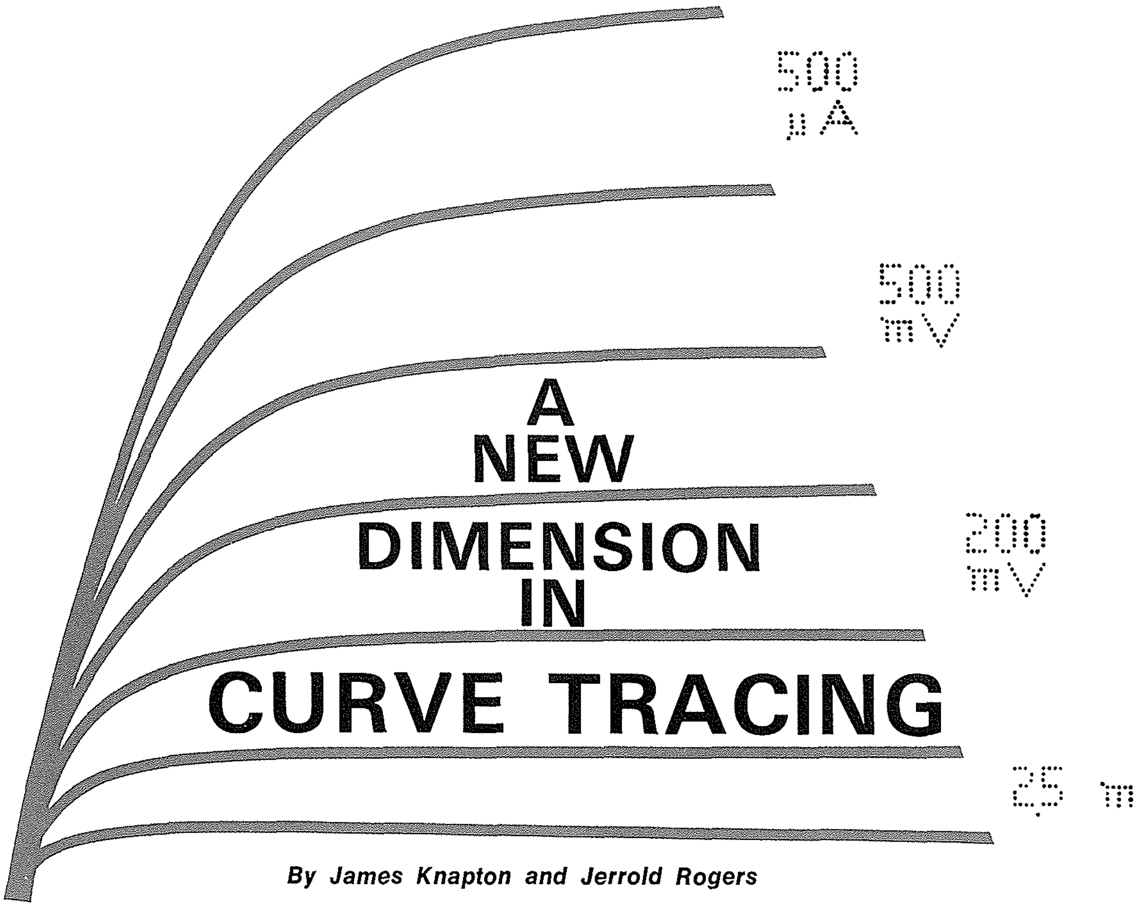
WELCOME TO TEKSCOPE. You may have noticed a change in SERVICE SCOPE over the past few issues. Our new name more accurately reflects our continuing effort to provide informative articles, presented in a readable manner, across the whole of Tektronix technology. Each issue of TEKSCOPE will contain articles describing instruments, measurements, and techniques.

SERVICE SCOPE remains as a feature of TEKSCOPE and will continue to provide information for those responsible for the quality of instrument performance.

We appreciate your interest in Tektronix and welcome your comments on our format.

NOTE: If the address on your issue is incorrect or if you have a friend who would like to receive TEKSCOPE, please call or drop a note to our nearest field office.

COVER: The Type 576 Curve Tracer combines a large-screen CRT with a unique readout capability to provide a new standard for semiconductor measurements (shown actual size).



A NEW DIMENSION IN CURVE TRACING

By James Knapton and Jerrold Rogers

Digital readout of vertical and horizontal deflection factors, step amplitude, and beta/div simplifies curve-tracing measurements substantially. This unique capability, combined with extended measurement characteristics provide an outstanding curve tracer value.

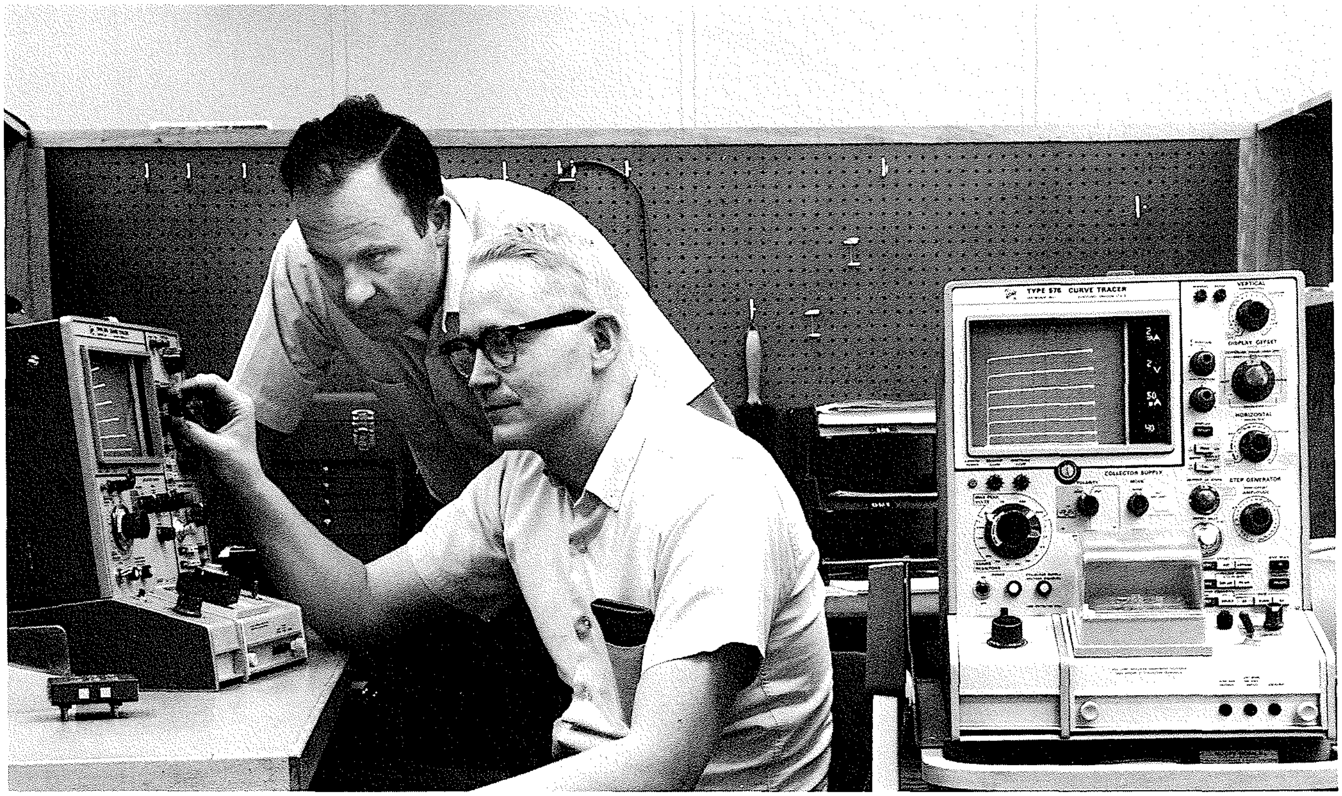
The Type 575 Transistor Curve Tracer was introduced over 10 years ago, when the semiconductor industry was in its infancy. At that time, the Type 575 Transistor Curve Tracer became established as an industry standard. Since that time, semiconductors have improved greatly and semiconductor technology has expanded to include not only transistors and diodes, but tunnel diodes, zeners, FET's, MOSFET's, SCR's, unijunctions, and a number of other useful devices.

The Type 576 is designed to meet the current and future measurement needs for these devices. In addition, the construction techniques utilized allow the instrument to adapt should related measurement needs arise.

The Type 576 is designed with a plug-in test-fixture so that operating characteristics may be changed substantially without affecting the basic instrument. This capability provides the Type 576 with greater flexibility in meeting future measurement requirements.

The most apparent development in the Type 576 is the readout feature. The fiber-optic readout display has been placed adjacent to the CRT where the user normally focuses his attention. Combining readout with the display accomplishes 3 important tasks: 1. The readout takes into consideration magnifiers and multipliers, and especially simplifies operation for new or infrequent users; 2. The necessary information for interpreting curves is automatically included on photographs, eliminating the possibility of incorrect labeling; 3. The simple, but bothersome arithmetic required to compute beta/div and g_m/div is automatically performed, eliminating another potential source of measurement error.

The readout logic, fiber-optic transmission system, and character readout sections have been placed on a single circuit card. This design concept makes it possible for the instrument to be purchased with or without the readout capability.



James Knapton, Project Manager, and Jerrold Rogers, Project Engineer, displaying a family of curves on the Type 576.

PROTECTIVE CONSIDERATIONS

An interlocked cover over the test terminals protects the operator from accidental shock in the 75-V, 350-V, and 1500-V ranges. A red light on the front panel warns the operator when dangerous potentials are present on the collector terminals. A yellow front-panel light informs the operator that the protective box must be engaged in order for the instrument to function properly.

A unique interlocking knob arrangement between the collector voltage ranges and the selectable series resistors offers a device protection feature. These concentric knobs allow the maximum power limit to be preset. As the voltage range is changed, the correct series resistors are automatically inserted to maintain the correct power limit. Six positions are available from 0.1 watt to 220 watts. This feature protects the device under test from overheating and relieves the operator of the necessity of computing which series resistor is required for device protection.

COLLECTOR SUPPLY INCLUDES DC MODE

Different modes have been incorporated into the collector sweep circuitry to provide the instrument with maximum versatility. A normal mode is provided which consists of positive or negative full-wave rectified AC (line frequency). This is the conventional mode for most measurements.

An AC mode supplies an unrectified line-frequency sweep symmetrical about 0 for viewing both forward and reverse characteristics on the same display. This is particularly useful for diode and FET testing since reverse breakdown and forward conduction characteristics may be observed simultaneously.

A DC mode provides positive or negative DC which can be swept manually by varying the variable voltage control from minimum to maximum. In this mode filter capacitors are switched into the collector supply output and the display is composed of a dot at the end of each curve. Manually varying the supply slowly traces out the curves. This mode is of particular interest when measuring low currents where trace looping, caused by device capacitance, limits resolution.

A leakage mode operates in conjunction with the DC collector mode and increases the vertical sensitivity 1000X allowing 1 nA/div displays. In this mode, the Type 576 monitors current into the emitter terminal instead of the collector. The leakage mode provides high-sensitivity displays for observing any two terminals of a device. The 1-nA/div position of this mode provides an excellent means of measuring diode leakage.

NEW DISPLAY CAPABILITIES

One of the most useful features of the Type 576 is the calibrated display offset with magnifier. This function provides 20 half-cm increments of position change (20 5-cm increments with 10X mag). Using this mode, the gain of either the vertical or horizontal deflection amplifier can be increased 10 times. This capability provides a 100-cm display on either axis with the calibrated offset showing precisely which portion of the display is being viewed. Use of display offset also increases accuracy substantially as shown in the figure below. Note that 2% measurements are typical over the largest range of the display area.

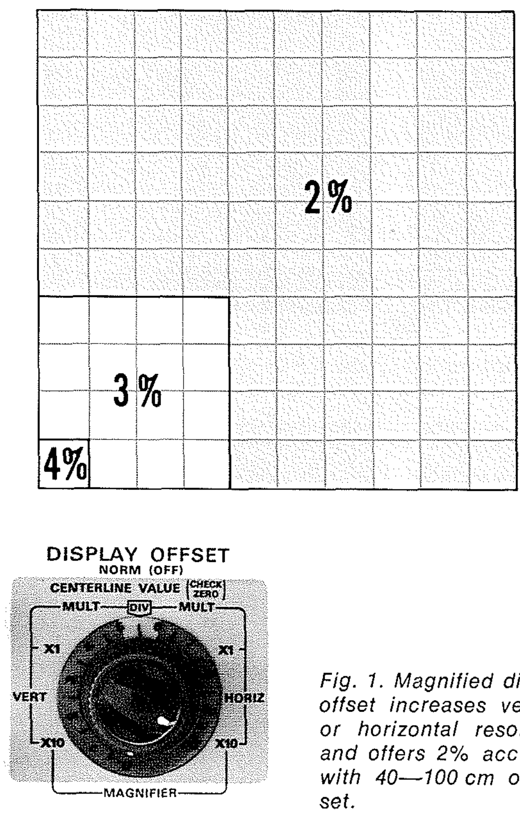


Fig. 1. Magnified display offset increases vertical or horizontal resolution and offers 2% accuracy with 40—100 cm of offset.

Both the vertical and horizontal positioning controls consist of a 5-position switch that positions the origin exactly 5 cm or 10 cm in either direction from normal. In addition, a concentric variable knob provides fine positioning ($\approx$5 cm). The polarity logic automatically positions the origin of the display from lower left corner to upper right corner when the collector sweep is changed from NPN family to PNP family. When switching to AC collector sweep, the origin is automatically positioned to center screen. A display-invert switch is provided for easy overriding of this logic, should it be desired to compare NPN and PNP in the same quadrant.

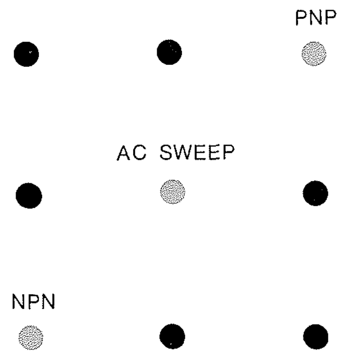


Fig 2. Automatic Display Positioning. NPN, PNP, and AC origins (blue) are automatically positioned when selecting the collector polarity. The detented position knobs (5-cm steps) allow quick positioning as shown above. The variable controls position the origin where desired.

STEP OFFSET PROVIDES NEW VERSATILITY

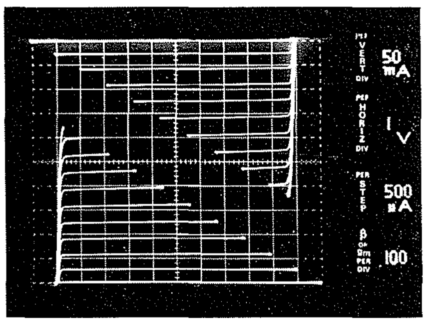
The step generator has been designed for maximum flexibility. A 10-turn calibrated control provides the ability to offset a complete family of steps. The first step may start from any DC level between 0 and 10 times the amplitude of one step. The operator may select the DC offset level to aid or oppose the steps. For example, negative DC voltage may be selected, allowing positive steps to start below the 0 bias point of a FET. By turning the step generator off, the DC offset level provides one curve operation for determining thresholds. This is a particularly interesting configuration since the curve is continuously variable over the wide range of currents and voltages available.

TYPE 576 MEASUREMENTS

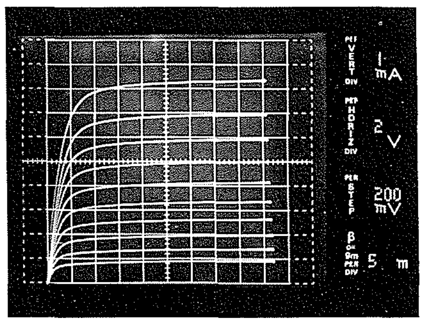
The wide range of base steps, the calibrated step offset, and the pulsed mode of operation provide the Type 576 with a truly versatile base step generator. The multi-mode collector supply (swept, DC, or AC), with its DC—1500 V range allows measurements over a wide spectrum. The vertical and horizontal display amplifiers, combined with the calibrated display offset with magnifier, provide a 2% measurement capability with 10X the resolution of a normal display.

Improved fixturing on the Type 576 extends versatility in making more tests with a greater number of device packages. Dual configurations are easily compared and the **DISPLAY INVERT** feature simplifies comparison of complementary devices. The use of Kelvin contacts in the high-current device adaptors minimizes the effect of voltage drops due to contact resistances. (Kelvin contacts bring the collector and emitter/voltage-sensing leads directly to the device, thus eliminating adaptor-to-test fixture and transistor-to-adaptor contact potentials).

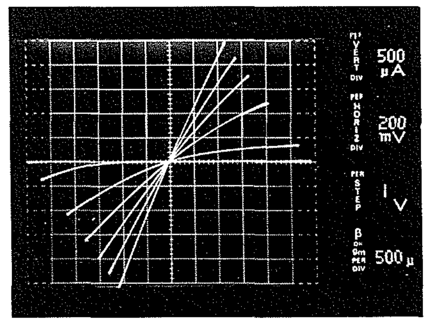
The waveforms below illustrate a few of the measurements that are easily made on the Type 576.



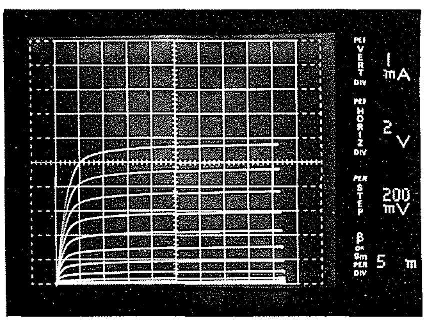
*Double exposure of PNP transistor. Only the **DISPLAY INVERT** was used to reposition the display.*



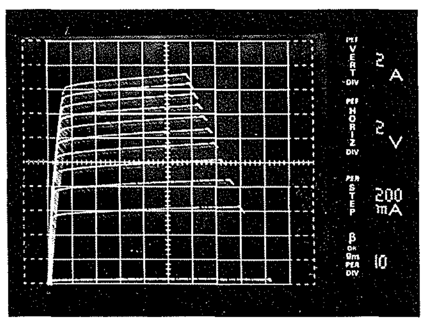
Enhancement and depletion modes of a FET. Opposing DC step offset starts + steps below zero bias point.



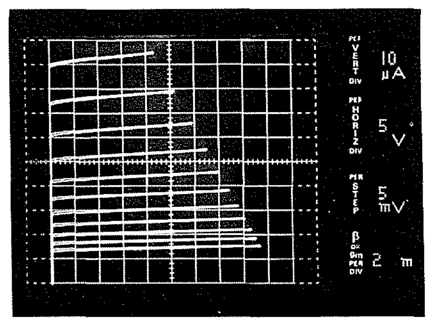
AC sweep permits FET measurements in the resistive region.



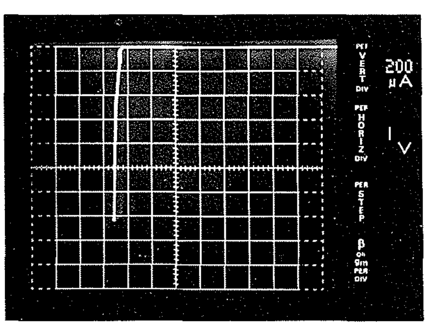
MOSFET drain family in depletion region.



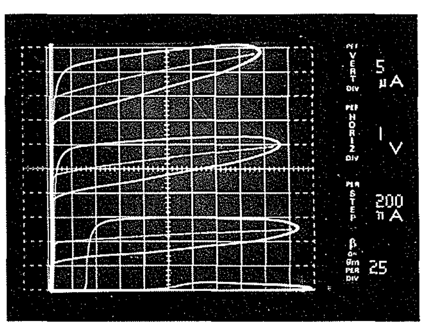
Power transistor with 17 A collector current. The 80-µs pulsed mode with DC collector and manual scan is used.



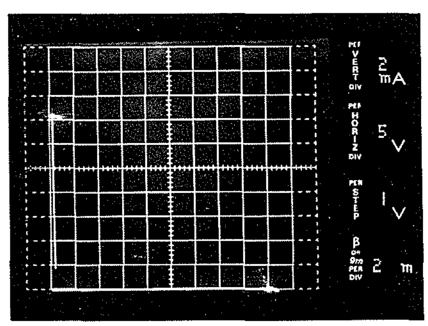
600-mV step offset positions small voltage steps within the transistor active base region.



Display offset with magnifier increases measurement resolution and accuracy. Center line value of 70 V shows zener voltage of 72.6 at 1 mA.



Double exposure. Looping caused by collector-to-base capacitance is eliminated by using the DC collector mode with manual scan (center lines).



SCR measurement in 300-µs pulsed mode measures holding current. Calibrated, variable DC offset allows direct reading of gate-firing potential.

Families of 1-10 digitally selectable steps may be observed. The single family mode normally holds the step generator off and, when triggered, provides one family of curves. Base step rates are NORM (1X the normal collector supply rate which is twice the line frequency), 0.5X and 2X. The wide step amplitude range provides current steps of 200 mA to 5 nA or voltage steps of 2 V to 5 mV. Combining maximum step offset and maximum step amplitudes (AID) provides maximum base voltages to 40 V. The maximum base current is 2 A.

PULSED BASE OPERATION

The Type 576 provides pulsed base operation in which steps are pulsed for either 80 μs or 300 μs selectable from the front panel. In this mode the base drive is applied for only a portion of a cycle and thus, the device is turned on only for short periods of time. This mode automatically connects in the DC mode collector supply to protect the device under test (the fast transitions of the narrow pulses combined with the leakage inductance of the collector sweep transformer could cause a harmful transient). This approach makes it unnecessary to degrade risetime (effective increase in pulse width) and lessen pulse definition. The 300-μs position is useful for checking power transistors while the 80-μs position is useful primarily for measuring small signal transistors at high power. This mode is particularly useful since it allows many devices to be checked without heat sinks. In addition, device characteristics may be viewed at higher power without exceeding safe dissipation limits.

The physical appearance of the Type 576 is unique to the Tektronix product line. Since curve tracers are not generally rackmounted, the front panel was sloped to permit better readability. The "front porch" design provided additional front-panel space and simplified the test fixture plug-in design.

Color has been extensively used on the Type 576 front panel to simplify operation and interrelate controls. For example, black push buttons indicate a single button function which are out for the most common operation, i.e., invert or 0.1X steps. Dark gray is used to denote the common mode of operation in multiple functions, such as zero offset, repetitive family, and base steps. Light gray buttons are used for all other options. Blue is used to relate the display offset relationships; green is used to relate the step generator polarity functions; yellow is used to relate controls for step generator voltage operation; and orange is used to signify the leakage mode setings. This liberal use of color allows the operator to set up individual tests with a minimum of difficulty.

The Type 576 is designed to minimize service problems. Low-voltage power supplies are short-proof and plug-in transistors and IC's are used throughout (including socket-mounted power transistors). Construction is all solid state with the exception of the CRT itself. For further information consult your local field engineer.

576 MEASUREMENT CAPABILITIES

DEVICE	FEATURES
DIODES	1 nA/div sensitivity for leakage measurements — 1500-V collector supply — Kelvin sensing for accurate high-current measurements.
FET's	40 V (step + offset) available for base drive — Step offset allows stepping through zero bias — 1 nA/div sensitivity measures gate leakage — AC sweep allows examination of resistive region.
SCR's	Calibrated variable step offset accurately determines gate firing potential — Holding current may be read directly.
POWER TRANSISTORS	Kelvin sensing for accurate high-current measurements — Pulsed base allows high-current beta measurements without exceeding dissipation limits or requiring heat sinks.
TRANSISTORS	EXTENDED RANGES ON ALL TRANSISTOR MEASUREMENTS — Small steps on top of 600 mV of offset permit observing several voltage driven steps within the active region.
TD's	AC sweep displays forward and reverse characteristics simultaneously.
ZENERS	High-resolution 2% voltage measurements of zener region.

SERVICE SCOPE

TROUBLESHOOTING YOUR OSCILLOSCOPE

By Charles Phillips
Product Service Technician
Factory Service Center

This first article of a series, discusses general techniques for localizing problems to one of the major blocks of an oscilloscope. Future articles will go into more detail on troubleshooting a major block to pinpoint a faulty stage or component.

The oscilloscope is an excellent tool for self diagnosis. In addition to the CRT display, front-panel indicators (trace-position indicators, trace finders, and pilot lights), and calibrator signals often provide sufficient information to isolate the problem.

Observing the effect of multi-function switches can do much to identify a problem. For example, using the second channel of a dual-trace unit can check vertical circuitry up to the point where switching occurs. In the case of a delaying-sweep or dual-beam oscilloscope, a portion of the circuitry may be used to display information on the oscilloscope itself. Detecting a common problem in all circuits indicates a problem in the power supply.

Switching to the external horizontal input, disconnects the sweep and is a means of determining whether a problem is associated with the horizontal amplifier. At the same time, it can indicate the condition of the unblanking circuitry.

Varying the trigger source switch between internal and external triggering checks the trigger pickoff circuitry. If the sweep will free run by adjusting the stability and trigger level control, additional circuitry may be checked. Comparing operation in different trigger modes can often localize a problem to a specific trigger stage.

Vertical preamplifier plug-in units are a quick way of checking performance to the vertical amplifier input. Once a problem is isolated to a specific plug-in unit, plug-in circuit boards (if used), may isolate the problem even further. Once a problem has been traced to a specific block, a close visual check may pinpoint the problem. Often times burned components or loose leads can be spotted that shorten the troubleshooting job. Substituting the tubes or transistors offers a quick means of checking a suspected stage. **Always** return the original component to its place if the problem remains.

FRONT-PANEL CONTROLS

The first step in a logical troubleshooting procedure is to preset the front-panel controls in order to be sure that the problem is not an operator problem. It is important to proceed in a logical order (i.e., clockwise) in order not to overlook a control.

All CRT controls may be set to mid-range with the exception of the intensity control. The intensity control normally turns on the CRT at approximately 10 o'clock on a post-accelerator CRT (high voltage at the front of CRT). In the case of the monoaccelerator (high voltage at the base of CRT), the CRT normally turns on at approximately 2 o'clock. These are only approximate figures and will vary from instrument to instrument. A setting much less than these may be insufficient for viewing while a setting much greater may damage the CRT.

The time base should be set to free run, internal triggering, and automatic if there is such a mode. Select a medium speed sweep such as 1 ms/div and select the A or main sweep unmagnified on the horizontal display.

Set the calibrator to a convenient figure such as 1 V. Adjust the vertical sensitivity to 0.2 V/div and select a single channel mode. Position controls and the attenuator balance should be adjusted midrange. In some cases it is convenient to turn the variable gain counterclockwise to lessen the effect of the attenuator balance control.

In the case of a plug-in, be sure that the plug-in is seated tightly and that there is no open connection. Plug-ins that use interlocks are particularly susceptible to this type of problem.

Place the input selector to the DC position and turn off X10 amplifiers if they are available. Substitute a plug-in if an additional one is available.

When troubleshooting a new instrument, take some time to familiarize yourself with the block diagram. Spending a few minutes with the instrument manual can give valuable insight into the particular problem.

THE BASIC OSCILLOSCOPE

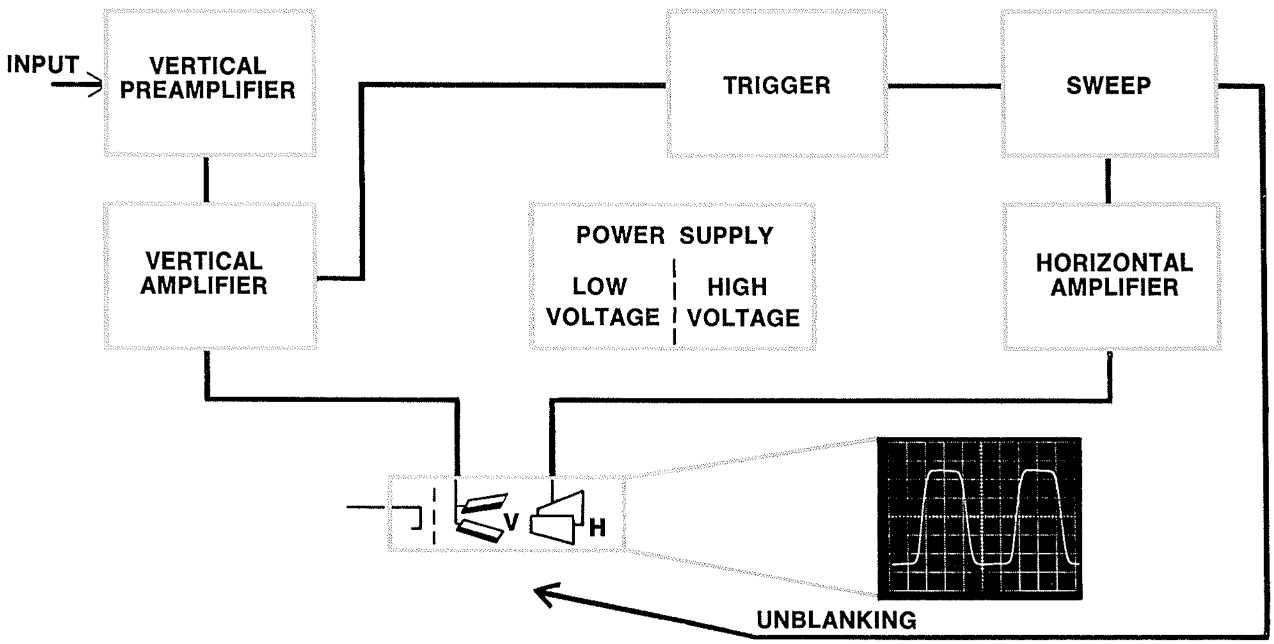
The simplified block diagram at right shows the major components of an oscilloscope. The ability to localize the trouble to one of these blocks is the first step in the troubleshooting process.

POWER SUPPLY

Power supply problems usually affect more than one of the major blocks of a block diagram. If there is no CRT indication, check the line fuse. If this is not the problem, check the power supplies with a voltmeter to determine which supply/supplies are at fault. If the supplies check out, then the problem is probably in one of the other stages. The use of an auto transformer to vary instrument line voltage can quickly verify proper power supply operation.

VERTICAL

When no spot or sweep is seen, use the trace finder or the position indicator to see which direction the spot or sweep is deflected. Use the position controls to see whether the display may be centered. Should the indicator lights show that the trace is deflected off-screen, invert the display. If the display goes off-screen in the other direction, the problem is before the invert switch.



For problems after the invert switch, use a shorting strap, and starting with the CRT deflection plates work stage by stage towards the input amplifier. The stage is working normally when the signal short causes a trace near the vertical center line of the CRT. A defective stage is indicated by the short not centering the trace on the CRT.

Vertical systems containing a plug-in are convenient since substitution may quicken the logical process.

HORIZONTAL

When the oscilloscope has a second sweep, this may be used to see if normal operation can be obtained. A calibrator signal to the external horizontal checks the operation of the horizontal amplifier. If the instrument has a plug-in horizontal, removing the plug-in unit should automatically center the spot. This is of additional assistance with oscilloscopes using deflection unblanking. Deflection unblanking positions the spot off-screen, except during sweep time, and no spot can be seen by overriding the intensity control.

SWEEP

Many instruments have a sweep output connector where the sweep may be monitored. This may give a clue as to where the problem lies. Gate outputs and vertical signal outputs also yield valuable information. Once a display is obtained, the signal should be applied to the input in order to make an approximate check on calibration. When horizontal calibration is off, the vertical calibration should be checked also before attempting to repair the horizontal. If vertical calibration is also incorrect, then the problem is most likely to be in the high-voltage power supply.

TRIGGER

If the instrument has trigger problems, a few simple steps can often determine which stage of the trigger is at fault. Checking operation of trigger circuit in different sources, modes, slopes, and coupling positions will often isolate a problem (for example, the automatic mode normally bypasses the initial trigger stages). Observing the effect of the stability and level controls gives additional information. In checking trigger circuits, always be sure that sufficient signal ($\approx$1 cm) is being applied to obtain a large observable deflection.

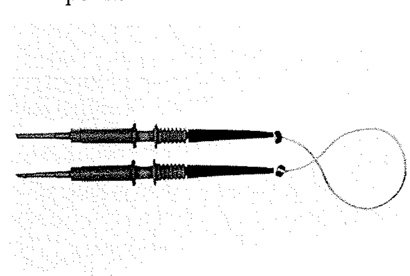
GENERAL

Most problems can be quickly categorized by interpreting results of front-panel controls. If a problem can not be categorized by these steps, then a test oscilloscope can likely determine the faulty stage.

Next: Troubleshooting a power supply

A CONVENIENT TOOL

A shorting strap is one of the most useful troubleshooting tools, as it permits many problems to be quickly pinpointed to a specific stage. A versatile shorting strap can be made by using two Tektronix pincher-tip probes (defective probes are ideal for this) connected together by a short piece of wire. Loop the wire through small ferrite beads (Tektronix PN 276-0507-00 or 276-0511-00 work nicely) as shown in the photo. If ferrite beads are not available, use 47-Ω resistors at each end to dampen oscillations when the strap is used. Alligator clips may be used instead of probe tips but they are much more prone to shorting an adjacent check point.



The strap is used to short the inputs or outputs of complementary stages together. If a stage is defective, applying the short to the input will have no effect on the output.

NEW CONCEPTS BOOKS

Four Circuit Concepts books are presently available. Titles currently in stock are: "Oscilloscope CRT's", 2nd Edition; "Storage CRT's and Circuits", 2nd Edition; "Television Waveform Processing Circuits"; and "Power Supply Circuits", 2nd Edition.

Two of a new series of Measurement Concepts books are completed. The titles currently available in this series are: Information Display Concepts; Semiconductor Device Measurement Concepts.

The material on pages 10 and 11 is taken from one chapter of Semiconductor Devices and is indicative of the content. Other chapters are Bipolar Transistors, Field Effect Transistors, Unijunction Transistors, Signal Diodes and Rectifying Diodes, Zener Diodes, and Tunnel Diodes and Back Diodes.

Should you wish further information on Tektronix Concepts Books, contact your local field engineer.

THYRISTORS (SCR's) AND OTHER PNPN DEVICES

Most of the conductance characteristics of four-layer semiconductor devices can be explored and measured on a transistor curve tracer. The characteristics of principal interest that may be measured are: (1) forward and reverse blocking (breakdown) voltages and currents; (2) the voltage drop at various forward currents for the **on** condition; (3) the gate-terminal turn-on voltage and current requirements for various values of applied anode-cathode voltage; (4) the value of forward current that holds the device in an **on** condition (holding current).

Thyristors are the same kind of semiconductor device as **Silicon Controlled Rectifiers.** The name thyristor is derived from **thyratron,** a gas tube controlled rectifier. The name **Silicon** Controlled Rectifier is to distinguish the solid-state device from the gas-tube device. Thyristors are largely used to control the conduction duty factor of applied alternating voltage, but they do have many other applications. They can be turned on at any time the applied voltage is of the correct polarity but then cannot be turned off until the applied voltage approaches zero volts, or the current which is flowing diminishes to a value that is very low compared to the permissible peak value.

FORWARD BLOCKING VOLTAGE AND REVERSE BLOCKING VOLTAGE

The forward blocking voltage of a thyristor is the voltage that may be applied between cathode and anode before the device switches to have a low impedance—assuming little or no voltage or current is applied to the control terminal and that the polarity of the cathode-anode voltage is correct.

Making a measurement of the forward blocking voltage of a thyristor using a curve tracer is done in very much the same way as measuring the reverse breakdown voltage of a transistor. First the gate terminal is usually either shorted to the cathode terminal or returned to the cathode through a resistor of specified value. In Fig 4-1 forward blocking voltage was measured at 114 volts for 5 μA or forward current at room temperature (Point A). The thyristor is rated to pass no more than 5 μA of peak forward blocking current at 60 volts, the rated peak forward blocking voltage, at a junction temperature of 125°C. A temperature-controlled oven would be needed to conduct the test at 125°C. **Reverse** blocking voltage would be measured in precisely the same way except the polarity of the sweep voltage would be reversed. Fig 4-2 is similar to Fig 4-1 except the applied voltage was increased until the thyristor switched to its **on** state with no gate voltage applied and a different vertical scale factor was used. A current-limiting resistor having a high resistance value was selected to limit

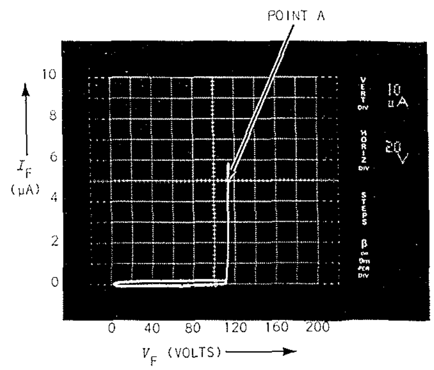


Fig. 4-1. Forward blocking voltage and current 2N5061 thyristor.

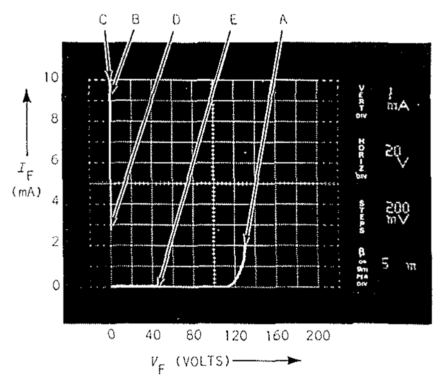


Fig 4-2. Switching conditions, 2N5061, with zero gate voltage drive.

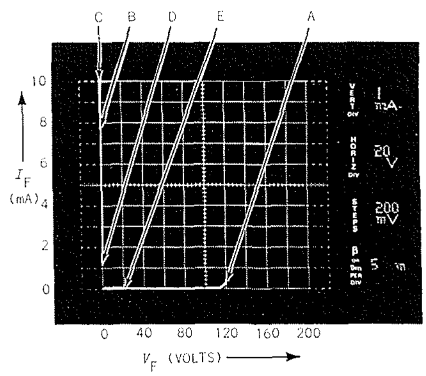


Fig. 4-3. Switching conditions, 2N5061, with small gate voltage drive.

the forward current. As the sweep voltage approaches its peak value and Point A is reached, avalanche breakdown occurs at the middle one of the three junctions, and the four-layer device appears to be simply two forward biased PN junctions in series. Current suddenly increases therefore, limited by the series resistance, and the forward voltage drop decreases to a very low value—Point B on the curve. As the sweep supply voltage increases further to its peak value, forward current increases from Point B to Point C. Current then diminishes as the sweep supply voltage drops toward zero. At Point D, not enough forward current remains to hold the thyristor in the **on** condition and current switches off to Point E.

The value of current at Point D is the holding current for that set of conditions. The conditions existing for Fig 4-2 are not a normal mode for operating a thyristor but represent a set of boundary conditions. Forward voltage is not usually applied if it exceeds the rated forward blocking voltage. And some current or voltage is usually applied to the gate terminal to switch the thyristor on. Fig 4-3 is very similar to Fig 4-2; the only difference is that a small steady value of turn-on voltage was applied to the gate terminal for

Fig 4-3. Two important differences should be noted: Switching takes place at a lower voltage and the value of holding current is reduced.

Holding current is usually specified to be equal to or less than some maximum value under stated conditions of temperature, load resistance and anode supply voltage. To select the specified value of load resistance using a transistor curve tracer, both the value of the current-measuring resistor and the selectable series resistor must be considered. Sometimes the correct value may be achieved only by using a third resistor applied at the test terminals. The gate voltage required to switch a thyristor to the **on** state at any given applied anode-cathode voltage can be determined on a Tektronix Type 576 transistor curve tracer.

By adjusting the peak supply voltage to the specified amount while the gate terminal voltage is zero, the gate voltage can then be slowly increased until switching occurs and the gate voltage

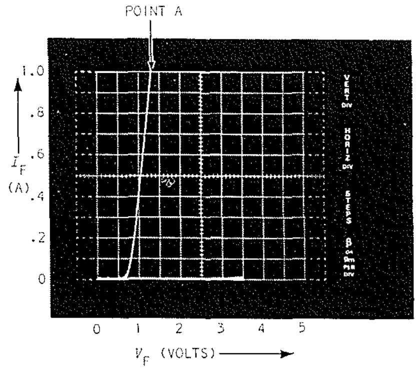


Fig 4-4. Forward conductance, 2N5061. Alternately on and off.

then read from the dial. Go-no go tests can be made by first dialing up the specified gate voltage and observing whether switching occurs or fails to occur. The source resistance for gate voltage drive may be specified. If so, the source resistance can be simulated by adding a resistor of appropriate value in series with the supply.

The gate **current** required to switch a thyristor to the **on** state may be tested or measured by means similar to those used for gate **voltage** turn-on measurements.

Fig 4-4 shows the high-current forward-conductance **on** characteristics of the same thyristor as used in the foregoing figures. The forward voltage drop at a current of one ampere is 1.3 volts. The specified maximum is 1.7 volts.

INSTRUMENTS FOR SALE

1—Type 526, SN 1544. Two years old —only a few hours use. Price: $1,500. Contact: D. K. McConnell, General Electrodynamics Corporation, 4430 Forest Lane, Garland, Texas 75040. Telephone: (214) Broadway 6-1161.

1—Type R561A, SN 5909. Contact: Siemens Medical of America, 685 Liberty Avenue, Union, New Jersey 07083. Telephone: (201) 688-5400, Ext. 257.

1—Type 514AD, SN 3955. Best offer. Contact: Mr. Seldon Lazarow, Nortec Computer Dev., Inc., 94 Nickerson Road, Ashland, Mass. 01721. Telephone: (617) 881-3160.

1—Type 2A60; 1—Type 3A72; 1—Type 3A1 Plug-Ins for 564 or 561A Oscilloscopes. Contact: Jack Hatton, The Meditron Company, Santa Ana, Calif. Telephone: (714) 541-0468.

Several Type 533A and various plug-ins. Contact: Henry Posner, Pacific Combustion Engineering Company, Los Angeles, Calif. Telephone: (213) 225-6191.

1—Type L Preamplifier, SN 11107. Contact: Alton Paris, 1789 Kingston Street, Aurora, Colorado.

1—Type 453 Oscilloscope, SN 438. Contact: Kappa Networks, 165 Roosevelt Avenue, Carteret, New Jersey 07008. Telephone: (201) 541-4226.

1—Type 067-0544-00 Calibration Fixture for Type 647, SN 233. New condition. Contact: Mr. Dan Pyko, S. S. Co., Standards Laboratories, 12800 North End Avenue, Oak Park, Michigan 48237. Telephone: (313) 398-2100.

1—Type 514AD, SN 6009. Excellent condition. Scope-Mobile® Cart and accessories. Contact: Mr. Isadore Werlin, 39 Coolidge Road, Medford, Massachusetts 02155. Telephone: (617) NI8-6700 or at home (617) HU8-0520.

1—Type Q Plug-In Unit, SN 2335. Contact: Dave Janicello, Photo-circuits Corporation, 33 Seacliff Avenue, Glen Cove, New York 11542. Telephone: (516) OR6-8000, Ext. 268.

1—Type 543, SN 351. Fully reconditioned. Price: $700.00. Contact: Palmer Agnew, 314 Front Street, Owego, New York 13827.

1—Type 502, SN 007130 with 202-2 Scope-Mobile® Cart. Excellent condition. Contact: Mr. A. W. Smith, Standard Screw Co., P. O. Box 1440, Hartford, Conn. 06102. Telephone: (203) 525-0821, Ext. 455.

1—Type 526, SN 1090. Price: $1,250.00. Contact: Mr. Al Kern, K. H. Q. Inc., 4202 South Regal, Spokane, Wash. 99203. Telephone: (509) KE4-0511.

1—Type 512, SN 766. Price: $75.00. Contact: Mr. Gerry Shefler, Beaverton School District, Beaverton, Oregon. Telephone: (503) 644-3101.

1—Type 67 Time Base Plug-In; 1—Type 72 Dual-Trace Plug-In; 1—Type 561; 2—Type 541A. Contact: J. Rezabek or Johnny Wienkam, Offshore Systems, Inc., 3000 Hicks Street, Houston, Texas 77007. Telephone: AC(713) 869-8241.

1—Type B Plug-In Unit. Price: approximately $80.00. Contact: Mr. Bob Goodman, Clark-Dunbar Company, 325 Jackson Street, Alexandria, Louisiana 71301. Telephone: (318) 443-7306.

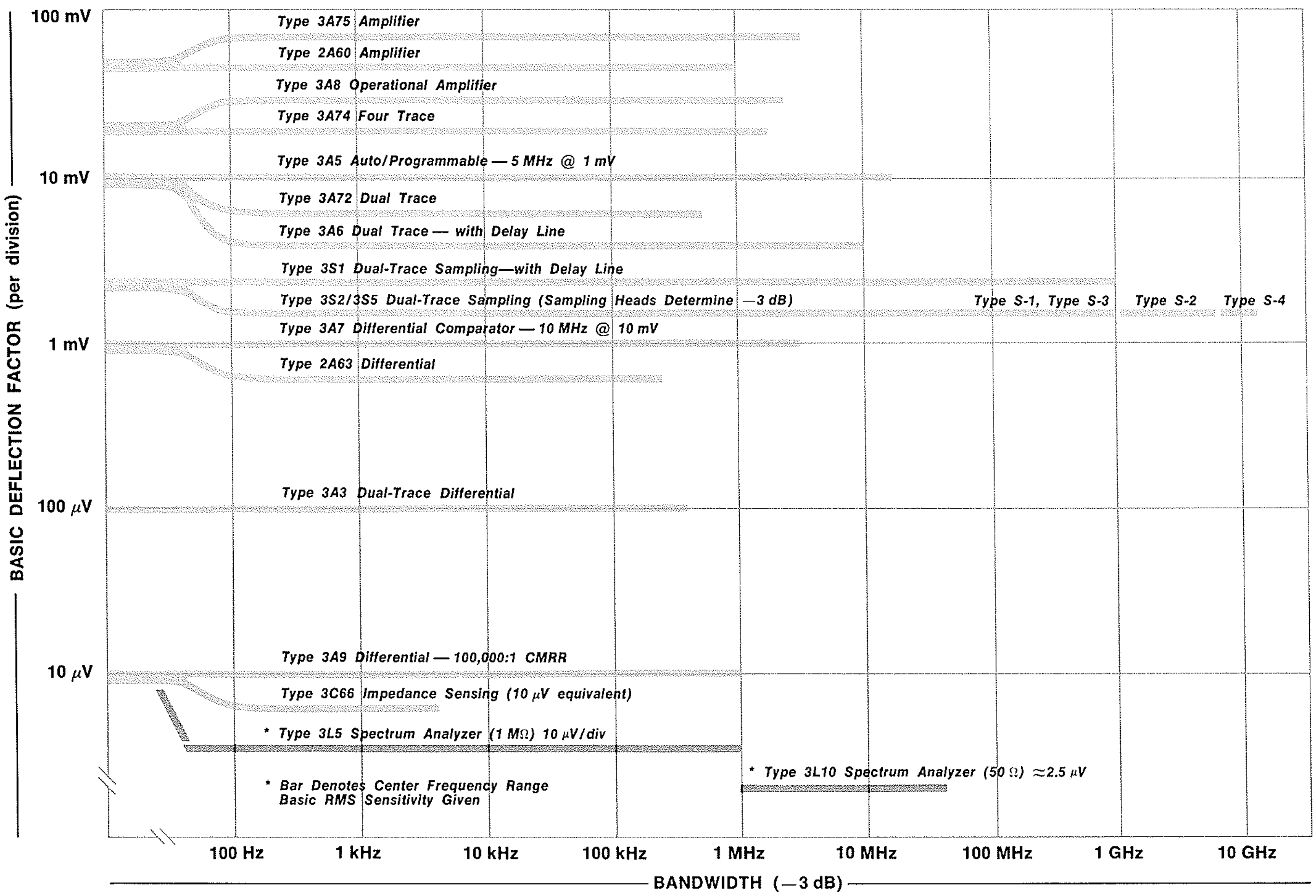
INSTRUMENTS WANTED

1—Type 515A/531A, or comparable scope for personal use. Contact: James Ladd, 5775 Kingfisher Lane, Clarkston, Mich. 48016. Telephone: (313) 332-8111, Ext. 7116. Home: (313) 625-1549.

1—Type 545/555/585 Series, with or without plug-ins. Write giving details and price. Contact: W. D. Van Amburg, CMR #5, Box 1449, APO Seattle 98737.

1 C-12 Camera. Contact: Bob Goodman, Clark-Dunbar Co., 325 Jackson Street, Alexandria, Louisiana 71301. Telephone: (318) 443-7306.

2—Type 201-1 Scope-Mobile® Carts. Contact: Mr. Seldon Lazarow, Nortec Computer Dev., Inc., 94 Nickerson Road, Ashland, Mass. 01721. Telephone: (617) 881-3160.



AN EXTENDED VALUE

By John Durecka

Two new solid-state oscilloscopes, the Type 561B and Type 564B offer improved performance over a wide range of deflection factors and bandwidth.

The advent of the Type 561B/564B marks the second major updating of the 560 Series in the 8-year history of the instrument. 5 years ago, in a significant performance upgrading, the Type 561A became the first Tektronix instrument with an internal graticule. At the same time, the power supplies and CRT were improved to optimize higher frequency instrument performance.

The 25 plug-ins presently available for this series attest to the popularity and versatility of this format. The current updating improves the performance and extends the measurement capability of existing 560-Series plug-ins. The use of plug-in sampling heads now provides DC-to-14 GHz performance. There are currently 17 vertical plug-in units (including 2 spectrum analyzer and 3 sampling units), 4 time-base units, and 3 sampling sweep units. In addition, the Type 565 Dual-Beam Oscilloscope, the Type 568 Digital Readout Oscilloscope, and the Type 129 Power Supply all accept these plug-in units (the Type 565 does not accept sampling plug-in units).

The Type 561B/564B is all solid state with the exception of the CRT. The new power supply design results in improved operation over the specified temperature range. The supplies are better regulated, more stable, and have a lower output impedance. This design holds signal crosstalk through the power supply to a minimum. Short-proof circuitry is designed into all low-voltage power supplies. As a result, low-voltage supplies may be shorted to ground or each other without damage to the instrument. Fig 1 illustrates the principle involved.

The Tektronix line-voltage selector feature is now present on the Type 561B/564B. This feature optimizes instrument performance whether operating at 115 V, 230 V, low line, high line, or mid line.

Power consumption of the Type 564B is decreased to less than 200 watts maximum while the 561B is decreased to less than 180 watts maximum (dependent upon plug-in units used). A major advantage of **this** solid-state power supply design is that most of the power is dissipated in the rear-mounted heat sink. This provides cooler operation of the plug-in units, as well as the main-frame circuitry.

The Type 561B calibrator performance has been significantly improved. The frequency is 1 kHz within 1% and amplitude accuracy is 2% from 0° — +50°C. A 10 mA, ±2% current loop is provided with both a DC and squarewave output to provide a current probe calibration signal.

The calibrator output has been changed from a 1-2-5 sequence to 5 decade steps from 4 mV to 40 V. The new 4-40-400 calibrator sequence chosen presents no fractional division display on any position of the 1-2-5 deflection-factor sequence.

The new calibrator is pictured in Fig. 2. Note that a 40-V DC position is also included so the calibrator accuracy may be checked with an accurate DC voltmeter, DVM, or differential comparator plug-in unit. 2-mV, 20-mV, and 200-mV 50-Ω outputs are available to provide an adequate range for sampling plug-in calibration. The calibrator is designed to be short proof to ground, thus offering additional protection to the instrument.

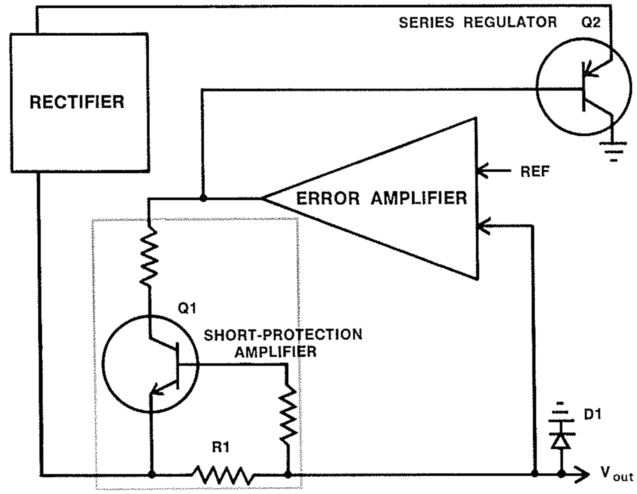


Fig. 1. Short-Proof Protection. Q1 is normally off. When a short demands high current from Q2, the drop across R1 turns Q1 on and reduces the conduction of Q2 to limit the output current. D1 protects from shorting to another supply.

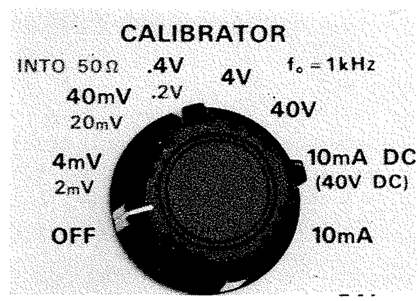
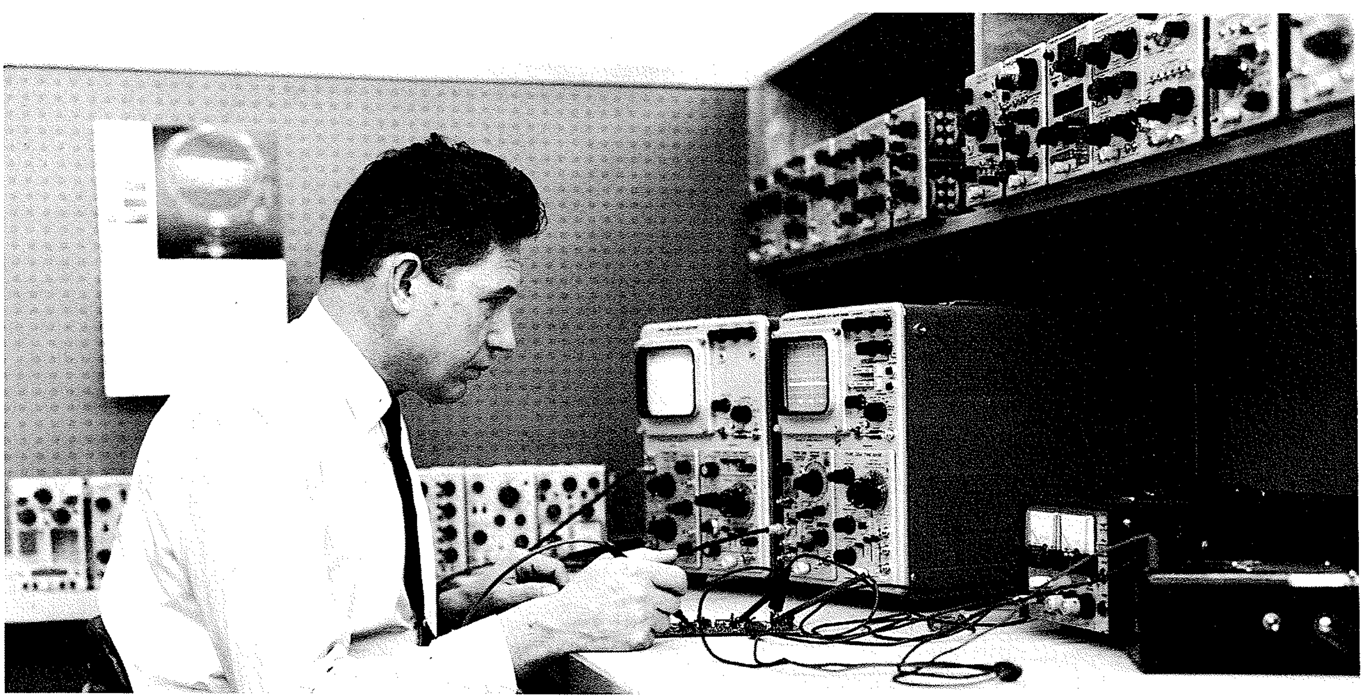


Fig. 2. Type 561/564B calibrator

John Durecka, Project Engineer, monitoring a circuit on a Type 561B and a Type 564B. Some of the 25 plug-in units currently in production are shown in the background.



STORAGE AUTO ERASE

The Type 564B MOD 121N combines Tektronix split-screen bistable storage with automatic erase circuitry. This mode increases the versatility of the instrument since the split-screen displays can be automatically (and remotely) erased after a preselected viewing time of 1-12 seconds. A SAVE mode is also incorporated into the Type 564B MOD 121N. In this position, the auto-erase cycle is interrupted and the stored information is preserved.

Remote operation is also a feature of the Type 564B MOD 121N. A rear-panel connector permits erasing of upper and/or lower half of the split screen from a remote location. In addition, the SAVE function may be controlled by a contact closure to ground.

Designing automatic erase into the 560-Series mainframe presented a difficult design problem, since it was necessary that all previous plug-ins be compatible with the circuitry. As a result, the auto-erase design chosen does **not** lock out the sweep during VIEW and ERASE. The sweep is running during this time, but the trace is blanked at the CRT grid. As a result of this design choice, all time base units, **even those without single sweep capability,** may be used for single-shot or auto-erase storage applications. The automatic-erase controls consist of an extra pushbutton for each half-screen display, AUTO ERASE, a variable VIEW TIME control (1-12 s) with SAVE position, and a rear-panel switch (Signal Triggered Sweep-Erase/Triggered Sweep).

For most applications of sweep speeds faster than ≈0.1 s/div, the Signal Triggered Sweep provides the optimum display. In this mode, an end-of-sweep detector resets the AUTO ERASE circuit and the next sweep after erase resets the logic to store the following sweep. The Erase Triggered Sweep position is useful at very slow sweep speeds to eliminate the waiting time between erasure and completion of the resetting sweep. In this mode, a sweep is initiated immediately after the end of erase. The table below indicates the modes available, limitations, and applications.

10-μV PERFORMANCE NOW AVAILABLE

The Type 3A9, DC-to-1 MHz Differential Amplifier Unit is illustrative of continued improvement in performance available within the 560 Series. Long-term drift of this unit is less than 10 μV/h and displayed noise is ≤12 μV (10 μV/div at 1-MHz bandwidth with a 25-Ω source resistance). The Type 3A9 provides a 100,000:1 CMRR from DC—100 kHz with deflection factors of 10 μV/div to 10 mV/div. Stacking of attenuators decreases the CMRR over the range of 20 mV/div to 10 V/div.

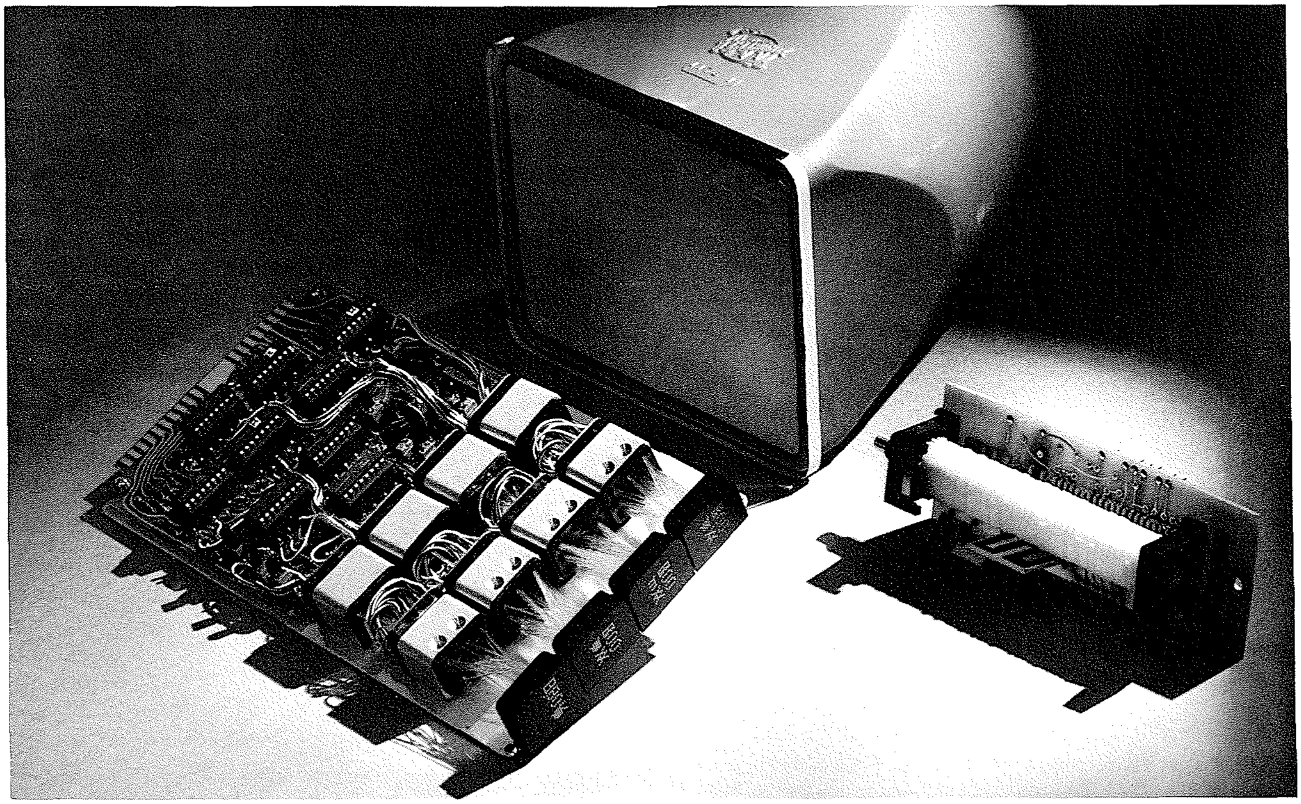
A separate input for a current probe has been provided on the Type 3A9, eliminating the necessity of an external current probe termination. When a P6019 or P6016 probe is used, this built-in termination extends the low-frequency response, providing a bandwidth of 10 Hz to 1 MHz. The convenient color-coded current/div scale allows direct reading of currents from 1 mA/div to 1 A/div.

A DC differential offset provides a variable DC voltage to measure small signal components (voltage or current) over a wide differential dynamic range (1 V-1000 V). The unit recovers to within 0.5% of zero level in less than 10 μs after removal of an applied voltage. Color coding on the front panel indicates at a glance the DC offset range for the various sensitivities. Both upper and lower 3-dB frequency points may be selected to optimize noise attenuation and to provide AC coupling at very low frequencies (0.1 Hz).

The Type 3A9 also provides a front-panel, DC-coupled SIGNAL OUTPUT for recording purposes. The signal is brought out at 1 V/div with a dynamic range of ±5 V, bandpass of DC-to-500 kHz, and output impedance of 100 Ω. An internal potentiometer allows precise adjustment to ground reference. The circuit is capable of driving loads of 10 kΩ and above. For further details on any aspect of the 560-Series Oscilloscopes and Plug-Ins contact your local field engineer.

AUTO ERASE MODES

MODE	OPERATION	USE
Signal Triggered Sweep	**Erasure occurs after viewtime. Sweep can be signal triggered after next retrace.**	**General-purpose sweep displays (0.1 s/div and faster).**
Signal Triggered Sweep (Erase pulse output grounded)	**Display erased at regular intervals at a rate set by viewtime multi-vibrator.**	**No sweep available — X-Y display.**
Erase Triggered Sweep	**Every sweep unblanked—sweep triggered from vertical—viewtime and erase time lost.**	**Slow-sweep, dual-trace displays with alternate erasure remotely controlled. Always at least 1 sweep of data displayed.**
Erase Triggered Sweep (Erase pulse output to external trigger)	**Sweep is triggered at end of erase. No coincidence between sweep starts and signal.**	**Spectrum Analyzer displays (0.5 s/div and slower).**
SAVE	**Interrupts auto-erase cycle.**	**Retains desired information on screen.**



COMPONENT TECHNOLOGY

Many different technologies are pursued within Tektronix to ensure maximum flexibility in design. Some of the significant Type 576 components developed at Tektronix are nearly overshadowed by the more dramatic overall performance of the instrument. These component technologies are responsible for many of the characteristics of the Type 576.

The new rectangular 6.5-inch CRT provides a 10 x 12 cm bright, high-resolution display, and has nearly twice the display area of the Type 575. This use of a large CRT also minimizes operator fatigue when the instrument is used in a production environment.

A high-reliability cam switch has been developed which reduces torque requirements by 50% over conventional switches. The low torque is a result of a more efficient system of actuating contacts. The cam switch has lower frictional drag than conventional switches since less clips are engaged for any switch position. Life tests indicate the life of this switch to be at least twice that of conventional switches used in this application. The switch is mounted on a circuit board which provides space for mounting closely associated components. The basic operation of Tektronix cam switches is much the same as a music box drum. Cam high points contact clips on the circuit board which close the circuit. The manufacture of the switch is applicable to numerically controlled equipment, and thus, the tolerances may be controlled more accurately.

The Type 576 is the first Tektronix instrument to use Tektronix integrated circuits. The use of Tektronix IC's in this application, simplified logic complexity and decreased the cost over the alternative of using commercially available IC's. 9 Tektronix developed and manufactured IC's of 5 different types compose the logic that is required for beta/div computation and lamp driving functions.

Tektronix assembles the optical fibers which transmit light from the lamps to the plastic front-panel display module where the characters are formed. A single card contains the IC decoder computer, lamp drivers, lamps, and display module.

Tektronix resistors, capacitors, transformers, inductors, relays, circuit boards, and plastics are used where necessary to assure the best overall design choice of component. This diversified technology assures the user of dependable components designed to do specific tasks and results in more stable consistent instrument performance.

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Editor: R. Kehrli Artist: N. Sageser For regular receipt of TEKSCOPE contact your local field engineer.

CURVE TRACING DISPLAYS

The Type 576 displays one or more characteristic curves of two and three terminal devices. By applying a constant voltage or current to an input terminal and sweeping the output terminal with a half sinewave of voltage, a single characteristic curve is generated. By applying a stair-step signal (step generator) to the input and sweeping the output terminal (collector supply) once for each successive step up to 10 curves can be displayed. For maximum flexibility, the steps may be current or voltage, positive or negative, and offset by a positive or negative value of current or voltage.

Although the collector sweep is normally a rectified sinewave, it may consist of an unrectified sinewave (simultaneous monitoring of reverse breakdown and forward conduction), or a manually controllable DC potential (eliminates the trace looping effect of the collector-to-base capacitance in low current devices).

The horizontal amplifier may select base volts or collector volts and the vertical amplifier may select collector current or emitter current (high-gain leakage mode). Both amplifier may select the step generator output.

A display amplifier with magnified offset capability provides display accuracies of up to 2% with either the horizontal or vertical amplifier.

The usual grounded emitter configuration for transistors normally displays collector voltage on the horizontal (or base volts) versus collector current at various drive levels. Grounded base configurations may also be shown.

The 576 Curve Tracer is useful for diodes, tunnel diodes, zener diodes, SCR's, small signal and power transistors, FET's, MOSFET's, unijunctions, and other devices. Some of the advantages of curve tracing versus a DC point-by-point measurement are as follows:

1. Irregular characteristics are visible that may be overlooked on a point-by-point basis.
2. The device may be monitored over a wide range of operating conditions.
3. Dependence of one parameter upon another is clearly seen.
4. Changing magnitudes of 2 parameters can be observed simultaneously.
5. Characteristics are obtained quickly and easily.
6. Quick comparison capability—quick permanent record by photography.