USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

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FIELD EFFECT TRANSISTORS

(Unipolar Transistors)

by Nelson Hibbs, Instructor

Tektronix Product Manufacturing Training Department

At last we have what amounts to a backward vacuum tube—a p-channel FET. In this device, electron current goes from drain (plate) to source (cathode).

The Field Effect Transistor (FET) is a comparatively new device whose operation differs radically from the more familiar n-p-n and p-n-p types of transistors. The FET is a single-junction *majority-carrier* device while the n-p-n and p-n-p transistors are double-junction *minority-carrier* devices.

FET manufacturers have settled on a new series of names for the three basic leads of this device; so, once again we encounter a change in terminology. Figure 1 compares an FET, a conventional transistor and the familiar vacuum-tube triode to show this change in basic-lead terminology.

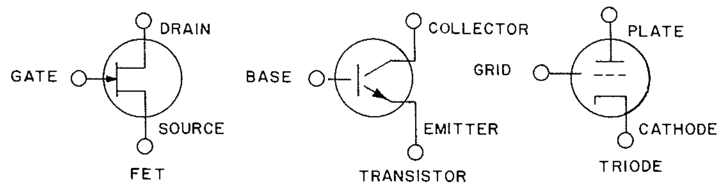


Figure 1. Comparison of basic lead terminology of FET's, transistors, and vacuum tubes.

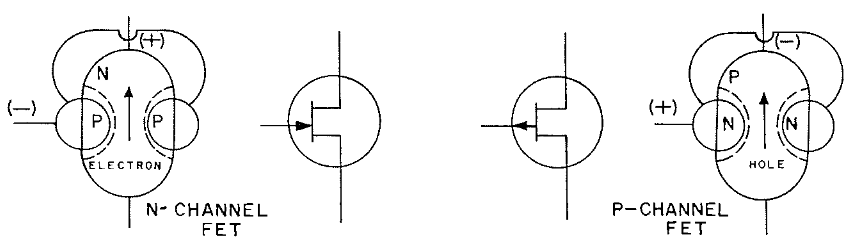


Figure 2. Comparison of an n-channel FET and a p-channel FET.

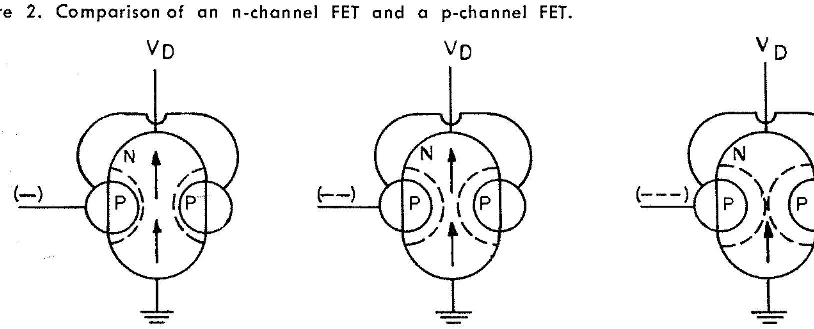


Figure 3. Illustration of how the voltage applied as back-bias can control the flow of current in an n-channel FET.

As with conventional transistors, which are represented by two types of devices (n-p-n and p-n-p), the FET is also represented by two types of devices. These are designated the n-channel and the p-channel types of devices (see Figure 2).

The electron in "n" material has a faster mobility than the hole in "p" material. Thus, the n-p-n transistor has a faster mobility than the p-n-p transistor and consequently a higher frequency response. A similar condition exists with the new FET's. The n-channel FET promises a greater frequency response than the p-channel device. This does not mean that the p-channel device is not being manufactured.

The FET is a single-junction device made up with the Source-to-Drain material (the majority-carrier path) doped in either the "n" or the "p" direction and with the Gate material doped in the opposite direction. By applying voltage so as to oppose the majority carriers in the channel (a negative voltage applied to the gate opposes electron flow in n-channel material—a positive voltage opposes hole flow in p-channel material) the device is back biased. Under these conditions, the n-channel or p-channel material becomes a constrictive layer of dielectric material past which majority carriers must flow and can thus be controlled. See Figure 3.

For a given voltage setting between the gate and the source (bias, if you will), the FET rapidly reaches a point of saturation in the source-to-drain majority-carrier path. This region of the curve gives the FET an effective R_p approaching infinity. This is where an increase in drain voltage (V_D) does not result in an increase in drain current (I_D). This area of the curve is spoken

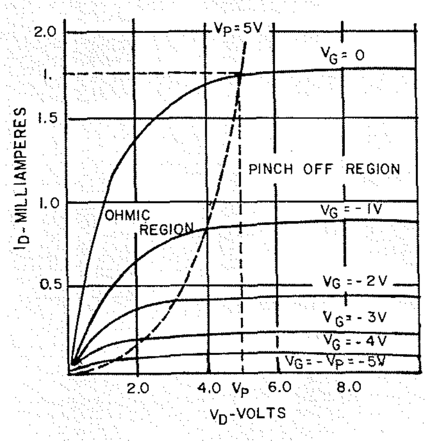


Figure 4. A chart of V_D vs I_D curves of an FET showing the pinch off region and Ohmic region at different values of bias voltage.

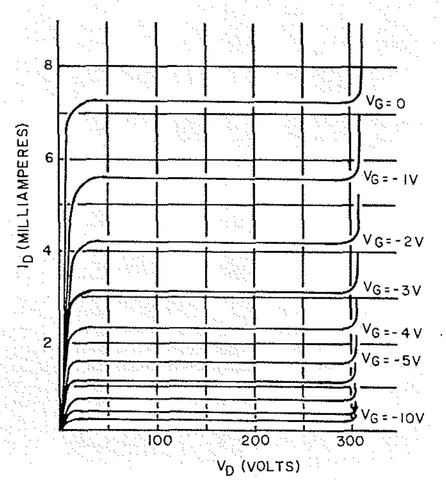


Figure 5. A chart of the V_D vs I_D curves of another FET showing Zener-knee breakdown of Gate-to-Drain back-biased diode. An extension of the curves shown in Figure 4 would reveal a similar tendency of this FET to avalanche at some certain V_D voltage.

of as the "Pinch-Off Region". See Figure 4. The area to the side of this (where an increase in V_D results in an increase in I_D—close to the graph axis) is termed the "Ohmic Region".

A study of the V_D vs I_D curves (see Figure 5) shows that with a given load line, the resultant transfer curve is non-linear. This non-linearity is relative to the deviation in the resistance represented in the majority-carrier path as controlled by the biasing voltage. The best "g_m" occurs under zero bias conditions and the forward voltage at which saturation of this path occurs is called V_p (pinch-off voltage). V_p is counted as a characteristic of the individual device. Thus, in order to find the active g_m at a bias different than zero, we must multiply the zero-bias g_m by the factor one minus the ratio of gate voltage-to-pinch-off voltage raised to the two-thirds power.

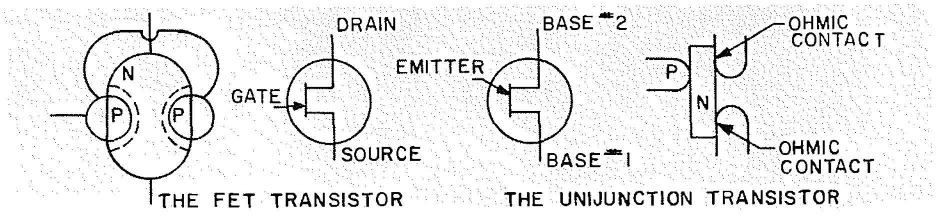


Figure 6. Comparison of an FET and a Unijunction transistor.

$$\text{Operational } g_m = g_m \text{ (at zero bias)} \left[1 - \left(\frac{V_G}{V_p}\right)^{2/3}\right]$$

Now, with a truly representative g_m available, one can closely predict the voltage gain of the device in a circuit by using the Pentode A_v formula:

$$A_v = \text{operational } g_m \times R_L.$$

Noting that the input to the device is a back-biased diode, one can see that it offers a high input impedance and that this back-biased junction will show a capacitative effect from gate-to-source and from source-to-drain. The latter also gives a miller effect. Note also, that the input-impedance will decrease with increasing frequencies at which the product $\frac{1}{2\pi f C_{GS}}$ becomes comparable to the input resistance. Also, the gain-bandwidth product will be approximately:

$$\text{Gain Bandwidth} = \frac{g_m}{2\pi\ (C_{in} + C_{out})}.$$

Again, similar to the vacuum tube pentode. This dictates the usual compromise between gain and bandwidth when using this device.

The FET should not be confused with the Unijunction Transistor. The theory of operation is totally different, although at first glance, the unijunction transistor looks almost like an n-channel FET. See Figure 6 for a comparison.

The unijunction transistor operates as a current-driven device with a *forward-biased* junction of p-to-n material injecting holes into the n material between the emitter and base #1 thus reducing the ohmic resistance of the contact. The FET operates with a voltage-driven gate and the resultant back-biased junction with the field restricting the majority-carrier flow through the body of the device. The FET, like a vacuum tube, is a normally "ON" device and must be turned "OFF". Conversely, the unijunction transistor is a normally "OFF" device (as a result of the ohmic contacts) and must be turned "ON" by the signal at the emitter—two totally different theories of operation.

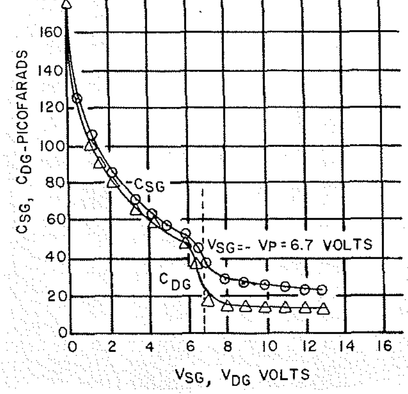


Figure 7. Variation of Source-to-Gate and Drain-to-Gate capacitance with voltage.

To summarize the properties and characteristics of the FET:

A. Input Impedance:

1. The FET is a high-input impedance device, the input terminal is essentially looking into a reverse-biased junction.
2. The FET has input capacitance that varies inversely with V_{SG} (bias). See Figure 7.

B. Mode of operation:

1. The FET is a voltage-controlled device just as a vacuum tube pentode.
2. The FET has a very, very high R_o (R_p) characteristic similar to a vacuum tube pentode.
3. The FET has a consistently non-linear g_m characteristic.

C. Output Impedance:

1. The FET is a high-output impedance device (current source). However, different means of manufacturing

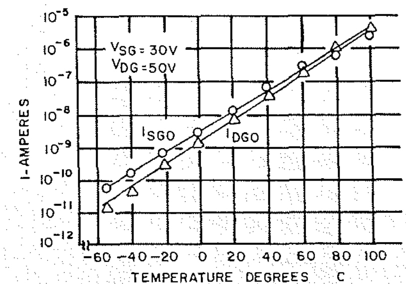
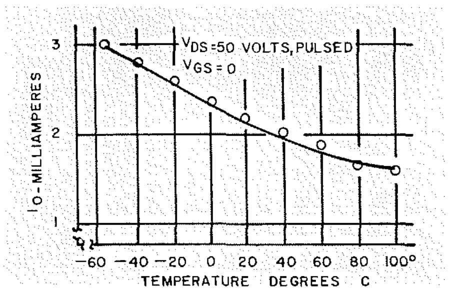


Figure 8. Plot showing leakage current from Source - to - Gate (I_{SGO}) and Drain - to - Gate (I_{DGO}) against temperature under zero bias conditions.

may result in relatively low ratings of this characteristic in comparison with the vacuum tube pentode.

Another noteworthy characteristic of FET's is their built-in protection against thermal run away. Because the input is a back-biased diode, the thermal-sensitive backward current (leakage current) flows from both the source-to-gate (I_{SGO}) and drain-to-gate (I_{DGO}). Plotting this linear current against temperature under zero bias conditions of the other element gives two straight line projections as shown in Figure 8.

This increase in leakage current in the gate junction has a resistive effect on the majority-carrier path resulting in a lower saturation current for a given bias voltage. For a graph of this action under zero bias conditions, and with the forward voltage from the drain to the source set at 50 volts, see Figure 9 (a). A cross graph of g_m and output resistance plotted against temperature is shown in Figure 9 (b). The combination



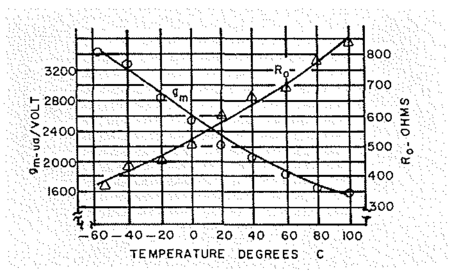


Figure 9. (a) Graph of saturation current under zero bias conditions and with the forward voltage from Drain-to-Source set at 50 volts. (b) Cross graph of g_m and output resistance plotted against temperature.

of these two reactions to temperature is such that as temperature goes up, g_m goes down and R_o (counterpart of R_p in vacuum tubes) goes up. In other words, as the gate starts to lose control of the drain current, a greater portion of the actual drain current will be passed on to the load resistor thus tending to maintain the same change of voltage at the output. This is what we mean when we say that FET's have built-in protection against thermal run away. This statement is not wholly true in the case of MOS (Metal-Oxide-Insulated) FET's.

The MOS FET's separate the gate and channel with a layer of intrinsic material. As temperature increases on this device, the channel apparently increases also as it starts to include some of the insulating layer into the main channel. The MOS FET reacts more to changes in temperature than the regular FET's even though they do away with leakage currents in the gate circuit.

With standard FET's, leakage currents in the gate lead have been reduced to the neighborhood of 0.001 to 0.0001 mA and this can be tolerated where instability of I_D with temperature change cannot.

Characteristic curves of FET's can be displayed on a Type 575 Transistor-Curve Tracer. The EMITTER-GROUND (SOURCE-GROUND) mode is used with the POLARITY control of the Collector Sweep set to NPN (for n-channel FET's) or PNP (for p-channel FET's). The POLARITY control of the Base Step Generator should be set to MINUS for n-channel and PLUS for p-channel FET's.

FET's that require more than 2.4 volts to drive them to cut off—and the great majority are in this category—will require that a 1 kΩ, 1% resistor be connected between the BASE (GATE) and EMITTER (SOURCE) binding posts on the test panel of the Type 575. This, in order to convert the BASE current, as indicated by the STEP SELECTOR switch in MA, to Gate V_{GS} voltage in volts. Thus, 1 mA per step into 1 kΩ gives 1 volt/step and twelve steps at 1 mA per step can give up to 12 volts—ample in most instances to drive any FET to cut off.

The four waveforms represented in Figures 10, 11, 12, and 13 were obtained in this manner. The FET used in these tests was an Amelco U-1346 field effect transistor.

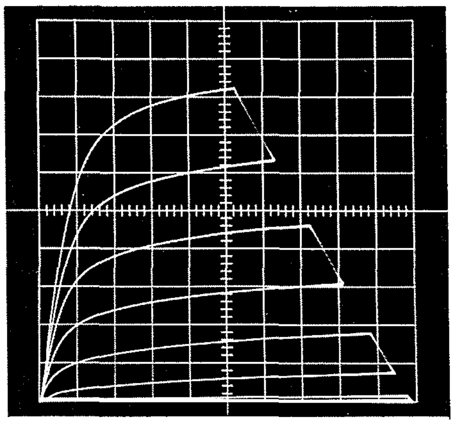


Figure 10. Drain characteristics. V_{DS} (horizontal) = 2 V/cm, I_D (vertical) = 1 mA/cm.

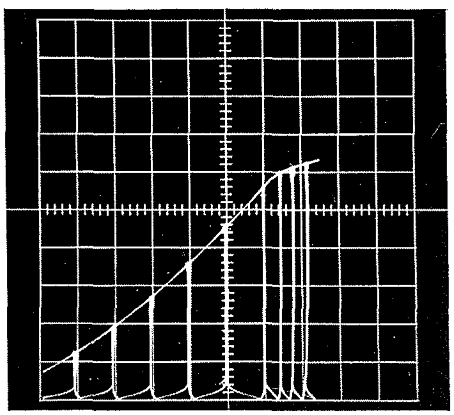


Figure 12. Transfer curve across zero bias. V_{GS} (horizontal) = 0.5 V/cm, I_{DSS} (vertical) = 2 mA/cm. Center vertical graticule line is zero bias. Negative bias to left, positive bias to right of center line. Crowding of markers on right hand side is due to gate drawing current.

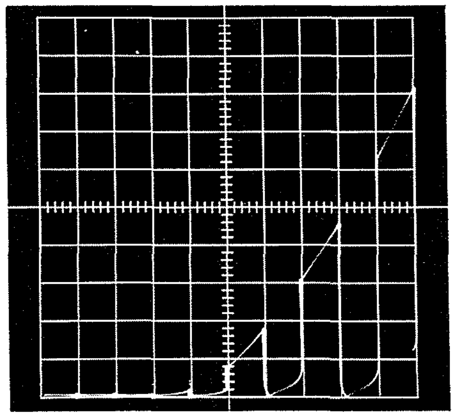


Figure 11. Drain current vs Gate Source Voltage (I_D vs V_{GS} with V_{DS} constant). V_{GS} (horizontal) = 0.5 V/cm, I_{DSS} (vertical) = 1 mA/cm.

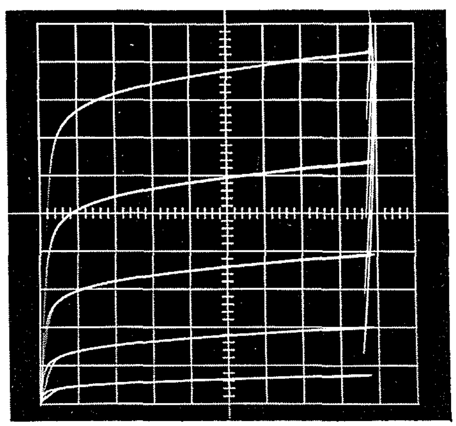


Figure 13. Drain curves showing avalanche (breakover at the Gate-to-Collector Zener Knee). V_{GS} (horizontal) = 5 V/cm, I_{DSS} (vertical) = 0.5 mA/cm.

TEKTRONIX-PRODUCED FILMS AVAILABLE

Ten films produced by Tektronix, Inc. have been certified as education films by the U.S. Information Service. These films are available on free loan as an aid to companies engaged in educational or training programs for their employees; or, if preferred, the films may be purchased.

Interested persons should contact their local Tektronix Field Office, Field Engineer, Field Representative or Distributor.

Listed below are the film titles, along with a brief review of the film:

"The Oscilloscope Draws a Graph" . . . A 20-minute color film in sound. The film explains that the oscilloscope display is usually in the form of a graph, and describes how to read or interpret the display.

"The Cathode-Ray Tube, Window to Electronics" . . . A 35-minute color film in sound with animated sequences. This film explains in simple terms how a cathode ray tube works. It depicts the heart of the oscilloscope, the cathode ray tube, as it is used in radar, sonar and many other electronic systems, including computers. The film also shows the step-by-step manufacturing process of cathode ray tubes at Tektronix, from the forming of metal "gun" parts to the final testing of completed tubes.

"The Square Wave" . . . A 25-minute black and white sound film. Discusses the theory of square waves, employed in computers and many other electronic devices; usually, in the form of coded information. Animated drawings show how sine waves contained in square waves are harmonically related. The film demonstrates the basic use of the square wave generator and oscilloscope and resulting information obtained from distortions. It discusses risetime and its importance in testing modern high speed electronic equipment. Suitable for audiences with at least a basic knowledge of electrical theory.

"Transmission Lines" . . . A 23-minute black and white sound film. Discusses the fundamentals of transmission lines. Animated drawings illustrate how electrical energy is transmitted along a line. An oscilloscope shows how reflections can occur in a line. Characteristic impedance, the importance of proper terminations, line losses, time delay, and velocity factor are also discussed.

"Time and Quantity" . . . A 27-minute black and white film in sound. Discusses the measurement of time and quantity from billions of years to billionths of a second. Shows the importance of the oscilloscope as the basic means of making accurate measurements of very small segments of time.

"The Oscilloscope, What It Is—What It Does" . . . A nine-minute color sound film. Presents a non-technical explanation of the oscilloscope and its uses. Stresses the importance of the instrument as a measuring tool in electronic and other fields. Oscilloscopes measure physical data in relation to small amounts of time. They are used in research, engineering, and education, and in production testing and maintenance of electronic computer and communication systems.

"Thevenin's Theorem" . . . A 12-minute black and white sound film. Presents a simplified approach to solving an electronic circuit which would otherwise involve complex mathematics.

"Solving the Unbalanced Bridge . . . A 17-minute black and white sound film. Normally a solution to an unbalanced bridge problem requires considerable mathematics involving three simultaneous equations. This lecture film shows and explains how simply this can be accomplished using Thevenin's Theory and Ohm's law.

"Triode Plate Characteristics . . . A 16-minute black and white sound film. Discusses plate characteristics of a typical triode (6DJ8) showing how the three basic tube characteristics, amplification factor, plate resistance, and transconductance, may be determined from a set of plate curves. It also plots a load line and shows how to determine the gain of a simple amplifier from these curves. In addition a continuous display of the curves of a tube under actual operating conditions is shown on the Type 570 Characteristic Curve Tracer, a special-purpose Tektronix oscilloscope.

"Ceramics and Electronics" . . . A 22-minute color film with sound. Shows the importance of ceramic elements in the electronic industries and stresses the application of ceramic insulating strips and other ceramic parts in oscilloscopes. It also shows the complete manufacturing process, including mixing of clays, firing, and glazing, at Tektronix.

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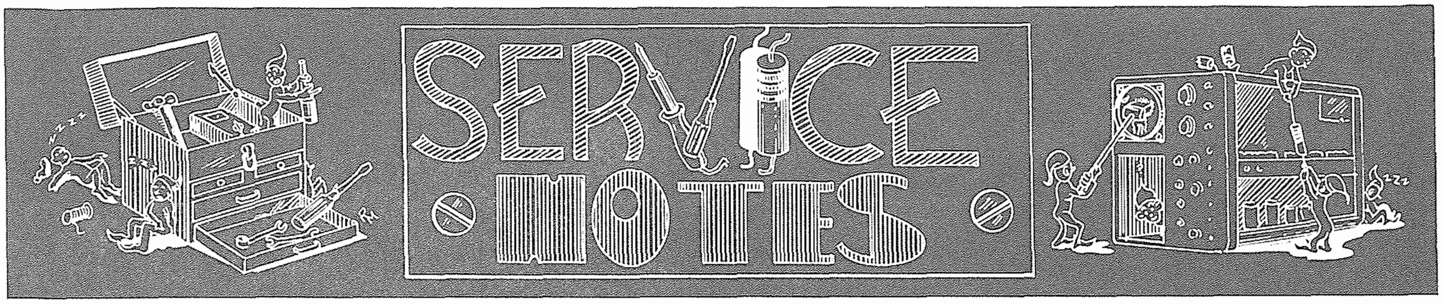
OOPS! WRONG PART NUMBER

In the October, 1965 issue of Service Scope two typographical errors involving part numbers, slipped by your editor. Both errors occurred in the article "Type M Four-Trace Plug-In Unit—Channels A, B, C, and D: Crosstalk". The part number listed as 283-0050-00 should have read 213-0005-00; and the part number listed as 210-0001-00 should have read 210-0201-00.

THE READER'S CORNER

"Current Measurements at Nanosecond Speeds" is the title of an article written by a Tektronix engineer and published in the October, 1965 issue of ELECTRONIC DESIGN NEWS. The article discusses the problems encountered when attempting to measure nanosecond and sub-nanosecond current pulses. It describes the use of a current transformer for accurate current measurements at nanosecond speeds.

Author of the article is Murlan R. Kaufman, Design Engineer with the Digital Instrument group at Tektronix, Inc. Reprints of the article are available. Contact your local Tektronix Field Office, Field Engineer, Field Representative or Distributor.



CRT MESH FILTER AND RFI SHIELD

Tektronix engineers have come up with a new CRT light filter and RFI shield that is unique. This new CRT Mesh Light Filter and RFI Shield is a metal screen of sub-visible mesh with the surface treated for extremely low reflectance. The screen is tautly mounted on a metal frame. This unique filter-shield is a direct replacement for the existing graticule cover on most Tektronix oscilloscopes. Two exceptions are the Type 422 and Type 453 Portable Oscilloscopes. The filter-shield for these instruments snaps into the CRT opening on the front panel.

The purpose of this new mesh filter-shield is to enhance visual CRT trace-to-background contrast and attenuate RFI radiated from the CRT faceplate. It accomplishes these purposes very well indeed. The curtailment of external ambient light reflections is highly efficient. Trace-to-background contrast is enhanced to a point where it provides an ability to view low-intensity traces in normal room light, or even in brighter-light environments. The metal mesh is grounded to the metal frame. Thus, when the filter-shield is in place on the oscilloscope, a ground path from mesh-to-frame-to-oscilloscope effectively carries a large part of the CRT-emitted RFI spectrum to chassis ground. Actual quantitative filtering depends upon the characteristics of the radiation and this varies between instrument types.

Following is a list of instrument types and the part number of the CRT Mesh Light Filter and RFI Shield they use:

TYPE	PART NUMBER
422	378-0571-00
453	378-0573-00
502, 502A, 503, 504, 515, 515A, 516, 517A, 524AD, 661; 530, 540, 550, and 580 Series	378-0572-00
506, 560 Series, 527, RM529, 647	378-0574-00

The CRT Mesh Light Filter and RFI Shields may be ordered through your local Tektronix Field Office, Field Engineer, Field Representative or Distributor.

DUST COVERS FOR OSCILLOSCOPES

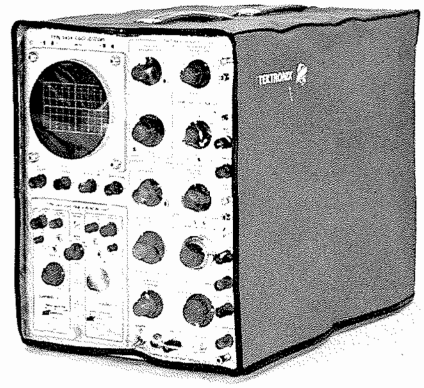


Figure 1. New dust cover for Tektronix oscilloscopes shown on a Type 545B Oscilloscope.

In response to numerous customer requests, we have designed and now have in stock dust covers for some Tektronix oscilloscopes. See Figure 1. The covers are made of blue vinyl material with a taffeta grained matte finish. There are black gimp seams around the bottom, front and back. A clear vinyl front allows easy identification of the oscilloscope and access holes in the top permit the oscilloscope to be moved with the cover in place. The Tektronix "bug" (trademark) and the word Tektronix are silk screened on the sides.

Covers are available for the following instruments:

TYPE	PART NUMBER
647 and 560 Series (except 565 and 567)	016-0067-00
500 Series	016-0068-00
565 and 567	016-0069-00
502 and 502A	016-0070-00
453	016-0074-00
422 (with AC/DC bat. pak.)	016-0075-00
422 (with AC pwr. sup. only)	016-0076-00

Covers may be ordered through your local Tektronix Field Office, Field Engineer, Field Representative or Distributor.

TEST POINTS FOR B PLUS

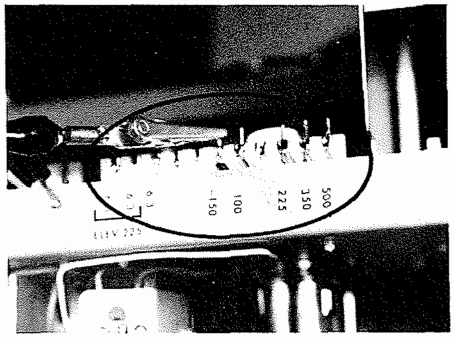


Figure 2. Short pieces of bare wire installed as B-plus test points in the ceramic strips of a Type 545B Oscilloscope.

L. E. Rishel, with the Otis Air Force Base in Massachusetts, has submitted to the Air Force and to Service Scope, a "do-it-yourself" modification that you may want to adopt.

The suggestion involves installing short pieces of bare wire in the ceramic-strip slots in Tektronix instruments at the B plus test points. These wires provide quick and easy attaching points for a voltage-measuring probe tip and are safe even when using the alligator clips often employed with a voltmeter.

We tried the modification on a Type 541A Oscilloscope (See Figure 2). Installation can be accomplished in a matter of minutes and offers no adverse effects on the scope's operation. The wire pieces need not extend more than ¼" above the ceramic strip. Installed thus, they provide an ample length for the voltage-probe tip to grasp, yet are not so long as to offer a hindrance in the normal maintenance and calibration of the oscilloscope.

With the emphasis toward ever more compact instruments, and the close spacing of components that results, we recognize the need for easily accessible test points. Some of our latest instruments have just such test points designed into them. We expect this trend to continue in future instruments.

TYPE 529 WAVEFORM MONITOR—HIGH FREQUENCY RESPONSE

Some Type 529 Waveform Monitors will show a HF (high frequency) response that differs when using the monitor push-pull, from that shown when using it single-ended. A capacitance unbalance between the "A" and "B" inputs most generally causes this unbalance. The unbalance results in a HF roll off of approximately 1.3 dB at 4 MHz. This effect becomes particularly noticeable when using the Type 529 in a balanced mode of operation, with the output terminated with a 110 or 120-ohm resistor—a practice employed by many telephone companies.

The following three-step procedure will correct the unbalance between input "A" and input "B" by balancing the emitter-to-ground capacitance of Q114 (input "A") and Q214 (input "B").

Step 1. From the underside of the Vertical Amplifier and DC Restorer chassis locate R119, a 100-ohm potentiometer that serves as the X5 Mag Gain adjustment. From R119 a bare strap runs to a 2.26 k, ⅛ W, 1% precision resistor in slot 11 of the adjacent ceramic strip. There is also a red and white wire running to another 2.26 k, ⅛ W, 1%, precision resistor in slot 9 of this same ceramic strip. Reverse these two leads at the ceramic strip. This should put the red and white wire at slot 11 and the bare strap at slot 9.

Step 2. Remove C133, a 2.8 pF, ceramic capacitor, located on the upper side of the RESPONSE switch. Re-install it on the VERTICAL MAG switch between the wiper on the last wafer of the switch and ground. Use the switch frame for ground.

Step 3. Adjust C133 for best common-mode rejection. You may need to readjust C269 for HF compensation.

EXTERNAL GRATICULES—RECOMMENDED CLEANING METHOD

We recommend the use of a mild soap, warm water (not hot) and gentle rubbing with a soft cloth for cleaning our external graticules.

We have employed several methods including silk screening, and (only quite recently) hot stamping, to imprint the reticules on external graticules. Accurately ruled reticules composed of sharply defined, consistently thin lines aid greatly in accurately interpreting or measuring the oscilloscope display. From this standpoint, there is little to choose between the silk screening and hot stamping methods. From the standpoint of visibility however, the hot stamped reticule offers a 10-to-1 advantage over reticules imprinted by other methods.

However, both the paint used in silk screening and the ink used in hot stamping the reticules are soluble in Anstac and other solvents. *Their use as a cleansing agent will remove the reticule from the graticule!* To be on the safe side, clean all graticules with a mild soap and warm water applied with a soft cloth and light rubbing action.

P6015 HIGH-VOLTAGE PROBE — REPLACEMENT OF DIELECTRIC

Only fluorocarbon 114 should be used when replacing the dielectric in a P6015 High-Voltage Probe. This gas is sold under several trade names all of which include the number 114. This number identifies the gas with the proper characteristics for use in the P6015 Probe. We supply a small can of fluorocarbon 114 with each P6015 Probe and stock additional cans for our customers' convenience. Tektronix Part Number is 252-0120-00.

The use of fluorocarbons other than 114 can involve a hazard. Some fluorocarbons are contained under a pressure much higher than that required by fluorocarbon 114. These higher-pressure fluorocarbons can be dangerous during the disassembly of a P6015 Probe. By escaping more violently than expected, they could damage personnel and equipment.

From the standpoint of toxicity, fluorocarbons offer no problem; they are not dangerously toxic.

NEW FIELD MODIFICATION KITS

TYPE 526 VECTORSCOPE — QUIET FAN MOTOR

This modification installs a lower rpm fan motor assembly for a reduction of the audible noise experienced from the original fan motor assembly. The new assembly is a direct replacement except for the addition of a motor capacitor which requires the drilling of two 5/32" holes in the rear panel of the Type 526. This modification is applicable to Type 526 Vectorscopes, sn's 101-909.

Order from your local Tektronix Field Office, Field Engineer, Field Representative, or Distributor. Specify Tektronix Part Number 040-0412-00.

TYPE RM16 OSCILLOSCOPE — SILICON RECTIFIERS

This modification replaces the selenium rectifiers with silicon rectifiers which offer greater reliability and longer life. It is applicable to Type RM16 Oscilloscopes, sn's 101-363. Order through your local Tektronix Field Office, Field Engineer, Field Representative, or Distributor. Specify Tektronix Part Number 040-0216-00.

TYPE 262 PROGRAMMER — AUTOMATIC SEQUENCER

This modification supplies an Automatic Sequencer for the Type 262 that will scan up to eight programs. The Sequencer consists of two etched circuits (a synchronizer circuit and a counter circuit) each mounted in its own plug-in circuit card. Installation is simple because the Type 262 Programmer was designed with the automatic sequencer feature in mind and provisions made for its addition later. To install the modification, you need only to plug the circuit cards into their respective plug-in receptacles in the Type 262.

Front panel switches, in conjunction with the Automatic Sequencer, allow for interrupting the automatic sequence in accordance with pre-established upper and lower limits. Any combination of upper, middle or lower limits may be used.

The Automatic Sequencer can be synchronized with data recording devices such as printers or card punchers or with various test fixtures.

Both manual push button and external control are retained with the Automatic Sequencer installed.

A maximum of three Type 262 Programmers in series will handle a total of 24 different measurement programs. With an Automatic Sequencer Modification Kit installed in each programmer the entire 24 measurement programs can be automatically scanned. The measurement rate can be synchronized with auxiliary equipment or determined by the Type 567 and Type 262.

In the synchronized mode of operation, the sum of the Type 6R1 display time and the Type 262 display time determines the measurement rate—up to eight measurements per second can be made in this mode.

In the triggered mode of operation, upon completion of a measurement the display is held until an external completion pulse is received. Up to six measurements per second can be made in this mode.

Order through your local Tektronix Field Office, Field Engineer, Field Representative or Distributor. Specify Tektronix Part Number 040-0331-00.

TYPE 180 TIME MARK GENERATOR AND TYPE 536 OSCILLOSCOPE — SILICON RECTIFIERS

Two Field Modification Kits, one for each of the above instruments, replace silenium rectifiers with silicon rectifiers. The silicon rectifiers offer greater stability and longer life.

Order through your local Tektronix Field Office, Field Engineer, Field Representative or Distributor. Specify, for:

TYPE	PART NUMBER
180A	040-0214-00
536	040-0215-00

TEKTRONIX TECHNICAL TERMINOLOGY

A handy guide to the electronic jargon used by Tektronix-oriented people.

Generally, in learning a foreign language, one is exposed primarily to the formal mode of that language. He will probably become quite adept at reading, speaking and writing the language in this form. However, when he encounters the language in its informal mode, the colloquialisms, slang expressions and trade jargon will almost surely puzzle and confuse him. Very probably, we in the United States are more prone to indulge in the vernacular than others.

Since Service Scope travels to our friends overseas, we do try to present its articles in the formal mode of our language. We do endeavor not to employ technical jargon and slang expressions. However, many of our overseas readers have expressed an amused (and perhaps confused) interest in these terms and expressions. For their benefit, we present here a few of these expressions and their interpretations.

AB, n. or a., Carbon composition resistor (from AB, trademark of Allen-Bradley Co.).

B.A., n. or a., Blanking Amplifier.

Bloom, v.i., To increase in size. The CRT display will bloom when high voltage supplies go out of regulation, reducing high voltage and increasing deflection sensitivity.

B.O., n. or a., Blocking Oscillator.

Bounce, n., Scattering of electrons that strike deflection structures in the CRT, producing flare (q.v.).

Blow-by, n., Capacitive coupling through an "off" diode gate.

Breathe, v.i., to vary slightly in level at a very slow rhythmic rate.

Bump, n., a short duration, small-amplitude aberration in transient response, somewhat wider (in time domain) than a wrinkle or glitch (q.v.).
Anticipation Bump, see preshoot.
Termination Bump, aberration due to a slight mismatch in a reverse- (source-) terminated delay line, appearing in time relatively long after the leading edge of a step function.

Cap, n. or a., Capacitor.

C.F., n. or a., Cathode-Follower.

Cathode Interface, n. a tube defect, specif., development of an insulating layer between the cathode sleeve metal and the emissive coating in a vacuum tube (incl CRT), resulting in an effective RC network in series with (part of) the cathode. Electrical effect is normal gain at very high frequencies, but lower gain at low frequencies. Time constants are in the ns-μs area, and are considerably affected by cathode temperature.

Cream, v.t., To ruin or destroy absolutely (by extension from pulverize).

Crunch, v.i., To saturate.
v.t., To drive into saturation, or to destroy.

D.A., n. or a., Distributed Amplifier.

Dag., n., Conductive coating, usually of carbon, applied to the inner walls of a CRT to maintain a large equipotential area; also used to form a helical resistor around the inner walls of a CRT to maintain a specific post-acceleration voltage gradient. From aquadag, a water suspension of carbon particles.

D.C. Shift, n., Shift of DC level following a step-function, over a few seconds or tenths. Similar to Dribble-up, but in a much longer time-domain.

Dogbone, n. or a., Ceramic tubular capacitor with radial leads.

Dot, n., A single sample presented on screen in pulse-sampling. **Dot Transient Response**, transient response independence from number of samples per display (sampling).

Dribble-up, n., Disproportionately long 50-100% or 90-100% response in relation to 10-50% or 10-90% risetime; usually with reference to the nanosecond time domain. Essentially similar to "DC Shift".

E.F., n. or a., Emitter-follower.

Eyeball, v.t., Originally, to avoid parallax error in oscilloscope measurements by lining up the reflection of the pupil of the eye with a graticule line and the trace. Now, to scrutinize in general.

Flare, n., Scattering of electrons in the CRT resulting in hazy light areas on the screen. Usually caused by bounce (q.v.) or secondary emission in the CRT. **Dag Flare**, Flare resulting from the beam striking the walls of the CRT. (See Dag).

Garbage, n. Large amplitude noise, commonly low-frequency noise, as contrasted with "Grass" (broadband noise).

Glitch, n., A waveform aberration consisting of a step or transient pulse in some portion of a CRT display which would be otherwise a smooth curve or straight line. A train of two or three small glitches might be referred to as a wrinkle (q.v.); a glitch of relatively long duration or smooth symmetry might be called a bump (q.v.). A glitch immediately (before or after) associated with the leading edge of a pulse usually carries its own terminology—e.g., pre-shoot, overshoot, hook, etc.

Grass, n., Baseline noise (broadband). CF "Garbage".

Gun, n., Electron gun. That portion of a CRT which generates and focuses the electron beam. The term does not usually include the deflection structure. **Gun** voltage refers, however, to the voltage from the CRT cathode to the average deflection-plate voltage.

Hook, n., A time constant (stray C or dielectric losses) in a compensated divider unrelated to the nominal component values. (From the effect on the display of a step function passed through such a divider.)

Hooky, a., Exhibiting or having a tendency to exhibit a hook (q.v.), especially of dielectric materials.

Interface, n., (1) The (electrical) boundary between two pieces of related or relate-able equipment. The conditions at the interface (typically an output-input relationship) determine electrical compatibility. The interface conditions between plug-in and main frame in an oscilloscope are usually standardized for interchangeability; i.e., voltage, current, and signal levels at this point are made to fall within specified limits. In computer usage, **interface equipment** is that which acts as a transducer between electronic and electromechanical, parallel and serial, or machine and human communications systems.
(2) Cathode Interface (q.v.).

Kluge, n., A lashup, a hastily or awkwardly constructed assembly.

Kluge, v.i., To collapse or fail utterly, usually violently.

Kluge, v.t., To shut down (permanently), smash or destroy.

Miller, n., A Miller integrator (sawtooth generator).

Mono., n., A monoaccelerator CRT.

Monoaccelerator, a. or n., (A CRT) having a single accelerating field, with no further acceleration of the electron beam between the deflection structure and the screen.

Multi, n., Multivibrator. Pronounced "Mul′-tee".

P.D.A., n. or a., Post-deflection accelerator (post deflection anode), or a CRT equipped with an accelerating field on the screen side of the deflection plates. Some manufacturers call this element the **"Ultor"**. **PDA** ratio: Ratio of the gun (cathode-to-deflection-plates) to post accelerator (deflection-plate-to-screen) voltages in a CRT.

Post, n., A post-deflection accelerator, or a tube equipped with such an accelerator. "10 kV on the post" means a 10 kV potential applied to this element. Distinguished from mono-accelerator CRT design.

Preshoot or **Prepulse**, n., A small negative excursion immediately preceding (the display of) a positive-going pulse, or vice versa.

Puff, n. or a., Picofarad (pF).

Puffer, n., A small capacitor, the value of which is indicated in picofarads. **One-puffer.**

Schmitt, n. or a., Schmitt (cathode-coupled) multivibrator ("Schmitt Trigger").

Slash, v.i., To produce a streak (usually vertical) instead of a dot (q.v.) on the CRT for each sample (sampling oscilloscopes).

Slash, n., A vertically elongated dot produced by spot motion during unblanking in pulse-sampling instruments.

Spudger, n., Fully insulated tool for dressing leads or components.

T.D., n. or a., Tunnel diode (Esaki diode).

Tweak, v.t., To adjust (an inductor, capacitor or internal calibration control) very slightly.

Tweaker, n., Tool for tweaking (usually one which fits only certain components).

Tweak up, v.t., To bring into proper adjustment by tweaking.

V.A., n. or a., Vertical Amplifier.

Wrinkle, n., A short-duration, small-amplitude aberration in transient response; usually a small echo in a delay line.

Service Scope

USEFUL INFORMATION FOR

USERS OF TEKTRONIX INSTRUMENTS

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