Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

NUMBER 29 PRINTED IN U.S.A DECEMBER, 1964

SIMPLIFYING TRANSISTOR LINEAR-AMPLIFIER ANALYSIS

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The complicated characteristic-family parameters for transistors are more useful for design purposes than for analysis. The best analytical tool is one that provides a means of quickly doing an adequate job of circuit analysis for trouble-shooting or evaluation purposes. This article suggests such a tool.

When a person thinks of a transistor amplifier, he usually thinks of a transistor in a circuit, behaving in some manner that depends on a set of measurements that have been made on the device. These measurements may be called h-parameter, r-parameter, or any of many other characteristic families. Each has its advantages, but they all have common disadvantages to the technician. They are complicated in nature and involve numerous variables. They are a means of measuring a transistor's charateristics, but say little about the circuit which uses that transistor. Published parameters are very general and, for a given type, will vary widely from one unit to another.

Designers have these variations in mind when they design a linear amplifier circuit. and some type of feedback is usually employed in order to make the circuit as independent of the transistor characteristics as is practical. Transistor parameters may vary 50% or more without appreciably altering the gain or linearity of a well designed amplifier.

As we will show later transistor parameters are more useful as a guide by which to judge the relative merits of one transistor against another than as an analytical tool. They also give the student of solid state theory some measurable quantities to identify, in order to grasp some of the more difficult concepts involved in semiconductor action.

The parameter families are more useful for design purposes than for analysis. The best analytical tool provides a means of quickly doing an adequate job of circuit analysis for trouble-shooting or evaluation purposes.

The approach we are about to present eliminates the use of published data, except for Beta. This by no means implies that the other parameters are not useful. It does say, however that it isn't necessary to apply all you know about transistors to get a general understanding of how an amplifier works. Anyone with a basic knowledge of transistor characteristics and of Ohm's law, will have no trouble applying this approach to transistor amplifiers.

Keep in mind that our approach is very general and is not intended for use where extreme accuracy is desired. You can expect an accuracy that varies no more than 10 to 20 percent from the true circuit values—depending upon how familiar you are with the transistor being used.

If a transistor is considered to be two PN junctions connected together, and if we then consider *only* the junction formed between emitter and base, we find that the E-I plot of that junction is roughly that shown in Figure 1. Line 1 on the graph is the plot of the Base-to-Emitter Voltage -vs- Base Current, and line 2 is the plot of Base-to-Emitter Voltage -vs- Emitter Current. If the slopes of the curves are measured at a

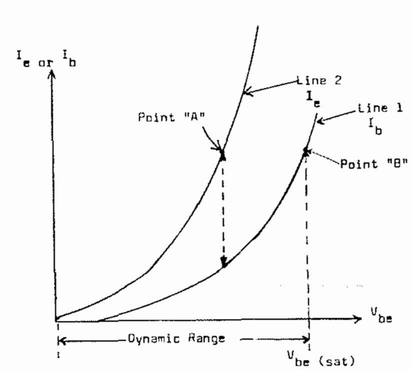


Figure 1 — Voltage -vs- current graph of the Base-to-emitter characteristics of a transistor. Line 1 is the plot of base current (I_b) -vs- Base-to-emitter voltage (V_{be}). Line 2 is the plot of emitter current (I_e) -vs- Base-to-emitter voltage (V_{be}). Point "A" indicates a typical operating point on the characteristic. With a common V_{be}, the ratio of I_e, to I_b at point "A" is: $I_e/I_b = \beta + 1$. Point "B" indicates the point at which the transistor goes into saturation. The area between $V_{be} =$ Ov and $V_{be\ sat}$ is the dynamic operating range of the device. The resistance represented by line 2 at any given point is approximately $0.026/I_e$. The resistance represented by line 1 at any given point is approximately $0.026/I_b$. Line 2 represents the resistance 1/gm and line 1 represents 1/gm $(\beta + 1)$.

common point in voltage (Point "A") there will be a considerable difference in the two. The slope of these curves is actually a plot of the dynamic resistance of the junction. The resistance shown by line 1 is approximately $(\beta+1)$ times that shown by line 2 for any point on the curve between the origin and point "β". If we can by some means determine the value of resistance represented by one line, and if we know β, then we can find the resistance represented by the other line.

The slope of line 2 at any point between the origin and point "β" is approximately equal to:

$\frac{0.026}{I_e}$ where I_e is the DC current at the point selected. (The value $0.026/I_e$ is justified in the basic physics of the device, and no further explanation is offered.)

To simplify the powers of ten involved, remember that the resistance shown by line 2 is:

$$\frac{26}{I_e \text{ expressed in ma.}}$$

(If $I_e = 10$ ma, then $r_{(\text{line } 2)} = \frac{26}{10} = 2.6\,\Omega$)

Now consider what this has to do with transistor circuits. Note that the slope of line 2 on the graph is:

$$\frac{\Delta V_{be}}{\Delta I_e}$$

(For a transistor in a common base configuration the slope represents:

$$\frac{\Delta E_{in}}{\Delta I_{in}}$$

which is input resistance.)

Assuming the transistor has a very high β, the input current (ΔI_e) will be approximately equal to the output current (ΔI_c). Then we can say that line 2 closely approximates the plot of:

$$\frac{\Delta E_{in}}{\Delta I_{out}}$$

In vacuum tube theory, $\frac{\Delta E_{in}}{\Delta I_{out}}$ is called $1/gm$, so lets's just call the resistance represented by line 2 of Figure 1 by the same name — $1/gm$.

All we've said so far is that the impedance looking into the emitter of a transistor is approximately equal to $1/gm$ of the device, and can be calculated by:

$$\frac{1}{gm} = \frac{26}{\text{DC value of emitter current in ma.}}$$

In series with $1/gm$ is a small resistance, R_{EB}, that is made up of the ohmic resistance of the leads and the semiconductor material. R_{EB} usually amounts to about $2\,\Omega$ to $5\,\Omega$. (For power transistors the value of R_{EB} may be as low as a few tenths of an ohm, while some special purpose and low performance types may have R_{EB}'s as large as $25\,\Omega$. The value of $2\,\Omega$ to $5\,\Omega$ fits most modern, high-performance, medium-power transistors.) For very low values of I_e, R_{EB} can be neglected since $1/gm$ will be fairly high. However, if the transistor is operating at several ma of emitter current, R_{EB} becomes an appreciable part of the total resistance from emitter to base, and must be added to $1/gm$.

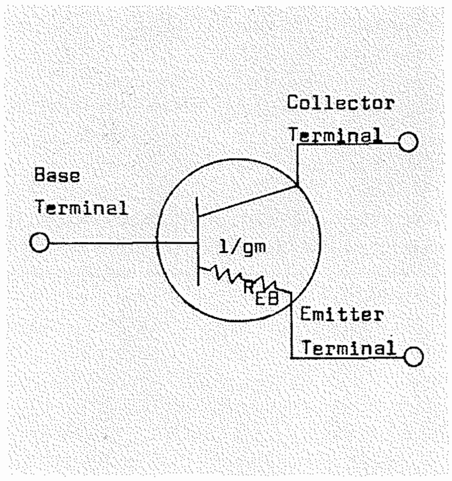


Figure 2 — Schematic equivalent of the emitter circuit of a transistor. $1/gm$ is the dynamic resistance of the junction due to carrier action and R_{EB} is the DC resistance in the leads and ohmic contacts of the leads within the transistor case.

Figure 2 shows what the transistor looks like between emitter and base. The sum of $R_{EB} + 1/gm$ is an operating characteristic of the device we shall call "transresistance". The notation for transresistance is r_{tr}.

An example of the application of this idea to circuit analysis can be seen by referring to the diagram in Figure 3 (a).

Assume the DC operating point has been solved for.

Since the driving voltage is on the base, the drive will be impressed across the transresistance of the device. Now, if we ignore the small error due to base current, (assume $i_c = i_e$) we have the relationship:

$$(1)\quad \frac{v_{in}}{r_{tr}} = \frac{v_{out}}{R_L}$$

From the relationship in (1) we obtain:

$$(2)\quad A_v = \frac{v_{out}}{v_{in}} = \frac{R_L}{r_{tr}}$$

The equivalent of the circuit in Figure 3 (a) is shown in Figure 3 (b).

For degenerative circuits, such as that shown in Figure 3 (c), the input voltage is developed across the transresistance and R_e in series. (The equivalent of the degenerative circuit is shown in Figure 3 (d).) The formula for voltage gain in this circuit is:

$$(3)\quad A_v = \frac{R_L}{r_{tr} + R_e}$$

When R_e is large with respect to r_{tr}, the gain is simply:

$$(4)\quad A_v = \frac{R_L}{R_e}$$

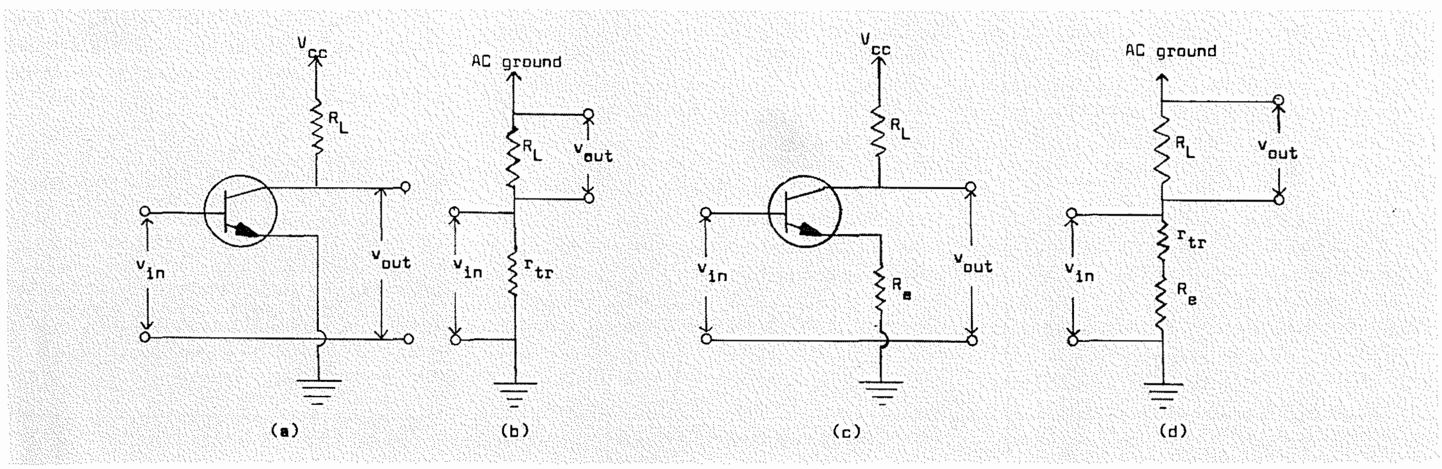


Figure 3 — (a) Common emitter voltage amplifier showing locotion of input and output terminals. (b) Equivalent circuit of 3 (a) shows v_{in} impressed acorss r_{tr}. That voltage causes current through R_L that is approximately equal to the current through r_{tr}. Hence: $v_{out}/V_{in} = A_v = R_L/r_{tr}$. (c) Common emitter amplifier using degeneration in the emitter. (d) Equivalent circuit of 3 (c) showing R_e in series with r_{tr} in the signal path. Voltage gain for this current: $A_v = R_L/r_{tr} + R_e$.

The above approach works very well for any configuration of amplifier, whether common base, common emitter or common collector. It also applies very well to paraphase and push-pull amplifiers, as long as the concept of transresistance is used to represent the resistance seen when looking into the emitter of the transistor. Of course the approach must be modified and added to, if it is to be applied at or near the frequency limits of the amplifier. Those modifications are beyond the intent of this writing and will be saved for a later discussion.

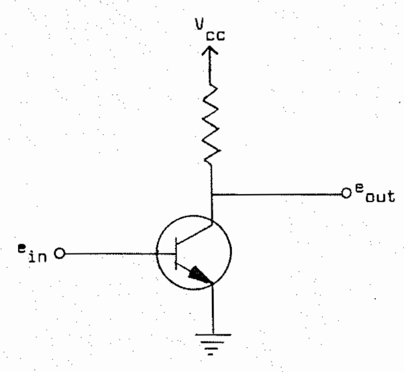


Figure 4 — Amplifier used as an example of the application of transresistance compared to h-parameters. The DC operating point is assumed to be set at $I_e = 5$ ma; $V_{ce} = 2.5$ v. The transistor is a 2N2475.

An example of how the foregoing method can be applied to amplifier analysis and how it compares to the h-parameter approach follows:

Figure 4 is a common emitter amplifier that uses a 2N2475 transistor. Table 1 gives the h-parameters for the transistor as measured on a Tektronix Type 575 Transistor Curve-Tracer.

TYPE 2N2475 TRANSISTOR	
I_e	5 ma
V_{ce}	2.5 ma
h_{ie}	1.4 k
h_{re}	1×10^{-4}
h_{fe}	180
h_{oe}	300 µv

Table 1 — List of the h-parameters for the Type 2N2475 transistor at $I_e = 5$ ma; $V_{ce} = 2.5$ v.

In this example we will determine voltage gain (A_v) and input resistance (r_{in}) using both the h-parameter method and the approach just described.

The solution using h-parameter follows:

$$(5)\quad A_v = \frac{hfe\ R_L}{\Delta\ h_e R_L + hie}$$

$\Delta\ h_e$ is defined as:

$$(6)\quad \Delta\ h_e = (hie)\ (hoe) - (hre)\ (hfe)$$

For the parameter in this example:

$$\Delta h_e = (1.4)\ (10^3\Omega)\ (3)\ (10^{-4}\text{mho}) - (180)\ (10^{-4})$$
$$= 0.42 - 0.018$$
$$= 0.402$$

Inserting circuit values in equation (5) yields:

$$A_v = \frac{(180)\ (100\,\Omega)}{(0.402)\ (100\,\Omega) + 1400\,\mu}$$
$$= 12.5$$

To find the input resistance:

$$(7)\quad r_{in} = \frac{hie + \Delta\ h_e\ R_L}{1 + hoe\ R_L}$$

Putting in circuit values:

$$r_{in} = \frac{1400\,\Omega + (0.402)\ (100\,\Omega)}{1 + (3)\ (10^{-4}\text{mho})\ (100\,\Omega)}$$
$$= 1.4\,k\Omega$$

Now let us solve for the same quantities using transresistance.

As we have shown:

$$(8)\quad r_{tr} = 1/gm + R_{EB}$$

and:

$$(9)\quad 1/gm = \frac{26}{I_e \text{ in ma.}}$$

R_{EB} is typically 2 Ω to 5 Ω for this type of transistor. For this example we will use $R_{EB} = 3\,\Omega$.

Therefore, for this circuit:

$$r_{tr} = \frac{26}{5\text{ ma}} + 3\,\Omega$$
$$= 8.2\,\Omega$$

From equation 2:

$$A_v = \frac{R_L}{r_{tr}}$$

For this example:

$$A_v = \frac{100\,\Omega}{8.2\,\Omega}$$
$$= 12.2$$

To find input resistance using transresistance it must first be shown that any impedance that appears in the emitter of a transistor will be seen as that impedance multiplied by (β +1) when measured from the base. Transresistance appears in the emitter of the transistor—therefore:

$$(10)\quad r_{in} = r_{tr}\ (\beta + 1)$$

For this example:

$$r_{in} = (8.2\,\Omega)\ (181)$$
$$= 1.4\,k\Omega$$

Comparing the two approaches we see that h-parameters give us:

$$A_v = 12.5$$
$$r_{in} = 1.4\,k\Omega$$

and the transresistance approach yields:

$$A_v = 12.2$$
$$r_{in} = 1.48\,k\Omega$$

As this shows, the results are very nearly the same regardless of the method used. The advantage of the transresistance method is that it didn't require the use of a set of parameters. Instead it was necessary only to know the beta of the transistor and to make one calculation. If R_{EB} had been assumed to be either of the two extreme values, the results would have still been within 20% of the answer given by h-parameters.

If we now take the same transistor and place it in a circuit such as the one in Figure 5, the voltage gain will be shown by equation 3.

$$A_v = \frac{R_L}{r_{tr} + R_e}$$

If we assume the DC operating point to be the same as that of the previous example, the voltage gain will be:

(Figure 5)

$$A_v = \frac{100\,\Omega}{8.2\,\Omega + 5\,\Omega}$$
$$= 7.6$$

The input resistance to this amplifier is now:

$$(11)\quad r_{in} = (R_e + r_{tr})\ (\beta + 1)$$
$$= (13.2\,\Omega)\ (181)$$
$$= 2.38\,k\Omega$$

Note that the addition of R_e would require modification of the DC levels around the circuit in order to maintain the same DC operating point for the transistor.

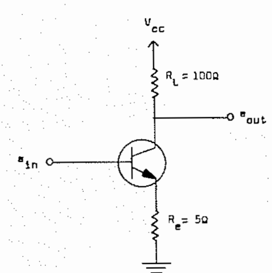


Figure 5 — Amplifier with the same type transistor set at the same operating point as that in Figure 4. This circuit has R_e added to reduce the voltage gain and increase the input resistance.

TYPE 530/540 SERIES OSCILLOSCOPES—
SIMPLIFIED MAIN SWEEP TRIGGER ADJUSTMENTS

By Sandy Sanford, Field Engineer with Tektronix
Product Information Department.

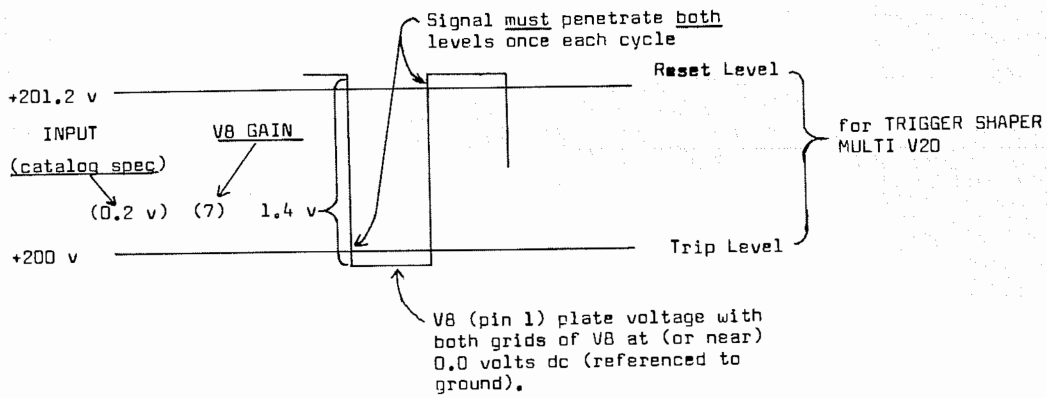


Figure 1. Graphic illustration of the three basic requirements of the trigger system; points a, b and c of this article.

Here is a systematic step-by-step adjustment procedure which will increase the length of time between necessary recalibrations of the MAIN SWEEP trigger circuits. As you work your way through these adjustments, any defective component or bad tube will be noticed—making your trouble-shooting easy.

By using this system you will satisfy three basic requirements of the trigger system:

a. Right-hand plate of V8 must not move up or down when grids of V8 are interchanged by turning the SLOPE switch.

b. Trip voltage level of the bistable multivibrator, V20, must be set to a few millivolts above the plate voltage of V8 as found above.

c. Width of the bistable multi hysteresis gap (difference in volts between the "trip" level and the "reset" level) must be set to about 1.2 volts.

In general, procedure set down here can be used to adjust similar trigger systems in many Tektronix oscilloscopes. The specifications will turn out to be different but the basic functions performed by each trigger system will be about the same.

I. Preset the front panel controls as follows:
- A. Sweep TIME/CM — 1 msec
- B. STABILITY control — Triggerable range (free-run less 10 degrees).
- C. TRIGGER SLOPE — +EXT.
- D. TRIGGERING MODE — DC.

II. Set TRIGGERING LEVEL:
- A. Connect 20,000 ohms/volt meter (first on 6 v range — then on 12 v range) across plates of trigger amplifier, pins 1 and 6 of V8.
- B. Turn TRIGGERING LEVEL control until meter reads "O".
- C. Change SLOPE switch to —EXT.
- D. Meter will read up scale or down scale. (If meter reads down scale, reverse the leads.)
- E. Voltage reading (on 12 v range):
  1. Turn TRIGGERING LEVEL control to ½ previous voltage reading.
  2. Now, moving from +EXT to —EXT should cause no change in voltage reading.
- F. Verify that white dot on TRIGGERING LEVEL knob is opposite the engraved Zero on the panel. If not, correct by loosening knob.

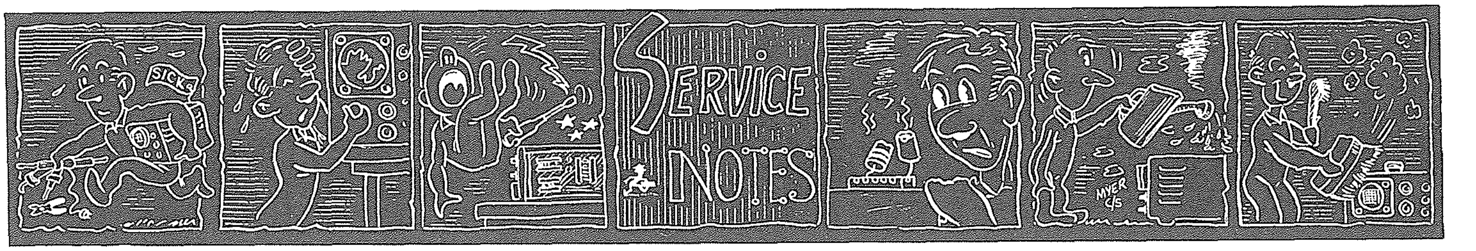
III. Check for grid current:
- A. With TRIGGER SLOPE +EXT
  1. Short EXT TRIGGER INPUT to ground (use 47-Ω resistor).
  2. Meter should move less than 100 mv (0.100).
- B. With TRIGGER SLOPE —EXT:
  1. Check for grid current as above.
  2. Replace tube if grid current is too high.

IV. INTERNAL TRIGGER DC LEVEL ADJ:
- A. Tie the vertical amplifier input to ground.
- B. Move spot to center of crt with HORIZONTAL POSITION control. Vertically position the spot or trace to the horizontal center-line of graticule.
- C. Set TRIGGER SLOPE to +INT.
- D. Turn INT. TRIG. DC LEVEL ADJ. pot until meter indicates voltage obtained in step II, E, 2.
  Note: Shifting from +INT to —INT to +EXT to —EXT should cause no change in meter voltage reading.

V. TRIGGER LEVEL CENTERING:
- A. Turn TRIGGER SENSITIVITY pot to mid-range.
- B. Turn TRIGGER LEVEL CENTERING pot:
  1. Clockwise to reset the Schmitt circuit (V20).
  2. Slowly counter-clockwise till Schmitt circuit has just triggered (this is indicated by one stroke of the sweep generator).
- C. If more than one stroke occurs, or if the Schmitt circuit triggers for both clockwise and counter-clockwise rotation of the TRIGGER LEVEL CENTERING POT, turn the TRIGGER SENSITIVITY pot 15° or 20° counter-clockwise from mid-range and recheck TRIGGER LEVEL CENTERING. The Schmitt circuit tube may need to be replaced.
- D. Remove meter leads.

VI. TRIGGER SENSITIVITY:
- A. Connect 200 mv calibrator square wave to VERTICAL INPUT *and* to EXT TRIGGER input.
- B. Set vertical VOLTS/CM switch for a 2 cm display.
- C. Reduce ac input (oscilloscope's line voltage) to 105 volts—or to a line voltage which just keeps all regulated power supplies functioning.
- D. Adjust TRIGGER LEVEL control slightly; system should trigger smoothly on 200 mv EXT. Square wave.
- E. Check that the trigger system will *not* trigger continuously on 100 mv—even with very careful adjustment of the TRIGGERING LEVEL control.
  Note: If oscilloscope triggers on 100 mv, turn TRIGGER SENSITIVITY counterclockwise 15° to 20° and recheck. Return oscilloscope's line voltage to 117 volts and again check the TRIGGER circuit for proper operation.

VII. PRESET STABILITY:
Follow procedure given in Instruction Manual.



TYPE 526 VECTORSCOPES — QUADRATURE PHASE DRIFT

Some Type 526 Vectorscopes have exhibited quadrature-phase-drift problems. The seat of the trouble seems to be L264, a 15-to-27 μh coil in the quadrature phasing circuit. In some environments this coil will absorb moisture during the periods the instrument is not in operation. The effect of L264 on the circuit will vary according to the amount of moisture absorbed and drift will occur as the heat from the instrument drives moisture from the coil during periods of operation.

Installation of a newly-designed moisture-resistant coil in the L264 position will help to correct this difficulty. For Type 526 instruments with serial numbers 101 through 511, with the exceptions of numbers 439, 477 and 492, specify Tektronix part number 050-210. For instruments with serial number 512 and up (and also serial numbers 439, 477 and 492) specify Tektronix part number 114-163. Order the new coil through your Tektronix Field Engineer or local Field Office.

TYPE 317 OSCILLOSCOPE — 120 CYCLE RIPPLE

Sometimes a Type 317 Oscilloscope will exhibit 120 cycles of ripple on the trace when the VOLTS/DIV switch is in the 10, 20, or 50 mv AC position. This may be due to a ground loop between C154 (a 500 μfd, ETM capacitor in the preamplifier circuit) and ground. Placing a short jumper between C154 and the front panel reduces the amount of ripple. By lifting the can of C154 above ground at its grounding strap and then running a separate ground from C154 to the shield of the Vertical Volts/Div switch you will completely eliminate the problem.

TYPE 545 OSCILLOSCOPE — POWER SUPPLY REGULATION

Do you have a stubborn problem of 60 cycle ripple in the 100-volt supply of your Type 545 Oscilloscope yet everything seems to check out as normal? If you do, try separating the common cathode and filament ground of V742, a 6AU6 tube in the low voltage power supply. Re-connect the filament lead to a separate ground lug of the tube socket. Sometimes, when the cathode and filament of this tube share the same ground lug, oxidation will occur between the ground lug and the chassis and allow the filament to modulate the cathode.

TYPE 502 OSCILLOSCOPE — LOW FREQUENCY DISTORTION

The recalibration instructions in the Type 502 Instruction Manual, under step 29 (Feedback Bal. Adj.), Figure 6-10 shows a typical low-frequency square-wave distortion. A simple modification will eliminate this distortion.

The distortion comes from the trigger pick-off cathode follower tube (V493) in the Upper and Lower-Beam Vertical amplifiers. Being single-ended, V493 produces a small change in current through the decoupling resistors R685 (or R686) when a signal is applied to the vertical amplifier. This change in current affects the nominal +100 volts enough to cause the distortion.

The modification returns the plates of V493 directly to the +100 volt supply (rather than through the decoupling network) and eliminates the difficulty.

Here are the instructions for making the modification:

Note: Follow this same procedure for both the Upper and Lower Beam Vertical Amplifiers.

1. Locate the two 1% resistors soldered to pin 1 of V493. (To make wiring easier, temporarily unsolder these resistors from pin 1 of V493 and bend them back out of the way.)
2. Unsolder the white-brown and the white-brown-black-brown wires from pin 5 of V493.
3. Unsolder the bare wire soldered to pin 2 of V493 and cut it off where it connects to pin 6.
4. Solder the two wires unsoldered in Step 2, to pin 2 of V493.
5. Solder one end of a length of #24 white-brown stranded wire to pin 5 of V493. Dress it along the underside of the cable leading to the +100 volt decoupling circuit (R685 and C685 or R686 and C686).
6. Solder the other end of the #24 white-brown stranded wire to the +100 volt supply at the rear of R685 or R686.
7. Resolder the two resistors unsoldered in Step 1.
8. Correct the schematic in your manual to conform to the work you have just done.
9. Refer to your Instruction Manual for the proper procedure and readjust the Feedback-Bal-Adj. Disregard Figure 6-10 in the manual.

P6038 DIRECT SAMPLING PROBE — REPAIR INFORMATION

The probe head of the P6038 Direct Sampling Probe (specifically designed for use with the Type 3S3 and 4S3 Sampling Plug-Ins) contains some rather delicate parts. These parts are critically arranged with some tolerances as close as 0.005 inches. Even the replacement of the diodes must be done with care and a jeweler's touch lest the diode clips be sprung. We suggest that P6038 probes in need of repair be returned to the factory via your local Tektronix Field Office. Here at the factory we have the necessary alignment jigs and special techniques to do a quick and efficient repair job.

AN INEXPENSIVE SURPLUS-SOLDER REMOVER

Art Baier, Maintenance Technician with the Tektronix Canada Ltd's Toronto Service Center, offers the following suggestion: Take a three or four inch length of ⅛" Teflon tubing and insert it in an ear syringe. This combination makes a useful tool for removing unwanted or excessive solder from connections and solder holes. It is particularly useful when replacing components on etched circuit boards. The tool can be used to either suck or blow the unwanted solder away from the connection. The heat resistance of the Teflon tubing is such that it will not melt from the soldering iron heat.

POTENTIAL CRT PROBLEM

The PME Lab at Ent Air Force Base in Colorado Springs, Colorado, reports a potential problem when using other than Tektronix crt's in Tektronix instruments. In the General Atronic's crt for the Type 545 Oscilloscope, pins 8 and 9 are shorted internally. If this crt is installed in the Type 545A Oscilloscope, there is a good chance of burning up the Astigmatism control—which they did!

The people at the PME Lab suggested that a note here in SERVICE SCOPE might prevent other Air Force Bases from making a similar mistake.

TYPE 310 AND TYPE 310A OSCILLOSCOPES — TRIGGER PROBLEM

If your Type 310 or 310A Oscilloscope reveals a lack of trigger capability after about ten minutes of operation, try replacing C671. This is a 0.01 μfd, 400 v, PT capacitor in the +300-volt circuit of the low-voltage supply. When it becomes leaky it can cause the difficulty described here. The replacement capacitor should be of the same value *and of Mylar or Di-Film construction.* The recommended replacement is Tektronix part number 285-511. Order through your Tektronix Field Engineer or local Field Office.

TYPE 527 TELEVISION WAVEFORM MONITOR — APPARENT DOUBLE TRIGGERING

Rick Ennis, Tektronix Field Engineer with our Greensboro, North Carolina, Field Office, calls our attention to a situation in which a Type 527 will appear to be double triggering. One of Rick's customers was interested in vertical-interval testing. However, when they attempted to monitor the signals with the DISPLAY switch in the VIT position, the Type 527 appeared to be double-triggering. They could not see the standard one or two interval test signals. Instead they noticed either two or four interval test signals. What they were seeing was the half-line interlace since the Type 527 was triggering at the field rate. To one not aware of this situation it does appear that the Type 527 is double-triggering. Much time can be wasted trying to correct the situation. As Rick explained, the indication was not double-triggering but in effect a meaure of the interlace.

To view the VIT signal you should go to the TWO FIELD position and set the MAGNIFIER to X25. This will show a single vertical-interval test signal.

NEW FIELD MODIFICATION KITS

TYPE 533, TYPE RM533, TYPE 543, AND TYPE RM543 OSCILLOSCOPE—SILICON RECTIFIER

This modification replaces the selenium rectifier SR752, used in the V152 heater supply, with silicon-diode rectifiers. The new rectifiers offer longer life and greater reliability. There is a difference in the voltage drop across the silicon rectifier and the selenium rectifier it replaces. To compensate for this difference a resistor is added in series with the silicon diodes.

Order through your Tektronix Field Engineer or local Field Office. Specify Tektronix part number 040-389.

NOTE: You may replace the remaining selenium rectifiers with silicon rectifiers in the above instruments by ordering Modification Kit 040-240.

TYPE 81 PLUG-IN ADAPTERS — GENERAL IMPROVEMENTS

This modification enhances the performance of the Type 81 Plug-In Adapter by:

1. Improving the transient response.
2. Decoupling power supply aberrations from the plug-in units.
3. Eliminating parasitic oscillations in the Type 581 or Type 585.
4. Eliminating the 75-volt supply oscillations which occur when using certain plug-ins.
5. Changing several components in the Vertical Amplifier.
6. Adding decoupling to the plug-in power supplies.
7. Changing two transistor types.
8. Elevating the plug-in filament supply.
9. Increasing the amplitude of the Alternate-Trace Sync pulse.

The modification applies to Type 81 Plug-In Adapters with serial number 101 through 4092.

Order through your Tektronix Field Engineer or local Field Office. Specify Tektronix part number 040-371.

TYPE RM647 OSCILLOSCOPE—RACK-MOUNT REAR SUPPORT

This modification supplies a rear support for the Type RM647, making it capable of withstanding 4G's of vibration. To complete the installation, the instrument must be fastened to the front rack rails with the RELEASE knobs and four screws.

This kit replaces Rackmount Rear Support Kit part number 016-065.

Please note, if the instrument is mounted in a backless rack using Relay Rack Cradle Assembly 040-344; or, if slide-out extensions are used, the instrument will not meet the 4G-vibration specification.

Order through your Tektronix Field Engineer or local Field Office. Specify Tektronix part number 040-394.

TYPE RM565 AND TYPE RM567 OSCILLOSCOPES — RELAY RACK CRADLE ASSEMBLY

This modification provides a rear-support cradle for mounting a Type RM565 or Type RM567 instrument in a backless relay rack on slide-out tracks. The slide-out track assemblies *are not* included in the modification. They must be ordered separately as follows:

Instrument	Quantity	Part Number
RM565 and RM567	1 pair	351-055

The slide-out tracks allow an instrument to be pulled out of the rack like a drawer. When pulled out, the instrument can be locked in any one of seven positions: horizontal, or 45°, 90°, or 105° above and below the horizontal.

The modification kit includes a detailed drawing giving all dimensions necessary to design a relay rack to support these instruments.

Order through your Tektronix Field Engineer or local Field Office. Specify Tektronix part number 040-346.

SOME CORRECTIONS

In the April, 1964 SERVICE SCOPE, the schematic on page 4 contains an error. The voltage to which the plate loads of 6DJ8 are returned is shown as +225 volts. If this were true, the T12G diodes would be held at about 74 volts and quiescently the 6DJ8 plates would be at about 205 volts. On receipt of a trigger large enough to cut off one half of the 6DJ8, the other plate would fall to about 185 volts. This would leave the diode back-biased by more than 100 volts and no signal could reach the trigger multivibrator. We don't believe the diode would like it much, either.

The voltage to which the plate loads of the 6DJ8 should be returned is 100 volts. Quiescently, then, the plate will sit at about 80 volts back-biasing the diode by some 5 volts. A trigger signal can then cause one plate to fall to nearly 60 volts allowing up to a 10-volt signal to reach the multivibrator —or had you already figured this out for yourself?!

In the October, 1964 SERVICE SCOPE, a typographical error occurred twice in the "Cathode Follower" article. On page 3, center column, the sentence "Thus electrons are drawn away from C_b more rapidly than they would if C_b were absent". The first C_b in this sentence should read C_p.

Reading on further (next sentence) "The action continues during the plate-voltage rise of V_1—each increase in plate voltage causing a corresponding rise in voltage at the tap of R_L so that electrons can be drawn rapidly away from C_b". Here, again, C_b should be changed to C_p. This is the capacitance which we are interested in changing terminal voltage on in a short period of time.

TEKTRONIX CANADA LTD. ANNOUNCES

A new uniform F.O.B.-DESTINATION price policy.

Because we are interested in our customers and the ease with which they may do business with us, Tektronix Canada Ltd. will absorb the p.o.e. (point-of-entry)-to-destination freight tariffs on Tektronix instruments purchased by our Canadian customers.

Prior to now, instrument prices were quoted f.o.b. point of entry (Toronto, Montreal or Vancouver) with the customer responsible for the expense of delivery from there to his location. Thus, the total cost of an instrument laid down at the customer's location could be at considerable variance with the quoted price.

The new price policy offers you, the customer, several distinct advantages:

You will find your purchase and budget planning problems considerably eased in so far as Tektronix instruments are concerned.

You will, with the quoted price, know the total cost of obtaining that instrument — no longer will you need concern yourself with bothersome insurance rates and difficult-to-figure freight charges.

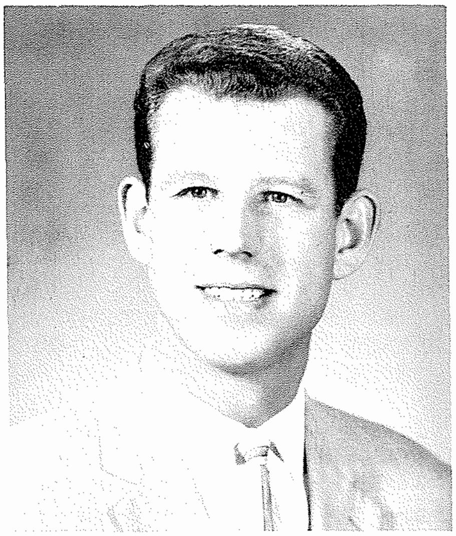
You will be relieved of the necessity to initiate and process possible claims for instruments damaged in transit. Although Tektronix has in the past volunteered to assist customers in this regard, it has until now remained an irksome chore that was primarily the customer's responsibility. Now, should you be unfortunate and receive a Tektronix instrument damaged in shipment you need only to notify Tektronix Canada Ltd., and the carrier handling the shipment. Then, hold for their inspection the carton and packing material in which the instrument was shipped. Tektronix guarantees delivery of a completely satisfactory and damage-free instrument.

In making this announcement we have saved the most important news until the last. A steadily increasing volume of Tektronix instruments shipped to Canada now allows us to route our freight to Canadian points-of-entry on a consolidated basis — and at some saving in expense. This saving we are passing on to you by making the F.O.B.-DESTINATION price policy available without an increase in instrument prices.

TEKTRONIX CANADA LTD. REPRESENTS ROHDE AND SCHWARZ IN CANADA

You can now enjoy for your Rohde and Schwarz instruments the same high degree of service, assistance and backup support that you expect for your Tektronix instruments. On October 1, 1964 Tektronix Canada Ltd. assumed the responsibility for the sales and servicing of Rohde and Schwarz products in Canada.

Rohde and Schwarz, a West Germany-based electronic instrument manufacturer, enjoys an excellent worldwide reputation. Typical products are signal generators, impedance measuring devices, frequency standards, etc. These products, which so nicely complement the Tektronix line of instruments, will allow your Tektronix Canada Ltd. Field Representative to more completely serve your electronic-instrument needs.



Melle Zegel

The Tektronix Canada Ltd. policy of continuing assistance with any problem involving oscilloscopes — selection, operation, application, maintenance or modification — has been extended to include Rohde and Schwarz instruments.

Melle Zegel, who recently joined Tektronix Canada Ltd., brings with him a vast fund of information and a comprehensive knowledge of Rohde and Schwarz instruments. Melle recently spent six months at their factory in Munich familiarizing himself with new instruments and attending their service and training school. The benefit of Melle's information and experience is available through your local Tektronix Field Representative. Please consult Melle and your Tektronix Field Representative whenever there is a need. They and Tektronix Canada Ltd. welcome every opportunity to assist you.

Service Scope

USEFUL INFORMATION FOR

USERS OF TEKTRONIX INSTRUMENTS

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Beaverton, Oregon

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