Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

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SOLVING POWER LINE PROBLEMS FOR BETTER SCOPE PERFORMANCE

Editor's note: Part 1 of this article appeared in the April 1961 issue of SERVICE SCOPE. As explained there, the problems that affect Tektronix instruments and arise from the condition of excessively high or low line voltage, seem to fall into three main categories: (1) continuous high or low line voltage; (2) fluctuations between high or low line voltage; and (3) serious waveform distortion, giving the effect of low line voltage. The first two of these categories were discussed in Part 1 and some suggested solutions outlined. Part 2, below, takes up the third category and concludes the article.

Part 2

The third major problem — serious waveform distortion — is the most difficult to overcome, since general-purpose correction systems are not always immediately available. To determine whether waveform distortion will seriously affect the performance of your instrument, use an oscilloscope to measure carefully the peak-to-peak voltage on the instrument's filament line, and compare this reading with the rms reading, as taken with a calibrated voltmeter. For 6.3 volts rms (indicating 117 volts rms power-line voltage) the peak-to-peak reading on the oscilloscope should be 17.8 volts. If this reading is less than 17.0 volts peak-to-peak, it indicates that the power supplied to the instrument is not adequate for proper power-supply regulation throughout the instrument's nominal 105-125 volts rms rating. The instrument will probably be in difficulty somewhere above 105 volts rms. A peak-to-peak reading of 15.5 volts or less for a 6.3 volts rms voltmeter reading indicates that the instrument's power supply will regulate only marginally even at 117 volts rms, on the power-line waveform supplied.

We have had reports of a few cases where local waveform distortion, combined with slight deterioration of tubes, rectifiers or capacitors in the oscilloscope, has caused a customer to go to considerable expense in component replacement because the instrument "dropped out" of regulation above what appeared to be 105 line volts. We suggest in these cases that an accurate measurement of the actual peak-to-peak line voltage be made before replacing other than obviously-failed components. An adapter such as that illustrated below (Figure C)

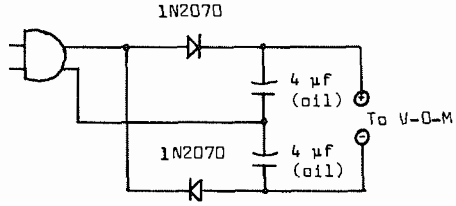


Figure C. Peak-to-peak reading adapter for 20,000 Ω/volt V-O-M.
Use of silicon diodes and oil-filled (or Mylar or paper) capacitors assures accurate voltage output.

RMS	Peak-to-Peak
105 v	297 v
117 v	331 v
125 v	354 v

can be used with a voltmeter to obtain peak-to-peak measurement of the line waveform at moderate construction cost. Alternatively an oscilloscope equipped for accurate differential voltage measurements in the 300-350 volt range can be used to make the peak-to-peak voltage measurement directly from the power line. It is not recommended that a scope be used "single ended" to measure its own power line voltage because of possible measurement errors and serious shock and damage hazards. The oscilloscope power supplies should continue to regulate properly down to 295 volts peak-to-peak. If the peak-to-peak line voltage is less than 295 volts for an rms reading of 105 volts, but the scope power supplies do regulate correctly at 295 peak-to-peak volts, then the trouble is mostly in the power-line waveform, and power-supply components are probably in good condition.

If power-line waveform distortion exists on the power lines into your building, the easiest solution may be to have the local power company correct the waveform for you. However, if it's caused by in-plant equipment (any high-current, nonlinear load will cause some distortion), it may be necessary to apply your own waveform-correction, using a filter of appropriate design and a transformer (to compensate for filter losses) between the power line and the oscilloscope. In extreme cases where severe fluctuations and transients are also involved, it may be necessary to employ a motor-generator set to obtain a steady, sinusoidal waveform. As before, be sure that the current rating of the filter or motor-generator set is adequate for oscilloscope operation (See Figure B).

Scope Type	Max. Power Consumption	Recommended Transformer Rating (Min)
310(A)	175 W	2 Amp
315	375 W	4 Amp
316	260 W	3 Amp
317	260 W	3 Amp
321	20 W	¼ Amp*
502	280 W	3 Amp
503	107 W	1 Amp
504	93 W	1 Amp
507	600 W	8 Amp
511(A)	240 W	3 Amp
512	280 W	3 Amp
513	475 W	6 Amp
514(A)	375 W	4 Amp
515(A)	300 W	3 Amp
516	300 W	3 Amp
517(A)	1250 W	15 Amp
519	660 W	7 Amp
524(A)	500 W	5 Amp
525	380 W	4 Amp
526	340 W	4 Amp
527	240 W	3 Amp
531(A)	455 W	5 Amp
532	475 W	5 Amp
533	500 W	6 Amp
535(A)	550 W	6 Amp
536	650 W	7 Amp
541(A)	520 W	6 Amp
543	530 W	6 Amp
545(A)	600 W	6 Amp
551	900 W	10 Amp
555	1050 W	12 Amp
561	175 W	2 Amp
570	400 W	5 Amp
575	410 W	5 Amp
581	640 W	7 Amp
585	725 W	8 Amp

*Power-line regulation not required if batteries are in place and line voltage does not exceed 125 v.

Figure B. Chart of Tektronix oscilloscope power requirements.

Incidentally, it should be mentioned that a step-up transformer alone should not be used where waveform distortion is the primary cause of power-supply regulation problems. If the peak-to-peak voltage of a seriously flattened power-line waveform is increased sufficiently to obtain good power-supply regulation, the unregulated filament lines in the scope will rise to excessive levels, causing premature tube failures from increased dissipation, gas, leakage, and filament burn-outs.

As with other problems in using or maintaining your Tektronix oscilloscope, you'll find your local Tektronix Field Engineer is anxious to help in identifying and solving any power-line problems that interfere with your instrument's best performance. A list of Tektronix Field Offices can be found in our current catalog, and is reprinted from time to time in Service Scope.

TESTING UNIJUNCTION TRANSISTORS WITH TRANSISTOR CURVE TRACER

By Walter Keller, Project Engineer, Cordis Corporation, Miami, Florida, with Jerry Kraxberger, Tektronix Field Engineer, St. Petersburg, Florida, assisting with write-up.

Editors note: If you are (as your editor was) *in a bit of a quandary* as to what is a unijunction transistor, a little research may be indicated.

The General Electric Transistor Manual, Fourth Edition, contains a description of unijunction transistors with an explanation of their theory of operation. I believe the short time required to read this material will be time well spent. It will aid in the more thorough understanding of Mr. Keller's and Mr. Kraxberger's article and perhaps give a greater appreciation of the versatility of unijunction transistors in many circuit applications.

The utility of a curve tracer for circuit design has proved itself to many. For those who have let it become a second "right arm", it is a major handicap when the curve tracer can not be employed to study one of the less conventional semiconductor groups.

In studying the uniformity of a few commercially acquired 2N492 transistors —particularly the intrinsic stand-off ratio[1] or the breakdown point of the emittor voltage as a function of the voltage between the bases—the following technique was used:

Employing any conventional transistor-curve tracer, connect B_1 of a unijunction transistor to ground and B_2 to the sweep voltage as the collector would be connected. Then connect the emitter to the stepping constant current source and shunt a 0.1 μf capacitor from B_1 to E. Sweep the bases with a positive half-sine-wave voltage and the emitter with a positive constant current just as one would do in the common emitter NPN connection. (See Figure 1.)

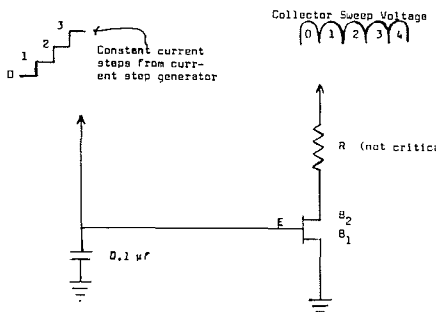


Figure 1

On a Tektronix Type 575 Transistor-Curve Tracer, connect B_2 to the terminal marked base, and B_1 to the terminal marked emitter (ground). Connect an 0.1 μf capacitor from emitter to ground. Apply voltages for the common emitter NPN transistor connection.

Consider a single emitter current step and the accompanying half-sine-wave voltage applied to B_2 (illustrated in Figure 2). Initially the current is stepped

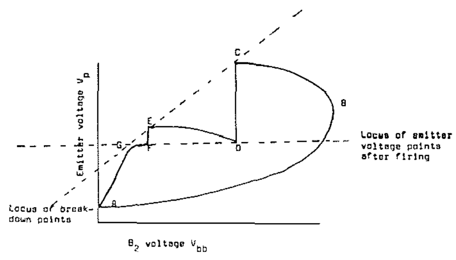


Figure 2

from zero to a positive value of constant current (say to step #1) as in Figure 1. This constant current step causes the capacitor C to charge at a linear rate and the instantaneous voltage is plotted as emitter voltage on the vertical axis in Figure 2. While the emitter voltage is increasing, the B_2 voltage (half-sine-wave which coincides with current in step #1) is increasing (moving to the right from A to B in Figure 2). Even though the voltage of B_2 reaches the peak value of B, the transistor is inactive because the capacitor charges rather slowly. As the B_2 instantaneous voltage decreases from point B to C, the capacitor voltage has increased sufficiently for the emitter to trigger the transistor into conduction causing the emitter voltage to discharge the capacitor voltage from C to D. Note that a second (E to F), and even a third, firing point can sometimes be observed. In Figure 2 we have shown only one complete emitter current step with its accompanying B_2 half-sine wave sweep. Figure 3 is an actual photograph of a General Electric Type 2N492 unijunction transistor (formerly called double-based diode) displayed on a Tektronix Type 575 Transistor-Curve Tracer. Front panel controls of the instrument were set as follows:

- Vertical—0.5 Base Volts/Div.
- Horizontal—1 Collector Volt/Div.
- Base Step Generator—Polarity to + and Step Selector to 0.01 ma/step.
- Collector Sweep—Polarity to + and Peak Volts to 10 volts on 20 volt range.
- Dissipating Limiting Resistor—to approx. 2 Ω.

Transistor Mounting Board—to grounded emitter position.

If one considers the locus of breakdown points (point C for each curve), a complete relation of emitter breakdown voltage as a function of B_2 voltage is obtained. All points below and to the right are nonconducting points; above and to the left are emitter and base voltages where conduction would occur with the conventional unijunction characteristics.

$$V_p = N\,V_{bb} + \frac{200}{T_J}$$

V_p=peak emitter voltage
N=intrinsic stand-off ratio (1) (2) (3)
V_{bb}=interbase voltage
T_J=junction temp. (Deg. Kelvin)

In Figure 2 V_p is the emitter voltage on the vertical axis and V_{bb} is the B_2 voltage on the horizontal axis for point C.

References:

1. "Silicon Unijunction Transistor Types", General Electric Company Brochure #Ecg357 Rep 1/60
2. General Electric Company Transistor Manual, 2nd. Edition, pp 40-44.
3. "A Handbook of Selected Semiconductor Circuits", NavShips 93483, NObsr 73231, BuShips, Navy Dept., pp 6-57, circuit #6-15.
4. T.P. Sylvan, "Bistable Circuits Using Unijunction Transistors", Electronics, December, 1958.

TYPE Z UNIT DAMAGE HAZARD

We have found a problem in the Type Z Differential-Comparator Units (with serial numbers below 749). Under a particular set of conditions this problem can cause trouble. The contacting sectors of the MODE switch are a few thousandths too wide. Consequently, if you turn the MODE switch too slowly when changing from one mode to another you may ground the input signal through the 10-Turn Precision Potentiometer...we traced several potentiometer failures to this problem. Also, you may short INPUT A directly to INPUT B as you turn the MODE switch.

You can minimize the chances of this trouble occurring by turning the MODE switch quickly when changing from one position to another—the trouble is more apt to occur if you hesitate between switch positions. However, a more practical way to protect the instrument is to install a Z-Unit Field Modification Kit, Tek number 040-262. The Kit contains four each 0.02μf, 150 v capacitors and 33 k, ¼ w, 10% composition resistors, a schematic diagram and installation instructions. There is no charge for this kit. Place your order through your Tektronix Field Engineer and be sure to include the serial number of the Z Unit for which the modification is intended.

If you prefer, you may obtain the capacitors and resistors locally and make the modification using the instructions that follow as your guide. First, however, consult the switch identification aid shown in figure 1 below.

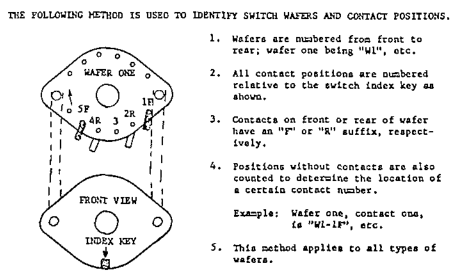


Figure 1

Here are the instructions for the modification:

INSTRUCTION:

( ) 1. Remove the strap connecting W2-12F to W1-12R of the mode switch (see figure 2, step 1).

( ) 2. Remove the white-violet wire from W1-12R (see figure 2, step 2).

( ) 3. Replace the .01 μf capacitor (located between W2-12F and the metal shield plate of the mode switch) with a .02 μf 150 v capacitor (see figure 2, step 3).

( ) 4. Solder one end of a .02 μf 150 v capacitor to W1-12R and solder the other end to the metal shield separating W1 and W2 (see figure 2, step 4).

( ) 5. Solder one end of a 33 k, ¼ w, 10¾ resistor to W2-12F (see figure 2, step 5).

( ) 6. Solder one end of another 33 k, ¼ w, 10% resistor to W1-12R (see figure 2, step 6).

( ) 7. Solder the remaining ends of the 33 k, ¼ w, 10% resistors (just installed) and the white-violet wire (removed in step 2) together (see figure 2, step 7).

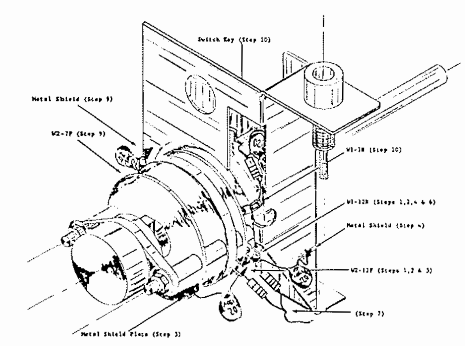
( ) 8. Parallel each of the remaining 33 k, ¼ w, 10% resistors with the remaining .02 μf 150 v capacitors. Clip both combinations to leads of approximately ¼ inch.

( ) 9. Replace the ground strap connecting W2-7R to the shield (separating W1 and W2) with one of the 33 k—.02 μf combinations described in step 8 (see figure 2, step 9).

( ) 10. Using a scribe or a sharp soldering aid, unsolder W1-1R from the shield. Solder the remaining combination of the 33 k—.02 μf from this contact to the key of the switch (see figure 2, step 10).

( ) 11. THIS COMPLETES THE INSTALLATION. Recheck your work.

Figure 2—Drawing showing installation steps for the above Z-Unit field modification.



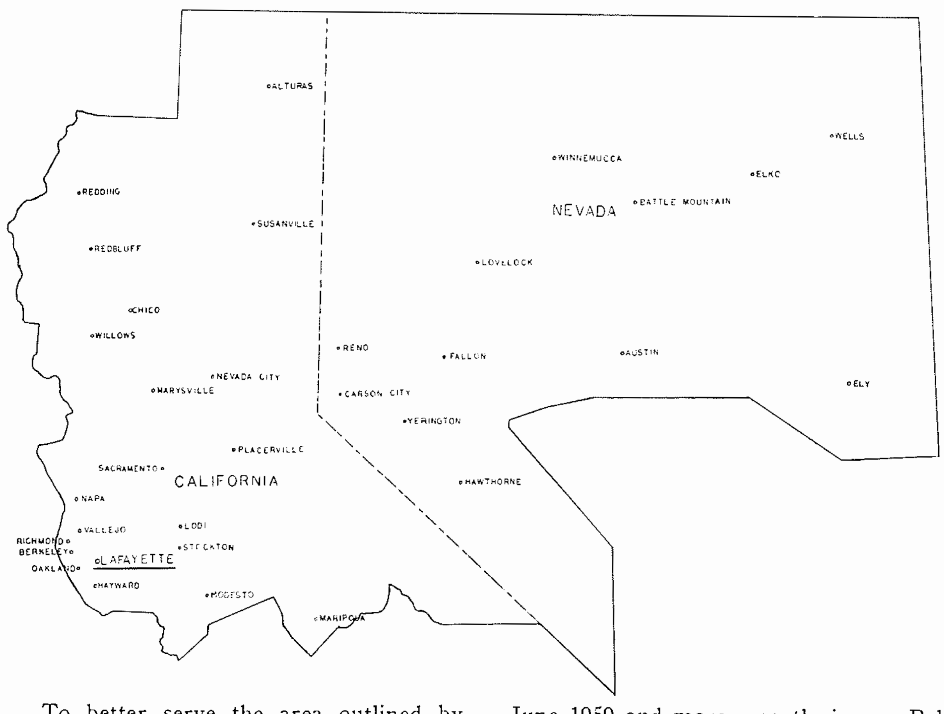
USED INSTRUMENTS FOR SALE

1 Type 524D	Jim Robertson Chief Engineer WLEX TV Lexington, Kentucky Phone LE 4-8747
1 Type 511AD s/n 1730	Harry Nickerson Chief Engineer Chalco Engineering Corporation 15126 Broadway Street Gardena, California
1 Type 511AD s/n 1223	Erich Frank University of Chicago Enrico Fermi Institute 5630 S. Ellis Street Chicago 37, Illinois Phone MI 3-0800, Ext. 3757
1 Type 535 s/n 7189	Chas. Hagen, Test Eng. Microsonics, Inc. 349 Lincoln Street Hingham, Mass.

USED INSTRUMENTS WANTED

1 Type 531 or Type 532	Donald Lusk 2521 South Pearl St. Denver 10, Colorado
1 Type 512 or Type 514	Douglas Waltz 410 West Park Avenue Kokomo, Indiana
1 530 Series (or equivalent) scope	George Jacobson 2931 Anzac Avenue Roslyn, Pennsylvania Phone TU 4-1345
1 Type 317 or other DC to 10 MC scope	Charles Woll 361 Holmes Road Holmes, Pennsylvania
1 Type 514D or Type 515	John Creedon Applied Radiation 2404 N. Main Street Walnut Creek, Calif.
2 Type 310 (instruments in need of repair preferred)	Howard E. Winch, CWO, W3 Det. 2, 714th AC& WRON Driftwood Bay, Alaska
1 Type 121 Amplifier (condition of instrument not important)	John West Tektronix, Inc. 442 Marrett Road Lexington 73, Mass.
1 Type 545	Chas. Hagen, Test Eng. Microsonics, Inc. 349 Lincoln Street Hingham Mass. Phone RI 9-3100
1 Type 524 and 1 Type 511	Test Equipment Co. 9012 Diana El Paso, Texas

ANOTHER NEW FIELD OFFICE



To better serve the area outlined by the map above, we have opened a new Tektronix Field Office at 3530 Golden Gate Way in the community of Lafayette, California. Strategically located in the fast-growing East Bay region, this office makes the many services offered by a Tektronix Field Office more conveniently available to people in this area.

Tektronix Field Engineer Howard King will be in charge of the new office. Howard joined Tektronix as a Field Engineer in 1956 serving in this capacity in our Long Island Field Office until June 1959 and more recently in our Palo Alto Field Office.

Tektronix Field Engineer Tony Bryan, presently with our Field Office in Endicott, New York, will join Howard in the new location on about July 1st.

Field Secretary Virginia Brown will assist Howard and Tony with details in the new office.

Telephone numbers of the new office are: For the Oakland, Berkeley, Richmond, Albany, San Leandro communities CLifford 4-5353; for all others YEllowstone 5-6101. TWX Number: LAF CAL 1639.

Form 3547 requested

Tektronix, Inc.
P. O. Box 500
Beaverton, Oregon

Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

BULK RATE
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MISSING OSCILLOSCOPES

Our Union, New Jersey Field Office sends word that a Type 310A Oscilloscope, serial number 29959, is missing and may have been stolen from the National Cash Register Co. of Newark, New Jersey. If you have any information on the whereabouts of this instrument, please contact the National Cash Register Co. in Newark, New Jersey.

A WORD OF THANKS AND A SUGGESTION

The February issue of SERVICE SCOPE carried an article warning against damage that can occur to the distributed amplifier of some Type 540/550 Series Oscilloscopes.

We wish to thank the many, many people who wrote us expressing appreciation for our candor in bringing the situation to your attention. Requests for the modification kits have been so numerous we have not been able to procure enough components to fill your orders promptly. We are asking for your patience until we are able to do so.

In the meantime we would like to emphasize the fact that chances are **extremely** small that you will have any trouble. If you wish to reduce these chances still further, we suggest that you check to see that the base of the CRT is clamped securely. Most cases of trouble have been caused by the vertical deflection-plate leads shorting to the edge of the CRT shield opening after the CRT has moved in its clamp; rough handling may cause slippage if the clamp is not secure. Some plastic electricians' tape placed around the shield opening will also help.

We do not wish to retract the recommendation that the modification be made—it can prevent a costly repair. However, some have felt a degree of panic which we did not intend and which cannot be justified.

Field Engineering Offices

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