FACTORY CALIBRATION PROCEDURE

CONTENTS:

Z

GENERAL:

This is not a field recalibration procedure as is the procedure in your instruction manual. This is a guide in calibrating brand-new instruments just assembled--instruments which have never been turned on before. Therefore, it calls out many procedures and adjustments that are rarely required for subsequent recalibration.

Even though we wrote this procedure primarily for our own factory test department, it may prove valuable to our customers also if used with some caution:

For all serial numbers

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TEKTRONIX, INC.
P.O. Box 500
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1. **Special test equipment**, if mentioned, is not available from Tektronix unless it also is listed in our current catalog. This special equipment is used in our test department to speed calibration. Usually you can either duplicate its function with standard equipment in your facility or devise alternate approaches.

2. **Factory circuit specifications** are not guaranteed unless they also appear as catalog or instruction manual specifications. Factory circuit specs usually are tighter than advertised specs. This helps insure the instrument will meet or exceed advertised specs after shipment and during subsequent field recalibrations over several years of use. Your instrument may not meet factory circuit specs but should meet catalog or instruction manual specs.

3. **Presetting controls**, if mentioned, usually is unnecessary. This is helpful for "first-time" calibration only. If internal controls are preset, you will have to perform a 100% recalibration. So don't preset controls unless you're certain a "start-from-scratch" policy is the best.

4. **Omissions** are sometimes called out. Factory calibration procedures are for our test department calibrators who first calibrate the instrument. Quality control men then check the initial calibration and perform additional fine points such as trimming resistor leads, installing shields, etc. You will need to perform most of the omissions as a part of your recalibration.

In this procedure, all front panel controls are in capital letters (SENSITIVITY) and internal adjustments are capitalized only (Gain Adj).

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1. MICROPHONICS:

No appreciable micro effect (especially ringing type) resulting from operation of front panel controls.

2. SEMI-CONDUCTOR VOLTAGE DROPS: S:

The voltage drops across the 105 volt zener diodes D7621 and D8621 must be within the range of 95 to 115 volts and must be within 2 volts of each other.

The voltage drops across the RT-6 zener diodes D7675 and D8679 must be within the range of 5.7 to 6.7 volts.

The voltage drop across the 140 volt zener diode D7635 must be within the range of 126 to 154 volts.

The emitter-to-base voltage drops across Q7672 and Q8672, 2N1102 transistors, must be within the range of 0.3 to 0.6 volts.

3. AMPLIFIER BALANCE:

Electrically center the POSITION control. With the collectors of Q7644 and Q8644 (OC171's) shorted together, set the trace to the oscilloscope vertical system electrical center using the Output CF Bal R7658 pot.

(a) When the jumper is placed between the OC171 bases, the trace shift must not exceed 3 mm.

(b) When the jumper is placed between the grids of V7634 and V8634 (12AU6's), the trace shift must not exceed 2 cm.

4. OUTPUT VOLTAGE:

The output DC voltage (amphenol connector pins 1 and 3 to ground) must be between 66 and 69 volts.

5. GAIN:

With the GAIN ADJUST at maximum (fully cw), the gain must exceed the proper setting by at least 10%.

Rotating the VAR ATTEN control from full cw to full ccw must reduce the vertical deflection to no more than 40% of the original deflection (4 cm of vertical deflection must be reduced to no more than 1.6 cm).

6. TRACE SHIFT:

With a 0.1 volt calibrator signal fed into both inputs and with both VOLTS/CM switches at .05, the trace must not shift more than 0.5 mm after switching from A ONLY to -B ONLY.

With the COMPARISON VOLTAGE polarity switch at 0, the input selector switch at A-B, and both inputs externally grounded, the trace must not shift more than 2 mm as the AC-DC switches are operated.

With the input selector at the TEST position and the Spectrol pot set at 10.0 (maximum), the trace must not shift more than 3 mm as the COMPARISON VOLTAGE polarity switch is moved from 0 to +, or 0 to -. The sum of the two shifts must not exceed 5 mm.

7. DIFFERENTIAL BALANCE:

With a 100 volt calibrator signal fed to both inputs, with both VOLTS/CM switches at .05, and with the input selector switch at A-B, the vertical deflection must not exceed .4 mm.

The straight line segments between spikes may be tilted diagonally, or rolled off at the spike. With the segments set head-to-tail, ignoring spikes, and the sweep free running at 50 msec/cm, the trace width must not exceed 1 mm.

8. CONTROL RANGE:

The VAR ATTEN BAL, DIFF BAL, Output CF Bal, and Amp DC Bal pots must all be set within ±90° mid range.

9. ACCURACY:

The turret attenuator ratios must be held to ±2% on all settings.

With the COMPARATOR VOLTAGE range switch at 1 v and the precision voltmeter at 1.000 volt, the Spectrol pot must read 1.000 volt ±2 minor divisions.

The Spectrol R7686 pot must be within .05% zero-based linearity.

10. PASSBAND:

Passband shall be no more than 3 db down at 14 mc with a 541, 541A, 543, 543A, 545, 545A, 551, or 555, and no more than 3 db down at 11 mc with a 531A, 533, 533A, or 535A.

CALIBRATION | REPAIR

1. RECOMMENDED EQUIPMENT:

1 Tektronix Type 545A oscilloscope
1 Tektronix Type 190A constant amplitude signal generator
1 Tektronix Type 105 square-wave generator
1 Tektronix Type 107 square-wave generator
1 Volt ohmmeter calibrated to 1% accuracy
1 Tektronix CS24 (011-029) capacitance standardizer
1 Tektronix B52R (011-001) 52Ω termination
1 Tektronix P52 (   ) 52Ω coax cable
1 Tektronix Test Cable (012-038) 30" flexible
1 Tektronix EP54 (013-019) plug-in extension
1 Tektronix B52-L10 (011-033) 52Ω 10 to 1 L pad
1 John Fluke Model 803 differential voltmeter

2. TEST SCOPE:

Sweep: internal, 5 millisec, 5X mag off
Trigger: plus internal, AC, stability cw

INSPECTION:

Check all switches and dials for smooth mechanical operation. Set the helidial exactly on zero. Run it out to 10. The dial should read about half a minor division over 10 (10.005). Make a thorough visual inspection for proper wire dress, cracked turrets, etc.

3. RESISTANCE CHECKS:

CIRCUIT	AMPHENOL CONNECTOR	RESISTANCE TO GROUND
output	1,3	9.8 k
ground	2	0
no connection	4,5,6,7,8,16	infinity
-150 v	9	10.7 k, *17.0 k
+100 v	10	8.7 k, * 7.7 k
+225 v	11	19. k, *14.0 k
+350 v	12	60 to 80 k
6DJ8 filament	13,14	infinity
filament string	15	72Ω

*With COMPARISON VOLTAGE polarity switch -.

4. Z UNIT PRESETS:

A VOLTS/CM and B VOLTS/CM	cw (.05, X1)
A and B AC-DC switches	DC
Input Selector	TEST
VAR ATTEN	cw
COMPARISON VOLTAGE POLARITY	0
COMPARISON VOLTAGE RANGE	100 v
COMPARISON VOLTAGE Spectrol pot	10 (cw)
GAIN ADJUST	1/6 turn from cw
VAR ATTEN BALANCE, DIFF BAL, POSITION, DC Amp Balance, Output CF Balance,	midrange

Connect Z Unit to scope using flexible test cable.

WARNING: Transistor cases are hot. Dangerous dc potentials exist on the 2N1302's and the 2N1303. Don't change transistors with power applied. The OC171's are safe IF the case lead has been properly removed and IF there are no internal element-to-case shorts.

5. VOLTAGE CHECKS:

Measure the voltage drops across the 105 volt zener diodes D7621 and D8621. The drops must be within the range of 95 to 115 volts, and within 2 volts of each other.

Read the cathode-to-ground voltage swing of V7613. When the COMPARISON VOLTAGE polarity switch is thrown to +, the cathode should swing approx 100 v positive. In -, the swing should be approx 100 v negative. Set the polarity switch back to 0.

Location	Voltage
D7675 and D8679 (RT-6 zener diodes)	5.7 to 6±7 v
Q7672 and Q8672 (2N1102's) emitter to base	0.3 to 0.6 v
V8623 filament lead with orange tracer	+12.2 v
Bracket mounted Q7618 base	-138.0 v
V7618 filament	-101.0 v
Junction R7645 and R8645 (100 Ω)	+210.0 v
Interconnecting plug pins 1 and 3	+66 to +69 v
Interconnecting plug pin 15	+75.0 v

6. OUTPUT CATHODE FOLLOWER BALANCE:

Mechanically center the POSITION control. Jumper between Q7644 and Q8644 collectors. Adjust Output CF Bal R7658 pot to center the trace.

CAUTION: With one end of the jumper on a transistor, the transistor will be destroyed if the other end of the jumper touches ground.

7. OUTPUT AMPLIFIER BALANCE:

Jumper between Q7644 and Q8644 bases. Trace shift not to exceed 3 mm.

8. DIFFERENTIAL AMPLIFIER BALANCE:

Jumper between V7634 and V8634 grids (pin 1). Trace shift not to exceed 2 cm.

9. VARIABLE ATTENUATOR BALANCE:

Obtain trace by using POSITION, DC Amp Balance, and VAR ATTEN BALANCE controls. Rotate the VAR ATTEN R7633 control back and forth through full range while adjusting the VAR ATTEN BALANCE R7619 pot for no trace shift.

10. AMPLIFIER DC BALANCE:

Center the POSITION control and adjust the Amp DC Bal R7640 pot to center the trace.

11. GAIN:

Set the input selector to A ONLY. Apply .2 volts from the scope calibrator to input A. With the VAR ATTEN control full cw, turn the GAIN ADJUST R8639 pot full cw. There must be at least 4.4 cm of vertical deflection. Set the GAIN ADJUST pot for exactly 4 cm of vertical deflection.

Change the input selector to -B ONLY and apply .2 volts from the scope calibrator to input B. Check to see that there is exactly 4 cm of vertical deflection. Vertical deflection must not exceed 1.6 cm with the VAR ATTEN full ccw. Rotate VAR ATTEN back to full cw.

12. DIFFERENTIAL BALANCE:

Set the input selector to A-B, apply 100 volts from the scope calibrator to both A and B inputs. Trigger the scope sweep. Adjust the DIFF BAL R7620 pot for minimum vertical deflection (ignore spikes). Maximum allowable deflection is .4 mm. When the DIFF BAL is properly set, the trace appears to be a straight line with spikes.

An ac mismatch between two tubes or components can cause the straight line segments to tilt diagonally. The amplitude of this "tenting" cannot exceed 1 mm. To check the amplitude, free-run the sweep at 50 msec/cm. The width of the trace must not exceed 1 mm.

Increase sweep speed to .5 msec/cm, remove all Z Unit inputs and rotate the input selector switch to TEST. It is necessary to repeat step 9 because of adjustment interaction.

13. TRACE SHIFT:

UNBALANCE: Move the POLARITY switch from 0 to + and from 0 to -. Maximum trace shift is 3 mm. The sum of the two shifts must not exceed 5 mm.

GAS: Set the POLARITY switch to 0 and the input selector to A-B. Externally ground both A and B inputs. Move each AC-DC switch from DC to AC. Trace shift not to exceed 2 mm. Return AC-DC switches to DC.

MICROPHONICS: Rap lightly on the front panel and watch for excessive ringing type microphonics. Remove the external grounds and return the input selector switches to TEST.

14. OUTPUT CATHODE FOLLOWER BALANCE:

Electrically center the POSITION R7653 control by attaching a VOM to the two center taps of the POSITION dual pot. Remove the flexible test cable and install the Z Unit in the scope. Jumper between pins 1 and 3 of the interconnecting plug to determine the electrical center of the scope's vertical system. Move the jumper to between the collectors of Q7644 and Q8644, and set the trace to the electrical center of the scope's vertical system by means of the Output CF Bal R7658 pot.

15. VARIABLE ATTENUATOR BALANCE:

Rotate the VAR ATTEN R7633 and adjust the VAR ATTEN BALANCE R7619 pot for no trace shift. This step should be checked after each of the next three steps because of adjustment interaction.

16. AMPLIFIER DC BALANCE:

With the POSITION control still centered, set the trace to the electrical center of the scope's vertical system by means of the Amp DC Bal R7640 pot.

17. GAIN:

Repeat step 11. Check to see that trace shift does not exceed .5 mm after switching from A ONLY to -B ONLY. Set the input selector to A-B. Check the operation of the PUSH TO DISCONNECT SIGNAL switches.

18. DIFFERENTIAL BALANCE:

Repeat step 12. Check the operation of the AC-DC switches by placing them in the AC positions and observing the trace. Return them to DC.

19. ATTENUATOR RATIOS:

Set the input selector switch to A ONLY, A VOLTS/CM to .05, and insert .2 volts of scope calibrator signal. There should be exactly 4 cm of vertical deflection (VAR ATTEN full cw). Check the other settings:

VOLTS/CM	CALIBRATOR	VERTICAL DEFLECTION
.05	.2 volt	4 cm exactly
.10	.5	5 ± 1 mm
.25	1.	4 ± .8 mm
.5	2.	4 ± .8 mm
1.0	5.	5 ± 1 mm
2.5	10.	4 ± .8 mm
5.	20.	4 ± .8 mm
10.	50.	5 ± 1 mm
25.	100.	4 ± .8 mm

Set the input selector to -B ONLY and repeat the above procedure.

20. INPUT CAPACITY:

Set the input selector to A ONLY and both VOLTS/CM switches to .05. Loosen the set screws on both VOLTS/CM outer knobs and remove them. This allows access to the attenuator adjustments through slots in the front panel. Each position of the VOLTS/CM control has a SHUNT and SERIES adjustment except for the .05 setting, which only has an input capacity trimmer (in the SERIES slot).

Apply 3.5 cm of a 1 kc signal from a 105 to input A through a P52 coax cable terminated with a CS24 capacitance standardizer. Set the sweep speed to display several cycles of the waveform.

Set up the 545A for double sync:

TIME/CM	.5 MILLISEC
TRIGGERING MODE	AC LF REJECT
TRIGGER SLOPE	+ INT

Rotate the STABILITY control from full cw until the TRIGGERING LEVEL control will trigger the sweep at only a single center point in its range. Rotate the STABILITY control to full cw. Now, using the VARIABLE TIME/CM control, the sweep will sync on both positive and negative triggers and a stable display of superimposed square waves can be obtained.

Adjust the input capacity trimmer in the attenuator for best square wave flat top, disregarding any leading edge spikes.

21. OUTPUT VOLTAGE DIVIDER COMPENSATIONS:

Increase the 105 frequency to 10 kc. Readjust the scope TIME/CM and VARIABLE controls to obtain a stable display of several superimposed square waves. Adjust C7655 and C8655 for best flat bottom, removing the spikes. The capacitors should be adjusted so that they are at approximately the same physical settings.

Set the input selector to A ONLY and connect the 105 to input A. Check to see if C7655 and C8655 are adjusted to give the best possible flat top on the displayed square waves. If not, adjust the capacitors for the best compromise between the two displays.

Decrease the 105 frequency to 1 kc and recheck the settings of both input capacity trimmers. The level of the leading edge (no overshoot or undershoot) should be even with the level of the trailing edge of the superimposed square waves.

Increase the frequency to 10 kc and recheck the adjustment of C7655 and C8655.

22. ATTENUATOR COMPENSATION:

Set the input selector to A ONLY and A VOLT/CM to .1. Apply 3.5 cm of 1 kc square wave from the 105 to input A. Adjust the SERIES trimmer for minimum overshoot. Adjust the SHUNT trimmer for a leading edge which is even with the level of the trailing edge. Care should be taken to insure the leading edge is not rolled off.

Proceed as above with the rest of the attenuator positions. After completion, recheck each setting. Set the VOLTS/CM switch full cw and replace the outer knob to read .05.

Repeat this step for the B attenuator.

23. HIGH FREQUENCY COMPENSATION:

Set the input selector to A ONLY. Apply 3.5 cm of a 1 mc signal from a 107 through a P52 cable terminated with a B52R. Trigger test scope - internal and set sweep speed to display the positive half of the 107 waveform.

Adjust L7645, L8645, L7632, and L8632 to obtain the sharpest leading edge on the displayed waveform without introducing overshoot. Keep the coil slugs at approx the same settings.

Set the input selector to -B ONLY, trigger the scope -int, and connect the 107 to input B. Check that the bottom of the waveform is as sharp as possible without overshoot. If not, set the coils for a compromise for the best display obtained between input A and input B (the A and B waveforms must be as alike as possible).

24. PASSBAND:

Set the input selector to A ONLY. Apply 28 mm of a 50 kc sine wave from a 190A to input A. Increase the frequency to 14 mc. There should be at least 20 mm of signal. Repeat for input B.

25. PRELIMINARY PRECISION VOLTAGE ADJUSTMENTS:

Connect an EP54 plug-in extension between the Z Unit and the scope. Set the COMPARISON VOLTAGE Spectrol pot to 10.000, the polarity switch to + and the range switch to 100 v.

Familiarize yourself with the operation of the John Fluke 803 differential voltmeter.

In each of the following steps, make both the Z Unit and 803 settings before connecting the 803 into the circuit. After the adjustment, and before proceeding to the next adjustment, disconnect the 803.

Before proceeding, be sure the scope's regulated supply voltages (as measured in the scope) are within value, ripple, and regulation specifications.

26. CAL 1:

Set the polarity switch to +; set the 803 for -107.7 volts and connect it between Test Pt A and ground. Adjust Cal 1 for a null on the 803.

27. CAL 2:

Set the polarity switch to - ; set the 803 for +107.7 volts and leave it connected between Test Pt A and ground. Adjust Cal 2 for a null on the 803.

NOTE: In these last two steps it is more important that the voltage magnitudes be identical rather than 107.7 volts. For instance, readings of -107.90 and +107.95 are better than -107.70 and +107.85. Keep the voltages between 107.3 and 108.1, however.

28. CAL 3:

Set the 803 at +107.7 volts and connect it between Test Pt B and ground. Set the polarity switch to +. Adjust Cal 3 for a null on the 803. If Cal 1 and Cal 2 are set at 107.9 volts, then adjust Cal 3 for the same voltage.

Occasionally, the voltage at Test Pt B may not come up to the proper magnitude. If the voltage drops across D7675 and D8679 are between 5.7 and 6.7 volts, the difficulty is probably being caused by low voltage drops, within tolerance, of V7689 and its zener string. The voltage drop across V7689 should be between 83 and 87 volts, and across D7688 it should be between 5.7 and 6.7 volts. D7686 and D7687 are 6.2 volt 10% zeners. Unless a component is defective, replacing V7689 with a higher voltage-drop tube should cure the trouble. Allow at least 10 minutes for proper warmup before adjusting Cal 3.

29. CAL 4:

Set the range switch to 100 v, the Spectrol pot at 10.000 not 10.005, the 803 for +100 volts and connect it between Test Pt C and ground. Adjust Cal 4 for a null on the 803.

If the voltage at Test Pt C doesn't come down to 100.000 volts, remove one of the shorting straps across R7685 (located on the range switch wafer). Remove the long strap that extends across the wafer. If the voltage is still not within range, remove the other starting strap.

30. CAL 5:

Set the range switch to 10 v and the 803 for 10.000 volts. Adjust Cal 5 for a null on the 803. Repeat steps 27 and 28 until interaction is overcome and readjustment is no longer necessary.

31. 1 VOLT RANGE:

Set the range switch to 1 v and the 803 for 1.000 volts. Null the 803 with the VOLTAGE COMPARATOR Spectrol pot. It must read 1.000 volts, ±2 minor divisions.

32. CONTINUITY TO ATTENUATOR TEST POINT:

Set the Spectrol pot full cw (approx 10.005). Check continuity between Atten Test Pt and Test Pt C (0 ohms, shorted).

33. LINEARITY OF SPECTROL R7686 POT:

Leave the COMPARATOR VOLTAGE range switch at 100 v. Set the Spectrol pot at 9.00, the 803 at +90.00 volts, and connect it from Test Pt C to ground. Adjust the Spectrol pot for a null on the 803. The Spectrol pot should read 9.00 ±1/2 minor division.

In the same manner, check the Spectrol pot to 8.00, 7.00, etc., for readings of 80.000, 70.000, etc. Tolerance is ±1/2 minor division on the Spectrol pot at the 803 null. Check each major division setting.

If the 1/2 minor division tolerance is exceeded, set the Spectrol pot exactly on the major division settings, null the 803 and read the millivolt deviation. If the deviations exceed those given in the following table, the Spectrol pot is not within 0.05% zero based linearity:

SPECTROL POT:	0	1	2	3	4	5
DEVIATION:	50	55	60	65	70	75

SPECTROL POT:	6	7	8	9	0
DEVIATION:	80	85	90	95	set at zero

The Spectrol pot may be within the maximum deviations given above and still be nonlinear. This is checked at the factory.

SPECTROL POT:	7	8	9
DEVIATION:	80	70	60

If the deviations exceed the values given in the second table, offset Cal 4 to bring the deviations to the tabular values.

Check the operation of the Spectrol pot lock.

CAUTION: Never connect an ohmmeter to the center tap of the COMPARISON VOLTAGE Spectrol pot R7686. If the center tap approaches either end of the pot, an ohmmeter battery can supply more than enough current to melt the fine wire of the pot.

34. THE END.