

NOTE REGARDING FACTORY CALIBRATION PROCEDURES

AND TEST SPECIFICATIONS

Factory Calibration Procedures and Test Specifications are intended for use at the factory as a general guide for calibrators and quality control men. Most of the tolerances listed in these sheets are closer than advertised specifications. This is done purposely in order to insure that the instrument will meet or exceed advertised specifications when it reaches the customer.

These calibration procedures and test specifications should be used, therefore, as a guide only.

Some of the test equipment referred to in the calibration procedures is not available commercially; the Tektronix field engineer will be glad to suggest alternate approaches.

FACTORY CALIBRATION PROCEDURE

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GENERAL:

This isn't a field recalibration procedure as is the procedure in your instruction manual. This is a guide in calibrating brand-new instruments, just assembled instruments that 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's valuable to others also if used with some caution:

1. **Special test equipment**, if mentioned, is not available from Tektronix unless it's listed also 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, devise alternate approaches, or build the special test equipment yourself.
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'll have to perform a 100% recalibration. So don't preset controls unless you're certain a "start-from-scratch" policy is the best.
4. **Quality control men steps**. 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. In some cases a factory calibration procedure instructs the calibrator not to perform these fine points. You'll ordinarily have to include these fine points in your calibration.

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

TENTATIVE
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For all serial numbers

TEK 061-416 January 1962
supercedes December 1961

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FACTORY CIRCUIT SPECIFICATIONS

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FACTORY CALIBRATION PROCEDURE

CALIBRATION

REPAIR

1. EQUIPMENT REQUIRED:

- a. 1 540 series scope
- 1 190 constant amplitude signal generator
- 1 105 square-wave generator
- 1 107 square-wave generator

- 1 CS47 input capacitance standardizer
- 1 52 Ω termination (011-045 preferred) or (011-001)
- 1 52 Ω cable

- 1 Resistor terminal board (392-124) with 10 k resistor
- 1 EP54 plug-in extension (013-019)
- 1 AC coupler, 1 μf (special)
- 1 Grid current testing device (special)

2. TEST SCOPE:

- a. Sweep: internal, 1 millisecc, mag off.
Trigger: plus internal, automatic, preset.

- b. Determine the scope's vertical amplifier electrical center by either: (1) inserting a test load unit, pressing the PRESS TO SHORT INPUT button, and noting vertical position of the trace; or (2) shorting pins 1 and 3 together on the blue Amphenol interconnecting plug, and noting vertical position of the trace.

3. INSPECTION:

- a. Visually inspect for proper wire dress. Check controls for smooth mechanical operation.

4. RESISTANCE CHECKS:

a.

Amphenol connector	resistance to ground	Amphenol connector	resistance to ground
1	3.9 k	9	1 meg
2	0	10	1.5 k
3	3.9 k	11	10 k
4	infinite	12	1 meg
5	infinite	13	infinite
6	infinite	14	infinite
7	infinite	15	70 Ω
8	infinite	16	infinite

5. O UNIT PRESETS:

a.

VERTICAL DISPLAY	EXT DC+
VERTICAL POSITION	midrange
VOLTS/CM	.05
VARIABLE VOLTS/CM	CALIBRATED
DC BAL	midrange
GAIN ADJ	midrange
OUTPUT DC LEVEL ADJ (A and B)	midrange

Vertical Position Range	midrange
Open Loop Gain (A and B)	midrange
Trimmers	midrange
Neutralizing capacitors	midrange

b. Plug the O Unit into the scope, using a plug-in extension.

6. DC OUTPUT LEVEL:

a. Measure voltage at Amphenol connector pin 1 to ground and pin 3 to ground; read 65 to 70 v.

7. DC BAL:

a. Center trace with VERTICAL POSITION R6550 control. Rotate VARIABLE VOLTS/CM while adjusting DC BAL R6536 for zero trace shift.

8. VERT POS RANGE:

a. Set VERTICAL POSITION midrange. Adjust Vertical Position Range R6557 to bring trace to scope's vertical amplifier electrical center.

9. GAS, GRID CURRENT AND MICROPHONICS:

a. Gas and grid current: Set A VOLTS/CM to .05, ground A INPUT, switch VERTICAL DISPLAY from DC+ to DC-; trace shift: 1 mm max.

b. Microphonics: Tap lightly on O Unit front panel; check for no excessive ringing microphonics.

10. DC SHIFT:

a. Set VERTICAL DISPLAY to EXT DC+, VOLTS-CM to .5, VARIABLE VOLTS/CM to CALIBRATED, and apply enough dc to deflect the trace 3 to 4 divisions (1.5 v from an ohmmeter). Trace shift after initial deflection: 1 mm max.

11. VERTICAL DISPLAY CONTROL:

- a. Trigger test scope externally. Set OUnit VERTICAL DISPLAY to EXT DC+, VOLTS/CM to .05, and VARIABLE VOLTS/CM to CALIBRATED. Apply .1v of calibrator signal to scope external trigger input and to OUnit EXT INPUT. Position bottom of the calibrator waveform to center graticule line.
- b. Change the VERTICAL DISPLAY to DC -; view top of the calibrator waveform on the center graticule line.
- c. Change VERTICAL DISPLAY to AC -; view middle of the calibrator waveform on the center graticule line.
- d. Change VERTICAL DISPLAY to AC +; view middle of the calibrator waveform on the center graticule line, inverted with respect to previous display.

12. GAIN ADJ:

- a. Same settings as step 11 above except: remove calibrator from scope external trigger input and trigger test scope internally. Set OUnit VERTICAL DISPLAY to EXT DC+.
- b. With .1v calibrator signal still applied, Gain Adj R6536 should make at least 2.2 cm deflection.
- c. Set Gain Adj R6536 for exactly 2 cm.

13. VOLTS/CM STEPS:

a. Set VERTICAL DISPLAY to EXTDC+, VOLTS-CM to .05 and VARIABLE VOLTS/CM to CALIBRATED. Apply a .2v calibrator signal to EXTINPUT. View exactly 4cm deflection.

b. Check all VOLTS/CM positions:

c. NOTE: "Deflection" column below lists 5 cm in most cases which is not directly obtainable on a 540 series scope. Indirectly obtain it by moving the top of the initial 4cm display (paragraph a) down exactly 1cm. With a .5v calibrator signal and a .05 VOLTS/CM setting the top of the display will rest on the top graticule line. Since 1cm of deflection is below the bottom graticule line, the total deflection is 5cm.

d. CALIBRATOR VOLTS/CM DEFLECTION

.2 v	.05	4 cm
.5 v	.1	5 cm
1 v	.2	5 cm
2 v	.5	4 cm
5 v	1	5 cm
10 v	2	5 cm
20 v	5	4 cm
50 v	10	5 cm
100 v	20	5 cm

14. INPUT AND NEUTRALIZING CAPACITORS:

- a. Set VOLTS/CM to .05, VERTICAL DISPLAY to EXT DC+ and VARIABLE VOLTS/CM to CALIBRATED. Apply 3.5cm of 1kc signal from a 105 through a 52Ω terminating resistor and a 47 pf standardizer to EXT INPUT.
- b. Adjust input cap C6541 for optimum flat top. Change VERTICAL DISPLAY to EXT DC - and adjust input cap C6521 for optimum flat top.
- c. Change VERTICAL DISPLAY back to EXT DC +, VARIABLE VOLTS/CM to min gain (full ccw just before CALIBRATED detent), and increase 105 output to again obtain 3.5 cm of vertical deflection. Adjust bottom neutralizing cap C6574 for optimum square wave.
- d. Rotate VARIABLE VOLTS/CM back to CALIBRATED and reduce 105 output for 3.5 cm vertical deflection. Readjust C6541 for optimum square wave.
- e. These two adjustments interact and must be readjusted until there is no change in wave shape when rotating VARIABLE VOLTS/CM.
- f. Repeat this step with VERTICAL DISPLAY in EXT DC -, adjusting C6521 and top neutralizing cap C6564 for optimum square wave.

15. VOLTS/CM COMPENSATIONS:

- a. Set VERTICAL DISPLAY to EXT DC+ and VARIABLE VOLTS/CM to CALIBRATED. Apply 3.5cm of 1kc signal from a 105 through a 47 pf standardizer to EXT INPUT. Adjust for optimum square wave as follows:

b. VOLTS/CM	SPIKE	LEVEL
.1	C6508B	C6508C
.2	09B	09C
.5	10B	10C
5	13B	13C

16. HF RESPONSE:

- a. Remove plug-in extension, set VERTICAL DISPLAY to EXT DC+, VOLTS/CM to .05, and VARIABLE VOLTS/CM to CALIBRATED. Apply 3 cm of 500kc signal from a 107 through a 52Ω terminating resistor to EXT INPUT. Set scope to .2 μsec/cm.
- b. Adjust L6544 and L6574 for best square wave.
- c. Change VERTICAL DISPLAY to EXT DC -. Adjust L6524 and L6564 for best square wave.

17. RISE TIME:

- a. Remove plug-in extension, set VOLTS/CM to .05, VARIABLE VOLTS/CM full cw, and VERTICAL DISPLAY to EXT DC+.
- b. Set scope for .1 μ sec sweep and 5X mag on. Apply 4 cm of a 500 kc signal from a 107 through a 52 Ω terminating resistor to the EXT INPUT. Rise-time: 15 nsec max (3/4 cm). Ringing: 1% max.

18. PASSBAND:

- a. Change scope to 100 μ sec/cm. Set O Unit VOLTS/CM to .05, VARIABLE VOLTS/CM to CALIBRATED, and VERTICAL DISPLAY to EXT DC+.
- b. Apply 3 cm of a 50 kc signal from a 190 through a 52 Ω terminating resistor to EXT INPUT. Change 190 frequency to 22 mc (don't change 190 amplitude). View at least 2.1 cm of signal remaining (3 db point).

19. OUTPUT DC LEVEL:

- a. Steps 19 through 27 apply to both A and B amplifiers. Perform all steps for A amplifier then repeat for B amplifier. B amplifier circuit symbol numbers are in parenthesis.
- b.

VERTICAL DISPLAY	A+
VOLTS/CM	.2
VARIABLE VOLTS/CM	CALIBRATED
LF REJECT	OFF
Zi	1 MEG
Zf	1 MEG
±GRID SELECTOR	-
- c. Push ZERO CHECK and note trace position. Release ZERO CHECK and push OUTPUT DC LEVEL switch to left and move trace with internal DC Level Range R5532 (R5582) adjust to position noted above. Make fine adjustments with front panel OUTPUT DC LEVEL ADJ R5522 (R5572).

20. OPEN LOOP GAIN:

- a.

VERTICAL DISPLAY	A+
VOLTS/CM	1
VARIABLE VOLTS/CM	CALIBRATED
LF REJECT	OFF
Zi	EXT
Zf	EXT
±GRID SELECTOR	-
- b. Apply a 1 mv calibrator signal to -GRID banana jack. You may have to readjust OUTPUT DC LEVEL ADJ to get trace on screen. Adjust Open Loop Gain R5548 (R5598) for 2.5 cm vertical deflection.

21. OUTPUT CONNECTORS, VOLTAGE AND CURRENT:

a.	VERTICAL DISPLAY	EXT DC+
	VOLTS/CM	20
	LF REJECT	OFF
	Zi	1 MEG
	Zf	1 MEG
	±GRID SELECTOR (A)	-

b. Apply a 100v calibrator signal through an ac coupler (special) to EXT INPUT. Adjust VARIABLE VOLTS/CM for 4 cm of deflection.

c. Remove calibrator signal from EXT INPUT and apply it to A INPUT. Connect a patch cord from A OUTPUT banana jack to EXT INPUT. View 4 cm of deflection. Move patch cord from A OUTPUT coax connector. Still view 4 cm of deflection.

d. Plug a 10 k ±1% (mounted on Tek 392-124) resistor between the A OUTPUT banana jack and GND. Still view 4 cm of deflection.

22. GRID CURRENT:

a.	VERTICAL DISPLAY	A+
	VOLTS/CM	.5
	VARIABLE VOLTS/CM	CALIBRATED
	LF REJECT	OFF
	Zi	EXT
	Zf	EXT
	±GRID SELECTOR	+

b. Change test scope to 5 sec/cm. Plug grid current testing device (special) into the six A amplifier banana jacks. Set testing device switch to the right and push right-hand button. View less than 3 cm vertical deflection for each cm of horizontal deflection.

c. Move switch to left and push left button. View less than 1.5 cm of vertical deflection for each cm of horizontal deflection.

23. NOISE:

a.	VERTICAL DISPLAY	A+
	VOLTS/CM	.05
	VARIABLE VOLTS/CM	CALIBRATED
	LF REJECT	OFF
	Zi	.01 MEG
	Zf	1 MEG
	±GRID SELECTOR	-

b. Ground A INPUT. Noise: .5 cm max.

24. Zi AND Zf VALUES:

Switch Zi to .01R and Zf to .1R

a. Change VOLTS/CM to 2 and LF REJECT to 1 CPS. Apply 4cm of a 1kc signal from a 105 through a 52Ω terminating resistor to A INPUT. Check as follows:

b.	Zi	Zf	Deflection
	.1 MEG	.1 MEG	.4 cm
	.01 MEG	.01 MEG	.4 cm
	.1 MEG	.2 MEG	.4 cm
	.1 MEG	.5 MEG	2.0 .4 cm
	.1 MEG	1 MEG	4 cm
	.2 MEG	1 MEG	2 cm
	.5 MEG	1 MEG	.8 cm
	1 MEG	1 MEG	.4 cm

c. Switch Zi to 1 μF and Zf to .1 μF. View 4 cm of deflection, then check as follows:

d.	Zi	Zf	Deflection
	.1 μF	.01 μF	4 cm
	.01 μF	.001 μF	4 cm
	.001 μF	.001 μF	.4 cm
	.01 μF	.01 μF	.4 cm
	.1 μF	.1 μF	.4 cm
	1 μF	1 μF	.4 cm

25. Zi--Zf EQUALIZATION:

- a. VERTICAL DISPLAY A -
- VOLTS/CM .05
- VARIABLE VOLTS/CM CALIBRATED
- LF REJECT OFF
- Zi 1 MEG
- Zf 1 MEG
- ±GRID SELECTOR -

b. Change 105 frequency to 10 kc, keep 4 cm.

c. Dress Operational Amplifier input, grid, and output leads for best square wave. DON'T ALTER LEAD DRESS ONCE SET. *Don't* alter it for any of the following paragraphs.

d. You must compensate the stray capacitance of the resistors used for Zi and Zf. Do this by selecting and installing capacitors in parallel with the resistors. Use either .68 or 1 pf or no capacitor. Select them for less than 5% roll-off, hook, or overshoot. Select the capacitors for passband also:

e. After capacitor selection is complete for each setting of Zi and Zf, check passband by applying exactly 3 cm of a 50 kc signal from a 190 through a 52Ω terminating resistor to A INPUT (or B INPUT). Change 190 to 750 kc. View 2.1 cm min (-3 db point).

f.	Zi AND Zf R MEG	Zi CAPACITOR increase pf to spike	Zf CAPACITOR increase pf to roll-off
1		C5509A (C5559A)	-- --
.5		B (B)	-- --
.2		C (C)	C5511C (C5561C)
.1		D (D)	D (D)
.01	-- --		E (E)

} Selected at factory

26. Zi AND Zf .0001 μ F AND 10 PF VALUES:

- | | | |
|----|---------------------|--------------|
| a. | VERTICAL DISPLAY | A+ |
| | VOLTS/CM | .2 |
| | VARIABLE VOLTS/CM | CALIBRATED |
| | LF REJECT | 1 KC |
| | Zi | .01 MEG |
| | Zf | .001 μ F |
| | \pm GRID SELECTOR | - |

b. Set scope to 2 μ sec/cm. Apply 4 cm of a 100 kc signal from a 105 through 52 Ω terminating resistor and an ac coupler (special) to A INPUT. View:



c. Change VOLTS/CM to 2 and Zf to .0001 μ F. Adjust C5512F (C5562F) for 4 cm of deflection. Change VOLTS/CM to 20 and Zf to 10 PF. Adjust C5512G (C5562G) for 4 cm deflection.

d. Change Zi to .001 μ F and Zf to .01 μ F. Remove the ac coupler. Change 105 to 2 cm of 100 kc. Change Zi to .0001 μ F and Zf to .001 μ F. Adjust C5512B (C5562B) for 2 cm of deflection.

e. Change Zi to 10 PF and Zf to .0001 μ F. Adjust C5512C (C5562C) for 2 cm of deflection (ignore square wave overshoot).

27. GAIN--BANDWIDTH:

- | | | |
|----|---------------------|------------|
| a. | VERTICAL DISPLAY | EXT DC+ |
| | VOLTS/CM | .5 |
| | VARIABLE VOLTS/CM | CALIBRATED |
| | LF REJECT | 1 KC |
| | Zi | 1 μ F |
| | Zf | 10 PF |
| | \pm GRID SELECTOR | - |

b. Apply 2 cm of a 50 kc signal from a 190 through a 52 Ω terminating resistor to EXT INPUT. Move 190 from EXT INPUT to A INPUT and change VERTICAL DISPLAY to A+. Increase 190 frequency until you get 2 cm deflection. This frequency should be greater than 13 mc.

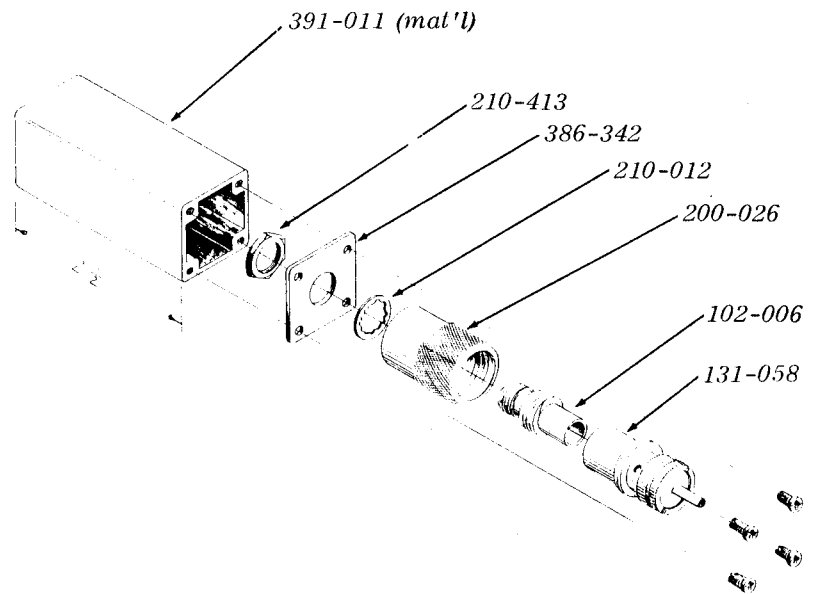
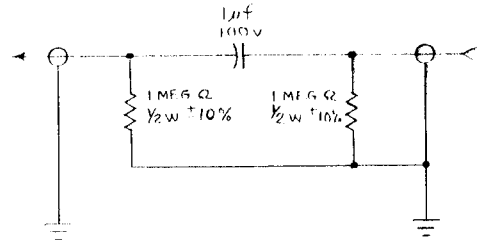
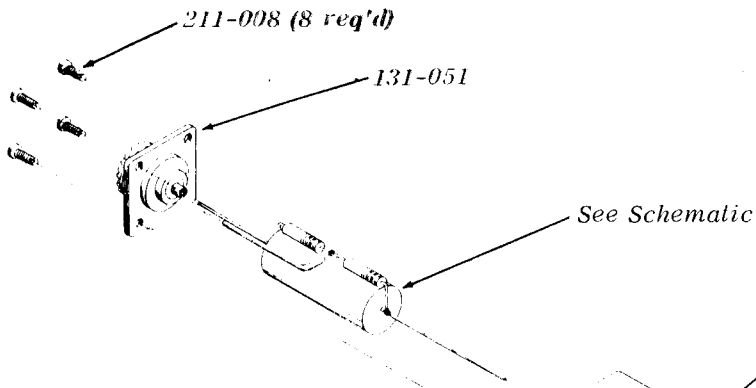
28. B AMPLIFIER REPEAT:

- a. Repeat steps 19 through 27 for B Amplifier.

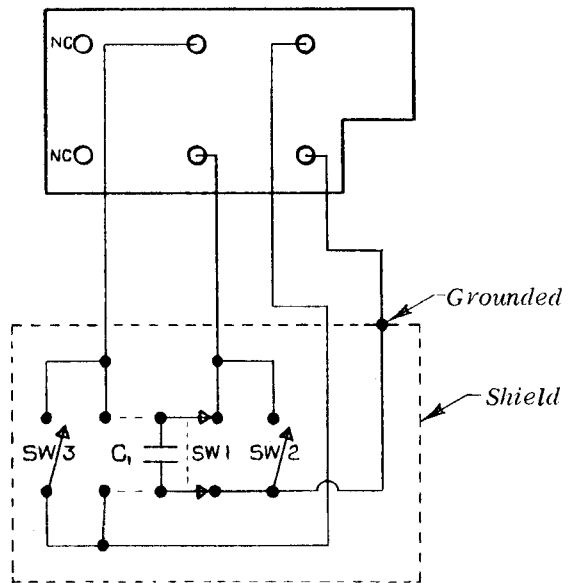
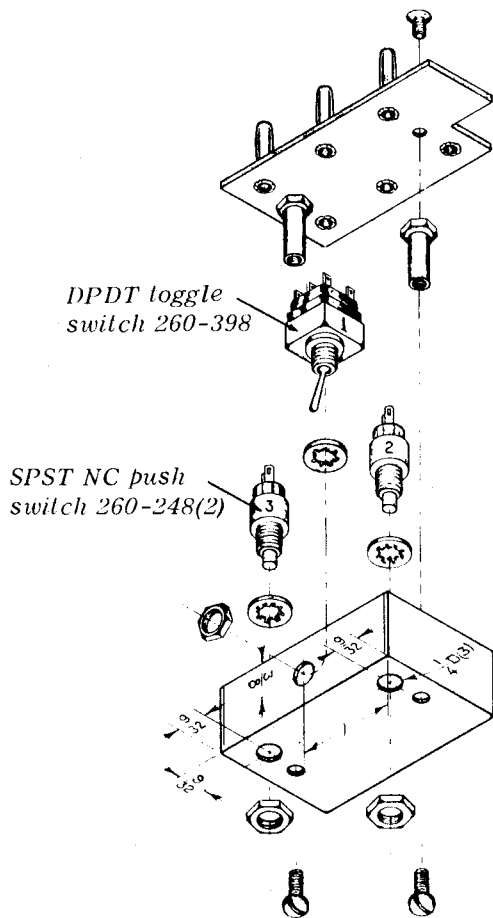
29. THE END.

SPECIAL TEST EQUIPMENT

AC COUPLER:



GRID CURRENT TESTER:



C₁-0.001 ± 1/4%