## 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.

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# FACTORY CALIBRATION PROCEDURE

CONTENTS:



CA

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.

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**For all serial numbers.**

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).

## FACTORY CIRCUIT SPECIFICATIONS

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.

The numbers listed beside the specifications are the factory calibration procedure steps where the check or adjustment is made.

**BALANCE:**

7a. Output V4383: electrical center ±2 cm.

8c. DC BAL: final adjust within ±90° of mr.

GAS AND MICROPHONICS:

9a. Gas: 2 mm max.

9b. Microphonics: no ringing type.

**VERTICAL POSITION:**

10b. Traces within 3 cm of each other and each within ±2 cm of electrical center.

10b. Vert Pos Range R4376: final adjust within ±90° of mr.

11a. Trace shift between NORMAL and INVERTED: ±1 cm max; slow drift: ±2 mm max.

11c. Trace shift between A or B ONLY and ADDED ALGEBRAICALLY: ±2 cm max.

**OUTPUT DC LEVEL:**

12a. 67.5 v ±2.5 v.

DUAL TRACE:

13a. Alternate: must alternate on all sweep rates between .1 sec and .1 μsec/cm.

Chopped:
14a. frequency: 100 kc ±20%.
14a. symmetry: ratio 3 to 2 max.
14a. flat top: distortion .5 mm max.

**GAIN:**

GAIN ADJ:
15b. range: ±10%.
15b. final adjust within ±90° of mr.

17a. ADDED accuracy: ±2%.

17b. Common mode rejection: 20 to 1.

26b. dc to 24 mc.

18a. VOLTS/CM accuracy: ±2%.

18a. VARIABLE range: 2.5 to 1.

**FREQUENCY RESPONSE:**

25b. DC: dc to 24 mc (-3 db point).

-- AC: 2 cps (-3 db point) to 24 mc (-3 db point).

CALIBRATION

NOTES

1. EQUIPMENT REQUIRED:

a. 1 Tektronix type 540 series oscilloscope as plug-in scope
1 Tektronix type 105 square-wave generator
1 Tektronix type 107 square-wave generator
1 Tektronix type 190 constant amplitude sine-wave generator

1 20 pf input capacitance standardizer (011-022)
1 52 Ω termination (011-001)
1 52 Ω cable, 42" (012-001)
1 Plug-in extension (013-019)
1 Dual connector (003-035)

1 Triplett type 630 multimeter; 20,000 Ω/v dc, checked for ±1% accuracy

1 Standard calibrator (special)

2. PRELIMINARY INSPECTION:

a. Check for unsoldered joints, rosin joints, lead dress and long leads. Check controls for smooth operation and proper indexing.

3. CA PRESETS:

a. CHANNELS A and B:

| | |
|---|---|
| AC-DC | DC |
| VOLTS/CM | .05 |
| VARIABLE volts/cm | cw |
| POLARITY | NORMAL |
| VERTICAL POSITION | mr |
| GAIN ADJ | cw |
| DC BAL | mr |
| MODE | ALTERNATE |
| Vert Pos Range R4376 | mr |
| C3322 and C4322 (input capacitors) | mr |
| All coil slugs | just below bottom of windings |

4. RESISTANCE CHECKS:

a. Check resistance to ground:

| use | amphenol connector pin | resistance (approx) |
|---|---|---|
| output | 1 | 8.5 k |
| gnd | 2 | 0 |
| output | 3 | 8.5 k |
| not used | 4 to 7 | inf |
| alt trig | 8 | 0 |
| -150 v | 9 | 12 k |
| +100 v | 10 | 2 k |
| +225 v | 11 | 6.3 k |
| +350 v | 12 | inf |
| 6.3 vac | 13 | inf |
| 6.3 vac | 14 | inf |
| +75 v fil | 15 | 65 Ω |
| alt trig | 16 | *320 k |

*inf below sn 34790

5. PLUG-IN SCOPE PRESETS:

a. Sweep: 1 millisec/cm.
Trigger: +int, ac, stability cw.

b. Determine plug-in scope's vertical amplifier electrical center by either:

1. Inserting a test load unit, pushing PRESS TO SHORT INPUT button and noting trace vertical position, or

2. Shorting amphenol connector pins 1 and 3 together and noting trace vertical position.

6. SETUP:

a. Use a plug-in extension (013-019) and plug CA Unit into plug-in scope. Turn power on.

7. OUTPUT BALANCE:

a. Connect a jumper between CA Unit output of V4383 12AT7 pins 2 and 7. Select V4383 so trace falls within ±2 cm of plug-in scope's electrical center (step 5b). Remove jumper.

8. PRELIMINARY DC BALANCE:

a. Move A trace to plug-in scope's electrical center with A VERTICAL POSITION. Rotate A VARIABLE volts/cm back and forth while adjusting A DC BAL for no trace shift.

b. Repeat for B.

c. Both A and B DC BAL adjustments must be within ±90° of mr after adjustment. Return VARIABLES cw.

9. GAS AND MICROPHONICS:

a. Ground A input. Switch A AC-DC back and forth between AC and DC. View trace shift (gas): 2 mm max. Return AC-DC to DC.

b. Rap lightly on CA Unit front panel. View microphonics: no ringing type. Leave input grounded.

c. Ground B and repeat for B.

10. VERTICAL POSITION RANGE:

a. Set both A and B VERTICAL POSITION controls to mr. Adjust Vert Pos Range R4376 so both traces are equidistant above and below plug-in scope's electrical center.

b. Traces must be within 3 cm of each other and each trace must be within ±2 cm of scope's electrical center. Vert Pos Range R4376 must be within ±90° of mr after adjustment.

11. POLARITY:

a. Move A trace to scope's electrical center with A VERTICAL POSITION. Switch POLARITY back and forth between NORMAL and INVERTED. View trace shift: ±1 cm max. View slow drift after initial shift (gas): ±2 mm max.

b. Repeat for B.

c. Return both A and B POLARITY controls to NORMAL. Move both traces to scope's electrical center with VERTICAL POSITION controls. Change MODE to ADDED ALGEBRAICALLY. View trace shift: ±2 cm max. Return MODE to ALTERNATE.

12. OUTPUT DC LEVEL:

a. Keep both traces to electrical center. Measure voltage between amphenol connector pin 1 and gnd. Read +65 to +70 v. Measure between pin 3 and gnd. Read +65 to +70 v.

13. ALTERNATE MODE:

a. Change VERTICAL POSITION controls so traces are about 2 cm apart. Change scope to .1 sec/cm. View display alternate between A and B traces. Check that display alternates between A and B traces from .1 sec to .1 μsec/cm.

14. CHOPPED MODE:

a. Keep traces about 2 cm apart. Change MODE to CHOPPED. Change scope to 2 μsec/cm, triggered. View one cycle of chopped waveform: 4.25 to 6.25 cm duration; waveform top duration to waveform bottom duration ratio (or vice versa) 3 to 2 max; .5 mm max flat-top distortion.

b. Set scope crt cathode selector (scope rear) to dual trace chopped blanking. View rise and fall portions of chopped waveform are blanked. Change crt cathode selector back to normal. View rise and fall portions unblanked.

15. GAIN:

a. Change scope to 1 millisec/cm. Change MODE to A ONLY. Keep VOLTS/CM at .05 and VARIABLE cw. Apply .1 v from standard calibrator (special) to A input.

b. Keep GAIN ADJ cw; view 2.2 cm deflection, min. Change GAIN ADJ ccw; view 1.8 cm deflection, max. Adjust GAIN ADJ for exactly 2 cm deflection. GAIN ADJ must be within ±90° of mr after adjustment.

c. Change MODE to B ONLY, apply calibrator to B input, and repeat for B.

16. AC-DC:

a. Keep MODE to B ONLY and keep calibrator applied to B input. Move bottom of calibrator waveform to center graticule line with B VERTICAL POSITION. Change B AC-DC to AC. View waveform shifts so it's approximately centered about center graticule line. Return B AC-DC to DC.

b. Change MODE to A ONLY, apply calibrator to A input, and repeat for A.

17. ADDED ALGEBRAICALLY:

a. Apply .1 v calibrator to *both* A and B inputs. Change MODE to ADDED ALGEBRAICALLY. Keep both POLARITY controls to NORMAL. View 4 cm deflection, ±.8 mm.

b. Change A (or B) POLARITY to INVERTED. Change calibrator to 1 v. View 1 cm deflection, max. If over 1 cm, vary VERTICAL POSITION controls. If still over 1 cm, reverse POLARITY controls and again vary VERTICAL POSITION controls, if necessary. One method must result in 1 cm or less deflection.

18. VOLTS/CM:

a. Change MODE to A ONLY and both POLARITY controls to NORMAL. Keep calibrator applied to both inputs. Check as follows:

| VOLTS/ CM | calibrator | deflection VARIABLE cw | ccw |
|---|---|---|---|
| .1 | .05 v | *2 cm | .8 cm max |
| .2 | .1 | 2 +2% | .8 |
| .5 | .2 | 2.5 | 1 |
| 1 | .5 | 2 | .8 |
| 2 | 1 | 2 | .8 |
| 5 | 2 | 2.5 | 1 |
| 10 | 5 | 2 | .8 |
| 20 | 10 | 2 | .8 |

*Adjusted, step 15

b. Change MODE to B ONLY and repeat for B. Remove calibrator.

19. A INPUT CAPACITY:

a. Remove plug-in extension and reinsert CA Unit, less extension, into scope. Change MODE to A ONLY and A VOLTS/CM to .05.

b. Connect a 52 Ω termination (011-001) to 105 output. Connect a 52 Ω cable (012-001) to 52 Ω termination and a 20 pf input capacitance standardizer (011-022) to other end of cable. Connect 20 pf standardizer to CA Unit, A input.

c. Set 105 for about 3.5 cm of 1 kc. Adjust C3322, input capacitor, for best square wave.

**20. A VOLTS/CM COMPENSATION:**

a. Keep 3.5 cm 1 kc 105 deflection and adjust for best square wave as follows:

| VOLTS/CM | adjust spike | level |
|---|---|---|
| .05 | | C3322 (adj, step 19) |
| .1 | C3311C | C3311B |
| .2 | 12C | 12B |
| .5 | 13C | 13B |
| 1 | 14C | 14B |
| 2 | 15C | 15B |
| 5 | 16C | 16B |
| 10 | 17C | 17B |
| 20 | 18C | 18B |

**21. B INPUT CAPACITY:**

a. Change MODE to B ONLY and B VOLTS/CM to .05. Change 105 (via 20 pf standardizer) to B input, keep 3.5 cm of 1 kc. Adjust C4322, input capacitor, for best square wave.

**22. B VOLTS/CM COMPENSATION:**

a. Keep 3.5 cm 1 kc 105 deflection and adjust for best square wave as follows:

| VOLTS/CM | adjust spike | level |
|---|---|---|
| .05 | | C4322 (adj, step 21) |
| .1 | C4311C | C4311B |
| .2 | 12C | 12B |
| .5 | 13C | 13B |
| 1 | 14C | 14B |
| 2 | 15C | 15B |
| 5 | 16C | 16B |
| 10 | 17C | 17B |
| 20 | 18C | 18B |

b. Remove 105.

23. HIGH FREQUENCY:

a. Connect a 52Ω cable to 107 output, connect a 52Ω termination to 52Ω cable and connect termination to CA Unit A input.

b. Change MODE to A ONLY and A VOLTS/CM to .1. Set 107 for about 3 cm of approx 500 kc. Adjust L3364, L4374, L3362, L3372, L3334 and L3354 for best square wave with no overshoot.

c. Change A VOLTS/CM to .05 and check for no square-wave overshoot or roll-off.

d. Change MODE to B ONLY and B VOLTS/CM to .1. Change 107 to B input. Adjust L4362, L4372, L4334 and L4354 for best square wave with no overshoot.

e. Change B VOLTS/CM to .05 and check for no square-wave overshoot or roll-off.

f. NOTE: L3364 and L4374 affect both A and B channels. Adjust for best square wave on both channels.

g. Remove 107.

24. FINAL DC BALANCE:

a. Change MODE to ALTERNATE. Move A trace to scope's electrical center with A VERTICAL POSITION. Rotate A VARIABLE volts/cm back and forth while adjusting A DC BAL for no trace shift.

b. Repeat for B.

25. FREQUENCY RESPONSE:

a. Change scope to .1 millisec/cm. Change MODE to A ONLY. Attach a 52Ω termination to 190 output and apply exactly 3 cm of 50 kc to A input.

b. Increase 190 frequency to 24 mc. View 2.1 cm deflection, min.

c. Change MODE to B ONLY and repeat for B.

d. Remove 190.

26. HIGH FREQUENCY COMMON MODE REJECTION:

a. Attach a dual connector (003-035) to CA Unit A and B inputs. Keep 52 Ω termination on 190 output and connect 190 to dual connector. Set both VOLTS/CM to .5. Set 190 for 2 cm of 50 kc.

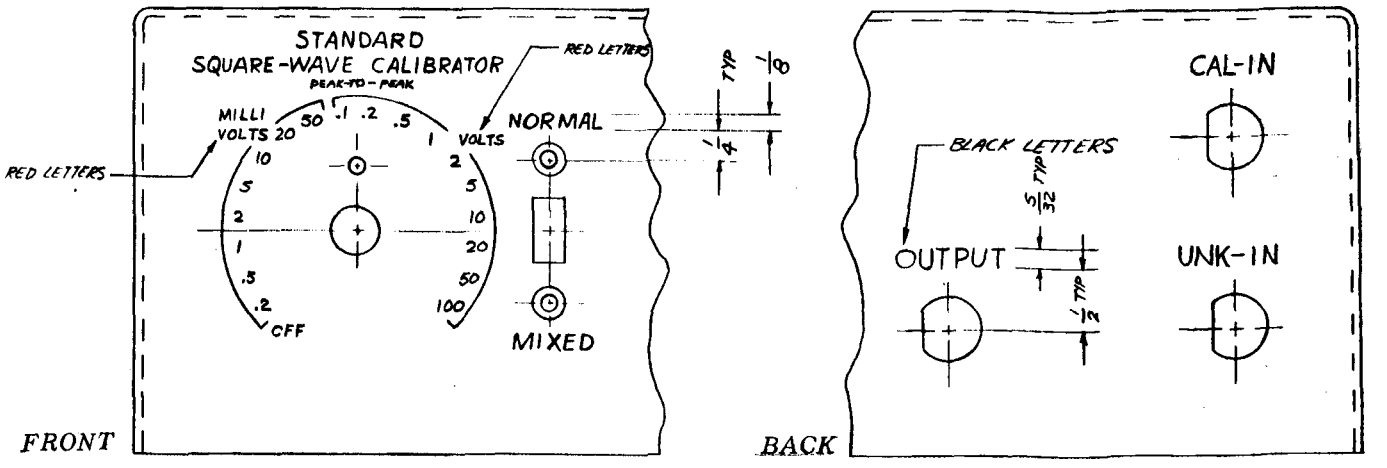
b. Change both VOLTS/CM to .05, MODE to ADDED ALGEBRAICALLY and A POLARITY to INVERTED. View deflection: 1 cm max. If over 1 cm, change A POLARITY to NORMAL and B POLARITY to INVERTED. One method must result in 1 cm or less deflection.

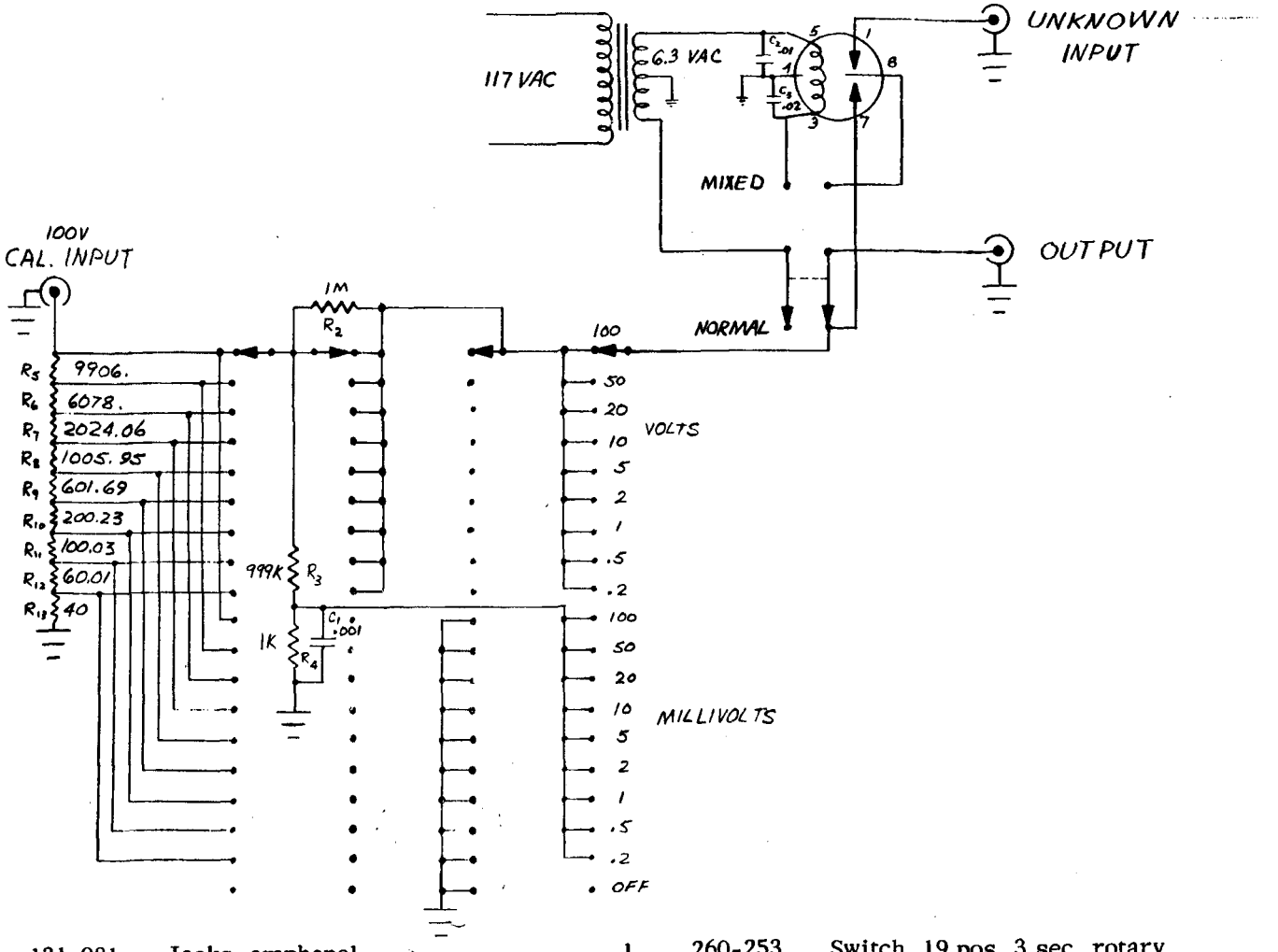
c. Change both AC-DC controls to AC. View deflection: 1 cm max.

27. THE END.

STANDARD CALIBRATOR:

Dwgs 600-B, 7-10-61 (front and rear panels); 601-B, 7-10-61 (schematic); 918-A, (parts).




| | | | | | |
|---|---|---|---|---|---|
| 3 | 131-081 | Jacks, amphenol | 1 | 260-253 | Switch, 19 pos. 3 sec. rotary |
| 1 | 131-093 | Receptacle, plug | 1 | 283-003 | Capacitor, .01 μfd discap |
| 1 | 136-011 | Socket, octal | 1 | 309-115 | Resistor, 1 k 1/2 w 1% |
| 2 | 210-406 | Screws, 4-40 1/4" | 1 | 309-014 | Resistor, 1 meg 1/2 w 1% |
| 6 | 210-457 | Nuts, 6-32 kep-type | 1 | 310-100 | Resistor, 1 meg 1 w 1% |
| 2 | 211-023 | Nuts, 4-40 | 1 | 366-057 | Knob, large black |
| 9 | 211-507 | Screws, 6-32 | 1 | 283-004 | Capacitor, .02 hi-kap 150 v |
| 1 | 260-228 | Switch, dpdt slide | 1 | 283-000 | Capacitor, .001 μfd discap 500 v |