# FACTORY CALIBRATION PROCEDURE

CONTENTS:

This is the guide for calibrating new instruments in Product Manufacturing. The procedure consists of 4 sections:

Equipment Required

Factory Test Limits - Factory Test Limits are limits an instrument must meet before leaving Manufacturing. These limits are often more stringent than advertised performance requirements. This is to insure that the instrument will meet advertised requirements after shipment, allows for individual differences in test equipment used, and (or) allows for changes in environmental conditions.

Short Form Procedure - The Short Form Procedure has the same sequence of steps and the same limits on checks or adjustments as the Main Procedure.

Main Procedure - The Main Procedure gives more detailed instructions for the calibration of the instrument. This procedure may require that some checks and adjustments be made so that performance is better than that required by the Factory Test Limits. This insures the Factory Test Limits will be met when side panels are added, permits some normal variation in test equipment and plug-in scopes, etc.

Abbreviations in this procedure will be found listed in TEKTRONIX STANDARD A-100. Definitions of terms used in this procedure may be found in TEKTRONIX STANDARD A-101.

In this procedure, all front panel control labels and Tektronix instrument names are in capital letters (VOLT/DIV, etc). Internal adjustment labels are capitalized only (Gain Adj, etc).

*This procedure is company confidential*

561B

January 1969

For all serial numbers.

CHANGE INFORMATION:

This procedure has been prepared by Product Manufacturing Staff Engineering. For information on changes made to this procedure, to make suggestions for changing this procedure, or to order additional copies: please contact PMSE, 39-307.

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EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

*a. TEKTRONIX Instruments*

| | |
|---|---|
| 1 | TYPE 547 OSCILLOSCOPE |
| 1 | TYPE 1A1 DUAL-TRACE PLUG-IN UNIT |
| 1 | TYPE 2A60 AMPLITUDE |
| 1 | TYPE 2B67 TIME BASE |
| *1 | TYPE 184 TIME-MARK GENERATOR |
| 1 | TYPE 76TU LINE VOLTAGE CONTROL UNIT |
| 1 | TYPE 106 SQUARE WAVE GENERATOR |
| 1 | TYPE P6006 10X PROBE |
| 1 | TYPE P6028 1X PROBE |
| 1 | TYPE P6019 CURRENT PROBE |

*b. Test Fixtures and Accessories*

| | |
|---|---|
| 1 | DC Voltage Bridge (DCVB) (067-0543-99)(See Note) |
| 1 | Standard Amplitude Calibrator (SAC) (067-0502-00) |
| 2 | TYPE 561B/564B Test-Load Unit (067-0593-99) |
| 1 | CRT Deflection Capacitance Normalizer (067-0500-00) |
| 2 | 50Ω BNC cable (012-0057-01) |
| *1 | Prescision 50Ω Termination (067-0515-00) |
| 1 | Adapter: GR to BNC male (017-0064-00) |
| 1 | Adapter: GR to BNC female (017-0063-00) |
| 1 | 50Ω BNC Termination (011-0049-00) |
| *1 | Model 881A Fluke Differential Voltmeter |
| 1 | Adapter: Binding Post to BNC female (013-0094-00) |

*c. Other Equipment*

| | |
|---|---|
| 1 | 20,000Ω/VDC Multimeter |

* Equipment must be traceable to NBS for certification of measurement characteristics.

Note: DCVB should be calibrated to ±0.5% accuracy at 3.3kV.

**Substitute test equipment may be used. The Plant Staff Engineer must approve any substitutions. All equipment listed must perform within its manufacturer's specifications, unless otherwise stated.**

Factory Test Limits are qualified by the conditions specified in the main body of the Factory Calibration Procedure. The numbers and letters to the left of the limits correspond to the procedure steps where the check or adjustment is made. Steps without Factory Test Limits (setups, presets, etc.) are not listed. Instruments may not meet Factory Test Limits if calibration or checkout methods and test equipment differ substantially from those in this procedure.

## 4. POWER SUPPLIES

c. LV power supply accuracy and ripple, 104 VAC to 126 VAC line:

| Supply | Voltage Limit | Ripple Limit 60/120 Hz | Ripple Limit 50 kHz |
|---|---|---|---|
| -100V | ±0.4% | ≤2mV | ≤10mV |
| -12.2V | ±0.9% | ≤2mV | ≤10mV |
| +125V | ±0.9% | ≤3mV | ≤10mV |
| +300V | ±1.3% | ≤5mV | ≤20mV |

d. HV Power supply: ±2%
e. HV regulation: ±0.5%
f. CRT Grid Bias
No spot with INTENSITY ccw
Spot with INTENSITY between 9 and 11 o'clock

## 5. CALIBRATOR

*b. Calibrator amplitude accuracy: ±1%
*c. Calibrator frequency: 1 kHz ±0.5%
d. Calibrator duty factor: 48% to 52%
e. Calibrator $t_r$ to $t_f$: ≤2.5µs at 40V
f. Calibrator current loop: waveform present

## 6. PLUG-IN CONNECTIONS

a. Interconnection continuity: Continuity between Left/Right Pins: 3/4, 4/3, 18/18, and 19/19
b. CRT grid modulation
Right side of 40V cal signal dimmed
c. Vertical compartment Line and Int Triggering: proper polarity
d. CRT horizontal deflection factor: 175V/10 div to 192.5V/10 div
e. CRT horizontal electrical center: ±8mm
f. CRT vertical deflection factor: 148V/8 div to 164V/8 div

6g. CRT vertical electrical center

| CRT Vert deflection factor | max error from graticule center |
|---|---|
| ≤156V/8 div | ±5.0mm |
| ≤158V/8 div | ±4.5mm |
| ≤160V/8 div | ±4.0mm |
| ≤162V/8 div | ±3.5mm |
| ≤164V/8 div | ±3.0mm |

h. Horizontal compartment Line and Int triggering: Proper polarity
i. CRT Chopped Blanking
Square wave $t_r$ blanked

## 7. TRACE ALIGNMENT

Range: ≥6°
Must align to graticule center
Alignment: ±1mm

## 8. CRT CHECKS

a. CRT expansion/compression: ≤1mm
b. External CRT cathode input: Modulation with ≤10V
c. Horizontal geometry: ≤1mm, total
d. Vertical geometry: ≤1mm, total
e. Focus: 100 markers in 10cm visible

## 9. CRT DEFLECTION PLATE CAPACITANCE NORMALIZATION

±0.5mm

THE END

* Indicates measurement characteristic; test equipment used must be traceable to NBS for instrument certification.

This instrument must meet Factory Test Limits before it leaves Manufacturing; therefore, it must be possible to inspect to these limits. Because of normal variations in test equipment and plug-in scopes, addition of side panels, etc, this procedure may require that some checks and adjustments be made so that performance is better than that required by Factory Test Limits.

## 1. PRESETS

## 2. RESISTANCE

## 3. LINE VOLTAGE SELECTOR

## 4. POWER SUPPLIES

a. Adjust -100V supply, R23
b. Check LV power supply current regulation
c. Check LV power supply accuracy and ripple

| Supply | Accuracy | Regulation | Ripple Limit 60/120 Hz | Ripple Limit 50 kHz |
|---|---|---|---|---|
| -100V | | ±0.1V | ≤2mV | ≤10mV |
| -12.2V | ±0.07V | ±0.06V | ≤2mV | ≤10mV |
| +125V | ±0.75V | ±0.1V | ≤3mV | ≤10mV |
| +300V | ±3.3V | ±0.3V | ≤5mV | ≤20mV |

d. Adjust HV supply, R206: -3300V
e. Check HV regulation: ±0.5%
f. Adjust CRT Grid Bias, R269
g. Preset Geometry, R265: 180V

## 5. CALIBRATOR

a. Set Calibrator amplitude, R166: 40V
b. Check Calibrator amplitude accuracy: ±1%
c. Set Calibrator frequency, R154: 1 kHz
d. Check Calibrator duty factor: 48% to 52%
e. Check Calibrator $t_r$ and $t_f$: ≤2.5µs at 40V
f. Check Calibrator current loop: waveform present

## 6. PLUG-IN CONNECTIONS

a. Check interconnection continuity: Continuity between Left/Right pins: 3/4, 4/3, 18/18, and 19/19
b. Check CRT grid modulation: Right side of 40V cal signal dimmed
c. Check Vertical compartment Line and Int triggering: Proper polarity
d. Check CRT horizontal deflection factor: 175V/10 div to 192.5V/10 div
e. Check CRT horizontal electrical center: ±8mm
f. Check CRT vertical deflection factor: 148V/8 div to 164V/8 div
g. Check CRT vertical electrical center:

| CRT Vert deflection factor | max error from graticule center |
|---|---|
| ≤156V/8div | ±5.0mm |
| ≤158V/8div | ±4.5mm |
| ≤160V/8div | ±4.0mm |
| ≤162V/8div | ±3.5mm |
| ≤164V/8div | ±3.0mm |

h. Check Horizontal compartment Line and Int triggering: Proper polarity
i. Check CRT Chopped Blanking: Square wave $t_r$ blanked

7. TRACE ALIGNMENT

Range: $\geq 6^{\circ}$

Must align to graticule center

Alignment: ±1mm

8. CRT CHECKS

a. Check CRT expansion/compression: ≤1mm

b. Check External CRT cathode input: Modulation with ≤10V

c. Check horizontal geometry: ≤1mm, total

d. Check vertical geometry: ≤1mm, total

e. Check focus: 100 markers in 10cm visible

9. CRT DEFLECTION PLATE CAPACITANCE NORMALIZATION

±0.5mm

THE END

## 1. PRESETS

TYPE 561B

| | |
|---|---|
| ASTIGMATISM | midr |
| FOCUS | ccw |
| INTENSITY | ccw |
| SCALE ILLUM | cw |
| CALIBRATOR | OFF |
| POWER | OFF |
| CRT CATHODE SELECTOR | NORMAL |
| Line Voltage Selector Plug | 115 |
| Line Voltage Range Plug | M |

Dress deflection plate leads away from the chassis and CRT shield; check the CRT neck pin seals for no cracks.

## 2. RESISTANCE

Measure the resistance between ground and each supply listed below. All test points are located on the Power Supply board.

| Supply | Test Point | Approx Resistance - Lead to Gnd | Approx Resistance + Lead to Gnd | Meter Range |
|---|---|---|---|---|
| -12.2V | P | 33Ω | 350Ω | X10 |
| -100V | S | 2kΩ | 5kΩ | X1K |
| +125V | I | 10kΩ | 2kΩ | X1K |
| +300V | F | 17kΩ | 6kΩ | X1K |

Measure the resistance between chassis ground and pins 5 and 9 of both plug-in connectors: 0Ω. These pins should all be returned to chassis ground near C97.

Install two Test Load units. Set both NO LOAD/FULL LOAD switches to FULL LOAD and POSITION controls cw.

## 3. LINE VOLTAGE SELECTOR

Connect TYPE 561B to TYPE 76TU and turn ON. Apply a line voltage of 115 VAC. With test scope, measure the P-P amplitude of the waveform at Pin AG (Power Supply board) for each combination of Line Voltage and Range selectors in the following table:

For first time operation, apply line voltage gradually from the TYPE 76TU.

Check fuses:

LINE FUSE: 3.2A Slo-Blo
230V FUSE: 2A Slo-Blo
HV FUSE: 150mA Fast-Blo

Check pilot light, and scale illum lights and pot for proper operation.

3. (cont'd)

| Line Voltage Selector | Range Selector | Approx P-P Voltage Pin AG |
|---|---|---|
| 115 | M | 160V |
| 230 | M | 80V |
| 230 | LO | 95V |
| 230 | HI | 74V |

Return Range Selector to M and Voltage Selector to 115.

## 4. POWER SUPPLIES

*a. Adjust -100V supply, R23*

Set DCVB to measure -100V, and connect it between gnd and DC jack on one Test Load. Adjust R23 for bridge null.

*b. Check LV power supply current regulation*

For each supply listed below use multimeter to check for approximate supply voltage at DC jack on one Test Load; if supply voltage appears correct, press OVERLOAD button on other Test Load and check overloaded supply voltage:

| Supply | Approx Overloaded Supply Voltage |
|---|---|
| -100V | -60V |
| -12.2V | -11V |
| +125V | +110V |
| +300V | +230V |

If supply voltage drops, press and release SHORT button. Again check overloaded supply voltage by pressing OVERLOAD button; voltage should drop as before.

b. Use OVERLOADED and SHORT buttons on one Test Load; make voltage measurements on the other Test Load.

An unusual overloaded supply voltage may indicate improper current regulation; those supplies should be closely examined before they are shorted.

*c. Check LV power supply accuracy and ripple*

Check accuracy of each supply at DC jack on Test Load with Line at 115 VAC and Load at FULL LOAD. Check regulation with Test Loads in Full Load at 104 VAC and Test Loads in NO LOAD at 126 VAC line.

4c. (cont'd)

| Supply | Accuracy | Regulation | Ripple Limit 60/120 Hz | Ripple Limit 50 kHz |
|---|---|---|---|---|
| -100V | | ±0.1V | ≤2mV | ≤10mV |
| -21.2V | ±0.07V | ±0.06V | ≤2mV | ≤10mV |
| +125V | ±0.75V | ±0.1V | ≤3mV | ≤10mV |
| +300V | ±3.3V | ±0.3V | ≤5mV | ≤20mV |

With test scope connected to RIPPLE jack on Test Load, measure ripple of each supply listed above at 104VAC and 115VAC line (FULL LOAD), and 126VAC line (NO LOAD); check both 60 and 120Hz ripple, and 50kHz ripple.

*d. Adjust HV supply, R206*

Set DCVB to measure -3300V, and connect it between gnd and TP -3300V. Adjust R206 for bridge null.

*e. Check HV regulation: ±0.5%*

Check that HV supply does not change more than 16.5V from 104VAC to 126VAC Line, with INTENSITY cw and ccw. Return INTENSITY ccw.

*f. Adjust CRT Grid Bias, R269*

Be sure INTENSITY, FOCUS, and CRT Grid Bias (R269) are ccw. Center Test Load POSITION controls. Set INTENSITY to 10 o'clock and turn R269 cw until a dim spot appears. Adjust FOCUS and ASTIGMATISM for a sharp spot; set R269 for a dim spot.

Turn INTENSITY ccw, and check for no spot. Turn POSITION controls cw.

*g. Preset Geometry, R256*

Adjust Geometry, R256 for 180V at center arm of pot.

## 5. CALIBRATOR

*a. Set Calibrator amplitude, R166*

Remove Q162 (Power Supply board) and set CALIBRATOR to 40V DC. Set DCVB to measure +40V, and connect it between CAL OUT gnd and center connection. Adjust R166 for bridge null.

a. The MODEL 881A Differential Voltmeter may also be used for this step.

5. (cont'd)

*b. Check Calibrator amplitude accuracy: ±1%*

With the MODEL 881A Differential Voltmeter measure the Calibrator's DC output indicated in the following table:

| CALIBRATOR | Unterminated Output | Terminated Output |
|---|---|---|
| 40V | 40V ±0.4V | |
| 4V | 4V ±0.04V | |
| 0.4V | 400mV ±4mV | 200mV ±2mV |
| 40mV | 40mV ±0.4mV | 20mV ±0.2mV |
| 4mV | 4mV ±0.04mV | 2mV ±0.02mV |

Install Q162.

*c. Set Calibrator frequency, R154*

Alternately display TYPE 561B 40V calibrator output and 1ms markers on test scope. Adjust R154 for one calibrator cycle per marker. Trigger test scope on markers and adjust R154 for no drift of calibrator signal. Maximum drift of calibrator signal is 5 cycles in 1 second.

*d. Check Calibrator duty factor: 48% to 52%*

Display one cycle of calibrator signal over 10 divisions of test scope. Pulse width must be ≥4.8cm and ≤5.2cm.

*e. Check Calibrator $t_r$ and $t_f$: ≤2.5µs at 40V*

Measure risetime and falltime of 40V Calibrator output: ≤2.5µs.

e. Use 42 in. BNC cable from CAL OUT to test scope to provide about 100pF load.

*f. Check Calibrator current loop*

With CALIBRATOR in 10mA position, check for waveform at current loop with TYPE P6019 CURRENT PROBE.

f. Displayed waveform should be alternate + and - spikes.

## 6. PLUG-IN CONNECTIONS

*a. Check interconnection continuity*

Press CONTINUITY A on one Test Load, and check that A neons on both load units light.

6a. (cont'd)

Press CONTINUITY B on one Test Load and check that B neons on both load units light.

Remove Test Load in VERTICAL. Press CONTINUITY B on HORIZONTAL load unit, and check that no neons light.

Install 2B67 in VERTICAL plug-in compartment.

*b. Check CRT grid modulation*

Display a dim, vertical trace on 561B. Apply a 40V Calibrator signal to Test Load SIGNAL INPUT and check that right side of cal signal dims.

*c. Check Vertical compartment Line and Int triggering: Proper polarity*

Connect a 1X probe from Test Load SIGNAL INPUT to Pin 8 on T1 (Power Transformer). Check for proper Line trigger polarity, while triggering 2B67 in LINE.

Trigger 2B67 in INT and check for proper polarity triggering with TYPE 2B67 LEVEL near 0.

*d. Check CRT horizontal deflection factor: 175V/10div to 192.5V/10div*

Connect multimeter across horizontal deflection plates and position trace to left edge of graticule; record the voltage. Position trace to right edge of graticule and record voltage. The sum of these absolute voltages should be $\geq$175V to $\leq$192.5V.

*e. Check CRT horizontal electrical center: ±8mm*

Short CRT horizontal deflection plates together and check spot centering: ±8mm from graticule center.

Put 2B67 in Horizontal compartment and Test Load in Vertical compartment.

6. (cont'd)

*f. Check CRT Vertical deflection factor: 148V/8div to 164V/8div*

Connect multimeter across vertical deflection plates and position trace to bottom edge of graticule; record the voltage. Position trace to top of graticule and record voltage. The sum of these absolute voltages should be ≥148V to ≤164V.

*g. Check CRT vertical electrical center*

Short CRT vertical deflection plates together and check spot centering; maximum error is a function of CRT vertical deflection factor:

| CRT Vert deflection factor | max error from graticule center |
|---|---|
| ≤156V/8div | ±5.0mm |
| ≤158V/8div | ±4.5mm |
| ≤160V.8div | ±4.0mm |
| ≤162V/8div | ±3.5mm |
| ≤164V/8div | ±3.0mm |

*h. Check Horizontal compartment Line and Int triggering: Proper polarity*

Connect a 1X probe from Test Load SIGNAL INPUT to Pin 8 on T1. Check for proper Line trigger polarity, while triggering 2B67 in LINE.

Trigger 2B67 in INT and check for proper polarity triggering with TYPE 2B67 LEVEL near 0.

*i. Check CRT Chopped Blanking*

Apply a 40V Calibrator signal to the Test Load SIGNAL INPUT and switch CRT CATHODE SELECTOR to CHOPPED BLANKING. Check that square wave risetime is blanked. Return CRT CATHODE SELECTOR to NORMAL.

## 7. TRACE ALIGNMENT

Display a focused, free running sweep on the TYPE 561B. Turn TRACE ALIGNMENT ccw and check that trace rotates ccw. Measure vertical rise of trace across 10 horizontal cm. Turn TRACE ALIGNMENT cw and measure vertical fall of trace in 10cm. The sum of these two distances must be ≥1cm (6° range).

Adjust TRACE ALIGNMENT so trace is parallel to center horizontal graticule line.

Check that the CRT faceplate is even with the rear of the bevel on the light conductor (eyebrow). Align the CRT so the graticule is parallel with the horizontal and vertical axes of the instrument.

## 8. CRT CHECKS

*a. Check CRT expansion/compression ≤1mm*

Apply square wave from TYPE 106 to Test Load SIGNAL INPUT and adjust for 2cm amplitude at graticule center. Check amplitude of square wave at top and bottom of graticule: 2.0cm ±0.1cm.

Exchange Test Load and TYPE 2B67, and repeat for horizontal deflection plates.

Return TYPE 2B67 to Horizontal compartment and install 2A60 in Vertical compartment.

*b. Check External CRT cathode input: ≤10V*

Apply 10V square wave to CRT EXT INPUT, and put CRT CATHODE SELECTOR in EXT INPUT position. Check for trace modulation. Remove signal and return CRT CATHODE SELECTOR to NORM.

*c. Check horizontal geometry: ≤1mm, total*

Display a square wave 1mm in amplitude on 561B. Check deviation of horizontal trace from graticule lines over entire graticule area. Deviations in opposite directions are added; total error should be ≤1mm. Adjust Geometry, R256, for optimum geometry at CRT bottom if necessary.

c. Check CRT for double peaking, burrs, grid emission, and flare; refer to Cathode Ray Tube Check Out Procedure for methods.

8. (cont'd)

*d. Check vertical geometry: ≤1mm, total*

With TYPE 2B67 TIME/DIV at 1mSEC, display 1ms and 0.1ms markers over the full vertical graticule area of the 561B. Check deviation of markers from graticule lines over entire graticule area. Deviations in opposite directions should be added; total error should be ≤1mm.

*e. Check focus*

Turn TYPE 2B67 VARIABLE to display 10 1ms markers in 10cm. Adjust FOCUS and ASTIGMATISM for a focused display at graticule center. Check that 0.1ms markers are visible over entire graticule area.

## 9. CRT DEFLECTION PLATE CAPACITANCE NORMALIZATION

Early Capacitance Normalizers require 50V or 100V for operation.

Install Capacitance Normalizer (067-0500-00) in Vertical compartment of TYPE 561B. Apply 40V Calibrator signal to Normalizer and trigger display. Adjust C109 and dress leads for square front corner of display.

Exchange TYPE 2B67 and Normalizer, and repeat, adjusting C102 for optimum front corner.

THE END