

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.

*This procedure is
company confidential*

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.

August 1968
For all serial
numbers.



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).

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. (DH)

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EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Test Equipment

- 1 TYPE 547 OSCILLOSCOPE
- 1 TYPE 1A1 PLUG-IN UNIT
- 1 TYPE 114 PULSE GENERATOR
- 1 TYPE 76TU LINE-VOLTAGE CONTROL UNIT

b. Test Fixture and Accessories

- 1 Test Display Generator (067-0561-00)
- *1 DC Voltage Bridge (067-0543-99)
- *1 Sine Wave Generator (067-0542-99)
- *1 Standard Amplitude Calibrator (SAC) (067-0502-00)
- 2 P6006 10X Passive Probes (010-0128-00)
- 3 50 Ω Terminations, BNC (011-0049-00)
- 3 50 Ω cables, BNC (012-0057-00)
- 1 Dual Input Cable, BNC (067-0525-00)

c. Other Equipment

- 1 20,000 Ω /V Multimeter

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

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

QUALIFICATION

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 (set-ups, 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

a. Line Voltage Selector Switch:

<u>Line Voltage Selector</u>	<u>Approximate Voltage</u>
115V	
LO	88
M	75
HI	69
230V	
LO	41
M	35
HI	32.5

b. +100V Supply: 100V $\pm 2\%$

c. Power Supplies Accuracy, Regulation and Ripple:

<u>Supply</u>	<u>Accuracy</u>	<u>Ripple</u>
+100	$\pm 2\%$	5mV, max
+12.5	$\pm 2\%$	5mV, max
-75	$\pm 2\%$	5mV, max
+16	14.7V to 24V	
+250	230V to 280V	

d. High Voltage: -3900V $\pm 5\%$

e. Scale Illumination: Continuous increase in light

5. Z AXIS OPERATION

- Amplifier Gain and Output DC Level:
Output Amplitude 46V $\pm 3V$
DC Level: 16V $\pm 7V$
- Maximum Input Voltage: + and - 10V
- Aberrations: +10%, -10% total
20% P-P
- Risetime and Falltime
Risetime $\leq 150ns$
Falltime $\leq 300ns$

6. FOCUS AND ASTIGMATISM

- Check Resolution: .75mm

7. GEOMETRY AND X & Y AMPLIFIERS

- X Amplifier Gain Range and Set Gain:
Range: 185 to 285 min
Gain: .1V/cm $\pm 5\%$
- X Amplifier Max Input Volts and Position Range:
Max Input Volts: + and - 10V
Position Range: 8cm
- Vertical Geometry: $\leq 1mm$
- Y Amplifier Gain Range and Set Gain:
Range: 160 to 295 min
Gain: .1V/cm $\pm 5\%$
- Y Amplifier Max Input Volts and Position Range:
Max Input Volts: + and - 10V
Position Range: 6cm
- Horizontal Geometry: $\leq 1mm$

8. TRACE ROTATION

- Trace Rotation: $\geq 6^\circ$

9. PHASE AND BANDWIDTH

- Phasing: $\leq 1^\circ$
- Bandwidth: $\geq 1MHz$

THE END

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

SHORT FORM PROCEDURE

Factory TEST LIMITS are limits an instrument must meet 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, it is necessary to set up some circuits so their performance is better than required by Factory Test Limits. Therefore, the instructions given in the Factory Calibration Procedure may call for checks or adjustments which result in less error than that allowed by the Factory Test Limits.

1. PRELIMINARY INSPECTION

- a. Check Fuses for proper value.
- b. Align and inspect CRT

2. PRESETS

3. RESISTANCE

- a. Check power supply resistance to ground:

<u>Supply</u>	<u>Approx Resistance</u>	<u>Meter Range</u>
+250	20k Ω	X1k
+100	4k Ω	X1k
+16	9.5k Ω	X1k
+12.5	400 Ω	X100
-75	4.75k Ω	X1k

4. POWER SUPPLIES

- a. Check Line Voltage Selector Switch:

<u>Line Voltage Selector</u>	<u>Approximate Voltage</u>
115V	
LO	88
M	75
HI	69
230V	
LO	41
M	35
HI	32.5

- b. Adjust +100V Supply (R434)
- c. Check Accuracy Regulation and Ripple

<u>Supply</u>	<u>Accuracy</u>	<u>Ripple</u>
+100	$\pm 2\%$	5mV, max
+12.5	$\pm 2\%$	5mV, max
-75	$\pm 2\%$	5mV, max
+16	14.7V to 24V	
+250	230V to +280V	

- d. Check High Voltage: -3900V $\pm 5\%$
- e. Check Scale Illumination

5. Z AXIS OPERATION

- a. Check Amplifier Gain and Output DC Level (TP130): Output Amplitude 46V $\pm 3V$
DC Level: 16V $\pm 7V$
- b. Check Maximum Input Voltage: + and - 10V
- c. Check aberrations do not exceed +10%, -10%, total 20% P-P
- d. Check Risetime and Faltime:
Risetime $\leq 150ns$
Faltime $\leq 300ns$

6. FOCUS AND ASTIGMATISM

- a. Setup
- b. Check Resolution: .75mm

7. GEOMETRY AND X & Y AMPLIFIERS

- a. Setup
- b. Check X Amplifier Gain Range and Set Gain (R74): Range: 185 to 285 min
Gain: .1V/cm
- c. Check X Amplifier Max Input Volts and Position Range:
Max Input Volts: + and - 10V
Position Range: 8cm
- d. Check Vertical Geometry: $\leq 1mm$
- e. Check Y Amplifier Gain Range and Set Gain (R24): Range: 160 to 295 min
Gain: .1V/cm
- f. Check Y Amplifier Max Input Volts and Position Range:
Max Input Volts: + and - 10V
Position Range: 6cm
- g. Check Horizontal Geometry: $\leq 1mm$

8. TRACE ROTATION

- a. Check Trace Rotation: $\geq 6^\circ$

9. PHASE AND BANDWIDTH

- a. Adjust And Check Phasing: $\leq 1^\circ$
- b. Check Bandwidth: $\geq 1\text{MHz}$

THE END

1. PRELIMINARY INSPECTION

a. *Check Fuses for proper value.*

b. *Align and inspect CRT*

Remove the CRT shield at the back of the TYPE 602. Loosen the neck clamps and align the CRT so the faceplate is flush with the front panel at all points. Tighten the neck clamp to 4-7 in.ozf and replace the shield.

Inspect the CRT for physical defects: phosphor defects, scratches, chips, cracks around neck pins etc. Refer to the CATHODE RAY TUBE CHECK OUT PROCEDURE for further information.

b. Do not reject a CRT without consulting a CRT checker or referring to the Cathode Ray Tube Check Out Procedure.

2. PRESETS

a. *Set the TYPE 602 controls:*

INTENSITY	ccw
FOCUS	ccw
VERT POSITION	midr
HORIZ POSITION	midr
SCALE ILLUM	ccw
TRACE ROTATION	midr
LINE (at rear)	115V
Range Selector	MED
Internal Adjustments	midr

b. *Set the TYPE 547 controls with TYPE 1A1 installed*

HORIZONTAL DISPLAY	B
MAIN TIME BASE (B)	
TRIGGERING LEVEL	0
TRIGGERING MODE	AUTO
TRIGGERING SLOPE	+
TRIGGERING COUPLING	AC
TRIGGERING SOURCE	NORM
TIME/CM	1mSEC

2. (cont'd)

c. Set the TYPE 1A1 controls:

MODE	CH 1
CHANNEL 1 & 2 VOLTS/CM	.005
CHANNEL 1 & 2 POSITION	midr
CHANNEL 1 & 2 VARIABLE VOLTS/CM	CALIB
CHANNEL 1 & 2 PULL FOR INVERT	Pushed in
CHANNEL 1 & 2 INPUT SELECTOR	DC

3. RESISTANCE

a. Check power supply resistance to ground (- polarity meter lead grounded)

<u>Supply</u>	<u>Approx Resistance</u>	<u>Meter Range</u>
+250	22k Ω	X1k
+100	4.4k Ω	X1k
+16	5.4k Ω	X1k
+12.5	400 Ω	X100
-75	5.4k Ω	X1k

4. POWER SUPPLIES

a. Check Line Voltage Selector Switch

Connect a multimeter across pins 10 and 11 of the power transformer and adjust the TYPE 76TU for 75VAC (across pins 10 & 11). While changing the Line Voltages as indicated in the table below.

<u>Line Voltage Selector</u>	<u>Approximate Voltage</u>
115V	
LO	88
M	75
HI	69
230V	
LO	41
M	35
HI	32.5

Remove the multimeter and return the Line Voltage Selector to 115V, M. Set the TYPE 76TU for 115VAC.

4. (cont'd)

b. Adjust +100V Supply: 100V $\pm 2\%$

Connect the TYPE 602 to the TYPE 76TU set for 115VAC and turn power on. Connect the DC Voltage Bridge between gnd and 100V supply TP. Adjust R434 for 100V.

c. Check Accuracy Regulation and Ripple

Using the DC Voltage Bridge and test scope at appropriate settings, check regulation and ripple of supplies as indicated below while varying the TYPE 76TU from 104VAC to 126VAC.

<u>Supply</u>	<u>Accuracy & Regulation</u>	<u>Ripple</u>
+100	$\pm 2\%$	5mV, max
+12.5	$\pm 2\%$	5mV, max
-75	$\pm 2\%$	5mV, max
+16	14.7V to 24V	
+250	+230V to +280V	

d. Check High Voltage: -3900V $\pm 5\%$

Connect the DC Voltage Bridge between ground and the High Voltage Test Point. Check for -3900V. $\pm 5\%$ ($\pm 195V$) check regulation from 104VAC to 126VAC. Must be -3900V $\pm 195V$.

e. Check Scale Illumination

Rotate the SCALE ILLUM control cw noting a continuous increase in light. Note that uniform lighting occurs over the graticule.

5. Z AXIS OPERATION*a. Check Amplifier Gain and Output*

DC Level: Output Amplitude 46V $\pm 3V$.
DC Level: 16V $\pm 7V$.

Connect a 50 Ω termination to the X and Y INPUTS on the TYPE 602. Set the Standard Amplitude Calibrator (SAC) AMPLITUDE control to the OFF position and connect a 50 Ω cable from its OUTPUT to the TYPE 602 Z INPUT. Set the test scope B TIME/CM to .5mSEC and TRIGGERING MODE to AUTO. Set the

5a. (cont'd)

TYPE 1A1 CHANNEL 1 VOLTS/CM to 1 and using the position control, set the trace 1cm up from the bottom graticule line.

Connect the X10 probe from INPUT 1 to TP130 on the Z Axis Amplifier board and note trace shift. The Output DC Level must be 16V \pm 7V. Disconnect the 50 Ω cable from the Z INPUT and note that a positive increase in the DC Level occurs. This increase should not exceed 10V. Reconnect the 50 Ω cable to the Z INPUT. Set the SAC AMPLITUDE control to 1 volts and note that the display amplitude is 46V \pm 3V.

Rotate the TYPE 602 INTENSITY control in the cw direction until a spot is visible on the screen. Set the SAC AMPLITUDE control to OFF and note that the spot disappears. By rotating the INTENSITY cw it must again be possible to obtain a spot on the screen. Disconnect the 50 Ω cable from the Z INPUT and note that the spot intensity increases. Reconnect the 50 Ω cable. Rotate the INTENSITY full ccw and set the SAC AMPLITUDE control to 1 VOLTS. No spot should appear.

b. Check Maximum Input Voltage: + and - 10V

Rotate the HORIZ and VERT POSITION controls full ccw. Set the SAC AMPLITUDE control to 10 volts and the MODE switch to +DC then -DC and return it to the square wave position. Set the HORIZ and VERT POSITION controls to midrange. It must be possible to repeat the checks in step a. Remove the SAC signal from the Z INPUT.

5. (Cont'd)

c. *Check Aberrations: +10%, -10%
total 20% P-P*

Set the TYPE 114 PERIOD to 1mS, WIDTH to SQUARE WAVE and AMPLITUDE to 1 to 3V +. Remove the X10 probe from TP130 and attach it to the inboard side of the Z INPUT connector. Connect a 50 Ω termination to the Z INPUT and connect a 50 Ω cable from the TYPE 114 OUTPUT. Set the TYPE 1A1 CHANNEL 1 VOLTS/CM to .05 and adjust the TYPE 114 VARIABLE AMPLITUDE for a 2cm display.

Remove the probe and connect it to TP130. Set the TYPE 1A1 CHANNEL 1 VOLTS/CM to 1 and the B TIME/CM to .1 μ SEC. Adjust the TRIGGERING LEVEL control for a stable display and check that aberrations do not exceed +10%, -10% total 20% P-P.

d. *Check Risetime and Falltime:*

*Risetime ≤ 150 ns
Falltime ≤ 300 ns*

Check risetime to be equal to or less than 150ns. Set the B TRIGGERING SLOPE to -, adjust the TRIGGERING LEVEL for a stable display and check falltime to be equal to or less than 300ns. Remove the X10 probe and the TYPE 114 signal. Remove the 50 Ω terminations from the X, Y and Z INPUTS.

6. FOCUS AND ASTIGMATISM

a. *Setup*

Set the Test Display Generator as follows:

DISPLAY controls

CONT-READY-SINGLE	-CONT
HORIZ-VERT-CROSS HATCH	-HORIZ
RASTER-SINGLE DOT	-RASTER
DOTS 100/80 - LINES 100	-LINES 100
DENSITY	-X1
VARIABLE DENSITY	-CALIB
Z AXIS PULSE	-9
HORIS-POSITIONING-VERT	-OFF
TIME/LINE mSEC	-ccw Pulled Out
AMPLITUDE	-cw

6a. (cont'd)

Connect a 50 Ω cable from the TYPE 602 Y INPUT to the Y (601) connector on the Test Display Generator. Connect a 50 Ω cable from the Z INPUT to the Z connector. Connect a 50 Ω cable from the X INPUT to the SAC OUTPUT and set the SAC AMPLITUDE control to .1 VOLTS. Set the FOCUS control to midrange and increase the INTENSITY as necessary to obtain two vertical lines.

b. Check Resolution .75mm

Adjust the INTENSITY, FOCUS and Astig (R277) for optimum definition of the display. Using TRACE ROTATION, adjust the traces so they are parallel with the vertical graticule lines. Set the SAC AMPLITUDE control to 1 VOLTS. Adjust the TYPE 602 Vert Gain (R24) to obtain 8cm in the vertical axis and the Horiz Gain (R74) for 7.5cm in the horizontal. Set the SAC AMPLITUDE control to .1 VOLTS and repeat FOCUS and Astig adjustments for optimum definition of the display. Using the HORIZ POSITION control move the display through the 10cm of graticule area. The display must remain focused well enough so that there is a darkened area between the two lines.

7. GEOMETRY AND X & Y AMPLIFIERS

a. Setup

Set the test scope B TIME/CM to .5mSEC. Set the TYPE 1A1 CHANNEL 1 & 2 VOLTS/CM to 1 and the MODE switch to ADD. Pull the CHANNEL 2 PULL FOR INVERT switch and connect a X10 probe to INPUT's 1 & 2. Connect the probes to the SAC OUTPUT and set the SAC AMPLITUDE control for 100 VOLTS. Adjust the TYPE 1A1 CHANNEL 1 & 2 VARIABLE VOLTS/CM controls for a null indication of the display. Remove the probes from the SAC OUTPUT and connect one to the left and one to the right horizontal deflection plate of the TYPE 602.

7. (cont'd)

- b. *Check X Amplifier Gain Range and Set Gain:*
Range: 185 to 285 min
Gain: .1V/CM

Set the SAC AMPLITUDE to .1 VOLTS and adjust the test scope for a stable display. While observing the test scope display, rotate the Horiz Gain (R74) fully ccw. The display amplitude must be equal to or less than 1.85cm. Rotate R74 full cw. The display amplitude must be equal to or greater than 2.85cm. Set the SAC AMPLITUDE control to .5 VOLTS and while observing the TYPE 602 display, adjust R74 for a display amplitude of 5cm in the center portion of the graticule.

- c. *Check X Amplifier Max Input Volts and Position Range:*
Max Input Volts: + and - 10V
Position Range: 8cm

Set the SAC AMPLITUDE control to 10 VOLTS and the MODE switch to +DC and then -DC. Return the MODE switch to the square wave position and the AMPLITUDE to 1 VOLTS. The two traces should again be 10cm apart. Set the SAC AMPLITUDE control to OFF. Using the HORIZ POSITION control, set the trace to center graticule line. Set the SAC AMPLITUDE control to .5 VOLTS and the MODE to +DC. Using the HORIZ POSITION control, it must be possible to set the trace back to the 2nd graticule line. Set the MODE to -DC. It must be possible to set the trace to the 8th graticule line. Return the SAC MODE switch to the square wave position.

- d. *Check Vertical Geometry: $\leq 1\text{mm}$*

Set the SAC AMPLITUDE control to 10 mVOLTS. Using the HORIZ POSITION control check geometry over the 10cm of graticule. Bowing must be equal to or less than 1mm.

7. (cont'd)

- e. *Check Y Amplifier Gain Range and
Set Gain: Range: 160 to 295 min
 Gain .1V/CM*

Remove the 50 Ω cable from the SAC OUTPUT and connect it to the Test Display Generator X (601) connector. Remove the 50 Ω cable from the Y (601) connector and connect it to the SAC OUTPUT. Set the Test Display Generator HORIZ-VERT-CROSS HATCH switch to VERT. Center the TYPE 602 display with the VERT and HORIZ POSITION control and FOCUS as necessary. Remove the probes from the horizontal deflection plates and connect them across the vertical deflection plates. Set the SAC AMPLITUDE control to .1 VOLTS and while observing the test scope display, rotate Vert Gain (R24) full ccw. The display amplitude must be equal to or less than 1.6cm. Rotate R24 full cw. The display amplitude must be equal to or greater than 2.95cm. Remove the probes from the deflection plates.

Set the SAC AMPLITUDE control to .5 VOLTS and adjust R24 for a display amplitude of 5cm.

- f. *Check Y Amplifier Max Input Volts
and Position Range:
Max Input Volts: + and - 10V
Position Range:*

Set the SAC AMPLITUDE control to 10 VOLTS and the MODE switch to +DC and then to -DC. Return the MODE switch to the square wave position and the AMPLITUDE control to .5 VOLTS. The display amplitude should again be 5cm. Set the SAC AMPLITUDE control to OFF. Using the VERT POSITION control, set the trace to the center graticule line. Set the SAC AMPLITUDE control to .2 VOLTS and the MODE to +DC. Using the VERT POSITION control it must be possible to set the trace to the bottom graticule line. Set the MODE switch to -DC. It must be possible to set the trace to the top graticule line. Return the SAC MODE switch to the square wave position.

7. (cont'd)

g. *Check Horizontal Geometry:* $\leq 1\text{mm}$

Set the SAC AMPLITUDE control to 10mVOLTS.

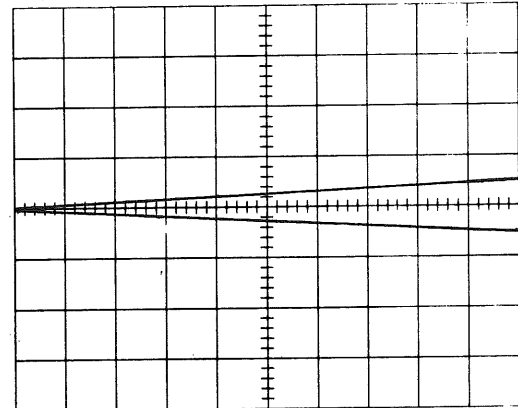
Using the VERT POSITION control check geometry over the 8cm of graticule. Bowing must be equal to or less than 1mm.

Set the SAC AMPLITUDE control to off.

8. TRACE ROTATION

a. *Check Trace Rotation:* $\geq 6^\circ$

Rotate TRACE ROTATION control full cw and ccw. Check for a minimum of 6° (1cm) or rotation of the trace (see notes). Adjust the TRACE ROTATION control so the trace is parallel with the center horizontal graticule line. Remove the cables from the X, Y and Z INPUT's.



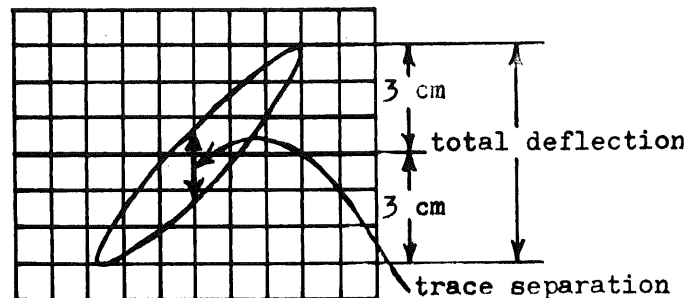
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 6°

9. PHASE AND BANDWIDTH

a. *Adjust And Check Phasing:* $\leq 1^\circ$

Connect a 50 Ω cable from the Sine Wave Generator to a BNC Dual Input Cable and connect the Dual Input connector to the X and Y INPUTS. Increase the INTENSITY if necessary.

Set the Sine Wave Generator for a frequency of 1MHz and adjust the AMPLITUDE controls so that the displayed diagonal line is 6cm in the vertical and 6cm in the horizontal direction (see notes). Adjust Phasing (C4) for a minimum trace separation. Maximum allowable trace separation is 1mm. Check trace separation at 500kHz for maximum trace separation of 1mm.



If test limit cannot be met, dressing C20, C29, C70 and C79 may help.

9. (cont'd)

b. Check Bandwidth: >1MHz

Remove the Dual Input Cable from the X and Y INPUTS. Connect a 50 Ω cable with 50 Ω termination from the Sine Wave Generator to the Y INPUT. Set the Sine Wave Generator to 10kHz and adjust the AMPLITUDE controls to obtain an 8cm vertical display. Increase the frequency to 1MHz and check for a display amplitude of at least 5.6cm (30% down).

Return the frequency to 10kHz, remove the signal from the Y INPUT and connect it to the X INPUT. Adjust the AMPLITUDE controls to obtain 10cm of horizontal display. Increase the frequency to 1MHz and check a display amplitude of at least 7cm.

THE END