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

3A6

December 1968

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.

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 561B OSCILLOSCOPE
1	TYPE 2B67 TIME BASE
1	TYPE 546 or 547 OSCILLOSCOPE
1	TYPE 1A1 DUAL TRACE PLUG-IN
1	TYPE P6006 10X PROBE
1	TYPE 106 SQUARE WAVE GENERATOR
*1	TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
1	TYPE 76TU LINE VOLTAGE CONTROL UNIT

b. Test Fixtures and Accessories

*1	STANDARD AMPLITUDE CALIBRATOR (SAC)(067-0502-00)
*1	LOW FREQUENCY SINE WAVE GENERATOR (LFSWG) (067-0542-00)
1	DC VOLTAGE BRIDGE (067-0543-99)
1	Plug-In Extension (013-0034-00)
1	47pF Input Normalizer (067-0541-00)
1	50Ω 10:1 Attenuator (011-0059-00)
1	50Ω Termination (011-0049-00)
1	GR to BNC female adapter (017-0063-00)
2	50Ω BNC Cables 42" (012-0057-01)
1	Dual Input Coupler (067-0525-00)
1	Micro-Shock Hammer (PMIE Dwg #1283B)

c. Other Equipment

1	20,000Ω/VDC Multimeter

*This 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 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. VOLTAGES AND BALANCE

a. +15V: +14.3 to +16.5V
b. +56V: +53.2 to +60.2V
c. Output DC Level: +190V, ±5% max
e. INV-NORM shift: 1div max
f. ADDED shift: 2div max
i. POSITION centering: ±2div max
j. Amplifier stability: ±0.5div max drift

5. ALTERNATE-CHOPPED MODES

a. ALTER operation: must alternate at all sweep speeds
b. CHOP frequency: 150kHz, ±35kHz
c. CHOP aberration: ≤0.1div P-P at normal intensity

6. VOLTS/DIV GAIN

c. CALIB range: ±20% min
e. CH 2 20mV gain adjustment: must match CH 1 20mV, ±1% max
f. CH 2 10mV gain adjustment: must match CH 1 10mV, ±1% max
g. ADDED error: 4div, ±2.5% max
h. Compression, expansion: 0.1div max total
i. VARIABLE ratio: ≥2.5:1
*j. Attenuator accuracy: ±2% max

7. MICROPHONICS AND GRID CURRENT

a. Microphonics: ≤1div
b. Grid current: ≤0.4div

8. VOLTS/DIV COMPENSATION

b,c. CH 1 & 2 compensation: Aberration ±2% max

9. TRANSIENT RESPONSE

b. High freq compensation: Aberration ±0.1div max with 4div display

10. CH 1 TRIGGER

b. CH 1 TRIGGER ONLY output: ≥3V for a 2div display ≤70ns risetime
c. Internal trigger output: ≥2.5V/div of display ≤70ns risetime

11. BANDWIDTH

*b. Bandwidth: ≥10MHz @-3dB

*12. AC LF RESPONSE ≤2Hz @-3dB

13. CHANNEL ISOLATION ≥60,000:1

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

THE END

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. PRELIMINARY INSPECTION

a. Install current modifications
b. Install transistor shields

2. PRESET CONTROLS

Preset external controls of TYPE 3A6, TYPE 2B67 and TYPE 561B. Preset TYPE 1A1 internal adjustments to midr

3. RESISTANCE CHECKS

a. Check interconnecting plug resistances--negative meter lead to gnd
b. Check protection diode resistances
c. Install TYPE 3A6

4. VOLTAGES AND BALANCE

a. Check accuracy of +15V: +14.3 to +16.5V
b. Check accuracy of +56V: +53.2 to +60.2V
c. Adjust Output DC Level: +190V ±5% max
d. Adjust CH 1 & 2 DC BAL for no trace shift
e. Check INV-NORM shift: 1div, max
f. Check ADDED shift: 2div, max
g. Adjust CH 1 Trig DC Level for a zero reading on Multimeter
h. Adjust Composite Trig DC Level for a zero reading on Multimeter
i. Check POSITION centering: ±2div, max
j. Check amplifier stability: ±0.5div, max drift

5. ALTERNATE-CHOPPED MODES

a. Check ALTER operation: must alternate at all sweep speeds
b. Check CHOP frequency: 150kHz, ±35kHz
c. Check CHOP aberration: $\leq$0.1div P-P at normal intensity

6. VOLTS/DIV GAIN

a. Check AC-DC-GND operation
b. Adjust CH 1 10mV gain for 6div
c. Check CALIB gain range for ±20% min, and set gain for 5div
d. Adjust CH 1 20mV Gain for 5div
e. Adjust CH 2 20mV Gain for best cancellation
f. Adjust CH 2 10mV Gain for best cancellation
g. Check ADDED error: 4div, ±0.1div max
h. Check compression, expansion for 2div, ±0.1div max total change
i. Check VARIABLE attenuator ratio for $\geq$2.5:1
j. Check attenuator accuracy: ±2%, max

7. MICROPHONICS AND GRID CURRENT

a. Check microphonics: $\leq$1div
b. Check grid current for $\leq$0.4div of trace shift

8. VOLTS/DIV COMPENSATION

b. Check or adjust CH 1 compensation: Aberration ±2% max
b. Check or adjust CH 2 compensation: Aberration ±2% max

9. TRANSIENT RESPONSE

b. Adjust high freq compensation: Aberration ±0.1div max

10. CH 1 TRIGGER

b. Check CH 1 TRIGGER ONLY output for ≥3V with a 2div display and ≤70ns of risetime

c. Check internal trigger output for ≥2.5V/div of display and ≤70ns of risetime

11. BANDWIDTH

b. Check bandwidth for ≥10MHz @-3dB

12. AC LF RESPONSE

Check for ≤2Hz @-3dB

13. CHANNEL ISOLATION

Check for ≤0.1div of signal on isolated channel

THE END

1. PRELIMINARY INSPECTION

a. Install current modifications
b. Install transistor shields

2. PRESET CONTROLS

a. TYPE 3A6 (CH 1 & 2)

MODE	CH 1
INV (CH 1) NORM	NORM
VOLTS/DIV	.01
VARIABLE	CALIB
POSITION	midr
DC BAL	midr
CALIB	cw
TRIGGER (CH 1) ONLY	pushed in
AC-DC-GND	DC

Set internal adjustments to midrange (skip atten comps).

b. TYPE 2B67

TIME/DIV	.1mSEC
VARIABLE	CALIBRATED
POSITION	centered
LEVEL	FREE RUN
MODE	NORM
SLOPE	+
COUPLING	AC SLOW
SOURCE	INT

c. TYPE 561B

The CRT CATHODE SELECTOR switch on the back panel should be in NORM position. Adjust the INTENSITY, FOCUS and ASTIGMATISM for a well defined trace.

Leave controls and adjustments for any step as they were in the step preceding unless noted otherwise.

3. RESISTANCE CHECKS

a. Check interconnecting plug resistances--negative meter lead to ground

Amphenol pin	Approx Resistance	Meter Range	Use
1	0.5Ω	X1	6.3VAC
2	0Ω	X1	6.3VAC
3	inf	X1k	Alt Sync Pulse
4-5	inf	X1k	unused
6	inf	X1k	+300V
7-8	inf	X1k	unused
9	0Ω	X1k	gnd
10	inf	X1k	+300V
11	35k	X10k	Int Trig
12	inf	X1k	unused
13-15	4k	X1k	+125V
16	10Ω	X10	-12.2V
17	inf	X1k	Output
18-19	inf	X1k	unused
20	4k	X1k	+125V
21	inf	X1k	Output
22	0Ω	X1k	gnd
23	3k	X1k	-100V
24	11k	X1k	Blanking Pulse

b. Check diode resistances

Use the Multimeter to check the forward and back resistances of the plug-in diodes for opens and shorts. Replace all defective components.

c. Install TYPE 3A6

Connect the TYPE 3A6 to the VERTICAL plug-in compartment with the plug-in extension. Install TYPE 2B67 directly into the HORIZONTAL plug-in compartment. Apply power to TYPE 561B through TYPE 76TU set for 117VAC and allow a few minutes of warm-up time for the TYPE 561B if not turned on previously.

4. VOLTAGES AND BALANCE

a. Check accuracy of +15V: +14.3 to +16.5V

Set the RANGE control of the DC VOLTAGE BRIDGE (DCVB) to the 110V position, POLARITY control to + and connect the DCVB leads between the D379-L379 junction and gnd. Adjust DCVB READOUT controls for a null indication and check READOUT dial for +15 volts: +14.3 to +16.5 volts.

b. Check accuracy of +56V: +53.2 to +60.2V

Connect the DCVB leads between the D451-R451 junction and gnd. Adjust DCVB READOUT controls for a null indication and check READOUT dial for +56 volts: +53.2 to +60.2 volts.

Remove the plug-in extension and install the TYPE 3A6 directly into plug-in scope. Allow a minimum of 10 minutes warm up before making any final checks or adjustments.

c. Adjust Output DC Level: +190V ±5% max

Momentarily short together the upper and lower vertical deflection plate pins and note a new trace position. This is the CRT electrical center. Position the trace to this value and connect the positive lead from the DCVB to one vertical plate pin. Set up the DCVB for exactly 190V and adjust Output DC Level (R346) for a null indication.

d. Adjust CH 1 & 2 DC BAL

Turn the VARIABLE controls through their range and adjust the DC BAL for no trace movement on each channel. Return both VARIABLE controls to CALIB.

4. (CONT)

e. Check INV-NORM shift: 1div, max

Position the CH 1 trace to the graticule center and change the INV-NORM control to INV. Check trace movement for ≤1div.

f. Check ADDED shift: 2div, max

Set MODE switch to ALTER and position both traces to CRT electrical center. Change the MODE switch to ADDED and check amount of trace shift for ≤2div. Return MODE to CH 1.

g. Adjust CH 1 Trig DC Level

Connect the Multimeter between pin 12 of the Horizontal compartment interconnecting plug and ground. Position the trace to CRT electrical center and pull out the TRIGGER CH 1 ONLY PULL control. Adjust the Channel 1 Trig DC Level (R171) for a zero reading on the Multimeter.

h. Adjust Composite Trig DC Level

Push in the TRIGGER CH 1 ONLY PULL control and reposition the trace to CRT electrical center. Adjust Comp Trig DC Level (R412) for a zero reading on the Multimeter. Recheck the CH 1 DC BAL and readjust for no shift if necessary. Recheck steps g and h and disconnect the Multimeter.

i. Check POSITION centering: ±2div, max

Set MODE to ALTER and CH 1 and 2 POSITION controls to mechanical center. Check that the traces are within 2div of electrical center.

j. Check amplifier stability: ±0.5div, max shift

Place both traces to graticule center. Raise line voltage to 125VAC for one minute and note trace drift to be less than ±0.5div from trace position at 117VAC. Repeat the check for 105VAC and return the line voltage to 117VAC.

5. ALTERNATE-CHOPPED MODES

a. Check ALTER operation: must alternate at all sweep speeds

Check for an alternate sweep at all positions of the TYPE 2B67 TIME/DIV control.

b. Check CHOP frequency: 150kHz, ±35kHz

Change MODE to CHOP and adjust both POSITION controls for a convenient amplitude. Change the TIME/DIV to 1μSEC and adjust TYPE 2B67 LEVEL for a stable triggered waveform positioned at graticule start. Check duration of 1 cycle to be ≥5.4div to ≤8.7div.

c. Check CHOP aberration: ≤0.1div P-P at normal intensity

Place CRT CATHODE SELECTOR switch in the CHOPPED BLANKING position and check aberrations to be ≤0.1div P-P at normal intensity with any combination of POSITION control settings. Return CRT CATHODE SELECTOR to NORM, change MODE to CH 2 and TYPE 2B67 LEVEL control to FREE RUN.

6. VOLTS/DIV GAIN

a. Check AC-DC-GND operation

Connect the Dual Input Coupler to CH 1 & 2 inputs and to the SAC through a 50Ω coax cable. Set SAC AMPLITUDE for approximately 2div of deflection and position bottom of waveform to graticule center. Switch to GND and note a single trace remaining at center. Switch to AC and note that waveform shifts downward to an average voltage level. Repeat the check in CH 1 and return input switches to DC.

6. (CONT)

b. Adjust CH 1 10mV Gain

Be sure the front panel CALIB adjustment is preset full cw. Set the SAC to 50mV and adjust 10mV Gain (R149) for 6div of amplitude.

c. Check CALIB gain range (±20% min) and set gain

Turn the CALIB adjustment through its range and check for an amplitude range of ≥6div to ≤4div. Adjust CALIB for exactly 5div.

d. Adjust CH 1 20mV Gain

Change the CH 1 VOLTS/DIV to .02 and the SAC to .1 VOLTS. Adjust 20mV Gain (R147) for 5div of amplitude.

e. Adjust CH 2 20mV Gain: must match CH 1 20mV, ±1% max

Set CH 2 VOLTS/DIV to .02, change INV (CH 1) NORM control to INV, change MODE to ADDED and SAC to .5 VOLTS. Adjust 20mV Gain (R247) for best cancellation: ≤0.25div of amplitude.

f. Adjust CH 2 10mV Gain: must match CH 1 10mV, ±1% max

Change CH 1 & 2 VOLTS/DIV to .01 and the SAC to .2 VOLTS. Adjust CH 2 10mV Gain (R249) for best cancellation: ≤0.2div of amplitude.

g. Check ADDED error: ±2.5% max

Return the INV (CH 1) NORM control to NORM and set the SAC to 20mV. Check for 4div of amplitude ±0.1div max.

h. Check compression, expansion: 0.1div max total

Change MODE to CH 1 and check for 2div of amplitude at graticule center. Move top of waveform to top graticule line and note compression or expansion error at 2div down. Move bottom of waveform to bottom graticule line and check error 2div away from bottom for no more than 0.1div change in amplitude from either the top or center amplitude.

6. (CONT)

i. Check VARIABLE attenuator ratio: ≥2.5:1

Raise the SAC to 50mV and note 5div of amplitude. Turn the VARIABLE control ccw and check for noise and open spots during rotation. The UNCAL neon should be on when VARIABLE is out of CALIB position. Check for ≤2div of amplitude at the ccw stop and return VARIABLE to CALIB. Change the VOLTS/DIV to .02 and SAC to .1 VOLTS and also check for proper operation. Change MODE to CH 2 and check the ratios in both positions of CH 2 VOLTS/DIV.

j. Check attenuator accuracy: ±2% max

Change CH 1 input switch to GND and check the VOLTS/DIV settings as in the following table:

VOLTS DIV	SAC AMPL	DEFL DIV	ERROR ± DIV
.01	50mV	5	0.1
.02	.1V	5	0.1
.05	.2V	4	0.08
.1	.5V	5	0.1
.2	1V	5	0.1
.5	2V	4	0.08
1	5V	5	0.1
2	10V	5	0.1
.5	20V	4	0.08
10	50V	5	0.1

Set MODE to CH 1, CH 1 input to DC, CH 2 input to GND and repeat the step for CH 1 attenuator.

7. MICROPHONICS AND GRID CURRENT

a. Check microphonics: ≤1div

Remove the Dual Input Coupler, change MODE to ALTER and set CH 1 input switch to GND. Hold the Micro-Shock Hammer to the top front of TYPE 561B and allow the slider to drop vertically. Check for ≤1div of microphonics.

7. (CONT)

b. Check grid current: ≤0.4div

Change the input switches to AC, individually, and check for ≤0.4div of trace shift.

8. VOLTS/DIV COMPENSATION

a. Setup

Set the controls as follows:

TYPE 3A6

MODE	CH 1
AC-DC-GND	DC

TYPE 2B67

TIME/DIV	.5mSEC
LEVEL	0

TYPE 106

REP RATE	1kHz
HI AMP-FAST RISE	HI AMP
AMPLITUDE	ccw

Connect the TYPE 106 OUTPUT--GR to BNC Adapter--50Ω BNC cable--10:1 Attenuator--50Ω Termination--47pF Input Normalizer--CH 1 input.

b. Check or adjust CH 1 compensation: Aberration ±2% max

Check or adjust the attenuator compensation for best square corner and flat top as in the following table. Adjust AMPLITUDE of TYPE 106 to maintain 5div of signal and remove 10:1 Attenuator and 50Ω Termination as necessary.

VOLTS/DIV	Corner	Level
.01	-----	C111
.02	-----	C112
.05	C103C	C103B
.1	C105C	C105B
.2	C107C	C107B
.5	check	
1	check	
2	C109C	C109B
5	check	
10	check	

8b. (CONT)

The flat top of the waveform must be within 0.1div of being level. If necessary, compromise adjustments to improve appearance of stacked positions.

c. Check or adjust CH 2 compensation: Aberration ±2% max

Set MODE to CH 2 and apply TYPE 106 cable setup to CH 2 input. Check or adjust the attenuator compensation for best square corner and flat top as in the following table:

VOLTS/DIV	Corner	Level
.01	---	C211
.02	---	C212
.05	C203C	C203B
.1	C205C	C205B
.2	C207C	C207B
.5	check	
1	check	
2	C209C	C209B
5	check	
10	check	

Remove TYPE 106 cable setup.

9. TRANSIENT RESPONSE

a. Setup

Set the controls as follows:

TYPE 3A6
VOLTS/DIV (CH 1 & 2) .01

TYPE 2B67
TIME/DIV 1μSEC

TYPE 106
REP RATE 300kHz
HI AMP-FAST RISE FAST RISE

Connect the TYPE 106 FAST RISE + OUTPUT--GR to BNC Adapter--50Ω BNC cable--50Ω Termination--CH 2 input.

9. (CONT)

b. Adjust high freq compensation: Aberration ±0.1div max with 4div display

Adjust the + TRANSITION AMPLITUDE of TYPE 106 for 4div of deflection. Position the display to graticule center and adjust L384 and L394 for optimum response. Check corner of waveform for ≤0.1div of aberration.

Change MODE to CH 1 and TYPE 106 signal setup to CH 1 input. Check for a similar waveform and readjust if necessary for best match. Maximum overshoot and ringing allowed on both channels is 0.1div.

10. CH 1 TRIGGER

a. Setup

Pull out the TRIGGER CH 1 ONLY PULL control and insert the 10:1 Attenuator between the 50Ω cable and the 50Ω Termination. Adjust the + TRANSITION AMPLITUDE for 2div of deflection.

b. Check CH 1 TRIGGER ONLY Output:
≥3V for a 2div display
≤70ns risetime

Connect the test scope 10X probe to pin 12 of the TYPE 561B Horizontal Compartment Amphenol connector. Set up test scope controls for a suitable display and check for a waveform of 3V min and a risetime of ≤70ns. Set CH 1 VOLTS/DIV to .02 and check that test scope waveform meets the same specifications. Return VOLTS/DIV to .01.

c. Check internal trigger output:
≥2.5V/div of display
≤70ns risetime

Push in the TRIGGER CH 1 ONLY PULL control and check the waveform on the test scope for ≥5V of amplitude with a risetime of ≤70ns.

10c. (CONT)

Remove the probe from 561B and disconnect the TYPE 106 signal setup.

11. BANDWIDTH

a. Setup

Connect the TYPE 191 OUTPUT--GR to BNC Adapter--50Ω BNC cable--50Ω Termination--CH 1 input.

b. Check bandwidth: ≥10MHz @-3dB

Adjust the TYPE 191 AMPLITUDE RANGE and AMPLITUDE controls for 6div of 50kHz signal. Increase the frequency of TYPE 191 until the deflection is reduced to 4.2div. Check the frequency of TYPE 191 for ≥10MHz @-3dB.

Remove the TYPE 191 signal setup.

12. AC LF RESPONSE ≤2Hz @-3dV

Setup the LFSWG FREQUENCY controls for a frequency of 2Hz and connect to CH 1 input with a 50Ω cable. Adjust LFSWG AMPLITUDE controls for 4div of deflection. Move the AC-DC-GND switch to AC and check for ≥2.8div of deflection. Repeat the check in CH 2.

Remove the LFSWG setup.

13. CHANNEL ISOLATION ≥60,000:1

Connect the TYPE 106 HI AMPLITUDE OUTPUT to CH 2 input. Set CH 2 VOLT/DIV to 10 and check that CH 1 VOLTS/DIV is set at .01. Adjust the TYPE 106 for a 6div deflection of 100kHz. Change MODE to CH 1 and check for ≤0.1div of signal on the trace.

13. (CONT)

Repeat the step for CH 2 by changing the TYPE 106 signal to CH 1 with CH 1 VOLTS/DIV set to 10 and CH 2 VOLT/DIV set to .01. Adjust for 6div of deflection on CH 1, then switch MODE to CH 2 and check for $\leq$0.1div of signal on the trace.

Remove input signals.

THE END