FACTORY CALIBRATION PROCEDURE

CONTENTS:

INTRODUCTION:

This is the guide for calibrating brand-new instruments, it therefore, calls out many procedures and adjustments that are rarely required for subsequent recalibration. *This procedure is company confidential.* In this procedure, all front panel control labels or Tektronix equipment names are in capital letters (VOLTS/DIV, etc.) internal adjustment labels are capitalized only (Gain Adj, etc.).

TYPE 86

Tek form number:

0-416
April 1967

For all serial numbers.

FACTORY TEST LIMITS:

We initially calibrate the instrument to Factory Test Limits. These limits are often more stringent than advertised performance requirements. This helps insure that the instrument will meet advertised requirements after shipment, allows for inaccuracies of test equipment used, and may allow for changes in environmental conditions.

QUALIFICATION:

Factory test limits are qualified by the conditions specified in the main body of the calibration procedure. The numbers and letters to the left of the limits correspond to the factory calibration procedure steps where the check or adjustment is made. Instruments may not meet factory test limits if calibration or check-out methods and test equipment differ substantially from those in this procedure.

ABBREVIATIONS:

Abbreviations in this procedure will be found listed in TEKTRONIX STANDARD A-100.

CHANGE INFORMATION:

This procedure has been prepared by Product Manufacturing Staff Engineering. For information on changes that have been made to this procedure, to make suggestions for changing this procedure, or to order additional copies: please contact PMSE, 47-261. (DC)

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

*	1	TYPE 580 SERIES OSCILLOSCOPE (Plug-in scope)
	1	TYPE 533A OSCILLOSCOPE with
	1	TYPE B PLUG-IN UNIT and
	1	P6006 10X PROBE (test scope)
*	1	TYPE 184 TIME-MARK GENERATOR
	1	TYPE 106 SQUARE-WAVE GENERATOR
*	1	TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR

b. Test Fixtures and Accessories

*	1	STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)
	1	TU5 Pulser (015-0038-00)
	1	105-TU5 Adapter (013-0075-00)
	1	Mercury Relay Pulser (PMPE Dwg #1261A)
	1	R Unit Plug-In Extension (013-0015-00)
	1	Plug-In Extension (013-0055-00)
	1	Flexible Extension Cable (012-0038-00)
	1	GR to BNC Female Adapter
	1	GR to BNC 50Ω in line termination (017-0083-00)
	3	50Ω Cables, BNC (012-0057-00)
	1	5ns Cable (017-0502-00)
	1	50Ω Termination (011-0049-00)
	1	50Ω 10:1 Attenuator (011-0059-00)
*	1	15pF Input RC Normalizer (011-0073-00)

c. Other Equipment

1	MULTIMETER, 20,000Ω/Volt DC (calibrated to ±1%)
1	Micro-shock hammer

* This equipment must be traceable to NBS for instrument certification.

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.

It is assumed that all equipment is provided with BNC connectors; if equipment used has other than BNC connectors, adapters, not listed, may be needed.

QUALIFICATION

Factory test limits are qualified by the conditions specified in the main body of the calibration procedure. The numbers and letters to the left of the limits correspond to the factory calibration procedure steps where the check or adjustment is made. Instruments may not meet factory test limits if calibration or checkout methods and test equipment differ substantially from those in this procedure.

1. PRELIMINARY INSPECTION

2. PRESETS

3. RESISTANCE

4. POWER SUPPLIES

b. Check the 50V supply voltage
50V ±6% max
c. Check the -25V supply voltage
-25V ±10% max

5. VERTICAL POSITION CONTROL

6. AC-GND-DC SWITCH AND VARIABLE VOLTS/CM CONTROL

Variable VOLTS/CM range 2:1, min

7. OUTPUT AMPLIFIER

b. Check output amplifier balance.
Plug-in scope electrical center
±0.5cm max
c. Check for microphonics
≤ 3cm with X10 gain

8. GRID CURRENT

a. Check trace shift: ≤0.5cm

9. VERTICAL POSITION KNOBS

10. POSITION RANGE ADJUSTMENTS

Trace within ±0.5cm of scope electrical center

11. GAIN

a. Adjust X1 Gain adj, R549 and check range.
Adjustment: ±2% max
Range: -5% and +10% min
b. Adjust X10 Gain, R356 and check range.
Adjustment: ±2% max
Range: ±10% max

*12. VOLTS/CM ACCURACY

Attenuator errors: ±2% max
Base line shift: ≤1mm

13. X1 HF COMP

b. Adjust X1 HF compensation
≤1 trace width of abberation in 2cm of deflection and ≤1mm of spike with AC coupling.

14. X10 HF COMP

b. Adjust X10 HF Compensation
≤0.5mm of aberrations in 2cm of deflection

*15. HF BANDWIDTH

b. Check X1 HF bandwidth:
85 MHz or more at -3.5dB

c. Check X10 HF bandwidth:
80 MHz or more at -3dB

16. ATTENUATORS

b. Adjust X1 series compensation
Max aberration: .2-20 VOLTS/CM, $\leq$ 0.020" first 50nS then 0.010"; 50 VOLTS/CM, 0.030" first 50nS, then 0.010"

c. Adjust X1 shunt compensation
Max aberration .1-20 VOLTS/CM, $\leq$ 0.020" first 50nS, then 0.010". 50 VOLTS/CM, 0.020" first 50nS, with 2cm of deflection then 0.007".

*17. AC COUPLED LOW FREQUENCY RESPONSE

b. Check AC coupled LF response
2Hz or less at -3dB

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

1. PRELIMINARY INSPECTION

Check for unsoldered joints, rosin joints, improper lead dress and long wire ends. Check for loose hardware and protruding parts. Check that all transistors are properly seated in their sockets. Check controls for smooth mechanical operation, proper indexing and spacing between knobs and front panel. Correct all defects found.

2. PRESETS

VOLTS/CM	.1
AC-GND-DC	DC
VARIABLE VOLTS/CM	CAL
GAIN	X1
VERTICAL POSITION	Centered
X1 and X10 POSITION RANGE	Centered
X1 GAIN ADJ	Centered

Internal Adjustments

Grid Current Zero (R121)	CW
H.F. Comp (R318)	CCW

Preset the remaining internal adjustments to midr.

3. RESISTANCE

Measure resistance from the amphenol 16 pin connector to ground as in the following table:

	Approximate Resistance		
Pin	Neg lead to gnd	Pos lead to gnd	Meter Scale
1	8KΩ	14.5KΩ	X1K
2	3.8KΩ	inf	X1K
3	inf(cap)	inf(cap)	X1K
4,5,6			
7,8	inf	inf	X1K
9	2.5KΩ	inf	X1K
10	0Ω	0Ω	X1K
11	2.5KΩ	inf	X1K
12,13	inf	inf	X1K
14	2.5KΩ	inf	X1K
15	3.4Ω	3.4Ω	X1
16	2.5KΩ	inf	X1K

4. POWER SUPPLIES

a. Setup

Connect the TYPE 86 to the plug-in scope with a flexible extension and turn the plug-in scope POWER ON. Connect the multimeter leads between pins 14 & 16 of the amphenol plug. Adjust the VERTICAL POSITION control for a zero reading on the lowest voltage range of the multimeter.

b. Check the 50V supply voltage 50V ±6%, max.

Set the multimeter to a range suitable to read 50V and connect the negative meter lead to ground. Check for 50V ±3V.

c. Check the -25V supply voltage -25V ±10%, max.

Connect the negative multimeter lead to the junction of D136-C136 and the positive multimeter lead to ground. Check for 25V ±2.5V.

5. VERTICAL POSITION CONTROL

Rotate the VERTICAL POSITION controls full cw. Adjust the X1 POSITION RANGE to place the trace at the top graticule line. Rotate the VERTICAL POSITION to move the trace to the bottom graticule line. Continue in this manner moving the trace to the bottom graticule line with VERTICAL POSITION then to the top graticule line with the X1 POSITION RANGE. Check for smooth movement of the trace as the VERTICAL POSITION control is rotated over its entire range. Recenter the trace with the X1 POSITION RANGE control and VERTICAL POSITION centered.

6. AC-GND-DC SWITCH AND VARIABLE VOLTS/CM CONTROL

Variable ratio: 2:1, min.

Set the VOLTS/CM switch to .05. Set the SAC for a .2V signal and connect the SAC to the INPUT. Rotate the VARIABLE VOLTS/CM from full cw to full ccw and check for a smooth change in the amplitude of the signal display and at least a 2:1 change in deflection factor. Return the VARIABLE VOLTS/CM control to the CAL position. Set the AC-GND-DC switch to DC and center the display vertically. Switch the AC-GND-DC switch to AC. The display should

6. (cont'd)

move down. Switch the AC-GND-DC switch to GND. The display should disappear into a single line.

7. OUTPUT AMPLIFIER

a. Setup

Connect amphenol connector pin 9 to pin 11 and note the vertical position of the trace. Remove the connection between amphenol connector pins 9 & 11 and use the VERTICAL POSITION control to place the trace at the position noted.

b. Check output amplifier balance: Plug-in scope electrical center ±0.5cm, max

b. If more than 0.5cm of unbalance try selecting 6DJ8's for V524, V534, V544.

Connect the output amplifier grid lines together and check for no more than 0.5cm shift in vertical position. Remove the connection between grid lines.

c. Check for loose tube socket connections

Move the output amplifier tubes in their sockets while observing the trace. Check for no erratic shift.

d. Check for microphonics: ≤3cm

Remove the flexible extension cable and plug the TYPE 86 directly into the plug-in scope plug-in compartment. Set GAIN to X10.

Set the AC-GND-DC switch to GND. Apply a shock to the top of the plug-in scope with a micro shock hammer. Raise weight to top and check that deflection of the trace is within limits.

8. GRID CURRENT

a. Check Trace Shift: ≤0.5cm

8. If the trace shifts more than 0.5cm try changing the nuvisitor (V133).

Change the VOLTS/CM to .01. Switch the AC-GND-DC from DC to GND and check vertical movement of the trace.

b. Adjust Grid Current Adj

Switch THE AC-GND-DC from DC to GND while adjusting R121 (Grid Current Zero) for no trace shift.

9. VERTICAL POSITION KNOB

Mechanical center: dot should not pass 6:00 o'clock.

9. R149 is a 330Ω ¼W resistor located above Q253.

Set the GAIN to X1. Center the X1 and X10 POSITION RANGE pot. Set the multimeter to a high current range and connect the multimeter leads across R149. Progressively set the multimeter to lower current ranges as you adjust the VERTICAL POSITION toward its electrical center. When a zero current reading is obtained, loosen the set screw holding the VERTICAL POSITION knob and position the white dot to 12:00 o'clock. Tighten the set screw making sure the DC mA reading remains at zero. Check the mechanical center of the VERTICAL POSITION control by rotating it from stop to stop. If the white dot goes past 6:00 o'clock replace the pot.

In tightening the knob set screws be sure to maintain spacing between the knob and front panel.

10. POSITION RANGE ADJUSTMENTS

Trace within ±0.5cm of scope electrical center.

Change the GAIN to X10. Rotate the VARIABLE VOLTS/CM back and forth and adjust X1 POSITION RANGE for minimum trace shift. (Use the X10 POSITION RANGE to keep the trace in view). Switch the GAIN back and forth between X10 and X1 and adjust the X10 POSITION RANGE for no trace shift.

11. GAIN

a. Adjust X1 Gain Adj, R549 and check range: Adjustment ±2%, max. Range: -5% to +10%, min.

Set the VOLTS/CM switch to .1. Set the GAIN to X1 and VARIABLE VOLTS/CM full cw. Set the SAC for .2 Volts and connect it to TYPE 86 INPUT. Rotate the X1 GAIN ADJ from full cw to full ccw and check for a range of at least 1.9cm to 2.2cm of deflection. Set the X1 GAIN ADJ for exactly 2cm of deflection.

b. Adjust X10 Gain, R356 and check range: Adjustment: ±2%, max. Range: ±10%, min.

Change the GAIN switch from X1 to X10. Reduce the SAC signal to 20 mVOLTS. Rotate R356 from full ccw to full cw and check for a range of at least 1.8cm to 2.2cm of deflection. Set R356 for 2cm of deflection.

12. VOLTS/CM ACCURACY

Attenuator errors, ±2%, max.
Base line shift ≤1mm

Check all VOLTS/CM positions as in the following table:

	VOLTS/CM	SAC	Display Amplitude	tolerance
	.01	20mVOLTS	2cm	±0.4mm
	.02	50mVOLTS	2.5cm	±0.5mm
X10	.05	.1 VOLTS	2cm	±0.4mm
GAIN	.1	.2 VOLTS	2cm	±0.4mm
	.2	.5 VOLTS	2.5cm	±0.5mm
	.5	2 VOLTS	4cm	±0.8mm
	1	2 VOLTS	2cm	±0.4mm
	2	5 VOLTS	2.5cm	±0.5mm
	5	20 VOLTS	4cm	±0.8mm
	.1	.2 VOLTS	2cm	±0.4mm
	.2	.5 VOLTS	2.5cm	±0.5mm
	.5	2 VOLTS	4cm	±0.8mm
X1	1	2 VOLTS	2cm	±0.4mm
GAIN	2	5 VOLTS	2.5cm	±0.5mm
	5	20 VOLTS	4cm	±0.8mm
	10	20 VOLTS	2cm	±0.4mm
	20	50 VOLTS	2.5cm	±0.5mm
	50	100 VOLTS	2cm	±0.4mm

13. X1 HF COMP

a. Setup

Connect TYPE 106 OUTPUT--GR to BNC Female Adapter--105-TU5 Adapter--50Ω cable--TU5--50Ω Termination--TYPE 86 INPUT. Set the TYPE 106 frequency controls for a 10 kHz signal. Set the TYPE 86 AC-GND-DC to DC, VOLTS/CM to .1 and GAIN to X1. Set the plug-in scope TIME/CM to .2μSEC.

Adjust the TU5 bias control just past the firing point.

b. Adjust X1 HF Compensation <1 trace width of aberration in 2cm of deflection and <1mm of spike with AC coupling.

Adjust C167, C168 and C524 for an optimum square wave. Check the display with TIME/CM settings of from .05μSEC to 50μSEC. Switch

13. (cont'd)

the AC-GND-DC to AC and check for excessive spike on the leading edge of the display.

14. X10 HF COMP

a. Setup

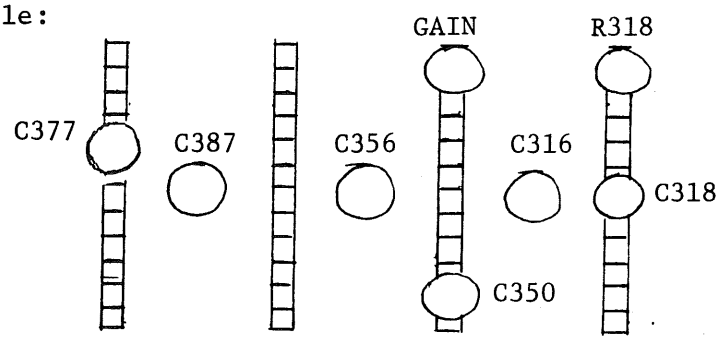
Insert a 50Ω X10 attenuator between the TU5 and the 50Ω termination at the TYPE 86 INPUT. Set the TYPE 86 GAIN to X10 and the AC-GND-DC to DC. Set the plug-in scope TIME/CM to .2μSEC.

b. Adjust X10 HF compensation ≤0.5mm of aberrations in 2cm of deflection.

Make adjustments as in the following table:

Sequence	adjust	for
1	C318	max spike
2	C356	max spike
3	C387	max spike
4	C316	min spike
5	R318	(turn cw) no ringing
6	C356	correct level
7	C318	
8 (5μs)	C377	corner
9 (5μs)	C350	correct level

b. X10 HF compensating adjustments are located on the main chassis as illustrated below.



It may be necessary to dress C510 and C511 relative to R510 and R511 in order to achieve optimum transient response.

15. HF BANDWIDTH

a. Setup:

Set the TYPE 86 input selector to DC and VOLTS/CM to .1. Connect TYPE 191 OUTPUT--5NS cable--GR to BNC 50Ω in line termination--TYPE 86 INPUT. Set the TYPE 191 FREQUENCY RANGE to 50 kHz ONLY, AMPLITUDE RANGE to 50-500mV and AMPLITUDE for a 2cm display.

b. Check X1 HF bandwidth 85 MHz or more at -3.5dB

Change the TYPE 191 FREQUENCY RANGE to 42-100 MEGAHERTZ and increase the TYPE 191 frequency vernier setting until the display amplitude drops to 1.34cm. Read the high frequency 3.5dB point from the dial.

b. In order to assure that the TYPE 86 will meet the bandwidth requirement of -3.5dB at 85 MHz in all TYPE 581A and 585A oscilloscopes it will be necessary to adjust the TYPE 86 for 85 MHz at -3dB, max, in a TYPE 581A or 585A whose bandwidth is -3dB at 95 MHz.

15. (cont'd)

c. Check X10 HF bandwidth
80 MHz or more at -3dB

Change the TYPE 191 AMPLITUDE RANGE to 5-5mv and FREQUENCY RANGE to 50 kHz ONLY. Change the TYPE 86 GAIN to X10 and adjust the TYPE 191 AMPLITUDE controls for a 2cm display. Switch the TYPE 191 FREQUENCY RANGE to 42-100 MEGAHERTZ and adjust the TYPE 191 frequency vernier control for a 1.4cm display. Read the high frequency 3dB point from the dial.

16. ATTENUATORS

a. Setup

Install an R unit plug-in extension between the TYPE 86 and plug-in scope. Preset the shunt capacitros approximately halfway out. (see table in step 16c for C numbers). Connect the mercury relay pulser to TYPE 86 INPUT. Connect TYPE 106 OUTPUT and SAC OUTPUT to the proper BNC connectors on the mercury relay pulser. Set the TYPE 86 INPUT selector to DC, GAIN to X1 and VOLTS/CM to .1. Set the TYPE 106 REPETITION RATE RANGE and MULTIPLIER controls to 2kHz, the SAC AMPLITUDE to 5 VOLTS and MODE to +DC.

b. Adjust X1 series compensation

Adjust the X1 series capacitors for an optimum square wave presentation as in the following table:

VOLTS/CM	SAC	ADJUST	Max aberration in 3cm
.2	5V	C107C	≤ 0.20" first 50nS, then 0.010"
.5	5V	C108C	≤ 0.20" first 50nS, then 0.010"
1	5V	C109C	≤ 0.20" first 50nS, then 0.010"
2	10V	C110C	≤ 0.20" first 50nS, then 0.010"
5	20V	C111C	≤ 0.20" first 50nS, then 0.010"
10	50V	C112C	≤ 0.20" first 50nS, then 0.010"
20	100V	C113C	≤ 0.20" first 50nS, then 0.010"
50	100V	C114C	≤0.020" for first 50nS with 2cm display then 0.007"

16. (cont'd)

c. Adjust X1 shunt compensation

Remove the mercury relay pulser. Connect TYPE 106--5ns cable--GR to BNC adapter--15PF input time constant normalizer--TYPE 86 INPUT. Adjust the TYPE 106 REPETITION RATE RANGE and multiplier controls for a 2.5 kHz signal. Adjust the X1 shunt capacitors as in the following table:

VOLTS/CM	ADJUST	Max aberration in 3cm
.1	C106	≤0.020" first 50ns then 0.010"
.2	C107B	≤0.020" first 50ns then 0.010"
.5	C108B	≤0.020" first 50ns then 0.010"
1	C109B	≤0.020" first 50ns then 0.010"
2	C110B	≤0.020" first 50ns then 0.010"
5	C111B	≤0.020" first 50ns then 0.010"
10	C112B	≤0.020" first 50ns then 0.010"
20	C113B	≤0.020" first 50ns then 0.010"
50	C114B	≤0.020" first 50ns then 0.010"

17. AC COUPLED LOW FREQUENCY RESPONSE

a. Setup

Connect the plug-in scope +GATE OUT to TYPE 86 INPUT with a BNC to Banana patch cord. Set the plug-in scope TIME/CM to .1 SEC and the TYPE 86 AC-GND-DC to AC and VOLTS/CM to 5. Turn the plug-in scope STABILITY fully cw and adjust the TYPE 86 VARIABLE VOLTS/CM for 4cm of deflection at the start of the trace.

b. Check AC coupled lf response 2Hz or less at -3dB

Measure the time from the 4cm amplitude point to the 1.5cm amplitude point. Must be 0.08 second or more.

THE END