FACTORY CALIBRATION PROCEDURE

CONTENTS:

INTRODUCTION:

647A

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.).

Tek form number:
0-361
February 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. (NC)

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 543B OSCILLOSCOPE
1	TYPE L PLUG-IN UNIT
1	TYPE D PLUG-IN UNIT
1	TYPE 10A2A DUAL-TRACE AMPLIFIER
1	TYPE 11B2 TIME BASE
* 1	TYPE 184 TIME MARK GENERATOR
1	TYPE 76 TU LINE VOLTAGE CONTROL
1	TYPE P6019 Current Probe

b. Test Fixtures and Accessories

* 1	067-0544-00 CALIBRATION FIXTURE
* 1	HF Sine-Wave Generator (067-0532-00)
* 1	DC Voltage Bridge (067-0543-99) (with voltage error recorded at 2.2kV)
* 1	Standard Amplitude Calibrator (067-0502-00)
1	Termination for Current Probe (011-0078-00)
1	Cannon Connector Checker (PMPE Dwg. #1190A)
2	50Ω Coaxial Cables W/BNC connectors (012-0057-00)
1	50Ω Termination W/BNC connectors (011-0049-00)

c. Other Equipment

1	Multimeter (Simpson Model 261 or equivalent)

d. Equipment for Sample Checks

1	TEKTRONIX TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
* 1	Resistance Bridge (0.1% or better accuracy at 50Ω)
1	LF Sine-Wave Generator (067-0542-00)

* 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

a. Make General Inspection
b. Align CRT
c. Preset controls
d. Check Power Supply Resistance
* e. Check Calibrator Output Resistance: (sample check) 0.2mV-0.1V, 0.4%
0.2V, 1.5%

2. POWER SUPPLIES

* b. Adjust Regulated Supplies: within ±0.1% with 067-0544-00
c. Check DC Change with Load Change: ≤0.1% zero to full load
d. Check 15 volt Short Circuit Protection
e. Check Ripple and Regulation: ≤2mV ripple 104 to 126 VAC, 112-136, 90-110
f. Check Unregulated Supply: 300V ±10% @ 115 VAC ≤10V ripple
* g. Adjust High Voltage/CRT Grid Bias: -2200V ±1%; set for dim spot with 20V at TP873
h. Check High Voltage Regulation: ≤1% change
i. Check HV Short Circuit Protection

3. CRT

b. Adjust Trace Rotation: ≥6° range, must adjust at least + & - 1° from horizontal
c. Adjust Orthogonality: 90° ±1
d. Check Horizontal Geometry: ≤1mm deviation from horizontal line
e. Check Horizontal Resolution: ≥130 lines/10cm

4. VERTICAL GAIN

a. Check Vertical Gain Range: ≤28.8 to ≥34.8V
* b. Adjust Vertical Gain and Centering
c. Check CRT Vertical Deflection Factor: 4.9 to 5.7V/cm
d. Check Vertical Centering Range: (sample check): at least + & - 1cm from electrical center

5. VERTICAL RESPONSE

b. Adjust Vertical HF Compensation: ≤3% aberrations; ≤4% preshoot
c. Check Symmetry: ≤3% aberrations ≤4% preshoot on negative pulse
d. Check Positioning Effect on Transient Response: ≤6% aberrations
e. Check Delay Line Aberrations: ≤1.25%
f. Check Low Frequency Linearity: ≤1.5mm compression or expansion
* g. Check Bandpass: ≥135 MHz @ -3dB

6. HORIZONTAL GAIN

b. Check Horizontal Gain Range: 132 to 154V
* c. Adjust Horizontal Gain and Centering: ≤0.5mm error
d. Check CRT Horizontal Deflection Factor: 13.2 to 15.4V/cm
e. Check Horizontal Centering Range (sample check): at least + & - 0.6cm from graticule center

7. HORIZONTAL COMPENSATION

* b. Adjust Horizontal HF Compensation: ≤2% timing error ≤10% non-linearity

8. CALIBRATOR

* a. Check Calibrator Voltage Accuracy:
100V and 0.1V, ±0.75%
all others, ±1.75%
* b. Check Calibrator Frequency: 1 kHz ±0.05%
c. Check Calibrator Risetime: ≤1μs
d. Check Calibrator Duty Cycle: 49.9 to 50.1%
* e. Check Calibrator Current Waveform: 5mA ±1.5%

9. UNBLANKING AMPLIFIER

b. Adjust Unblanking Compensation: ≤3% overshoot; ≤50ns risetime

10. FRONT PANEL CONTROLS

a. Check Horizontal Position Range: at least + & - 0.5cm from graticule center
b. Check Beam Finder: Beam must remain inside graticule area at extreme settings of position control
c. Check Scale Illum
d. Check Intensity, Focus and Astigmatism

11. MULTI-TRACE Chopped transients must be blanked

12. Z AXIS

b. Check CRT Grid Input:
sensitivity: ≤4V causes noticeable intensity modulation
usable freq range: DC to ≥10 MHz
c. Check CRT Cathode Input: sensitivity: ≤5V causes noticeable intensity modulation
usable freq range: 50 kHz to ≥100 MHz
d. Check CRT Cathode Input (sample check): 500 Hz causes noticeable intensity modulation @ ≤5V
e. Check CRT Grid Input Resistance (sample check): 22kΩ ±10%

13. AC POLARITY AC voltage at amphenol plugs must be in phase

14. CANNON PLUG

pin A	-75V
pin B	-15V
pin C	gnd
pin D	+15V
pin E	+100V
pin F	single swp reset

15. NEONS (RM647A ONLY)

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

THE END

1. PRELIMINARY

a. Make General Inspection

Check for unsoldered and rosin connections. Check for loose hardware and protruding parts. Check the controls for smooth mechanical operation, proper indexing and knob spacing. Check the fuses for correct value. Correct all defects found. Install the HV shield.

a. F601 2A
F602 4A
F613 1/2A
F703 3/4A
F743 3/4A
F820 1A slo blo

b. Align CRT

Align the CRT so the plastic ring around the faceplate is flush with the front panel. Tighten the CRT clamp. Check the CRT neck pin connectors. Check for faceplate and phosphor defects.

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

c. Preset controls

Preset the controls and adjustments as follows:

FOCUS	midr
INTENSITY	ccw
ASTIGMATISM	midr
TRACE ROTATION	midr
SCALE ILLUM	ccw
HORIZONTAL POSITION	midr
VERNIER	midr
CRT GRID BIAS	ccw
POWER	OFF
CALIBRATOR	OFF
HV Adj	ccw
Line Range Selector	104-126 VAC

d. Check Power Supply Resistance

Supply (+ meter lead connected to gnd and X1K meter scale)	Approx Resistance to gnd
-75V	3.5KΩ
-15V	1.5-2kΩ (varies with INTENSITY)
+15V	150Ω
+100V	2.5KΩ
+300V	7KΩ

e. Check Calibrator Output Resistance (sample check) *0.2mV-0.1V: 50Ω ±0.4%*
0.2V: 50Ω ±1.5%

e. SAMPLE CHECKS ARE NOT MADE ON 100% OF THE INSTRUMENTS, BUT ARE DONE ON A SAMPLING BASIS.

Connect a DC resistance bridge (0.1% or better accuracy) to the CAL OUT jack. Check for the specified resistance with the CALIBRATOR switch set as follows:

CALIBRATOR	Resistance
0.2mV-0.1V	50Ω ±0.4%
0.2V	50Ω ±1.5%

2. POWER SUPPLIES

a. Setup

Install the Test Load (067-0544-00 Calibration Fixture) in the HORIZONTAL compartment of the TYPE 647A. Apply power to the TYPE 647A via TYPE 76TU. Set the line voltage to 115 VAC. Allow 20 minutes operating time before making adjustments. Set the front panel controls as follows:

Test Load

PULSE RATE	OFF
HORIZ CAL	5
LOAD	ZERO
SOURCE	GND
Voltage	-75V

Test scope (with TYPE D)

TIME/CM	1mSEC
TRIGGERING MODE	AUTO
SOURCE	LINE
SLOPE	+
MV/CM	1
MV/CM MULTIPLIER	5
Input Selector	A, DC

Connect a 50Ω coaxial cable from the Test Load OUTPUT jack to the TYPE D INPUT A.

b. Adjust Regulated Supplies ±0.1%

Adjust the test scope VERTICAL POSITION so the trace is at graticule center (zero reference). Change the Test Load SOURCE sw to DC ERROR and adjust the -75 Volts for min possible error on the test scope (1cm = 0.1% error).

Change the Voltage sw to +100V and adjust the +100 Volts for min possible error. Repeat the adjustment of the -75 Volts and +100 Volts until they are both set for min possible error. Tighten the locking nuts.

Set the Test Load Voltage sw to -15 and +15, and adjust the -15 VOLTS and +15 VOLTS for min possible error. Tighten the locking nuts. Recheck voltages after tightening lock nuts.

The error on any of the regulated supplies must not exceed 0.1% (1.0cm).

2. (cont'd)

c. Check DC Change with Load Change ≤0.1%

Switch the LOAD from ZERO to FULL. The DC error on each supply must not change by more than 0.1% (1cm). Return the LOAD to NO LOAD.

c. The 067-0544-00 must be in the HORIZONTAL plug-in compartment for this check.

d. Check 15 Volt Short Circuit Protection

Change the SOURCE sw to GND. Short the +15V supply to gnd with an ammeter on the 12A scale. The ammeter should read about 2.5A. Remove the ammeter and recheck the supply for correct voltage.

Repeat the check for the -15V supply. The ammeter should read about 1.1A.

e. Check Ripple and Regulation ≤2mV ripple 104-126 VAC, 112-136 VAC, 90-110 VAC

Set the Test Load SOURCE sw to RIPPLE and the TYPE D deflection factor to 1mV/cm. Check each supply for regulation and no more than 2mV ripple while varying the line voltage from 104 to 126 VAC. Check with the LOAD sw at ZERO and FULL.

e. Test limits for line ranges apply only if the line distortion reduces the P to P line voltage by 5% or less.

If a plug-in other than a TYPE D is used for checking ripple the bandwidth must be between 250 kHz and 2 MHz.

Change the line voltage range to HI and repeat the regulation and ripple check except vary the line voltage from 112 to 136 VAC.

Change the line voltage range to LO and repeat the regulation and ripple check except vary the line voltage from 90 to 110 VAC.

Connect an AC voltmeter across pins 35 and 39 on the power transformer. Note the voltage reading. Change the line voltage range to 230 VAC operation. The voltage across pins 35 and 39 must be ½ of the voltage noted previously.

Return the line voltage range to 104-126 VAC operation and set the line voltage to 115 VAC. Return the LOAD sw to ZERO.

f. Check Unregulated Supply 300V ±10% @ 115 VAC; ≤10V ripple

Check the +300V supply with a voltmeter. The voltage must be 270V to 330V with the line voltage at 115 VAC.

Use the test scope and an AC coupled 10X probe to measure the ripple on the +300V supply. The ripple must not exceed 10V. Remove the probe.

2. (cont'd)

g. Adjust High Voltage/CRT Grid Bias -2200V ±1%

Set the DC Voltage Bridge to read 2200V. Connect the DC Voltage Bridge between TP833 and gnd. Adjust the High Voltage (R801) for zero error as read on the DC Voltage Bridge.

Connect a DC coupled 10X probe from the test scope to TP873. Adjust the INTENSITY control for a DC level of 20 volts above gnd.

Adjust the CRT Grid Bias (R832) so the CRT beam is just visible on the screen.

h. Check High Voltage Regulation ≤1% change

Install the Test Load in the VERTICAL PLUG-IN compartment. Monitor the high voltage with the DC Voltage Bridge. Position the CRT beam off screen and set the INTENSITY control to max and change the line voltage from 104 to 126 VAC. The high voltage must not change by more than 22 volts (with line volts and/or intensity change).

i. Check HV Short-Circuit Protection

Turn the INTENSITY to full ccw. Turn the TYPE 647A POWER OFF. Connect a meter lead between gnd and the high voltage post accelerator supply. Turn the TYPE 647A POWER ON. Check that F820 does not blow. Connect a 10X probe from the test scope to the collector of Q820. The HV oscillator must pulse approx ever 0.5 to 2s (indicates protection circuit is working). Remove the short and check that the high voltage returns to normal.

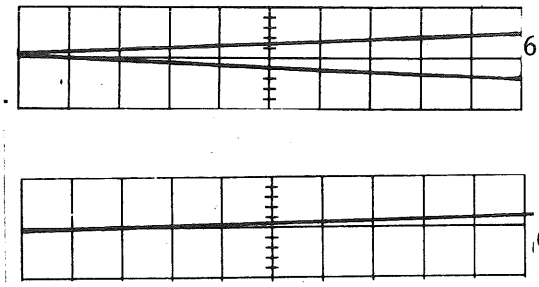
3. CRT

a. Setup

Install the 11B2 in the HORIZONTAL plug-in compartment. Set the TYPE 11B2 TRIGGER MODE to AUTO and TIME/CM to 1mSEC.

3. (cont'd)

b. Adjust Trace Rotation >6° total range must adjust + & -1° from horizontal



Adjust the FOCUS, INTENSITY and ASTIGMATISM controls for a well-defined trace of normal brightness. Vary the TRACE ROTATION throughout its range of adjustment. The trace rotation must change by at least 6° total. The trace must adjust at least + & - 1° past the horizontal (see notes). Center the trace and adjust the TRACE ROTATION so the trace is parallel with the horizontal graticule lines.

c. Adjust Orthogonality 90° ±1°

Apply 1ms and .1ms time marks from the TYPE 184 to the Test Load TIME MARK IN jack. Adjust the Test Load POSITION and ATTEN so the time marks cover the graticule area. Adjust the TYPE 11B2 trigger for a triggered display. Adjust the VARIABLE TIME/CM so there is one 1ms time mark/cm.

Use the .1ms time marks and adjust the Y Axis Alignment (R865) and the Geometry (R863) for optimum vertical lines. Deviation from a straight vertical line, at all points in the graticule area, must not exceed 1mm (1°).

d. Check Horizontal Geometry ≤1mm

Remove the time marks and free run the sweep. Position the trace from top to bottom of the graticule area. Deviation from a straight horizontal line, at all points in the graticule area, must not exceed 1mm.

e. Check Horizontal Resolution ≥130 lines/10cm

Apply 1ms time marks to the Test Load TIME MARK IN. Adjust the TIME/CM VARIABLE so there is exactly 13 1ms time marks in 10cm. Change the time marks to .1ms and adjust the POSITION and ATTEN controls so the time marks cover the entire graticule area.

Adjust the FOCUS and ASTIGMATISM controls for optimum focus in the center portion of the graticule area. There must be no blending of time marks at any point in the graticule area.

4. VERTICAL GAIN

a. Check Vertical Gain Range ≤28.8 to ≥34.8V

Connect the voltmeter across the CRT vertical deflection plates. Rotate the Vert Gain (R414) full cw. Set the Test Load VERTICAL control to +3 and note the meter reading (V_1). Set the Test Load VERTICAL to -3 and note the meter reading (V_2). $|V_1| + |V_2|$ must be at least 34.8V.

Rotate the Vert Gain full ccw. Note the meter reading (V_1). Set the Test Load VERTICAL to +3 and note the meter reading (V_2). $|V_1| + |V_2|$ must not exceed 28.8V.

Remove the voltmeter connections.

b. Adjust Vertical Gain and Centering

Adjust the Vert Gain (R414) and Vert Cent (R441) so the trace is on the top graticule line when the Test Load VERTICAL control is at +3 and on the bottom graticule line when the VERTICAL control is at -3.

c. Check CRT Vertical Deflection Factor 4.9 to 5.7V/cm

Connect a voltmeter across the CRT vertical deflection plates. Set the Test Load VERTICAL sw to +3 and note the voltmeter reading (V_1). Set the VERTICAL sw to -3 and note the voltmeter reading (V_2). $V_1 + V_2$ must be between 29.4V and 34.2V.

4. (cont'd)

d. Check Vertical Centering Range (sample check) + & - 1cm

Locate the CRT vertical electrical center by shorting the vertical deflection plates together. Set the Test Load VERTICAL control to TIME MARK and position the trace to the CRT electrical center.

Check that the Vertical Centering has sufficient range to position the trace + and - 1cm from the CRT electrical center.

Reset the Vertical Centering (step 4b).

5. VERTICAL RESPONSE

a. Setup

Set the front panel controls as follows:

TYPE 11B2

TIME/CM	.5μSEC
HORIZ DISPLAY	A
TRIG MODE	NORM
SLOPE (A)	+
SOURCE	INT
COUPLING	AC

Test Load

VERTICAL	+ PULSE POLARITY
PULSE RATE	one setting below HIGH

Adjust the TYPE 11B2 TRIG LEVEL for a triggered display. Adjust the pulse AMPLITUDE for 4cm.

b. Adjust Vertical HF Compensation
≤3% aberrations
≤4% preshoot

Center the display vertically on the graticule. Adjust the high frequency compensation for optimum risetime with minimum aberrations. Adjust as follows:

5b. (cont'd)

Adjust	TIME/CM	Approx region of adjustment
R467	.5µs	.1 to .3µs
R465	.1µs	25 to 75ns
C465	50ns	25 to 125ns
R475	20ns	10 to 30ns
R429 & C437	10ns	corner to 10ns
C435	10ns	corner to 10ns
L428	10ns	corner to 10ns (ringing)
*R428	10ns	corner to 10ns (ringing)

Overshoot, rounding, tilt and PTP ringing must not exceed 3%. Preshoot must not exceed 4%.

*RM647A only.

c. Check Symmetry *≤3% aberrations*
≤4% preshoot

Change the PULSE POLARITY to -. Recenter the display on the graticule area. Check the preshoot and aberrations on the negative going transient. Overshoot, rounding, tilt and PTP ringing must not exceed 3%. Preshoot must not exceed 4%.

d. Check Positioning Effect on Transient Response *≤6% aberrations*

Increase the PULSE AMPLITUDE to 6cm. Position the bottom of the pulse to the top graticule line. Overshoot, rounding, tilt and/or PTP ringing must not exceed 6%.

Change the PULSE POLARITY to +. Position the top of the pulse to the bottom graticule line. Overshoot, rounding, tilt and/or PTP ringing must not exceed 6%.

e. Check Delay Line Aberrations *≤1.25%*

Change the TIME/CM to .1µSEC. Adjust the PULSE AMPLTIUDE for 4cm. The termination aberrations (about 3cm from the corner of the pulse) must not exceed 0.5mm.

f. Check Low Frequency Linearity *≤1.5mm*

Change the PULSE RATE to one mark above LOW and the TIME/CM to about 1mSEC. Adjust the PULSE AMPLITUDE for a 2cm centered display.

Position the signal vertically over the graticule area. Note the minimum (compression) and maximum (expansion) amplitudes obtained. The difference between minimum and maximum amplitudes must not exceed 1.5mm.

5. (cont'd)

g. Check Vertical Bandpass ≥135 MHz @ -3dB

Set the Test Load VERTICAL sw to CW. Connect the output of the 067-0532-00 Constant Amplitude Signal Generator to the CW INPUT. Set the frequency to 3 MHz and adjust the amplitude for 4cm. Increase the frequency until amplitude decreases to 2.8cm. The frequency must be at least 135 MHz.

6. HORIZONTAL GAIN

a. Setup

Remove the TYPE 11B2 and install the Test Load in the HORIZONTAL plug-in compartment. Adjust the FOCUS, INTENSITY and ASTIGMATISM controls for a fine dim spot.

b. Check Horizontal Gain Range ≤132V to ≥154V

Connect a voltmeter across the CRT horizontal deflection plates. Rotate the Horiz Gain (R377) full cw. Set the Test Load HORIZ CAL to 0. Note the voltmeter reading (V_1). Set the HORIZ CAL to 10 and note the voltmeter reading (V_2). $V_1 + V_2$ must be at least 154V.

Rotate the Horiz Gain full ccw. Note the voltmeter reading (V_1). Change the HORIZ CAL to 0 and note the voltmeter reading (V_2). $V_1 + V_2$ must not exceed 132V.

Remove the voltmeter connections.

c. Adjust Horizontal Gain and Centering ≤0.5mm error

Adjust Horiz Gain (R377) and Horiz Center (R364) so the spot is on the 1cm graticule line when the Test Load HORIZ CAL is at 1 and on the 9cm graticule line when the HORIZ CAL is at 9.

Check for no more than 0.5mm deviation from the respective graticule lines at all other settings of the HORIZ CAL sw.

6. (cont'd)

d. Check CRT Horizontal Deflection 13.2 to 15.4V/cm

Connect a voltmeter across the CRT horizontal deflection plates. Set the HORIZ CAL to 0 and note the voltage reading (V1). Set the HORIZ CAL to 10 and note the voltage reading (V2). V1 + V2 must be between 132V and 154V.

e. Check Horizontal Centering Range (sample check) + & - 0.6cm

Locate the CRT horizontal electrical center by shorting the horizontal deflection plates together. Install the TYPE 11B2 in the HORIZONTAL plug-in compartment. Set the HORIZ DISPLAY to EXT INPUT and position the dot to the electrical center.

Check that the Horizontal Centering control has sufficient range to position the dot at least + and -0.6cm from the electrical center.

Reset the Horizontal Centering (step 6b).

7. HORIZONTAL COMPENSATION

a. Setup

Set the front panel controls as follows:

TYPE 11B2

HORIZ DISPLAY	A
TIME/CM	.1μSEC
TRIG MODE	NORM
MAG	OFF
Trigger COUPLING	AC LF REJ
Trigger SOURCE	EXT

Test Load

VERTICAL	TIME MARK
ATTEN	cw
PULSE RATE	OFF

Apply 10ns time marks from the TYPE 184 to the Test Load TIME MARK IN jack. Apply 1μs external triggers from the TYPE 184 to the TYPE 11B2 A TRIG IN. Adjust the TRIG LEVEL control for a triggered display.

b. Adjust Horizontal HF Compensation
≤2% timing error
≤10% non-linearity

Center the display on the graticule area and change the MAG to X10.

Adjust equally between C377 and C397 for optimum linearity in the center 8cm of the sweep. Adjust C378 for 1 mark/cm in the center 8cm.

Except for the first 5cm, check the entire sweep for 1 mark/cm ±2%.

Non-linearity in any 8cm segment of the sweep (exclude first 5cm) must not exceed 10% (see notes). Remove the time marks and external trigger signal.

b. Percent non-linearity is measured as follows: Measure the total distance in cm between the 1st and 9th time mark (middle 8). Divide this distance by 8 (number of time mark intervals), this is the average distance between time marks (t_{av}). Note the time mark interval (t_d) that has maximum deviation from the average. Percent non-linearity is expressed as follows: $\frac{t_{av} - t_d}{t_{av}}$ X100.

If t_d is larger than t_{av} then $\frac{t_d - t_{av}}{t_{av}}$ X100.

e.g. If the 1st and 9th time marks are right on their respective graticule lines then all time marks in between must be within 1mm of their respective graticule lines.

8. CALIBRATOR

a. Check Calibrator Voltage Accuracy
100 & .1V: ±0.75%; all others: ±1.75%

Remove the Test Load and install the TYPE 10A2A in the VERTICAL plug-in compartment. Turn POWER OFF and remove Q945. Turn POWER ON. Connect a 50Ω coaxial cable from the CAL OUT to the SAC UNKNOWN INPUT. Connect a 50Ω coaxial cable from the SAC OUTPUT to the TYPE D INPUT A. Set the front panel controls as follows:

SAC	
MODE	+DC, MIXED
AMPLITUDE	100V
TYPE 647A	
CALIBRATOR	100 VDC
Test Scope	
TIME/CM	2mSEC
TRIGGERING	
LEVEL	midr
MODE	TRIG
SLOPE	-
COUPLING	AC
SOURCE	LINE
TYPE D	
Input selector	A, AC
MILLIVOLTS/CM	10
MV/CM MULTIPLIER	50

Check the calibrator for the specified accuracy: Change the TYPE D deflection factor as necessary to obtain a readable display.

1KC CALIBRATOR setting	Max allowed error
100 VDC	750mV
100 V	750mV
50	875mV
20	350mV
10	175mV
5	87.5mV
2	35mV
1	17.5mV
.5	8.75mV
.2	3.5mV
.1	*0.75mV

* Add the error in percent to the worse case error in the same direction that was found in the previous settings. The total error must not exceed 1.75%.

a. The SAC chops between the SAC precision calibrator and the TYPE 647A calibrator. The test scope display is a square-wave with an amplitude equal to the difference between the two calibrators. With the test scope triggered as directed in the setup the first complete half cycle is the SAC, therefore the polarity of the first square-wave indicates the direction of the error in the TYPE 647A calibrator.

8a. (cont'd)

Replace Q945. Connect the 1KC CALIBRATOR OUTPUT directly to the TYPE D INPUT A. Check the remaining switch settings for the approx voltage amplitude.

b. Check Calibrator Frequency 1 kHz ±0.05%

Apply 1ms and 1s time marks from the TYPE 184 to the TYPE 10A2A INPUT. Connect the CALIBRATOR to the TYPE 11B2 external TRIG INPUT. Set the TRIG MODE to NORM, SOURCE to EXT and TIME/CM to 1mSEC. Adjust the TRIG LEVEL for a triggered display.

Check the drift of the 1ms time marks over a period of 10s. The drift must not exceed 5cm. Remove the time marks.

c. Check Calibrator Risetime $\leq$*1.5µs*

Check the TYPE 11B2 .5µs/cm timing accuracy and if necessary adjust for no timing error.

Connect an 18" 50Ω coaxial cable from the CAL OUT to the TYPE 10A2A INPUT. Set the CALIBRATOR to 100 VAC and the TYPE 10A2A VOLTS/CM to 20. Check the 10% to 90% risetime of the calibrator waveform. The risetime must not exceed 1.5µs.

d. Check Calibrator Duty Cycle 49.9 to 50.1%

Adjust the TIME/CM so there is exactly 1/2 cycles of calibrator waveform in 10cm. Adjust the TRIG LEVEL so the sweep starts at the same amplitude point on the calibrator waveform when triggering on + and - slope.

Set the SLOPE to + and the MAG to X10. Position the display so the positive half cycle of the calibrator ends at the center of the graticule. Change the SLOPE to -. The negative half cycle must end within ±2mm of graticule center.

e. Check Calibrator Current Waveform
**5mA ±1.5%*

Connect the Termination for Current Probe to the TYPE 10A2A INPUT. Set the VOLTS/CM to .01 and the Termination to 2mA/MV. Connect a P6019 current probe from the Termination to the 5mA current loop. Set the 1KC CALIBRATOR to the 5mA position.

There must be a square-wave displayed of approx 2.5mm in amplitude. (see notes)

* The accuracy of the 5mA current waveform is determined by the resistor string that was checked previously with the SAC.

9. UNBLANKING AMPLIFIER

a. Setup

Set the TYPE 11B2 as follows:

TIME/CM	.1μSEC
HORIZ DISPLAY	A
TRIG MODE	FREE RUN

Remove the TYPE D from the test scope and install the TYPE L. Connect a compensated 10X probe from the test scope to TP873. Set the test scope TIME/CM to about 1μSEC and adjust for a triggered display.

Vary the INTENSITY control throughout its range. The unblanking waveform should vary from 0V at about +10VDC level to about 55V at a +40VDC level.

b. Adjust Unblanking Compensation
≤3% overshoot
≤50ns risetime

Adjust the INTENSITY control for a 30 volt unblanking pulse. Adjust C879 for optimum flat top on the unblanking pulse. Overshoot on the unblanking pulse must not exceed 3%. Check the unblanking pulse for a risetime of no more than 50ns.

10. FRONT PANEL CONTROLS

a. Check Horizontal Position Range
+ & - 0.5cm from graticule center

Set the TIME/CM to 1mSEC and TRIG MODE to AUTO.

Rotate the HORIZ POSITION and VERNIER controls full cw. The start of the sweep must position at least 0.5cm to the right of graticule center.

Rotate the HORIZ POSITION and VERNIER full ccw. The end of the sweep must position at least 0.5cm to the left of graticule center.

10. (cont'd)

b. Check Beam Finder

Depress the BEAM FINDER and rotate the HORIZONTAL and VERTICAL POSITION controls throughout their range.

The sweep must compress and remain in the graticule area with extreme settings of POSITION controls.

c. Check Scale Illum

Rotate the SCALE ILLUM from full ccw to full cw. The control must work smoothly and the graticule illumination must increase evenly with max illumination at full cw.

d. Check Intensity, Focus and Astigmatism

Rotate the INTENSITY control from full ccw to full cw. The intensity must increase evenly with smooth control rotation. At full ccw there must be no intensity. The trace should appear at an INTENSITY setting of about 5.

Check the FOCUS and ASTIGMATISM controls for smooth control operation.

11. MULTI-TRACE

Set the TYPE 11B2 TIME/CM to .5μSEC and TRIG MODE to AUTO. Set the TYPE 10A2A MODE to CHOP. There must be a chopped display and the chopping transients must be blanked (no vertical lines between chopped segments).

12. Z AXIS INPUTS

a. Setup

Connect the output of the TYPE 191 through a 50Ω termination and a BNC T connector to the CRT GRID input jack and the TYPE 11B2 TRIG IN jack. Set the TYPE 11B2 TRIG MODE to NORM, trigger SOURCE to EXT and TIME/CM to 20μSEC.

12. (cont'd)

b. Check CRT Grid Input
Sensitivity: ≤4V causes noticeable intensity modulation
Usable freq range: DC to ≥10 MHz

Set the TYPE 191 frequency to 50 kHz and adjust the amplitude to 4 volts. Adjust the TYPE 11B2 TRIG LEVEL for a stable display. Decrease the intensity and check for intensity modulation on the trace as the frequency is varied from 50 kHz to 10 MHz. Change the TIME/CM as necessary to maintain a readable display.

c. Check CRT Cathode Input
Sensitivity: ≤5V causes noticeable intensity modulation
Usable freq range: 50 kHz to ≥100 MHz

Remove the gnd strap from the CRT CATHODE input jack. Connect the output of the TYPE 191 to the CRT CATHODE INPUT jack. Set the TYPE 191 frequency to 50 kHz and amplitude to 5 volts. Check for intensity modulation on the trace as the frequency is varied from 50 kHz to 100 MHz. Remove the hook-up.

d. Check CRT Cathode LF Input (sample check)
500 Hz causes noticeable intensity modulation @ ≤5V

Replace the TYPE 191 with the LF Sine-Wave Generator (067-0542-00). Set the frequency to 500 Hz and the amplitude to 5V. Set the TIME/CM to 2mSEC. Check for intensity modulation on the trace.

e. Check CRT Grid Input Resistance (sample check) 22kΩ ±10%

Turn the POWER OFF. Check the reading of the multimeter when measuring a 22kΩ ±1% resistor. Connect the multimeter between gnd and the CRT GRID input jack. The input resistance must read 22kΩ ±10%.

Remove the multimeter connections and turn the POWER ON.

13. AC POLARITY

Set the front panel controls as follows:

TYPE 11B2

TIME/CM	5mSEC
HORIZ DISPLAY	A
TRIG MODE	NORM
COUPLING	AC
SOURCE	LINE

TYPE 10A2A

VOLTS/CM (CH1)	10
Input coupling (CH1)	AC
MODE 1	CH1

Connect a 10X probe from the CH1 INPUT to the AC line voltage at the thermal cut-out. Check that the polarity of the display corresponds to the settings of the SLOPE switch. Change the TYPE 10A2A VOLTS/CM to .2 and connect the 10X probe to pin 30 on the VERTICAL amphenol plug. Check that the polarity of the display corresponds to the settings of the SLOPE switch.

14. CANNON PLUG

Connect the Cannon Connector Checker to J101 on the rear panel. Check for the specified voltages at the following pins:

A	-75V
B	-15V
D	+15V
E	+100V

Check for continuity between pin C and gnd.

Apply a 5V calibrator signal to the TYPE 10A2A INPUT and the CAL IN jack on the Cannon Connector Checker. Set the VOLTS/CM to 2 and adjust the TRIG LEVEL for a triggered display.

Change the TRIG MODE to SINGLE SWEEP. Check that the READY NEON is lit and the display remains triggered.

15. NEONS (RM647A ONLY)

Remove the power cord from the AC outlet and unsolder a wire on TK601. Reconnnect the power cord. Check that the OVER TEMP neon is lit.

Remove the power cord and resolder the wire to TK601.

THE END