FACTORY CALIBRATION PROCEDURE

CONTENTS:

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

This procedure is company confidential

453

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.

December 1968

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.

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.

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. *TEKTRONIX Instruments*

	1	TYPE 453 OSCILLOSCOPE
	1	TYPE 106 SQUARE-WAVE GENERATOR
*	1	TYPE 184 TIME-MARK GENERATOR
*	1	TYPE 191 CONSTANT-AMPLITUDE SIGNAL GENERATOR
	1	TYPE P6006 10X PROBE
	1	TYPE P6028 1X PROBE
	1	TYPE P6019 CURRENT PROBE
	1	TYPE 76TU LINE VOLTAGE CONTROL UNIT

b. *Test Fixtures and Accessories*

*	1	STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)
	1	SINE-WAVE GENERATOR (1Hz to 1MHz) (067-0542-99)
	1	DC VOLTAGE BRIDGE (DCVB) (067-0543-99)
	1	Mercury switch pulser (PMPE Dwg. #1261A)
	1	50Ω GR to BNC in line Termination (017-0083-00)
	2	50Ω BNC Terminations (011-0049-00)
	1	50Ω 2X Attenuator, GR connectors (017-0081-00)
	1	50Ω 5X Attenuator, GR connectors (017-0079-00)
	1	50Ω 10X Attenuator, GR connectors (017-0078-00)
	1	Passive Termination (011-0078-00)
	1	20pF Input RC Normalizer (067-0538-00)
	1	GR to BNC Male adapter (017-0064-00)
	1	BNC T connector (103-0030-00)
	1	BNC Female to Female Adapter (103-0028-00)
	2	5ns cables, GR connectors (017-0502-00)
	2	50Ω 42" BNC cables (012-0057-00)
	2	50Ω 18" BNC cables (012-0076-00)
	1	Dual Input Coupler (067-0525-00)
	2	Test fuse holders (PMPE Dwg #2002-A)

c. *Other Equipment*

	1	20,000Ω/volt DC Multimeter

* 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.

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

b. -12 volts: ±0.02V, max
* c. +1V: ±5mV, max
+.1V: ±0.5mV, max
+12 volts: -0V to +0.2, max
d. +75 volts: ±0.2V, max
e. Ripple and regulation: 2mV, max
HI: 112VAC to 136VAC
M: 104VAC to 126VAC
LO: 90VAC to 110VAC

5. HIGH VOLTAGE

-1950V
±2%, max

6. CRT GRID BIAS

10 to 14V

7. TRACE ALIGNMENT

a. TRACE ROTATION: Range: 6°, min
b. Y Axis alignment: ±0.1div, max
c. Geometry: 0.1div, max

8. SCALE ILLUM

no illumination ccw
max illumination cw

10. STEP ATTEN BAL

10div of total range, min
at least 2div from stop
at proper setting

11. VERTICAL POSITION CENTERING

±1div of graticule center

12. BALANCE

a. VARIABLE balance: ±1div of graticule center
b. CH 2 INVERT balance: ±1div of graticule center

13. GAIN

b. CH 1 GAIN Range: + & -5%
c. CH 2 GAIN Range: + & -5%
* d. ADD gain ±1%, max

14. VERTICAL POSITION POTS

b. Vertical position pot smoothness: Jumps and reversal (vertical must Position in the "jump" area); 0.1div max within graticule area; 0.2div max outside graticule area (exclude first and last 3div of trace movement)

15. VOLTS/DIV

* a. VOLTS/DIV accuracy error: ±2%, max
b. VARIABLE range: 2.5:1, min

17. VERTICAL LINEARITY

Compression, Expansion: 0.1div, max

18. INPUT CURRENT

a. CH 1 INPUT current: $\leq$1 trace width
b. CH 2 INPUT current: $\leq$1 trace width

19. ALTERNATE

Requirement: two traces at all TIME/DIV positions

20. VOLTS/DIV COMPENSATION

b. CH 1 compensation
   Flat topped waveform: ±1%, max
c. CH 2 compensation
   Flat topped waveform: ±1%, max

21. HIGH FREQUENCY COMPENSATION

b. CH 1 20mV HF compensation
   Aberrations: ±2%, max
d. CH 2 HF compensation
   Aberrations: ±2%, max
e. Added mode transient response
   Aberrations: ±6%, max
f. 10mV compensation
   Aberrations: ±2%, max
g. 5mV compensation
   Aberrations: ±2%, max

22. COMMON MODE REJECTION RATIO

*b. CMRR: 20:1, min at 20MHz

23. HF BANDWIDTH

*b. 20mV/DIV HF bandwidth 53.5MHz or more at -3dB
*c. 10mV/DIV HF bandwidth 47.5MHz or more at -3dB
*d. 5mV/DIV HF bandwidth 42MHz or more at -3dB
e. CH 2 HF bandwidths -3dB point within 7MHz of CH 1
*f. Added mode HF bandwidth 53.5MHz or more at -3dB

24. CH 1 OUT

*b. Bandwidth: 25MHz or more at -3dB
c. Deflection factor: 1mV/div, min

25. VERTICAL POSITION RANGE

b. Position range: + and - 13.5 to 16.5div

26. ATTENUATOR ISOLATION

b. Isolation: 10,000:1, min at 20MHz

27. TRANSIENT RESPONSE

a. - Polarity transient response
   Aberrations: ±2%, max
b. Positioning effect on transient response: ±5%, max
c. Attenuator transient response
   Aberrations:
   5mV to 20mV ±2%, max
   50mV to 2V ±3%, max
   5V to 10V ±6%, max
d. Repeat step 28 for CH2

29. TRIGGERING

a. High Freq Triggering Jitter: 1ns, max

	10MHz	50MHz
INT AC	.2div	1div
LF REJ	.2div	1div
DC	.2div	1div

29. TRIGGERING (CONT)

	10MHz	50MHz
EXT AC	50mV	200mV
LF REJ	50mV	200mV
DC	50mV	200mV

b. HF REJ .2div of 50kHz not triggered at 1MHz

c. Low Freq triggering (30Hz)

	INT	EXT
AC	.2div	50mV
HF REJ	.2div	50mV

d. LF REJ: triggering .2div of 30kHz; no triggering at 100Hz

e. SINGLE SWEEP: same triggering level as in NORM

f. LINE: triggered on correct polarity

30. TRIGGERING LEVEL RANGE

b. EXT LEVEL range: + and -2V, min

c. EXT ÷ 10 LEVEL range: + and - 20V, min

31. SWEEP RECOVERY

0.2div of sweep shift, max

32. AUTO RECOVERY TIME

b. Recovery time: 50 to 100ms

*34. DELAY TIME LINEARITY

Error: ±1.5 minor div, max

37/ X10 MAG

*a. Mag Gain Error: ±1%, max
*b. Non-Linearity ±1%, max
c. Mag Regis Shift: ±.1div, max

38. SWEEP LENGTH

a. B sweep length 11 divisions ±.5 div, max

b. A sweep length From 4 divisions or less to 11 divisions ±0.5div

c. A SWEEP LENGTH POT
.2div open spots of reversals between 4th and 10th div;
.4div past 10th, disregard below 4th div

39. VARIABLE RANGE

a. A VARIABLE range 2.5:1, min
b. B VARIABLE range 2.5:1, min

40. POSITION RANGE

a. ↔ Position. Range: ends of sweep past graticule center

b. ↔ FINE. Range: 5 to 8div

42. HIGH SPEED TIMING

*c. .1SEC/DIV X10 MAG timing error: ±3%, max over the entire sweep excluding the first and last 3div

43. A SWEEP TIME/DIV

*a. MAG OFF Error: ±2%, max
*b. X10 MAG Error: ±3%, max

44. B SWEEP TIME/DIV

*a. MAG OFF Error: ±2%, max
*b. X10 MAG Error: ±3%, max

*45. DELAY TIME ACCURACY

1μSEC to 50mSEC Error: ±1%, max
.1SEC to 5SEC Error: ±2%, max

46. DELAY TIME JITTER

0.3div, max

47. EXT HORIZ

*b. Ext Horiz Gain Error: ±2%, max
*c. Deflection Factor
EXT: 270mV/div ±15%
EXT ÷ 10: 2.7V/div ±20%
*d. Bandwidth: 5mHz or more at -3dB

48. CHOPPED OPERATION

b. Chopped frequency 500kHz ±20%, max

49. CALIBRATOR

*b. Cal Freq: 1KHz ±0.1%
c. Duty Cycle: 50% ±0.8%
*d. Risetime: 1μs, max

50. Z AXIS

b. Sensitivity: 5V, min
c. Max usable frequency: 50MHz, min

52. TRACE FINDER

Trace must remain in viewing area and indicate proper direction.

53. A AND B GATES

a. A GATE. Amplitude: 12V ±5%, max
b. B GATE. Amplitude: 12V ±5%, max

54. HOLDOFF

a. HF STAB. Holdoff: 0.2μs, min
b. A Sweep holdoff
.1μSEC to 5μSEC less than 2.5μs
10, 20, and 50μSEC 3.5-10μs
.1, .2 and .5mSEC 35-100μs
1, 2 and 5mSEC .35-1ms
10, 20 and 50mSEC 3.5-10ms
.1 SEC to 5 SEC 35-100ms

THE END

* Indicates measurement characteristics; 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 DELAY-TIME MULTIPLIER
b. Check CRT
c. Install current modifications

2. PRESETS

a. Preset all external controls
b. Preset all internal controls

3. RESISTANCE

a. Check power supply resistance
b. Check power plug resistance

4. POWER SUPPLIES

a. Check Line Voltage Selector
b. Adjust -12V, R1122
c. Adjust +12V, R1152: -0V to
  +.2V, max
  1V, ±5mV, max
  .1V ±.5mV, max
d. Adjust +75V, R1182:
e. Check +150V unregulated supply
  voltage: approx 150V
  ripple: approx 2.5V @120Hz
f. Check ripple and regulation
  ripple 2mV, max
  regulation: HI; 112 to 136VAC
  M; 104 to 126VAC
  LO; 90 to 110VAC

5. HIGH VOLTAGE

Adjust High Voltage, R900

6. CRT GRID BIAS

Adjust grid bias, R940

7. TRACE ALIGNMENT

a. Check TRACE ROTATION range:
  6°, min
b. Adjust ASTIG and Y axis align
c. Adjust Geometry, R982: Curvature
  .1 div, max

8. SCALE ILLUM

No illumination ccw
Max illumination cw

9. CRT

Check CRT

10. STEP ATTEN BAL

Check for 10div of total range, min at least 2div from stop at proper setting

11. VERTICAL POSITION CENTERING

Adjust position center

12. BALANCE

a. Check VARIABLE balance ±1div graticule center
b. Check INVERT balance ±1div graticule center

13. GAIN

b. Check CH 1 Gain Range + & -5%
c. Check CH 2 Gain Range + & -5%
d. Check ADD gain Add error: ±1%, max

14. VERTICAL POSITION POTS

b. Check Vertical position pot smoothness

15. VOLTS/DIV

a. Check VOLTS/DIV accuracy ±2%, max
b. Check VARIABLE range: 2.5:1, min

16. INPUT SELECTOR SWITCHES

17. VERTICAL LINEARITY

Check compression and expansion .1div, max

18. INPUT CURRENT

a. Check CH 1 INPUT current: ≤1 trace width
b. Check CH 2 INPUT current: ≤1 trace width

19. ALTERNATE

Two traces at all TIME/DIV positions

20. VOLTS/DIV COMPENSATION

b. Adjust CH 1 compensation Flat topped waveform ±1%, max
c. Adjust CH 2 compensation Flat topped waveform ±1%, max

21. HIGH FREQUENCY COMPENSATION

b. Adjust CH 1 20mV/div HF compensation aberrations ±2%, max
c. Select R195
d. Adjust CH 2 20mV/DIV HF compensation aberrations ±2%, max
e. Check transient response with MODE in ADD. Aberrations: ±6%, max
f. Adjust 10mV/DIV compensation aberrations: ±2%, max
g. Adjust 5mV compensation aberrations ±2%, max

22. COMMON MODE REJECTION RATIO

b. Check common mode rejection ratio 20:1, min at 20MHz

23. HF BANDWIDTH

b. Check 20mV/DIV HF bandwidth: 53.5MHz or more at -3dB

23. (CONT)

c. Check 10mV/DIV HF bandwidth:
47.5MHz or more at -3dB
d. Check 5mV HF bandwidth:
42MHz or more at -3dB
e. Check CH 2 HF bandwidths:
-3dB point must be within
7MHz or CH 1
f. Check ADD MODE HF bandwidth:
53.5MHz or more at -3dB

24. CH 1 OUT

b. Check bandwidth 25MHz or more
at -3dB
c. Check deflection factor 1mV/DIV,
min

25. VERTICAL POSITION RANGE

b. Check position range + and - 13.5
to 16.5div

26. ATTENUATOR ISOLATION

b. Check attenuator isolation
10,000:1, min at 20MHz

27. TRANSIENT RESPONSE

a. Check - polarity transient
response ±2%, max
b. Check position effect on transient
response ±5%, max
c. Check attenuators
transient response:
5mV to 20mV ±2%, max
50mV to 2V ±3%, max
5V to 10V ±6%, max
Risetime: 6.6ns, max
d. Repeat step 28 for CH2

28. TRIGGER LEVEL CENTERING

b. Adjust A trig level centering,
R462
c. Adjust norm Trig DC level centering,
R285
d. Adjust CH 1 Trig level centering,
R60
e. Adjust B trig level centering,
R662

29. TRIGGERING

a. Check high frequency triggering
jitter: 1ns, max
b. Check HF REJ requirement:
triggering on 0.2div of 50kHz
No triggering on 0.2div at 1MHz
c. Check low frequency Triggering
d. Check LF REJ
Requirement: triggering on 0.2div
of 30kHz
No triggering on 0.2div at 100Hz
e. Check SINGLE SWEEP
Requirements: triggers with same
triggering level setting as in
NORM TRIG
f. Check LINE triggering
Requirement: triggering on correct
polarity

30. TRIGGERING LEVEL RANGE

b. Check EXT LEVEL range + and - 2V, min
c. Check EXT ÷ 10 LEVEL range + and -
20V, min

31. SWEEP RECOVERY

0.2div of sweep shift, max

32. AUTO RECOVERY TIME

b. Check AUTO recovery time: 50 to 100ms

33. SWEEP START, A SWEEP CAL

b. Preset B Sweep Start, R758
c. Preset A Sweep CAL, R531
d. Adjust Sweep Start and A Sweep Cal

34. DELAY-TIME MULTIPLIER LINEARITY

±1.5 minor div, max

35. NORM GAIN

Adjust R835 for 1 marker per div

36. B SWEEP CAL

Adjust R741 for 1 marker per div

37. X10 MAG

a. Adjust MAG GAIN, R845 Error: ±1%, max
b. Check linearity, Non linearity ±1%, max
c. Adjust Mag Regis, R855 Shift: ±0.1div, max

38. SWEEP LENGTH

a. Check B Sweep length: 11 divisions ±0.5div, max
b. Check A Sweep length: from 4div or less to 11div ±0.5div
c. Check A SWEEP LENGTH pot: .2div open spots or reversals between 4th and 10th div; .4div past 10th, disregard below 4th div

39. VARIABLE RANGE

a. Check A VARIABLE range: 2.5:1, min
b. Check B VARIABLE range: 2.5:1, min

40. POSITION RANGE

a. Check ↔ POSITION range: ends of sweep past graticule center
b. Check ↔ POSITION FINE range: 5 to 8div

41. 1μSEC/DIV TIMING

a. Adjust C530A
b. Adjust C740A

42. HIGH SPEED TIMING

b. Adjust horizontal amplifier transient response C882 and C892
c. Check high speed X10 MAG timing Error: ±3%, max over the entire sweep excluding the first and last 3div

43. A SWEEP TIME/DIV

a. Check timing with MAG OFF, .1μSEC to 5 SEC Error: ±2%, max (0.16div in 8div)
b. Check timing with X10 MAG .1μSEC to 5μSEC/DIV Error: ±3%, max (0.24div in 8div)

44. B SWEEP TIME/DIV

a. Check timing with MAG OFF Error: ±2%, max
b. Check timing with X10 MAG Error: .1μSEC to 5μSEC ±3%, max (0.24div in 8div)

45. DELAY TIME ACCURACY

1μSEC to 50mSEC Error: ±1%, max
.1 SEC to 5 SEC Error: ±2%, max

46. DELAY TIME JITTER

0.3div, max

47. EXT HORIZ

b. Adjust Ext Horiz Gain, R645
Error: ±2%, max
c. Check deflection factor
EXT: 270mV/div ±15%
EXT ÷ 10: 2.7V/div ±20%
d. Check bandwidth 5MHz or more at -3dB

48. CHOPPED OPERATION

b. Check chopped frequency: 500kHz ±20%, max
c. Check blanking

49. CALIBRATOR

b. Adjust CAL frequency, T1225: 1kHz ±0.05%
c. Check duty cycle: 50% ±0.8%
d. Check risetime 1μs, max
e. Check PROBE LOOP

50. Z AXIS

a. Adjust compensation C1036: Front corner ±.1div from level
b. Check sensitivity: 5V, min
c. Check max usable frequency: 50MHz, min

51. B END A

b. Check B ends A operation

52. TRACE FINDER

Trace must remain in viewing area and indicate proper direction.

53. A and B GATES

a. Check A GATE amplitude: 12V ±5%, max
b. Check B GATE amplitude: 12V ±5%, max

54. HOLDOFF

a. Check HF STAB Holdoff: 0.2μS, min
b. Check A sweep holdoff

TIME/DIV	holdoff
.1μSEC to 5μSEC	less than 2.5μs
10, 20 and 50μSEC	3.5-10μs
.1, .2 and 5mSEC	35-100μs
1, 2 and 5mSEC	.35-1ms
10, 20 and 50mSEC	3.5-10ms
.1 SEC to 5SEC	35-100ms

THE END

1. PRELIMINARY INSPECTION

a. Check DELAY-TIME MULTIPLIER

Turn the DELAY-TIME MULTIPLIER ccw to the stop. Check for a dial reading of 0.2. If the dial reading is not 0.2 at the ccw stop, loosen the dial set screw and reposition the dial on the shaft. Tighten the set screw and check that the dial operates smoothly.

b. Check CRT

Inspect the CRT for phosphor defects, scratches, chips and cracks around neck pins. Check neck pins for proper connection and tightness.

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

c. Install Current modifications

2. PRESETS

a. Preset TYPE 453 external controls

INTENSITY	ccw
FOCUS	ccw
SCALE ILLUM	midr
CH 1 & CH 2	
VOLTS/DIV	20mV
VARIABLE	CAL
↕ POSITION	midr
INPUT Selector	DC
STEP ATTEN BAL	midr
GAIN	midr
MODE	CH 1
INVERT	in
DELAY-TIME MULTIPLIER	ccw
A AND B TIME/DIV	1mSEC
A VARIABLE	CAL
A SWEEP MODE	NORM TRIG
B SWEEP MODE	TRIGGERABLE AFTER DELAY TIME
HORIZ DISPLAY	A
MAG	OFF
A SWEEP LENGTH	FULL

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

2a. (CONT)

↔	
POSITION	midr
A & B TRIGGERING	
LEVEL	cw
SLOPE	+
COUPLING	AC
SOURCE	INT
POWER	ON
ASTIG	midr
TRACE ROTATION	midr
B TIME/DIV	
VARIABLE	CAL
CALIBRATOR	1V
LINE VOLTAGE	
SELECTOR	LO
RANGE	230

b. Preset all internal adjustments to midr

3. RESISTANCE

a. Check power supply resistance

Measure power supply resistance to ground at the LV Regulator Board as follows:

SUPPLY	TEST POINT	APPROX RESISTANCE NEG LEAD TO GND	METER SCALE
-12V	Pin H	80Ω	X10
+12V	Pin D	70Ω	X10
+75V	Pin B	1K	X1K
+150V (unreg)	F1204	2.6K	X1K

b. Check power plug resistance

Measure resistance of power plug to ground. Resistance should measure infinite.

4. POWER SUPPLIES

a. Check Line Voltage Selector

Remove line voltage selector cover and insert fuses using test fuse holders. Connect a 10X Probe from the test scope input to terminal 14 of T1101. Connect the TYPE 453 power cord to the TYPE 76TU outlet and adjust the TYPE 76TU for a 50V P-P signal on the test scope. Check the line voltage selector as in the following table:

Selector	P-P Voltage
230V	
LO	50V (set)
M	44V
HI	40V
115V	
HI	80V

Remove both fuses. Connect the power cord to a source of 115VAC power and turn POWER ON. Check that the pilot light is not lighted. Remove the power cord from 115VAC source and change the line selector to 230. Again plug the power cord into a source of 115VAC and check that the pilot light is not lighted. Replace the 2a fuse and check that the pilot light does not light. Return the line selector to 115.

b. Adjust -12 volts, R1122

Connect the DCVB to Pin G of the LV Regulator Board. Adjust R1122 for -12V.

b. Connect common input of DCVB to the ground plug on the front panel of 453.

c. Adjust +12 volts, R1152:
1V, ±5mV, max
.1V, ±0.5mV, max
+12V, -0V to +0.2V, max

Remove Q1255 from the calibrator board. Connect the DCVB to the 1KC CAL BNC connector. Adjust R1152 for 1V. Set the CALIBRATOR switch to .1V.

4c. (CONT)

Check for 0.1V ±0.5mV. Replace Q1255 and connect the DCVB to Pin D of the LV Regulator board. Check for 12.0 to 12.2 volts.

d. Adjust +75 volts, R1182

Connect the DCVB to Pin B of the LV regulator board. Adjust R1182 for 75V.

e. Check +150V unregulated voltage:
Voltage: approx 150V
Ripple: approx 2.5V @120Hz

Check voltage and ripple at Pin Q of the LV regulation board.

f. Check ripple and regulation

Check ripple and regulation while changing the line voltage over the indicated range for each setting of the LINE VOLTAGE SELECTOR.

HI	112VAC to 136VAC
M	104VAC to 126VAC
LO	90VAC to 110VAC

Check ripple with the test scope and regulation with the DCVB as in the following table:

Power Supply	Max Error	Max Ripple
-12V	±0.02V	2mV
+12V	-0V to +0.2V	2mV
+75V	±0.2V	2mV

Return the line to 115VAC and the LINE VOLTAGE SELECTOR to M. Remove the Test Fuse holder and replace Line Voltage Selector Cover.

5. HIGH VOLTAGE -1950V

Connect the DCVB to the -1950V TP and adjust R900 for -1950V. Check the regulation from 104VAC line to 126VAC line. Remove the DCVB connection.

5. High Voltage, R900 must be adjusted for zero indicated error when using the DCVB.

6. CRT GRID BIAS

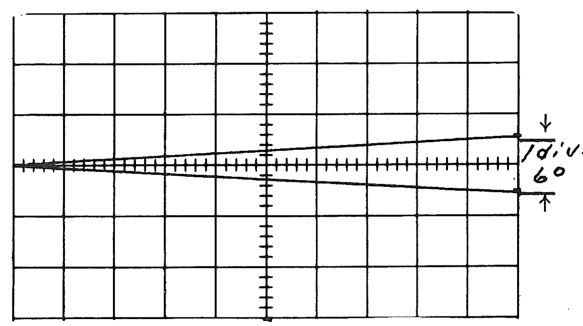
Set the A SWEEP MODE switch to SINGLE SWEEP. Adjust the INTENSITY control for +12 volts at TP1047 (Z axis board). Adjust R940 so a focused spot is just visible.

7. TRACE ALIGNMENT

a. Check TRACE ROTATION Range: 6^{o}, min

Set the A SWEEP MODE to AUTO TRIG. Center the trace vertically. Rotate the TRACE ROTATION control from full ccw to full cw and check the range of adjustment.

a.



TRACE ROTATION

Check that the trace movement is in the same direction as the TRACE ROTATION control. Adjust the TRACE ROTATION to align the trace with the center horizontal graticule line.

b. Adjust ASTIG and Y axis align, R989
Y axis alignment error: ±0.1div, max

Connect the TYPE 184 MARKER OUTPUT to TYPE 453 CH 1 INPUT and push the .1ms and 1ms MARKER SELECTOR buttons. Set the CH 1 VOLTS/DIV so markers extend from the bottom to the top of the graticule. Adjust the A TRIGGERING LEVEL for a stable display. Adjust the ASTIG and FOCUS for a well defined trace. Adjust Y axis align, R989, to align the center marker with the center vertical graticule line.

c. Adjust Geometry, R982: Curvature 0.1 div, max

Adjust the Geometry, R982, for minimum curvature of the markers. Recheck Y axis alignment at the center of the graticule. Readjust Y axis align, R989 as necessary. Remove the TYPE 184 markers. Position the trace to the top and bottom graticule lines and note the deviation from a straight line: 0.1 div, max.

8. SCALE ILLUM

No illumination ccw
Max illumination cw

Rotate the SCALE ILLUM control through its range. Check for a smooth change in illumination with no illumination at full ccw and maximum illumination at full cw.

9. CRT

Check the CRT for double-peaking, flare, grid emission, cathode interface, charging, burrs and adequate scan area.

10. This is simplified description of CRT defects. For a more detailed description see the CRT checkout procedure or consult a trained CRT checker.

10. STEP ATTEN BAL

10div of total range, min
At least 2div from stop at proper setting.

Adjust CH 1 STEP ATTEN BAL for no trace shift as CH 1 VOLTS/DIV is switched between 20mV and 5mV. Set CH 1 VOLTS/DIV to 20mV. Position the trace to the top graticule line. Rotate the STEP ATTEN BAL ccw and check the number of divisions of range. Rotate the STEP ATTEN BAL cw to return the trace to the top graticule line. Use the POSITION control to place the trace on the bottom graticule line. Rotate the STEP ATTEN BAL cw and again check the number of divisions of range from cw to ccw. Must be 10div, min. Make the final adjustment for no trace shift as the CH 1 VOLTS/DIV is switched between 20mV and 5mV. Return the CH 1 VOLTS/DIV to 20mV. Check that there are at least 2div of adjustment left before the control hits the stop. Change the MODE to CH 2 and repeat step 11 for CH 2 STEP ATTEN BAL.

11. It may be necessary to preadjust the gain in order to achieve the 2div min test limit.

11. VERTICAL POSITION CENTERING

Adjust CH 2 ↕ POSITION for 0 Volts at Pin Z of the vertical preamp board. Adjust CH 2 Position Center, R155 to position the trace to graticule center. Lossen the set screw on CH 2 ↕ POSITION and position the knob to the center of rotation, then tighten the set screw. Change the MODE to CH 1 and repeat step 12, adjusting CH 1 ↕ POSITION for 0V at Pin W and CH 1 Position Center, R55 to center the trace.

12. BALANCE

a. *Check VARIABLE balance: ±1div of graticule center*

Adjust the CH 1 ↕ POSITION to a point where the trace returns to the same position at both extremes of the VARIABLE VOLTS/DIV control. Trace must be within 1div of graticule center. Change the MODE to CH 2 and repeat step 13a for CH 2 VARIABLE VOLTS/DIV.

b. *Check INVERT Balance: ±1div of graticule center*

Adjust CH 2 ↕ POSITION to a point where there is no trace shift as the INVERT button is pulled or pushed. Trace must be within 1div of graticule center.

13. GAIN

a. *Setup*

Set CH 1 and CH 2 VOLTS/DIV to 20mV, VARIABLE controls to CAL and MODE to CH 1. Set the SAC AMPLITUDE to .1 VOLTS and connect the SAC OUTPUT to CH 1 and CH 2 INPUT using a dual input coupler.

13. (CONT)

b. Check CH 1 GAIN Range and adjust gain: Range + & -5%

Turn the CH 1 GAIN full cw then full ccw and check for a range of at least 4.75 to 5.25 divisions of deflection. Adjust the GAIN for exactly 5 divisions of delection.

c. Check CH 2 GAIN Range and adjust gain: Range + & -5%

Change the MODE to CH 2 and check CH 2 GAIN for a range of at least 4.75 to 5.25 divisions of deflection.

Change the MODE to ADD and pull the INVERT button. Adjust CH 2 GAIN for signal cancellation.

d. Check ADD gain Add error: ±1%, max

Push the INVERT button. Set the SAC AMPLITUDE to 50mVOLTS. Check for 5 divisions of deflection ±1%.

14. VERTICAL POSITION POTS

a. Setup

Push the INVERT button. Change the MODE switch to ADD. Rotate CH 1 POSITION cw and CH 2 POSITION ccw.

b. Check Vertical Position Pot smoothness: Jumps and reversals (vertical must position in the "jump" area); 0.1div max within graticule area; 0.2div max outside of graticule area (Exclude first and last 3div of trace movement)

Turn the CH 2 POSITION control cw to position the trace to the top graticule line, then turn the CH 1 POSITION control ccw to position the trace to the bottom graticule line. Continue moving the trace up with CH 2 POSITION then down with CH 1 POSITION. Check that the trace may be placed at any position on the graticule excluding that portion of rotation at the ends of each control that results in three graticule divisions of trace movement.

b. Within Graticule: is defined as within 3div of graticule center, when attenuators are balanced and MODE is switched to a single Channel.

15. VOLTS/DIV

a. Check VOLTS/DIV accuracy
Error: ±2%, max

Set the MODE to CH 1 and set CH 2 input selector to GND. Check CH 1 VOLTS/DIV accuracy as in the following table:

VOLTS/DIV	SAC	DIV DEFLECTION	±DIV
5mV	20mV	4	.08
10mV	50mV	5	.1
20mV	.1 V	5	.1
50mV	.2 V	4	.08
.1	.5 V	5	.1
.2	1 V	5	.1
.5	2 V	4	.08
1	5 V	5	.1
2	10 V	5	.1
5	20 V	4	.08
10	50 V	5	.1

b. Check VARIABLE range: 2.5:1, min

Set CH 1 VOLTS/DIV to 20mV and SAC AMPLITUDE to .1 VOLTS. Turn CH 1 VARIABLE VOLTS/DIV full ccw and check for 2 divisions of deflection, max. UNCAL neon must be off when the VARIABLE is fully cw and on in all other positions.

Return CH 1 VARIABLE to CAL. Change CH 1 input selector to GND and CH 2 input selector to DC. Change the MODE to CH 2. Repeat steps 16a and 16b for CH 2.

16. INPUT SELECTOR SWITCHES

Position the baseline of the display to graticule center. Change the CH 2 input selector to GND and check for a baseline trace with no vertical deflection.

Change the CH 2 input selector to AC and check for a square-wave display approximately centered around the vertical graticule center line.

Change the MODE to CH 1 and repeat step 17 for CH 1 input selector.

17. VERTICAL LINEARITY

Check compression and expansion:
0.1div, max

Change SAC to 50mV and use VARIABLE VOLTS/DIV to obtain exactly 2div of deflection at graticule center. Position top of display to top graticule line and note compression or expansion: .1div, max. Position bottom of display to bottom graticule line and again note compression or expansion: .1div, max. Return VARIABLE to CAL.

Change MODE to CH 2 and repeat comoression, expansion check. Remove SAC signal.

18. INPUT CURRENT

a. *Check CH 1 INPUT current: $\leq$1 trace width*

Set CH 1 VOLTS/DIV to 5mV, INTENSITY control to mid-range, A TIME/DIV to 1mS. Switch INPUT between GND and DC, check for 1 trace width or less of vertical shift. Ambient light must simulate covers on.

b. *Check CH 2 INPUT current: $\leq$1 trace width*

Set CH 2 VOLTS/DIV to 5mV, INTENSITY control to mid-range, A TIME/DIV to 1mS. Switch INPUT between GND and DC, check for 1 trace width or less of vertical shift. Ambient light must simulate covers on.

19. ALTERNATE — Two traces at all TIME/DIV positions

Set the MODE to ALT and A TRIGGERING LEVEL full cw and A SWEEP LENGTH for 4div of sweep. Adjust POSITION controls for a display of two traces 2 divisions apart.

Check for a display of two horizontal traces on all TIME/DIV positions.

Return A SWEEP LENGTH to FULL.

20. VOLTS/DIV COMPENSATION

a. Setup

TYPE 106 HI AMPLITUDE OUTPUT--GR to BNC adapter--50Ω cable--50Ω 10:1 attenuator--50Ω termination--20pF input RC normalizer--TYPE 453 CH 1 INPUT. Set the TYPE 453 MODE to CH 1, VOLTS/DIV to 20mV, input selector to DC, TIME/DIV to .2mSEC and adjust the TRIGGERING LEVEL for a stable display. Adjust the TYPE 106 controls for 4 divisions of 1kHz signal.

b. Adjust CH 1 compensation:
Flat topped waveform ±1%, max

Adjust or check for an optimum squarewave display as in the following table removing the 10:1 attenuator as necessary:

VOLTS/DIV	SERIES Corner	SHUNT (Flat top)
20mV		C17
10mV	check	check
5mV	check	check
50mV	C6C	C6B
.1	C7C	C7B
.2	C8C	C8B
.5	check	C11 for best
1	check	compromise
2	C9C	C9B
5	check	check
10	check	check

Check all positions without normalizer.

21. The addition of side panels may cause slight variations in characteristics.

20. (CONT)

c. Adjust CH 2 compensation:
Flat topped waveform ±1%, max

Change the TYPE 453 MODE to CH 2. Move the TYPE 106 connection to CH 2 INPUT. Adjust or check for an optimum square-wave display as in the following table:

VOLTS/DIV	SERIES (corner)	SHUNT (flat top)
20mV		C117
10mV	check	check
5mV	check	check
50mV	C106C	C106B
.1	C107C	C107B
.2	C108C	C108B
.5	check	C111 for best
1	check	compromise
2	C109C	C109B
5	check	check
10	check	check

Check all positions without normalizer.

21. HIGH FREQUENCY COMPENSATION

a. Setup

TYPE 106 + OUTPUT--5ns cable--2X Attenuator--50Ω GR to BNC in line termination--TYPE 453 CH 1 INPUT.

Set the TYPE 453 MODE to CH 1 and CH 1 and CH 2 VOLTS/DIV to 20mV.

Set the TYPE 106 selector switch to FAST RISE, REPETITION RATE RANGE and multiplier to 100kHz and + TRANSITION AMPLITUDE for 4 divisions of display amplitude.

22. The addition of side panels may cause slight variations in characteristics.

b. Adjust CH 1 20mV/DIV hf compensation Aberrations: ±2%, max

Set TYPE 453 TIME/DIV to .1μ SEC. Preset C45A, C54, C49, R49, R328, C328 and C336 for a reasonably good square wave presentation.

b. The Vertical Preamp board has four components to be selected for best high frequency compensation. All of the selected components except R195 are mounted in sockets. Select the components in the order given in the following table:

21b. (CONT)

Selected Component	Range of Values (to provide a 2 to 3% total compensating effect)	Device(s) for which this provides a compensating effect	Conditions for selecting (20 mV/DIV, four-division 100 kHz signal applied	Selection procedure
1. C38	.001 to .01 μF	Q23, Q33	MODE CH 1 10μs/DIV MAG OFF	Select for best flat top over first 2 to 5 microseconds
2. C264	14 to 47 pF	Delay line	MODE CH 1 2μs/DIV MAG OFF	Select for best flat top over first 0.2 to 0.6 microseconds
3. C138	.001 to .01μF	Q123, Q133	MODE CH 2 10μs/DIV MAG OFF	Select for best flat top over first 2 to 5 microseconds
4. R195	24 k to 300 kΩ	Q84, Q94, Q184, Q194	MODE CH 2 2μs/DIV MAG OFF	Select for best match of Channel 2 to Channel 1 over first 0.5 microseconds

C38 and C138 are selected from among the following capacitors:

.001μF	283-0067-00	200V	±10%
.0015	283-0114-00	200V	±20%
.0022	283-0119-00	200V	±5%
.0027	283-0142-00	200V	±5%
.0033	283-0041-00	500V	±5%
.0047	283-0083-00	500V	±5%
.01	283-0079-00	250V	±20%

C264 is selected from among the following capacitors:

14 pF	281-0577-00	500V	±5%
18 pF	281-0578-00	500V	±5%
22 pF	281-0511-00	500V	±2.2pF
27 pF	281-0512-00	500V	±2.7pF
33 pF	281-0629-00	600V	±5%
39 pF	281-0603-00	500V	±5%
47 pF	281-0519-00	500V	±4.7pF

21b. (CONT)

Set the TIME/DIV to .2μSEC and adjust C263 and C265 for most uniform level at the top of the waveform. Change the MAG to X10.

Adjust C45A, C49A, C54A, R49, R328, C328 and C336 for optimum square wave response and risetime. P-P aberrations including overshoot, undershoot, ringing and level must not exceed 2% of signal amplitude.

c. Select R195

Change MODE to CH 2 and TYPE 106 signal to CH 2 INPUT. Switch MAG to OFF and TIME/DIV to 1 SEC. Check for optimum level of top of square-wave. Select value of R195 (½W 5%) if necessary for optimum waveform.

d. Adjust CH 2 20mV/DIV hf compensation aberrations: ±2%, max

Change the TYPE 453 TIME/DIV to .2μSEC and MAG to X10. Adjust C145A, C149, C154 and R149 for optimum square-wave response . Compromise CH 1 and CH 2 adjustments as necessary to obtain similar response.

P-P aberrations must no exceed 2%.

e. Check transient response with MODE in ADD. aberrations: ±6%, max

Change the MODE to ADD. Position the display to graticule center with both POSITION controls near midr. Check P-P aberrations for 6% max.

f. Adjust 10mV/DIV compensation aberrations: ±2%, max

Replace the 2X attenuator with a 5X attenuator. Change the MODE to CH 1 and CH 1 and CH 2 VOLTS/DIV to 10mV.

Adjust C44A, C44C and R44C for optimum square-wave response with not more than 2% P-P aberrations. Move the TYPE 106

21f. (CONT)

signal to CH 2 INPUT and change the MODE to CH 2. Adjust C144A, C144A, C144C and R144C for optimum square-wave response with not more than 2% P-P aberrations.

g. Adjust 5mV compensation aberrations: ±2%, max

Replace the 5X attenuator with a 10X attenuator. Change the CH 1 and CH 2 VOLTS/DIV to 5mV.

Adjust L143A, C143A, C143C and R143C for optimum square-wave response with not more than 2% P-P aberrations.

Move the TYPE 106 signal to CH 1 INPUT and change the MODE to CH 1. Adjust L43A, C43A, C43C and R43C for optimum square-wave response with not more than 2% P-P aberrations.

22. COMMON MODE REJECTION RATIO

a. Setup

Connect TYPE 191 OUTPUT--5ns cable--50Ω 10X attenuator--50Ω GR to BNC termination--dual input coupler--CH 1 INPUT CH 2 INPUT.

Set both VOLTS/DIV switches to 50mV and adjust the TYPE 191 for 3.2 divisions of 50kHz.

b. Check common mode rejection ratio 20:1, min at 20MHz

Change both VOLTS/DIV switches to 20mV, MODE to ADD and pull the INVERT button. Set the TYPE 191 to 20MHz and check vertical deflection: CMRR is ratio of displayed amplitude to CH 1 amplitude.

b. To determine CH 1 amplitude switch mode to CH 1 and VOLTS/DIV to 50mV and multiply amplitude by 2½.

23. HF BANDWIDTH

a. Setup

TYPE 191--5ns cable--50Ω X10 attenuator--50Ω GR to BNC termination--TYPE 453 CH 1 INPUT.

Set the MODE to CH 1 and CH 1 VOLTS/DIV to 20mV.

b. Check 20mV/DIV HF bandwidth 53.5MHz or more at -3dB

Adjust the TYPE 191 for 4 divisions of 50kHz signal. Increase the frequency until the deflection is reduced to 2.8 divisions. Read the high frequency -3dB point from the TYPE 191 dial, 53.5MHz or more.

c. Check 10mV/DIV HF bandwidth: 47.5MHz or more at -3dB

Change the VOLTS/DIV to 10mV. Adjust the TYPE 191 for 4 divisions of 50kHz signal. Increase the frequency until the deflection is reduced to 2.8 divisions. Read the high frequency -3dB point from the TYPE 191 dial, 47.5MHz or more,

d. Check 5mV/DIV HF bandwidth: 42MHz or more at -3dB

Change the VOLTS/DIV to 5mV and adjust the TYPE 191 for 4 divisions of 50kHz signal. Increase the frequency until the deflection is reduced to 2.8 divisions. Read the high frequency -3dB point from the TYPE 191 dial, 42MHz or more.

e. Check CH 2 HF bandwidths: -3dB point must be within 7MHz of CH 1

Change the VOLTS/DIV to CH 2 and move the TYPE 191 signal to CH 2 INPUT. Repeat steps 24b, c and d for CH 2.

24. Bandwidth limits listed are to insure meeting advertised requirements when probes are used.

The addition of side panels may cause slight variations in characteristics.

23. (CONT)

f. Check ADD MODE HF bandwidth: 53.5MHz or more at -3dB

Set both VOLTS/DIV switches to 20mV, CH 1 input selector to GND and MODE to ADD. Adjust the TYPE 191 for 4 divisions of 50kHz signal. Increase the frequency until the deflection is reduced to 2.8 divisions. Read the high frequency -3dB point from the TYPE 191 dial, must read 53.5MHz or more.

Change the CH 2 input selector to GND, CH 1 input selector to DC and TYPE 191 signal connection to CH 1 INPUT. Repeat Step 24f for CH 1.

24. CH 1 OUT

a. Setup

Connect TYPE 191 OUTPUT--5ns cable--5X attenuator--50Ω GR to BNC termination--TYPE 453 CH 1 INPUT.

Set both VOLTS/DIV to 5mV, MODE to CH 2 and both input selectors to DC. Connect CH 1 OUT to CH 2 INPUT with an 18" BNC cable.

b. Check bandwidth 25MHz or more at -3dB

Adjust the TYPE 191 for 4 divisions of 50KHz signal. Increase the frequency until the deflection is redcued to 2.8divisions. Read the high frequency -3dB point from the TYPE 191 dial, must read 25MHz or more.

c. Check deflection factor 1mV/div, min

Remove the TYPE 191 signal connection and connect the SAC OUTPUT to TYPE 453 CH 1 INPUT. Set the SAC AMPLITUDE to 5mVOLTS. Check for a minimum of 5 divisions of deflection.

25. VERTICAL POSITION RANGE

a. Setup

Set both VOLTS/DIV to 20mV and MODE to CH 1. Connect TYPE 191 to CH 1 INPUT.

b. Check position range:
+ and -13.5 to 16.5div

Adjust TYPE 191 for 3div of 50kHz signal with AMPLITUDE RANGE to 50-500mV. Switch AMPLITUDE RANGE to .5-5V and turn CH 1 POSITION full ccw. Top of the waveform must be within 1.5div of graticule center. Turn POSITION full cw and check that the bottom of the waveform is within 1.5div of graticule center.

Change MODE to CH 2 and TYPE 191 signal to CH 2 INPUT. Repeat POSITION range check for CH 2.

26. ATTENUATOR ISOLATION

a. Setup

Set CH 1 VOLTS/DIV to 2, CH 2 VOLTS/DIV to 5mV and CH 2 INPUT to GND. Connect TYPE 191 to CH 1 INPUT and adjust for 5div of 20MHz.

b. Check attenuator isolation
10,000:1, min at 20MHz

Switch MODE to CH 2 and check vertical deflection for .2div, max.

Change CH 1 VOLTS/DIV to 5mV, CH 2 to 2 VOLTS/DIV and MODE to CH 1. Switch CH 1 input to GND and CH 2 input to DC. Apply TYPE 191 signal to CH 2 INPUT and check vertical deflection for .2div, max. Return CH 1 and CH 2 VOLTS/DIV to 20mV.

27. TRANSIENT RESPONSE

a. *Check - polarity transient response ±2%, max*

Connect SAC and TYPE 106 outputs to mercury switch pulser. Connect pulser output to CH 1 INPUT. Set SAC to .2 VOLTS - DC and TYPE 453 A TRIGGERING SLOPE to -. Adjust TYPE 106 AMPLITUDE and FREQUENCY for best waveform. Adjust pulser amplitude for 4div pulse positioned to graticule center. Check P-P aberrations for 2%, max.

b. *Check position effect on transient response ±5%, max*

Adjust pulser amplitude for 6div deflection. Position bottom of waveform to top graticule line. Note aberrations: 5%, max

Switch SAC to +DC and TRIGGERING SLOPE to +. Position top of waveform to bottom graticule line and note aberrations: 5%, max.

c. *Check attenuators*
Transient response:
5mV to 20mV ±2%, max
50mV to 2V ±3%, max
5V to 10V ±6%, max
Risetime: 6.6ns, max

Check transient response and risetime on all CH 1 VOLTS/DIV ranges maintaining 4div signal with switch on SAC and pulser amplitude control.

d. *Repeat step 28 a,b and c for CH 2*

28. The addition of side panels may cause slight variations in characteristics.

c. Using TYPE 184, preset .1μs MAG ON timing before checking risetime.

28. TRIGGER LEVEL CENTERING

a. *Setup*

CH 1 input selector	DC
MODE	CH 1
TRIGGER	NORM
A SWEEP MODE	AUTO TRIG
B SWEEP MODE	TRIGGERABLE AFTER DELAY TIME

28a. (CONT)

Set TYPE 191 to 50kHz and apply signal to CH 1 INPUT. Adjust for .2div deflection and position display to horizontal center-line of graticule.

b. Adjust A Trig Level Centering, R462

Center A TRIGGERING LEVEL and adjust R462 for a stable display. Check that A SWEEP TRIG'D light is lit when sweep is triggered.

c. Adjust Norm Trig DC Level Centering, R285

Change A TRIGGERING COUPLING Switch to DC and adjust R285 for a stable display.

c. R285 is located on the vertical preamp board adjacent to the MODE switch.

d. Adjust CH 1 Trig Level Centering, R60

Change TRIGGER switch to CH 1 only and adjust R60 for a stable display. Return TRIGGER to NORM.

d. R60 is located on the outside edge of the vertical preamp board.

e. Adjust B Trig Level Centering, R662

Set HORIZ DISPLAY to DELAYED SWEEP (B) and center B TRIGGERING LEVEL. Adjust R662 for a stable display.

Return HORIZ DISPLAY to A.

29. TRIGGERING

30. Internal triggering requirements must be met in both norm and CH 1 ONLY positions of the trigger switch.

a. Check high frequency triggering Jitter: 1ns, max

Connect TYPE 191 OUTPUT--5ns cable--50Ω 2X attenuator--50Ω GR to BNC termination--BNC T adapter--18" BNC cable--CH 1 INPUT
18" BNC cable--A EXT TRIG INPUT

Set the TYPE 453 TIME/DIV to .1μSEC, MAG to X10 and A SWEEP MODE to NORM TRIG. Check for stable triggering as in the following table:

29a. (CONT)

	10MHz	50MHz	SOURCE
INT AC	.2div	1div	INT
LF REJ	.2div	1div	INT
DC	.2div	1div	INT
EXT AC	50mV	200mV	EXT
LF REJ	50mV	200mV	EXT
DC	50mV	200mV	EXT

Change A SWEEP MODE to AUTO TRIG, SOURCE to INT, HORIZ DISPLAY to DELAYED SWEEP (B) and change the TYPE 191 signal connection to B EXT TRIG INPUT. Repeat 10MHz and 50MHz triggering checks for B sweep.

b. Check HF REJ Requirement:
triggering on 0.2div of 50kHz
No triggering on 0.2div at 1MHz

Set TYPE 191 for .2div of 50kHz. Switch triggering to HF REJ, INT and check that stable triggering can be obtained. Change to 1MHz and check that sweep will not trigger.

Change HORIZ DISPLAY to DELAYED SWEEP (B) and repeat.

c. Check low frequency triggering

Remove the TYPE 191 signal. Connect the SINEWAVE GENERATOR--50Ω cable--BNC T adapter--18" BNC cable--CH 1 INPUT
BNC T adapter--18" BNC cable--X10 ATTEN--B EXT TRIG INPUT

Adjust the SINEWAVE GENERATOR controls for a .5V display of 30Hz signal and check A and B LF triggering as follows:

COUPLING	INT	EXT
AC	.2 div	50mV
HF REJ	.2 div	50mV

Switch HORIZ DISPLAY to A and cables to A EXT TRIG INPUT. Repeat 30 Hz triggering checks.

29. (CONT)

d. Check LF REJ
Requirement: triggering on 0.2div of 30kHz
No triggering on 0.2div at 100Hz

Change SINE-WAVE GENERATOR to 30kHz and trigger COUPLING to LF REJ. Check for stable triggering. Change to 100Hz and check that sweep will not trigger.

Repeat for B SWEEP. Return COUPLING to AC. Switch HORIZ DISPLAY to A.

e. Check SINGLE SWEEP
Requirement: triggers with same triggering level setting as in NORM TRIG

Change SINE-WAVE GENERATOR to 1kHz and A TRIGGERING COUPLING to AC. Adjust A TRIGGERING LEVEL so display is just triggered. Remove signal from INPUT and switch to SINGLE SWEEP. Push RESET button and check that light comes on. Re-apply signal to INPUT and check that sweep runs and light extinguishes. Remove SINE-WAVE GENERATOR.

f. Check LINE triggering
Requirement: triggering on correct polarity

Set CH 1 VOLTS/DIV to 10, TIME/DIV to 2mSEC and TRIGGERING SOURCE to LINE. Connect 10X probe from CH 1 INPUT to line voltage source. Check for correct line trigger polarity with SLOPE to + and -.

Switch A SWEEP MODE to AUTO TRIG and HORIZ DISPLAY and DELAYED SWEEP (B). Repeat line triggering check.

Remove probe.

30. TRIGGERING LEVEL RANGE

a. Setup

Connect SAC OUTPUT to CH 1 INPUT and B EXT TRIG INPUT using T connector. Set SAC to 2 VOLTS + DC MIXED. Set COUPLING to DC and SOURCE to EXT.

b. Check EXT LEVEL range + and - 2V, min

With SLOPE in + turn LEVEL full cw and check that display is not triggered.

Change SAC to -DC and SLOPE to -. Turn LEVEL full ccw and check that display is not triggered.

c. Check EXT ÷ 10 LEVEL range + and -20V, min

Change SAC to 20V and SOURCE to EXT ÷ 10. Repeat LEVEL range checks in + and - SLOPE.

Change HORIZ DISPLAY to A and SAC signal to A EXT TRIG INPUT. Repeat EXT and EXT ÷ 10 LEVEL range checks for A trigger. Remove SAC signal and return TRIGGERING SOURCE to INT.

31. SWEEP RECOVERY — 0.2div of sweep shift, max

Set A SWEEP MODE to AUTO TRIG, TIME/DIV to 5μSEC and MAG to X10. Position start of sweep to center of graticule. Rotate HF STAB thru its range and check shift of sweep start for 0.2div of sweep shift, max.

32. AUTO RECOVERY TIME

a. Setup

Connect the TYPE 184 MARKER OUTPUT to TYPE 453 CH 1 INPUT and press the 50mS MARKER SELECTOR. Set CH 1 VOLTS/DIV to .5, TIME/DIV to 50μSEC, MAG OFF and A SWEEP MODE to AUTO.

32. (CONT)

b. Check AUTO recovery time: 50 to 100mS

Check that stable triggering may be obtained by adjusting the LEVEL control. Press the .1S MARKER SELECTOR. Check that sweep will not trigger stably on the leading edge of the marker.

33. SWEEP START, A SWEEP CAL

a. Setup

A TIME/DIV	1mSEC
B TIME/DIV	5µSEC
B SWEEP MODE	B STARTS AFTER DELAY TIME
HORIZ DISPLAY	A INTEN DURING B

Set TYPE 184 for 1mS markers.

b. Preset B Sweep Start, R758

Set DELAY-TIME MULTIPLIER to 1.00 Adjust R758 so intensified portion starts at 2nd marker.

c. Preset A Sweep Cal, R531

Set DELAY-TIME MULTIPLIER to 9.00. Adjust R531 so intensified portion starts at 10th marker.

d. Adjust Sweep Start and A Sweep Cal

Set HORIZ DISPLAY to DELAYED SWEEP (B) and DELAY-TIME MULTIPLIER to 1.00. Adjust R758 so displayed pulse starts at the beginning of the sweep.

Set DELAY-TIME MULTIPLIER to 9.00 and adjust R531 so displayed pulse starts at beginning of the sweep.

Repeat sweep start and A Sweep Cal adjustments as necessary because of interaction.

34. DELAY-TIME MULTIPLIER LINEARITY

±1.5 minor div, max

Set DELAY TIME MULTIPLIER to 8.00. Rotate the dial as necessary to position start of pulse to beginning of sweep. Note deviation of dial reading from 8.00: 1.5 minor div, max.

Repeat check for each major div of the DELAY-TIME MULTIPLIER dial between 8.00 and 2.00.

35. NORM GAIN

Set HORIZ DISPLAY to A and adjust R835 for 1 marker per div.

Unless noted otherwise, use the middle 8 horizontal div when adjusting or checking timing.

36. B SWEEP CAL

Set DELAY-TIME MULTIPLIER full ccw, B SWEEP MODE to B TRIGGERABLE AFTER DELAY TIME, HORIZ DISPLAY to DELAYED SWEEP (B) and B TIME/DIV to 1mSEC. Adjust R741 for 1 marker per div.

37. X10 MAG

a. Adjust Mag Gain, R845
Error: ±1%, max

Press the TYPE 184 .1mS MARKER SELECTOR. Set HORIZ DISPLAY to A and MAG to X10. Adjust R845 for 1 marker per division.

b. Check linearity
Non-linearity ±1%, max

Check linearity over the entire sweep. Non-linearity over any 8 division portion of the sweep must not exceed ±1%.

37. (CONT)

c. Adjust Mag Regis, R855 Shift:

Press the TYPE 184 5mS MARKER SELECTOR. Position the middle marker to graticule center. Set the MAG to OFF and adjust R855 to place the center marker on graticule center. Repeat the adjustment until no shift occurs as MAG is switched between X10 and OFF.

38. SWEEP LENGTH

a. Check B sweep length: 11 divisions ±0.5 division

Set A TIME/DIV to 2mSEC, B TIME/DIV to 1mSEC and HORIZ DISPLAY to DELAYED SWEEP (B). Press TYPE 184 1mS and .1mS MARKER SELECTORS. Check B sweep length for 10.5 to 11.5 divisions.

b. Check A sweep length: From 4 divisions or less to 11 divisions ±0.5 division

Change the HORIZ DISPLAY to A and A TIME/DIV to 1mSEC. With A SWEEP LENGTH at FULL check the sweep length for 10.5 to 11.5 divisions. Turn the A SWEEP LENGTH full ccw and check the sweep length for 4 divisions, max.

c. A SWEEP LENGTH Pot: .2div open spots or reversals between 4th and 10th div; .4div past 10th, disregard below 4th div

Return A SWEEP LENGTH to FULL.

39. VARIABLE RANGE

a. Check A VARIABLE range: 2.5:1, min

Change the TYPE 184 markers to 10ms. Turn A VARIABLE full ccw and note the spacing between markers: 4 divisions, max. Check that the UNCAL neon is lit when the VARIABLE is in any position except full cw (CAL).

39. (CONT)

b. Check B VARIABLE range: 2.5:1, min

Set A TIME/DIV to 5mSEC, B TIME/DIV to 1mSEC and HORIZ DISPLAY to DELAYED SWEEP (B). Turn B VARIABLE (right side of instrument), full ccw and note the spacing between markers: 4 divisions, max.

Check that the UNCAL neon is lit when the VARIABLE is in any position except full cw (CAL).

40. POSITION RANGE

a. Check ↔POSITION range: ends of sweep to graticule center

Return the HORIZ DISPLAY to A and set A TIME/DIV to 1mSEC. Turn the ↔ POSITION full cw. The start of the sweep must be to the right of graticule center. Turn the ↔POSITION full ccw. The end of the sweep must be to the left of graticule center.

b. Check ↔ POSITION FINE range: 5 to 8 divisions

Position the right marker to graticule center. Set MAG to X10 and check the range of the FINE control. Must be between 5 and 8 divisions. Return MAG to OFF.

41. 1μSEC/DIV TIMING

a. Adjust C530A

Change the TYPE 184 markers to 1μS. Set A and B TIME/DIV to 1μSEC. ADjust C530A for 1 mark per division.

b. Adjust C740A

Set the HORIZ DISPLAY to DELAYED SWEEP (B). Adjust C740A for 1 mark per division.

42. HIGH SPEED TIMING

a. Setup

Set A and B TIME/DIV to .1μSEC and HORIZ DISPLAY to A. Change the TYPE 184 markers to 20nS. Position the start of the display to the left edge of the graticule. Change the MAG to X10.

42. (CONT)

b. Adjust horizontal amplifier transient response

Adjust C882 and C892 to obtain equal spacing between each cycle to the left and right of graticule center.

Keep C882 and C892 adjustments approximately equal.

c. Check high speed X10 MAG timing Error: ±3%, max over the entire sweep excluding the first and last 3div

Check timing accuracy over the entire length of the sweep excluding the first and last 3 cycles of the displayed waveform.

c. When determining the first and last 3 cycles of the display, keep the intensity below the point of overriding the blanking voltage.

43. A SWEEP TIME/DIV

a. Check timing with MAG OFF, .1μSEC to 5 SEC Error: ±2%, max (0.16div in 8div)

Switch MAG to OFF and check TIME/DIV accuracy as follows:

A TIME/DIV	TYPE 184	CHECK FOR
.1μSEC	.1μS	1 mark/div
.2μSEC	.1μS	2 marks/div
.5μSEC	.5μS	1 mark/div
1μSEC	1μS	1 mark/div
2μSEC	1μS	2 marks/div
5μSEC	5μS	1 mark/div
.1 SEC	.1 S	1 mark/div
.2 SEC	.1 S	2 marks/div
.5 SEC	.5 S	1 mark/div
1 SEC	1 S	1 mark/div
2 SEC	1 S	2 marks/div
5 SEC	5 S	1 mark/div

b. Check timing with X10 MAG .1μSEC to 5μSEC/DIV Error: ±3%, max (0.24div in 8div)

Set MAG to X10 and check accuracy of entire sweep except as noted.

43b. (CONT)

TIME/DIV	TYPE 184	CHECK FOR	DISREGARD
.1μSEC	10nS	1 cycle/div	First and last 3 cycles
.2μSEC	20nS	1 cycle/div	First and last 3½ cycles
.5μSEC	50nS	1 cycle	First 2 cycles
1μSEC	.1μS	1 cycle/div	First div
2μSEC	.1μS	2 cycles/div	First div
5μSEC	.5μS	1 mark/div	First div

44. B SWEEP TIME/DIV

a. *Check timing with MAG OFF*
Error: ±2%, max

Set DELAY TIME MULTIPLIER to 0.50 and HORIZ DISPLAY to DELAYED SWEEP (B). Check B sweep timing as follows: max error, ±.16div.

B TIME/DIV	TYPE 184	CHECK FOR
.1μSEC	.1μS	1 cycle/div
.2μSEC	.1μS	2 cycles/div
.5μSEC	.5μS	1 mark/div
1μSEC	1μS	1 mark/div
2μSEC	1μS	2 marks/div
5μSEC	5μS	1 mark/div
10μSEC	10μS	1 mark/div
20μSEC	10μS	2 marks/div
50μSEC	50μS	1 mark/div
.1mSEC	.1mS	1 mark/div
.2mSEC	.1mS	2 marks/div
.5mSEC	.5mS	1 mark/div
1mSEC	1mS	1 mark/div
2mSEC	1mS	2 marks/div
5mSEC	5mS	1 mark/div
10mSEC	10mS	1 mark/div
20mSEC	10mS	2 marks/div
50mSEC	50mS	1 mark/div
.1 SEC	.1 S	1 mark/div
.2 SEC	.1 S	2 marks/div
.5 SEC	.5 S	1 mark/div

b. *Check timing with X10 MAG Error:*
.1μSEC to 5μSEC ±3%, max (0.24div in 8div)

Set MAG to X10 and check accuracy of entire sweep except as noted.

44b. (CONT)

TIME/DIV	TYPE 184	CHECK FOR	DISREGARD
.1µSEC	20nS	1 cycle/2 div	First and last 3 cycles
.2µSEC	20nS	1 cycle/div	Fisrt and last 3½ cycles
.5µSEC	50nS	1 cycle/div	First 2 cycles
1µSEC	.1µS	1 cycle/div	First div
2µSEC	.1µS	2 cycles/div	First div
5µSEC	.5µS	1 mark/div	First div

45. DELAY TIME ACCURACY

1µSEC to 50mSEC Error: ±1%, max
.1µSEC to 5µSEC Error: ±2%, max

Set HORIZ DISPLAY to DELAYED SWEEP (B) and B SWEEP MODE to B STARTS AFTER DELAY TIME.

Check the following sweep speeds by adjusting DELAY-TIME MULTIPLIER so start of sweep occurs at top of 2nd marker (approx 1.00). Note dial error from 1.00.

Turn dial so start of sweep occurs at top of 10th marker (approx 9.00). Error difference between 2nd and 10th markers may now be determined from the dial.

A TIME/DIV	B TIME/DIV	TYPE 184	Max error on dial
1µSEC	.1µSEC	1µS	±8 minor div
2µSEC	.1µSEC	1µS	
5µSEC	.5µSEC	5µS	
10µSEC	1µSEC	10µS	
20µSEC	1µSEC	10µS	
50µSEC	5µSEC	50µS	
.1mSEC	10µSEC	.1mS	
.2mSEC	10µSEC	.1mS	
.5mSEC	50µSEC	.5mS	
1mSEC	.1mSEC	1mS	
2mSEC	.1mSEC	1mS	
5mSEC	.5mSEC	5mS	
10mSEC	1mSEC	10mS	
20mSEC	1mSEC	10mS	
50mSEC	5mSEC	50mS	
.1 SEC	10mSEC	.1 S	±16 minor div
.2 SEC	10mSEC	.1 S	
.5 SEC	50mSEC	.5 S	
1 SEC	.1 SEC	1 S	
2 SEC	.1 SEC	1 S	
5 SEC	.5 SEC	5 S	

46. The addition of side panels may cause slight variations in characteristics.

46. DELAY TIME JITTER 0.3div, max

Set A TIME/DIV to 1mSEC and B TIME/DIV to 1μSEC. Set TYPE 184 for 1ms markers and line voltage to 126VAC.

Adjust DELAY TIME MULTIPLIER to about 1.00 to display pulse on screen. Note jitter on pulse leading edge: 0.3div, max.

Adjust DELAY TIME MULTIPLIER to about 9.00 to display pulse on screen. Note jitter on pulse leading edge: 0.3div, max.

Remove TYPE 184 signal and return line voltage to 115VAC.

47. EXT HORIZ

a. Setup

CH 1 POSITION	midr
CH 1 VOLTS/DIV	20mV
MODE	CH 2
TRIGGER	CH 1 ONLY
HORIZ DISPLAY	EXT HORIZ
B TRIGGERING SOURCE	INT
B TRIGGERING COUPLING	DC

b. Adjust Ext Horiz Gain, R645
Error: ±2%, max

Apply a .1 volt signal from the SAC to CH 1 INPUT. Adjust R645 for 5 divisions of horizontal deflection.

c. Check deflection factor
EXT: 270mV/div ±15%
EXT ÷ 10: 2.7V/div ±20%

Change B TRIGGERING SOURCE to EXT and connect the SAC signal cable to EXT TRIG INPUT or EXT HORIZ. Set SAC AMPLITUDE to 2 VOLTS. Check for 6.5 to 8.7 divisions of horizontal deflection.

47c. (CONT)

Change B TRIGGERING SOURCE to EXT ÷ 10 and SAC AMPLITUDE to 20 VOLTS. Check for 6.2 to 9.2 divisions of horizontal deflection. Remove the SAC signal connection.

d. Check bandwidth 5MHz or more at -3dB

Connect TYPE 191--5ns cable--50Ω GR to BNC termination--TYPE 453 CH 1 INPUT

Set B TRIGGERING SOURCE to INT and adjust the TYPE 191 for 6 divisions of 50kHz signal. Increase TYPE 191 frequency until the deflection is reduced to 4.2 divisions. Read the -3dB high frequency from the TYPE 191 dial, must read 5MHz or more.

Remove the TYPE 191 signal connection.

48. CHOPPED OPERATION

a. Setup

MODE	CHOP
TRIGGER	NORM
TIME/DIV	.5μSEC
HORIZ DISPLAY	A

b. Check chopped frequency: 500KHz ±20%, max

Position the traces 4div apart and adjust LEVEL for a stable display. Check the duration of one complete cycle of chopped waveform for 1.7 to 2.5μSEC.

c. Check blanking

Check for complete blanking switching transients between chopped segments with the INTENSITY control centered.

49. CALIBRATOR

a. Setup

Set MODE to ALT and TIME/DIV to 1mSEC. Connect 1 KC CAL to CH 1 INPUT and TYPE 184 MARKER OUTPUT to CH 2 INPUT. Set TYPE 184 for 1ms markers. Adjust TRIGGERING LEVEL and POSITION for stable display.

b. Adjust Cal Freq, T1225: 1kHz ±0.05%

Adjust T1225 for one cycle of calibrator waveform for each 1mS marker.

Switch TRIGGER to CH 1 ONLY and adjust T1225 for minimum drift of time marks. Drift must not exceed 5div in 10 seconds.

Remove time marks and set MODE to CH 1.

50b. The addition of side panels may cause slight variations in characteristics.

c. Check duty cycle: 50% ±0.8%

Set A TIME/DIV to .1mSEC. Center displayed waveform on graticule and switch MAG to X10. Switch A TRIGGERING SLOPE to + and - and note horizontal shift between rising and falling portions of waveform. Must not be more than 1.6div.

d. Check risetime 1μs, max

Set MAG to OFF, A TIME/DIV to .2μSEC and A TRIGGERING SLOPE to +. Check 10% to 90% risetime of calibrator waveform for 1μs, max.

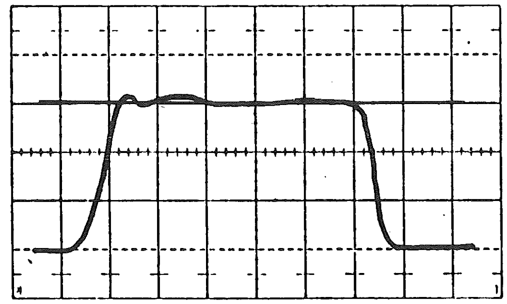
e. Check PROBE LOOP

Connect TYPE 453 PROBE LOOP--P6019 probe--Passive termination--test scope input.

Set the passive termination slide switch to 2mA/mV and test scope VOLTS/DIV to 50mV. Check for a square wave display on the test scope.

50. Z AXIS

a. Adjust compensation C1036
Front corner ±.1div from level



Set TEST SCOPE VOLTS/DIV to .5. Connect 10X Probe to TP1047. Set TYPE 453 TIME/DIV to .1μSEC, A SWEEP Mode to AUTO TRIG, and A TRIGGERING LEVEL cw. Adjust INTENSITY so displayed waveform amplitude is 3div. Adjust C1036 for optimum square wave.

b. Check sensitivity: 5V, min

Connect 5 volt SAC signal to Z AXIS INPUT and A EXT TRIG INPUT using T connector and clip lead to BNC adapter. Remove GND strap and connect black lead of adapter to GND post. Set TIME/DIV to .5mSEC and A TRIGGERING SOURCE to EXT. Check for trace modulation at normal intensity.

Remove the SAC signal from Z AXIS INPUT.

c. Check max usable frequency: 50MHz, min

Set the TYPE 191 for 5V of 50MHz signal and connect TYPE 191--5ns cable--50Ω GR to BNC termination--BNC T adapter--clip-lead adapter--Z AXIS INPUT Probe adapter--10X Probe--TYPE 453 vert INPUT.

Set TIME/DIV to .2μSEC and MAG to X10. Reduce INTENSITY to a low level and check for noticeable intensity modulation of the trace.

Disconnect signal and replace GND strap.

51. B END A

a. Setup

A TIME/DIV	2mSec
B TIME/DIV	.1mSEC
A SWEEP MODE	AUTO TRIG
B SWEEP MODE	B STARTS AFTER DELAY TIME
HORIZ DISPLAY	A INTEN DURING B
A SWEEP LENGTH	B ENDS A

b. Check B ENDS A operation

Turn DELAY-TIME MULTIPLIER thru its range and check that A sweep ends after intensified portion.

Return A SWEEP LENGTH to FULL and HORIZ DISPLAY to A.

52. TRACE FINDER

trace must remain in viewing area and indicate proper direction

Turn MAG ON, A TIME/DIV at 1mSEC, and push in TRACE FINDER. Turn vertical and horizontal POSITION controls full cw and ccw. Check that the trace remains within the viewing area and indicates proper direction.

53. A AND B GATES

a. Check A GATE amplitude: 12V ±5%, max

With A SWEEP MODE in AUTO TRIG turn LEVEL full cw. Connect A GATE to test scope INPUT.

Check for 12V ±5% gate waveform the duration of which will be the total sweep time of the TYPE 453.

53. (CONT)

b. Check B GATE amplitude: 12V ±5%, max

Set HORIZ DISPLAY to DELAYED SWEEP (B) and DELAY-TIME MULTIPLIER full ccw. Connect B GATE to test scope INPUT.

Check waveform for 12V ±5%.

54. HOLDOFF

a. Check HF STAB Holdoff: 0.2μS, min

Set HORIZ DISPLAY to A and connect A GATE to test scope input. Set A TIME/DIV to .1μSEC and check change in duration of negative portion of waveform while adjusting HF STAB for at least .2μSEC.

Leave HF STAB set for min duration of waveform

b. Check A sweep holdoff

Check duration of negative portion of gate waveform at all sweep speeds as follows:

TIME/DIV	holdoff
.1μSEC to 5μSEC	less than 2.5μs
10, 20 and 50μSEC	3.5-10μs
.1, .2 and .5mSEC	35-100μs
1, 2 and 5mSEC	.35-1ms
10, 20 and 50mSEC	3.5-10ms
.1 SEC to 5 SEC	35-100ms

THE END