FACTORY CALIBRATION PROCEDURE

CONTENTS:

546

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.).

Tek form number:
0-302
July 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.

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

* 1	TYPE 547 OSCILLOSCOPE with
* 1	TYPE 1A1 DUAL-TRACE PLUG-IN UNIT
1	TYPE P6006 X10 PASSIVE PROBE
1	TYPE P6028 X1 PASSIVE PROBE
1	TYPE P6019 AC CURRENT PROBE (test scope)
1	TYPE 76TU LINE-VOLTAGE CONTROL UNIT
* 1	TYPE 184 TIME-MARK GENERATOR
* 1	TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR

b. Test Fixtures and Accessories

1	PASSIVE TERMINATION (011-0078-00)
* 1	067-0521-00 CALIBRATION FIXTURE (1M1) with a known risetime
* 1	STANDARD AMPLITUDE CALIBRATOR (067-0502-00) (SAC)
* 1	50Ω TERMINATION ±0.1% (067-0120-00)
1	50Ω TERMINATION, BNC (011-0049-00)
3	50Ω coax calbes, BNC (012-0057-00)
2	BNC "T" connectors (103-0030-00)
2	"18" patch cords, banana plug to BNC (012-0091-00)
1	BNC female to UHF male adapter (103-0015-00)
1	TYPE 546-547 EXTERNAL FUNCTION CHECKER (067-0564-99)

c. Other Equipment

1	20,000Ω/VDC multimeter
1	Audio Generator (0.1 to 15V PTP at 1 and 2 kHz)
2	Shorting straps

* 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

a. Set DELAY-TIME MULTIPLIER dial: 0.15 to ≥10.15

2. PRESET CONTROLS

3. RESISTANCE CHECKS

4. POWER SUPPLIES

a. Check time-delay relay: 15 to 60 seconds
b. Adjust -150V, R616: -150V ±2%
c. Check power supply voltage and regulation

Supply	Max Error	Max Ripple
-150	±2%	3mV
+100	±2%	7mV
+225	±2%	3mV
+350V	±2%	20mV
+75V	±10	7mV

e. Adjust High Voltage R840: -1850V ±2%
f. Check high voltage regulation: no blooming

5. AMPLITUDE CALIBRATOR

a. Adjust Cal Ampl R943: ≤1% error at 100VDC
* b. Check voltage accuracy: within ±2% except 100 VOLTS & 100 VDC ±1%
* c. Check R_O = 50Ω accuracy: within ±2%
d. Check for correct output
e. Check symmetry: 45% to 55%
f. Check frequency: 1 kHz ±25%

5. (cont'd)
g. Check risetime: 5 VOLTS ≤0.4μseconds
100 VOLTS ≤0.6μseconds
h. Check 5mA : present on loop

6. CRT

a. Check graticule alignment: ≤3° tilt
b. Check TRACE ROTATION range: at least + & - 3° from electrical center
c. Adjust Geometry R861: ≤1mm bowing
d. Check horizontal focus: 0.5mm resolution
e. Check orthogonality: ≤1° deviation
f. Check horizontal geometry: ≤1mm bowing
g. Check vertical focus: 0.5mm resolution

7. VERTICAL AMPLIFIER

a. Check stage unbalance: ≤0.5cm
b. Adjust Vert DC Bal R1004: range, at least + & -1cm; deviation from center, ≤1cm
c. Adjust Vertical Gain R1017: range, at least +10% & -5% accuracy, within ±2%
d. Check compression or expansion: ≤0.5mm
e. Check common mode rejection: ≥30.1
f. Check DC Shift: ≤0.5mm

8. ALTERNATE TRACE AND CHOPPED BLANKING

a. Check alternate trace sync pulse: amplitude ≥60V, risetime ≤1μs
b. Check slave pulse: amplitude ≥40V risetime ≤0.7μs
c. Check alternate operation: alternates at all sweep rates
d. Check chopped blanking: transients blanked

9. FRONT PANEL INDICATOR LIGHTS

a. Check graticule lighting
b. Check position indicating neons: correct indicator must be on before spot leaves the scan area, and off before the spot is 1cm past the graticule center line
c. Check MAG ON neon: Off in EXT, on in all other positions of the HORIZONTAL DISPLAY switch with SWEEP MAGNIFIER on.

10. TRIGGER ADJUSTMENTS

b. Adjust Trigger Sens, R245 (R45) and Trigger Level Centering, R225 (R25): 100mV
c. Adjust Int Trig DC Level R209, (R9): 4mm at graticule center
d. Check for oscillations: none
e. Align TRIGGERING LEVEL knob
f. Check TRIGGERING LEVEL range: Normal, at least + & -2V; X10, at least + & -20V
g. Check AUTO triggering: $\leq$20Hz
h. Check line triggering: Correct slope
i. Check PLUG-IN INT triggering
j. Check triggering:

	COUPLING	TRIGGERED	NOT TRIGGERED
NORM INT:	+ & - AC	2mm 1kHz	½mm 1kHz
	+ & - DC	4mm change in DC level	--------
	+ & - LF REJ	2mm 2kHz	4mm 2kHz
EXT:	+ & - AC & DC	0.1V 1kHz	0.02V 1kHz

11. SINGLE SWEEP

SINGLE SWEEP on .5cm signal
READY lights operate

12. EXTERNAL DELAY INPUT

b. Check +GATE B, Pin c: $\geq$2V amplitude $\leq$70ns risetime
c. Check Pin d, GND: "B" neon lit
d. Check Pin b: "A" neon lit in 2 positions
e. Check Pin a: A DLY'D sweep disappears

13. SINGLE SWEEP RESET INPUT

14. EXTERNAL WAVEFORMS

a. Check VERT SIG OUT: amplitude $\geq$0.30V/cm, risetime $\leq$20ns
b. Check SWEEP A: $\geq$9.0V/cm at 1mSEC
c. Check DLY'D TRIG: amplitude $\geq$10V
d. Check +GATE A: amplitude $\geq$20V
e. Check +GATE B: amplitude $\geq$20V

15. HOLDOFF

TIME/CM	A and B holdoff
.1µSEC	9-27µs
.2 to 5µSEC	5-15µs
10 to 50µSEC	16-28µs
.1 to .5mSEC	70-130µ
1 to 5mSEC	0.9-1.7ms
10 to 50mSEC	9-17ms
.1 to .5 SEC	90-170ms
1 to 5 SEC	0.5-0.9s

16. TIME BASE B UNBLANKING

a. Check BRIGHTNESS range: $\geq$20V
b. Adjust B unblanking time constant, C163: $\geq$40,000:1 ratio =

17. MAGNIFIER REGISTRATION

b. Adjust Swp/Mag Regis R569: $\pm$1mm

18. HORIZONTAL AMPLIFIER GAIN

* a. Adjust X10 Cal R544: $\pm$3%
* b. Adjust X1 Cal R566: $\pm$1%
* c. Check X5 and X2 magnified: $\pm$3%

19. TIME BASE A/TIME BASE B MATCH

b. Adjust A Sweep Cal 290Y: $\pm$0.5%
c. Adjust A Sweep Length R325: 10.2 to 10.8cm at 1ms/cm

19. (cont'd)

d. Adjust B Sweep Length R125: 10.2 to 10.8cm at 1ms/cm
e. Check VARIABLE TIME/CM: ratio ≥2.5:1

20. DELAY PICKOFF

* b. Adjust Delay Start R418 and Delay Stop R415: ±0.15%
* c. Check incremental accuracy: ±0.15%

21. TIME BASE B TIMING

b. Adjust timing: C90C, C90B, C90A & C99: ≤0.8% error
c. Check fast sweep linearity: <0.5% error
d. Check timing accuracy: ≤0.8% error

22. HIGH SPEED COMPENSATION

* a. Adjust C572, C582, C591, C576 & C586: ≤3% error
* b. Adjust X10 mag C557H: ≤3% error
* c. Adjust X5 mag C557F: ≤3% error
* d. Adjust X2 mag C557D: ≤3% error

23. TIME BASE A TIMING

* a. Adjust timing, C290C, C290B, C290A & C299: ≤1% error
* b. Check timing accuracy: ≤1% error

24. TRIGGER DELAY

a. Check trigger delay: ≤100ns
b. Check delay jitter: ≤1/40,000
c. Check B sweep foldover: none in 10.5cm

25. EXTERNAL HORIZONTAL AMPLIFIER

b. Adjust Ext Horiz DC Bal R519: ≤1cm shift
c. Adjust X1 compensation C524: ≤3% overshoot or rolloff
* d. Check gain: ≤90mV/cm
e. Check VAR 10-1 ratio: ≥10.1
f. Adjust X10 compensation C503C: ≤3% overshoot or rolloff
g. Check X10 attenuation: ±2%
* h. Check bandwidth: ≥450 kHz at -3dB

26. Z AXIS MODULATION

≤10V peak to peak required for intensity unblanking

27. TRANSIENT RESPONSE

a. Adjust Vertical HF compensation:
+ PULSE: ≤0.6mm aberration
- PULSE: ≤0.7mm aberration
* b. Check risetime: ≤6.25ns
c. Check spoiler switch: risetime ≤10ns
d. Check positioning effect: ≤1.5mm
e. Check corner symmetry: ≤0.5mm

28. HIGH FREQUENCY TRIGGERING

a. Check external: 200mV at 50 MHz
b. Check internal: 0.6cm at 50 MHz AC and AC LF REJ with ≤2mm jitter

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

THE END

1. PRELIMINARY INSPECTION

a. Make General Examination

Check for unsoldered joints, rosin joints, improper lead dress and long ends. Check controls for smooth mechanical operation and proper indexing except TRIGGERING LEVEL and TRACE SEPARATION knobs which haven't been adjusted or tightened yet. Correct all defects found.

b. Align and inspect CRT

Inspect CRT for mechanical defects: phosphor defects, scratches, cracks around neck pins, etc.

Check that CRT neck pin connections are tight and that HV shields are installed.

Loosen CRT clamp and position CRT so that the implosion shield and light guide are flush. Place a scribed graticule over the CRT and align the CRT. Tighten the CRT clamp and remove the scribed graticule.

Check that graticule light shields are in place and that graticule lamps are positioned correctly.

c. Check fuse

115V 50-60 Hz: 159-0011-00 6.25A mdx slo-blo
230V 50-60 Hz: 159-0005-00 3A mdx slo-blo

d. Set DELAY-TIME MULTIPLIER dial: 0.15 to ≥10.15

Set DELAY-TIME MULTIPLIER dial full ccw. If dial doesn't read 0.15, loosen dial set screw, reposition dial on shaft for a reading of 0.15, and retighten set screw. Rotate dial; check for smooth operation and a reading of ≥10.15 at the cw end of its rotation.

2. PRESET CONTROLS

POWER	OFF	Leave controls and adjustments for each step as they were in the preceding step unless otherwise directed.
INTENSITY	ccw	
FOCUS	ccw	
ASTIGMATISM	ccw	

2. (cont'd)

SCALE ILLUM	ccw
TRACE SEPARATION	---
BRIGHTNESS	cw
HORIZONTAL DISPLAY	A
SWEEP MAGNIFIER	X1 OFF
SINGLE SWEEP	NORMAL
DELAY-TIME MULTIPLIER	5.00
HORIZONTAL POSITION	cw
VERNIER	cw
AMPLITUDE CALIBRATOR	OFF
CRT CATHODE SELECTOR (rear)	EXTERNAL

TIME BASE A and B	
TRIGGERING LEVEL	cw (in)
MODE	TRIG
SLOPE	+
COUPLING	AC
SOURCE	NORM INT
TIME/CM	1mSEC
VARIABLE	CALIBRATED

All internal adjustments midrange

3. RESISTANCE CHECKS

a. Check plug-in load switch

Measure resistance from back terminal of the plug-in load switch to GND. Approx 75Ω with the switch in center position and >5kΩ full in and full out.

b. Check power supply resistance

Plug in the 1M1 and set TEST FUNCTION switch to LOW LOAD and the VERTICAL POSITION cw. Check the resistance to GND of the regulated supplies located on ceramic strip next to power transformer.

Supply	Approx resistance
-150V	1-2kΩ
+100V	1-2kΩ
+225V	2-3kΩ
+350V	25-35kΩ

4. POWER SUPPLIES

a. Check time-delay relay: 15 to 60 seconds

Connect the TYPE 546 power cord to the TYPE 76TU and set the TYPE 76TU to 115V as read on its meter. Turn TYPE 546 POWER switch ON, check for a delay of 15 to 60 seconds before the audible click. While waiting for the time-delay relay, check for no DC voltage on the regulated supplies.

b. Adjust -15V, R616: -150V ±2%

Connect the multimeter between the -150V supply and GND. Adjust R616 for -150 VDC.

c. Check power supply voltage and regulation

Check power supply error and ripple as shown in the following table, while varying line voltage from 102.5VAC to 127.5VAC and with 1M1 set up for HIGH LOAD and LOW LOAD (See note).

Supply	Max Error	Max Ripple
-150VDC	±3V	3mV
+100VDC	±2V	7mV
+225VDC	±4.5V	3mV
+350VDC	±7V	20mV
+ 75VDC	±7.5V	7mV

Return TYPE 76TU to 115V.

HIGH LOAD conditions:

TEST FUNCTION	HIGH LOAD (1M1)
TRIGGER MODE	AUTO
SWEEP MAG	X10
AMP CAL	Any except OFF

LOW LOAD conditions:

TEST FUNCTION	LOW LOAD (1M1)
TRIGGER MODE	TRIG
SWEEP MAG	X1 OFF
AMP CAL	OFF

+75VDC measured at Pin 15 of the plug-in compartment connector.

d. Check elevated filaments

Location	Approx DC elevation
T601 term 34	+100V
T601 term 32	+35V
T601 term 5	HV (-185V)

e. Adjust High Voltage R840: -1850V ±2%

Connect the multimeter to the junction of R857-C854 and adjust High Voltage, R840, for -1850V ±2% (37V). Remove meter leads.

f. Check High Voltage Regulation: no blooming

Return SWEEP MAGNIFIER to X1 OFF and center HORIZONTAL POSITION and VERNIER and 1M1 VERTICAL POSITION. Rotate INTENSITY back and forth and check for no blooming between 103.5VAC and 126.5VAC. Return line voltage to 115V.

Some variation in intensity may be noted when varying the line voltage. This is due to the change in CRT heater voltage and can be ignored.

5. AMPLITUDE CALIBRATOR

a. Adjust Cal Ampl R943: ≤1 error at 100VDC

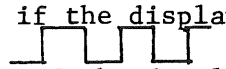
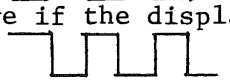
Set both TRIGGERING MODE switches to TRIG. Connect a coax cable from the SAC output to the test scope vertical input. Connect a coax cable from TYPE 546 CAL OUT to SAC UNK-IN. Set AMPLITUDE CALIBRATOR to 100VDC and the SAC to 100V, MIXED, +DC. Remove V945 from the TYPE 546. Set the test scope TYPE 1A1 VOLTS/CM to 1. Trigger the test scope in AUTO, -LINE and set TIME/CM to .5mSEC. Adjust R943 for zero deflection on the test scope.

b. Check voltage accuracy: within ±2% (except 100 VOLTS & VDC: within 1%)

Change the instrument controls as listed in the following table while checking the AMPLITUDE CALIBRATOR error, trace separation.

AMPLITUDE CALIBRATOR	SAC VOLTS	TYPE 1A1 VOLTS/CM	max trace separation
100VDC	100	1	1cm
100	100	1	1cm
50	50	.5	2cm
20	20	.2	2cm
10	10	.1	2cm
5	5	.05	2cm
2	2	.02	2cm
1	1	.01	2cm
.5	.5	.005	2cm
.2	.2	.005	8mm
.1	.1	.005	4mm

Add the error found in the .1 VOLTS position to the worst error of the same direction observed in the previous positions. The total error must be less than ±2%.

b. The start of the sweep shows the level of the SAC voltage. The unknown voltage is the next level. The unknown voltage is more positive than the SAC if the display looks like this:  and less positive if the display looks like this:  .

c. Check R_o = 50Ω accuracy: within ±2%

Set AMPLITUDE CALIBRATOR to .2 VOLTS and the SAC to .1 VOLTS. Insert the special 50Ω TERMINATION at CAL OUT. Check for ≤4mm of trace separation. Change AMPLITUDE CALIBRATOR to .1 VOLTS and the SAC to 50mVOLTS Check for ≤2mm trace separation. Replace V945, and remove the special 50Ω TERMINATION.

5. (cont'd)

d. Check for correct output

Set SAC OUTPUT to UNKNOWN and change the instrument controls as listed in the table below while checking the remainder of AMPLITUDE CALIBRATOR for approximately the correct amplitude.

AMPLITUDE CALIBRATOR mVOLTS	TYPE 1A1 VOLTS/CM	Approx DEFLECTION
50	.02	2.5cm
20	.005	4cm
10	.005	2cm
5	.005	1cm
2	500 V/CM	4cm
1	500 V/CM	2cm
.5	500 V/CM	1cm
.2	500 V/CM	0.4cm

d. The accuracy of these positions was verified in step 5b. This step is necessary to check for wiring errors and switch defects.

500μV/CM is obtained by coupling the CH1 SIGNAL OUTPUT to CHANNEL 2 INPUT with both VOLTS/CM switches at .005.

e. Check symmetry: 45% to 55%

Set the test scope TRIGGERING SOURCE to INT and TIME/CM to 50μSEC. Set TYPE 1A1 VOLTS/CM to .2 and change AMPLITUDE CALIBRATOR to 1 VOLT. Adjust test scope VARIABLE TIME/CM for 1 cycle in 10cm. Check the length of the half cycles; 4.5 to 5.5cm.

f. Check frequency: 1 kHz ±25%

Set test scope TIME/CM to 1mSEC and return VARIABLE to CALIBRATED. Check for 8 to 12 cycles in 10cm.

g. Check risetime: 100 VOLTS ≤0.6μsec
5 VOLTS ≤0.4μsec

Remove coax cables from test scope vertical input and TYPE 546 CAL OUT. Connect a X10 probe from test scope vertical input to TYPE 546 CAL OUT. Change TYPE 1A1 VOLTS/CM to 2 and TYPE 546 AMPLITUDE CALIBRATOR to 100 VOLTS. Set test scope TIME/CM to .5μSEC and check risetime, ≤0.6μs. Change AMPLITUDE CALIBRATOR to 5 VOLTS and TYPE 1A1 VOLTS/CM to .1. Check risetime: ≤0.4μs.

h. Check 5mA⌐¬: present on loop

Connect the PASSIVE TERMINATION and P6019 to the TYPE 1A1. Set TYPE 1A1 VOLTS/CM to .005. Remove the X10 probe from

h. Accuracy of 5mA⌐¬ is determined by the accuracy of the resistor string which has already been checked.

5h. (cont'd)

TYPE 546 CAL OUT. Connect the P6019 probe to 5mA ⊓⊔ loop. Set the PASSIVE TERMINATION to 2mA/mV. Check for no deflection on the test scope in the voltage positions and approx 5mm amplitude square-wave in the 5mA ⊓⊔ position.

6. CRT

a. Check graticule alignment: ≤3° tilt

Set both TRIGGERING MODE switches to AUTO STABILITY and advance INTENSITY and SCALE ILLUM as necessary. Connect the voltmeter across the terminals of the trace rotation coil L778. Adjust TRACE ROTATION for 0 volts. Check for ≤0.5cm tilt in 10cm (≤3°). Remove meter leads.

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

Be careful when connecting the meter; if trace rotator coil is shorted to ground, V91 heater will be destroyed.

b. Check TRACE ROTATION range: at least +&- 3° from trace position at OV

Rotate TRACE ROTATION cw and ccw. Check that the trace rotates in the direction at OV. Set TRACE ROTATION so the trace is parallel with the graticule center line.

c. Adjust Geometry R861: ≤1mm bowing

Connect the TYPE 184 to the 1M1 EXT INPUT. Set the TYPE 184 for 1mS markers. Set TIME BASE A TIME/CM to .5mSEC and TRIGGER LEVEL to X10. Trigger TIME BASE A; it may be necessary to adjust Trigger Level Centering R225 to trigger the scope. Adjust VARIABLE TYPE/CM for 1 time marker/cm. Change the TYPE 184 to .1mS markers. Adjust R861 for ≤1mm bowing in 6cm.

When triggering on high amplitude markers, set TRIGGERING LEVEL switch to X10 position.

d. Check horizontal focus: ≥0.5mm resolution

Change the TYPE 184 to 50μS markers. Adjust INTENSITY, FOCUS and ASTIGMATISM for the best definition of time markers, check for no overlap of time markers within the graticule.

6. (cont'd)

e. Check orthogonality: ≤1° deviation

Change the TYPE 184 to .1mS markers. Position a time marker at the intersection of the bottom graticule line and the center vertical line. Check tilt at the top graticule line ≤1mm (1°).

f. Check horizontal geometry: ≤1mm bowing

Remove TYPE 184 signal, set TRIGGERING LEVEL cw and return VARIABLE TIME/CM to CALIBRATED.

Position trace to top, center and bottom of the graticule. Check for ≤1mm of trace bowing.

g. Check vertical focus: ≥0.5mm resolution

Connect a coax cable from CAL OUT to 1M1 EXT INPUT. Set TIME/CM to 5μSEC. Set AMPLITUDE CALIBRATOR to 2 VOLTS and adjust 1M1 VARIABLE for 1cm of display. Change AMPLITUDE CALIBRATOR to .1 VOLT. Adjust INTENSITY, FOCUS and ASTIGMATISM for best definition. Position the display over the full 6cm of the graticule and check for no overlap. Remove coax cable from CAL OUT and 1M1 EXT INPUT.

7. VERTICAL AMPLIFIER

a. Check stage unbalance: ≤0.5cm

Short Q1114 and Q1134 collectors together to locate electrical center. Trace must be ≤0.5cm from graticule center.

Caution- do not short collectors to ground.

Short cases (collectors) of Q1074 and Q1084 together. Trace must be ≤0.5cm from electrical center.

Short the cases of Q1034 and Q1044 together. Trace must be ≤0.5cm from (1) electrical center and (2) position noted in previous check.

Short the cases of Q1014 and Q1024 together. Trace must be ≤0.5cm from (1) electrical center and (2) position noted in previous check.

7. (cont'd)

b. Adjust Vert DC Bal R1004: range at least +&- 1cm; deviation, ≤1cm from center

Set the 1M1 to COMMON MODE. Rotate R1004 cw and ccw; check for ≥1cm movement each direction from graticule center. Adjust R1004 for a centered trace.

c. Adjust Vertical Gain, R1017: range, at least +10% & -5%; accuracy, within 2%

Set 1M1 TEST FUNCTION to GAIN SET. Connect 100 VOLTS from the SAC to 1M1 EXT INPUT. Rotate R1017 and check for range of ≤3.8 to ≥4.4cm. Set R1017 for exactly 4cm of deflection.

d. Check compression or expansion: ≤0.5mm

Set the SAC to 2 VOLTS. Set 1M1 to LOW LOAD and adjust VARIABLE for 2cm of deflection at graticule center. Check for 2cm ±0.5mm at both top and bottom of the graticule.

e. Check common mode rejection: ≥30:1

Set the SAC to 1 VOLT and 1M1 TEST FUNCTION to COMMON MODE. Check for ≤3mm of display. (30:1)

f. Check DC Shift: ≤0.5mm

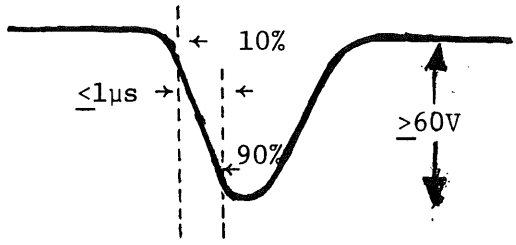
Remove the SAC cable from 1M1 EXT INPUT. Set 1M1 TEST FUNCTION to GAIN SET. Position the trace to the bottom of the graticule. Change 1M1 TEST FUNCTION switch to COMMON MODE. Check the slow drift following the initial 3cm shift, ≤0.5mm.

8. ALTERNATE TRACE AND CHOPPED BLANKING

a. Check alternate trace sync pulse: amplitude ≥60V, risetime ≤1μs

Set A & B TIME/CM to .1μSEC. Set 1M1 TEST FUNCTION to ALTERNATE. Connect the test scope 10X probe to pin 16 of J11, the plug-in compartment connector. Check the amplitude and risetime of the pulse at all rates.

Alternate trace sync pulse



8. (cont'd)

b. Check slave pulse: amplitude ≥40V, risetime ≤0.7μs

Change the test scope X10 probe to the collector of Q454. Check the amplitude and risetime of the negative pulse: amplitude ≥40V, risetime ≤0.7μs. Remove the probe.

c. Check alternate operation: all sweep rates

Connect 20V calibrator signal to 1M1 INPUT and check alternate sweep at all sweep rates faster than 1 SEC in A and B positions of the HORIZONTAL DISPLAY switch.

The calibrator signal identifies the lower alternate trace and aids verification of slow sweep alternate display.

d. Check chopped blanking: transients blanked

Remove the signal and change 1M1 TEST FUNCTION switch to CHOPPED. Set both TIME/CM switches to 5μSEC. Check both TIME BASE A and B for blanking of transients when CRT CATHODE SELECTOR (rear scope) is switched to CHOPPED BLANKING. Return CATHODE SELECTOR to EXTERNAL CRT CATHODE.

9. FRONT PANEL INDICATOR LIGHTS

a. Check graticule lights

Rotate SCALE ILLUM and check that both graticule lamps extinguish with ccw rotation and brighten with cw rotation.

b. Check position indicating neons: correct indicator on before spot leaves the scan area and off before spot is 1cm past the graticule center line

CRT scan area is the total range in which there can be a display on the CRT.

Turn TYPE 546 INTENSITY ccw. Change HORIZONTAL DISPLAY to EXT X10. Remove the cable from 1M1 EXT INPUT. Set the 1M1 to HIGH LOAD.

Turn INTENSITY cw until a visible spot is obtained. Position the spot back and forth on the scan area with HORIZONTAL POSITION control and check the operation of the indicating neons. The proper beam position indicator neon must come on before the spot moves out of the scan area. The opposite position indicator must be off before the spot is 1cm past graticule center.

9b. (cont'd)

Position the spot up and down with the 1M1 VERTICAL POSITION control. Check operation of vertical position indicators.

c. *Check MAG ON neon: Off in EXT, on in all other positions of the HORIZONTAL DISPLAY switch with SWEEP MAGNIFIER on.*

Rotate SWEEP MAGNIFIER through all of its positions and check for extinguished MAG ON neon. Leave SWEEP MAGNIFIER at X10. Rotate HORIZONTAL DISPLAY switch around to A and check that MAG ON neon is lit in all positions except EXT. Rotate SWEEP MAGNIFIER switch to X1 OFF and check the neon in each position.

10. TRIGGER ADJUSTMENTS

a. *Setup*

Apply a 100mV square wave signal from the SAC to the "T" connector on the 1M1 EXT INPUT. Ground the outboard terminal of the TRIGGER LEVEL X10 switch and connect the test scope 10X probe to the junction of the 56 resistor and 5 H coil, R252-L250 (R52-L50).

This step is written to provide calibration instructions for both Time Bases, with the circuit numbers for Time Base B shown in parenthesis. Complete the trigger adjustments for Time Base A to the end of Step 10h; then repeat for Time Base B.

Set the TRIGGERING controls of both Time Bases as follows:

SLOPE	+
MODE	TRIG
SOURCE	EXT
COUPLING	AC

b. *Adjust Trigger Sens R245 (R45) and Trigger Level Centering R225 (R25): 100mV*

Turn Trigger Sens R245 (R45) and Trigger Level Centering R225 (R25) fully cw. Turn R245 (R45) ccw until a stable square wave appears on the test scope; then turn R225 (R25) ccw until the test scope display breaks up. Continue to alternate back and forth between the two adjustments until R245 (R45) is set to the most ccw position giving a stable square wave display on the test scope.

10b. (cont'd)

Check that the test scope display does not "break up" in + SLOPE or - SLOPE. Readjust R245 (R45) and R225 (R25) if necessary.

Unground the TRIGGER LEVEL switch terminal.

Change the SAC to 20mVOLTS and check that the display cannot be triggered at any setting of the TRIGGER LEVEL and SLOPE controls.

Change the SAC to 100mVOLTS and check that a single setting of TRIGGER LEVEL can be found that will provide a triggered display in both + and - SLOPE.

Set the SAC to 5 VOLTS and adjust 1M1 VARIABLE for 1cm of amplitude. Change TRIGGER SOURCE to NORM INT.

Change the SAC to .2 VOLTS (0.4mm display) and check that the display cannot be triggered at any setting of the TRIGGER LEVEL and SLOPE controls.

Change the SAC to .5 VOLTS (1mm display) and check that the display can be triggered in both + and - SLOPE with readjustment of TRIGGER LEVEL.

Change the SAC to 1 VOLT (2mm display) and check that triggered displays can be obtained in + SLOPE and - SLOPE without readjustment of TRIGGER LEVEL.

c. Adjust Int Trig DC Level R209 (R9): 4mm at graticule center

Set the SAC TO 10 VOLTS and the 1M1 to GAIN SET (4mm display). Position the TYPE 546 display to the graticule center. Change COUPLING to DC. Ground the outboard terminal of the TRIGGER LEVEL X10 switch again and adjust Int Trig DC Level R209 (R9) for a stable display.

Remove the ground from the TRIGGER LEVEL switch.

d. Check for oscillations: none

Set COUPLING to AC and SAC to .5 VOLTS (1mm display). Check for no oscillations on the test scope display when the TRIGGER LEVEL is rotated through its range.

Remove the SAC signal from the "T" connector.

10. (cont'd)

e. Align TRIGGER LEVEL knob

Set the test scope VOLTS/CM to 0.1 DC-coupled and establish its zero volts DC reference line.

Connect the test scope's 10X probe to the outboard terminal of TRIGGER LEVEL X10 switch and adjust TRIGGER LEVEL for zero volts on the test scope. Without moving the pot shaft, set the knob index to front panel "0", tighten the setscrew, and re-check the test scope display.

f. Check TRIGGERING LEVEL range:
Normal, at least + & -2V;
X10, at least + & -20V

Check the voltage swing on the test scope display when the TRIGGERING LEVEL control is rotated through its range. Check for a range of at least + and -2 volts.

Pull TRIGGERING LEVEL knob out for 10X RANGE INCREASE and check for a range of at least + and -20 volts.

Push in on TRIGGERING LEVEL knob and remove the test scope probe.

g. Check AUTO triggering: ≤20Hz repetition rate

Apply 50mS markers from the TYPE 184 to 1M1 EXT INPUT. Set the TYPE 546 front panel controls as follows:

1M1 VARIABLE	1cm display
TIME/CM	10mS
TRIGGERING MODE	AUTO STABILITY
TRIGGERING LEVEL	Stable display

Change the TYPE 184 to 100mS and check for an untriggered display at all settings of the TRIGGERING LEVEL control.

Remove the TYPE 184 markers and check that the baseline remains when TRIGGERING LEVEL is rotated from one extreme to the other.

Set the TRIGGERING MODE switch to TRIG and check that no baseline exits while the sweep is not triggered.

10. (cont'd)

h. Check LINE triggering: correct slope

Change TRIGGERING SOURCE to LINE. Connect the 10X probe from 1M1 EXT INPUT "T" connector to the fuse holder.

Check that the display triggers on the correct slope with COUPLING in AC and DC.

Remove the 10X probe from the TYPE 546.

Calibrate Time Base A triggering to the end of Step 12h; then repeat the procedure for Time Base B.

i. Check PLUG IN INT triggering

Apply a 100 volt square wave signal from the SAC to the 1M1 EXT INPUT. Set the front-panel controls as follows:

TRIGGERING SOURCE	PLUG IN INT
TRIGGERING LEVEL	0
TIME/CM	1mSEC
(1M1) TEST FUNCTION	CHOPPED

Rotate the VARIABLE TIME/CM and check that the square wave signal is triggering the display.

Remove the SAC from the "T" connector.

j. Check sine-wave triggering

Connect the output of the LF Sine Wave Generator to the "T" connector. Adjust amplitude and frequency of the applied signal as directed in the following chart.

Be sure to check triggering of both time bases in both positions (+ and -) of the SLOPE switches.

COUPLING	SOURCE	LFSWG Frequency	Signal Amplitude, P-P: Stable display with TRIGGER LEVEL fixed	Signal Amplitude, P-P: No display in any setting of TRIGGER LEVEL
AC	NORM INT	1 kHz	2mm	½mm
DC	NORM INT	1 kHz	4mm*	----
AC LF REJ	NORM INT	200 Hz	----	4mm
AC LF REJ	NORM INT	2 kHz	2mm	½mm
AC	EXT	1 kHz	0.1 V	0.02 V
DC	EXT	1 kHz	0.1 V	0.02 V

* When positioned within ½cm of graticule center; anywhere on the graticule with adjustment of TRIGGER LEVEL.

Disconnect the LF Sine Wave Generator from the "T" connector.

11. SINGLE SWEEP

Set both TRIGGERING SOURCE switches to INT NORM. Apply .5 VOLTS from the SAC to 1M1 EXT INPUT and adjust VARIABLE for 0.5cm amplitude. Set HORIZONTAL DISPLAY switch to A. Adjust A TRIGGERING LEVEL for a stable display. Set HORIZONTAL DISPLAY switch to B and adjust B TRIGGERING LEVEL for a stable display. Remove the SAC signal from 1M1 EXT INPUT.

Press SINGLE SWEEP to RESET. Check for lit READY neons.

Reapply SAC signal to 1M1 EXT INPUT. Check that both sweeps run once (set HORIZONTAL DISPLAY to A, then to B) and the neon extinguishes.

Check all functions of HORIZONTAL DISPLAY switch for correct SINGLE SWEEP operation as directed in the following table:

HORIZONTAL DISPLAY	lit READY neon	display
A	A and B	A sweep only
B	A and B	B sweep only
B INTENS BY A	B only	one B intens by A sweep
A DLY'D	B only	one sweep of A delayed sweep
EXT X1	A and B	none
EXT X10	A and B	none

Remove the SAC signal. Return SINGLE SWEEP switch to NORMAL.

12. EXTERNAL DELAY INPUT

a. Setup

Connect a 50Ω coax cable from the TYPE 546 CAL OUT to the EXTERNAL FUNCTION CHECKER, CAL INPUT. Connect a 50Ω cable from SINGLE SWEEP RESET INPUT to EXTERNAL FUNCTION CHECKER, SINGLE SWEEP INPUT. Connect the 4 conductor cable from the EXTERNAL FUNCTION CHECKER to the TYPE 546 EXTERNAL DELAY INPUT.

12a. (cont'd)

Set the TYPE 546 as follows:

HORIZONTAL DISPLAY	B
B TIME/CM	.1μSEC
B TRIGGERING MODE	AUTO
AMPLITUDE CALIBRATOR	100 VDC

Set EXTERNAL FUNCTION CHECKER to position number 1. Connect test scope 10X probe to + GATE B binding post on EXTERNAL FUNCTION CHECKER. Ground probe to the EXTERNAL FUNCTION CHECKER.

b. Check + GATE B, pin c: amplitude ≥2V risetime ≤70ns

Check pulse on test scope: 2V min, risetime 70ns max. Remove probe.

c. Check pin d, GND: B neon on Checker lit

Rotate HORIZONTAL DISPLAY thru all positions and check that B neon on the EXTERNAL FUNCTION CHECKER is lit. Set B TIME/CM to 1mSEC. Set A TRIGGERING MODE to AUTO.

d. Check pin b: A neon on Checker is lit in B INTENS BY 'A'.

Rotate HORIZONTAL DISPLAY switch thru all positions and check that A neon on FUNCTION CHECKER is lit only in B INTENS BY 'A'.

e. Check pin a: A DLY'D sweep disappears

Set EXTERNAL FUNCTION CHECKER to position 2.

Set HORIZONTAL DISPLAY to A DLY'D. With the trace displayed, set FUNCTION CHECKER to position 1 and note that A DLY'D sweep disappears.

13. SINGLE SWEEP RESET INPUT

Set both A and B TIME/CM to .1mSEC, HORIZONTAL DISPLAY to A. Check normal display of sweep. Set SINGLE SWEEP switch to SINGLE SWEEP and note sweep disappears. Set FUNCTION CHECKER to position 2. Press reset button on the EXTERNAL FUNCTION CHECKER and check for a single sweep. Remove the EXTERNAL FUNCTION CHECKER and return SINGLE SWEEP switch to NORMAL.

14. EXTERNAL WAVEFORMS

a. Check VERT SIG OUT:
amplitude, ≥0.30V/cm
risetime, ≤20ns

Set 1M1 TEST FUNCTION to + PULSE and REPETITION RATE to MED. Adjust 1M1 AMPLITUDE for a 4cm display. Connect test scope 10X probe to VERT SIG OUT binding post and check test scope waveform. Amplitude 1.2V min and risetime, 20ns, max.

b. Check SWEEP A: ≥9.0V/cm at 1mSEC

Set A TIME/CM to 1mSEC. Connect the test scope 10X probe to SWEEP A binding post. Check sawtooth amplitude: 9.0V/cm of TYPE 547 sweep. If sweep is 10.5cm, min amplitude is 94.5V.

c. Check DLY'D TRIG: amplitude, ≥10V

Connect the test scope 10X probe to DLY'D TRIG binding post. Check the pulse amplitude, 10V min. Check for a DLY'D TRIG pulse at all B TIME/CM and HORIZONTAL DISPLAY to B.

d. Check + GATE A: amplitude ≥20V

Connect the test scope 10X probe to the +GATE A binding post. Check square-wave amplitude, 20V min.

e. Check + GATE B: amplitude ≥20V

Connect the test scope 10X probe to +GATE B binding post. Check the square-wave amplitude, 20V min.

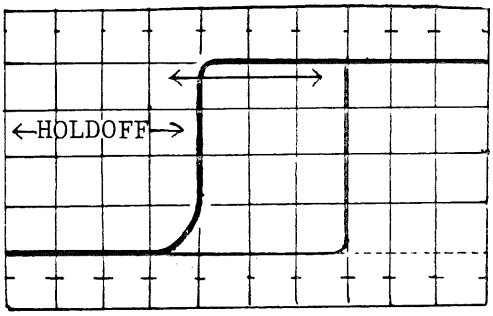
15. HOLDOFF

Check TIME BASE B and then TIME BASE A holdoff with test scope 10X probe on + GATE B and then + GATE A. Set test scope to DC triggering -Slope, and DC-coupled Vertical Input. Set both A and B TRIGGERING LEVELS cw. Set 1M1 TEST FUNCTION to LOW LOAD. Use the following table:

15. (cont'd)

TIME/CM	A & B holdoff
.1µSEC	9-27µs
.2µSEC to 5µSEC	5-15µs
10µSEC to 50µSEC	16-28µs
.1mSEC to .5mSEC	70-130µs
1mSEC to 5mSEC	0.9-1.7ms
10mSEC to 50mSEC	9-17ms
.1 SEC to .5 SEC	90-170ms
1 SEC to 5 SEC	0.5-0.9 s

Measuring holdoff from the + GATE.



16. TIME BASE B UNBLANKING

a. Check BRIGHTNESS range: ≥20V

Set both TIME/CM switches to 10µSEC, and set both TRIGGERING LEVELS cw. Set test scope Vertical VOLTS/CM to 2, INPUT DC and connect a 10X probe to V193 pin 3. Set test scope TIME/CM to .2mSEC and adjust triggering for a stable display.

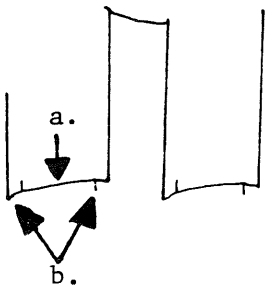
Set BRIGHTNESS control fully cw and check the position of the top of the pulses. Rotate BRIGHTNESS fully ccw and check the position of the tops of the pulses, 20V (1.0cm) or more from previous position. Set BRIGHTNESS control for equal DC level of A and B unblanking pulses.

b. Adjust B unblanking time constant C186: ≥40,000:1 ratio

Adjust C186 for min aberration of the unblanking pulses. Remove the test scope probe from V193.

Set B TIME/CM to 20mSEC and A TIME/CM to 5µSEC. Set BRIGHTNESS ccw and adjust INTENSITY for a trace. Slowly rotate B BRIGHTNESS cw until 2 traces of equal intensity are obtained.

b. Unblanking pulses



17. MAGNIFIER REGISTRATION

a. Setup

Connect the TYPE 184 to 1M1 EXT INPUT. Set the TYPE 184 for .1mS, 1mS and 5mS markers.

17. (cont'd)

Set the TYPE 546 as follows:

B TIME/CM	1mSEC
HORIZONTAL DISPLAY	B
TRIGGERING MODE	TRIG
TRIGGERING SLOPE	+
TRIGGERING COUPLING	AC
TRIGGERING SOURCE	NORM INT

b. Adjust Swp/Mag Regis, R569: ±1mm

Adjust B TRIGGERING LEVEL for a stable display. Check the position of the middle 5mS marker. Set SWEEP MAGNIFIER to X10. Position the middle 5mS marker to the graticule center. Set SWEEP MAGNIFIER to X1 OFF. Adjust Swp/Mag Regis R569 to return the marker to graticule center. Repeat until interaction is eliminated.

18. HORIZONTAL AMPLIFIER GAIN

a. Adjust X10 Cal R544: ±3%

Set SWEEP MAGNIFIER to X10. Adjust X10 Cal R544 for one .1mS marker per cm.

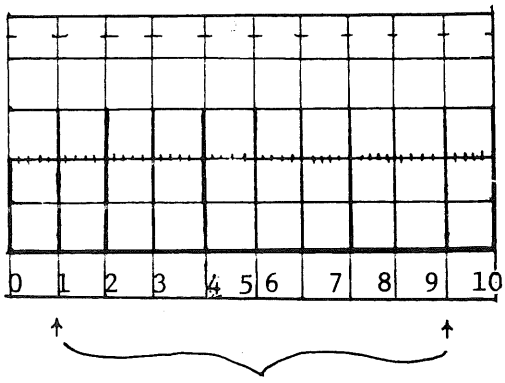
b. Adjust X1 Cal R566: ±1%

Set SWEEK MAGNIFIER to X1 OFF. Adjust X1 Cal R566 for one 1ms marker per cm. Adjustment of R544 and R566 interact; repeat until interaction is eliminated.

c. Check X5 and X2 magnified: ±3%

Set SWEEP MAGNIFIER to X5. Check for two .1mS markers per cm, ±3% max. Set SWEEP MAGNIFIER to X2. Check for one 1mS marker per 2cm, ±3% max. Set SWEEP MAGNIFIER to X1 OFF. Recheck Swp/Mag Regis (Step 17b).

Unless noted otherwise, use the middle 8 horizontal centimeters when making horizontal amplifier gain and timing checks or adjustments.



19. TIME BASE A/TIME BASE B MATCH

a. Setup

Preset TYPE 546 as follows:

HORIZONTAL DISPLAY	A
SWEEP MAGNIFIER	X1 OFF
A and B TIME/CM	1mSEC
A and B TRIGGERING	TRIG, +, AC, NORM INT
BRIGHTNESS	cw

19. (cont'd)

b. Adjust A Sweep Cal R290Y: ±0.5%

Position the display to the left so that the start of the sweep is at the left edge of the graticule. Switch HORIZONTAL DISPLAY between A and B and adjust A Sweep Cal R290Y so TIME BASE A timing matches that of TIME BASE B over the middle eight centimeters of the display.

Set HORIZONTAL DISPLAY to A and check the position of the marker at the 9th cm line. Position it to the center graticule line. Set SWEEP MAGNIFIER to X10 and readjust R290Y to align the markers with each other.

c. Adjust A Sweep Length R325: 10.2 to 10.8cm

Adjust A Sweep Length R325 for 10.5cm of sweep length.

d. Adjust B Sweep Length R125: 10.2 to 10.8cm

Adjust B Sweep Length R125 to equal A sweep length.

e. Check VARIABLE TIME/CM: ratio ≥2.5:1

Set HORIZONTAL DISPLAY to A and set the TYPE 184 for 5mS markers. Rotate VARIABLE TIME/CM ccw. Check distance between markers, 2cm max. Check that UNCALIBRATED neon is on. Repeat for other TIME BASE.

20. DELAY PICKOFF

a. Setup

HORIZONTAL DISPLAY	B INTENS BY 'A'
A TRIGGERING	AUTO, +, AC, NORM INT
A TIME/CM	10μSEC
B TIME/CM	1mSEC
B Triggering	TRIG, +, AC, NORM,INT

Set the TYPE 184 for 1mS markers.

20. (cont'd)

b. Adjust Delay Start, R418 and Delay Stop, R415: ±0.15%

Adjust the BRIGHTNESS and INTENSITY for an easily seen intensified zone. Set the DELAY-TIME MULTIPLIER to 1.00. Adjust Delay Start R418 so intensified zone falls on the 1cm marker and the delayed sweep starts on the rising portion of its marker.

Set the DELAY-TIME MULTIPLIER to 9.00. Adjust Delay Stop R415 so intensified zone falls on the 9cm marker and the delayed sweep starts on the rising portion of its marker.

Delay Start and Delay Stop adjustments interact, so repeat as necessary.

c. Check incremental accuracy: ±0.15%

Adjust the DELAY-TIME MULTIPLIER to the rising portion of each marker between 1.00 and 9.00. Check dial reading 1.00, ±1.5 minor div max, between markers.

d. Check triggering at 0.15 DTM setting

Set HORIZONTAL DISPLAY to A DEL'YD.
Set DELAY TIME MULTIPLIER to 0.15 and check for a display.

21. TIME BASE B TIMING

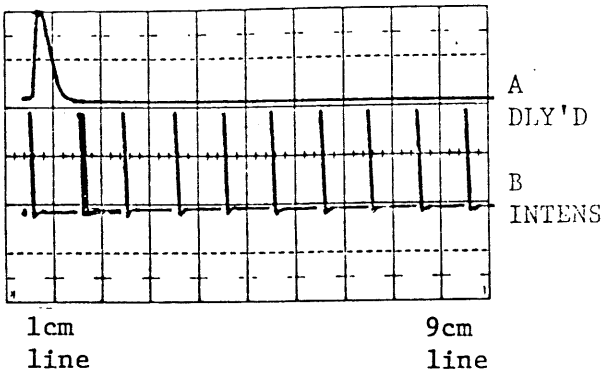
a. Preset Timing

Set HORIZONTAL DISPLAY to B. Set B TIME/CM to 10μSEC. Change TYPE 184 to 10μs markers. Adjust B TRIGGERING LEVEL for a stable display. Preset TIME BASE B timing using the following table:

TIME/CM	TYPE 184	adjust	for
10μSEC	10μS	C90C	1 marker/cm
1μSEC	1μS	C90B	1 marker/cm
.5μSEC	1μS	C90A	1 marker/2cm
.1μSEC	.1μS	C99	1 marker/cm

21. (cont'd)

b. Adjust B timing, C90C, C90B, C90A & C99: within 0.8%



Set the HORIZONTAL DISPLAY switch to B INTENS BY 'A' ALT A DLY'D. Change B TIME/CM to 10μSEC and A TIME/CM to 1μSEC. Set the TYPE 184 to 10μS markers. Set DELAY-TIME MULTIPLIER to 1.00. Use the HORIZONTAL POSITION control to position the falling portion of the delayed time marker to coincide with the intersection of the horizontal and vertical graticule lines 1cm from the left edge. Change the DELAY-TIME MULTIPLIER to 9.00 and adjust C90C to bring the time marker to the same position. Readjust C90C as necessary. Use this method and the following table to adjust fast timing.

B TIME/CM	A TIME/CM	TYPE 184	adjust	max error (dial minor div)
10μSEC	1μSEC	10μS	C90C	±6.4
1μSEC	.1μSEC	1μS	C90B	±6.4
.5μSEC	.1μSEC	.1μS,	C90A	±6.4 (Apply 1μS trigger from TYPE 184)
.1μSEC	.1μSEC	.1μS	C99	for 1 marker/cm on intensified trace

Repeat until interaction is eliminated.

c. Check fast sweep linearity: within 0.5%

Set B TIME/CM to .5μSEC and rotate the DELAY-TIME MULTIPLIER to 1.00. Position the nearest marker to the 1cm graticule line with the HORIZONTAL POSITION control. Set the DELAY-TIME MULTIPLIER dial to 2.00 and check for ≤4 minor dial div of error between markers. Repeat, checking linearity at each major dial division from 1.00 to 9.00.

d. Check timing accuracy: within 0.8%

Set DELAY-TIME MULTIPLIER to 1.00 and set B TRIGGERING SOURCE to NORM INT. Use the HORIZONTAL and VERTICAL POSITION controls to position the falling portion of the delayed time marker to coincide with an intersection of the horizontal and vertical graticule lines. Change the DELAY-TIME MULTIPLIER to ≈ 9.00 and set it to bring the time marker to the same position.

21. (cont'd)

Check that the DELAY-TIME MULTIPLIER dial is set to 9.00 ±6.4 minor divisions. Use this method and the following table to check time base B timing accuracy.

B TIME/CM	A TIME/CM	TYPE 184
.2µSEC	.1µSEC	.1µS
.5µSEC	.1µSEC	.1µS
1µSEC	.1µSEC	1µS
2µSEC	.2µSEC	1µS

Trigger TIME BASE B +INT.

5µSEC	.5µSEC	5µS
10µSEC	1µSEC	10µS
20µSEC	2µSEC	10µS
50µSEC	5µSEC	50µS

Set HORIZONTAL DISPLAY to A DLY'D; check as before with DELAY-TIME MULTIPLIER at 0.50 and 8.50.

.1mSEC	10µSEC	.1mS
.2mSEC	20µSEC	.1mS
.5mSEC	50µSEC	.5mS
1mSEC	.1mSEC	1mS
2mSEC	.2mSEC	1mS
5mSEC	.5mSEC	5mS
10mSEC	1mSEC	10mS
20mSEC	2mSEC	10mS
50mSEC	5mSEC	50mS
.1 SEC	1mSEC	.1 S
.2 SEC	2mSEC	.1 S
.5 SEC	5mSEC	.5 S
1 SEC	.1 SEC	1 S
2 SEC	.2 SEC	1 S
5 SEC	.5 SEC	5 S

22. HIGH SPEED COMPENSATION

a. Adjust C572, C582, C591, C576 & C586: within 3%

Set HORIZONTAL DISPLAY to B and B TIME/CM to .1µSEC. Change the TYPE 184 to .1µS and recheck adjustment of C99. Preset C576 and C586 4 to 6 turns from max. Change TYPE 184 to 20nS and adjust the TRIGGERING LEVEL for a stable display. Set SWEEP MAGNIFIER to X10.

22a. (cont'd)

Use an insulated tool to adjust C572 and C582 for max expansion of the sweep. Adjust C591 for max sweep expansion and best linearity (to be reset later).

Adjust C576 and C586 for best timing at sweep center. These two capacitors should not be allowed to differ in adjustment. If the sweep seems too long with C576 and C586 at this setting, adjust C572 to reduce displayed gain.

If C576 and C586 don't seem to have enough range, repeat adjustment procedure for C572, C582, & C591. If, after the repeat, the compensation is worse rather than better, C576 and C586 were preset to the wrong values. Back off C576 and C586 a turn or two and redo the compensation.

b. Adjust X10 mag, C557H: within 3%

Position start of sweep to graticule left edge. Adjust B TRIGGERING LEVEL so that a cycle peak falls at the 4cm mark. Position trace so this cycle peak falls at the start of the graticule. Adjust C557H for 1 cycle per 2cm. Readjust C591 for the best linearity. Check the center of the sweep for accuracy. Readjust C572 for correct gain.

If center of sweep is out of timing specifications, slight adjustment of C576 & C586 should correct.

Set SWEEP MAGNIFIER to X1 OFF. Adjust HORIZONTAL POSITION so the start of the sweep is at the left edge of the graticule. Note the display at the 8th cm line and slowly position it to the left until it is at the center line.

Set SWEEP MAGNIFIER to X10 and check for 1 cycle/2cm $\pm$2.4mm. Check magnified sweep linearity at a number of points between the 1st and 8th unmagnified cm of display.

c. Adjust X5 mag, C557F: within 3%

Set SWEEP MAGNIFIER to X5. Position the third cycle at the start of the graticule Adjust C557F for 1 cycle per cm, excluding the first and last 2cm of sweep.

d. Adjust X2 mag, C557D: within 3%

Set SWEEP MAGNIFIER to X2. Adjust C557D for 5 cycle/2cm, exclude the first 1cm of display. Set SWEEP MAGNIFIER to X1.

23. TIME BASE A TIMING

a. Set timing: max error, ±1%

Change HORIZONTAL DISPLAY to A, TIME BASE A TIME/CM to 10μSEC and TRIGGERING MODE to TRIG. Apply 10μS markers from the Type 184 and adjust TRIGGERING LEVEL for a stable display.

Use the following table to set timing:

A TIME/CM	TYPE 184 Markers	Adjust or Check	For
10μSEC	10μS	C290C	1 mark/cm
20μSEC	10μS		2 marks/cm
50μSEC	50μS	(check)	1 mark/cm
1μSEC	1μS	C290B	1 mark/cm
2μSEC	1μS	(check)	2 marks/cm
5μSEC	5μS	(check)	1 mark/cm
.5μSEC	1μS	C290A	1 mark/cm
	Apply 10μS triggers from Type 184 to A and B TRIGGER INPUT.		
.1μSEC	.1μS	C299	1 mark/cm

Time Base A Sweep Cal R290Y was set in Step 19b.

Repeat the above procedure to eliminate interaction until all adjustments are satisfactory.

b. Check timing accuracy: within 1% (.8mm in 8cm)

.1μSEC	.1μS	(check)	1 mark/cm
.2μSEC	.1μS		2 marks/cm
.5μSEC	.5μS		1 mark/cm
1μSEC	1μS		1 mark/cm
2μSEC	1μS		2 marks/cm
5μSEC	5μS		1 mark/cm
10μSEC	10μS		1 mark/cm
20μSEC	10μS		2 marks/cm
50μSEC	50μS		1 mark/cm
.1mSEC	.1mS		1 mark/cm
.2mSEC	.1mS		2 marks/cm
.5mSEC	.5mS		1 mark/cm
1mSEC	1mS		1 mark/cm
2mSEC	1mS		2 marks/cm
5mSEC	1mS		1 mark/cm
10mSEC	10mS		1 mark/cm
20mSEC	10mS		2 marks/cm
50mSEC	50mS		1 mark/cm

23b. (cont'd)

10mSEC	10mS	1 mark/cm
20mSEC	10mS	2 marks/cm
50mSEC	50mS	1 mark/cm
.1 SEC	.1 S	1 mark/cm
.2 SEC	.1 S	2 marks/cm
.5 SEC	.5 S	1 mark/cm
1 SEC	1 S	1 mark/cm
2 SEC	1 S	2 marks/cm
5 SEC	1 S	1 mark/cm

24. TRIGGER DELAY

a. Check trigger delay: ≤100 nseconds

Change the TYPE 184 to 1μS time markers.

Set the controls of the TYPE 546 as follows:

HORIZONTAL DISPLAY	B INTENS BY 'A'
SWEEP MAGNIFIER	X1 OFF
A and B TIME/CM	.1 SEC
A Trigger	AUTO, +, AC, NORM INT
B Trigger	TRIG, +, AC, NORM INT

Adjust B TRIGGERING LEVEL for a stable display. Position first B sweep time mark to an intercept point on the graticule.

Set HORIZONTAL DISPLAY to A DLY'D. Set DELAY-TIME MULTIPLIER to 10.00 and fine-adjust the dial to place the delayed pulse at the same intercept point as B pulse was before.

Note difference from 10.00. Each minor div on the dial is equal to 1nsecond.

Example: Dial reading of 9.20 indicates 80nsecond trigger delay.

b. Check delay jitter: ≤1/40,000

Set the DELAY TIME MULTIPLIER to approx 10.00, placing the delayed waveform on screen. Set A TIME/CM to 1μSEC. Check the horizontal jitter of the display: ≤2.5mm.

Set DELAY-TIME MULTIPLIER to approx 1.00 and check jitter as before.

24. (cont'd)

c. Check B sweep foldover: none in 10.5cm

Change both A and B TIME/CM switches to 2μSEC. Set B TRIGGERING MODE to AUTO. Remove the TYPE 184 signal from the 1M1 EXT INPUT. Rotate INTENSITY control to full ccw, then back cw until the trace is just visible; turn INTENSITY control cw 1 minor division from this point. Check end of B trace for foldover: there must be no visible foldover within 10.5cm of the start of sweep.

25. EXTERNAL HORIZONTAL AMPLIFIER

a. Setup

Connect the SAC through a T-connector to the HORIZ INPUT and A TRIGGER INPUT connectors. Connect a patch cord from SWEEP A binding post to 1M1 EXT INPUT. Set the SAC to .5 VOLTS.

Preset the TYPE 546 as follows:

HORIZONTAL DISPLAY	EXT X1
VAR 10-1	cw
A TIME/CM	1mSEC
A TRIGGERING SOURCE	EXT
A TRIGGERING LEVEL	midrange

b. Adjust Ext Horiz DC Bal R519: ≤1cm shift

Adjust HORIZONTAL POSITION control to place the left edge of the display at graticule center. Adjust 1M1 VARIABLE for several cycles of display. Rotate VAR 10-1 back and forth and adjust Ext Horiz DC Bal R519 for no shift of the left edge of the display.

Switch HORIZONTAL DISPLAY back and forth between EXT X1 and EXT X10. Any baseline shift indicates V 514 is probably gassy and should be replaced.

c. Adjust X1 compensation C524: ≤3% Overshoot or rolloff

Return HORIZONTAL DISPLAY to EXT X1. Set VAR 10-1 cw and center the square-wave on the graticule. Adjust C524 for the best corner, ≤3% overshoot or rolloff (1.8mm).

25. (cont'd)

d. Check gain: ≤90mV/cm

Check display amplitude ≥5.5cm with VAR 10-1 cw.

e. Check VAR 10-1 ratio: ≥10:1

Set VAR 10-1 ccw, change SAC to 5 VOLTS and check amplitude for ≤ that observed in 28d. Set VAR 10-1 cw.

f. Adjust X10 compensation, C503C: ≤3%

Set HORIZONTAL DISPLAY to EXT X10 and adjust C503C for ≤3% overshoot or rolloff.

If a shift in baseline level is observed when HORIZONTAL DISPLAY is changed from X1 to X10, the External Horizontal Input tube V514 is probably gassy and should be replaced.

g. Check X10 attenuation accuracy: within ±2%

Set VAR 10-1 for 5cm of amplitude. Change the SAC to .5 VOLTS and HORIZONTAL DISPLAY to EXT X1. Check for 5cm ±1mm.

h. Check bandwidth: ≥450 kHz at -3dB

Remove "T" connector from TRIGGER INPUT and patch cord from HORIZ INPUT.

Set VAR 10-1 cw. Connect the TYPE 191 OUTPUT with a 50Ω TERMINATION to the HORIZ INPUT. Adjust the TYPE 191 for 4cm of display at 50 kHz. Change the TYPE 191 frequency to 450 kHz. Check for ≥2.8cm of display.

Change the HORIZONTAL DISPLAY switch to EXT X10 and repeat bandwidth check. Recheck DC BAL. Remove TYPE 191 signal, 50Ω TERMINATION and patch cord. Set HORIZONTAL DISPLAY to A.

26. Z AXIS MODULATION ≤10V P-P sufficient for intensity blanking

Remove the EXTERNAL CRT CATHODE GND strap, set CRT CATHODE SELECTOR to EXTERNAL CRT CATHODE and connect the SAC ⊔⊓ signal to the EXTERNAL CRT CATHODE binding post. Set the SAC AMPLITUDE to 10 VOLTS. Check for intensity modulation (a series of dashes). Remove the adapter from the binding post, reconnect the GND strap and change the CRT CATHODE SELECTOR switch to CHOPPED BLANKING.

27. TRANSIENT RESPONSE

a. Adjust Vertical HF compensation:
+ PULSE; ≤0.6mm aberration
- PULSE; ≤0.7mm aberration

Set HORIZONTAL DISPLAY to B. Change B TIME/CM to .1μSEC and TRIGGERING MODE to AUTO. Set 1M1 TEST FUNCTION to + PULSE and REPETITION RATE to MED. Adjust the AMPLITUDE and VERTICAL POSITION controls for a 4cm display centered on the graticule. Adjust TRIGGERING LEVEL for a stable display.

Make final adjustments with SWEEP MAGNIFIER at X10. Move back and forth between the X10 and X1 OFF positions and the .1μSEC and 1μSEC TIME/CM positions to check the overall level.

Most of the Vertical HF adjustments interact, so repeat as necessary to obtain a waveform with flat top and minimum aberrations, ≤0.4mm with waveform centered on the graticule.

The Vertical HF compensations should be adjusted for ≤1% aberration to allow for test equipment tolerances.

adjustment	location
L1157, adjust for min wrinkles at leading edge	main vert amp chassis
C1029, delay line termination, approx 340nsec from start of sweep	main vert amp chassis
C1076, med time constant compensation	EC board
C1105, fast time constant compensation	EC board
C1106, med time constant compensation	EC board
C1126, long time constant compensation	EC board
R1076, adjust with C1076	EC board
R1106, adjust with C1106	EC board
C1027, adjust for ≤6.7ns risetime (see step b)	main Vert Amp chassis

Switch 1M1 TEST FUNCTION to -PULSE and TRIGGERING SLOPE to -. Vertically position the display to the center 4cm of the graticule and check for ≤0.4mm overshoot or rolloff.

27. (cont'd)

b. Check risetime: ≤6.25ns

Adjust the 1M1 AMPLITUDE for a 4cm display. Set the TIME/CM to .1μSEC and the SWEEP MAGNIFIER to X10 and measure the risetime.

c. Check spoiler switch: risetime ≤10ns

Depress the spoiler switch, lower left corner of the plug-in compartment, and check risetime, ≤10ns.

d. Check positioning effect: ≤1.5mm

Move the top of the pulse to the bottom graticule line. Check for 1.5mm or less change in the top of the waveform.

28. HIGH FREQUENCY TRIGGERING

a. Check external: 200mV 50 MHz signal

Remove the 1M1 from the TYPE 547 and install the TYPE 1A1 in its place. Connect the SAC output coax cable to the CHANNEL 1 INPUT. Set CHANNEL 1 INPUT SELECTOR to DC, VOLTS /CM to .05 and VARIABLE VOLTS/CM to CALIB. Set the SAC to .2 VOLTS and adjust CHANNEL 1 .05V/CM GAIN for 4cm of display.

Install a BNC "T: connector on the CHANNEL 1 INPUT. Connect a 50Ω coax cable through a 50Ω TERMINATION from the "T" to the TIME BASE B TRIGGER INPUT. Connect the OUTPUT of the TYPE 191 with a 50Ω TERMINATION to the remaining side of the "T" connector. Set the TYPE 191 for a 200mV 50 kHz signal, then change the frequency to 50 MHz. Check + and - SLOPE in AC, AC LF REJ and DC COUPLING. Use both TRIG and AUTO STABILITY MODES. Change 50Ω TERMINATION and cable from B TRIGGER INPUT to A TRIGGER INPUT. Change HORIZONTAL DISPLAY to A and repeat checks for TIME BASE A.

b. Calculating risetime

The risetime of the system under test is determined by the formula:

$$T_r = \sqrt{(T_r\ 1M1)^2 + (T_r\ 546)^2}$$

Where:

T_r = actual risetime of the 546/1M1 system

T_r 1M1 = actual risetime of the 1M1 alone

T_r 546 = actual risetime of the TYPE 546 alone

Therefore the risetime of the 1M1 must be known before the risetime of the TYPE 546 can be determined.

For example, if the T_r of the 1M1 is 2.55ns and the test limit for the TYPE 546 calls for a T_r of ≤6.25ns, then the maximum observed risetime of the system should be:

$$T_r = \sqrt{(2.55)^2 + (6.25)^2} = 6.75\text{ns}$$

28. (cont'd)

b. Check internal: 6mm 50MHz signal AC and AC LF REJ, ≤2mm jitter

Change TIME BASE A SOURCE switch to INT NORM. Increase the TYPE 191 OUTPUT AMPLITUDE for a display of 6mm. Set SWEEP MAGNIFIER to X10. Check + and - SLOPE, AC and AC LF REJ COUPLING in both TRIG and AUTO STABILITY MODE. Change HORIZONTAL DISPLAY to B and repeat checks for TIME BASE B.

THE END