FACTORY CALIBRATION PROCEDURE

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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:

0-331 July 1967

For all serial numbers.

Supersedes January 1964



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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.

PMSE

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. (KM)



COMPANY CONFIDENTIAL

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 50 Ω TERMINATION, BNC (011-0049-00)
 - 3 50 Ω coax cables, BNC (012-0057-00)
 - 2 BNC "T" connectors (103-0030-00)
 - 2 18" patch cords, banana plug to BNC (012-0091-00)
 - BNC female to UHF male adapter (103-0015-00)
 - TYPE 547 EXTERNAL FUNCTION CHECKER (067-0564-99)
 - c. Other Equipment
 - 1 $20,000\Omega/VDC$ multimeter
 - 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.
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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
- Set DELAY-TIME MULTIPLIER dial: d. 0.15 to >10.15
- 2. PRESET CONTROLS
- RESISTANCE CHECKS
- 4. POWER SUPPLIES
- Check time-delay relay: 15 to 60 seconds а.
- Adjust -150V, R616: -150V $\pm 2\%$ Ъ.
- Check power supply voltage and regulation c.

Max Error	Max Ripple
±2%	3mV
±2%	7mV
±2%	3mV
±2%	20mV
±10%	7mV
	±2% ±2% ±2% ±2%

- Adjust High Voltage, R840: e. -1850V ±2%
- f. Check high voltage regulation: no blooming
- 5. AMPLITUDE CALIBRATOR
- Adjust Cal Ampl, R943: within ±1% a.
- Check voltage accuracy: within ±2% Ъ. except 100 VOLTS & 100 VDC, within ±1%
- * c. Check $R_0 = 50\Omega$ accuracy: within $\pm 2\%$
 - Check for correct output d.
 - Check symmetry: 45% to 55% e.
 - Check frequency: 1 kHz ±25%

- 5. (cont'd)
- g. Check risetime: 5 VOLTS <0.4µs 100 VOLTS <0.6μs
 - h. Check 5mA T: present on loop
 - 6. CRT
 - Check graticule alignment: $\leq 3^{\circ}$ tilt
 - Check TRACE ROTATION range: at least $+ & -3^{\circ}$ from electrical center
 - Adjust Geometry, R861: $\leq 1 \text{mm bowing}$ Check horizontal focus: 0.5 mm
 - resolution
 - Check orthogonality: $\leq 1^{\circ}$ deviation e.
 - f. Check horizontal geometry: <1mm bowing
- Check vertical focus: 0.5mm g. resolution
- 7. VERTICAL AMPLIFIER
- Check stage unbalance: <0.5cm a.
- 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:
- e. Check common mode rejection: >30:1
- f. Check DC Shift: <0.5mm
- 8. TRACE SEPARATION
- Tighten TRACE SEPARATION knob: traces superimposed at 0
- b. Check TRACE SEPARATION range: ≥ 3 to ≤ 5 cm
- 9. ALTERNATE TRACE AND CHOPPED BLANKING
- Check alternate trace sync pulse: amplitude $\geq 60 \text{V}$, risetime <1µs
- b. Check slave pulse: amplitude >40V risetime <0.7µs
- Check alternate operation: alternates at all sweep rates

- 9. (cont'd)
- d. Check chopped blanking: transients blanked
- 10. AUTOMATIC DISPLAY SWITCHING
- 11. SCALE ILLUM, POSITION INDICATING AND MAG ON LIGHTS
- a. Check graticule lighting
- Check position indicating neons: correct indicator must be on before spot leaves the scan area, and off before the spot is 2cm 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
- 12. TRIGGERING 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: <20 Hz repetition rate
- h. Check line triggering: correct slope
- i. Check PEUG-IN INT triggering
- j. Check triggering:

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

13. SINGLE SWEEP

SINGLE SWEEP on .5cm signal READY lights operate

- 14. EXTERNAL DELAY INPUT
- b. Check +GATE B, pin c: >2V amplitude <70ns risetime
- c. Check pin d, GND: "B" neon lit
- e. Check pin a: A DLY'D sweep disappears
- 15. SINGLE SWEEP RESET INPUT
- 16. SWEEP SWITCHING MULTIVIBRATOR AND TRIGGER AMPLIFIER
- a. Check sweep switching multivibrator: amplitude, 28V \pm 2V risetime, \leq 2.5 μ s falltime, \leq 0.3 μ s
- b. Check trigger amplifier: amplitude, $\ge 10 \text{V}$ falltime, $< 0.1 \mu \text{s}$
- 17. EXTERNAL WAVEFORMS
- a. Check VERT SIG OUT: amplitude >0.30V/cm, risetime <20ns
- b. Check SWEEP A: >9.0V/cm at 1 mSEC
- c. Check DLY'D TRIG: amplitude >10V
- d. Check +GATE A: amplitude >20V
- e. Check +GATE B: amplitude >20V
- 18. HOLDOFF

TIME/CM	A and B holdoff
.1µSEC	9-27μs
.2 to 5µSEC	5–15µs
10 to 50μSEC	16-28µs
.1 to $.5$ mSEC	70 –13 0µs
1 to 5mSEC	0.9 - 1.7 ms
10 to 50mSEC	9-17ms
.1 to .5 SEC	90-170 ms
1 to 5 SEC	0.5-0.9s

19. TIME BASE B UNBLANKING

- a. Check BRIGHTNESS range: >30V
- b. Adjust B unblanking time constant, C186: >40,000:1 ratio

20. MAGNIFIER REGISTRATION

b. Adjust Swp/Mag Regis, R569: ±1mm

21. HORIZONTAL AMPLIFIER GAIN

- * a. Adjust X10 Cal, R544: ±3%
- * b. Adjust X1 Cal, R566: ±1%
- * c. Check X5 and X2 magnified: ±3%

22. TIME BASE A/TIME BASE B MATCH

- b. Adjust A Sweep DC Level, R470: range >1cm
- c. Adjust A Sweep Cal, 290Y: ±0.5%
- d. Adjust A Sweep Length, R325: 10.2 to 10.8cm at 1ms/cm
- e. Adjust B Sweep Length, R125: 10.2 to 10.8cm at lms/cm

23. DELAY PICKOFF

- * b. Adjust Delay Start, R418 and Delay Stop, R415: ±0.15%
- * c. Check incremental accuracy: ±0.15%
 - d. Check Delayed sweep at DTM setting of 0.15
 - e. Check jitter: <1/40,000

24. TIME BASE B TIMING

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

25. 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: $\frac{-3}{3}$ error

26. TIME BASE A TIMING

- * b. Adjust timing C290C, C290B, C290A & C299: <1% error
 - c. Check fast timing match: <lcm difference
- * d. Check timing accuracy: <1% error

27. TRIGGER DELAY AND B SWEEP FOLDOVER

- a. Check trigger delay: <100ns
- b. Check B sweep foldover: none in 10.5cm

28. EXTERNAL HORIZONTAL AMPLIFIER

- c. Adjust X1 compensation C524:
 <3% overshoot or rolloff</p>
- * d. Check gain: <90mV/cm
 - e. Check VAR $10-\overline{1}$ ratio: >10:1
 - f. Adjust X10 compensation, C503C: <3% overshoot or rolloff
 - g. Check X10 attenuation: ±2%
- * h. Check bandwidth: >450 kHz at -3dB

29. Z AXIS MODULATION

<10V peak to peak required for intensity modulation

30. TRANSIENT RESPONSE

- a. Adjust Vertical HF compensation:

 +Pulse: <0.6 mm aberration
 -Pulse: <0.7 mm abberration
- * b. Check risetime: <6.25ns
 - c. Check spoiler switch: risetime <10ns
 - d. Check positioning effect: <1.5mm
 - e. Check corner symmetry: <0.5mm

- 31. HIGH FREQUENCY TRIGGERING
- a. Check external: 200mV at 50 MHz
- b. Check internal: 0.6cm at 50 MHz AC and AC LF REJ with ≤ 2 mm jitter
- * Indicates measurement characteristic; test equipment used must be traceable to the NBS for instrument certification.

THE END

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 black 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 reading of >10.15 at the cw end of its rotation.

PRESET CONTROLS

POWER	OFF
INTENSITY	CCW
FOCUS	CCW
ASTIGMATISM	CCW
SCALE ILLUM	ccw
TRACE SEPARATION	
BRIGHTNESS	CW
HORIZONTAL DISPLAY	Α
SWEEP MAGNIFIER	X1 OFF
SINGLE SWEEP	NORMAL
DELAY-TIME MULTIPLIER	5.00
HORIZONTAL POSITION	cw
VERNIER	CW
AMPLITUDE CALIBRATOR	OFF

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

2. (cont'd)

CRT CATHODE SELECTOR (rear)

TIME BASE A and B

TRIGGERING LEVEL cw (in)

MODE TRIG

SLOPE +

COUPLING AC

SOURCE NORM INT

TIME/CM 1mSEC

VARIABLE CALIBRATED

TRACE ROTATION midrange
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 750Ω with the switch in center position and ${>}5k\Omega$ 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	$1-2k\Omega$
+100V	$1\mathbf{-2k}\Omega$
+225V	2-3kΩ
+350V	25-35kΩ

4. POWER SUPPLIES

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

Connect the TYPE 547 power cord to the TYPE 76TU and set the TYPE 76TU to 115V as read on its meter. Turn TYPE 547 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.

4. (cont'd)

b. Adjust -150V, 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 while varying line voltage from 103.5 to 126.5VAC. Change the 1M1 to HIGH LOAD, turn the TYPE 547 AMPLITUDE CALIBRATOR to 5mAΩ, SWEEP MACNIFIER to X10 and both TRIGGERING MODE switches to AUTO STABILITY. Check power supply, error and ripple while varying line voltage from 103.5 to 126.5VAC.

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

Return TYPE 76TU to 115V.

d. Check elevated filaments

Locat	ion		Approx DC elevation
T601	term	34	+100V
T601	term	32	+350V
T601	term	5	HV (-1850V)

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

Connect the multimeter to the junction of R857-C854 and adjust High Voltage, R840, for $-1850V \pm 2\%$ (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.

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

Some variation in intensity may be noted when varying the line voltage. This is due to the change in CRT heater current and may 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 the TYPE 547 CAL OUT to the SAC UNK-IN. Set the AMPLITUDE CALIBRATOR to 100VDC and the SAC to 100V, MIXED, +DC. Remove V945 from the TYPE 547. Set the test scope TYPE 1Al VOLTS/CM to 1. Trigger the test scope in AUTO, -LINE and set the TIME/CM to .5mSEC. Adjust R943 for zero deflection on the test scope.

b. Check voltage accuracy: within ±2% (except 100 VOLTS & 100 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	2 cm
.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%.

c. Check $R_O = 50\Omega$ accuracy: within $\pm 2\%$

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

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:

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	TYPE 1A1	Approx
mVOLTS	VOLTS/CM	DEFLECTION
50	.02	2.5cm
20	.005	4cm
10	.005	2cm
5	.005	1cm
2	500μ∇/CM	4cm
1	500μV/CM	2cm
• 5	500μV/CM	1cm
. 2	500μV/CM	0.4cm

e. Check symmetry: 45% to 55%

Set test scope TRIGGERING SOURCE to INT and TIME/CM to $50\mu SEC$. 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 ±20%

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

g. Check risetime: 100 VOLTS $\leq 0.6 \mu s$ 5 VOLTS $\leq 0.4 \mu s$

Remove coax cables from test scope Vertical INPUT and TYPE 547 CAL OUT. Connect a X10 probe from test scope Vertical INPUT to TYPE 547 CAL OUT. Change TYPE 1A1 VOLTS/CM to 2 and TYPE 547 AMPLITUDE CALIBRATOR to 100 VOLTS. Set test scope TIME/CM to .5 μ SEC and check risetime: $<0.6\mu$ s. Change AMPLITUDE CALIBRATOR to 5 VOLTS and TYPE 1A1 VOLTS/CM to .1. Check risetime: $<0.4\mu$ s.

h. Check $5mA_{\square}$: 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 TYPE 547 CAL OUT. Connect the P6019 probe to 5mA — loop.

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

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

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

NOTES

5. (cont'd)

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: $\leq 3^\circ$

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. Be careful when connecting the meter; if trace rotator coil is shorted to ground, V91 heater will be destroyed. Adjust TRACE ROTATION for 0 volts. Check for <0.5cm tilt in 10cm (<3). Remove meter leads.

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 of rotation + & - 0.5cm from the position at OV. Set TRACE ROTATION so the trace is parallel with graticule center line.

c. Adjust Geometry R861: <1mm bowing

Connect the TYPE 184 to 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 TIME/CM for 1 time marker/cm. Change the TYPE 184 to .1ms markers. Adjust R861 for <1mm bowing in 6cm.

d. Check horizontal focus: <0.5mm resolution

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

e. Check orthogonality: $\leq 1^{\circ}$ 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 ≤ 1 mm (1°) .

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

6. (cont'd)

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 ≤ 1 mm 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 the CAL OUT and the 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 ≤ 0.5 cm from graticule center.

Short cases (collectors) of Q1074 and Q1084 together. Trace must be $\leq 0.5 \, \mathrm{cm}$ from electrical center.

Short the cases of Q1034 and Q1044 together. Trace must be $\leq 0.5 \, \text{cm}$ from (1) electrical center and (2) position noted in previous check.

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

b. Adjust Vert DC Bal R1004: range at least +&- lcm; 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.

Caution - do not short collectors to ground.

7. (cont'd)

c. Adjust Vertical Gain R101:
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 ≥ 4.4 cm. Set R1017 for exactly 4cm of deflection.

- d. Check compression or expansion: <0.5mm Set the SAC to 2 VOLTS. Set 1M1 to LOW LOAP and adjust VARIABLE for 2cm of deflection at graticule center.
- e. Check common mode rejection: >30:1
 Set the SAC to 1 VOLT and the 1M1
 TEST FUNCTION to COMMON MODE. Check for
 <3mm of display. (30:1)
- f. Check DC Shift: ≤ 0.5 mm

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

8. TRACE SEPARATION

a. Tighten TRACE SEPARATION knob: traces superimposed at 0

Set the HORIZONTAL DISPLAY to A ALT B, and the 1M1 TEST FUNCTION to GAIN SET. Temporarily tighten the TRACE SEPARATION knob. Position one trace over the other with the TRACE SEPARATION control, loosen the knob and set the index at "0". Tighten the knob and check that the traces are superimposed at "0".

b. Check TRACE SEPARATION range: >3 to <5cm

Check for 3 to 5cm of trace separation with the TRACE SEPARATION at both cw and ccw.

9. ALTERNATE TRACE AND CHOPPED BLANKING

a. Check alternate trace sync pulse: amplitude \geq 60%, risetime \leq 1 μ s

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 sweep rates.

b. Check slave pulse: amplitude $\geq 40V$, risetime $< 0.7 \mu s$

Change the test scope X10 probe to the collector of Q454. Check the amplitude and risetime of the negative pulse: amplitude $\geq 40\text{V}$, risetime $\leq 0.7\mu\text{s}$. Remove the probe.

c. Check alternate operation: all sweep rates

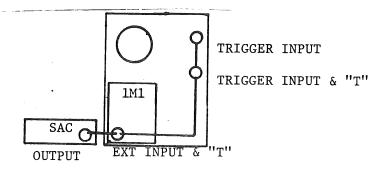
Connect 20V calibrator signal to 1M1 INPUT and check alternate sweep at all sweep rates faster than 1 SEC in A, A ALT B, and B positions of the HORIZONTAL DISPLAY switch.

d. Check chopped blanking: transients blanked

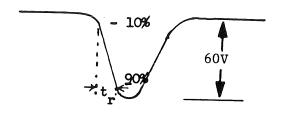
Remove the signal and change lM1 TEST FUNCTION switch to CHOPPED. Set both TIME/CM switches to 5µSEC. Check both TIME BASE A and B for blanking of transients when the CRT CATHODE SELECTOR (rear scope) is switched to CHOPPED BLANKING Return CATHODE SELECTOR to EXTERNAL CRT CATHODE.

10. AUTOMATIC DISPLAY SWITCHING

Connect 10 VOLTS from the SAC as follows:



a. Alternate trace sync pulse



The calibrator signal identifies the lower alternate trace and aids verification of alternation at slow sweep rates.

10. (cont'd)

Set both TRIGGERING SOURCE switches to EXT and both TIME/CM switches to .5mSEC. Return the 1M1 TEST FUNCTION switch to ALTERNATE and HORIZONTAL DISPLAY to A ALT B. Adjust A TRIGGERING LEVEL for a triggered display. Rotate both TIME/CM switches, check that A affects the squarewave and B does not. Use the following table to check display switching:

HORIZONTAL DISPLAY switch	number of traces	TRACE SEPARATION	DELAY TIME MULTIPLIER	BRIGHTNESS control	READY íights lit
A	2	inoperati v e	inoperative	inoperative	A and B
ALT	2	moves A trace	inoperative	B trace	A and B
В	2	inoperative	inoperative	both traces	A and B
B INTENS BY 'A'	2	inoperative	operative	non-intens portion of 2 traces	B only
ALT	4	moves delayed pair	operative 3 traces	non-intens portion of 2 traces	B only
A DLY'D	2	inoperative	operative	inoperative	B only
Change the	A TRIGGERIN	NG MODE to TRIG.			
B INTENS BY 'A'	2	inoperative	delayed	non-intens portion of 2 traces	
ALT	4	moves delayed pair	delayed 2 traces	non-intens portion of 2 traces	
A DLY'D	2	inoperative	delayed	inoperative	

11. SCALE ILLUM., POSITION INDICATING, AND MAG ON 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 prior to crossing the graticule center line. b. CRT scan area is the total range in which there can be a display on the CRT.

11. (cont'd)

Turn TYPE 547 INTENSITY ccw. Change the HORIZONTAL DISPLAY switch to EXT X10. Remove the cable from the 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 the 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 2cm past graticule center.

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

12. TRIGGERING 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 56Ω resistor and $5\mu H$ coil, R252-L250 (R52-L50).

Set the TEIGGERING controls of both Time Bases as follows:

SLOPE +
MODE TRIG
SOURCE EXT

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 12h; then repeat for Time Base B.

12. (cont'd)

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.

Check that the test scope display does not "break up" in + SLOPE or - SLOPE. Read-just 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.

Change the SAC to 50mVOLTS and check that triggered + SLOPE and - SLOPE displays can be obtained with readjustment of TRIGGER LEVEL.

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.

12. (cont'd)

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 TYPE 547 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.

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 "O", tighten the setscrew, and recheck 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 at least + 2 volts at the cw end of rotation and not more than - 2 volts at the ccw end.

Pull TRIGGERING LEVEL knob out for 10X RANGE INCREASE and check for more than + 20V and less than - 20V.

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

12. (cont'd)

g. Check AUTO triggering: <20Hz repetition rate

Apply 50mS markers from the TYPE 184 to 1M1 EXT INPUT. Set the TYPE 547 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.

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 547.

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

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

12j. (cont'd)

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

13. SINGLE SWEEP

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

Press SINGLE SWEEP to RESET. Check for lit B READY neon.

Reapply SAC signal to the IMI EXT INPUT. Check that both sweeps run once (B Sweep first), and the neon extinguishes.

Check all functions of HORIØ2NTAL DISPLAY switch for correct SINGLE SWEEP operation. as directed in the following table:

Once the sweep circuits are reset, repeated switching of the SINGLE SWEEP switch to RESET should not affect the READY neons. Once they have been lit, they should extinguish only when a proper input signal is applied.

13. (cont'd)

HORIZONTAL DISPLAY	Lit READY neon	Display
A	A and B	A sweep only
A ALT B	B only	both sweeps
В	A and B	B sweep only
B INTENS BY A	B only	one B intens by A sweep
B INTENS BY A ALT A DLY'D	B only	one sweep will run, rearm and reapply signal-other sweep will run
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.

14. EXTERNAL DELAY INPUT

a. Setup

Connect a 50Ω coax cable from the TYPE 547 CAL OUT to the EXTERNAL FUNCTION CHECKER, CAL INPUT. Connect a 50Ω cable from the SINGLE SWEEP RESET INPUT to the EXTERNAL FUNCTION CHECKER SINGLE SWEEP INPUT. Connect the 4 conductor cable from the EXTERNAL FUNCTION CHECKER to the TYPE 547 EXTERNAL DELAY INPUT.

Set the TYPE 547 as follows:

HORIZONTAL DISPLAY	В
B TIME/CM	.lµSEC
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.

14. (cont'd)

b. Check + GATE B, pin c: amplitude $\geq 2V$ 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 the HORIZONTAL DISPLAY switch 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 hecker is lit in 2 positions

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

e. Check pin a: A DLY'D sweep disappears
Set EXTERNAL FUNCTION CHECKER to position
2.

Set HORIZONTAL DISPLAY to B INTENSIFIED BY 'A' ALT A DLY'D. With both traces displayed set FUNCTION CHECKER to position 1 and note that the A DLY'D sweep

15. SINGLE SWEEP RESET INPUT

Set both A and B TIME/CM to .1mSEC, HORI-ZONTAL 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.

16. SWEEP SWITCHING MULTIVIBRATOR AND TRIGGER AMPLIFIER

a. Check sweep switching multivibrator: amplitude, 28V ±2V; risetime, <2.5µs; falltime, <0.3µs

Set TYPE 547 HORIZONTAL DISPLAY switch to A ALT B. Connect the test scope X10 probe to Q475 collector. Check the square-wave for: 28V ±2V amplitude, risetime 2.5us, max, falltime 0.3us, max.

b. Check trigger amplifier: amplitude, >10V; falltime, <0.1µs

Connect the test scope 10X probe to Q464 collector. Check the signal for: 10V min amplitude and falltime of $0.1\mu s$, max.

17. EXTERNAL WAVEFORMS

a. Check VERT SIG OUT:

amplitude, 0.30V/cm">>0.30V/cm
risetime, <a href="mailto:<20ns"><20ns

Set 1M1 TEST FUNCTION +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.)V/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 switch positions. Set HORIZONTAL DISPLAY to B.

d. Check + GATE A: $amplitude \ge 20V$

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

e. Check + GATE B: amplitude >20V

Connect the test scope 10X probe to +GATE

Connect the test scope LOX probe to HGAIL

B binding post. Check the square-wave amplitude,
20V min.

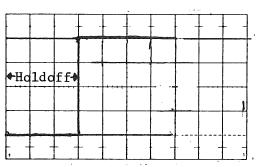
547

18. HOLDOFF

Check TIME BASE B and then TIME BASE A holdoff with test scope 10X probe on + GATE B and then + GATE A. Set testscope to -SLOPE, DC TRIGGERING, and DC-coupled Vertical INPUT. Set the 547 A and B TRIGGERING LEVELS cw. Set 1M1 TEST FUNCTION to LOW LOAD. Use the following table:

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

Measuring holdoff from the + GATE.



19. TIME BASE B UNBLANKING

a. Check BRIGHTNESS range: >30V

Set both TIME/CM switches to $10\mu SEC$, and set both TRIGGERING LEVELS cw. Set the 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.

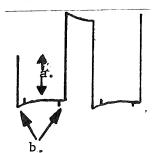
Set BRIGHTNESS control cw and check the position of the top of the pulses. Rotate BRIGHTNESS control ccw and check the position of the tops of the pulses, 30V (1.5cm) or more from previous position. Set BRIGHTNESS control for equal DC level of A and B unblanking pulses.

b. Adjust B unblanking time constant C186: \(\geq 40,000:1\) 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 $5\mu SEC$. Set BRIGHTNESS ccw and adjust INTENSITY for a trace. Slowly rotate BRIGHTNESS cw until 2 traces of equal intensity are obtained.

b. Unblanking pulses



20. MAGNIFIER REGISTRATION

a. Setup

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

Set the TYPE 547 as follows:

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

b. Adjust Swp/Mag Regis R569: within +1mm

Adjust 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.

21. HORIZONTAL AMPLIFIER GAIN

Regis (Step 20b).

c.

- a. Adjust X10 Cal, R544: within ±3%

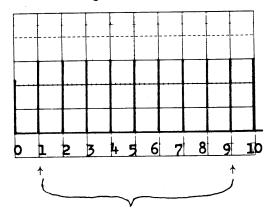
 Set SWEEP MAGNIFIER to X10. Adjust

 X10 Cal R544 for one lmS marker per cm.
- b. Adjust X1 Cal, R566: ±1%

 Set SWEEP 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.

Check X5 and X2 magnified:

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



22. TIME BASE A/TIME BASE B MATCH

a. Setup

Preset TYPE 547 as follows:

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

BRIGHTNESS

cw

b. Adjust A Sweep DC Level, R470: range, >1cm

Adjust A and B TRIGGERING LEVEL for a stable display. Adjust TRACE SEPARATION so both sweeps coincide. Set SWEEP MAGNIFIER to X10. Position display to the right until the start of both traces is visible. Rotate A Sweep DC Level R470 thru its range and check trace shift: >1cm. Adjust A Sweep DC Level R470 so the start of sweeps coincide.

c. Adjust A Sweep Cal, R290Y: within +0.5%

Set SWEEP MAGNIFIER to X1 OFF and position the display to the left so that the start the sweep is at the left edge of the graticule. Adjust A Sweep Cal R290Y so TIME BASE A timing matches that of TIME BASE B over the middle eight centimeters of the display.

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.

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

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

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

Adjust B Sweep Length R125 to equal A sweep length.

f. Check VARIABLE TIME/CM: ratio >2.5:1

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

23. DELAY PICKOFF

a. Setup

HORIZONTAL DISPLAY B INTENS BY 'A'

A TRIGGERING AUTO, +, AC, NORM INT

A TIME/CM 10μ SEC

B TIME/CM lmSEC

B TRIGGERING TRIG, +, AC, NORM INT

Set the TYPE 184 for 1mS markers.

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

Adjust the BRIGHTNESS and INTENSITY for an easily seen intensified zone. Change HORIZONTAL DISPLAY to B INTENS BY 'A' ALT A DLY'D. Adjust TRACE SEPARATION and positioning so the delayed presentation is above the intensified presentation. 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 9 cm 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: within $\pm 0.15\%$
- 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 Delayed sweep at DTM setting of 0.15 Set HORIZONTAL DISPLAY to A DELY'D. Set DELAY TIME MULTIPLIER to 0.15 and check for a display.
- e. Check delay jitter: <1/40,000

 Set the DELAY TIME MULTIPLIER to approx 10.00, placing the delayed wave form on screen.

23e. (cont'd)

Check the horizontal jitter of the display as follows:

A TIME/CM	B TIME/CM	MAXIMUM JITTER
1μSEC	1mSEC	2.5mm
2µSEC	2mSEC	5 mm
5μSEC	5mSEC	· 5 mm

Set DELAY TIME MULTIPLIER to approx 1.00 and repeat the check for delay jitter.

24. TIME BASE B TIMING

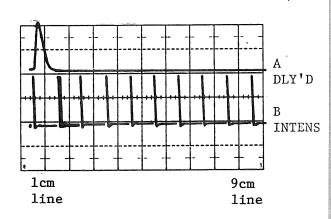
a. Preset Timing

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

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

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 $10\mu SEC$ and A TIME/CM to $1\mu SEC$. Set the TYPE 184 to $10\mu S$ 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 lcm 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 (<u>dial minor div</u>)
10μSEC 1μSEC	1μSEC .1μSEC	10μS 1μS	С90С С90В	±6.4 ±6.4
.5μSEC	.1µSEC	.lµS	C90A	±6.4 (apply lµs trigger from TYPE 184)
.lµSEC	.1µSEC	.1µS	C99	for 1 marker/cm on intensified trace

24b. (cont'd)

Repeat until interaction is eliminated.

c. Check fast sweep linearity: within 0.5% Set B TIME/CM to .5mSEC 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.

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
$1 \mu SEC$.1µSEC	1µS
2µSEC	.2µSEC	1 μS

Trigger TIME BASE B +INT.

5µSEC	.5µSEC	5µS
10μSEC	1µSEC	10µS
20μS E C	2μSEC	10µS
50uSEC	5uSEC	50uS

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

.1mSEC	$10 \mu SEC$.1mS
.2mSEC	20µSEC	.1mS
.5mSEC	50 _u SEC	.5mS

24d. (cont'd)

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

25. HIGH SPEED COMPENSATION

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

Set HORIZONTAL DISPLAY to B and B TIME/CM to .1 μ SEC. Change the TYPE 184 to .1 μ S 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.

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.

b. Adjust X10 mag, C557H:: within <u>+</u>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 C576 and C586 don't seem to have enough range, repeat adjustment procedure for C572, C582, and C591. If, after the repeat, the compensation is worse rather than better, C576 and C586 were preset to the wrong valves. Back C576 and C586 off a turn or two and redo the amplifier compensation.

If center of sweep is out of timing specs, slight adjustment of C576 and C586 should correct.

25b. (cont'd)

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 graticule center. Set SWEEP MAGNIFIER to X10 and check for 1 cycle/2cm ±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.

26. TIME BASE A TIMING

a. Preset timing

Change HORIZONTAL DISPLAY switch to A, TIME BASE A TIME/CM to $10\mu SEC$ and TRIGGERING MODE to TRIG. Set the TYPE 184 to $10\mu S$ markers and adjust the TRIGGERING LEVEL for a stable display. Use the following table to preset timing:

TIME/CM	TYPE 184	adjust	for
10µSEC	10μS	C290C	1 marker/cm
1µSEC	1μS	С290В	1 marker/cm
.5µSEC	1μS	C290A	1 marker/2cm
.1µSEC	.1µS	C299	1 marker/cm

b. Adjust A timing, C290C, C290B, C290A & C299: coincidence with B timing within ±1%

Change both TIME/CM switches to $10\mu SEC$ and the HORIZONTAL DISPLAY to A ALT B. Set the TYPE 184 to $10\mu S$ time markers. Adjust both TRIGGERING LEVEL controls for stable displays. Use the TRACE SEPARATION control to position the A trace over the B trace. Set the second time marker (1cm from start) at graticule center. Set SWEEP

Time Base A Sweep Cal R290Y already been adjusted; see Step 22c.

26b. (cont'd)

MAGNIFIER to X10 and adjust the TRIGGERING LEVEL controls for coincidence of the two time markers. Set SWEEP MAGNIFIER to X1 and position the 9cm marker to graticule center. Set SWEEP MAGNIFIER to X10 and adjust C290C for coincidence of the time markers. Use this procedure with the following table:

both TIME/CM	TYPE 184	adjust	Max error in cm at #9 (X10 mag)
$10\mu SEC$ $1\mu SEC$ $.5\mu SEC$ $.1\mu SEC$	10_{μ} S 1_{μ} S 1_{μ} S $.1_{\mu}$ S	C290C C290B C290A C299	0.8 0.8 0.8 0.8mm (X1 mag)
-	F	H	ORIZONTAL DISPLAY at A

Repeat until interaction is eliminated.

c. Check fast timing match: <1cm difference

Leave both TIME/CM switches set at .1 μ SEC. Set HORIZONTAL DISPLAY to A ALT B. Apply 20nS and .1 μ S markers and set SWEEP MAGNIFIER to X10. Adjust both TRIGGER LEVEL controls to align the markers located 4cm from the start of the sweep.

Set SWEEP MAGNIFIER to X1 and position the markers located 9cm from the start of the sweep to graticule center. Return the SWEEP MAGNIFIER to X10 and check coincidence by slowly turning the HORIZ-ONTAL POSITION cw; <1cm difference.

d. Check timing accuracy: within +1% Change HORIZONTAL DISPLAY to A and use the following table to check timing accuracy. Max error: 0.8mm.

TIME/CM	TYPE 184	markers/cm
.2µSEC	.1µS	2
.5µSEC	$1 \mu S$	1 marker/2cm
1µSEC	1μS	1
2µSEC	1 μS	2
5µSEC	5μS	1
10µSEC	10μS	1
20µSEC	10 μS	2
50μSEC	50μS	1

26d. (cont'd)

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

27. TRIGGER DELAY AND B SWEEP FOLDOVER

a. Check trigger delay: <100ns

Change the TYPE 184 to $1\mu S$ time markers. Set the A TRIGGERING MODE to AUTO and the HORIZONTAL DISPLAY to B INTENS BY 'A' ALT A DLY'D. Set the TIME/CM switches to $.1\mu$ SEC. Adjust TRACE SEPARATION to align the delayed trace baseline with the B trace baseline. Adjust the DELAY-TIME MULTIPLIER to align the delayed pulse with the B trace pulse. Note the difference between the DELAY TIME MULTIPLIER reading and 10.00. Each minor div of the dial is equal to 1 nsec.

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

b. Check B sweep foldover: none in 10.5cm

Change the HORIZONTAL DISPLAY switch to A ALT B and both A and B TIME/CM switches to $2\mu SEC$. 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.

28. 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 547 as follows:

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

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

Adjust HORIZONTAL POSITION 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.

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

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).

- d. Check gain: <90mV/cm
- Check display amplitude ≥ 5.5 cm 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 \leq that observed in 28d. Set VAR 10-1 cw.

f. Adjust X10 compensation, C503C: <3% overshoot or rolloff

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

28. (cont'd)

g. Check X10 attenuation: ±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 \geq 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.

29. Z AXIS MODULATION <10V P-P sufficient for intensity blanking

Attach a BNC female to UHF male adapter to the SAC output cable. Remove the EXTERNAL CRT CATHODE GND strap and plug the adapter into 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.

30. TRANSIENT RESPONSE

Adjust Vertical HF compensation: α. + PULSE, <0.6mm aberration - PULSE, <0.7mm aberration

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

Make final adjustments with SWEEP MAGNI-FIER at X10. Move back and forth between the X10 and X1 OFF positions and the .1 μ SEC and 1μ SEC TIME/CM positions to check the overall level.

Most of the ertical HF adjustments interact, so repeat as necessary to obtain a waveform with flat top and minimum aberrations 0.4mm max 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 ≤ 6.7 ns risetime (see step b)

main Vert Amp chassis

30a. (cont'd)

Switch 1M1 TEST FUNCTION to -PULSE and TRIGGERING SLOPE to -. Vertically position the display to the center 4cm of the graticule and check for <0.5mm overshoot or rolloff.

b. Check risetime: <6.25ns

Adjust the 1M1 AMPLITUDE for a 4cm display. Set the TIME/CM to .1 μ SEC 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.

31. HIGH FREQUENCY TRIGGERING

a. Check external: 200mV at 50 MHz

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 the CHANNEL 1 INPUT SELECTOR to DC, VOLTS/CM to .05 and VARIABLE VOLTS/CM to CALIB. Set the SAC to .2 VOLTS and adjust the CHANNEL 1 .05V/CM GAIN for 4cm of display.

b. Calculating risetime

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

$$T_r = \sqrt{(T_r 547)^2 + (T_r 1M1)^2}$$

Where:

 T_r = observed risetime

 T_r 547 = actual risetime of the Type 547

 $T_r 1M1 = actual risetime of the 1M1$

Therefore the risetime of the 1M1 must be known before the risetime of the TYPE 547 can be determined.

For example, if the T_r of the 1M1 is 2.55ns and the specification for the TYPE 547 call for a T_r of <6.25ns, then the maximum observed risetime of the system is:

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

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31a. (cont'd)

Install a BNC "T" connector on the CHANNEL 1 INPUT. Connect a 50Ω coax cable with 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 200mV at 50 kHz 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 TIME BASE A TRIGGER INPUT. Change HORIZONTAL DISPLAY to A and repeat checks for TIME BASE A.

b. Check internal: 6mm 50MH₂ 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