FACTORY CALIBRATION PROCEDURE

CONTENTS:

INTRODUCTION:

556

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:
0-126
February 1967

For all serial numbers.

Supersedes
April 1966

FACTORY TEST LIMITS:

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

QUALIFICATION:

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

ABBREVIATIONS:

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

CHANGE INFORMATION:

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

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

* 1	TYPE 547 OSCILLOSCOPE
1	TYPE 1A1 DUAL TRACE PLUG-IN UNIT
* 1	TYPE 184 TIME MARK GENERATOR
* 1	TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
1	TYPE P6019 CURRENT PROBE
1	TYPE P6006 X10 PROBE
1	TYPE P6028 X1 PROBE
1	TYPE 77TU LINE VOLTAGE CONTROL UNIT

b. Test Fixtures and Accessories

2	CALIBRATION FIXTURE (067-0521-00)(1M1)
2	50Ω BNC Terminations (011-0049-00)
1	BNC T connector (103-0030-00)
2	50Ω BNC cables (012-0057-00)
3	50Ω BNC cables (012-0076-00)
1	Patch cord (012-0031-00)
1	Passive Termination (011-0078-00)
* 1	DC Voltage Bridge (DCVB) (067-0543-99)
* 1	STANDARD AMPLITUDE CALIBRATOR (SAC)(067-0502-00)
* 1	50Ω Termination ±0.1% (067-0120-00)
1	Peak Line Voltage Comparator (067-0527-00)
* 1	LF Sine Wave Generator (067-0542-99)

c. Other Equipment

1	20,000Ω/VDC Multimeter

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

Substitute test equipment may be used. The Plant Staff Engineer must approve any substitutions. All equipment listed must perform within its manufacturer's specifications, unless otherwise stated.

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

QUALIFICATION

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

1. PRELIMINARY INSPECTION

2. PRESET CONTROLS

3. RESISTANCE

4. POWER SUPPLIES

c. Adjust power supply voltages

Supply	Adjust	Max error
-150V	R1498	±1%
+100V	R1459	±1%
+225V	R1439	+125V above +100V supply ±0.2%, max

d. Check ripple and regulation

Supply	Max error	Max ripple
-150V	±1%	5mV
+100V	±1%	5mV
+225V	+125V above 100V supply ±0.2%, max	15mV
+350V	±2%	10mV
+ 10V	±1V	----
+ 6V	+2V -1V	----

e. Adjust -1850V and check regulation:
error; ±1%, max
regulation; ±1%, max

5. AMPLITUDE CALIBRATOR

* a. Adjust Cal Ampl Error: ±0.25%, max

5. (cont'd)

* b. Check accuracy from 50 to .1 VOLTS
error: ±1.25%, max

c. Check risetime: 1.5µs, max

d. Check frequency: 1 kHz ±25%

e. Check duty cycle: 45% to 55%

* f. Check terminated voltage accuracy
error: ±2%, max

6. CRT

b. Check horizontal deflection plate and graticule alignment
Tilt: ±3°, max

c. Check and adjust TRACE ROTATION
Range: 3°, min

d. Adjust vertical geometry
deviation: 1mm, max

e. Check horizontal geometry
deviation: 1mm, max

f. Check orthogonality
deviation: ±0.5mm in 3cm, max

g. Check horizontal focus
Resolution: 200 marks/10cm, no overlap in center 8cm

h. Check vertical focus
Resolution: no overlap of 0.5mm signal

7. VERTICAL AMPLIFIERS

a. Find CRT electrical center
±0.6cm, max from graticule center

b. Check transistor stage unbalance:
0.6cm, max from previous stage or CRT electrical center

c. Adjust DC Bal
error: ±0.5cm, max
range: + & - 2cm, min from graticule center

* d. Adjust Gain
error: ±2%, max
range: + & -5%, min

* e. Adjust crossover gain
error: ±2%, max
range: + & -5%, min

f. Check compression and expansion:
0.5mm, max

g. Check gain change with line voltage change: ±1%, max

* h. Check common mode rejection: 30:1 min

i. Check trace shift with line voltage change: ±2mm, max

8. DUAL TRACE AND CHOPPED OPERATION

a. Check alternate waveform amplitude: 60V, min; risetime: 1μs, max

b. Check alternate operation: all sweep rates

9. TRIGGERING

b. Adjust Trigger Level Centering, R545 (R745) and Trigger Sensitivity R555(R755) stable triggering + & - on 0.1V
no stable triggering + or - on 50mV

c. Check trigger level range, Zero knob, and check EXT Triggering:
Normal + & - 2V, min; X10 + & - 20V, min;
+ & - EXT triggering 200mV with LEVEL fixed; 100mV with LEVEL adjustable

d. Check internal triggering
Triggering: 2mm at 10 MHz

e. Check HF REJ
Triggering: must not trigger on 1cm signal at 6 MHz or above. Must trigger on 2mm 30 Hz to 60 kHz

f. Check LINE and LF REJ
LF REJ: must not trigger on 3cm at 30 Hz must trigger on 2mm at 2.5 kHz

g. Check AUTO STABILITY: trigger on 1cm, 20 Hz signal. Free run with no signal

h. Check PLUG-IN INT triggering: 200mV

i. Check crossover triggering: 2mm at 10 MHz

j. Check DC triggering: 3.5mm at graticule center

10. SINGLE SWEEP

11. BEAM FINDER

12. TRACE SEPARATION

Check trace separation range: upper beam trace must overlap lower beam trace 1mm, min; must separate from lower beam by 4.1cm, min

13. SCALE ILLUMINATION

14. UNCALIBRATED AND MAG INDICATORS

15. BASIC TIMING

* a. Adjust UPPER BEAM X10 Cal
error: ±0.8%, max

* b. Adjust UPPER BEAM X1 Cal
error: ±0.8%, max

c. Adjust UPPER BEAM Swp Mag Regis:
±2mm shift, max

d. Adjust A Sawtooth Amplitude
Sweep Length: 10.1 to 10.5cm

f. Adjust B Sawtooth Amplitude
Sweep Length: 10.1 to 10.5cm

* g. Adjust LOWER BEAM X10 Cal
error: ±0.8%, max

* h. Adjust LOWER BEAM X1 Cal
error: ±0.8%, max

i. Adjust LOWER BEAM Swp Mag Regis:
±2mm shift, max

j. Adjust A & B Sawtooth Current
error: ±3%, max

16. DELAY PICKOFF

* c. Check incremental accuracy
error: ±1.5 minor div, max

d. Check delay jitter: 2.5mm, max

17. CONSTANT RANGE visible change

18. TIME BASE A TIMING

* a. Adjust 10μSEC timing
error: ±0.8%, max

* b. Adjust 1μSEC timing
error: ±0.8%, max

* c. Adjust .1 and .5μSEC timing
error: ±1%, max

* d. Check .2μSEC timing
error: ±1%, max

* e. Check A TIME/CM 2μSEC to 5 SEC
error: ±0.8%, max

19. TIME BASE B TIMING

a. Adjust and check TIME BASE B
error: ±1%, max

20. VARIABLE TIME/CM

range: 2.5:1, min

21. HORIZONTAL AMPLIFIER 50 MHz COMPENSATION

* b. Adjust compensations error: ±3%, max
* c. Adjust X10 Mag Comp error: ±3% between 4th and 70th cm

22. TRIGGER DELAY

150ns, max

23. EXTERNAL HORIZONTAL AMPLIFIER

b. Adjust Ext Horiz DC Bal
unbalance: 2cm, max
c. Adjust compensations, check deflection factor and VAR 1-10
deflection factor: ≤0.1V/cm
aberrations: ±3%, max
VAR 1-10 ratio: ≥10:1
d. Adjust X1 compensation
aberrations: ±3%, max
* e. Check attenuation accuracy
error: ±2%, max
* f. Check Ext Horiz bandwidth: DC to 400 kHz at -3dB

24. EXT CRT CATHODE

25. EXTERNAL WAVEFORMS

a. Check A & B SAWTOOTH
amplitude: 94.5 volts, min
b. Check A & B GATE
amplitude: 10 volts, min
c. Check DLY'D TRIG
amplitude: 7 volts, min

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

26. HOLDOFF

TIME/CM	A and B Holdoff	
	T1	T2
0.1µSEC	≥2µs	≤25µs
0.2µSEC	≥1.5µs	≤15µs
0.5µSEC	≥1µs	≤12µs
1µSEC	≥1µs	≤10µs
2µSEC	≥1µs	≤10µs
5µSEC	≥1µs	≤10µs
10µSEC	≥5µs	≤25µs
20µSEC	≥5µs	≤25µs
50µSEC	≥5µs	≤25µs
0.1mSEC	0.25ms to 0.4ms	
0.2mSEC	0.25ms to 0.4ms	
0.5mSEC	0.25ms to 0.4ms	
1mSEC	2.0ms to 5.0ms	
2mSEC	2.0ms to 5.0ms	
5mSEC	2.0ms to 5.0ms	
10mSEC	30.0ms to 45.0ms	
20mSEC	30.0ms to 45.0ms	
50mSEC	30.0ms to 45.0ms	
0.1 SEC	0.25 s to 0.5 s	
0.2 SEC	0.25 s to 0.5 s	
0.5 SEC	0.25 s to 0.5 s	
1 SEC	1.0 s to 3.0 s	
2 SEC	1.0 s to 3.0 s	
5 SEC	1.0 s to 3.0 s	

27. VERTICAL AMPLIFIER

* b. Adjust transient response
risetime: 6.75ns, max
aberrations: ±1.25%, max
c. Adjust position effect on transient response: ±1.25%, max
d. Check corner symmetry
aberrations: ±1.25%, max

28. HF TRIGGERING

Check HF Triggering
amplitude: 1.0cm; jitter: 2ns, max

29. HORIZONTAL POSITION

a. Check horizontal POSITION range: traces must position past graticule center in both directions.
b. Check horizontal POSITION vernier: ≥2.5cm of range at center of display, ≥1cm of range at cw and ccw ends

THE END

1. PRELIMINARY INSPECTION

a. Make General Examination

Check for unsoldered joints, rosin joints, lead dress and long leads. Check for loose hardware and protruding parts. Check controls for smooth mechanical operation, proper indexing, and knob spacing from front panel. Correct all defects found and install HV Shields (200-0644-00 and 200-0645-00).

b. Check Fuses

Line Voltage			
	F1401	10A	Slo-Blo
	F1402	5A	Slo-Blo
-150	F1482	.75A	
+100	F1478	1A	
+225	F1446	1.5A	
+350	F1424	.75A	

c. Align and inspect CRT

Align the CRT so the faceplate is even with the light guide. Orient the CRT Horizontal Graticule lines by placing a scribed external graticule over the CRT faceplate. Tighten CRT clamp and recheck alignment. Check CRT for scratches, cracks around neck pins and phosphor defects. Check tightness of CRT rear support bracket holding screws. Place shield or filter over CRT faceplate and light guide and replace graticule cover.

c. Do not reject a CRT without consulting a trained CRT Checker or referring to the CRT Check Out Procedure.

d. Check DELAY TIME MULTIPLIER (DTM)

Set DTM fully ccw and if necessary, position dial on shaft for a reading of 0.20. Check for a dial reading of 10.20 min at full cw setting.

2. PRESET CONTROLS

a. Preset TYPE 556 controls

POWER ON	OFF
DTM	1.0
AMPLITUDE CALIBRATOR	OFF
SCALE ILLUMINATION	0
TRACE SEPARATION	midr
CONTRAST	cw
TRACE ROTATION	midr

2. Do not preset internal adjustments for recalibration unless you are sure that a complete recalibration is necessary.

2a. (cont'd)

	UPPER BEAM	LOWER BEAM
TRIGGERING LEVEL	cw (push in)	cw (push in)
MODE	AUTO	AUTO
SLOPE	+	+
COUPLING	AC	AC
SOURCE	NORM INT, LEFT	NORM INT, RIGHT
TIME/CM	1mSEC	1mSEC
VARIABLE TIME/CM	CALIBRATED	CALIBRATED
DISPLAY	LEFT PLUG-IN A	RIGHT PLUG-IN B
DISPLAY MAG	X1	X1
A AND B MODE	NORM	NORM
VAR 1-10	cw	cw
HORIZ POSITION	midr	midr
INTENSITY	0	0
FOCUS	0	0
ASTIGMATISM	0	0
CRT CATHODE SELECTOR (rear of scope)	EXT CRT CATHODE	EXT CRT CATHODE
all internal adjusts	midr	midr

b. Install two 1M1's and preset controls

TEST FUNCTION	LOW LOAD
VARIABLE	midr
AMPLITUDE	midr
VERTICAL POSITION	midr
REPETITION RATE	MED

3. RESISTANCE

Check power supply resistance from the fuses to ground as in the following table:

Power supply	test point	approx resistance	reverse polarity	meter scale
+100V	F1478	195Ω	200Ω	X100
-150V	F1482	790Ω	850Ω	X100
+225V	F1446	900Ω	650Ω	X100
+350V	F1424	2700Ω	4200Ω	X1000

Check that the power supply primary jumpers are connected for 115VAC operation as follows:

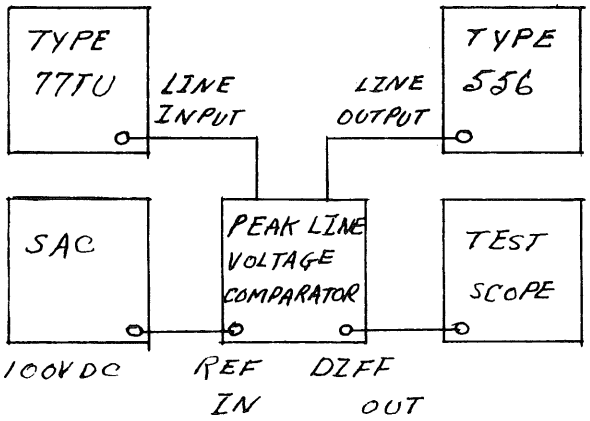
J to K
L to M
RED ON YELLOW to 0
GREEN ON YELLOW to 0
P to T
Q to R

3. The power supply fuses are located on the bottom of the instrument to either side of the power supply board.

4. POWER SUPPLIES

a. Setup

Make connections as in the following diagram:



Set the COMPARISON VOLTAGE switch to 110 and the COMPARISON VOLTAGE helidial to 5.0. Slowly increase the output of the TYPE 77TU until waveform peaks 2cm in amplitude are displayed on the test scope.

b. Check 115 VAC-230 VAC line

Measure and note the AC voltage between power supply board terminals H & I (approximately 145 VAC). Remove the TYPE 556 power cord and change the transformer primary connections to 230 VAC line as follows:

RED ON YELLOW TO K
L TO M
GREEN ON YELLOW TO P
Q TO R

Reconnect the TYPE 556 power cord and check that AC voltage between power supply board terminals H & I is one half that previously measured. Return the transformer primary connections to 115 VAC line.

c. Adjust power supply voltages

Connect the DCVB to the output side of the fuses. Adjust each supply in turn for a null indication as in the following table:

Supply	Adjust	Max Error
-150V	R1498	±1%
+100V	R1459	±1%
+225V	R1439	+125V above +100V supply ±0.2%, max

a. For first time turn-on reduce the line to 10 VAC and check heater supplies for approximately .5 VAC.

4. (cont'd)

d. Check ripple and regulation

Use the DCVB and test scope to check power supply, ripple and regulation from 100 VAC to 130 VAC line high load, then at low load as in the following table:

Supply	Max Error	Max Ripple
-150V	±1%	5mV
+100V	±1%	5mV
+225V	+125V above +100V supply ±0.2%, max	15mV
+350V	±2%	10mV
+ 10V	±1V	--
+ 6V	+2V -1V	--

d. Use the peak line voltage comparator to measure line voltage.

For high load set the 1M1 TEST FUNCTION to HIGH LOAD, TYPE 556 A & B TRIGGERING MODE switches to AUTO STABILITY, DISPLAY MAG switches to X10 and AMPLITUDE CALIBRATOR on.

For low load set the 1M1 TEST FUNCTION to LOW LOAD, TYPE 556 A & B TRIGGERING MODE switches to AUTO STABILITY, DISPLAY MAG switches to X1 and AMPLITUDE CALIBRATOR OFF.

Change the transformer primary connections to 104 VAC line as follows:

J TO L
K TO M
P TO R
Q TO T

Check power supply ripple and regulation from 90 VAC to 117 VAC line at high load and at low load as before.

Return the transformer primary connections to 115 VAC line.

e. Adjust -1850V and check regulation
error: ±1%, max
regulation: ±1%, max

Connect the DCVB to the UPPER BEAM HV Test Point and adjust High Voltage, R1382 for null indication.

Rotate INTENSITY control from full ccw to full cw and check HV test points for -1850 ±1% from 100 VAC line to 130 VAC line. Repeat step for LOWER BEAM adjusting R1332. Return line voltage to 115 VAC.

5. AMPLITUDE CALIBRATOR

a. Adjust Cal Ampl error: ±.25%, max

From TYPE 556 CAL OUT connect a cable to the UNKNOWN IN on SAC. Set SAC mode to +DC, MIXED and SAC AMPLITUDE to 100 VOLTS. Connect the SAC OUTPUT to the test scope vertical, AC coupled. Set TYPE 556 AMPLITUDE CALIBRATOR to 100 VOLTS (not DC) and place a clip lead from the -150 volt

a. The SAC chops between the SAC precision calibrator and the TYPE 556 calibrator. The test scope display is a square-wave with an amplitude equal to the difference between the two calibrators. With the test scope triggered in -LINE the

5a. (cont'd)

supply to V1605B, pin 8. Adjust R1628 for null deflection on test scope. Switch AMPLITUDE CALIBRATOR to 100 VDC and check for null on test scope.

b. Check accuracy from 50 to .1 VOLTS error: ±1.25%, max

Note the TYPE 556 AMPLITUDE CALIBRATOR error at the following control settings:

AMPLITUDE CALIBRATOR & SAC VOLTS	TYPE 1A1 VOLTS/CM	max deflection
50	.5	1.25cm
20	.2	1.25cm
10	.1	1.25cm
5	.05	1.25cm
2	.02	1.25cm
1	.01	1.25cm
.5	.005	1.25cm
.2	.005	5cm
.1	.005	2.5cm

Add the % error found in the .1 volts SAC position to the largest % error in the same direction in previous positions. This total error must not exceed 1.25%.

Remove the clip lead and connect the AMPLITUDE CALIBRATOR CAL OUT to the test scope input using the 20" BNC cable (012-0076-00). Check the remaining switch positions for approx voltage amplitude.

c. Check risetime: 1.5μs, max

Set AMPLITUDE CALIBRATOR .2 VOLTS and check risetime from the 10% to 90% amplitude points of the leading edge.

d. Check frequency: 1 kHz ±25%

Set test scope TIME/CM to .2mSEC and check for 2 cycle calibrator signal ±.5 cycle over the 10cm.

e. Check duty cycle: 45% to 55%

Set test scope TIME/CM to 50μSEC and adjust VARIABLE TIME/CM for one cycle of signal over 10cm. Check pulse duration at the 50% amplitude points: 4.5 to 5.5cm.

a. (cont'd)

the first complete half cycle is the SAC, therefore the polarity of the next half cycle indicates the direction of the error in the TYPE 556 calibrator.

5. (cont'd)

f. Check terminated voltage accuracy
Error: ±2%, max

Set SAC AMPLITUDE to .1 VOLTS and MODE to⊓⊔ . Apply square-wave directly to SAC OUTPUT (not MIXED) and connect SAC OUTPUT to test scope vertical input. Set test scope vertical deflection factor to .02 VOLTS/CM and adjust the VARIABLE VOLTS/CM for exactly 5cm deflection. Remove SAC connections.

Set TYPE 556 AMPLITUDE CALIBRATOR to .2 VOLTS, terminate the CAL OUT in 50Ω ±0.1% and connect to test scope vertical input. Check for 5cm ±2% waveform on the test scope.

g. Check 5mA current loop

Connect TYPE 556 5mA -- P6019 probe -- Passive Termination -- TYPE 1A1 input. Set the passive termination slide switch to 2mA/mV and the TYPE 1A1 VOLTS/CM to .05. Check that a waveform is present in the 5mA position of the AMPLITUDE CALIBRATOR switch and not in other positions.

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

6. CRT

a. Check visible defects

Check CRT for double peaking, grid emission, flare, interface, charging and burrs. (See CRT Check Out Procedure for test methods).

a. Do not reject CRT without the authorization of a trained CRT checker or reference to the CRT Check Out Procedure.

b. Check Horizontal Deflection Plate & Graticule alignment: ±3°, max

Set A and B TRIGGERING MODE to AUTO, connect voltmeter across terminals of trace rotator coil L1390 and adjust TRACE ROTATION for zero voltage.

Position the start of the traces to the left edge and to the center horizontal graticule line. Note where the traces intersect the 10th graticule line: ±0.5cm from graticule vertical center. Remove the meter.

The TYPE 556 has two overlapping 6cm scan areas. The bottom edge of the UPPER BEAM graticule is 1cm below the LOWER BEAM graticule center. The top of the LOWER BEAM graticule is 1cm above UPPER BEAM graticule center.

Adjustments listed are for upper beam. Lower beam adjustments are in parenthesis.

6. (cont'd)

c. Check and adjust TRACE ROTATION
range: 3°, min

Turn TRACE ROTATION fully cw and ccw. Note the point the traces intersect the 10th graticule line at the controls extremes, + & - 0.5cm from previously noted trace position with 0V across L1390.

Adjust TRACE ROTATION so the traces are aligned within 0.33mm of their respective horizontal graticule centers. Maximum beam deviation from each other 0.5mm.

d. Adjust Vertical Geometry
deviation: 1mm, max

Apply 1mS and .1mS markers from a TYPE 184 to both 1M1 EXT INPUTS. Set the A & B TIME/CM to .5mSEC. Adjust the A TIME/CM VARIABLE and B TIME/CM VARIABLE for a 1ms marker/cm. Adjust Sawtooth Amplitude R678 (R878) for approx 10.5cm sweep length. Adjust Edge Geom, R1391 and Center Geom, R1342 for minimum bowing. Maximum deviation of vertical trace from vertical graticule line: 1mm.

Remove the markers and recheck TRACE ROTATION setting.

d. If difficulty is encountered triggering the display, attach a 50Ω BNC cable from the TYPE 184 TRIGGER OUTPUT to TYPE 556 TRIGGER INPUT.

e. Check Horizontal Geometry
deviation: 1mm, max

Position the traces to the top and bottom of their respective graticules and check for horizontal deviation: ≤1mm.

f. Check Orthogonality
deviation: ±0.5mm in 3cm, max

Connect the TYPE 184 MARKER AMPLIFIER OUTPUT to the left 1M1 EXT INPUT with a 50Ω cable. Press .1ms and 1ms MARKER SELECTOR button. Position the bottom of the display 1cm below the upper beam graticule center and check that the baseline is parallel with the horizontal graticule line. (Adjust TRACE ROTATION as necessary.) Align the 1ms time marks with the vertical graticule lines at the baseline. Check that the time marks are not displaced from the graticule lines more than 0.5mm at a point 3cm above the baseline.

6f. (cont'd)

Change the TYPE 184 signal to the right 1M1 EXT INPUT. Position the bottom of the display 1cm below the lower beam graticule center and check that the baseline is parallel with the horizontal graticule line. (Adjust TRACE ROTATION as necessary.) Align the 1ms time marks with the vertical graticule lines at the baseline. Check that the time marks are not displaced from the graticule lines more than 0.5mm at a point 3cm above the baseline.

g. Check horizontal focus

Use A and B VARIABLE TIME/CM to display 20 1ms marks/10cm and note that all .1ms markers in the center 8cm are well defined and have no overlap. Remove markers.

h. Check vertical focus

Connect CAL OUT to 1M1 EXT INPUT, set TIME/CM to 5μSEC, set AMPLITUDE CALIBRATOR to 10V, and adjust 1M1 VARIABLE for 5cm deflection.

Set AMPLITUDE CALIBRATOR to 0.1V, and adjust FOCUS, ASTIGMATISM and INTENSITY for well-defined trace at graticule center. Position the traces vertically over full 6cm of their respective graticule areas and check that both traces are well-defined, with no overlap. Remove calibrator signal.

i. Check scan area

Set TYPE 184 to 10nS and connect to both 1M1 EXT INPUTS. Increase intensity settings to flood the screen and note that the vertical scan area is slightly greater than the graticule height. Check for phosphor defects. Remove TYPE 184 signal.

7. VERTICAL AMPLIFIERS

a. Find CRT electrical center ±0.6cm, max, from graticule center

Short the upper beam CRT vertical deflection plate leads together and note the trace vertical position relative to upper beam graticule center.

7a. (cont'd)

Remove the connection from the upper beam CRT vertical deflection plate leads. Short the lower beam CRT vertical deflection plate leads together and note the trace position relative to lower beam graticule center. Remove the short.

b. Check transistor stage unbalance: 0.5cm, max from previous stage or CRT electrical center

b. CAUTION: Care must be taken to avoid grounding any transistor stage.

Short the bases of Q43 ane Q143 (Q233 and Q433) together and note the vertical trace position. Remove the short. Short the bases of Q3 and Q103 (Q203 and Q403) together and note the trace vertical position. Remove the short.

c. Adjust DC Bal
error: ±0.5cm, max
range: + & -2cm, min from graticule center

Set 1M1's to COMMON MODE. Set Vert DC Bal, R5 (R205) full cw, then full ccw. Check range. Adjust R5 (R205) to set trace at graticule center.

d. Adjust Gain
error: ±2%, max; range: + & -5%, min

Connect the SAC OUTPUT to left 1M1 EXT INPUT. Set SAC to 100 VOLTS and both 1M1's to GAIN SET. Adjust R12 (R212) through its entire range and check for a deflection change of $\leq$3.8cm to $\geq$4.2cm. Center display and set Vert Gain for exactly 4cm. Repeat for right plug-in.

e. Adjust crossover gain
error: ±2%, max; range: + & -5%, max

Set UPPER BEAM DISPLAY to RIGHT PLUG-IN A. Adjust R34 through its entire range and check for 3.8 to 4.2cm of range. Adjust for 4cm. Set UPPER BEAM DISPLAY to LEFT PLUG-IN A.

f. Check compression and expansion: 0.5mm, max

Set SAC to 50V and position display to upper and lower limits of their respective graticules. Check UPPER BEAM and LOWER BEAM displays for no more than 0.5mm compression and/or expansion.

7. (cont'd)

g. Check Gain change with line voltage change: ±1%, max

Vary line voltage source from 100 to 130 VAC and check UPPER BEAM and LOWER BEAM displays for no more than ±1% gain change.

h. Check common mode rejection: 30:1, min

Set both 1M1's to COMMON MODE, SAC AMPLITUDE to 1 VOLT and note deflection of UPPER BEAM and LOWER BEAM displays: 3mm, max. Remove SAC signal.

i. Check trace shift with line voltage change: ±2mm, max

Remove input signal and vary line voltage source from 100 to 150 VAC. Check UPPER BEAM and LOWER BEAM for no more than 2mm trace shift.

8. DUAL TRACE AND CHOPPED OPERATION

a. Check alternate waveform amplitude: 60V, min
risetime: 1µs, max

Connect 10X probe from test scope to pin 1 of V1043 and check waveform amplitude and risetime of negative excursion at all sweep rates. Change 10X probe to pin 1 of V1063 and repeat step 8a.

b. Check alternate operation: all sweep rates

Connect SAC to both 1M1 INPUTS. Set the SAC to 10V. Set both 1M1's to ALTERNATE, check upper beam and lower beam displays for alternate trace operation from 1mSEC to 0.1µSEC positions of A and B TIME/CM switches. SAC signal will be displayed on one trace only. Set UPPER BEAM display to LEFT PLUG-IN B and check alternate trace operation from 1mSEC to .1µSEC of B TIME/CM.

Check alternate trace operation with UPPER BEAM DISPLAY set to RIGHT PLUG-IN A and to RIGHT PLUG-IN B.

c. Check dual-trace chopped blanking

Change both 1M1 TEST FUNCTIONS to CHOPPED. Set UPPER BEAM DISPLAY to LEFT PLUG-IN A. Adjust A TIME/CM and TRIGGERING LEVEL for a stable display of several cycles of chopped waveform. Change UPPER BEAM CRT

8c. (cont'd)

CATHODE SELECTOR (scope rear) to CHOPPED BLANKING and check that fast chopping transients (vertical lines) disappear. Repeat check of chopped waveform using LOWER BEAM CRT CATHODE SELECTOR switch and B sweep.

Repeat for UPPER BEAM with DISPLAY in LEFT PLUG-IN B; RIGHT PLUG-IN A; RIGHT PLUG-IN B; using appropriate time base and trigger level controls. Switch both CRT CATHODE SELECTOR switches to EXTERNAL CRT CATHODE and set the 1M1's to LOW LOAD.

9. TRIGGERING

a. Setup

Connect SAC OUTPUT -- 50Ω cable -- BNC T connector at left (right) 1M1 EXT INPUT 50Ω cable -- TYPE 556 A (B) TRIGGER INPUT. Set the UPPER BEAM DISPLAY to LEFT PLUG-IN A and the LOWER BEAM DISPLAY to B. Set B TRIGGERING to TRIG, +, AC, EXT and RIGHT. Set A TRIGGERING to TRIG, +, AC, EXT and LEFT. Use a clip lead to ground point Y on the A (B) sweep trigger switch board.

Set the test scope TYPE 1A1 CHANNEL 1 INPUT SELECTOR to AC, VOLTS/CM to .01 and MODE to CH1. Connect a X10 probe from the rear lead of R555 (R755) to TYPE 1A1 INPUT 1.

a. R555 (R755) is a 43.2k precision resistor located at the top rear of the trigger circuit board.

b. Adjust Trigger Level Centering, R545 (R745) and Trigger Sensitivity, R555 (R755)
stable triggering: + & - on 0.1V
no stable triggering: + or - on 50mV

Turn the Trigger Sensitivity ccw, then slowly cw until the display on the test scope increases in amplitude. Adjust the Triggering Level Centering for equal amplitude displays on the test scope as A TRIGGERING SLOPE (B TRIGGERING SLOPE) is changed from + to -. Reduce the SAC AMPLITUDE to 50mVOLTS. Adjust the Trigger Sensitivity for no stable trigger in either + or - positions of the SLOPE switch.

9. (cont'd)

c. Check Trigger Level Range, Zero Knob, and Check EXT Triggering
Range: Normal +&-2V, min; X10 +&-20V, min
+&-EXT Triggering: 200mV with LEVEL fixed; 100mV with LEVEL adjustable

Remove clip lead and connect the X10 probe, DC coupled, to pin A of Trigger Circuit board. Rotate the A(B) TRIGGERING LEVEL from stop to stop and note voltage excursion on test scope: + & -2 volts min. Repeat with TRIGGERING LEVEL knob pulled out and note voltage excursion: + & -20 volts min. Remove probe and push TRIGGERING LEVEL knob in. Adjust control for stable SAC display on TYPE 556 and without disturbing setting, zero the knob on the shaft. Set A(B) SOURCE to EXT. TYPE 556 must trigger on 100mV with an adjustment of TRIGGERING LEVEL. TYPE 556 must trigger on 200mV, + & - SLOPE with one setting of TRIGGERING LEVEL. Remove SAC signal and set A(B) SOURCE to NORM INT.

d. Check internal triggering
Triggering: 2mm at 10 MHz

Connect a TYPE 191 to both 1M1 EXT INPUT's. Adjust the TYPE 191 for a 2mm display of 10 MHz signal. Check for stable triggering in the AC and LF REJECT positions of the A(B) COUPLING switches.

e. Check HF REJ Triggering: must not trigger on 1cm signal at 6 MHz or above. Must trigger on 2mm, 30 Hz to 60 kHz.

Switch A(B) COUPLING to HF REJ and from the LF Sine Wave Generator apply 2mm of 60 kHz to left (right) 1M1 EXT INPUT. Check for stable triggering. Change generator frequency to 30 Hz and again check for stable triggering.

Remove the LF Sine Wave Generator connections and connect the TYPE 191 to left (right) 1M1 EXT INPUT. Apply 1cm of 6 MHz signal and check for no triggering.

9. (cont'd)

f. Check LINE and LF REJ
LF REJ: must not trigger with 3cm 30 Hz signal. Must trigger with 2mm 2.5 kHz signal.

Set A(B) SOURCE to LINE and connect 10X probe from the left (right) 1M1 to line voltage source. Check for correct line trigger polarity with + and - TRIGGERING SLOPE settings. Set SOUCE to INT and check for triggered display, adjusting LEVEL if necessary. Switch COUPLING to LF REJ.

Connect 3cm of 30 Hz signal from the LF Sine Wave Generator to the left (right) 1M1 and check that display will not trigger. Change the LF Sine Wave Generator to supply 2mm of 2.5 kHz and check for stable triggering.

g. Check AUTO STABILITY
Trigger on 1cm, 20 Hz signal
Free run with no signal

Change the COUPLING switches to AC and MODE switches to AUTO STABILITY. Adjust the LF Sine Wave Generator controls for 1cm of 20 Hz signal display. Set the TYPE 556 A TIME/CM (B TIME/CM) to 20mSEC. The TYPE 556 must trigger with an adjustment of TRIGGERING LEVEL controls. Check that the traces free run as the TRIGGERING LEVEL controls are rotated beyond the triggered area in either direction.

h. Check PLUG-IN INT

Set A(B) SOURCE to PLUG-IN INT and apply 5 volts SAC signal to the left (right) 1M1. Connect the test scope X10 probe to the junction of R526 and R528 (R726-R728) and adjust the 1M1 VARIABLE's for 200mV test scope display. Check for stable triggering with adjustment of TRIGGERING LEVEL.

h. The R526-R528 (R726-R728) junction is at the bottom end of the 100k resistor .005 F capacitor combination on the trigger switch board.

i. Check crossover triggering

From the TYPE 191 apply 2mm of 10 MHz signal to the 1M1s. Set A and B TIME/CM to 0.1μSEC, A & B TRIGGERING MODE to TRIG, and A & B SOURCE to NORM. Set UPPER BEAM DISPLAY to RIGHT PLUG-IN A and A SOURCE to RIGHT. Check for stable A triggering. Switch B SOURCE to LEFT and check for stable triggering.

9i. (cont'd)

Return UPPER BEAM DISPLAY switch to LEFT PLUG-IN A, A SOURCE to LEFT and B SOURCE to RIGHT.

j. Check DC

Change A and B COUPLING to DC. Set the TYPE 191 for a 3.5mm display at the center line of the respective graticules. Check for stable A and B triggering.

10. SINGLE SWEEP

Apply 5mm of SAC signal to both 1M1s and adjust TRIGGERING LEVEL's for a stable display. Set A and B MODE switches to SINGLE SWEEP and remove SAC signal. Push both RESETS and note both lights are on. Reapply SAC signal and note that both sweeps run once and lights extinguish.

Return A and B MODE switches to NORM and TRIGGERING MODE switches to AUTO STABILITY.

11. BEAM FINDER

Push BEAM FINDER and check that traces will remain on CRT as the 1M1 VERTICAL POSITION controls are rotated through their range.

12. TRACE SEPARATION

Set UPPER BEAM DISPLAY to RIGHT PLUG-IN A and LOWER BEAM DISPLAY to B, check range of TRACE SEPARATION control as viewed on CRT: upper beam trace must overlap lower beam trace by 1mm, must separate from lower beam by 4.1cm.

13. SCALE ILLUMINATION

Rotate SCALE ILLUM and check that lights are brightest at the cw position and extinguished at the ccw extreme. Illumination should change smoothly as control is rotated.

14. UNCALIBRATED AND MAG INDICATORS

Check that UNCAL Indicators are lit at any position of the VARIABLE TIME/CM controls except full cw (detent). Check that the X10 indicators are on at the X10 DISPLAY MAG positions.

15. BASIC TIMING

a. Adjust UPPER BEAM X10 Cal
Error: ±0.8%, max

Presets:

	UPPER BEAM	LOWER BEAM
DISPLAY	LEFT PLUG-IN A	B
TIME/CM	1mSEC	1mSEC
DISPLAY MAG	X10	X10

Apply TYPE 184 1mS and .1mS markers to both 1M1 INPUTS. Adjust A and B TRIGGERING LEVEL for a stable display and adjust X10 Cal, R1146 for one .1mS marker/cm.

b. Adjust UPPER BEAM X1 Cal
Error: ±0.8%, max

Set UPPER BEAM DISPLAY MAG to X1 and adjust X1 cal, R1167 for one 1mS marker/cm.

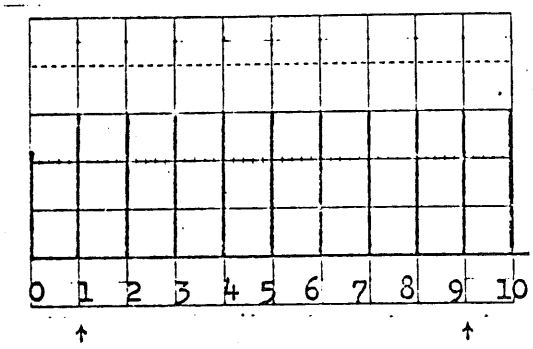
c. Adjust UPPER BEAM Swp/Mag Regis:
±2mm shift, max

Switch UPPER BEAM DISPLAY MAG to X10 and position start of trace to the graticule center line. Switch UPPER BEAM DISPLAY MAG to X1 and adjust R1168 to again place start of trace at graticule center. Repeat as necessary.

a. While making timing adjustments place top of markers to graticule horizontal center line to compensate for geometry deviations.

Horizontal gain and timing measurements.

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



15. (cont'd)

d. Adjust A Sawtooth Amplitude:
Sweep length 10.1 to 10.5cm

Apply TYPE 184 1mS and .5mS markers to both 1M1 INPUTS. Adjust R678 for 10.5cm sweep length. Return UPPER BEAM DISPLAY MAG to X10.

e. Adjust B Sawtooth Slope Adjust

Set UPPER BEAM DISPLAY to LEFT PLUG-IN B and apply TYPE 184 1mS and .1mS markers. Adjust R861 for one .1mS marker/cm on the upper beam display.

f. Adjust B Sawtooth Amplitude:
Sweep length 10.1 to 10.5cm

Adjust R878 to match B sweep length to A sweep length.

g. Adjust LOWER BEAM X10 Cal
Error: ±0.8%, max

Ovserve lower beam. Adjust R1246 for one .1mS marker/cm.

h. Adjust LOWER BEAM X1 Cal
Error: ±0.8%, max

Switch LOWER BEAM DISPLAY MAG to X1. Adjust R1267 for one 1mS marker/cm.

i. Adjust LOWER BEAM Swp/Mag Regis:
±2mm shift, max

Switch LOWER BEAM DISPLAY MAG to X10 and position start of trace to graticule center line. Switch LOWER BEAM DISPLAY MAG to X1 and adjust R1268 to again place start of trace to graticule center. Repeat adjustment as necessary to compensate for interaction.

j. Adjust A & B Sawtooth Current
Error: ±3%, max

Connect a 2 VOLT SAC signal through a compensated X10 probe to test scope TYPE 1A1 INPUT 1. Set TYPE 1A1 VOLTS/CM to .05 and adjust VARIABLE VOLTS/CM for exactly 4cm of deflection. Move the X10 probe tip to the junction of R884 and R885. Adjust R884 for a 4cm sawtooth display on the test scope. Repeat for A Sawtooth at the junction of R684 and R685, adjusting R684.

j. R884-R885 are directly in front of and slightly below the B sweep X10 Cal pot. R684 and R685 are similarly situated in the A sweep chassis.

16. DELAY PICKOFF

a. Preset TYPE 556 controls

	UPPER BEAM
DISPLAY	RIGHT PLUG-IN A
TRIGGERING	TRIG, +, AC, NORM INT, RIGHT (not triggered)
A MODE	NORM
A TIME/CM	1mSEC

	LOWER BEAM
DISPLAY	B
TRIGGERING	AUTO, +, AC, NORM INT, RIGHT (free run)
B MODE	DLY'D BY A
B TIME/CM	10μSEC

Apply 1mS markers from TYPE 184 to the 1M1 on the right.

b. Set Delay Start and Stop

Set DTM to 1.00 adjust R918 to place intensified zone on the 1st cm marker (second time mark) and to place the rising portion of the delayed sweep marker to the start of the delayed sweep trace. Set DTM to 9.00 and adjust R914 to place intensified zone on the 9th cm marker and to place the rising portion of the delayed sweep marker to the start of the trace. Repeat adjustments until the rising portion of the sweep markers are at the start of the sweep with the DTM at 1.00 and 9.00.

c. Check incremental accuracy
Error: ±1.5 minor div, max

Set DTM to place rising portion of each marker between 1.00 and 9.00 at the start of the trace, note dial error: 1.5 minor div, max.

d. Check delay jitter: 2.5mm, max

Set DTM to observe the 9th cm marker on the delayed sweep at each of the following settings and check for 2.5cm or less of jitter on markers leading edge:

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

17. CONTRAST RANGE visible change

Set A TIME/CM to 1mSEC, A TRIGGERING MODE to AUTO STABILITY, A TRIGGERING LEVEL fully cw, and position free running sweep to graticule center. Set B TIME/CM to .5mSEC, B TRIGGERING MODE to AUTO STABILITY, B TRIGGERING LEVEL fully cw, CONTRAST cw, and switch B MODE to DLY'D BY A. Set the DTM to 5.00. Turn UPPER BEAM INTENSITY cw until the first 5cm of trace start to appear. Turn the CONTRAST control throughout its range and check that the intensity of the first 5cm of the upper beam changes.

18. TIME BASE A TIMING

a. Adjust 10µSEC timing Error: ±0.8%, max ≤(6.4 minor div)

Apply TYPE 184 10µS markers. Set A TIME/CM to 10µSEC, B TIME/CM to 1µSEC and set DTM so the delayed sweep starts at the top of the second marker. Note the dial reading difference from 1.00. Change the DTM to 9.00 plus or minus the noted difference and adjust C660G so the top of the tenth marker is at the start of the sweep. Recheck adjustment and repeat as needed.

b. Adjust 1µSEC timing Error: ±0.8%, max ≤(6.4 minor div)

Set TYPE 184 to 1µS, set A TIME/CM to 1µSEC, B TIME/CM to .1µSEC and adjust C660H for 8.00 difference between second and tenth markers. Recheck and readjust if necessary.

c. Adjust .1 and .5µSEC timing Error: ±1%, max

Externally trigger the A sweep with 10µS triggering from the TYPE 184. Set A TIME/CM to .5µSEC and apply 1µS markers. Adjust C660J for one marker/2cm on the upper beam display. Disregard first marker.

18c. (cont'd)

Set B DISPLAY MAG to X10. Set A TIME/CM to .1μSEC, TYPE 184 to .1μS and adjust C681 for 1 cycle/cm. C681 and C660J interact, repeat adjustments as necessary. Set DTM to 1.00 and note position of marker on delayed sweep. Set DTM to 9.00 and adjust C660J to place marker as noted at 1.00. Check incremental accuracy of all markers between first and ninth, error: ≤8.0 minor div of DTM.

d. Check .2μSEC timing
Error: ±1%, max

Set A TIME/CM to .2μSEC and DTM to 1.00. Apply .1μS markers from TYPE 184 and note position of marker on the delayed sweep.

Rotate DTM cw and count 16 markers. Place 16th marker to position noted at 1.00. Dial should read 9.00 ±8.0 minor div.

e. Check A TIME/CM 2μSEC to 5 SEC
Error: 0.8%, max

Set A TIME/CM to 2μSEC, SOURCE to NORM INT, DISPLAY MAG to X1 and set TYPE 184 to 1μS markers. Adjust DTM so the 1st cm marker is intensified and the delayed sweep starts on the top point of the delayed sweep marker. Note the dial reading difference from 1.00. Change the DTM to about 9.00 so as to intensify the 9th cm marker and to place the top point of the delayed sweep marker at the sweep start. Note the difference from reading at 1.00: ≤6.4 minor div. Check the remaining A TIME/CM positions similarly using the following table:

A TIME/CM	B TIME/CM	TYPE 184	MARKS/CM
2μSEC	0.1μSEC	1μS	2
5μSEC	0.1μSEC	5μS	1
10μSEC*	1μSEC	10μS	1
20μSEC	1μSEC	10μS	2
50μSEC	1μSEC	50μS	1
0.1mSEC	10μSEC	.1mS	1
0.2mSEC	10μSEC	.1mS	2
0.5mSEC	10μSEC	.5mS	1
1mSEC*	0.1mSEC	1mS	1
2mSEC	0.1mSEC	1mS	2
5mSEC	0.1mSEC	5mS	1

* Adjusted previously.

c. To achieve higher resolution place the time mark on the delayed sweep at a horizontal and vertical graticule intercept point.

18f. (cont'd)

10mSEC	1mSEC	10mS	1
20mSEC	1mSEC	10mS	2
50mSEC	1mSEC	50mS	1
0.1 SEC	10mSEC	.1 S	1
0.2 SEC	10mSEC	.1 S	2
0.5 SEC	10mSEC	.5 S	1
1 SEC	0.1 SEC	1 S	1
2 SEC	0.1 SEC	1 S	2
5 SEC	0.1 SEC	1 S	5

Set B MODE to NORMAL and set A TIME/CM to 1mSEC.

19. TIME BASE B TIMING

a. Adjust and check TIME BASE B
Error: ±1%, max

a. Check for interaction and readjust fast speeds as necessary.

Adjust and check time base B accuracy following the table below:

B TIME/CM	TYPE 184	check or asjust	marks/ cm, ±1%
10µSEC	10µS	C860G	1
20µSEC	10µS	check	2
50µSEC	50µS	check	1
1µSEC	1µS	C860H	1
2µSEC	1µS	check	2
5µSEC	5µS	check	1
0.5µSEC	.5µS	C860J	1
0.1µSEC	.1µS	C881	1
0.2µSEC	.1µS	check	2

Set B TIME/CM to .1mSEC. Set UPPER BEAM DISPLAY to LEFT PLUG-IN B. Apply .1µS markers to left 1M1 and adjust C882 for 1 mark/cm. Move TYPE 184 signal back to right 1M1.

0.1mSEC	.1mS	check	1
0.2mSEC	.1mS	check	2
0.5mSEC	.5mS	check	1
1mSEC	1mS	check	1
2mSEC	1mS	check	2
5mSEC	5mS	check	1
10mSEC	10mS	check	1
20mSEC	10mS	check	2
50mSEC	50mS	check	1
0.1 SEC	.1 S	check	1
0.2 SEC	.1 S	check	2
0.5 SEC	.5 S	check	1
1 SEC	1 S	check	1
2 SEC	1 S	check	2
5 SEC	5 S	check	1

20. VARIABLE TIME/CM range: 2.5:1, min

Set both TIME/CM switches to 1mSEC and set TYPE 184 to supply 10ms markers to both verticals. Set B VARIABLE TIME/CM full ccw and note distance between markers: 4cm max. Repeat with UPPER BEAM DISPLAY set to LEFT PLUG-IN A and check A VARIABLE TIME/CM. Note that UNCAL neons are lit in any position of VARIABLE but CALIBRATED (detent). Return both VARIABLES to CALIBRATED.

21. HORIZONTAL AMPLIFIER 50 MHz COMPENSATION

a. Setup

Connect TYPE 184 MARKER OUTPUT -- 50Ω cable -- 50Ω termination -- BNC T connector at one 1M1 EXT INPUT -- 50Ω cable -- other 1M1 EXT INPUT. Connect TYPE 184 TRIGGER OUTPUT -- 50Ω cable -- 50Ω termination -- BNC T at one TYPE 556 TRIGGER INPUT -- 50Ω cable -- other TYPE 556 TRIGGER INPUT. Set TYPE 184 MARKER SELECTOR to 10nS∿ and TRIGGER SELECTOR to 1μS. Set TYPE 556 A & B TIME/CM switches to .1μSEC and A & B TRIGGERING SOURCE switches to EXT.

b. Adjust compensations Error: ±3%, max

Position start of sweep to left graticule edge and set DISPLAY MAG to X10. Use an insulated tool to adjust C1172 and C1182 (C1272 and C1282) for maximum expansion of the sweep and adjust C1193 (C1293) for max sweep expansion and best linearity (to be reset later). Adjust C1174 and C1184 (C1274 and C1284) for best timing at sweep center. If the sweep seems too long with C1174 and C1184 (C1274 and C1284) at this settings, adjust C1172 (C1272) to reduce displayed gain.

21. (cont'd)

c. Adjust X10 mag comp Error: ±3% between 4th and 70th cm

Position start of sweep to graticule left edge and adjust TRIGGERING LEVEL so a sinewave peak falls at the 4th graticule line. Position trace so this peak falls at the first centimeter line and adjust C1165 (C1265) for 1 cycle/2cm. Readjust C1193 (C1293) for best linearity and recheck center of sweep. Readjust C1172 (C1272) for correct timing.

Check timing error throughout 65cm range: ≤±3%. If nonlinearity is noted in the 20cm range, recheck C1192 (C1293) and C1172 (C1272). Recheck timing throughout 65cm range.

22. TRIGGER DELAY 150ns, max

Apply 1μS markers to lower beam vertical and preset TYPE 556 as follows:

	UPPER BEAM	LOWER BEAM
DISPLAY	RIGHT PLUG-IN A	B
DISPLAY MAG	X1	X1
A MODE	NORM	
B MODE	DLY'D BY A	
DTM	10.00	
A & B TIME/CM	.1μSEC	
A TRIGGERING	TRIG, +, AC, NORM, INT, RIGHT	
B TRIGGERING	AUTO, +, AC, NORM, INT, RIGHT	

Position traces to start at same point and adjust DTM to superimpose B marker on that of A. Note dial reading difference to be equal to or less than 150ns. Each minor dial division equals 1ns. Return B MODE to NORM and UPPER BEAM DISPLAY to LEFT PLUG-IN A.

23. EXTERNAL HORIZONTAL AMPLIFIER

a. Setup

A SAWTOOTH -- 50Ω cable -- 1M1 EXT INPUT.

SAC output -- BNC T to UPPER BEAM EXT HORIZ IN and A TRIGGER INPUT.

Preset controls:

UPPER BEAM DISPLAY	LEFT PLUG-IN EXT
DISPLAY MAG	X10
A TIME/CM	1mSEC
A TRIGGERING	AUTO, +, AC, EXT
SAC	.5 VOLTS

b. Adjust Ext Horiz DC Bal
Unbalance: 2cm, max

Position the left edge of the display to graticule center and adjust R1110 (R1210) for no baseline shift as VAR 1-10 is rotated through its range. Set VAR 1-10 full cw.

c. Adjust Compensations, check deflection factor and VAR 1-10
deflection factor: $\leq$.1V/cm
aberrations: ±3%, max
VAR 1-10 ratio: $\geq$10:1

Note horizontal deflection: 5cm, min. Adjust C1115 (C1215) for best front corner and flat top. Check aberrations. Rotate VAR 1-10 full ccw and note deflection. Must be less than 1/10 of previous deflection. Return VAR 1-10 full cw. Set SAC to 5 volts and DISPLAY MAG to X1.

d. Adjust X1 compensation
Aberrations: ±3%, max

Adjust C1100B (C1200B) for best front corner and flat top. Check aberration.

e. Check attenuation accuracy
Error: ±2%, max

Note deflection at X1, switch DISPLAY MAG to X10 and SAC AMPLITUDE to .5 VOLTS. Check deflection to be within 2% of that observed previously. Remove SAC signal.

23. (cont'd)

f. Check Ext Horiz Bandwidth:
DC to 400 kHz at -3dB

Set the LF Sine Wave Generator to supply 20 kHz and apply to UPPER BEAM EXT HORIZ IN. Use LF Sine Wave Generator Amplitude control to obtain 4cm of horizontal deflection and change generator frequency to 400 kHz. Note 2.8cm horizontal deflection minimum.

g. Check Lower Beam EXT Horizontal

Repeat steps a through f for LOWER BEAM using adjustments listed in parenthesis.

24. EXT CRT CATHODE

Remove BNC grounding caps from EXT CRT CATHODE. Set A TIME/CM to 1mSEC and connect 10V calibrator signal to EXT CRT CATHODE. Note that the display is intensity modulated at normal intensity with CRT CATHODE SELECTOR set to EXT CRT CATHODE.

Remove calibrator signal and replace BNC grounding cap. Repeat check for lower beam.

25. EXTERNAL WAVEFORMS

a. Check A & B Sawtooth
Amplitude: 94.5 volts, min

Connect test scope X10 probe to A SAWTOOTH and check waveform amplitude. Repeat for B SAWTOOTH.

b. Check A & B GATE
Amplitude: 10 volts, min

Connect probe to A GATE and measure waveform amplitude. Repeat for B GATE.

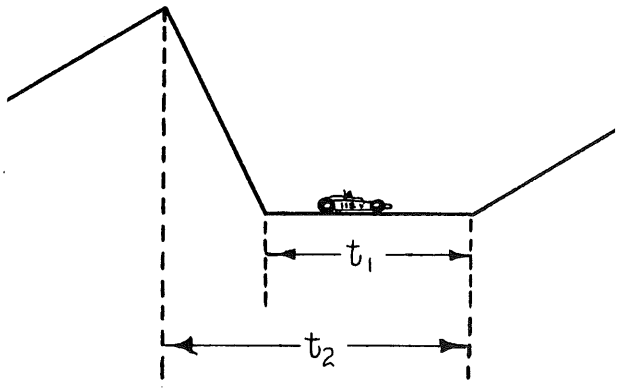
c. Check Dly'd Trig
Amplitude: 7 volts, min

Connect probe to DLY'D TRIG and measure waveform amplitude at all sweep speeds.

26. HOLDOFF

Connect test scope X10 probe to junction of D681-D675 (D881-D875) and check holdoff as follows:

TIME/CM	A and B holdoff T1	T2
0.1µSEC	≥2µs	≤25µs
0.2µSEC	≥1.5µs	≤15µs
0.5µSEC	≥1µs	≤12µs
1µSEC	≥1µs	≤10µs
2µSEC	≥1µs	≤10µs
5µSEC	≥1µs	≤10µs
10µSEC	≥5µs	≤25µs
20µSEC	≥5µs	≤25µs
50µSEC	≥5µs	≤25µs
0.1mSEC		0.25ms to 0.4ms
0.2mSEC		0.25ms to 0.4ms
0.5mSEC		0.25ms to 0.4ms
1mSEC		2.0ms to 5.0ms
2mSEC		2.0ms to 5.0ms
5mSEC		2.0ms to 5.0ms
10mSEC		30.0ms to 45.0ms
20mSEC		30.0ms to 45.0ms
50mSEC		30.0ms to 45.0ms
0.1 SEC		0.25 s to 0.5 s
0.2 SEC		0.25 s to 0.5 s
0.5 SEC		0.25 s to 0.5 s
1 SEC		1.0 s to 3.0 s
2 SEC		1.0 s to 3.0 s
5 SEC		1.0 s to 3.0 s



27. VERTICAL AMPLIFIER

a. Setup

Set UPPER BEAM DISPLAY to LEFT PLUG-IN A, A TIME/CM to .1µSEC and A TRIGGERING to AUTO, AC, NORM INT. Set 1M1 TEST FUNCTION to + PULSE and adjust amplitude for 5cm display. Position pulse to CRT center.

b. Adjust transient response
Risetime: 6.75nS, max
Aberrations: ±1.25%, max

Make the following adjustments and repeat as necessary to obtain optimum flat top and front corner on waveform. Make final adjustments with DISPLAY MAG set at X10, switching between X10 and X1 to check over-all level. Check risetime and aberrations.

R69 (R269) should be preset for optimum long term flattop. (TIME/CM @ .1mSEC and 1M1 REP RATE to LO).

27b. (cont'd)

Inductors	Capacitors	Resistors
L64	C55	R54
L164	C53	R52
L43	C54	
L143	C51	
	C17	
	C10	

L64 and L164 should be preset with tops of slugs near center of coils.

Set UPPER BEAM DISPLAY to RIGHT PLUG-IN A and make following adjustments to obtain optimum front corner and flat top. Check risetime and aberrations.

L43 and L143 should be preset with tops of slugs near top of coils.

Capacitors	Resistors
C30	R31
C31	
C32	
C19	

Set LOWER BEAM DISPLAY to RIGHT PLUG-IN B and make following adjustments to obtain front corner and flat top. Check risetime and aberrations.

L224 and L424 must be preset with tops of slugs near top of coils.

Inductors	Capacitors	Resistors
L254	C245	R244
L454	C242	R242
L224	C241	
L424	C218	
	C210	
	C244	

L254 and L454 should be preset with tops of slugs near tops of coils.

c. Adjust position effect on transient response Total aberration: ±1.25%, max

Position top of waveform over entire graticule and adjust R-69 (R259) for minimum front corner change. Recheck risetime and aberrations.

d. Check corner symmetry
Aberrations: ±1.25%, max

Switch 1M1 TEST FUNCTION to -PULSE and position waveform to center 4cm of graticule. Check aberrations.

28. HF TRIGGERING

Amplitude: 1.0cm
Jitter: 2ns, max

Switch 1M1's to LOW LOAD, A and B TRIGGERING MODE to TRIG and apply 1.0cm of 50 MHz signal from TYPE 191 to both verticals. Check for stable display with $\leq$2mm jitter on both beams and on + & - SLOPE. Change TYPE 191 AMPLITUDE to observe 2cm, switch COUPLING to DC and check for stable triggering.

Switch A TRIGGERING SOURCE to RIGHT and B TRIGGERING SOURCE to LEFT. Check for stable triggering on both beams and + & - SLOPE.

29. HORIZONTAL POSITION

a. Check horizontal POSITION range

Set A and B TIME/CM to 1mSEC and remove all connections except power.

Position both extremes horizontally to the extremes and check that traces can be positioned past the center of the graticule in both directions.

b. Check horizontal POSITION vernier

Connect .1mS and 1mS time marks from TYPE 184 to both 1M1 EXT INPUTS. Change A and B DISPLAY MAG to X10. Check for at least 2.5cm of range of UPPER BEAM and LOWER BEAM DISPLAY POSITION vernier at the center of the display. Check ccw and cw ends of rotation for at least 1cm of vernier control.

THE END