

# 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:

0-295  
September 1966

For all serial numbers.



533A

## FACTORY TEST LIMITS:

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

## QUALIFICATION:

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

## ABBREVIATIONS:

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

## CHANGE INFORMATION:

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



EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. *TEKTRONIX Instruments*

- 1 TYPE 530 SERIES OSCILLOSCOPE
- 1 TYPE 1A1 DUAL-TRACE PLUG-IN UNIT and
- 1 P6006 X10 PASSIVE PROBE (010-0127-00) and
- 1 P6028 X1 PASSIVE PROBE (010-0074-00) (test scope)
- \* 1 TYPE 1A2 DUAL-TRACE PLUG-IN UNIT
- \* 1 TYPE 184 TIME-MARK GENERATOR
- \* 1 TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
- 1 TYPE 76 TU LINE-VOLTAGE CONTROL UNIT

b. *Test Fixtures and Accessories*

- \* 1 067-0521-00 CALIBRATION FIXTURE (1M1)
- 4 50 $\Omega$  coax cables, BNC (012-0057-00)
- 1 50 $\Omega$  Termination, BNC (011-0049-00)
- 1 BNC "T" Connector (103-0030-00)
- 2 BNC to binding post adapters (103-0033-00)
- 1 BNC to clip lead adapter (013-0076-00)
- 3 18 inch patch cords with banana plugs (012-0031-00)
- \* 1 STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)
- 1 Micro Shock Hammer (PMPE Dwg. # 1283-B)
- 1 47pF ceramic capacitor (281-0518-00)

c. *Other Equipment*

- 1 20,000 $\Omega$ /VDC multimeter
- 1 Grounding strap
- 1 Soldering aid

\* 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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## FACTORY TEST LIMITS

### 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 CHECKS

#### 4. LOW VOLTAGE SUPPLIES

- a. Check time-delay relay: 15 to 60 sec
- b. Adjust -150V Adj, R616: -150V DC
- c. Check power supply voltage and regulation:

<u>Supply</u>	<u>Tolerance</u>	<u>Max Ripple</u>
-150V	±2%	5mV
+100V	±2%	10mV
+225V	±2%	5mV
+350V	±2%	20mV
+500V	±2%	20mV

#### 5. HIGH VOLTAGE

- a. Adjust High Voltage Adj, R811:  
-1350V ±2%
- b. Check high voltage regulation:  
≤20V, no blooming

#### 6. AMPLITUDE CALIBRATOR

- a. Adjust Cal Adj, R879: 100V
- \* b. Check voltage accuracy: ±2%
- c. Check for correct output
- d. Check symmetry: 45 to 55%
- e. Check frequency: 1 kHz ±20%

#### 7. CRT

- a. Align the CRT: ≤1mm

#### 8. VERTICAL AMPLIFIER BALANCE

- b. Check microphonics: ≤2.5mm,  
no ringing
- c. Check amplifier balance: ≤0.75cm
- d. Check vertical amplifier balance:  
≤2cm

#### 9. BEAM POSITION INDICATORS AND SCALE ILLUM

- a. Check beam position indicators:  
correct one on, other off before  
spot leaves the graticule
- b. Check SCALE ILLUM: max cw, off ccw

#### 10. GEOMETRY AND FOCUS

- a. Adjust Geometry. R842: ≤1mm, bowing
- b. Check horizontal focus: definition  
of 1mm marks center 8.8cm
- c. Check horizontal geometry: ≤1mm,  
bowing
- d. Check vertical focus: definition  
of 1mm spaced traces

#### 11. VERTICAL AMPLIFIER

- \* a. Set Gain, R570: range at least  
+ & - 10%, accuracy ±2%

11. (cont'd)
  - b. Check gain change with line voltage change:  $\leq 5\%$
  - c. Check compression or expansion:  $\leq 1\text{mm}$
  - d. Check drift with line voltage change:  $\leq 0.5\text{cm}$
  - e. Check DC shift:  $\leq 1\text{mm}$

## 12. DUAL TRACE AND CHOPPED BLANKING

- a. Check alternate sweep: all sweep rates
- b. Check chopped blanking: transients blanked

## 13. TRIGGERING

- b. Adjust Triggering Level Centering, R39: + & - 0.2V
- c. Adjust Trig Sens, R37: will not trigger on 0.1V
- d. Adjust Int Trig DC Level Adj, R3: 4mm within 4mm of center
- e. Set TRIGGERING LEVEL knob: + & - at 0
- f. Set PRESET STABILITY: 50% of range,  $\pm 5\%$
- g. Check triggering:

<u>INT</u>		<u>EXT</u>	
AC	2mm	AC	0.2V
AC LF REJ	2mm	AC LF REJ	0.2V
DC	4mm within 4mm	DC	0.2V
AUTO	2mm	AUTO	0.2V

- h. Check TRIGGERING LEVEL range: at least + & - 10V
- i. Check line triggering: correct slope

## 14. HIGH FREQUENCY SYNC

- a. Check external HF SYNC: 1.5V at 5 MHz and 30 MHz  $\leq 1\text{mm}$  jitter
- b. Check internal HF SYNC: 1.5cm at 5 MHz and 30 MHz  $\leq 1\text{mm}$  jitter

## 15. HORIZONTAL AMPLIFIER

- \* a. Adjust X10 Cal, R342:  $\pm 4\%$
- \* b. Adjust X100 Cal, R356:  $\pm 4\%$
- \* c. Adjust X1 Cal, R368:  $\pm 2\%$
- d. Adjust Sweep Length, R176: 10.5cm  $\pm 0.3\text{cm}$

- 15e. Adjust Swp/Mag Regis, R359:  $\pm 1\text{mm}$  shift
- f. Adjust DC Shift, R365:  $\leq 2\text{mm}$
- \* g. Check SWEEP MAGNIFIED accuracy:  $\pm 4\%$
- h. Check VARIABLE TIME/CM: ratio  $\geq 2.5:1$

## \* 16. SLOW SWEEP TIMING

$\pm 2\%$ ; except 1, 2 & 5 SEC  $\pm 2.5\%$

## 17. HORIZONTAL POSITIONING AND AMPLIFIER TIME CONSTANT

- a. Check POSITION control: + & - 5cm
- b. Adjust horizontal amplifier input time constant, C337:  $\leq 4\text{cm}$

## 18. FAST SWEEP TIMING

- \* a. Adjust 10 $\mu\text{sec}$  timing, C160E: accuracy  $\pm 2\%$
- \* b. Adjust 1 $\mu\text{sec}$  timing, C160C: accuracy  $\pm 2\%$
- \* c. Adjust .5 $\mu\text{sec}$  timing, C160A: accuracy  $\pm 2\%$
- \* d. Adjust .1 $\mu\text{sec}$  timing, C361: accuracy  $\pm 2\%$
- \* e. Adjust 20nsec timing: accuracy  $\pm 4\%$  linearity  $\pm 1\%$
- \* f. Adjust fast sweep magnified timing: accuracy  $\pm 4\%$
- \* g. Check fast sweep unmagnified timing: accuracy  $\pm 2\%$
- h. Check MAGNIFIER ON and UNCALIBRATED lights: ON, lit when sweep is magnified; UNCALIBRATED, lit when sweep rate is faster than 20nsec/cm

## 19. SINGLE SWEEP

- a. Adjust Lockout Level Adj, R125: +11V  $\pm 10\%$  from free run
- b. Check SINGLE SWEEP and READY light single sweep on triggering signal; READY light lit when sweep is armed

20. INTENSITY MODULATION

<20V

21. FRONT PANEL WAVEFORMS

VERT SIG OUT >1.5V/cm

SAWTOOTH OUT >130V

+GATE OUT >20V

22. HOLDOFF

4 $\mu$ sec to 400msec

23. EXTERNAL HORIZONTAL AMPLIFIER

- a. Adjust Ext Horiz Amp DC Bal, R334:  
<1cm
- \* b. Adjust gain, R361M: range at least  
 $\pm 10\%$  accuracy  $\pm 2\%$
- c. Check EXTERNAL HORIZONTAL VARIABLE  
VOLTS/CM: ratio  $\geq 10:1$
- d. Compensate attenuator, C310 & C313:  
 $\pm 2\%$  of .1 VOLTS/CM
- \* e. Check bandwidth: -3dB at  $\geq 500$  kHz

24. HIGH FREQUENCY RESPONSE

- c. Adjust delay line termination:  
 $\leq 1\%$  aberration
- d. Adjust delay line:  $\leq 1\%$  aberration  
and deviation from level
- e. Adjust transient response:  $\leq 1\%$   
overshoot or rolloff

\* 25. VERTICAL AMPLIFIER BANDWIDTH

-3dB at  $\geq 15$  MHz

THE END

1. PRELIMINARY INSPECTION

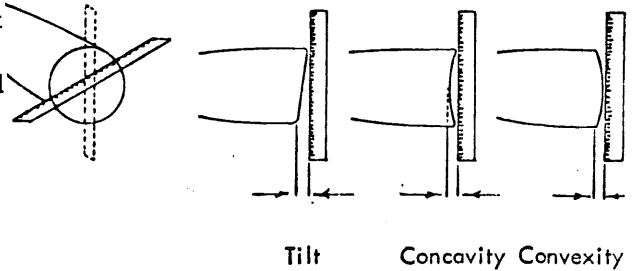
a. *General*

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

b. *CRT*

Check that CRT neck pin connections are tight and that HV shields are installed. Loosen CRT clamp, remove graticule, push CRT forward to a straight edge firmly placed against the front panel, across a diameter of the CRT. Check gap within phosphor area with rule:  $\leq 3/64"$ , max.

b. CRT face plate tilt



c. *Check fuse*

117V 60 Hz:	159-0013-00	6 amp	3ag Fast-Blo
117V 50 Hz:	159-0011-00	6.25 amp	3ag Slo-Blo
234V 60 Hz:	159-0005-00	3 amp	3ag Fast-Blo
234V 50 Hz:	159-0006-00	3 amp	3ag Slo-Blo

2. PRESET CONTROLS

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

FOCUS	ccw
INTENSITY	ccw
ASTIGMATISM	ccw
SCALE ILLUM	cw
TRIGGERING LEVEL	--
STABILITY	ccw (not PRESET)
TRIGGER SLOPE	+INT
TRIGGERING MODE	AC
TIME/CM	1mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	NORMAL (X1)
SINGLE SWEEP	NORMAL SWEEP
HORIZONTAL POSITION	midr
VERNIER	midr
EXTERNAL HORIZONTAL	
VOLTS/CM	10
VARIABLE	CALIBRATED
AMPLITUDE CALIBRATOR	OFF
POWER	OFF
CRT CATHODE SELECTOR	
(scope rear)	EXTERNAL CRT CATHODE

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

## 2. (cont'd)

Install 1M1 in TYPE 533A and preset as follows:

VERTICAL POSITION	midr
VARIABLE	midr
AMPLITUDE	midr
TEST FUNCTION	HIGH LOAD
REPETITION RATE	HIGH

3. RESISTANCE CHECKS

Measure the resistance to gnd of the following supplies. These supplies may be found on the ceramic strip inboard from T601.

<u>Supply</u>	<u>Approx Resistance</u>
-150 VDC	3k $\Omega$
+100 VDC	500 $\Omega$
+225 VDC	6k $\Omega$
+350 VDC	20k $\Omega$ (reverse meter leads)
+500 VDC	30k $\Omega$
+325 VDC unreg	3.5k $\Omega$
+ 75 VDC	400 $\Omega$

Check the resistance of T601 term 1 and 4 to gnd, infinity.

4. LOW VOLTAGE SUPPLIES

a. *Check time-delay relay: 15 to 60 sec*

Connect the TYPE 533A power cord to the TYPE 76 TU. Set the TYPE 76 TU for 117V as read on its meter. Turn TYPE 533A POWER switch ON, check for 15 to 60 secs before the audible click.

b. *Adjust -150V Adj, R616: -150 VDC*

Connect the multimeter leads from the -150V supply to gnd and adjust R616, -150V Adj, for -150 VDC.

c. *Check power supply voltage and regulation*

Set line voltage at 105V. Check the power supply voltages and ripple as given below:

c. +100 VDC Supply Ripple

The max ripple for the +100 VDC supply includes high voltage hash.

4c. (cont'd)

<u>Supply</u>	<u>Tolerance</u>	<u>Max Ripple</u>
-150 VDC	±3V	5mV
+100 VDC	±2V	10mV
+225 VDC	±4.5V	5mV
+350 VDC	±7V	20mV
+500 VDC	±10V	20mV

Repeat with 1M1 at LOW LOAD and line voltage at 125V. Return the TYPE 76 TU to 117V.

d. *Check elevated heaters*

Check the following terminals of T601 for elevation.

<u>T601 term</u>	<u>Approx DC voltage to gnd</u>
22 and 23	+95V
27 and 28	+220V
9 and 16	+350V
24 and 25	-1350V

## 5. HIGH VOLTAGE

a. *Adjust High Voltage Adj, R811:*  
-1350V ±2%

Connect the multimeter leads between the filament end of R856 and gnd. Adjust the High Voltage Adj, R811 for -1350V, ±2%.

b. *Check High Voltage Regulation: <20V,  
no blooming*

Set the TYPE 533A STABILITY cw. Slowly increase INTENSITY and adjust 1M1 VERTICAL POSITION control for a trace. With trace defocused, set the INTENSITY control cw. Set the TYPE 76 TU to 105V and check for -1350V ±20V with no blooming.

Set the TYPE 76 TU to 125V and check for -1350V ±20V with no blooming. Return TYPE 76 TU to 117V. Set INTENSITY ccw.



6. AMPLITUDE CALIBRATOR

a. *Adjust Cal Adj, R879: 100V*

Connect a 50Ω coax cable from the TYPE 533A CAL OUT to the SAC UNKNOWN INPUT. Set the AMPLITUDE CALIBRATOR to 100 VOLTS. Connect a 50Ω coax cable from the SAC OUTPUT to the test scope TYPE 1A1 DUAL TRACE PLUG-IN UNIT, INPUT 1. Set the TYPE 1A1 CHANNEL 1 VOLTS/CM to .5 and the INPUT SELECTOR to AC. Set the SAC to 100V, +DC, MIXED.

Remove V875 from the TYPE 533A. Set test scope TIME/CM to 5mSEC and trigger controls to AUTO, +LINE.

Set the Cal Adj, R879, for a null voltage (the display is a straight line).

\* b. *Check voltage accuracy: ±2%*

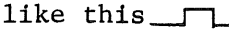
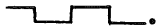
Change the instrument controls as listed in the table below while checking the AMPLITUDE CALIBRATOR error (trace separation).

<u>TYPE 533A &amp; SAC VOLTS</u>	<u>TYPE 1A1 VOLTS/CM</u>	<u>Max Deflection</u>
100	1	2cm
50	.5	2cm
20	.2	2cm
10	.1	2cm
5	.05	2cm
2	.02	2cm
1	.01	2cm
.5	.005	2cm
.2	.005	8mm
.1	.005	4mm

Add the error found in the .1 volt position to the worst error of the same direction in the previous positions. This total error must not be more than 2%.

c. *Check for correct output*

Reinsert V875. Set the SAC OUTPUT switch to UNKNOWN and change the instrument controls as listed in the table below while checking the remainder of the AMPLITUDE CALIBRATOR for approximately the correct amplitude.

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

c. The accuracy of these positions was verified in step 6b. This step is necessary to check for wiring errors and switch defects.

6c. (cont'd)

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

500 $\mu$ V/CM is obtained by coupling the CH1 SIGNAL OUTPUT to CHANNEL 2 INPUT with both VOLTS/CM switches at .005 and the MODE switch to CH2.

d. *Check symmetry: 45 to 55%*

Set the test scope TRIGGER SLOPE to +INT and TIME/CM to 50 $\mu$ SEC. Set the TYPE 1A1 MODE switch to CH1 and the CHANNEL 1 VOLTS/CM to .05. Set TYPE 533A AMPLITUDE CALIBRATOR to .2 VOLTS and trigger test scope for a stable display. Adjust the test scope VARIABLE TIME/CM for 1 cycle of square-wave in 10cm. Check the length of the half cycles, 4.5 to 5.5cm.

e. *Check frequency: 1 kHz  $\pm$ 20%*

Set the test scope TIME/CM to 1mSEC, return VARIABLE to CALIBRATED. Check for 8 to 12 cycles in 10cm. Remove SAC connections.

## 7. CRT

a. *Align the CRT: <1mm tilt*

Slowly rotate the TYPE 533A INTENSITY control until the trace appears. Adjust the FOCUS and ASTIGMATISM controls for minimum trace width. Tighten the CRT clamp and use the 1M1 VERTICAL POSITION control and CRT rotator (located on the CRT clamp) to align the trace with the graticule center line, <1mm tilt.

b. *Align the graticule*

Connect the TYPE 191 to the 1M1 EXT INPUT and set it for a 50 kHz, 5 volts signal. Position the display to cover the CRT. Adjust the graticule cam to center the graticule over the CRT display.

## 7. (cont'd)

*c. Check for phosphor defects*

Check the illuminated area of the CRT for any phosphor defects. Remove the TYPE 191 signal.

c. If defects are noted consult the Cathode Ray Tube Check Out Procedure or the CRT checker.

8. VERTICAL AMPLIFIER BALANCE*a. Find CRT electrical center*

Short the CRT vertical deflection plates together with an insulated soldering aid and note trace vertical position (CRT electrical center).

*b. Check microphonics  $\leq 2.5\text{mm}$ , no ringing*

Use the micro shock hammer on top of 533A and check display for microphonics: 2.5mm, max; with no ringing.

*c. Check amplifier balance:  $\leq 0.75\text{cm}$* 

Use a jumper to connect output amplifier grids together (V533 pin 8 to V543 pin 8). Check trace shift from CRT electrical center:  $\pm 0.75\text{cm}$ , max. Remove jumper. Short V533 pin 7 to V543 pin 7. Check trace shift from CRT electrical center:  $\pm 0.75\text{cm}$ , max. Remove jumper.

*c. Vertical Balance*

Proper vertical amplifier balance is essential for minimum vertical compression or expansion, minimum vertical trace shift with varying line voltages and proper delay line-tuning.

*d. Check vertical amplifier balance:  $\leq 2\text{cm}$* 

Set the 1M1 TEST FUNCTION to COMMON MODE. Check trace shift from the CRT electrical center;  $\pm 2\text{cm}$ , max.

9. BEAM POSITION INDICATORS AND SCALE ILLUM*a. Check beam position indicators: correct one on, other one off before spot leaves the graticule*

Change the HORIZONTAL DISPLAY switch to EXT. Center the spot with the positioning controls. With the 1M1 VERTICAL POSITION control move the spot up 3cm,  $\uparrow$  on  $\downarrow$  off. Repeat in the other direction,  $\downarrow$  on  $\uparrow$  off. Return the spot to graticule center.

## 9a. (cont'd)

With the HORIZONTAL POSITION control move the spot to the left 5cm, ← on → off. Repeat in the other direction, → on ← off. Return the HORIZONTAL DISPLAY switch to NORMAL (X1).

*b. Check SCALE ILLUM: max cw, off ccw*

Set the SCALE ILLUM control ccw and check for no graticule illumination. Slowly rotate the SCALE ILLUM cw, check for increasing brilliance with max at cw.

10. GEOMETRY AND FOCUS

*a. Adjust Geometry, R842: <1mm bowing*

Connect the MARKER AMPLIFIER OUTPUT of the TYPE 184 to the 1M1 EXT INPUT. Set the TYPE 184 for .1mS time marks. Adjust the STABILITY and TRIGGERING LEVEL for a stable display. It may be necessary to adjust Trig Level Centering, R39, to trigger the display. Position the display down so that the baseline is not visible. Adjust R842, Geometry, for minimum bowing of marks.

*b. Check horizontal focus: definition of 1mm marks center 8.8cm*

Set the TYPE 184 for 1mS time marks. Set TYPE 533A TIME/CM to .5mSEC. Adjust TRIGGERING LEVEL and STABILITY for a stable display if necessary. Adjust the VARIABLE TIME/CM and R368, if necessary, for 1 mark/cm.

Change the TYPE 184 to .1mS time marks. Re-adjust TRIGGERING LEVEL and STABILITY if necessary. Adjust INTENSITY, FOCUS and ASTIGMATISM for the best defined display. Check for no overlap of time marks anywhere in the center 8.8cm of the graticule. Return VARIABLE TIME/CM to CALIBRATED.

*c. Check horizontal geometry: <1mm bowing*

Remove the time marks from the 1M1 EXT INPUT. Set the STABILITY cw. Check geometry at the bottom, center and top of the graticule, 1mm or less bowing.

## 10. (cont'd)

- d. *Check vertical focus: definition of  
1mm spaced traces*

Connect a coax cable from the SAC OUTPUT to the 1M1 EXT INPUT. Set the SAC to 1 VOLT  $\square$ . Adjust the 1M1 VARIABLE for a display amplitude of 1cm. Set the SAC to .1 VOLT. Adjust the FOCUS, ASTIGMATISM and INTENSITY for best resolution. Position the display to the top, center and bottom of the graticule, check for no overlap of the traces.

11. VERTICAL AMPLIFIER

- a. *Set Gain, R570: range, at least  
+ & - 10%; accuracy  $\pm 2\%$*

Set the 1M1 TEST FUNCTION to GAIN SET. Change SAC AMPLITUDE to 100 VOLTS. Set Gain, R570, cw and check for 4.4cm or more of display. Set Gain ccw and check for 3.6cm or less amplitude. Set Gain, R570, for 4cm.

- b. *Check gain change with line voltage  
change:  $\leq 5\%$*

Set the TYPE 76 TU to 105V and check amplitude, 4cm  $\pm 2$ mm. Set the TYPE 76 TU to 125V and check amplitude, 4cm  $\pm 2$ mm. Return TYPE 76 TU to 117V.

- c. *Check compression or expansion:  $\leq 1$ mm*

Set the 1M1 TEST FUNCTION switch to LOW LOAD. Adjust the VARIABLE and VERTICAL POSITION for a 2cm display at graticule center. Position the display to the top and then the bottom of the graticule, check for 2cm  $\pm 1$ mm at top and bottom.

- d. *Check drift with line voltage change:  
 $\leq 0.5$ cm*

Remove the coax cable from the 1M1 EXT INPUT. Change the TYPE 76 TU to 105V, wait until trace stops drifting. Position trace to graticule center line. Change TYPE 76 TU to 125V. Check trace shift, 0.5cm or less. Return TYPE 76 TU to 117V.

## 11. (cont'd)

e. *Check DC shift:  $\leq 1\text{mm}$*

Set the 1M1 TEST FUNCTION switch to COMMON MODE, check position of trace. Change TEST FUNCTION switch to HIGH LOAD and position the trace 3cm from COMMON MODE position. Turn TEST FUNCTION switch to COMMON MODE, wait several seconds. Change the TEST FUNCTION switch to HIGH LOAD, the trace will shift rapidly 3cm. Check for 1mm or less drift following the initial trace shift.

12. DUAL TRACE AND CHOPPED BLANKING

a. *Check alternate sweep: all sweep rates*

Set the 1M1 TEST FUNCTION switch to ALTERNATE. Check the TYPE 533A display for 2 traces on all sweep rates from  $.1\mu\text{SEC}$  to 5 SEC.

b. *Check chopped blanking: transients blanked*

Set the 1M1 TEST FUNCTION switch to CHOPPED. Set the TIME/CM switch to  $2\mu\text{SEC}$  and adjust the STABILITY control for a stable display of square-waves.

Change the CRT CATHODE SELECTOR (scope rear panel) to DUAL TRACE CHOPPED BLANKING and check for blanking of vertical lines (chopping transients). Return CRT CATHODE SELECTOR to EXTERNAL CRT CATHODE and 1M1 TEST FUNCTION to HIGH LOAD.

a. *Slow sweep alternate*

Alternate sweep must operate on all sweep rates. Sweep rates slower than  $5\text{mSEC}$  are difficult to check. If in doubt apply 10 volts from the calibrator to the 1M1 EXT INPUT and check for two traces every other sweep.

13. TRIGGERING

a. *Setup*

Set the TYPE 533A as follows:

TIME/CM	$50\mu\text{SEC}$
TRIGGERING MODE	DC
TRIGGER SLOPE	+EXT
STABILITY	for display on the CRT
1M1 VARIABLE	cw

Set the test scope as follows:

TIME/CM	$20\mu\text{SEC}$
TRIGGERING MODE	AUTO
TRIGGER SLOPE	+INT

## 13a. (cont'd)

## TYPE 1A1 unit

CHANNEL 1 VOLTS/CM	.02
CHANNEL 2 VOLTS/CM	.1
INPUT SELECTORS	AC
MODE	CH1

Connect the X1 probe from the TYPE 1A1 INPUT 2 to V45 pin 6. Connect a grounding strap from the junction of R19-R20 to gnd.

Attach a BNC "T" connector to the 1M1 EXT INPUT. Connect the TYPE 191 to one side of the "T" with a 50 $\Omega$  cable. Connect a 50 $\Omega$  cable and 50 $\Omega$  Termination from the other side of the "T" to the 1A1 INPUT 1. Set the TYPE 191 FREQUENCY RANGE to 50 kHz. Adjust the AMPLITUDE controls for an output of .1 VOLTS as read on the test scope. Change the coax cable and 50 $\Omega$  Termination to the TYPE 533A TRIGGER INPUT. Switch TYPE 1A1 MODE to CH2.

*b. Adjust Triggering Level Centering, R39*

Switch TYPE 533A TRIGGER SLOPE switch back and forth between + & - EXT and adjust the Triggering Level Centering, R39 for a stable display on the test scope. Continue to adjust R39 for stable triggering in both +EXT and -EXT while adjusting TRIG SENS, R37, for the minimum sensitivity which will still permit stable triggering.

*c. Adjust Trig Sens, R37: will not trigger on 0.1V*

Reduce the sensitivity of the trigger circuit by adjusting R37, to the point where a stable trigger cannot be obtained in either +EXT or -EXT.

*d. Adjust Int Trig DC Level Adj, R3:  
4mm within 4mm of center*

Set the TYPE 191 AMPLITUDE controls for 4mm of signal on the TYPE 533A. Position the bottom of the display to the graticule center line.

Set the TYPE 533A TRIGGERING MODE to DC and TRIGGER SLOPE to +INT. Adjust the Int Trig DC Level Adj, R3, for a stable display. Switch the TRIGGER SLOPE between +INT and -INT and adjust R3 for stable triggering.

13. (cont'd)

e. *Set TRIGGERING LEVEL knob: + & - at 0*

Set the TYPE 533A TRIGGERING MODE to AC. Adjust the TYPE 191 for 2mm of display. Remove the strap from the junction of R19-R20. Tighten the TRIGGERING LEVEL knob set screw enough to allow movement of the pot. Set the knob to the position where a stable trigger is obtained. Switch the TRIGGER SLOPE switch between +INT and -INT and adjust the TRIGGERING LEVEL for stable triggering in both slopes.

Loosen the TRIGGERING LEVEL knob set screw and set the index dot straight up and re-tighten. Check that a stable trigger in both + and - INT slopes is obtained at 0. Remove the X1 probe from V45 pin 6.

f. *Set PRESET STABILITY: 50% of range, ±5%*

Set the 1M1 TEST FUNCTION switch to COMMON MODE, the TYPE 533A TRIGGER SLOPE to +LINE. Set the STABILITY control to PRESET. Connect the multimeter from the center arm of the PRESET STABILITY pot to gnd.

Adjust the PRESET ADJUST until the display appears, check the meter reading. Rotate the PRESET ADJUST clockwise until the trace brightens and check the meter reading. Set the PRESET ADJUST for a reading half-way between the two readings, ±5%.

Remove the meter leads, set the 1M1 TEST FUNCTION to HIGH LOAD and the TYPE 533A TRIGGER SLOPE to +INT.

g. *Check triggering*

Use the following table to check triggering:

<u>TRIGGERING MODE</u>	<u>signal amplitude</u>	<u>condition</u>
AUTO	2mm	INT + & -
AC LF REJ	2mm	INT + & - use TRIGGERING LEVEL
AC	2mm	INT + & - use TRIGGERING LEVEL
DC	4mm	INT + & - within 4mm of graticule center, +INT within 4mm of -INT, use VERTICAL POSITION
DC	0.2V	EXT use TRIGGERING LEVEL
AC	0.2V	EXT + & - use TRIGGERING LEVEL
AC LF REJ	0.2V	EXT + & - use TRIGGERING LEVEL
AUTO	0.2V	EXT + & -



## 13. (cont'd)

- h. Check TRIGGERING LEVEL RANGE:  
at least + & - 10V*

Remove the 50 $\Omega$  cable connected to the TYPE 191 from the "T" connector. Remove the 50 $\Omega$  Termination from the TYPE 533A TRIGGER INPUT and reconnect the cable. Connect the SAC OTUPUT to the "T" connector. Set the SAC to 10 VOLTS, +DC, MIXED. Set the TRIGGERING MODE to DC, TRIGGER SLOPE to +EXT and adjust the STABILITY and TRIGGERING LEVEL for a stable display. Rotate the TRIGGERING LEVEL to the + extreme and check for enough range to lose triggering.

Change TRIGGER SLOPE to -EXT, SAC to -DC, rotate the TRIGGERING LEVEL to the - extreme and check for enough range to lose triggering.

- i. Check line triggering: correct slope*

Remove the SAC signal and connect a 10X probe from the "T" connector to the fuse holder. Set the TRIGGERING MODE to AC, TRIGGER SLOPE to +LINE and TIME/CM to 10mSEC. Adjust the STABILITY and TRIGGERING LEVEL for a stable display. Check for the correct phase in both + and - LINE. Remove the 10X probe from the fuse holder and "T" connector.

14. HIGH FREQUENCY SYNC

- a. Check external HF Sync: 1.5V at 5 MHz  
and 30 MHz  $\leq$  1mm jitter*

Set the TRIGGERING MODE to HF SYNC, TRIGGER SLOPE to +EXT and TIME/CM to .1 $\mu$ SEC.

Connect the 50 $\Omega$  cable from the TYPE 191 to the "T" connector. Remove the 50 $\Omega$  cable from the TYPE 533A TRIGGER INPUT, connect a 50 $\Omega$  Termination to the cable and connect the termination to the TYPE 1A1 INPUT 1. Set the TYPE 191 for 1.5 volts of 50 kHz signal. Remove the 50 $\Omega$  cable and 50 $\Omega$  Termination from the TYPE 1A1 and connect it to the TYPE 533A TRIGGER INPUT. Change the TYPE 191 frequency to 5MHz and adjust the TYPE 533A STABILITY for a stable display, 1mm or less jitter.

## 14a. (cont'd)

Set the TYPE 191 frequency to 30 MHz and set the TYPE 533A HORIZONTAL DISPLAY to SWEEP MAGNIFIED X5. Adjust the STABILITY for a stable display, 1mm or less display jitter.

*b. Check internal HF SYNC: 1.5cm at 5 MHz  
and 30 MHz  $\leq$  1mm jitter*

Remove the 50 $\Omega$  cable and 50 $\Omega$  Termination from the "T" connector and TRIGGER INPUT. Increase the signal amplitude to 1.5cm. Set the TRIGGER SLOPE to +INT. Adjust the STABILITY control for a stable display, 1mm or less of jitter.

Change the TYPE 533A HORIZONTAL DISPLAY to NORMAL (X1) and the TYPE 191 frequency to 5 MHz. Adjust the TYPE 191 AMPLITUDE controls for 1.5cm of display. Adjust the TYPE 533A STABILITY for a stable display, 1mm or less of jitter.

Remove the cable and "T" connector from the 1M1.

15. HORIZONTAL AMPLIFIER

*a. Adjust X10 Cal, R342:  $\pm$ 4%*

Set the TYPE 533A TRIGGERING MODE to AC and the TRIGGER SLOPE to +EXT. Set the TIME/CM to 1mSEC. Set the TYPE 184 TRIGGER SELECTOR to 1mS and connect the TRIGGER OUTPUT to the TYPE 533A TRIGGER INPUT. Connect 10 $\mu$ S, .1mS and 1mS marks from the TYPE 184 to the 1M1 EXT INPUT. Adjust the TYPE 533A TRIGGERING LEVEL and STABILITY controls for a stable display.

Turn the HORIZONTAL DISPLAY switch to X10 and adjust the X10 Cal, R342 (located on C337 shield) for one 100 $\mu$ S mark/cm.

*b. Adjust X100 Cal, R356:  $\pm$ 4%*

Set the HORIZONTAL DISPLAY switch to X100 and adjust the X100 Cal, R356 for one 10 $\mu$ S mark/cm.

*c. Adjust X1 Cal, R368:  $\pm$ 2%*

Set the HORIZONTAL DISPLAY switch to NORMAL (X1) and adjust the X1 Cal, R368, for one 1mS mark/cm. Recheck the X10, X100 and X1 for interaction.

a. Use the center 8cm of the graticule to adjust and check sweep accuracy.

## 15. (cont'd)

d. *Adjust Sweep Length, R176: 10.5cm  $\pm$ 0.3cm*

Set the HORIZONTAL DISPLAY switch to NORMAL (X1), and adjust the Sweep Length, R176, for 10.5cm.

e. *Adjust Swp/Mag Regis, R359:  $<$ 1mm shift*

Set the HORIZONTAL DISPLAY switch to X100. Use the TYPE 533A HORIZONTAL POSITION control to bring the start of the sweep to the graticule center line. Change the HORIZONTAL DISPLAY switch to NORMAL (X1) and return the start of the sweep to the center with the Swp/Mag Regis, R359.

f. *Adjust DC Shift, R365:  $<$ 2mm*

Set the HORIZONTAL DISPLAY switch to X100. Use the HORIZONTAL POSITION control to position the start of the sweep to graticule center. Set the SINGLE SWEEP switch to SINGLE SWEEP. Wait a few seconds, then return SINGLE SWEEP switch to NORMAL SWEEP and adjust the DC Shift, R365, to eliminate trace drift.

g. *Check SWEEP MAGNIFIED accuracy:  $\pm$ 4%*

Set the HORIZONTAL POSITION control to midr, and use the VERNIER control to align time marks with the graticule lines. Use the following table to check out magnified accuracy:

HORIZONTAL		
<u>DISPLAY</u>	<u>time marks/cm</u>	<u>max error</u>
X100	1 10 $\mu$ S mark/cm	$\pm$ 3.2mm
X50	2 10 $\mu$ S mark/cm	$\pm$ 3.2mm
X20	1 .1mS mark/2cm	$\pm$ 3.2mm
X10	1 .1mS mark/cm	$\pm$ 3.2mm
X5	2 .1mS mark/cm	$\pm$ 3.2mm
X2	1 1mS mark/2cm	$\pm$ 3.2mm

h. *Check VARIABLE TIME/CM: ratio  $>$ 2.5:1*

Set the TYPE 184 for 1mS time marks only. Set the TYPE 533A HORIZONTAL DISPLAY switch to NORMAL (X1). Slowly rotate the VARIABLE TIME/CM ccw. Check that the UNCALIBRATED neon is lit when the VARIABLE is out of the CALIBRATED position. Check for 5 time marks or more/2cm at the ccw end of rotation. Return the VARIABLE TIME/CM to CALIBRATED.

16. SLOW SWEEP TIMING ±2%; except 1, 2  
& 5 SEC ±2.5%

Using the following table check slow sweep rate accuracy:

TYPE 533A TIME/CM	TYPE 184 time marks	time marks/cm	max error
.1mSEC	.1mS	1	1.6mm
.2mSEC	.1mS	2	1.6mm
.5mSEC	.5mS	1	1.6mm
1mSEC	1mS	1	1.6mm
2mSEC	1mS	2	1.6mm

Change the TYPE 184 TRIGGER SELECTOR to .1 S.

5mSEC	5mS	1	1.6mm
10mSEC	10mS	1	1.6mm
20mSEC	10mS	2	1.6mm
50mSEC	50mS	1	1.6mm
.1 SEC	.1 S	1	1.6mm
.2 SEC	.1 S	2	1.6mm

Change the TYPE 184 TRIGGER SELECTOR to 1 S.

.5 SEC	.5 S	1	1.6mm
1 SEC	1 S	1	2mm
2 SEC	1 S	2	2mm

Change the TYPE 533A TRIGGER SLOPE to +INT.

5 SEC	5 S	1	2mm
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17. HORIZONTAL POSITIONING AND AMPLIFIER TIME CONSTANT

a. Check POSITION control: + & - 5cm

Set the TYPE 184 time marks to 1mS. Set the TYPE 533A TIME/CM to 1mSEC. Rotate the HORIZONTAL POSITION control and VERNIER cw. Check that the start of the trace is to the right of the graticule center line. Set the HORIZONTAL POSITION control and VERNIER ccw, and check that the number 10 time mark is to the left of the graticule center line.

b. Adjust Horizontal Amplifier input time constant, C337: <4cm shift

Set the TYPE 184 for 10μS time marks. Change the TYPE 533A TIME/CM to .1mSEC. Adjust the TRIGGERING LEVEL for a stable display. Set the HORIZONTAL DISPLAY switch to X100. Use the HORIZONTAL POSITION control to move the start of the trace to the graticule center line. Change the TIME/CM to 50μSEC and adjust C337 to return the start of the trace to graticule center.

18. FAST SWEEP TIMING

a. *Adjust 10μS timing, C160E: accuracy ±2%*

Set the TYPE 184 TRIGGER SELECTOR to 10μS and set the TYPE 533A TRIGGER SLOPE to +EXT. Set the TYPE 533A TIME/CM to 10μSEC and the HORIZONTAL DISPLAY to NORMAL (X1). Adjust C160E for 1 mark/cm.

b. *Adjust 1μS timing, C160C: accuracy ±2%*

Change the TYPE 184 to 1μS time marks. Set the TYPE 533A TIME/CM to 1μSEC, and adjust C160C for 1 mark/cm.

c. *Adjust .5μS timing, C160A: accuracy ±2%*

Change the TYPE 533A TIME/CM to .5μSEC, and adjust C160A for 1 mark/2cm.

d. *Adjust .1μS timing, C361A: accuracy ±2%*

Change the TYPE 184 to .1μS. Set the TYPE 533A TIME/CM to .1μSEC, and adjust C361A for 1 mark/cm.

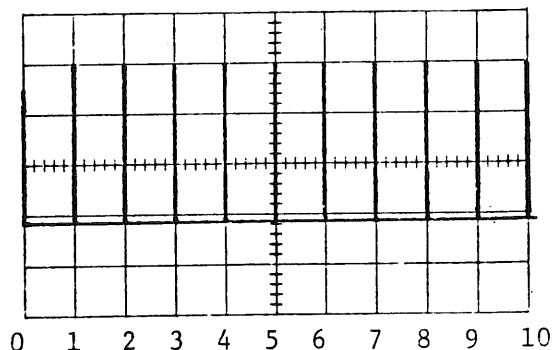
e. *Adjust 20nS timing, C382, C378, C394, C387 and C388: Accuracy ±4%; linearity ±1%*

Remove the coax cable from the 1M1 EXT INPUT. Connect a BNC to clip lead adapter to the cable. Connect a 47pF capacitor to the red lead. Connect the other end of the 47pF capacitor to one of the vertical CRT leads. Change the TYPE 184 to 20nS.

Set the TYPE 533A TIME/CM to 2μSEC and the HORIZONTAL DISPLAY to X100. Set C387 and C388 to 1/4 inch out. Locate the portion of sweep being adjusted by turning HORIZONTAL DISPLAY to NORMAL X1 and positioning the trace as indicated below. Change HORIZONTAL DISPLAY to X100 and adjust timing as follows:

<u>position of trace unmagnified</u>	<u>portion of sweep</u>	<u>adjustment</u>	<u>adjust for</u>
start of trace at 0 graticule line	center 10cm	C394	best linearity
start at number 4 graticule line	20th 10cm	C378	best timing
end of trace at number 6 graticule line	80th 10cm	C382	best timing
start of trace at 0 graticule line	center 10cm	C387 and C388	best timing

e. Time mark and graticule line identification.



18e. (cont'd)

Check and readjust C394, C378, C382, C387 and C388 using the preceding table until the sweep accuracy is  $\pm 4\%$  or less over the center 800cm of sweep.

f. *Adjust fast sweep magnified timing: accuracy  $\pm 4\%$*

Check or adjust all magnified fast sweep rates using the following table:

<u>TYPE 533A</u> <u>TIME/CM</u>	<u>HORIZONTAL</u> <u>DISPLAY</u>	<u>TYPE</u> <u>184</u>	<u>adjust</u>	<u>adjust or</u> <u>check for</u>
10 $\mu$ SEC	X100	20nS		5 cycles/cm $\pm 3.2\text{mm}$
5 $\mu$ SEC	X100	20nS		5 cycles/2cm $\pm 3.2\text{mm}$
2 $\mu$ SEC	X100	20nS		1 cycle/cm $\pm 3.2\text{mm}$
1 $\mu$ SEC	X50	20nS		1 cycle/cm $\pm 3.2\text{mm}$
.5 $\mu$ SEC	X20	20nS	C361J	5 cycles/4cm $\pm 3.2\text{mm}$
.2 $\mu$ SEC	X10	20nS	C361G	1 cycle/cm $\pm 3.2\text{mm}$
.1 $\mu$ SEC	X5	20nS	C361E	1 cycle/cm $\pm 3.2\text{mm}$
.1 $\mu$ SEC	X2	20nS	C361C	5 cycles/2cm $\pm 3.2\text{mm}$

f. OUT OF TOLERANCE MAGNIFIED SWEEP

Readjust C160A, C160C and C160E as required to bring in magnified sweep accuracy. Unmagnified sweep must remain within tolerance.

Remove the TYPE 184 signal from the CRT vertical deflection plate. Reconnect the TYPE 184 signal to the 1M1. Set the TYPE 184 for .1 $\mu$ S. Set the HORIZONTAL DISPLAY to NORMAL X1. Recheck for 1 cycle/cm  $\pm 2\%$ . Continue checking magnified sweep rates using the following table:

<u>TYPE 533A</u> <u>TIME/CM</u>	<u>HORIZONTAL</u> <u>DISPLAY</u>	<u>TYPE</u> <u>184</u>	<u>check for</u>
.2 $\mu$ SEC	X2	.1 $\mu$ S	1 mark/cm $\pm 3.2\text{mm}$
.5 $\mu$ SEC	X2	.1 $\mu$ S	5 marks/2cm $\pm 3.2\text{mm}$
.5 $\mu$ SEC	X5	.1 $\mu$ S	1 mark/cm $\pm 3.2\text{mm}$
1 $\mu$ SEC	X5	.1 $\mu$ S	2 marks/cm $\pm 3.2\text{mm}$
1 $\mu$ SEC	X10	.1 $\mu$ S	1 mark/cm $\pm 3.2\text{mm}$
2 $\mu$ SEC	X10	.1 $\mu$ S	2 marks/cm $\pm 3.2\text{mm}$
2 $\mu$ SEC	X20	.1 $\mu$ S	1 mark/cm $\pm 3.2\text{mm}$
5 $\mu$ SEC	X20	.1 $\mu$ S	5 marks/2cm $\pm 3.2\text{mm}$
5 $\mu$ SEC	X50	.1 $\mu$ S	1 mark/cm $\pm 3.2\text{mm}$
10 $\mu$ SEC	X50	.1 $\mu$ S	2 marks/cm $\pm 3.2\text{mm}$
10 $\mu$ SEC	X100	.1 $\mu$ S	1 mark/cm $\pm 3.2\text{mm}$

18. (cont'd)

g. *Check fast sweep unmagnified: accuracy ±2%*

Set the TYPE 533A HORIZONTAL DISPLAY to NORMAL and TIME/CM to 50μSEC. Set the TYPE 184 TRIGGER SELECTOR to .1mS and time marks to 50μS. Using the following table, check all sweep rates to .1μSEC.

<u>TYPE 533A</u> <u>TIME/CM</u>	<u>TYPE 184</u> <u>time marks</u>	<u>check for</u>	<u>max error</u>
50μSEC	50μS	1 mark/cm	1.6mm
20μSEC	10μS	2 marks/cm	1.6mm
10μSEC	10μS	1 mark/cm	1.6mm
5μSEC	5μS	1 mark/cm	1.6mm
2μSEC	1μS	2 marks/cm	1.6mm
1μSEC	1μS	1 mark/cm	1.6mm
.5μSEC	.5μS	1 mark/cm	1.6mm
.2μSEC	.1μS	2 marks/cm	1.6mm
.1μSEC	.1μS	1 mark/cm	1.6mm

h. *Check MAGNIFIER ON and UNCALIBRATED lights: ON, lit when sweep is magnified; UNCALIBRATED, lit when sweep is faster than 20ns/cm*

Change the TYPE 533A HORIZONTAL DISPLAY switch to X2 and check the operation of the MAGNIFIER UNCALIBRATED and ON lights as follows:

<u>TIME/CM</u>	<u>HORIZONTAL</u> <u>DISPLAY</u>	<u>MAGNIFIER ON</u>	<u>UNCALIBRATED</u>
.1μSEC	X2	on	off
.1μSEC	X5	on	off
.1μSEC	X10	on	on
.2μSEC	X10	on	off
.2μSEC	X20	on	on
.5μSEC	X20	on	off
.5μSEC	X50	on	on
1μSEC	X50	on	off
1μSEC	X100	on	on
2μSEC	X100	on	off
2μSEC	EXT	off	off
2μSEC	NORMAL (X1)	off	off

19. SINGLE SWEEP

a. *Adjust Lockout Level Adj, R125: +11V from free run ±10%*

Set the TYPE 533A TIME/CM to .5mSEC. Remove all connections from the 1M1 and TYPE 533A. Set TRIGGER SLOPE to +INT. Connect the multimeter from V125 pin 2 to gnd. Set the STABILITY control to the point just before the sweep runs, and note the meter reading.

## 19a. (cont'd)

Set the TYPE 533A SINGLE SWEEP switch to SINGLE SWEEP. Set the TYPE 533A STABILITY control cw. Adjust the Lockout Level Adj, R125, for a reading 11 volts less negative than the original reading. Remove the meter leads.

- b. *Check SINGLE SWEEP and READY light:  
single sweep on triggering signal;  
READY light lit when sweep is armed*

Set the SINGLE SWEEP switch to NORMAL, and return the STABILITY control to the point where the sweep just starts. Set the SINGLE SWEEP switch to SINGLE SWEEP and rotate the STABILITY control cw. Check that the READY light and sweep do not come on. Set the SINGLE SWEEP switch to NORMAL SWEEP. Connect a coax cable from the TYPE 533A CAL OUT to the IM1 EXT INPUT. Set the TYPE 533A AMPLITUDE CALIBRATOR to .5 VOLTS. Using the STABILITY, TRIGGERING LEVEL and IM1 VARIABLE controls, obtain a stable display of 2mm amplitude. Set the SINGLE SWEEP switch to SINGLE SWEEP and check that the display extinguishes. Push the SINGLE SWEEP switch to RESET, observe the READY light lights and a sweep is generated.

Remove the coax cable from the IM1 EXT INPUT. Push the SINGLE SWEEP switch to RESET and check that the READY light is lit. Reconnect the coax cable to the IM1 EXT INPUT and check that a sweep is generated and the READY light extinguishes. Return SINGLE SWEEP switch to NORMAL SWEEP.

20. INTENSITY MODULATION<20V

Remove the coax cable from the IM1 EXT INPUT. Remove the strap between the EXTERNAL CRT CATHODE and GND, on the TYPE 533A rear panel. Check that the CRT CATHODE SELECTOR switch is in EXTERNAL CRT CATHODE. Connect a 20 volt signal from the SAC to the EXTERNAL CRT CATHODE binding post. Set the STABILITY control cw. Set the TYPE 533A TIME/CM switch to 1mSEC and check the trace for intensity modulation; a series of bright dots or dashes. Remove the signal from the binding post and reinstall the strap and change the CRT CATHODE SELECTOR to DUAL TRACE CHOPPED BLANKING.



21. FRONT PANEL WAVEFORMS      VERT SIG OUT    ≥1.5V/cm  
    SAWTOOTH OUT    ≥130V  
    +GATE OUT       ≥20V

Connect the TYPE 533A CAL OUT to the 1M1 EXT INPUT with a coax cable. Set the AMPLITUDE CALIBRATOR for 2 VOLTS. Adjust the 1M1 VARIABLE for 2cm of vertical display. Set the test scope TYPE 1A1 INPUT SELECTOR to DC. Set the test scope TRIGGERING MODE to DC and TRIGGER SLOPE to -INT. Use the test scope X10 probe and check the following amplitudes:

VERT SIG OUT      3 volts min  
 SAWTOOTH OUT    130 volts min  
 + GATE OUT       20 volts min

Remove the coax cable from the 1M1 EXT INPUT and the TYPE 533A CAL OUT.

22. HOLDOFF                      4μsec to 400msec

With the test scope X10 probe connected to the + GATE OUT jack measure holdoff using the following table:

<u>TYPE 533A TIME/CM</u>	<u>test scope TIME/CM</u>	<u>holdoff</u>
.1, .2 and .5μSEC	2μSEC	4-9μs
1, 2 and 5μSEC	10μSEC	15-40μs
10, 20 and 50μSEC	10μSEC	15-40μs
.1, .2 and .5mSEC	.1mSEC	150-400μs
1, 2 and 5mSEC	1mSEC	1.5-4ms
10, 20 and 50mSEC	10mSEC	15-40ms
.1, .2, .5, 1, 2 and 5 SEC	.1 SEC	150-400ms

Remove the X10 probe.

23. EXTERNAL HORIZONTAL AMPLIFIER

- a. *Adjust Ext Horiz Amp DC Bal,*  
*R334:  $\leq 1\text{cm}$  shift*

Set the TYPE 533A TIME/CM switch to 2mSEC. Install a BNC to binding post adapter on the 1M1 EXT INPUT. Connect a patch cord from the SAWTOOTH OUT binding post to the 1M1 EXT INPUT. Set the HORIZONTAL DISPLAY switch to EXT. Set the EXTERNAL HORIZONTAL VOLTS/CM to .1. Use the HORIZONTAL POSITION control to keep the display on the graticule. Rotate the EXTERNAL HORIZONTAL VARIABLE back and forth while adjusting the Ext Horiz Amp DC Bal, R334, for no trace shift. Set the EXTERNAL HORIZONTAL VARIABLE to CALIBRATED.

- b. *Adjust gain, R361M: range at least  $\pm 10\%$*   
*accuracy  $\pm 2\%$*

Install a BNC "T" connector on the TRIGGER INPUT connector. Install a BNC to binding post adapter on one side of the "T" connector. Connect a patch cord from the EXT HORIZ IN to the BNC to binding post adapter. Connect the output coax cable from the SAC to the other side of the "T" connector. Set the TRIGGER SLOPE to +EXT and the SAC to .5 VOLTS. Position the display to the center of the graticule with the HORIZONTAL POSITION control. Check the cw extreme of R361M for 5.5cm or more of display amplitude and ccw for 4.5cm or less. Adjust R361M for 5cm amplitude.

Set the EXTERNAL HORIZONTAL VOLTS/CM to 1 and the SAC to 5 VOLTS. Check for 5cm  $\pm 1\text{mm}$ . Set the EXTERNAL HORIZONTAL VOLTS/CM to 10 and the SAC to 50 volts and check for 5cm  $\pm 1\text{mm}$ .

- c. *Check EXTERNAL HORIZONTAL VARIABLE*  
*VOLTS/CM: ratio  $\geq 10:1$*

Rotate the VARIABLE ccw set the EXTERNAL HORIZONTAL VOLTS/CM to 1 and check for 5cm or less of horizontal amplitude. Return the VARIABLE to CALIBRATED.

- d. *Compensate attenuator, C310 and C313:*  
 *$\pm 2\%$  of .1 volts/cm*

Set the SAC to .5 VOLTS and set the EXTERNAL HORIZONTAL VOLTS/CM to .1. Set the TYPE 533A TIME/CM to 5mSEC. Adjust the TRIGGERING LEVEL and STABILITY for a stable display. Check the amount of rolloff or overshoot. Change the EXTERNAL HORIZONTAL VOLTS/CM to 1 and the SAC to 5 VOLTS. Adjust C310 to match the waveform at .1 volts/cm.

## 23d. (cont'd)

Set the SAC to 50 VOLTS and the EXTERNAL HORIZONTAL VOLTS/CM to 10. Adjust C313 to match the waveform at .1 volts/cm.

*e. Check bandwidth: -3dB at  $\underline{>500}$  kHz*

Remove the patch cords and adapters from the TRIGGER INPUT and EXTERNAL HORIZ IN. Set the EXTERNAL HORIZONTAL VOLTS/CM switch to .1. Set the STABILITY control cw. Connect the TYPE 191 to the EXTERNAL HORIZ IN with a 50 $\Omega$  cable, a 50 $\Omega$  Termination and a BNC to clip lead adapter. Set the TYPE 191 FREQUENCY RANGE to 50 kHz and adjust the AMPLITUDE and AMPLITUDE RANGE controls for 6cm of display. Change the TYPE 191 frequency to .5 MEGAHERTZ and check for 4.2cm or more remaining. Remove the TYPE 191, 50 $\Omega$  cable, 50 $\Omega$  Termination and adapter from the TYPE 533A and set the HORIZONTAL DISPLAY switch to NORMAL (X1). Remove the patch cord and adapter from the 1M1 EXT INPUT and SAWTOOTH OUT.

24. HIGH FREQUENCY RESPONSE

*a. Setup*

Set the TYPE 533A TIME/CM to .1 SEC, TRIGGER SLOPE to INT -. Set the 1M1 TEST FUNCTION switch to + PULSE. Adjust the TYPE 533A STABILITY and TRIGGERING LEVEL for a stable display.

*b. Preset delay line*

Preset the vertical amplifier and delay line as follows:

L506 and L523 slugs just below the windings  
L553 and L563 bottom slugs just into the  
windings and top slugs 1/8 inch  
from top of coil form

C553 and C563 midr  
delay line trimmers C903 thru C940 1/4 inch out  
L955 and L956 1/4 of the slug into the windings.

*c. Adjust delay line termination:  $\underline{<1\%}$   
aberration*

Adjust the TYPE 533A VARIABLE TIME/CM for approx 1 cycle/10cm. Adjust 1M1 AMPLITUDE and VERTICAL POSITION controls for 3cm, centered.

## 24c. (cont'd)

Adjust L553, L563 (both top and bottom slugs) C553 and C563 to eliminate the termination aberration. Keep the slugs in L563 even with the slugs in L553.

d. *Adjust delay line: <1% aberration and deviation from level*

Adjust the delay line trimmer capacitors a little at a time (1/2 turn or so) keeping them even. After each time trimmers have been adjusted, change the TYPE 533A TIME/CM switch to 2 $\mu$ SEC and check the slant of the top of the pulses. This is the deviation from level, 1% (0.5mm) max. If the top is not level repeat steps 25c. and d.

e. *Adjust transient response: <1% overshoot or rolloff*

Return the TYPE 533A TIME/CM switch to .1 $\mu$ SEC and adjust L955 and L956 for the best front corner, 1% (0.5mm) or less overshoot or rolloff. If the range of L955 and L956 is not adequate L506 and L523 may need to be adjusted. Keep the coil slugs in L955 and L956, and L506 and L523 equal. Recheck the termination and delay line trimmers for 1% or less aberration and 1% or less deviation from level

## 25. VERTICAL AMPLIFIER BANDWIDTH -3dB at >15 MHz

Remove the LM1 from the TYPE 533A and install a TYPE 1A2 PLUG-IN UNIT. Set the TYPE 1A2 MODE to CH1, CHANNEL 1 INPUT SELECTOR to DC and VOLTS/CM to .05.

Connect the TYPE 191 to the TYPE 1A2 CHANNEL 1 INPUT with a 50 $\Omega$  coax cable and 50 $\Omega$  Termination. Set the TYPE 191 FREQUENCY RANGE to 50 kHz. Adjust the TYPE 191 AMPLITUDE controls for 4cm of display amplitude with the TYPE 533A TIME/CM at 1mSEC and STABILITY cw.

Set the TYPE 191 FREQUENCY RANGE to 8-18 MEGAHERTZ and adjust the frequency dial for 2.8cm of deflection remaining (-3dB point). Check the reading of the TYPE 191 frequency dial for >15 MHz.