

FACTORY CALIBRATION PROCEDURE

CONTENTS:

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

Equipment Required

Factory Test Limits - Factory Test Limits are limits an instrument must meet before leaving Manufacturing. These limits are often more stringent than advertised performance requirements. This is to insure that the instrument will meet advertised requirements after shipment, allows for individual differences in test equipment used, and (or) allows for changes in environmental conditions.

Short Form Procedure - The Short Form Procedure has the same sequence of steps and the same limits on checks or adjustments as the Main Procedure.

Main Procedure - The Main Procedure gives more detailed instructions for the calibration of the instrument. This procedure may require that some checks and adjustments be made so that performance is better than that required by the Factory Test Limits. This insures the Factory Test Limits will be met when side panels are added, permits some normal variation in test equipment and plug-in scopes, etc.

Abbreviations in this procedure will be found listed in TEKTRONIX STANDARD A-100. Definitions of terms used in this procedure may be found in TEKTRONIX STANDARD A-101.

In this procedure, all front panel control labels and Tektronix instrument names are in capital letters (VOLT/DIV, etc). Internal adjustment labels are capitalized only (Gain Adj, etc).

CHANGE INFORMATION:

This procedure has been prepared by Product Manufacturing Staff Engineering. For information on changes made to this procedure, to make suggestions for changing this procedure, or to order additional copies: please contact PMSE, 39-307. (HD)

*This procedure is
company confidential*

531A

Tek form number:
0-293
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For all serial
numbers.



EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

- 1 TYPE 647 OSCILLOSCOPE with
- 1 TYPE 10A2 PLUG-IN UNIT and
- 1 TYPE 11B2 PLUG-IN UNIT (test scope)
- *1 TYPE 184 TIME MARK GENERATOR
- *1 TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
- 1 TYPE 76TU LINE VOLTAGE CONTROL UNIT
- 1 TYPE 1A2 PLUG-IN UNIT
- 1 TYPE P6028 1X Probe
- 1 TYPE P6006 10X Probe

b. Test Fixtures and Accessories

- *1 STANDARD AMPLITUDE CALIBRATOR (067-0502-00)
- 1 SINE WAVE GENERATOR (067-0542-99)
- *1 CALIBRATION FIXTURE (067-0521-00)
- 1 50 Ω Termination, BNC (011-0049-00)
- 2 Coaxial cables 50 Ω 42 inches BNC (012-0057-00)
- 2 UHF Male to BNC Female Adapters (103-0015-00)
- 1 GR to BNC Female Adapter (017-0063-00)
- 1 Micro Shock Hammer

c. Other Equipment

- 1 Multimeter 20,000 Ω /Volt (Simpson 262 or equivalent)

*This equipment must be traceable to NBS for certification of measurement characteristics.

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

FACTORY TEST LIMITS

QUALIFICATION

Factory Test Limits are qualified by the conditions specified in the main body of the Factory Calibration Procedure. The numbers and letters to the left of the limits correspond to the procedure steps where the check or adjustment is made. Steps without Factory Test Limits (set-ups, presets, etc.) are not listed. Instruments may not meet Factory Test Limits if calibration or checkout methods and test equipment differ substantially from those in this procedure.

4. POWER SUPPLIES

- a. Time delay relay: 15 to 60s delay
- b. Power Supply Max Error Max Ripple

-150	±3V	5mV
+100	±2V	10mV
+225	±4.5V	5mV
+350	±7V	20mV
+500	±10V	20mV

 regulation: 104.5VAC line to 125.5 VAC line, high and low load
- c. High voltage regulation: no trace bloom or voltage change >20V from 104.5VAC to 125.5VAC line

5. GEOMETRY

- a. CRT alignment: 0.5mm max error
- c. Geometry: bowing 1mm, max

6. FOCUS

- a. Horizontal focus: no overlap of 1mm spaced marks over the center 8.8cm of graticule
- b. Vertical focus: no overlap of 1mm spaced marks.

7. BEAM POSITION INDICATORS

- b. Beam position indicators: the proper beam position indicator must light and the opposite neon must go out before the spot leaves the graticule area.

- c. SCALE ILLUM: on max, cw; off, ccw

8. 5X MAGNIFIER AND VARIABLE INDICATORS

- a. MAG ON indicator

<u>HORIZONTAL DISPLAY</u>	<u>Indicator neon</u>
5X MAG	on
all other positions	off

- b. UNCALIBRATED indicator: neon must be off when TIME/CM VARIABLE is in the cw (CALIBRATED) position and lit in all other positions of the VARIABLE control.

- 9. INTENSITY MODULATION: $\leq 20V$

10. VERTICAL AMPLIFIER

- a. Output amplifier balance: 0.75cm
- b. Driver cathode follower balance: 0.75cm
- c. Overall amplifier balance: 3cm
- d. Microphonics: 2.5mm, max
- *e. Vertical Gain: ±2%, max error range: +10% to -10%
- f. Compression/expansion: 1mm, max, with 2cm display
- g. DC shift: 1mm, max, after 3cm deflection
- h. Vertical drift: 0.5cm, max, from 104.5VAC to 125.5VAC line

11. ALTERNATE TRACE AND CHOPPED BLANKING

- a. Alternate Trace: operates at all sweep speeds
- b. Alternate trace sync pulse: amplitude $\geq 60V$; negative pulse rise-time $\leq 1\mu s$
- c. Chopped Blanking: blanking of fast chopping transients

12. AMPLITUDE CALIBRATOR

- *b. Accuracy: $\pm 2\%$, all positions
- c. Calibrator period: $1\text{ms} \pm 20\%$
- d. Duty cycle: 45% to 55%

13. TRIGGERING

- f. PRESET STABILITY: 50% of range, $\pm 5\%$
- g. Triggering:

	$\pm \text{INT}$	$\pm \text{EXT}$
AC	2mm	0.2V
AC LF REJ	2mm	0.2V
DC	4mm within 4mm	0.2V
AUTO	2mm	0.2V

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

14. HIGH FREQUENCY SYNC

- a. External HF sync: 1.5V at 5MHz and 30MHz; $\leq 1\text{mm}$ jitter
- b. Internal HF sync: 1.5cm at 5MHz and 30MHz; $\leq 1\text{mm}$ jitter

15. LOW AND HIGH FREQUENCY TRIGGERING

	INT	EXT
a. AC at 5MHz:	1cm	1.0V
b. DC at 5MHz:	2cm	1.0V
c. AUTO at 2MHz:	1cm	1.0V
d. AC LF REJ at 200Hz:	Inoperable	
	2cm	2.0V

*16. HORIZONTAL AMPLIFIER

- b. Sweep Magnified: $\pm 3\%$

17. SWEEP LENGTH

- a. Sweep length: 10.2 to 10.8cm

18. NORM MAG REGISTRATION

- a. Normal/Magnified registration: $\pm 0.5\text{cm}$ at graticule center.

19. VARIABLE TIME/CM

- a. VARIABLE ratio: 2.5 to 1

*20. SLOW SWEEP TIMING

- a. Slow sweep timing: $\pm 2\%$ except 1, 2 & 5 SEC $\pm 2.5\%$

*21. FAST SWEEP TIMING

- b. Horizontal compensation: $\pm 2\text{mm}$
- i. Fast sweep timing: $\pm 2\%$; magnified $\pm 3\%$

22. FRONT PANEL WAVEFORMS

VERT SIG OUT: $\geq 1.5\text{V/CM}$
 SAWTOOTH OUT: $\geq 130\text{V}$
 + GATE OUT: $\geq 20\text{V}$

23. HOLDOFF

Holdoff: $4\mu\text{s}$ to 400ms

24. EXTERNAL HORIZONTAL AMPLIFIER

- a. Ext Horiz Amp DC Balance: 1cm shift, max
- b. X10 Horizontal Amp: $\pm 3\%$ aberrations referenced to X1
- c. External horizontal deflection factor: 5.6cm/V, min
- d. EXT HORIZ ATTEN X10: $\pm 2\%$
- e. EXTERNAL HORIZ ATTENUATOR 10-1: 10 to 1 ratio, min
- *f. Horizontal Bandpass: 350kHz at -3dB or less

25. HIGH FREQUENCY RESPONSE

Transient response: $\leq 1\%$ aberration or deviation from level.

26. VERTICAL AMPLIFIER BANDWIDTH

-3dB at $\geq 15\text{MHz}$

[NOTE: THE FOLLOWING CHECKS ARE NOT MADE
ON 100% OF THE INSTRUMENTS BUT ARE DONE ON
A SAMPLING BASIS]

27. VERT SIG OUT FREQUENCY RESPONSE

a,b. $\leq 10\text{Hz}$ to $\geq 5\text{MHz}$ at -3dB

28. TRIGGER FREQUENCY RESPONSE

a,b. AC: $\leq 150\text{Hz}$ to $\geq 2\text{MHz}$

AUTO: $\leq 50\text{Hz}$ to $\geq 0.75\text{MHz}$

AC LF REJ: $\leq 10\text{kHz}$ to $\geq 2\text{MHz}$

SHORT FORM PROCEDURE

Factory TEST LIMITS are limits an instrument must meet before it leaves Manufacturing; therefore, it must be possible to inspect to these limits. Because of normal variations in test equipment and plug-in scopes, addition of side panels, etc, it is necessary to set up some circuits so their performance is better than required by Factory Test Limits. Therefore, the instructions given in the Factory Calibration Procedure may call for checks or adjustments which result in less error than that allowed by the Factory Test Limits.

1. PRELIMINARY INSPECTION

- a. Check shield
- b. Check CRT: tilt 1/32 inch, max concavity or convexity 1/32 inch, max
- c. Check fuse

2. PRESET CONTROLS

3. RESISTANCE

4. POWER SUPPLIES

- a. Check time delay relay: 15 to 60 seconds
- b. Adjust -150V Adj, R616 and check regulated voltages: $\pm 2\%$ must regulate: 104.5VAC line to 125.5VAC line, high and low load
- c. Adjust HV Adj, R840, and check HV regulation: voltage: -1350V regulation: no trace bloom or voltage change >20V from 104.5VAC to 125.5VAC line

5. GEOMETRY

- a. Align CRT
- b. Adjust graticule: center of scan area
- c. Adjust Geom Adj, R861: bowing 1mm, max

6. FOCUS

- a. Check horizontal focus: no overlap of 1mm spaced marks over the center 8.8cm of graticule
- b. Check vertical focus: no overlap of 1mm spaced marks

7. BEAM POSITION INDICATORS AND SCALE ILLUMINATION

- b. Check beam position indicators: The proper beam position indicator must light and the opposite neon must go out before the spot leaves the graticule area
- c. Check SCALE ILLUM: on max, cw; off, cw

8. 5X MAGNIFIER AND VARIABLE INDICATORS

- a. MAG ON indicator

<u>HORIZONTAL DISPLAY</u>	<u>Indicator neon</u>
5X MAG	on
all other positions	off

- b. UNCALIBRATED
TIME/CM VARIABLE
- | <u>Indicator
neon</u> |
|---------------------------|
| off |
| on |

9. INTENSITY MODULATION $\leq 20V$

10. VERTICAL AMPLIFIER

- a. Check output amplifier balance: 0.75cm
- b. Check driver cathode follower balance: 0.75cm
- c. Check overall amplifier balance: 2cm
- d. Check for microphonics: 2.5mm, max
- *e. Adjust Vert Gain Adj, R570: 4cm range: +10% to -10%

- 10f. Check compression/expansion: 1mm, max at top or bottom of the graticule with 2cm display
- g. Check DC shift: 1mm, max after 3cm deflection
- h. Check vertical drift: 0.5cm, max from 104.5VAC to 125.5VAC line
11. ALTERNATE TRACE AND CHOPPED BLANKING
- a. Check alternate trace at all sweep speeds
- b. Check alternate trace sync pulse: amplitude $\geq 60V$; negative pulse rise-time $\leq 1\mu s$
- c. Check chopped blanking
12. AMPLITUDE CALIBRATOR
- a. Adjust Cal Adj, R879: 100V
- *b. Check accuracy: $\pm 2\%$ all positions
- c. Check calibrator period: 1ms $\pm 20\%$
- d. Check calibrator duty cycle: 45% to 55%
13. TRIGGERING
- b. Adjust Triggering Level Centering, R39
- c. Adjust Trig Sens, R47: will not trigger on 0.05V
- 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
- g. Check triggering:
- | <u>$\pm INT$</u> | | <u>$\pm EXT$</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 5MHz and 30MHz $\leq 1mm$ jitter
- b. Check internal HF sync: 1.5cm at 5MHz and 30MHz $\leq 1mm$ jitter
15. LOW AND HIGH FREQUENCY TRIGGERING
- a. Check AC triggering: 1cm INT or 1.0V EXT at 5MHz
- b. Check DC triggering: 2cm INT or 1.0V EXT at 5MHz
- c. Check AUTO triggering: 1cm INT or 1.0V EXT at 2MHz
- d. Check AC LF REJ: Inoperable with 2cm INT or 2.0V EXT at 200Hz
- *16. HORIZONTAL AMPLIFIER
- b. Adjust Mag Gain, R375: linearity 1%
- c. Adjust Swp Cal, R348
17. SWEEP LENGTH
- a. Adjust Sweep Length, R176: 10.5cm
18. NORM MAG REGISTRATION
- a. Adjust Norm/Mag Regis, R358: trace start at graticule center
19. VARIABLE TIME/CM
- a. Check VARIABLE ratio: 2.5 to 1
- *20. SLOW SWEEP TIMING
- a. Check slow sweep timing: $\pm 2\%$ except 1, 2, & 5 SEC $\pm 2.5\%$

*21. FAST SWEEP TIMING

- b. Adjust horizontal compensation, C330
- c. Adjust 10 SEC timing, C160E: $\pm 2\%$
- d. Adjust 1 SEC timing, C160C: $\pm 2\%$
- e. Adjust .5 SEC timing, C160A: $\pm 2\%$
- f. Adjust .1 SEC timing, C348: $\pm 2\%$
- g. Adjust 20ns timing, C364, C384, C375: $\pm 3\%$
- h. Check 40ns timing: $\pm 3\%$
- i. Check fast sweep timing: $\pm 2\%$

22. FRONT PANEL WAVEFORMS

VERT SIG OUT $\geq 1.5V/cm$
SAWTOOTH OUT $\geq 130V$
+ GATE OUT $\geq 20V$

23. HOLD OFF

$4\mu s$ to 400ms

24. EXTERNAL HORIZONTAL AMPLIFIER

- a. Adjust Ext Horiz Amp DC Balance, R307: no shift
- b. Adjust C301C: X10 to match X1
- c. Check external horizontal deflection factor: 5.6cm/V, min
- d. Check EXT HORIZ ATTEN X10: $\pm 2\%$
- e. Check EXTERNAL HORIZ ATTENUATOR 10-1: 10:1 ratio, min
- *f. Check horizontal bandpass: 350kHz at -3dB or less

25. 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 rounding

*26. VERTICAL AMPLIFIER BANDWIDTH

-3dB at $\geq 15MHz$

[NOTE: THE FOLLOWING CHECKS ARE NOT MADE ON 100% OF THE INSTRUMENTS BUT ARE DONE ON A SAMPLING BASIS]

27. VERT SIG OUT FREQUENCY RESPONSE

- a. High frequency response: $\geq 5MHz$ at 3dB down
- b. Low frequency response: $\leq 10Hz$ at 3dB down

28. TRIGGER FREQUENCY RESPONSE

- a. Check low frequency response:
 $\leq 150Hz$ in AC
 $\leq 50Hz$ in AUTO
 $\leq 10Hz$ in AC LF REJ
- b. Check high frequency response:
 $\geq 2MHz$ in AC
 $\geq 2MHz$ in AC LF REJ
 $\geq 0.75MHz$ in AUTO

1. PRELIMINARY INSPECTION*a. Check shield*

See that a HV shield is installed

*b. Check CRT: tilt 1/32 inch, max;
concavity or convexity 1/32 inch,
max.*

Check that CRT neck pins are tight.
Loosen the CRT clamp. Remove graticule,
push CRT forward to straight edge firmly
placed against the front panel. Check
gap within the phosphor area with rule:
1/32 inch, max. Tighten the CRT clamp.
Note the CRT serial number and code date.
Inspect the CRT for structural defects
including: phosphor defects
scratches
cracks around neck pins.
Replace graticule.

c. Check fuse

Fuse must match the line voltage source
as follows:

Connected for

117VAC, 50Hz	3ag	6.25A	slo-blo
117VAC, 60Hz	3ag	6A	fast-blo
234VAC, 50Hz	3ag	3A	slo-blo
234VAC, 60Hz	3ag	3A	fast-blo

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

2. PRESET CONTROLS

FOCUS	ccw
INTENSITY	ccw
ASTIGMATISM	ccw
SCALE ILLUM	cw
HORIZONTAL DISPLAY	NORMAL
EXTERNAL HORIZ ATTENUATOR 10-1	cw
HORIZONTAL POSITION	midr
VERNIER horizontal position	ccw
AMPLITUDE CALIBRATOR	OFF
POWER	off

2. (continued)

TRIGGERING LEVEL	
STABILITY	ccw(not PRESET)
TRIGGER SLOPE	+INT
TRIGGERING MODE	AC
TIME/CM	1 MILLISEC
VARIABLE time/cm	CALIBRATED
CRT CATHODE SELECTOR	
(scope rear)	EXTERNAL CRT CATHODE
C375 (internal)	$\frac{1}{4}$ turn from max
All other internal adjustments, except vertical amplifier	midr

3. RESISTANCE

a. Setup

Install a CALIBRATION FIXTURE in the TYPE 531A. Preset the CALIBRATION FIXTURE controls as follows:

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

b. Measure resistance

Measure resistance between each power supply and ground as in the following table:

<u>Test Point</u>	<u>Approx Resistance</u>
Transformer term 1	inf
Transformer term 4	inf
-150V	4k Ω
+100V	500 Ω
+225V	5-8k Ω
+350V	10k Ω
+500V	15-30k Ω

Ohmmeter may have to be reversed when measuring the +350V supply because of protection diode across filter capacitor

4. POWER SUPPLIES

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

Apply power to the TYPE 531A via a TYPE 76TU. Set line voltage to 117VAC. TURN the POWER switch ON. Check for a delay of 15 to 60 seconds before the time-delay relay closes with an audible click.

For first time turn-on of raw instruments, reduce the line voltage to 19VAC and measure power transformer secondary voltages.

4.a (cont'd)

Remove the fuse. The line voltage must not remain on terminals 1 or 4 of the power transformer. Replace the fuse.

- b. Adjust -150V Adj, R616, and check regulated voltages: $\pm 2\%$; must regulate 104.5VAC to 125.5VAC line, high and low load*

Adjust -150 V Adj, R616, to bring all regulated power supplies within tolerance:

<u>Power Supply</u>	<u>Max Error</u>	<u>Max Ripple</u>
-150V	$\pm 3V$	5mV
+100	$\pm 2V$	10mV
+225	$\pm 4.5V$	5mV
+350	$\pm 7V$	20mV
+500	$\pm 10V$	20mV

Check maximum ripple from 104.5VAC to 125.5VAC, HIGH LOAD and **LOW LOAD**. Return line voltage to 117VAC.

- c. Adjust HV Adj, R840, and check HV regulation: voltage: -1350V regulation: no trace bloom or voltage change $> 20V$ from 104.5VAC to 125.5VAC line*

Set the multimeter to a range suitable to read -1350V and connect the meter to the HV Adj Test Point (R847 - R857 junction) and adjust the HV Adj, R840, for a -1350V reading on the multimeter. Turn STABILITY cw. Lower the line voltage to 104.5VAC and vary the INTENSITY control from full cw to full ccw while checking the reading on the multimeter. In similar fashion check the regulation at 125.5VAC line. Check for no trace blooming while varying the line from 104.5VAC to 125.5VAC. Return the line voltage to 117VAC.

- d. Check elevated heaters*

Check the elevated heater supply voltages according to the following table:

<u>Transformer terminal</u>	<u>Approx DC voltage</u>
22 and 23	+95V
27 and 28	+220V
9 and 16	+350V
24 and 25	-1000 to -1500

4.a (cont'd)

It is important that shorted filament secondaries be located before full line voltage is applied because the cables may burn up before the fuse blows.

5. GEOMETRY*a. Align CRT*

Turn FOCUS, INTENSITY and ASTIGMATISM controls as needed to get a usable, well-defined trace. Position trace to graticule center and use CRT clamp vernier rotation knob to align trace parallel to horizontal graticule lines.

b. Adjust graticule: center of scan area

Apply 1ms and .1ms markers to the X100 AMPLIFIER input of the SAC. Connect the X100 AMPLIFIER OUTPUT to the CALIBRATION FIXTURE EXT INPUT. Adjust STABILITY and TRIGGER LEVEL for a stable display. Adjust CALIBRATION FIXTURE VARIABLE for a display height greater than the vertical scan.

It may be necessary to preadjust Trig Level Centering, R39, in order to obtain a stable display.

Adjust the graticule cam to place the 6cm vertical graticule in the center of the CRT vertical scan.

c. Adjust Geom Adj, R861: bowing 1mm, max

Adjust R861 for min bowing of the vertical lines. Check over the entire graticule for 1mm or less bowing within the 6cm height of the graticule. Remove the X100 AMPLIFIER OUTPUT.

VARIABLE TIME/CM may be adjusted to obtain 1ms/cm display. Each time mark would then represent 1mm.

Turn the STABILITY control cw. Turn the CALIBRATION FIXTURE VARIABLE full ccw. Position the trace over the entire graticule area with the VERTICAL POSITION control. Check for 1mm or less of bowing.

6. FOCUS*a. Check horizontal focus: no overlap of 1mm spaced marks over the center 8.8cm of the graticule*

Apply TYPE 184 MARKER OUTPUT to CALIBRATION FIXTURE EXT INPUT. Turn CALIBRATION FIXTURE VARIABLE cw. Adjust STABILITY for stable display. Adjust the TIME/CM VARIABLE for 10 marks/cm. Check that the FOCUS and ASTIGMATISM controls can be adjusted so all marks in the center 8.8cm of the graticule are clearly defined with no overlap. Remove CALIBRATION FIXTURE EXT INPUT.

6. (cont'd)

- b. *Check vertical focus: no overlap of 1mm spaced marks*

Apply SAC square wave OUTPUT to CALIBRATION FIXTURE EXT INPUT. Turn STABILITY cw. Turn SAC AMPLITUDE to 1 VOLT and adjust CALIBRATION FIXTURE VARIABLE for 1cm of display. Turn SAC AMPLITUDE to .1 VOLT. Position the display over the entire graticule area. Check for a clearly defined display with no overlap of the two lines within the graticule area. Remove CALIBRATION FIXTURE EXT INPUT.

7. BEAM POSITION INDICATORS AND SCALE ILLUMINATION

- a. *Setup*

HORIZONTAL DISPLAY	X10 EXT HORIZ ATTN
STABILITY	ccw (not PRESET)
INTENSITY	minimum useable

- b. *Check beam position indicators:
The proper beam position indicator must light and the opposite neon must go out before the spot leaves the graticule area*

<u>Position Control</u>	<u>Turn</u>	<u>Spot Must Move</u>	<u>Beam Position Indicator</u>
VERTICAL POSITION	cw	up	↑
VERTICAL POSITION	ccw	down	↓
HORIZONTAL POSITION	cw	right	→
HORIZONTAL POSITION	ccw	left	←
Turn HORIZONTAL DISPLAY to NORMAL			

- c. *Check SCALE ILLUM: on max, cw;
off, ccw*

Turn the SCALE ILLUM control full cw. Observe maximum graticule illumination. Turn the SCALE ILLUM control fully ccw. The illumination should decrease smoothly from full illumination to no illumination.

8. 5X MAGNIFIER AND VARIABLE INDICATORS

- a. *MAG ON indicator*

8.a (cont'd)

<u>HORIZONTAL DISPLAY</u>	<u>Indicator neon</u>
5X MAG	on
all other positions	off

b. *UNCALIBRATED indicator*

<u>TIME/CM VARIABLE</u>	<u>Indicator neon</u>
CALIBRATED	off
all other positions	on

9. INTENSITY MODULATION <20V

Remove CRT ground strap by loosening the EXT CRT CATHODE and GND binding posts at the rear of the scope. Swing the strap away from the EXT CRT CATHODE binding post, making sure the strap pivots on the GND binding post. Turn TRIGGER SLOPE to + EXT.

Connect SAC square wave OUTPUT to TRIGGER INPUT and EXT CRT CATHODE making sure the CRT CATHODE SELECTOR switch is in the proper position. Adjust SAC for 20 VOLTS and STABILITY for a stable display. Check that alternate light and dark trace segments are displayed.

Remove the EXT CRT CATHODE and TRIGGER INPUT signals and replace CRT ground strap.

10. VERTICAL AMPLIFIERa. *Check output amplifier balance:*
0.75cm

Turn the STABILITY control cw. Short-circuit the CRT vertical deflection plates together and note the trace vertical position. This is the CRT vertical electrical center. Remove the short circuit.

Connect a jumper from V533 pin 8, to V543 pin 8. The trace must not shift more than 0.75cm from electrical center.

The VOM leads may be used as a jumper by placing the VOM in its highest ampere range.

10 (cont'd)

- b. *Check driver cathode follower
balance: 0.75mm, max*

Connect a jumper from V533 pin 7 to V543 pin 7. The trace must not shift more than 0.75cm from CRT electrical center.

- c. *Check overall amplifier balance:
±2cm, max*

Turn the CALIBRATION FIXTURE TEST FUNCTION switch to COMMON MODE. The trace must not shift more than 2cm from CRT electrical center.

- d. *Check for microphonics: 2.5mm, max*

Set the TIME/CM switch to 10 MILLISEC. Apply a shock from a micro-shock hammer at the top of the TYPE 531A front panel. Check for 0.25cm or less of microphonics with no ringing type.

- e. *Adjust Vert Gain Adj, R570: 4cm±2%
Range: +10% to -10%*

Turn CALIBRATION FIXTURE TEST FUNCTION switch to GAIN SET. Apply 100V square wave from SAC to EXT INPUT. Turn TIME/CM to .1 MILLISEC. Turn Gain Adj, R570, full cw and check for at least 4.8cm of display. Turn Gain Adj, R570, full ccw and check for 3.2cm or less of display. Adjust Gain Adj, R570, for exactly 4cm display.

- f. *Check compression/expansion: 1mm
max at top or bottom of the grat-
icule with 2cm display*

Turn SAC AMPLITUDE to 50 VOLTS. Position the display to the top and bottom of the graticule and check for 2cm of deflection ±1mm, maximum. Remove EXT INPUT.

- g. *Check DC shift: 1mm, max after 3cm
deflection*

Position trace 3cm from the COMMON MODE position. Switch TEST FUNCTION between GAIN SET and COMMON MODE. Trace will change position rapidly and then may slowly drift up or down. Check for a drift of less than 1mm.

10 (cont'd)

- h. Check vertical drift: 0.5cm,
max from 104.5VAC to 125.5VAC*

Check the trace drift while varying the line voltage from 104.5VAC to 125.5VAC.

11. ALTERNATE TRACE AND CHOPPED BLANKING

- a. Check alternate trace at all sweep speeds*

Turn TEST FUNCTION switch to ALTERNATE, TIME/CM to 1 MILLSEC and position trace so that both of the vertical position indicators are on. Check for two traces in all TIME/CM positions. In .1, .2, .5, 1, 2 and 5 SEC positions of the TIME/CM switch, the vertical position neons should flash alternately at the start of each sweep and may be the only indication that the alternate sweep circuit is functioning.

Another method of checking for alternate trace on lowest sweep rates is to apply a 100V square wave from SAC to EXT INPUT and check for 2 traces on every other sweep.

- b. Check alternate trace sync pulse:
amplitude $\geq 60V$
negative pulse risetime $\leq 1\mu s$*

Set TIME/CM to $2\mu SEC$. Connect a 10X probe from test scope to pin 16 Amphenol connector. Set test scope VOLTS/CM to 2 and TIME/CM to $1\mu SEC$. Check for at least 3cm of negative pulse amplitude with a risetime of $1\mu s$ or less. Remove 10X probe.

- c. Check chopped blanking*

Set TEST FUNCTION to CHOPPED, TRIGGER SLOPE to +INT and adjust STABILITY control for a stable display of square waves.

Change the CRT CATHODE SELECTOR to CHOPPED BLANKING and check for blanking of the vertical lines (fast chopping transients).

Change the CRT CATHODE SELECTOR to EXTERNAL CRT CATHODE and the TEST FUNCTION to HIGH LOAD.

12. AMPLITUDE CALIBRATOR

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

Connect CAL OUT to SAC UNKNOWN INPUT. Set SAC AMPLITUDE to 100V, MODE to +DC

12.a (cont'd)

and MIXED. Turn AMPLITUDE CALIBRATOR to 100 VOLTS and remove V875 from the 531A. Connect SAC OUTPUT to test scope vertical input. Set test scope VOLTS/CM to 1 and test scope TIME/CM to 5mSEC. Trigger test scope on +LINE, AUTO. Set test scope input to AC.

Set the Cal Adj, R879, for a null (the square wave display becomes a straight line).

b. Check accuracy: $\pm 2\%$ all positions

Check the AMPLITUDE CALIBRATOR ERROR as the controls are changed according to the following table:

<u>AMPLITUDE CALIBRATOR and SAC VOLTS</u>	<u>TEST SCOPE VOLTS/CM</u>	<u>max deflection</u>
100	1.0	2cm
50	0.5	2cm
20	0.2	2cm
10	0.1	2cm
5	0.05	2cm
2	0.02	2cm
1	0.01	2cm
.5	0.005	2cm
.2	0.002	2cm
.1	0.001	2cm

Add the error found in the .1 VOLTS position to the errors found in the previous positions. The algebraic sum must not exceed 2%.

c. Check calibrator period: 1ms $\pm 20\%$

Set the SAC MODE to UNKNOWN INPUT and the test scope to .05 VOLTS/CM. Replace V875. Set test scope triggering for + INT AC and TIME/CM for 0.2ms. Check for 1 cycle in 4 to 6cm of display. Check for AMPLITUDE CALIBRATOR square wave out in all MILLIVOLTS positions.

d. Check calibrator duty cycle: 45% to 55%

Change test scope TIME/CM for 50 μ s and adjust the test scope VARIABLE for 1 cycle in 10cm. Check that $\frac{1}{2}$ cycle occupies from 4.5cm to 5.5cm. Remove connector from AMPLITUDE CALIBRATOR CAL OUT.

The first complete half cycle of the test scope display is the SAC voltage. The next half cycle will be the error voltage. The direction of error can be determined by the direction of the error voltage. A positive going waveform indicates a positive error and a negative going waveform indicates a negative error.

13. TRIGGERING*a. Setup*

Set the TYPE 531A as follows:

TIME/CM	50 μ SEC
TRIGGERING MODE	DC
TRIGGER SLOPE	+EXT
STABILITY	for display on the CRT
CALIBRATION FIXTURE VARIABLE	cw

Set the test scope as follows:

TIME/CM	20 μ SEC
COUPLING	AC
TRIGGER SLOPE	+
SOURCE	INT
CHANNEL 1 VOLTS/CM	.02
CHANNEL 2 VOLTS/CM	.1
INPUT SELECTORS	AC
MODE	CH1

Connect the X1 probe from the test scope 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 CALIBRATION FIXTURE EXT INPUT. Connect the TYPE 191 to one side of the "T" with a 50 Ω cable. Connect a 50 Ω Termination from the other side of the "T" to the test scope INPUT 1. Set the TYPE 191 FREQUENCY RANGE to 50kHz. Adjust the AMPLITUDE controls for an output of .05 VOLTS as read on the test scope. Change the coax cable and 50 Ω Termination to the TYPE 531A TRIGGER INPUT. Switch test scope to CH2.

b. Adjust Triggering Level Centering, R39

Switch TYPE 531A 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, R47, for the minimum sensitivity which will still permit stable triggering.

c. Adjust Trig Sens, R47: will not trigger on 0.05V

Reduce the sensitivity of the trigger circuit by adjusting R47, to the point where a stable trigger cannot be obtained in either +EXT or -EXT.

13 (cont'd)

- 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 531A. Position the bottom of the display to the graticule center line.

Set the TYPE 531A 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.

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

Set the TYPE 531A 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 retighten. 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 TEST FUNCTION switch to COMMON MODE, the TYPE 531A 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 reading half-way between the two readings.

Remove the meter leads, set the TEST FUNCTION to HIGH LOAD and the TYPE 531A TRIGGER SLOPE to +INT.

The difference between the two meter readings will normally be >15V.

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 + & -

*h. Check TRIGGERING LEVEL range:
at least + and - 10V*

Remove the 50 Ω cable connected to the TYPE 191 from the "T" connector. Remove the 50 Ω Termination from the TYPE 531A TRIGGER INPUT and reconnect the cable. Connect the SAC OUTPUT 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 5MHz
and 30MHz \leq 1mm jitter*

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

14.a (cont'd)

Connect the 50 Ω cable from the TYPE 191 to the "T" connector. Remove the 50 Ω cable from the TYPE 531A TRIGGER INPUT, connect a 50 Ω Termination to the cable and connect the termination to the test scope INPUT 1. Set the TYPE 191 for 1.5 volts of 50kHz signal. Remove the 50 Ω cable and 50 Ω Termination from the test scope and connect it to the TYPE 531A TRIGGER INPUT. Change the TYPE 191 frequency to 5MHz and adjust the TYPE 531A STABILITY for a stable display, 1mm or less jitter.

Set the TYPE 191 frequency to 30MHz and set the TYPE 531A HORIZONTAL DISPLAY to 5X MAG. Adjust the STABILITY for a stable display, 1mm or less display jitter.

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

Remove the 50 Ω cable and 50 Ω Termination from the "T" connector. Do not remove the other end from the TRIGGER INPUT. Adjust CALIBRATION FIXTURE VARIABLE for signal amplitude of 1.5cm. Set the TRIGGER SLOPE to +INT. Adjust the STABILITY control for a stable display, 1mm or less of jitter.

Change the TYPE 531A HORIZONTAL DISPLAY to NORMAL and the TYPE 191 frequency to 5MHz. Adjust the CALIBRATION FIXTURE VARIABLE control for 1.5cm of display. Adjust the TYPE 533A STABILITY for a stable display, 1mm or less of jitter.

15. LOW AND HIGH FREQUENCY TRIGGERING

*a. Check AC triggering: 1cm INT
or 1.0V EXT at 5MHz*

Reconnect the 50 Ω cable and 50 Ω Termination to the "T" connector. Change the TYPE 191 AMPLITUDE controls for a signal amplitude of 1.0V. Set TRIGGER SLOPE to +EXT and TRIGGERING MODE to AC. Adjust the TYPE 531A for a stable display at 5MHz. Change TRIGGERING MODE to AC LF REJ. Check for a stable display at 5MHz.

15.a (cont'd)

Remove the 50 Ω cable and 50 Ω Termination from the "T" connector. Change TRIGGER SLOPE to +INT. Adjust the CALIBRATION FIXTURE VARIABLE for 1cm of display. Adjust the TYPE 531A for a stable display. Change Triggering Mode to AC. Check for a stable display at 5MHz.

b. Check DC triggering: 2cm INT or 1.0V EXT at 5MHz

Change TRIGGERING MODE to DC. Increase display to 2cm. Adjust TYPE 531A for a stable display at 5MHz.

Change TRIGGERING SLOPE to +EXT. Connect the 50 Ω cable and 50 Ω Terminator to the "T" connector. Adjust the TYPE 531A for a stable display at 5MHz.

c. Check AUTO triggering: 1.0cm INT or 1.0V EXT at 2MHz

Change TIME/CM to .2 μ SEC and TRIGGERING MODE to AUTO. Change the TYPE 191 frequency to 2MHz. Check for a stable display. Change TRIGGER SLOPE to +INT and remove the 50 Ω Terminator from the "T" connector. Adjust the CALIBRATION FIXTURE VARIABLE for a 1cm display. Check for a stable display. Remove the TYPE 191 connections.

d. Check AC LF REJ: Inoperable INT 2.0cm INT or 2.0V EXT at 200Hz

Connect the SINE WAVE GENERATOR to the CALIBRATION FIXTURE EXT INPUT and the TYPE 531A TRIGGER INPUT. Set the TIME/CM to 2 MILLISEC. Set the SINE WAVE GENERATOR for 2.0V out at 200Hz. Adjust the CALIBRATION FIXTURE VARIABLE for 2cm of display. Change TRIGGERING MODE to AC LF REJ. If should be impossible to obtain a stable display in any position of the TRIGGERING LEVEL and STABILITY controls.

Disconnect EXT INPUT and TRIGGER INPUT.

16. HORIZONTAL AMPLIFIER

a. Setup

Connect the type 184 to the CALIBRATION FIXTURE EXT INPUT. Set the 184 for .1ms and 1ms markers. Set the TYPE 531A TIME/CM

16.a (cont'd)

to 1 MILLISEC. Turn the HORIZONTAL DISPLAY to 5XMAG. Set TRIGGER SLOPE TO +INT and TRIGGERING MODE to AC. Adjust STABILITY and TRIGGERING LEVEL for a stable display

b. Adjust Mag Gain, R375: linearity 1%

Adjust Mag Gain, R375, for two .lms marks per cm at the center of the sweep.

Check timing accuracy over the entire sweep. Check for maximum error of 0.8mm

c. Adjust Swp Cal, R348

Switch HORIZONTAL DISPLAY to NORM. Adjust Swp Cal, R348, for one lms mark per cm.

a. Unless other wise stated, use the middle 8 horizontal centimeters when making horizontal amplifier gain and timing checks or adjustments.

17. SWEEP LENGTH

a. Adjust Sweep Length, R176: 10.5cm

18. NORM MAG REGISTRATION

a. Adjust Norm/Mag Regis, R358

Switch HORIZONTAL DISPLAY to 5X MAG. Position the start of the trace to the graticule center. Switch HORIZONTAL DISPLAY to NORMAL and Adjust Norm/Mag Regis, R358, for trace start at the graticule center. Repeat as necessary.

19. VARIABLE TIME/CM

a. Check VARIABLE ratio: 2.5 to 1

Set 184 for 10ms markers. Check 10ms equal 10cm. Turn VARIABLE ccw. Check 10ms equals 4cm or less.

20. SLOW SWEEP TIMING

- a. Using the following table check slow sweep rate accuracy: $\pm 2\%$; except 1, 2 and 5 SEC $\pm 2.5\%$

<u>TYPE 531A</u> <u>TIME/CM</u>	<u>TYPE 184</u> <u>time marks</u>	<u>time</u> <u>marks/cm</u>	<u>max</u> <u>error</u>
.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
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
.5 SEC	.5 S	1	1.6mm
1 SEC	1 S	1	2mm
2 SEC	1 S	2	2mm
5 SEC	5 S	1	2mm

21. FAST SWEEP TIMING

- a. Setup

Connect the TYPE 184 TRIGGER OUTPUT to TYPE 531A TRIGGER INPUT. Set 184 for 10 μ s trigger and 10 μ s markers. Set TRIGGER SLOPE to +EXT and set STABILITY and TRIGGERING LEVEL for a stable display.

- b. Adjust Horizontal Compensation, C330:

Change HORIZONTAL DISPLAY to 5X MAG. Switch between .1 MILLISEC and 50 μ SEC and adjust C330 for coincidence of the first time mark.

- c. Adjust 10 μ SEC timing, C160E: $\pm 2\%$

Set TIME/CM to 10 μ SEC and HORIZONTAL DISPLAY to NORM. Adjust C160E for 1 mark/cm.

- d. Adjust 1 μ SEC timing, C160 C: $\pm 2\%$

Change the TYPE 184 to 1 μ S and the TIME/CM to 1 μ SEC. Adjust C160C for 1 mark/cm.

21 (cont'd)

e. *Adjust .5 μ SEC timing, C160A: $\pm 2\%$*

Change the TIME/CM to .5 μ SEC. Adjust C160A for 1 mark/2cm.

f. *Adjust .1 μ SEC timing, C348: $\pm 2\%$*

Change the TYPE 184 to .1 μ S and the TIME/CM to .1 μ SEC. Adjust C348 for 1 mark/cm.

g. *Adjust 20ns timing, C346, C384, C375: $\pm 3\%$*

Connect the TYPE 184 MARKER OUTPUT to one of the vertical CRT leads through a 47pF capacitor. Change the 184 output to 20ns.

Disregard the first 7 cycles at the left end of the trace.

Change HORIZONTAL DISPLAY to 5X MAG. Adjust C364 and C384 for 1 cycle/cm at the center of the trace. Adjust C375 for 1 cycle/cm at the left end of the trace. Check for correct timing over the entire trace.

h. *Check 40ns timing: $\pm 3\%$*

Change TIME/CM to .2 μ SEC and check for 2 cycles/cm at the center of the trace.

i. *Check fast sweep timing: $\pm 2\%$*

Connect the TYPE 184 MARKER OUTPUT to the CALIBRATION FIXTURE EXT INPUT. Change the 184 TRIGGER SELECTOR to .1mS. Change TYPE 531A HORIZONTAL DISPLAY to NORM.

Check fast sweep accuracy using the following table.

<u>TYPE 531A</u> <u>TIME/CM</u>	<u>TYPE 184</u> <u>time marks</u>	<u>check for</u>	<u>max error</u>
50 μ SEC	50 μ S	1 mark/cm	1.6mm
20 μ SEC	10 μ S	2 marks/cm	1.6mm
10 μ SEC	10 μ S	1 mark/cm	1.6mm
5 μ SEC	5 μ S	1 mark/cm	1.6mm
2 μ SEC	1 μ S	2 marks/cm	1.6mm
1 μ SEC	1 μ S	1 mark/cm	1.6mm
.5 μ SEC	.5 μ S	1 mark/cm	1.6mm
.2 μ SEC	.1 μ S	2 marks/cm	1.6mm
.1 μ SEC	.1 μ S	1 mark/cm	1.6mm

Remove the EXT INPUT and TRIGGER INPUT cables.

22. FRONT PANEL WAVEFORMS VERT SIG OUT $\geq 1.5V/cm$
 SAWTOOTH OUT $\geq 130V$
 +GATE OUT $\geq 20V$

Connect the TYPE 531A CAL OUT to the EXT INPUT with a coax cable. Set the AMP-LITUDE CALIBRATOR for 2 VOLTS. Adjust the CALIBRATION FIXTURE VARIABLE for 2cm of vertical display. Set the test scope 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 EXT INPUT and the TYPE 531A CAL OUT.

23. HOLDOFF 4 μ sec to 400msec

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

TYPE 531A TIME/CM	test scope TIME/CM	holdoff
.1, .2 and .5 μ SEC	2 μ SEC	4-9 μ s
1, 2 and 5 μ SEC	10 μ SEC	15-40 μ s
10, 20 and 50 μ SEC	10 μ SEC	15-40 μ s
.1, .2 and .5mSEC	.1mSEC	150-400 μ s
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.

24. EXTERNAL HORIZONTAL AMPLIFIER

a. *Adjust Ext Horiz Amp DC Balance, R307:
 no shift*

Connect a jumper lead from SAWTOOTH OUT to EXT INPUT. Switch HORIZONTAL DISPLAY to EXT HORIZ ATTEN X1. Turn STABILITY control fully cw. Center the vertical trace on the graticule. Rotate the EXTERNAL HORIZ ATTENUATOR back and forth while adjusting EXT HORIZ AMP DC Balance, R317, for no trace shift. Leave the EXTERNAL HORIZ ATTENUATOR control fully cw.

24 (cont'd)

b. Adjust C301C: X10 to match X1

Connect a 0.5V signal from SAC to the HORIZ INPUT and the TRIGGER INPUT. Set the TIME/CM to .2 MILLISEC, TRIGGER SLOPE to +EXT and TRIGGERING MODE to AC. Adjust TRIGGERING LEVEL and STABILITY for a stable display. Check the waveform for aberrations.

Change the HORIZONTAL DISPLAY to X10 and SAC for 5V out. Adjust C301C to match the X1 waveform.

c. Check external horizontal deflection factor: 5.6cm/V, min

Set HORIZONTAL DISPLAY to X1 and SAC for 1V out. With the EXTERNAL HORIZ ATTENUATOR fully cw, check for 5.6cm deflection, min.

d. Check EXT HORIZ ATTEN X10: $\pm 2\%$

Set SAC for 2V out and EXTERNAL HORIZ ATTENUATOR for exactly 10cm of horizontal amplitude. Change HORIZONTAL DISPLAY to X10 and SAC to 20V out. Check for 10cm of amplitude $\pm 2\text{mm}$.

e. Check EXTERNAL HORIZ ATTENUATOR 10-1; 10:1 ratio, min

Change SAC to 10V out and EXTERNAL HORIZ ATTENUATOR to full cw. Check amplitude. Turn EXTERNAL HORIZ ATTENUATOR fully ccw. Change the SAC out to 100V. The horizontal deflection should be equal to or less than the full cw amplitude. Remove the SAC.

f. Check horizontal bandpass: 350kHz at -3dB or less

Turn the EXTERNAL HORIZ ATTENUATOR fully cw and the HORIZONTAL DISPLAY to X1. Turn STABILITY cw.

Apply 4cm of 50kHz from TYPE 191 to HORIZ INPUT. Increase the TYPE 191 output frequency to 350kHz. Check for 2.4cm minimum deflection.

Remove TYPE 191 and SAWTOOTH OUT connections.

25. HIGH FREQUENCY RESPONSE*a. Setup*

<u>CALIBRATION FIXTURE</u>	067-0521-00
TEST FUNCTION	+ PULSE
REPITION RATE	HIGH
AMPLITUDE	3cm
VERTICAL POSITION	centered

TYPE 531A

TIME/CM	.1 SEC
HORIZONTAL DISPLAY	NORMAL
STABILITY	stable display
TRIGGERING LEVEL	" "
TRIGGER SLOPE	+INT
TRIGGERING MODE	AC

b. Preset delay line

Preset the vertical amplifier and delay line ad 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: $\leq 1\%$ aberration

Adjust the TYPE 531A VARIABLE TIME/CM for approx 1 cycle/10cm.

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: $\leq 1\%$ 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 531A TIME/CM switch to 2 μ 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: $\leq 1\%$ overshoot or rounding

Return the TYPE 531A TIME/CM switch to .1 μ SEC and adjust L955 and L956 for the

25.e (cont'd)

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.

26. VERTICAL AMPLIFIER BANDWIDTH -3dB at >15MHz

Remove the CALIBRATION FIXTURE from the TYPE 531A 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 Ω coax cable and 50 Ω Termination. Set the TYPE 191 FREQUENCY RANGE to 50kHz. Adjust the TYPE 191 AMPLITUDE controls for 4cm of display amplitude with the TYPE 531A 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 >15MHz.

[NOTE: THE FOLLOWING CHECKS ARE NOT MADE ON 100% OF THE INSTRUMENTS BUT ARE DONE ON A SAMPLING BASIS]

27. VERTICAL SIGNAL OUT FREQUENCY RESPONSE

*a. High frequency response: >5MHz at
3dB down*

Connect the test scope to the VERT SIG OUT binding post through a 10X probe. Apply 2cm of 50kHz signal to the 1A2 CHANNEL 1 INPUT from the TYPE 191. Adjust the test scope for 4cm of deflection. Change the TYPE 191 frequency to 5MHz and check for at least 2.8cm of vertical deflection on the test scope. Remove the TYPE 191 from the 1A2 CHANNEL 1 INPUT.

27 (cont'd)

b. Low frequency response: <10Hz

Connect the SINE WAVE GENERATOR to the 1A2 INPUT CHANNEL 1 and adjust the SINE WAVE GENERATOR for 4cm at 50kHz on the test scope. Change the SINE WAVE GENERATOR frequency to 10Hz and check for at least 2.8cm deflection on the test scope. Remove the 10X probe.

28. TRIGGER FREQUENCY RESPONSE*a. Check low frequency response:*

<150Hz in AC
<10kHz in AC LF REJ
<50Hz in Auto

Adjust the SINE WAVE GENERATOR for 150Hz. Connect the SINE WAVE GENERATOR to the 1A2 INPUT and the TRIGGER INPUT and adjust the output for 0.2V out. Turn the 1A2 to 1V/cm and check that a stable trace can be obtained in +EXT and +INT AC.

Change the SINE WAVE GENERATOR frequency to 10kHz and check that a stable trace can be obtained in +EXT and +INT AC LF REJ.

Change the SINE WAVE GENERATOR frequency to 50Hz and the TYPE 531A for AUTO triggering. Check for a stable display in +INT and +EXT. Remove SINE WAVE GENERATOR.

b. Check high frequency response:

>2MHz in AC
>2MHz in AC LF REJ
>0.75MHz in AUTO

Connect the TYPE 191 to the 1A2 INPUT and the TRIGGER INPUT. Adjust TYPE 191 frequency to 2MHz and output voltage to 0.2V. Check that a stable trace can be obtained in +INT AC and +EXT AC. Check that a stable trace can be obtained in +INT and +EXT AC LF REJ.

Change TYPE 191 frequency to 750kHz and check for a stable trace in +EXT and +INT AUTO.

Remove the TYPE 191 connections.