

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.

*This procedure is
company confidential*

317

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.

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For all serial numbers.



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.

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EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. *TEKTRONIX Instruments*

- 1 TYPE 530 series OSCILLOSCOPE
- 1 TYPE B PLUG-IN
- 1 TYPE P6006 10X probe
- 1 TYPE P6028 1X probe
- 1 TYPE 76TU LINE VOLTAGE CONTROL UNIT
- *1 TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
- 1 TYPE 106 SQUARE-WAVE GENERATOR
- *1 TYPE 184 TIME-MARK GENERATOR

b. *Test Fixtures and Accessories*

- *1 STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)
- 2 50 Ω 42" BNC cables (012-0057-00)
- 1 50 Ω BNC Termination (011-0049-00)
- 3 BNC to BNC 18" patch cords (012-0087-00)
- 1 Variable Normalizer (Dwg No. 1761-C)
- 1 Micro Hammer (Dwg #1283-B)

c. *Other Equipment*

- 1 20,000 Ω /volt DC Multimeter

* 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

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 (setups, 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

- b. -150V supply, $\pm 2\%$
- c. Accuracy, ripple and regulation

Supply	Error	Max P-P Ripple		
		105 VAC	117 VAC	125 VAC
-150	$\pm 3V$	20mV	10mV	20mV
+100	$\pm 2V$	20mV	10mV	20mV
+300	$\pm 6V$	30mV	15mV	30mV

- d. High Voltage, -1300V: $\pm 2\%$

5. CALIBRATOR

- *a. Accuracy: $\pm 2\%$
- b. Duty cycle: 45 to 55%

7. CRT

- b. CRT faceplate tilt: $\pm 3/64''$
- d. Geometry: 1/2 minor div
- e. HV regulation: 105 to 125 VAC
- g. Focus: No overlap of 1/2 minor div spaced TYPE 184 marks in middle 8.8 div.

8. VERTICAL AMPLIFIER

- a. Microphonics: Main amp: 0.2 div, max
Preamp: 0.4 div, max, no ringing type
- b. Grid current: 0.2 div, max
- d. Vertical Amplifier balance: within 1 div of graticule center
- e. Preamp hum: 0.1 div, max

9. GAIN

- a. Main amp gain range: 4.5 to 5.5 div
- b. Preamp gain range: 4.5 to 5.5 div

- 9d. Compression and expansion:
.1 div, max
- e. Check VARIABLE range: 2.5:1, min
- *f. VOLTS/DIV accuracy: $\pm 2\%$

10. VOLTS/DIV COMPENSATIONS

- b. VOLTS/DIV compensation: $\pm .25$ minor div
- c. Low freq comp: slant at .01 VOLTS/DIV equals slant at .1 VOLTS/DIV: $\pm 5\%$

11. TIME BASE TRIGGERING

- c. Polarity: must trigger on proper slope
- e. Preset stability range: $\geq 15V$
- g. Trigger operation
 - INT: AUTO Must trigger + and - on 1/2 major division of signal.
 - INT: AC Must trigger + and - on .5 minor division of signal without moving TRIGGERING LEVEL control.
 - INT: DC Must trigger + and - on 1 minor division of signal within ± 1 minor division of graticule center. Must trigger on + and - 2 minor divisions of signal without moving TRIGGERING LEVEL control.
 - EXT: AUTO Must trigger on $\pm 1.0V$.
 - AC and DC Must trigger on .1 volt signal.

12. LINE TRIGGER

b. Line triggering: Correct polarity

13. HF SYNC

b. HF SYNC: 2 div of 20 MHz

14. HORIZONTAL AMPLIFIER GAIN

*b. Mag Gain Adjust: ±3%

*c. Horiz Gain Adjust: ±2%

15. SWEEP LENGTH

Sweep length: 10.2 to 10.8 div

17. LF TIMING

*a. Check LF timing: ±2% except for 1 and 2 SEC: 2.5%

b. VARIABLE time/div ratio: 2.5:1, min

c. Adjust C310: ±2%

18. HF TIMING

*c. HF timing: ±2%

MAG ON: ±3% except .2μSEC ±4%

19. EXT HORIZONTAL

b. EXT HORIZ deflection factor: >7 div with 10V input

20. FRONT PANEL WAVEFORMS

a. SAWTOOTH OUT: 130V, min

b. + GATE OUT: 20V, min

21. HOLDOFF

TIME/DIV

.2 and .5μSEC

.1 to 50μSEC

.1 to .5mSEC

1 to 5mSEC

10 to 50mSEC

.1 to 2 SEC

Holdoff

4 to 12μs

15 to 45μs

150 to 450μs

1.5 to 4.5ms

12.5 to 37.5ms

125 to 375ms

22. CRT CATHODE INPUT

b. Intensity modulation: 10V, min

23. VERTICAL AMPLIFIER HF

Aberrations or tilt: ≤1%

24. FREQUENCY RESPONSE

*b. Frequency response preamp:

>10 MHz at -3dB

*c. Frequency response main amp:

>10.5 MHz at -3dB

THE END

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

SHORT FORM PROCEDURE

This instrument must meet Factory Test Limits 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, this procedure may require that some checks and adjustments be made so that performance is better than that required by Factory Test Limits.

1. PRELIMINARY INSPECTION

- a. Install current modifications
- b. Check fuses
- c. Inspect CRT

2. PRESETS

- a. Preset external controls
- b. Preset internal controls

3. RESISTANCE CHECKS

Check power supply resistance

4. POWER SUPPLIES

- b. Adjust -150 Adjust
- c. Check accuracy, ripple and regulation
- d. Adjust High Voltage Adjust
- e. Check elevated heaters

5. CALIBRATOR

- a. Check accuracy: $\pm 2\%$
- b. Check duty cycle: 45 to 55%

6. SCALE ILLUM AND NEONS

- a. Check SCALE ILLUM
- b. Check indicator neons

7. CRT

- a. Check for CRT defects
- b. Check CRT faceplate tilt: $\pm 3/64''$
- c. Align CRT
- d. Adjust Geometry: 1/2 minor div
- e. Check High Voltage regulation
- f. Adjust Astigmatism
- g. Check focus

8. VERTICAL AMPLIFIER

- a. Check microphonics: Main amp: 0.2 div, max; Preamp: 0.4 div, max, no ringing type
- b. Check grid current: 0.2 div, max
- c. Adjust VARIABLE ATTEN BAL
- d. Check vertical amplifier balance: within 1 div of graticule center
- e. Check Preamp hum: 0.1 div, max

9. GAIN

- a. Check main amp gain range and adjust gain: 4.5 to 5.5 div
- b. Check preamp gain range and adjust gain: 4.5 to 5.5 div
- c. Check drift and gain change drift: 0.5 div, max gain change: ± 1.5 minor div
- d. Check compression and expansion: 0.1 div, max
- e. Check VARIABLE range: 2.5:1, min
- * f. Check VOLTS/DIV accuracy: $\pm 2\%$

10. VOLTS/DIV COMPENSATIONS

- b. Adjust VOLTS/DIV compensation: $\pm .25$ minor div
- c. Adjust Low Freq Comp

11. TIME BASE TRIGGERING

- b. Adjust Trigger Sens and Trigger Level Centering
- c. Check polarity
- d. Adjust Int Trig DC Level
- e. Check Preset Stability range and adjust: $\geq 15V$
- f. Adjust TRIGGERING LEVEL knob
- g. Check trigger operation

12. LINE TRIGGER

- b. Check LINE triggering

13. HF SYNC

- b. Check HF SYNC: 2 div 20 MHz

14. HORIZONTAL AMPLIFIER GAIN

- b. Adjust Mag Gain Adjust
- c. Adjust Horiz Gain Adjust

15. SWEEP LENGTH

Adjust Sweep Length, R82: 10.5 div

16. NORM MAG REGISTRATION

Adjust Norm Mag Regis

17. LF TIMING

- a. Check LF timing: $\pm 2\%$, except for 1 and 2 SEC: $\pm 2.5\%$
- b. Check VARIABLE time/div ratio: 2.5 to 1 min
- c. Adjust C310

18. HF TIMING

- b. Adjust HF timing
- c. Check HF timing: $\pm 2\%$
MAG ON: $\pm 3\%$ except $.2\mu\text{SEC} \pm 4\%$

19. EXT HORIZONTAL

- b. Check EXT HORIZ deflection factor: ≥ 7 div with 10V input

20. FRONT PANEL WAVEFORMS

- a. Check SAWTOOTH OUT: 130V, min
- b. Check + GATE OUT: 20V, min

21. HOLDOFF

Check holdoff

<u>TIME/DIV</u>	<u>Holdoff</u>
.2 and .5 μSEC	4 to 12 μs
1 to 50 μSEC	15 to 45 μs
.1 to .5mSEC	150 to 450 μs
1 to 5mSEC	1.5 to 4.5ms
10 to 50mSEC	12.5 to 37.5ms
.1 to 2 SEC	125 to 375ms

22. CRT CATHODE INPUT

- b. Check intensity modulation: Must modulate with $\leq 10V$ input

23. VERTICAL AMPLIFIER HF

- b. Adjust delay line and termination
- c. Adjust Preamp coils

24. FREQUENCY RESPONSE

- b. Check frequency response preamp: ≥ 10 MHz at -3dB
- c. Check frequency response main amp: ≥ 10.5 MHz at -3dB

THE END

1. PRELIMINARY INSPECTION

a. *Install current modifications*

b. *Check fuses*

117 VAC 3 amp Slo-Blo

234 VAC 1.6 amp Slo-Blo

c. *Inspect CRT*

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

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

2. PRESETS

a. *External controls*

FOCUS	ccw
INTENSITY	.ccw
SCALE ILLUM	cw
VOLTS/DIV	.1
VARIABLE VOLTS/DIV	CALIBRATED
AC-DC	DC
TRIGGER SELECTOR	AC +INT
STABILITY	ccw
TRIGGERING LEVEL	midr
HORIZ DISPLAY	NORM
TIME/DIV	1 MILLISEC
VARIABLE TIME/DIV	CALIBRATED
VERTICAL POSITIONING	midr
HORIZONTAL POSITIONING	midr
CALIBRATOR	OFF
POWER	OFF

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

b. *Internal adjustments*

C358 1/4 turn from max

All other internal adjustments midr.

3. RESISTANCE CHECKS

Check power supply resistance.

Connect multimeter from ground to Power Supply test points on ceramic strip next to power transformer. Check the following resistances.

3. (cont'd)

<u>Supply</u>	<u>Approx Resistance</u>
-150	4k
+100	4k
+300	12k
Transformer term 1	inf
Transformer term 4	inf

4. POWER SUPPLIES

a. *Setup*

Connect TYPE 317 to TYPE 76TU, and adjust to 117 VAC. Turn power on and allow 60 second warm-up time.

b. *Adjust -150 Adjust*

Connect multimeter between -150V test point and ground and adjust R617 for -150V $\pm 2\%$.

c. *Check accuracy, ripple and regulation*

<u>Supply</u>	<u>Error</u>	<u>Max P-P ripple</u>		
		<u>105 VAC</u>	<u>117 VAC</u>	<u>125 VAC</u>
-150	$\pm 3V$	20mV	10mV	20mV
+100	$\pm 2V$	20mV	10mV	20mV
+300	$\pm 6V$	30mV	15mV	30mV

d. *Adjust high voltage*

Connect multimeter to High Voltage test point and adjust R811 for -1300V.

e. *Check elevated heaters*

Using multimeter check heater supplies as follows:

<u>Transformer terms</u>	<u>Approx Voltage</u>
20-21	-1300V
23-24	+ 140V
25-26	+ 95V

5. CALIBRATOR

a. *Check accuracy: $\pm 2\%$ all settings*

Preset the test scope as follows:

VOLTS/CM	.5
VARIABLE VOLTS/CM	CALIBRATED
INPUT SELECTOR	AC

5a. (cont'd)

Connect the AMPLITUDE CALIBRATOR under test to the SAC/UNK IN connector. Connect the SAC/OUTPUT through a coaxial cable to the test scope vertical input.

Set the SAC to +100V, DC mixed. Set the AMPLITUDE CALIBRATOR under test to 100 VOLTS. Remove V573 from the instrument under test.

Trigger the test scope in AUTO, + LINE and set TIME/CM to 5mSEC. The start of the test scope sweep will be the SAC voltage or reference point. The direction of error can be determined by the direction of the first difference voltage. A positive going waveform would indicate a positive going error and a negative going waveform would indicate a negative error.

Set the Cal Adj, R510 for a null voltage (the point where the display appears as a straight line).

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

TYPE 310A CALIBRATOR	SAC VOLTS	test scope	
		VOLTS/CM	deflection max
100 VOLTS	100	.01	adjustable
50	50	.5	2cm
20	20	.2	2cm
10	10	.1	2cm
5	5	.05	2cm
2	2	.02	2cm
1	1	.01	2cm
.5	.5	.005	2cm
.2	.2	.005	.8cm
.1	.1	.005	.4cm
.05	.05	.005	.2cm

b. Check duty cycle: 45 to 55%

Remove cables to TYPE 317 and replace V573. Connect a multimeter to Cal Test Pt. and note that in any CALIBRATOR switch position except OFF, the meter reads between 45 and 55V. Remove multimeter.

6. SCALE ILLUM AND NEONS*a. Check SCALE ILLUM*

Turn SCALE ILLUM cw: both lights must increase brilliance.

Turn SCALE ILLUM ccw: both lights must extinguish completely.

b. Check indicator neons

Turn VARIABLE VOLTS/DIV ccw from CALIBRATED: VERTICAL UNCALIBRATED neon must come on. Return to CALIBRATED: Neon must extinguish.

Turn VARIABLE TIME/DIV ccw from CALIBRATED: TIME-BASE UNCALIBRATED neon must come on. Return to CALIBRATED: neon must extinguish.

Switch HORIZ DISPLAY to MAG: MAG neon must come on. Return to norm.

7. CRT*a. Check for CRT defects*

Check for cathode ray tube interface, flare, grid emission, burrs, scan, open or shorted elements, and phosphor defects.

b. Check CRT faceplate tilt: $\pm 3/64$ "

Remove the graticule. Push CRT forward against a straight edge placed against the bezel. Check tilt, convexity, concavity within viewing area: $\pm 3/64$ ".

c. Align CRT

Replace the graticule. Adjust Intensity and positioning controls for a trace on CRT. Focus the trace. Rotate the CRT to align the trace with the center Horiz graticule line. Tighten CRT clamp, and recheck trace alignment. Replace graticule and tighten hold down screw.

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

7. (cont'd)

d. Adjust Geometry: 1/2 minor div

Connect 1mSEC and 100 μ SEC marks from TYPE 184 to TYPE 317 VERTICAL INPUT. With STABILITY and TRIGGERING LEVEL controls, obtain a triggered display. Adjust HORIZ GAIN Adj for 1 large marker per div.

Adjust R861 for minimum curvature of the markers: 1/2 minor div.

e. Check high voltage regulation

Connect multimeter to High Voltage Test Point. Rotate INTENSITY from ccw to cw and check display for no blooming. Check meter for less than 20 volt change of -1300 volt supply. Return INTENSITY to usable level. Change line voltage control from 105 VAC to 125 VAC and repeat checks for regulation.

f. Adjust Astigmatism

Decrease amplitude of time marks to approx 1 div. Adjust FOCUS and R856 for best focus at center of display.

g. Check focus

Increase amplitude of time marks to approx 8 div. Check that all 100 μ SEC marks within the middle 8.8 div are well-defined with no overlap. Remove TYPE 184 markers.

8. VERTICAL AMPLIFIER*a. Check microphonics*

main amp: 0.2 div, max

preamp: 0.4 div max, no ringing type

Ground VERTICAL INPUT. Switch VOLTS/DIV to .1. Using micro hammer check micro for less than .2 div.

Switch VOLTS/DIV to .01 and repeat check with micro hammer. Micro must be less than .4 div with no ringing type

8. (cont'd)

b. *Check grid current: 0.2 div, max*

Change VOLTS/DIV to .1. Switch AC-DC switch to AC and check for no more than .2 div trace shift. Switch AC-DC switch to DC and VOLTS/DIV switch to .01. Again check that trace shift does not exceed .2 div. Return VOLTS/DIV to .1.

c. *Adjust VARIABLE ATTEN BAL*

Adjust VARIABLE ATTEN BAL for no trace shift while rotating VARIABLE VOLTS/DIV. Return VARIABLE VOLTS/DIV to CALIBRATED.

d. *Check Vertical Amplifier Balance*

With the VERTICAL POSITIONING control at midr the trace must be within 1 div of graticule center.

e. *Check Preamp hum: 0.1 div, max*

Switch VOLTS/DIV to .01, TIME/DIV to 5 MILLISEC. Hum on trace must be less than .1 div. Remove ground from INPUT.

9. GAIN

a. *Check main amp gain range and adjust gain: 4.5 to 5.5 div*

Apply .5 volts from SAC to vertical INPUT. Switch VOLTS/DIV to .1 and TIME/DIV to .1 MILLISEC. Adjust R244 through its range checking for smooth operation and a gain range of 4.5 to 5.5 div. Adjust to 5 div.

b. *Check Preamp gain range and adjust gain: 4.5 to 5.5 div*

Change SAC voltage to .05V. Switch VOLTS/DIV to .01. Adjust R154 through its range checking for smooth operation and a gain range of 4.5 to 5.5 div. Adjust to 5 div.

9. (cont'd)

- c. *Check drift and gain change*
drift: 0.5 div, max
gain change: ±1.5 minor div

Switch VOLTS/DIV to .1. Obtain 4 div of deflection with VARIABLE. Turn Line Voltage Source to 105 VAC. Note gain change: 1.5 minor div max, and vertical drift: .5 div max. Return to 117 VAC and allow to stabilize.

Change Line Voltage Source to 125 VAC and repeat gain change and drift check. Return Line Voltage to 117 VAC.

- d. *Check compression and expansion:*
0.1 div, max

With VARIABLE, obtain 2 div of deflection centered vertically on graticule. Position display to top of graticule and note gain change, then move display to bottom of graticule and again note gain change. Gain change, top or bottom, must not exceed .1div, max. Return VARIABLE to CALIBRATED.

- e. *Check VARIABLE range: 2.5:1, min*

Apply 50 volts from SAC. Switch VOLTS/DIV to 20. Note 2.5 div deflection. Rotate VARIABLE through its range to minimum deflection. Note ≤ 1 div. Return to CALIBRATED.

- f. *Check VOLTS/DIV accuracy: ±2%*

<u>VOLTS/DIV</u>	<u>SAC</u>	<u>Deflection</u>	<u>Error</u>
.01	.05	5 div	adjusted
.02	.1	5	±.5 min div
.05	.2	4	±.4
.1	.5	5	adjusted
.2	1	5	±.5
.5	2	4	±.4
1	5	5	±.5
2	10	5	±.5
5	20	4	±.4
10	50	5	±.5
20	100	5	±.5
50	100	2	±.2

Remove SAC signal.

- c. Leave at 105 VAC for at least 30 seconds. While waiting, switch TIME/DIV to 2 SEC and check that sweep will follow. If not, change V83.

10. VOLTS/DIV COMPENSATIONS*a. Setup*

TYPE 106 -- 50 Ω cable -- 50 Ω termination
 -- Variable Normalizer -- TYPE 317 INPUT.

*b. Adjust VOLTS/DIV compensation:
 \pm .25 minor div*

Adjust TYPE 106 for 4 div of 1 kHz signal. Trigger display and adjust and check for best squarewave as follows:
 \pm .25 minor div.

<u>VOLTS/DIV</u>	<u>adjust</u>	
	<u>front corner</u>	<u>level</u>
.1	check	check
.2	C132	C130
.5	C126	C124
1	C118	C116
2	check	check
5	check	check
10	C112	C110
20	check	check
50	check	check
.05	C141	check
.02	check	check
.01	check	check

c. Adjust Low Freq Comp

Set VOLTS/DIV to .1, TIME/DIV to 5 MILLISEC, AC-DC to AC. Adjust TYPE 106 for 6 div of 50 Hz signal. Note slope of waveform. Set VOLTS/DIV to .01 and adjust TYPE 106 for 6 div of signal.

Adjust R175 to match the slope previously noted, \pm 5%. Remove TYPE 106 signal.

11. TIME BASE TRIGGERING*a. Setup*

Set test scope INPUT to AC, VOLTS/CM to 1, TIME/CM to 1 MILLISEC, and trigger to AUTO + INT.

Set TYPE 317 controls as follows: VOLTS/DIV to .5, CALIBRATOR VOLTS to .05, TIME/DIV to .5 MILLISEC, TRIGGER SELECTOR to AC + INT, and STABILITY cw. Connect patch cords from CAL OUT to VERT INPUT and to trigger INPUT. Ground the junction of R428 and R426.

11. (cont'd)

b. Adjust Trigger Sens and Trigger Level Centering

Connect 10X probe from test scope to pin 6 V435. Turn Trigger Sens R443 cw. Adjust TRIGGER Level Centering R437 until an oscillation is seen on the test scope. Adjust R443 ccw until oscillation ceases. Continue this procedure until a stable squarewave appears on the test scope.

c. Check polarity

Turn STABILITY ccw until signal is triggered on TYPE 317. Switch TRIGGER SELECTOR from + INT to - INT and check for proper polarity.

d. Adjust Int Trig DC Level

Switch CALIBRATOR VOLTS to .1. Set TRIGGER SELECTOR to DC. Center display on graticule. Adjust R258 for stable squarewave on test scope. Check for correct polarity. Trace may have to be repositioned to obtain correct polarity.

e. Check Preset Stability range and adjust: $\geq 15V$

Remove patch cord from vertical INPUT. Connect 10X probe to center arm of Preset Stability pot. Switch test scope INPUT to DC. Set scope under calibration as follows: TRIGGER SELECTOR to AUTO + LINE, STABILITY to PRESET, and TIME/DIV to .1 MILLISEC. Rotate Preset Stability cw until trace appears. Note DC level on test scope. Rotate further cw until trace brightens. Again note DC level. Turn Preset Stability ccw until DC level is midway between the 2 noted levels. Check that total range is $\geq 15V$. Remove 10X probe. Remove ground from R428 and R426 junction.

f. Adjust TRIGGERING LEVEL knob

Change TRIGGER SELECTOR to AC + INT, TIME/DIV to .5 MILLISEC. Connect patch cord from CAL OUT to Vertical INPUT. Adjust TRIGGERING LEVEL knob for stable trigger. Loosen set screw on knob until knob turns freely. Center white dot to "0" on front panel and tighten set screw.

11. (cont'd)

g. Check trigger operation

Using signal from CALIBRATOR, check triggering operation as follows.

- INT: AUTO Must trigger + and - on 1/2 major division of signal.
- INT: AC Must trigger + and - on .5 minor division of signal without moving TRIGGERING LEVEL control.
- INT: DC Must trigger + and - on 1 minor division of signal within ± 1 minor division of graticule center. Must trigger on + and - 2 minor divisions of signal without moving TRIGGERING LEVEL control.
- EXT: AUTO Must trigger on $\pm 1.0V$.
- AC and DC Must trigger on .1 volt signal.

Remove patch cords.

12. LINE TRIGGER*a. Setup*

Set TIME/DIV to 5 MILLISEC and TRIGGER SELECTOR to AUTO, LINE. Connect a 10X probe from vertical INPUT to an external 117 VAC source.

b. Check LINE triggering

Check for proper slope on display, switching from + to - LINE. Remove probe.

13. HF SYNC*a. Setup*

Connect TYPE 191 to vertical INPUT TYPE 317 using a BNC cable and 50Ω termination. Switch TIME/DIV to .2 μ SEC, HORIZ DISPLAY to MAG, and TRIGGER SELECTOR to HF SYNC + INT.

13. (cont'd)

b. Check HF Sync

Adjust TYPE 191 for 2 div of 20 MHz.
Rotate STABILITY until a stable trace
is obtained. Slap top of scope to check
for microphonic tubes. Remove TYPE 191.

14. HORIZONTAL AMPLIFIER GAIN*a. Setup*

Connect 1mSEC and 100 μ SEC markers from
TYPE 184 thru 50 Ω BNC cable and 50 Ω BNC
terminator to TYPE 317. Switch TIME/DIV
to 1 MILLISEC, HORIZ DISPLAY to NORM,
TRIGGER SELECTOR to AC + INT. Trigger
the display.

b. Adjust Mag Gain Adjust

Switch HORIZ DISPLAY to MAG and adjust
R358 for two 100 μ SEC marks per div.

c. Adjust Horiz Gain Adj

Turn HORIZ DISPLAY to NORM and adjust
R325 for one 1mSEC mark per div.

Unless noted otherwise, use
the middle 8 horizontal div
when adjusting or checking
timing.

15. SWEEP LENGTH

Adjust R82 for a sweep length of 10.5
div.

16. NORM-MAG REGISTRATION*Adjust Norm Mag Regis*

Set HORIZ DISPLAY to MAG and use HORIZONTAL
POSITIONING control to bring first time
mark (start of sweep) to graticule center.
Switch HORIZ DISPLAY to NORM and adjust
Norm/Mag Regis R335 to again bring first
time mark to graticule center. Repeat
adjustments until the first time mark
does not shift when switching between
NORM and MAG. Check at center and rear
end of sweep. Leave HORIZ DISPLAY in NORM.
Horizontal positioning should move 10th
marker to at least center graticule mark.

17. LF TIMING

- a. *Check LF Timing: $\pm 2\%$ except for
1 and 2 sec: 2.5%*

TIME/CM	184 marks	check for	
.1mSEC	.1 μ S	1 mark/div	$\pm .8$ min div
.2mSEC	.1 μ S	2 marks/div	$\pm .8$ min div
.5mSEC	.5 μ S	1 mark/div	$\pm .8$ min div
1mSEC	1mS	1 mark/div	$\pm .8$ min div
2mSEC	1mS	2 marks/div	$\pm .8$ min div
5mSEC	5mS	1 mark/div	$\pm .8$ min div

Position base line off-screen to prevent phosphor burns.

10mSEC	10mS	1 mark/div	$\pm .8$ min div
20mSEC	10mS	2 marks/div	$\pm .8$ min div
50mSEC	50mS	1 mark/div	$\pm .8$ min div
.1 SEC	100mS	1 mark/div	$\pm .8$ min div
.2 SEC	100mS	2 marks/div	$\pm .8$ min div
.5 SEC	500mS	1 mark/div	$\pm .8$ min div
1 SEC	1 S	1 mark/div	± 1 min div
2 SEC	1 S	2 marks/div	± 1 min div

- b. *Check VARIABLE TIME/DIV ratio:
2.5 to 1 min*

Switch TIME/DIV to 1mSEC and TYPE 184 to 10mSEC markers. Turn VARIABLE TIME/DIV ccw: UNCALIBRATED neon must light up and 3rd 184 mark must cross to left of the 8th graticule line. Return VARIABLE cw (CALIBRATED): UNCALIBRATED neon must go out.

- c. *Adjust C310*

Set HORIZ DISPLAY to MAG and TYPE 184 to 10 μ sec marks. Switch TIME/DIV back and forth between 50 μ SEC and .1 MILLISEC. Adjust C310 for coincidence of first time mark. Leave in NORM.

18. HF TIMING

a. Setup

Connect TYPE 184 time marks to vertical INPUT and TRIGGER INPUT using T connector. Change TRIGGER SELECTOR to + EXT.

b. Adjust HF timing

Change TYPE 184 to 10μSEC marks and trigger display. Adjust as follows:

<u>TIME/DIV</u>	<u>184 marks</u>	<u>adjust</u>	<u>for</u>
10μSEC	10μS	C160E	1 mark/div, ±.8 min div
1μSEC	1μS	C160C	1 mark/div, ±.8 min div
.5μSEC	1μS	C160A	1 mark/2 div, ±.8 min div

Turn HORIZ DISPLAY to MAG.

.2μSEC	.1μS	C324	2 marks/div, 1.6 min div
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Switch 184 to 20nS, remove cable from vertical INPUT and with a small cap in series, connect cable directly to one of the CRT vertical deflection plate pins. With HORIZONTAL POSITIONING, look at start of sweep and adjust C358 for best linearity between second and tenth cycles.

Position center of sweep to graticule center. Adjust C350 and C372 for 2 cycles/div. With HORIZONTAL POSITIONING, check timing and linearity, disregarding first and last 10% of sweep.

b. C350 and C372 should be adjusted together, i.e., equal capacitance.

c. Check HF Timing ±2%

MAG ON: ±3% except .2μSEC ±4%

<u>TIME/DIV</u>	<u>HORIZ DISPLAY</u>	<u>184 marks</u>	<u>check for</u>
.2μSEC	MAG	20nS	2 cycles/div ±1.6 min div
.2μSEC	NORM	.1μS	2 marks/div ±.8 min div
.5μSEC	MAG	.1μS	1 mark/div ±1.2 min div
.5μSEC	NORM	1μS	1 mark/2 div ±.8 min div
1μSEC	NORM	1μS	1 mark/div ±.8 min div
2μSEC	NORM	1μS	2 marks/div ±.8 min div
5μSEC	NORM	5μS	1 mark/div ±.8 min div
10μSEC	NORM	10μS	1 mark/div ±.8 min div
20μSEC	NORM	10μS	2 marks/div ±.8 min div
50μSEC	NORM	50μS	1 mark/div ±.8 min div

Disconnect TYPE 184.

19. EXT HORIZONTAL

a. Setup

Apply 10 volts of CALIBRATOR signal to the HORIZ INPUT, change the HORIZONTAL DISPLAY to EXT, set STABILITY cw.

b. Check EXT HORIZ deflection factor

Check for ≥ 7 div of display. Rotate STABILITY ccw and check for smooth operation, with no deflection at ccw. Set HORIZONTAL DISPLAY to NORM and remove CALIBRATOR signal from HORIZ INPUT.

b. With HORIZONTAL DISPLAY in EXT the STABILITY control becomes a variable attenuator for the HORIZ INPUT.

20. FRONT PANEL WAVEFORMS

a. Check SAWTOOTH OUT: 130V, min

Set TIME/DIV at 1 MILLISEC and free run sweep. Use test scope and 10X probe and measure the SAWTOOTH OUT: 130V, min.

b. Check + GATE OUT: 20V, min

With 10X probe check the + GATE OUT jack. Must be at least 20V.

21. HOLDOFF

Check holdoff

Connect 10X probe to pin 3, V61. Check holdoff as follows:

<u>TIME/DIV</u>	<u>Holdoff</u>
.2 and .5 μ SEC	4 to 12 μ s
1 to 50 μ SEC	15 to 45 μ s
.1 to .5mSEC	150 to 450 μ s
1 to 5mSEC	1.5 to 4.5ms
10 to 50mSEC	12.5 to 37.5ms
.1 to 2 SEC	125 to 375ms

Remove 10X probe.

22. CRT CATHODE INPUT*a. Setup*

Switch TIME/DIV to 1 MILLISEC. Loosen CRT CATHODE and GND binding post on rear of scope and swing strap away from CRT CATHODE post (strap must pivot on GND post).

b. Check Intensity modulation: 10V, min

Connect 10V from CAL OUT to CRT CATHODE. Note that the signal intensity modulates the sweep at normal intensity. Remove CAL OUT signal and replace strap on binding posts.

23. VERTICAL AMPLIFIER HF*a. Setup*

TYPE 106---50 Ω cable---50 Ω term---vertical INPUT

Set 106 to 50 kc VOLT/DIV to .1 and TIME/DIV to 2 μ SEC. Adjust scope under calibration for a stable display of three major divisions of squarewave centered vertically on CRT.

b. Adjust delay line and termination

Beginning with trimmers at termination end and working toward front of line, go over line a time or two to straighten up level and smooth largest bumps.

Straighten up termination by turning slugs in coils the same direction equally. Do not unbalance these coils or the back of the line will ring. Coils should smooth all bumps from back of line. Continue along line until it is smooth and level; leave front end alone.

After you have the line smooth and level, place tweakers in coils at end of delay line. Bring up front end by turning slugs toward opening of coils. Turn both slugs equally. If this causes ringing in line that will not come out, turn the same coils in opposite directions from each other. If this does not help, reverse the direction of the slugs.

The two 6AU6 coils usually will not need further adjustment unless there is a spike or rolloff on front corner.

23. (cont'd)

c. Adjust preamp coils

Turn VOLTS/DIV to .01 and adjust 106 for three major divisions of signal. Set slug in L477 (.9-1.6 μ H) to center of winding. Turn slug in L450 (23-55 μ H) until front end straightens up.

Check that waveform has less than 1% aberrations or tilt (1 trace width).

Remove 106 signal.

24. FREQUENCY RESPONSE*a. Setup*

TYPE 191 50 Ω cable---50 Ω termination. With VOLTS/DIV set to .01, adjust TYPE 191 for exactly 4 div of 50kHz.

*b. Check frequency response preamp:
 >10 MHz at -3dB*

Switch TYPE 191 to 10MHz and note vertical deflection: 2.8 div, min.

*c. Check frequency response main amp:
 >10.5 MHz at -3dB*

With VOLT/DIV set to .1V, adjust TYPE 191 for exactly 4 div of 50kHz. Switch TYPE 191 to 10.5MHz and note vertical deflection: 2.8 div, min.

Remove TYPE 191.

THE END