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).

This procedure is company confidential

515A

December 1968

For all serial numbers.

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.

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 530 Series OSCILLOSCOPE
1	TYPE 106 SQUARE-WAVE GENERATOR
*1	TYPE 184 TIME-MARK GENERATOR
*1	TYPE 191 CONSTANT-AMPLITUDE SIGNAL GENERATOR
1	TYPE P6006 10X PROBE
1	TYPE P6028 1X PROBE
1	TYPE 76TU LINE VOLTAGE CONTROL UNIT

b. Test Fixtures and Accessories

*1	STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)
2	50Ω 42" BNC cables (012-0057-00)
1	50Ω BNC Termination (011-0049-00)
1	BNC T connector (103-0030-00)
2	50Ω 18" BNC cables (012-0076-00)
1	Variable Normalizer (Dwg #1761-C)
1	Micro Shock Hammer (PMPE Dwg #1283-B)

c. Other equipment

1	20,000Ω/VDC 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 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.

1. PRELIMINARY INSPECTION

b. CRT face plate tilt: ≤3/64"

3. LV POWER SUPPLY

c. Check regulated low voltage power supplies for tolerance, ripple, and regulation while changing line voltage source between 105 and 125VAC

Supply	max error	max P to P ripple 105VAC	117VAC	125VAC
-150V	±3V	25mV	15mV	25mV
+100V	±2V	15mV	10mV	15mV
+300V	±6V	30mV	20mV	30mV

4. HV POWER SUPPLY

a. -1675: ±2%
b. Regulation: 105 to 125VAC

5. CALIBRATOR

*a. Accuracy: ±2% all settings
b. Calibrator frequency: 800 to 1200Hz
c. Duty cycle: 45 to 55%

7. CRT

a. Align CRT: ±0.5 minor div
b. Geometry: 1mm max deviation within graticule area
e. Focus
max trace width anywhere in graticule, .040 inch
max trace width in center 4 vert by 8 horiz cm, .035 inch
max trace width in center 3 vert by 6 horiz cm, .030 inch
f. HORIZ Geometry: 1mm max deviation within graticule area

8. DC BALANCE

b. CRT electrical center: ≤0.5cm from graticule center
c. Vertical amp balance: 1cm max trace distance from graticule center with VERTICAL POSITIONING at midr and DC BAL properly adjusted.

9. MICROPHONICS, GRID CURRENT

a. Microphonics: .25cm max, no ringing type
b. Grid current: ≤2mm
c. Heater-cathode leakage: 1 trace width hum, max

10. GAIN

b. Gain range: ±10%, min
c. AC-DC gain match: ±2%
d. Gain change and drift at 105VAC and 125VAC
gain: 2mm max
drift: .5cm max
*e. VOLTS/CM accuracy: ±2%
f. VARIABLE VOLTS/CM: 2.5:1

11. COMPRESSION, EXPANSION

b. Compression, expansion: ±0.5mm max

12. VOLTS/CM COMPENSATION

b. Volts/cm compensation: 1mm max variation from square corner and flat top

13. TRIGGERING

c. Trig Sens Adj: no stable triggering on 0.1V signal
e. Preset stability: 50% of range ±25%
f. TRIGGERING LEVEL range: + and - 25V min
g. Triggering characteristics

TRIGGER SELECTOR	TRIGGERING LEVEL	Signal
+ & - INT AC	variable	2mm 1kHz SAC
+ & - INT AUTO	---	5mm 1kHz SAC
+ & - INT DC	fixed	4mm 1kHz SAC
	(+ & - within 4mm of graticule center, +INT within 4mm of -INT, use VERTICAL POSITION)	
+ & - EXT AC	variable	0.5V 1kHz SAC
+ & - EXT DC	variable	0.5V 1kHz SAC
EXT AUTO	---	1.0V 1kHz SAC
+ & - INT AC	variable	4mm 2MHz 191
+ & - INT AUTO	---	1cm 2MHz 191
+ & - INT DC	variable	1.5cm 2MHz 191
+ & - EXT AC	variable	1.5V 2MHz 191
+ & - EXT AUTO	---	2.0V 2MHz 191
HF SYNC INT	---	2cm 20MHz 191
HF SYNC EXT	---	2V 20MHz 191

h. Line triggering: must trigger on proper slope

14. DELAY LINE AND JF ADJUSTMENTS

b. HF compensations: 1% waveform Aberrations, max

15. BANDPASS

*b. Bandpass: ≥15MHz at -3dB

16. HF SYNC

b. HF SYNC: ≤1mm trace width on 2div 20MHz

17. SWEEP TIMING

c. Horizontal jitter: 2mm, max
e. VARIABLE TIME/CM: 3:1 min
f. Sweep Length: 10.2 to 10.8cm
*g. 1mSEC to 2SEC timing: ±2%
*j. .2μSEC to .5mSEC timing: ±2% magnified error: ±3%, except .2μSEC, ±4%
linearity error: ±1%
1mSEC must be within 1% of MAG OFF timing

18. HORIZONTAL POSITIONING RANGE

must be able to position any part of the sweep, from start to the 10th cm, to graticule center

19. EXTERNAL HORIZONTAL

a. Sensitivity: 0.7cm/v, min
c. EXT HORIZ BANDPASS: ≥500kHz at -3dB

21. TIME BASE HOLDOFF

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

22. CRT CATHODE INPUT

b. Intensity modulation: must have intensity modulation with 20V calibrator signal and normal intensity

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

THE END

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 CRT face plate tilt: ≤3/64"
c. Check fuse
d. Check CRT
e. Check graticule lights

2. PRESETS

a. Preset external controls
b. Preset internal adjustments

3. LV POWER SUPPLY

a. Check power supply resistance
b. Adjust -150V Adj
c. Check regulated low voltage power supplies for tolerance, ripple, and regulation while changing line voltage source between 105 and 125VAC
d. Check unregulated supplies
e. Check elevated heaters

4. HV POWER SUPPLY

a. Adjust -1675 Adj
b. Check HV regulation

5. CALIBRATOR

a. Check accuracy: ±2% all settings
b. Check calibrator frequency: 800 to 1200Hz
c. Check duty cycle: 45 to 55%

6. SCALE ILLUM, NEON INDICATORS

a. Check SCALE ILLUM
b. Check uncalibrated neons
c. Check MAG neon

7. CRT

a. Align CRT: ±0.5 minor div
b. Adjust Geom Adj: 1mm max deviation within graticule area
c. Check CRT defects
d. Adjust graticule cam
e. Check focus
f. Check HORIZ geometry: 1mm max deviation within graticule area

8. DC BALANCE

a. Adjust DC BAL
b. Check CRT electrical center ≤0.5cm from graticule center
c. Check vertical amp balance: 0.25cm, max

9. MICROPHONICS, GRID CURRENT

a. Check microphonics: 0.25cm, max no ringing type
b. Check grid current: 2mm, max
c. Check heater-cathode leakage: 1 trace width hum, max

10. GAIN

a. Setup
b. Adjust Gain Adj and check range: ±10%
c. Check AC-DC gain match: ±2%
d. Check gain change and drift at 105VAC and 125VAC
gain: 2mm max
drift: 0.5cm, max
e. Check VOLTS/CM accuracy: ±2%
f. Check VARIABLE VOLTS/CM: 2.5:1

11. COMPRESSION, EXPANSION

a. Setup
b. Check compression, expansion: 0.5mm, max

12. VOLTS/CM COMPENSATION

a. Setup
b. Adjust VOLTS/CM compensation: 1mm max variation from square corner and flat top

13. TRIGGERING

a. Adjust TRIGGERING LEVEL mechanical zero:
b. Adjust Triggering Level centering
c. Adjust Trig Sens Adj
d. Adjust Int Trig DC level
e. Adjust Preset Stability: 50% or range ±25%
f. Check TRIGGERING LEVEL range: + and - 25V, min
g. Check triggering characteristics
h. Check LINE triggering: triggering on proper slope

14. DELAY LINE AND HF ADJUSTMENTS

a. Setup
b. Adjust HF compensations: 1% waveform aberrations, max

15. BANDPASS

a. Setup
b. Check bandpass: ≥15MHz at -3dB

16. HF SYNC

a. Setup
b. Check HF Sync: ≤1mm trace width on 2div 20MHz

17. SWEEP TIMING

a. Setup
b. Adjust Mag Gain Adj
c. Check Horizontal jitter: 2mm, max
d. Adjust Swp Gain Adj
e. Check VARIABLE TIME/CM: 3:1 min
f. Adjust Swp Length
g. Check 1mSEC to 2SEC timing: ±2%
h. Adjust Norm/Mag Regis
i. Adjust C210
j. Check and adjust .2μSEC to .5mSEC timing: ±2% magnified error: ±3% except .2 SEC, ±4%
Linearity error: ±1%

18. HORIZONTAL POSITIONING RANGE

Check Horiz range

19. EXTERNAL HORIZONTAL

a. Check sensitivity: 0.7cm/v, min
b. Check EXT HORIZ ATTEN
c. Check EXT HORIZ Bandpass: ≥500kHz at -3dB

20. EXTERNAL OUTPUTS

a. Check SAWTOOTH OUT
b. Check + GATE OUT

21. TIME BASE HOLDOFF

Check holdoff

22. CRT CATHODE INPUT

a. Setup
b. Check intensity modulation

THE END

1. PRELIMINARY INSPECTION

a. Install current modifications

b. Check CRT face plate tilt: ≤3/64"

Loosen CRT clamp, remove graticule and graticule cover. Push CRT forward to a plastic straight edge firmly placed against the front panel, across a diameter of the CRT. Check gap within phosphor area must be ≤3/64".

c. Check fuse

3a mdx slo-blo

d. Check CRT

Inspect the CRT for phosphor defects, scratches, chips and cracks around neck pins. Check neck pins for proper connection and tightness.

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

e. Check graticule lights

Replace graticule. Check that graticule lights extend out flush with graticule face, ±1/32". Replace graticule cover.

2. PRESETS

a. Preset external controls

TRIGGER SELECTOR	AC + INT
STABILITY	ccw (not preset)
TRIGGERING LEVEL	ccw
HORIZ DISPLAY	NORM
TIME/CM	1mSEC
VARIABLE	cw (calibrated)
FOCUS	cw
INTENSITY	ccw
ASTIGMATISM	cw
SCALE ILLUM	cw
VERTICAL POSITIONING	midr
HORIZONTAL POSITIONING	midr
SQUARE-WAVE CALIBRATOR	OFF
POWER	OFF
INPUT SELECTOR	INPUT 1, AC
VOLTS/CM	.05
VARIABLE	cw (calibrated)

2. (CONT)

b. Preset internal adjustments

All internal adjustments midr.

3. LV POWER SUPPLY

a. Check power supply resistance

Check resistance of power supplies to ground as fellows.

Supply	approx resistance
T600 premary, 1 and 4	inf
-150	5k
+100V	8k
+300V	16k

b. Adjust -150 Adj

Connect TYPE 515A to variable line voltage source set at 117VAC. Turn TYPE 515A power on. Connect multimeter to -150V test point and adjust R617 for -150V.

c. Check regulated low voltage power supplies for tolerance, ripple, and regulation while changing line voltage source between 105 and 125VAC

	max	max P to P ripple		
Supply	error	105VAC	117VAC	125VAC
-150V	±3V	25mV	15mV	25mV
+100V	±2V	15mV	10mV	15mV
+300V	±6V	30mV	20mV	30mV

d. Check unregulated supplies

Check V635A pin 2, pin 5, and V610 pin 5 for 120Hz.

3. (CONT)

e. Check elevated heaters

Using multimeter check following terminals to ground for proper elevation.

Term	Approx voltage from ground
T600 term 18 or 19	+100V
T600 term 22 or 23	+150V
T600 term 24 or 25	-1675V

4. HV POWER SUPPLY

a. Adjust -1675 Adj

Adjust R741 for -1675V at V720 anode. May be measured at T600 term 24 or 25 if scope does not contain Mod 101.

b. Check HV regulation 105 to 125VAC

Turn STABILITY cw, FOCUS ccw, INTENSITY cw. Multimeter reading should not change while changing TYPE 76TU from 117VAC to 105VAC, and from 117VAC to 125VAC.

Return TYPE 76TU to 117VAC.

5. CALIBRATOR

a. Check accuracy: ±2% all settings

Preset the test scope as follows:

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

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 V550 from the instrument under test.

5a. (CONT)

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, R561 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).

		test scope	
TYPE 515A CALIBRATOR	SAC VOLTS	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 Calibrator frequency 800 to 1200Hz

Set the SAC to UNKNOWN ONLY. Reinstall V550 in the instruments under test. Set the test scope to + INT, and set the TIME/CM to 1mSEC. Set the test scope VOLTS/CM to .1. Check calibrator frequency 800 to 1200Hz.

5. (CONT)

c. Check duty cycle: 45 to 55%

Change test scope triggering from + to - and note test scope display: center of calibrator waveform (point where calibrator switches from plus to minus) lies at center of test scope graticule, ±.5cm, indicating duty cycle between 45 and 55%.

Remove cables from TYPE 515A.

6. SCALE ILLUM, NEON INDICATORS

a. Check SCALE ILLUM

Turn SCALE ILLUM full cw: both graticule bulbs must increase brilliance. Turn ccw; both graticule bulbs must completely extinguish.

b. Check uncalibrated neons

Check that vertical UNCALIBRATED neon is lit when VARIABLE VOLTS/CM is out of CALIBRATED.

Check that UNCALIBRATED neon is lit when VARIABLE TIME/CM is out of CALIBRATED.

Return both to CALIBRATED, both neons must be extinguished within the detent.

c. Check MAG neon

Set HORIZ DISPLAY to MAG. Note MAG neon is lit. Return to NORM, neon must extinguish.

7. CRT

a. Align CRT: ±0.5 minor div

Adjust controls for a well defined trace at graticule center. Rotate CRT so trace is parallel with center graticule line. Tighten CRT clamp, recheck trace position, and face plate tilt in relation to front panel.

b. Adjust Geom Adj: 1mm max deviation within graticule area

Connect TYPE 184 to TYPE 515A INPUT 1 using 50Ω cable. Using .1mS markers preset TYPE 515A Swp Gain for 10 marks per div. Adjust R753 for min bowing of the trace. Remove TYPE 184 signal.

c. Check CRT defects

Connect the TYPE 191 to TYPE 515A INPUT 1. Adjust controls to "flood" the CRT. Check for any phosphor defects, holes, burns, spots, etc.

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

d. Adjust graticule cam

Position the graticule for an equal amount of scan above and below the graticule. Tighten the graticule cam.

Remove TYPE 191 signal.

d. The graticule may be adjusted away from midcenter position to bring geometry, focus, compression, etc. within specs.

e. Check focus

Set TIME/CM to 1mSEC and VOLTS/CM to 1. Switch SAC to 2 volts and apply to INPUT 1. Adjust triggering, INTENSITY, FOCUS and ASTIGMATISM for a well defined display.

Adjust VARIABLE VOLTS/CM for exactly 1cm of signal and free-run sweep. Reduce SAC voltage to .1 volts. This gives two traces separated by about .040 inch, which is the maximum trace width allowable anywhere in the graticule area. Position the traces throughout the graticule area and check for no overlapping.

7e. (CONT)

Within the center 3 x 6cm, the maximum allowed trace width is .030 inch. In the center 4 x 8cm the maximum is .035 inch.

	maximum spot size
area A	.030 inch
area B	.035 inch
area C	.040 inch

Remove SAC from INPUT 1 and connect it to EXT HORIZ INPUT. Connect a cable between INPUT 1 and sawtooth out of test scope set to 1msec. Set HORIZ DISPLAY to EXT. With VOLTS/CM, HORIZ INPUT ATTEN (STABILITY) and SAC, obtain as above two traces about .040 inch apart sweeping at about 1msec/cm.

Again position the two traces throughout the graticule area and check the trace width using the same figures as before.

Return VARIABLE VOLTS/CM to CALIBRATED, HORIZ DISPLAY to NORM and remove all cable connections.

f. Check Horiz Geometry: 1mm max deviation within graticule area

Move the trace to the top and bottom graticule lines and check bowing: 1mm, max in 10cm.

8. DC BALANCE

a. Adjust DC BAL

Set VERTICAL POSITIONING to midr. Move DC BAL full cw then ccw: trace must move completely off the CRT face in each extreme.

Adjust DC BAL for no trace movement while rotating VARIABLE VOLTS/DIV back and forth thru its range. Leave VARIABLE at CALIBRATED.

b. Check CRT electrical center ≤0.5cm from graticule

Short CRT vertical deflection plates together and note that trace is a maximum of 0.5cm from the center graticule line.

c. Check vertical amp balance: 0.25cm max

With VERTICAL POSITIONING at midr note trace distance from graticule center: 1cm, max.

9. MICROPHONICS, GRID CURRENT

a. Check microphonics: .25cm, max no ringing type

Set VOLTS/CM to .05. Ground INPUT 1 of TYPE 515A. Use microhammer and check display for microphonics: .25cm, max; no ringing type.

b. Check grid current: 2mm max

Change INPUT SELECTOR from AC to DC and note trace shift: 2mm max.

c. Check heater-cathode leakage: 1 trace width hum, max

Set VOLTS/CM to .05 and TIME/CM to 10msec. Check trace for 60Hz hum: 1 trace width max.

Unground INPUT 1 and set TIME/CM to 1mSEC.

10. GAIN

a. Setup

Connect SAC OUT to TYPE 515A INPUT
1. Set SAC to .2V.

b. Adjust Gain Adj and check range: ±10%

Turn R396 full cw. Note deflection: 4.4cm, min. Turn full ccw. Note deflection: 3.6cm, max. Adjust for 4cm deflection at graticule center.

c. Check AC-DC gain match: ±2%

Change INPUT SELECTOR to AC and note deflection: 4cm, ±2%, max.

d. Check gain change and drift at 105VAC and 125VAC
gain: 2mm max
drift: .5cm max

Switch INPUT SELECTOR to DC. Set line to 105VAC. Note gain change; 2mm, max; and vertical drift; .5cm, max.

Also check that sweep continues to cycle with TIME/CM at 2SEC. Reset to 1mSEC.

Return line to 117VAC and allow stabilization.

Increase line voltage to 125VAC and again note gain change; 2mm max; and vertical drift; .5cm, max.

Reset line to 117VAC.

e. Check VOLTS/CM accuracy: ±2%

Check VOLTS/CM accuracy from .05 to 20: ±2%.

f. Check VARIABLE VOLTS/CM: 2.5:1

Rotate VARIABLE VOLTS/CM to max atten. Note deflection: ≤2cm. Note any noise or open spots during a full rotation of VARIABLE. Return to CALIBRATED.

11. COMPRESSION, EXPANSION

a. Setup

Adjust SAC, VOLTS/CM, and VARIABLE VOLTS/CM for 2cm display at graticule center.

b. Check compression, expansion: 0.5mm max

Position top of display to top graticule line. Note deflection: 2cm, ±0.5mm. Position bottom of display to bottom graticule line. Note deflection: 2cm, ±0.5mm.

12. VOLTS/CM COMPENSATION

a. Setup

Connect TYPE 106 to TYPE 515A INPUT 1 using variable normalizer, 50Ω terminator and 50Ω BNC cable.

Maintain 4cm of 1kHz display from TYPE 106.

b. Adjust VOLTS/CM compensation: 1mm max variation from square corner and flat top

Adjust or check for variation from square corner and flat top as follows

VOLTS/CM	check or adjust corner	level
.05		
.1	C306	C305
.2	C312	C311
.5	C316	C315
1	check	
2	check	
5	C320	C319
10	check	
20	check	

Remove TYPE 106 signal.

13. TRIGGERING

a. Adjust TRIGGERING LEVEL mechanical zero

Connect multimeter leads between the junction of R23-R25 and ground. Adjust the TRIGGERING LEVEL for zero volts. Use the lowest voltage meter range for final adjustment. Loosen the TRIGGERING LEVEL knob set screw. Position the knob on the shaft so the white dot is aligned with "0". Tighten the set screw (check that the meter reading remains at zero). Remove the meter leads. Rotate the TRIGGERING LEVEL knob full ccw and full cw. Check that the white dot does not go past 6 o'clock in either direction.

b. Adjust Triggering Level Centering

Set TYPE 515A controls as follows:

TRIGGER SELECTOR	+EXT
	DC
STABILITY	ccw (not preset)
TIME/CM	50μSEC
VOLTS/CM	.05

Preset Triggering Level Centering, Trig Sens Adj and Int Trig DC Level Adj to midr. Connect TYPE 191--BNC T to TYPE 515A INPUT 1 -- 50Ω cable -- TYPE 515A TRIGGER INPUT. Adjust TYPE 191 controls for a .2V 50kHz signal. Ground the junction of R23-R25 with a clip lead. Connect a X10 probe from test scope vertical input to pin 6 of V30. Adjust the Trigger Level Centering, R40 and Trig Sens Adj, R28 for a square-wave display on the test scope. Check for the same duty cycle with the TRIGGER SELECTOR in +INT and -INT positions.

c. Adjust Trig Sens Adj: no stable triggering on .1V signal

Switch the TRIGGER SELECTOR between + and - EXT and check for stable triggering. Adjust the TYPE 191 for a .1 volt signal. Switch the TRIGGER SELECTOR between + and - EXT and adjust Trig Sens Adj for no stable triggering. Adjust the TYPE 191 for a 0.3 volt signal and recheck for stable triggering + and - EXT.

a. R23 and R25 are a 1 meg resistor and a 3.9 meg resistor respectively located on the trigger switch.

Allow sufficient clearance so the TRIGGERING LEVEL knob does not rub against the panel. Tighten the set screw securely enough to prevent the knob turning on the shaft, but not enough to cause the concentric shafts to bind.

13. (CONT)

d. Adjust Int Trig DC Level Adj

Rotate the STABILITY fully cw. Center the display with the VERTICAL POSITIONING control. Adjust the TYPE 191 for 4mm of deflection on the TYPE 515A. Turn the STABILITY ccw (not preset). Change the TRIGGER SELECTOR to INT DC. Switch the TRIGGER SELECTOR between +INT and -INT and adjust the Int Trig DC Level for a stable test scope display on both positions. Adjust the TYPE 515A STABILITY for a triggered sweep and check for stable triggering of the TYPE 515A + and - INT DC within ±4mm of graticule center.

Remove the ground lead from R23-R25 junction.

d. If the Trig Sens Adj is changed in the course of adjusting Int Trig DC Level, repeat step 15c.

e. Adjust Preset Stability: 50% of range ±25%

Change the TYPE 515A TRIGGER SELECTOR to AUTO +LINE, STABILITY to PRESET and TIME/CM to .1μSEC. Connect the multimeter leads between the center arm of R146 and ground. Turn R146 cw until the trace just appears. Note the meter reading. Continue turning R146 cw until the trace brightens. Again note the meter reading. The difference in noted readings must be 15V, min. Adjust R146 midway between the two meter readings.

e. Voltage at which trace first appears: approx -43V. Voltage at which trace brightens: approx -73V.

f. Check TRIGGERING LEVEL range: + and - 25V min

Remove the TYPE 191 connection from the BNC T connector at TYPE 515A INPUT 1. Connect SAC -- 50Ω cable -- BNC T at TYPE 515A INPUT 1. Set SAC AMPLITUDE to 50 VOLTS. Set the TYPE 515A TRIGGER SELECTOR to +EXT, AC, TIME/CM to 5mSEC VOLTS/CM to .5mSEC VOLTS/CM to 10 and TRIGGERING LEVEL to 0. Adjust the STABILITY control to the most cw position that a stable square-wave can be displayed. Rotate the TRIGGERING LEVEL from fully ccw to fully cw and check that a stable display is not maintained at extremes of the TRIGGERING LEVEL control. Change the TRIGGER SELECTOR to -EXT and rotate the TRIGGERING LEVEL from fully ccw to fully cw. Check that a stable square-wave display is not maintained at extremes of the TRIGGERING LEVEL control.

13. (CONT)

g. Check triggering characteristics

Check triggering as in the following table:

TRIGGER SELECTOR	TRIGGERING LEVEL	signal frequency	signal amplitude	signal generator
+ & - INT AC	*variable*	1 kHz	2mm	SAC
+ & - INT AUTO	---	1 kHz	5mm	SAC
+ & - INT DC	*fixed*	1 kHz	*4mm (+ & - within 4mm of graticule center, +INT within 4mm of -INT, use VERTICAL POSITION)*	SAC
+ & - EXT AC	variable	1 kHz	0.5V	SAC
+ & - *EXT DC*	variable	1 kHz	0.5V	SAC
EXT AUTO	---	1 kHz	1V	SAC
+ & - INT AC	variable	*2 MHz*	*4mm*	191
+ & - INT AUTO	---	*2 MHz*	*1cm*	191
+ & - INT DC	variable	2 MHz	*1.5cm*	191
+ & - *EXT AC*	variable	2 MHz	*1.5V*	191
+ & - EXT AUTO	---	2 MHz	*2V*	191
HF SYNC INT	---	20 MHz	2cm	191
HF SYNC EXT	---	20 MHz	2V	191

Remove the signal cables and BNC T from TYPE 515A.

h. Check LINE triggering: triggering on proper slope

Connect a X10 probe to TYPE 515A INPUT 1 and connect the probe tip to 115VAC at the fuse holder. Set the TYPE 515A VOLTS/CM to 20 and TIME/CM to 5mSEC. Check for a stable trigger of the proper slope in +LINE and -LINE, AC, DC and AUTO.

14. DELAY LINE AND HF ADJUSTMENTS

a. Setup

Connect TYPE 106 to INPUT 1 using 50Ω termination and 50Ω BNC cable. Switch VOLTS/CM to .05, INPUT SELECTOR to DC, TIME/CM to .2μSEC and TRIGGER SELECTOR to AC -INT.

b. Adjust HF compensations: 1% waveform aberrations, max

Adjust the 106 for 3cm of 500kHz Position the pulse vertically to the CRT center.

Most of the vertical hf adjustments interact, repeat as necessary to obtain a waveform with flat top and minimum aberrations. Set TIME/CM as needed to check overall waveform level or to check individual adjustments. Adjust delay line trimmers, termination network and vertical amplifier inductors for minimum aberration of 1% or less (0.3mm).

Remove TYPE 106 signal.

15. BANDPASS

a. Setup

Connect TYPE 191 to TYPE 515A INPUT 1 using 50Ω termination and 50Ω cable. Set STABILITY cw, TIME/CM to 1mSEC, and VOLTS/CM to .05.

b. Check Bandpass: ≥15MHz at -3dB

Adjust TYPE 191 for 4cm of 50kHz. Set TYPE 191 to 15MHz and note deflection ≥2.8cm.

16. HF SYNC

a. Setup

Change TRIGGER SELECTOR to HF SYNC, + INT, TIME/CM to .2μSEC and HORIZ DISPLAY to MAG. Adjust TYPE 191 for 2div of 20MHz.

b. Check HF Sync: ≤1mm trace width on 2div 20MHz

Check that a stable display may be obtained by adjusting STABILITY.

Lightly rap on top of TYPE 515A to check for micro tubes. Check for less than 1mm trace width or a dual signal appearance.

17. SWEEP TIMING

a. Setup

Connect TYPE 184 thru 50Ω BNC Cable to TYPE 515A INPUT 1. Preset 515A TIME/CM to 1mSEC, TRIGGER SELECTOR to AC, +INT, and HORIZ DISPLAY to MAG. Set TYPE 184 to 1mSEC and 100μSEC markers.

b. Adjust Mag Gain Adj

Adjust R259 for two 100μsec markers per cm.

c. Check Horizontal jitter: 2mm, max

Switch TIME/CM to 50μSEC and VARIABLE ccw. Position trace so that last time mark is visible. The width of this time mark cannot exceed 2mm.

Return TIME/CM to 1mSEC and VARIABLE to CALIBRATED.

d. Adjust Sweep Gain Adj

Switch HORIZ DISPLAY to NORM. Adjust R225 for one 1mSEC mark per cm.

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

17. (CONT)

e. Check VARIABLE TIME/CM: 3:1 min

Set TYPE 184 to 10msec markers. Rotate VARIABLE TIME/CM ccw, examining display for any open spots in the variable's range. Check for 3 markers/ cm min. Return VARIABLE to CALIBRATED.

f. Adjust Sweep Length

Change TYPE 184 to 500µSEC markers. Adjust R156 for 10.5cm sweep length. Change TYPE 184 to 1msec markers and check for no change in sweep length.

g. Check 1msec to 2SEC timing: ±2%

Check timing as follows:

TIME/CM	184	display
1mSEC	1mS	1 mark/cm ±1.6mm
2mSEC	1mS	2 marks/cm ±1.6mm
5mSEC	5mS	1 mark/cm ±1.6mm
10mSEC	10mS	1 mark/cm ±1.6mm
20mSEC	10mS	2 marks/cm ±1.6mm
50mSEC	50mS	1 mark/cm ±1.6mm
.1SEC	100mS	1 mark/cm ±1.6mm
.2SEC	100mS	2 marks/cm ±1.6mm
.5SEC	500mS	1 mark/cm ±1.6mm
1SEC	1S	1 mark/cm ±1.6mm
2SEC	1S	2 marks/cm ±1.6mm

h. Adjust Norm/Mag Regis

Set TIME/CM to .1mSEC and TYPE 184 to 10µS markers. Switch HORIZ DISPLAY to MAG and move the start of the trace to graticule center. Switch HORIZ DISPLAY to NORM and adjust R235 to move the start of the trace to graticule center.

i. Adjust C210

Switch HORIZ DISPLAY to MAG. Move the start of the trace to graticule center. Change TIME/CM to 50µSEC, and adjust C210 to bring the start of the trace back to graticule center.

17. (CONT)

j. Check and adjust .2μSEC to .5μSEC timing: ±2% magnified error: ±3%, except .2μSEC, ±4%

Set TIME/CM to .5μSEC. Change TYPE 184 to .1μS markers and adjust C160A for 1 mark per div.

Switch TIME/CM to .2μSEC. Insert 20nS sinewave to vertical plate of TYPE 515A. Adjust C260 for best linearity at start of the sweep. Check linearity over the rest of the sweep.

Adjust C272 for 2 cycles/cm.

Adjustment of C160A, C224, and C260 interact, repeat as necessary.

Check that 1mSEC MAG ON is within 1% of 1mSEC MAG OFF timing.

Set HORIZ DISPLAY to NORM and check and adjust as follows.

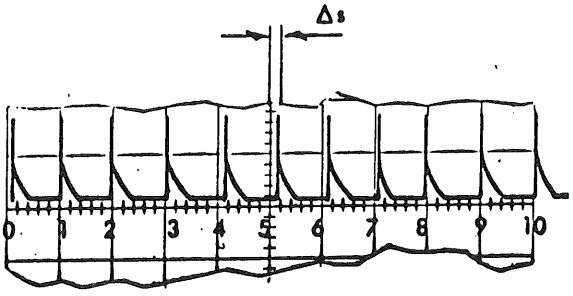
TIME/CM	184 Signal	Adjust or check	display
.2μSEC	.1μS	C224	2 marks/cm ±1.6mm
1μSEC	1μS	C160C	1 mark/cm ±1.6mm
2μSEC	1μS	check	2 marks/cm ±1.6mm
5μSEC	5μS	check	1 mark/cm ±1.6mm
10μSEC	10μS	C160E	1 mark/cm ±1.6mm
20μSEC	10μS	check	2 marks/cm ±1.6mm
50μSEC	50μS	check	1 mark/cm ±1.6mm
.1mSEC	100μS	check	1 mark/cm ±1.6mm
.2mSEC	100μS	check	2 marks/cm ±1.6mm
.5mSEC	500μS	check	1 mark/cm ±1.6mm

j. Timing and linearity explanation.

Timing is the relationship of the timing markers to the first and ninth graticule lines.

Linearity is the relationship of the timing markers to any other graticule line between the first and ninth graticule lines, divided by the length of measurement, and multiplied by 100. i.e.....

$$\text{Linearity} = \frac{\Delta s}{8\,\text{cm}} \times 100$$



Timing must be right on for this check. Magnified error is checked similarly.

18. HORIZONTAL POSITIONING RANGE

Check Horiz Range

With TIME/CM at 500μSEC and TYPE 184 at 500μS markers you must be able to position any part of the sweep from start to the 10th cm, to graticule center.

Remove TYPE 184 signal.

19. EXTERNAL HORIZONTAL

a. Check sensitivity: 0.7cm/v, min

Set stability full cw and HORIZ DISPLAY to EXT. Apply 2 VOLTS from SAC to EXT HORIZ INPUT. Note deflection over full 10cm: 1.4cm, min.

b. Check EXT HORIZ ATTEN

Set SAC to 5V. Rotate EXT HORIZ ATTEN full ccw noting attenuation of the signal and checking for rough or open spots during rotation.

Remove SAC signal and return STABILITY to full cw (Free run).

c. Check EXT HORIZ bandpass ≥500kHz at -3dB

Connect TYPE 191 to TYPE 515A using 50Ω BNC cable and 50Ω BNC terminator. Adjust TYPE 191 for 4div of 50kHz. Increase frequency to 500kHz and note deflection: ≥2.8cm.

20. EXTERNAL OUTPUTS

a. Check SAWTOOTH OUT

Switch TIME/CM to .2μSEC and HORIZ DISPLAY to NORM. Use test scope and 10X probe and check waveform shape and amplitude: approx 150V, except approx 190V for three fastest sweep rates.

b. Check + GATE OUT

Check + GATE OUT for waveform shape and amplitude: approx 25V. Return TIME/CM to 1mSEC and check for no rounding of rear corner.

21. TIME BASE HOLDOFF

Check Holdoff

Set test scope to DC and connect 10X probe to front of C210 and check holdoff as follows:

TIME/CM	holdoff
.2 and .5μSEC	4 to 12μs
1 to 50μSEC	15 to 45μs
.1 to .5mSEC	150 to 450μs
1 to 5mSEC	1.5 to 4.5ms
10 to 50mSEC	12.5 to 37.5ms
.1 to 2SEC	125 to 375ms

22. CRT CATHODE INPUT

a. Setup

Set TIME/CM at 1mSEC. Loosen CRT CATHODE and GND binding posts and swing strap away from CRT CATHODE binding post. Strap must pivot around GND binding post.

Connect CAL OUT to CRT CATHODE. Set CALIBRATOR to 20 VOLTS.

b. Check intensity modulation: modulation with 20V calibrator signal

Check for a modulated trace at normal intensity. Remove CAL OUT connection and reconnect CRT GRD strap.

THE END