

# 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*

321A

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.

June 1968

For all serial  
numbers 6000 and up.



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. (RS)

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## EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

### *a. TEKTRONIX Instruments*

- 1 TYPE 453 OSCILLOSCOPE (test scope)
- 1 TYPE P6006 10X PROBE
- 1 TYPE P6028 1X PROBE
- \*1 TYPE 184 TIME MARK GENERATOR
- 1 TYPE 106 SQUARE WAVE GENERATOR
- \*1 TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
- 1 TYPE TU76 LINE VOLTAGE CONTROL UNIT

### *b. Test Fixtures and Accessories*

- \*1 Standard Amplitude Calibrator (SAC) (067-0502-00)
- 1 Low Frequency Sinewave Generator (LFSWG) (067-0542-99)
- \*1 DC Voltage Bridge (DCVB) (067-0543-99)
- 1 DC Power Supply, 11.5-35 Volts (PMIE Dwg # 1761C)
- 1 Variable Normalizer (PMIE Dwg # 1761C)
- 1 50 $\Omega$  BNC Cable 42" (012-0057-01)
- 1 BNC "T" connector (103-0030-00)
- 1 GR to BNC female (017-0063-00)
- 1 50 $\Omega$  BNC 5:1 attenuator (011-0060-00)
- 1 50 $\Omega$  BNC 10:1 attenuator (011-0059-00)
- 1 Patch Cord BNC to banana plug-jack 18" (012-0091-00)
- 1 Patch Cord banana plug-jack to banana plug-jack (012-0024-00)
- 1 321A AC power cord (161-0015-01)
- 1 Cabinet, side (387-0969-00) (Modified)

### *c. Other equipment*

- 1 20,000 $\Omega$ /VDC Multimeter

\*Equipment must be traceable to NBS for certification of measurement characteristics.

- b. Side panel must have small holes to accommodate adjusting attenuator compensation.

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.

#### 1. PRELIMINARY INSPECTION

- d. Graticule lights  $\pm 3/64$ " from graticule face

#### 3. RESISTANCE CHECKS

Power supply resistance to gnd:  
10V reg must read infinite

#### 4. POWER SUPPLIES

- c. Regulation 10V reg supply:  
10V,  $\pm 0.5\%$ , from 102-128VAC

#### 5. D.C. OPERATION

- b. Check 10V regulation: 10V,  $\pm 0.5\%$   
from 11.5 and 35 volts DC

#### 6. BATTERY OPERATION

- b. 10V regulation: 10V,  $\pm 0.5\%$

#### 7. "LOW BATTERIES" INDICATOR LIGHT

Light indicates: 11.0V  $\pm 0.2$ V

### 8. BATTERY CHARGER

b.	POWER & CHARGER SWITCH	CURRENT
FULL	HIGH	500-570
	LOW	270-320
TRICKLE	LOW	48-58
	HIGH	50-63
EXT ON	HIGH	43-53
	LOW	39-49
	DRY CELL	

### 9. REGULATED POWER SUPPLY

SUPPLY	LIMIT	MAX RIPPLE
+45	45-47V	10mV
+10V	9.4-9.8V	25mV
+10V (dec)	9.2-9.8V	10mV
-10V	10.8-11.2V	5mV
-10V (dec #1)	11.1-11.5V	5mV
-10V (dec #2)	10.8-11.2V	5mV
-45V	44.5-46.5V	20mV
-47.5	47-49V	100mV
-720	715-745V	2V
+3.3k	3140-3260V	-

### 10. SCALE ILLUM, CRT, INTENSITY

- a. SCALE ILLUM, no illumination ccw, max illumination cw
- c. CRT alignment: .05div trace tilt; CRT face plate  $\pm 3/64$
- d. INTENSITY; no intensity ccw, max intensity cw

### 11. VERTICAL BALANCE

- a. DC BAL: 0.2div at graticule extremes, 3div of range remaining
- b. Vertical bal:  $\pm 1$ div of center

### 12. STABILITY

- b. STABILITY range:  $\geq 0.9$ V

# 13. FOCUS, ASTIGMATISM AND VERTICAL GAIN

Range of Gain Adj (R468)  $\pm 10\%$  min

# 14. GEOMETRY

0.1div bowing max

# 15. COMPRESSION AND EXPANSION 0.1div, max

# 16. ATTENUATOR ACCURACY

\*a. Attenuator accuracy  $\pm 2\%$

b. VARIABLE attenuator ratio:  $\geq 2.5:1$

# 17. CALIBRATOR

a. CAL 4div  $\pm 2\%$

\*b. CAL OUT: 500mV  $\pm 3\%$

c. CAL frequency: 2kHz  $\pm 20\%$

# 18. TRIGGERING

b. 1kHz triggering: 0.2div INT; 1V EXT

e. 6mHz triggering: 0.8div INT; 2.5V EXT

# 19. CRT GRID INPUT

b. CRT grid input: Modulate with 5V at 1kHz

# 20. TRANSIENT RESPONSE

b. High frequency compensation:  $+2\%$   $-2\%$ , total of 3% P-P

# 21. ATTENUATOR COMPENSATION

a. Setup

b. Attenuator compensation:  $\pm 1\%$

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

# 22. BANDWIDTH

\*b. .01V bandwidth:  $\geq 6\text{MHz}$  at  $-3\text{dB}$

# 24. SWEEP LENGTH

10.2 to 10.8div

# 25. HORIZONTAL POSITION RANGE

Horizontal position range: ends of sweep must go past center of graticule

# 27. NORMAL-MAGNIFIED REGISTRATION

0.4div shift

# 28. VARIABLE TIME/DIV $\geq 2.5:1$

# 30. TIMING ACCURACY

\*a. Timing 5X MAG off:  $\pm 2\%$  max

\*b. Timing 5X MAG on:  $\pm 3\%$  max

# 31. EXTERNAL HORIZONTAL DEFLECTION

\*b. EXT HORIZ deflection: 1V/div,  $+7\%$ ,  $-9\%$  with 5X MAG on

# 32. EXTERNAL HORIZONTAL BANDWIDTH

\*b. EXT HORIZ bandwidth:  $\geq 1.1\text{MHz}$  at  $-3\text{dB}$

# 33. HOLD OFF

TIME/DIV

.5 to 5 $\mu\text{SEC}$

10 to 50 $\mu\text{SEC}$

.1 to .5MILLISEC

1 to 5 MILLISEC

10MILLISEC to

.5SEC

HOLD OFF

6-18 $\mu\text{SEC}$

78-84 $\mu\text{SEC}$

6.6 to 1.54mSEC

4 to 12mSEC

60-140mSEC

THE END

## 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. Install current modifications
- b. Check fuses & fuse cover
- c. Inspect CRT
- d. Install graticule and adjust lights even with graticule

### 2. TYPE 321A PRESETS

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

### 3. RESISTANCE CHECKS

- a. Check power supply resistance to gnd: 10V reg must read infinite

### 4. POWER SUPPLIES

- a. Setup
- b. Adjust 10V reg supply for no error
- c. Check 10V regulation: 10V,  $\pm 0.5\%$  from 102-128VAC

### 5. DC OPERATION

- a. Setup
- b. Check 10V regulation: 10V,  $\pm 0.5\%$ , from 11.5 to 35 volts DC

### 6. BATTERY OPERATION

Check 10V regulation: 10V,  $\pm 0.5\%$

### 7. "LOW BATTERIES" INDICATOR LIGHT

Check for indicate: 11.0V  $\pm 0.2V$

### 8. BATTERY CHARGER

- b. Check charge currents:

POWER & CHARGER SWITCH		CURRENT
FULL	HIGH	500-570
	LOW	270-320
TRICKLE	LOW	48-58
	HIGH	50-63
EXT ON	HIGH	43-53
	LOW	39-49
	DRY CELL	

### 9. REGULATED POWER SUPPLYS

Check power supply voltages and ripple

SUPPLY	LIMIT	MAX RIPPLE
+45	45-47V	10mV
+10V	9.4-9.8V	25mV
+10V (dec)	9.2-9.8V	10mV
-10V	10.8-11.2V	5mV
-10V (dec #1)	11.1-11.5V	5mV
-10V (dec #2)	10.8-11.2V	5mV
-45V	44.5-46.5V	20mV
-47.5	47-49V	100mV
-720	715-745V	2V
+3.3k	3140-3260V	-

### 10. SCALE ILLUM, CRT, INTENSITY

- a. Check SCALE ILLUM, no illumination ccw, max illumination cw
- b. Check for CRT defects
- c. Align CRT: no trace tilt; CRT faceplate:  $\pm 3/64$
- d. Check INTENSITY

## 11. VERTICAL BALANCE

- a. Adjust DC BAL for no shift:  
0.2div at graticule extremes,  
3div of range remaining
- b. Check vertical bal:  $\pm 1$ div of  
center
- c. Check INPUT current: 0.05div

## 12. STABILITY

- a. Setup
- b. Check STABILITY range:  $\geq 0.9V$
- c. Adjust STABILITY control for  
center of range

## 13. FOCUS, ASTIGMATISM AND VERTICAL GAIN

- a. Adjust Focus and Astigmatism
- b. Check range of Gain Adj; (R468)  
 $\pm 10\%$  min
- c. Set Gain Adj (R468) for exactly  
5div

## 14. GEOMETRY

Adjust GEOMETRY: 0.1div bowing, max

## 15. COMPRESSION AND EXPANSION

Check for compression or expansion:  
0.1div max

## 16. ATTENUATOR ACCURACY

- a. Check attenuator accuracy  $\pm 2\%$
- b. Check VARIABLE attenuator ratio:  
 $> 2.5:1$
- c. Check INPUT switch

## 17. CALIBRATOR

- a. Adjust CAL to 4div
- b. Check CAL OUT 500mV  $\pm 3\%$
- c. Check CAL frequency: 2kHz  $\pm 20\%$

## 18. TRIGGERING

- a. Setup
- b. Check 1kHz triggering: 0.2div INT;  
1v EXT
- c. Setup
- d. Check 6mHz triggering: 0.8div INT;  
2.5V EXT

## 19. CRT GRID INPUT

- b. Check CRT grid input: must  
modulate with 5V of 1kHz signal  
applied

## 20. TRANSIENT RESPONSE

- a. Setup
- b. Adjust high frequency compensation:  
 $+2\%$   $-2\%$  total of 3% P-P

## 21. ATTENUATOR COMPENSATION

- b. Check or adjust attenuator  
compensation  $\pm 1\%$

## 22. BANDWIDTH

- a. Setup
- b. Check .01V bandwidth:  $\geq 6$ mHz at  
-3dB

## 23. HORIZONTAL GAIN

- b. Adjust HORIZONTAL GAIN

## 24. SWEEP LENGTH

Adjust sweep length to 10.5div

25. HORIZONTAL POSITION RANGE

Check horizontal position range:  
Ends of sweep past center of  
graticule

26. MAG GAIN

Adjust Mag Gain (R348)

27. NORMAL-MAGNIFIED REGISTRATION

Check Norm-Mag Registration: 0.4div  
5X MAG on to off at center of sweep

28. VARIABLE TIME/DIV

Check VARIABLE TIME/DIV ratio:  
>2.5:1

29. .5 $\mu$ SEC TIMING

Adjust .5 $\mu$ sec timing (C160L)

30. TIMING ACCURACY

- a. Check timing with 5X MAG off:  $\pm 2\%$ , max
- b. Check timing with 5X MAG on:  $\pm 3\%$ , max

31. EXTERNAL HORIZONTAL DEFLECTION

- a. Setup
- b. Check EXT HORIZ deflection: 1V/DIV,  
+7%, -9% with 5X MAG on

32. EXTERNAL HORIZONTAL BANDWIDTH

- a. Setup
- b. Check EXT HORIZ bandwidth:  $\geq 1.1$ MHz  
at -3dB

33. HOLD OFF

Check hold off:

TIME/DIV

.5 to 5 $\mu$ SEC

10 to 50 $\mu$ SEC

.1 to .5MILLISEC

1 to 5MILLISEC

10MILLISEC to .5SEC

HOLD OFF

6-18 $\mu$ SEC

78-84 $\mu$ SEC

6.6 to 1.54mSEC

4 to 12mSEC

60-140mSEC

THE END

1. PRELIMINARY INSPECTION

a. *Install current modifications*

b. *Check fuses and fuse cover*

F601 .25A Fast-Blo

F621 1.5A Fast-Blo

Fuse cover properly installed

c. *Inspect CRT*

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

d. *Install graticule and adjust lights  $\pm 3/64$ "*

Install the graticule and adjust the graticule lights. Place a straight edge on the graticule over the light bulbs. Loosen the adjustment screw on the appropriate chassis. Position the bulb so it is even with the straight edge and not touching casting.

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

2. TYPE 321A PRESETS

a. *Preset external controls*

INTENSITY	ccw
SCALE ILLUM	ccw
FOCUS	midr
ASTIGMATISM	midr
HORIZONTAL POSITION	midr
VERTICAL POSITION	midr
POWER	ON BATT
TIME/DIV	1 MILLISEC
VARIABLE	CALIB
5X PULL	IN
VOLTS/DIV	.01
DC BAL	CALIB
AC-DC-GND	DC
STABILITY	ccw
TRIGGERING	
INT-EXT	INT
AC-DC	AC
SLOPE	+
LEVEL	FREE RUN



## 2. (cont'd)

*b. Preset internal adjustments*

Set all internal adjustments at midr.

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

3. RESISTANCE CHECKS

Check power supplies to ground (+ lead to gnd.)

<u>Check Point</u>	<u>Typical Resistance</u>
T601 pin 1	Inf
T601 pin 4	Inf
10V regulated	Inf
+45V	400 $\Omega$
+10V	130 $\Omega$
-10V	1.5k $\Omega$

4. POWER SUPPLIES*a. Setup*

SAC - OUTPUT--BNC cable--test scope  
UNKNOWN IN--X1 Probe--"+" end of C657

Connect ground lead of probe to the "-" end of C657.

Connect TYPE 321A to TYPE TU76. Set TYPE TU76 to 115V and turn TYPE 321A POWER to ON EXT. Check that pilot light comes on.

## 4. (cont'd)

*b. Adjust 10V reg supply*

Set SAC to 10V. Set test scope  
TIME/DIV to 10mS, VOLTS/DIV to  
.01V, trigger SOURCE to LINE.  
Adjust R651 for a straight line display.

*c. Check regulation 10V reg supply:  
±0.5% from 102-128 VAC*

Vary TU76 between 102V and 128V AC. Display  
must not exceed 5div in amplitude. Re-  
turn TU76 to 115 VAC. Remove AC Line Cord.

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5. D.C. OPERATION*a. Setup*

DC POWER SUPPLY--DC PWR CORD--TYPE 321A

*b. Check 10V regulation: ±0.5% from  
11.5 to 35 volts DC*

Check for no more than 5 div of square  
wave displayed at 11.5, 20, 22, 35VDC  
settings of D.C. Power Supply. Remove  
D.C. PWR Cord.

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6. BATTERY OPERATION*a. Setup*

DC POWER SUPPLY--BATT PWR CORD--TYPE 321A

*b. Check 10V regulation: ±0.5%*

Set DC POWER SUPPLY to BATTERY OPERATION,  
LIGHT OFF. Check test scope display for  
no more than 5 div square wave. Remove  
SAC connection.

7. "LOW BATTERIES" INDICATOR LIGHT

11.0V  $\pm 0.2\%$ V

Switch BATTERY OPERATION to LIGHT  
OFF position; light must not be on.  
Switch to LIGHT ON; light must  
indicate.

Remove BATT PWR CORD, replace with  
AC line cord.

8. BATTERY CHARGER*a. Setup*

Connect multimeter between battery  
terminals.

*b. Check charge currents to limits  
below:*

<u>POWER &amp; CHARGER SWITCH</u>		<u>CURRENT</u>
FULL	HIGH	500-570
	LOW	270-320
TRICKLE	LOW	48-58
	HIGH	50-63
EXT ON	HIGH	43-53
	LOW	39-49
	DRY CELL	

b. Prolonged operation of  
charge circuit with meter across  
battery terminals may damage R692,  
R693 and R694.

9. REGULATED POWER SUPPLYS*a. Check power supply voltages  
and ripple. Check voltages  
with voltmeter.*

<u>SUPPLY</u>	<u>LIMIT</u>	<u>MAX RIPPLE</u>
+45	45-47V	10mV
+10V	9.4-9.8V	25mV
+10V (dec)	9.2-9.8V	10mV
-10V	10.8-11.2V	5mV
-10V (dec #1)	11.1-11.5V	5mV
-10V (dec #2)	10.8-11.2V	5mV
-45V	44.5-46.5V	20mV
-47.5	47-49V	100mV
-720	715-745V	2V
+3.3k	3140-3260V	-

Remove test leads and probe from TYPE  
321A.

9. Location (See Page 24)

+45V	CSP 24	Swp
+10V	CSP 14	Swp
+10V (dec)	CSM 1	Pow
-10V	CSP 10	Swp
-10 (dec #1)	CSL 9	Pow
-10 (dec #2)	CSQ 9	Swp
-45	CSP 1	Swp
-47.5	CSQ 3	Swp
-720	CSP	Swp

+3.3kV H.V. Test Point

-720 should be checked with  
INTENSITY full cw.

10. SCALE ILLUM, CRT, INTENSITY

a. Check SCALE ILLUM, no illumination  
ccw, max illumination cw

b. Check for CRT defects

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

c. Align CRT: no trace tilt;  
CRT faceplate:  $\pm 3/64$ "

Turn INTENSITY and adjust positioning controls for a trace on CRT. Focus the trace. Rotate the CRT to align the trace with a horiz graticule. Slide CRT forward against graticule. Tighten CRT clamp. Recheck trace alignment by positioning the left end of trace exactly on center horiz graticule line. Check right end of trace for no excursion above or below center graticule line.

Check CRT face plate tilt, convexity, or concavity relative to the graticule corner indentations in the front subpanel. Use a straight edge firmly placed against the front subpanel graticule indentations, across a diameter of the CRT face. Check gap within viewing area:  $3/64$ " max.

d. Check INTENSITY: no intensity ccw,  
max intensity cw

Center trace on CRT with position controls, turn INTENSITY control full ccw, and check for no trace. Turn INTENSITY control in a cw direction and look for a smooth increase in intensity of trace with max trace intensity at full cw rotation. Return INTENSITY to normal setting.

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

11. VERTICAL BALANCE AND INPUT CURRENT

- a. *Adjust DC BAL: 0.2div at graticule extremes, 3div range remaining*

Adjust DC BAL for no shift at center graticule as VARIABLE is rotated. Position trace to each graticule extreme and check for less than .2div of shift when VARIABLE is rotated. DC BAL must have at least three div of range left when adjusted.

- b. *Check vertical bal:  $\pm 1$ div of center*

Set VERTICAL POSITION to midr, check that trace is within 1div of graticule center. Short the front and rear wiper of the VERTICAL POSITION control; trace must remain within 1div of graticule center.

- c. *Check INPUT current: 0.05div*

Switch AC-DC-GND switch between DC and GND and check for less than 0.05 div of trace shift.

- c. Components contributing to INPUT current are light sensitive; therefore it may be necessary to lower ambient light to simulate side panels when checking.

12. STABILITY

- a. *Setup*

Connect a 6" patch cord from external TRIGGERING INPUT to a front panel ground post. Set controls as follows:

TIME/DIV	100 $\mu$ SEC
TRIGGERING	
INT-EXT	EXT
LEVEL	AUTO
STABILITY	ccw

- b. *Check STABILITY range:  $\geq 0.9V$*

Attach 10X probe to test scope, and set test scope to DC, and VOLTS/DIV to .05. Connect the 10X probe to the junction of D131 and the base of Q135. Turn STABILITY cw until a trace first appears on the TYPE 321A CRT, note the voltage on the test scope. Continue turning STABILITY cw until the TYPE 321A trace brightens, again note the voltage. There must be 0.9V difference.

## 12. (cont'd)

*c. Adjust STABILITY control*

Adjust STABILITY control to the center of its range.

Remove the test scope probe and remove the patch cord from the external TRIGGERING INPUT. Set TRIGGERING INT-EXT to INT.

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13. FOCUS, ASTIGMATISM AND VERTICAL GAIN*a. Adjust Focus and Astigmatism*

Set SAC to 50mV and connect OUTPUT to INPUT of TYPE 321A. Set TYPE 321A VOLTS/DIV to .01 volts. Center the waveform on the CRT with the VERTICAL POSITION and HORIZONTAL POSITION controls. Adjust FOCUS and ASTIGMATISM controls for best defined display; check to see that each control has some range of adjustment left.

*b. Check range of Gain Adj (R468)  $\pm 10\%$  min*

Set R468 to full cw, note deflection: at least 5.5div. Set R468 to full ccw, note deflection: 4.5 major div or less.

*c. Set Gain Adj (R468)*

Set R468 for exactly 5div of deflection.

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14. GEOMETRY*0.1div bowing, max*

Set TRIGGERING LEVEL to FREE RUN. Set SAC to 1mV. Check for two traces, 0.1div apart. Move traces to top horizontal graticule line, check for bowing; move the traces 1div down. Adjust Geom Adj R861 for the straightest trace. Move the traces to the bottom horizontal graticule line and check bowing of the traces. Move the traces up 1div, again check bowing. Adjust Geom Adj R861 for best compromise between 1div from top and 1div from bottom.

15. COMPRESSION AND EXPANSION

0.1 div, max

Set SAC to 50m/VOLTS. Position the display to the center of the graticule and adjust VARIABLE VOLTS/DIV for exactly 2 div. Position the top of the display to the top graticule line and check for change in amplitude (compression or expansion):

0.1div, max. Position the bottom of the display to the bottom graticule line; check for no more than 0.1div change in amplitude from either the top or the center amplitude. Return VARIABLE to CALIB.

16. ATTENUATOR ACCURACY

a. Check attenuator accuracy  $\pm 2\%$

Set SAC to .1 volt and TYPE 321A VOLTS/DIV to .02. Check for 5div of deflection  $\pm 0.1$ div. Check the remainder of the VOLTS DIV settings as in the table below:

VOLTS/ DIV POSITION	SAC AMPLI- TUDE	DEFLECTION DIV	$\pm$ DIV
.05	.2volts	4	0.08
.1	.5	5	0.1
.2	1	5	0.1
.5	2	4	0.08
1	5	5	0.1
2	10	5	0.1
5	20	4	0.08
10	50	5	0.1
20	100	5	0.1

b. Check VARIABLE attenuator ratio:  
>2.5:1

Turn VARIABLE VOLTS/DIV for maximum attenuation, check for 2div or less deflection. Return VARIABLE VOLTS/DIV to CALIB.

c. Check INPUT switch

Position bottom of display to graticule center. Switch AC-DC-GND to GND, trace should remain at center. Switch AC-DC-GND to AC display should be approximately centered on CRT. Remove SAC connecting cable.

## 17. CALIBRATOR

a. *Adjust CAL 4div  $\pm 2\%$*

Switch VOLTS/DIV to CAL 4DIV and  
adjust R884 for 4div amplitude  
on CRT.

b. *Check CAL OUT: 500mV  $\pm 3\%$*

Connect DCVB to CAL OUT 500mV.  
Short base of R874 to ground. Check  
for 500mV  $\pm 3\%$ . Disconnect DCVB.

c. *Check CAL frequency: 2kHz  $\pm 20\%$*

Set TIME/DIV to .1 MILLISEC. Check  
for 0.42 to 0.62ms/cycle.

## 18. TRIGGERS

a. *Setup*

LFSWG--50 $\Omega$  BNC cable--BNC T connector--  
VERTICAL INPUT  
--PATCH CORD--TRIGGERING INPUT

b. *Check 1kHz triggering: 0.2div  
INT; 1V EXT*

Set VOLTS/DIV to 1, LEVEL to AUTO and  
AC-DC to AC. Set LFSWG for 0.2div display  
of 1kHz signal. Position display to  
graticule center. Check that it is possible  
to trigger in + and - SLOPE by  
adjusting LEVEL control. Set LEVEL for  
stable trigger and switch AC-DC to DC.  
Display must trigger in + slope and -  
slope within 1 div of graticule center,  
without adjusting LEVEL. Increase AMP-  
LITUDE of LFSWG to 1div of display.  
Switch INT-EXT to EXT and repeat AC checks.

c. *Setup*

TYPE 191--50 $\Omega$  BNC cable--BNC 50 TERMINATION--  
BNC T connector  
VERTICAL INPUT  
--PATCH CORD--TRIGGERING INPUT



## 18. (cont'd)

- d. Check 6MHz triggering: 0.8div  
INT; 2.5V EXT; jitter:  $\leq 10\text{ns}$

Set LEVEL to FREE RUN, INT-EXT to INT and AC-DC to AC. Set TYPE 191 for 0.8div of 6MHz signal. Check that it is possible to trigger in + and - SLOPE by adjusting LEVEL control. Jitter must be less than 10ns. Set AC-DC to DC and repeat SLOPE and jitter checks. Switch TYPE 191 to 50kHz and increase AMP-LITUDE to 2.5div. Set TYPE 191 to 6MHz. Set INT-EXT to EXT. Repeat SLOPE and jitter checks in both positions of the AC-DC switch. Set LEVEL to AUTO and check for stable triggering.

- d. It may be necessary to vary the frequency slightly to obtain stable triggering in AUTO, EXT mode of operation.

## 19. CRT GRID INPUT

## a. Setup

SAC--BNC 50 $\Omega$  cable--BNC T Connector--  
--TYPE 321A INPUT  
--PATCH CORD--CRT GRID (red jack ungrounded)

- b. Check CRT grid input: Modulate with 5V at 1kHz

Set the VOLTS/DIV control to 1 set SAC at 5V. Check to see that the top of the display can be seen and the bottom cannot at some setting of the INTENSITY control. Remove the connection to the CRT GRID jack and reinsert the grounding strap. Remove the cable from the SAC to the TYPE 321A INPUT.

## 20. TRANSIENT RESPONSE

## a. Setup

TYPE 106 +FASTRISE OUTPUT--BNC cable--  
5X Atten--50 $\Omega$  termination--TYPE 321A INPUT

Set the TYPE 321A VOLTS/DIV to .01V.  
Set the TYPE 106 selection switch to FAST RISE, REPETITION RATE RANGE and multiplier to 100kHz and + TRANS-  
ITION AMPLITUDE for 4 divisions of display amplitude.

## 20. (cont'd)

- b. *Adjust high frequency compensation  
+2% -2%, total of 3% P-P*

Adjust C508 for optimum risetime and squarewave response.

Remove TYPE 106 signal.

21. ATTENUATOR COMPENSATIONa. *Setup*

TYPE 106 HI AMPLITUDE OUTPUT--GR to BNC  
Adapter--50 $\Omega$  BNC Cable--10X Attenuator--  
50 $\Omega$  BNC Termination--Variable Normalizer--  
TYPE 321A INPUT

Install left side panel.

- b. *Check or adjust attenuator  
compensation  $\pm 1\%$*

Check or adjust the attenuator compensation for best square corner and flat top as in the following table. Adjust amplitude of TYPE 106 signal to maintain 4div of signal.

<u>VOLTS/DIV</u>		
<u>Position</u>	<u>Corner</u>	<u>Level</u>
.01	Variable normalizer	
.02	C418C	C418A
.05	C416C	C416A
.1	C414C	C414A
.2	Check	Check
.5	Check	Check
1	C412C	C412A
2	Check	Check
5	Check	Check
10	C410C	C410A
20	Check	Check

Remove normalizer and check that all ranges remain within  $\pm 1\%$ . It may be necessary to readjust series compensations. Remove connections from TYPE 321A INPUT.

- 20b. Remove 10X Attenuator and 50 $\Omega$  Terminator as necessary to maintain 4div of signal.

---

## 22. BANDWIDTH

### *a. Setup*

TYPE 191 -- BNC cable --50 $\Omega$  termination  
- TYPE 321A INPUT

### *b. Check .01V bandwidth $\geq$ 6MHz at -3dB*

Set TYPE 191 to 50kHz. Adjust amplitude for 4div display. Increase frequency of TYPE 191 until deflection is reduced to 2.8div. Check frequency: 6MHz or greater. Remove TYPE 191 signal from TYPE 321A INPUT.

---

## 23. HORIZONTAL GAIN

### *a. Setup*

TYPE 184 -- BNC cable -- 50 $\Omega$  terminator  
-- TYPE 321A INPUT.

### *b. Adjust HORIZONTAL GAIN*

Set TIME/DIV to 1msec. Set TYPE 184 for .1mS and 1mS markers. Adjust Horiz Gain R338 for 1 large marker per div.

---

## 24. SWEEP LENGTH

Adjust sweep length, R176 for 10.5div of horizontal deflection.

---

## 25. HORIZONTAL POSITION RANGE

Turn HORIZONTAL POSITION ccw. Right end of trace must be to the left of center graticule. Turn HORIZONTAL POSITION cw. Left end of trace must be to the right of center graticule.

---

26. MAG GAIN

Pull out 5X MAG PULL knob.  
Adjust Mag Gain R348, for 1  
large marker per 5div and 2 small  
markers per div.

---

27. NORMAL-MAGNIFIED REGISTRATION

0.4div max

Place 6th large marker on  
graticule center. Push in 5X  
MAG PULL knob and check for no  
more than .4div of horizontal  
deflection.

---

28. VARIABLE TIME/DIV      >2.5:1

Set TIME/DIV to .1 MILLISEC,  
turn VARIABLE TIME/DIV full ccw.  
Check for 1 large marker every  
4div or less. Return VARIABLE  
TIME/DIV to CALIB.

---

29. .5 $\mu$ SEC TIMING

Set TIME/DIV to .5 $\mu$ SEC. Set TYPE  
184 for .5 $\mu$ S markers. Adjust C160L  
for 1 marker per div.

---

30. TIMING ACCURACY

*a. Check timing with 5X MAG off:*  
*8div  $\pm 2\%$ , max*

Check TIME/DIV accuracy for  $\pm 2\%$  max  
error over center 8div.

30a. (cont'd)

<u>TIME/DIV</u>	<u>TYPE 184</u>	<u>MARKERS/DIV</u>
.5SEC	.5S	1
.2	.1S	2
.1	.1S	1
50MILLISEC	50mS	1
20	10mS	2
10	10mS	1
5	5mS	1
2	1mS	2
1	1mS	1
.5	.5mS	1
.2	.1mS	2
.1	.1mS	1
50 $\mu$ SEC	50 $\mu$ S	1
20	10 $\mu$ S	2
10	10 $\mu$ S	1
5	5 $\mu$ S	1
2	1 $\mu$ S	2
1	1 $\mu$ S	1
.5	.5 $\mu$ S	1

b. Check timing with 5X MAG on:  $\pm 3\%$  max

b. Disregard first and last 10% of MAG on sweeps when checking timing.

<u>TIME/DIV</u>	<u>TYPE 184</u>	<u>MARKERS/DIV</u>
.5SEC	.1S	1
.2SEC	10mS	4
.1SEC	10mS	2
50MILLISEC	10mS	1
20MILLISEC	1mS	4
10MILLISEC	1mS	2
5MILLISEC	1mS	1
2MILLISEC	.1mS	4
1MILLISEC	.1mS	2
.5MILLISEC	.1mS	1
.2MILLISEC	10 $\mu$ S	4
.1MILLISEC	10 $\mu$ S	2
50 $\mu$ SEC	10 $\mu$ S	1
20 $\mu$ SEC	1 $\mu$ S	4
10 $\mu$ SEC	1 $\mu$ S	2
5 $\mu$ SEC	1 $\mu$ S	1
2 $\mu$ SEC	.1 $\mu$ S	4
1 $\mu$ SEC	.1 $\mu$ S	2
.5 $\mu$ SEC	.1 $\mu$ S	1

---

**31. EXTERNAL HORIZONTAL DEFLECTION***a. Setup*

SAC--50 $\Omega$  cable--BNC T connector--  
VERTICAL INPUT--18" Patch Cord--EXT HORIZ  
INPUT

*b. Check EXT HORIZ DEFLECTION: 1V/div  
+7%, -9% with 5X MAG on*

Set TIME/DIV control to EXT HORIZ INPUT,  
pull 5X MAG PULL out. Set SAC for 5V.  
Check for 5div of deflection  $\pm .35\text{div}$ ,  $-.45\text{div}$ .

---

**32. EXTERNAL HORIZONTAL BANDWIDTH***a. Setup*

TYPE 191--BNC cable--50 $\Omega$  termination--  
TYPE 321A EXT HORIZ INPUT

*b. Check EXT HORIZ bandwidth  $\geq 1.1\text{MHz}$   
at -3dB*

Set TYPE 191 to 50kHz. Adjust TYPE 191  
for 4div deflection. Increase frequency  
until deflection is reduced to 2.8. Check  
frequency: 1.1MHz or greater.

---

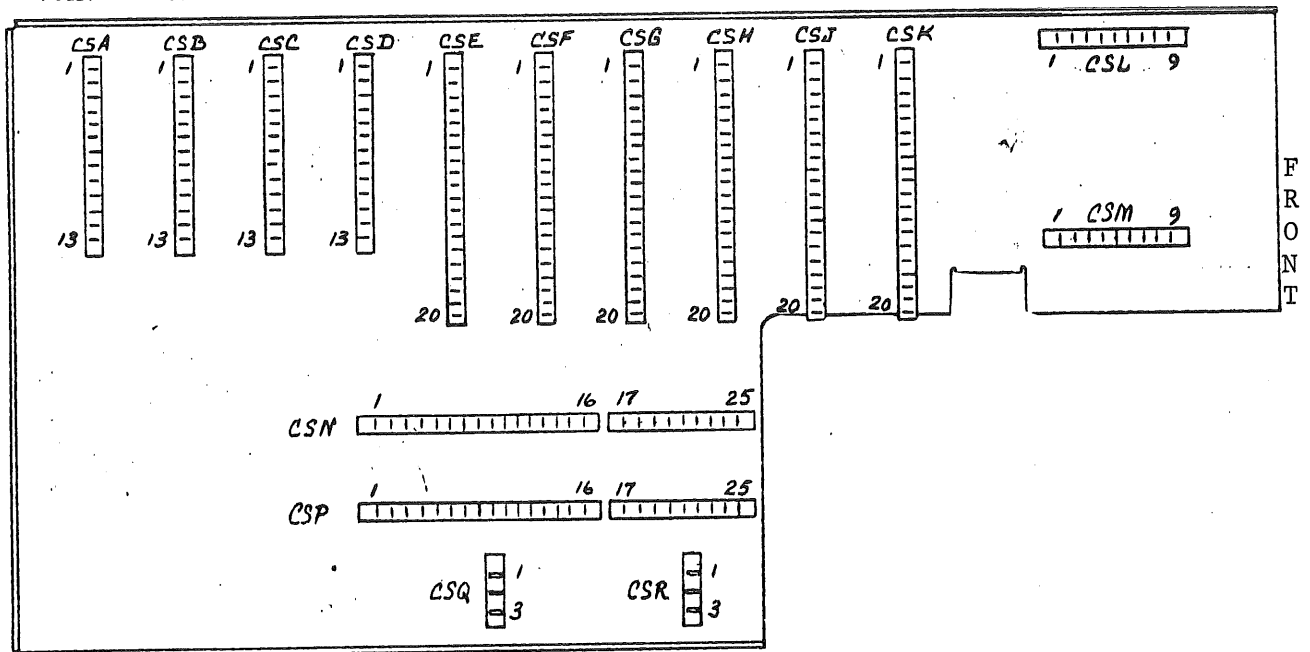
**33. HOLD OFF**

Connect 10X probe from test scope to the  
ungrounded end of C312. Measure hold-off  
on each TIME/DIV position.

TIME/DIV	HOLD OFF
.5 to 5 $\mu\text{SEC}$	6-18 $\mu\text{SEC}$
10 to 50 $\mu\text{SEC}$	78-84 $\mu\text{SEC}$
.1 to .5 MILLISEC	6.6 to 1.54mSEC
1 to 5 MILLISEC	4 to 12mSEC
10 MILLISEC to .5SEC	60-140mSEC

THE END

# V.A. & POWER



## SWEEP

