FACTORY CALIBRATION PROCEDURE

CONTENTS:

INTRODUCTION:

3S1

This is the guide for calibrating brand-new instruments, it therefore, calls out many procedures and adjustments that are rarely required for subsequent recalibration. *This procedure is company confidential.* In this procedure, all front panel control labels or Tektronix equipment names are in capital letters (VOLTS/DIV, etc.) internal adjustment labels are capitalized only (Gain Adj, etc.).

Tek form number:

0-435
June 1967
For all serial numbers.

FACTORY TEST LIMITS:

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

QUALIFICATION:

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

ABBREVIATIONS:

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

CHANGE INFORMATION:

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

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 546 or 547 OSCILLOSCOPE (test scope)
* 1	TYPE W PLUG-IN UNIT
1	TYPE 1S1 SAMPLING UNIT
1	TYPE P6006 10X PASSIVE PROBE
1	TYPE P6028 1X PASSIVE PROBE
1	TYPE 567 READOUT OSCILLOSCOPE (plug-in scope)
1	TYPE 6R1A DIGITAL UNIT
* 1	TYPE 3T77A SAMPLING SWEEP
1	TYPE 2B67 TIME BASE
1	TYPE 111 PRETRIGGER PULSE GENERATOR (with 2z mod, 067-0517-00)
1	TYPE 113 DELAY CABLE
1	TYPE 281 TDR PULSER
1	TYPE 76TU LINE-VOLTAGE CONTROL UNIT

b. Test Fixtures and Accessories

1	20mA In-line Tunnel Diode (PMPE drawing #1667-B)
1	20mA Tunnel Diode Driver (PMPE drawing #1666-B)
* 1	50Ω AMPLITUDE CALIBRATOR (067-0508-00)
1	50Ω Input Z Bridge (067-0012-00)
1	Variable Attenuator (067-0511-00)
3	50Ω 10X Attenuators, GR(017-0078-00)
1	50Ω 5X Attenuator, GR(017-0079-00)
1	50Ω 2X Attenuator, GR(017-0080-00)
1	50Ω End-line Termination, GR(017-0081-00)
1	50Ω GR874-T (017-0069-00)
3	50Ω 10ns coax cables, GR(017-0501-00)
1	50Ω 5ns coax cable, GR(017-0502-00)
2	50Ω 2ns coax cables, GR(017-0505-00)
1	50Ω coax cable, BNC (012-0057-00)
1	GR to BNC male adapter (017-0064-00)
1	Flexible Extension (012-0066-00)
2	Plug-in Extensions (013-0034-00)
1	18" banana plug to banana plug patch cord (012-0039-00)

c. Other Equipment

1	20,000Ω/VDC Multimeter

* This equipment must be traceable to the NBS for instrument certification.

Substitute test equipment may be used. The Plant Staff Engineer must determine that the substitute equipment is equivalent and must determine proper control settings, etc. It is assumed that all equipment listed is within its manufacturer's specifications, unless otherwise stated.

QUALIFICATION

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

1. PRELIMINARY INSPECTION

2. TYPE 3S1 PRESETS

3. RESISTANCE CHECKS

b. Check INPUT resistance: 50Ω ±1Ω

4. POWER SUPPLIES

b. Adjust and check +12.2V and +100V supplies: +12.2V ±1%, 2mV ripple, max from 104 to 126 VAC; +100V ±5%, 10mV ripple, max from 104 to 126 VAC

5. DUAL-TRACE DRIVER

a. Adjust free run frequency: 100 kHz ±5%, max

b. Check interdot blanking pulse width: at least 2μs and no more than 4μs at the 50% points

6. CHECK DIGITAL SWITCHING PULSE:

positive level, more positive than +0.7V; negative level, more negative than -0.7V

7. PRESET MEMORY GATE WIDTH

8. AVALANCHE VOLTS

9. BRIDGE BALANCE: with the DC OFFSET control set for no trace shift when switching the mVOLTS/DIV from 200 to 2, the OFFSET OUT must not exceed 1 volt

10. SMOOTHING BALANCE: trace shift; 1 division, max

11. INVERTER ZERO: trace shift; 0.2 division, max

12. B GAIN

* b. Adjust B Digital Gain: 1V/div ±2%, max.

c. Check and set VERT GAIN: range; from 9 or less to 13 or more

* d. Check B inverted digital gain: within ±2% of B normal digital gain

e. Check B VARIABLE: from no more than 0.7:1 to at least 2.5:1

* f. Check B mVOLTS/DIV: error; ±2%, max

13. TRIGGER TAKEOFF, A OUT AND B OUT

a. Check trigger takeoff amplitude: at least 0.12X signal voltage

b. Check A OUT and B OUT: 200mV/displayed division ±2%, max

14. A GAIN

* b. Adjust A Digital Gain: 1V/div ±2%, max

* c. Adjust A-B Bal: within 2% of VERT GAIN setting

* d. Check A inverted digital gain: within 2% of A normal digital gain

e. Check A VARIABLE: from no more than 0.7:1 to at least 2.5:1

* f. Check A mVOLTS/DIV: error; ±2%, max

15. A + B

16. VERTICAL CENTERING

a. Set Vertical Centering: both traces within 1 division of CRT electrical center

b. Check centering in A + B: ±1 div, max

17. POSITION RANGE AND POSITION NEONS

a. Check POSITION range: at least +5 and -5 divisions

b. Check position neons: correct one on, other one off, when the trace is further than 0.5 division from the CRT vertical electrical center

18. DC OFFSET

b. Check OFFSET:
DC OFFSET range; at least +1 & -1 volt
OFFSET OUT range; at least +10 & -10 volts
OFFSET OUT accuracy; 10X DC OFFSET ±2%, max

19. RISETIME

* b. Set risetime: 330 to 350ps

20. TIME COINCIDENCE

b. Check time difference: 30ps, max

21. ABERRATIONS

c. Check aberrations with TYPE 281:
+2% and -2%, max in 1st 5ns;
+1% and -1%, max after 1st 5ns

d. Check aberrations with In-line TD:
+2% and -2%, max in 1st 5ns

22. CROSSTALK

b. Check crosstalk: 1% P-P, max

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

23. MEMORY GATE WIDTH

24. LOOP GAIN AND ONE DOT CAPABILITY

b. Check one dot capability: no more than ±4% error in loop gain for positive going signals when loop gain is set to unity for negative going signals

25. DTR CHANGE IN SMOOTH: no more than 0.3:1

26. DISPLAYED SIGNAL AMPLITUDE CHANGE IN SMOOTH: no more than ±3%

27. DOT RESPONSE

a. Check DOT RESPONSE range: from no more than 0.95 to at least 1.25 dot transient response

b. Check change in DTR with changes in mVOLTS/DIV setting: must be able to obtain unity loop gain for either positive going or negative going signals with the DOT RESPONSE control

28. BASELINE SHIFT WITH REP RATE CHANGE: 10mV, max (with rep rate change from 30 Hz to 100 kHz)

29. MEMORY SLASH: 0.1 div, max (at 20 Hz)

30. TANGENTIAL NOISE

b. Check tangential noise: 2mV, max

31. STROBE KICKOUT

b. Check strobe kickout: 200mV P-P, max (into 50Ω)

32. REAL TIME OPERATION

1. PRELIMINARY INSPECTION

Check for unsoldered joints, rosin joints, improper lead dress and long ends. Check for loose hardware and protruding parts. Check controls for smooth mechanical operation, proper indexing and knob spacing from front panel.

2. TYPE 3S1 PRESETS

A and B	
POSITION	midr
DC OFFSET	midr
mVOLTS/DIV	200
VARIABLE	CAL
INVERT-NORM	INVERT
DOT RESPONSE	midr
mode	DUAL TRACE
SMOOTH-NORMAL	NORMAL
VERT GAIN	midr
INTERNAL TRIGGER	OFF
SAMPLING MODE	TRIGGERED
all internal adjustments	midr

Leave controls and adjustments for any step as they were in the preceding step unless instructed to do otherwise.

3. RESISTANCE CHECKS

a. Check P11 and internal power supplies

Using the following table, check the resistance to ground of P11 and the TYPE 3S1 internal power supplies.

Test point or pin#	Approx resistance on X1K scale	
	- lead ground	+ lead ground
1	∞	∞
2	∞	∞
3	∞	∞
4	0	0
5	∞	∞
6	∞	∞
7	∞	∞
8	∞	∞

3a. (cont'd)

Test Point or Pin#	Approx resistance on X1k scale - lead ground	+ lead ground
9	0	0
10	75kΩ	12kΩ
11	0	0
12	75kΩ	50kΩ
13	∞	∞
14	∞	∞
15	4kΩ	4kΩ
16	800Ω	800Ω
17	75kΩ	13kΩ
18	0	0
19	0	0
20	9kΩ	9kΩ
21	75kΩ	13kΩ
22	4kΩ	4kΩ
23	5kΩ	4kΩ
24	5kΩ	10kΩ
TP817	15kΩ	5kΩ
TP838	∞	5kΩ
TP839	500Ω	500Ω

b. Check INPUT resistance: 50Ω ±1Ω

Using the 50Ω INPUT Z BRIDGE, measure the resistance of A INPUT and B INPUT: 50Ω ±2%.

b. If the input resistance error is much greater than 1% it may be difficult to meet the A OUT, B OUT test limits.

4. POWER SUPPLIES

a. Setup

Install the TYPE 3T77A and TYPE 6R1A in the TYPE 567 plug-in scope. Using the two solid extensions, install the TYPE 3S1 in the plug-in scope. Connect the plug-in scope to the TYPE 76TU and turn the power on.

b. Adjust and Check +12.2V and +100V supplies: +12.2V ±1%, 1mV ripple, max from 104 to 126 VAC; +100V ±5%, 10mV ripple, max from 104 to 126 VAC

Connect a 1X probe from INPUT A of the TYPE W to test point 839 (TP839) and adjust R832 (+12.2V adjust) for exactly +12.2V. Connect the probe to TP817 and check the accuracy of the +100V supply. Check ripple and regulation of both supplies over the specified line voltage range. Remove the 1X probe.

4b. Internal supplies - use the TYPE W COMPARISON VOLTAGE to check the value of the supplies.

4. (cont'd)

c. Check probe power

Check for the presence of -12.2V at pin B and +100V at pin D of both probe power connectors on the TYPE 3S1 front panel.

5. DUAL TRACE DRIVER

a. Adjust free run frequency: 100 kHz ±5%

Connect the 1X probe from INPUT A of the TYPE W to TP38 on the TYPE 3S1 strobe board. Set the TYPE 3T77A TRIGGER SENSITIVITY full ccw and the TYPE 3S1 SAMPLING MODE to FREE RUN.

Set the test scope TIME/CM to 1μSEC and adjust L24 for a test scope display of one pulse in 10cm.

b. Check interdot blanking pulse width: at least 2μs and no more than 4μs at the 50% points

Set the TYPE 3T77A TRIGGER SENSITIVITY full cw and the TYPE 3S1 SAMPLING MODE to TRIGGERED. Check that the width of the pulse displayed on the test scope is at least 2μs and no more than 4μs at the 50% points.

6. CHECK DIGITAL SWITCHING PULSE:

positive level, more positive than +0.7V;
negative level, more negative than -0.7V

Connect the 1X probe from the TYPE W to TP707 on the TYPE 3S1 strobe board. Switch the TYPE W MILLIVOLTS/CM to 5, the INPUT ATTEN to 100 and the input selector to GND. Position the trace to the test scope graticule center. Switch the TYPE W input selector to DC. Set the test scope TIME/CM to 10μSEC and the TYPE 3T77A TIME/DIV to 10nSEC. Check that the positive and negative levels of the waveform displayed on the test scope are more than 1.4 cm from the graticule center (0V level). Remove the 1X probe.

7. PRESET MEMORY GATE WIDTH

Connect the 1X probe to TP58 on the TYPE 3S1 strobe board and set the test scope TIME/CM to .1μSEC. Adjust R52 (Memory Gate Width) for a pulse width of approx .3μs at the 50% points. Remove the 1X probe.

8. AVALANCHE VOLTS

Set both of the TYPE 3S1 mVOLTS/DIV switches to 20. Using the DC OFFSET controls to keep the traces on screen, adjust R5 (Avalanche volts) for the least amount of noise on the traces.

8. It will probably be necessary to readjust Avalanche Volts later in this procedure for risetime, noise, etc.

9. BRIDGE BALANCE:

with the DC OFFSET control set for no trace shift when switching the mVOLTS/DIV from 200 to 2, the OFFSET OUT must not exceed 1 volt.

Return both of the TYPE 3S1 mVOLTS/DIV switches to 200. Reset the DC OFFSET controls for 0 volts at A OFFSET OUT and B OFFSET OUT. Adjust R192 (A Bridge Balance) and R492 (B Bridge Balance) for no trace shift when switching the A mVOLTS/DIV and B mVOLTS/DIV from 200 to 2.

9. Bridge balance is affected by Avalanche Volts, Bridge Volts, Snap-Off Current, blow-by compensations, balance transformer lead dress and, in general, anything that affects the strobe pulse or the sampling bridge. Repeat the adjustment of the Bridge Balance controls as necessary throughout this procedure to eliminate trace shift when switching the mVOLTS/DIV from 200 to 2.

10. SMOOTHING BALANCE: trace shift; 1 division, max

Return both mVOLTS/DIV switches to 200. Adjust R247 (A Smoothing Balance) and R547 (B Smoothing Balance) for no trace shift when switching from NORMAL to SMOOTH.

11. INVERTER ZERO: trace shift; 0.2 division, max

With both mVOLTS/DIV switches at 200, adjust R283 (A Inverter Zero) and R583 (B Inverter Zero) for no trace shift when switching from INVERT to NORM.

12. B GAIN

a. Setup

50Ω AMPLITUDE CALIBRATOR OUTPUT -- 5ns cable -- TYPE 3S1 B INPUT

50Ω AMPLITUDE CALIBRATOR TRIGGER OUTPUT -- coax cable -- TYPE 3T77A EXT INPUT

Preset as follows:

50Ω AMPLITUDE CALIBRATOR

VOLTS	1.2
TEST-OPERATE	OPERATE

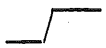
TYPE 3S1

A and B	
DC OFFSET	0V at OFFSET OUT
mVOLTS/DIV	200
VARIABLE	CAL
INVERT-NORM	NORM
mode	CHAN B
INTERNAL TRIGGER	B
SAMPLING MODE	TRIGGERED

TYPE 3T77A

TIME/DIV	2μSEC
VARIABLE	CAL
TIME EXPANDER	X1
DOTS PER DIV	100
TIME POSITION	full cw
SWEEP MODE	NORMAL
trigger source	+ EXT

TYPE 6R1A

MODE	B VOLTAGE
B VOLTAGE	
A VOLTAGE	
RESOLUTION	LO ONE SWEEP
CRT INTENSIFICATION	
MEMORY ZONES	ON

test scope

TIME/CM	50mSEC
Vc RANGE	+ 11
Vc	1300
INPUT	DC
INPUT ATTEN	10
DISPLAY	A-Vc
MILLIVOLTS/CM	10

12a. (cont'd)

Adjust the TYPE 3T77A TRIGGER SENSITIVITY for a stable display on the plug-in scope. Center the display vertically with the TYPE 3S1 B POSITION control. Set the TYPE 6R1A B 0% zone to the middle of the bottom of the displayed waveform and the B 100% zone to the middle of the top of the waveform.

Connect a 1X probe from INPUT A of the TYPE W to test point 613 (TP613) on the TYPE 3S1 Channel B board.

b. Adjust B Digital Gain: 1 V/div ±2%, max

Set the top of the waveform displayed on the test scope to the center of the graticule. Change the Vc to 700 and adjust R601 (B Digital Gain) to place the bottom of the waveform at the center of the test scope graticule. Return the Vc to 1300 and reposition the top of the waveform to the graticule center if necessary. Repeat until the amplitude of the test scope display is exactly 6 volts as measured with the Vc.

Remove the 1X probe.

c. Check and set VERT GAIN: range; from 9 or less to 13 or more

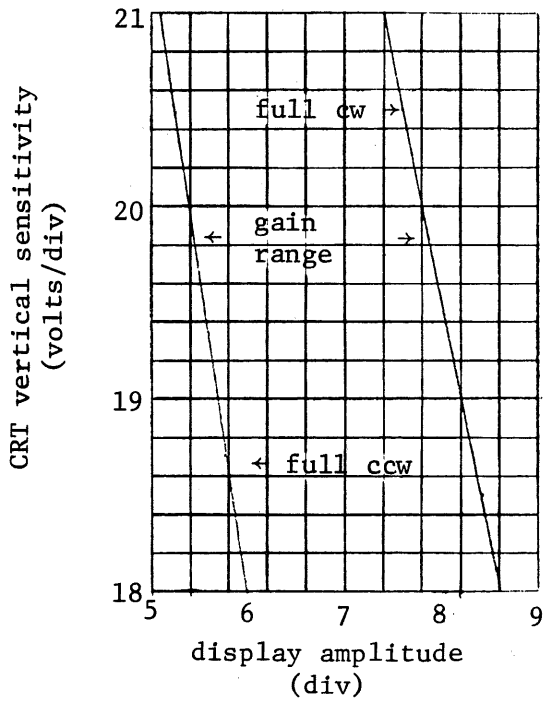
Set VERT GAIN full ccw and check the plug-in scope display for an amplitude equal to or less than the amplitude indicated by the CRT sensitivity graph. Set VERT GAIN full cw and check for a display amplitude equal to or greater than the amplitude indicated by the graph. Set VERT GAIN for a display amplitude of exactly 6 divisions.

d. Check B inverted digital gain: within ±2% of B normal digital gain

Switch the TYPE 3S1 B INVERT-NORM to INVERT. Check for 6 divisions of display ±0.12 division, max.

Return the INVERT-NORM to NORM.

12c. CRT sensitivity graph



12. (cont'd)

e. Check B VARIABLE: from no more than 0.7:1 to at least 2.5:1

Set the TYPE 3S1 B VARIABLE full ccw and check for a display amplitude of no more than 4.2 divisions.

Rotate the VARIABLE cw and check for a smooth increase in amplitude from full ccw to full cw.

Check that the UNCAL neon is on and the TYPE 6R1A decimal neon and units of measure nixie are off only when the VARIABLE is out of the CAL (detent) position.

With the VARIABLE full cw, set the 50Ω AMPLITUDE CALIBRATOR VOLTS to .3 and check for a display amplitude of at least 3.75 divisions. Return the VARIABLE to CAL.

f. Check B mVOLTS/DIV: ±2%, max

Use the following table to check each setting of the TYPE 3S1 B mVOLTS/DIV for 6 ±0.12 divisions of display amplitude and for the correct ÷, decimal, and units of measure ground return switching.

TYPE 3S1 B mVOLTS/DIV	50Ω AMPLITUDE CALIBRATOR VOLTS	TYPE 6R1A readout (approx)
200	1.2	01.20V
100	.6	0600.MV
50	.3	0300.MV
20	.12	0120.MV
10	.06	060.0MV
5	.03	030.0MV
2	.012	012.0MV

Return the TYPE 3S1 B mVOLTS/DIV to 200 and the 50Ω AMPLITUDE CALIBRATOR VOLTS to 1.2.

g. Check A VERT - B HORIZ operation

Switch the TYPE 3S1 to the A VERT - B HORIZ mode. Check for approximately 6 divisions of display. Check that the TYPE 3S1 A POSITION control moves the display vertically and the B POSITION control moves the display horizontally. Check that the TYPE 3T77A

12g. (cont'd)

HORIZONTAL POSITION control does not move the display. Return the TYPE 3S1 mode switch to CHAN B.

13. TRIGGER TAKEOFF, A OUT AND B OUT

a. Check trigger takeoff amplitude: at least 0.12X signal voltage

Connect the 1X probe from INPUT A of the TYPE W to the junction of the TYPE 3S1 INTERNAL TRIGGER switch and the coax from the channel B trigger takeoff. Set the TYPE W Vc RANGE to 0, the INPUT to DC, the INPUT ATTEN to 10, and the MILLIVOLTS/CM to 5. Check for at least 144mV with the TYPE 3S1 INTERNAL TRIGGER switch in each position.

Move the 50Ω AMPLITUDE CALIBRATOR OUTPUT cable to the TYPE 3S1 A INPUT and the 1X probe to the junction of the INTERNAL TRIGGER switch and the coax from the A trigger takeoff. Check for at least 144mV in each position of the TYPE 3S1 INTERNAL TRIGGER switch.

b. Check A OUT and B OUT: 200mV/displayed division ±2%, max

Connect the 1X probe to the TYPE 3S1 A OUT. Set the TYPE W INPUT ATTEN to R≃∞ and the MILLIVOLTS/CM to 10. With the Vc RANGE at 0, set the top of the displayed waveform to the center of the test scope graticule with the TYPE W POSITION control.

Switch the Vc RANGE to -11 and adjust the Vc to position the bottom of the displayed waveform to the center of the test scope graticule. Check for a Vc of 1.2 volts ±0.024V.

Move the 50Ω AMPLITUDE CALIBRATOR OUTPUT cable to the TYPE 3S1 B INPUT and the 1X probe to the B OUT. Repeat the above check.

Remove the 1X probe.

14. A GAIN

a. Setup

Connect the 50Ω AMPLITUDE CALIBRATOR OUTPUT cable to the TYPE 3S1 A INPUT.

Preset as follows:

50Ω AMPLITUDE CALIBRATOR

VOLTS	1.2

TYPE 3S1

Channel A	
DC OFFSET	0V at OFFSET OUT
mVOLTS/DIV	200
VARIABLE	CAL
INVERT-NORM	NORM
mode	CHAN A
INTERNAL TRIGGER	OFF

TYPE 6R1A

MODE	A VOLTAGE

TYPE W

Vc RANGE	+ 11
Vc	1300
INPUT ATTEN	10

Center the display vertically with the TYPE 3S1 A POSITION control. Set the TYPE 6R1A A 0% zone to the middle of the bottom of the displayed waveform and the A 100% zone to the middle of the top of the waveform. Connect the 1X probe from INPUT A of the TYPE W to TP313 on the TYPE 3S1 Channel A Board.

b. Adjust A Digital Gain: 1V/div ±2%, max

Set the top of the waveform displayed on the test scope to the center of the graticule. Change the Vc to 700 and adjust R301 (A Digital Gain) to place the bottom of the waveform at the center of the test scope graticule. Return the Vc to 1300 and repeat as necessary until the amplitude of the test scope display is exactly 6 volts as measured with the Vc. Remove the 1X probe.

c. Adjust A-B Bal: within ±2% of VERT GAIN setting

Adjust R765 (A-B Bal) for a plug-in scope display amplitude of exactly 6 divisions.

14. (cont'd)

d. Check A inverted digital gain: within 2% of A normal digital gain

Switch the TYPE 3S1 A INVERT-NORM to INVERT. Check for 6 divisions of display ±0.12 division, max. Return the INVERT-NORM to NORM.

e. Check A VARIABLE: from no more than 0.7:1 to at least 2.5:1

Set the TYPE 3S1 A VARIABLE full ccw and check for a display amplitude of no more than 4.2 divisions.

Rotate the VARIABLE cw and check for a smooth increase in amplitude from full ccw to full cw. Check that the UNCAL neon is on and the TYPE 6R1A decimal neon and units of measure nixie are off only when the VARIABLE is out of the CAL (detent) position.

With the VARIABLE full cw, set the 50Ω AMPLITUDE CALIBRATOR VOLTS to .3 and check for a display amplitude of at least 3.75 divisions. Return the VARIABLE to CAL.

f. Check A mVOLTS/DIV: ±2%, max

Use the following table to check each setting of the TYPE 3S1 A mVOLTS/DIV for 6 ±0.12 divisions of display amplitude and for the correct ÷, decimal and units of measure ground return switching.

TYPE 3S1 mVOLTS/DIV	50Ω AMPLITUDE CALIBRATOR VOLTS	TYPE 6R1A readout (approx)
200	1.2	01.20 V
100	.6	0600. MV
50	.3	0300. MV
20	.12	0120. MV
10	.06	060.0 MV
5	.03	030.0 MV
2	.012	012.0 MV

15. A + B

a. Setup

50Ω AMPLITUDE CALIBRATOR OUTPUT -- 5ns cable --
-- GR T -- 2ns cable -- TYPE 3S1 A INPUT
-- 2ns cable -- TYPE 3S1 B INPUT

50Ω AMPLITUDE CALIBRATOR TRIGGER OUTPUT -- coax cable -- TYPE 3T77A EXT INPUT

Preset as follows:

50Ω AMPLITUDE CALIBRATOR VOLTS 1.2

TYPE 3S1

A and B

DC OFFSET	0V at OFFSET OUT
mVOLTS/DIV	200
INVERT-NORM	NORM

b. Check A + B

Adjust the TYPE 3S1 A and B VARIABLES for a 3 division display in each channel. Switch the TYPE 3S1 to the A + B mode and check for a 6 division display.

Return the VARIABLES to the CAL position and remove the 50Ω AMPLITUDE CALIBRATOR connections.

16. VERTICAL CENTERING

a. Set Vertical Centering: both traces within 1 division of CRT vertical electrical center

Switch the TYPE 3S1 mode switch to DUAL TRACE and set the TYPE 3T77A TRIGGER SENSITIVITY full cw. Center both POSITION controls and check that the DC OFFSET controls are set for 0 volts at the OFFSET OUT jacks. Adjust R766 (Vertical Centering) to position the traces equidistant from the CRT vertical electrical center.

b. Check centering in A + B: ±1 div, max

Switch the TYPE 3S1 mode switch to A + B and check the distance of the trace from the CRT vertical electrical center.

17. POSITION RANGE AND POSITION NEONS

a. Check POSITION range: at least + and - 5 divisions

Set the TYPE 3S1 mode switch to CHAN A and the A POSITION control to 12 o'clock. Move the trace to the bottom graticule line with the DC OFFSET control. Set the A POSITION control full cw and check that the trace is at least one division above the graticule center. Return the A POSITION control to 12 o'clock and move the trace to the top graticule line with the DC OFFSET control. Set the A POSITION control full ccw and check that the trace is at least one division below the graticule center.

b. Check POSITION neons: correct one on, other one off, when the trace is further than 0.5 division from the CRT vertical electrical center

Using the A POSITION and DC OFFSET controls, check that the correct POSITION neon is on and the other is off when the trace is further than 0.5 division from the CRT vertical electrical center.

Set the TYPE 3S1 mode switch to CHAN B and repeat this step for channel B.

18. DC OFFSET

a. Preset TYPE W

Vc RANGE	0
Vc	10.000
input selector	GND
INPUT ATTEN	R≃∞
DISPLAY	A-Vc
MILLIVOLTS/CM	50

b. Check OFFSET:

DC OFFSET range; at least +1 and -1 volt

OFFSET OUT range; at least +10 and -10 volts

OFFSET OUT accuracy; 10X DC OFFSET ±2%, max

18b. (cont'd)

Connect a 1X probe from INPUT A of the TYPE W to the TYPE 3S1 B OFFSET OUT jack. Position the test scope trace to the center of the graticule. Switch the TYPE W input selector to DC and adjust the TYPE 3S1 B DC OFFSET control to return the test scope trace to graticule center. Move the plug-in scope trace to the bottom graticule line with the TYPE 3S1 B POSITION control. Set the B DC OFFSET control full cw and check that the plug-in scope trace is at least one division above the graticule center. Switch the TYPE W Vc RANGE to -11 and check that the test scope trace is at or below the graticule center.

Adjust the TYPE 3S1 DC OFFSET to place the plug-in scope trace exactly one division above the graticule center. Adjust the TYPE W Vc to place the test scope trace at graticule center. Check that the Vc is between 9.800 and 10.200.

Reset the Vc RANGE to 0, the Vc to 10.000 and return the test scope trace to graticule center with the TYPE 3S1 DC OFFSET control. Move the plug-in scope trace to the top graticule line with the TYPE 3S1 POSITION control. Set the DC OFFSET controll full ccw and check that the plug-in scope trace is at least one division below the graticule center. Switch the TYPE W Vc RANGE to +11 and check that the test scope trace is at or above the graticule center.

Adjust the TYPE 3S1 DC OFFSET control to place the plug-in scope trace exactly one division below the graticule center. Adjust the TYPE W Vc to place the test scope trace at graticule center. Check that the Vc is between 9.800 and 10.200.

Set the TYPE 3S1 mode switch to CHAN A, move the probe to the A OFFSET OUT jack and repeat this step for channel A.

19. RISETIME

a. Setup

Test scope -- 20mA TD Driver -- BNC to GR adapter -- 5ns cable -- 20mA In-line TD -- TYPE 3S1 A INPUT.

Preset as follows:

TYPE 3S1

A and B	
POSITION	midr
DC OFFSET	midr
mVOLTS/DIV	200
VARIABLE	CAL
INVERT-NORM	NORM
mode	CHAN A
SMOOTH-NORMAL	NORMAL
INTERNAL TRIGGER	A
SAMPLING MODE	TRIGGERED

TYPE 3T77A

TIME EXPANDER	X1
DOTS PER DIV	100
SWEEP MODE	NORMAL
TIME/DIV	5μSEC
VARIABLE	CAL
trigger source	-INT

Free run the test scope TIME BASE A at 2μSEC/CM.

b. Set risetime: 330 to 350ps

Adjust the TYPE 3T77A TRIGGER SENSITIVITY for a stable display. Set the 20mA TD Driver SAWTOOTH switch to 150V and adjust the AMPLITUDE control so that the 20mA In-line TD switches in the middle of the top of the waveform displayed on the plug-in scope. Change the TYPE 3T77A TIME/DIV to 1nSEC and adjust the TIME POSITION to place the negative going step produced by the 20mA In-line TD near the graticule center. Change the TYPE 3S1 A mVOLTS/DIV to 100 and adjust the VARIABLE to obtain a 5 division display. Switch the TYPE 3T77A TIME EXPANDER to X10 and return the negative going step to the graticule center with the TIME POSITION control. Adjust R76 (Snap-Off Current) to obtain a risetime of 350ps between the 10 and 90% points on the negative going step.

b. Interactions of controls. Risetime (and loop gain) can be increased by an increase in Avalanche Volts, an increase in Snap-Off Current, or a decrease in Bridge Volts. Each of these controls also affect the balance of the bridge. It is usually necessary to make compromises with each of these controls in order to obtain the proper risetime while maintaining the ability to balance the bridge, set loop gain to unity and keep noise within the test limit.

19b. (cont'd)

Disconnect the 20mA In-line TD from the TYPE 3S1 A INPUT and connect it to the B INPUT. Change the mode switch to CHAN B and the INTERNAL TRIGGER switch to B. Obtain a 5 division display as was done in channel A and check the risetime. If the risetime is not 350ps, readjust R76 to eliminate one-half of the error.

Adjust R498 (B Bridge volts) to eliminate the rest of the error. Change the 20mA In-line TD, the mode switch and the INTERNAL TRIGGER switch back to channel A and adjust R198 (A Bridge volts) to bring the risetime back to 350ps.

20. TIME COINCIDENCE

a. Setup

Test scope -- 20mA TD Driver -- BNC to GR adapter -- 5ns cable -- 20mA In-line TD --GR T
-- 2ns cable -- TYPE 3S1 A INPUT
-- 2ns cable -- TYPE 3S1 B INPUT

Preset the TYPE 3S1 and TYPE 3T77A as in Step 19a.

b. Check time difference: 30ps, max

Adjust the TYPE 3T77A TRIGGER SENSITIVITY for a stable display. Adjust the 20mA TD Driver AMPLITUDE control so that the 20mA In-line TD switches in the middle of the top of the waveform displayed on the plug-in scope. Change the TYPE 3T77A TIME/DIV to 1nSEC and adjust the TIME POSITION to place the negative going step produced by the 20mA In-line TD near the graticule center. Change the TYPE 3S1 mode switch to DUAL-TRACE, the SMOOTH-NORMAL to SMOOTH and both mVOLTS/DIV to 50. Adjust the A and B VARIABLE controls to obtain equal amplitude displays of about 6 divisions. Switch the TYPE 3T77A TIME EXPANDER to X10 and return the negative going step to the center of the graticule with the TIME POSITION control. Superimpose the tops of the two waveforms. Eliminate any time

b. Excessive time difference. If the time difference between channels exceeds 30ps, determine which channel has the most delay and decrease its delay by shortening the leads on one end of the strobe balance transformer for that channel.

20b. (cont'd)

difference between the 50% points of the two waveforms by sliding the connection between one of the 2ns cables and the GR T apart slightly. Reverse the 2ns cables at the TYPE 3S1 INPUTS. Check the displayed time difference and divide it by two to obtain the time difference between channels.

21. ABERRATIONS

a. Setup

TYPE 3T77A EXT INPUT -- 5X Atten -- 5ns cable -- 10X Atten -- TYPE 281 -- TYPE 3S1 A INPUT

Preset as follows:

TYPE 3S1

A and B	
POSITION	midr
DC OFFSET	midr
mVOLTS/DIV	200
VARIABLE	CAL
INVERT-NORM	NORM
mode	CHAN A
SMOOTH-NORMAL	NORMAL
INTERNAL TRIGGER	OFF
SAMPLING MODE	TRIGGERED

TYPE 3T77A

TIME EXPANDER	X1
DOTS PER DIV	100
SWEEP MODE	NORMAL
TIME/DIV	2μSEC
VARIABLE	CAL
TIME POSITION	full cw
trigger source	-EXT

b. Adjust blowby compensations

Adjust the TYPE 3T77A TRIGGER SENSITIVITY and the TYPE 3S1 A VARIABLE for a stable 5 division display. Change the TYPE 3S1 A mVOLTS/DIV to 10. Adjust C133, C130, and C131 for best flatness of the bottom of the waveform.

21. (cont'd)

c. Check aberrations with TYPE 281:
+2% and -2%, max in 1st 5ns;
+1% and -1%, max after 1st 5ns

Position the last division of the bottom of the waveform to the graticule horizontal center. Check that the entire bottom of the waveform, after the first 5ns, is within one division of the graticule center.

Note the vertical position of the trace one division after the leading edge. Change the TYPE 3T77A TIME/DIV to .2μSEC. Set the leading edge of the waveform to the left edge of the graticule with the TIME POSITION control. Set the portion of the waveform at the right edge of the graticule to the vertical position noted one division after the leading edge at 2μSEC/DIV. Check that the entire bottom of the waveform, after the first 5ns, is with one division of the graticule center.

Again note the vertical position of the trace one division after the leading edge. Change the TYPE 3T77A TIME/DIV to 20nSEC and return the leading edge of the waveform to the left edge of the graticule. Set the portion of the trace at the right edge of the graticule to the vertical position noted one division after the leading edge at .2μSEC/DIV. Check that the entire bottom of the waveform, after the first 5ns, is within one division of the graticule center.

Again note the vertical position of the trace one division after the leading edge. Change the TYPE 3T77A TIME/DIV to 2nSEC and return the leading edge of the waveform to the left edge of the graticule. Set the portion of the trace at the right edge of the graticule to the vertical position noted one division after the leading edge at 20nSEC/DIV. Check that the bottom of the waveform, after the first 5ns, is within one division of the graticule center and

21c. (cont'd)

that the first 5ns are within two divisions.

Note the reference level of the trace at the right edge of the graticule and remove the TYPE 281.

d. Check aberrations with In-line TD: +2% and -2%, max in 1st 5ns

Connect the 20mA In-line TD to the TYPE 3S1 as follows:

Test scope -- 20mA TD Driver -- BNC to GR adapter -- TYPE 113 -- 20mA In-line TD -- TYPE 3S1 A INPUT.

Change the TYPE 3T77A TIME/DIV to 5μSEC, the trigger source to -INT, the TYPE 3S1 mVOLTS/DIV to 200 and the INTERNAL TRIGGER to A. Adjust the TYPE 3T77A TRIGGER SENSITIVITY for a stable display. Set the 20mA TD Driver AMPLITUDE control so that the 20mA In-line TD switches in the middle of the top of the displayed waveform. Change the TYPE 3T77A TIME/DIV to 2nSEC and adjust the TIME POSITION to place the negative going step produced by the In-line TD near the graticule center. Change the TYPE 3S1 mVOLTS/DIV to 100 and adjust the VARIABLE to obtain a 5 division display. Now change the mVOLTS/DIV to 10 and return the bottom of the display to the graticule with the DC OFFSET control. Set the negative going step to the left edge of the graticule with the TYPE 3T77A TIME POSITION. Set the portion of the trace at the right edge of the graticule to the vertical reference level noted just before removal of the TYPE 281. Check that the first 5ns of the displayed waveform after the initial rise are within one division of the graticule center.

Repeat this entire step for channel B. When finished with this step, leave the setup as it is for the next step.

22. CROSSTALK

a. Preset TYPE 3S1

A mVOLTS/DIV	2
B mVOLTS/DIV	50
A and B VARIABLES	CAL
mode	DUAL TRACE

b. Check crosstalk: 1% P-P, max

Connect a 50Ω End-line Termination to the TYPE 3S1 A INPUT. Measure the amplitude of the negative going step displayed on channel B and check that the peak to peak amplitude of the crosstalk displayed on channel A does not exceed 1% of this amplitude.

Reverse the connections to the TYPE 3S1 INPUTS and change A mVOLTS/DIV to 50 and B mVOLTS/DIV to 2. Check that the crosstalk displayed on channel B does not exceed 1% peak to peak. Remove the connections from the TYPE 3S1.

23. MEMORY GATE WIDTH

a. Setup

TYPE 111 PULSE OUTPUT -- 10X Attenuator -- 10ns cable -- 2X Attenuator -- Variable Attenuator -- TYPE 3S1 A INPUT

TYPE 111 PRETRIGGER OUTPUT -- 10X Attenuator -- 5X Attenuator -- 10ns cable -- TYPE 3T77A EXT INPUT

Connect a 10ns cable to the TYPE 111 CHARGE LINE.

Set the TYPE 3S1 A and B mVOLTS/DIV to 50 and the mode switch to CHAN A. Set the TYPE 3T77A TIME/DIV to 10nSEC and the trigger source to +EXT. Set the TYPE 111 for two triggers per pulse with a positive going 100 kHz rep rate pulse.

b. Adjust Memory Gate Width

Adjust the TYPE 3T77A TRIGGER SENSITIVITY and TIME POSITION and the TYPE 111 TRIGGER TO PULSE TIME DIFFERENCE to obtain a stable

23b. (cont'd)

two triggers per pulse (2Z) display.

Adjust R52 (Memory Gate Width) for maximum seperation between the top of the pulse and the baseline under the pulse.

b. If more than one maximum is observed, leave R52 set to the maximum closest to the ccw end of the pot.

24. LOOP GAIN AND ONE DOT CAPABILITY

a. Set Loop Gain

Turn off the 2Z and adjust the Variable Attenuator for a 5 division display of the TYPE 111 pulse. Turn the 2Z back on and adjust R212 (A Loop Gain) to place the baseline under the pulse at the same level as the baseline preceding the pulse. (This is unity loop gain for negative going signals).

a. Be sure the TYPE 3S1 DOT RESPONSE controls are set to midr at the beginning of this step.

b. Check one dot capability: no more than ±4% error in loop gain for positive going signals when loop gain is set to unity for negative going signals

Check that the amplitude of the displayed pulse is 5 divisions ±0.2 division. If the amplitude is not exactly 5 divisions, adjust R212 to eliminate one-half of the error. (This provides equal loop gain error for both positive going and negative going signals).

25. DTR CHANGE IN SMOOTH: no more than 0.3 to 1

Change the TYPE 3S1 SMOOTH-NORMAL switch to SMOOTH. Adjust the Variable Attenuator for a 6 division display of the tall pulse. Check that the difference in amplitude between the short pulse and the tall pulse does not exceed two divisions.

26. DISPLAYED SIGNAL AMPLITUDE CHANGE IN SMOOTH: no more than ±3%

Set the TYPE 3S1 SMOOTH-NORMAL switch to NORMAL. Turn off the 2Z and adjust the

26. (cont'd)

Variable Attenuator for a 5 division display of the TYPE 111 pulse. Change the TYPE 3S1 SMOOTH-NORMAL switch to SMOOTH and check that the amplitude of the displayed pulse is still 5 divisions ±0.15 division. Return the TYPE 3S1 SMOOTH-NORMAL switch to NORMAL.

27. DOT RESPONSE

a. Check DOT RESPONSE range: from no more than 0.95 to at least 1.05 dot transient response

With the 2Z off, make sure the amplitude of the displayed pulse is exactly 5 divisions. Turn on the 2Z and set the DOT RESPONSE control full ccw. Check that the amplitude of the tall pulse is no more than 4.75 divisions. Set the DOT RESPONSE control full cw and check that the amplitude of the tall pulse is at least 5.25 divisions.

b. Check change in DTR with changes in mVOLTS/DIV setting: must be able to obtain unity loop gain for either positive going or negative going signals with the DOT RESPONSE control.

Change the TYPE 3S1 mVOLTS/DIV to 200. Turn off the 2Z and adjust the Variable Attenuator for a 5 division display of the TYPE 111 pulse. Turn on the 2Z and check that the amplitude of the tall pulse can be adjusted to 5 division with the DOT RESPONSE control. Check that the baseline under the tall pulse can be placed at the same level as the baseline preceding the pulse with the DOT RESPONSE control. Repeat this check at each mVOLTS/DIV setting.

b. Attenuators may be added to or removed from the TYPE 111 PULSE OUTPUT as necessary during this step.

28. BASELINE SHIFT WITH REP RATE CHANGE:

10mV, max (with rep rate change from 30 Hz to 100 kHz)

Remove the TYPE 111 signal from the TYPE 3S1 INPUT. Set the TYPE 3S1 mVOLTS/DIV to 5 and

28. (cont'd)

the TYPE 111 REPETITION RATE controls for a 30 Hz rep rate pulse. Note the vertical position of the trace. Set the TYPE 3T77A TRIGGER SENSITIVITY full cw and check that the trace does not shift vertically more than 2 divisions.

28. The TYPE 3T77A TIME/DIV must be set to .2μSEC or faster.

29. MEMORY SLASH: 0.1 div, max (at 20 Hz)

Set the TYPE 3S1 mVOLTS/DIV to 200 and the TYPE 111 REPETITION RATE controls for a pulse rep rate of 20 Hz. Adjust the TYPE 3T77A TRIGGER SENSITIVITY for a triggered sweep. Check that the vertical movement of the dots does not exceed 0.1 division.

Repeat steps 24 thru 29 for channel B.

30. TANGENTIAL NOISE

a. Setup

50Ω AMPLITUDE CALIBRATOR OUTPUT -- 5ns cable -- 10X Attenuator -- 10X Attenuator -- Variable Attenuator -- TYPE 3S1 A INPUT

Preset as follows:

TYPE 3S1

A and B	
mVOLTS/DIV	2
VARIABLE	CAL
INVERT-NORM	NORM
mode	CHAN A
SMOOTH-NORMAL	NORMAL
INTERNAL TRIGGER	OFF
SAMPLING MODE	TRIGGERED

TYPE 3T77A

TIME EXPANDER	X1
DOTS PER DIV	100
TIME/DIV	10nSEC
TRIGGER SENSITIVITY	full cw
RECOVERY TIME	full ccw

Set the 50Ω AMPLITUDE CALIBRATOR VOLTS to .3.

30. (cont'd)

b. Check tangential noise: 2mV, max

Adjust the Variable Attenuator to the point where the two traces begin to merge into one wide trace with no dark area in the center. Remove one of the 10X Attenuators and check for no more than 6.6 divisions of separation between the centers of the two traces.

Change the TYPE 3S1 mode switch to CHAN B and repeat this check for Channel B. Remove the 50Ω AMPLITUDE CALIBRATOR connections.

31. STROBE KICKOUT

a. Setup

Remove the TYPE W from the test scope and install a TYPE 1S1 in its place. Connect a patch cord from the TYPE 1S1 HORIZ OUTPUT to the test scope HORIZ INPUT. Set the test scope HORIZONTAL DISPLAY to EXT X10 and the TYPE 1S1 TRIGGER SOURCE to FREE RUN. Use the test scope HORIZONTAL POSITION control and the TYPE 1S1 VERT POSITION and DC OFFSET controls to center the trace. Adjust the test scope VAR 10-1 for a sweep length of about 10.2CM.

Connect a 5ns cable from the TYPE 3S1 A INPUT to the TYPE 1S1 SIGNAL IN. Connect a 50Ω coax cable from the TYPE 3T77A TRIG OUT to the TYPE 1S1 EXT TRIG.

Preset as follows:

TYPE 3S1

A and B mVOLTS/DIV	200
INTERNAL TRIGGER	OFF
SAMPLING MODE	TRIGGERED

TYPE 3T77A

SWEEP MODE	MANUAL
MANUAL SCAN	full cw
TIME/DIV	10nSEC
TIME POSITION	full cw
TRIGGER SENSITIVITY	full cw
RECOVERY TIME	full cw

a. The horizontal deflection factor of the test scope is not critical during this step. The vertical deflection factor should be calibrated with a 50Ω AMPLITUDE CALIBRATOR by adjusting the TYPE 1S1 VERT GAIN control.

31a. (cont'd)

TYPE 1S1

TIME POSITION	near midr
SMOOTHING	NORM
SAMPLES/CM	9 o'clock
DISPLAY MODE	NORMAL
mVOLTS/CM	50
VARIABLE	CAL
TIME POSITION RANGE	500ns
TIME/CM	1nSEC
TRIGGER SOURCE	+EXT

b. Check strobe kickout: 200mV P-P, max (into 50Ω)

Adjust the TYPE 1S1 TRIGGER SENSITIVITY and TIME POSITION controls for a stable display of the strobe kickout pulse from the TYPE 3S1. Check that the peak to peak amplitude of the pulse is no greater than 200 mV. Move the 5ns cable from the A INPUT of the TYPE 3S1 to the B INPUT and check that the peak to peak amplitude of the pulse does not exceed 200 mV.

Remove the cables from the TYPE 3S1 and TYPE 3T77A.

32. REAL TIME OPERATION

a. Setup

Turn off the power to the plug-in scope. Remove the TYPE 3T77A and install a TYPE 2B67 in its place.

Preset as follows:

TYPE 3S1

A and B	
mVOLTS/DIV	100
VARIABLE	CAL
mode	CHAN B
SMOOTH-NORMAL	NORMAL
INTERNAL TRIGGER	B
SAMPLING MODE	FREE RUN

32. (cont'd)

TYPE 2B67

TIME/DIV	1mSEC
MODE	NORM
TRIGGERING SLOPE	+
COUPLING	AC SLOW
SOURCE	INT

Connect a BNC male to GR adapter and a 5ns cable from the plug-in scope AMPLITUDE CALIBRATOR 500mV (INTO 50Ω) output to the TYPE 3S1 B INPUT. Set the AMPLITUDE CALIBRATOR rep rate switch to ≈1 KC.

b. Check real time operation

Turn on the power to the plug-in scope. Check that a stable 5 division display can be obtained by adjusting the TYPE 2B67 TRIGGERING LEVEL.

Change the 5ns cable to the A INPUT of the TYPE 3S1 and change the mode switch to CHAN A and the INTERNAL TRIGGER switch to A. Check for a stable 5 division display. Return the SAMPLING MODE to TRIGGERED.

THE END