FACTORY CALIBRATION PROCEDURE

CONTENTS:

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

Equipment Required

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

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

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

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

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

CHANGE INFORMATION:

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

This procedure is company confidential

284

Tek form number: 0-447V
October 1967
For all serial numbers.

EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. TEKTRONIX Instruments

1	TYPE 540 series OSCILLOSCOPE (test scope)
1	TYPE 1A1 DUAL-TRACE PLUG-IN UNIT
1	TYPE 1S2 SAMPLING UNIT
1	TYPE P6028 1X PASSIVE PROBE
1	TYPE 661 OSCILLOSCOPE
*1	TYPE 5T3 TIMING UNIT
1	TYPE 4S1 50Ω DUAL-TRACE SAMPLING UNIT
1	TYPE 4S2A 50Ω DUAL-TRACE SAMPLING UNIT (modified for faster T_r)
*1	TYPE 184 TIME-MARK GENERATOR
1	TYPE 76TU LINE-VOLTAGE CONTROL UNIT

b. Test Fixtures and Accessories

1	18" banana plug to banana plug patch cord (012-0031-00)
1	50Ω cable, BNC (012-0057-00)
1	GR to BNC female adapter (017-0063-00)
1	GR to BNC male adapter (017-0064-00)
2	GR 874-EL 90° elbows (017-0070-00)
1	50Ω GR 874-L20 20cm airline (017-0084-00)
1	50Ω 5ns RG58C/U cable, GR (017-0512-00)
2	50Ω 2ns RG58C/U cables, GR (017-0505-00)
1	Mixer-rectifier (modified 067-0081-00, see PMPE drawing #1780-A)
*1	Precision DC 50Ω Termination (067-0515-00)
*1	DC Voltage Bridge (DCVB) (067-0543-99)

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 approve any substitutions. All equipment listed must perform within its manufacturer's specifications, unless otherwise stated.

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.

3. POWER SUPPLIES

c. Accuracy: +20V ±1%, max
-20V ±3%, max
Ripple: 2mV, max from 90VAC to 136VAC

4. SQUARE WAVE PERIODS

*b. Square wave periods:
10µs ±0.2%, max
1µs ±0.2%, max
100ns ±0.05%, max

5. SQUARE WAVE AMPLITUDE

*c. Square wave amplitude error:

	10 µs	1 µs	100 ns
1 V	±0.5%	±0.5%	±2%†
100 mV	±1.0%	±1.0%	±2.5%†
10 mV	±1.5%	±1.5%	±3.0%†

† 20 ns after transition

6. SQUARE WAVE DUTY FACTOR: 48% to 52%

7. SQUARE WAVE TRIGGER AMPLITUDE:
200mV ±20%, max

8. SINE WAVE PERIODS:
10ns ±0.5%, max
1ns ±0.5%, max

9. SINE WAVE AMPLITUDES

b. Sine wave amplitudes:
100mV ±20%, max

10. SINE WAVE TRIGGER AMPLITUDE

b. Sine wave trigger amplitude:
200mV ±40%, max

11. PULSER INTERNAL REFLECTIONS

b. Pulser internal reflections:
±5%, max

12. BIAS BALANCE

b. Bias balance: baseline at 0V ±10mV, max

13. PULSE REPETITION RATE:
50kHz ±10%, max

14. PULSE AMPLITUDE:
at least +200mV

15. PULSE WIDTH: 1µs +50%, -0%

16. PULSE RISETIME

b. Pulse risetime: 70ps or less

17. ABERRATIONS

b. Aberrations: no more than +3%, -3% or 3% P-P during the first 2ns no more than +2%, -2%, or 2% P-P after the first 2ns.

18. LEAD TIME

b. 5ns lead time: 5ns ±3ns
c. 50ns lead time: 50ns ±3ns

19. PRETRIGGER AMPLITUDE: 200mV ±20%

20. PRETRIGGER PULSE WIDTH: at least 10ns

21. PRETRIGGER PULSE RISETIME: 3ns or less

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

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. FUSES

2. TYPE 284 PRESETS

3. POWER SUPPLIES

a. Check resistance
b. Check line voltage range selector
c. Adjust and check +20V (R227) and -20 supplies: accuracy; +20V ±1%
-20V ±3%
ripple; 2mV, max from 90VAC to 136VAC

4. SQUARE WAVE PERIODS

a. Setup
b. Adjust square wave periods:
10µs (L4) ±0.2%, max
1µs (L14) ±0.2%, max
100ns (L21) ±0.5%, max

5. SQUARE WAVE AMPLITUDE

a. Setup
b. Set amplitude (R51) and check attenuators:
Amplitude setting; 1V±0.5%, max
1st attenuator (R98) error; ±0.5%, max
2nd attenuator (R99) error; ±0.5%, max
c. Check square wave amplitude error:

	10µs	1µs	100ns
1V	±0.5%	±0.5%	±2%*
100mV	±1.0%	±1.0%	±2.5%*
10mV	±1.5%	±1.5%	±3.0%*

* 20 ns after tranition

6. SQUARE WAVE DUTY FACTOR (R31):
48% to 52%

7. SQUARE WAVE TRIGGER AMPLITUDE:
200mV ±20%, max

8. SINE WAVE PERIODS: 10ns (C62) ±0.5, max; 1ns (C73) ±0.5%, max

9. SINE WAVE AMPLITUDES

a. Setup
b. Adjust sine wave amplitudes:
1ns amplitude (C72); 100mV ±20%, max
10ns amplitude (C66); 100mV ±20%, max

10. SINE WAVE TRIGGER AMPLITUDE

a. Setup
b. Check sine wave trigger amplitude:
200mV ±40%, max

11. PULSER INTERNAL REFLECTIONS

a. Setup
b. Check pulser internal reflections:
±5%, max

12. BIAS BALANCE

a. Setup
b. Adjust Bias Balance (R123):
baseline at 0V

13. PULSE REPETITION RATE:
50kHz ±10%, max

14. PULSE AMPLITUDE: at least
+200mV

15. PULSE WIDTH: 1μs +50%, -0%

16. PULSE RISETIME
a. Setup
b. Check pulse risetime: 70ps
or less

17. ABERRATIONS

a. Setup
b. Check aberrations: no more
than +3%, -3% or 3% P-P during
the first 2ns; no more than
+2%, -2% or 2% P-P after the
first 2ns.

18. LEAD TIME

a. Setup
b. Adjust Snapoff Current (R174):
5ns ±3ns lead time
c. Check 50ns lead time: 50ns ±3ns

19. PRETRIGGER AMPLITUDE: 200mV ±20%

20. PRETRIGGER PULSE WIDTH: at least
10ns

21. PRETRIGGER PULSE RISETIME: 3ns or less

1. FUSES

Check that the line fuse is an MDL 1/10A and the 230V fuse is an MDL 1/16A.

2. TYPE 284 PRESETS

SQUARE WAVE AMPLITUDE	1.0V
PERIOD	1ns
MODE	SQUARE WAVE OR SINE WAVE OUTPUT
TD BIAS	midr
LEAD TIME	5ns
power	off
line voltage range selector	230
allternal controls	midr

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

3. POWER SUPPLIES

a. Check resistance

Check that the +20V and -20V supplies are not shorted to ground when the MODE switch is at SQUARE WAVE OR SINE WAVE OUTPUT with the PERIOD switch in each position and when the MODE switch is at PULSE OUTPUT.

b. Check line voltage range selector

Connect the TYPE 284 to the TYPE 76TU and turn the power on. Set the TYPE 76TU for an output voltage of 115V and measure the AC voltage between the TYPE 284 power transformer (T201) terminals 8 and 10 and between 5 and 7. Turn the power off and change the line voltage range selector to 115. Turn the power back on and check that the AC voltage between terminals 8 and 10 of the transformer is now twice what it was.

c. Adjust and check +20V and -20V supplies:

accuracy; + 20V ±1%, max
- 20V ±3%, max
ripple; 2mV, max from 90VAC to 136VAC

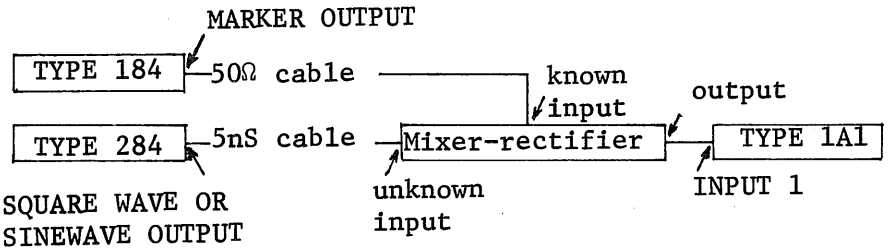
3.c (continued)

Connect the DC Voltage Bridge (DCVB) to TP226. Adjust R227 for a DCVB reading of +20V. Connect the DCVB to TP 262 and check for a reading of -20V ±0.4V.

Connect a 1X probe from the TYPE 1A1 to TP226. Lower the output voltage of the TYPE 76TU to the point where the +20V supply breaks out of regulation, then increase the TYPE 76TU output voltage until the supply again breaks out of regulation. Check that the supply regulates, with a line frequency related ripple of no more than 2mV, from 90VAC to 136VAC when the MODE switch is at SQUARE WAVE OR SINE WAVE OUTPUT with the PERIOD switch at each position and when the MODE switch is at PULSE OUTPUT. Connect the 1X probe to TP262 and repeat this ripple and regulation check for the -20V supply.

4. SQUARE WAVE PERIODS

a. Setup



Set the TYPE 184 MARKER SELECTOR to 10μs. Set the TYPE 284 SQUARE WAVE AMPLITUDE to 100 mV, the PERIOD to 10μs and the MODE to SQUARE WAVE OR SINE WAVE OUTPUT.

b. Adjust square wave periods:
10µs ±0.2%, max
1µs ±0.2%, max
100ns ±0.5%, max

Adjust the test scope to trigger on the beat frequency and adjust L4 for as low a beat frequency as possible (no higher than 200Hz - 1 cycle/cm at 5mSEC/CM). Change the TYPE 184 MARKER SELECTOR and TYPE 284 PERIOD to 1µs. Adjust L14 for the lowest beat frequency possible (no higher than 2kHz - 1 cycle/cm at .5mSEC/CM). Change the TYPE 184 MARKER SELECTOR to .1µs and the TYPE 284 PERIOD to 100ns. Screw the slug of L21 out until the 100ns oscillator stops. Screw the slug back in one turn past the point where the oscillator begins to oscillate again and check that the observed beat frequency is no higher than 5kHz (1 cycle/cm at .2mSEC/CM).

Remove the 5ns cable from the TYPE 284 and the Mixer-rectifier. Leave the rest of the Mixer-rectifier connections as they are for step 8.

5. SQUARE WAVE AMPLITUDE

a. Setup

TYPE 284 SQUARE WAVE OR SINE WAVE OUTPUT--PRECISION DC 50Ω TERM--DCVB.

Remove Q35 from the TYPE 284. Set the TYPE 284 SQUARE WAVE AMPLITUDE to 1.0V and the PERIOD to 10µs.

b. Set Amplitude and check attenuator:
Amplitude setting; 1V ±0.5%, max
1st attenuator (R98) error; ±0.5%, max
2nd attenuator (R99) error; ±0.5%, max

Adjust R51 for a DCVB reading of exactly 1 volt. Switch the TYPE 284 SQUARE WAVE AMPLITUDE to 100mV. Check for a DCVB reading of 100mV ±0.5mV, max. Switch the SQUARE WAVE AMPLITUDE to 10mV, move the DCVB ± Input lead to the output of the 1st attenuator (R98) (2 F1 on the SQUARE WAVE AMPLITUDE switch) and check for a DCVB reading of 100mV ±0.5mV, max. Remove the 50Ω TERM and DCVB.

b.

To calculate the error introduced by either attenuator when the output of the 1.0V position is not exactly one volt, add the error (in %) of the 1.0V position to the error measured at the output of the attenuator if the errors are of the opposite polarity. If the errors are of the same polarity, subtract the 1.0V error from the error measured at the output of the attenuator.

c. Check square wave amplitude error:

	10μs	*1μs*	*100ns*
1V	*±0.5%*	*±0.5%*	*±2%**
100mV	*±1.0%*	*±1.0%*	*±2.5%**
10mV	*±1.5%*	*±1.5%*	*±3.0%**

** 20ns after tranition*

Set the TYPE 284 SQUARE WAVE AMPLITUDE to 1.0V. Connect the SQUARE WAVE OR SINE WAVE OUTPUT through a 5ns cable to the TYPE 4S1 CHANNEL A INPUT. Connect the TYPE 284 TRIGGER OUTPUT through a 50Ω cable and a BNC to GR adapter to the TYPE 5T3 50Ω EXT TRIG INPUT.

Set the sampling system Controls as follows:

TYPE 661	
HORIZONTAL DISPLAY	X1
TYPE 5T3	
SAMPLES/CM	50
EQUIVALENT TIME/CM	1μSEC
VARIABLE	CAL
TIME POSITION RANGE	10μS
TRIG SOURCE	FREE RUN
SLOPE	+
EXT TRIG MODE	50Ω DC
SWEEP MODE	NORM
TYPE 4S1	
MODE	A ONLY
MILLIVOLTS/CM	10
VARIABLE	CAL
DISPLAY	NORMAL
SMOOTHING	NORMAL
TRIGGERING	A DC

Adjust the VERT POSITION and DC OFFSET controls to place the trace at the graticule center. Reinstall Q35 in the TYPE 284 and switch the TYPE 5T3 TRIG SOURCE to EXT. Check that the top of the displayed waveform is within 0.5cm of the graticule center. Switch the TYPE 284 PERIOD to 1μs and the TYPE 5T3 EQUIVALENT TIME/CM to .1μSEC leaving the TIME POSITION RANGE at 10μS. Check that the top of the displayed waveform is within 0.5cm of the graticule center. Change the TYPE 284 PERIOD to 100ns and the

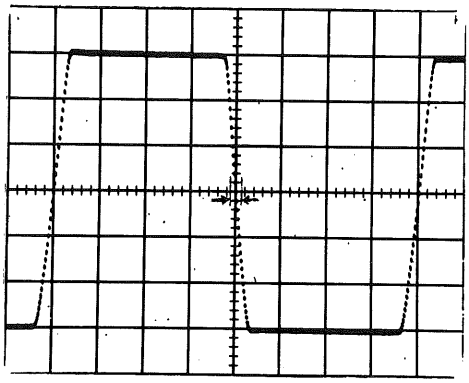
5.c (continued)

TYPE 5T3 EQUIVALENT TIME/CM to 10 nSEC, leaving the TIME POSITION RANGE at 10μS. Check that the top of the displayed waveform, excluding the first 20ns, is within 2.0cm of the graticule center.

6. SQUARE WAVE DUTY FACTOR: 48% to 52%

Change the TYPE 284 PERIOD to 10μs, the TYPE 5T3 EQUIVALENT TIME/CM to 2μSEC and the TYPE 4S1 MILLIVOLTS/CM to 200. Adjust the TYPE 4S1 VERT. POSITION and DC OFFSET and the MILLIVOLTS/CM VARIABLE to obtain a centered, 6cm display. Adjust the TYPE 5T3 TIME POSITION to place a positive going 50% amplitude point of the square wave behind the number one graticule line and the EQUIVALENT TIME/CM VARIABLE to place the second positive going 50% amplitude point behind the number nine graticule line. Adjust R31 in the TYPE 284 to place the negative going 50% amplitude point of the square wave behind the center graticule line. Change the TYPE 284 PERIOD to 1μs and the TYPE 5T3 EQUIVALENT TIME/CM to .2μSEC. Readjust the TIME POSITION and EQUIVALENT TIME/CM VARIABLE controls as necessary to obtain one cycle in the center 8cm of the graticule with the two positive going 50% amplitude points at the number one and number nine graticule lines. Check that the negative going 50% amplitude point is within 0.16cm of the graticule center. Change the TYPE 284 PERIOD to 100ns and the TYPE 5T3 EQUIVALENT TIME/CM to 20mSEC. Obtain a centered display as before and check that the negative going 50% amplitude point is within 0.16 cm of the graticule center. Remove the signal from the TYPE 4S1 INPUT and return the TYPE 4S1 MILLIVOLTS/CM VARIABLE and TYPE 5T3 EQUIVALENT TIME/CM VARIBLE to CAL.

6. Square wave duty factor. Negative going 50% amplitude point of vertically centered squarewave must cross the horizontal graticule center within the limits as shown below when the two positive going 50% amplitude points are properly aligned with graticule lines 1 and 9.



It may be necessary to adjust R31 so that the duty factor of the 10μs period is not exactly 50% in order to bring the duty factor of all three periods within limits.

7. SQUARE WAVE TRIGGER AMPLITUDE:
200mV ±20%, max

Connect the TYPE 284 TRIGGER OUTPUT to the TYPE 4S1 CHANNEL A INPUT. Change the TYPE 5T3 TRIG SOURCE to INT and adjust the TRIG LEVEL to obtain a stable display. Change the TYPE 4S1 MILLIVOLTS/CM to 50 and check for a trigger pulse amplitude of 4cm ±0.8cm. Change the TYPE 284 PERIOD to 1μs and the TYPE 5T3 EQUIVALENT TIME/CM to .2μSEC. Check for a pulse amplitude of 4cm ±0.8cm. Change the TYPE 284 PERIOD to 10μs and the TYPE 5T3 EQUIVALENT TIME/CM to 2μSEC. Check for a pulse amplitude of 4cm ±0.8cm.

Remove the signal from the TYPE 4S1 INPUT and turn the TYPE 661 POWER off. Remove the TYPE 4S1 and install the TYPE 4S2A in its place. Turn the TYPE 661 POWER back on.

8. SINE WAVE PERIODS: 10ns ±0.5%, max
1ns ±0.5%, max

Connect the TYPE 184 and TYPE 284 to the Mixer-rectifier as in step 4a. Set the TYPE 184 marker selector to 10ns∿ and the TYPE 284 PERIOD to 10ns. Adjust the test scope to trigger on the beat frequency and adjust C62 for as low a beat frequency as possible (no higher than 500kHz - 1 cycle/cm at 2μSEC/CM). Remove the 50Ω cable from the TYPE 184 MARKER OUTPUT and connect it to the H.F. OUTPUT. Set the TYPE 184 H.F. SELECTOR to 2nS∿ and the TYPE 284 PERIOD to 1ns. Adjust C73 for the lowest beat frequency possible (no higher than 5MHz - 1 cycle/cm at .2μSEC/CM). Remove the output of the 5ns cable from the Mixer-rectifier.

9. SINE WAVE AMPLITUDES

a. Setup

Connect the 5ns cable from the TYPE 284 SQUARE WAVE OR SINE WAVE OUTPUT to the TYPE 4S2A CHANNEL B INPUT. Connect a 50Ω cable and GR to BNC adapter from the TYPE 284 TRIGGER OUTPUT to the TYPE 5T3 50Ω EXT TRIGGER INPUT. Set the TYPE 4S2A MILLIVOLTS/CM to 20, the TYPE 5T3 TRIG SOURCE to EXT, the EXT TRIG MODE to UHF SYNC and the EQUIVALENT TIME/CM to 1nSEC.

b. Adjust sine wave amplitudes: 100mV ±20%, max

Adjust the TYPE 5T3 UHF SYNC for a stable display. With the TYPE 284 PERIOD at 1ns, adjust C72 for a 5cm display. Change the TYPE 5T3 EQUIVALENT TIME/CM to 10nSEC and the TYPE 284 PERIOD to 10ns. Adjust C66 for a 5cm display.

The adjustments made in steps 8 and 9 interact. Repeat these two steps as necessary.

Turn off the test scope power and remove the TYPE 1A1. Install a TYPE 1S2 in its place, set the test scope INTENSITY full ccw and turn the test scope power back on.

10. SINE WAVE TRIGGER AMPLITUDE

a. Setup

Connect the 5ns cable from the TYPE 284 SQUARE WAVE OR SINE WAVE OUTPUT to the TYPE 5T3 50Ω EXT TRIG INPUT. Connect the 50Ω cable from the TYPE 284 TRIGGER OUTPUT to the TYPE 4S2A CHANNEL B INPUT. Set the TYPE 284 PERIOD to 1ns. Set the TYPE 452A MILLIVOLTS/CM to 50 and the TYPE 5T3 EQUIVALENT TIME/CM to 1nSEC.

10. (continued)

b. Check sine wave trigger amplitude: 200mV ±40%, max

Adjust the TYPE 5T3 UHF SYNC for a stable display and check for a display amplitude of 4cm ±1.6cm. Change the TYPE 284 PERIOD to 10ns and the TYPE 5T3 EQUIVALENT TIME/CM to 10nSEC. Check for a display amplitude of 4cm ±1.6cm.

Remove the cables and the power cord from the TYPE 284.

11. PULSER INTERNAL REFLECTIONS

a. Setup

Connect an 18" banana plug to banana plug patch cord from the TYPE 1S2 HORIZ OUTPUT to the test scope HORIZ INPUT. Connect a pair of GR elbows between the TYPE 1S2 .25V PULSE SOURCE and the lower THRU SIGNAL CHANNEL connector. Install a 20cm airline on the upper THRU SIGNAL CHANNEL connector.

Preset as follows:

test scope

TRIGGERING MODE	TRIG
LEVEL	full cw
HORIZONTAL DISPLAY	EXT X10
CRT CATHODE SELECTOR	CHOPPED BLANKING

TYPE 1S2

OFFSET	midr
FINE	midr
RESOLUTION	HIGH
DISPLAY MODE	NORMAL
VERTICAL UNITS/DIV	.5
VARIABLE	CAL
ϕ-VOLTS	ρ
HORIZONTAL UNITS/DIV	DISTANCE
POSITION	0
RANGE	10m
DIELECTRIC	AIR
MAGNIFIER	X20
VARIABLE	CAL
MODE	.25V INT PULSE

11.a (cont'd)

Slowly increase the test scope INTENSITY control while varying the HORIZONTAL POSITION back and forth until a visable display is obtained. Adjust the test scope VAR 10-1 and HORIZONTAL POSITION controls to obtain a 4cm shift of the 50% amplitude point of the reflected pulse when the 20cm airline is removed or installed (the airline must be fully seated when installed). With the airline installed, adjust the TYPE 1S2 VERT GAIN for 4cm of vertical deflection between the beginning and the end of the trace.

b. Check pulser internal reflections: ±5%, max

Place the 50% amplitude point of the reflected pulse behind the number two graticule line with the TYPE 1S2 POSITION control. Connect the TYPE 284 PULSE OUTPUT to the open end of the 20cm airline. Change the TYPE 1S2 VERTICAL UNITS/DIV to .05 and position the first 2cm of the display to the graticule center with the OFFSET controls. Check that the remainder of the display, after the first 2cm , is within 1cm of the graticule center. Remove the TYPE 284 from the airline.

12. BIAS BALANCE

a. Setup

Connect a 5ns cable from the TYPE 284 PULSE OUTPUT to the TYPE 4S2A CHANNEL B INPUT. Connect the TYPE 284 TRIGGER OUTPUT to the TYPE 5T3 50Ω EXT TRIG INPUT with a 50Ω cable and a GR to BNC adapter.

12a. (continued)

Preset as follows:

TYPE 284

MODE	PULSE OUTPUT
LEAD TIME	50ns
TD BIAS	full ccw

TYPE 661

HORIZONTAL DISPLAY	X1

TYPE 5T3

SAMPLES/CM	50
TIME POSITION	full cw
FINE	full cw
SWEEP MODE	NORM
TIME POSITION RANGE	100nS
EQUIVALENT TIME/CM	10nSEC
VARIABLE	CAL
TRIG SOURCE	EXT
SLOPE	+
EXT TRIG MODE	50Ω DC

TYPE 4S2A

MODE	B ONLY
MILLIVOLTS/CM	50
DISPLAY	NORMAL
SMOOTHING	full ccw

b. *Adjust Bias Balance: baseline at 0V*

Adjust the TYPE 5T3 TRIG LEVEL and RECOVERY TIME and the TYPE 4S2A VERT. POSITION and DC OFFSET controls to obtain a triggered sweep with the trace 2cm below the graticule center. Slowly adjust the TYPE 284 TD BIAS clockwise until a pulse appears on the TYPE 661. Continue turning the TD BIAS clockwise until the pulse disappears to the left. Set the TD BIAS halfway between these two points.

Change the TYPE 4S2A MILLIVOLTS/CM to 5, disconnect the 5ns cable from the CHANNEL B INPUT and position the trace to the graticule center with the DC OFFSET control. Reconnect the 5ns cable and adjust R123, in the TYPE 284, to place the baseline of the pulse at the graticule center.

12b. (continued)

The TD BIAS and Bias Balance adjustments interact. Repeat as necessary.

13. PULSE REPETITION RATE: 50kHz ±10%, max

Change the TYPE 5T3 EOUIVALENT TIME/CM to 5μSEC, the TYPE 452A MILLIVOLTS/CM to 50 and the SMOOTHING to NORMAL. Check for 4cm ±0.4cm between pulses.

14. PULSE AMPLITUDE: at least +200mV

Leaving the TYPE 5T3 TIME POSITION RANGE at 100ns, change the EQUIVALENT TIME/CM to .2μSEC. With the TYPE 452A MILLIVOLTS/CM at 50, check for a displayed pulse amplitude of at least 4 cm.

15. PULSE WIDTH: 1μs +50%, -0%

With the TYPE 5T3 EQUIVALENT TIME/CM at .2μSEC, check for a displayed pulse width of at least 5cm and no more than 7.275cm.

16. PULSE RISETIME

a. Setup

Remove the 5ns cable and install a 20cm airline between the TYPE 284 PULSE OUTPUT and the TYPE 4S2A CHANNEL A INPUT. Set the TYPE 5T3 TIME POSITION RANGE to 100nS and the EQUIVALENT TIME/CM to 10nSEC. Change the TYPE 4S2A MILLIVOLTS/CM to 100 and adjust the VARIABLE to obtain a 5cm display.

b. Check pulse risetime: 70ps or less

Change the TYPE 5T3 TIME POSITION RANGE to 20nS and the EQUIVALENT TIME/CM to 50 pSEC. Position the rising portion of the pulse waveform near the graticule center with the TYPE 5T3 TIME POSITION controls.

16. (cont'd)

Measure the displayed risetime of the pulse between the 10% and 90% points. Calculate the TYPE 284 pulse risetime by using the following formula:

$$\text{TYPE 284 } T_r = \sqrt{(\text{displayed } T_r)^2 - (\text{TYPE 4S2A } T_r)^2}$$

17. ABERRATIONS

a. Setup

Disconnect the 20cm airline from the TYPE 4S2A CHANNEL A INPUT and connect it to the CHANNEL B INPUT. Change the TYPE 5T3 TIME POSITION RANGE to 100nS, the EQUIVALENT TIME/CM to 10nSEC and set the TIME POSITION controls full cw. Set the TYPE 4S2A CHANNEL B MILLIVOLTS/CM to 100 and adjust the VARIABLE to obtain a 5cm display. Leaving the TYPE 5T3 TIME POSITION RANGE at 100nS, change the EQUIVALENT TIME/CM to 1nSEC. Set the TIME POSITION controls full ccw. Without moving the VARIABLE, change the TYPE 4S2A CHANNEL B MILLIVOLTS/CM to 10. Position the trace to the graticule center with the DC OFFSET control.

b. Check aberrations: no more than +3%, -3% or 3% P-P during the first 2ns; no more than +2%, -2% or 2% P-P after the first 2ns.

Adjust the TYPE 5T3 TIME POSITION controls to display the top of the pulse. Check that the aberrations contributed by the TYPE 284 do not exceed the specified limits.

18. LEAD TIME

a. Setup

Turn off the TYPE 661 POWER, remove the TYPE 4S2A, install the TYPE 4S1 in its place and turn the TYPE 661 POWER back on.

18.a (cont'd)

Connect a 2ns cable from the TYPE 284 PULSE OUTPUT to the TYPE 4S1 CHANNEL B INPUT. Connect a GR to BNC male adapter and a 2ns cable from the TYPE 284 TRIGGER OUTPUT to the TYPE 4S1 CHANNEL A INPUT.

Preset as follows:

TYPE 284

MODE	PULSE OUTPUT
LEAD TIME	5ns

TYPE 661

HORIZONTAL DISPLAY	X1

TYPE 5T3

SAMPLES/CM	50
SWEEP MODE	NORM
TIME POSITION RANGE	20nS
EQUIVALENT TIME/CM	1nSEC
VARIABLE	CAL
TRIG SOURCE	INT
SLOPE	+

TYPE 4S1

MODE	DUAL TRACE
CHANNEL A and CHANNEL B	
MILLIVOLTS/CM	50
VARIABLE	CAL
DISPLAY	NORMAL
SMOOTHING	NORMAL

b. Adjust Snapoff Current: 5ns ±3ns lead time

Adjust the TYPE 5T3 TRIG LEVEL and TIME POSITION controls for a stable display of the leading edges of the two pulses. Adjust R174, in the TYPE 284, for a 5ns time interval between the 50% amplitude points of the leading edges of the two pulses.

b. The GR to BNC male adapter adds approx ¼ns of delay to the signal path of the pretrigger pulse. This makes the time interval between the pretrigger pulse and the output pulse appear approx ¼ns shorter than it really is.

c. Check 50ns lead time: 50ns±3ns

Change the TYPE 5T3 EQUIVALENT TIME/CM to 10nSEC and the TYPE 284 LEAD TIME to 50ns. Check for a 50ns ±3ns time interval between the 50% amplitude points of the leading edges of the two pulses.

19. PRETRIGGER AMPLITUDE: 200mV±20%

Change the TYPE 4S1 MODE to A ONLY. With the MILLIVOLTS/CM at 50, check that the displayed amplitude of the pretrigger pulse is 4cm ±0.8cm.

20. PRETRIGGER PULSE WIDTH: at least 10ns

Check that the width of the displayed pretrigger pulse is at least 10ns at the 50% amplitude points.

21. PRETRIGGER PULSE RISETIME: 3ns or less

Change the TYPE 5T3 EQUIVALENT TIME/CM to 1nSEC and adjust the TYPE 4S1 MILLIVOLTS/CM VARIABLE for a 5cm display. Check that the risetime between the 10% and 90% amplitude points of the pulse does not exceed 3ns.