

# INSTRUCTION MANUAL

Serial Number \_\_\_\_\_

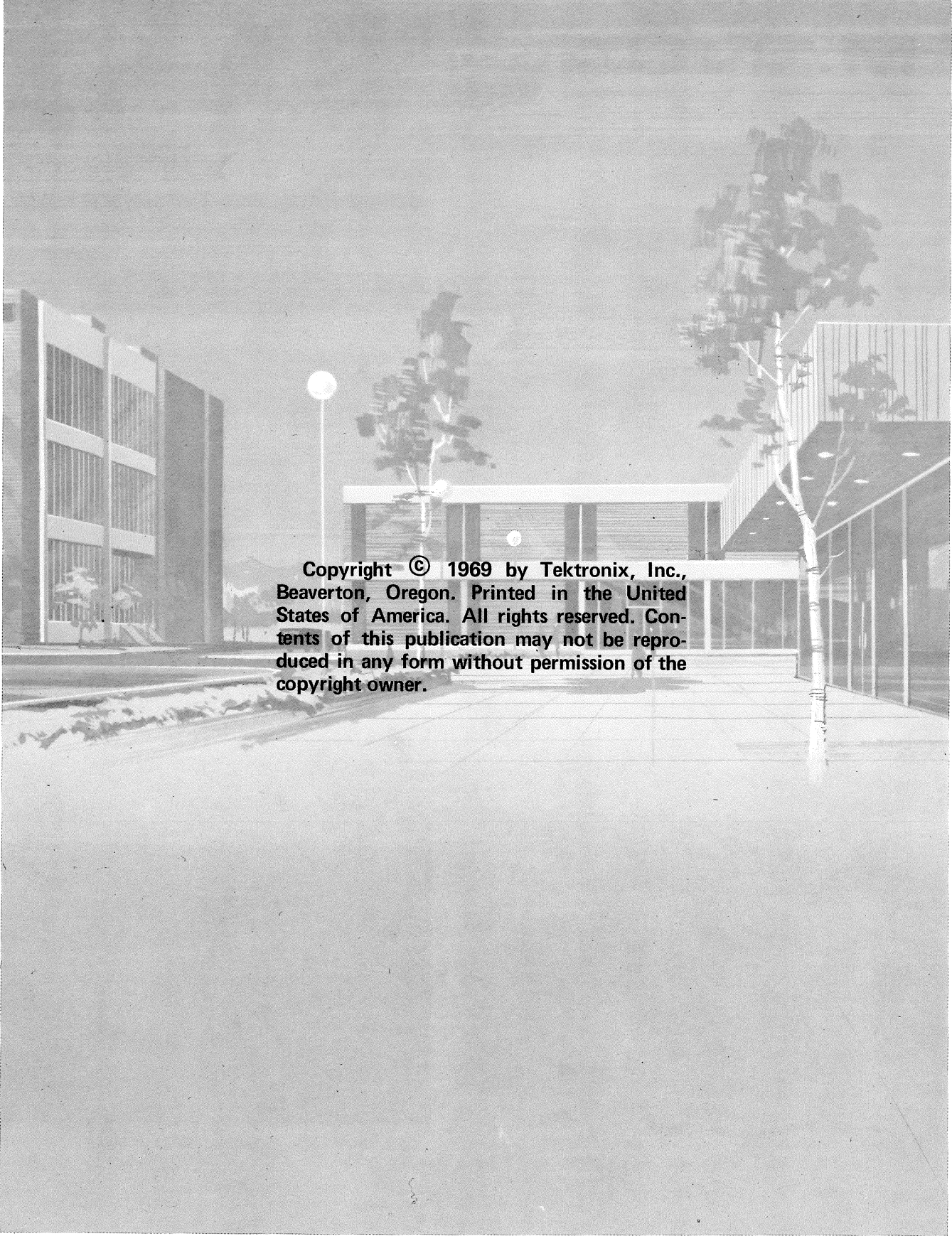
DIGITAL MEASUREMENT SYSTEM

**SYSTEM  
CALIBRATION  
TYPE S-2**

*Tektronix, Inc.*

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070-3012-00

A black and white photograph of a modern building complex. On the left is a tall, multi-story building with a grid of windows. In the center is a lower, single-story building with a flat roof. To the right is another building with a glass facade. A wide, paved plaza extends from the foreground towards the buildings. A tall, thin street lamp stands on the left side of the plaza. Several trees are planted around the buildings and plaza. The sky is clear and light-colored.

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**The Manual titled 'System Digital Measurement Calibration Procedure Introduction' contains the Equipment Required list for this Calibration Procedure.**

# SYSTEM CALIBRATION

## TYPE S-2

### CALIBRATION RECORD AND INDEX

This outline is provided to serve as a verification and calibration record. It may be reproduced for that purpose or for use as a calibration guide for calibrators who are familiar with the procedure.

Type S-2 Sampling Head Serial No. \_\_\_\_\_

Calibration Date \_\_\_\_\_

Calibrated by \_\_\_\_\_

- |  |        |
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### Preliminary Procedure

This system procedure is provided for calibration of one Type S-2 Sampling Head Unit. Calibration of each Type S-2 can be accomplished for each step or the entire procedure can be repeated for each Type S-2.

1. Check the sampling head 50  $\Omega$  DC resistance. With the sampling head separated from the sampling unit, use a DC Resistance Bridge and measure the DC input resistance. Connect one lead to the input connector outer conductor, and the other lead to the center conductor. Be sure the bridge does not apply more than  $\pm 2$  volts to the input terminals.

The sampling head input resistance must be 50  $\Omega$ ,  $\pm 1\%$ .

2. Connect the Type S-2 to the Channel A or B connector on the interconnecting cable (Connect the sampling heads to the channel in which they will be used). Allow a 5 minutes warmup of the system before proceeding.

3. Set the controls as follows:

#### Type 3S6 (both Channels)

Mode switch	Ch A
Units/Div	50

Variable	Cal
Invert	Pushed in
DC Offset	0
Normal-Smooth	Normal

#### Type 3T6

Horiz Pos	Midrange
Horiz Gain	As set
Samples/Sweep	1000
Decade	0 200 ps/div
Multiplier	2
Delay	0015 (minimum)
Program Selector	Int
Triggering	
Sensitivity	Fully clockwise
Recovery Time	Midrange
Mode	Ext
Polarity	+

#### Type 230

Triggered Measurement	Off
Display Time	Midrange
Measurement Mode	Time
CRT Intensification	
Time Measurement	On
Ref Zones	Both
Measurement Averaging	1
Channel A Ref Zones	
0% Position	.5 cm (one position clockwise from top center)
100% Position	.5 cm (one position clockwise from top center)
0% Level	.3 cm
100% Level	.3 cm
Channel B Ref Zones	
0% Position	.5 cm (one position clockwise from top center)
100% Position	.5 cm (one position clockwise from top center)
0% Level	.3 cm
100% Level	.3 cm
Time Measurement Start Point	
Channel	A
Level	% Between Zones
Offset dials	10
Slope	+, 1st
Time Measurement Stop Point	
Channel	A
Level	% Between Zones
Offset dials	90
Slope	+, 1st

**Type 284**

Mode	Pulse Output
Lead Time	75 ns

**1. Check Risetime**

a. Connect the Type 284 Pulse Output to the 20 ns delay 50  $\Omega$  coaxial cable (item 25 equipment required list) to the Type S-2 input connector.

**NOTE**

System risetime check requires about 100 ns trigger lead time. Trigger lead time of the Type 284 is 75 ns. Add 20 ns of delay cable in the signal path of the Type 284 Pulse Output as given in part a, or 25 ns of cable can be placed between J158 and P158 within the Type 284 increasing the Type 284 lead time to 100 ns (use at least 20 cm air line in the signal path).

b. Connect a BNC coaxial cable (5 ns or less delay) from the Type 284 Trigger Output to the Type 3T6 external trigger input connector J123 (located on the rear panel of the Type R568).

c. Obtain a step display of the signal fed to Channel A. Use the Type 3T6 front panel Delay controls (15 ns minimum) to position the pulse rise as in Fig. 1.

**NOTE**

If the display cannot be positioned into view, the Type 284 TD Bias control may require adjustment. Refer to the Type 284 instruction manual (Operating Section) for adjustment information, if necessary.

d. Once the display is obtained, position it and the digital unit 0% and 100% zones as shown in Fig. 1. Read

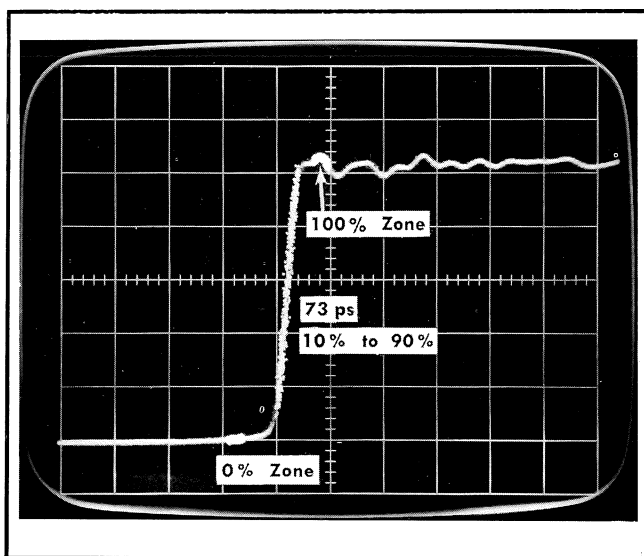


Fig. 1. Risetime Measurement display.

the risetime from the digital unit. Two readings of the 10% to 90% risetime are possible depending upon the cable or airline connecting the Type 284 Pulse Output to the S-2 input.

(1) 86 ps or less when a 20 cm airline only is used. (The 86 ps limit is calculated for the conditions of a 70 ns risetime Type 284 and a 50 ps risetime Type S-2.)

(2) 140 ps or less when a 20 ns coaxial cable (item 25 on the equipment required list) is used.

e. If the risetime conditions in part d are met, disregard step 2 and precede with step 3.

**2. Adjust Risetime**

a. Remove the Sampling Head cover. Use the same connections and readout display as in step 1.

b. Each internal control has its particular effect upon sampling head operation.

(1) Avalanche Volts, R66, alters strobe pulse amplitude and risetime, which affects the display risetime and loop gain. Clockwise rotation makes risetime slower.

(2) Snap-Off Current, R57, alters loop gain, strobe amplitude and display noise, and must be slightly readjusted any time the Avalanche Volts control setting is changed.

(3) Gain, R46, alters loop gain by changing the Pre-amplifier gain.

(4) Bridge Volts, R26, sets the reverse voltage of the sampling diodes. Decreasing the bridge volts (counterclockwise rotation) slows the displayed risetime by permitting a longer diode conduction time due to fixed amplitude strobe pulses. Keeping the bridge Volts control near maximum (clockwise) allows better sampling loop gain linearity as well as a larger input signal dynamic range.

(5) Bridge Bal, R22, introduces an internal offset voltage to the feedback loop to cancel normal error signals in the sampling loop, including normal unbalance in the sampling bridge. R22 is adjusted (with DC offset at zero) to cancel most of the trace vertical shift as the Units/Div switch position is changed.

(6) Transient Response, R13, adjusts the magnitude of blow-by correction signal. (Not important when setting risetime.)

c. Assuming that the risetime is slow, adjust the Avalanche Volts control about 5° counterclockwise.

Check the risetime and continue to adjust the Avalanche Volts control until the risetime is 86 ps or less, 10% to 90% (140 ps or less when the 20 ns coaxial cable is used).

d. Initial adjustment of the Snap-Off control requires that it be adjusted for maximum loop gain.

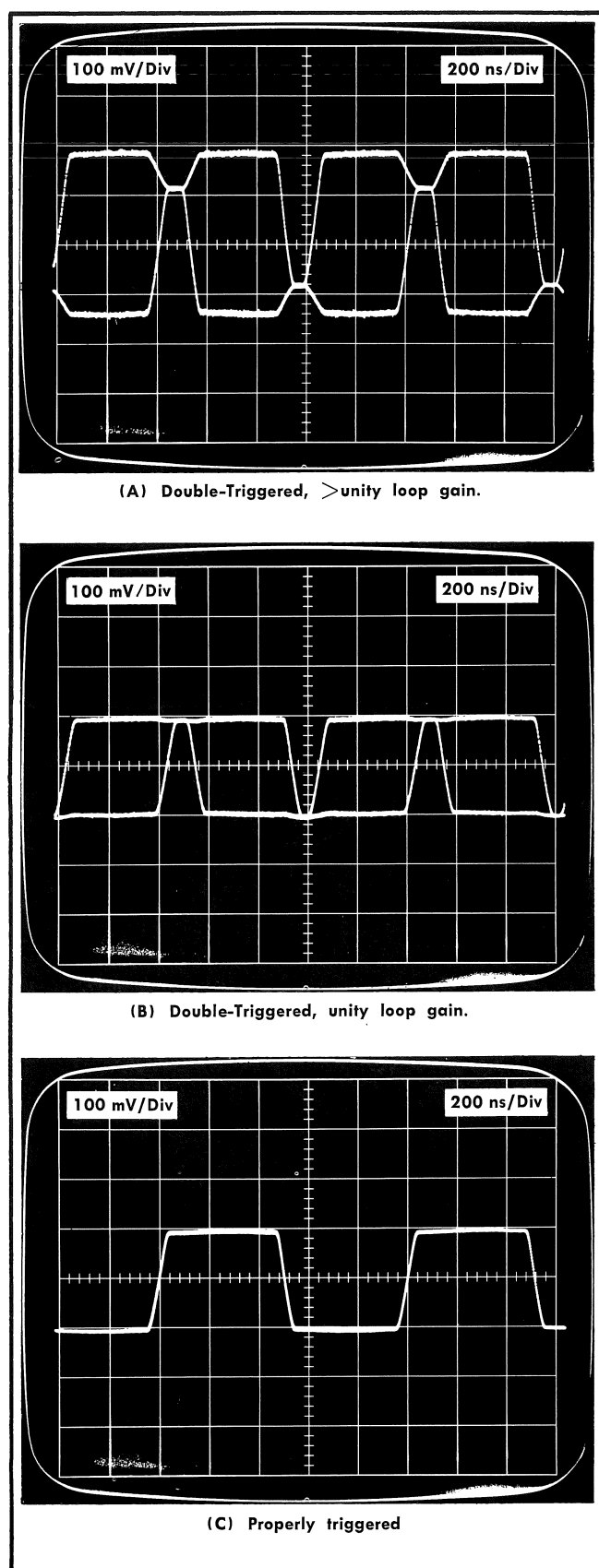


Fig. 2. Typical display for unity loop gain adjustment.

The procedure is as follows:

(1) Set the Type 284 Period switch to 1  $\mu$ s, the Mode switch for a square wave output and the Square Wave Amplitude control for 1.0 V output. Connect a 5X attenuator onto the Type 284 Square Wave Output connector. Remove the 20 ns coaxial cable from the Pulse Output connector and connect it to the 5X attenuator.

(2) Set the Type 3S6 Units/Div switch to 200. Set the Type 3T6 Decade switch to 7 and the Multiplier switch to 2 for a 200 ns/div sweep rate. Turn the Type 3T6 Trigger Sensitivity control into the free run region, and adjust the Trigger Recovery Time control for a double-triggered display similar to Fig. 2A or B. Fig. 2A shows greater than unity loop gain and Fig. 2B shows unity loop gain.

(3) Adjust the Snap-Off Current control for maximum loop gain.

e. Return the controls and connections to display and measure the risetime as in part c. This is accomplished by the following procedure:

(1) Disconnect the 20 ns coaxial cable at the 2X attenuator and connect it to the Pulse Output connector. Set the Type 3S6 Units/Div switch to 50.

(2) Set the Type 3T6 Decade switch to 0 and the Multiplier switch to 2 for a 200 ps/div sweep rate. Set the Trigger Sensitivity control for a stable display, and set the 0% and 100% zones on the Type 230 to measure the risetime 10% to 90% of the step rise.

f. As the Snap-Off Current control is turned, the display will move. The display shift is in the form of a rising or a dipping arc. The vertical component of the display movement is a result of a change in Snap-Off Current, rather than any signal input change. The peak of the arc in either the positive or the negative direction occurs very near the point at which maximum loop gain occurs. Set the Snap-Off Current control to the point where the display is at the peak of the arc, rather than precisely at maximum loop gain. This produces minimum display noise with proper risetime. Check the risetime after this adjustment of 86 ps or less, 10% to 90% (140 ps or less when the 20 ns input coaxial cable is used). Repeat c through f, if necessary.

g. To adjust the Type S-2 Gain control, a display showing loop gain is required. The procedure is as follows:

(1) Set the Type 284 Period switch to 1  $\mu$ s, the Mode switch for a square wave output and the Square Wave Amplitude control for 1.0 V output. Connect a 5X attenuator onto the Type 284 Square Wave connector. Remove the 20 ns coaxial cable from the Pulse Output connector and connect it to the 5X attenuator.

(2) Set the Type 3S6 Units/Div switch to 200. Set the Type 3T6 Decade switch to 7 and the Multiplier switch to 2 for a 200 ns/div sweep rate. Turn the Type 3T6 Trigger

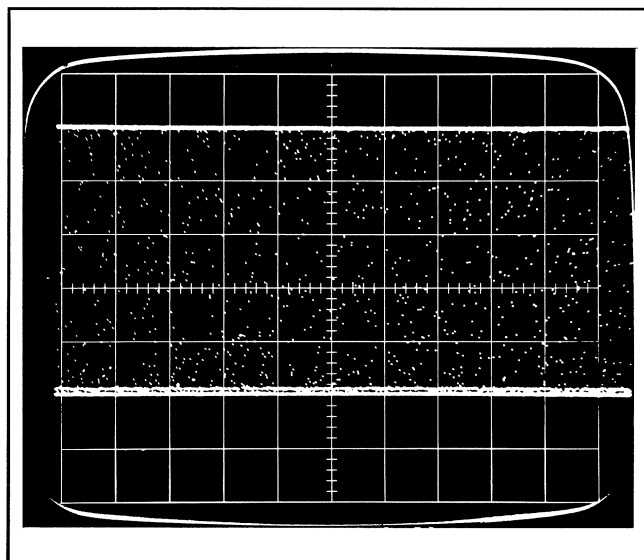


Fig. 3. Unity loop gain set at the top of the display.

Sensitivity control into the free run region, and adjust the Trigger Recovery Time control for a double-triggered display similar to Fig. 2A or B. Fig. 2A shows greater than unity gain and Fig. 2B shows unity loop gain.

(3) Set the Type 3S6 Dot Response control on the front-panel to its electrical midpoint. The electrical midpoint is found by watching the change in trace spread through the total range of adjustment of the control. Set the control for a trace spread halfway between the maximum loop gain and minimum loop gain.

(4) Adjust the Type S-2 Gain control for unity loop gain as indicated in Fig. 2B.

### 3. Adjust the Sampling Head Bridge Bal Control

a. Disconnect the 20 ns delay signal cable at the 5X attenuator. Leave the Trigger cable connected to the Type 284 for a displayed no-signal trace.

b. Set the Type 3S6 DC Offset controls for zero volts at TP663 (for Channel A) and TP763 (for Channel B). Location is on the Offset circuit board.

c. Change the Units/Div switch from 200 to 20 and adjust the Bridge Bal, R22 for no more than one division of trace movement as the switch is changed from 200 to 20.

d. Connect the signal cable (disconnected in part a) to the 5X attenuator for the next step.

### 4. Check Loop Gain Linearity

Requirement—Dot will move full amplitude  $\pm 5\%$  of any signal up to 200 mV peak to peak when the Type 3T6 Sampling Sweep Unit is either double triggered or free-run.

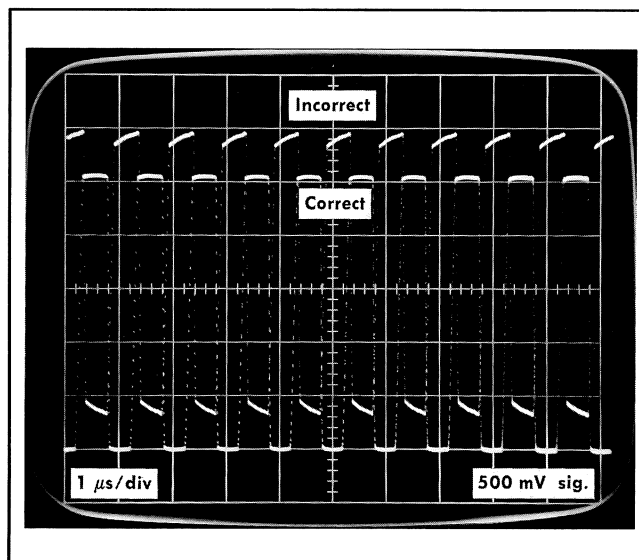


Fig. 4. Double exposure showing adjustment of R13, Transient Response control.

#### NOTE

Correct adjustment of the Bridge Balance control (not more than 1 division trace movement with rotation of the Units/Div switch) and the sampling unit Smoothing Balance, R167/R367, in the Type 3S6 (no trace movement as the Normal-Smooth switch is changed from Normal to Smooth) is necessary for correct operation.

a. Set the Type 3T6 trigger sensitivity control for a stable trace. Set the Type 3S6 Normal-Smooth switch to Normal and use the Type 3S6 Variable control to obtain 5 divisions of amplitude (200 mV input).

b. Disconnect the BNC coaxial cable at the Type 284 Trigger Output connector. Turn the Type 3T6 Trigger Sensitivity and Recovery Time controls for a free run display as in Fig. 3.

c. Set the Type 3S6 Dot Response control on the front-panel so the top of the square wave is at unity loop gain (one trace). The bottom of the square wave can show two traces, the separation (loop gain overshoot or undershoot) must not be greater than 5%, or 1.25 minor divisions. If the loop gain linearity exceeds the 5%, repeat the Type 3S6 calibration step 3 (Adjust Memory Gate Width controls) in this system procedure.

### 5. Adjust Transient Response Control, R13

a. Connect the Type 284 Square Wave Output to the Type S-2 input connector through a 5X attenuator. Connect the Type 284 Trigger Output connector to the Type 3T6 external trigger input at connector J123. Set the Type 284 Period switch to 1  $\mu$ s, and the Square Wave Amplitude switch to 1.0 V.



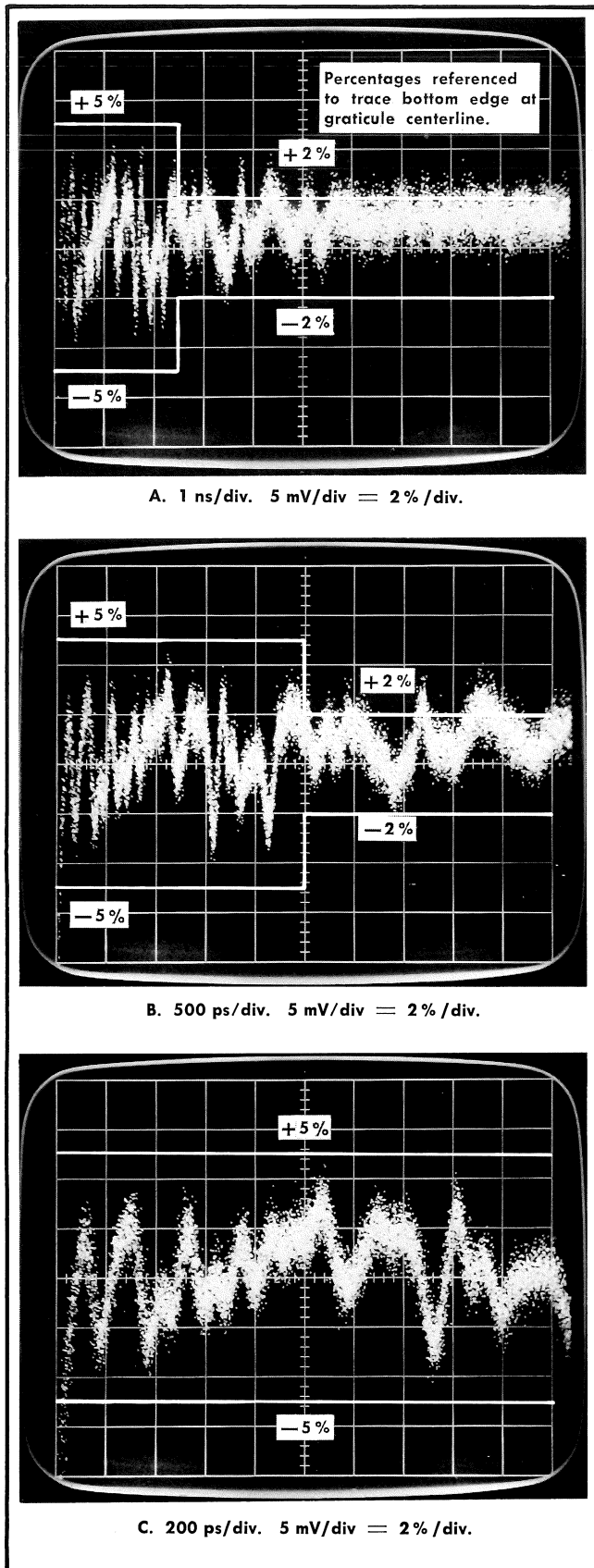


Fig. 5. Check of Type S-2 pulse flatness deviation.

b. Set the Type 3T6 Decade switch to 6 and the Multiplier switch to 1 for a 1  $\mu$ s/div sweep rate. Obtain a triggered display.

c. The display should be one cycle per division with the square wave top and bottom flat (parallel to a graticule line). Fig. 4 is a double exposure showing a correct adjustment of the Transient Response control, and an incorrect adjustment. The tilt of the square wave can be either rising or falling when R13 is not correctly adjusted.

d. Adjust R13 so the square wave display is flat.

## 6. Check Pulse Flatness Deviation

### NOTE

Some minor aberrations are due to the Type 284. The requirement limits include deviations that are part of the Type 284. Therefore, the Type S-2 limits apply only when testing with the Type 284, and with a 20 cm air line between the pulser and the Sampling Head. The system calibration requires an additional 20 ns signal delay which adds some additional deviations. Use 20 ns coaxial delay cable (item 25 of the equipment required list).

a. Connect the Type 284 Pulse Output to the Type S-2 input connector through a 20 ns delay coaxial cable. Set the Type 284 Mode switch to the Pulse Output position.

b. Connect a BNC coaxial cable (5 ns or less delay) from the Type 284 Trigger Output to the Type 3T6 external trigger input connector J123.

c. Set the Type 3T6 Decade switch to 9 and the Multiplier switch to 1 for a 1 ns/div sweep rate. Set the Trigger Sensitivity control for a stable display.

d. Set the Type 3S6 Units/Div switch to 100 and adjust the Variable control for 5 divisions from the baseline to the flat top of the display.

e. Set the Type 3S6 Units/Div switch to 10 without disturbing the Variable control, and center the top of the display with the DC Offset control; adjust 3T6 Delay Dial to time position the pulse; see Fig. 5A.

f. Check that the pulse will not deviate from flat more than +5% to -5% for the first 2.5 ns after the pulse reaches 50% amplitude, nor deviate more than +2% to -2% (total 4%) thereafter. Change the sweep rates as listed under the three parts of Fig. 5 and check the deviation as shown.

### NOTE

The deviation given in (f) above doesn't include the deviation of the 20 ns delay cable nor of any additional attenuators.

## Type S-2

g. This completes the Type S-2 system calibration. Additional Sampling Head checks are included in the Type 3S6 system procedure continuing with step 5. To use the Type S-2 in place of the Type S-3 in this procedure, connect the Type S-2 in place of the Type VP-2 and termina-

## System Calibration

tion GR874-W50B, and delete the reference to the S-3 probe. Also in step 7 Check Tangential Noise, check for 10 mV or less Tangential Noise.

h. Continue the system procedure, Type 3S6 step 5.



