FACTORY CALIBRATION PROCEDURE

CONTENTS:

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

Equipment Required

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

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

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

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

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

This procedure is company confidential

S-4

April 1969

For all serial numbers.

CHANGE INFORMATION:

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

EQUIPMENT REQUIRED

All TEKTRONIX test equipment must be calibrated to Factory Test Limits using methods specified in the applicable TEKTRONIX Factory Calibration Procedure. Other test equipment should be calibrated to its manufacturer's specifications. Exceptions to calibration procedures, which are necessary to improve the measurement capability of some test equipment, e.g. calibrated to ±0.5% accuracy at some specific setting, are noted on this Equipment Required List.

Equivalent test equipment may be used. A Test-Final Staff Engineer must approve any substitutions.

a. TEKTRONIX Instruments

2 TYPE 560 SERIES OSCILLOSCOPE
2 TYPE 3T2 RANDOM SAMPLING SWEEP
2 TYPE 3S2 SAMPLING UNIT
1 TYPE S-2 SAMPLING HEAD
1 TYPE S-3 SAMPLING HEAD
1 TYPE S-50 PULSE GENERATOR HEAD
1 TYPE 111 PRETRIGGER PULSE GENERATOR (with 2Z mod, 067-0517-00)
1 TYPE 284 PULSE GENERATOR

b. Test Fixtures and Accessories

1 50Ω Input Z Bridge (067-0112-00)(modified, see PMIE dwg #2385-A)
1 Variable Attenuator (067-0511-00)
1 50mA Tunnel Diode Driver (067-0578-99)
1 50mA In-line Tunnel Diode (067-0598-99)
1 50Ω cable, BNC (012-0057-00)
2 50Ω cable, 18" BNC (012-0076-00)
1 Sampling Head Extender (012-0124-00)
1 50Ω cable, BNC/BSM (012-0127-00)
1 Adapter, GR to 3mm male (015-1007-00)
1 Adapter, GR to 3mm female (015-1008-00)
1 50Ω 500ps rigid coax, 3mm (015-1015-00)
1 Adapter, GR to BNC female (017-0063-00)
3 50Ω 10X attenuator, GR (017-0078-00)
3 50Ω 10ns cable, GR (017-0501-00)
1 50Ω 2ns cable, GR (017-0505-00)

c. Other equipment

1 20,000Ω/VDC multimeter

FACTORY TEST LIMITS

Factory Test Limits are qualified by the conditions specified in the main body of the Factory Calibration Procedure. The numbers and letters to the left of the limits correspond to the procedure steps where the check or adjustment is made. Steps without Factory Test Limits (setups, presets, etc.) are not listed. Instruments may not meet Factory Test Limits if calibration or checkout methods and test equipment differ substantially from those in this procedure.

1. INPUT RESISTANCE:

   50Ω ±5%, max

2. STROBE ADJUSTMENTS

b. Strobe kickout amplitude: 50mV, max

3. DOT TRANSIENT RESPONSE:

   for input signals up to 500mV P-P, loop gain must be within 5% of unity for positive going signals when loop gain is set to unity for negative going signals

4. BASELINE SHIFT WITH REP RATE CHANGE: 10mV, max (with rep rate change from 30Hz to 50kHz)

5. STEP RESPONSE

b. Risetime of TYPE S-4: 25ps or less
c. Combined risetime of TYPE S-4 and TYPE S-50: 35ps or less
d. Aberrations in the first 400ps after the 90% amplitude point: no more than +10%, -10%, total of 20% P-P.
e. Aberrations from 25ns after the 90% amplitude point: no more than +2%, -2%, total of 4% P-P
f. Aberrations from 400ps to 25ns after the 90% amplitude point: no more than 0%, + 10%, total of 10% P-P

6. RANDOM NOISE

b. Random noise: 5mV, max.

7. GATE BAL: range; at least 80mV each way from balance

8. MAXIMUM OPERATING SIGNAL VOLTAGE

b. Maximum operating signal voltage: at least 1.0V P-P without distortion

9. TRIGGER TAKEOFF: amplitude into 50Ω; at least 0.68 X input signal voltage

THE END

SHORT FORM PROCEDURE

This instrument must meet Factory Test Limits before it leaves Manufacturing; therefore, it must be possible to inspect to these limits. Because of normal variations in test equipment and plug-in scopes, addition of side panels, etc, this procedure may require that some checks and adjustments be made so that performance is better than that required by Factory Test Limits.

1. CHECK INPUT RESISTANCE:

   50Ω ±5%, max

2. STROBE ADJUSTMENTS

   a. Setup
   b. Adjust R66 (Avalanche Volts) and R57 (Snap-off Current) and minimize strobe kickout: amplitude; 50mV peak, max. Time; adjusted to within 1.2ns of the start of the kickout

3. ADJUST R49 (GAIN) AND CHECK DOT TRANSIENT RESPONSE:

   for input signals up to 500mV P-P, loop gain must be within 5% of unity for positive going signals when loop gain is set to unity for negative going signals

4. CHECK BASELINE SHIFT WITH REP RATE CHANGE: 10mV, max (with rep rate change from 30Hz to 50kHz)

5. STEP RESPONSE

   a. Setup
   b. Check risetime of TYPE S-4: 25ps or less
   c. Check combined risetime of TYPE S-4 and TYPE S-50: 35ps or less
   d. Check aberrations in the first 400ps after the 90% amplitude point: no more than +10%, -10%, total of 20% P-P
   e. Adjust R18 (Transient Response) and check aberrations from 25ns after the 90% amplitude point: no more than +1%, -1%, total of 2% P-P
   f. Check aberrations from 400ps to 25ns after the 90% amplitude point: no more than 0%, +9% , total of 9% P-P

6. RANDOM NOISE

   a. Setup
   b. Check random noise: 5mV, max

7. ADJUST R32 (GATE BAL): range; at least 120mV each way from balance

8. MAXIMUM OPERATING SIGNAL VOLTAGE

   a. Setup
   b. Check maximum operating signal voltage: at least 1.0V P-P without distortion

9. CHECK TRIGGER TAKEOFF:

   amplitude into 50Ω; at least 0.70 X input signal voltage

THE END

1. INPUT RESISTANCE: 50Ω ±5%, max

Connect the 50Ω Input Z Bridge to the input of the TYPE S-4 and measure its input resistance.

2. STROBE ADJUSTMENTS

a. Setup

Preset all TYPE S-4 adjustments to midrange. Connect the TYPE S-4 to channel B of the plug-in scope TYPE 3S2 with a Sampling Head Extender. Turn on the plug-in scope and allow the TYPE S-4 to warm-up for at least 5 minutes before making any adjustments.

Make the following connections:

TYPE 111 PULSE OUTPUT--10X Atten--10ns cable--Variable Atten

TYPE 111 PRETRIGGER OUTPUT--10X atten 10X atten--10ns cable--TYPE 3T2 50Ω TRIGGER INPUT

TYPE 111 CHARGE LINE--10ns cable

Preset as follows:

plug-in scope

TYPE 3S2

channel B POSITION	midr
DC OFFSET	midr
DOT RESPONSE	midr
units/div	100
VARIABLE	CAL
mode	CH B
NORMAL-SMOOTH	NORMAL

TYPE 3T2

TIME POSITION	full cw
FINE	full cw
RANGE	100ns
START POINT	WITH TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X1
DISPLAY MODE	NORMAL
TRIG SENSITIVITY	full cw
POLARITY	+
SOURCE	EXT

a. TYPE 3S2 DOT RESPONSE midr is defined as a memory output of 2.50 volts with a Normalizer Head installed and the units/div at 100. (See the TYPE 3S2 FCP).

TYPE 3S2 DC OFFSET will be at midr when the DC voltage at the OFFSET OUT is at zero.

2a. (CONT)

TYPE 111

REPETITION RATE	near MAX
RANGE	10kc
OUTPUT POLARITY	+
TRIGGER TO PULSE TIME DIFFERENCE	midr
TWO TRIGGERS PER PULSE (2Z)	pushed in (off)

test scope

TYPE 3S2 with TYPE S-2 in channel A

channel A POSITION	midr
DC OFFSET	midr
DOT RESPONSE	midr
unit/div	50
VARIABLE	CAL
mode	CH A
NORMAL-SMOOTH	NORMAL

TYPE 3T2

TIME POSITION	full cw
FINE	full cw
RANGE	100ns
START POINT	WITH TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X20
DISPLAY MODE	NORMAL
TRIG SENSITIVITY	full ccw
POLARITY	-
SOURCE	EXT

b. Adjust Avalanche Volts and Snap-off Current and minimize strobe kickout: amplitude; 50mV peak, max

While keeping the trace on the screen of the plug-in scope with the TYPE 3S2 DC OFFSET, adjust R66 (Avalanche Volts) ccw until the trace becomes quite.

2b. (CONT)

Connect the TYPE S-4 input through a 3mm male to GR adapter to the input of the TYPE S-2 in the test scope. Connect a 50Ω cable from the plug-in scope (the scope in which the TYPE S-4 is being calibrated) TYPE 3T2 PULSE OUT to the test scope TYPE 3T2 50Ω TRIGGER INPUT.

Adjust the plug-in scope TYPE 3T2 TRIG SENSITIVITY for a triggered sweep and change the DISPLAY MODE to MANUAL. Change the plug-in scope TYPE 3S2 units/div to 2.

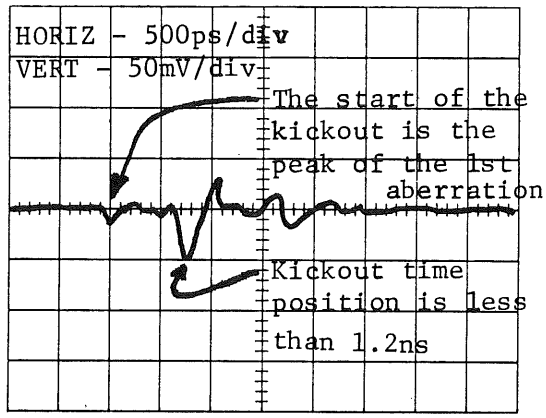
Adjust the test scope TYPE 3T2 TRIG SENSITIVITY and the plug-in scope MANUAL SCAN for a stable display of the strobe kickout from the TYPE S-4.

Rotate the plug-in scope TYPE 3S2 DC OFFSET control from one end of its range to the other and check for a spike in the kickout that is positive when the DC OFFSET control is ccw from the center of its range and negative when the control is cw from the center. Return DC OFFSET to midr. Adjust R57 (Snap-off Current) in the TYPE S-4 to place this spike within 1.2ns of the start of the kickout. Change the plug-in scope TYPE 3S2 units/div to 100. Adjust the amplitude of the kickout to minimum by changing the point where R51 or R53 is soldered to the clipping line.

Disconnect the adapter from the input of the TYPE S-2 and connect it to the Variable Attenuator. Change the plug-in scope TYPE 3T2 DISPLAY MODE to NORMAL and adjust the TYPE 3S2 DC OFFSET and the TYPE 111 TRIGGER TO PULSE TIME DIFFERENCE to DISPLAY the TYPE 111 pulse. Adjust the Variable Attenuator for about 5 divisions of display amplitude. Turn on the TYPE 111 2Z and adjust R66 for maximum separation between the top of the pulse and the baseline under it.

Install the TYPE S-4 in a housing that has access holes for each of the adjustments. Recheck strobe kickout and readjust it if necessary.

b. It is very inportant that that the strobe kickout is adjusted to 1.2ns or less from its start. This will prevent the kickout from "pulling" the output TD of the S-50, which would make the S-50 appear to have a faster risetime than it really has.



3. DOT TRANSIENT RESPONSE: for input signals up to 500mV P-P, loop gain must be within 5% of unity for positive going signals when loop gain is set to unity for negative going signals

Turn off the TYPE 111 2Z and adjust the Variable Attenuator for exactly 5 divisions of display amplitude. Turn the TYPE 111 2Z on and adjust R49 (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.) Check that the amplitude of the pulse is still 5 divisions ±0.25 division, max.

3. It may be necessary to readjust R66 and R57 slightly to obtain dot transient response within 5%. If readjustment is necessary, recheck strobe kickout.

Adjust Gate Bal (R32) and check Gate Bal range (see step 7 of this procedure). The strobe adjustments will effect Gate Bal.

4. BASELINE SHIFT WITH REP RATE CHANGE: 10mV, max (with rep rate change from 30Hz to 50kHz)

Disconnect the GR to 3mm male adapter from the TYPE S-4 input. Set the TYPE 3S2 units/div to 5 and the TYPE 111 REPETITION RATE controls for a 30Hz rep rate pulse. Note the vertical position of the trace. Set the TYPE 3T2 TRIG SENSITIVITY full cw and check that the trace does not shift more than 2 divisions.

5. STEP RESPONSE

a. Setup

Connect the 50mA TD Driver as follows:

5mA TD Driver Pulse Output--2ns cable--50mA In-line TD--TYPE S-4 input

5mA TD Driver Pretrigger Output--GR to BNC female adapter--18" 50Ω cable--TYPE 3T2 50Ω TRIGGER INPUT

Preset as follows:

TYPE 3S2	
B POSITION	midr
DELAY	cw
units/div	100
mode	CH B
NORMAL-SMOOTH	NORMAL

5a. (Con't)

TYPE 3T2

TIME POSITION	midr
FINE	midr
RANGE	100ns
START POINT	WITH TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X10
VARIABLE	CAL
DISPLAY MODE	NORMAL
TRIG POLARITY	+
SOURCE	EXT
SAMPLES/DIV	var (sw450↓)

b. Check risetime of TYPE S-4: 25ps or less

Turn on the 50mA TD Driver and adjust the TYPE 3T2 TRIG SENSITIVITY for a triggered sweep. Adjust the TYPE 3S2 DC OFFSET, the TYPE 3T2 TIME POSITION controls and the 50mA TD Driver Bias to display the drive pulse with the 50mA In-line TD switching to its high state at the top of the pulse.

Change the TYPE 3T2 TIME MAGNIFIER to X50 and the TYPE 3S2 units/div to 50. Adjust the TYPE 3T2 TIME POSITION controls and the TYPE 3S2 DC OFFSET to center the portion of the display where the In-line TD switches to its high state. Adjust the TYPE 3S2 VARIABLE to obtain a 5 division display of the TD switching waveform. Change the TYPE 3T2 DISPLAY MAG to X10 and measure the displayed risetime between the 10% and 90% amplitude points.

Calculate the risetime of the TYPE S-4 using the following formula:

$$T_{rS-4} = \sqrt{(T_r \text{ displayed})^2 - (16)^2}$$

Remove Inline TD from TYPE S-4.

c. Check combined risetime of TYPE S-4 and TYPE S-50: 35ps or less

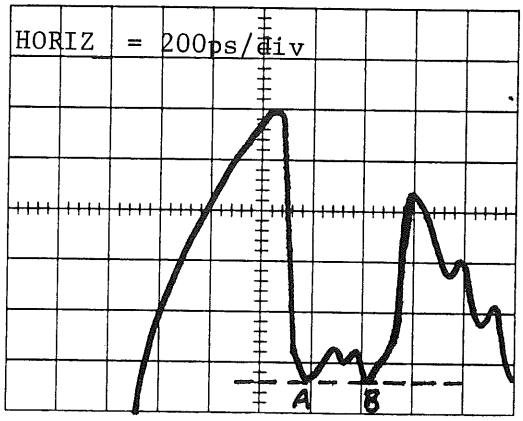
Install a TYPE S-50 in channel A of the plug-in scope TYPE 3S2.

TYPE S-50 PULSE OUTPUT--500ps rigid coax TYPE S-4 input

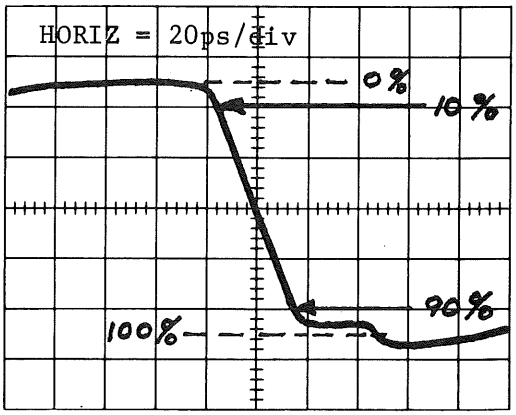
TYPE S-50 PRETRIG OUT--BNC/BSM cable--TYPE 3T2 50Ω TRIGGER INPUT

b. For greater accuracy in observing S-4 risetime adjust the TYPE 3T2 SAMPLES/DIV for greator dot density (ccw).

The following is an S-4 Inline TD waveform illustrating proper setting of 50mA TD Driver Dias, note points A and B.



The following is an S-4, Inline TD waveform illustrating the 0% and 100% amplitude points and the 10% and 90% risetime points.



The reference points in this graph are established in the same manner as those established in step 5c.

5c. (Con't)

Return the TYPE 3T2 DISPLAY MAG and TIME MANGIFIER to X1 and the TYPE 3S2 units/div to 100, and VAR to CAL.

Adjust the TYPE 3T2 TRIG SENSITIVITY, TYPE 3S2 DC OFFSET and TYPE S-50 STABILITY for a stable display of the fast transition of the TYPE S-50 pulse. Change the TYPE 3T2 DISPLAY MAG to X10 and the TIME MAGNIFIER to X50. Adjust the TIME POSITION controls to return the fast transition of the pulse to the center of the graticule. Adjust the TYPE 3S2 VARIABLE for 5 divisions between the 0% and 100% zones (see note). Check that the 10% to 90% risetime of the displayed pulse does not exceed 35ps.

d. Check aberrations in the first 400ps after the 90% amplitude point: no more than +10%, -10%, total of 20% P-P

Change the TYPE 3T2 TIME MAGNIFIER to X20. Using the 100% zone established in part c of this step, check that the aberrations in the first 400ps after the 90% amplitude point do not exceed 0.5 division. Disconnect the 500ps coax from the TYPE S-50 and the BNC/BSM cable from the TYPE 3T2.

Remove the TYPE S-50 from channel A of the TYPE 3S2.

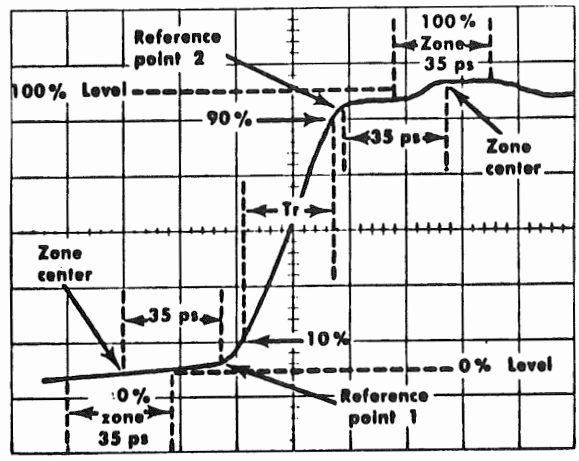
e. Adjust Transient Response and check aberrations from 25ns after the 90% amplitude point: no more than +1%, -1% total of 2% P-P

Connect the TYPE 284 as follows:

TYPE 284 PULSE OUTPUT--GR to 3mm female adapter--500ps rigid coax--TYPE S-4 input

TYPE 284 TRIGGER OUTPUT--18" 50Ω cable--TYPE 3T2 50Ω TRIGGER INPUT

c. 0% & 100% Zones



Two reference points are chosen at the points where the slope is at its maximum rate of change. The 0% and 100% levels are the average amplitude within the zones which are one t_r (the specified combined risetime of the TYPE S-4 and TYPE S-50, 35ps) in width. The 0% zone is centered 1 t_r before the first reference point and the 100% zone is centered 1 t_r after the second reference point.

5e. (Con't)

Change the TYPE 3T2 TIME POSITION RANGE to 1μs, the START POINT to BEFORE TRIGGER, the DISPLAY MAG to X1 and the TIME MAGNIFIER to X1. Adjust the TRIG SENSITIVITY and TIME POSITION controls and the TYPE 3S2 DC OFFSET for a stable display with the leading edge of the pulse one division from the left edge of the graticule.

Using the point 50ns before the leading edge as the 0% amplitude point and the point 500ns after the leading edge as the 100% point, adjust the TYPE 3S2 VARIABLE to obtain 5 divisions between these two points. Change the units/div to 20 (4%/div) and place the 100% amplitude point at the horizontal graticule center. Switch TYPE 3T2 TIME GAG to X10. Adjust R18 (Trans-sient Response) so that the aberrations after 25ns do not exceed +2%, -2%, total of 4% P-P.

f. Check aberrations from 400ps to 25ns after the 90% amplitude point: no more than 0%, +9% total of 9% P-P

Change the TYPE 3T2 TIME POSITION RANGE to 100ns, and the TIME MAGNIFIER to X2. Check the aberrations from 5ns to 25ns after the 90% amplitude point. Change the TIME MAGNIFIER to X20 and check the aberrations from 400ps to 5ns after the 90% amplitude point.

f. If the aberrations from 400ps to 25ns exceed +9% it may be possible to reduce them by readjusting R18 (Transient Response). If R18 is readjusted for this purpose then recheck the aberrations after 25ns (step 5e).

The 100% reference point will drift, making it necessary to reset it periodically with the TYPE 3S2 POSITION control.

6. RANDOM NOISE

a. Setup

TYPE 284 SQUARE WAVE OUTPUT--10X atten--Variable Atten--GR to 3mm male adapter--TYPE S-4 input

6a. (Con't)

Preset as follows:

TYPE 284

SQUARE WAVE AMPLITUDE	100mV
PERIOD	10μs
MODE	SQUARE WAVE

TYPE 3S2

DOT RESPONSE	set for unity loop gain
units/div	10
VARIABLE	CAL
mode	CH B
NORMAL-SMOOTH	NORMAL

a. Any error in loop gain at the units/div setting used to check random noise will produce an error in the noise measurement.

TYPE 3T2

TIME POSITION RANGE	100ns
START POINT	WITH TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X1
DISPLAY MODE	NORMAL
TRIG SENSITIVITY	full cw

b. Check random noise: 5mV, 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. Change the TYPE 284 SQUARE WAVE AMPLITUDE to 1.0V and check for no more than 3.33 divisions of separation between the two traces.

7. GATE BALANCE: range; at least 200mV each way from balance

Remove the Sampling Head Extender and install the TYPE S-4 directly in the TYPE 3S2. Adjust the TYPE 3S2 B DC OFFSET for 0 volts at the B OFFSET out jack. Adjust R32 (Gate Bal) in the TYPE S-4 for no trace shift when the TYPE 3S2 units/div is switched from 200 to 2. Set the units/div to 200 and adjust the B POSITION control to place the trace at the graticule center. Adjust R32 from one end to the other and check that the trace moves at least + and - one division from the graticule center.

7. If Gate Bal does not meet limits it may be possible to bring it into limits by readjusting the strobe circuits.

7. (Con't)

Readjust R32 for no trace shift when the units/div is switched from 200 to 2.

8. MAXIMUM OPERATING SIGNAL VOLTAGE

a. Setup

TYPE 284 SQUARE WAVE OUTPUT--GR to 3mm female adapter--500ps rigid coax--TYPE S-4 input

Connect the TYPE S-4 to CH B of the plug-in scope TYPE 3S2 with a Sampling Head Extender

TYPE 284 TRIGGER OUTPUT--50Ω cable--TYPE 3T2 50Ω TRIGGER INPUT

Preset as follows:

TYPE 284

SQUARE WAVE AMPLITUDE	100mV
MODE	SQUARE WAVE
PERIOD	1μs

TYPE 3S2

units/div	20
mode	CH B
NORMAL-SMOOTH	NORMAL

TYPE 3T2

TIME POSITION RANGE	10μs
START POINT	WITH TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X5

b. Check maximum operating signal voltage: at least 1.0V P-P without distortion

Adjust the TYPE 3T2 TRIG SENSITIVITY for a stable display. Note the amplitude of and the shape of the top and bottom portions of the waveform. Change the TYPE 3S2 units/div to 200 and the TYPE 284 SQUARE WAVE AMPLITUDE to 1.0V. Check that the top and bottom portions of the waveform are not distorted.

9. TRIGGER TAKEOFF: amplitude into 50Ω; at least 0.70X input signal voltage

Install a TYPE S-2 in channel A of the plug-in scope TYPE 3S2 and connect a BNC/BSM cable from the TYPE 3S2 TRIG OUT to the TYPE S-2 input. Set the TYPE 3S2 mode switch to CH A, the TRIG OUT to B and the A units/div to 20. Change the TYPE 284 SQUARE WAVE AMPLITUDE to 100mV. Check that the amplitude of the display is at least 70mV.

THE END