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-1

11/9/70

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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. (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 P6006 10X PASSIVE PROBE
1 TYPE P6028 1X PASSIVE PROBE
1 TYPE 568 OSCILLOSCOPE (plug-in scope)
*1 TYPE 3T2 RANDOM SAMPLING SWEEP
1 TYPE 3S2 SAMPLING UNIT

1 TYPE 284 PULSE GENERATOR
1 TYPE 111 PRETRIGGER PULSE GENERATOR (with 2Z Mod, 067-0517-00)
1 TYPE 76TU LINE-VOLTAGE CONTROL UNIT

b. Test Fixtures and Accessories

1 50Ω Input Z Bridge (067-0112-00)
1 Variable Attenuator (067-0511-00)
1 Normalizer Head (067-0572-00)
1 Head Extender Cable (012-0124-00)
3 50Ω 10X Attenuators, GR (017-0078-00)
1 50Ω 5X Attenuator, GR (017-0079-00)
1 50Ω 2X Attenuator, GR (017-0080-00)
3 50Ω 10ns RG58C/U cables (017-0501-00)
1 50Ω 5ns RG58C/U cable (017-0512-00)
2 50Ω cables, BNC (012-0057-00)
1 GR to BNC male adapter (017-0060-00)
1 BNC female to BSM female adapter (103-0036-00)
1 18" banana plug to banana plug patch cord (012-0039-00)
1 20cm air line, GR 874-L20 (017-0084-00)

c. Other Equipment

1 20,000Ω/VDC Multimeter

*This equipment must be traceable to the NBS for certification of measurement characteristics.

Substitute test equipment may be used. The Plant Staff Engineer must approve any substitutions. All equipment listed must perform within its manufacturer's specifications, unless otherwise stated.

Factory Test Limits 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. PRESET TYPE S1 ADJUSTMENTS

2. CHECK INPUT RESISTANCE:

   50Ω ±1%, max

   R46 MID RANGE
   R2C FULL CW.

3. STROBE ADJUSTMENTS

a. Setup
b. Adjust R66 (Avalanche Volts) and R57 (Snap-Off Current)

4. DOT TRANSIENT RESPONSE

a. Setup
b. Adjust (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.

5. CHECK BASELINE SHIFT WITH REP RATE CHANGE:

   10mV, max (with rep rate change from 30Hz to 50kHz)

6. TRANSIENT RESPONSE

a. Setup ±.5%
b. Adjust R13 (Transient Response)
c. Check risetime: 350ps or less
d. Check aberrations: no more than +0.5%, -3%, total 3.5% P-P within 5ns after t_o; no more than +0.5% -0.5%, total 1% P-P thereafter

7. TANGENTIAL NOISE

a. Setup
b. Check tangential noise: 2mV, max

8. ADJUST BRIDGE BALANCE (R22): range; at least 200mV each way from balance

9. TRIGGER TAKEOFF

a. Setup
b. Check trigger takeoff amplitude: at least 0.10X input signal voltage
c. Check trigger takeoff risetime: 0.6ns or less between the 10% and 50% amplitude points
d. Check trigger takeoff strobe kickback: no more than 10mV P-P

THE END

1. PRESET TYPE S-1 ADJUSTMENTS

Set R26 (Bridge Volts) full cw.
Set R57 (Snap-off Current) and
R46 (Gain) ~~approximately 30° from the~~ to FULL cw ~~end~~. Set all other adjustments to midrange.

2. CHECK INPUT RESISTANCE: 50Ω ±1%, max

Connect the 50Ω INPUT Z BRIDGE to the input of the TYPE S-1 and measure its input resistance.

Install the TYPE S-1 in a shell that has access holes for each of the adjustments.

3. STROBE ADJUSTMENTS

a. Setup

Connect the TYPE S-1 to channel B of the TYPE 3S2 with a Head Extender Cable. Turn on the TYPE 568 and allow the TYPE S-1 to warm up for at least 5 minutes before making any adjustments.

Preset as follows:

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	midr
FINE	midr
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.

3. (CONT)

b. Adjust Avalanche Volts and Snap-off Current

While keeping the trace on screen with the TYPE 3S2 POSITION and DC OFFSET controls, adjust R66 (Avalanche Volts) ccw until the trace becomes quiet and note the position of the trace. Continue adjusting R66 ccw until the trace again becomes noisy and note the position of the trace. Adjust R66 to the point where the trace is halfway between the two positions noted.

Change the TYPE 3S2 units/div to 2. While keeping the trace on screen with the TYPE 3S2 DC OFFSET, adjust R57 (Snap-off Current) ccw and note the vertical movement of the trace. This movement should pass through a peak (either up or down) that is near the cw end rotation. Leave R57 adjusted to a low noise spot near this peak. Return the TYPE 3S2 units/div to 100.

Remove the Head Extender Cable and plug the TYPE S-1 (installed in a shell) into channel B of the TYPE 3S2.

4. DOT TRANSIENT RESPONSE

a. Setup

TYPE 111 PULSE OUTPUT--10X Atten--2X Atten--10ns cable--Variable Atten--TYPE S-1 input

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

Connect a 10ns cable to the TYPE 111 CHARGE LINE

Preset as follows:

TYPE 3S2

DOT RESPONSE	midr
units/div	100
VARIABLE	CAL

4a. (CONT)

TYPE 3T2

TIME POSITION	midr
FINE	midr
RANGE	100ns
START POINT	WITH TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X1

TYPE 111

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

b. Adjust 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.

Adjust the TYPE 3T2 TRIG SENSITIVITY and TIME POSITION controls and the TYPE 111 TRIGGER TO PULSE TIME DIFFERENCE to obtain a stable display of the TYPE 111 pulse. Adjust the Variable Attenuator for exactly 5divisions of display amplitude. Turn the TYPE 111 2Z on and adjust R46 (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 tall pulse is 5 divisions ±0.25 division, max.

b. The difference in loop gain for positive going and negative going signals is affected by Avalanche Volts and Snap-off Current settings and by the bridge diodes.

5. CHECK BASELINE SHIFT WITH REP RATE CHANGE:

10mV, max (with rep rate change from 30Hz to 50kHz)

Remove the TYPE 111 signal from the TYPE S-1 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.

5. Baseline shift with rep rate change is primarily caused by bridge diodes. If the shift exceeds the test limit, remove the bridge diode holder and reinsert it in the opposite direction. If the shift still exceeds the test limit, replace the bridge. If the bridge is reversed or replaced, step 4 must be repeated.

5. (CONT)

Set the TYPE 3T2 TRIG SENSITIVITY full cw and check that the trace does not shift vertically more than 2 divisions.

Disconnect the TYPE 111 PRETRIGGER OUTPUT from the TYPE 3T2 50Ω TRIGGER INPUT.

6. TRANSIENT RESPONSE

a. Setup

Remove the TYPE S-1 from the TYPE 3S2 and reinstall it with the Head Extender Cable.

Connect TYPE 284 PULSE OUT -----20cm airline--- TYPE S-1 INPUT.

Preset controls as follows:

TYPE 3S2	
MV/DIV	100
TYPE 3T2	
TRIGGER POLARITY	+
RANGE	10μs
DISPLAY MAX	X1
START POINT	BEFORE TRIGGER

b. Adjust Transient Response (R13)

With the 3S2 VARIABLE MV/DIV obtain 5div of display. Change the MV/DIV to 5 (1%/div). Adjust R13 for flatest wave form. (Watch the very front corner so it does not roll off.) Aberrations from 100ns to pulse end must not exceed + and -0.5%.

6. (Cont.)

c. Check risetime: 350ps max

Preset the TYPE 284 MODE to PULSE OUT and LEAD TIME to 75ns.

Connect TYPE 284 PULSE OUT---20cm airline---S-1 INPUT.
Change START POINT to WITH TRIGGER. Adjust the TYPE 3T2 TRIG SENSITIVITY and TIME POSITION controls for a stable display with the leading edge of the pulse near the center of the graticule. Adjust the TYPE 3S2 VARIABLE for a 5 division display.

Change the TYPE 3T2 TIME POSITION RANGE to 100ns, the DISPLAY MAG to X10 and the TIME MAGNIFIER to X10. Check for a 10% to 90% risetime of 350ps or less.

d. Check aberrations: no more than +0.5%, -3% (3.5% P-P) within 5ns after t_o; no more than +0.5%, -0.5% (1.0% P-P) thereafter

Place the DISPLAY MAG and TIME MAG to X1. Change the TYPE 3S2 MV/DIV to 5. Place the 100ns point of the pulse at graticule center. Check from 5ns to 100ns for no more than -0.5% +0.5% aberrations.

Change the TIME MAG to X10. Check from t_o to 5ns for no more then -3.0% +0.5% aberrations.

Remove the TYPE 284 connections and install the TYPE S-1 in the TYPE 3S2.

6c. (CONT)

Connect the TYPE 281 as follows:

TYPE S-1 input--TYPE 281--10X Atten--2X Atten--5ns cable--GR to BNC adapter--TYPE 3T2 50Ω TRIGGER INPUT

LONG TERM AB
5 MM
½ CM

Remove the TYPE W from the test scope and install a TYPE 1S1 in its place. Connect the TYPE 281 probe power connector to the TYPE 1S1 PROBE POWER.

Preset TYPE 3T2:

TIME POSITION RANGE	10μs
START POINT	BEFORE TRIGGER
DISPLAY MAG	X1
TIME MAGNIFIER	X2
VARIABLE	CAL
TRIG POLARITY	-
SOURCE	EXT

Adjust the TYPE 3T2 TRIG SENSITIVITY and TIME POSITION controls for a stable display of the negative going leading edge of the pulse from the TYPE 281. With the TYPE 3S2 units/div at 100, adjust the VARIABLE for a 5 division display. Without disturbing the variable, change the units/div to 5. Move the leading edge of the pulse to the left edge of the graticule and place the right end of the trace at the center horizontal graticule line.

Adjust R13 (Transient Response) for optimum flatness of the display. Check that the aberrations are within 0.5div of the center horizontal graticule line. Change the TYPE 3T2 time MAGNIFIER to X1. the TIME POSITION RANGE to 1μs and set the TIME POSITION controls full ccw. Position the right edge of the trace to the center horizontal graticule line. Change the TYPE 3T2 TIME MAGNIFIER to X50 and adjust the TIME POSITION controls so that the leading edge of the pulse enters the graticule at the upper left corner. Check that the aberrations after the first 5ns are within 0.5 division of the center horizontal graticule line. Remove the TYPE 281 connections from the TYPE 1S1, TYPE S-1 and TYPE 3T2. Remove the TYPE 1S1 from the test scope and reinstall the TYPE W in its place.

7. TANGENTIAL NOISE

a. Setup

50Ω AMPLITUDE CALIBRATOR OUTPUT--10X Atten--5ns cable--Variable Atten--TYPE S-1 input

Set the 50Ω AMPLITUDE CALIBRATOR VOLTS to .03, the TYPE 3S2 units/div to 2 and the TYPE 3T2 TRIG SENSITIVITY full cw.

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. Change the 50Ω AMPLITUDE CALIBRATOR VOLTS to .3 and check for no more than 6.66 divisions of separation between the two traces.

8. BRIDGE BALANCE: range; at least 200mV each way from balance

Set the TYPE 3T2 TRIG SENSITIVITY full cw and the TYPE 3S2 B DC OFFSET for 0 volts at B OFFSET OUT. Adjust R22 (Bridge Bal) in the TYPE S-1 for no trace shift when the TYPE 3S2 B 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 R22 from one end to the other and check that the trace moves at least + and - one division from the graticule center.

Readjust R22 for no trace shift when the units/div is switched from 200 to 2.

9. TRIGGER TAKEOFF

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.

a. The vertical and horizontal deflection factors of the TYPE 1S1 and test scope combination must be calibrated before the checks in this step are made.

50Ω AMPLITUDE CALIBRATOR OUTPUT--
5ns cable--TYPE S-1 input

TYPE 3S2 TRIG OUT--BSM to BNC adapter--
50Ω cable--BNC to GR adapter--TYPE 1S1
SIGNAL IN

Preset as follows:

50Ω AMPLITUDE CALIBRATOR

TEST-OPERATE	OPERATE
VOLTS	1.2

TYPE 3S2

A and B	
POSITION	midr
DC OFFSET	midr
DOT RESPONSE	set to unity
units/div	200
VARIABLE	CAL
mode	CH A
TRIG OUT	A

TYPE 3T2

TIME POSITION	full cw
FINE	full cw
RANGE	100ns
START POINT	WITH TRIGGER
TIME MAGNIFIER	X1
VARIABLE	CAL
DISPLAY MODE	MANUAL
MANUAL SCAN	full cw
TRIG SENSITIVITY	full ccw
POLARITY	+

9a. (cont'd)

TYPE 1S1

SMOOTHING	NORM
SAMPLES/CM	9 o'clock
DISPLAY MODE	NORMAL
mVOLTS/CM	20
VARIABLE	CAL
TIME POSITION RANGE	50μS
TIME/CM	5μSEC
VARIABLE	CAL
VERT POSITION	midr
DC OFFSET	midr
TRIGGER SOURCE	+ INT

b. Check trigger takeoff amplitude: at least 0.10X input signal voltage

Adjust the TYPE 1S1 TRIGGER SENSITIVITY and DC OFFSET controls to obtain a stable display of the TYPE 3S2 TRIG OUT signal. Check that the amplitude of the display is at least 6 divisions.

c. Check trigger takeoff risetime: 0.6ns or less between the 10% and 50% amplitude points

Disconnect the 5ns cable from the 50Ω AMPLITUDE CALIBRATOR OUTPUT and connect it to the TYPE 284 PULSE OUTPUT. Change the TYPE 1S1 TIME POSITION RANGE to 500nS, the TIME/CM to 10nSEC and set the TIME POSITION controls full cw. Adjust the TYPE 1S1 TRIGGER SENSITIVITY, DC OFFSET and mVOLTS/CM VARIABLE for a stable 5 division display. Change the TYPE 1S1 TIME POSITION RANGE to 50nS and the TIME/CM to .5nSEC. Adjust the TYPE 1S1 TIME POSITION controls to display the leading edge of the TYPE 3S2 TRIG OUT waveform and check its risetime between the 10% and 50% amplitude points.

b. NOTICE!

The TYPE S-1 trigger takeoff amplitude, risetime and strobe kickback, as checked in this step, are partially determined by the TRIG OUT circuitry in the TYPE 3S2. If the TRIG OUT characteristics of the TYPE 3S2 are exceptionally good, a type S-1 that appears marginal may not meet the test limits when checked with a normal TYPE 3S2.

9. (CONT)

d. Check trigger takeoff strobe kick-back: no more than 50mV P-P

Remove the 5ns cable from the TYPE S-1 input. Connect a 50Ω cable from the TYPE 3T2 PULSE OUT to the TYPE 1S1 EXT TRIG. Set the TYPE 3T2 TRIG SENSITIVITY full cw. Set the TYPE 1S1 TRIGGER SOURCE to EXT -, the TIME/CM to 10nSEC, the mVOLTS/CM to 5 and the VARIABLE to CAL. Adjust the TYPE 1S1 TRIGGER SENSITIVITY, DC OFFSET and TIME POSITION controls for a stable display of the strobe kickback from the TYPE 3S2 TRIG OUT. Rotate the TYPE 3S2 B DELAY from one end to the other and check that the peak to peak amplitude of the strobe kickback does not exceed 50mV.

THE END