

# FACTORY CALIBRATION PROCEDURE

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## INTRODUCTION:

This isn't a field recalibration procedure as is the procedure in your instruction manual. This is a guide in calibrating brand-new instruments, just assembled instruments that have never been turned on before. Therefore it calls out many procedures and adjustments that are rarely required for subsequent recalibration.

Even though we wrote this procedure primarily for our own factory test department, it's valuable to others also if used with some caution:

1. Special test equipment, if mentioned, is not available from Tektronix unless it's listed also in our current catalog. This special equipment is used in our test department to speed calibration. Usually you can either duplicate its function with standard equipment in your facility, devise alternate approaches, or build the special test equipment yourself.
2. Factory circuit specifications are not guaranteed unless they also appear as catalog or instruction manual specifications. Factory circuit specs usually are tighter than advertised specs. This helps insure the instrument will meet or exceed advertised specs after shipment and during subsequent field recalibrations over several years of use. Your instrument may not meet factory circuit specs but should meet catalog or instruction manual specs.
3. Presetting internal adjustments, if mentioned, usually is unnecessary. This is helpful for "first-time" calibration only. If internal adjustments are preset, you'll have to perform a 100% recalibration. So don't preset them unless you're certain a "start-from-scratch" policy is the best.
4. Quality control men steps. Factory calibration procedures are for our test department calibrators who first calibrate the instrument. Quality control men then check the initial calibration and perform additional fine points such as trimming resistor leads, installing shields, etc. In some cases a factory calibration procedure instructs the calibrator not to perform these fine points. You'll ordinarily have to include these fine points in your calibration.

In this procedure, all front panel controls for the instrument under test are in capital letters (SENSITIVITY) and internal adjustments are capitalized only (Gain Adj).

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# 3B3



# ABBREVIATIONS:

a	amp	min	minimum
ac	alternating current	mm	millimeter
approx	approximately	mpt	metalized, paper tubular (capacitor)
b	base	msec	millisecond
bulb	light, lamp, etc.	mt	mylar, tubular (capacitor)
c	collector	mv	millivolt
ccw	counterclockwise or full counterclockwise	$\mu$	micro ( $10^{-6}$ )
cer	ceramic	$\mu$ f	microfarad
cm	centimeter	$\mu$ h	microhenry
comp	composition (resistor)	$\mu$ sec	microsecond
cps	cycles per second	n	nano ( $10^{-9}$ )
crt	cathode ray tube	nsec	nanosecond
cw	clockwise or full clockwise	$\Omega$	ohm
db	decibel	p	pico ( $10^{-12}$ )
dc	direct current	pbt	paper, "bathtub" (capacitor)
div	division	pcc	paper covered can (capacitor)
e	emitter	pf	picofarad ( $\mu\mu$ f)
emc	electrolytic, metal cased (capacitor)	piv	peak inverse voltage
fil	filament	pmc	paper, metal cased (capacitor)
freq	frequency	poly	polystyrene
gmV	guaranteed minimum value (capacitor)	pot	potentiometer
gnd	chassis ground	prec	precision (resistor)
h	henry	pt	paper, tubular (capacitor)
hv	high voltage	ptm	paper, tubular molded (capacitor)
inf	infinity	ptp	peak-to-peak
int	internal	sec	second
k	kilo ( $10^3$ )	sn	serial number
k	kilohm	term	terminal
m	milli ( $10^{-3}$ )	tub	tubular (capacitor)
ma	milliamp	unreg	unregulated
max	maximum	v	volt
mc	megacycle	var	variable
meg	megohm	w	watt
mh	millihenry	WW	wire wound
mid r	midrange or centered	x-former	transformer

# TEST SPECIFICATIONS

(Tentative)

1. Sweep length controls must adjust within  $\pm 90^\circ$  of the center of rotation.
2. Sweep Gating Threshold must adjust within  $\pm 90^\circ$  of the center of rotation.
3. Delay Start and Delay Stop controls must adjust within  $\pm 90^\circ$  of the center of rotation.
4. Sweep Mag Regis must adjust within  $\pm 90^\circ$  of the center of rotation.
5. With 5X Gain control set at maximum, the gain must be at least 10% more than the proper setting.
6. Normal Sweep and Delayed Sweep triggering requirements are as follows:
 

INT	AC	With a .5 v (or 2 mm) signal (essentially dc to 5 mc) and 1.25 v or .5 cm (above 5 mc to 10 mc) signal, the sweep must trigger on $\pm$ SLOPE by adjusting the LEVEL control.
	DC	
	AUTO (normal sweep)	
EXT	AC	The sweep must trigger on .5 v signal (essentially dc to 10 mc). With EXT TRIG ATTEN, the sweep must trigger on 5 v signal (essentially dc to 10 mc).
	DC	
	AUTO (normal sweep)	
7. Triggering LEVEL must be within  $\pm 30^\circ$  of 0 with triggering set on INT, AC and  $\pm$ SLOPE.
8. POSITION control must have sufficient range to position the trace .2 major divisions to the right and left of the CRT electrical center.
9. The range of SWEEP CAL control must meet the following specifications with various CRT horizontal deflection plate sensitivities:
 

<u>Horizontal Sensitivity</u>	<u>% of deflection more than proper setting</u>	<u>% of deflection less than proper setting</u>
17.5 V/DIV	15%	5%
18.7 V/DIV	10%	10%
19.3 V/DIV	5%	15%
10. VAR. TIME/DIV must have a range of at least 2.5:1.
11. The Delayed Sweep Timing error must be within  $\pm 2\%$  on .5  $\mu$ SEC/DIV through .1 SEC/DIV and  $\pm 2.5\%$  on .2 SEC/DIV through 1 SEC/DIV.
12. The Normal Sweep Timing error must be as follows:
 

<u>Timing error</u>	<u>Sweep rates</u>
$\pm .625\%$ ( $\pm 2.5$ minor div. as read on Delay Time dial)	5 $\mu$ sec to .2 sec included
$\pm 2.5\%$ ( $\pm 2$ mm as read on CRT)	.5 sec and 1 sec.
$\pm 2.0\%$ ( $\pm 1.6$ mm as read on CRT)	.5 $\mu$ sec to 2 $\mu$ sec included
13. The Normal Sweep linearity error, as read on the Delay Time dial must be within  $\pm .2\%$  on 5  $\mu$ sec through .2 sec.
14. The fixed delay time between the Normal and Delayed Sweeps must be less than 500 nsec.

15. The sweep timing error on any range must be within  $\pm 3\%$  ( $\pm 2.4$  mm as read on the CRT) with 5X Mag on.
16. The sweep linearity must be within 1% with 5X MAG on.
17. Delay jitter must not be more than 1 part in 20,000 (4 mm maximum).
18. Normal sweep hold-off time must be as follows:

<u>SWEEP RATES</u>	<u>HOLD-OFF TIME</u>
.5, 1 & 2 $\mu$ SEC/DIV	5 - 10 $\mu$ sec
5, 10 & 20 $\mu$ SEC/DIV	10 - 15 $\mu$ sec
50, 100 & 200 $\mu$ sec/DIV	40 - 70 $\mu$ sec
.5, 1 & 2 mSEC/DIV	.5 - 1 msec
5, 10 & 20 mSEC/DIV	5 - 10 msec
50 mSEC/DIV )	
.1, .2, .5 & 1 SEC/DIV)	50 - 100 msec

# FACTORY CALIBRATION PROCEDURE

## (Tentative)

The following instruments and equipment are needed for a complete calibration of Type 3B3 Plug-In:

- 1 Type 561A Oscilloscope
- 1 Type 75 Plug-In or Equivalent
- 1 Type 180 Time Marker Generator or equivalent
- 1 Test scope
- 1 Type TU-4 Test Load
- 1 52  $\Omega$  Coaxial cable
- 1 Plug-In Extension

The Type 75 Plug-In should be set up as follows unless otherwise stated:

POSITION	Mid-range
VOLTS/DIV	1
VARIABLE	CAL
AC-DC-GND	DC

### PRELIMINARY INSPECTION:

Check for wiring errors, unsoldered joints, long wire ends and wire dress. Check all controls for smooth mechanical operation. Make the following resistance-to-ground checks at the 24-pin amphenol connector:

Conn. pin number	Approx. res. ohms	Conn. pin number	Approx. res. ohms	Conn. pin number	Approx. res. ohms
1	75	9	0	17	45 k
2	75	10	30 k	18	infinite
3	infinite	11	infinite	19	infinite
4	6.5 k	12	infinite	20	10 k
5	0	13	13 k	21	45 k
6	30 k	14	3 k	22	0
7	infinite	15	8 k	23	4 k
8	infinite	16	3	24	infinite

### PRESET CONTROLS:

POSITION	Mid-range
MODE	NORM
5X MAG	OFF
TIME/DIV	1 mSEC
DELAY TIME RANGE	1 mSEC
VAR. TIME/DIV	CALIB
DELAY TIME	1.00
SWEEP CAL.	Mid-range
NORM-SINGLE SWEEP-RESET	NORM

Set DELAYED SWEEP TRIGGERING and NORMAL or DELAYING SWEEP TRIG. as follows:

LEVEL	0	COUPLING	AC
SLOPE	+	SOURCE	EXT
	EXT TRIG ATTEN	IN	

Set all internal controls to mid-range. Preset all timing variable capacitors at mid-range. Plug Type 75 into the VERTICAL compartment of scope. Plug Type 3B3 into scope by using a plug-in extension. Turn POWER ON and allow sufficient time for the unit to warm up before proceeding with the test procedure.

1. CHECK ZENER REGULATED VOLTAGE:

Using a DC Voltmeter, check +15 v zener regulated voltage at the cathode of D398. It should be measured between +13.5 and +16.5 v.

2. ADJUST NORMAL SWEEP GATING THRESHOLD:

Set MODE switch to NORM, COUPLING to AC and SOURCE to EXT. Short the 17.8 k resistor (R143). Adjust NORMAL SWEEP GATING THRESHOLD control until the sweep just free-runs. Remove the short from R143 and observe the trace disappear.

3. ADJUST DELAYED SWEEP GATING THRESHOLD:

Free-run normal sweep by switching COUPLING to AUTO. Note: normal sweep free-runs on the AUTO position only. Disable delayed sweep triggering by switching SOURCE to EXT. Turn MODE to TRIG DLY'D SWP. Short the 17.8 k resistor (R243) on the delayed sweep. Adjust DELAYED SWP GATING THRESHOLD control until the delayed sweep just free-runs. Remove the short from R243 and observe the trace disappear. Remove the plug-in extension and re-install the Time Base plug-in into scope.

4. CHECK ALTERNATE SWEEP OPERATION:

Remove the Type 75 and install a TU-4 Test Load unit. Set the TU-4 to DUAL TRACE. Check for alternate sweep with the MODE set at NORM and DLY'D SWP. Remove the TU-4 and re-install the Type 75 into the scope.

5. CHECK NORMAL SWEEP TRIGGER AND DELAYED SWEEP TRIGGER FOR PROPER OPERATION:

Set MODE to NORM and SOURCE to INT. Apply CALIBRATOR signal to the vertical Input to obtain one minor division of vertical deflection. With COUPLING set at AUTO, AC and DC, check that the normal sweep triggers properly on  $\pm$ SLOPE by adjusting the LEVEL control. Check DC MODE for proper triggering at the top and bottom of the graticule.

Set SOURCE to EXT. Apply .5 v CALIBRATOR signal to EXT TRIG INPUT and VERT. INPUT and check for proper external triggering. With the CALIBRATOR signal set at 5 v, pull EXT TRIG ATTEN switch out and check for proper triggering. Push EXT TRIG ATTEN switch in.

Free-run the normal sweep by setting COUPLING to AUTO. Set MODE to TRIG DLY'D SWEEP and check the delayed sweep trigger for proper operation by repeating the above procedure.

Remove the CALIBRATOR signal. From Type 180 apply a 5 mc signal to the VERT. INPUT to obtain one minor division of vertical deflection. Check the normal sweep trigger and delayed sweep trigger for proper triggering with the SOURCE set at INT and TIME/DIV & DELAY TIME RANGE at .5  $\mu$ SEC. Apply a 10 mc signal to the VERT. INPUT to produce .5 major divisions of vertical deflection. Again check both triggers for proper triggering. Remove the signal from the VERTICAL INPUT.



6. CHECK NORMAL SWEEP TRIGGER FOR LINE TRIGGERING:  
Set VOLTS/DIV to 5, TIME/DIV to 5 mSEC and MODE to NORM. Apply a 60 cps signal from the fuse holder through a 10X Probe to the VERT. INPUT. Check that the normal sweep triggers on proper phase with SOURCE switch at LINE and  $\pm$ SLOPE. Remove the 60 cps signal from the VERT. INPUT.
7. CHECK SINGLE SWEEP OPERATION:  
Set SOURCE to INT and COUPLING to AC. Apply CALIBRATOR signal to the VERT. INPUT to obtain one minor division of vertical deflection and adjust NORMAL SWEEP TRIGGERING LEVEL for stable display. Disconnect the signal from the input and set NORM-SINGLE SWEEP-RESET switch to SINGLE SWEEP. Note that the READY neon is off. Push the SINGLE SWEEP switch to RESET and release it back to SINGLE SWEEP position. The READY neon should light.  
Apply the CALIBRATOR signal to the VERT. INPUT and observe that a single display appears on the CRT and READY neon extinguishes. Remove the CALIBRATOR signal from the input. Push and release the SINGLE SWEEP-RESET switch and repeat the single sweep operation by reapplying the CALIBRATOR signal to the VERT. INPUT.
8. ADJUST SWEEP CAL:  
Set MODE to NORM, SOURCE to INT, COUPLING to AUTO, SLOPE to +, NORM-SINGLE SWEEP-RESET to NORM and TIME/DIV at 1 mSEC. From Type 180 apply 1 msec time markers to the VERT INPUT. Check the adjustment range of the control. Adjust SWEEP CAL control for one time marker per major division. Note: timing adjustments should always be made from the first division line (second marker) to the ninth division line (tenth marker) on the graticule.
9. ADJUST NORMAL SWEEP LENGTH:  
Using set up as in the previous step, adjust Normal Sweep Length control for 10.5 major divisions of horizontal display. Check the range of POSITION control.
10. ADJUST DELAYED SWEEP LENGTH:  
Set MODE to TRIG DLY'D SWP and DELAY SWEEP TRIGGERING SOURCE to INT. Turn TIME/DIV to 2 mSEC and advance DELAY TIME RANGE to 1 mSEC. Set the DELAYED SWEEP TRIGGERING LEVEL for a stable display. Adjust Delayed Sweep Length for 10.5 major divisions of horizontal display.
11. ADJUST 5X GAIN:  
Set MODE to NORM and TIME/DIV to 1 mSEC. From Type 180 apply 1 mSEC and 100  $\mu$ SEC time markers to the VERT. INPUT. Set the LEVEL control for a stable display. Pull 5X MAG switch out and adjust 5X Gain control for one large marker per every five major divisions and two small markers per every major division. Check the linearity over the entire magnified sweep.
12. ADJUST SWEEP MAG REGIS:  
Using the set-up as in the previous step, pull 5X MAG switch out and position the trace so that the first large time marker falls on the CRT electrical center. Push 5X MAG in and adjust Swp Mag Resig. so that the first time marker again falls on the electrical center. Repeat the adjustment until there is no shift between 5X MAG on and off. Check to see that the 5X MAG on and off register properly at the middle and at the end of the sweep. (Re-check the last four steps for interaction.)

### 13. CHECK DELAYED SWEEP RATES:

Push 5X MAG switch in. Set MODE to TRIG DLY'D SWP, SOURCE to INT, SLOPE to + and COUPLING to AC. From Type 180 apply appropriate time markers to the VERT INPUT. Adjust the LEVEL control for a stable display and check the timing of DELAYED SWEEP from 50  $\mu$ SEC to 1 SEC sweep rates as follows:

<u>TIME/DIV &amp; DLY TIME RNGE</u>	<u>TIME MARKERS</u>	<u>MARKERS per DIV</u>
50 $\mu$ SEC	50 $\mu$ SEC	1
.1 mSEC	100 $\mu$ SEC	1
.2 mSEC	100 $\mu$ SEC	2
.5 mSEC	500 $\mu$ SEC	1
1 mSEC	1 mSEC	1
2 mSEC	1 mSEC	2
5 mSEC	5 mSEC	1
10 mSEC	10 mSEC	1
20 mSEC	10 mSEC	2
50 mSEC	50 mSEC	1
.1 SEC	100 mSEC	1
.2 SEC	100 mSEC	2
.5 SEC	500 mSEC	1
1 SEC	1 SEC	1

Note: All timing checks should always be made from the first division line (second marker) to the ninth division line (tenth marker) on the graticule. The overall timing error must be within  $\pm 2\%$  ( $\pm 1.6$  mm) and  $\pm 2.5\%$  ( $\pm 2$  mm) on two slowest sweep rates.

### 14. ADJUST DELAYED SWEEP RATES:

Use set-up as in the previous step. From Type 180 apply appropriate time markers to the VERT INPUT and adjust the timing capacitors as follows:

<u>TIME/DIV &amp; DLY TIME RNGE</u>	<u>TIME MARKERS</u>	<u>ADJ.</u>	<u>MARKERS per DIV</u>	<u>PERMISSIBLE TIMING ERROR</u>
10 $\mu$ SEC	10 $\mu$ SEC	C260D	1	$\pm 2\%$ ( $\pm 1.6$ mm)
20 $\mu$ SEC	10 $\mu$ SEC	check	2	$\pm 2\%$ ( $\pm 1.6$ mm)
5 $\mu$ SEC	5 $\mu$ SEC	check	1	$\pm 2\%$ ( $\pm 1.6$ mm)
1 $\mu$ SEC	1 $\mu$ SEC	C260B	1	$\pm 2\%$ ( $\pm 1.6$ mm)
2 $\mu$ SEC	1 $\mu$ SEC	check	2	$\pm 2\%$ (1.6 mm)
.5 $\mu$ SEC	1 $\mu$ SEC	check	1/2 div.	$\pm 2\%$ (1.6 mm)
.5 $\mu$ SEC	10 mc	w/5X MAG*	1 cycle/div.	$\pm 3\%$ ( $\pm 2.4$ mm)

\*With 5X MAG on, check the entire magnified sweep with the exception of the first and last three cycles.

### 15. ADJUST DELAY START AND DELAY STOP:

Turn MODE to INTEN, 5X MAG OFF, TIME/DIV to 1 mSEC and DELAY TIME RANGE to 10  $\mu$ SEC. Apply 1 mSEC time markers to the VERT INPUT. Adjust NORMAL SWEEP TRIG LEVEL for stable display. Check DELAY TIME dial for mechanical zero. Turn DELAY TIME to 1.00 and adjust DELAY START until the bright portion just passes to the right of the second time marker. Then turn DELAY TIME dial to 9.00 and adjust the DELAY STOP until the bright portion just passes to the right of the tenth time marker. Set MODE to DLY'D SWP and make final adjustments by viewing the start of the magnified time marker. Readjust both controls so that the leading edge of 2nd and 10th markers corresponds to the start of DELAYED SWEEP with DELAY TIME dial set at 1.00 and 9.00 respectively. Because of the interaction between these adjustments, it is necessary to repeat several times. Check linearity of the DELAY TIME dial at all major divisions from 1 to 9.



# 16. CHECK TIME DELAY JITTER:

Set MODE to INTEN and TIME/DIV to 1 mSEC. Apply 1 msec time markers to the VERT. INPUT and adjust the LEVEL control for a stable display. Advance DELAY TIME RANGE to 1  $\mu$ SEC. Set DELAY TIME so that the intensified portion of the sweep superimposes on the second time marker. Turn MODE to DLY'D SWP and observe the horizontal jitter (2 mm max.). Repeat the same procedure at the 10th time marker and check the horizontal jitter (4 mm max.).

# 17. CHECK NORMAL SWEEP RATES:

Set MODE to NORM, COUPLING to AC and TIME/DIV to appropriate position. Apply .5 sec time markers to the VERT. INPUT. Adjust the TRIGGERING LEVEL for stable display and check the timing of .5 sec and 1 sec sweep rates ( $\pm 2$  mm).

Set TIME/DIV at .2 SEC and DELAY TIME RANGE at 2 mSEC. Apply 100 msec time markers to the VERT INPUT. Adjust LEVEL control for stable display. Set MODE to INTEN. Turn DELAY TIME dial to 1.00 so that the intensified portion superimposes on the 2nd marker. Then set MODE to DLY'D SWP and make fine setting on the dial so that the leading edge of the marker coincides with the start of DELAYED SWEEP. Note the error of delay start on the dial. Turn DELAY TIME dial to 9.00 and repeat the same procedure on the 10th marker. The difference between the delay time settings with error at 1.00 and 9.00 must be less than 2.5 minor divisions on the dial.

Advance both TIME/DIV and DELAY TIME RANGE settings one step at a time and apply appropriate time markers corresponding to NORMAL SWEEP rates. Repeat the above procedure to check the NORMAL SWEEP timing from .1 sec to 50  $\mu$ sec.

# 18. ADJUST NORMAL SWEEP RATES:

Use the same procedure as in the previous step. Set NORMAL SWEEP TIME/DIV at 10  $\mu$ SEC and DELAYED SWEEP DELAY TIME RANGE at .5  $\mu$ SEC. Apply 10  $\mu$ sec time markers to the VERT INPUT and adjust C160D for 1 marker/ea. maj. div. with MODE in INTEN. Set MODE to DLY'D SWP. Slightly readjust C160D so the timing error is less than 2.5 min. div. as read on the helidial. Repeat procedure to check timing error of 5 & 20  $\mu$ SEC as read on DELAY TIME dial (2.5 minor divisions). Apply appropriate time markers to the VERT. INPUT. Make adjustment and checks as follows:

<u>TIME/DIV</u> <u>settings</u>	<u>TIME</u> <u>MARKERS</u>	<u>ADJ.</u>	<u>MARKERS</u> <u>per DIV.</u>	<u>PERMISSIBLE</u> <u>TIMING ERROR</u>
1 $\mu$ SEC	1 $\mu$ SEC	C160B	1	$\pm 2\%$ ( $\pm 1.6$ mm)
2 $\mu$ SEC	1 $\mu$ SEC	check	2	$\pm 2\%$ ( $\pm 1.6$ mm)
.5 $\mu$ SEC	1 $\mu$ SEC	check	1/2 div.	$\pm 2\%$ ( $\pm 1.6$ mm)
.5 $\mu$ SEC	10 mc	*w/5X MAG	1 cycle/div	$\pm 3\%$ ( $\pm 2.4$ mm)

\*With 5X MAG on check the entire magnified sweep with the exception of the first and last three cycles.

# 19. CHECK FIXED DELAY TIME BETWEEN NORMAL & DELAYED SWEEPS:

Set NORMAL SWEEP As follows: TIME/DIV and DELAY TIME RANGE to 5  $\mu$ SEC, MODE to NORM, SLOPE to +, COUPLING to AC and LEVEL to full clockwise. Turn DELAY TIME dial to 1.00. Apply 1  $\mu$ sec time markers to the VERT INPUT and rotate the NORMAL SWEEP TRIGGERING LEVEL control counter-clockwise until the NORMAL SWEEP is just being triggered on the leading edge of the first marker. Use the top of the first marker on the first graticule line

20. CHECK FIXED DELAY TIME BETWEEN NORMAL & DELAYED SWEEPS, Continued:

as a reference for the fixed delay time measurement. Set MODE to DLY'D SWP and carefully rotate the DELAY TIME dial counter-clockwise until the top of the first marker again appears on the first graticule line. The displacement of the DELAY TIME dial from 1.00 setting must be less than five minor divisions (500 nsec fixed delay).

21. CHECK NORMAL SWEEP HOLD-OFF TIME:

Set MODE to NORM and COUPLING to AUTO. Set test scope for dc input and 5 VOLTS/DIV. Connect a 10X probe from the test scope to the right-hand horizontal deflection plate. Check all ranges of the TIME/DIV switch for sufficient sweep hold-off time.