T.O. 33K3-4-2590-1

TECHNICAL MANUAL

CALIBRATION PROCEDURE

FOR

OSCILLOSCOPE

2445B

(TEKTRONIX)

CALIBRATION LAB
INSTRUCTION MANUAL FOR
Oscilloscope

Model #: 2445B **Date:** 1MAR00
Cal Tech: [signature]

DISTRIBUTION WITHIN GIDEP IS AUTHORIZED BY DEPARTMENT OF THE AIR FORCE,HQ AEROSPACE GUIDANCE AND METROLOGY CENTER (AFMC) NEWARK AFB OHIO, LETTER DATED 4 AUGUST 1992

15 APRIL 1994
CHANGE 2 - 30 SEPTEMBER 1995

18

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates of issue for original and changed pages are:

Original ..... 0 ..... 15 April 1994
Change ..... 1 ..... 30 September 1994
Change ..... 2 ..... 30 September 1995

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 16, CONSISTING OF THE FOLLOWING:

Page No.	* Change No.	Page No.	* Change No.	Page No.	* Change No.
Title	2				
A	2				
1 - 2	0				
3	1				
4	2				
5	0				
6	2				
7 - 14	0				

* Zero in this column indicates an original page

OSCILLOSCOPE

2445B

(TEKTRONIX)

1 **CALIBRATION DESCRIPTION:**

Table 1.

Test Instrument (TI) Characteristics	Performance Specifications	Test Method
Calibrator	Range: .4 V p-p into 1 M Ω standard voltage Accuracy: ±1%	Compared against a
Vertical Deflection	Range: 2 mV to 5 V/div, CH 1 and CH 2; .1 V and .5 V/div, CH 3 and CH 4 Accuracy: ±2%, CH 1 and CH 2; ±10%, CH 3 and CH 4	Checked with a standard voltage
Delta Volts	Range: 8 x V/div setting Accuracy: ± (1.25% of rdg +0.03 div)	
Trigger Level Readout	Range: 18 x V/div setting Accuracy: ± (3% of rdg + 3% of p-p signal +0.2 div +0.5 mV) + (0.5 mV X Probe attenuation factor)	
Vertical Bandwidth Channel 1 and 2	Range: DC to 150 MHz (200 MHz, S/N B030000 and above) frequency. Vertical	Apply a constant amplitude signal while changing deflection
compared	Accuracy:	against deflection at a
	50 Ω, Down not more than 3 dB; 1 M Ω Down not more than 4.7 dB	referenced frequency
Channel 3 and 4	Range: DC to 150 MHz (200 MHz, S/N B030000 and above) Accuracy: Down not more than 4.7 dB without Probe; 3.0 dB with Probe	
Triggering (A & B)	Range: INT, 1.5 div @ 250 MHz; 0.75 div @ 250 MHz, CH 3 and CH 4 Accuracy: Minimum	Apply minimum signals and check for stable display

Table 1 (Cont.)

Test Instrument (TI) Characteristics	Performance Specifications	Test Method
Sweep Time (A & B)	Range: A, 10 ns to .5 sec/div B, 10 ns to 50 ms/div	Checked with standard Time Mark signals
	Accuracy: A: ±1.5%	
	Accuracy: B: ±1.8%	
	Magnifier: X10	
	Accuracy: ±2.0%	
Delta Time	Range: ±10 X A sec/div	
	Accuracy: ±(0.5% of time interval ±0.3% of full scale)	
X-Y	Sensitivity Range: 2 mV to 5 V/div	Checked with a standard voltage
	Accuracy: ±2%	
	Bandwidth Range: DC to 3 MHz	Apply a constant amplitude signal while changing frequency. Horizontal deflection compared against deflection at a referenced frequency
	Accuracy: Down not more than 3 dB	
Parametric Measurements	Period Range: 2 ns to 100 ms	Checked with standard Time Mark signals
	Accuracy: 0.5% + 0.5 ns	
	Frequency Range: Calculated as 1/period	Checked with a standard voltage
	Accuracy: Same as period	
	Volts Range: ± p, p-p Average	
	Average: 5% of rdg +5 mV +0.5 mV Probe attenuation factor	

2 EQUIPMENT REQUIREMENTS:

	Noun	Minimum Use Specifications	Calibration Equipment	Sub-Item
2.1	CALIBRATION	Range: 10 mV to 20 V p-p	Tektronix	

	GENERATOR	Accuracy: ±0.25%	PG506 P/O F5030A1

	Noun	Minimum Use Specifications	Calibration Equipment	Sub-Item
2.2	LEVELED SINE WAVE GENERATOR	Range: 50 kHz to 250 MHz Accuracy: ±5%	Tektronix SG503 P/O F5030A1	
2.3	FEEDTHROUGH TERMINATION	Range: 50 Ω Accuracy: N/A	Tektronix 011-0049-01	
2.4	TERMINATION ATTENUATOR	Range: As Necessary Accuracy: N/A	As Available	
2.5	ATTENUATOR PROBE	Range: X10 Accuracy: N/A	Tektronix P6131/P6136 Supplied with TI	
2.6	TIME MARK GENERATOR	Range: 5 ns to .5 s Accuracy: ±0.25%	Tektronix TG501 P/O F5030A1	
2.7	METER CALIBRATOR	Range: 0 to .4 VDC Accuracy: DC ±0.2%	Fluke 5100B	
2.8	PROBE TIP TO BNC	Range: N/A Accuracy: N/A	Tektronix 013-0227-00	

3 PRELIMINARY OPERATIONS:

3.1 Review and become familiar with the entire procedure before beginning calibration process.

WARNING

Unless otherwise designated, and prior to beginning the Calibration Process, ensure that all test equipment voltage and/or current outputs are set to zero (0) or turned off, where applicable. Ensure that all equipment switches are set to the proper position before making connections or applying power.

3.2 Connect TI and calibration equipment to a 115 VAC/60 Hz power source. Set all POWER switches to ON and allow a 20 minute warm-up period. After warm-up period, momentarily press and hold both the CH 1 and CH 2 upper Input Coupling buttons until a moving dot display replaces the normal signal. This performs a DC Balance of CH 1 and CH 2 and the readout indicates "DC BALANCE IN PROGRESS". The signal and readout will return to normal when complete.

3.3 Unless otherwise specified, TI controls should be set for several cycles of stable display with ample amplitude.

3.4 Set TI controls as follows:

BW LIMIT	off
VAR (all)	cal (detent)
CH 1 and CH 2 INPUT COUPLING	1 M Ω DC

VERTICAL MODE	CH 1
DELTA T	off
DELTA V	off
TRACK/INDEP	INDEP
A TRIGGER MODE	AUTO
SOURCE	VERT
SLOPE	+
TRIGGER COUPLING	DC
A & B SEC/DIV	1 ms

3.5 Use the Calibration Generator positive going, fast rise, output terminated into 50 Ω at TI, set TI and Generator controls as required and check TI high frequency compensation for abnormal overshoot or aberrations. If questions arise, see Maintenance T.O. or Commercial Manual. Do not attempt to optimize High-frequency compenstation adjustments unless the TI has failed bandwidth check.

4 CALIBRATION PROCESS:

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

4.1 CALIBRATOR CALIBRATION:

4.1.1 Connect TI CALIBRATOR to the CH 1 INPUT.

4.1.2 Adjust TI CH 1 VOLTS/DIV and VAR controls for 4 divisions of vertical display centered on the CRT.

4.1.3 Disconnect TI CALIBRATOR from the CH 1 INPUT.

4.1.4 Connect the Meter Calibrator OUTPUT to TI CH 1 INPUT.

4.1.5 Set the Meter Calibrator controls as follows:

INT/EXT	INT
OPR/STDBY	STDBY
LOCAL/REM	LOCAL
CLEAR	depress twice

4.1.6 Depress the Meter Calibrator switches in the following sequence: 0, V, ENTER, OPR.

4.1.7 Adjust TI position control to align the Sweep on the second graticule below the center horizontal line.

4.1.8 Depress the Meter Calibrator switches in the following sequence: .4, V, ENTER.

4.1.9 Use the Meter Calibrator EDIT control to adjust the output for 4 divisions of vertical deflection.

4.1.10 The Meter Calibrator output readout must indicate 0.396 to 0.404.

4.1.11 Set the Meter Calibrator to STDBY and disconnect from TI.

4.1.12 Return TI CH 1 VOLTS/DIV VAR control to the CAL (detent) position.

4.2 VERTICAL DEFLECTION CALIBRATION:

4.2.1 Connect the Calibration Generator to TI CH 1 INPUT and switch on DELTA VOLTS. BW LIMIT may be switched on for ease of measurement.

4.2.2 Set TI CH 1 VOLTS/DIV control to the first position listed in the Range column of Table 2.

4.2.3 Set the Calibration Generator AMPLITUDE control to the first position listed in the Applied column of Table 2.

4.2.4 Adjust the Calibration Generator VARIABLE (OUT) control for the amount of vertical display listed in the Deflection column of Table 2.

4.2.5 The Calibration Generator readout display must indicate within 2%.

4.2.6 Set the Calibration Generator VARIABLE (OUT) control to the IN position.

4.2.7 Adjust TI Delta REF or DLY POS control to align the reference cursor to the bottom of the applicable waveform on the CRT.

4.2.8 Adjust TI DELTA control to align the delta cursor with the top of the applicable waveform on the CRT.

4.2.9 The Delta V readout must be within the values listed in the Readout Limits column of Table 2.

4.2.10 Set TI TRIGGER coupling to DC and SLOPE to positive. Adjust TI A TRIGGER LEVEL control at the most positive voltage that produces a barely triggered jittering display.

4.2.11 The TI Trigger Level readings must be within the values listed in the + Peak Limits column of Table 2.

4.2.12 Adjust TI A TRIGGER LEVEL control at the most negative voltage that produces a barely triggered jittering display.

4.2.13 The TI Trigger Level readings must be within the values listed in the - Peak Limits column of Table 2.

4.2.14 Repeat steps 4.2.2 through 4.2.13 for the remaining values listed in Table 2.

Table 2.

Range (V/DIV)	Applied (V p-p)	Deflection	Readout (Limits)	Trigger Level Readout + Peak	-Peak
2 mV	10 m	5	9.81 to 10.2 mV	8.0 to 12.0 mV	+1.7 to -1.7 mV
5 mV	20 m	4	19.6 to 20.4 mV	16.8 to 23.2 mV	+2.6 to -2.6 mV
10 mV	50 m	5	49.0 to 50.9 mV	44.0 to 56.0 mV	+4.5 to -4.5 mV
20 mV	.1	5	98.1 to 102.0 mV	89 to 111 mV	+8.0 to -8.0 mV
50 mV	.2	4	196 to 204 mV	178 to 222 mV	+16.0 to -16.0 mV
.1	.5	5	490 to 509 mV	450 to 550 mV	+35 to -35 mV

Table 2. (Cont)

Range (V/DIV)	Applied 10 m	Deflection	Readout (Limits)	Trigger Level Readout + Peak	-Peak
.2	1	5	.981 to 1.02 V	.9 to 1.1 V	+0.07 to -0.07 V
.5	2	4	1.96 to 2.04 V	1.78 to 2.22 V	+0.16 to -0.16 V
1	5	5	4.90 to 5.09 V	4.5 to 5.5 V	+0.35 to -0.35 V
2	10	5	9.81 to 10.2 V	9 to 11 V	+0.7 to -0.7 V
5	20	4	19.6 to 20.4 V	17.8 to 22.2 V	+1.6 to -1.6 V

4.2.15 Set the Calibration Generator for a minimum output. Disconnect from TI CH 1 INPUT and connect to the CH 2 INPUT.

4.2.16 Set TI VERTICAL MODE to CH 2.

4.2.17 Repeat steps 4.2.2 through 4.2.14 utilizing CH 2 controls.

4.2.18 Set the Calibration Generator for a minimum output. Disconnect from TI CH 2 INPUT and connect to the CH 3 INPUT.

4.2.19 Set TI VERTICAL MODE and SOURCE to CH 3 and VOLTS/DIV (CH 3 & CH 4) to .1 V.

4.2.20 Set the Calibration Generator AMPLITUDE control to .5 V.

4.2.21 The TI CRT vertical display must be between 4.5 and 5.5 divisions.

4.2.22 Set TI CH 3 VOLTS/DIV to .5 V.

4.2.23 Set the Calibration Generator AMPLITUDE control to 2 V.

4.2.24 The TI CRT vertical display must be between 3.6 and 4.4 divisions.

4.2.25 Set the Calibration Generator for a minimum output. Disconnect from TI CH 3 INPUT and connect to CH 4 INPUT.

4.2.26 Set TI VERTICAL MODE and SOURCE to CH 4.

4.2.27 Repeat steps 4.2.20 through 4.2.24 utilizing CH 4 controls.

4.2.28 Set the Calibration Generator for a minimum output, disconnect from TI, and switch off the Delta V.

4.3 VERTICAL BANDWIDTH CALIBRATION:

4.3.1 Set TI VERTICAL MODE to display CH 1 only and BW LIMIT to OFF.

4.3.2 Set TI VOLTS/DIV (ALL) to .1 V, the INPUT COUPLING (both) to 1 M Ω DC, and the TRIGGER SOURCE to VERT.

4.3.3 Connect the Leveled Sine Wave Generator #1 (2.2) OUTPUT through the 50 Ω Feedthrough Termination to TI CH 1 INPUT.

4.3.4 Set the Leveled Sine Wave Generator frequency controls to 50 kHz. Adjust the Output controls for 6 divisions of vertical display centered on TI CRT.

4.3.5 Increase the Leveled Sine Wave Generator frequency controls until TI CRT vertical display decreases to 3.5 divisions.

4.3.6 The Leveled Sine Wave Generator frequency controls must indicate 150 MHz or more. (200 MHz or more for S/N B030000 or more)

4.3.7 Remove the 50 Ω Feedthrough Termination from the hook-up and set TI CH 1 INPUT COUPLING to 50 Ω DC.

4.3.8 Repeat step 4.3.4.

4.3.9 Increase the Leveled Sine Wave Generator frequency controls until TI CRT vertical display decreases to 4.2 divisions.

4.3.10 Repeat step 4.3.6.

4.3.11 Disconnect the Leveled Sine Wave Generator from TI CH 1 INPUT connector and connect to TI CH 2 INPUT connector through the 50 Ω Feedthrough Termination.

4.3.12 Set TI VERTICAL MODE to display CH 2 only.

4.3.13 Repeat steps 4.3.4 through 4.3.10 utilizing CH 2 controls.

4.3.14 Disconnect the Leveled Sine Wave Generator from TI.

4.3.15 Set TI VERTICAL MODE to display CH 3 only.

NOTE

Use TI Calibration output to verify that the Probe compensation, if supplied with TI, is properly adjusted.

4.3.16 Remove the Grabber tip and plastic barrel from the X10 Attenuator Probe. Use the Probe Tip to BNC Adapter and connect the X10 Attenuator Probe to the Leveled Sine Wave Generator OUTPUT. Connect the X10 Probe to the TI CH 3 INPUT.

NOTE

If the X10 is not available as required in step 4.3.16, then connect the Generator OUTPUT to the Attenuator (as required). Connect the Attenuator to TI CH 3 INPUT through the 50 Ω Feedthrough Termination.

4.3.17 Set the Leveled Sine Wave Generator frequency controls to 50 kHz and adjust the Output controls for 4 divisions of vertical display centered on TI CRT.

4.3.18 Increase the Leveled Sine Wave Generator frequency controls until TI CRT vertical display decreases to 2.8 divisions. (2.3 divisions if the X10 Attenuator Probe is not available).

4.3.19 The Leveled Sine Wave Generator frequency control must indicate 150 MHz or more.

4.3.20 Disconnect the Leveled Sine Wave Generator from TI CH 3 INPUT and connect to TI CH 4 INPUT.

4.3.21 Set TI VERTICAL MODE to display CH 4 only.

4.3.22 Repeat steps 4.3.17 through 4.3.19 using the appropriate CH 4 controls.

4.3.23 Set TI VOLTS/DIV (all) to 0.5 V CH 1 & 2 to 50 Ω DC, and the TRIGGER SOURCE to VERT.

4.3.24 Remove the X10 Attenuator Probe and Probe to BNC adapter. Connect the Leveled Sine Wave Generator to the Attenuator (as required). Connect the Attenuator through the 50 Ω Feedthrough Termination to TI CH 4 INPUT.

4.4 TRIGGERING CALIBRATION:

4.4.1 Set the Leveled Sine Wave Generator frequency controls to 250 MHz. (200 MHz for S/N B030000 and more). Adjust the Output controls for 0.75 divisions (0.5 divisions for S/N B030000 and above) of vertical display on TI CRT.

4.4.2 A stable display on TI CRT must be observed by adjusting the LEVEL and TIME/DIV controls.

4.4.3 Disconnect the Leveled Sine Wave Generator from TI CH 4 INPUT and connect to the CH 3 INPUT.

4.4.4 Set TI VERTICAL MODE and SOURCE to CH 3.

4.4.5 Repeat steps 4.4.1 and 4.4.2.

4.4.6 Disconnect the Leveled Sine Wave Generator from TI CH 3 INPUT and remove the 50 Ω load. Connect the Leveled Sine Wave Generator to the CH 2 INPUT.

4.4.7 Set TI VERTICAL MODE and SOURCE to CH 2.

4.4.8 Adjust the Leveled Sine Wave Generator output controls for 1.5 divisions of vertical display on TI CRT. (1.0 divisions for S/N B030000 and above)

4.4.9 Repeat step 4.4.2.

4.4.10 Set TI Vertical MODE and SOURCE to CH 1.

4.4.11 Disconnect the Leveled Sine Wave Generator from TI CH 2 INPUT and connect to CH 1 INPUT.

4.4.12 Repeat step 4.4.2.

4.4.13 Disconnect the Leveled Sine Wave Generator from TI.

4.5 SWEEP CALIBRATION:

4.5.1 Connect the Time Mark Generator MARKER OUT to TI CH 1 INPUT and switch on the DELTA TIME.

4.5.2 Set TI A & B SEC/DIV (knobs locked) to the first position listed in the Range column of Table 3.

4.5.3 Set the Time Mark Generator MARKER control to the first marker listed in the Applied column of Table 3.

4.5.4 Adjust TI horizontal position to align the 2nd marker with the 2nd vertical graticule line.

4.5.5 Adjust the Time Mark Generator VARIABLE (OUT) control and TI horizontal position control for one marker per division over the center eight divisions on the CRT.

4.5.6 The Time Mark Generator readout must indicate within 1.5%.

4.5.7 Push in the Time Mark Generator VARIABLE (OUT) control button.

4.5.8 Adjust TI REF or DLY POS to align the reference cursor with the second time marker.

4.5.9 Adjust TI DELTA control to align the delta cursor with the tenth marker.

4.5.10 The Delta T readout must be within the corresponding limits listed in the Limits column of Table 3.

4.5.11 Repeat steps 4.5.2 through 4.5.10 for the remaining values in Table 3.

Table 3.

Range A & B SEC/DIV	Applied (marker)	Limits (readout)
10 ns	10 ns	79.30 to 80.70 ns
20 ns	20 ns	158.60 to 161.40 ns
50 ns	50 ns	396.5 to 403.5 ns
.1 µs	.1 µs	793.0 to 807.0 ns
.2 µs	.2 µs	1586.0 to 1614.0 ns
.5 µs	.5 µs	3965 to 4035 ns
1 µs	1 µs	7.930 to 8.070 µs
2 µs	2 µs	15.86 to 16.14 µs
5 µs	5 µs	39.65 to 40.35 µs
10 µs	10 µs	79.30 to 80.70 µs
20 µs	20 µs	158.60 to 161.40 µs
50 µs	50 µs	396.5 to 403.5 µs
.1 ms	.1 ms	793.0 to 807.0 µs
.2 ms	.2 µs	1586.0 to 1614.0 µs
.5 ms	.5 ms	3965 to 4035 µs
1 ms	1 ms	7.930 to 8.070 ms

2 ms	2 ms	15.86 to 16.14 ms
5 ms	5 ms	39.65 to 40.35 ms
10 ms	10 ms	79.30 to 80.70 ms
20 ms	20 ms	158.60 to 161.40 ms

Table 3. (Cont.)

Range A & B Sec/Div	Applied (marker)	Limits (readout)
50 ms	50 ms	396.5 to 403.5 ms
* .1 s	.1 s	793.0 to 807.0 ms
* .2 s	.2 s	1578.0 to 1622.0 ms
* .5 s	.5 s	3945 to 4055 ms

* A SEC/DIV only

4.5.12 Set TI A & B SEC/DIV to 1 μs and switch on the X10 MAG.

NOTE

Use only that portion of the sweep that is in view after the X10 MAG has been set.

4.5.13 Set the Time Mark Generator MARKER control to .1 μs.

4.5.14 Adjust the Time Mark Generator VARIABLE (OUT) control and TI horizontal position control for one marker per division over the center eight divisions on the CRT.

4.5.15 The Time Mark Generator readout must indicate within 2.0%.

4.5.16 Set TI control as follows:

X10	off
B trigger MODE	RUN AFT DLY

4.5.17 Repeat steps 4.5.2 through 4.5.6 utilizing the B SEC/DIV (knobs unlocked) control for all B SEC/DIV settings listed in the Range column of Table 3 (the Time Mark Generator must indicate within 1.8% for B sweep).

4.5.18 Disconnect the Time Mark Generator from TI.

4.6 X-Y CALIBRATION:

4.6.1 Set TI controls as follows:

CH 2	on
ALL OTHER CHANNELS	off

VOLTS/DIV (CH 1)	.1
INPUT (CH 1)	1 M Ω DC
INPUT (CH 2)	1 M GND
A & B SEC/DIV	X-Y (knobs locked)

4.6.2 Connect the Calibration Generator AMPL OUT to the TI CH 1 INPUT connector.

4.6.3 Set the Calibration Generator AMPLITUDE control to .5 V. Adjust the VARIABLE (OUT) control for 5 divisions of horizontal display centered on TI CRT.

4.6.4 The Calibration Generator Readout display must indicate within 2%.

4.6.5 Disconnect the Calibration Generator from TI.

4.6.6 Connect the Leveled Sine Wave Generator #1 (2.2) OUTPUT through the 50 Ω Feedthrough Termination to TI CH 1 INPUT connector.

4.6.7 Set the Leveled Sine Wave Generator frequency controls to 50 kHz. Adjust the Output controls for 8 divisions of horizontal display centered on TI CRT.

4.6.8 Increase the Leveled Sine Wave Generator frequency controls to 3 MHz.

4.6.9 The TI CRT horizontal display must be 5.6 divisions or more.

4.6.10 Disconnect the Leveled Sine Wave Generator from TI.

4.7 PARAMETRIC MEASUREMENTS:

4.7.1 Set TI controls as follows:

CH 1	ON
ALL OTHER CHANNELS	OFF
CH 1 VOLTS/DIV	200 mV
CH 1 INPUT COUPLING	50 Ω DC
A & B SEC/DIV	100 ns (knobs locked)

4.7.2 Connect the Time Mark Generator MARKER OUT to the CH 1 INPUT.

4.7.3 Set the Time Mark Generator controls for .1 μs markers.

4.7.4 Set TI CH 1 VOLTS/DIV and TI CH 1 VOLTS/DIV VAR for 4 divisions or more of display.

4.7.5 Push the MEASURE button.

4.7.6 Select FREQ from the menu.

4.7.7 The TI PERIOD readout must indicate 99.0 to 101.0 ns.

4.7.8 The TI FREQUENCY readout must indicate 9.95 to 10.05 MHz.

4.7.9 Disconnect the Time Mark Generator from TI CH 1 INPUT.

4.7.10 Set the TI controls as follows:

CH 1 VOLTS/DIV	100 mV
A & B SEC/DIV	1 ms
CH 1 INPUT COUPLING	1 M Ω DC

4.7.11 Connect the Calibration Generator to TI CH 1 INPUT.

4.7.12 Set the Calibration Generator AMPLITUDE control for .5 V.

4.7.13 Push TI MEASURE button.

4.7.14 Select VOLTS from the menu.

4.7.15 The TI CH 1 p-p readout must indicate 469.5 to 530.5 mV.

4.7.16 Disconnect and secure all equipment.

CALIBRATION PERFORMANCE TABLE

4.1 CALIBRATOR CALIBRATION:

Range	Applied	Limits
.4 V p-p	.4 VDC	0.396 to 0.404 V p-p

4.2 VERTICAL DEFLECTION CALIBRATION: (both channels)

Range (VOLTS/DIV)	Applied (V-p-p)	Readout	Limits + Peak	Limits - Peak
2 m	10 m	9.81 to 10.20 mV	8.0 to 12.0 mV	+1.7 to -1.7 mV
5 mV	20 m	19.6 to 20.4 mV	16.8 to 23.2 mV	+2.6 to -2.6 mV
10 mV	50 m	49.0 to 50.9 mV	44.0 to 56.0 mV	+4.5 to -4.5 mV
20 mV	.1	98.1 to 102.0 mV	89 to 111 mV	+8.0 to -8.0 mV
50 mV	.2	196 to 204 mV	178 to 222 mV	+16 to -16 mV
.1	.5	490 to 509 mV	.450 to .550 V	+.035 to -.035 V
.2	1	0.981 to 1.020 V	.90 to 1.10 V	+.07 to -.07 V

.5	2	1.96 to 2.04 V	1.78 to 2.22 V	+.16 to .-16 V
1	5	4.90 to 5.09 V	4.50 to 5.50 V	+.35 to -.35
2	10	9.81 to 10.2 V	9.0 to 11.0 V	+0.7 to -0.7 V
5	20	19.6 to 20.4 V	17.8 to 22.2 V	+1.6 to -1.6 V

CALIBRATION PERFORMANCE TABLE (Cont)

4.3 VERTICAL BANDWIDTH CALIBRATION: (both channels) (Cont)

Range	Applied	Limits
(50 Ω) DC to 150 MHz (200 MHz, S/N B030000 and above)	50 kHz 150 MHz (200 MHz, S/N B030000 and above)	6 div (reference) 4.2 div or more
1 (M Ω) DC to 150 MHz (200 MHz, S/N B030000 and above)	50 kHz 150 MHz (200 MHz, S/N B030000 and above)	6 div (reference) 3.5 div or more CH 1 & 2
	50 kHz 150 MHz (200 MHz) S/N B030000 and above)	4 div (reference) 2.8 div or more 2.3 without Probe

4.4 TRIGGERING CALIBRATION: (A & B)

Range	Applied	Limits
CH 1 & CH 2	1.5 div @ 250 MHz (1.0 div @ 200 MHz, S/N B030000 and above)	stable display
CH 3 & CH 4	0.75 div @ 250 MHz (0.5 div @ 200 MHz, S/N B030000 and above)	stable display

4.5 SWEEP TIME CALIBRATION: (A & B)

Range (TIME/DIV)	Applied (Marker)	Limits Delta Time
10 ns	10 ns	79.30 to 80.70 ns
20 ns	20 ns	158.60 to 161.40 ns
50 ns	50 ns	396.5 to 403.5 ns
.1 µs	.1 µs	793.0 to 807.0 ns
.2 µs	.2 µs	1586.0 to 1614.0 ns
.5 µs	.5 µs	3965 to 4035 ns

1 µs	1 µs	7.930 to 8.070 µs
2 µs	2 µs	15.86 to 16.14 µs
5 µs	5 µs	39.65 to 40.35 µs
10 µs	10 µs	79.30 to 80.70 µs
20 µs	20 µs	15.86 to 161.4 µs
50 µs	50 µs	396.5 to 403.5 µs

CALIBRATION PERFORMANCE TABLE (Cont)

4.5 SWEEP TIME CALIBRATION: (A & B) (Cont)

Range (TIME/DIV)	Applied (Marker)	Limits Delta Time
.1 ms	.1 ms	793.0 to 807.0 µs
.2 ms	.2 µs	1586 to 1614 µs
.5 ms	.5 ms	3965 to 4035 µs
1 ms	1 ms	7.930 to 8.070 ms
2 ms	2 ms	15.86 to 16.14 ms
5 ms	5 ms	39.65 to 40.35 ms
10 ms	10 ms	79.30 to 80.70 ms
20 ms	20 ms	158.6 to 161.4 ms
50 ms	50 ms	396.5 to 403.5 ms
* .1 s	.1 s	793.0 to 807.0 ms
* .2 s	.2 s	1578 to 1622 ms
* .5 s	.5 s	3945 to 4055 ms
1 µs X10	.1 µs	784.4 to 815.6 ns

* A SEC/DIV only

4.6 X-Y CALIBRATION:

Range	Applied	Limits
.1 V/DIV	.5 V p-p	4.90 to 5.10 div
DC to 3 MHz	50 kHz 3 MHz	8 div (reference) 5.6 div or more

4.7 PARAMETRIC CALIBRATION:

Range	Applied	Limits
TIME	.1 μs	99.0 to 101 ns
FREQ	.1 μs	9.95 to 10.05 MHz
VOLTS	.5 V	469.5 to 530.5 mV