TECHNICAL MANUAL

CALIBRATION PROCEDURE

FOR

DIGITAL OSCILLOSCOPE

WAVESURFER 44MXS-B

(LECROY)

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1 CALIBRATION DESCRIPTION:

Table 1.

Test Instrument (TI) Characteristics	Performance Specifications	Test Method
DC Accuracy	Range: 2 mV to 1 V/div, 50 Ω coupled; 2 mV to 10 V/div, 1 MΩ coupled Accuracy: (with 0 mV offset) 2 mV/div, ≤±(3.5% of reading + 1.0% of FS * + 1 mV); 5 mV/div, ≤±(3.0% of reading + 1.0% of FS * + 1 mV); 10 mV to 10 V/div, ≤±(1.5% of reading + 1.0% of FS * + 1 mV)	Compared to a standard voltage
DC Offset	Range: 50 Ω and 1 MΩ coupled: 2 to 99 mV/div, ±1 V; 100 mV/div to 1 V/div, ±10 V 1 MΩ coupled only: 1.02 to 10 V/div, ±100 V Accuracy: ±(1.5% of offset + 0.5% of FS * + 1 mV)	
Bandwidth	Range: 2 mV to 1 V/div, 50 Ω coupled, DC to 400 MHz Accuracy: Down not more than 3 dB	Apply a constant amplitude signal while changing frequency. Vertical deflection compared against deflection at a referenced frequency
Trigger	Range: All Channels (Internal) and External Trigger sources; DC levels of -2.5, 0 and +2.5 major screen div; Positive and Negative slopes Accuracy: ±(4.0% of FS * + 2 mV)	Compared to a standard signal
Time Base Accuracy	Range: 200 ps to 1000 s/div Accuracy: (5 to 40 ºC) ≤±10 ppm	Compared to a known frequency source

* FS = 8 div

2 EQUIPMENT REQUIREMENTS:

Noun	Minimum Use Specifications	Calibration Equipment	Sub-Item
2.1 OSCILLOSCOPE CALIBRATOR	Range: 0 to ±30 VDC Accuracy: ±0.475% of setting Range: Leveled Sinewave: 600 to 720 mV p-p, 10 kHz to 400 MHz Accuracy: Flatness, ±5% relative to 50 kHz; Frequency, ±2.5 ppm	Fluke 9500B/3200AF	

3 PRELIMINARY OPERATIONS:

3.1 Review and become familiar with the entire procedure before beginning the 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. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

3.2 Connect the test equipment to the appropriate power source. Set POWER switch to ON and allow a warm-up period as required by the manufacturer.

3.3 Connect the TI to the appropriate power source. Press the TI ⏻ switch and allow a 20 minute warm-up period.

3.4 Throughout the Calibration Process, the TI front panel push-buttons and knobs appear in **bold**, the touch screen menu selections in ***bold italicized***, and the icon and function softkeys in *italicized* font.

3.5 Press TI **Touch Screen** to enable the touch screen as needed during the Calibration Process.

3.6 When numeric entries are required, access a soft keypad by pressing the appropriate TI function softkey twice.

3.7 Perform only those portions of the procedure that pertain to TI being calibrated.

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

NOTE

The Active Head (p/o Oscilloscope Calibrator) is an integral part of the Oscilloscope Calibrator. All connections are to be made through the Active Head.

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 DC ACCURACY CALIBRATION:

4.1.1 Set the TI controls as follows:

File	***Recall Setup…***
Recall Default	
Horizontal **s ↔ ns**	*1.00 µs*
C1	
Volts/div	*2.00 mV*
Bandwidth	*20MHz*
Averaging	*5*, then *OK*
C2	
Volts/div	*2.00 mV*
Bandwidth	*20MHz*
Averaging	*5*, then *OK*
Vertical **3**	
Volts/div	*2.00 mV*
Bandwidth	*20MHz*
Averaging	*5*, then *OK*
Vertical **4**	
Volts/div	*2.00 mV*
Bandwidth	*20MHz*
Averaging	*5*, then *OK*
Measure	***Measure Setup…***
Show Table (checked)	
P1	*Mean*
	C1

P2 *Mean*

C2

P3 *Mean*

C3

P4 *Mean*

C4

Vertical **2** (press twice to turn channel off)

Vertical **3** (press twice to turn channel off)

Vertical **4** (press twice to turn channel off)

Close

4.1.2 Connect the Oscilloscope Calibrator to the TI 1 connector.

4.1.3 Set the Oscilloscope Calibrator for the first value listed in the Applied column of Table 2 into 1 MΩ. Set the OUTPUT to ON.

Table 2.

Volts/Div	Applied (VDC)	Limits (VDC)
2.00 m	+6 m	+4.630 to +7.370 m
	-6 m	-7.370 to -4.630 m
5.00 m	+15 m	+13.150 to +16.850 m
	-15 m	-16.850 to -13.150 m
10.0 m	+30 m	+27.75 to +32.25 m
	-30 m	-32.25 to -27.75 m
20.0 m	+60 m	+56.50 to +63.50 m
	-60 m	-63.50 to -56.50 m
50.0 m	+150 m	+142.75 to +157.25 m
	-150 m	-157.25 to -142.75 m
100 m	+300 m	+286.5 to +313.5 m
	-300 m	-313.5 to -286.5 m

Table 2. (Cont.)

Volts/Div	Applied (VDC)	Limits (VDC)
200 m	+600 m	+574.0 to +626.0 m
	-600 m	-626.0 to -574.0 m
500 m	+1.5	+1.4365 to +1.5635
	-1.5	-1.5635 to -1.4365
1.00	+3	+2.874 to +3.126
	-3	-3.126 to -2.874
2.00 *	+6	+5.749 to +6.251
	-6	-6.251 to -5.749
5.00 *	+15	+14.374 to +15.626
	-15	-15.626 to -14.374
10.0 *	+30	+28.75 to +31.25
	-30	-31.25 to -28.75

* DC1MΩ coupled only.

4.1.4 Press TI **Clear Sweeps** and allow at least 100 sweeps as indicated on the TI display before proceeding.

4.1.5 Verify the TI P1:mean(C1) indication is within the corresponding values listed in the Limits column of Table 2.

4.1.6 Set the Oscilloscope Calibrator OUTPUT to OFF.

4.1.7 Set the Oscilloscope Calibrator for the next value listed in the Applied column of Table 2 into 1 MΩ. Set the OUTPUT to ON.

4.1.8 Repeat steps 4.1.4 through 4.1.6.

4.1.9 Set TI Vertical **V ↔ mV** to the next value listed in the Volts/Div column of Table 2.

4.1.10 Set the Oscilloscope Calibrator for the next value listed in the Applied column of Table 2 into 1 MΩ. Set the OUTPUT to ON.

4.1.11 Repeat steps 4.1.4 through 4.1.8.

4.1.12 Repeat steps 4.1.9 through 4.1.11 for the remaining values listed in Table 2.

4.1.13 Set the TI controls as follows:

C1	
Volts/div	*2.00 mV*
Coupling	*DC50Ω*
Close	

4.1.14 Repeat steps 4.1.3 through 4.1.12 for the applicable values listed in Table 2 with the Oscilloscope Calibrator output impedance set to 50 Ω.

4.1.15 Disconnect the Oscilloscope Calibrator from the TI 1 connector and connect to the TI 2 connector.

4.1.16 Press TI Vertical **1**, then Vertical **2** to turn C1 off and C2 on.

4.1.17 Repeat steps 4.1.3 through 4.1.14 for TI C2, using C2 controls and settings.

4.1.18 Disconnect the Oscilloscope Calibrator from the TI 2 connector and connect to the TI 3 connector.

4.1.19 Press TI Vertical **2**, then Vertical **3** to turn C2 off and C3 on.

4.1.20 Repeat steps 4.1.3 through 4.1.14 for TI C3, using C3 controls and settings.

4.1.21 Disconnect the Oscilloscope Calibrator from the TI 3 connector and connect to the TI 4 connector.

4.1.22 Press TI Vertical **3**, then Vertical **4** to turn C3 off and C4 on.

4.1.23 Repeat steps 4.1.3 through 4.1.14 for TI C4, using C4 controls and settings.

4.1.24 Disconnect the test setup.

4.2 DC OFFSET CALIBRATION:

4.2.1 Set the TI controls as follows:

File	***Recall Setup…***
Recall Default	
Horizontal **s ↔ ns**	*50.0 ns*
C1	
Offset	*750 mV*
Averaging	*5*, then *OK*
C2	
Offset	*750 mV*
Averaging	*5*, then *OK*

VERTICAL **3**	
Offset	*750 mV*
Averaging	*5*, then *OK*
VERTICAL **4**	
Offset	*750 mV*
Averaging	*5*, then *OK*
Measure	***Measure Setup***
Show Table (checked)	
P1	*Mean*
	C1
P2	*Mean*
	C2
P3	*Mean*
	C3
P4	*Mean*
	C4
Vertical **2** (press twice to turn channel off)	
Vertical **3** (press twice to turn channel off)	
Vertical **4** (press twice to turn channel off)	
Close	

4.2.2 Connect the Oscilloscope Calibrator to the TI 1 connector.

4.2.3 Set the Oscilloscope Calibrator Amplitude for -750 mV DC into 1 MΩ. Set the OUTPUT to ON.

4.2.4 Press TI **Clear Sweeps** and allow at least 100 sweeps as indicated on the TI display before proceeding.

4.2.5 Verify the TI P1:mean(C1) indication is within -764.25 to -735.75 mV.

4.2.6 Touch TI *C1*, set the *Offset* to *-750 mV*, then touch *Close.*

4.2.7 Set the Oscilloscope Calibrator Amplitude for +750 mV DC.

4.2.8 Press TI **Clear Sweeps** and allow 100 sweeps as indicated on the TI display before proceeding.

4.2.9 Verify the TI P1:mean(C1) indication is within +735.75 to +764.25 mV.

4.2.10 Set the Oscilloscope Calibrator OUTPUT to OFF.

4.2.11 Set the TI controls as follows:

C1	
Offset	*750 mV*
Coupling	*DC50Ω*
Close	

4.2.12 Set the Oscilloscope Calibrator Amplitude for -750 mV DC into 50 Ω. Set the OUTPUT to ON.

4.2.13 Repeat steps 4.2.4 through 4.2.10.

4.2.14 Disconnect the Oscilloscope Calibrator from the TI 1 connector and connect to the TI 2 connector.

4.2.15 Press TI Vertical **1**, then Vertical **2** to turn C1 off and C2 on.

4.2.16 Repeat steps 4.2.3 through 4.2.13 for TI C2, using C2 controls and settings.

4.2.17 Disconnect the Oscilloscope Calibrator from the TI 2 connector and connect to the TI 3 connector.

4.2.18 Press TI Vertical **2**, then Vertical **3** to turn C2 off and C3 on.

4.2.19 Repeat steps 4.2.3 through 4.2.13 for TI C3, using C3 controls and settings.

4.2.20 Disconnect the Oscilloscope Calibrator from the TI 3 connector and connect to the TI 4 connector.

4.2.21 Press TI Vertical **3**, then Vertical **4** to turn C3 off and C4 on.

4.2.22 Repeat steps 4.2.3 through 4.2.13 for TI C4, using C4 controls and settings.

4.2.23 Disconnect the test setup.

4.3 <u>BANDWIDTH CALIBRATION:</u>

4.3.1 Set the TI controls as follows:

File	***Recall Setup…***
Recall Default	
Horizontal **s ↔ ns**	*20.0 µs*
C1	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*5*, then *OK*

C2	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*5*, then *OK*
VERTICAL **3**	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*5*, then *OK*
VERTICAL **4**	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*5*, then *OK*
Measure	***Measure Setup…***
Show Table (checked)	
P1	*Peak to peak*
	C1
P2	*Peak to peak*
	C2
P3	*Peak to peak*
	C3
P4	*Peak to peak*
	C4
Vertical **2** (press twice to turn channel off)	
Vertical **3** (press twice to turn channel off)	
Vertical **4** (press twice to turn channel off)	
Close	

4.3.2 Connect the Oscilloscope Calibrator to the TI 1 connector.

4.3.3 Set the Oscilloscope Calibrator for a 600 mV p-p leveled sine wave at 50 kHz into 50 Ω. Set the OUTPUT to ON.

4.3.4 Adjust TI Trigger **Level** as necessary for a stable display.

4.3.5 Adjust the Oscilloscope Calibrator output controls for a TI P1:pkpk(C1) indication of as close as possible to 600 mV.

4.3.6 Press TI **Clear Sweeps** and allow at least 100 sweeps as indicated on the TI display.

4.3.7 Set the Oscilloscope Calibrator Frequency to 400 MHz.

4.3.8 Adjust the TI Horizontal controls as necessary for several cycles of display. Touch TI ***Timebase***, ***Horizontal Setup***, set the Sampling Mode to *RIS*, then touch *Close*.

4.3.9 Press TI **Clear Sweeps** and allow at least 100 sweeps as indicated on the TI display.

4.3.10 Verify the TI P1:pkpk(C1) average indication is ≥425 mV.

4.3.11 Set the Oscilloscope Calibrator OUTPUT to OFF.

4.3.12 Disconnect the Oscilloscope Calibrator from the TI 1 connector and connect to the TI 2 connector.

4.3.13 Press TI Vertical **1**, then Vertical **2** to turn C1 off and C2 on.

4.3.14 Touch TI ***Timebase***, ***Horizontal Setup***, *RealTime*, then set the *Time/Division* to *20.0 µs*.

4.3.15 Touch TI ***Trigger***, ***Trigger Setup***, *Source*, *C2*, then *Close*.

4.3.16 Repeat steps 4.3.3 through 4.3.11 for TI C2, using C2 controls, settings and readouts.

4.3.17 Disconnect the Oscilloscope Calibrator from the TI 2 connector and connect to the TI 3 connector.

4.3.18 Press TI Vertical **2**, then Vertical **3** to turn C2 off and C3 on.

4.3.19 Touch TI ***Timebase***, ***Horizontal Setup***, *RealTime*, then set the *Time/Division* to *20.0 µs*.

4.3.20 Touch TI ***Trigger***, ***Trigger Setup***, *Source*, *C3*, then *Close*.

4.3.21 Repeat steps 4.3.3 through 4.3.11 for TI C3, using C3 controls, settings and readouts.

4.3.22 Disconnect the Oscilloscope Calibrator from the TI 3 connector and connect to the TI 4 connector.

4.3.23 Press TI Vertical **3**, then Vertical **4** to turn C3 off and C4 on.

4.3.24 Touch TI ***Timebase***, ***Horizontal Setup***, *RealTime*, then set the *Time/Division* to *20.0 µs*.

4.3.25 Touch TI ***Trigger***, ***Trigger Setup***, *Source*, *C4*, then *Close*.

4.3.26 Repeat steps 4.3.3 through 4.3.11 for TI C4, using C4 controls, settings and readouts.

4.3.27 Disconnect the test setup.

4.4 TRIGGER CALIBRATION:

4.4.1 Set the TI controls as follows:

File	***Recall Setup…***
Recall Default	
Horizontal **s ↔ ns**	*10.00 µs*
C1	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*10*, then *OK*
C2	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*10*, then *OK*
Vertical **3**	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*10*, then *OK*
Vertical **4**	
Volts/div	*100 mV*
Coupling	*50ΩDC*
Averaging	*10*, then *OK*
Cursors	***Cursors Setup…***
Horizontal (Time)	
X1	*0.0 ns*
X2	*0.0 ns*
Vertical **2** (press twice to turn channel off)	
Vertical **3** (press twice to turn channel off)	

Vertical **4** (press twice to turn channel off)

Close

4.4.2 Connect the Oscilloscope Calibrator to the TI 1 connector.

4.4.3 Set the Oscilloscope Calibrator for a 10 kHz, 700 mV p-p leveled sinewave into 50 Ω. Set the OUTPUT to ON.

4.4.4 Adjust the Oscilloscope Calibrator for 7.2 div of vertical deflection on the TI display.

4.4.5 Press TI **Clear Sweeps** and allow at least 10 sweeps as indicated on the TI display.

4.4.6 Verify the TI C1 ↓ and ↑ (cursors) indications are within -34.0 to +34.0 mV.

4.4.7 Touch TI ***Trigger***, ***Trigger Setup***, set the slope to *Negative*, then touch *Close*.

4.4.8 Repeat steps 4.4.5 and 4.4.6.

4.4.9 Touch TI ***Trigger***, ***Trigger Setup***, set the slope to *Positive*, *Level* to +250 mV, then touch *Close*.

4.4.10 Repeat steps 4.4.5 through 4.4.8 verifying the TI C1 ↓ and ↑ (cursors) indications are within +216 to +284 mV when performing step 4.4.6.

4.4.11 Repeat steps 4.4.9 and 4.4.10 for a TI trigger level setting of -250 mV, verifying the C1 ↓ and ↑ (cursors) indications are within -284 to -216 mV.

4.4.12 Set the Oscilloscope Calibrator OUTPUT to OFF.

4.4.13 Disconnect the Oscilloscope Calibrator from the TI 1 connector and connect to the TI 2 connector.

4.4.14 Press TI Vertical **1**, then Vertical **2** to turn C1 off and C2 on.

4.4.15 Set the TI controls as follows:

Trigger

Trigger Setup

Slope	*Positive*
Source	*C2*

Close

4.4.16 Set the Oscilloscope Calibrator OUTPUT to ON.

4.4.17 Repeat steps 4.4.4 through 4.4.12 for TI C2 using the C2 controls and settings.

4.4.18 Disconnect the Oscilloscope Calibrator from the TI 2 connector and connect to the TI 3 connector.

4.4.19 Press TI Vertical **2**, then Vertical **3** to turn C2 off and C3 on.

4.4.20 Set the TI controls as follows:

Trigger	
Trigger Setup	
Slope	*Positive*
Source	*C3*
Close	

4.4.21 Set the Oscilloscope Calibrator OUTPUT to ON.

4.4.22 Repeat steps 4.4.4 through 4.4.12 for TI C3 using C3 controls and settings.

4.4.23 Disconnect the Oscilloscope Calibrator from the TI 3 connector and connect to the TI 4 connector.

4.4.24 Press TI Vertical **3**, then Vertical **4** to turn C3 off and C4 on.

4.4.25 Set the TI controls as follows:

Trigger	
Trigger Setup	
Slope	*Positive*
Source	*C4*
Close	

4.4.26 Set the Oscilloscope Calibrator OUTPUT to ON.

4.4.27 Repeat steps 4.4.4 through 4.4.12 for TI C4 using C4 controls and settings.

4.4.28 Disconnect the test setup.

4.5 <u>TIME BASE ACCURACY CALIBRATION:</u>

4.5.1 Set the TI controls as follows:

File	***Recall Setup…***
Recall Default	
Horizontal **s ↔ ns**	*500 ms*
Vertical **2** (press twice to turn channel off)	
C1	
Volts/div	*100 mV*
Coupling	*50ΩDC*

Trigger **Normal**	
Measure	***Measure Setup…***
Show Table (checked)	
P1	*Frequency*
	C1
Close	

4.5.2 Connect the Oscilloscope Calibrator to the TI 1 connector.

4.5.3 Set the Oscilloscope Calibrator for a 600 mV p-p leveled sinewave at 10 MHz into 50 Ω. Set the OUTPUT to ON.

4.5.4 Verify the TI P1:freq(C1) indication is within -100 to +100 Hz.

4.5.5 Set the Oscilloscope Calibrator OUTPUT to OFF.

4.5.6 Set all POWER switches to OFF or STBY. Disconnect and secure all equipment.

CALIBRATION PERFORMANCE TABLE

Not Required