408 N. Canal St. Ste A
South San Francisco, CA 94080
support@saleae.com
www.saleae.com

PERFORMANCE VERIFICATION GUIDE

Logic MSO

Overview

This document serves as a procedure for verifying the key specifications of the Saleae Logic MSO Oscilloscopes as listed in Table 1.

Model	Channels & Bandwidth	Resolution & Memory	Part Number	Model Number
2x100 • Standard	2 Channels, 100 MHz	9-bit, 100 MSa	SAL-00195	992-00059
2x100 • Pro	2 Channels, 100 MHz	12-bit, 1000 MSa	SAL-00204	992-00062
4x100 • Standard	4 Channels, 100 MHz	9-bit, 100 MSa	SAL-00207	992-00063
4x100 • Pro	4 Channels, 100 MHz	12-bit, 1000 MSa	SAL-00216	992-00066
4x200 • Standard	4 Channels, 200 MHz	9-bit, 100 MSa	SAL-00219	992-00067
4x200 • Pro	4 Channels, 200 MHz	12-bit, 1000 MSa	SAL-00228	992-00070

Table 1: Logic MSO Series Oscilloscopes Models

Warm-Up

Before calibrating, ensure that the Saleae Logic MSO has warmed up for at least 30 minutes and reaches a temperature of at least 49°C. The software must be running and connected to the device in order for it to warm up. The software will display Logic MSO's temperature in the bottom right corner. All other test equipment used for calibration must be warmed up for the duration specified in the respective datasheet. The room temperature must stay within 23°C ± 5°C for the duration of the procedure.

Equipment

Two options are described in the table below for providing the required standards for calibration and verification. However, any calibrated and NIST traceable equipment that meets the minimum specifications can be used.

Equipment List			
Equipment	Qty	Minimum Specifications	Recommended Equipment
[1] Option 1: Signal Generator + Digital Multimeter	1	Time base accuracy: ±3.5 ppm DC Amplitude: +10/-10V range (High-Z) Accuracy: ±0.0035% reading + 0.0005% range Sine frequency: 200 MHz	Teledyne T3AFG350 BK Precision 5493C
Option 2: Oscilloscope Calibrator	1	Time base accuracy: ±3.5 ppm DC Amplitude: +10/-10V range (High-Z) Accuracy: ±(0.025% + 25 µV) Sine frequency: 200 MHz Resistance: ±0.1%, Capacitance: 2% ±0.25pF	Fluke 9500B
50 ohm feed-through termination (SMA)	1	50 Ohm	Pasternack PE6026
Short Coax Cable (BNC)	1	Male to Male, 3 feet	Amphenol CO-058BNCX200-003
BNC to SMB adapter	1	Female BNC to Female SMB	Amphenol 242186
BNC to SMA adapter	1	Female BNC to Female SMA	Molex 0733860041
SMA to SMB adapter	1	Female SMA to Female SMB	Molex 0733860224
[1]BNC T-adapter	1	1 Male 2 Female	Amphenol 112461
[1]BNC to banana adapter	1	BNC Female	Pomona 1269

Table 2: Required Equipment List

[1]Marked items in Table 2 are only required for Option 1.

DC Vertical Accuracy Verification

$$\pm 2\%\ \mathbf{FSR}\ [V] \pm 1\%\ \mathbf{OFFSET}\ [V] \pm 2\ \mathbf{mV}$$

Setup Option 1:

1. Connect the signal generator to the T-adapter.
2. Connect the T-adapter to the DMM using a BNC cable and the BNC to banana adapter.
3. Connect the T-adapter to Logic MSO using a BNC cable and the BNC to SMB adapter.

Setup Option 2:

1. Connect the calibrator to Logic MSO using the BNC cable and the BNC to SMB adapter.

Process:

For each test condition listed in Table 3 below and each channel of Logic MSO, perform the following:

1. Make sure the correct Logic MSO input is connected.
2. If using Option 1, set the correct DC output voltage on the signal generator (high-z mode) and verify that it is correct using the DMM. Make fine-tuning adjustments if necessary. If using Option 2, set the correct DC output voltage on the calibrator.
3. Using Logic2 Software, set the correct Full Scale Range in Device Settings for the appropriate Channel.
4. Make sure the probe input setting is set to 1:1 and DC coupling.
5. Using the Mean measurement feature, record the voltage with Logic MSO.

DC Vertical Accuracy Test Conditions				
Test Condition	Minimum	Measured	Maximum	Uncertainty
FS Range: 10 mV, Input: −3 mV, Offset: 0 V	−5.12 mV	-	−0.89 mV	3.65 µV
FS Range: 10 mV, Input: 3 mV, Offset: 0 V	0.89 mV	-	5.12 mV	3.65 µV
FS Range: 20 mV, Input: −6 mV, Offset: 0 V	−8.24 mV	-	−3.77 mV	3.8 µV
FS Range: 20 mV, Input: 6 mV, Offset: 0 V	3.77 mV	-	8.24 mV	3.8 µV
FS Range: 50 mV, Input: −15 mV, Offset: 0 V	−17.6 mV	-	−12.41 mV	4.25 µV
FS Range: 50 mV, Input: 15 mV, Offset: 0 V	12.41 mV	-	17.6 mV	4.25 µV
FS Range: 100 mV, Input: −30 mV, Offset: 0 V	−33.2 mV	-	−26.81 mV	5 µV
FS Range: 100 mV, Input: 30 mV, Offset: 0 V	26.81 mV	-	33.2 mV	5 µV
FS Range: 200 mV, Input: −60 mV, Offset: 0 V	−64.39 mV	-	−55.61 mV	9.4 µV
FS Range: 200 mV, Input: 60 mV, Offset: 0 V	56.61 mV	-	64.39 mV	9.4 µV
FS Range: 500 mV, Input: −150 mV, Offset: 0 V	−157.99 mV	-	−142.03 mV	13 µV
FS Range: 500 mV, Input: 150 mV, Offset: 0 V	142.03 mV	-	157.99 mV	13 µV
FS Range: 1 V, Input: −300 mV, Offset: 0 V	−313.98 mV	-	−286.04 mV	19 µV
FS Range: 1 V, Input: 300 mV, Offset: 0 V	286.04 mV	-	313.98 mV	19 µV
FS Range: 2 V, Input: −600 mV, Offset: 0 V	−625.97 mV	-	−574.06 mV	71 µV
FS Range: 2 V, Input: 600 mV, Offset: 0 V	574.06 mV	-	625.97 mV	71 µV
FS Range: 5 V, Input: −1.5 V, Offset: 0 V	−1.56 V	-	−1.44 V	102.5 µV
FS Range: 5 V, Input: 1.5 V, Offset: 0 V	1.44 V	-	1.56 V	102.5 µV
FS Range: 10 V, Input: −3 V, Offset: 0 V	−3.12 V	-	−2.88 V	155 µV
FS Range: 10 V, Input: 3 V, Offset: 0 V	2.88 V	-	3.12 V	155 µV
FS Range: 20 V, Input: −6 V, Offset: 0 V	−6.24 V	-	−5.76 V	260 µV
FS Range: 20 V, Input: 6 V, Offset: 0 V	5.76 V	-	6.24 V	260 µV
FS Range: 50 V, Input: −10 V, Offset: 0 V	−10.470 V	-	−9.60 V	400 µV
FS Range: 50 V, Input: 10 V, Offset: 0 V	9.60 V	-	10.40 V	400 µV

Table 3: DC Vertical Accuracy Test Conditions

Time Base Accuracy Verification

$\pm 25\ \text{ppm} \pm 5 \frac{\text{ppm}}{\text{year}}\ \text{at} + 25°C$

Setup:

1. Connect the coax to the signal generator or calibrator.
2. Connect the coax to Logic MSO with 50 ohm termination, using the BNC to SMA adapter, the terminator, and the SMA to SMB adapter.

Process:

For each test condition listed in Table 4 below and each channel of Logic MSO, perform the following:

1. Set the signal generator output to a sine wave, 10 MHz, 1Vpp amplitude, 50 ohm output.
2. Logic MSO settings:
   a. 1:1 probe attenuation.
   b. 2 volts full scale range, 0 volts offset.
   c. Bottom Right Time Settings to Maximum time zoom (12.5ns Range) and 1ms time offset
   d. Trigger on rising edge, 0 volts, normal mode, channel 0.
3. Measure offset between sine wave zero crossing point and 1 ms vertical line. This offset is delta T, and used to compute the time base accuracy. The absolute value in nanoseconds is equal to the error in ppm.

Time Base Accuracy Test Conditions				
Test Condition	Minimum	Measured	Maximum	Uncertainty
Time Zoom: 1 ns/Div, Input: 10 MHz Sine 1 Vpp, Time Offset: 1 ms	−25 ppm	-	25 ppm	7 ppm

Table 4: Time Base Accuracy Test Conditions

Bandwidth Verification

$-3\ \text{dB @200 MHz OR 100 MHz}$

Setup:

1. Connect the coax to the signal generator or calibrator.
2. Connect the coax to Logic MSO with 50 ohm termination, using the BNC to SMA adapter, the terminator, and the SMA to SMB adapter.

Process:

For each test condition listed in Table 5 below and each channel of Logic MSO, perform the following:

1. Set the signal generator or calibrator output to the Vrms1 setting.
2. Using Logic2 Software, record the AC RMS reading for at least 5 cycles.
3. Set the signal generator or calibrator output to the Vrms2 setting using 100 or 200 MHz depending on your Logic MSO model.
4. Using Logic2 Software, record the AC RMS reading for at least 5 cycles.
5. Calculate Amplitude Loss (dB) = $20 \times \log\left(\frac{V_{\text{rms2}}}{V_{\text{rms1}}}\right)$

Bandwidth Test Conditions					
Test Condition	Vrms1	Vrms2	Amplitude Loss	Limit	Uncertainty
Vrms1: 1 MHz Sine, 0.5 Vpp Vrms2: 200/100 MHz Sine, 0.5 Vpp FS Range/Attenuation: 1 V/x1	-	-	-	−2 dB	0.3 dB
Vrms1: 1 MHz Sine, 1 Vpp Vrms2: 200/100 MHz Sine, 1.5 Vpp FS Range/Attenuation: 2 V/x10	-	-	-	−2 dB	0.3 dB
Vrms1: 1 MHz Sine, 1.5 Vpp Vrms2: 200/100 MHz Sine, 1.5 Vpp FS Range/Attenuation: 20 V/x100	-	-	-	−2 dB	0.3 dB

Table 5: Bandwidth Test Conditions

*Amplitude Loss (dB) = 20 × log(Vrms2/Vrms1)

Input Impedance and Capacitance

$1\ \mathrm{M\Omega}\ (\pm 2\%) \parallel 16\ \mathrm{pF}\ (\pm 4\ \mathrm{pF})$

Setup:

1. Connect the coax to the calibrator, the other end of the cable should have the SMA to SMB adapter, however, it should not be connected to Logic MSO for the initial cable reading.
2. Connect the cable and SMA to SMB adapter to Logic MSO once the cable reading has been taken.

Process:

For each test condition listed in the table below and each channel of Logic MSO, perform the following:

1. Set the Calibrator to measure capacitance.
2. First, measure the capacitance of the cable and adapter while unconnected to Logic MSO.
3. Connect the cable to the channel under test.
4. Measure the capacitance while connected to Logic MSO.
5. Calculate Logic MSO channel capacitance by subtracting the cable capacitance: Logic MSO Channel Capacitance = Capacitance reading while connected to Logic MSO - Cable and Adapter Capacitance reading.
6. Set the Calibrator to measure impedance and take a reading.

Input Impedance and Capacitance Test Conditions				
Test Condition	Impedance	Channel Capacitance	Limit	Uncertainty
FS Range/Attenuation: 1 V/x1	-	-	±200 kΩ, ±2 pF	±10 kΩ, ±0.6 pF
FS Range/Attenuation: 2 V/x10	-	-	±200 kΩ, ±2 pF	±10 kΩ, ±0.6 pF
FS Range/Attenuation: 20 V/x100	-	-	±200 kΩ, ±2 pF	±10 kΩ, ±0.6 pF

Table 6: Input Impedance and Capacitance Test Conditions