

SHS1000 Series Performance Verification

Oscilloscope Performance Test

This chapter mainly explains how to perform tests to make sure that the handheld oscilloscope meets the performance specifications. For accurate test results, please let the test equipment and the oscilloscope warm up 30 minutes before testing.

Here is a list of the required equipment for the test:

Table Test equipment

Description	Critical Specifications	Example
DC Voltage Source	6 mV~300 V, $\pm 0.1\%$ accuracy	FLUKE 5522A
Sine Wave Generator	10 Hz~300 MHz, $\pm 0.1\%$ amplitude accuracy	FLUKE 9500B
BNC Cable	BNC (m) to BNC (m), About 1m long	
50 Ω Feedthrough Termination	50 Ω BNC (f) to BNC (m)	

Verify Test Results

To verify whether a test passes, whether the readings are within the limits, it is necessary for you to record the readings in the Performance Test on Test Record.

Self-Test

This internal procedure is automatically performed every time the SHS powers on. No test equipment is required. Verify that no error messages are displayed before continuing with the procedure.

Self-Calibration

You must perform the Self-Calibration operation. If the environmental temperature changes by more than 5°C, you must perform the Self-Calibration operation again.

To verify DC Gain Accuracy

DC Gain Accuracy error = $| 1 - \{ (V_{\text{pos}} - V_{\text{neg}}) / (V_{\text{Setting}(+)} - V_{\text{Setting}(-)}) \} |$
 $< 3\%$

Note: "VSetting" represents DC voltage output level
 This test verifies DC Gain Accuracy of all channels.

Steps:

1. Set the DC voltage source output level to 0 V.
2. Connect channel 1 of the SHS to the DC voltage source of FLUKE 9500B/FLUKE 5522A using its specified cable.
3. Set the Volts/Div of channel 1 to 100 V/div.
4. Set the DC voltage output level to the positive voltage listed below and then record the reading as V_{pos} .
5. Reverse the polarity of the DC voltage source and then record the reading as V_{neg} .
6. $V_{\text{sub}} = V_{\text{pos}} - V_{\text{neg}}$, calculate V_{sub} and then check to see if it is in the accuracy limits range.
7. Set the Volts/Div of channel 1 from 5 V/div to 5 mV/div, and then record the reading in the same way as step 4 to 6.
8. Set DC voltage source output level to 0 V.
9. Disconnect the connection of channel 1.
10. Check channel 2 in the same way as step 1 to 9.

Table DC Gain Accuracy

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DC Gain Accuracy	5 mV/div-100 V/div : $\leq \pm 3\%$
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Volt/div	DC voltage output levels	Accuracy limits range for V_{sub}
100 V/div	+300 V, -300 V	582 V ~ 618 V
50 V/div	+150 V, -150 V	291 V ~ 309 V
20 V/div	+60 V, -60 V	116.4 V ~ 123.6 V
10 V/div	+30 V, -30 V	58.2 V ~ 61.8 V
5 V/div	+15 V, -15 V	29.1 V ~ 30.9 V
2 V/div	+6 V, -6 V	11.64 V ~ 12.36 V
1 V/div	+3 V, -3 V	5.82 V ~ 6.18 V
500 mV/div	+1500 mV, -1500 mV	2.91 V ~ 3.09 V
200 mV/div	+600 mV, -600 mV	1.164 V ~ 1.236 V
100 mV/div	+300 mV, -300 mV	582 mV ~ 618 mV
50 mV/div	+150 mV, -150 mV	291 mV ~ 309 mV
20 mV/div	+60 mV, -60 mV	116.4 mV ~ 123.6 mV
10 mV/div	+30 mV, -30 mV	58.2 mV ~ 61.8 mV
5 mV/div	+15 mV, -15 mV	29.1 mV ~ 30.9 mV

To verify Bandwidth

This test checks the bandwidth of two input channels. In the test, both the impedance of FLUKE 9500B and the SHS are required to be set to 50 Ω . The FLUKE 9500B impedance can be changed on the front panel, but for the SHS, it proves to be a little different since it is designed with only 1M Ω in impedance. So a 50 Ω feedthrough terminator is needed essential to complete the verification.

Table Input Impedance for SHS1000

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Model	Channels	Bandwidth	Input Impedance
SHS1102	2	100 MHz	1M Ω
SHS1062	2	60 MHz	1M Ω

Add the 50 Ω feedthrough terminator to the end of the probe specified for the FLUKE 9500B.

To test the bandwidth at 500 mV/div and 200 mV/div

Steps: 1. Connect channel 1 of the SHS to Sine Wave Generator of FLUKE 9500B via its specified probe.

2. Set the SHS Volt/Div to 500 mV/div, the Sec/Div to 50 ms/div.

3. Set the frequency of Sine Wave Generator of FLUKE9500B to 10 Hz.

4. Set the amplitude of Sine Wave Generator to 3 V.

5. Press the MEASURE button on the front panel of the SHS to display Vpp measurement.

6. Set the frequency of Sine Wave Generator to:

- 60 MHz if you are testing an SHS1062
- 100 MHz if you are testing an SHS1102

Table Bandwidth test data

Volts/Div	Input frequency	Vpp measured
500 mV/div	10 Hz	3.0 V
	100 Hz	
	1 kHz	
	10 kHz	
	100 kHz	
	1 MHz	
	10 MHz	
	20 MHz	
	30 MHz	
	...	
	bandwidth	
	10 Hz	1.2 V
	100 Hz	
	1 kHz	
	10 kHz	

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200 mV/div	100 kHz	
	1 MHz	
	10 MHz	
	20 MHz	
	30 MHz	
	...	
	bandwidth	

7. Every time you set to a frequency, adjust the Sec/Div such that at least one full period of the waveform or more is visible.
8. The Vpp measurement of the waveform will decrease as the input frequency increases. Increasing the input frequency gradually until the Vpp measurement gets closest to 2.12 V.
9. Disconnect channel 1.
10. Check channel 2 in the same way as steps 1 to 9.

For test at 200 mV/div, please perform the same operation as that at 500 mV/div, except for the initial amplitude and amplitude at bandwidth listed below.

Table Amplitude at bandwidth

Volts/Div	Initial amplitude	Amplitude at bandwidth	Initial frequency
500 mV/div	3 V	$0.707 \times 3 \text{ V} = 2.12 \text{ V}$	10 Hz
200 mV/div	1.2 V	$0.707 \times 1.2 \text{ V} = 0.848 \text{ V}$	10 Hz

To verify Time Base Accuracy

This test checks the time base accuracy of one channel. In the test, both the impedance of FLUKE 9500B and the SHS are required to set to 50Ω. The input impedance of the FLUKE 9500B can be changed via the front panel. But for the SHS, you need to add a 50Ω feedthrough terminator at the end of spec head of FLUKE 9500B.

Time Base Accuracy: Freq/10 MHz < 50 ppm

Steps:

1. Connect selected channel of the SHS to the Sine Wave Generator of FLUKE 9500B.

2. Set the frequency of the Sine Wave Generator to 10 MHz.
3. Set the SHS Volts/Div to 500 mV/div.
4. Set the SHS Sec/Div to 1 ms/div.
5. Press MEASURE button on the front panel of the SHS to display Freq measurement.
6. Calculate Freq/10 MHz to see if the value is within the range of 50 ppm, which means correct time base accuracy.
7. Disconnect the test connection

To verify Trigger Sensitivity

To test trigger sensitivity at the frequency of 100 kHz, 10 MHz and bandwidth.

Table Trigger sensitivity data

Volts/Div	Frequency	Trigger Range
500 mV/div	100 kHz	500 mVpp
500 mV/div	10 MHz	500 mVpp
500 mV/div	bandwidth	750 mVpp

- Steps:
1. Connect the selected channel of the SHS to the Sine Wave Generator of the FLUKE 9500B.
 2. Set the SHS Volts/Div to 500 mV/div.
 3. Set the SHS Sec/Div to 5us/div.
 4. Set the frequency of the Sine Wave Generator to 100 kHz.
 5. Set the amplitude of the Sine Wave Generator to 500 mVpp, so that the Vpp measurement of the SHS is approximately 500 mV.
 6. Press 'arrows of Trigger level' button to move the waveform to the screen center.
 7. Adjust the Trigger level within the waveform range to check for a stable trigger.
 8. Set the SHS Sec/Div to 50 ns/div.
 9. Set the frequency of the Sine Wave Generator to 10 MHz.
 10. Set the amplitude of the Sine Wave Generator to 500 mVpp, so that the Vpp measurement of the SHS is approximately 500 mV.
 11. Press 'arrows of Trigger level' button to move the waveform to the screen center.

12. Adjust the Trigger level within the waveform range to check if there is stable trigger.
13. Set the SHS Sec/Div to 5 ns/div.
14. Set the frequency of the Sine Wave Generator to:
 - 60 MHz if you are testing a SHS1062
 - 100 MHz if you are testing a SHS1102
15. Set the amplitude of the Sine Wave Generator to 750 mVpp, so that the Vpp measurement of the SHS is approximately 750 mV.
16. Press 'arrows of Trigger level' button to move the waveform to the screen center.
17. Adjust the Trigger level within the waveform range to check if there is stable trigger.
18. Disconnect the test connection.
19. Check channel 2 in the same way as step 1 to 18.

Multimeter Performance Test

Use the performance verification tests in this section to verify the measurement performance of the instrument using the instrument's specifications listed in the product data sheet.

Performance verification tests are recommended as an acceptance test when you first receive the instrument or after performing calibration. If the instrument fails performance verification, calibration adjustment or repair is required.

Performance verification test items

- DC Voltage and DC current accuracy verification
- Resistance accuracy verification
- AC Voltage and AC current accuracy verification
- Capacitance accuracy verification

Recommended Test Equipment

The recommended test equipment for the performance verification and calibration is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Application	Recommended Equipment
DC Voltage and DC Current Gain Verification	Fluke 5522A
Resistance Verification	Fluke 5522A
AC Voltage and AC Current Verification	Fluke 5522A
Capacitance Verification	Fluke 5522A

Performance verification step

1. Connect the calibrator to the input terminals correctly.
2. Configure each function and range in the order shown in the table. Provide the input shown in the table.
3. Make a measurement and return the result. Compare measurement results to the test limits shown in the table. (Be certain to allow for appropriate source settling time.)

Test Considerations

- Ensure that the test ambient temperature is stable and between 18°C and 28°C. Ideally the calibration should be performed at 23°C ± 2°C.
- Ensure ambient relative humidity is less than 80%.
- Allow a 30 minute warm up period with a copper short connected.
- These specifications are tested under the battery supply.

DC Voltage and DC Current Gain Verification

Input			Error from Nominal (1 years)
Range	Function	Resolution	
60.00 mV	DC Volts	10 uV	±750 µV
600.0 mV		100 uV	±6.5 mV
6.000 V		1 mV	±65 mV
60.00 V		10 mV	±650 mV
600.0 V		100 mV	±6.5 V
1000V		1 V	±15 V

DC Voltage and DC Current Gain Verification (con't)

Input			Error from Nominal (1 years)
Range	Function	Resolution	
60.00 mA	DC Current	10 μ A	± 2.45 mA
600.0 mA		100 μ A	± 24.5 mA
6.000 A		1 mA	± 305 mA
10.00 A		10 mA	± 505 mA

Resistance Verification

Input			Error from Nominal (1 years)
Range	Function	Resolution	
600.0 Ω	Resistance	0.1 Ω	± 6.5 Ω
6.000 k Ω		1 Ω	± 65 Ω
60.00 k Ω		10 Ω	± 650 Ω
600.0 k Ω		100 Ω	± 6.5 k Ω
6.000 M Ω		1 k Ω	± 65 k Ω
60.00 M Ω		10 k Ω	± 2.45 M Ω

AC Voltage and AC Current Verification

Input			Error from Nominal (1 years)
Range	Frequency	Resolution	
60.00 mV	20 Hz~400 Hz	10 μ V	± 750 μ V
600.0 mV		100 μ V	± 6.5 mV
6.000 V		1 mV	± 65 mV
60.00 V		10 mV	± 650 mV
600.0 V		100 mV	± 6.5 V
750.0 V		100 mV	± 11.8 V

Input			Error from Nominal (1 years)
Range	Frequency	Resolution	
60.00 mA	20Hz~400Hz	10 μ A	± 2.45 mA
600.0 mA		100 μ A	± 24.5 mA
6.000 A		1 mA	± 305 mA
10.00 A		10 mA	± 550 mA

Capacitance Verification

Input		Error from Nominal (1 year)
Range	Resolution	
40.00 nF	0.01 nF	±1.7 nF
400.0 nF	0.1 nF	±20.5 nF
4.000 uF	1 nF	±205 nF
40.00 µF	10 µF	±2.05 uF
400.0 µF	100 µF	±20.5 uF

End