SHS800 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, including the oscilloscope warm up 30 minutes before testing.

Here are the required equipment for the test:

Table Test equipment

Description	Critical Specifications	Example
DC Voltage Source	6 mv~30 V, ± 0.1% accuracy	FLUKE 9500B
Sine Wave Generator	10 Hz~300 MHz, ± 0.1 % amplitude accuracy	FLUKE 9500B
BNC Cable	BNC (m) to BNC (m), About 1 m long	
50Ω Feedthrough Termination	50Ω 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℃, you must perform the Self Calibration operation again.

To verify DC Gain Accuracy

DC Gain Accuracy error = | 1- { (Vpos－Vneg) / (VSetting(+)－VSetting(-)) } | <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 10 V/div.
4. Set the DC voltage output level to the positive voltage listed below and then record the reading as Vpos.
5. Reverse the polarity of the DC voltage source and then record the reading as Vneg.
6. $V_{sub} = V_{pos} - V_{neg}$, calculate $\mathbf{V_{sub}}$ 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 2 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 by repeating steps 1 to 9 with channel 2 as the input.

Table DC Gain Accuracy

DC Gain Accuracy	5 mV/div-100 V/div: ≤ ± 3% ; 2 mV/div: ≤ ± 4%

Volt/div	DC voltage output levels	Accuracy limits range for V_{sub}
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
2 mV/div	+6 mV, -6 mV	11.52 mV ~ 12.48 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 set to 50Ω, we could complete that for FLUKE 9500B by easy operation on the front panel. But for the SHS, it proves to be a little different since it is designed with only 1MΩ input impedance. So a 50Ω feedthrough terminator is required to complete the verification.

Table Input Impedance for SHS800

Model	Channels	Bandwidth	Input Impedance

SHS820*	2	200 MHz	1MΩ
SHS815	2	150 MHz	1MΩ
SHS810	2	100 MHz	1MΩ
SHS806	2	60 MHz	1MΩ

The 50Ω feedthrough terminator is added to end of the probe specified for FLUKE 9500B.

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

***Notes:**

When testing the SHS820, set the acquisition sample mode to EQU TIME before testing bandwidth. This is because the sample rate of the SH820 is 500 MSa/s and the Bandwidth is 200 MHz.

To change the acquisition sample mode, press the SCOPE function button > Acquire > and set Mode to EQU TIME

Steps: 1. Connect channel 1 of the SHS to the Sine Wave Generator of the 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 the Sine Wave Generator of the FLUKE 9500B to 10 Hz.
4. Set the amplitude of the 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 a SHS806
- 100 MHz if you are testing a SHS810
- 150 MHz if you are testing a SHS815
- 200 MHz if you are testing a SHS820

Table Bandwidth test data

Volts/Div	Input frequency	Vpp measured
	10 Hz	3.0 V
	100 Hz	
	1 kHz	
	10 kHz	

500 mV/div	100 kHz	
	1 MHz	
	10 MHz	
	20 MHz	
	30 MHz	
	…	
	bandwidth	
200 mV/div	10 Hz	1.2 V
	100 Hz	
	1 kHz	
	10 kHz	
	100 kHz	
	1 MHz	
	10 MHz	
	20 MHz	
	30 MHz	
	…	
	bandwidth	

7. Every time you change the input frequency, confirm that the display is showing at least one full sine wave. Adjust the Sec/Div to a proper value to display a perfect waveform.
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 the connection of channel 1.
10. Check channel 2 in the same way as steps 1 to 9.

For testing 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	0.707×3 V=2.12 V	10 Hz
200 mV/div	1.2 V	0.707×1.2 V=0.848 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. It is convenient for FLUKE 9500B by easy operation on the front panel. But for SHS, you need to add a 50Ω feedthrough terminator at the end of the test head of the FLUKE 9500B.

Time Base Accuracy: Freq/10 MHz< 50 ppm

Steps:

1. Connect selected channel of the SHS to the Sine Wave Generator of the 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 maximum scope 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	Max bandwidth	750 mVpp

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

2. Set the SHS Volts/Div to 500 mV/div.

3. Set the SHS Sec/Div to 5 us/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 center of the display.
7. Adjust the Trigger level within the waveform range to check if there is 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 a 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 SHS806
- 100 MHz if you are testing a SHS810
- 150 MHz if you are testing a SHS815
- 200 MHz if you are testing a SHS820

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 CH1 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 using the battery as the power 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	±6.5mV
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

Input			Error from Nominal (1 years)
Range	Function	Resolution	
60.00 mA	DC Current	10 uA	±2.45 mA
600.0 mA		100 uA	±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 kΩ		1 Ω	±65 Ω
60.00 kΩ		10 Ω	±650 Ω
600.0 kΩ		100 Ω	±6.5 kΩ
6.000 MΩ		1 kΩ	±65 kΩ
60.00 MΩ		10 kΩ	±2.45 MΩ

AC Voltage and AC Current Verification

Input			Error from Nominal (1 years)
Range	Frequency	Resolution	
60.00 mV		10 uV	±750 uV

600.0 mV	20 Hz~400 Hz	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
750.0 V		100 mV	±11.8 V

Input			**Error from Nominal (1 years)**
Range	**Frequency**	**Resolution**	
60.00 mA	20Hz~400Hz	10 uA	±2.45 mA
600.0 mA		100 uA	±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