



RIGOL

DHO900 Series

Digital Oscilloscope

Performance Verification

Oct. 2023



Guaranty and Declaration

Copyright

© 2023 RIGOL TECHNOLOGIES CO., LTD. All Rights Reserved.

Trademark Information

RIGOL® is the trademark of RIGOL TECHNOLOGIES CO., LTD.

Notices

- RIGOL products are covered by P.R.C. and foreign patents, issued and pending.
- RIGOL reserves the right to modify or change parts of or all the specifications and pricing policies at the company's sole decision.
- Information in this publication replaces all previously released materials.
- Information in this publication is subject to change without notice.
- RIGOL shall not be liable for either incidental or consequential losses in connection with the furnishing, use, or performance of this manual, as well as any information contained.
- Any part of this document is forbidden to be copied, photocopied, or rearranged without prior written approval of RIGOL.

Product Certification

RIGOL guarantees that this product conforms to the national and industrial standards in China as well as the ISO9001:2015 standard and the ISO14001:2015 standard. Other international standard conformance certifications are in progress.

Contact Us

If you have any problem or requirement when using our products or this manual, please contact RIGOL.

E-mail: service@rigol.com

Website: <http://www.rigol.com>

Section	Description	Page
	List of Figures.....	III
	List of Tables.....	IV
1	Safety Requirement	1
1.1	General Safety Summary	1
1.2	Safety Notices and Symbols	3
2	Specifications	4
3	Document Overview	6
4	Overview	8
4.1	Test Preparations	8
4.2	Test Result Record	9
4.3	Specifications	10
5	Performance Verification Test	11
5.1	Impedance Test	11
5.1.1	Specification	11
5.1.2	Test Connection Diagram	12
5.1.3	Test Procedures	12
5.1.4	Test Record From	12
5.2	Input Capacitance Test	13
5.2.1	Specification	13
5.2.2	Test Connection Diagram	13
5.2.3	Test Procedures	13
5.2.4	Test Record From	14
5.3	DC Gain Accuracy Test	14
5.3.1	Specification	14
5.3.2	Test Connection Diagram	15
5.3.3	Test Procedures	15
5.3.4	Test Record From	16
5.4	DC Offset Accuracy Test	18
5.4.1	Specification	18
5.4.2	Test Connection Diagram	18
5.4.3	Test Procedures	18
5.4.4	Test Record From	19
5.5	Bandwidth Test	20

5.5.1	Specification	20
5.5.2	Test Connection Diagram	21
5.5.3	Test Procedures	21
5.5.4	Test Record Form	22
5.6	Time Base Accuracy Test	23
5.6.1	Specification	23
5.6.2	Test Connection Diagram	24
5.6.3	Test Procedures	24
5.6.4	Test Record Form	25
6	Appendix: Test Record Form	26

List of Figures

Figure 4.1 Self-calibration Menu	9
Figure 5.1 Input Impedance Test Connection Diagram	12
Figure 5.2 Input Capacitance Test Connection Diagram	13
Figure 5.3 DC Gain Accuracy Test Connection Diagram	15
Figure 5.4 DC Offset Accuracy Test Connection Diagram	18
Figure 5.5 Bandwidth Test Connection Diagram	21
Figure 5.6 Time Base Accuracy Test Connection Diagram	24

List of Tables

Table 2.1 Specifications	4
Table 5.1 Test Devices	11

1 Safety Requirement

1.1 General Safety Summary

Please review the following safety precautions carefully before putting the instrument into operation so as to avoid any personal injury or damage to the instrument and any product connected to it. To prevent potential hazards, please follow the instructions specified in this manual to use the instrument properly.

- **Use Proper Power Cord.**

Only the power cord designed for the instrument and authorized for use within the local country could be used.

- **Ground the Instrument.**

The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, connect the earth terminal of the power cord to the Protective Earth terminal before connecting any input or output terminals.

- **Connect the Probe Correctly.**

If a probe is used, the probe ground lead must be connected to earth ground. Do not connect the ground lead to high voltage. Improper way of connection could result in dangerous voltages being present on the connectors, controls or other surfaces of the oscilloscope and probes, which will cause potential hazards for operators.

- **Observe All Terminal Ratings.**

To avoid fire or shock hazard, observe all ratings and markers on the instrument and check your manual for more information about ratings before connecting the instrument.

- **Use Proper Overvoltage Protection.**

Ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the operator might be exposed to the danger of an electric shock.

- **Do Not Operate Without Covers.**

Do not operate the instrument with covers or panels removed.

- **Do Not Insert Objects into the Air Outlet.**

Do not insert objects into the air outlet, as doing so may cause damage to the instrument.

- **Use Proper Fuse.**

Please use the specified fuses.

- **Avoid Circuit or Wire Exposure.**

Do not touch exposed junctions and components when the unit is powered on.
- **Do Not Operate With Suspected Failures.**

If you suspect that any damage may occur to the instrument, have it inspected by RIGOL authorized personnel before further operations. Any maintenance, adjustment or replacement especially to circuits or accessories must be performed by RIGOL authorized personnel.
- **Provide Adequate Ventilation.**

Inadequate ventilation may cause an increase of temperature in the instrument, which would cause damage to the instrument. So please keep the instrument well ventilated and inspect the air outlet and the fan regularly.
- **Do Not Operate in Wet Conditions.**

To avoid short circuit inside the instrument or electric shock, never operate the instrument in a humid environment.
- **Do Not Operate in an Explosive Atmosphere.**

To avoid personal injuries or damage to the instrument, never operate the instrument in an explosive atmosphere.
- **Keep Product Surfaces Clean and Dry.**

To avoid dust or moisture from affecting the performance of the instrument, keep the surfaces of the instrument clean and dry.
- **Prevent Electrostatic Impact.**

Operate the instrument in an electrostatic discharge protective environment to avoid damage induced by static discharges. Always ground both the internal and external conductors of cables to release static before making connections.
- **Proper Use of Battery.**

Do not expose the battery (if available) to high temperature or fire. Keep it out of the reach of children. Improper change of battery (note: lithium battery) may cause explosion. Use the RIGOL specified battery only.
- **Handle with Caution.**

Please handle with care during transportation to avoid damage to keys, knob interfaces and other parts on the panels.

1.2 Safety Notices and Symbols

Safety Notices in this Manual:



WARNING

Indicates a potentially hazardous situation or practice which, if not avoided, will result in serious injury or death.



CAUTION

Indicates a potentially hazardous situation or practice which, if not avoided, could result in damage to the product or loss of important data.

Safety Notices on the Product:

- **DANGER**

It calls attention to an operation, if not correctly performed, could result in injury or hazard immediately.

- **WARNING**

It calls attention to an operation, if not correctly performed, could result in potential injury or hazard.

- **CAUTION**

It calls attention to an operation, if not correctly performed, could result in damage to the product or other devices connected to the product.

Safety Symbols on the Product:



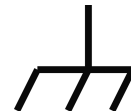
Hazardous Voltage



Safety Warning



Protective Earth Terminal



Chassis Ground



Test Ground

2 Specifications

This chapter lists the technical specifications of the DHO900 series oscilloscope.

DHO900 series digital oscilloscope achieves 1.25 GSa/s sample rate, a fast waveform capture rate of 1,000,000 wfms/s with the UltraAcquire mode, up to 50 Mpts memory depth, 12-bit vertical resolution, all combined with excellent noise floor performance and vertical accuracy to meet your requirements for more accurate measurements.

To meet specifications, these conditions must be met:

- The instrument must have been calibrated in an ambient temperature between 18°C and 28°C.
- The instrument must be operating within the environmental limits. (For the specific environment requirements, refer to *DHO900 Data Sheet*).
- The instrument must be powered from a source that meets the requirement for the power supply. (For the power specifications, refer to *DHO900 Data Sheet*).
- The instrument must have been operating continuously for at least 30 minutes within the specified operating temperature range.

The following table shows some of the technical specifications of DHO914, DHO914S, DHO924, and DHO924S. For other technical specifications of DHO900, please refer to *DHO900 Data Sheet*.

Table 2.1 Specifications

Overview of the DHO900 Series Technical Specifications				
Model	DHO914	DHO914S	DHO924	DHO924S
Analog Bandwidth	125 MHz	125 MHz	250 MHz	250 MHz
No. of Input Channels	4 analog channel inputs, 16 digital channel inputs			
Input Coupling	DC, AC, or GND			
Input Impedance	1 MΩ ± 1%			
Sampling Mode	Real-time sampling			
Bandwidth Limit (Typical)	20 MHz, FULL; selectable for each channel			
Max. Analog Channel Sample Rate	1.25 GSa/s (single channel ^[1]), 625 MSa/s (half channels ^[2]), 312.5 MSa/s (all channels ^[3])			

Overview of the DHO900 Series Technical Specifications	
Max. Memory Depth	50 Mpts (single channel ^[1]), 25 Mpts (half channels ^[2]), 10 Mpts (all channels ^[3])
Max. Waveform Capture Rate	30,000 wfms/s (Vector Mode) 1,000,000 wfms/s (UltraAcquire Mode)
Vertical Resolution	12 bits
DC Gain Accuracy ^[4]	±1% (>5 mV/div, Full Scale) ±2% (≤5 mV/div, Full Scale, Typical)
Time Base Accuracy	±25 ppm ± 5 ppm/year
Trigger Source	Analog channels (CH1 to CH4), digital channels (D0 to D15)

NOTE

[1]: If any one of the channels is enabled, it is called single channel mode.

[2]: If two of the channels are enabled, it is called half channels mode.

[3]: If any three channels or all four channels are enabled, it is called all channels mode.

[4]: 200 μ V/div and 500 μ V/div are a magnification of 1 mV/div setting. For vertical accuracy calculations, use full scale of 8 mV.

3 Document Overview

This manual is designed to guide you to properly test the performance specifications of RIGOL DHO900 series digital oscilloscope. For the operation methods mentioned in the test procedures, refer to User Guide of this product.



TIP

For the latest version of this manual, download it from the official website of RIGOL (<http://www.rigol.com>).

Publication Number


PVA37100-1110

Software Version

Software upgrade might change or add product features. Please acquire the latest version of the manual from RIGOL website or contact RIGOL to upgrade the software.

Format Conventions in this Manual

1. Key


The front panel key is denoted by the menu key icon. For example,  indicates the "Default" key.

2. Menu

The menu item is denoted by the format of "Menu Name (Bold) + Character Shading" in the manual. For example, **Setup** indicates the "Setup" sub-menu under the "Utility" function menu. You can click or tap **Setup** to access the "Setup" menu.

3. Operation Procedures

The next step of the operation is denoted by ">" in the manual. For example, 

> **Storage** indicates first clicking or tapping  and then clicking or tapping **Storage**.

4. Connector

The front/rear panel connector is denoted by "Brackets + Connector Name (Bold)", for example, [**AUX OUT**].

Content Conventions in this Manual

DHO900 series digital oscilloscope includes the following models. Unless otherwise specified, this manual takes DHO924S as an example to illustrate the methods for the performance verification of DHO900 series.

Model	Max. Analog Bandwidth	No. of Analog Channels
DHO914	125 MHz	4
DHO914S	125 MHz	4
DHO924	250 MHz	4
DHO924S	250 MHz	4



4 Overview

4.1 Test Preparations

Before the test, make the following preparations.

1. Self-test
2. Warm-up (make sure that the instrument has been running for at least 30 minutes)
3. Self-calibration

Self-test

After the instrument is connected to the power source, press the power key  at the lower-left corner of the front panel to power on the instrument. You can also click or tap  > **Utility** > **Setup**. Then select "Switch On" for the **Power status** menu. After the instrument is connected to power source, it will start directly.

During the start-up process, the instrument performs a series of self-tests. After the self-test, the splash screen is displayed.

If the oscilloscope cannot start normally, refer to the "Troubleshooting" chapter in *DHO900 User Guide* to locate the problem and resolve it. Do not perform self-calibration or performance tests until the instrument passes the self-test.

Self-calibration

The self-calibration program can quickly make the oscilloscope work in an optimal state to get the precise measurement results. You can perform self-calibration at any time, especially when the changes of the ambient temperature reach or above 5°C. Make sure that the oscilloscope has been warmed up or operating for more than 30 minutes before the self-calibration.

1. Disconnect all the input channels.
2. In "Utility" menu, click or tap **SelfCal**. The self-calibration interface will be displayed as shown below.

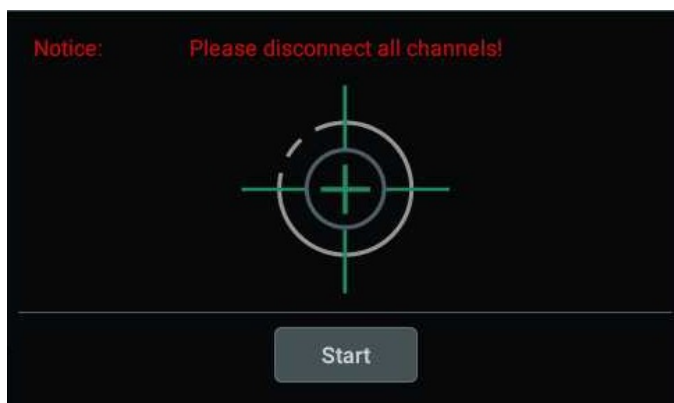


Figure 4.1 Self-calibration Menu

- Click or tap **Start**, and then the oscilloscope will start to execute the self-calibration program.
 - After starting the self-calibration program, you can click or tap **Exit** to cancel self-calibration operation at any time.
3. After completing the self-calibration, restart the oscilloscope. In the **Horizontal** menu, select "Average" for the **Acquisition** item. Then click or tap the input field of the Averages item to set the number of averages to 16 with the pop-up numeric keypad.
 4. Set the vertical scale of each channel to 2 mV/div and view the offset of the waveform of each channel. If the offset is greater than 0.5 div, check whether there are interference signals around you and whether the power source is well grounded. After that, perform self-calibration again.
 5. Click or tap **Close** to close the self-calibration information window.

4.2 Test Result Record

Record and keep the test result of each test. In the last chapter of this manual, a test result record form is provided. The form lists all the test items and their corresponding performance limits as well as spaces for users to record the test results.



TIP

It is recommended that users photocopy the test record form before each test and record the test results in the copy so that the form can be used repeatedly.

4.3 Specifications

The specification of each test item is provided in this manual. For other technical parameters, refer to *DHO900 Data Sheet* (download it from RIGOL website: www.rigol.com).



TIP

All the specifications are valid only when the oscilloscope has been warmed up for more than 30 minutes within the specified operating temperature range (18°C to 28°C).

5 Performance Verification Test

This chapter takes DHO924S as an example to illustrate the performance verification test methods and procedures of DHO900 series digital oscilloscope. This manual recommends the following test devices. You can also use other devices that fulfill the "Specification" in [Table 5.1 Test Devices](#).

Table 5.1 Test Devices

Device	Specification	Recommended Model
Oscilloscope Calibrator	DC: ± 1 mV to ± 200 V, $\pm(0.025\% + 25 \mu\text{V})$ Steady-state Sine: (5 mV~5 V) @ (0.1 Hz~3.2 GHz), $\pm 1.5\%$ Resistance: $\pm 0.1\%$ Capacitance: 1 pF to 35 pF, $\pm 2\% \pm 0.25$ pF	Fluke 9500B



TIP

1. Make sure that the oscilloscope passes the self-test and the self-calibration is performed before executing the performance verification tests.
2. Make sure that the oscilloscope has been warmed up for at least 30 minutes before executing any of the following tests.
3. Please reset the instrument to the factory setting before or after executing any of the following tests.

5.1 Impedance Test

5.1.1 Specification

Input Impedance	
Analog Channel	0.99 M Ω to 1.01 M Ω

5.1.2 Test Connection Diagram

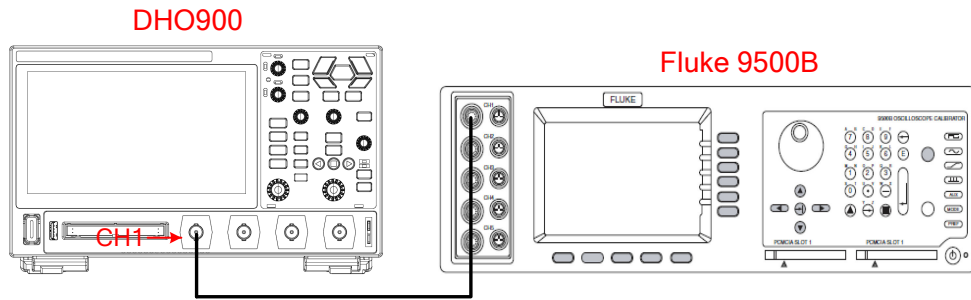


Figure 5.1 Input Impedance Test Connection Diagram

5.1.3 Test Procedures



WARNING

Before connecting, disconnecting, or moving the test hookup, disable the output of the signal generator to avoid causing the dangerous voltage.

1. Connect the active head of Fluke 9500B to CH1 of the oscilloscope, as shown in *Figure 5.1*.
2. Configure the oscilloscope:
 - a. To enable the channel, perform any of the following operations:
 - Click or tap the channel status label at the bottom of the screen to enable CH1.
 - Press the front-panel 1 key to enable the channel.
 - In the **Vertical** menu, select the CH1 tab. Select **ON** for the **Display** item to turn CH1 on.
 - b. Set the vertical scale of CH1 to 50 mV/div.
3. Turn on Fluke 9500B; set its impedance to 1 MΩ and select the resistance measurement function. Read and record the resistance measured.
4. Adjust the vertical scale of CH1 to 500 mV/div; read and record the resistance measured.
5. Turn off CH1. Measure the resistances of CH2, CH3, and CH4 respectively using the method above and record the measurement results.

5.1.4 Test Record From

Channel	Vertical Scale	Test Result	Limit	Pass/Fail
CH1	50 mV/div		0.99 MΩ to 1.01 MΩ	

Channel	Vertical Scale	Test Result	Limit	Pass/Fail
	500 mV/div		0.99 M Ω to 1.01 M Ω	
CH2	50 mV/div		0.99 M Ω to 1.01 M Ω	
	500 mV/div		0.99 M Ω to 1.01 M Ω	
CH3	50 mV/div		0.99 M Ω to 1.01 M Ω	
	500 mV/div		0.99 M Ω to 1.01 M Ω	
CH4	50 mV/div		0.99 M Ω to 1.01 M Ω	
	500 mV/div		0.99 M Ω to 1.01 M Ω	

5.2 Input Capacitance Test

5.2.1 Specification

Input Capacitance	
Specification	15 pF \pm 3 pF

5.2.2 Test Connection Diagram

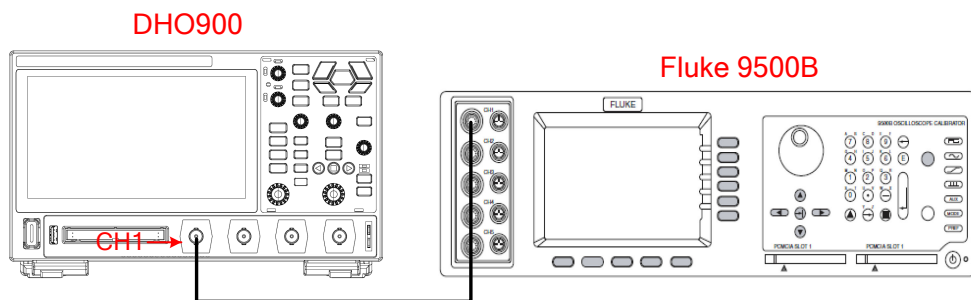


Figure 5.2 Input Capacitance Test Connection Diagram

5.2.3 Test Procedures



WARNING

Before connecting, disconnecting, or moving the test hookup, disable the output of the signal generator to avoid causing the dangerous voltage.

1. Connect the active head of Fluke 9500B to CH1 of the oscilloscope, as shown in *Figure 5.2*.
2. Configure the oscilloscope:
 - a. To enable CH1, perform any of the following operations:
 - Click or tap the channel status label at the bottom of the screen to enable CH1.

- Press the front-panel 1 key to enable the channel.
- In the **Vertical** menu, select the CH1 tab. Select **ON** for the **Display** item to turn CH1 on.

b. Set the vertical scale of CH1 to 50 mV/div.

- 3.** Turn on Fluke 9500B; set its impedance to 1 MΩ and select the capacitance measurement function. Read and record the capacitance measured.
- 4.** Adjust the vertical scale of CH1 to 500 mV/div; read and record the capacitance measured.
- 5.** Turn off CH1. Measure the capacitances of CH2, CH3, and CH4 respectively using the method above and record the measurement results.

5.2.4 Test Record From

Channel	Vertical Scale	Test Result	Limit	Pass/Fail
CH1	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	
CH2	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	
CH3	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	
CH4	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	

5.3 DC Gain Accuracy Test

5.3.1 Specification

DC Gain Accuracy	
Specification ^[1]	±1% (>5mV/div, full scale) ±2% (≤5mV/div, full scale)

NOTE

[1]: Full Scale = 8 x Current Vertical Scale. 200 μV/div and 500 μV/div are a magnification of 1 mV/div setting. For vertical accuracy calculations, use full scale of 8 mV for 200 μV/div and 500 μV/div.

5.3.2 Test Connection Diagram

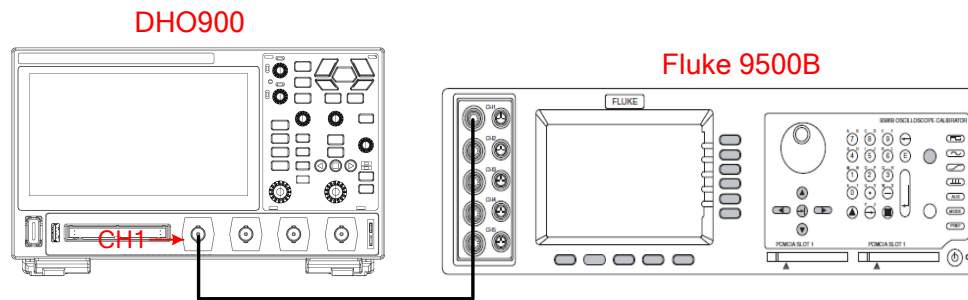


Figure 5.3 DC Gain Accuracy Test Connection Diagram

5.3.3 Test Procedures



WARNING

Before connecting, disconnecting, or moving the test hookup, disable the output of the signal generator to avoid causing the dangerous voltage.

1. Connect the active head of Fluke 9500B to CH1 of the oscilloscope, as shown in *Figure 5.3*.
2. Set the impedance of Fluke 9500B to 1 M Ω .
3. Output a DC signal with +3 div voltage (V_{out1}) via Fluke 9500B.
4. Configure the oscilloscope:
 - a. To enable CH1, perform any of the following operations:
 - Click or tap the channel status label at the bottom of the screen to enable CH1.
 - Press the front-panel 1 key to enable the channel.
 - In the **Vertical** menu, select the CH1 tab. Select **ON** for the **Display** item to turn CH1 on.
 - b. Click or tap the channel status label at the bottom of the screen. Then the **Vertical** menu is displayed. Click or tap **Probe** to enter the **Probe** setting menu. Set the probe attenuation ratio to "1X".
 - c. Set the vertical scale to 1 mV/div.
 - d. Set the horizontal time base to 1 μ s/div.
 - e. Set the vertical offset to 0.

- f. In the **Horizontal** menu, select "Average" for the **Acquisition** item. Then click or tap the input field of **Averages** to set the number of averages to 32 with the pop-up numeric keypad.
 - g. Adjust the trigger level to prevent the signals from being triggered by mistake.
5. In the **Measure** menu, click or tap **Vertical** measurement item to select "Vavg". The Vavg result is displayed in the "Result" sidebar at the right side of the screen. Read and record the measurement result of Vavg1.
 6. Adjust Fluke 9500B to make it output a DC signal with -3 div voltage (Vout2).
 7. Enable the average measurement function. Read and record Vavg2.
 8. Calculate the relative error of this vertical scale: $|(V_{avg1} - V_{avg2}) - (V_{out1} - V_{out2})| / \text{Full Scale} \times 100\%$.
 9. Keep the other settings of the oscilloscope unchanged.
 - a. Set the vertical scale to 2 mV/div, 5 mV/div, 10 mV/div, 20 mV/div, 50 mV/div, 100 mV/div, 200 mV/div, 500 mV/div, 1 V/div, 2 V/div, 5 V/div, and 10 V/div.
 - b. Adjust the output voltage of Fluke 9500B to 3 x the current vertical scale and -3 x the current vertical scale respectively.
 - c. Repeat Step 3-7 and record the test results.
 - d. Calculate the relative error of each vertical scale: $|(V_{avg1} - V_{avg2}) - (V_{out1} - V_{out2})| / \text{Full Scale} \times 100\%$.
 10. Turn off CH1. Test the relative error of each scale of CH2, CH3, and CH4 respectively using the method above and record the test results.

5.3.4 Test Record From

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		Vavg1	Vavg2	Calculation Result ^[1]		
CH1	1 mV/div				≤2%	
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	
	100 mV/div				≤1%	
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
2 V/div				≤1%		

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		Vavg1	Vavg2	Calculation Result ^[1]		
	5 V/div				≤1%	
	10 V/div				≤1%	
CH2	1 mV/div				≤2%	
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	
	100 mV/div				≤1%	
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
	2 V/div				≤1%	
	5 V/div				≤1%	
	10 V/div				≤1%	
	CH3	1 mV/div				≤2%
2 mV/div					≤2%	
5 mV/div					≤2%	
10 mV/div					≤1%	
20 mV/div					≤1%	
50 mV/div					≤1%	
100 mV/div					≤1%	
200 mV/div					≤1%	
500 mV/div					≤1%	
1 V/div					≤1%	
2 V/div					≤1%	
5 V/div					≤1%	
10 V/div					≤1%	
CH4		1 mV/div				≤2%
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	
	100 mV/div				≤1%	
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
	2 V/div				≤1%	
	5 V/div				≤1%	

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		Vavg1	Vavg2	Calculation Result ^[1]		
	10 V/div				≤1%	

NOTE

[1]: The calculation formula is $|(V_{avg1} - V_{avg2}) - (V_{out1} - V_{out2})| / \text{Full Scale} \times 100\%$; wherein, V_{out1} is 3 x the current vertical scale and V_{out2} is -3 x the current vertical scale.

5.4 DC Offset Accuracy Test

5.4.1 Specification

DC Offset Accuracy	
Specification	<p>≤200 mV/div ($\pm 0.1 \text{ div} \pm 2 \text{ mV} \pm 1.5\%$ of the offset value)</p> <p>>200 mV/div ($\pm 0.1 \text{ div} \pm 2 \text{ mV} \pm 1.0\%$ of the offset value)</p>

5.4.2 Test Connection Diagram

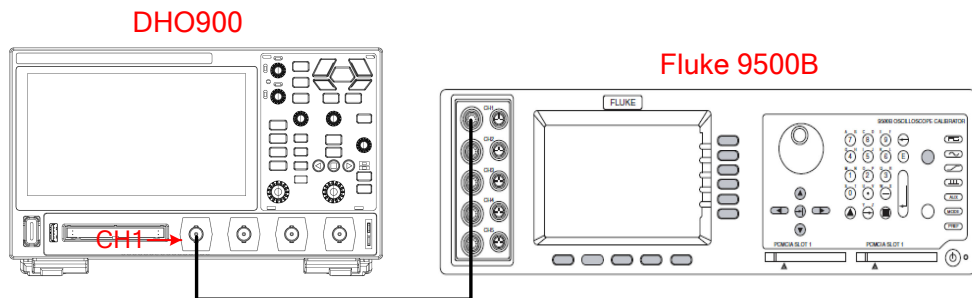


Figure 5.4 DC Offset Accuracy Test Connection Diagram


5.4.3 Test Procedures



WARNING

Before connecting, disconnecting, or moving the test hookup, disable the output of the signal generator to avoid causing the dangerous voltage.

1. Connect the active head of Fluke 9500B to CH1 of the oscilloscope, as shown in *Figure 5.4*.
2. Set the impedance of Fluke 9500B to 1 MΩ.
3. Configure the oscilloscope:

- a. Press the front-panel  key to restore the oscilloscope to the default settings.
 - b. Set the vertical scale to 10 mV.
 - c. Click or tap the **BW Limit** drop-down button to "20M".
 - d. Set the offset to 1 V, as shown in *Test Record From*. Close the Vertical menu.
 - e. Click or tap the horizontal label at the top of the screen. Then the **Horizontal** menu is displayed. In this menu, set the time base to 1 ms/div. Select "Average" for the **Acquisition** item. Then click or tap the input field of the **Averages** item to set the number of averages to 16 with the pop-up numeric keypad. Close the Horizontal menu.
 - f. Adjust the trigger level to prevent the signals from being triggered by mistake.
4. Set the output of Fluke 9500B to -1 V.
 5. In the **Measure** menu, click or tap **Vertical** measurement item to select "Vavg". The Vavg result is displayed in the "Result" sidebar at the right side of the screen. Read and record the measurement result.
 6. Set the vertical offset of the oscilloscope to 0 V.
 7. Set the output of Fluke 9500B to 0 V. Read the value from the "Result" sidebar and record the measurement result.
 8. Repeat Step 2-7. Measure and record the average results of different vertical scales and offsets according to *Test Record From*.

5.4.4 Test Record From

Channel Setting	Vertical Scale	Offset	Test Result	Min.	Max.
CH1, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
5 V/div	-100 V		98.50 V	101.50 V	
CH2, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V

Channel Setting	Vertical Scale	Offset	Test Result	Min.	Max.
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
	5 V/div	-100 V		98.50 V	101.50 V
CH3, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
5 V/div	-100 V		98.50 V	101.50 V	
CH4, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
5 V/div	-100 V		98.50 V	101.50 V	

5.5 Bandwidth Test

5.5.1 Specification

Bandwidth			
Amplitude Loss ^[1]	DHO914	125 MHz	-3 dB, all channel modes
	DHO914S	125 MHz	-3 dB, all channel modes
	DHO924	250 MHz	-3 dB, all channel modes
	DHO924S	250 MHz	-3 dB, all channel modes

NOTE

[1]: Amplitude Loss (dB) = $20 \times \lg(V_{\text{rms2}}/V_{\text{rms1}})$; wherein, V_{rms1} is the measurement result of amplitude effective value at 1MHz and V_{rms2} is the measurement result of amplitude effective value at full bandwidth.

5.5.2 Test Connection Diagram

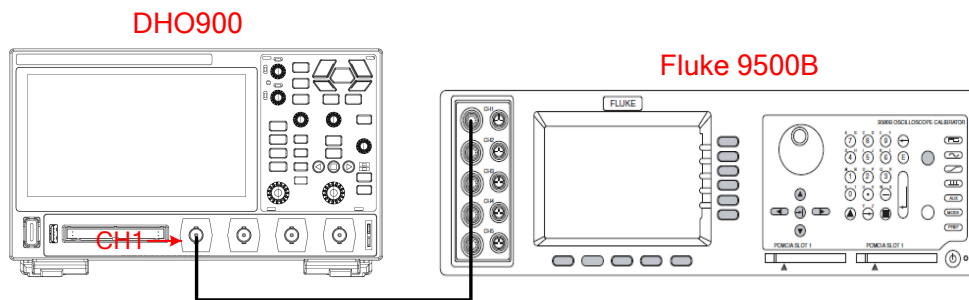


Figure 5.5 Bandwidth Test Connection Diagram

5.5.3 Test Procedures

**WARNING**

Before connecting, disconnecting, or moving the test hookup, disable the output of the signal generator to avoid causing the dangerous voltage.

1. Connect the active head of Fluke 9500B to CH1 of the oscilloscope, as shown in *Figure 5.5*.
2. Turn on Fluke 9500B and set its impedance to 1 MΩ.
3. Configure the oscilloscope:
 - a. Turn on CH1.
 - Click or tap the channel status label at the bottom of the screen to enable CH1.
 - Press the front-panel 1 key to enable the channel.

- In the **Vertical** menu, select the CH1 tab. Select **ON** for the **Display** item to turn CH1 on.
 - b. Click or tap the channel status label of CH1 at the bottom of the screen. Then the **Vertical** menu is displayed. Click or tap **Probe** to enter the **Probe** setting menu. Set the probe attenuation ratio to "1X".
 - c. Set the vertical scale to 50 mV/div.
 - d. Set the vertical offset to 0 V. Then close the **Vertical** menu.
 - e. Click or tap the horizontal label at the top of the screen. Then the **Horizontal** menu is displayed. In this menu, you can set the horizontal time base to 500 ns/div.
 - f. Set the horizontal position to 0 s. Close the **Horizontal** menu.
 - g. Set the trigger level to 0 V.
4. Output a Sine signal with 1 MHz frequency and 6 div amplitude (e.g. 50 mV/div vertical scale, 300 mVpp amplitude Sine signal) via the Fluke 9500B. Adjust the horizontal time base to display five cycles of the waveforms on the screen.
 5. In the **Measure** menu, click or tap **Vertical** measurement item to select "AC.RMS". The AC.RMS measurement result is displayed in the "Result" sidebar at the right section of the screen. Read the value and record the measurement result as Vrms1.
 6. Use the Fluke 9500B to output a Sine signal with the maximum bandwidth of the oscilloscope and 6 div amplitude. The bandwidth frequency differs for different oscilloscope models. For details, please refer to *Specification*. Adjust the horizontal time base to display five cycles of the waveforms on the screen.
 7. Check the AC.RMS "Result" sidebar at the right section of the screen. Read and record the data as Vrms2.
 8. Calculate the amplitude loss with the following formula: Amplitude Loss (dB) = $20 \times \lg(V_{rms2}/V_{rms1})$.
 9. Repeat Step 2-7. Measure Vrms1 and Vrms2, and calculate the amplitude loss of 500 mV/div vertical scale.
 10. Turn off CH1. Measure CH2, CH3, and CH4 respectively using the method above and record the measurement results.

5.5.4 Test Record From

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		V _{rms1}	V _{rms2}	Amplitude Loss ^[1]		
CH1	50 mV/div				-3 dB to 3 dB	

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		V _{rms1}	V _{rms2}	Amplitude Loss ^[1]		
	500 mV/div				-3 dB to 3 dB	
CH2	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	
CH3	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	
CH4	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	

NOTE

[1]: Amplitude Loss (dB) = $20 \times \lg(V_{rms2}/V_{rms1})$; wherein, V_{rms1} is the measurement result of amplitude effective value at 1MHz and V_{rms2} is the measurement result of amplitude effective value at full bandwidth.

5.6 Time Base Accuracy Test

5.6.1 Specification

Time Base Accuracy	
Specification	$\pm(25 \text{ ppm} + 5 \text{ ppm}^{[1]}/\text{year} \times \text{Number of Years that the Instrument Has Been Used}^{[2]})$

NOTE

[1]: Clock Drift.

[2]: For the number of years that the instrument has been used, please calculate it according to the date in the verification certificate provided when the instrument leaves factory.

5.6.2 Test Connection Diagram

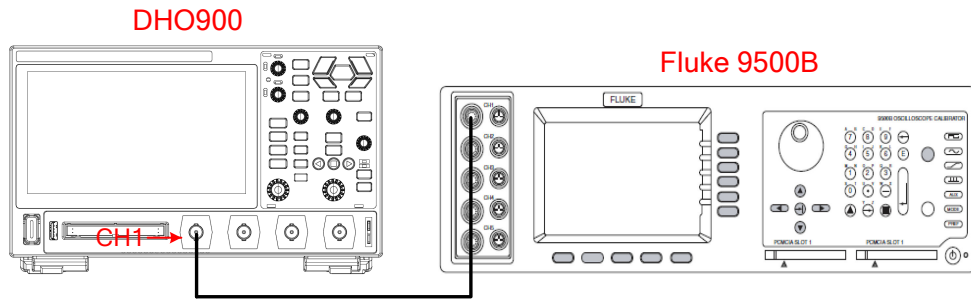


Figure 5.6 Time Base Accuracy Test Connection Diagram



5.6.3 Test Procedures




WARNING

Before connecting, disconnecting, or moving the test hookup, disable the output of the signal generator to avoid causing the dangerous voltage.

1. Connect the active head of Fluke 9500B to CH1 of the oscilloscope, as shown in *Figure 5.6*.
2. Output a Sine signal with 10 MHz frequency and 1 V_{pp} amplitude via Fluke 9500B.
3. Configure the oscilloscope:

- a. Press the front-panel  key to restore the oscilloscope to the default settings.
- b. Turn on CH1.
 - Click or tap the channel status label at the bottom of the screen to enable CH1.
 - Press the front-panel  key to enable the channel.
 - In the **Vertical** menu, select the CH1 tab. Select **ON** for the **Display** item to turn CH1 on.
- c. Click or tap the channel status label of CH1 at the bottom of the screen. Then the **Vertical** menu is displayed. Click or tap **Probe** to enter the **Probe** setting menu. Set the probe attenuation ratio to "1X".
- d. Set the vertical scale to 200 mV/div.
- e. Set the vertical offset to 0 V. Then close the **Vertical** menu.
- f. Click or tap the horizontal label at the top of the screen. Then the **Horizontal** menu is displayed. In this menu, you can set the horizontal time base to 1 ns/div.

- g. Set the horizontal position to 1 ms. Close the **Horizontal** menu.
- h. Click or tap the trigger label at the top of the screen. Set the trigger level to 0 V.
4. Click or tap  > **Cursor**. Then the "Result" sidebar is displayed at the right section of the screen. Click or tap the "Result" sidebar and select **Setting** in the pop-up window. In the **Mode** item, select **Manual** to enable the manual cursor measurement function. Then measure the offset (ΔT) of the middle point of the signal (namely the crossing point of the rising edge of the current signal and the trigger level line) relative to the screen center and record the measurement result.
 5. Calculate the time base accuracy, namely the ratio of ΔT to the horizontal position of the oscilloscope. For example, if the offset measured is 1 ns, then the time base accuracy is 1 ns/1 ms = 1 ppm.
 6. Calculate the time base accuracy limit by using the following formula: $\pm(25 \text{ ppm} + 5 \text{ ppm/year} \times \text{Number of Years that the Instrument Has Been Used})$.

5.6.4 Test Record From

Channel	Test Result ΔT	Calculation Result ^[1]	Limit	Pass/Fail
CH1			$\pm(25 \text{ ppm} + 5 \text{ ppm/year} \times \text{Number of Years that the Instrument Has Been Used}^{[2]})$	

NOTE

[1]: Calculation Result = Test Result ΔT /1 ms.

[2]: For the number of years that the instrument has been used, please calculate it according to the date in the verification certificate provided when the instrument leaves factory.

6 Appendix: Test Record Form

RIGOL DHO900 Series Digital Oscilloscope Performance Verification Test Record Form

Model: _____ Tested by: _____ Test Date: _____

Impedance Test Record Form

Channel	Vertical Scale	Test Result	Limit	Pass/Fail
CH1	50 mV/div		0.99 MΩ to 1.01 MΩ	
	500 mV/div		0.99 MΩ to 1.01 MΩ	
CH2	50 mV/div		0.99 MΩ to 1.01 MΩ	
	500 mV/div		0.99 MΩ to 1.01 MΩ	
CH3	50 mV/div		0.99 MΩ to 1.01 MΩ	
	500 mV/div		0.99 MΩ to 1.01 MΩ	
CH4	50 mV/div		0.99 MΩ to 1.01 MΩ	
	500 mV/div		0.99 MΩ to 1.01 MΩ	

Input Capacitance Test Record Form

Channel	Vertical Scale	Test Result	Limit	Pass/Fail
CH1	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	
CH2	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	
CH3	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	
CH4	50 mV/div		15 pF ± 3 pF	
	500 mV/div		15 pF ± 3 pF	

DC Gain Accuracy Test Record Form

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		Vavg1	Vavg2	Calculation Result ^[1]		
CH1	1 mV/div				≤2%	
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		Vavg1	Vavg2	Calculation Result ^[1]		
	100 mV/div				≤1%	
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
	2 V/div				≤1%	
	5 V/div				≤1%	
	10 V/div				≤1%	
CH2	1 mV/div				≤2%	
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	
	100 mV/div				≤1%	
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
	2 V/div				≤1%	
	5 V/div				≤1%	
	10 V/div				≤1%	
CH3	1 mV/div				≤2%	
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	
	100 mV/div				≤1%	
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
	2 V/div				≤1%	
	5 V/div				≤1%	
	10 V/div				≤1%	
CH4	1 mV/div				≤2%	
	2 mV/div				≤2%	
	5 mV/div				≤2%	
	10 mV/div				≤1%	
	20 mV/div				≤1%	
	50 mV/div				≤1%	
	100 mV/div				≤1%	

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		Vavg1	Vavg2	Calculation Result ^[1]		
	200 mV/div				≤1%	
	500 mV/div				≤1%	
	1 V/div				≤1%	
	2 V/div				≤1%	
	5 V/div				≤1%	
	10 V/div				≤1%	

NOTE

[1]: The calculation formula is $|(V_{avg1} - V_{avg2}) - (V_{out1} - V_{out2})| / \text{Full Scale} \times 100\%$; wherein, V_{out1} is 3 x the current vertical scale and V_{out2} is -3 x the current vertical scale.

DC Offset Accuracy Test Record Form

Channel Setting	Vertical Scale	Offset	Test Result	Min.	Max.
CH1, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
5 V/div	-100 V		98.50 V	101.50 V	
CH2, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
5 V/div	-100 V		98.50 V	101.50 V	
CH3, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV

Channel Setting	Vertical Scale	Offset	Test Result	Min.	Max.
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
	5 V/div	-100 V		98.50 V	101.50 V
CH4, 20 MHz BW	10 mV/div	1 V		-1.02 V	-0.98 V
	10 mV/div	0 V		-3.00 mV	3.00 mV
	10 mV/div	-1 V		0.98 V	1.02 V
	200 mV/div	8 V		-8.14 V	-7.86 V
	200 mV/div	0 V		-22.00 mV	22.00 mV
	200 mV/div	-8 V		7.86 V	8.14 V
	1 V/div	20 V		-20.30 V	-19.70 V
	1 V/div	0 V		-102.00 mV	102.00 mV
	1 V/div	-20 V		19.70 V	20.30 V
	5 V/div	100 V		-101.50 V	-98.50 V
	5 V/div	0 V		-502.00 mV	502.00 mV
	5 V/div	-100 V		98.50 V	101.50 V

Analog Bandwidth Test Record Form

Channel	Vertical Scale	Test Result			Limit	Pass/Fail
		V _{rms1}	V _{rms2}	Amplitude Loss ^[1]		
CH1	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	
CH2	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	
CH3	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	
CH4	50 mV/div				-3 dB to 3 dB	
	500 mV/div				-3 dB to 3 dB	

NOTE

[1]: Amplitude Loss (dB) = $20 \times \lg (V_{\text{rms}2}/V_{\text{rms}1})$; wherein, $V_{\text{rms}1}$ is the measurement result of amplitude effective value at 1MHz and $V_{\text{rms}2}$ is the measurement result of amplitude effective value at full bandwidth.

Time Base Accuracy Test Record Form

Channel	Test Result ΔT	Calculation Result ^[1]	Limit	Pass/Fail
CH1			$\pm(25 \text{ ppm} + 5 \text{ ppm/year} \times \text{Number of Years that the Instrument Has Been Used}^{[2]})$	

NOTE

[1]: Calculation Result = Test Result $\Delta T/1 \text{ ms}$.

[2]: For the number of years that the instrument has been used, please calculate it according to the date in the verification certificate provided when the instrument leaves factory.

HEADQUARTER

RIGOL TECHNOLOGIES CO., LTD.
No.8 Keling Road, New District, Suzhou,
JiangSu, P.R.China
Tel: +86-400620002
Email: info@rigol.com

EUROPE

RIGOL TECHNOLOGIES EU GmbH
Carl-Benz-Str.11
82205 Gilching
Germany
Tel: +49(0)8105-27292-0
Email: info-europe@rigol.com

NORTH AMERICA

RIGOL TECHNOLOGIES, USA INC.
10220 SW Nimbus Ave.
Suite K-7
Portland, OR 97223
Tel: +1-877-4-**RIGOL**-1
Fax: +1-877-4-**RIGOL**-1
Email: info@rigol.com

JAPAN

RIGOL JAPAN CO., LTD.
5F,3-45-6,Minamiotsuka,
Toshima-Ku,
Tokyo,170-0005,Japan
Tel: +81-3-6262-8932
Fax: +81-3-6262-8933
Email: info-japan@rigol.com

RIGOL® is the trademark of **RIGOL TECHNOLOGIES CO., LTD.** Product information in this document is subject to update without notice. For the latest information about **RIGOL**'s products, applications and services, please contact local **RIGOL** channel partners or access **RIGOL** official website: www.rigol.com