

# **RIGOL**

## **Calibration Guide**

### **DS6000 Series Digital Oscilloscope**

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**RIGOL Technologies, Inc**



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## Document Overview

This manual guides users to calibrate the **RIGOL** DS6000 series digital oscilloscope correctly. Wherein, **Thorn Calibration**, **Equivalent Calibration** and **Delay Calibration** must be performed in project mode.

### Main contents in this manual:

#### ◆ Calibration Notices

*Calibration Preparations*

*Project Mode*

*Calibration Sequence*

*To Resume Calibration*

#### ◆ Calibration Procedures

*Step 1: 30-minute Warm-up*

*Step 2: Thorn Calibration*

*Step 3: Self-Calibration (Vertical Calibration)*

*Step 4: Equivalent Calibration*

*Step 5: Delay Calibration*

### Format Conventions in this Manual:

Front Panel Key: denoted by "Text Box + Button Name (Bold)", for example, **UTIL**.

Menu Softkey: denoted by "Character Shading + Menu Word (Bold)", for example, **Self-Cal**.

Operation Step: denoted by an arrow "→", for example, **UTIL** → **Self-Cal**.

### Content Conventions in this Manual:

In this manual, DS6104 is taken as an example to illustrate the calibration method. The introductions in this manual are applicable to all the models of the DS6000 series.

Model	DS6104	DS6102	DS6064	DS6062
Analog Bandwidth	1 GHz	1 GHz	600 MHz	600 MHz
Number of Channels	4	2	4	2
Max Real-time Sample Rate	5 GSa/s			
Standard Memory Depth	140 Mpts			
Waveform Capture Rate	Up to 180 000 wfs/s			



# Calibration Notices

## Calibration Preparations

Prepare the following device and cables before performing the calibration.

- **RIGOL** DG5000 signal function/arbitrary waveform generator (1)
- Dual-BNC (M) cable (1, as shown in Figure 1)
- One-to-five BNC (M) cable (1, as shown in Figure 2)



Figure 1 Dual-BNC (M) Cable

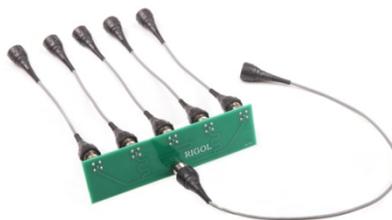


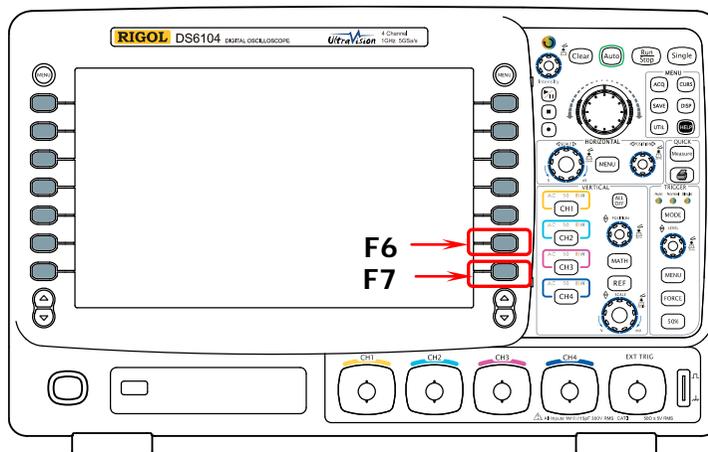
Figure 2 One-to-five BNC (M) Cable

**Note:** Warm up the instrument for 30 minutes before performing the calibration.

## Project Mode

1. Turn on the oscilloscope.
2. Press **MENU** → **Type** in the **TRIGGER** control area at the lower-right corner of the front panel and use  to select "Edge".
3. Press **F7**<sup>[1]</sup>, **F6**<sup>[1]</sup>, **F7**, **UTIL** and the menu page down key  successively to open the third page of the "UTILITY" menu.

**Note**<sup>[1]</sup>: The definitions of **F7** and **F6** are as shown in the figure below.



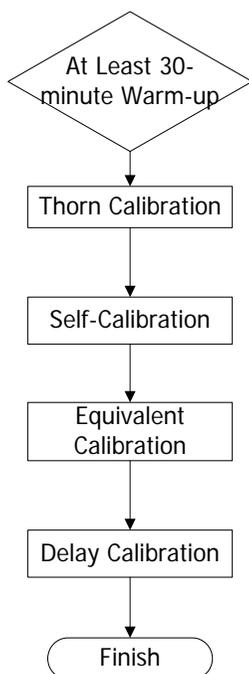
4. Press **Project** to enter project mode.
5. After entering project mode, press the menu page down key  to select the second page of the "PROJECT" menu where you can perform thorn calibration, equivalent calibration and delay calibration.

### Tips

- You can return to normal mode from project mode by repeating step 2 and step 3.
- The oscilloscope enters normal mode by default when it is restarted.

## Calibration Sequence

The calibration sequence is as shown in the figure below. It is recommended to calibrate the instrument following the thorn calibration, self-calibration, equivalent calibration and delay calibration sequence; wherein, thorn calibration, equivalent calibration and delay calibration must be performed in project mode.



## To Resume Calibration

Press **ResumeCal** to restore the oscilloscope to its factory parameters when the calibration fails or the oscilloscope fails to save the parameters.

# Calibration Procedures

## Step 1: 30-minute Warm-up

Make sure that the oscilloscope has been running for at least 30 minutes before performing the calibration.

## Step 2: Thorn Calibration

The thorn calibration calibrates the thorns of the waveform of each channel of the oscilloscope.

Make sure the oscilloscope has been warmed up for 30 minutes before performing thorn calibration. Then, follow the steps below to calibrate the instrument.

1. Disconnect the connections of all the channels (including the external trigger channel).
2. Enter the project mode according to the introductions of the **"Project Mode"**; press **ThornCal** and the oscilloscope starts to perform thorn calibration.
3. It takes about 5 minutes (3 minutes for dual-channel models) to finish the calibration. Restart the oscilloscope when "Calibration finished, please restart the oscilloscope!" is displayed.
4. Press **ACQ** → **Acquisition** to select "Normal" and press **Mem Depth** to select "Auto".
5. Turn all the channels on and rotate **VERTICAL**  **SCALE** to set the vertical scale of each channel to 200 mV/div.

6. Rotate **HORIZONTAL**  **SCALE** to set the horizontal time base of the oscilloscope under calibration to 2 ms, 5 ms and 10 ms respectively and view whether there are evident thorns on the waveforms at the different horizontal time bases. Perform thorn calibration again when evident thorns occur.

## Step 3: Self-Calibration (Vertical Calibration)

The self-calibration calibrates the vertical offset of the waveform of each channel of the oscilloscope.

Make sure that the oscilloscope has been warmed up for more than 30 minutes before performing self-calibration. Then, follow the steps below to calibrate the oscilloscope.

1. Connect the analog input channels and the external trigger channel of the oscilloscope to the **[Trig Out/Calibration]** connector at the rear panel using a one-to-five BNC (M) cable.
2. Press **UTIL** → **Self-Cal** to enter the self-calibration interface.
3. Press **Start** and the oscilloscope starts to execute the self-calibration program.
4. It takes about 20 minutes (15 minutes for dual-channel models) to finish the calibration. Restart the oscilloscope when "Calibration finished, please restart the oscilloscope!" is displayed.
5. Press **ACQ** → **Acquisition** to select "Average", and then, press **Averages** to set the number of averages to 16.
6. Disconnect the input signals of all the channels. Rotate **VERTICAL**  **SCALE** to set the vertical scale of each channel to 2 mV/div and view the vertical offset of the waveform of each channel. Perform self-calibration again if the offset exceeds 1 div.

## Step 4: Equivalent Calibration

The equivalent calibration calibrates the trigger position of the signal measured by the oscilloscope.

Make sure the oscilloscope has been warmed up for 30 minutes before performing equivalent calibration. Then, follow the steps below to calibrate the instrument.

1. Connect CH1 of the oscilloscope to the **[Trig Out/Calibration]** connector at the rear panel using a dual-BNC (M) cable. Enter the project mode according to the instructions of the **"Project Mode"**; press **EqualCal** and the oscilloscope starts to perform equivalent calibration.
2. It takes about 4 minutes (3 minutes for dual-channel models) to finish the calibration. Restart the oscilloscope when "Calibration finished, please restart the oscilloscope!" is displayed.
3. Press **UTIL** → **Aux Output** to select "Fast".
4. Press **CH1** → **Input** to set the input impedance of CH1 to 50 Ω. Rotate **VERTICAL**  **SCALE** to set the vertical scale of CH1 to 200 mV/div. Rotate **TRIGGER**  **LEVEL** to adjust the trigger level to make the waveform trigger stably. Rotate **VERTICAL**  **POSITION** to adjust the vertical position of CH1 to display the waveform within the screen range.
5. Rotate **HORIZONTAL**  **SCALE** to set the horizontal time base to 10 ns and 2 ns respectively and observe whether there is large jitter at the trigger position of the signal. If large jitter occurs, please perform equivalent calibration again.

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## Step 5: Delay Calibration

The delay calibration calibrates the zero offset of the waveform measured by the oscilloscope.

Make sure the oscilloscope has been warmed up for 30 minutes before performing delay calibration. Then, follow the steps below to calibrate the instrument.

1. Output a square signal with 100 kHz frequency, 10 V<sub>pp</sub> amplitude and 50 Ω impedance from DG5000 (rise/fall time ≤ 2.5 ns).
2. Connect the above-mentioned signal to the 4 analog input channels (except the external trigger channel) of the oscilloscope using a one-to-five BNC (M) cable.
3. Enter the project mode according to the introductions of the “**Project Mode**”; press **DelayCal** and the oscilloscope starts to perform delay calibration.
4. It takes about 2 minutes (1 minute for dual-channel models) to finish the calibration. Restart the oscilloscope when “Calibration finished, please restart the oscilloscope!” is displayed.
5. Rotate **HORIZONTAL**  **SCALE** to set the horizontal time base of the oscilloscope under calibration to 500 ps (for 600MHz bandwidth models, the horizontal time base is 1 ns) and observe whether the waveform deviates from the zero point. If yes, perform delay calibration again.
6. Keep the horizontal time base setting unchanged. Turn all the channels on; then turn any of the channels off. View whether the other channels are affected and whether the waveforms jump. If yes, perform delay calibration again.

**By now, the calibration procedures finish.**