RIGOL

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# Jitter Measurement

## Advanced Feature for Oscilloscopes

Application Note

Apr. 2026

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# Contents



# 2. Document Overview

This document is designed to introduce the basic jitter measurement feature of RIGOL's oscilloscopes. The contents include:

- Basic concepts and working principles of basic jitter measurements;
- How to use the basic jitter measurement feature on the oscilloscope;
- Test procedures for completing the basic jitter measurement test on a typical signal.

This document is intended for engineering technicians who need to perform signal basic jitter analysis on an oscilloscope.

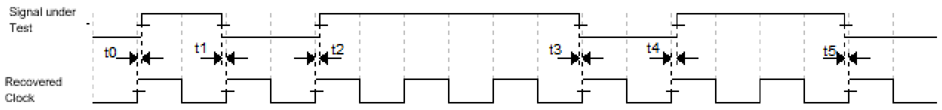
For the clock recovery of the oscilloscope in this manual, download *Clock Recovery Application Note* and the relevant manuals of the oscilloscope from the official website of RIGOL (www.rigol.com).

# 3. Jitter Measurement Working Principle

The basic jitter measurement analysis feature of the oscilloscope enables accurate measurement of key jitter parameters of the signal being measured, and provides a comprehensive analysis of Time Interval Error (TIE) in the time-domain, frequency-domain, and statistical domain. TIE represents the deviation of the signal edge from the ideal clock position, and it is a core indicator for identifying deterministic jitter such as crosstalk, power modulation, or data-related jitter.

RIGOL's oscilloscopes support five measurement items related to the basic jitter analysis, including TIE, Cycle-Cycle, positive-positive pulse width (Pos-Pos), negative-negative pulse width (Neg-Neg), and duty cycle. The following sections introduce them in details.

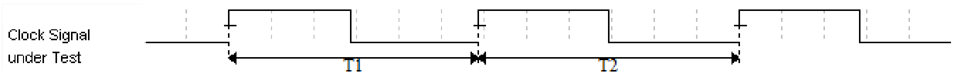
## 3.1 TIE




TIE represents the variation of each valid edge of the clock from the ideal position. Before measuring TIE, recover the clock signal first (see *Clock Recovery Application Note* for details). TIE is the time difference between the edge of the signal under test and the valid edge of the recovered clock signal. In the figure, the valid edge of the recovered clock is the rising edge, i.e., $t_0$,$t_1$, ...tn.

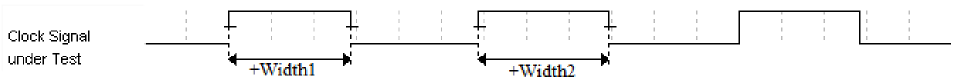
## 3.2 Cycle-Cycle




Cycle-to-Cycle Jitter $(Period - Period)$ is the difference in period between two adjacent clock cycles, referred to as cycle period. In the above figure, $T_1$ and $T_2$ indicate the period of the clock signal under test. It is calculated based on the following formula:

$$Period - Period = T_2 - T_1$$

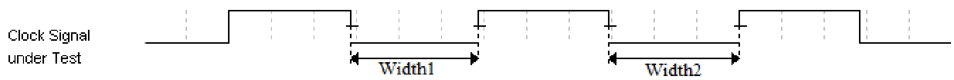
## 3.3 Pos-Pos




Positive pulse width to positive pulse width $(+width - +width)$ is abbreviated as Pos-Pos. In the above figure, $+Width_1$ and $+Width_2$ indicate the positive pulse width of the clock signal under test. It is calculated based on the following formula:

$$+width - +width = +Width_2 - +Width_1$$

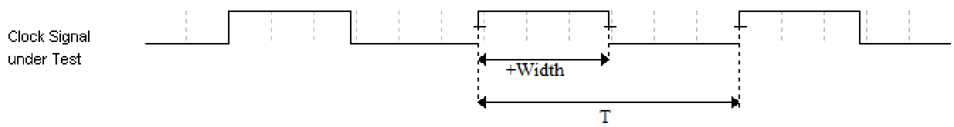
## 3.4 Neg-Neg




Negative pulse width to negative pulse width $(-width - -width)$ is abbreviated as Neg-Neg. In the above figure, $Width_1$ and $Width_2$ indicate the negative pulse width of the clock signal under test. It is calculated based on the following formula:

$$-width - -width = Width_2 - Width_1$$

## 3.5 Duty

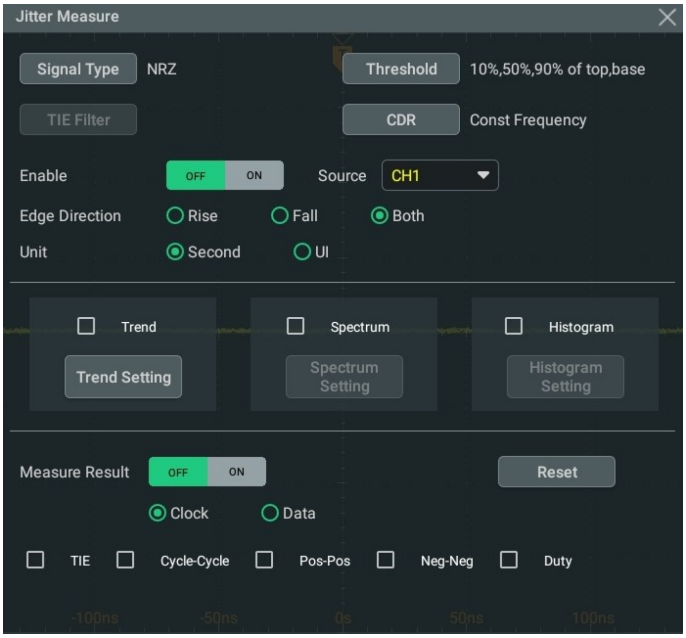



Duty cycle is defined as the positive pulse width/period x 100% of the clock signal under test. It is calculated based on the following formula:

$$Duty = +Width/T * 100$$

# 4. Jitter Measurement

Click or tap the function navigation icon at the lower-left corner of the screen to open the function navigation. Then, click or tap the **Jitter Measure** icon to enter the jitter measurement setting menu.




- **Signal Type**

  Click or tap this button to enter the signal type interface. Click or tap the drop-down button of **SIGNAL** to select "NRZ", "PAM3", or "PAM4".

- **Threshold Settings**

  Click or tap **Threshold** to open the threshold settings interface. For the threshold settings, refer to descriptions in *Clock Recovery Application Note*.

- **TIE Filter**

  Not available currently.

- **CDR (Clock and Data Recovery)**

  Click or tap this button to open the clock recovery interface. For details about the settings of CDR, refer to descriptions in *Clock Recovery Application Notes*.

- **Enable or Disable the Jitter Measurement**

  OFF: By default, the basic jitter measurement is disabled.

  ON: Performs the specified measurement such as TIE based on the configurations, and plots measurement results in the specified graph.

- **Source**

  Sets the channel of the oscilloscope to which the signal under test is connected.

- **Edge Direction**

  Rise: only measures the measurement items such as TIE at the rising edge of the signal under test.

  Fall: only measures the measurement items such as TIE at the falling edge of the signal under test.

  Both: measures the measurement items such as TIE at both the rising and falling edges of the signal under test.

- **Unit**

  Second: The measurement results of the measurement items such as TIE are presented in time, expressed in second.

  UI: The measurement results of the measurement items such as TIE are presented as multiples of the single unit interval (UI) of the signal under test, such as 0.01UI.

- **Trend**

  Trend graph is plotted based on TIE measurement results. In the trend setting interface, you can enable or disable the smoothing operation for the trend graph, set the smoothing factor for the trend graph.

- **Spectrum**

  Spectrum graph is plotted based on the TIE measurement results. Currently, you are not allowed to self-define the parameters for the spectrum graph.

- **Histogram**

  Histogram graph is plotted based on TIE measurement results. Currently, you are not allowed to self-define the parameters for the histogram graph.

- **Measurement Result**

  When the basic jitter measurement is enabled, the Measure Result menu is automatically enabled by default.

  OFF: By default, the measurement result window is not displayed.

  ON: displays the measurement result window on the screen.

- **Clock/Data**

  Selects the type of signal under test. You can select it to be a clock signal or a data signal.

  **Clock signals** support measurement items such as TIE, cycle-cycle, pos-pos, neg-neg, and duty cycle.

  **Data signals** only support TIE measurement.

- **Select the Measurement Item**

  Check the checkbox of the specified measurement item to be performed. The measurement results will be displayed in the measurement result window if you enable the display of the result. If you enable the basic jitter measurement, the

TIE measurement item is automatically selected by default, and the measurement results are displayed.

When performing the cycle-cycle, pos-pos, neg-neg, and duty cycle measurements for the clock signals, the edge direction shall select "Both".

- **Reset**

  Click or tap **Reset**, then the oscilloscope will clear the accumulative results of the current measurement items and restart the measurement.

# 5. Typical Application

The following section takes RIGOL DS9000 series oscilloscope (with JITTA option installed) as an example to introduce how to perform the basic jitter analysis of several typical high-speed serial digital signals.
When using the oscilloscope to perform the basic jitter measurement, make the following configurations: set the sample rate to 20 GSa/s; adjust the time base to make the oscilloscope's memory depth greater than 32 Mpts; and set the bandwidth limit as required**.**

## 5.1 Clock Signal

### 5.1.1 Test Procedures

**Step 1:** Input the clock signal under test to CH1 of the oscilloscope.

**Step 2:** In the "Horizontal" system menu, set the memory depth to Auto, and the sample rate is automatically adjusted to 20 Gsa/s. Set the time base to 200 μs to make its memory depth to 40 Mpts.

**Step 3:** In the "Vertical" system menu, set the vertical scale of CH1 to 100 mV (make the signal amplitude take up the whole display area).

**Step 4:** In the **Jitter Measure** interface, set "Signal Type" to NRZ.

**Step 5:** Click or tap **Threshold** to select 10%, 50%, 90% of top, base. Set **Level Setting** to Default.

**Step 6:** Click or tap **CDR** to enter the CDR interface. Click or tap the drop-down button of **CDR Method** to select **Constant Frequency**. Set **Data Rate Method** to Auto. Click or tap **Advanced Setting** to enter the advanced setting interface. Click or tap to select **Rise** for **Edge Direction**.

**Step 7:** In the "Jitter Measure" interface, click or tap the drop-down button of **Source** to select "CH1"; set **Edge Direction** to "Both"; set **Unit** to "Second". Check the checkbox of "Trend", "Spectrum", and "Histogram" to generate these graphs. Set the input signal type to "Clock". By default, TIE is selected when you enable the jitter measurement. Select the rest measurement items, including **Cycle-Cycle, Pos-Pos, Neg-Neg, and Duty.**

**Step 8:** Enable the basic jitter measurement, and you will see the measurement results.

### 5.1.2 Measurement Result

The following figure shows the basic jitter measurement of a 50 MHz clock signal.


## 5.2 NRZ Data Signal

### 5.2.1 Test Procedures

**Step 1:** Input the signal under test to CH1 of the oscilloscope.

**Step 2:** In the "Horizontal" system menu, set the memory depth to Auto, and the sample rate is automatically set to a fixed value 20 GSa/s. Adjust the time base to make its memory depth to 40 Mpts.

**Step 3:** In the "Vertical" system menu, set the vertical scale of CH1 to 50 mV (make the signal amplitude take up the whole display area).

**Step 4:** In the **Jitter Measure** interface, set "Signal Type" to NRZ.

**Step 5:** Click or tap the "Threshold" menu to enter the threshold setting interface. Click or tap the drop-down button of **Threshold** to select "threshold+/-hysteresis". Click or tap **AutoSet**, the data rate of the signal will be measured automatically.

**Step 6:** Click or tap **CDR** to enter the CDR interface. Click or tap the drop-down button of **CDR Method** to select "**First Order PLL"**. Set **Data Rate** to 1.25Gb/s. Click or tap **Advanced Setting** to enter the advanced setting interface. Set **PLL Settling Time** to 5.00T; set PLL Idle Clock to 80. Click or tap to select **Both** for **Edge Direction**.

**Step 7:** In the "Jitter Measure" interface, click or tap the drop-down button of **Source** to select "CH1"; set **Edge Direction** to "Both"; set **Unit** to "Second". Check the checkbox of "Trend", "Spectrum", and "Histogram" to generate these graphs. Set the input signal type to "Data".

**Step 8:** Enable the basic jitter measurement, and you will see the measurement results.

### 5.2.2 Measurement Result

The following figure shows the jitter measurement results of the 1.25 GHz PRBS signal under test.


## 5.3 PCIE 1.0 SSC Signal

### 5.3.1 Test Procedures

**Step 1:** Input the single-ended signal converted from the PCIE differential signal under test to CH1 of the oscilloscope.

**Step 2:** In the "Horizontal" system menu, set the memory depth to Auto, and the sample rate is automatically set to a fixed value 20 GSa/s. Adjust the time base to make its memory depth to 40 Mpts.

**Step 3:** In the "Vertical" system menu, set the vertical scale of CH1 to 100 mV (make the signal amplitude take up the whole display area).

**Step 4:** In the **Jitter Measure** interface, set "Signal Type" to NRZ.

**Step 5:** Click or tap **Threshold** to select 10%, 50%, 90% of top, base. Set **Level Setting** to Default.

**Step 6:** Click or tap **CDR** to enter the CDR interface. Click or tap the drop-down button of **CDR Method** to select "**Second Order PLL"**. Click or tap **Measure Data Rate** to measure the data rate of the signal automatically. Click or tap **Advanced Setting** to enter the advanced setting interface. Set **PLL Settling Time** to 5.00T; set PLL Idle Clock to 80. Click or tap to select **Both** for **Edge Direction**.

**Step 7:** In the "Jitter Measure" interface, click or tap the drop-down button of **Source** to select "CH1"; set **Edge Direction** to "Both"; set **Unit** to "Second". Check the checkbox of "Trend", "Spectrum", and "Histogram" to generate these graphs. Set the input signal type to "Data".

**Step 8:** Enable the basic jitter measurement, and you will see the measurement results.

### 5.3.2 Measurement Result

The following figure shows the jitter measurement results of PCIE 1.0 SSC signal.


## 5.4 PAM4 Data Signal

### 5.4.1 Test Procedures

**Step 1:** Input the PAM4 signal under test to CH1 of the oscilloscope.

**Step 2:** In the "Horizontal" system menu, set the memory depth to Auto, and the sample rate is automatically set to a fixed value 20 GSa/s. Adjust the time base to make its memory depth to 40 Mpts.

**Step 3:** In the "Vertical" system menu, set the vertical scale of CH1 to 50 mV (make the signal amplitude take up the whole display area).

**Step 4:** In the **Jitter Measure** interface, set "Signal Type" to PAM4.

**Step 5:** Click or tap **Threshold** to enter the threshold setting interface. Click or tap the drop-down button of **Threshold** to select 50% of levels. Set **Level Setting** to PAM Auto Level.

**Step 6:** Click or tap **CDR** to enter the CDR interface. Click or tap the drop-down button of **CDR Method** to select **Constant Frequency**. Set **Symbol Rate** to "1.25GBd". Set **Data Rate Method** to Semi-Auto. Click or tap **Advanced Setting** to enter the advanced setting interface. Click or tap to select **Rise** for **Edge Direction**.

**Step 7:** In the "Jitter Measure" interface, click or tap the drop-down button of **Source** to select "CH1"; set **PAM Threshold** to Threshold 01. Set **Edge Direction** to "Both"; set **Unit** to "Second". Check the checkbox of "Trend", "Spectrum", and "Histogram" to generate these graphs. Set the input signal type to "Data".

**Step 8:** Enable the basic jitter measurement, and you will see the measurement results.

## 5.4.2 Measurement Result

The following figure shows the jitter measurement results of PAM4 data signal.



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