RIGOL

TF-ENET-STP

Ethernet Compliance Analysis Test Fixture

User Guide

Nov. 2022

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1 Document Overview

This manual introduces the layout and application of the Ethernet compliance test fixture TF-ENET-STP. This fixture supports the 1000Base-T and 100Base-T compliance tests, shortening the test time and ensuring the accuracy of the test results.

TIP

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

Publication Number

FGA29100-1110

Format Conventions in this Manual

1. **Key**

   The front panel key is denoted by the menu key icon. For example, Default 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, **Test Item** indicates clicking or tapping the "Test Item" tab in the current operation interface to enter the "Test Item" menu.

3. **Operation Procedures**

   The next step of the operation is denoted by ">" in the manual. For example, **LAN Analysis** > **Test Item** indicates that first clicking or tapping **LAN Analysis**, then clicking or tapping **Test Item**.

2 Product Overview

The TF-ENET-STP fixture is used for 1000Base-T and 100Base-T Ethernet compliance tests.

As the Ethernet signal is a high-speed signal, you cannot use the probe to measure the Ethernet cable that is working directly. You have to measure at a place terminated with the impedance at the end of the signal. Therefore you need to use the test fixture to perform the Ethernet compliance test.

The TF-ENET-STP test fixture includes TC2, TC3, TC4, and TC5, which are used for different test items.

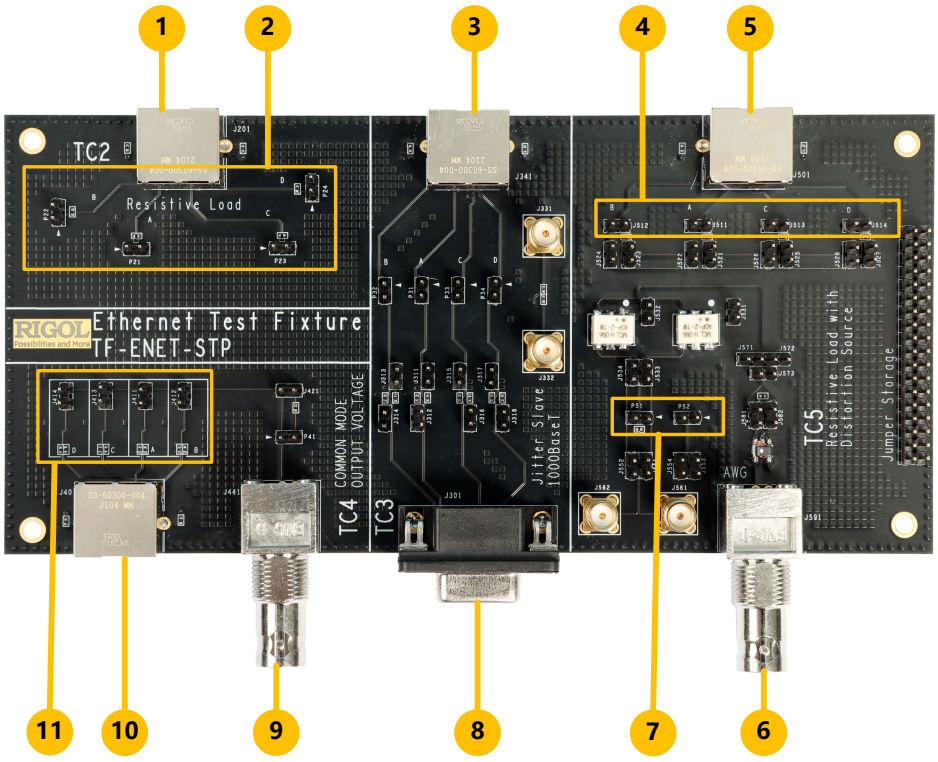

Figure 2.1 Fixture Layout

Table 2.1 Description

No.	Pin Name	Description
1	J201	Indicates the LAN interface of TC2.
2	P21/P22/P23/P24	Indicate four test points on TC2 that can be connected to the differential probe for testing the test pairs Pair A, Pair B, Pair C, and Pair D.

No.	Pin Name	Description
3	J341	Indicates the LAN interface of TC3.
4	J511/J512/J513/J514	Indicate four short jumpers used for testing the test pairs Pair A, Pair B, Pair C, and Pair D.
5	J501	Indicates the LAN interface of TC5.
6	J591	Indicates the single-ended input port (BNC male) of TC5 that is connected to the disturbing signal.
7	P51/P52	Indicate the test points of TC5 that are connected to the differential probe.
8	J301	Indicates the port on TC3 that is connected to that of the Link Partner.
9	J441	Indicates the single-ended output port (BNC male) of TC4 that is connected to the oscilloscope.
10	J401	Indicates the LAN interface of TC4.
11	J411/J412/J413/J414	Indicate four short jumpers used for testing the test pairs Pair A, Pair B, Pair C, and Pair D.

3 To Prepare for the Test

Before the Ethernet compliance test, prepare the following test tools and make the following preparations.

Table 3.1 Test Tool List

Device	Description
Test Fixture	Includes TC2, TC3, TC4, and TC5
Digital Oscilloscope	Supports the Ethernet compliance test
Function/Arbitrary Waveform Generator	Meets the specifications requirement for generating the disturbing signal
DUT	A DUT with the 100Base-T and 1000Base-T Ethernet interfaces
Link Partner	A DUT with the 1000Base-T Ethernet interface
Connection Cable	CAT6 Network Cable
Probe	Differential Probe and Single-ended Probe
Jumper Cap	Used to short-circuit the golden pin

Digital Oscilloscope

Prepare an oscilloscope equipped with the Ethernet compliance test and analysis function. The bandwidth of the oscilloscope is at least 1 GHz, and its memory depth is at least 200 Mpts.

For the digital oscilloscope used for the test, please make sure you have performed the following operations on it.

- Before the test, ensure that the instrument is within the calibration period.
- Take a 30-minute warm-up for the oscilloscope before use.
- When the ambient temperature variation reaches or exceeds 5℃, perform the self-calibration operation. For detailed operation procedures, refer to relevant contents specified in User Guide.

- Perform the "Function Inspection" and "Probe Compensation" operation on the oscilloscope. For detailed operation procedures, refer to relevant contents specified in User Guide.

Recommended oscilloscope model: RIGOL's DS70000 Series.

Function/Arbitrary Waveform Generator

The output frequency shall be ensured with the following conditions: bandwidth 50 MHz, amplitude 10 V_{pp}.

For the Function/Arbitrary Waveform Generator used for the test, please make sure you have performed the following operations on it.

- Before the test, ensure that the instrument is within the calibration period.
- The instrument must have been operating continuously for at least 30 minutes within the specified operating temperature range (18℃ to 28℃).

Recommended Function/Arbitrary Waveform Generator model: RIGOL's DG5000 Series Function/Arbitrary Waveform Generator. For detailed operations of the Function/Arbitrary Waveform Generator, refer to the User Guide of the specified model.

Probe

Prepare one differential probe and one single-ended probe. The bandwidth of the differential probe shall be greater than 1.5 GHz.

Recommended probe model: RIGOL's PVA7000 and PVA8000 series active differential probes. For detailed operations of the probe, refer to the User Guide of the specified probe model.

4 1000Base-T Compliance Test

According to the rules of IEEE 802.3 standards for the 1000BASE-T physical layer compliance test, the DUT is required to perform a series of compliance testings in the four test modes.

- **Test Mode 1:**
  - Test items: Template, Volt, and Droop
  - Two test scenarios: With Disturbing Signal and Without Disturbing Signal
- **Test Mode 2:**
  - Jitter Master Mode, used to test the integrity of the clock signal.
  - Four test scenarios: With TX_TCLK, Filtered Jitter Master Mode; Without TX_TCLK, Filtered Jitter Master Mode; With TX_TCLK, Unfiltered Jitter Master Mode; Without TX_TCLK, Unfiltered Jitter Master Mode.
- **Test Mode 3:**
  - Jitter Slave Mode, used to measure the capability of the slave clock in tracking the master clock and the integrity of clock signal restored from the slave device.
  - Four test scenarios: With TX_TCLK, Filtered Jitter Slave Mode; Without TX_TCLK, Filtered Jitter Slave Mode; With TX_TCLK, Unfiltered Jitter Slave Mode; Without TX_TCLK, Unfiltered Jitter Slave Mode.
- **Test Mode 4:**
  - Test items: Transmitter Distortion and Common-mode Output Voltage.
  - Four test scenarios: Without Disturbing Signal, Without TX_TCLK; Without Disturbing Signal, With TX_TCLK; With Disturbing Signal, Without TX_TCLK; With Disturbing Signal, With TX_TCLK.

Table 4.1 1000Base-T Test Items and Fixtures

Test Item	Fixture			
	TC2	TC3	TC4	TC5
Without Disturbing Signal, Peak Output Voltage	√			
With Disturbing Signal, Peak Output Voltage				√
Without Disturbing Signal, Maximum Output Droop	√			
With Disturbing Signal, Maximum Output Droop				√
Without Disturbing Signal, Differential Output Templates	√			
With Disturbing Signal, Differential Output Templates				√
Without TX_TCLK, Unfiltered Jitter Master Mode	√			
Without TX_TCLK, Filtered Jitter Master Mode	√			
With TX_TCLK, Unfiltered Jitter Master Mode		√		
With TX_TCLK, Filtered Jitter Master Mode	√	√		
Without TX_TCLK, Unfiltered Jitter Slave Mode	√			
Without TX_TCLK, Filtered Jitter Slave Mode	√			
With TX_TCLK, Unfiltered Jitter Slave Mode		√		
With TX_TCLK, Filtered Jitter Slave Mode	√	√		
Without Disturbing Signal, Without TX_TCLK, Transmitter Distortion	√			
Without Disturbing Signal, With TX_TCLK, Transmitter Distortion	√			
With Disturbing Signal, Without TX_TCLK, Transmitter Distortion				√

Test Item	Fixture			
	TC2	TC3	TC4	TC5
With Disturbing Signal, With TX_TCLK, Transmitter Distortion				√
Common-Mode Voltage			√	

4.1 Without Disturbing Signal, Template/Volt/Droop Test

Test Mode 1 includes Template, Volt, and Droop tests. Use TC2 to perform the tests. This section introduces the test by taking RIGOL DS70000 series to work with the differential probe as an example.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap  > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** > **1000Base-T** to select the 1000Base-T Ethernet signal.
3. Click or tap **Test Item** > **1000Base-T(IEEE 802.3 Section 40)** > **Without Disturbing Signal** > **Template/Volt/Droop**. The Template/Volt/Droop test without the disturbing signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.1* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

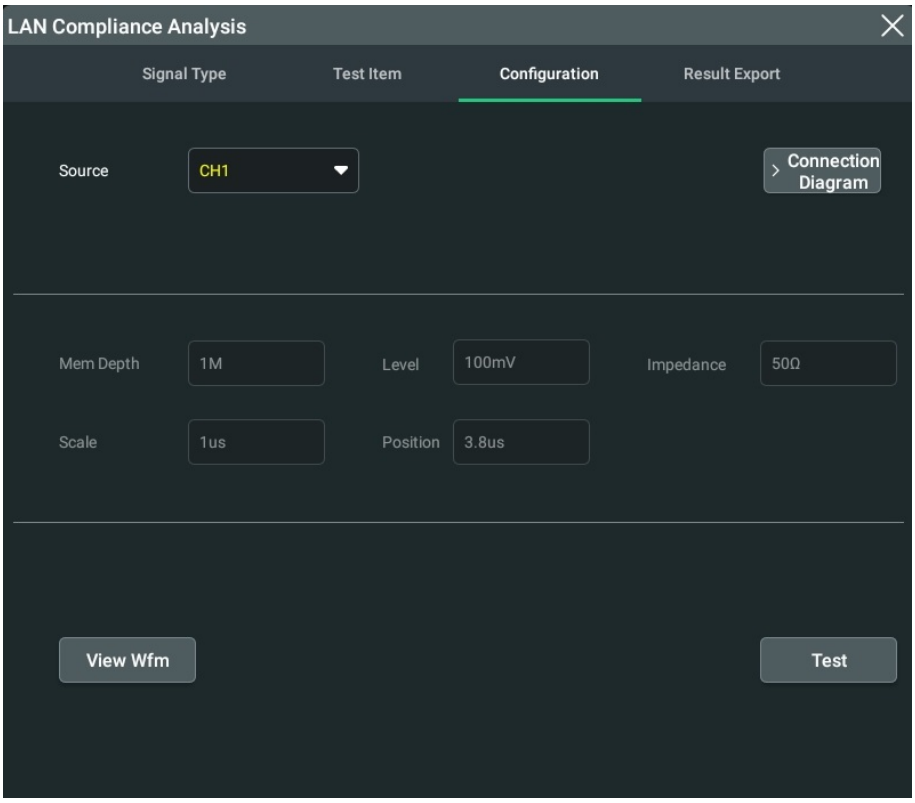

Figure 4.1 Test Configuration

Connect the Device

Test Connection Diagram

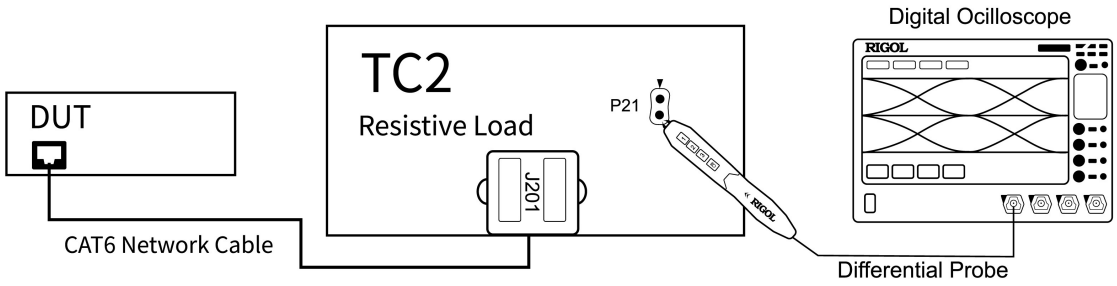

Figure 4.2 Test Mode 1 Connection Diagram

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.

Test Procedures

1. Set the DUT to generate a Test Mode 1 signal.

2. Connect the differential probe to P21 test point of TC2.
3. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
4. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
6. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window. For details, refer to *Template/Volt/Droop Test Results*.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for different test pairs on TC2, refer to the following table or *Figure 2.1* .

Table 4.2 Test Points Specified for Different Test Pairs on TC2

Test Pair	Test Point
Pair A	P21
Pair B	P22
Pair C	P23
Pair D	P24

4.2 With Disturbing Signal, Template/Volt/Droop Test

Test Mode 1 includes Template, Volt, and Droop tests. For Test Mode 1 with the disturbing signal, use TC2 and TC5 to perform the test. This section introduces the test by taking RIGOL DS70000 series to work with the differential probe as an example.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.

2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **With Disturbing Signal** > **Template/Volt/Droop**. The Template/Volt/Droop test with the disturbing signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.3* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

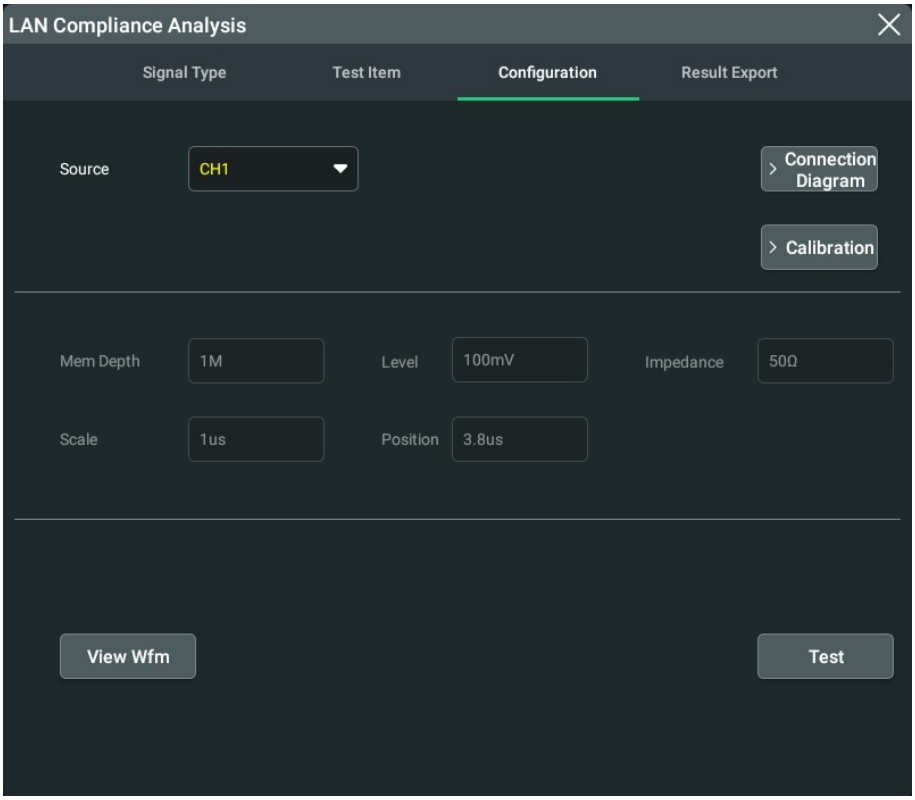

Figure 4.3 Test Configuration

4.2.1 To Calibrate the Disturbing Signal

For the test scenarios with the disturbing signal, perform calibration on the disturbing signal.

Device Connection Diagram

Use TC5 to calibrate the disturbing signal according to the following connection diagram.

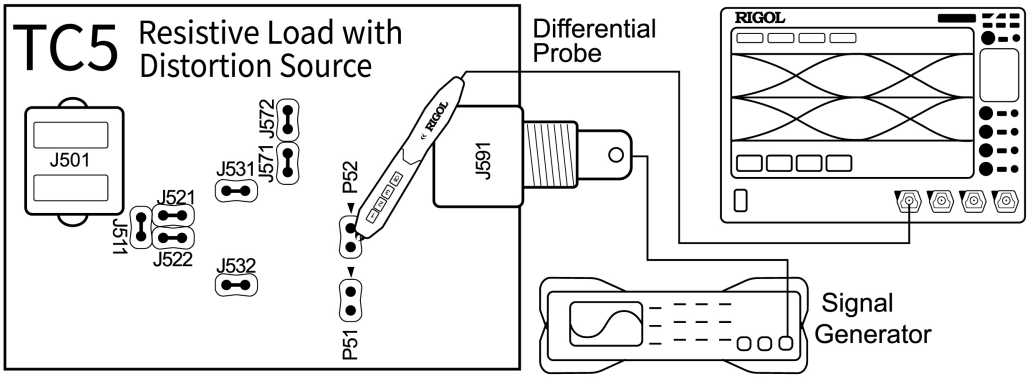

Figure 4.4 Connection Diagram of Calibration for Disturbing Signals

- Connect the output terminal of the Signal Generator to J591 of TC5 by using the BNC cable.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P52 of TC5.
- Short the jumpers J531, J532, J571, J572, J522, J521, and J511.

Operation Procedures

1. Set the Function/Arbitrary Waveform Generator to generate a disturbing Sine signal whose frequency is 31.25 MHz, amplitude is 2.8 V_{pp}.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.5* .
4. Click or tap **Measure** in the Disturbing Signal section to measure the disturbing signal generated from the waveform generator. Then the measured value will be displayed.

5. Compare the measured value with the expected value. If the measured value is not close to the expected value, please modify the amplitude and clock frequency of the Function/Arbitrary Waveform Generator. Restart to measure it and compare the values again to make their values approximately equal to each other.

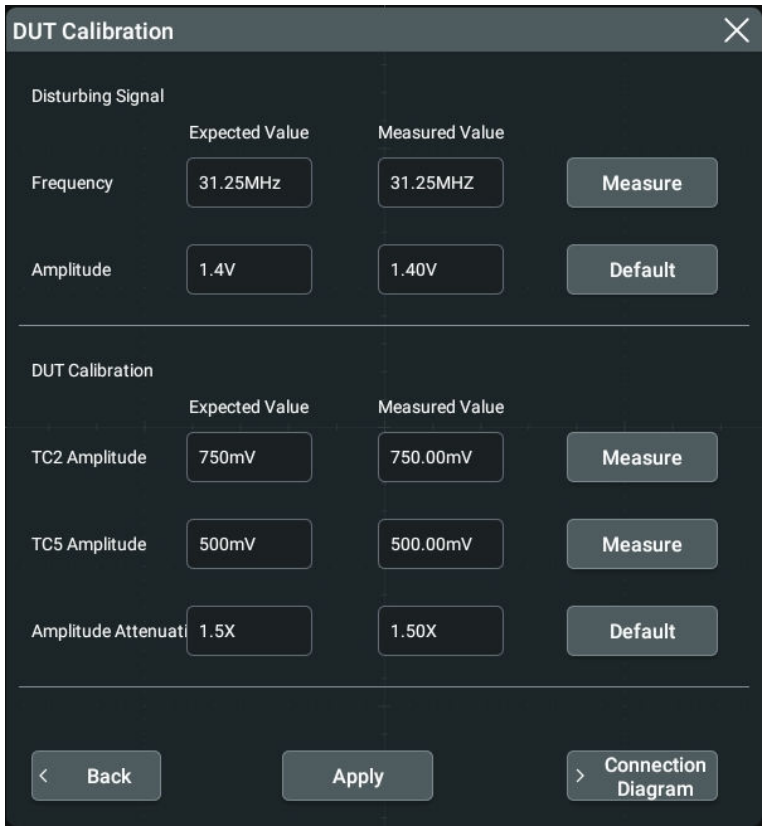

Figure 4.5 Fixture Calibration

4.2.2 Test Fixture Compensation

TC2 Amplitude Test

Use TC2 module of the test fixture to carry out the amplitude test. Connect the devices according to the following figure.

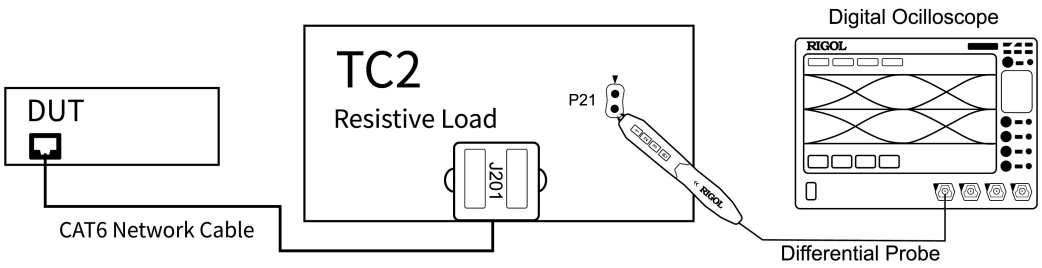

Figure 4.6 TC2 Calibration Connection Diagram

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P21 of TC2.

1. Set the DUT to generate a Test Mode 1 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.5* .
4. Click or tap **Measure** at the right part of the TC2 Amplitude in the DUT Calibration section to obtain the measured value of TC2 amplitude.

TC5 Amplitude Test

Use TC5 module of the test fixture to carry out the amplitude test. Connect the devices according to the following figure.

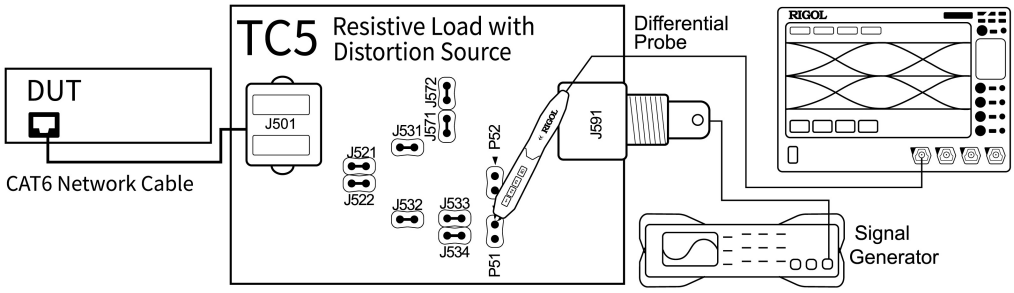

Figure 4.7 TC5 Calibration Connection Diagram

- Connect J501 of TC5 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the output terminal of the Function/Arbitrary Waveform Generator to J591 of TC5 by using the BNC cable. Disable the output of the generator to set its output value to zero.
- Short the jumpers J531, J532, J571, J572, J522, J521, J533, and J534.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P51 of TC5.

1. Set the DUT to generate a Test Mode 1 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.5* .
4. Click or tap **Measure** at the right part of the TC5 Amplitude in the DUT Calibration section to obtain the measured value of TC5 amplitude.
5. After finishing the measurement of TC2 and TC5 amplitudes, click or tap **Apply** to complete the fixture compensation.
6. Click or tap **Back** to return to the Configuration menu.

4.2.3 Test Procedures

After calibrating the disturbing signal and the fixture, perform the template, volt, and droop tests with the disturbing signal. Connect the test devices according to the following figure.

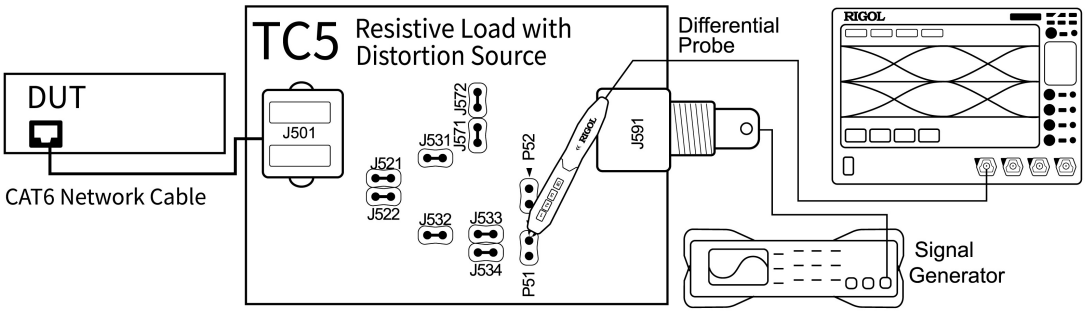

Figure 4.8 Connection Diagram of Test Mode 1 with the Disturbing Signal

- Connect J501 of TC5 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the output terminal of the Signal Generator to J591 of TC5 by using the BNC cable.
- Connect the differential probe to CH1 of the oscilloscope.

Test Procedures

1. Set the DUT to generate a Test Mode 1 signal.
2. Set the Function/Arbitrary Waveform Generator to generate a disturbing signal whose frequency is 31.25 MHz, amplitude 2.8 Vpp.
3. Short the jumpers J531, J532, J571, J572, J522, J521, J533, and J534.
4. Use the differential probe to connect P51 test point of TC5.
5. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
6. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.

7. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
8. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

NOTE

Four test pairs are available on TC5 of the fixture. The above operation takes Pair A as an example. For the tests of the other three test pairs, repeat the above procedures. Note that the specified jumpers for different test pairs are different. For the jumpers specified for different test pairs on TC5, refer to the following table or *Figure 2.1* .

Table 4.3 Jumpers Specified for Different Test Pairs on TC5

Test Pair	Jumper
Pair A	J531, J532, J571, J572, J522, J521, J533, and J534
Pair B	J531, J532, J571, J572, J524, J523, J533, and J534
Pair C	J531, J532, J571, J572, J526, J525, J533, and J534
Pair D	J531, J532, J571, J572, J528, J527, J533, and J534

4.2.4 Template/Volt/Droop Test Results

Test Waveform

The waveform of the signal generated from the DUT in Test Mode 1 is shown in the following figure. Multiple test points are marked in the figure.

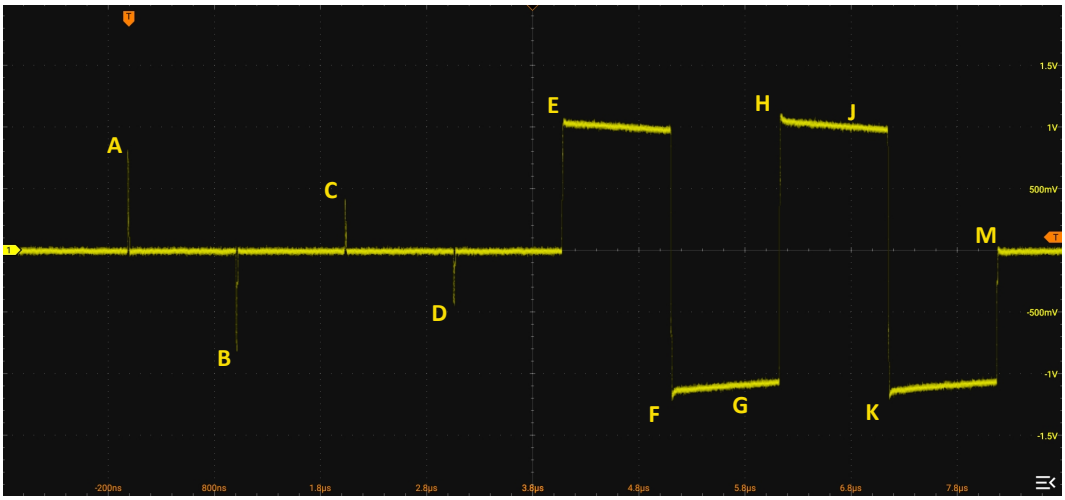

Figure 4.9 Typical Waveform of Test Mode 1 Signal

Test Mode 1 includes Template, Volt, and Droop tests. The test points of the waveforms for each test item are shown in the following table.

Table 4.4 Test Mode 1 Signal Waveform Test Point

Test Item	Test Point
Template Test	A, B, C, D, F, and H
Peak Voltage Test	A, B, C, and D
Droop Test	F, G, H, and J

Pass Conditions

The pass conditions for Template, Volt, and Droop tests are shown in the following table.

Table 4.5 Pass Conditions for Test Mode 1

Test Item	Test Contents	Pass Conditions	
		Min.	Max.
Peak Output Voltage	Peak Differential Output Voltage A	0.67 V	0.82 V
	Peak Differential Output Voltage B		
	% Diff A & B	0%	1%
	% Diff C & (A and B)	0%	2%
	% Diff D & (A and B)		
Differential Output Templates	Test A, B, C, D, F, and H	-	-
Maximum Output Droop	Max. Output Droop (Point F and Point G)	73.1%	-
	Max. Output Droop (Point H and Point J)		

Test Mode 1 Test Result Diagram

The test result diagrams of the Template/Volt/Droop tests are shown in the following figures.

- **Template Test**

  A, B, C, and D test points share one template; F and H test points share another template.

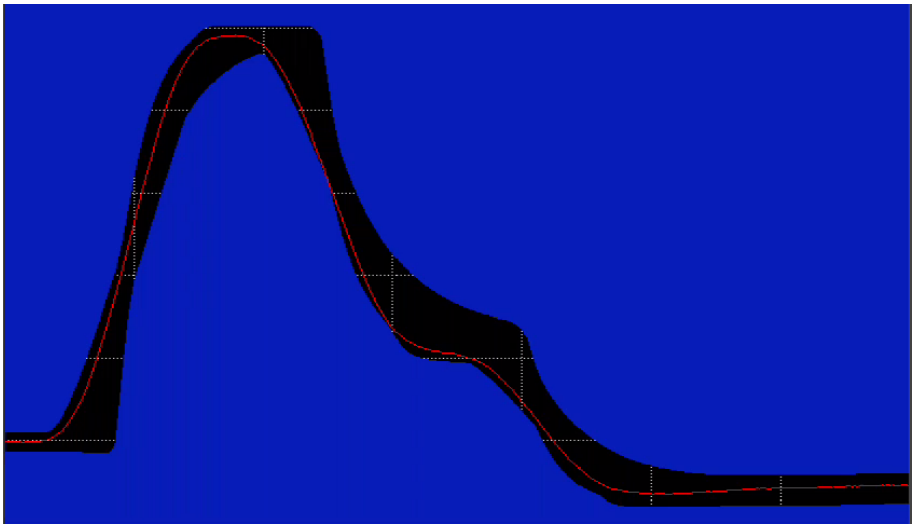

Figure 4.10 Differential Output Template for Test Point A, B, C, and D

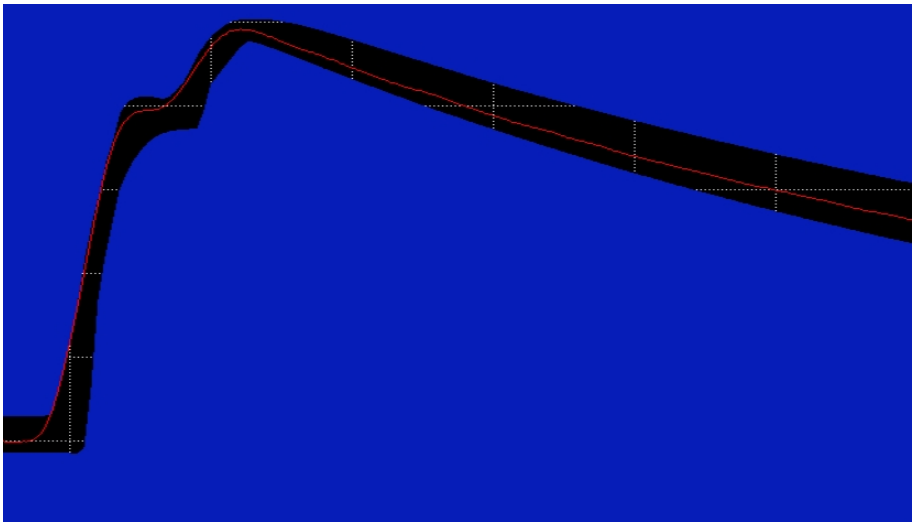

Figure 4.11 Differential Output Template for Test Point F and H

- **Output Droop Test**

  Test for Point F, G, H, and J

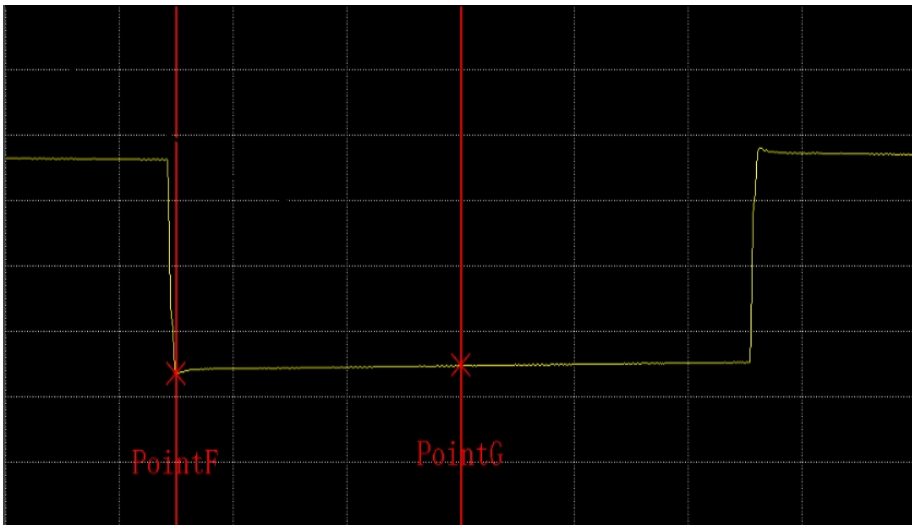

Figure 4.12 Max. Output Droop (Point F and Point G)

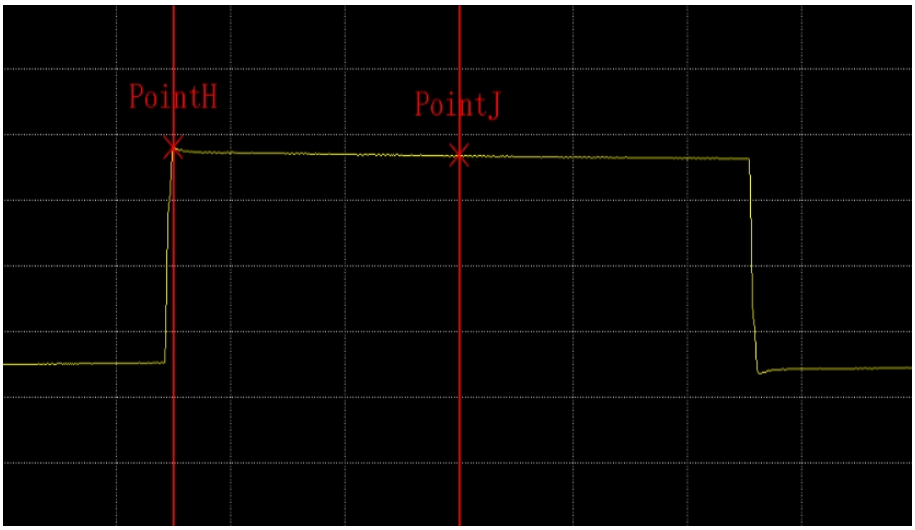

Figure 4.13 Max. Output Droop (Point H and Point J)

4.3 Without TX_TCLK, Jitter Master Mode

When the clock signal of the DUT is unavailable, two different test items are available according to whether the MDI jitter waveforms are filtered or not. The device connection methods for the filtered or unfiltered test items are illustrated in detail in the test procedures. This section takes RIGOL DS70000 series oscilloscope to work with the differential probe as an example to introduce it.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.

2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Click or tap the **Test Item** tab to enter the "Test Item" menu and select the following test items.
   - Without TX_TCLK, Unfiltered Jitter Master Mode

     Select **1000Base-T(IEEE 802.3 Section 40)** > **Without TX_TCLK** > **Unfiltered Jitter Master Mode(40.6.1.2.5)**. The unfiltered jitter master mode without the clock signal is selected.
   - Without TX_TCLK, Filtered Jitter Master Mode

     Select **1000Base-T(IEEE 802.3 Section 40)** > **Without TX_TCLK** > **Filtered Jitter Master Mode(40.6.1.2.2)**. The filtered jitter master mode without the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.14* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

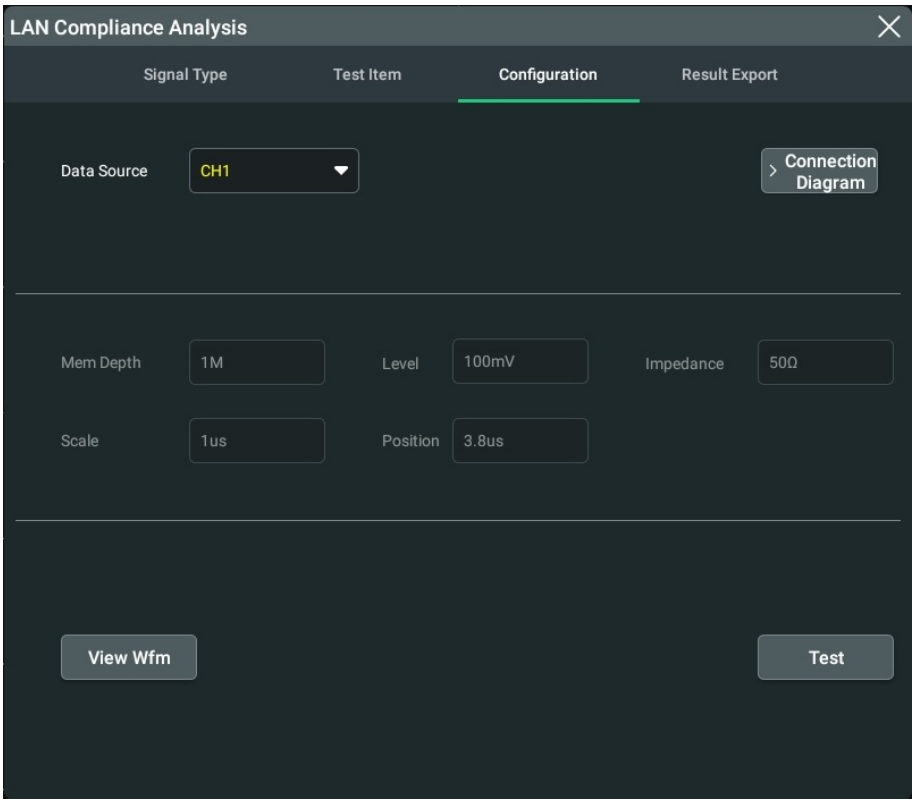

Figure 4.14 Test Configuration

4.3.1 Test Procedures

Connect the devices according to the following figure.

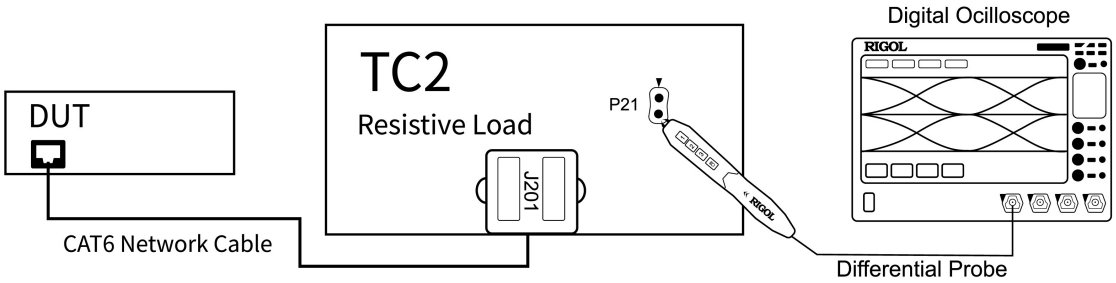

Figure 4.15 Test Connection Diagram for Jitter Master Mode without TX_TCLK

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.

Test Procedures

1. Set the DUT to generate a Test Mode 2 signal.
2. Connect the differential probe to P21 test point of TC2.
3. In the "Configuration" menu, click or tap the drop-down button of **Data Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
4. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
6. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for different test pairs on TC2, refer to *Table 4.2 Test Points Specified for Different Test Pairs on TC2* or *Figure 2.1* .

4.3.2 Test Results

Test Waveform

The waveform of the MDI data signal generated from the DUT in Test Mode 2 is shown in the following figure.

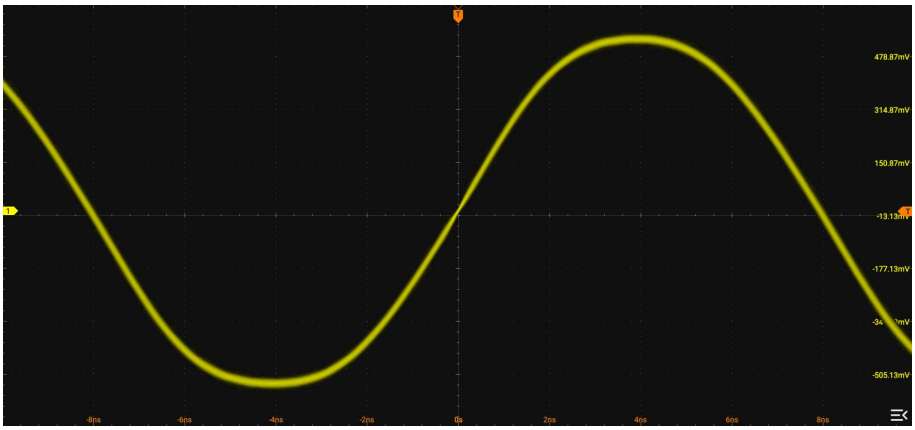

Figure 4.16 MDI Data Signal Waveform

Pass Conditions

The pass conditions for the test items in Test Mode 2 are shown in the following table.

Table 4.6 Pass Conditions for Test Mode 2

Test Item	Clock Signal	Filter	Pass Conditions	
			Min.	Max.
Jitter Master Mode	Without TX_TCLK	Unfiltered	0 ns	1.4 ns
	Without TX_TCLK	Filtered	0 ns	0.3 ns
	With TX_TCLK	Unfiltered	0 ns	1.4 ns
	With TX_TCLK	Filtered	0 ns	0.3 ns

Jitter Measurement Graph

The jitter TIE trend graph of the MDI data signal is shown in the following figure.

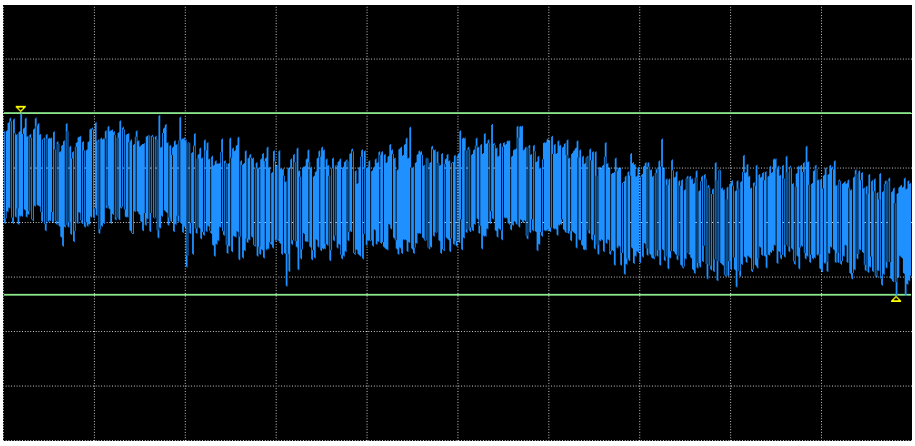

Figure 4.17 Jitter TIE Trend Graph

4.4 With TX_TCLK, Unfiltered Jitter Master Mode

When the TX_TCLK signal of the DUT is available, use TC2 to perform this test. This section takes RIGOL DS70000 series as an example to introduce the test.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap  > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **With TX_TCLK** > **Unfiltered Jitter Master Mode(40.6.1.2.5)**. The unfiltered jitter master mode with the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.18* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

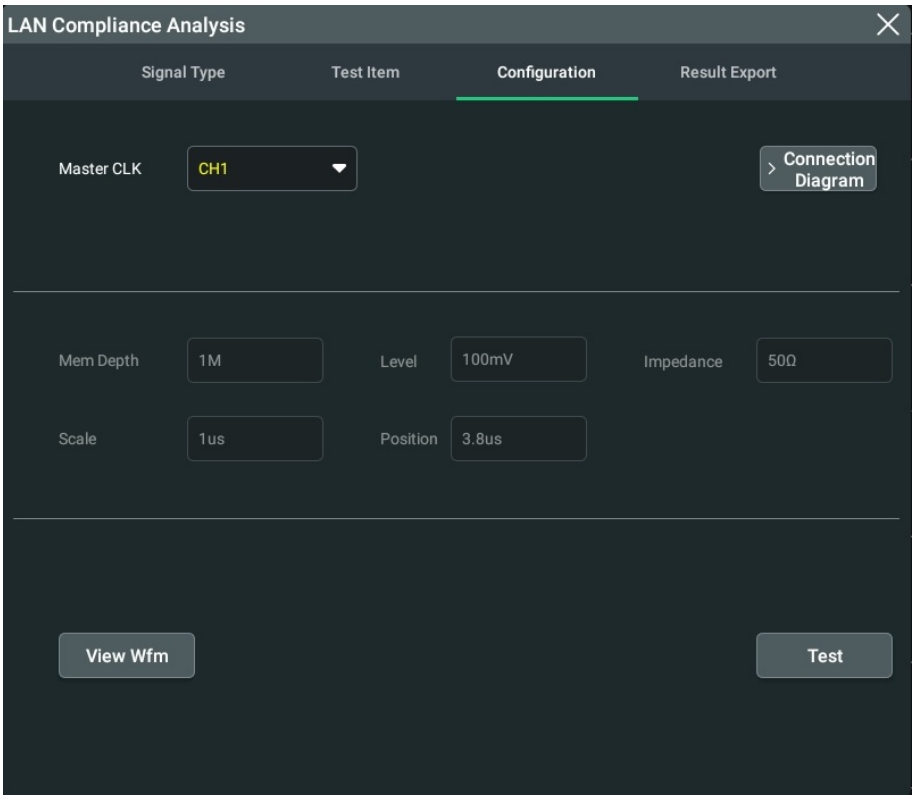

Figure 4.18 Test Configuration

4.4.1 Test Procedures

Connect the devices according to the following figure.

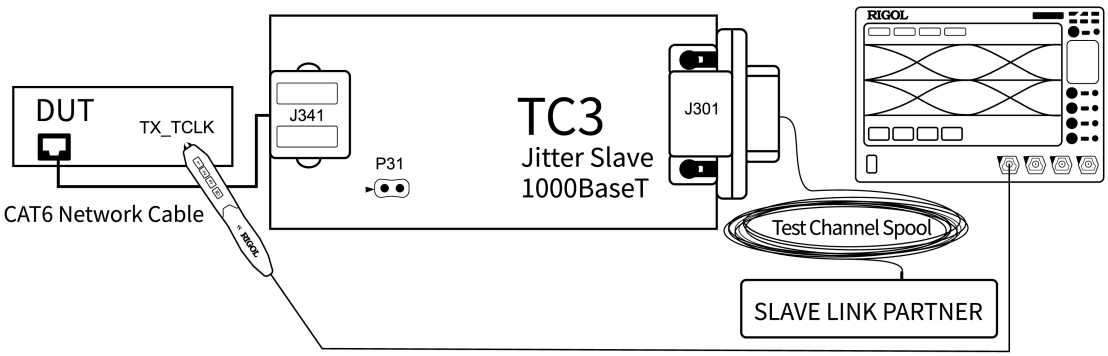

Figure 4.19 Connection Diagram

- Connect J341 of TC3 and the test port of the DUT by using the CAT6 Ethernet cable.

- Connect J301 of TC3 and the test port of the Link Partner by using the CAT6 Ethernet cable.
- Connect one end of the single-ended probe to CH1 of the oscilloscope and the other end to the TX_TCLK clock signal port of the DUT.

Test Procedures

1. Set the DUT to serve as the master device and the Link Partner as the slave device. Ensure that they work in normal mode.
2. In the "Configuration" menu, click or tap the drop-down button of **Master CLK** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
3. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
4. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
5. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

4.4.2 Test Results

Test Waveform

Set the DUT in normal mode to Master and generate a 125 MHz clock signal. Its waveform is as follows:

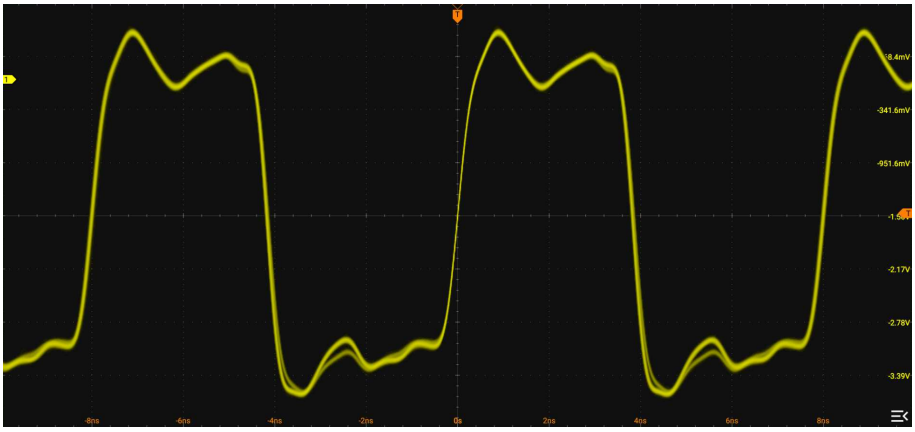

Figure 4.20 Clock Signal Waveform

Jitter Measurement Graph

The jitter TIE trend graph of the master clock signal generated from the DUT in normal mode is shown in the following figure.

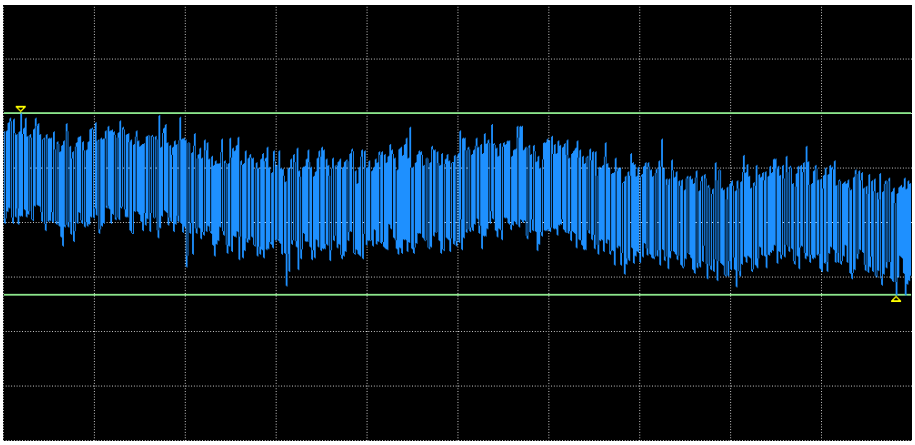

Figure 4.21 Jitter TIE Trend Graph

Pass Conditions

Pass conditions for the unfiltered jitter master mode (with TX_TCLK): the peak-to-peak value of the measured signal jitter should be smaller than 1.4 ns.

For more information, refer to *Pass Conditions for Test Mode 2*.

4.5 With TX_TCLK, Filtered Jitter Master Mode

When the TX_TCLK signal of the DUT is available, use TC2 and TC3 to perform this test. This section takes RIGOL DS70000 series as an example to introduce the test.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** > **1000Base-T** to select the 1000Base-T Ethernet signal.
3. Click or tap **Test Item** > **1000Base-T(IEEE 802.3 Section 40)** > **With TX_TCLK** > **Filtered Jitter Master Mode(40.6.1.2.2)**. The filtered jitter master mode with the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.22* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

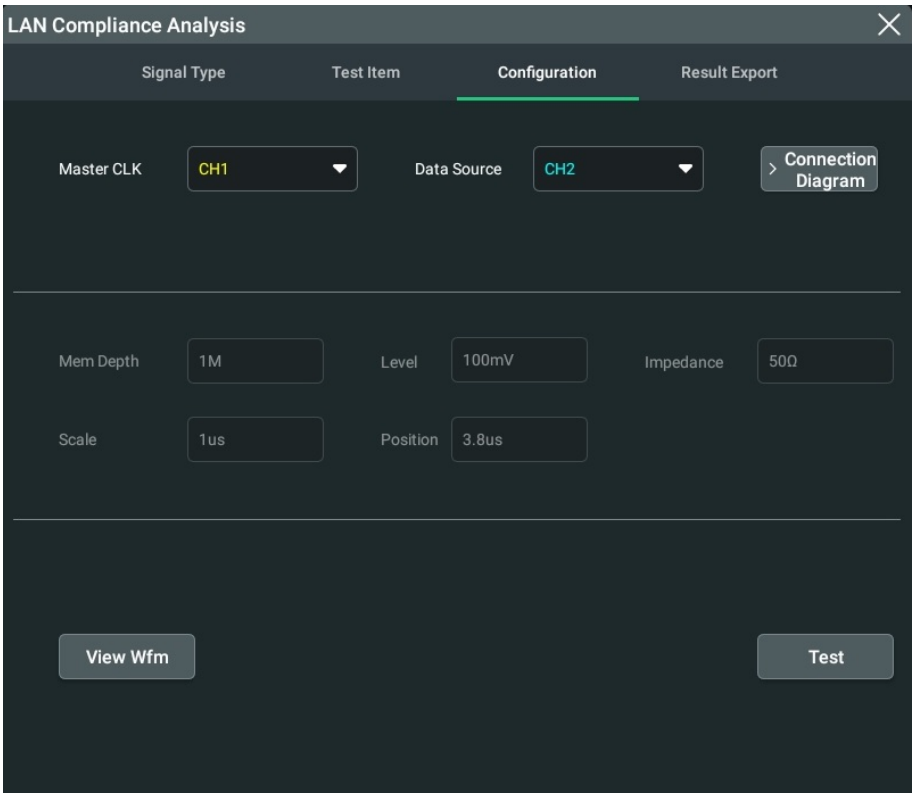

Figure 4.22 Test Configuration

4.5.1 Test Procedures

1. Use TC3 of the test fixture to test the jitter of the clock signal of the slave device relative to that of the clock signal of the master device. Connect the devices according to the following connection diagram.

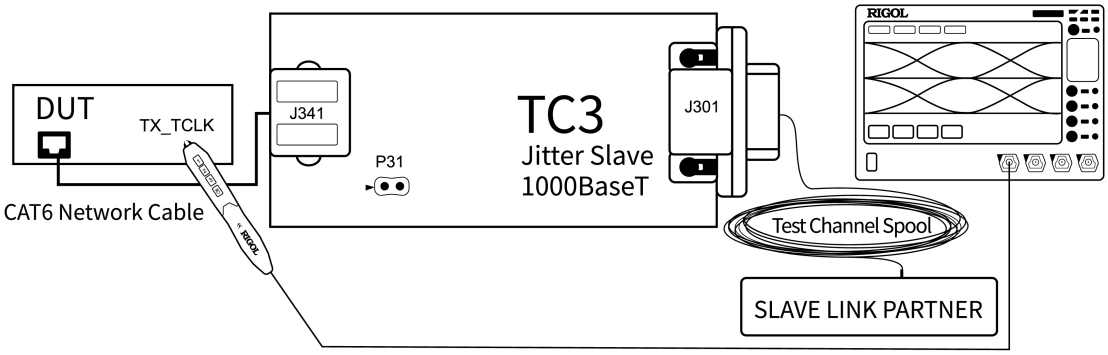

Figure 4.23 Test Connection Diagram for Master Clock Signal

- Connect J341 of TC3 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect J301 of TC3 and the test port of the Link Partner by using the CAT6 Ethernet cable.
- Connect one end of the single-ended probe to CH1 of the oscilloscope and the other end to the TX_TCLK port of the DUT.

2. Set the DUT to serve as the master device and the Link Partner as the slave device. Ensure that they work in normal mode.

3. In the "Configuration" menu, click or tap the drop-down button of **Master CLK** to select CH1. Click or tap the drop-down button of **Data Source** to select CH2. Ensure that the selected channels are consistent with those you use in the device menu under the connection diagram.

4. Click or tap the Configuration tab to In the "Configuration" menu, then click or tap **Test** to start testing the jitter of the master clock. Wait for a while until a prompt message that informs you to switch to another device is displayed.

5. Switch a device. Use TC2 of the test fixture to test the jitter of the MDI data signal of the master device relative to that of the clock signal of the slave device. Connect the devices according to the following connection diagram.

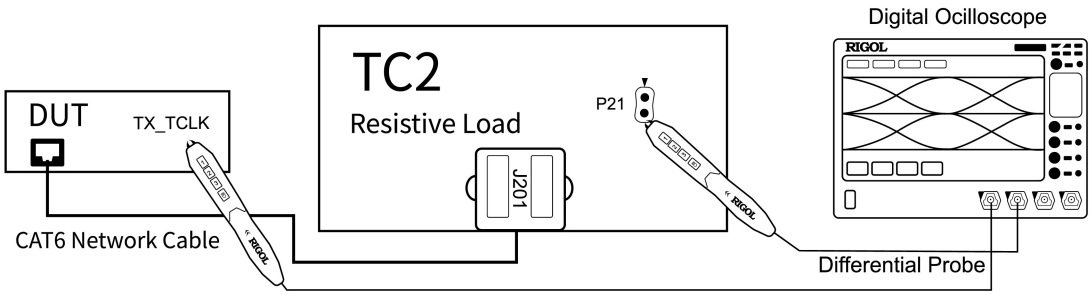

Figure 4.24 Test Connection Diagram for Master Data Signal

- Connect the test port of the DUT to J201 of TC2.
- Connect one end of the single-ended probe to CH1 of the oscilloscope and the other end to the TX_TCLK port of the DUT.
- Connect one end of the differential probe to CH2 of the oscilloscope.

6. Set the DUT to generate a Test Mode 2 signal.

7. Connect the differential probe to P21 test point of TC2.

8. Click or tap **OK** to Start. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.

9. After finishing the analysis, you can view the waveform in the waveform view and view the test results in the "1000Base-T Test Results" window.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for different test pairs on TC2, refer to *Table 4.2 Test Points Specified for Different Test Pairs on TC2* or *Figure 2.1* .

4.5.2 Test Results

Test Waveform

The test waveforms of the this test item includes two parts:

1. Set the DUT in normal mode to Master and generate a 125 MHz clock signal, as shown in *Figure 4.20* .

2. After switching the connection diagram, the master clock signal generated from the DUT in Test Mode 2 and the MDI data signal measured by using TC2 are shown in *Figure 4.16* .

Jitter Measurement Graph

The test results include

- Master DUT clock jitter
- Jitter of the MDI data signal generated from the DUT in Test Mode 2 relative to that of the master clock signal

The jitter TIE trend graph of the master clock signal relative to MDI data signal is shown in the following figure.

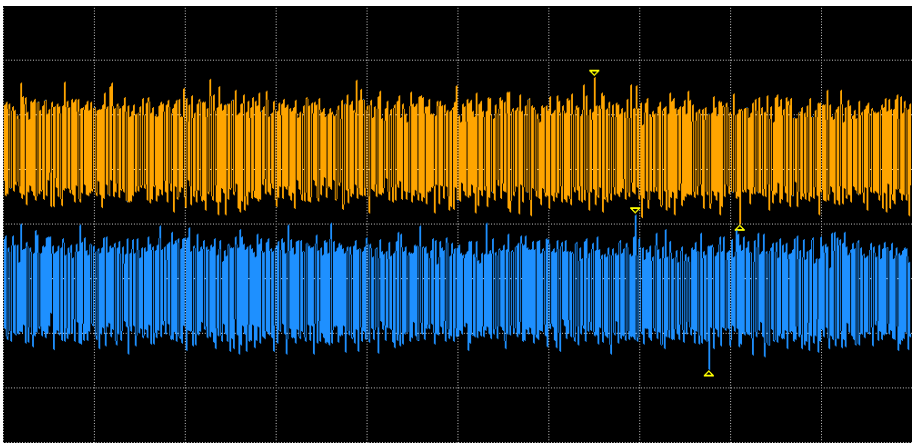

Figure 4.25 Jitter TIE Trend Graph

Pass Conditions

Pass conditions for the filtered jitter master mode (with TX_TCLK): the peak-to-peak value of the measured signal jitter should be smaller than 0.3 ns.

For more information, refer to *Pass Conditions for Test Mode 2*.

4.6 Without TX_TCLK, Jitter Slave Mode

When the TX_TCLK clock signal of the DUT is unavailable, two different test items are available according to whether the MDI data signal has filters or not. The connection methods for the filtered or unfiltered test items are the same as their test procedures. For the detailed operation procedure, this section takes RIGOL DS70000 series oscilloscope to introduce it.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap  > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Click or tap the **Test Item** tab to enter the "Test Item" menu and select the following test items.
   - Without TX_TCLK, Unfiltered Jitter Slave Mode

     Select **1000Base-T(IEEE 802.3 Section 40)** > **Without TX_TCLK** > **Unfiltered Jitter Slave Mode(40.6.1.2.5)**. The unfiltered jitter slave mode without the clock signal is selected.
   - Without TX_TCLK, Filtered Jitter Slave Mode

     Select **1000Base-T(IEEE 802.3 Section 40)** > **Without TX_TCLK** > **Filtered Jitter Slave Mode(40.6.1.2.2)**. The filtered jitter slave mode without the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.14* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

4.6.1 Test Procedures

Connect the devices according to the following figure.

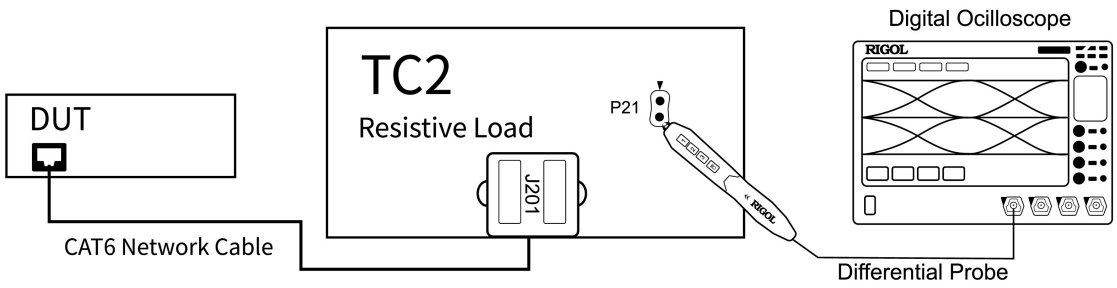

Figure 4.26 Test Connection Diagram for Jitter Slave Mode without TX_TCLK

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.

Operation Procedures

1. Set the DUT to generate a Test Mode 2 signal.
2. Connect P21 of TC2 by using the differential probe.
3. In the "Configuration" menu, click or tap the drop-down button of **Data Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
4. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing. Wait for a while until a prompt message that informs you to switch to another device is displayed.
6. Switch the DUT and set it to generate a Test Mode 3 signal.
7. Click or tap **OK** to continue testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
8. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for

different test pairs on TC2, refer to *Table 4.2 Test Points Specified for Different Test Pairs on TC2* or *Figure 2.1* .

4.6.2 Test Results

Test Waveform

The MDI data signals generated from the DUT in Test Mode 2 and Test Mode 3 are consistent. The signal waveform is shown in the following figure.

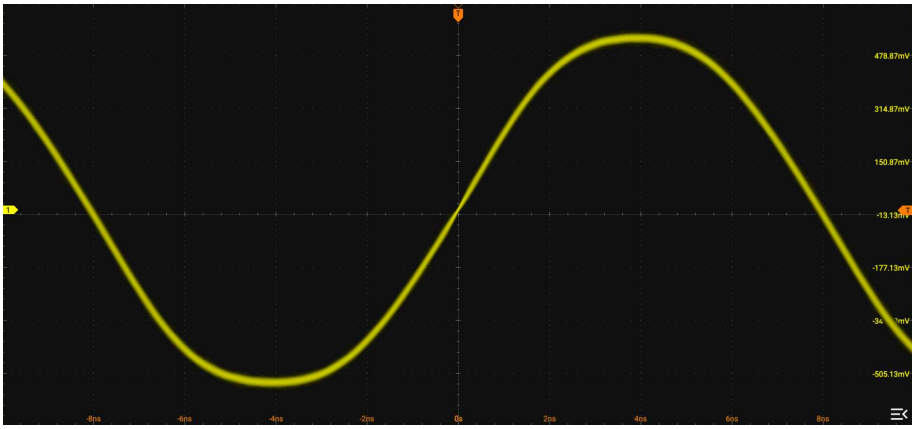

Figure 4.27 Data Signal Waveform

Jitter Measurement Graph

The test results include

- Jitter results of the MDI data signal from the DUT in Test Mode 2.
- Jitter results of the MDI data signal from the DUT in Test Mode 3.

The jitter TIE trend graph is shown in the following figure.

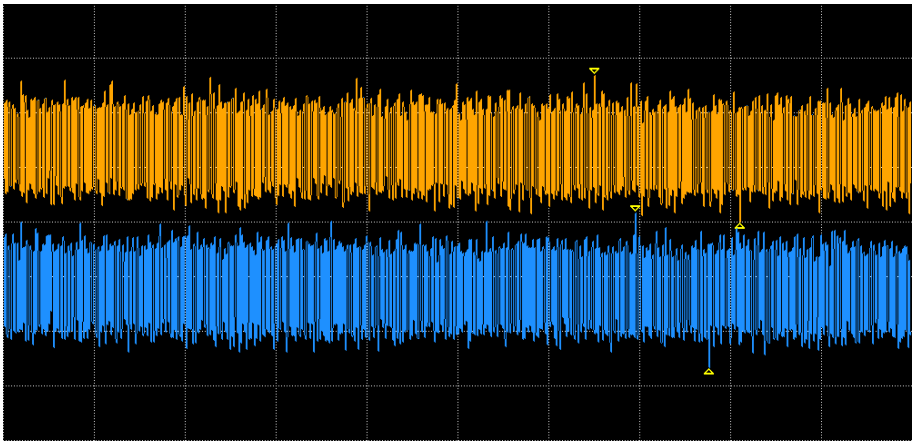

Figure 4.28 Jitter TIE Trend Graph

Pass Conditions

The pass conditions for the test items in Test Mode 3 are shown in the following table.

Table 4.7 Pass Conditions for Test Mode 3

Test Item	Clock Signal (TX_TCLK)	Filtered/ Unfiltered	Pass Conditions	
			Min.	Max.
Jitter Slave Mode	Without TX_TCLK	Unfiltered	0 ns	1.4 ns
	Without TX_TCLK	Filtered	0 ns	0.4 ns
	With TX_TCLK	Unfiltered	0 ns	1.4 ns
	With TX_TCLK	Filtered	0 ns	0.4 ns

4.7 With TX_TCLK, Unfiltered Jitter Slave Mode

It is required to test the clock jitter of the slave DUT relative to that of the master DUT.

When the TX_TCLK signal of the DUT is available, use TC3 to perform this test. This section takes RIGOL DS70000 series as an example to introduce the test.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap  > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **With TX_TCLK** > **Unfiltered Jitter Slave Mode(40.6.1.2.5)**. The unfiltered jitter slave mode with the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.29* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

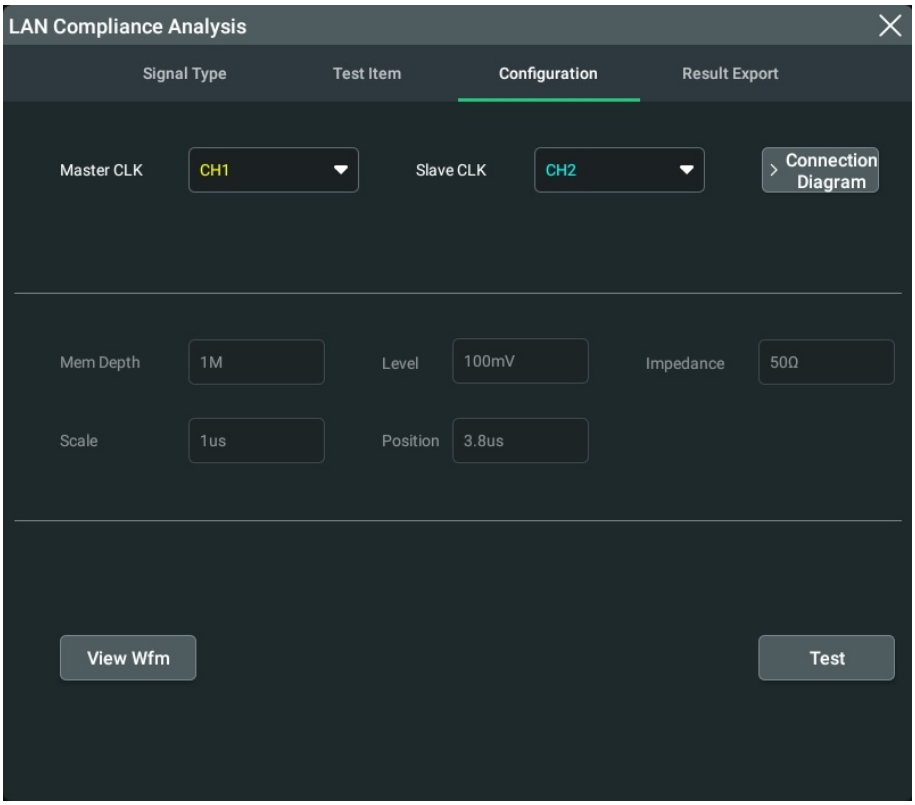

Figure 4.29 Test Configuration

4.7.1 Test Procedures

Connect the devices according to the following figure.

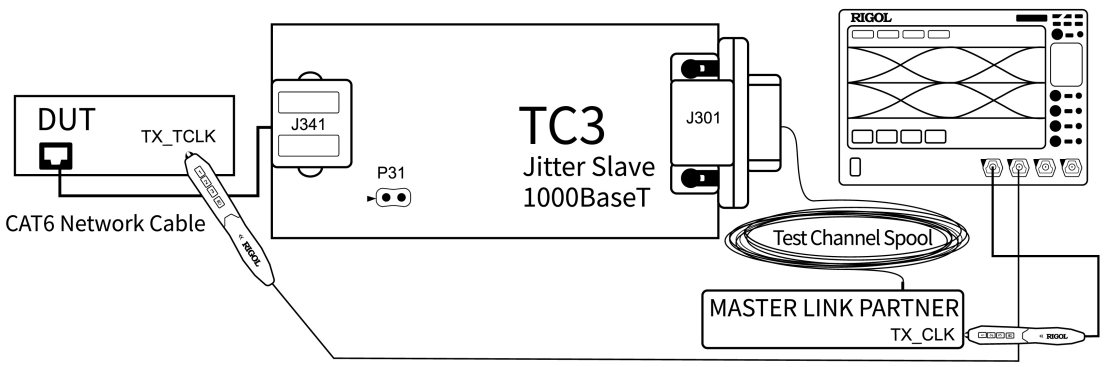

Figure 4.30 Test Connection Diagram for Unfiltered Jitter Slave Mode (With TX_TCLK)

- Connect Link Partner to J301 of TC3 by using the CAT6 Ethernet cable.

- Connect the test port of the DUT to J341 of TC3 by using the CAT6 Ethernet cable.
- Connect one end of Single-ended Probe 1 to CH1 of the oscilloscope and the other end to the TX_TCLK port of the Link Partner.
- Connect one end of Single-ended probe 2 to CH2 of the oscilloscope and the other end to the TX_TCLK port of the DUT.

Test Procedures

1. Set the DUT to Slave and work in normal mode.
2. Set the Link Partner to Master and work in normal mode.
3. In the "Configuration" menu, click or tap the drop-down button of **Master CLK** to select CH1. Click or tap the drop-down button of **Slave CLK** to select CH2. Ensure that the selected channels are consistent with those you use in the device menu under the connection diagram.
4. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
6. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

4.7.2 Test Results

This test item includes two signals. Their waveforms are as follows:

- Set the DUT in normal mode to Slave and generate a 125 MHz clock signal.
- Set the Link Partner in normal mode to Master and generate a 125 MHz clock signal.

Test Diagram

Slave clock jitter

The measured jitter TIE trend is shown in the following figure.

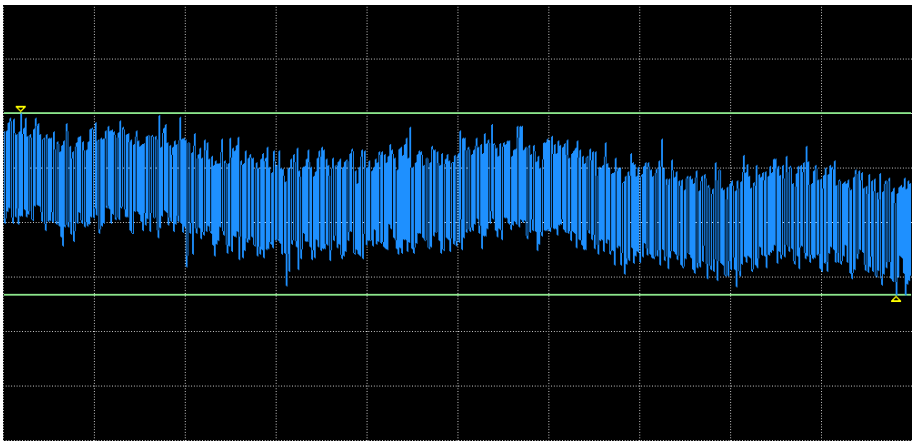

Figure 4.31 Jitter TIE Trend Graph

Pass Conditions

Pass conditions for the unfiltered jitter slave mode (with TX_TCLK): the peak-to-peak value of the measured signal jitter should be smaller than 1.4 ns.

For more information, refer to *Pass Conditions for Test Mode 3*.

4.8 With TX_TCLK, Filtered Jitter Slave Mode

When the TX_TCLK signal of the DUT is available, use TC2 and TC3 to perform this test. This section takes RIGOL DS70000 series as an example to introduce the test.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **With TX_TCLK** > **Filtered Jitter Slave Mode(40.6.1.2.2)**. The filtered jitter slave mode with the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.32* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

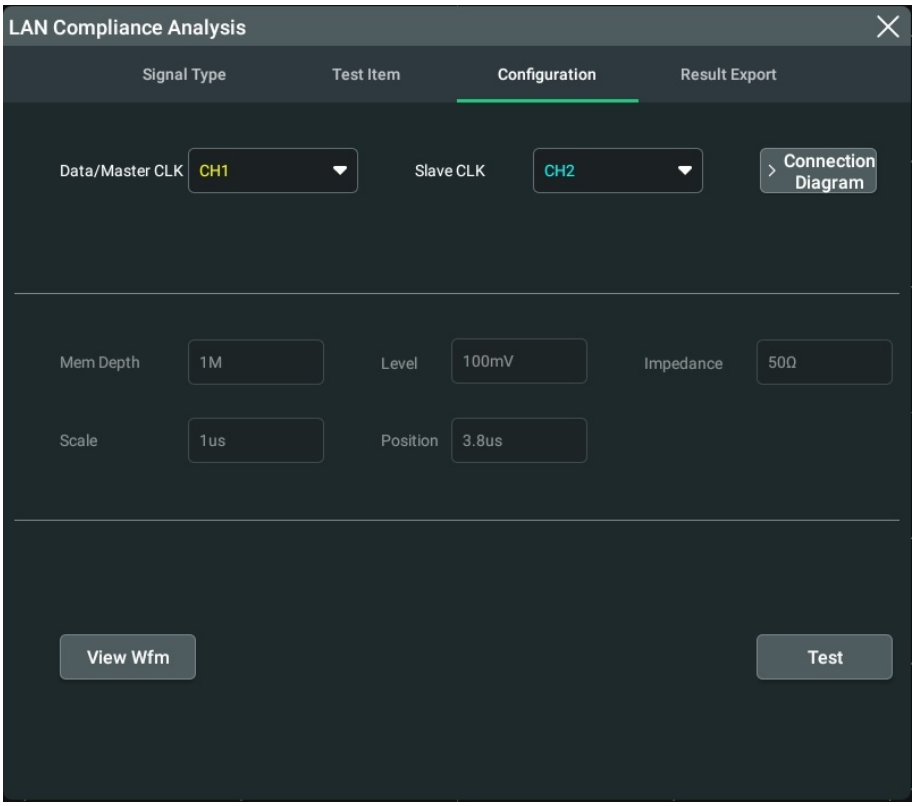

Figure 4.32 Test Configuration

4.8.1 Test Procedures

1. Use TC3 of the test fixture to test the jitter of the clock signal of the slave device relative to that of the clock signal of the master device. Connect the devices according to the following connection diagram.

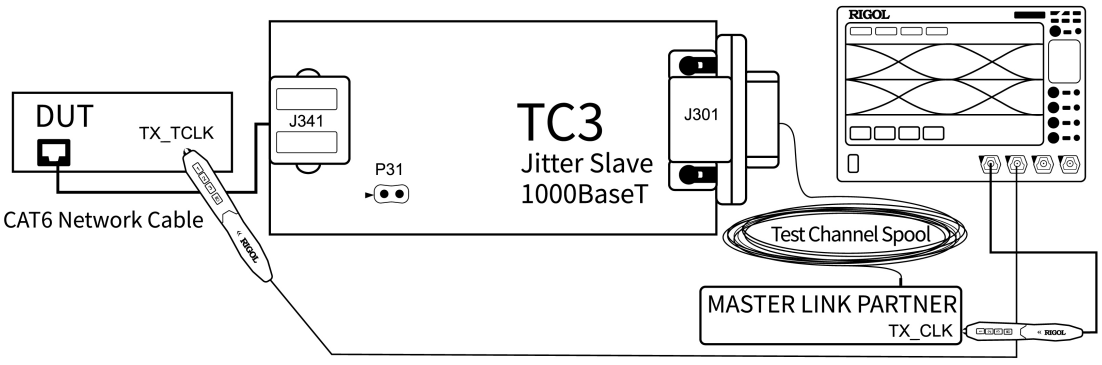

Figure 4.33 Test Connection Diagram for Slave Clock Signal

- Connect J341 of TC3 and the test port of the DUT by using the CAT6 Ethernet cable.

- Connect J301 and the test port of the Master Link Partner by using the CAT6 Ethernet cable.
- Connect one end of Single-ended Probe 1 to CH1 of the oscilloscope and the other end to the TX_TCLK port of the Link Partner.
- Connect one end of Single-ended probe 2 to CH2 of the oscilloscope and the other end to the TX_TCLK port of the DUT.

2. Set Master Link Partner and DUT to work in normal mode; set Link Partner to Master and DUT to Slave.
3. In the "Configuration" menu, click or tap the drop-down button of **Data/Master CLK** to select CH1. Click or tap the drop-down button of **Slave CLK** to select CH2. Ensure that the selected channels are consistent with those you use in the device menu under the connection diagram.
4. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing the jitter of the master clock. Wait for a while until a prompt message that informs you to switch to another device is displayed.
6. Switch a device. Use TC2 of the test fixture to test the jitter of the MDI data signal of the master device relative to that of the clock signal of the slave device. Connect the devices according to the following connection diagram.

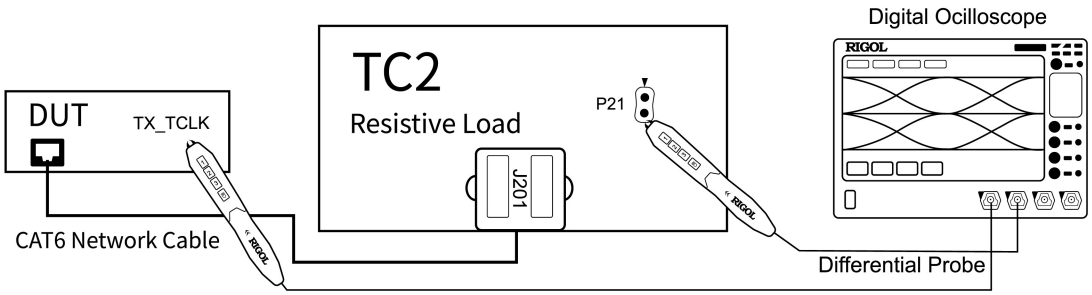

Figure 4.34 Test Connection Diagram for Slave Data Signal

- Connect the test port of the DUT to J201 of TC2.
- Connect the differential probe to CH1 of the oscilloscope.

7. Connect the differential probe to P21 test point of TC2.

8. Set the DUT to generate a Test Mode 3 signal.
9. Click or tap **OK** to Start. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
10. After finishing the analysis, you can view the waveform in the waveform view and view the test results in the "1000Base-T Test Results" window.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for different test pairs on TC2, refer to *Table 4.2 Test Points Specified for Different Test Pairs on TC2* or *Figure 2.1* .

4.8.2 Test Result

This test item includes two tests before and after switching the device. The signal for each test is as follows:

- Before Switching to Another DUT
  - Set the Link Partner in normal mode to Master and generate a 125 MHz clock signal.
  - Set the DUT in normal mode to Slave and generate a 125 MHz clock signal.
- After Switching to Another DUT
  - 125 MHz clock signal sent from the TX_TCLK port of the DUT in Test Mode 3.
  - MDI data signal generated from the DUT in Test Mode 3, as shown in *Figure 4.27* .

Jitter Measurement Graph

The test results include

- Master Link Partner clock jitter;
- Slave DUT clock jitter;
- Jitter results of the MDI data signal generated from the DUT in Test Mode 3.

The jitter TIE trend graph is shown in the following figure.

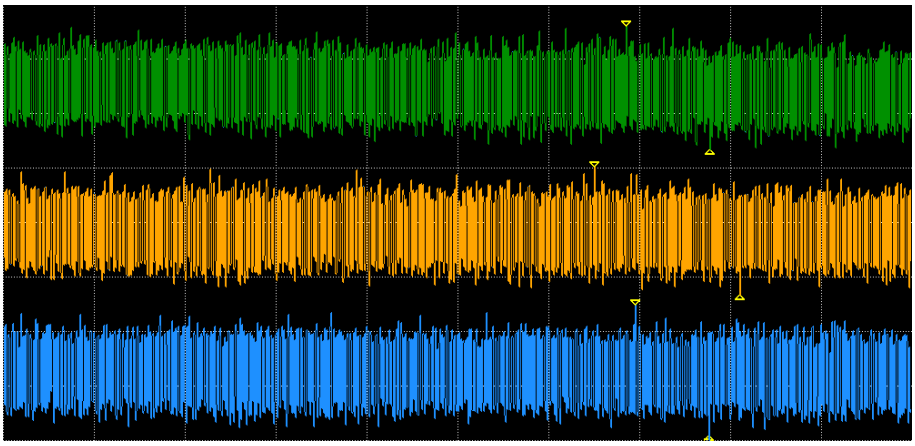

Figure 4.35 Jitter TIE Trend Graph

Pass Conditions

Pass conditions for the filtered jitter slave mode (with TX_TCLK): the peak-to-peak value of the measured signal jitter should be smaller than 0.4 ns.

For more information, refer to *Pass Conditions for Test Mode 3*.

4.9 Transmitter Distortion (Without Disturbing Signal, Without TX_TCLK)

When the TX_TCLK signal of the DUT is unavailable, use TC2 to perform this test. This section introduces the transmitter distortion test by taking RIGOL DS70000 series to work with the differential probe as an example.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **Without Disturbing Signal** > **Without TX_TCLK**. The signal transmitter distortion without disturbing signal and without the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.36* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

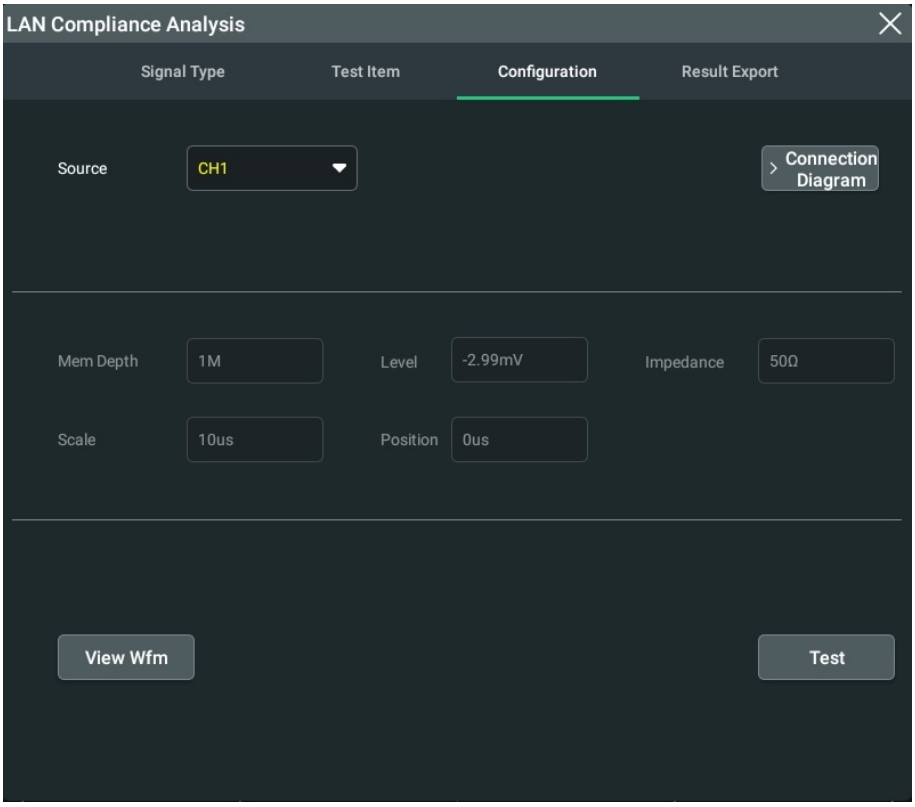

Figure 4.36 Test Configuration

Connect the Device

Connect the devices according to the following figure.

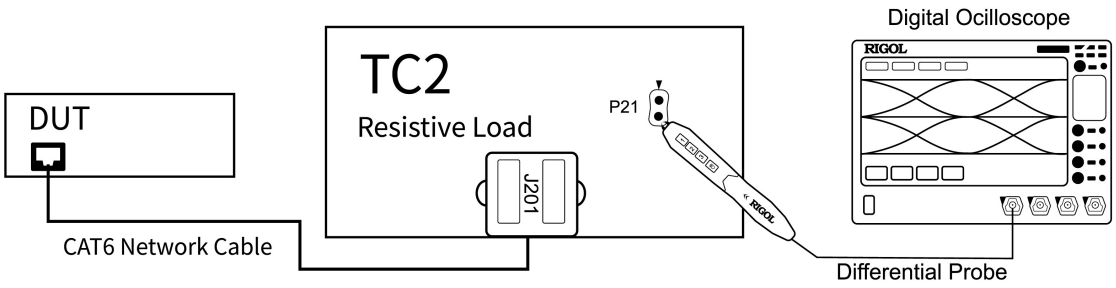

Figure 4.37 Test Connection Diagram for Transmitter Distortion (Without Disturbing Signal, Without TX_TCLK)

- Connect J201 of TC2 and test port of the DUT by using the CAT6 Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.

Test Procedures

1. Set the DUT to generate a Test Mode 4 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
3. Connect the differential probe to P21 test point of TC2.
4. Click or tap the Configuration tab to enter the "Configuration" menu, then click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
5. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window. For details, refer to *Test Results*.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for different test pairs on TC2, refer to *Table 4.2 Test Points Specified for Different Test Pairs on TC2* or *Figure 2.1* .

4.10 Transmitter Distortion (Without Disturbing Signal, With TX_TCLK)

Performs transmitter distortion without disturbing signal and with the clock signal. TC2 is used in this test. This section introduces the transmitter distortion test by taking RIGOL DS70000 series to work with the differential probe as an example.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **Without Disturbing Signal** > **With TX_TCLK**. The transmitter distortion test without disturbing signal and with the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and

impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu.

In this menu, you can view the parameters, as shown in *Figure 4.38* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

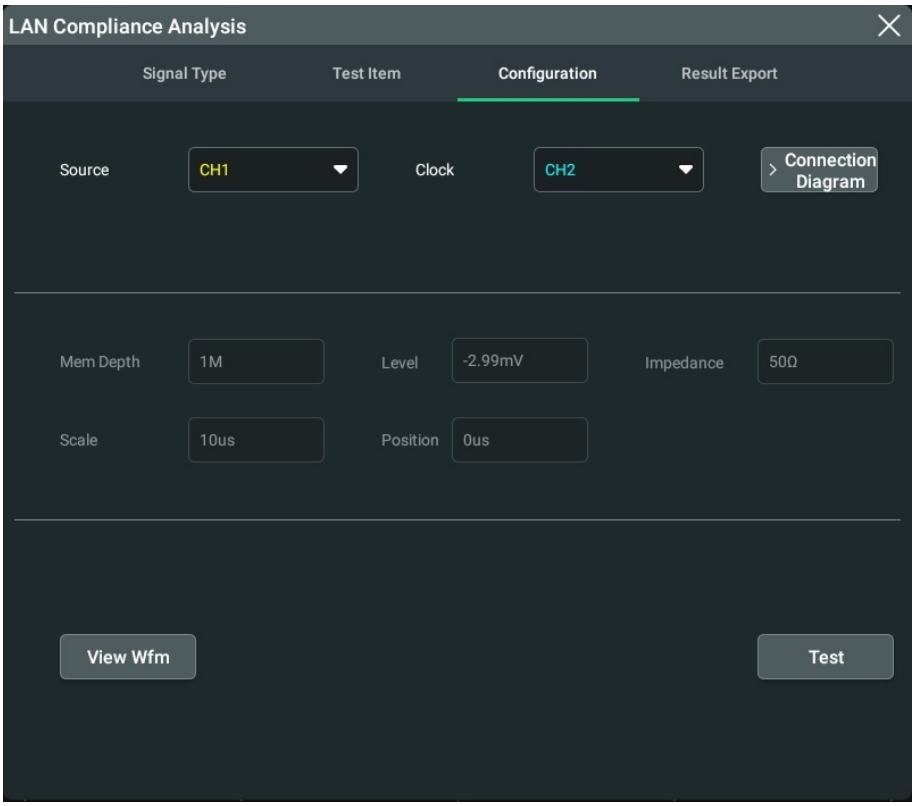

Figure 4.38 Test Configuration

Connect the Device

Connect the device according to the connection diagram.

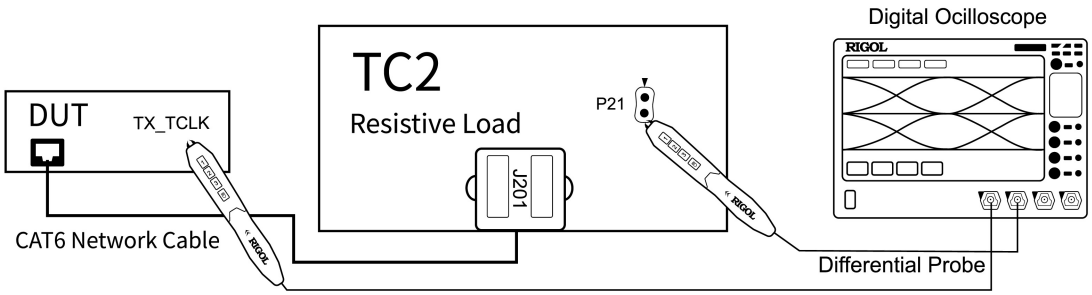

Figure 4.39 Test Connection Diagram for Transmitter Distortion (Without Disturbing Signal, With TX_TCLK)

- Connect J201 of TC2 and test port of the DUT by using the CAT6 Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.
- Connect one end of the single-ended probe to CH2 of the oscilloscope and the other end to the TX_TCLK port of the DUT.

Test Procedures

1. Set the DUT to generate a Test Mode 4 signal.
2. Test P21 point of TC2 by using the differential probe.
3. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Click or tap the drop-down button of **Clock** to select CH2. Ensure that the selected channels are consistent with those you use in the device connection diagram.
4. Click or tap the Configuration tab to enter the "Configuration" menu, then click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
5. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window. For details, refer to *Test Results*.

NOTE

Four pairs of test points are available on TC2. The above operation procedures take testing Pair A as an example. For the testing of other three pairs, perform the above procedures. Note that the specified test point for a different test pair is different. For the test point specified for

different test pairs on TC2, refer to *Table 4.2 Test Points Specified for Different Test Pairs on TC2* or *Figure 2.1* .

4.11 Transmitter Distortion (With Disturbing Signal, Without TX_TCLK)

Use TC5 to perform the transmitter distortion (with disturbing signal, without TX_TCLK) test. Under the condition of having the disturbing signal and not having TX_TCLK, to perform the transmitter distortion test, you need to have one oscilloscope that supports the Ethernet compliance test to work with the differential probe. This section introduces the transmitter distortion test by taking RIGOL DS70000 series to work with the differential probe as an example.

1. In DS70000 operation interface, click or tap  > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **With Disturbing Signal** > **Without TX_TCLK**. The transmitter distortion test with the disturbing signal but without the clock signal is selected. The waveform of the specified test item will be displayed according to the automatically set waveform parameters.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.40* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

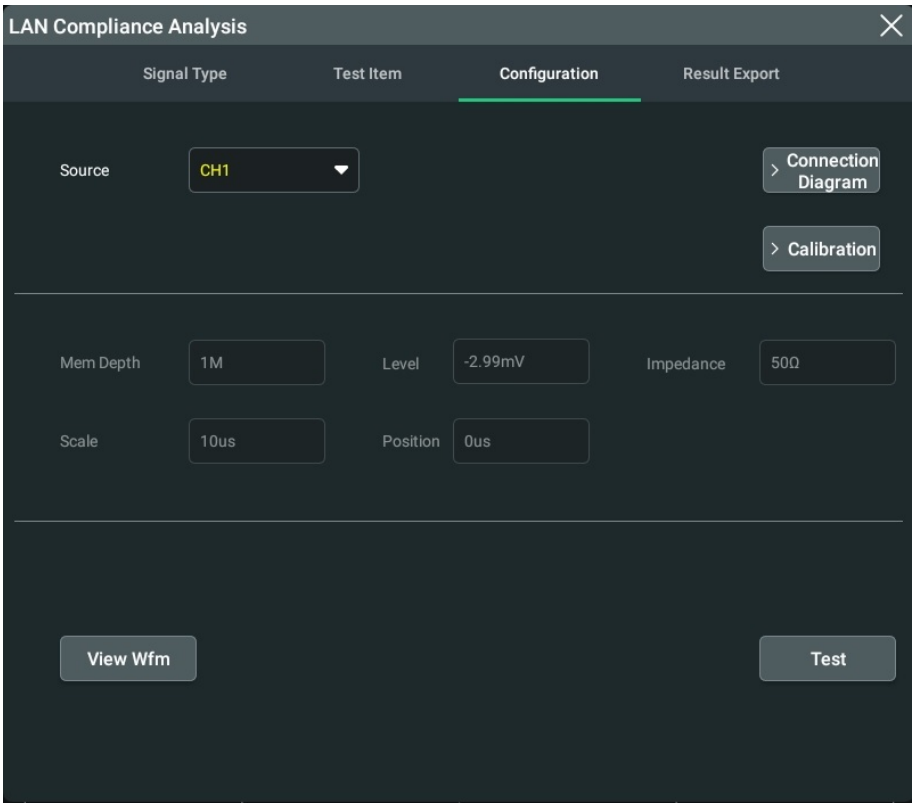

Figure 4.40 Test Configuration

4.11.1 To Calibrate the Disturbing Signal

For the test scenarios with the disturbing signal, perform calibration on the disturbing signal.

Device Connection Diagram

Use TC5 to calibrate the disturbing signal according to the following connection diagram.

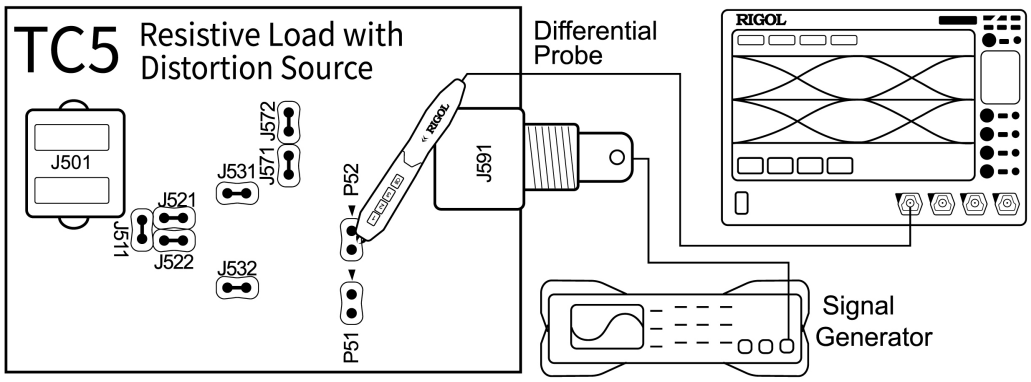

Figure 4.41 Connection Diagram of Calibration for Disturbing Signals

- Connect the output terminal of the Signal Generator to J591 of TC5 by using the BNC cable.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P52 of TC5.
- Short the jumpers J531, J532, J571, J572, J522, J521, and J511.

Operation Procedures

1. Set the Function/Arbitrary Waveform Generator to generate a Sine signal whose frequency is 28.833 MHz, amplitude 5.4 V_{pp}.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.5* .
4. Click or tap **Measure** in the Disturbing Signal section to measure the disturbing signal generated from the waveform generator. Then the measured value will be displayed.
5. Compare the measured value with the expected value. If the measured value is not close to the expected value, please modify the amplitude and clock frequency of the Function/Arbitrary Waveform Generator. Restart to measure it and compare the values again to make their values approximately equal to each other.

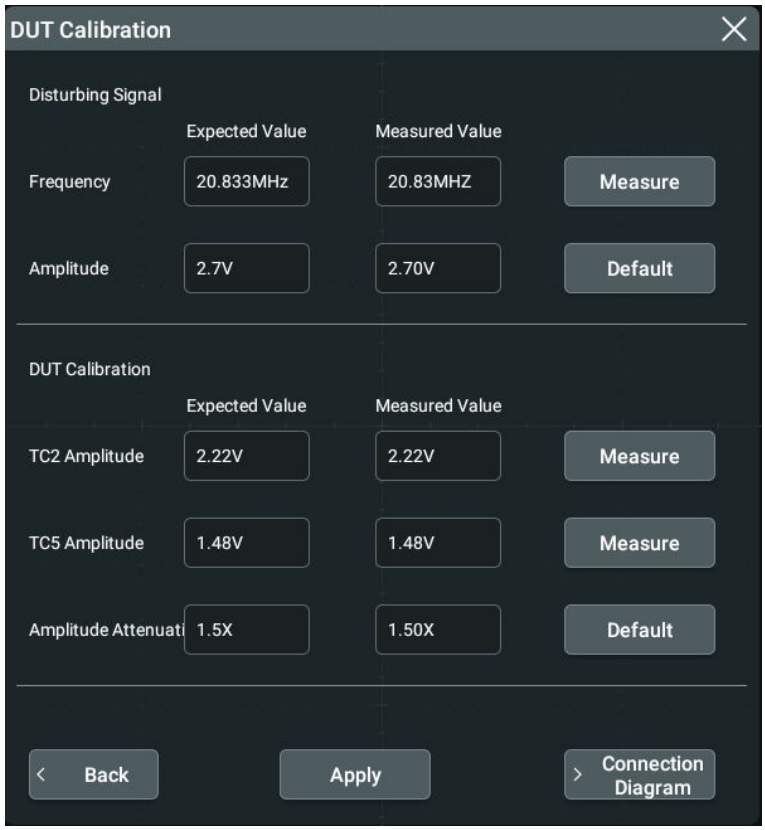

Figure 4.42 Fixture Calibration

4.11.2 Test Fixture Compensation

TC2 Amplitude Test

Use TC2 module of the test fixture to carry out the amplitude test. Connect the devices according to the following figure.

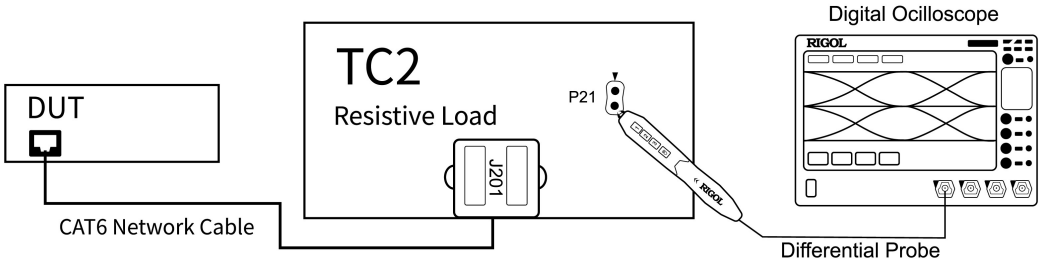

Figure 4.43 TC2 Calibration Connection Diagram

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.

- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P21 of TC2.

1. Set the DUT to generate a Test Mode 4 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.42* .
4. Click or tap **Measure** at the right part of the TC2 Amplitude in the DUT Calibration section to obtain the measured value of TC2 amplitude.

TC5 Amplitude Test

Use TC5 module of the test fixture to carry out the amplitude test. Connect the devices according to the following figure.

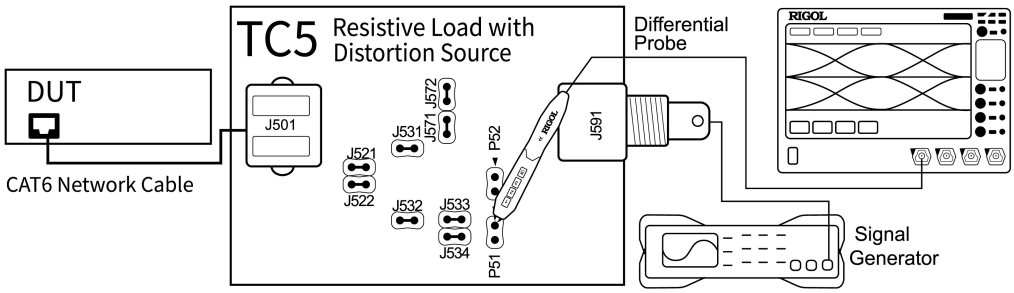

Figure 4.44 TC5 Calibration Connection Diagram

- Connect J501 of TC5 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the output terminal of the Function/Arbitrary Waveform Generator to J591 of TC5 by using the BNC cable. Disable the output of the generator to set its output value to zero.
- Short the jumpers J531, J532, J571, J572, J522, J521, J533, and J534.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P51 of TC5.

1. Set the DUT to generate a Test Mode 4 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.42* .
4. Click or tap **Measure** at the right part of the TC5 Amplitude in the DUT Calibration section to obtain the measured value of TC5 amplitude.
5. After finishing the measurement of TC2 and TC5 amplitudes, click or tap **Apply** to complete the fixture compensation.
6. Click or tap **Back** to return to the Configuration menu.

4.11.3 Test Procedures

After calibrating the disturbing signal and the fixture, perform the transmitter distortion (with disturbing signal and without TX_TCLK) test. Connect the devices according to the following figure.

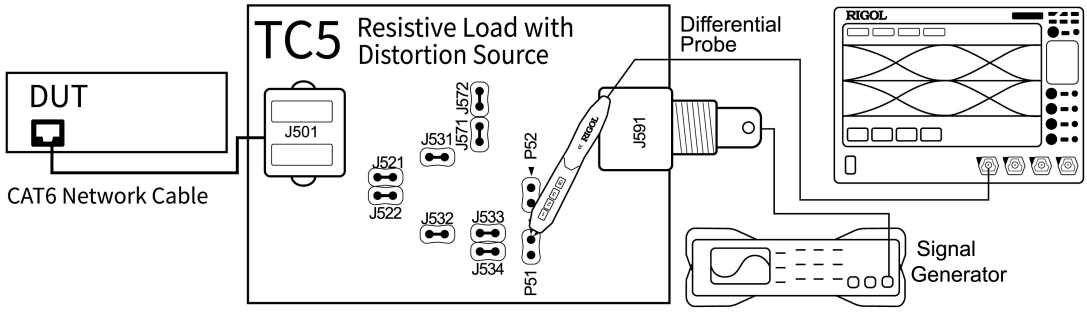

Figure 4.45 Test Connection Diagram for Transmitter Distortion (With Disturbing Signal, Without TX_TCLK)

- Connect the output terminal of the Function/Arbitrary Waveform Generator to J591 of TC5 by using the BNC cable.
- Connect J501 of TC5 and test port of the DUT by using the Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.

Test Procedures

1. Set the DUT to generate a Test Mode 4 signal.
2. Set the Function/Arbitrary Waveform Generator to generate the disturbing signal whose frequency is 28.833 MHz, amplitude 5.4 V_{pp}.
3. Short the jumpers J531, J532, J571, J572, J522, J521, J533, and J534.
4. Use the differential probe to connect P51 test point of TC5.
5. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
6. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
7. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
8. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window. For details, refer to *Test Results*.

NOTE

Four test pairs are available on TC5 of the fixture. The above operation takes Pair A as an example. For the tests of the other three test pairs, repeat the above procedures. Note that the specified jumpers for different test pairs are different. For the jumpers specified for different test pairs on TC5, refer to *Table 4.3 Jumpers Specified for Different Test Pairs on TC5* or *Figure 2.1* .

4.12 Transmitter Distortion (With Disturbing Signal, With TX_TCLK)

Under the condition of having the disturbing signal and TX_TCLK, to perform the transmitter distortion test, you need to have one oscilloscope that supports the Ethernet compliance test to work with the differential probe. This section introduces the transmitter distortion test by taking RIGOL DS70000 series to work with the differential probe as an example.

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.

3. Select **1000Base-T(IEEE 802.3 Section 40)** > **With Disturbing Signal** > **With TX_TCLK**. The transmitter distortion test with the disturbing signal and with the clock signal is selected.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.46* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

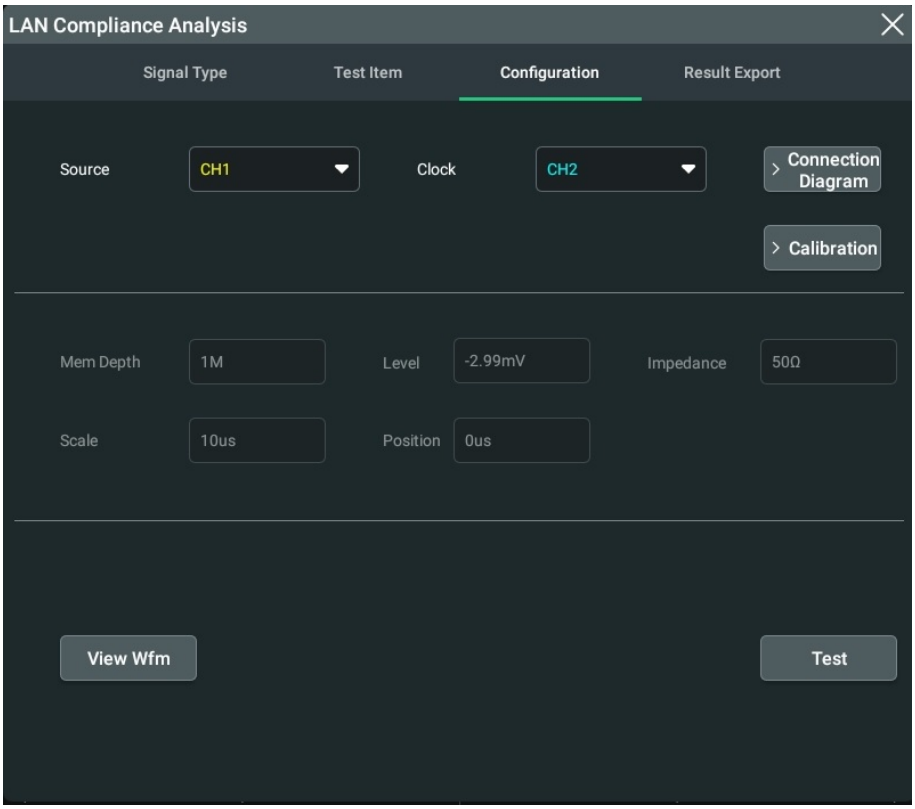

Figure 4.46 Test Configuration

4.12.1 To Calibrate the Disturbing Signal

For the test scenarios with the disturbing signal, perform calibration on the disturbing signal.

Device Connection Diagram

Use TC5 to calibrate the disturbing signal according to the following connection diagram.

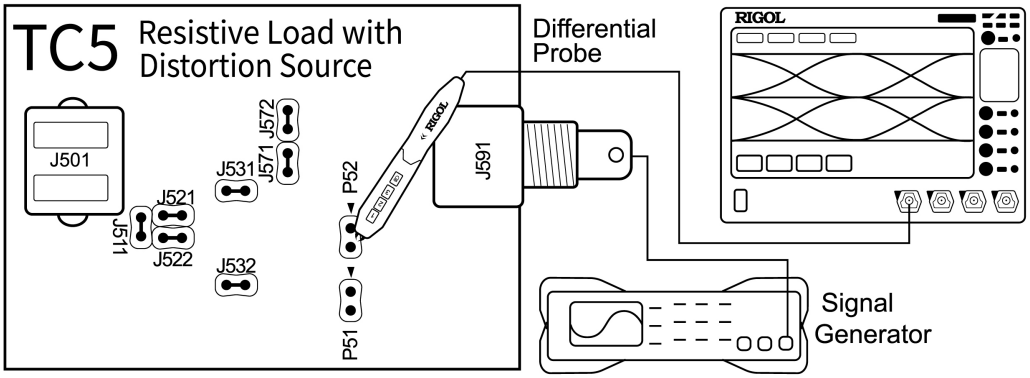

Figure 4.47 Connection Diagram of Calibration for Disturbing Signals

- Connect the output terminal of the Signal Generator to J591 of TC5 by using the BNC cable.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P52 of TC5.
- Short the jumpers J531, J532, J571, J572, J522, J521, and J511.

Operation Procedures

1. Set the Function/Arbitrary Waveform Generator to generate a Sine signal whose frequency is 28.833 MHz, amplitude 5.4 V_{pp}.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.5* .
4. Click or tap **Measure** in the Disturbing Signal section to measure the disturbing signal generated from the waveform generator. Then the measured value will be displayed.

5. Compare the measured value with the expected value. If the measured value is not close to the expected value, please modify the amplitude and clock frequency of the Function/Arbitrary Waveform Generator. Restart to measure it and compare the values again to make their values approximately equal to each other.

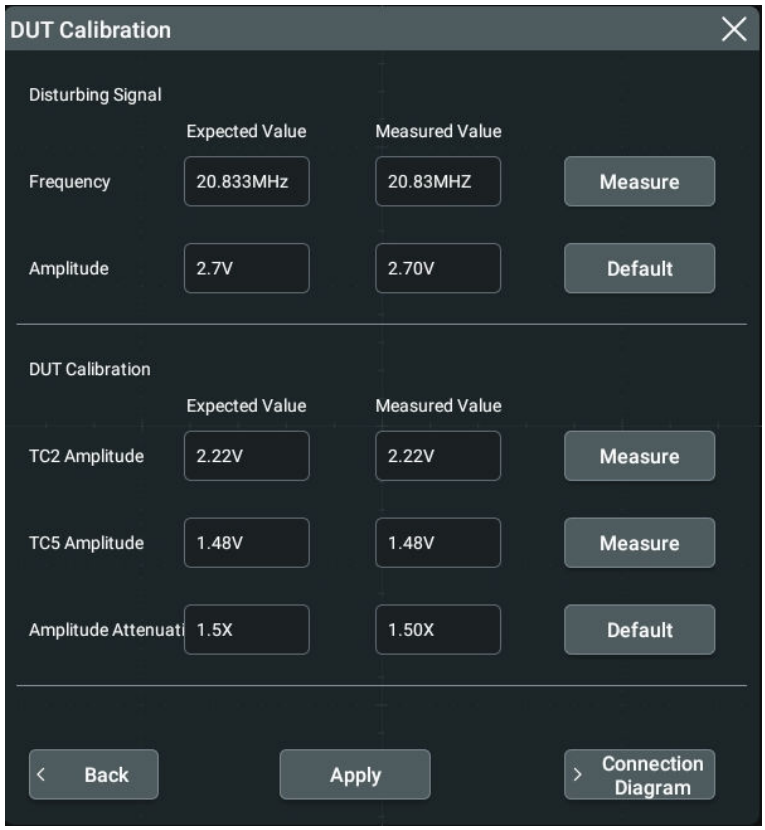

Figure 4.48 Fixture Calibration

4.12.2 Test Fixture Compensation

TC2 Amplitude Test

Use TC2 module of the test fixture to carry out the amplitude test. Connect the devices according to the following figure.

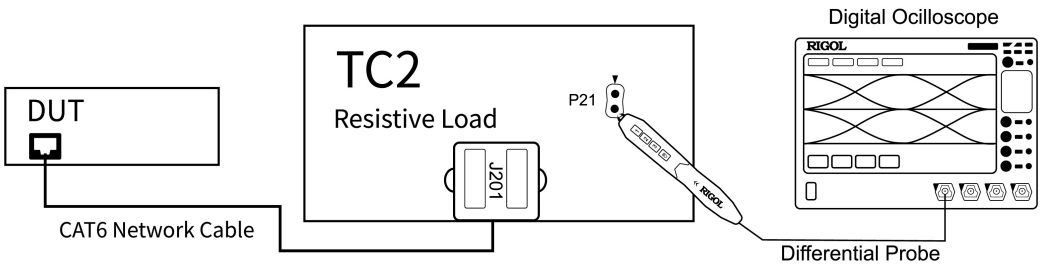

Figure 4.49 TC2 Calibration Connection Diagram

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P21 of TC2.

1. Set the DUT to generate a Test Mode 4 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.42* .
4. Click or tap **Measure** at the right part of the TC2 Amplitude in the DUT Calibration section to obtain the measured value of TC2 amplitude.

TC5 Amplitude Test

Use TC5 module of the test fixture to carry out the amplitude test. Connect the devices according to the following figure.

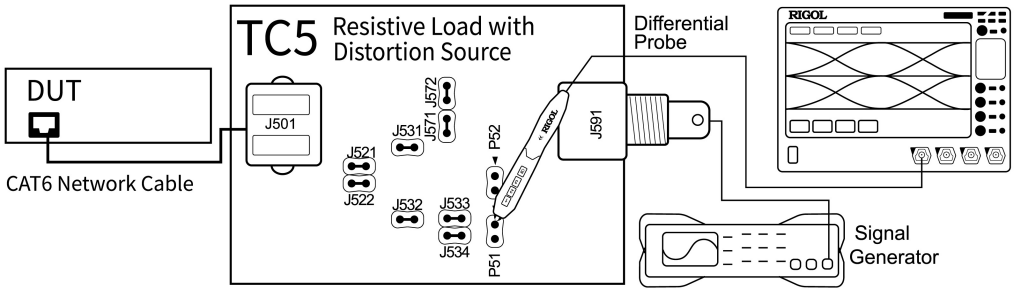

Figure 4.50 TC5 Calibration Connection Diagram

- Connect J501 of TC5 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the output terminal of the Function/Arbitrary Waveform Generator to J591 of TC5 by using the BNC cable. Disable the output of the generator to set its output value to zero.
- Short the jumpers J531, J532, J571, J572, J522, J521, J533, and J534.
- Connect one end of the differential probe to CH1 of the oscilloscope and the other end to P51 of TC5.

1. Set the DUT to generate a Test Mode 4 signal.
2. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device menu under the connection diagram.
3. In the Configuration menu, click or tap **Calibration** to enter the fixture calibration menu, as shown in *Figure 4.42* .
4. Click or tap **Measure** at the right part of the TC5 Amplitude in the DUT Calibration section to obtain the measured value of TC5 amplitude.
5. After finishing the measurement of TC2 and TC5 amplitudes, click or tap **Apply** to complete the fixture compensation.
6. Click or tap **Back** to return to the Configuration menu.

4.12.3 Test Procedures

Use TC5 to perform transmitter distortion (with disturbing signal, with TX_TCLK) test. Connect the device according to the connection diagram.

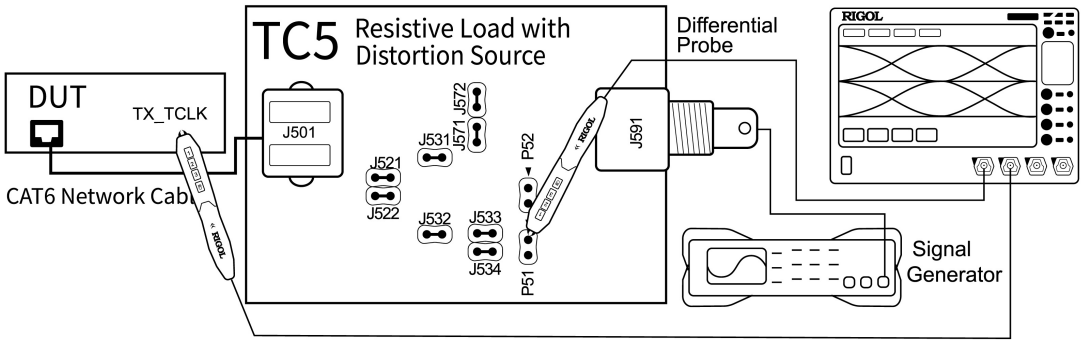

Figure 4.51 Test Connection Diagram for Transmitter Distortion (With Disturbing Signal, With TX_TCLK)

- Connect the output terminal of the Function/Arbitrary Waveform Generator to J591 of TC5 by using the BNC cable.
- Connect J501 of TC5 and test port of the DUT by using the Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.
- Connect one end of the single-ended probe to CH2 of the oscilloscope and the other end to the TX_TCLK port of the DUT.

Test Procedures

1. Set the DUT to generate a Test Mode 4 signal.
2. Set the signal generator to generate a disturbing signal whose expected amplitude and frequency values are shown in the "DUT Calibration" menu.
3. Short the jumpers J531, J532, J571, J572, J522, J521, J533, and J534.
4. Use the differential probe to connect P51 test point of TC5.
5. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Click or tap the drop-down button of **Clock** to select CH2. Ensure that the selected channels are consistent with those you use in the device menu under the connection diagram.

6. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
7. Click or tap the Configuration tab to enter the "Configuration" menu, then click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
8. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

NOTE

Four test pairs are available on TC5 of the fixture. The above operation takes Pair A as an example. For the tests of the other three test pairs, repeat the above procedures. Note that the specified jumpers for different test pairs are different. For the jumpers specified for different test pairs on TC5, refer to *Table 4.3 Jumpers Specified for Different Test Pairs on TC5* or *Figure 2.1* .

4.12.4 Test Results

Test Waveform

The waveform of the transmitter distortion test signal from the DUT is shown below.

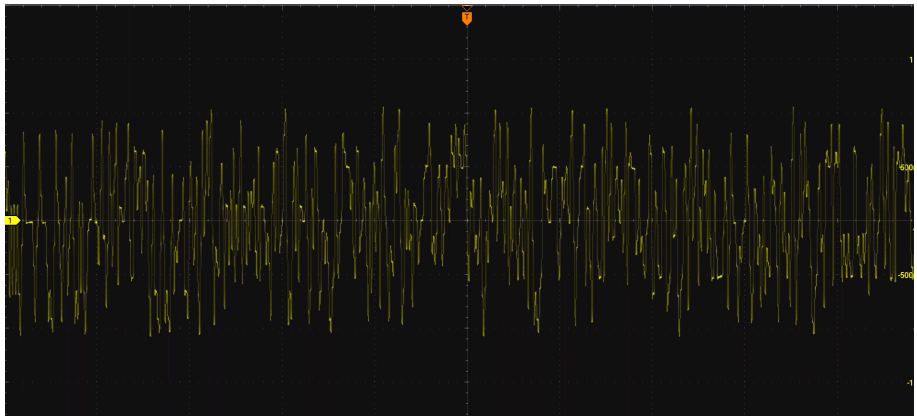

Figure 4.52 Test Mode 4 Waveform

Pass Conditions

The pass conditions for the four test items of transmitter distortion are the same.

Table 4.8 Pass Conditions for Transmitter Distortion

Test Item	Disturbing Signal	TX_TCLK	Pass Conditions	
			Min.	Max.
Transmitter Distortion	Without Disturbing Signal	Without TX_TCLK	0 mV	10 mV
	Without Disturbing Signal	With TX_TCLK		
	With Disturbing Signal	With TX_TCLK		
	With Disturbing Signal	Without TX_TCLK		

Test Diagram

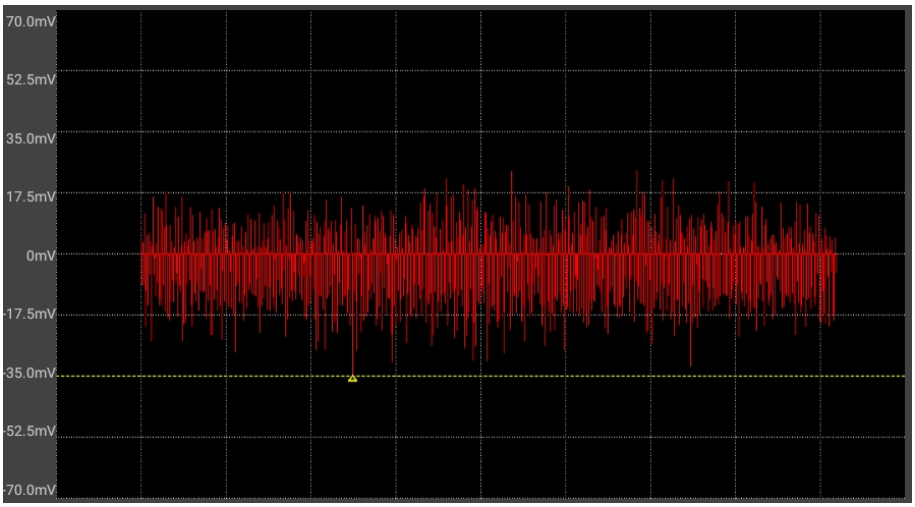

Figure 4.53 Transmitter Distortion Test Diagram

4.13 Common-Mode Output Voltage Test

Use TC4 to perform the common-mode output voltage test. This section takes RIGOL DS70000 series as an example to introduce the test.

Select the Signal Type and Test Item

1. In DS70000 operation interface, click or tap > **LAN Analysis** to enter the "LAN Compliance Analysis" interface.
2. Click or tap **Signal Type** to enter the "Signal Type" menu. Select **1000Base-T**.
3. Select **1000Base-T(IEEE 802.3 Section 40)** > **Common** > **Common-mode Output Voltage (40.8.3.3)** to perform the common-mode output voltage test.
4. After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and

impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 4.54* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

5. In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "1000Base-T Test Result" window.

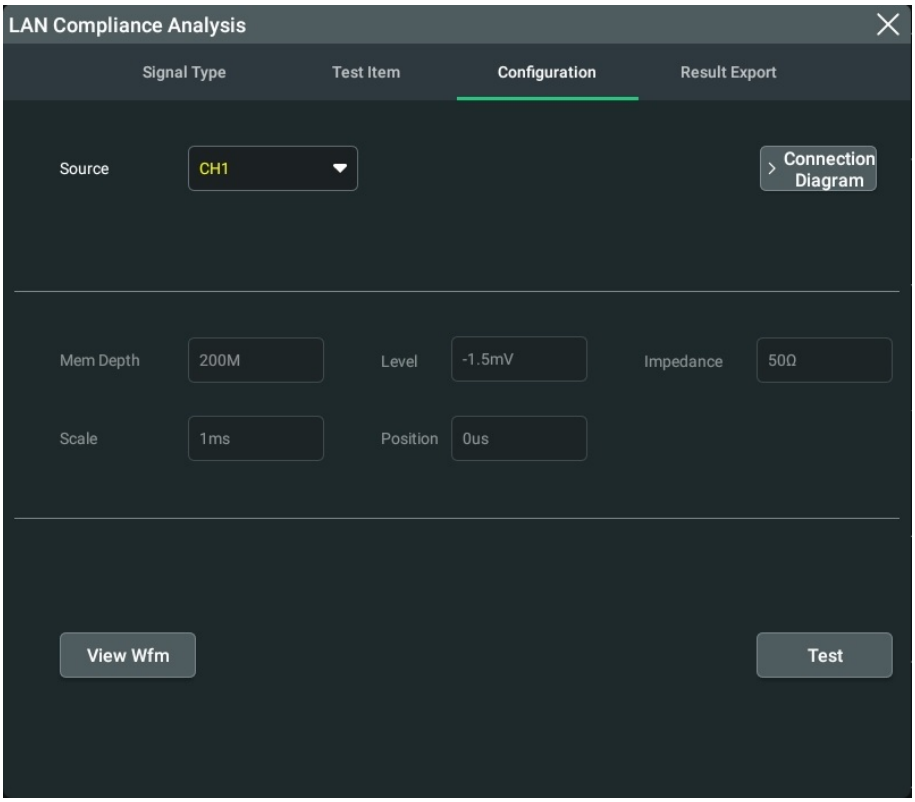

Figure 4.54 Test Configuration

4.13.1 Test Procedures

Connect the device according to the connection diagram.

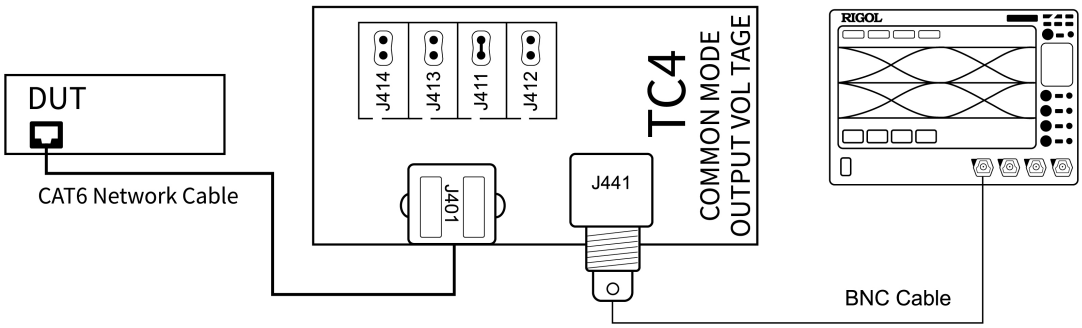

Figure 4.55 Test Connection Diagram of Common-mode Output Voltage

- Connect J401 of TC4 and test port of the DUT by using the Ethernet cable.
- Connect J441 of TC4 and CH1 of the oscilloscope by using the BNC cable.

Test Procedures

1. Set the DUT to generate a Test Mode 4 signal.
2. Short the jumper J411 of TC4.
3. In the "Configuration" menu, click or tap the drop-down button of **Source** to select CH1. Ensure that the selected channel is consistent with that you use in the device connection diagram.
4. Click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
6. After finishing the analysis, you can view the test results in the "1000Base-T Test Results" window.

NOTE

Four test pairs are available on TC4 of the fixture. The above operation takes Pair A as an example. For the tests of the other three test pairs, repeat the above procedures. Note that the specified jumpers for different test pairs are different. For the jumpers specified for different test pairs on TC4, refer to the following table or *Figure 2.1* .

Table 4.9 Jumpers Specified for Different Test Pairs on TC4

Test Pair	Jumper
Pair A	J411
Pair B	J412
Pair C	J413
Pair D	J414

4.13.2 Test Results

The waveform of the signal from the DUT in common-mode output voltage test is shown in the figure below.

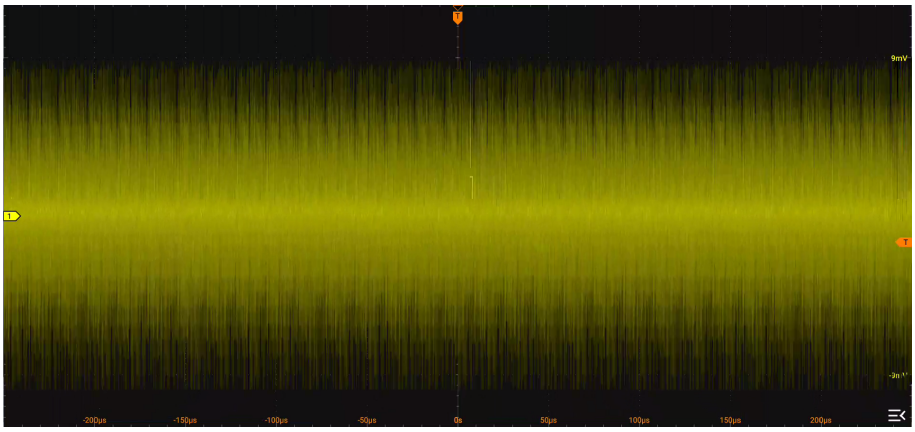

Figure 4.56 Test Waveform

The following table shows the pass conditions.

Table 4.10 Pass Conditions

Test Item	Pass Conditions	
	Min.	Max.
Common-mode Output Voltage	0 mV	50 mV

5 100Base-T Compliance Test

The TF-ENET-STP fixture is used for 100Base-T test, which supports the following test items. Only TC2 module is used in the test.

Table 5.1 100Base-T Test Items and Fixtures

Test Item	Fixture			
	TC2	TC3	TC4	TC5
Output Voltage	√			
Amplitude Symmetry	√			
Rise/Fall Time	√			
Rise/Fall Time Symmetry	√			
Overshoot	√			
Duty Cycle Distortion	√			
Eye	√			
Jitter	√			

The connection of the devices for all the test items in the 100Base-T compliance test is the same as specified in the test operation procedure. This section takes RIGOL DS70000 series oscilloscope working with the differential probe as an example to introduce the test methods for multiple test items of the 100Base-T Ethernet signals.

5.1 To Select the Signal Type and Test Item

Select the Signal Type

Click or tap **Signal Type** > **100Base-T** to select the 100Base-T Ethernet signal.

Select the Test Item

Click or tap the **Test Item** tab to enter the "Test Item" menu and select the following test items.

- Out Voltage

  100Base-T(ANSI3.263-1995) > **Out Voltage(9.1.2.2)**

- Amplitude Symmetry

  100Base-T(ANSI3.263-1995) > **Amplitude Symmetry(9.1.4)**

- Rise/Fall Time

  100Base-T(ANSI3.263-1995) > Rise/Fall Time(9.1.6)

- Rise/Fall Time Symmetry

  100Base-T(ANSI3.263-1995) > Rise/Fall Time Symmetry(9.1.6)

- Eye

  100Base-T(ANSI3.263-1995) > Eye(Annex J)

- OverShoot

  100Base-T(ANSI3.263-1995) > OverShoot(9.1.3)

- Distortion Based on Duty Cycle

  100Base-T(ANSI3.263-1995) > Distortion Based on Duty Cycle(9.1.8)

- Jitter

  100Base-T(ANSI3.263-1995) > Jitter(9.1.9)

Configure Parameters

After the specified signal type and test item are selected, the oscilloscope outputs a waveform based on the automatically set parameters such as level, scale, and impedance. Click or tap the **Configuration** tab to enter the "Configuration" menu. In this menu, you can view the parameters, as shown in *Figure 5.1* .

TIP

These parameters displayed in the "Configuration" menu are the parameters for the previewed test waveform. After starting the test, the parameters will be automatically adjusted.

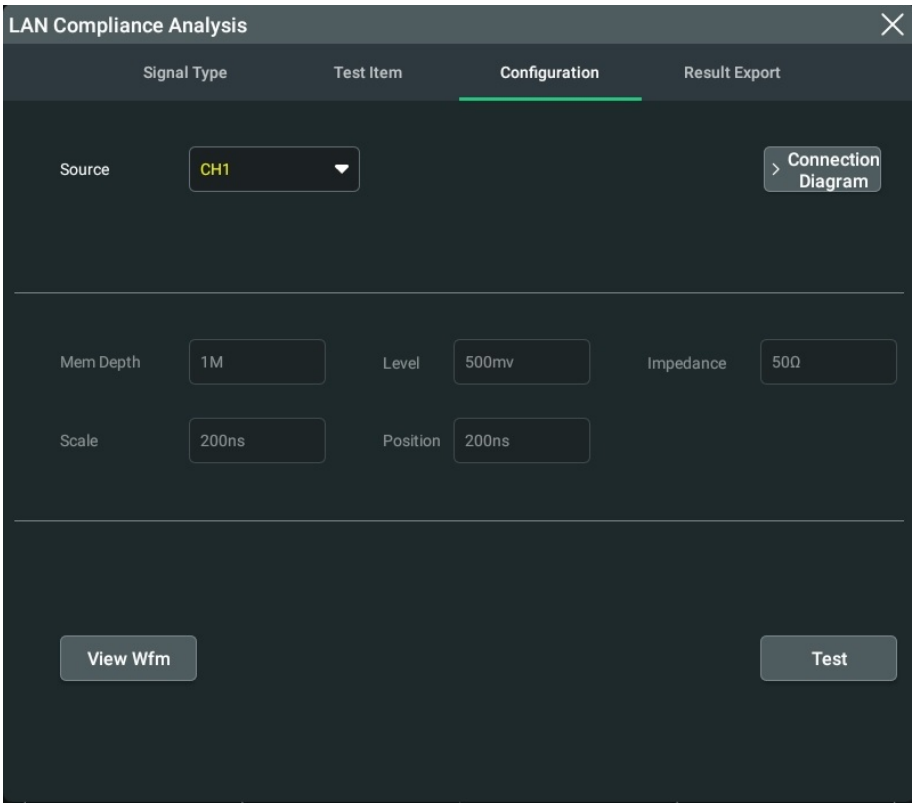

Figure 5.1 100Base-T Signal Test Configuration

Test Results

In the "LAN Compliance Analysis" interface, click or tap **Result Export** to enter the result export menu. Set **Report** to ON to open the "100Base-T Test Results" window.

5.2 Test Procedures

Use TC2 module of the test fixture to carry out the test. Connect the devices according to the connection diagram.

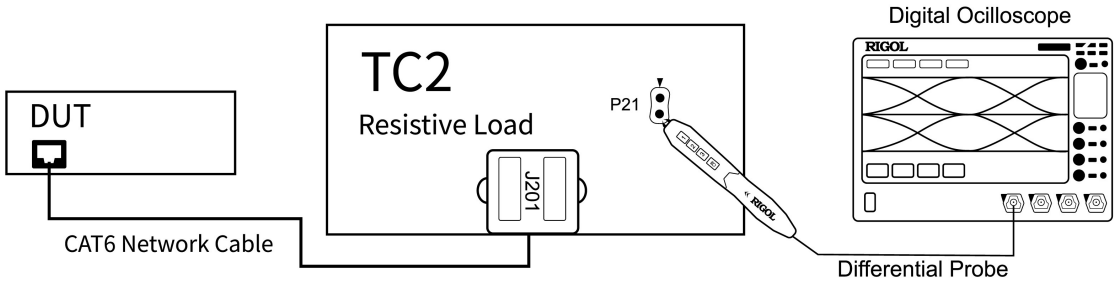

Figure 5.2 Test Connection Diagram

- Connect J201 of TC2 and the test port of the DUT by using the CAT6 Ethernet cable.
- Connect the differential probe to CH1 of the oscilloscope.

1. Configure the oscilloscope with Ethernet compliance test function and select the specified channel based on the device connection to complete the test setup.
2. Set the DUT to transmit scrambled idles.
3. Connect the differential probe to P21 test point of TC2.
4. In the "Configuration" menu, click or tap **View Wfm** to preview the waveform for the specified test item in the waveform view to ensure that the waveform is properly output.
5. Click or tap **Test** to start testing. The "Compliance Analysis" dialog box is displayed. Wait for its analysis result.
6. After finishing the analysis, you can view the test results in the "100Base-T Test Results" window.

5.3 Test Results

Test Waveform

The waveform of the 100Base-T test signal from the DUT is shown below.

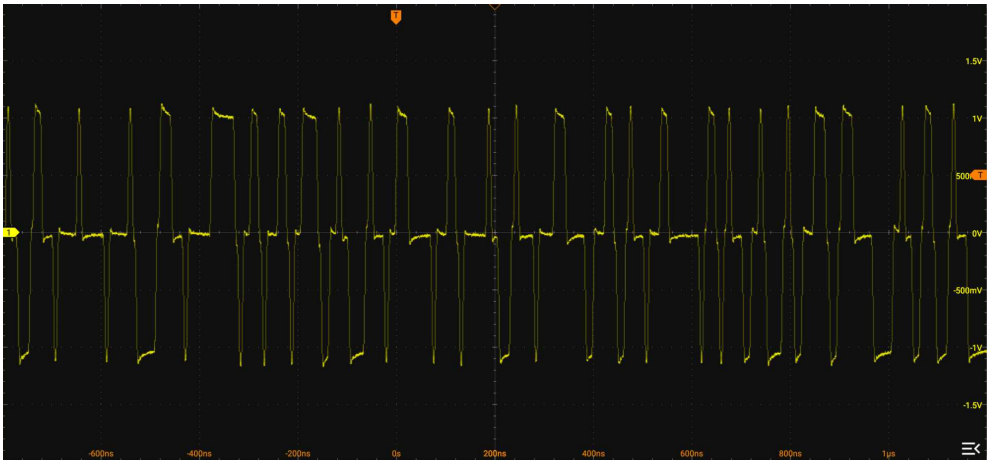

Figure 5.3 100Base-T Test Waveform

Pass Conditions

The pass conditions for the test items of the 100Base-T signal are shown in the following table.

Table 5.2 Pass Conditions for the Test Items of the 100Base-T Signal Type

Test Item	Description	Pass Conditions	
		Min.	Max.
Out Voltage	+Vout	950 mV	1050 mV
	-Vout	-1050 mV	-950 mV
Amplitude Symmetry	Signal Amplitude Symmetry	0.98	1.02
Rise/Fall Time	Rise Time Test for Positive Pulse (+Ve)	3 ns	5 ns
	Rise Time Test for Negative Pulse (-Ve)		
	Fall Time Test for Positive Pulse (+Ve)		
	Fall Time Test for Negative Pulse (-Ve)		
Rise/Fall Time Symmetry	Rise/Fall Time Symmetry Test for Positive Pulse (+Ve)	0 ps	500 ps
	Rise/ Fall Time Symmetry Test for Negative Pulse (-Ve)		
OverShoot	Overshoot Test for Positive Pulse (+Ve)	0%	5%
	Overshoot Test for Negative Pulse (-Ve)		
Distortion Based on Duty Cycle	Duty Distortion Test	0 ps	500 ps
Eye	Eye Diagram	N/A	N/A
Jitter	Jitter Test with Positive Polarity (+Ve)	0 ns	1.4 ns
	Jitter Test with Negative Polarity (-Ve)		

Signal Measurement Diagram

The following figure shows the measurement result of the eye test and jitter test.

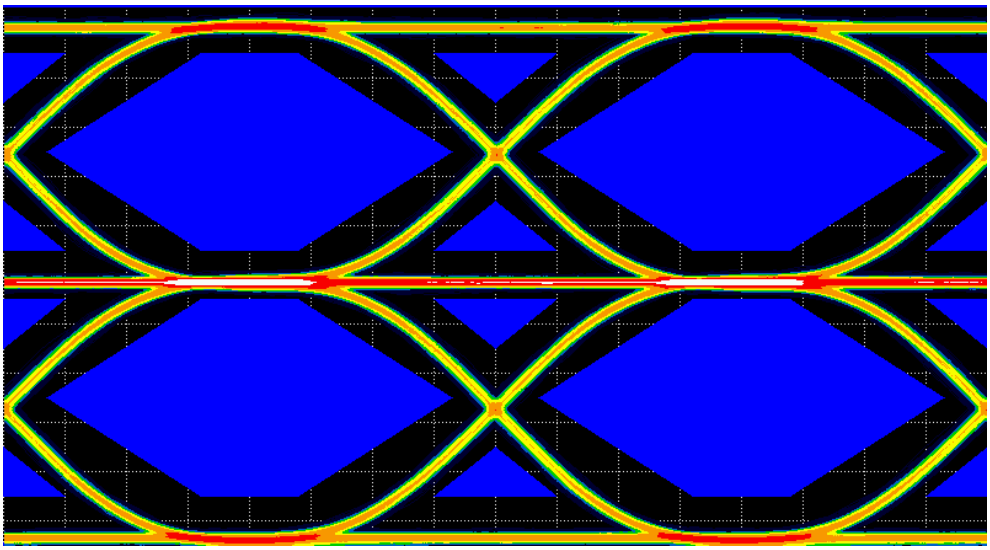

Figure 5.4 Eye Measurement

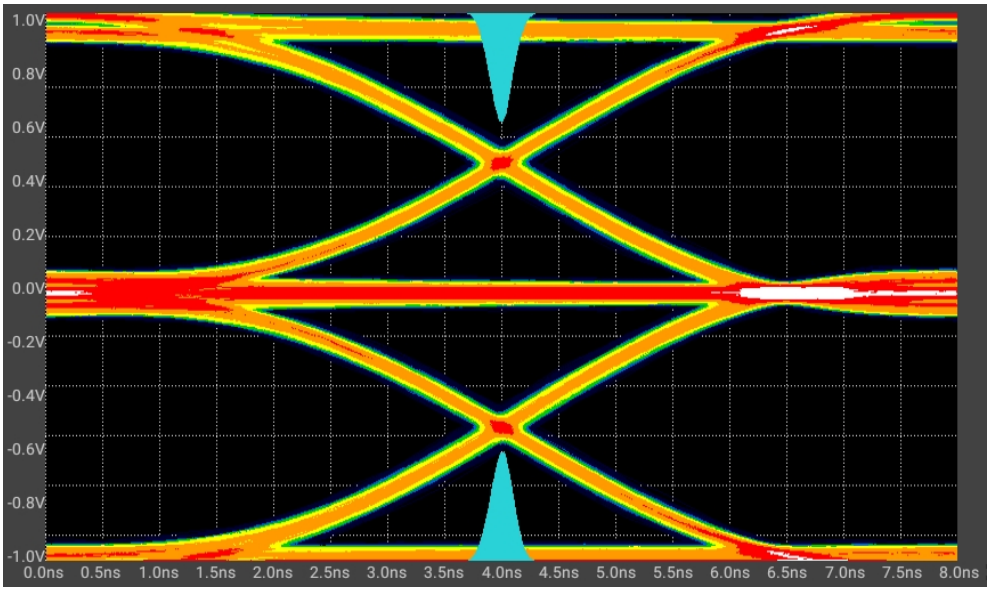

Figure 5.5 Jitter Measurement

6 Appendix

6.1 Appendix A: Order Information

Order Information	Order No.
Fixture Model	
Ethernet Test Fixture CAT6 Cable, 10 cm, 1	TF-ENET-STP (1 set)
Recommended Accessories	
Single-ended/Differential Active Probe	RIGOL PVA7000 Series RIGOL PVA8000 Series

For all the fixtures and recommended accessories, please contact the local office of RIGOL.

6.2 Appendix B: Warranty

RIGOL TECHNOLOGIES CO., LTD. (hereinafter referred to as RIGOL) warrants that the product mainframe and product accessories will be free from defects in materials and workmanship within the warranty period. If a product proves defective within the warranty period, RIGOL guarantees free replacement or repair for the defective product.

To get repair service, please contact your nearest RIGOL sales or service office.

There is no other warranty, expressed or implied, except such as is expressly set forth herein or other applicable warranty card. There is no implied warranty of merchantability or fitness for a particular purpose. Under no circumstances shall RIGOL be liable for any consequential, indirect, ensuing, or special damages for any breach of warranty in any case.

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