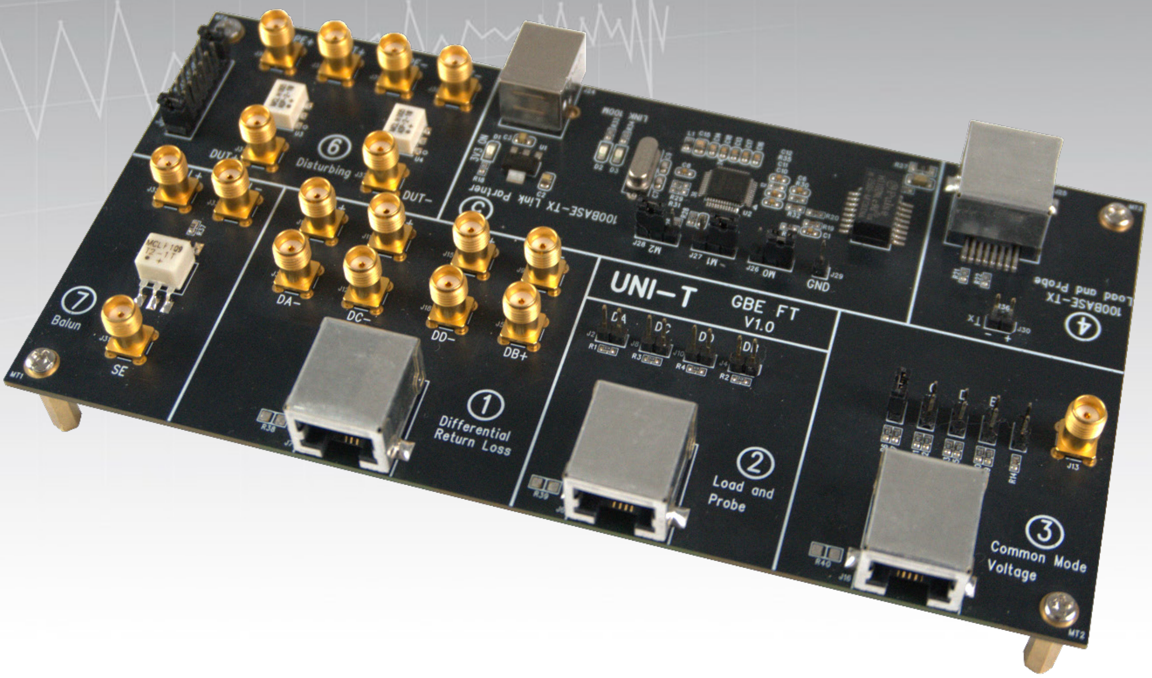
UNI-T

100M BASE-Tx Ethernet Compliance Software



User Manual REV.1.0

June 2025

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1. Ethernet Compliance Analysis Overview

Ethernet is currently the most widely used computer networking technology, with its origins dating back to 1973. Before 2008, 10Mbps Ethernet was generally sufficient to meet the networking requirements of that period. Can you remember if the broadband speed you had at that time was less than 10Mbps? Later, 100Mbps Ethernet, commonly known as Fast Ethernet, was introduced. It was designed to deliver 100Mbps transmission over existing twisted-pair cabling, representing a tenfold improvement in speed. 100BASE-TX is one of the physical layer specifications defined under the Fast Ethernet standard.

Ethernet compliance testing is defined by IEEE and ANSI standards. Unlike USB or Wi-Fi, there is no official certification authority for Ethernet that issues compliance reports or certificates. Nevertheless, Ethernet compliance testing during device development is widely practiced. This process verifies whether the physical layer signal quality of a device complies with international standards such as IEEE, thereby ensuring that Ethernet products from different manufacturers remain interoperable. For 100BASE-TX, compliance testing generally covers items such as amplitude testing, time-domain testing, jitter testing, and eye diagram mask testing.

2. Test Items and Standard

2.1 Test Items

- AOI Template Test
- AOI Rise/Fall Edge Time Test
- Overshoot Test
- Peak Differential Voltage Test
- Jitter/Duty Ratio Distortion Test

2.2 Test Standard

Test Items	Test Sub-itmes	Reference Standard
AOI Template Test	UTP AOI template	IEEE 802.3-2018, Clause 25 ANSI X3.263-1995, Appendix J
AOI Rise/Fall Edge Time Test	AOI $+V_{out}$ fall time	IEEE 802.3-2018, Clause 25 ANSI X3.263-1995, Section 9.1.6
	AOI $-V_{out}$ rise time	
	AOI $+V_{out}$ rise time	
	AOI $-V_{out}$ fall time	
	AOI $+V_{out}$ rise/fall time symmetry	
	AOI $-V_{out}$ rise/fall time symmetry	

Overshoot Test	Overshoot (Positive pulse width)	IEEE802.3-2018, Clause 25 ANSI X3.263-1995, Section 9.1.3
	Overshoot (Negative pulse width)	
Peak Differential Voltage Test	UTP differential output voltage (Pos)	IEEE802.3-2018, Clause 25 ANSI X3.263-1995, Section 9.1.2.2
	UTP differential output voltage (Neg)	
	Signal amplitude symmetry	
Jitter/Duty Ratio Distortion Test	Duty ratio distortion	IEEE 802.3-2018, Clause 25 ANSI X3.263-1995, Section 9.1.8
	Transmitter jitter (Pos)	IEEE 802.3-2018, Clause 25 ANSI X3.263-1995, Section 9.1.9
	Transmitter jitter (Neg)	

3. Test Equipment

3.1 Requirements

- Oscilloscope: Bandwidth ⩾ 1GHz, with Ethernet compliance test software installed
- Ethernet Compliance Test Fixture: Provides signal access points.
- Active Differential Probe: Bandwidth ⩾ 1.5GHz

3.2 Configuration

Oscilloscope	⩾ 1GHz bandwidth, recommended: MSO7000X, MSO8000HD series
Active Differential Probe	⩾ 1.5GHz bandwidth, recommended: UT-PD1500, UT-PD2500
Test Fixture	UNI-T Ethernet compliance test fixture (UT-GBE-FT) or association-recommended
100BASE-T Compliance Test Software	UNI-T CTS-ENET100
CAT6 Network Cable	Compliant with transmission line requirements

Oscilloscopes

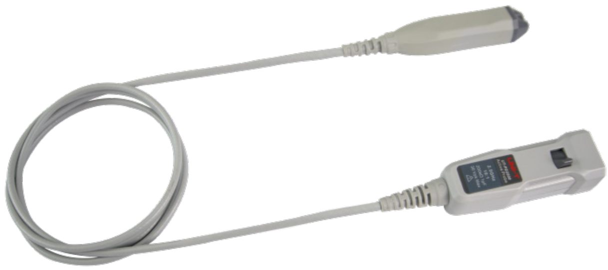
UNI-T's high-bandwidth oscilloscopes, MSO8000HD and MSO7000X series, offer bandwidths from 1GHz to 8GHz and sampling rates up to 20GSa/s. MSO8000HD's 12-bit ADC provides accurate measurement data essential for compliance testing. Its excellent signal integrity characteristics, such as noise floor below 800μV at 50mV/div, ENOB > 7bits across full bandwidth, and low intrinsic jitter of 150fs RMS, ensure reliable compliance analysis data.

MSO8000HD | 8GHz | 20GSa/s

MSO7000X | 2GHz | 10GSa/s

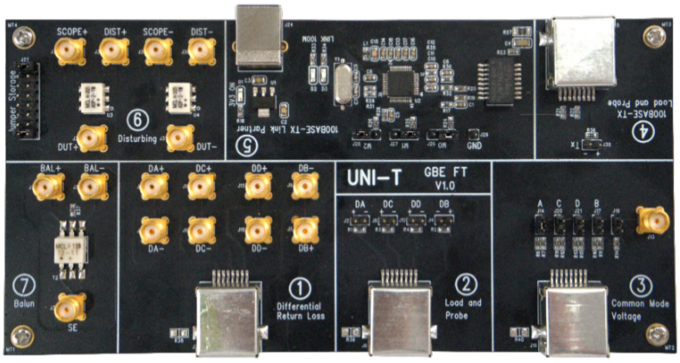
Active Differential Probe

The association requires probes with a bandwidth of at least 1.5GHz for compliance analysis to ensure accurate results. UNI-T offers self-developed UT-PD2500 (2.5GHz) and UT-PD1500 (1.5GHz) active differential probes to support Ethernet compliance testing. These probes provide a reliable connection to the DUT (Device Under Test) and offer a very high price-to-performance ratio.



Test Fixture

The UT-GBE-FT fixture is designed for use with the CTS-ENET-100 in Ethernet compliance analysis. It supports both 100BASE-T and 1000BASE-T compliance testing and is divided into multiple zones, each serving distinct functions to facilitate signal access. The fixture provides multiple test points to minimize interference and ensure accurate signal quality verification. For detailed specifications, refer to the *Ethernet Signal Quality Test Fixture-User Manual*.



Ethernet Test Main Fixture

Return Loss Calibration Fixture

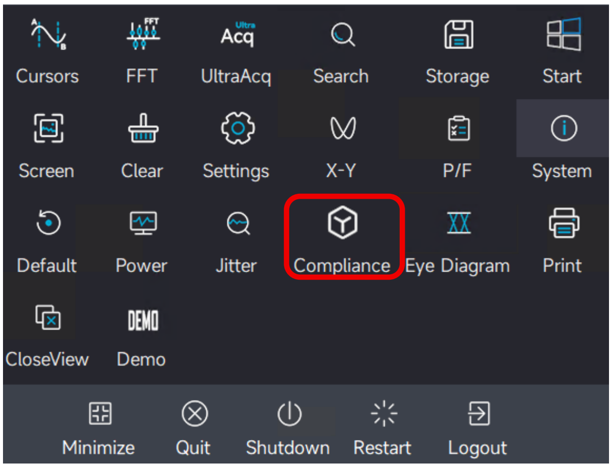
4. Compliance Test Software

UNI-T CTS-ENET100 physical-layer compliance test software automatically configures the oscilloscope and executes tests. It provides graphical guidance for switching fixtures or probes, ensuring accurate and repeatable results.

Key Features

- Supports single-test execution or batch testing
- Optimized, intuitive user interface for visual monitoring of the oscilloscope and connections, enabling fast test setup and electrical performance verification
- Fully automated oscilloscope control, with automatic configuration for each test item
- Generates comprehensive test reports including results, pass/fail status, test margins, and waveform images
- Allows flexible configuration of test parameters and traces for debugging and characterization
- Supports multiple rounds of tests for result verification and analysis

Click the **Compliance** icon in the Start menu to enable the compliance test function, as shown in the figure below.



Compliance Test Software

Compliance test software functions: Test settings, test status, save settings, and test report.

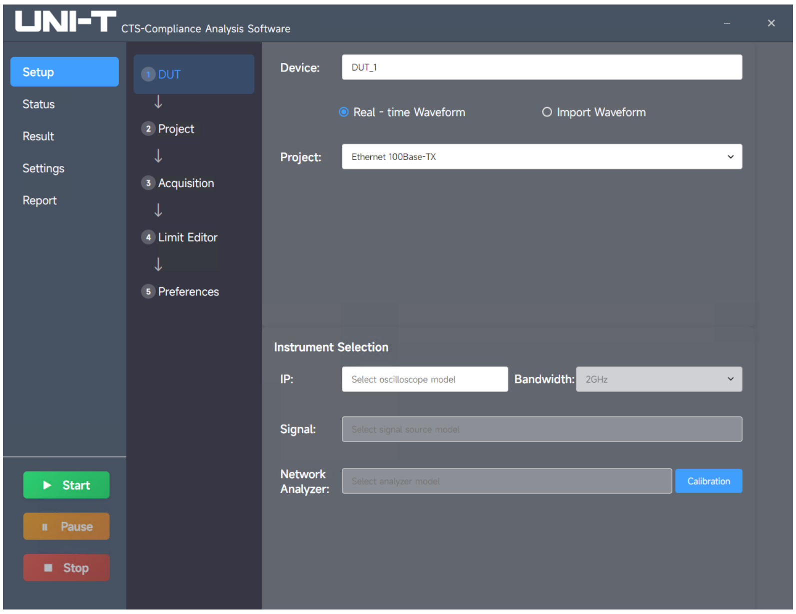
4.1 Test Setup

Click **Setup** to open the menu and configure the test.

DUT:

Project: Ethernet 100Base-TX

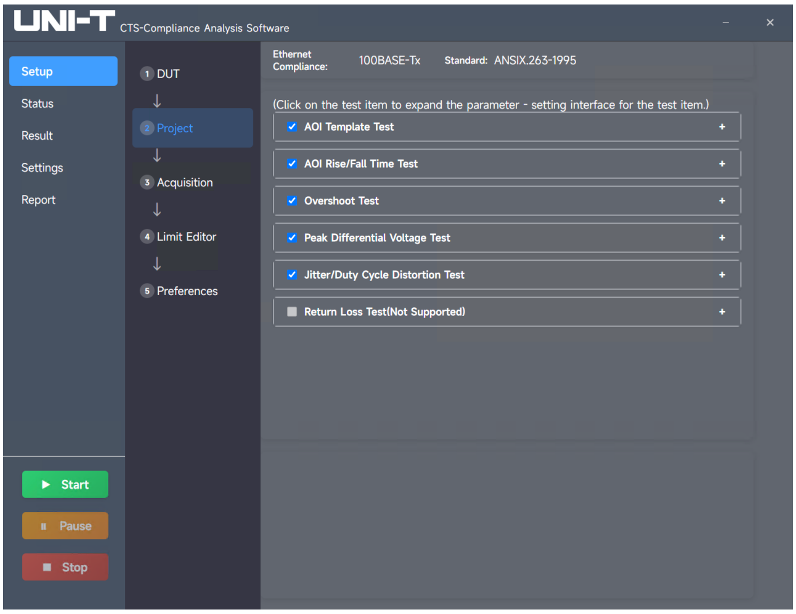
IP: If testing locally, oscilloscope model selection is not required.



Test Settings

Project:

In this section, select the test items to be executed. A check mark appears in front of each selected item. After making your selections, click **Start** in the lower-left corner to begin testing.



Test Items Settings

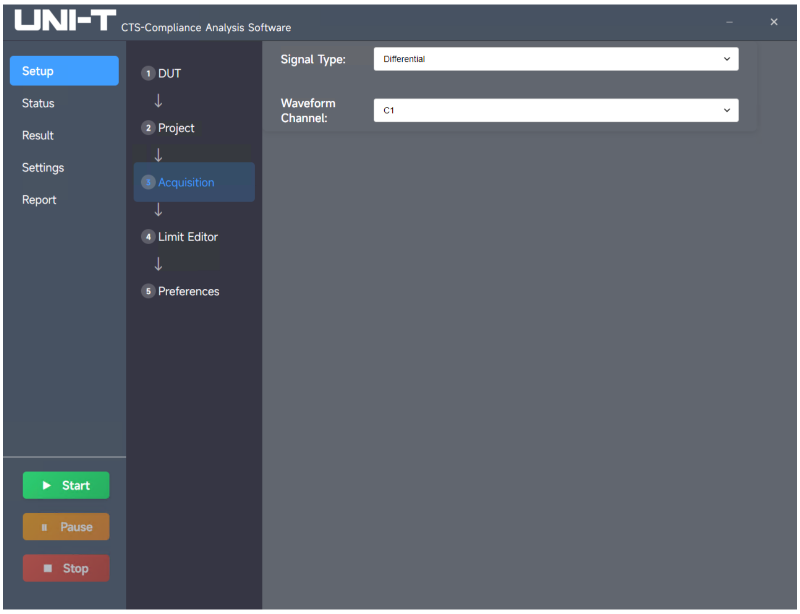
Click the + symbol on the right side of a test item to expand its sub-items. Selecting a sub-item allows you to configure it individually.

AOI template test: Configure the number of acquisitions, failure threshold, and template size.

Other test items: Configure the number of averages and the acquisition mode.

Acquisition:

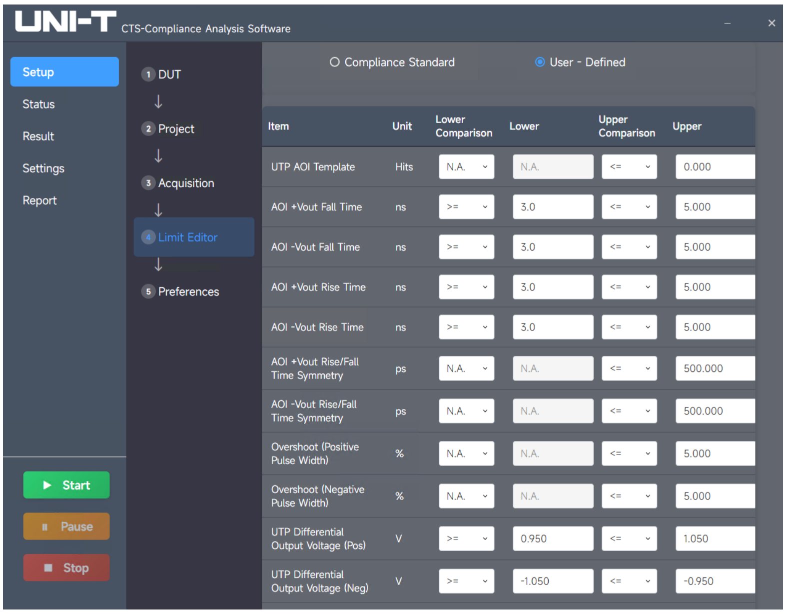
Set the input signal type and channel.



Waveform Acquisition Settings

Limit Editor:

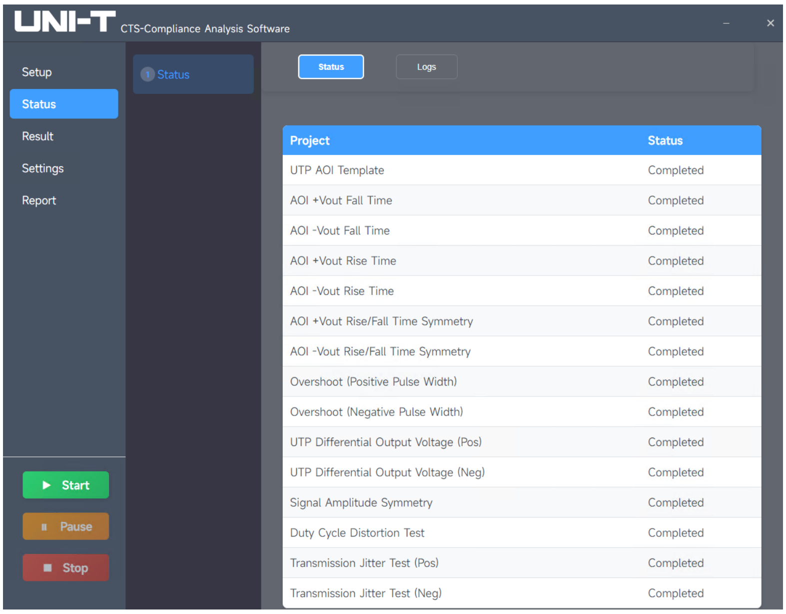
For selected test items, users can view the compliance standards in the limit editor, which can also customize the limits according to their requirements.



Limit Editor Settings

4.2 Test Status

Click the **Status** to open the menu and check the status of selected test item and the test log.

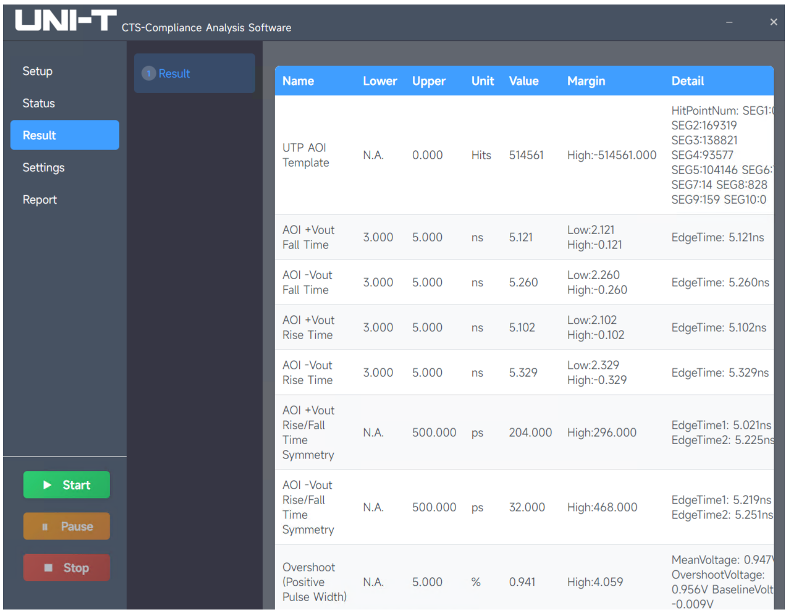


Test Status Settings

4.3 Test Results

After testing, click the **Results** to review the results of executed test items.

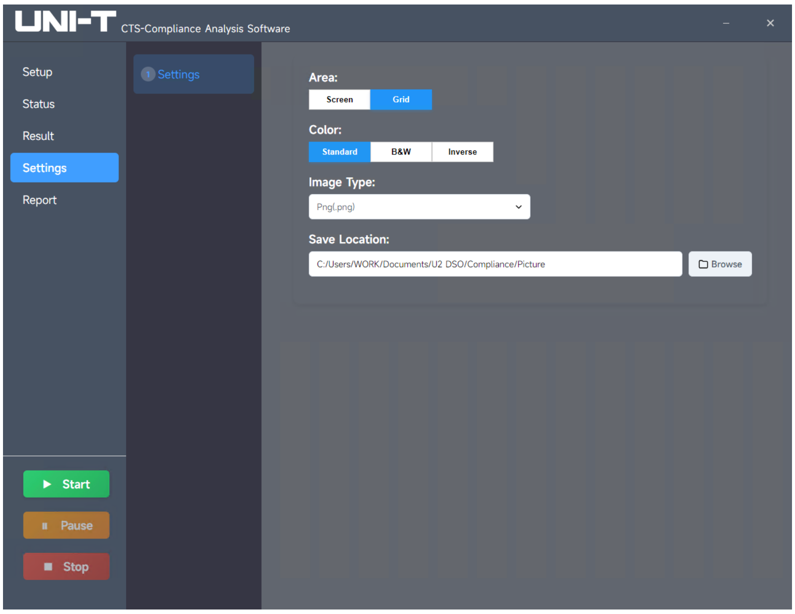
Test results table: Upper/lower reference threshold, test value, gain, description, and pass/fail test result.



Test Results Settings

4.4 Save Settings

Click the **Settings** to set screenshot capture settings, including the capture area, screenshot color, image type, and save location.

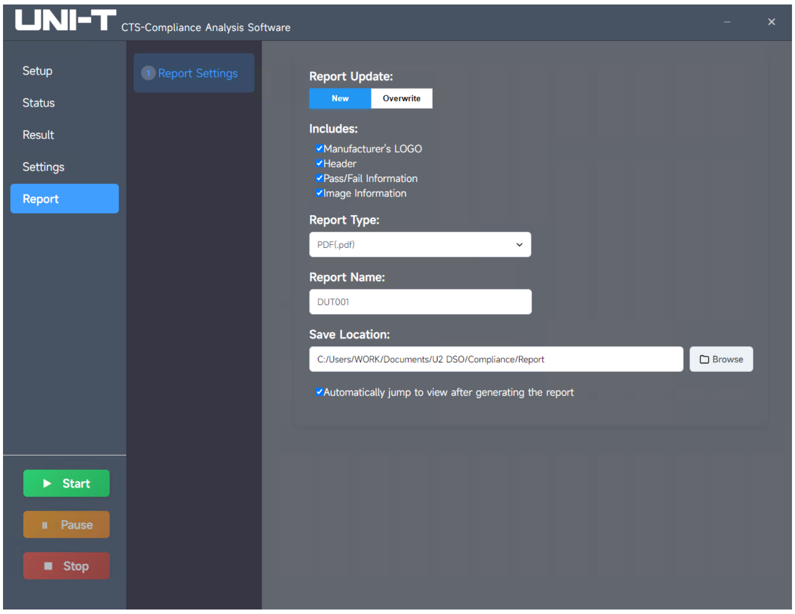


Save Settings

4.5 Test Report

Click the **Report** to open the menu and configure the settings.

Test report: Report update, report contents, report type, report name, save location, and settings for auto-incrementing report names, auto-creating reports, auto-opening reports.



Test Report Settings

After testing, a comprehensive report is generated immediately, including Pass/Fail results, data tables, and screenshots for each test.

UNI-T **100Base-Tx Ethernet Compliance Test Report**

Overall Information	
Application Info	
Application Name	CTS Ethernet
Application Version	1.01.0001
Device Info	
Scope Model Number	MSO8000HD
Scope Software Version	2.01.0000-Q5
Scope Serial Number	AHD8225220007
Test Info	
DUT ID	DUT_1
Overall Test Result	Pass
Compliance Limits	IEEE Std. 802.3 Specification
Test Time	2025-09-02 16:22:05.938
Excute Time	00:03:39.240
Acquisition Mode	Live

Result Summary

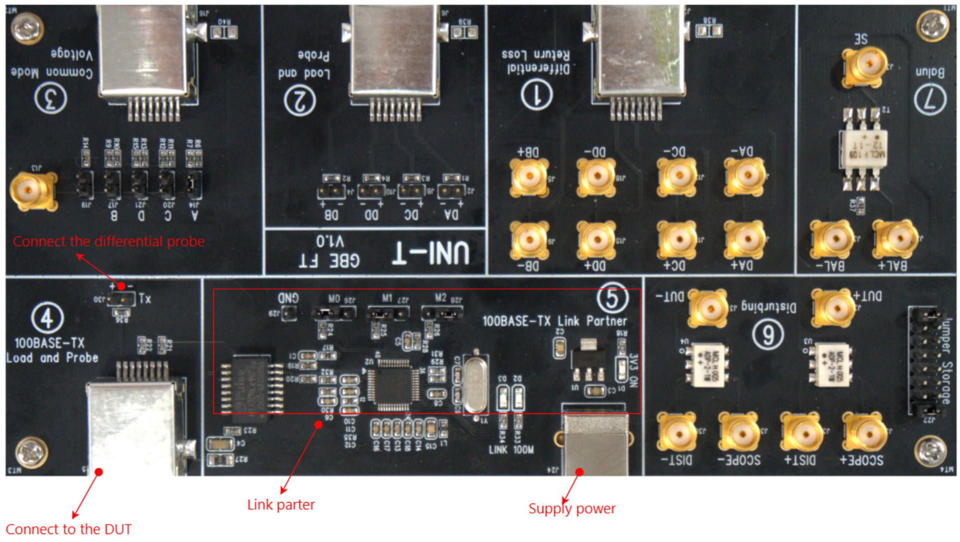
Test Name	Result	Measure Value	Pass Limit
UTP AOI Template	Pass	0Hits	Value <= 0.000
AOI +Vout Fall Time	Pass	3.981ns	3.000 <= Value <= 5.000
AOI -Vout Fall Time	Pass	3.987ns	3.000 <= Value <= 5.000
AOI +Vout Rise Time	Pass	3.919ns	3.000 <= Value <= 5.000
AOI -Vout Rise Time	Pass	3.973ns	3.000 <= Value <= 5.000
AOI +Vout Rise/Fall Symmetry	Pass	39.000ps	Value <= 500.000
AOI -Vout Rise/Fall Symmetry	Pass	33.000ps	Value <= 500.000
Overshoot(Pos)	Pass	1.173%	Value <= 5.000
Overshoot(Neg)	Pass	0.586%	Value <= 5.000
UTP +Vout Differential Output Voltage	Pass	1.018V	0.950 <= Value <= 1.050
UTP -Vout Differential Output Voltage	Pass	-1.019V	-1.050 <= Value <= -0.950
Signal Amplitude Symmetry	Pass	1.001%	0.980 <= Value <= 1.020
Duty Cycle Distortion	Pass	248.178ps	Value <= 500.000
Transmit Jitter(Pos)	Pass	0.631ns	Value <= 1.400
Transmit Jitter(Neg)	Pass	0.584ns	Value <= 1.400
Pass:15 Fail:0 Skipped:0			

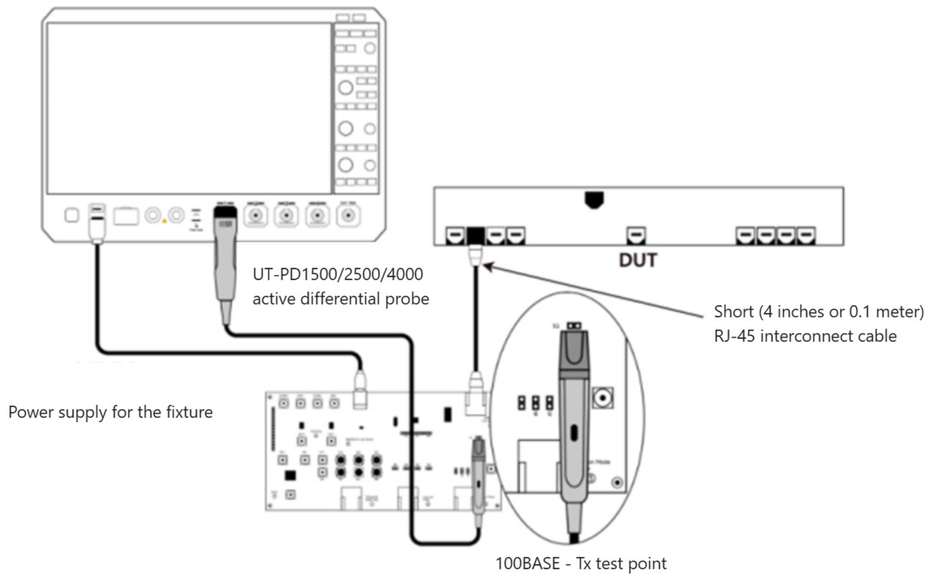
5. Test Environment Setup and Packet Transmission Control

When performing compliance testing on 100BASE-TX Ethernet, the IEEE 802.3 standard defines requirements for various test waveforms. The DUT must generate the corresponding waveforms for each test item. A packet transmission tool is software that allows the DUT to send specific test packets as required.

Induced packet transmission uses the auto-negotiation mode of 100BASE-TX. The Link Partner, built into the test fixture, automatically transmits 100Mbps idle waveforms without additional configuration. Connect the Tx (transmit) signal from the fixture's Ethernet port to the Rx (receive) terminal of the DUT. When the DUT receives the 100Mbps idle waveform, it will return the same waveform. Insert a differential probe into the two-pin header to capture the waveform and display it on the oscilloscope.

The test environment setup is shown in the figure below.





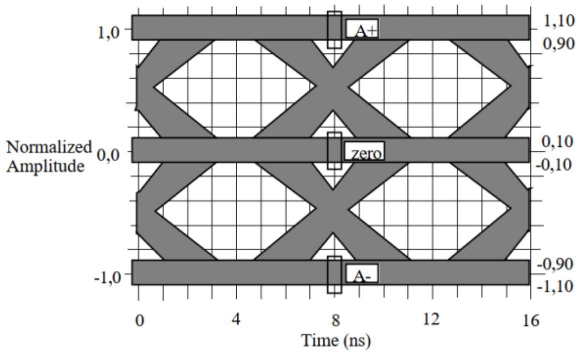
6. Compliance Test Items

6.1 AOI Template Test

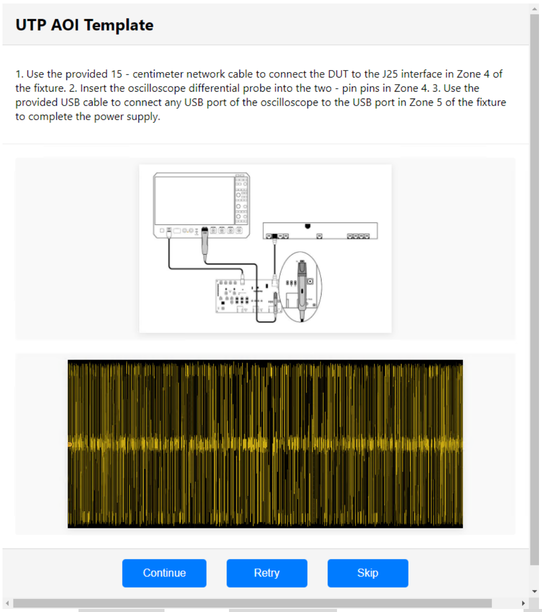
6.1.1 Calculation Method

AOI (output interface) mask test is used to verify whether transmission signals comply with industry-standard specifications, including jitter, overshoot, rise and fall times, and signal noise. The mask is defined in the annex of the ANSI X3.263 standard, which specifies a 5% geometric tolerance for the mask.

During the test, the software controls the mask and attempts to find the best match with the Ethernet eye diagram waveform. If any mask violation occurs, the test is marked as Fail. To perform this test, the DUT must transmit idle-mode waveforms encoded with MLT-3.



6.1.2 Test Procedure



(1) Select AOI rise/fall time test: In **Setup** —> **Project** menu, select **AOI**.

(2) Configure waveform acquisition: In the **Acquisition** menu, set the signal type (differential or single-ended) and the channel source.

(3) Select comparison standard: In **Limit Editor** menu, select the desired comparison standard.

(4) Start the test: Click **Start**.

(5) Set up the test environment: Configure the test environment according to the connection diagram prompted by the software. After confirmation, click **Continue** to start the test.

(6) Handle connection or waveform errors: If a connection or waveform error occurs, the log will display a timeout and re-display the connection diagram. Follow the prompts to correct the connection, resend the waveform, and click **Continue** to proceed.

(7) Oscilloscope verification and testing: During the test, the oscilloscope will verify that the correct test signal is present on the selected source, configure itself to capture pulses, and measure the signal according to compliance parameters. The software will then record the results.

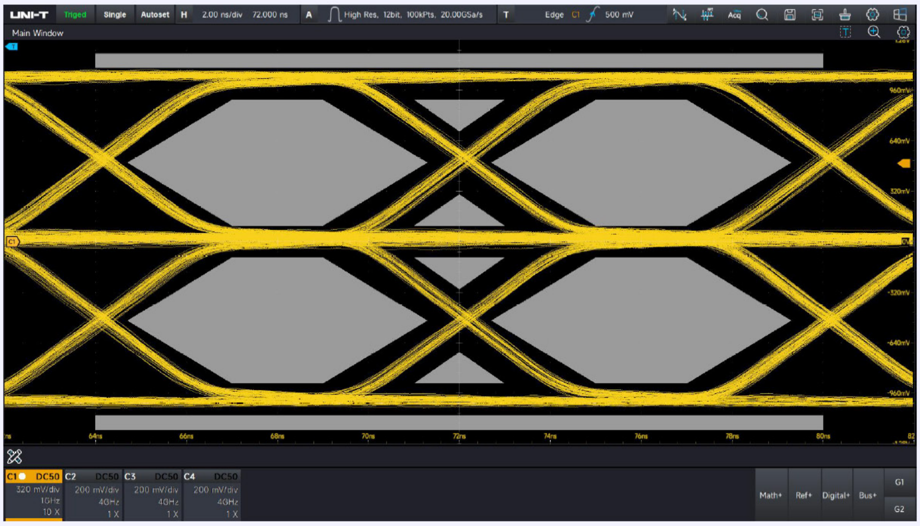
6.1.3 Test Results

UTP AOI Template **Pass**

Standard : IEEE Std. 802.3(ANSI X3.263-1995, Annex J)
Template testing refers to measuring whether the eye pattern formed by the superposition of signal waveforms complies with the specifications of the standard template. The passing criterion is that there are no intersection points between the actual signal eye pattern and the standard template.

Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
0	Hits	N.A.	0.000	High:0.000	No hits

UTP AOI Template



6.2 AOI Rise/Fall Time Test

6.2.1 Calculation Method

This test measures the rise and fall times of both positive and negative pulse widths, and evaluates the symmetry between rise and fall times.

AOI + V_{out} rise time: Measures the rise time of the positive pulse width (from 0V to $+V_{out}$). Threshold: 3 to 5ns.

AOI + V_{out} fall time: Measures the fall time of the positive pulse width (from $+V_{out}$ to 0V). Threshold: 3 to 5ns.

AOI + V_{out} rise/fall time symmetry: The difference between the rise time and fall time of the positive pulse width must be ≤ 500ps.

AOI - V_{out} rise time: Measures the rise time of the negative pulse width (from 0V to $-V_{out}$). Threshold: 3 to 5ns.

AOI - V_{out} fall time: Measures the fall time of the negative pulse width (from $-V_{out}$ to 0V). Threshold: 3 to 5ns.

AOI - V_{out} rise/fall time symmetry: The difference between the rise time and fall time of the negative pulse width must be ≤ 500ps.

AOI overall rise/fall time symmetry: The difference between the maximum and minimum rise/fall times across all positive and negative pulse widths must be ≤ 500ps.

6.2.2 Test Procedure

(8) Select AOI rise/fall time test: In **Setup** —> **Project** menu, select **AOI Rise/Fall Time**.

(9) Configure waveform acquisition: In the **Acquisition** menu, set the signal type (differential or single-ended) and the channel source.

(10) Select comparison standard: In **Limit Editor** menu, select the desired comparison standard.

(11) Start the test: Click **Start**.

(12) Set up the test environment: Configure the test environment according to the connection diagram prompted by the software. After confirmation, click **Continue** to start the test.

(13) Handle connection or waveform errors: If a connection or waveform error occurs, the log will display a timeout and re-display the connection diagram. Follow the prompts to correct the connection, resend the waveform, and click **Continue** to proceed.

(14) Oscilloscope verification and testing: During the test, the oscilloscope will verify that the correct test signal is present on the selected source, configure itself to capture pulses, and measure the signal according to compliance parameters. The software will then record the results.

6.2.3 Test Results

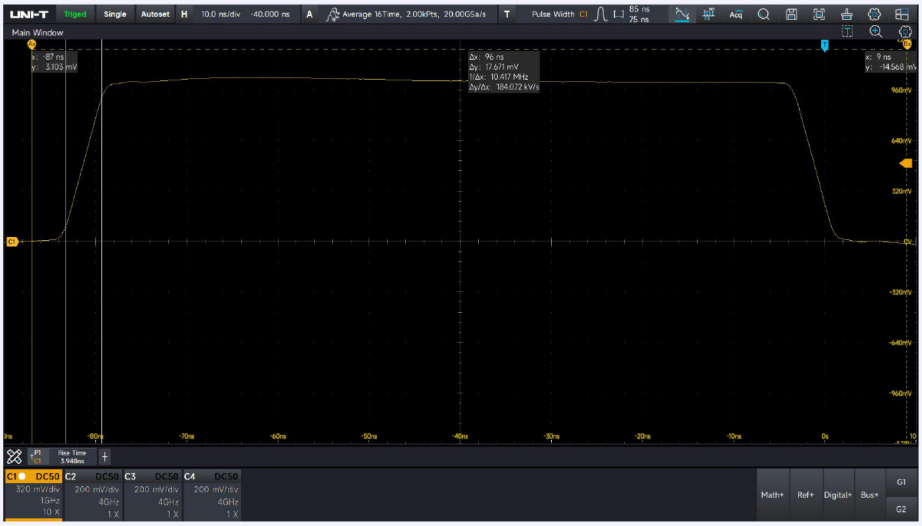
AOI + V_{out} Rise Time

Measure the time required for the signal to rise from 0V to $+V_{out}$. The standard specifies the measurement range as 10% ($+V_{out}$) to 90% ($+V_{out}$) on the rising edge.

Calculation Method: The rise time t_{rise} is defined as the interval from the 10% ($+V_{out}$) to 90% ($+V_{out}$) on the rising edge of the positive pulse width, which must meet the standard: $3.0ns \le t_{rise} \le 5.0ns$.

AOI +Vout Rise Time					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
3.657331	ns	3.000000	5.000000	Low:0.657331 High:1.342669	EdgeTime: 3.657331ns

AOI +Vout Rise Time



AOI + V_{out} Fall Time

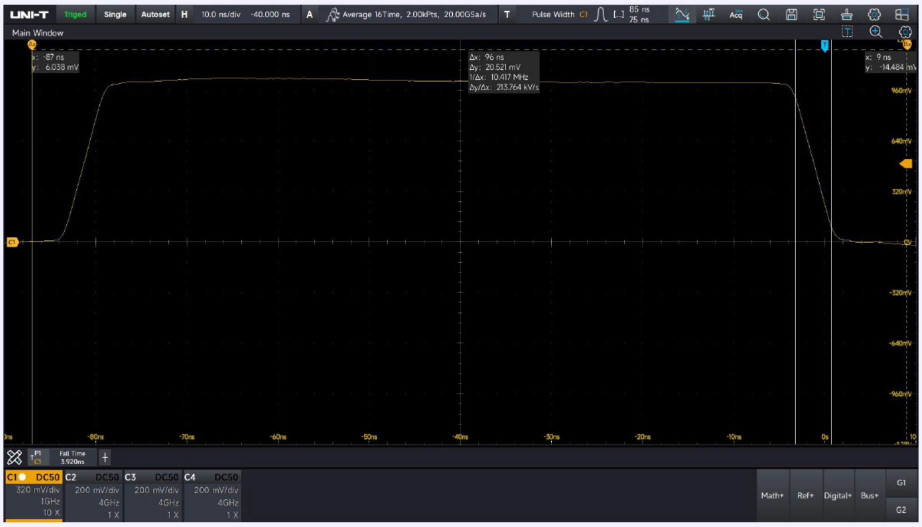
Measure the time required for the signal to fall from $+V_{out}$ to 0V. The standard specifies the measurement range as 90% ($+V_{out}$) to 10% ($+V_{out}$) on the falling edge.

Calculation Method: The fall time t_{fall} is defined as the interval from the 90% ($+V_{out}$) to 10% ($+V_{out}$) on the falling edge of the positive pulse width, which must meet the standard: 3.0ns ≤ t_{fall} ≤ 5.0ns.

AOI +Vout Fall Time **Pass**

Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
3.764722	ns	3.000000	5.000000	Low:0.764722 High:1.235278	EdgeTime: 3.764722ns

AOI +Vout Fall Time

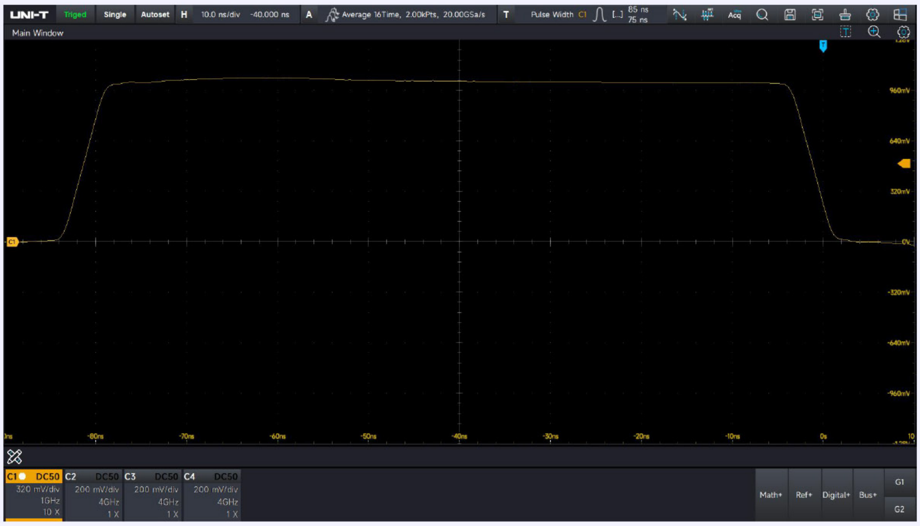


AOI + V_{out} Rise/Fall Time Symmetry

Measure the difference between the rise time and fall time of the positive pulse width, which must meet the standard: ≤ 500ps.

AOI +Vout Rise/Fall Symmetry					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
49.000000	ps	N.A.	500.000000	High:451.000000	EdgeTime1: 3.660950ns EdgeTime2: 3.710697ns

AOI +Vout Rise/Fall Symmetry



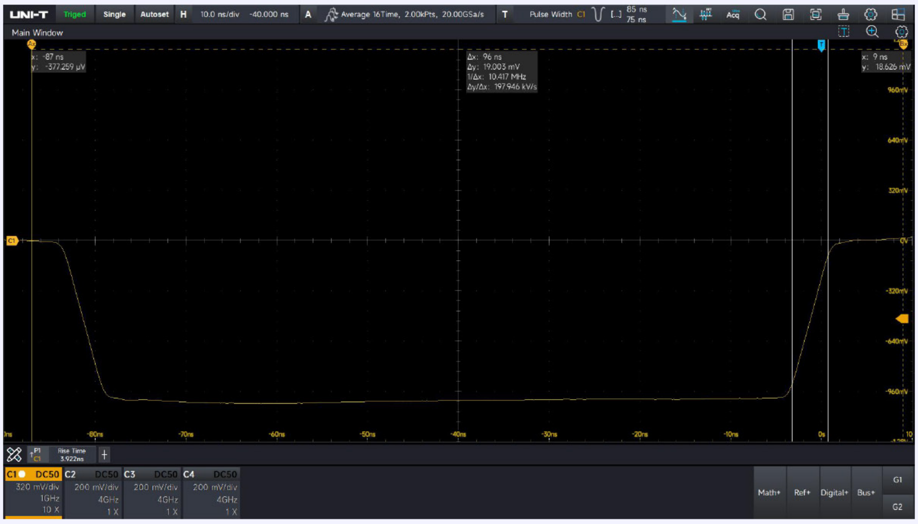
AOI -V_{out} Rise Time

Measure the time required for the signal to rise from -V_{out} to 0V. The standard specifies the measurement range as 10% (-V_{out}) to 90% (-V_{out}) on the rising edge.

Calculation Method: The rise time t_{rise} is defined as the interval from the 10% (-V_{out}) to 90% (-V_{out}) on the rising edge of the negative pulse width, which must meet the standard: 3.0ns ≤ t_{rise} ≤ 5.0ns.

AOI -Vout Rise Time					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
3.707693	ns	3.000000	5.000000	Low:0.707693 High:1.292307	EdgeTime: 3.707693ns

AOI -Vout Rise Time



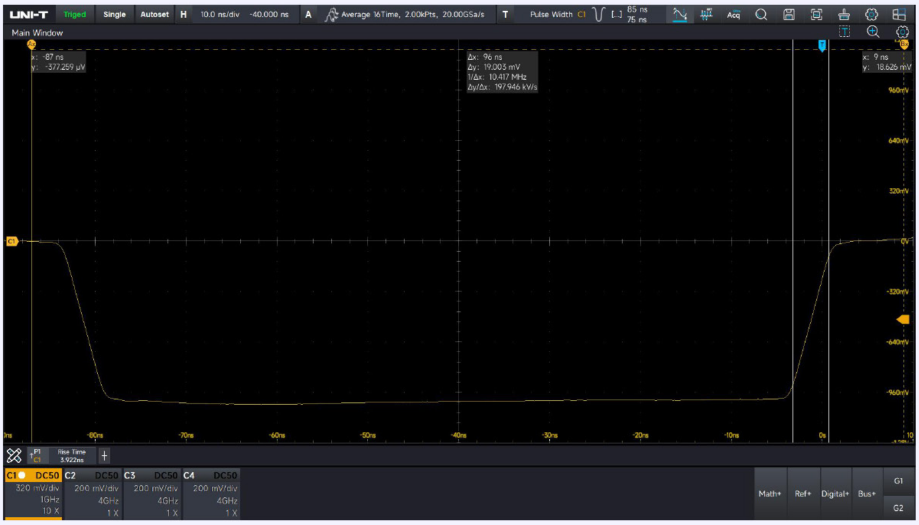
AOI -V_{out} Fall Time

Measure the time required for the signal to fall fom 0V to -V_{out}. The standard specifies the measurement range as 90% (-V_{out}) to 10% (-V_{out}) on the falling edge.

Calculation Method: The fall time t_{fall} is defined as the interval from the 90% (-V_{out}) to 10% (-V_{out}) on the falling edge of the negative pulse width, which must meet the standard: 3.0ns ≤ t_{fall} ≤ 5.0ns.

AOI -Vout Fall Time					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
3.660930	ns	3.000000	5.000000	Low:0.660930 High:1.339070	EdgeTime: 3.660930ns

AOI -Vout Rise Time

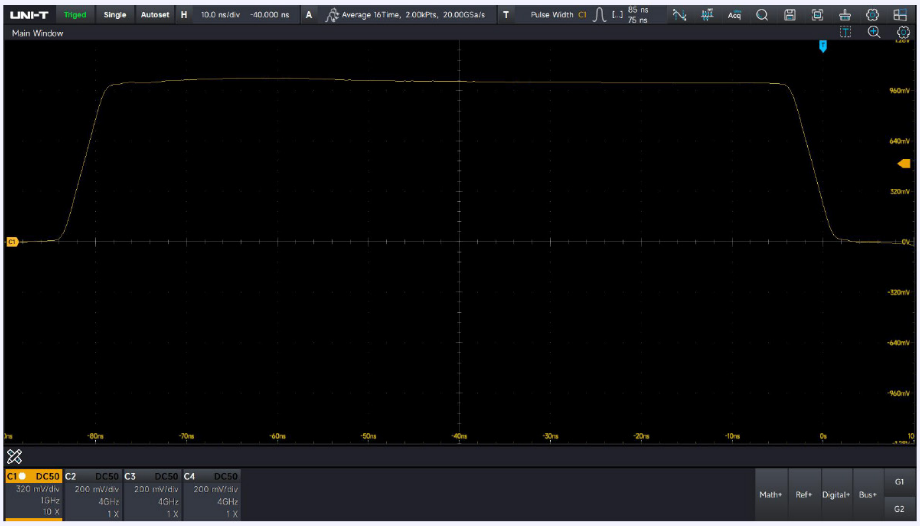


AOI -V_{out} Rise/Fall Time Symmetry

Measure the difference between the rise time and fall time of the negative pulse width, which must meet the standard: ≤ 500ps.

AOI -Vout Rise/Fall Symmetry					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
28.000000	ps	N.A.	500.000000	High:472.000000	EdgeTime1: 3.736878ns EdgeTime2: 3.708724ns

AOI +Vout Rise/Fall Symmetry



6.3 Overshoot Test

6.3.1 Calculation Method

The overshoot test is used to verify whether the waveform overshoot of the DUT is within the specified compliance limits. Separate tests are performed for positive and negative pulses. If the overshoot is less than 5% of the average differential output voltage, the result is Pass; otherwise, it is Fail.

6.3.2 Test Procedure

(1) Select overshoot test: In **Setup** —> **Project** menu, select **Overshoot**.

(2) Configure waveform acquisition: In the **Acquisition** menu, set the signal type (differential or single-ended) and the channel source.

(3) Select comparison standard: In **Limit Editor** menu, select the desired comparison standard.

(4) Click **Start** .

(5) Set up the test environment: Configure the test environment according to the connection diagram prompted by the software. After confirmation, click **Continue** to start the test.

(6) Handle connection or waveform errors: If a connection or waveform error occurs, the log will display a timeout and re-display the connection diagram. Follow the prompts to correct the connection, resend the waveform, and click **Continue** to proceed.

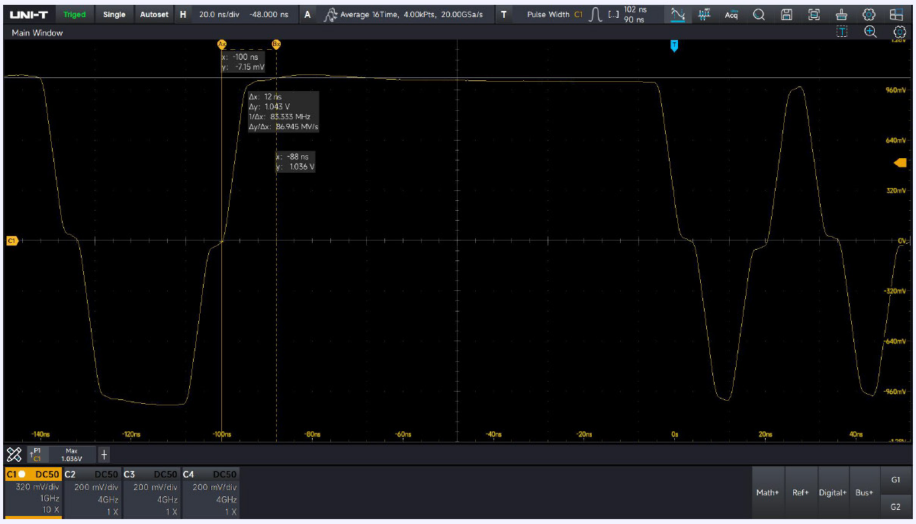
(7) Oscilloscope verification and testing: During the test, the oscilloscope will verify that the correct test signal is present on the selected source, configure itself to capture pulses, and measure the signal according to compliance parameters. The software will then record the results.

6.3.3 Test Results

Overshoot (Positive Pulse Width)

Overshoot(Pos)					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
2.234696	%	N.A.	5.000000	High:2.765304	MeanVoltage: 0.997838V OvershootVoltage: 1.019500V BaselineVoltage: 0.028489V

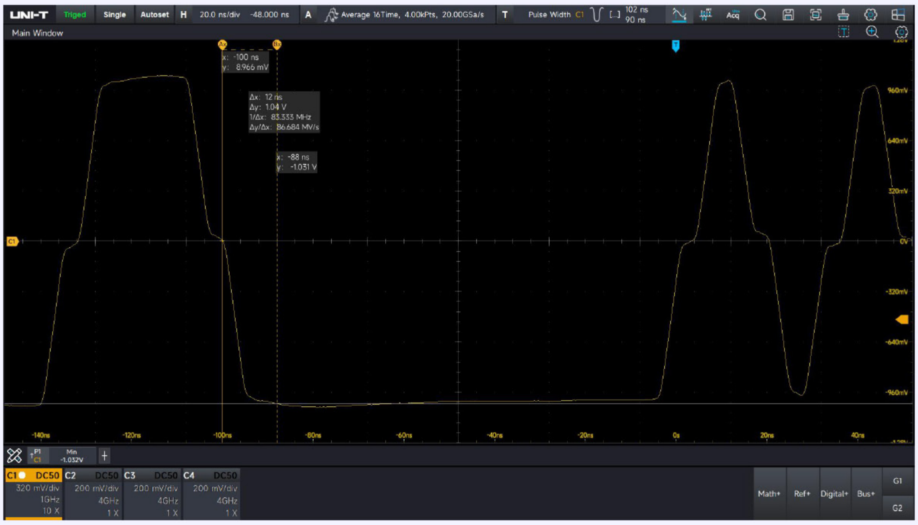
Overshoot(Pos)



Overshoot (Negative Pulse Width)

Overshoot(Neg)					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
2.157247	%	N.A.	5.000000	High:2.842753	MeanVoltage: -0.965920V OvershootVoltage: -0.986852 V BaselineVoltage: 0.004391V

Overshoot(Neg)



6.4 Peak Differential Voltage Test

6.4.1 Calculation Method

The peak differential voltage test includes differential output voltage amplitude test and signal amplitude symmetry test.

Differential output voltage amplitude: This test is used to verify whether the differential output voltage of the DUT is within the compliance limits. The test measures the average amplitudes of the positive and negative pulses in the Ethernet differential output waveform. The absolute voltage amplitude shall be within 950mV to 1050mV.

Signal amplitude symmetry: This test is used to calculate the symmetry of the DUT's differential output by calculating the ratio between the average positive amplitude and the average negative amplitude. The absolute value of this ratio shall be within 0.98 to 1.02.

6.4.2 Test Procedure

(1) Select peak differential voltage test: In **Setup** —> **Project** menu, select **Peak Differential Voltage**.

(2) Configure waveform acquisition: In the **Acquisition** menu, set the signal type (differential or single-ended) and the channel source.

(3) Select comparison standard: In **Limit Editor** menu, select the desired comparison standard.

(4) Start the test: Click **Start**.

(5) Set up the test environment: Configure the test environment according to the connection diagram prompted by the software. After confirmation, click **Continue** to start the test.

(6) Handle connection or waveform errors: If a connection or waveform error occurs, the log will display a timeout and re-display the connection diagram. Follow the prompts to correct the connection, resend the waveform, and click **Continue** to proceed.

(7) Oscilloscope verification and testing: During the test, the oscilloscope will verify that the correct test signal is present on the selected source, configure itself to capture pulses, and measure the signal according to compliance parameters. The software will then record the results.

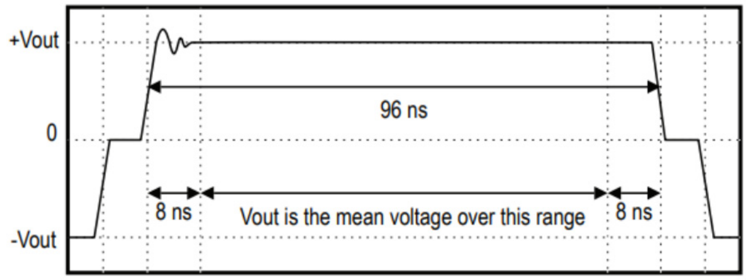
6.4.3 Test Results

UTP Differential Output Voltage (Pos)

The measurement method for the unshielded twisted pair (UTP) differential output voltage (positive pulse, $+V_{out}$) is as follows:

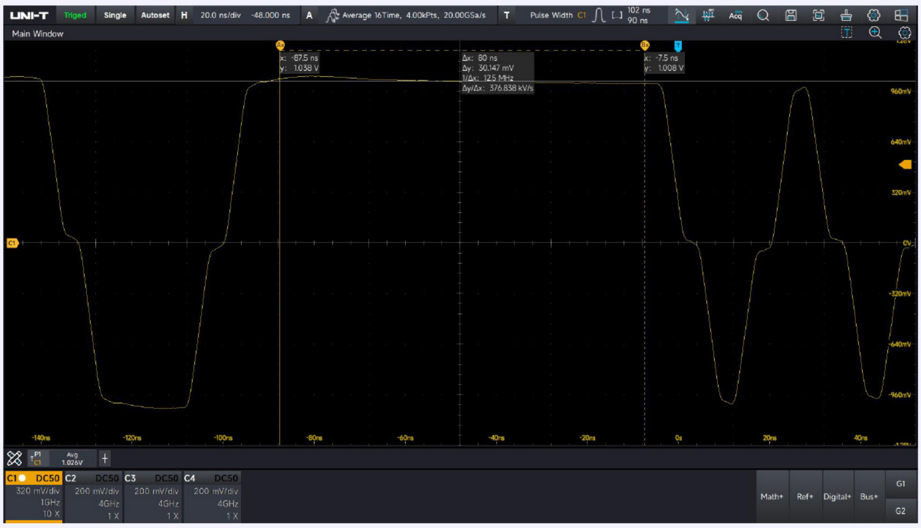
After the signal transitions from 0V to $+V_{out}$, capture the waveform within the time window from 8 ns after the 50% point of the rising edge to 8ns before the 50% point of the falling edge. The average voltage is then calculated over this interval.

The test is considered Pass if the result satisfies 950mV $\leq V_{out} \leq$ 1050mV; otherwise, it is considered Fail.



UTP +Vout Differential Output Voltage					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
0.971229	V	0.950000	1.050000	Low:0.021229 High:0.078771	MeanVoltage: 0.998882V BaseLineVoltage: 0.027654V

UTP +Vout Differential Output Voltage



TP Differential Output Voltage (Neg)

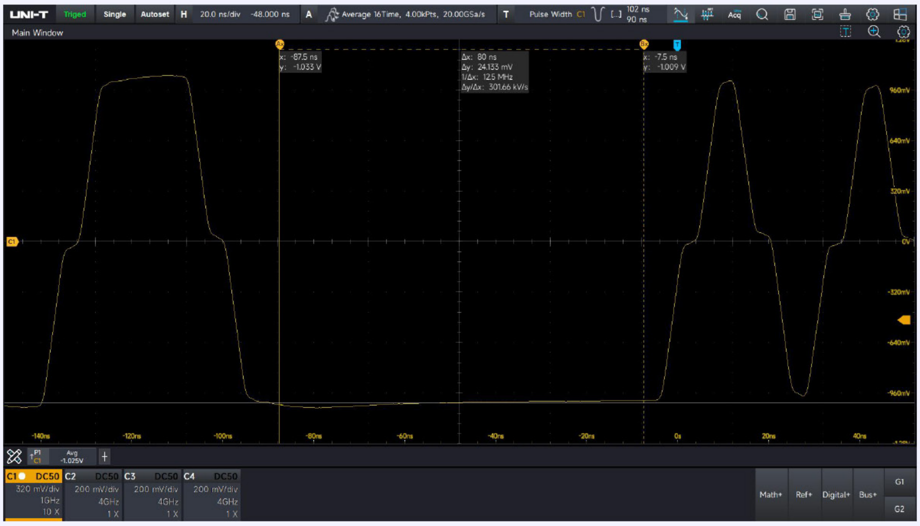
The measurement method for the unshielded twisted pair (UTP) differential output voltage (negative pulse, $-V_{out}$) is as follows:

After the signal transitions from 0V to $-V_{out}$, capture the waveform within the time window from 8ns after the 50% point of the falling edge to 8ns before the 50% point of the rising edge. The average voltage is then calculated over this interval.

The test is considered Pass if the result satisfies $950mV \leq V_{out} \leq 1050mV$; otherwise, it is considered Fail.

UTP -Vout Differential Output Voltage					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
-0.971275	V	-1.050000	-0.950000	Low:0.078725 High:0.021275	MeanVoltage: -0.964121V BaseLineVoltage: 0.007154V

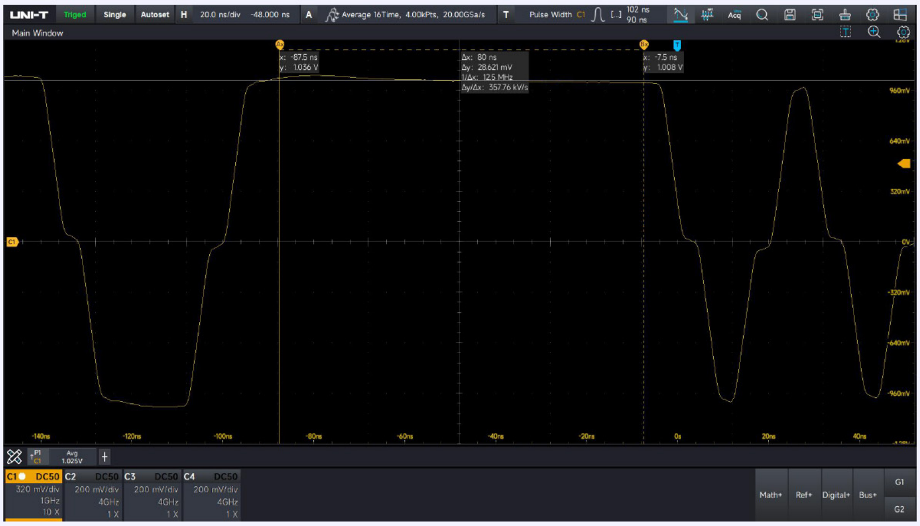
UTP -Vout Differential Output Voltage



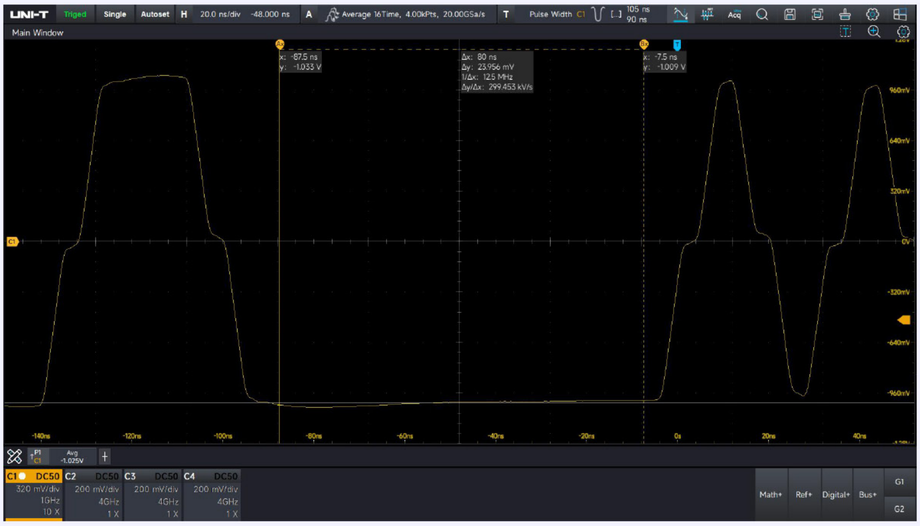
Amplitude Symmetry

Signal Amplitude Symmetry					Pass
Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
1.000293	%	0.980000	1.020000	Low:0.020293 High:0.019707	MeanVoltagePos: 0.999863V BaselineVoltagePos: 0.028724V MeanVoltageNeg: -0.965488V BaselineVoltageNeg: 0.005367V

Signal Amplitude Symmetry(Pos)



Signal Amplitude Symmetry(Neg)



6.5 Jitter/Duty Ratio Distortion Test

6.5.1 Calculation Method

Transmitter Jitter Test

The transmitter jitter test measures peak-to-peak jitter in accordance with the limits specified in Clause 9.1.9 of ANSI X3.263-1995. This test evaluates the total transmission jitter, which is primarily caused by duty cycle distortion and baseline drift. The method involves constructing a histogram of waveform crossing points and performing cumulative statistical analysis. For MLT-3 signals used in 100BASE-Tx, jitter must be measured at both the upper and lower voltage crossing points.

Transmitter Jitter (Positive Pulse Width)

According to the standard, the maximum jitter shall not exceed 1.4ns. To perform this test, the DUT must transmit idle-mode waveforms encoded with MLT-3. For transmitter jitter testing, the specification does not require calculating the number of edges or Unit Intervals (UIs) for total jitter. Instead, between 40,000 and 100,000 UIs are acquired. The differences between the actual edge positions of the positive pulse widths and the corresponding ideal clock positions are measured. The peak-to-peak jitter is then calculated as the difference between the maximum and minimum deviations.

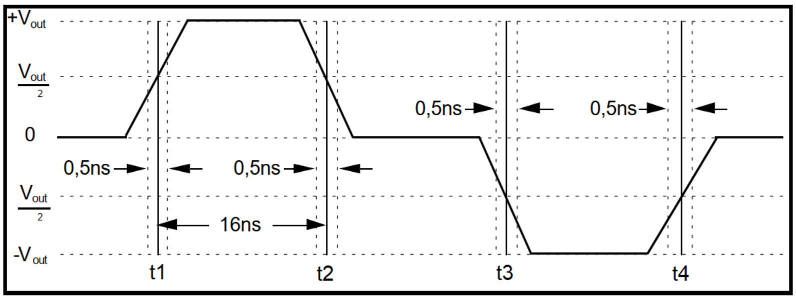
Transmitter Jitter (Negative Pulse Width)

The test procedure is the same as for positive pulse widths (mentioned above), except that measurements are taken at the edges of the negative pulse widths.

Duty Ratio Distortion Test

The duty ratio distortion test is performed in accordance with the limits specified in Clause 9.1.8 of ANSI X3.263-1995. This test evaluates signal symmetry by measuring the difference between the durations of the high-level and low-level signals. Pass/fail determination is based on the maximum deviation between the actual crossing point width and the theoretical value.

For this test, the times at which the captured average waveform crosses the $V_{out}/2$ voltage level are measured.



The calculation of Tx (x = 1, 2, 3, 4, 5, 6) is defined as follows:

- T1 = $t_1 - t_0$ - 16ns
- T2 = $t_2 - t_1$ - 16ns
- T3 = $t_3 - t_2$ - 16ns
- T4 = $t_2 - t_0$ - 32ns
- T5 = $t_3 - t_1$ - 32ns
- T6 = $t_3 - t_0$ - 48ns

Peak-to-peak duty ratio distortion= Max absolute value (T_1, T_2, T_3, T_4, T_5, T_6)

The standard requires the maximum peak-to-peak duty ratio distortion must be less than 500ps.

6.5.2 Test Procedure

(1) Select jitter/duty ratio distortion: In **Setup** —> **Project** menu, select **Jitter/Duty Ratio Distortion**.

(2) Configure waveform acquisition: In the **Acquisition** menu, set the signal type (differential or single-ended) and the channel source.

(3) Select comparison standard: In **Limit Editor** menu, select the desired comparison standard.

(4) Start the test: Click **Start**.

(5) Set up the test environment: Configure the test environment according to the connection diagram prompted by the software. After confirmation, click **Continue** to start the test.

(6) Handle connection or waveform errors: If a connection or waveform error occurs, the log will display a timeout and re-display the connection diagram. Follow the prompts to correct the connection, resend the waveform, and click **Continue** to proceed.

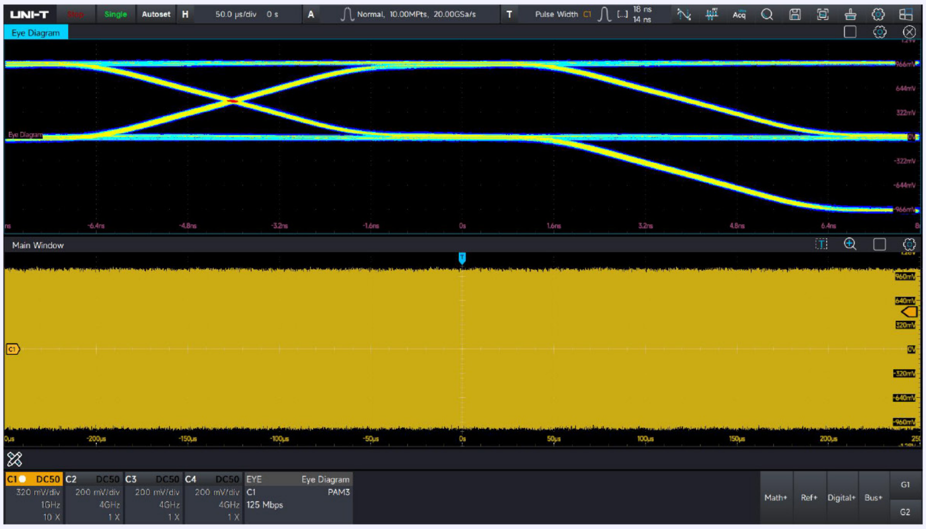
(7) Oscilloscope verification and testing: During the test, the oscilloscope will verify that the correct test signal is present on the selected source, configure itself to capture pulses, and measure the signal according to compliance parameters. The software will then record the results.

6.5.3 Test Results

Transmit Jitter(Pos) **Pass**

Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
1.181	ns	N.A.	1.400	High:0.219	MaxPeakValue:498.304ps MinPeakValue:-682.808ps

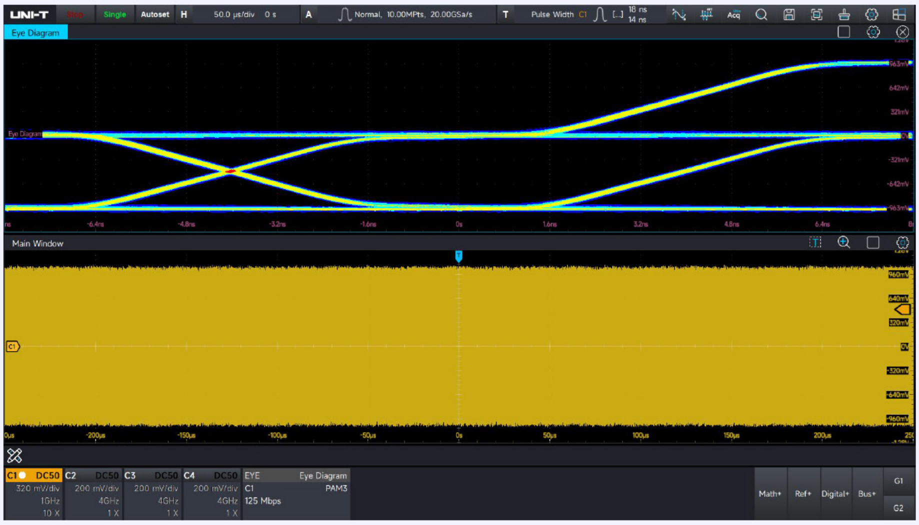
Transmit Jitter(Pos)



Transmit Jitter(Neg) **Pass**

Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
1.319	ns	N.A.	1.400	High:0.081	MaxPeakValue:708.110ps MinPeakValue:-611.307ps

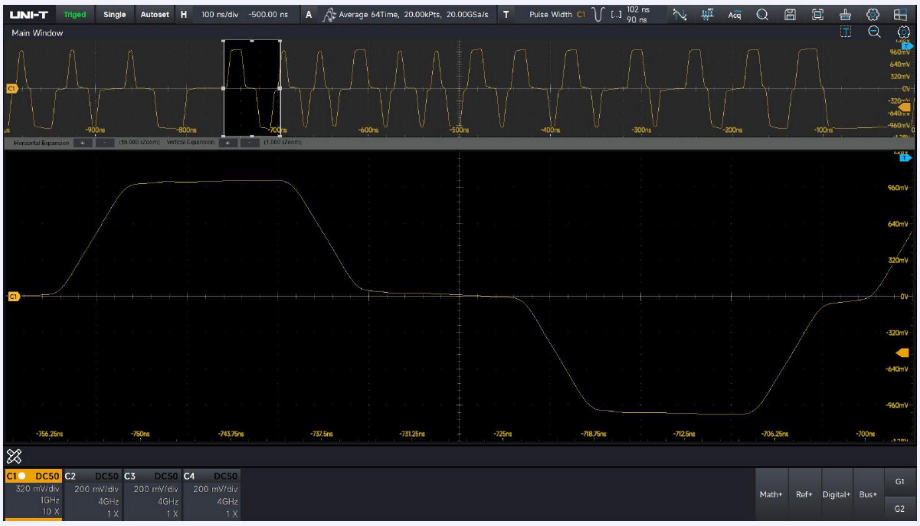
Transmit Jitter(Neg)



Duty Cycle Distortion **Pass**

Measure Value	Unit	Lower Limit	Upper Limit	Margin	Comments
270.556	ps	N.A.	500.000	High:229.444	T1: 201.156 T2: -270.556 T3: 220.778 T4: -69.401 T5: -49.778 T6: 151.377

Duty Cycle Distortion



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