



RIGOL

TF-AENET-STP

Automotive Ethernet
Compliance Test Solution

Data Sheet
DSM03102-1110
Oct. 2024

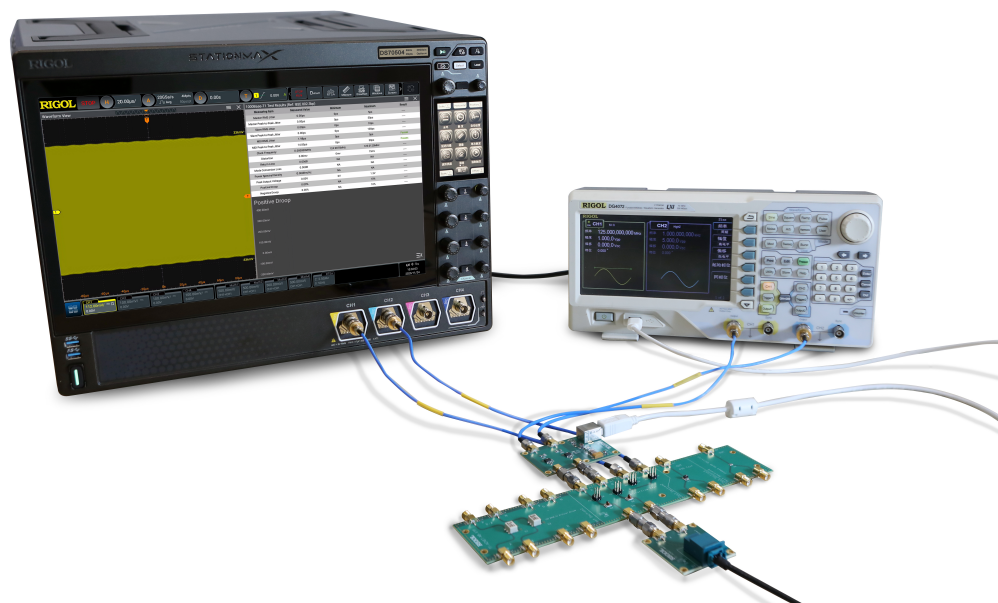
Automotive Ethernet Compliance Test Solution

As the automotive industry becomes intelligent and network connected, in-vehicle Ethernet technology is more and more widely used in automobiles, such as entertainment, communication, navigation and assisted driving. To ensure the stability and reliability of these functions, the automotive Ethernet compliance test becomes an important link for the function test and verification.

RIGOL's DS70000 series oscilloscope and the Automotive Ethernet compliance analysis option (DS70000-AENETC) can work with the fixture (TF-AENET-STP) to provide the flexible and convenient test solutions for the Automotive Ethernet compliance analysis.

Technical Advantage

- Support IEEE and OPEN Alliance protocol standards, wide test coverage
 - IEEE 802.3bw, 100BASE-T1, 100 Mbps
 - OPEN Alliance TC8, 100BASE-T1, 100 Mbps
 - IEEE 802.3bp, 1000BASE-T1, 1 Gbps
- Support multiple test scenarios and multiple test items
- Test device connection diagram and test procedures are available on the test operation interface of the oscilloscope, easy for users to follow the instructions to complete the test.
- Support waveform preview, capable of judging whether the previewed waveform is accurate for the test
- Support generating user-defined HTML or PDF test report, with test results and measurement values in it
- Provide the test devices and accessories necessary for the test, as well as the operation guide



Protocol Specifications

100Base-T1 (IEEE802.3bw)

Reference Standard	Test Item	Test Mode
IEEE 802.3bw-2015 96.5.4.1	Transmitter Output Droop	Test Mode 1
IEEE 802.3bw-2015 96.5.4.3	MDI Output Jitter(Master)	Test Mode 2
IEEE 802.3bw-2015 96.5.4.5	Transmit Clock Frequency	
IEEE 802.3bw-2015 96.5.4.3	Slave TX_TCLK Jitter	Test Mode 3
IEEE 802.3bw-2015 96.5.4.2	Transmitter Distortion	Test Mode 4
IEEE 802.3bw-2015 96.5.4.4	Power Spectral Density	Test Mode 5
IEEE 802.3bw-2015 96.5.6	Peak Differential Output	
IEEE 802.3bw-2015 96.7.1.3	MDI Return Loss	
IEEE 802.3bw-2015 96.8.2.2	MDI Mode Conversion Loss	

100Base-T1 (Open Alliance TC8)

Reference Standard	Test Item
OABR_PMA_TX_01	Transmitter Output Droop
OABR_PMA_TX_02	MDI Output Jitter(Master)
OABR_PMA_TX_03	Transmit Clock Frequency
OABR_PMA_TX_04	Power Spectral Density (PSD)
OABR_PMA_TX_05	MDI Return Loss
OABR_PMA_TX_06	MDI Mode Conversion Loss
OABR_PMA_TX_07	MDI Common Mode Emission
OABR_PMA_TX_08	Transmitter Distortion

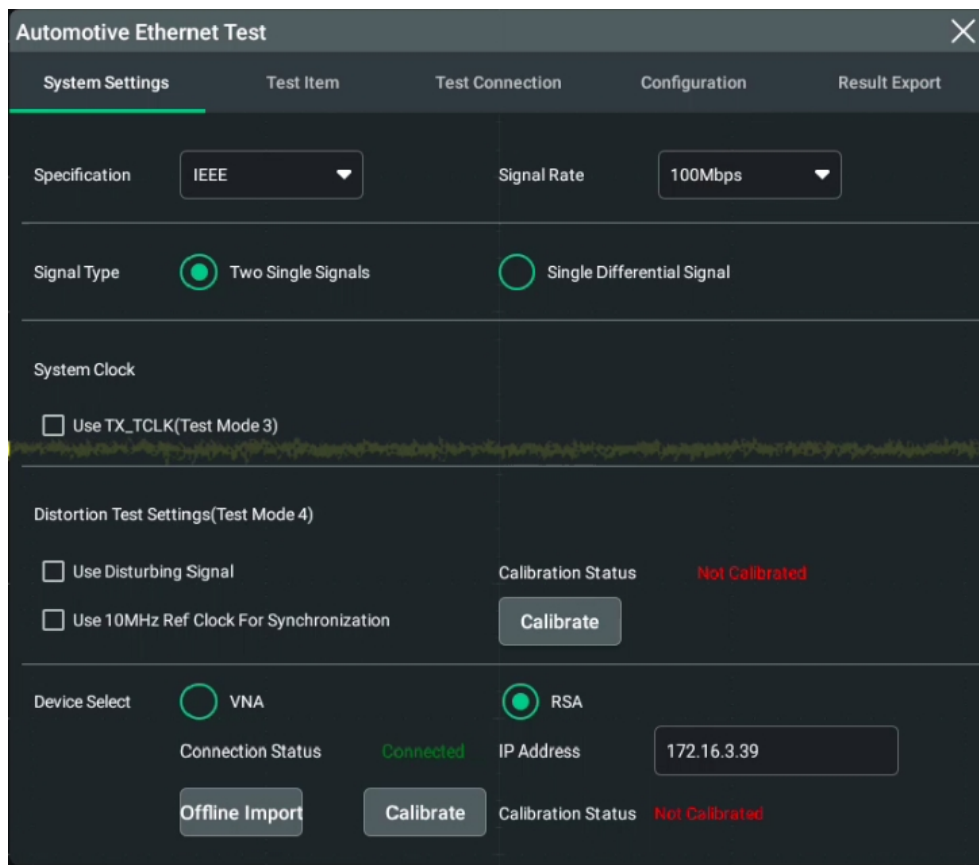
1000Base-T1 (IEEE 802.3bp)

Reference Standard	Test Item	Test Mode
IEEE 802.3bp-2016 97.5.3.3	Master Timing Jitter	Test Mode 1
IEEE 802.3bp-2016 97.5.3.3	Slave Timing Jitter	
IEEE 802.3bp-2016 97.5.3.3	MDI Jitter	Test Mode 2
IEEE 802.3bp-2016 97.5.3.6	Transmit Clock Frequency	
IEEE 802.3bp-2016 97.5.3.2	Transmitter Distortion	Test Mode 4
IEEE 802.3bp-2016 97.5.3.4	Power Spectral Density	Test Mode 5
IEEE 802.3bp-2016 97.5.3.5	Peak Differential Output	
IEEE 802.3bp-2016 97.5.3.1	Transmitter Output Droop	Test Mode 6
IEEE 802.3bp-2016 97.7.2.1	MDI Return Loss	
IEEE 802.3bp-2016 97.7.2.2	MDI Mode Conversion Loss	

Features

DS70000 series oscilloscope is equipped with the Automotive Ethernet Compliance test as an option, which can help you select the test item, configure the test, perform the test with the given test procedures, and generate the test result report.

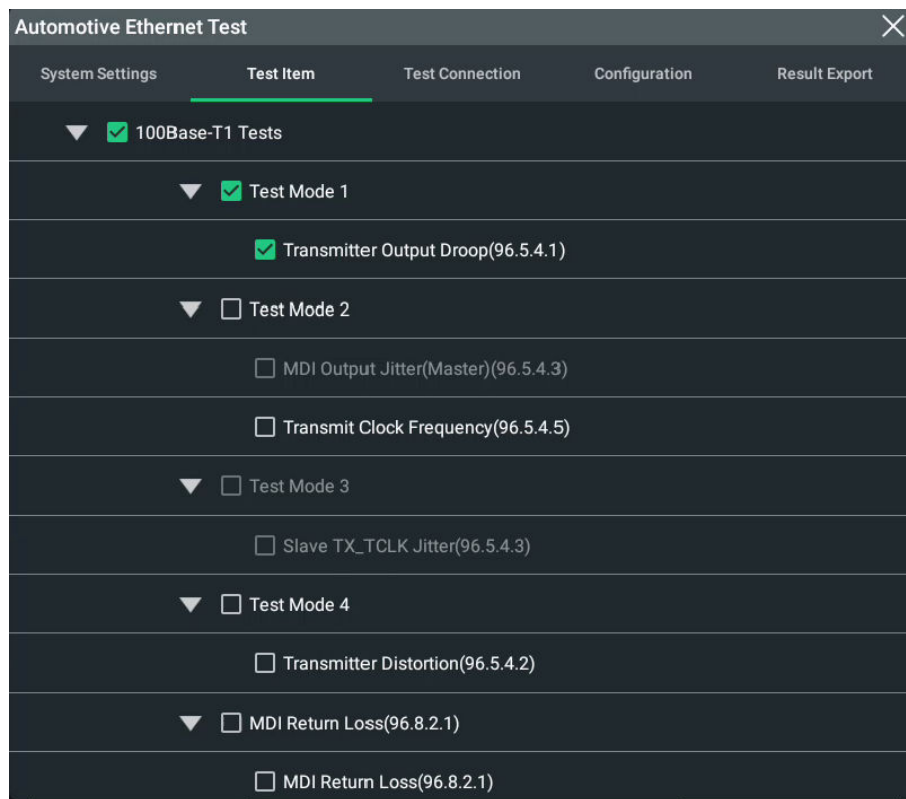
Configure Multiple Test Scenarios Flexibly



- Select the protocol specifications and the signal rate by clicking or tapping the drop-down button of "Specifications" and "Signal Rate".
- In DS70000, you can select "Two Single Signals" or "Single Differential Signal" as the test signal for the specified test.
- Select the desired DUT for different tests. You can select the clock signal (TX_TCLK) or MDI signal for the jitter test.
- Four test scenarios can be set up depending on whether involving the disturbing signal or reference clock signal. The test schemes are different for different test scenarios.
- To perform the loss test, use the VNA device or RIGOL's RSA3000N series spectrum analyzer equipped with the VNA mode.

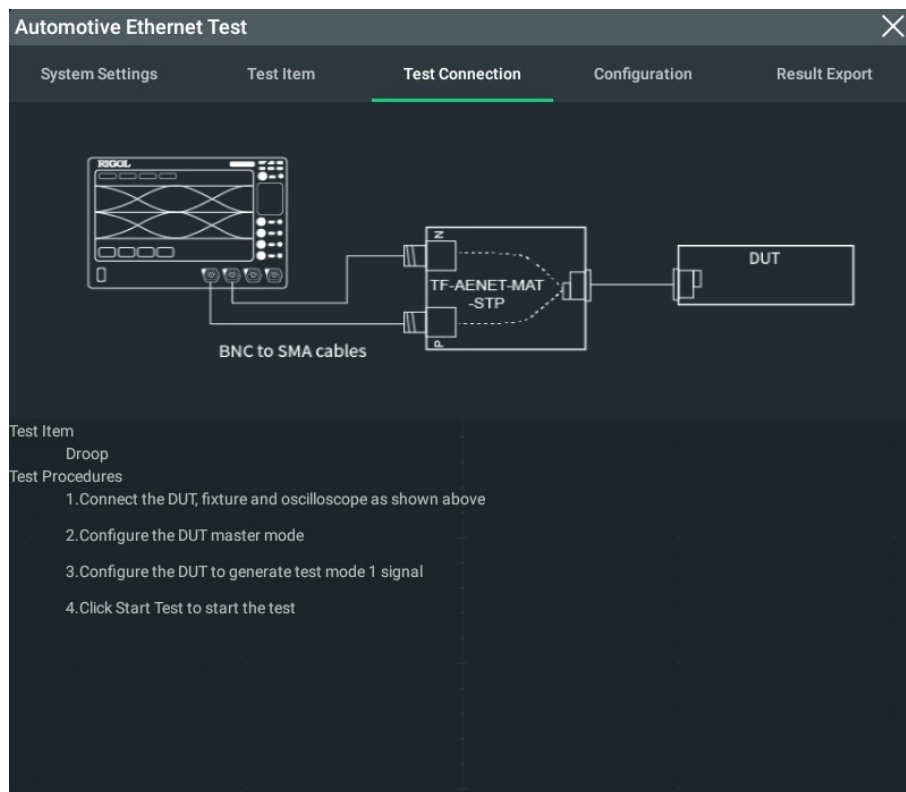
- Support online configuration and offline import.

Complete Multiple Test Items at a Time



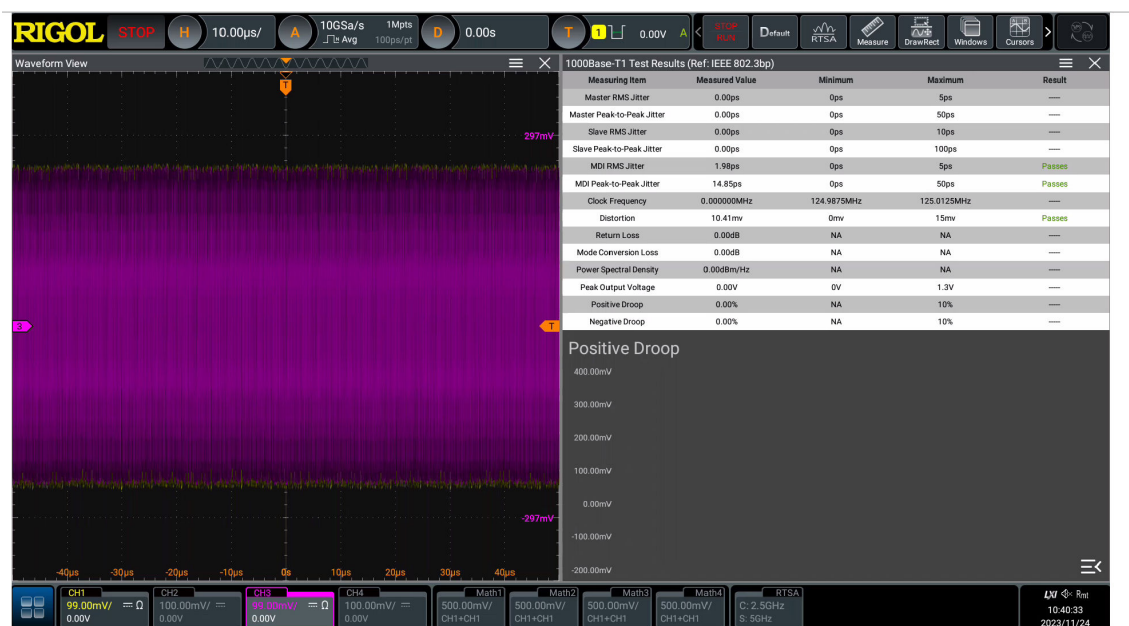
Select one test item or multiple test items.

Guide Users to Perform the Test with Given Test Procedures



Provide test device connection, device calibration, and test procedures for users to complete the test.

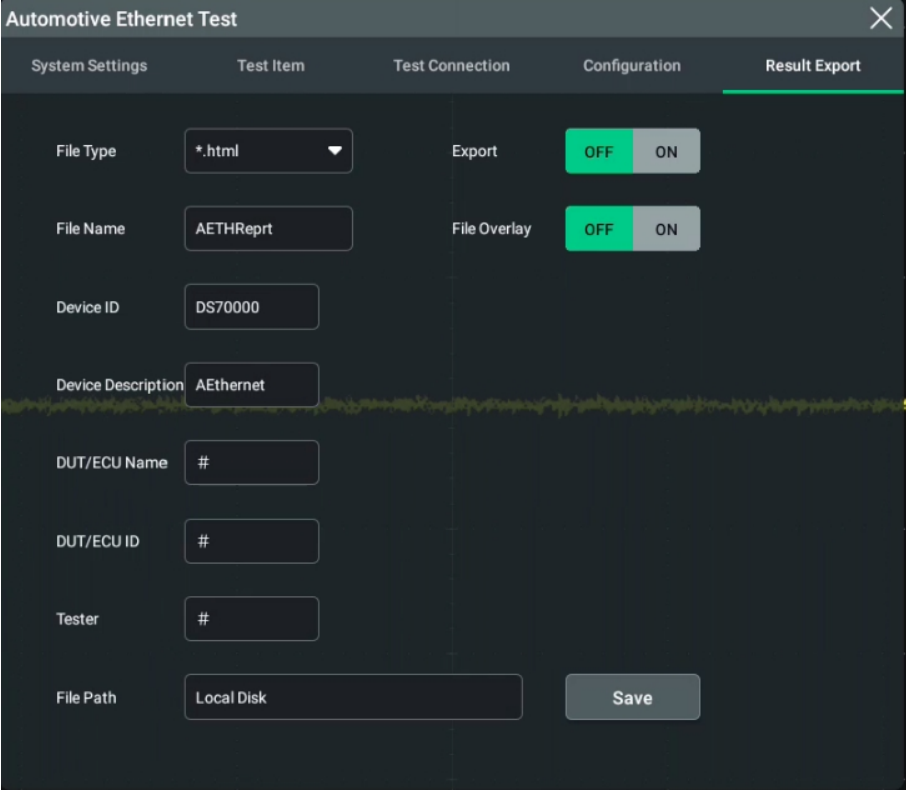
Display the Waveforms under Test and the Test Results



- Preview the waveforms under test before launching the test to ensure the waveforms are properly output.

- During the test, a message can be displayed, prompting you to configure the device or test connection for the next test item (if multiple items are selected).
- After the test is completed, the test waveforms and the test results are displayed, showing the test values and pass/fail results for the specified test items.

Generate the Test Report



The screenshot shows the 'Automotive Ethernet Test' application window with the 'Result Export' tab selected. The interface is divided into two main sections: configuration on the left and export options on the right.

System Settings	Test Item	Test Connection	Configuration	Result Export
File Type	*.html		Export	OFF (selected) ON
File Name	AETHReprt		File Overlay	OFF (selected) ON
Device ID	DS70000			
Device Description	AEthernet			
DUT/ECU Name	#			
DUT/ECU ID	#			
Tester	#			
File Path	Local Disk			Save

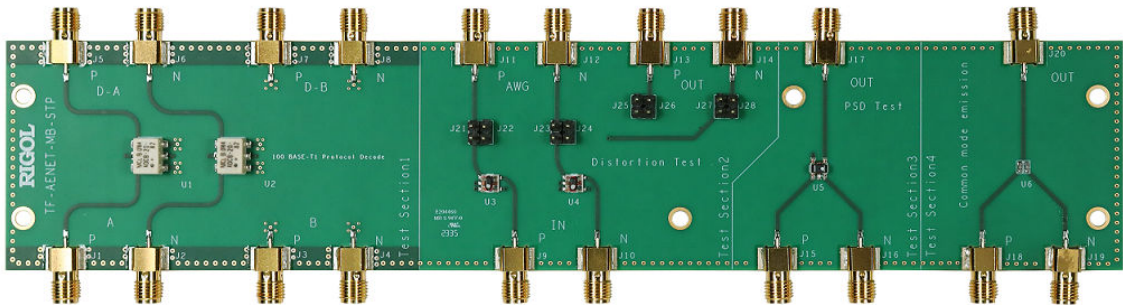
Support outputting the test report in "*.html" or "*.pdf" format and save it to the specified path.

Test Fixture

The test fixtures for the Automotive Ethernet Test are listed below. They are used for different test items.

Fixture Name	Fixture Model	Usage
Breakout Board	TF-AENET-MB-STP	Used for the distortion test, power spectral density test, peak differential output test, and common mode test
Preamplifier Board	TF-AENET-PAB-STP	Used for the transmitter distortion test
Frequency Divider Board	TF-AENET-FDB-STP	Used for the transmitter distortion test
Matrix Switching Board	TF-AENET-MSB-STP	Used for the MDI return loss test
Adaptor SMA-MATenet	TF-AENET-MAT-STP	Used for the transmitter output droop test, jitter test, clock frequency test, transmitter distortion test, peak differential output test, MDI return loss test, and MDI mode conversion loss test
Adaptor SMA-H-MTD	TF-AENET-MTD-STP	
Welding Adaptor	TF-AENET-PAD-STP	

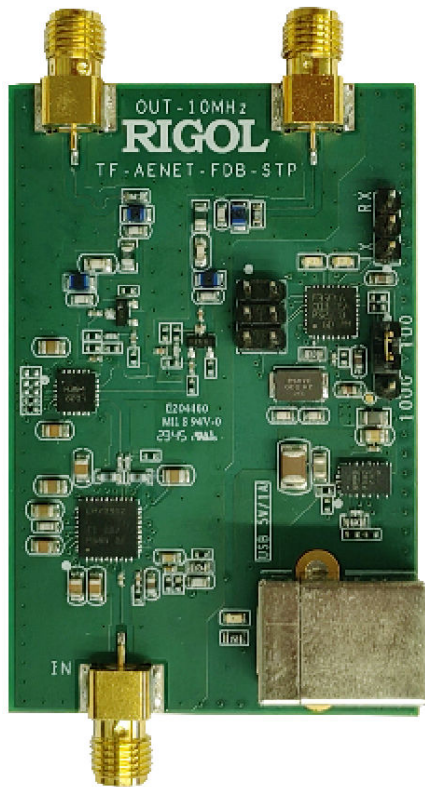
The fixture layout is shown below.



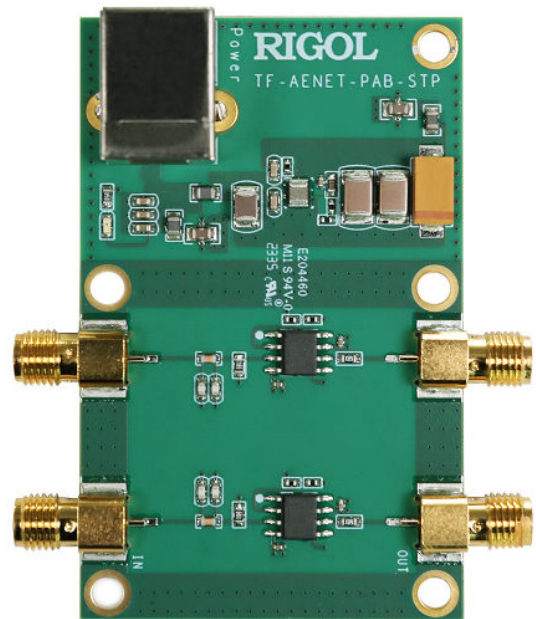
Breakout Board: TF-AENET-MB-STP



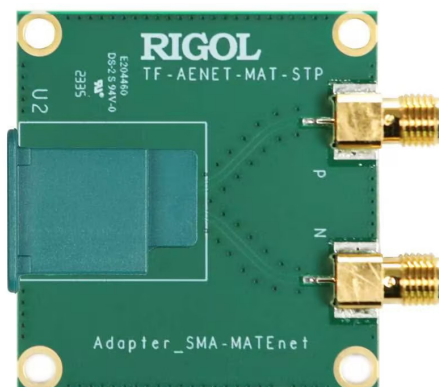
Matrix Switching: TF-AENET-MSB-STP



Frequency Divider Board: TF-AENET-FDB-STP



Preamplifier Board: TF-AENET-PAB-STP



Adaptor SMA-MATEnet TF-AENET-MAT-STP

Adaptor Board Model	MDI Interface
TF-AENET-MAT-STP	MATEnet Interface
TF-AENET-PAD-STP	Welding Adaptor
TF-AENET-MTD-STP	H-MTD Interface

Test Devices

Before performing the Automotive Ethernet compliance test, prepare the following test devices.

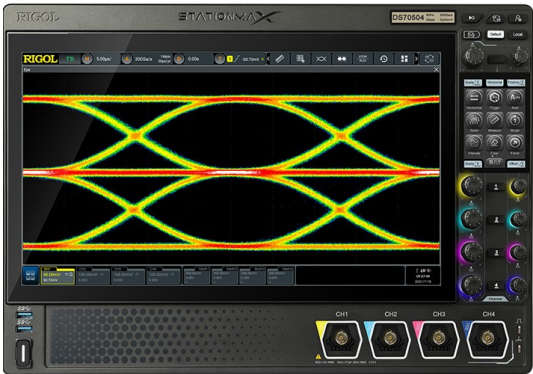
Test Devices and Descriptions

Device	Description
Digital Oscilloscope	Supports the Automotive Ethernet compliance test as an option Recommended DS70000 Series Digital Oscilloscope
Function/Arbitrary Waveform Generator	Generates the disturbing signal required for the test. Recommended Function/Arbitrary Waveform Generator model: RIGOL's DG4000 Series Function/Arbitrary Waveform Generator.
Spectrum Analyzer	Supports the VNA mode. Recommended spectrum analyzer: RIGOL's RSA3000N series spectrum analyzer
VNA Calibration Kit	CK106A and CK106E system calibration kits: Open, Short, and Load.
Low Pass Filter	TF-AENET-FB-STP, used for distortion test.

Specifications Required for the Test Devices

Device	Protocol	
	100Base-T1	1000Base-T1
Digital Oscilloscope	Min. 1 GHz Bandwidth, 2CH	Min. 2 GHz Bandwidth, 2CH
Differential Probe	Min. 1 GHz Bandwidth	Min. 2 GHz Bandwidth
Function/Arbitrary Waveform Generator	Min. 12 MHz Bandwidth, 2CH Single-ended: 5.4 Vpp; Differential: 2.7 Vpp	Min. 125 MHz Bandwidth, 2CH Single-ended: 3.6 Vpp; Differential: 1.8 Vpp
VNA	Frequency range: 1 MHz to 66 MHz 2-Port	Frequency range: 2 MHz to 600 MHz 2-Port

RIGOL Products Used for the Test



DS7000 Series Digital Oscilloscope



RSA3000N Series Spectrum Analyzer



DG4000 Series Function/Arbitrary Waveform Generator



CK106A Calibration Kit



CK106E Calibration Kit

Specifications

All the specifications are guaranteed except the parameters marked with "typ.".

Fixture Specifications

Breakout Board		
100 BASE-T1 Protocol Decode	Mainline Loss (1 MHz to 1GHz, typ.)	< 1 dB
	Coupling (1 MHz to 1 GHz, typ.)	19 dB to 21 dB
	Directivity (1 MHz to 1 GHz, typ.)	> 18.5 dB
	Interface	SMA (50Ω, Male)
Distortion Test	Mainline Loss (1 MHz to 1 GHz, typ.)	< 4 dB
	Coupling (1 MHz to 1 GHz, typ.)	17 dB to 32 dB
	Interface	SMA (50Ω, Male)
PSD Test	Mainline Loss (1 MHz to 1 GHz, typ.)	< 3.5 dB
	Coupling (1 MHz to 1 GHz, typ.)	4.5 dB to 5.5 dB
	Interface	SMA (50Ω, Male)
Frequency Divider Board		
Input	Freq	125 MHz or 66.67 MHz
	Amplitude	50 mV _{pp} to 1.4 V _{pp} (-22 dBm, 6.9 dBm)
	Interface	SMA (50Ω, Male)
Output		10 MHz Sine
	Interface	SMA (50Ω, Male)

Matrix Switching Board

Port Standing Wave (1 MHz to 800 MHz)	<1.4
Mainline Loss (1 MHz to 1GHz, typ.)	>2 dB
Interface	SMA (50Ω, Male)

Preamplifier Board

Input Gain (< 125 MHz)	>2 dB
Interface	SMA (50Ω, Male)

Environment

Environment

Temperature Range	Operating	+5°C to + 40°C
	Non-operating	-40°C to + 70°C
Altitude		Below 4,600m

Mechanical Characteristics

Mechanical Characteristics (W x H x L)

Breakout Board	50 mm x 11 mm x 240 mm (approx.)
Preamplifier Board	42 mm x 12 mm x 66 mm (approx.)
Frequency Divider Board	40 mm x 12 mm x 66 mm (approx.)
Matrix Switching Board	40 mm x 22 mm x 130 mm (approx.)

Appendix A: Order Information

Order Information	Order No.
DS70000 Option	
100M/1000M Automotive Ethernet Compliance Test	DS70000-AENETC
Kits and Fixtures	
Automotive Ethernet MATenet Interface Fixtures and Kits: breakout board, adaptor SMA-MATenet, and welding adaptor	TFB-AENET-MAT-STP
Automotive Ethernet H-MTD Interface Fixtures and Kits: breakout board, adaptor SMA-H-MTD, and welding adaptor	TFB-AENET-MTD-STP
Automotive Ethernet Breakout Board	TF-AENET-MB-STP
Automotive Ethernet Frequency Divider Board	TF-AENET-FDB-STP
Automotive Ethernet Preamplifier Board	TF-AENET-PAB-STP
Automotive Ethernet Matrix Switching Board	TF-AENET-MSB-STP
Recommended Accessories	
Automotive Ethernet Adaptor SMA-H-MTD	TF-AENET-MTD-STP
Automotive Ethernet Adaptor SMA-MATenet	TF-AENET-MAT-STP
Automotive Ethernet Welding Adaptor	TF-AENET-PAD-STP
Low Pass Filter	TF-AENET-FB-STP
RF Cable SMA(M)-SMA(M)	CB-SMAM-SMAM-100-L-18G
VNA Calibration Kit	CK106A
	CK106E

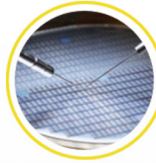
For all the fixtures and recommended accessories, please contact the local office of RIGOL.

Boost Smart World and Technology Innovation

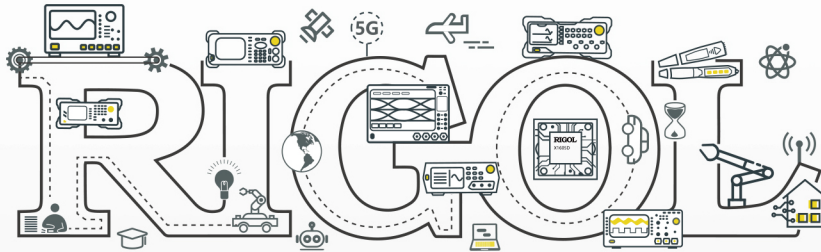
Industrial Intelligent
Manufacturing



Semiconductors



Education &
Research



Communication

System Integration



New Energy



- 5G Cellular-5G/WIFI
- UWB/RFID/ ZIGBEE
- Digital Bus/Ethernet
- Optical Communication

- Digital/Analog/RF Chip
- Memory and MCU Chip
- Third-Generation Semiconductor
- Solar Photovoltaic Cells

- New Energy Automobile
- PV/Inverter
- Power Test
- Automotive Electronics

*Provide Testing and Measuring Products
and Solutions for Industry Customers*

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