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Model 4975 SPE Noise Generator & Analyzer

**Single Pair Ethernet Testing Solution
Includes Printable Reports**



The Telebyte 4975 SPE Noise Generator & Analyzer is a multi-function test instrument designed specifically for testing Single Pair Ethernet (SPE) as defined in the Ethernet-APL Data Test Specification v1.0 and the IEEE 802.3cg-2019 standard. This specialized instrument can be used to test a wide range of applications and features such as noise generation (including background and impulsive noise), noise capture to replicate field environments in the lab, Power Spectral Density (PSD) and power level measurements, Transmitter clock frequency, distortion and jitter measurements, Voltage Droop, PoDL / SPoE measurements and more.

This physical layer compliance test solution ensures interoperability between different designs and applications from hardware vendors. It can be configured with arbitrary waveform generator (AWG) cards, noise generation software, an A/D capture card, digital analysis software to emulate a storage oscilloscope and FFT Spectrum Analyzer, high-impedance differential mode probes and more. Save signal captures and run the test report to automatically analyze pass/fail criteria for IEEE 802.3cg and Ethernet-APL Test Data Specification v1.0 and document with a data report.

When the Model 4975 SPE Noise Generator & Analyzer is used with the Telebyte Model 4950 SPE Cable Emulator (see separate datasheet), the test suite can be used for multi-vendor interoperability, performance testing on different twisted pair cable lengths and noise environments and compliance testing using the Ethernet-APL Worst Case Communication Channels for Trunk or Spur ports.

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Highlights

- Expandable, Modular Design
 - Portable Industrial Computer holds up to 3 PCIe cards (combination of AWG cards and/or capture card)
 - Purchase only those components needed for specific requirement
- Noise Generation
 - Arbitrary Wave Form Generator (AWG) sample rate - 625 MS/s, 16-bit from 1kHz to 300MHz
 - Generate AWGN, alien crosstalk, impulse noise, RFI, Ripple Voltage with a Crest Factor > 5
 - Wide dynamic range of AWGN from -70 dBm/Hz to -155 dBm/Hz in 0.1 dB increments*
 - Import real world noise from capture card
 - Receive Packet Error Rate Stress Test noise with Alien Crosstalk and Ripple Voltage Noise
 - Generates sinusoidal 1Vpp 1MHz signal for transmitter distortion test
- Digital Analyzer
 - A/D Capture Card sample rate - 500 MS/s, 14-bit from 20kHz to 250MHz
 - Capture, analyze and monitor live noise/interference on a single twisted pair cable
 - Analyze in time and frequency domain
 - Performs PSD mask verification and Tx Power level
 - Perform Transmitter distortion, timing, jitter and droop measurements
 - Testing on both sides of network simultaneously
 - Generate 10Base-T1L 802.3cg and Ethernet-APL Compliance test report in PDF format
- Applications
 - IEEE 802.3cg-2019 and Ethernet-APL Data Test Specification v1.0 Compliance testing
 - IEEE 802.3cg Section 146.5.5.3 Alien Crosstalk Noise Rejection
 - Cable Tray "6 around 1" Alien Crosstalk
 - Performance Testing
 - Interoperability Testing
- Integrate with Telebyte's 4950 SPE Cable Emulator
 - Test APL.146.2.1 – Receive Packet Error Rate Stress Test
 - Alien Crosstalk
 - Ripple Voltage if port is a power source or powered load

**when used with integrated differential mode noise injector in the model 4950*

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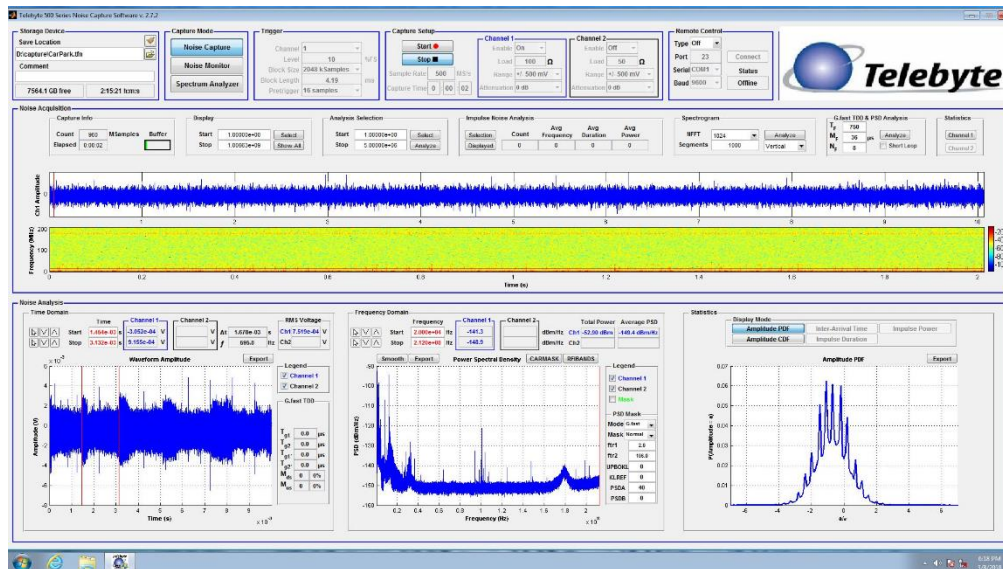
Noise Generation

User-friendly configuration software allows the user to select and build impairment models common to an Industrial Ethernet implementation. The 4975 can generate a wide variety of interferences including background Gaussian noise which may be used for IEEE 802.3cg 146.5.5.3 Alien Crosstalk Noise Rejection, high frequency impulse noise from the AC electrical loads (REIN) and other types of impulsive noise, FM radio, Broadcast TV, Spark Plug Ignition noise, Power over Data Line (PoDL / SPoE) noise, Power Line Communication (PLC) noise, Ripple Voltage and more. In addition, user-defined files in several formats (such as MATLAB, CSV and Excel) may be imported.

Noise Capture

It is vital to test link performance in noisy conditions such as those found in factory environments with harsh EMC radiated noise. The effects of real-world noise environments on the twisted pair (including impulse noise, RFI, inductive noise, and background noise floor) can be captured, recorded and played back using the noise generation function of the 4975 to replicate different noise environments during lab testing.

Sample Noise Capture



Cable Emulation

IEEE 802.3cg and the Ethernet-APL Port Profile and Data Test Specifications define the cable models for testing 10Base-T1L for both Trunk and Spur cable segments. Telebyte's model 4950 (see separate datasheet) is a cable emulator that is fully compliant with the cable models in IEEE 802.3cg and Ethernet-APL standards. It includes integrated differential model noise injectors at the input and output of the cable. Testing with the 4950 cable emulator and the noise generator function of the 4975 provides a powerful tool for gaining insight into the performance of 10Base-T1L network equipment.



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IEEE 802.3cg Compliance Testing with the Model 4975

Power Spectral Density (PSD) and Power Level Measurement

Power Spectral Density is a frequency domain measurement that typically requires a spectrum analyzer. The 4975 uses a 14-bit analog-to-digital converter (ADC) that samples at 500 MS/s in the time domain and writes this data to the disk. An FFT algorithm is then employed to provide the frequency spectrum view of the saved data. The computed PSD is then compared with the specification by using lower and upper masks to arrive at the result for both the 2.4V and 1.0V peak to peak modes. The DUT is set in Test Mode 3 for the PSD measurement and the Transmit power level. The transmit power level is also verified to be between -0.2dBm and 2.2dBm for the 1.0 Vpp operating mode and between 7.4dBm and 9.8dBm for the 2.4 Vpp mode. This requirement is defined in IEEE 802.3cg section 146.5.4.4 Transmitter Power Spectral Density (PSD).

Transmitter Clock Frequency and Jitter Measurements

Transmitter output voltage, clock frequency, and timing jitter are measured with the DUT in Test Mode 1. The symbol-to-symbol jitter must be less than +/- 10 ns and the transmit signal clock and receiver frequency tolerance at 7.5 MBd must have a short term variation of less than 0.10 ppm/second. The Transmit Voltage level must follow the operating mode of 1.0 Vpp or 2.4 Vpp. This requirement is defined in IEEE 802.3cg sections 146.5.4.3 Transmitter Timing Jitter, and 146.5.4.5 Transmit Clock Frequency.

Droop Measurement

The Transmitter Output Voltage droop measurements are performed with the DUT in Test Mode 2 using the correct load termination of 100 ohms +/- 0.1%. The maximum allowed droop is 10% for both the positive and negative voltage peaks with voltages measured at 133.3ns and 800ns, respectively from the zero crossing. This requirement is defined in IEEE 802.3cg sections 146.5.4.1 Transmitter Output Voltage and 146.5.4.2 Transmitter Output Droop.

10Base-T1L 802.3cg Compliance Test Report

The test measurements are captured by the 4975, stored to the system data storage drive and post processed. The measurements are analyzed and compiled in a pass/fail report outputted in a pdf file with numerical data and graphs. The report includes the following sections from the IEEE 802.3cg test specification: 146.5.4.1 Transmitter Output Voltage, 146.5.4.2 Transmitter Output Droop, 146.5.4.3 Transmitter Timing Jitter, 146.5.4.4 Transmitter Power Spectral Density (PSD) and 146.5.4.5 Transmit Clock Frequency.



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Ethernet-APL Compliance Testing with the Model 4975

Power Spectral Density (PSD) and Power Level Measurement

Power Spectral Density is a frequency domain measurement that typically requires a spectrum analyzer. The 4975 uses a 14-bit analog-to-digital converter (ADC) that samples at 500 MS/s in the time domain and writes this data to the disk. An FFT algorithm is then employed to provide the frequency spectrum view of the saved data. The computed PSD is then compared with the specification by using lower and upper masks to arrive at the result for both the 2.4V and 1.0V peak to peak modes. The DUT is set in Test Mode 3 for the PSD measurement and the Transmit power level. The transmit power level is also verified to be between -0.2dBm and 2.2dBm for the 1.0 Vpp operating mode and between 7.4dBm and 9.8dBm for the 2.4 Vpp mode. This requirement is defined in Ethernet-APL Test Data Specification v1.0 section Test.APL.146.1.4 Transmitter Power Spectral Density (PSD) and Power Level.

Transmitter Clock Frequency, Distortion and Jitter Measurements

Transmitter output voltage, clock frequency, and timing jitter are measured with the DUT in Test Mode 1. The symbol-to-symbol jitter must be less than +/- 10 ns and the transmit signal clock and receiver frequency tolerance at 7.5 MBd must have a short-term variation of less than 0.10 ppm/second. The Transmit Voltage level must follow the operating mode of 1.0Vpp or 2.4Vpp. Power Sources and Powered Devices are expected to include circuitry to limit voltages especially intrinsically safe spur devices. To support PoDL/SPOE these components may cause distortion in the transmitter signal which must be tested to insure it is less than 50mV in amplitude. This requirement is defined in Ethernet-APL Test Data Specification v1.0 sections Test.APL.146.1.3 Transmitter Timing Jitter, Test.APL.146.1.5 Transmit Clock Frequency, and Test.APL.146.1.7 APL Transmitter Distortion.

Droop Measurement

The Transmitter Output Voltage droop measurements are performed with the DUT in Test Mode 2 using the correct load termination of 100 ohms +/- 0.1%. The maximum allowed droop is 10% for both the positive and negative voltage peaks with voltages measured at 133.3ns and 800ns, respectively from the zero crossing. The Ethernet-APL Test Data Specification allows for a greater droop equal to 15% when a power coupling network is involved. This requirement is defined in Ethernet-APL Test Data Specification v1.0 sections Test.APL.146.1.1 Transmitter Output Voltage, and Test.APL.146.1.2 Transmitter Output Droop.

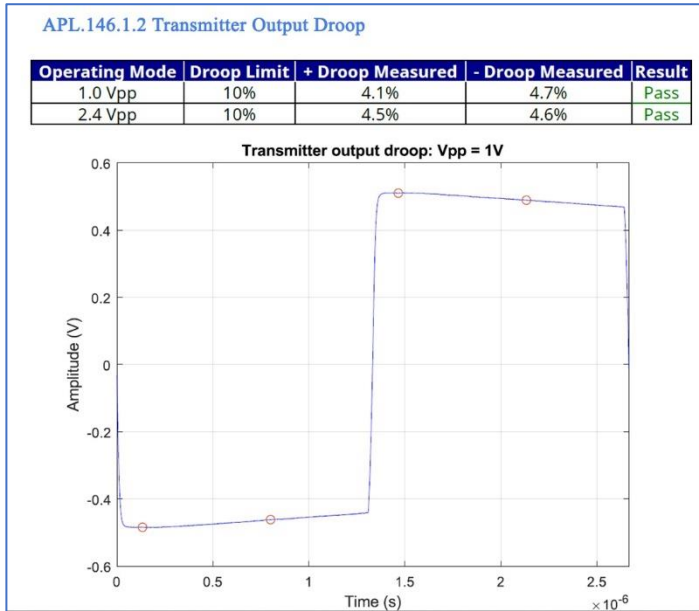
Ethernet-APL Compliance Test Report

The test measurements are captured by the 4975, stored to the system data storage drive and post processed. The measurements are analyzed and compiled in a pass/fail report outputted in a pdf file with numerical data and graphs. The report includes the following sections from the Ethernet-APL Test Data Specification v1.0: Test.APL.146.1.1 Transmitter Output Voltage, Test.APL.146.1.2 Transmitter Output Droop, Test.APL.146.1.3 Transmitter Timing Jitter, Test.APL.146.1.4 Transmitter Power Spectral Density (PSD) and Power Level, Test.APL.146.1.5 Transmit Clock Frequency and Test.APL.146.1.7 APL Transmitter Distortion.



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Report Examples



APL 146.1.2 Transmitter Output Droop



802.3cg 146.5.4.4 Transmitter Power Spectral Density (PSD)

Standards Based Testing and Customer Care

Software and Support Maintenance Contract

Telebyte values our customers and understands time is valuable. We believe your success is our success. We help you get started testing quickly by providing guidance on the setup and use of our software to produce valid test results.

Telebyte tracks the standards and updates the 4975 software* based on update releases and customer requests on a quarterly basis.

Included in the first year of ownership: We are pleased to include the 1-Year Software & Support Maintenance Contract with the purchase of Telebyte hardware and software*.

Available for purchase after the first year: Beginning on the first one-year anniversary of the date of purchase, the Annual Software & Support Maintenance Contract provides any software updates for the product* that are released during the term of the contract** as well as unlimited support via webinar, email or phone for the term of the contract.

*Model 4900-NS1 software and/or Model 4975-500 software

** One, two and three-year contracts available



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Specifications

4975-00: Portable Industrial Computer Specification	
Remote Commands	Telnet connection Command Line Interface (CLI)
Power supply	AC 90 V to 264 V, 47 to 63 Hz
Operating Temperature Range	0 to 50 ° C
Operating Relative Humidity	5% - 95% non-condensing
Mechanical Dimensions	DxWxH: 9.5" D x 13.5" W x 17.5" H
Weight	32 lbs.
Connectors	10 USB 3.0 Ports, 4 USB 2.0 Ports (2 front), 2 RJ-45 Gigabit LAN
Display	Integrated 17.3-in WUXGA+ (1920 x 1080) display

4975-A01: 2-Port AWG Card Specification	
Bandwidth	1 kHz to 300 MHz
Max Sample Rate	625 MS/s
Noise Outputs	2
Vertical Resolution	16 bits
Sample Memory	4 GB
Output Impedance	50Ω unbalanced
Noise Floor	-149 dBm/Hz

4975-A02: 4-Port AWG Card Specification	
Bandwidth	1 kHz to 300 MHz
Max Sample Rate	625 MS/s
Noise Outputs	4
Vertical Resolution	16 bits
Sample Memory	4 GB
Output Impedance	50Ω unbalanced
Noise Floor	-149 dBm/Hz

4975-N01: Single-Channel Differential Mode Noise Injector	
Bandwidth	20 kHz to 30 MHz
Output Impedance	4kΩ Minimum (20 kHz to 30 MHz)
Input Impedance	50Ω unbalanced (100Ω unbalanced)
Output Mode	Differential, balanced
Noise Floor	Below -145 dBm/Hz as measured at the output of the noise injector
Insertion Loss	13.0/35 dB ± 0.5 dB
Connectors	SMA Female Connector for 4975 Noise Generator, RJ45 (2) Female Connectors for Loop Simulator (external cable provided) and for the Ethernet link w/ adapter cable.
Max. Voltage	60VDC
Max. Current	1.579A
Operating Temperature Range	0 to 50 ° C
Operating Relative Humidity	Maximum 80% for up to 31° C, decreasing linearly to 50% at 40°C
Mechanical Dimensions	2.6" W x 1.4" H x 4.7" D
Power supply	AC 90 V to 264 V, 47 to 63 Hz, 10 W (supports 1-4 Noise Injectors)



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Specifications continued

4975-CA1: 2-Port A/D Capture Card	
Max Sample Rate	500 MS/s
Vertical Resolution	14 bits
Sample Memory	4 GB
Noise Floor	-150 dBm/Hz
Bandwidth	250 MHz
Capture Channels	2
Input Impedance	50Ω unbalanced

4975-P01: Single-Channel Differential Mode Probe	
Max. Signal Level (In Band)	+/- 5 Vpp 0 dB attenuation, +/- 50 Vpp 20 dB attenuation
Max. Voltage	60VDC
Max. Current	1.579A
Input Impedance	> 4K-ohms Balanced
Attenuation	0 dB or 20 dB switchable with overload indicator
Output Noise Floor	Below -145 dBm/Hz over Band
Bandwidth	20 kHz to 250 MHz
Connectors	Input: 2, RJ-45's for inserting into line Output: 50 ohms SMB connector
Power	+12V provided from external modular supply

Specifications subject to change without notice.

Ordering Options

A. Base Unit – Must select

Model Number	Description
4975-001	Base System – Portable Industrial Computer <ul style="list-style-type: none"> Built-in keyboard and monitor 16 GB DDR4 RAM OS: 1 TB SSD Windows 10 Professional 64-bit

B. Software – Select at least one

Model Number	Description
4900-NS1	Universal Noise Generator Software License (requires at least one AWG card from D.) Includes one year of Software & Support Maintenance with purchase.
4975-500	500 Series Digital Analyzer Software License (Requires A/D Capture Card from E, and Data Storage from F, and Probe from G. Includes one year of Software & Support Maintenance with purchase.

C. Optional Noise Libraries

Model Number	Description
4975-L01	Industrial Noise Library (requires 4900-NS1 in B.)

D. Optional Arbitrary Waveform Generator (AWG) card

Model Number	Description
4975-A01	2-Port AWG Card - 600 MS/s, supports 1 kHz to 300MHZ
4975-A02	4-Port AWG Card - 600 MS/s, supports 1 kHz to 300MHZ



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Ordering Options continued

E. Optional A/D Capture Card

Model Number	Description
4975-CA1	2-Port A/D Capture Card - 500 MS/s, supports up to 250MHz

F. Optional Data Storage (Base unit has 2 available M.2 slots)

Model Number	Description
4975-D01	500 GB M.2 SATA Internal Solid-State Drive
4975-D02	1 TB M.2 SATA Internal Solid-State Drive
4975-D03	2 TB M.2 SATA Internal Solid-State Drive

G. Optional Probe

Model Number	Description
4975-P01	Single-Channel Differential Mode Probe 250 MHz

H. Optional Injector

Model Number	Description
4975-N01	Single-Channel Differential Mode Noise Injector (1 kHz to 30 MHz)

I. Optional Warranty & Calibration Contracts

Model Number	Description
4975-E01	Three-year extended warranty for Model 4975-001
4975-E02	Three-year extended warranty for Model 4975-002
4975-E03	Three-year extended warranty for Model 4975-A01
4975-E04	Three-year extended warranty for Model 4975-A02
4975-E05	Three-year extended warranty for Model 4975-C01
4975-C01	Three-year calibration contract for Model 4975-001
4975-C02	Three-year calibration contract for Model 4975-002
4975-C03	Three-year calibration contract for Model 4975-A01
4975-C04	Three-year calibration contract for Model 4975-A02
4975-C05	Three-year calibration contract for Model 4975-C01

I. Optional Software & Support Maintenance Contracts

Model Number	Description
4975-M01	Annual Software & Support Maintenance Contract for 4900-NS1
4975-M02	2-Year Software & Support Maintenance Contract for 4900-NS1
4975-M03	3-Year Software & Support Maintenance Contract for 4900-NS1
4975-M04	Annual Software & Support Maintenance Contract for 4975-500
4975-M05	2-Year Software & Support Maintenance Contract for 4975-500
4975-M06	3-Year Software & Support Maintenance Contract for 4975-500

J. Optional Cable Emulator (see separate datasheet)

Model Number	Description
4950-001 Or 4950-002	10BASE-T1L Cable Emulator (up to 20 MHz) with Integrated Differential Mode Noise Injector and SCCP Protocol Analyzer