

# N4372E Lightwave Component Analyzer

## Opto-electronic S-parameter measurements up to 110 GHz

### Industry-First 110 GHz Turn-Key Test System for Optical RX and TX

Based on the N5290A and N5291A 900 Hz to 110/120 GHz PNA Millimeter-Wave Systems, the new N4372E Lightwave Component Analyzer offers unprecedented bandwidth for both, optical receiver testing and optical transmitter testing.

### Traceable S<sub>21</sub> Measurement Across the Entire CWDM Wavelength Window

TX/RX manufacturers are approaching higher baud rates in RZ/NRZ and PAM formats, which pushes the envelope on high-bandwidth S-parameter testing. Up to now, the industry had only access to testing optical transmitters to 110 GHz bandwidth. The new N4372E not only addresses opto-electronic tests up to 110 GHz in an extended wavelength range down to 1260 nm but offers also RX test up to 110 GHz in the full 1260 nm to 1620 nm range, thanks to a transmitter that is calibrated traceable to NIST.

### Setup for measurement of a photonic device

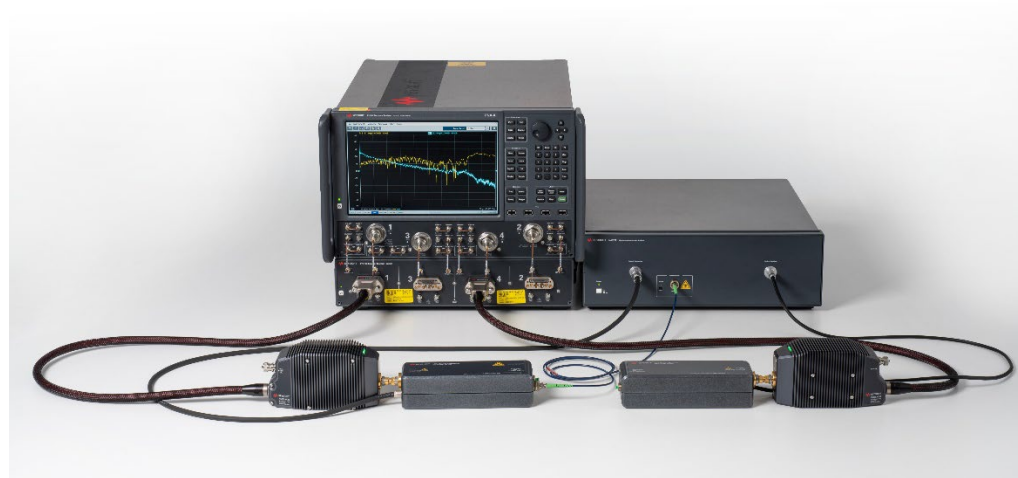


Figure 1: N4372E system setup



The N4372E extends Keysight's LCA family for high frequency parametric testing of optical TX and RX up to 110 GHz. It is the only electro-optic vector network analyzer system realizing both E-to-O and O-to-E S-parameter measurements up to 110GHz.

## Target Test Devices

Transmitters and receivers are typically tested for their frequency response and electrical return loss over a range of bias voltages, optical input power levels, operating currents and ambient temperatures. The LCA's built-in optical power meter allows to check and control the user-selectable operating power, but also gives an indication of a bent fiber or a bad connection. The LCA optical transmitter's input port is normally connected to the built-in laser source of the LCA controller. With an auxiliary tunable laser, the verification of S-parameters over wavelength is enabled. With the LCA's fast update of the electro-optic transfer function measurement, operating parameters can be quickly adjusted to determine the optimum operating point of such devices.

### Transmitters (E/O)

Mach-Zehnder modulators (MZM), electro-absorption modulators (EAM), directly modulated lasers and transmitter optical subassemblies (TOSA) represent the most common optical transmitters. Dual-drive optical modulators can be characterized with 4-port PNA versions of the LCA, using three RF extender heads.

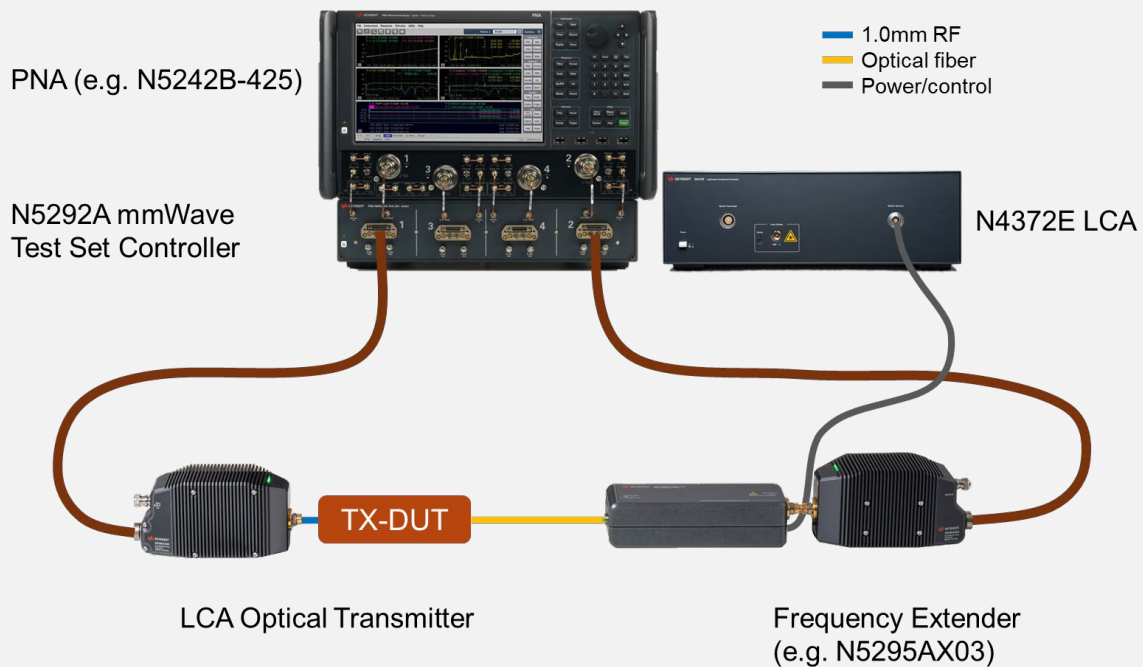


Figure 2: Optical transmitter test configuration

### Receivers (O/E)

PIN photodiodes, avalanche photodiodes (APD), receiver optical subassemblies (ROSA) and integrated PIN-TIA receivers are examples of optical receivers. 4-port PNA versions of the LCA can characterize PIN-TIA combinations with differential output for differential gain, common-mode rejection and gain imbalance, using three RF extender heads.

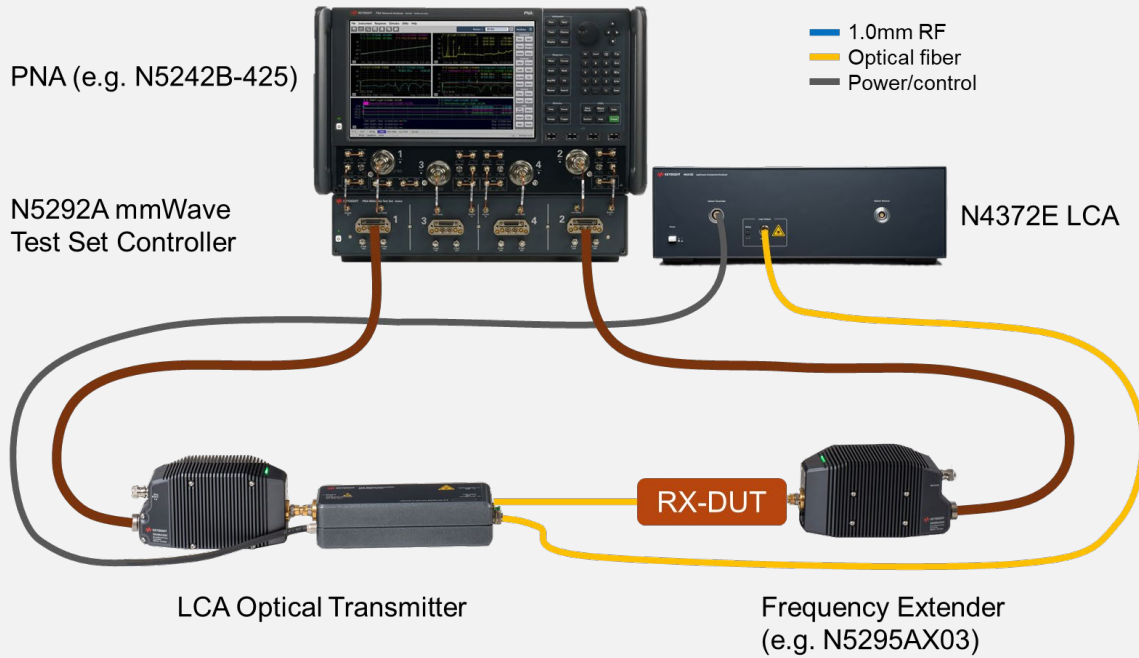


Figure 3: Photodiode test configuration

### Optical Devices (O/O)

Transmission systems are typically tested for bandwidth and group delay. Passive optical components can be tested for insertion loss, bandwidth limitations caused by dispersion effects, and for optical group delay.

### Electronic Devices (E/E)

Measurements of amplifiers, filters and transmission lines focus on transmission bandwidth, insertion loss or gain, impedance match and group delay.

## Measurement Capabilities

Responsivity (S21, amplitude and phase)	Reflectivity (S11, S22, amplitude and phase)
<ul style="list-style-type: none"> <li>Absolute frequency response, the conversion efficiency of a transmitter, or the responsivity and gain of a receiver</li> <li>Relative frequency response, the filter shape of the electro-optical conversion or of the gain of an amplifier</li> <li>3-dB bandwidth of the electro-optical or electrical transfer function</li> <li>Group Delay vs. frequency of the transfer function</li> <li>Optical Insertion Loss (IL)</li> </ul>	<ul style="list-style-type: none"> <li>Electrical reflectivity at the RF port</li> <li>Impedance match</li> </ul>
	<b>Balanced measurements (requires min. 3 extender heads)</b>
	<ul style="list-style-type: none"> <li>Differential gain, gain imbalance</li> <li>Differential frequency response</li> <li>Common-mode rejection</li> <li>Common-mode transfer function</li> </ul>

## Receiver Test Specifications (N4372E-310, N4372E-311)

System Specifications	≤ 26.5 GHz	≤ 50 GHz	≤ 65 GHz	≤ 100 GHz (#010) ≤ 110 GHz (#011)
Calibrated frequency range	10 MHz to 100 GHz (option 010) 10 MHz to 110 GHz (option 011)			
Wavelength	1310 nm ± 20 nm (options 100, 102) 1550 nm ± 20 nm (options 101, 102)			
Operating wavelength range	1260 nm to 1620 nm <sup>1</sup>			
Relative frequency response uncertainty <sup>2</sup>	≤ ± 0.9 dB ≤ ± 0.7 dB, typ.	≤ ± 1.2 dB ≤ ± 0.8 dB, typ.	≤ ± 1.9 dB ≤ ± 1.3 dB, typ.	≤ ± 2.3dB, typ.
Phase uncertainty <sup>2</sup> (typical)	≤ ± 2.4°	≤ ± 3.2°	≤ ± 5.0°	≤ ± 9.0°
Min. measurable freq. response (noise floor) <sup>2</sup>	-60 dB(A/W)	-60 dB(A/W)	-55 dB(A/W)	-50 dB(A/W), typical
Absolute average power measurement uncertainty	≤ ± 0.5 dB			

1 External laser source required

2 Specification applies at 1550 nm wavelength.

## Transmitter Test Specifications (N4372E-301, N4372E-311)

Specifications apply at 1550 nm.

System Specifications	≤ 26.5 GHz	≤ 50 GHz	≤ 65 GHz	≤ 100 GHz (#010) ≤ 110 GHz (#011)
Calibrated frequency range	10 MHz to 100 GHz (option 010) 10 MHz to 110 GHz (option 011)			
Operating wavelength range	1260 nm to 1620 nm			
Relative frequency response uncertainty <sup>1</sup>	≤ ± 0.8 dB ≤ ± 0.6 dB, typ.	≤ ± 1.0 dB ≤ ± 0.7 dB, typ.	≤ ± 1.6 dB ≤ ± 1.1 dB, typ.	≤ ± 2.3 dB ≤ ± 1.8dB, typ.
Phase uncertainty <sup>1</sup> (typical)	≤ ± 2.3°	≤ ± 3.2°	≤ ± 4.5°	≤ ± 8.0°
Min. measurable freq. response (noise floor) <sup>1</sup>	-64 dB(W/A)	-64 dB(W/A)	-59 dB(W/A)	-59 dB(W/A)
Maximum optical power	+14 dBm			

<sup>1</sup> Specification applies at 1550 nm wavelength.

## General Specifications

### LCA Controller

LCA Controller	Laser Output
Wavelengths	1310 nm ± 20 nm (options 100, 102) 1550 nm ± 20 nm (options 101, 102)
Output power	+14 dBm
Fiber type	Panda polarization maintaining fiber (PMF). Electrical field is oriented in slow axis, in line with the connector key.
Laser Safety Information	<p>All laser sources listed above are classified as Class 1M according to IEC 60825-1 (2017).</p> <p>All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2007-06-24.</p> <div style="border: 2px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p><b>INVISIBLE LASER RADIATION DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS CLASS 1M LASER PRODUCT (IEC 60825-1)</b></p> </div>

## LCA Optical Transmitter

LCA Optical Transmitter	Laser Input
Wavelength range	1260 nm to 1620 nm
Maximum optical input power	+17 dBm
Insertion loss, characteristic	8 dB
Fiber type	Panda polarization maintaining fiber (PMF). Electrical field is oriented in slow axis, in line with the connector key.
Optical Output	
Maximum optical output power	+6 dBm (internal laser)
Fiber type	Panda polarization maintaining fiber (PMF). Electrical field is oriented in slow axis, in line with the connector key
Electrical Input	
RF connector	1 mm, male, rugged
Maximum RF input power	+21 dBm

## LCA Optical Receiver

LCA Optical Receiver	Optical Input
Wavelength range	1260 nm to 1620 nm
Power measurement range	-25 dBm to +6 dBm
Maximum optical input power	+14 dBm
Fiber type	Single mode
Electrical Output	
RF connector	1 mm, male, rugged

## Environmental Conditions

Environmental Conditions	LCA Controller, LCA Optical Transmitter, LCA Optical Receiver
Storage temperature	-40 °C to +70°C
Operating temperature	+10°C to +40°C
Relative humidity	15% to 80%, non-condensing
Maximum operating altitude	2000 m (6600 ft)

## Ordering Information

Option	Test Set Configurations; must choose one
N4372E-301	LCA with Receiver-only Test Set (Transmitter/ EO-Measurements)
N4372E-310	LCA with Transmitter-only Test Set (Receiver/ OE-Measurements)
N4372E-311	LCA with Transmitter and Receiver Test Set (OE-, EO-, OO-Measurements)

Option	Receiver Test Options, available with N4372E-310, -311; must choose one
N4372E-010	Transmitter Operating Frequency Range 100 GHz
N4372E-011	Transmitter Operating Frequency Range 110 GHz

Option	Receiver Test Options, available with N4372E-310, -311; must choose one
N4372E-100	Test Set with 1310 nm Source
N4372E-101	Test Set with 1550 nm Source
N4372E-102	Test Set with 1310 nm and 1550 nm Source

Option	Connector Options; must choose one
N4372E-021	Straight FC/PC
N4372E-022	Angled FC/APC



Option	2-Port PNA/ PNA-X Configurations
N4372E-221	PNA, 2 Port, 26.5 GHz (N5222B-201, -020) with Config. Test Set, IF Inputs
N4372E-222	PNA, 2 Port, 26.5 GHz (N5222B-205, -020) with Config. Test Set, IF Inputs, LFE
N4372E-223	PNA, 2 Port, 26.5 GHz (N5222B-219, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-224	PNA-X, 2 Port, 26.5 GHz (N5242B-201, -020) with Config. Test Set, IF Inputs
N4372E-225	PNA-X, 2 Port, 26.5 GHz (N5242B-205, -020) with Config. Test Set, IF Inputs, LFE
N4372E-226	PNA-X, 2 Port, 26.5 GHz (N5242B-219, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-229	Integration of customer's 26.5 GHz, 2 Port PNA(-X) B with at least option -020, -201
N4372E-271	PNA, 2 Port, 67 GHz (N5227B-201, -020) with Config. Test Set, IF Inputs
N4372E-272	PNA, 2 Port, 67 GHz (N5227B-205, -020) with Config. Test Set, IF Inputs, LFE
N4372E-273	PNA, 2 Port, 67 GHz (N5227B-219, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-274	PNA-X, 2 Port, 67 GHz (N5247B-201, -020) with Config. Test Set, IF Inputs
N4372E-275	PNA-X, 2 Port, 67 GHz (N5247B-219, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-279	Integration of customer's 67 GHz, 2 Port PNA(-X) B with at least option -020, -201
N4372E-299	Integration of customer's 110/120 GHz, 2 Port PNA(-X) B System
Option	Millimeter-Wave Test Set Controller for 2-Port PNA/ PNA-X (required)
N4372E-TC2	Test Set Controller, 2-Port (N5292A-200)
Option	Interconnect Kits for 2-Port PNA/ PNA-X
N4372E-IK1	Interconnect Kit for 2 Port PNA(-X) with 3.5 mm Ports (N5292A-222)
N4372E-IK2	Interconnect Kit for 2 Port PNA(-X) with 2.4 mm or 1.85 mm Ports (N5292A-224)

Option	4-Port PNA/ PNA-X Configurations
N4372E-421	PNA, 4 Port, 26.5 GHz (N5222B-401, -020) with Config. Test Set, IF Inputs
N4372E-422	PNA, 4 Port, 26.5 GHz (N5222B-405, -020) with Config. Test Set, IF Inputs, LFE
N4372E-423	PNA, 4 Port, 26.5 GHz (N5222B-419, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-424	PNA-X, 4 Port, 26.5 GHz (N5242B-401, -020) with Config. Test Set, IF Inputs
N4372E-425	PNA-X, 4 Port, 26.5 GHz (N5242B-419, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-426	PNA-X, 4 Port, 26.5 GHz (N5242B-425, -020) with Config. Test Set, IF Inputs, LFE, Attenuators
N4372E-429	Integration of customer's 26.5 GHz, 4 Port PNA(-X) B with at least option -020, -401
N4372E-471	PNA, 4 Port, 67 GHz (N5227B-401, -020) with Config. Test Set, IF Inputs
N4372E-472	PNA, 4 Port, 67 GHz (N5227B-405, -020) with Config. Test Set, IF Inputs, LFE
N4372E-473	PNA, 4 Port, 67 GHz (N5227B-419, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-474	PNA-X, 4 Port, 67 GHz (N5247B-401, -020) with Config. Test Set, IF Inputs
N4372E-475	PNA-X, 4 Port, 67 GHz (N5247B-419, -020) with Config. Test Set, IF Inputs, Bias-Tee, Attenuators
N4372E-476	PNA-X, 4 Port, 67 GHz (N5247B-425, -020) with Config. Test Set, IF Inputs, LFE, Attenuators
N4372E-479	Integration of customer's 67 GHz, 4 Port PNA(-X) B with at least option -020, -401
N4372E-499	Integration of customer's 110/120 GHz, 4 Port PNA(-X) B System
Option	Millimeter-Wave Test Set Controller for 4-Port PNA/ PNA-X (required)
N4372E-TC4	Test Set Controller, 4-Port (N5292A-400)
Option	Interconnect Kits for 4-Port PNA/ PNA-X
N4372E-IK3	Interconnect Kit for 4 Port PNA(-X) with 3.5 mm Ports (N5292A-442)
N4372E-IK4	Interconnect Kit for 4 Port PNA(-X) with 2.4 mm or 1.85 mm Ports (N5292A-444)

Option	Frequency Extender Heads (2 required for single-ended devices, min. 3 for balanced devices)
N4372E-FE1	Frequency extender 110 GHz, 1.2m cable (N5293AX01)
N4372E-FE2	Frequency extender 110 GHz, 1.2 m cable, LFE, bias-tee (N5293AX03)
N4372E-FE3	Frequency extender 120 GHz, 1.2 m cable (N5295AX01)
N4372E-FE4	Frequency extender 120 GHz, 1.2 m cable, LFE, bias-tee (N5295AX03)

Option	Recommended Calibration Kits and Accessories
N4372E-801	Calibration Kit, 1 mm, DC to 120 GHz (85059B)
N4372E-802	USB Thermocouple Power Sensor, DC to 120 GHz (U8489A)
N4372E-803	Verification Kit, 1 mm (85059V)

## Lightwave Component Analyzers Online Information

[www.keysight.com/find/lca](http://www.keysight.com/find/lca)

Learn more at: [www.keysight.com](http://www.keysight.com)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

