DATA SHEET

N4373E 43.5/50/67 GHz Single-Mode Fiber Lightwave Component Analyzer for 100G/400G/1T Electro-Optical Test

General Information

The performance of digital, photonic transmission is ultimately described by the Bit Error Ratio (BER), but it is the analog nature of electro-optical subcomponents like modulators, PIN-TIA receivers and detectors that determines the performance of the entire transmission system.
Only a careful design of these electro-optical components over a wide modulation signal bandwidth guarantees successful operation in the transmission system.

The Keysight N4373E Lightwave Component Analyzer (LCA) is the ideal choice to characterize such electro-optical components for 40G/100GbE, for 400 Gbit/s and 1 Tbit/s transmission systems. Using the advanced measurement capabilities of the new N52xxB series PNA Microwave Network Analyzers, all S-parameter related characteristics of the device under test, like responsivity and 3 dB-cutoff frequency, can be qualified from 10 MHz to 43.5 GHz, 50 GHz or 67 GHz.

KEYSIGHT TECHNOLOGIES

Productivity and Operator Guidance

The N4373E LCA has been designed with high productivity in mind: As an integrated, turn-key solution, it speeds up time-to-market when implementing the test strategy for a new device. Compared to home-grown measurement solutions that leave the responsibility for accuracy and traceability to the user, high confidence in measurement results is maintained through self-test routines, which take uncertainty out of the calibration and measurement procedures.

An easy-to-perform, highly automated user calibration routine based on the e-Cal module reduces the number of manual operator tasks, therefore shortens the measurement preparation time. The guidance provided by the instrument during user calibration and measurement setup further reduces operator-induced uncertainties.

Accuracy and Traceability

The N4373E LCA is built from carefully selected and matched opto-electronic and electronic components. Temperature-stabilized transmitter and receiver components ensure measurements are reproducible over days without user re-calibration.

Because measurements at high absolute and relative accuracy improve both, development results, and production yield, every LCA is undergoing an extended factory calibration across multiple optical power levels to minimize noise and ripple in the measurement traces.

Factory calibration against reference standards traceable to national standards ensures that test results can be compared among test locations worldwide. For balanced measurements, traceability is ensured up to frequencies as high as 67 GHz.

Software and Remote Control

Software, user interface and remote control are identical across the N437xB/ N437xD and N437xE generations of LCAs. They also share a common user interface, just like the recent PNA generations, to reduce operator training needs.

Remote control via LAN over the state-of-the-art Microsoft .NET or COM interface, or through the industry-standard, easy-to-use SCPI remote interface simplifies the LCA’s integration into an automated test environment. This is particularly helpful when an opto-electronic component’s frequency response needs to be qualified over a wide range of parameters – a cumbersome and failure-prone process if done manually.

Target Test Devices

Transmitters and receivers are typically tested for their frequency response 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 optional, auxiliary PMF input (Option 050) enables the measurement of optically filtered/ demultiplexed O/E devices at specific wavelengths as proposed by the IEEE 802.3 standards and MSAs, or the verification of S-parameters over wavelength using an external tunable laser. With the LCA's fast characterization of the electro-optic transfer function, operating parameters can be 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.

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 common-mode rejection and gain imbalance.

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)	Absolute frequency response, the conversion efficiency of a transmitter, or the responsivity and gain of a receiver
	Relative frequency response, the filter shape of the electro-optical conversion or of the gain of an amplifier
	3-dB bandwidth of the electro-optical or electrical transfer function
	Group Delay vs. frequency of the transfer function
	Optical Insertion Loss (IL)
Reflectivity (S11 or S22, amplitude and phase)	Electrical reflectivity at the RF port
	Impedance match
Balanced measurements (requires 4-port PNA)	Differential gain, gain imbalance
	Common-mode rejection, common-mode transfer function

Key Specifications

Relative Frequency Response Uncertainty
± 0.8 dB @ 50 GHz (typical)
± 1.3 dB @ 65 GHz (typical)
Absolute frequency response uncertainty
± 1.2 dB @ 50 GHz (typical)
± 1.8 dB @ 65 GHz (typical)
Noise floor
–60 (55) dB (A/W) for O/E measurements @ 50 (65) GHz
–64 (59) dB (W/A) for E/O measurements @ 50 (65) GHz
Typical phase uncertainty
± 2.3°
Transmitter wavelength
1550 nm ± 20 nm
1310 nm ± 20 nm
1290 to 1610 nm with external source input
Built-in optical power meter
For fast transmitter power verification and indication of breaks, bends and bad connections
Powerful remote control
State-of-the-art programming interface based on Microsoft .NET or COM and SCPI
Auxiliary optical input (option 050)
PMF input, connects external laser source through a PMF optical switch to the internal modulator

Definitions

Generally, all specifications are valid at the stated operating and measurement conditions and settings, with uninterrupted line voltage.

Specifications (guaranteed)

Describes warranted product performance that is valid under the specified conditions. Specifications include guard bands to account for the expected statistical performance distribution, measurement uncertainties, changes in performance due to environmental changes and aging of components.

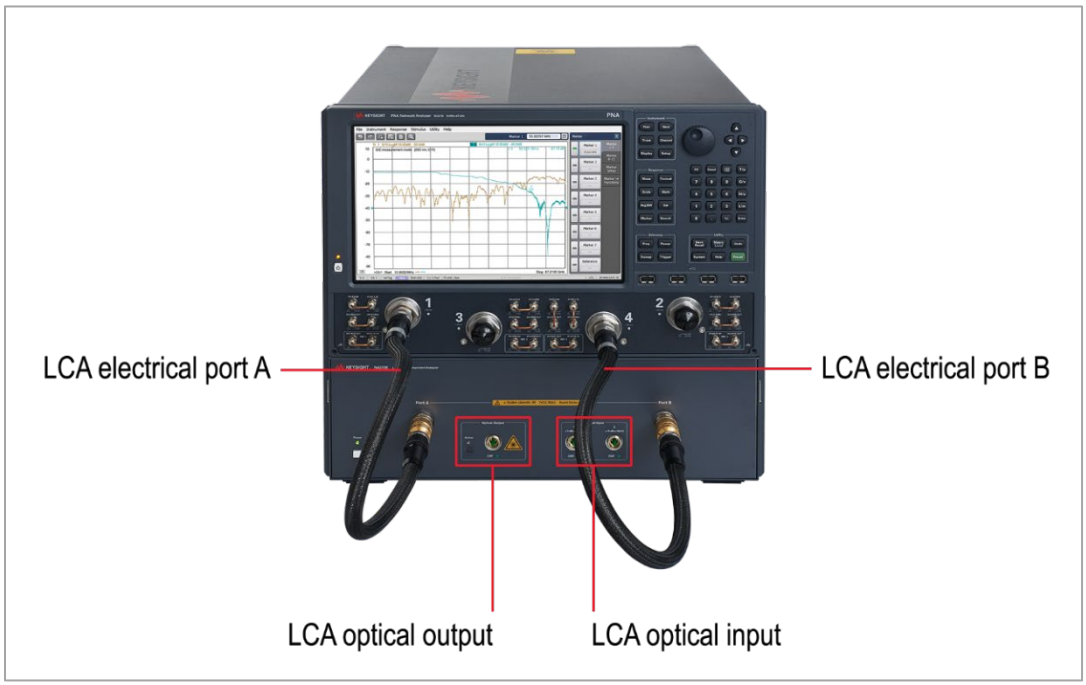
Typical values (characteristics)

Describe the product performance that is usually met but not guaranteed. Typical values are based on data from a representative set of instruments.

General characteristics

Give additional information for using the instrument. These are general descriptive terms that do not imply a level of performance.

LCA inputs and outputs



Explanation of Terms

Responsivity

For electro-optical devices (e.g. modulators) this describes the ratio of the optical modulated output signal power to the RF amplitude at the device input.

For opto-electrical devices (e.g. photodiodes) this describes the ratio of the RF amplitude at the device output to the modulated optical signal input power.

Relative frequency response uncertainty

Describes the maximum deviation of the shape of a measured trace from the (unknown) real trace. This specification has strong influence on the accuracy of the 3-dB cut-off frequency determined for the device under test.

Absolute frequency response uncertainty

Describes the maximum difference between any amplitude point of the measured trace and the (unknown) real value. This specification is useful to determine the absolute responsivity of the device versus modulation frequency.

Frequency response repeatability

Describes the deviation of repeated measurement without changing any parameter or connection relative to the average of this measurements.

Minimum measurable frequency response

Describes the average measured responsivity when no modulation signal is present at the device under test. This represents the noise floor of the measurement system.

Keysight N4373E Specifications

Measurement conditions

- Network analyzer set to −1 dBm electrical output power
- Modulation frequency range from 10 MHz to 43.5/50/65GHz, depending on selected network analyzer option
- Number of averages: 1
- 100 Hz IFBW (“Reduce IF bandwidth at low frequency” enabled) with modulation frequency step size 10 MHz and measurement points on a 10 MHz raster (if not stated otherwise)
- Network analyzer set to “stepped sweep – sweep moves in discrete steps”
- Network analyzer configured in reverse coupler configuration (“RCVB B in” to “CPLR THRU”, “SOURCE OUT” to “CPLR ARM”) on network analyzer port connected to LCA receiver
- After full two-port electrical calibration using an Electronic Calibration Module, Keysight N4694A, at constant temperature (± 1 °C) with network analyzer set to −15 dBm electrical output power
- Modulation-bias optimization set to “every sweep”
- Using the supplied flexible test port cables 1.85 mm f m (Part number N4697-60030) for NA options x7z and 2.4 mm f m (Part number 85133-60043) for NA options x4z and x5z
- Measurement frequency grid equals electrical calibration grid
- Tested from Port 1 to Port 2, respectively from Port 1 to Port 4 for 4-port PNA
- DUT signal delay ≤ 0.1/IF-BW
- Specified temperature range: +20 °C to +26 °C
- After warm-up time of 90 minutes
- Using high quality electrical and optical connectors in perfect condition
- Using internal laser source

The optical test set always has angled connectors. Depending on the selected option (-021 straight, -022 angled) the appropriate jumper cable will be delivered. This jumper cable must always be used to connect the device under test to the optical test set to protect the test set’s connectors and is required for performance tests.

Transmitter and Receiver Specifications

Optical Test Set		
Operation frequency range	N5227B PNA	10 MHz to 67 GHz
	N5225B PNA	10 MHz to 50 GHz
	N5224B PNA	10 MHz to 43.5 GHz
Connector type	Optical input	SMF angled with Keysight universal connector interface
	Optical output	
	Optical source input (rear, option 050)	9/125 µm Panda PMF angled, with Keysight universal connector interface, TE mode in slow axis, in line with connector key
	RF	1.85 mm male
LCA optical input		
Operating input wavelength range		1290 nm to 1610 nm [3]
Maximum linear average input power [1]	Optical input 1	+4 dBm @ 1310 nm
		+5 dBm @ 1550 nm
	Optical input 2	+14 dBm @ 1310 nm
		+15 dBm @ 1550 nm
Maximum safe average input power	Optical input 1	+7 dBm
	Optical input 2	+17 dBm
Optical return loss (typical) [1]		> 25 dBo
Average power measurement range [1]	Optical input 1	−25 dBm to +5 dBm on optical input 1
	Optical input 2	−15 dBm to +15 dBm on optical input 2
Average power measurement uncertainty (typical) [1]		± 0.5 dBo
LCA optical output (Internal source)		
Optical modulation index (OMI) at 10 GHz (typical)…		> 27% @ +5 dBm RF power
		> 47% @ +10 dBm RF power
Output wavelength	Option -100, -102	(1310 ± 20) nm
	Option -101, -102	(1550 ± 20) nm
Average output power range		−1 dBm to +5 dBm @ 1550 nm
		−2 dBm to +4 dBm @ 1310 nm
Average output power uncertainty (typical) [2]		± 0.5 dBo
Average output power stability, 15 minutes (typical)		± 0.5 dBo

[1] Wavelength within range as specified for LCA optical output.
[2] After modulator optimization.
[3] Excluding water absorption wavelengths.

Optical Test Set	
External optical source input (-050)	
Recommended optical input power [4]	+8 to +15 dBm
Optical input power damage level	+20 dBm
Typical loss at quadrature bias point	9 dB
Operating input wavelength range	1290 nm to 1610 nm [3]
LCA RF test port input	
Maximum safe input level at port A or B	+15 dBm RF, 7V DC

[3] Excluding water absorption wavelengths.
[4] Required source characteristics: SMSR > 35 dB, line width < 10 MHz, power stability < 0.1 dB pp, PER > 20 dB, unmodulated, single mode fiber.

Specifications for Electrical to Optical Measurements at 1310 nm (E/O Mode)

N4373E with network analyzer: N5224B, N5225B, N5227B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- At optical input 1 ("+ 7 dBm max"). At optical input 2 ("+ 17 dBm max"), specifications are typically the same for 10 dB higher incident average and modulated optical power.
- For wavelength: (1310 ± 10) nm (Option -100, 102).
- Specifications apply to the frequency range of the used PNA. For N5225B specifications are typical for frequency range 47 GHz to 50 GHz.

System performance	DUT response	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty	≥ −24 dB (W/A) [1]	± 0.8 dBe typical	± 1.0 dBe (± 0.7 dBe, typical)	± 1.1 dBe (± 0.8 dBe, typical)	± 1.1 dBe (± 0.8 dBe, typical)	± 2.4 dBe (± 1.7 dBe, typical)
	≥ −34 dB (W/A) (typical)	± 0.8 dBe	± 0.8 dBe	± 0.8 dBe	± 0.8 dBe	± 1.8 dBe
	≥ −44 dB (W/A) (typical)	± 0.9 dBe	± 0.9 dBe	± 0.9 dBe	± 2.2 dBe	± 4.0 dBe
Absolute frequency response uncertainty	≥ −24 dB (W/A) [1]	± 1.7 dBe typical	± 2.4 dBe (± 1.7 dBe, typical)	± 2.6 dBe (± 1.8 dBe, typical)	± 2.7 dBe (± 1.9 dBe, typical)	± 3.2 dBe (± 2.2 dBe, typical)
Frequency response repeatability (typical)	≥ −24 dB (W/A) [1]	± 0.03 dBe	± 0.03 dBe	± 0.05 dBe	± 0.15 dBe	± 0.25 dBe
	≥ −34 dB (W/A)	± 0.03 dBe	± 0.03 dBe	± 0.11 dBe	± 0.4 dBe	± 0.8 dBe
	≥ −44 dB (W/A)	± 0.03 dBe	± 0.03 dBe	± 0.6 dBe	± 1.3 dBe	± 2.2 dBe
Min. measurable freq. response (noise floor) [2, 3, 4]	-	−64 dB (W/A)	−64 dB (W/A)	−64 dB (W/A)	−64 dB (W/A)	−59 dB (W/A)
Phase uncertainty (typical) [5]	≥ −24 dB (W/A) [1]	± 3.5°	± 3.0°	± 2.7°	± 3.7°	± 5.5°
	≥ −34 dB (W/A)	± 3.5°	± 3.5°	± 2.7°	± 4.8°	± 9.0°
Group delay uncertainty	-	Derived from phase uncertainty, see section "Group delay uncertainty". Example: ± 2.0° → ± 8 ps (1 GHz aperture)				

[1] For DUT response max. −13 dB (W/A).
[2] IFBW = 10 Hz.
[3] Average value over frequency range.
[4] In reverse coupler configuration, for normal configuration add typically 35 dB (0.05 GHz to 0.2 GHz), 12 dB (0.2 GHz to 0.7 GHz), 8 dB (> 0.7 GHz).
[5] Except phase wrap aliasing (Example: A DUT group delay of 5 ns (1 m cable length) requires a frequency step size of ≤ 0.2 GHz to avoid phase wraps). Excluding a constant group delay offset of < ± 0.3 ns typical. (Cable length uncertainty < ± 0.06 m). A constant group delay offset leads to a phase offset $\Delta\Phi = 360° \times \Delta GD \times fmod$ (in deg).

Specifications for Electrical to Optical Measurements at 1550 nm (E/O Mode)

N4373E with network analyzer: N5224B, N5225B, N5227B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- At optical input 1 ("+ 7 dBm max"). At optical input 2 ("+ 17 dBm max"), specifications are typically the same for 10 dB higher incident average and modulated optical power.
- For wavelength: (1550 ± 20) nm (Option -101, 102).
- Specifications apply to the frequency range of the used PNA.
  For N5225B specifications are typical for frequency range 47 GHz to 50 GHz.

System performance	DUT response	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty	≥ −26 dB (W/A) [1]	± 0.7 dBe, typical	± 0.8 dBe (± 0.6 dBe, typical)	± 0.8 dBe (± 0.6 dBe, typical)	± 1.0 dBe (± 0.7 dBe, typical)	± 1.6 dBe (± 1.1 dBe, typical)
	≥ −36 dB (W/A) (typical)	± 0.7 dBe	± 0.6 dBe	± 0.6 dBe	± 0.9 dBe	± 1.3 dBe
	≥ −46 dB (W/A) (typical)	± 0.7 dBe	± 0.7 dBe	± 0.7 dBe	± 1.6 dBe	± 2.7 dBe
Absolute frequency response uncertainty	≥ −26 dB (W/A) [1]	± 1.2 dBe, typical	± 1.8 dBe (± 1.2 dBe, typical)	± 1.8 dBe (± 1.2 dBe, typical)	± 1.9 dBe (± 1.2 dBe, typical)	± 2.7 dBe (± 1.8 dBe, typical)
Frequency response repeatability (typical)	≥ −26 dB (W/A) [1]	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.1 dBe	± 0.2 dBe
	≥ −36 dB (W/A)	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.3 dBe	± 0.5 dBe
	≥ −46 dB (W/A)	± 0.02 dBe	± 0.02 dBe	± 0.1 dBe	± 1.0 dBe	± 2.0 dBe
Min. measurable freq. response (noise floor) [2, 3, 4]	-	−64 dB (W/A)	−64 dB (W/A)	−64 dB (W/A)	−64 dB (W/A)	−59 dB (W/A)
Phase uncertainty (typical) [5]	≥ −26 dB (W/A) [1]	± 3.5°	± 3.0°	± 2.3°	± 3.2°	± 4.5°
	≥ −36 dB (W/A)	± 5.5°	± 3.5°	± 2.3°	± 4.2°	± 6.5°
Group delay uncertainty	-	Derived from phase uncertainty, see section "Group delay uncertainty". Example: ± 2.0° → ± 8 ps (1 GHz aperture)				

[1] For DUT response max. −13 dB (W/A).
[2] IFBW = 10 Hz.
[3] Average value over frequency range.
[4] In reverse coupler configuration, for normal configuration add typically 35 dB (0.05 GHz to 0.2 GHz), 12 dB (0.2 GHz to 0.7 GHz), 8 dB (> 0.7 GHz)
[5] Except phase wrap aliasing (Example: A DUT group delay of 5 ns (1 m cable length) requires a frequency step size of ≤ 0.2 GHz to avoid phase wraps). Excluding a constant group delay offset of < ± 0.3 ns typical. (Cable length uncertainty < ± 0.06 m). A constant group delay offset leads to a phase offset $\Delta\Phi = 360° \times \Delta GD \times fmod$ (in deg).

Specifications for Optical to Electrical Measurements at 1310 nm (O/E Mode)

N4373E with network analyzer: N5224B, N5225B, N5227B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- For external source optical input (Option -050), all specifications are typical[2, 5, 6]
- For wavelength: (1310 ± 10) nm (Option -100, 102).
- Specifications apply to the frequency range of the used PNA.
  For N5225B specifications are typical for frequency range 47 GHz to 50 GHz.

System performance	DUT response	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty [2]	≥ −19 dB (A/W) [1]	± 0.8 dBe, typical	± 1.0 dBe (± 0.7 dBe)[7]	± 1.1 dBe (± 0.8 dBe)[7]	± 1.7 dBe (± 1.2 dBe)[7]	± 2.2 dBe (± 1.5 dBe)[7]
	≥ −29 dB (A/W) (typical)	± 0.8 dBe	± 0.7 dBe	± 0.8 dBe	± 1.3 dBe	± 1.6 dBe
	≥ −39 dB (A/W) (typical)	± 0.9 dBe	± 0.9 dBe	± 0.9 dBe	± 1.7 dBe	± 2.8 dBe
Absolute frequency response uncertainty [2]	≥ −29 dB (A/W) [1]	(± 1.5 dBe)[7]	± 2.4 dBe (± 1.5 dBe)[7]	± 2.4 dBe (± 1.5 dBe)[7]	± 2.8 dBe (± 1.8 dBe)[7]	± 3.2 dBe (± 2.1 dBe)[7]
Frequency response repeatability (typical) [2]	≥ −19 dB (A/W) [1]	± 0.03 dBe	± 0.03 dBe	± 0.05 dBe	± 0.3 dBe	± 0.5 dBe
	≥ −29 dB (A/W)	± 0.03 dBe	± 0.03 dBe	± 0.15 dBe	± 0.5 dBe	± 0.7 dBe
	≥ −39 dB (A/W)	± 0.03 dBe	± 0.03 dBe	± 0.3 dBe	± 0.5 dBe	± 0.8 dBe
Min. measurable freq. response (noise floor) [2, 3, 4, 8]	-	−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)
Phase uncertainty (typical) [2, 9]	≥ −19 dB (A/W) [1]	± 3.5°	± 3.0°	± 2.7°	± 4.4°	± 6.0°
	≥ −29 dB (A/W)	± 5.5°	± 3.5°	± 2.7°	± 4.9°	± 7.5°
Group delay uncertainty	-	Derived from phase uncertainty, see section “Group delay uncertainty”. Example: ± 2.0° → ± 8 ps (1 GHz aperture)				

[1] DUT response max. −10 dB (A/W).
[2] For +4 dBm average output power from LCA optical output.
[3] IFBW = 10 Hz.
[4] Average value over frequency range.
[5] After CW responsivity and user calibration with external source.
[6] Requires option -100 or -102.
[7] Typical with internal source.
[8] In reverse coupler configuration, for normal configuration add typically 35 dB (0.05 GHz to 0.2 GHz), 12 dB (0.2 GHz to 0.7 GHz), 8 dB (> 0.7 GHz).
[9] Except phase wrap aliasing (Example: A DUT group delay of 5 ns (1 m cable length) requires a frequency step size of ≤ 0.2 GHz to avoid phase wraps). Excluding a constant group delay offset of < ± 0.3 ns typical. (Cable length uncertainty < ± 0.06 m). A constant group delay offset leads to a phase offset $\Delta\Phi = 360° \times \Delta GD \times fmod$ (in deg).

Specifications for Optical to Electrical Measurements at 1550 nm (O/E Mode)

N4373E with network analyzer: N5224B, N5225B, N5227B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- For external source optical input (Option -050), all specifications are typical[2, 5, 6]
- For wavelength: (1550 ± 20) nm (Option -101, 102).
- Specifications apply to the frequency range of the used PNA.
  For N5225B specifications are typical for frequency range 47 GHz to 50 GHz.

System performance	DUT response	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty [2]	≥ −15 dB (A/W) [1]	± 0.7 dBe, typical	± 0.8 dBe (± 0.6 dBe) [7]	± 0.9 dBe (± 0.7 dBe) [7]	± 1.2 dBe (± 0.8 dBe) [7]	± 1.9 dBe (± 1.3 dBe) [7]
	≥ −25 dB (A/W) (typical)	± 0.8 dBe	± 0.7 dBe	± 0.8 dBe	± 0.9 dBe	± 1.4 dBe
	≥ −35 dB (A/W) (typical)	± 0.9 dBe	± 0.7 dBe	± 0.8 dBe	± 1.3 dBe	± 1.7 dBe
Absolute frequency response uncertainty [2]	≥ −25 dB (A/W) [1]	(± 1.1 dBe) [7]	± 1.9 dBe (± 1.1 dBe) [7]	± 1.9 dBe (± 1.1 dBe) [7]	± 2.0 dBe (± 1.2 dBe) [7]	± 2.8 dBe (± 1.6 dBe) [7]
Frequency response repeatability (typical) [2]	≥ −15 dB (A/W) [1]	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.3 dBe	± 0.5 dBe
	≥ −25 dB (A/W)	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.5 dBe	± 0.7 dBe
	≥ −35 dB (A/W)	± 0.02 dBe	± 0.02 dBe	± 0.06 dBe	± 0.5 dBe	± 0.8 dBe
Min. measurable freq. response (noise floor) [2, 3, 4, 8]	-	−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)	−55 dB (A/W)
Phase uncertainty (typical) [2, 9]	≥ −19 dB (A/W) [1]	± 3.5°	± 3.0°	± 2.4°	± 3.2°	± 5.0°
	≥ −29 dB (A/W)	± 5.5°	± 3.5°	± 2.4°	± 5.0°	± 7.0°
Group delay uncertainty	-	Derived from phase uncertainty, see section “Group delay uncertainty”. Example: ± 2.0° → ± 8 ps (1 GHz aperture)				

[1] DUT response max. −10 dB (A/W).
[2] For +5 dBm average output power from LCA optical output.
[3] IFBW = 10 Hz.
[4] Average value over frequency range.
[5] After CW responsivity and user calibration with external source.
[6] Requires option -101 or -102.
[7] Typical with internal source.
[8] In reverse coupler configuration, for normal configuration add typically 35 dB (0.05 GHz to 0.2 GHz), 12 dB (0.2 GHz to 0.7 GHz), 8 dB (> 0.7 GHz).
[9] Except phase wrap aliasing (Example: A DUT group delay of 5 ns (1 m cable length) requires a frequency step size of ≤ 0.2 GHz to avoid phase wraps). Excluding a constant group delay offset of < ± 0.3 ns typical. (Cable length uncertainty < ± 0.06 m). A constant group delay offset leads to a phase offset $\Delta\Phi = 360° \times \Delta GD \times fmod$ (in deg).

Specifications for Optical to Optical Measurements at 1310 nm (O/O Mode)

N4373E with network analyzer: N5224B, N5225B, N5227B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- At optical input 1 ("+7 dBm max"). At optical input 2 ("+17 dBm max"), specifications are typically the same for 10 dB higher incident average and modulated optical power.
- For external source optical input (Option -050), all specifications are typical. [2, 5, 6]
- For wavelength: (1310 ± 10) nm (Option -100, 102).
- Specifications apply to the frequency range of the used PNA. For N5225B specifications are typical for frequency range 47 GHz to 50 GHz.

System performance	DUT response	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty [2]	≥ −3 dBe (≥ −1.5 dBo) [3]	± 0.4 dBe, typ. (± 0.2 dBo)	± 0.4 dBe (± 0.2 dBo)	± 0.4 dBe (± 0.2 dBo)	± 0.5 dBe (± 0.25 dBo)	± 0.6 dBe (± 0.3 dBo)
	≥ −13 dBe (≥ −6.5 dBo) (typical)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.7 dBe (± 0.35 dBo)	± 1.0 dBe (± 0.5 dBo)
	≥ −23 dBe (≥ −11.5 dBo) (typical)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.9 dBe (± 0.45 dBo)	± 1.5 dBe (± 0.75 dBo)
Absolute frequency response uncertainty [2]	≥ −3 dBe (≥ −1.5 dBo) [3]	± 0.9 dBe, typ. (± 0.45 dBo)	± 0.9 dBe (± 0.45 dBo)	± 0.9 dBe (± 0.45 dBo)	± 1.0 dBe (± 0.50 dBo)	± 1.2 dBe (± 0.6 dBo)
Frequency response repeatability (typical) [2]	≥ −3 dBe (≥ −1.5 dBo) [3]	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.15 dBe	± 0.3 dBe
	≥ −13 dBe (≥ −6.5 dBo)	± 0.03 dBe	± 0.03 dBe	± 0.1 dBe	± 0.4 dBe	± 0.8 dBe
	≥ −23 dBe (≥ −11.5 dBo)	± 0.03 dBe	± 0.03 dBe	± 0.1 dBe	± 1 dBe	± 1.5 dBe
Min. measurable freq. response (noise floor) [1, 2, 4, 7]	-	−55 dBe, typical (−27.5 dBo)	−42 dBe (−21 dBo)	−42 dBe (−21 dBo)	−42 dBe (−21 dBo)	−36 dBe (−18 dBo)
Phase uncertainty (typical) [2, 8]	≥ −3 dBe [3] (≥ −1.5 dBo)	± 3.5°	± 3.0°	± 2.2°	± 2.7°	± 3.5°
	≥ −13 dBe (≥ −6.5 dBo)	± 5.5°	± 3.5°	± 2.2°	± 3.3°	± 4.0°
Group delay uncertainty	-	Derived from phase uncertainty, see section "Group delay uncertainty". Example: ± 2.0° → ± 8 ps (1 GHz aperture)				

[1] IFBW = 10 Hz.
[2] For +4 dBm average output power from LCA optical output.
[3] For DUT response max. +6 dBe (+3 dBo) gain.
[4] Average value over frequency range.
[5] After CW responsivity and user calibration with external source.
[6] Requires option -100 or -102.
[7] In reverse coupler configuration, for normal configuration add typically 35 dB (0.05 GHz to 0.2 GHz), 12 dB (0.2 GHz to 0.7 GHz), 8 dB (> 0.7 GHz).
[8] Except phase wrap aliasing (Example: A DUT group delay of 5 ns (1 m cable length) requires a frequency step size of ≤ 0.2 GHz to avoid phase wraps).

Specifications for Optical to Optical Measurements at 1550 nm (O/O Mode)

N4373E with network analyzer: N5224B, N5225B, N5227B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- At optical input 1 ("+7 dBm max"). At optical input 2 ("+17 dBm max"), specifications are typically the same for 10 dB higher incident average and modulated optical power.
- For external source optical input (Option -050), all specifications are typical. [2, 5, 6]
- For wavelength: (1550 ± 20) nm (Option -101, 102).
- Specifications apply to the frequency range of the used PNA.
  For N5225B specifications are typical for frequency range 47 GHz to 50 GHz.

System performance	DUT response	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 65 GHz
Relative frequency response uncertainty [2]	≥ −3 dBe (≥ −1.5 dBo) [3]	± 0.3 dBe, typ. (± 0.15 dBo)	± 0.3 dBe (± 0.15 dBo)	± 0.3 dBe (± 0.15 dBo)	± 0.4 dBe (± 0.2 dBo)	± 0.6 dBe (± 0.3 dBo)
	≥ −13 dBe (≥ −6.5 dBo) (typical)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.6 dBe (± 0.3 dBo)	± 1.0 dBe (± 0.5 dBo)
	≥ −23 dBe (≥ −11.5 dBo) (typical)	± 0.2 dBe (± 0.1 dBo)	± 0.2 dBe (± 0.1 dBo)	± 0.3 dBe (± 0.15 dBo)	± 0.7 dBe (± 0.35 dBo)	±1.3 dBe (± 0.65 dBo)
Absolute frequency response uncertainty [2]	≥ −3 dBe (≥ −1.5 dBo) [3]	± 0.4 dBe, typ. (± 0.2 dBo)	± 0.4 dBe (± 0.2 dBo)	± 0.4 dBe (± 0.2 dBo)	± 0.7 dBe (± 0.35 dBo)	± 0.9 dBe (± 0.45 dBo)
Frequency response repeatability (typical) [2]	≥ −3 dBe (≥ −1.5 dBo) [3]	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.1 dBe	± 0.2 dBe
	≥ −13 dBe (≥ −6.5 dBo)	± 0.02 dBe	± 0.02 dBe	± 0.02 dBe	± 0.3 dBe	± 0.5 dBe
	≥ −23 dBe (≥ −11.5 dBo)	± 0.02 dBe	± 0.02 dBe	± 0.1 dBe	± 1.0 dBe	± 2.0 dBe
Min. measurable freq. response (noise floor) [1, 2, 4, 7]	-	−55 dBe, typical (−27.5 dBo)	−42 dBe (−21 dBo)	−42 dBe (−21 dBo)	−42 dBe (−21 dBo)	−36 dBe (−18 dBo)
Phase uncertainty (typical) [2, 8]	≥ −3 dBe [3] (≥ −1.5 dBo)	± 3.5°	± 3.0°	± 2.2°	± 2.6°	± 3.0°
	≥ −13 dBe (≥ −6.5 dBo)	± 5.5°	± 3.5°	± 2.2°	± 3.0°	± 3.5°
Group delay uncertainty	-	Derived from phase uncertainty, see section "Group delay uncertainty". Example: ± 2.0° → ± 8 ps (1 GHz aperture)				

[1] IFBW = 10 Hz.
[2] For +5 dBm average output power from LCA optical output.
[3] For DUT response max. +6 dBe (+3 dBo) gain.
[4] Average value over frequency range.
[5] After CW responsivity and user calibration with external source.
[6] Requires option -101 or -102.
[7] In reverse coupler configuration, for normal configuration add typically 35 dB (0.05 GHz to 0.2 GHz), 12 dB (0.2 GHz to 0.7 GHz), 8 dB (> 0.7 GHz).
[8] Except phase wrap aliasing (Example: A DUT group delay of 5 ns (1 m cable length) requires a frequency step size of ≤ 0.2 GHz to avoid phase wraps).

Specifications for Electrical-Electrical Measurements (E/E Mode)

All specifications of the N5224B, N5225B, N5227B Option 200, 201, 219, 400, 401, or 419 Network Analyzer apply depending on selected LCA Option -x4z, -x5z, -x7z. Please see the corresponding Network Analyzer data sheet and User's Guide.

Group delay uncertainty

For more details see specifications of the N5224B, N5225B, N5227B Option 200, 201, 219, 400, 401, or 419.

Group delay

Group delay is computed by measuring the phase change within a specified aperture (for aperture see below):

$$GD\ [s] = \frac{\text{Phase change [deg]}}{\text{Aperture [Hz]} * 360} \qquad \text{(Equation 1)}$$

Group delay uncertainty

Is calculated from the specified phase uncertainty and from the aperture (for aperture see below):

$$GD\ [\pm s] = \frac{\text{Phase uncertainty [}\pm\text{deg]}}{\text{Aperture [Hz]} * 360} * \text{sqrt}(2) \qquad \text{(Equation 2)}$$

Aperture

Determined by the frequency span and the number of points per sweep:
Aperture: (frequency span) / (number of points–1)

GD Range

The maximum group delay is limited to measuring no more than ± 180 degrees of phase change within the selected aperture (see Equation 1).

General Characteristics

Weight	Net	Packaged
43.5 GHz LCA (2/4 port)	58/61 kg (128/135 lbs)	58/61 kg (128/135 lbs)
50 GHz LCA (2/4 port)	58/61 kg (128/135 lbs)	58/61 kg (128/135 lbs)
67 GHz LCA (2/4 port)	60/63 kg (133/139 lbs)	80/83 kg (177/183 lbs)
Assembled Dimensions (H x W x D)		
43.5/50/67 GHz LCA	413 mm x 438 mm x 605 mm (16.3 in x 17.3 in x 23.8 in)	
Power Requirements		
43.5/50/67 GHz LCA	100 to 240 V~, 50 to 60 Hz, max. 400 VA	

Shipping Content	
43.5/50 GHz LCA	**67 GHz LCA**
N5224B/N5225B NA according to ordered option	N5227B NA according to ordered option
3x 85133-60043 f-m flexible test port MW cable (4-port network analyzer) or 2x 85133-60043 f-m flexible test port MW cable (2-port network analyzer)	3x N4697-60030 f-m flexible test port MW cable (4-port network analyzer) or 2x N4697-60030 f-m flexible test port MW cable (2-port network analyzer)
1x 85056-60006 (2.4 mm f-f adapter)	1x N5520B-FG (1.85 mm f-f adaptor)
1x N4373E optical test set	1x N4373E optical test set
2x 85058-60121 test port adapter (f)-(f)	
3x 81000NI optical adaptor (1x additional 81000NI optical adaptor for external input option 050)	
2x N4373-87907 0.5 m FC/APC - FC/PC patch cord and 1x 1005-0256 FC/FC feedthrough adapter (option 021), or 2x N4373-87906 0.5 m FC/APC - FC/APC patch cord and 1x 1005-1027 FC/FC feedthrough adapter (option 022) (1x PMF patch cord 1.0 m FC/APC narrow key for external input option 050)	
1x 8121-1242 USB cable	
1x 0960-3245 keyboard	
1x 0960-3248 mouse	
1x E5525-10285 UK6 report	
1x startup guide	
1x LCA support CD	
2x local power cord	
1x RoHS addendum for photonic T&M products, 1x RoHS addendum for photonic T&M accessories	
1 x N4373-88700 mounting kit	

Connectivity	
LCA electrical input	**LCA electrical output**
1.85 mm (m)	1.85 mm (m)
LCA optical input 1	**LCA optical input 2**
9 µm single-mode fiber, angled, with Keysight universal adapter	9 µm single-mode fiber, angled, with Keysight universal adapter
LCA external source input (Option -050 only)	**LCA optical output**
9 µm polarization maintaining single-mode fiber, angled, with Keysight universal adapter	9 µm single-mode fiber, angled, with Keysight universal adapter
Storage Temperature Range	
−40 °C to +70 °C	
Operating Temperature Range	
+5 °C to +35 °C	
Humidity	
15% to 80% relative humidity, non-condensing	
Altitude (Operating)	
0 ... 2000 m	
Recommended Recalibration Period	
1 year	
Laser Safety Information	
All laser sources listed above are classified as Class 1M according to IEC 60825-1 (2014). All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2007-06-24.	

Ordering Information

The N4373E consists of an optical test set and an electrical network analyzer which are mechanically connected. To protect your network analyzer investment, Keysight offers the integration of an already owned PNA/PNA-X with the optical test set as listed below.

All systems with Keysight standard warranty.

LCA N4373E Family Options	
Wavelength options	**Description**
N4373E-100	1310 nm source optical test set
N4373E-101	1550 nm source optical test set
N4373E-102	1300 nm and 1550 nm source optical test set
Network analyzer options	**Description**
N4373E-240	43.5 GHz, 2 ports, single source PNA (N5224B-200) and RF-cables
N4373E-241	43.5 GHz, 2 ports, single source PNA (N5224B-201) with configurable test set and RF-cables
N4373E-242	43.5 GHz, 2 ports, single source PNA (N5224B-219) with configurable test set, extended power range, bias-tees and RF-cables
N4373E-250	50 GHz, 2 ports, single source PNA (N5225B-200) and RF-cables
N4373E-251	50 GHz, 2 ports, single source PNA (N5225B-201) with configurable test set and RF-cables
N4373E-252	50 GHz, 2 ports, single source PNA (N5225B-219) with configurable test set, extended power range, bias-tees and RF-cables
N4373E-270	67 GHz, 2 ports, single source PNA (N5227B-200) and RF-cables
N4373E-271	67 GHz, 2 ports, single source PNA (N5227B-201) with configurable test set and RF-cables
N4373E-272	67 GHz, 2 ports, single source PNA (N5227B-219) with configurable test set, extended power range, bias-tees and RF-cables
N4373E-440	43.5 GHz, 4 ports, dual source PNA (N5224B-400) and RF-cables
N4373E-441	43.5 GHz, 4 ports, dual source PNA (N5224B-401) with configurable test set and RF-cables
N4373E-442	43.5 GHz, 4 ports, dual source PNA (N5224B-419) with configurable test set, extended power range, bias-tees and RF-cables
N4373E-450	50 GHz, 4 ports, dual source PNA (N5225B-400) and RF-cables
N4373E-451	50 GHz, 4 ports, dual source PNA (N5225B-401) with configurable test set and RF-cables
N4373E-452	50 GHz, 4 ports, dual source PNA (N5225B-419) with configurable test set, extended power range, bias-tees and RF-cables
N4373E-470	67 GHz, 4 ports, dual source PNA (N5227B-400) and RF-cables
N4373E-471	67 GHz, 4 ports, dual source PNA (N5227B-401) with configurable test set and RF-cables

N4373E-472	67 GHz, 4 ports, dual source PNA (N5227B-419) with configurable test set, extended power range, bias-tees and RF-cables
N4373E-249	Integration of customer's 43.5 GHz, 2 port PNA (N5224A/B or N5244A/B) with any configuration and RF-cables [1]
N4373E-259	Integration of customer's 50 GHz, 2 port PNA (N5225A/B or N5245A/B) with any configuration and RF-cables [1]
N4373E-279	Integration of customer's 67 GHz, 2 port PNA (N5227A/B or N5247A/B) with any configuration and RF-cables [1]
N4373E-449	Integration of customer's 43.5 GHz, 4 port PNA (N5224A/B or N5244A/B) with any configuration and RF-cables [1]
N4373E-459	Integration of customer's 50 GHz, 4 port PNA (N5225A/B or N5245A/B) with any configuration and RF-cables [1]
N4373E-479	Integration of customer's 67 GHz, 4 port PNA (N5227A/B or N5247A/B) with any configuration and RF-cables [1]
Software options	**Description**
S93010A [2]	Time-domain measurements
Connector options	**Description**
N4373E-021	Straight FC/PC SM
N4373E-022	Angled FC/APC SM
Test set options	**Description**
N4373E-050	External optical input
Recommended Accessories	
Rack mount kit for network analyzer	**Description**
1CM042A	Rack mount flange kit - 265.9 mm height for installation without handles
E3663AC	Basic rail kit (for system II instruments)
Rack mount kit for LCA test set	**Description**
34192A	Rack mount flange kit - 132.6 mm height for installation without handles
E3663AC	Basic rail kit (for system II instruments)

[1] Guaranteed specifications apply only for the above-mentioned network analyzer options.
[2] For information about other software options, refer to the network analyzer configuration guide.

Optical Instruments Online Information

Optical test instruments
www.keysight.com/find/oct

Lightwave component analyzers
www.keysight.com/find/lca

Polarization solutions
www.keysight.com/find/pol

Electro-optical converters
www.keysight.com/find/ref

Optical test instruments accessories
www.keysight.com/comms/oct-accessories

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