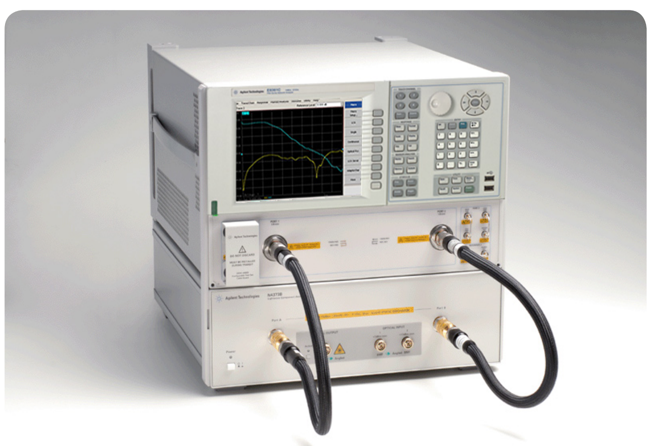
Agilent
N4373C
67 GHz Single-Mode Lightwave Component Analyzer for 40/100G electro-optical test

Data Sheet



Agilent Technologies

General Information

Agilent's N4373C Lightwave Component Analyzer (LCA) offers a modulation bandwidth of 67 GHz which makes it the ideal choice to develop and characterize electro-optical components, for the upcoming 40G/10GbE as defined in IEEE802.3ba.

Accuracy

For these modern optical transmission systems with advanced modulation schemes it is key for the electro-optical components to have very flat S21 transfer function in amplitude and delay. This performance can be achieved only with electro-optical S-parameter test as provided by the N4373C LCA.

In addition fast, accurate, repeatable and traceable characterization of these electro-optical components, like lasers, modulators and detectors is required, to guarantee the performance with respect to modulation bandwidth, jitter, gain, and distortion.

By optimizing the electrical and the optical design of the N4373C for lowest noise and ripple, the accuracy has been improved by better than a factor of 2, compared to its predecessor, the 86030A 50GHz LCA. This increased accuracy improves the yield from tests performed with the N4373C by narrowing margins needed to pass the tested devices.

This advanced design together with temperature-stabilized transmitter and receiver ensures repeatable measurements over hours without recalibration

Turn-key solution

The fully integrated "turn-key" N4373C helps reduce time to market, compared to the time-consuming development of a self-made setup. In addition you get a fully specified easy transferable and reliable test instrument. With guaranteed specifications Agilent takes the responsibility to provide you with accurate and traceable test results that can only be achieved in a turn key solution.

High productivity

The N4373C achieves fast measurements by including the E8361C Performance Network Analyzer. A unique new calibration concept significantly reduces setup time to a maximum of several minutes, depending on the selected measurement parameters. This results in increased productivity in R&D or on the manufacturing floor.

Using the advanced measurement capabilities of the network analyzer, all S-parameter related characteristics of the device under test, like responsivity and 3dB-cutoff frequency, can be qualified with the new N4373C Lightwave Component Analyzer from 10 MHz to 67 GHz.

Network analyzer

The N4373C LCA is based on the new E8361C network analyzer with an identical and well known user interface across all Agilent network analyzers.

Key benefits

- **High absolute and relative accuracy measurements improve the yield of development and production processes. With the excellent accuracy and reproducibility, measurement results can be compared among test locations world wide.**
- **High confidence and fast time-to-market with a NIST-traceable turnkey solution.**
- **Significantly increased productivity using the fast and easy measurement setup with an unique new calibration process leads to lower cost of test.**
- **External optical source input option to test at customer selected wavelength.**
- **Common PNA and LCA user interface across all N437xB/C LCA series.**
- **Identical LCA software and remote control across the N437xB family simplifies integration.**

Relative frequency response uncertainty:
± 0.8 dB @ 50 GHz (typ)
± 1.3 dB @ 65 GHz (typ)

Absolute frequency response uncertainty:
± 1.2 dB @ 50 GHz (typ)
± 1.8 dB @ 65 GHz (typ)

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:
1550nm ± 20 nm
1310nm ± 10 nm
1290 - 1610 nm with external source input

Built-in optical power meter
For fast transmitter power verification

Powerful remote control:
State of the art programming interface based on Microsoft .NET or COM.

Warranty:
1 year warranty is standard for the N4373C Lightwave Component Analyzer.
Extension to 3 or 5 years available on request.

Agilent N4373C Applications

In digital photonic transmission systems, the performance is ultimately determined by Bit Error Ratio Test (BERT). As this parameter describes the performance of the whole system, it is necessary to design and qualify subcomponents like modulators and PIN detectors, which are analog by nature, with different parameters that reflect their individual performance.
These components significantly influence the overall performance of the transmission system with the following parameters:

- 3dB bandwidth of the electro-optical transmission.
- Relative frequency response, quantifying the electro-optical shape of the conversion.
- Absolute frequency response, relating to the conversion efficiency of signals from the input to the output, or indicating the gain of a receiver.
- Electrical reflection at the RF port.
- Group delay of the electro-optical transfer function.

Only a careful design of these electro-optical components over a wide modulation signal bandwidth guarantees successful operation in the transmission system.

Electro-optical components

The frequency response of detector diodes, modulators and directly modulated lasers typically depends on various parameters, like bias voltages, optical input power, operating current and ambient temperature. To determine the optimum operating point of these devices, an LCA helps by making a fast characterization of the electro-optic transfer function while optimizing these operating conditions.
In manufacturing it is important to be able to monitor the processes in regular time slots to keep up the throughput and yield. In this case the LCA is the tool of choice to monitor transmission characteristic and absolute responsivity of the manufactured device.

Electrical components

Electrical components such as amplifiers, filters and transmission lines are used in modern transmission systems and require characterization to ensure optimal performance. Typical measurements are bandwidth, insertion loss or gain, impedance match and group delay.

Agilent N4373C Features

Turnkey solution

In today's highly competitive environment, short time-to-market with high quality is essential for new products. Instead of developing a home-grown measurement solution, which takes a lot of time and is limited in transferability and support, a fully specified and supported solution helps to focus resources on faster development and on optimizing the manufacturing process.
In the N4373C all optical and electrical components are carefully selected and matched to each other to minimize noise and ripple in the measurement traces. Together with the temperature stabilized environment of the core components, this improves the repeatability and the accuracy of the overall system. Extended factory calibration data at various optical power levels ensures accurate and reliable measurements that can only be achieved with an integrated solution like the N4373C.

Easy calibration

An LCA essentially measures the conversion relation between optical and electrical signals. This is why user calibration of such systems can evolve into a time consuming task. With the new calibration process implemented in the N4373C, the tasks that have to be done by the user are reduced to one pure electrical calibration. The calibration with an electrical calibration module is automated and needs only minimal manual interaction.

Built-in performance verification

Sometimes it is necessary to make a quick verification of the validity of the calibration and the performance of the system. The N4373C's unique calibration process allows the user to perform a self-test without external reference devices. This gives full confidence that the system performance is within the user's required uncertainty bands.

State-of-the-art remote control

Testing the frequency response of electro-optical components under a wide range of parameters, which is often necessary in qualification cycles, is very time consuming. To support the user in minimizing the effort for performing this huge number of tests, all functions of the LCA can be controlled remotely via LAN over the state-of-the-art Microsoft .NET or COM interface. This interface is identical for all LCA of the N437xB/C series.
Based on programming examples for VBA with Excel, Agilent VEE and C++, it is very easy for every user to build applications for their requirements.
These examples cover applications like integration of complete LCA measurement sequences.

Integrated optical power meter

In applications where optical power dependence characterization is needed, the average power meter can be used to set the exact average output power of the LCA transmitter by connecting the LCA optical transmitter output, optionally through an optical attenuator, to the LCA optical receiver input. By adjusting the transmitter output power in the LCA user interface or the optical attenuation, the desired transmitter optical power can be set.

In cases where an unexpectedly low responsivity is measured from the device under test, it is very helpful to get a fast indication of the CW optical power that is launched into the LCA receiver. The cause might be a bad connection or a bent fiber in the setup. For this reason too, a measurement of the average optical power at the LCA receiver is very helpful for fast debugging of the test setup.

Selectable output power of the transmitter

Most PIN diodes and receiver optical subassemblies need to be characterized at various average optical power levels. In this case it is necessary to set the average input power of the device under test to the desired value. The variable average optical output power of the LCA transmitter offers this feature. Together with an external optical attenuator, this range can be extended to all desired optical power levels.

Group delay and length measurements

In some applications it is necessary to determine the electrical or optical length of a device. With the internal length calibration of the electro-optical paths with reference to the electrical and optical inputs or outputs, it is possible to determine the length of the device under test

External optical source input

For applications where test of opto-electric devices need to be done at a specific optical wavelength like proposed in the IEEE 802.3ba standard, the N4373C-050 option offers an external optical input to the internal modulator where an external tunable laser can be applied. As modulators are polarization sensitive devices, this input is a PMF input to a PMF optical switch to maintain the polarization at the internal modulator and keep loss at a minimum.

This external optical source input is required when O/E devices with integrated filter are to be characterized, or generaly when the O/E converter needs to be tested at different wavelengths than the internal source.

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)

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.

Explanation of terms

Responsivity

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

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.

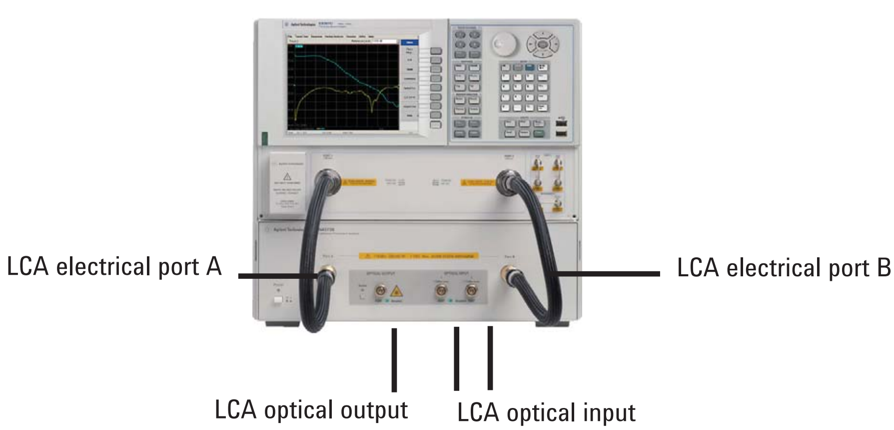
Frequency response repeatability

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.

Definition of LCA input and output names



Measurement capabilities

3dB cut-off frequency (S21),
Responsivity (S21),
Electrical reflection (S11 or S22),
Group Delay vs. frequency,
Insertion Loss (IL),
Transmission bandwidth,
all electrical S-parameter measurements.

Target test devices

Transmitter (E/O)

- Mach-Zehnder modulators
- Electro-absorption modulators (EAM)
- Directly modulated lasers
- Transmitter optical subassemblies (TOSA)

Receiver (O/E)

- PIN diodes
- Avalanche photodiodes (APD)
- Receiver optical subassemblies (ROSA)

Optical (O/O)

- Passive optical components
- Optical fibers and filters
- Optical transmission systems

Agilent N4373C Specifications

Measurement conditions

- Network analyzer set to -8 dBm electrical output power
- Modulation frequency range from 10 MHz to 65 GHz
- 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 differently stated).
- Network analyzer set to "stepped sweep" – sweep moves in discrete steps"
- Port 2 of network analyzer configured in reverse coupler configuration ("RCVB B in" to "CPLR THRU", "SOURCE OUT" to "CPLR ARM")
- After full two-port electrical calibration using an Electronic Calibration Module, Agilent N4694A, at constant temperature (±1° C).
- Modulation-bias optimization set to "every sweep"
- Using the supplied flexible test port cables 1.85mm f m (Part Number N4697-60200).
- Measurement frequency grid equals electrical calibration grid.
- Tested from Port 1 to Port 2.
- 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.

Transmitter and Receiver Specifications

Optical Test set		Option -302, -392
Operation frequency range		10 MHz to 67 GHz
Connector type	optical input	SMF angled with Agilent versatile connector interface
	optical output	
	optical source input (rear)	PMF angled, with Agilent versatile connector interface, polarization orientation aligned with connector key
	RF	1.85 mm male

LCA optical input	
Operating input wavelength range	1290 nm to 1610 nm [f4]
Maximum linear average input power [f1]	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 (typ.) [f1]	> 25 dBo
Average power measurement range[f1]	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 (typ.) [f1]	±0.5 dBo

LCA optical output (internal source)	
Optical modulation index (OMI) (typ.)	> 5 % @ -8 dBm RF power @ 1 GHz modulation frequency
Output wavelength (option -100, 102) (option -101, 102)	(1310 ± 10) nm (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 (typ.)[f2]	±0.5 dBo
Average output power stability, 15 minutes (typ.)	±0.5 dBo

External optical source input (-050)	
Required optical input power [f3]	+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 [f4]

LCA RF test port input	
Maximum safe input level at port A or B	+15 dBm RF, 7V DC

[f1] Wavelength within range as specified for LCA optical output.
[f2] After modulator optimization.
[f3] Required source characteristics: SMSR > 35dB, linewidth < 10MHz, power stability < 0.1dB pp, PER > 20dB, unmodulated, single mode.
[f4] Excluding water absorption wavelength.

Specifications for electro to optical measurements at 1310 nm (E/O mode)

N4373C system with network analyzer E8361C/A -014

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).

System performance		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	DUT response					
	≥ -24 dB(W/A) [f1]	±0.8 dBe typ.	±1.0 dBe (±0.7 dBe typ)	±1.1 dBe (±0.8 dBe typ)	±1.1 dBe (±0.8 dBe typ)	±2.4 dBe (±1.7 dBe typ)
	≥ -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	DUT response					
	≥ 24 dB(W/A) [f1]	±1.7 dBe typ	±2.4 dBe (±1.7 dBe typ)	±2.6 dBe (±1.8 dBe typ)	±2.7 dBe (±1.9 dBe typ)	±3.2 dBe (±2.2 dBe typ)
Frequency response repeatability (typ)	DUT response					
	≥ -24 dB(W/A)[f1]	±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
Minimum measurable frequency response (noise floor) [f2] [f4]		-64 dB(W/A)	-64 dB(W/A)	-64 dB(W/A)	-64 dB(W/A)	-59 dB(W/A)
Phase uncertainty (typ.) [f3]	DUT response					
	≥-24 dB(W/A) [f1]	±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)				

[f1] For DUT response max. -13 dB(W/A).

[f2] IFBW = 10 Hz.

[f3] 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 typ. (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).

[f4] Average value over frequency range.

Specifications for electro to optical measurements at 1550 nm (E/O mode)

N4373C system with network analyzer E8361C/A -014

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).

System performance		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	DUT response					
	≥ -26 dB(W/A) [f1]	±0.7 dBe typ.	±0.8 dBe (±0.6 dBe typ)	±0.8 dBe (±0.6 dBe typ)	±1.0 dBe (±0.7 dBe typ)	±1.6 dBe (±1.1 dBe typ)
	≥ -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	DUT response					
	≥ -26 dB(W/A) [f1]	±1.2 dBe typ	±1.8 dBe (±1.2 dBe typ)	±1.8 dBe (±1.2 dBe typ)	±1.9 dBe (±1.2 dBe typ)	±2.7 dBe (±1.8 dBe typ)
Frequency response repeatability (typ)	DUT response					
	≥ -26 dB(W/A)[f1]	±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 dBe	±2.0 dBe
Minimum measurable frequency response (noise floor) [f2] [f4]		-64 dB(W/A)	-64 dB(W/A)	-64 dB(W/A)	-64 dB(W/A)	-59 dB(W/A)
Phase uncertainty (typ.) [f3]	DUT response					
	≥-26 dB(W/A) [f1]	±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)				

[f1] For DUT response max. -13 dB(W/A).

[f2] IFBW = 10 Hz.

[f3] 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 typ. (cable length uncertainty < ±0.06 m). A constant group delay offset leads to a phase offset Δφ = 360° × ΔGD × fmod (in deg).

[f4] Average value over frequency range.

Specifications for optical to electrical measurements at 1310 nm (O/E mode)

N4373C system with network analyzer E8361C/A -014

Specifications are valid under the stated measurement conditions.

- For external source optical input all specifications are typical [f2][f5][f6].
- For wavelength: (1310 ±10) nm (option -100,102)

System performance		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 [f2]	DUT response					
	≥ -19 dB(A/W) [f1]	±0.8 dBe typ.	±1.0 dBe (±0.7 dBe [f7])	±1.1 dBe (±0.8 dBe [f7])	±1.7 dBe (±1.2 dBe [f7])	±2.2 dBe (±1.5 dBe [f7])
	≥ -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 f2]	DUT response					
	≥ -29 dB(A/W) [f1]	(±1.5 dBe [f7])	±2.4 dBe (±1.5 dBe [f7])	±2.4 dBe (±1.5 dBe [f7])	±2.8 dBe (±1.8 dBe [f7])	±3.2 dBe (±2.1 dBe [f7])
Frequency response repeatability (typ) f2]	DUT response					
	≥ -19 dB(A/W)[f1]	±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
Minimum measurable frequency response (noise floor) [f2] [f3][f8]		-60 dB(A/W)	-60 dB(A/W)	-60 dB(A/W)	-60 dB(A/W)	-55 dB(A/W)
Phase uncertainty (typ.) [f2,f4]	DUT response					
	≥-19 dB(A/W) [f1]	±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)				

[f1] For DUT response max. -10 dB(A/W).
[f2] For +4 dBm average output power from LCA optical output.
[f3] IFBW = 10 Hz.
[f4] 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 typ. (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).
[f5] After CW responsivity and user calibration with external source.
[f6] Requires option -100 or -102.
[f7] Typical with internal source.
[f8] Average value over frequency range.

Specifications for optical to electrical measurements at 1550 nm (O/E mode)

N4373C system with network analyzer E8361C/A -014

Specifications are valid under the stated measurement conditions.

- For external source optical input all specifications are typical [f2][f5][f6].
- For wavelength: (1550 ±20) nm (option -101,102)

System perfor-mance		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 uncer-tainty [f2]	DUT response					
	≥ -15 dB(A/W)[f1]	±0.7 dBe typ.	±0.8 dBe (±0.6 dBe [f7])	±0.9 dBe (±0.7 dBe [f7])	±1.2 dBe (±0.8 dBe [f7])	±1.9 dBe (±1.3 dBe [f7])
	≥ -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)	±0.8 dBe.	±0.7 dBe	±0.8 dBe	±1.3 dBe	±1.7 dBe
Absolute frequency response uncertainty f2]	DUT response					
	≥ -25 dB(A/W) [f1]	(±1.1 dBe [f7])	±1.9 dBe (±1.1 dBe [f7])	±1.9 dBe (±1.1 dBe [f7])	±2.0 dBe (±1.2 dBe [f7])	±2.8 dBe (±1.6 dBe [f7])
Frequency re-sponse repeatabil-ity (typ) f2]	DUT response					
	≥ -15 dB(A/W)[f1]	±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
Minimum measurable frequency response (noise floor) [f2] [f3][f8]		-60 dB(A/W)	-60 dB(A/W)	-60 dB(A/W)	-60 dB(A/W)	-55 dB(A/W)
Phase uncertainty (typ.) [f2,f4]	DUT response					
	≥-15 dB(A/W) [f1]	±3.5°	±3.0°	±2.4°	±3.2°	±5.0°
	≥-25 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)				

[f1] For DUT response max. -10 dB(A/W).
[f2] For +5 dBm average output power from LCA optical output..
[f3] IFBW = 10 Hz.
[f4] 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 typ. (cable length uncertainty <±0.06 m). A constant group delay offset leads to a phase offset $\Delta\phi = 360° \times \Delta GD \times f_{mod}$ (in deg).
[f5] After CW responsivity and user calibration with external source.
[f6] Requires option -101 or -102.
[f7] Typical with internal source.
[f8] Average value over frequency range.

Specifications for optical to optical measurements at 1310 nm (O/O mode)

N4373C system with network analyzer E8361C/A -014

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 all specifications are typical [f2][f5][f6].
- For wavelength: (1310 ±10) nm (option -100, 102)

System performance		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 [f2]	DUT response					
	≥ -3 dBe (≥-1.5 dBo) [f4]	±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 [f2]	DUT response					
	≥ -3 dBe (≥-1.5 dBo) [f4]	±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 dBe)
Frequency response repeatability (typ.) [f2]	DUT response					
	≥ -3 dBe (≥-1.5 dBo) [f4]	±0.02 dBe	±0.02 dBe	±0.03 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
Minimum measurable frequency response (noise floor) [f1] [f2][f7]		-55 dBe typ. (-27.5 dBo)	-42 dBe (-21 dBo)	-42 dBe (-21 dBo)	-42 dBe (-21 dBo)	-36 dBe (-18 dBo)
Phase uncertainty (typ.) [f2,f3]	DUT response					
	≥ -3 dBe [f4] (≥-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)				

[f1] IFBW = 10 Hz.
[f2] For +4 dBm average output power from LCA optical output.
[f3] 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).
[f4] For DUT response max. +6 dBe (+3 dBo) gain.
[f5] After CW responsivity and user calibration with external source.
[f6] Requires option -100 or -102.
[f7] Average value over frequency range.

Specifications for optical to optical measurements at 1550 nm (O/O mode)

N4373C system with network analyzer E8361C/A -014

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 all specifications are typical [f2][f5][f6]
- For wavelength: (1550 ±20) nm (option -101,102)

System performance		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 f2]	DUT response					
	≥ -3 dBe (≥-1.5 dBo) [f4]	±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 f2]	DUT response					
	≥ -3 dBe (≥-1.5 dBo) [f4]	±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 dBe)
Frequency response repeatability (typ.) f2]	DUT response					
	≥ -3 dBe (≥-1.5 dBo) [f4]	±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
Minimum measurable frequency response (noise floor) [f1] [f2][f7]		-55 dBe typ. (-27.5 dBo)	-42 dBe (-21 dBo)	-42 dBe (-21 dBo)	-42 dBe (-21 dBo)	-36 dBe (-18 dBo)
Phase uncertainty (typ.) [f2,f3]	DUT response					
	≥ -3 dBe [f4] (≥-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)				

[f1] IFBW = 10 Hz.
[f2] For +5 dBm average output power from LCA optical output.
[f3] 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).
[f4] For DUT response max. +6 dBe (+3 dBo) gain.
[f5] After CW responsivity and user calibration with external source.
[f6] Requires option -100 or -102.
[f7] Average value over frequency range.

Specifications for electrical-electrical measurements (E/E mode)

All specifications of the E8361C-014 Network Analyzer apply.
Please see the corresponding Network Analyzer data sheet and User's Guide.

Group delay uncertainty

For more details see specifications of the E8361C.

Group delay

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

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

Group delay uncertainty

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

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

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

Assembled dimensions: (H x W x D)

41.3 cm x 43.8 cm x 47.3 cm,
(16.3 in x 17.3 in x 18.7 in)

Weight

Product net weight:
38 kg (83.6 lbs)

Packaged product:
58 kg (127.6 lbs)

Power Requirements

100 to 240 V~, 50 to 60 Hz

2 power cables

E8361C-014	max. 350 VA
Optical test set:	max. 40 VA

Network-analyzer

Option 302	E8361C-014

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 re-calibration period

1 year

Shipping contents

1x Network-analyzer E8361C-014
1x N4373C optical test set
2x N4697-60200 f-m flexible test port MW cable
2x 85058-60121 test port adapter
1x N5520B-FG 1.85 mm (f)-(f), adapter DC – 67GHz
3x 81000NI optical adaptor

1x 8121-1242 USB cable
1x 1150-7896 Keyboard
1x 1150-7799 Mouse
1x E5525-10285 UK 6 report
1x 4373B-90A01 Getting started
1x 4373B-90CD1 Support CD
2x Local power cord
1x RoHS addendum for Photonic T&M Accesoires
1x RoHS addendum for Photonic T&M products

Additional, option dependent shipping contents:

-021 straight connector:
2x N4373-87907 0.5m FC/APC - FC/PC patch cord
1x 1005-0256 FC/FC feedthrougth adapter
-022 angled connector:
2x N4373-87906 0.5m FC/APC - FC/APC patch cord
1x 1005-1027 FC adaptor for angled-PC
-050 external optical source input
1x PMF patchcord 1.0m FC/APC narrow key
1x 81000NI optical adaptor FC

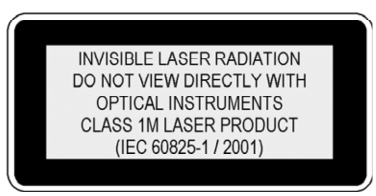
LCA connector types at optical testset

LCA electrical input	1.85 mm (f)
LCA electrical output	1.85 mm (m)
LCA optical input 1	9um single-mode angled [1], with Agilent universal adapter
LCA optical input 2	9um single-mode angled [1], with Agilent universal adapter
LCA optical output	9um single-mode angled[1], with Agilent universal adapter
LCA external source input (Option -050 only)	9um polarization maintaining single-mode angled, with Agilent universal adapter

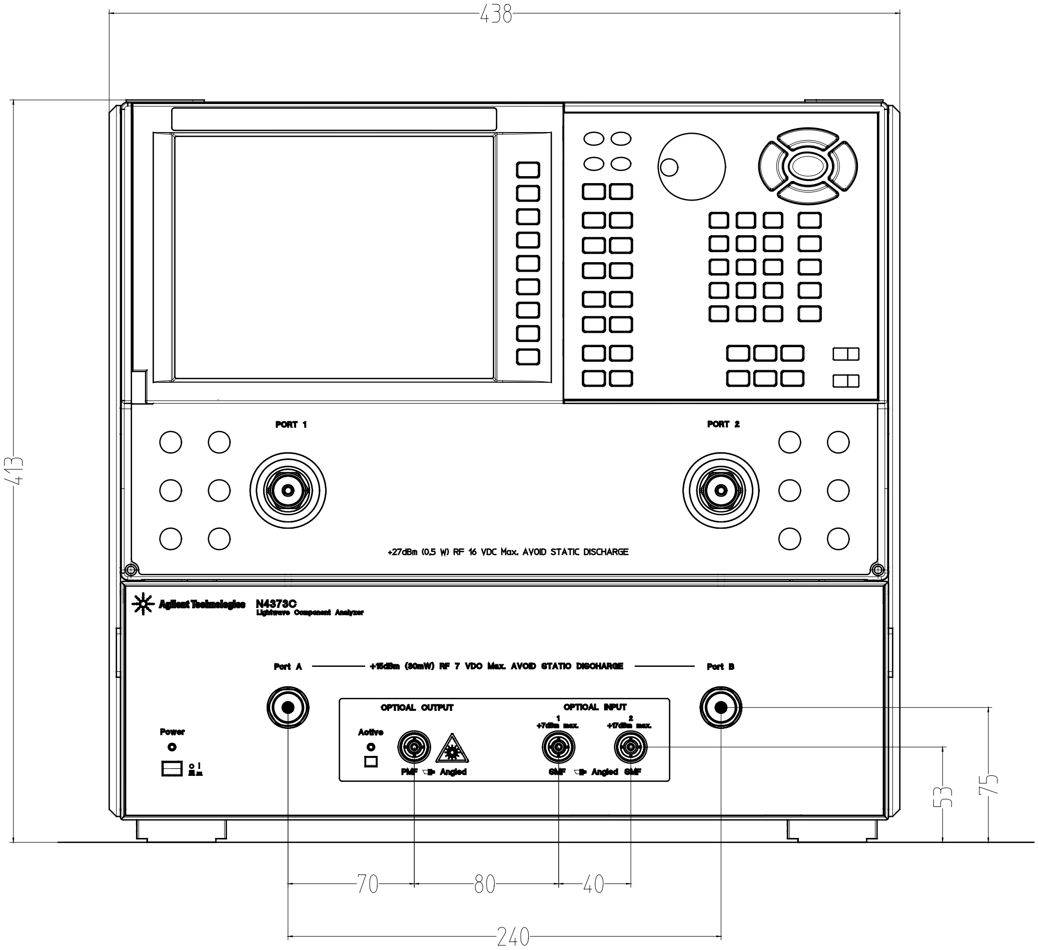
[1] The optical test set always has angled connectors. Depending on the selected option (-021 straight, -022 angled) the appropriate jumper cable will be delivered. This jumper cable must always be used in front to the optical test set to protect the connectors at the optical test set

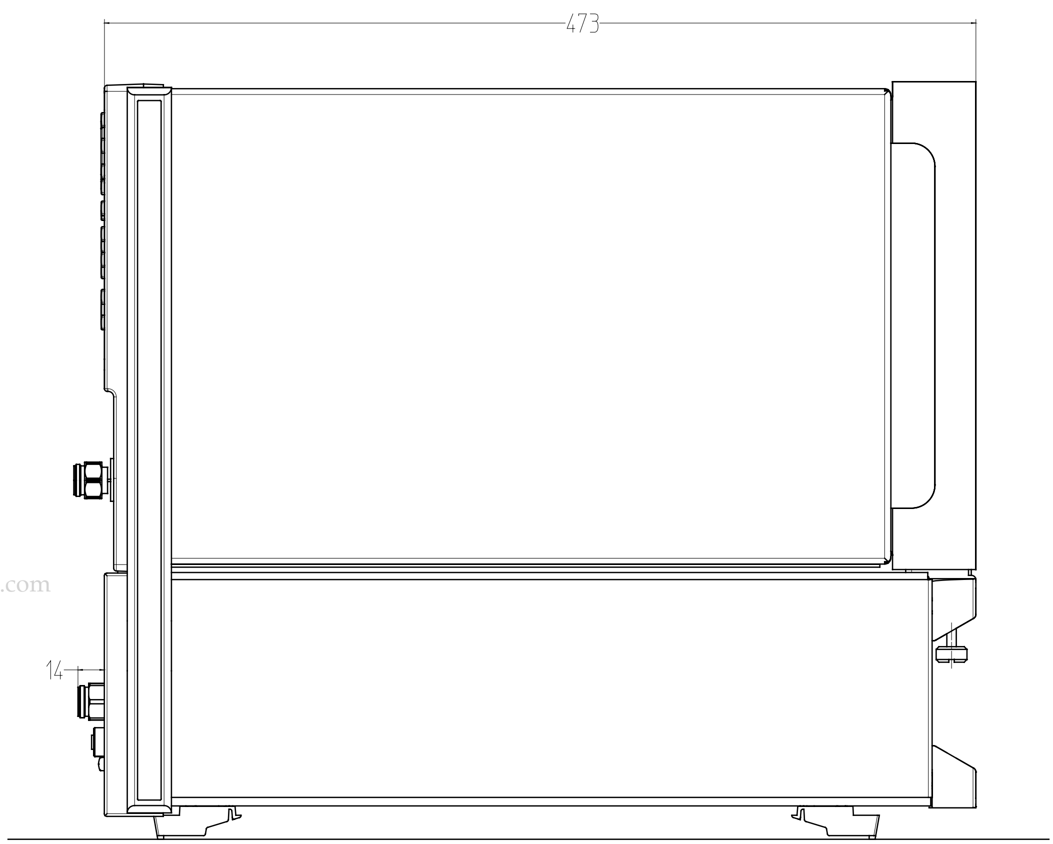
Laser Safety Information

All laser sources listed above are classified as Class 1M according to IEC 60825 1 (2001).
All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2001-July-26.



Mechanical Outline Drawings, option -302, -392 (all dimensions in mm)





Ordering informations

The N4373C consists of an optical test set and an electrical network analyzer which are mechanically connected.
To protect your network analyzer investment, Agilent offers the integration of an already owned PNA with the optical test set as listed below.
All systems have 1 year warranty.

N4373C LCA ordering options

Network-analyzer options	
N4373C - 302	67 GHz, 2 port PNA (E8361C-014)

Network-analyzer integration options	
N4373C - 392	Integration of customer's 67 GHz, 2 port PNA (E8361A/C-014, 010) all other NWA and options call factory

Optical wavelength options	
N4373C-100	1310nm Single Wavelength Source
N4373C-101	1550nm Single Wavelength Source
N4373C-102	1310 & 1550 nm Dual Wavelength Source

Configuration independent options	
N4373C-010	Time Domain Operation for Networkanalyzer
N4373C-050	Testset with external optical source Input
N4373C-021	Straight Fiber Interface single mode
N4373C-022	Angled Fiber Interface single mode

Service and Repair	
R1280A	1 year Return-to-Agilent warranty extended to 3 or 5 years
R1282A	Calibration up front support plan 3 or 5 year coverage

Required accessories (to be ordered separately)	
N4694A	2 port MW Electrical Calibration Module (-00F recommended)

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Product specifications and descriptions in this document subject to change without notice.

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