Agilent
N4376B
20 GHz and 26.5 GHz Multimode Lightwave Component Analyzer
Data Sheet

Agilent Technologies

General Information

Agilent's N4376B Lightwave Component Analyzer (LCA) is the instrument of choice to test short wavelength 10G Ethernet, Fibre Channel FCx8, FCx10 and FCx16 electro-optical components, with up to 20 or 26.5 GHz modulation range. The N4376B also supports the test of transmitter and receivers for optical computer backplanes and optical chip-to-chip connections in high speed computers and server applications.

Modern optical transmission and datacom systems require fast, accurate and repeatable characterization of the core electro-optical components. These core subcomponents (lasers, modulators and detectors) have significant impact on the performance of the transmitter and the receiver with respect to modulation bandwidth, jitter, gain, and distortion of the final transceiver.

For frequency dependent responsivity measurements the N4376B extends opto-electronic S-parameter measurements to multimode devices in the 850 nm wavelength range, which was not possible with the standard 8703A/B LCA 8703A/B.

With a completely new design of the optical test set and a new RF-switched architecture, together with the latest PNA family of network analyzers, the N4376B guarantees excellent electro-optical measurement performance. In addition a unique new calibration concept significantly reduces time from powering up the LCA until the first calibrated measurement can be made. This increases productivity in R&D and on the manufacturing floor.

The fully integrated "turnkey" solution reduces time to market, compared to the time-consuming development of a self-made setup.

By optimizing the electrical and optical design of the N4376B for lowest noise and ripple, the accuracy has been improved by more than a factor of 3 and is now independent of the electrical reflection coefficient of the device under test.

It's the excellent accuracy that improves the yield from tests performed with the N4376B, by narrowing margins needed to pass the tested devices. Traceability ensures worldwide comparability of test results.

The advanced optical design together with temperature-stabilized transmitter and receiver ensures repeatable measurements over days without recalibration.

Using the advanced measurement capabilities of the network analyzer, all S-parameter related characteristics of the device under test, like responsivity, ripple and 3dB-cutoff frequency, can be qualified with the new N4376B Lightwave Component Analyzer from 10 MHz to 20/26.5 GHz.

The network analyzer

The N4376B comes in two basic versions. The economic line is based on a PNA-L network-analyzer and is available as a 2 port system. The high end version is based on the new PNA-X and, extended optical modulation index (OMI) and is available with 2 or4 ports. The PNA-X based LCA is calibrated up to 26.5 GHz.

Key benefits

- **Traceable multimode S21 test, right at 850 nm target wavelength.**
- **IEEE 802.3ae launched power distribution leads to test results comparable to the final application**
- **Fast and easy measurement setup and calibration for all standard tests**
- **High confidence and fast time-to-market with a 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.**
- **Test right at target launch condition eliminates test uncertainty**
- **Identical LCA software and remote control across the N437xB family simplifies integration**

Relative frequency response uncertainty @ 20GHz:
± 1.5 dB
± 1.0 dB (typical)

Absolute frequency response uncertainty @ 20GHz:
± 2.0 dB (typ.)for E/O measurements
± 1.8 dB (typ.)for O/E measurements

Noise floor @ 20GHz:
-69 dB W/A for E/O measurements
-68 dB A/W for O/E measurements

Transmitter wavelength:
850 nm ± 10 nm

Supported connectors
LC or SC straight

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 N4376B Lightwave Component Analyzer;
Extension to 3 years available.

Agilent N4376B Applications

In digital photonic transmission systems, the performance is ultimately determined by bit error ratio test (BERT), which describes the performance of the whole system. However it is necessary to design and qualify subcomponents like modulators and receivers, which are analog by nature, with different parameters. Those parameters are core to the overall system performance.
These electro-optical components significantly influence the overall performance of the transmission system via 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

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 amplified or unamplified 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 parallel the LCA also measures the electrical return loss.
In manufacturing it is important to be able to monitor the processes regularly to keep up the throughput and yield. In this case the LCA is the tool of choice to monitor transmission characteristics and absolute responsivity of the manufactured device. The remote control of the N4376B offers another tool to improve the productivity by making automated measurements and analysis of the measured data.

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 linearity. The new switched architecture offers direct access to the electrical outputs and inputs of the network-analyzers just by selecting electrical- to electrical measurement mode in the LCA user interface.

Agilent N4376B 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 N4376B 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 N4376B.

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 N4376B, the tasks that have to be done by the user are reduced to one pure electrical calibration. The calibration with an electrical microwave 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 N4376B'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.
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 (ROSA's) 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.

Large signal measurements

LCA S21 measurements are typically small-signal linear transfer function measurements. If an electro-optical component must be tested under large signal conditions, normal balanced measurements might lead to wrong measurement results.

The PNA-X based version of the LCA offers true balanced measurements for differential ports by offering two independent high power RF sources. With this setup the LCA measures the correct S21 transfer function of E/O components, even in the nonlinear regime.

To stimulate O/E components like PIN-TIA receivers under optical large signal conditions, the PNA-X based LCA offers a variable optical modulation index > 50%.

IEEE 802.3ae multimode launch condition

Multimode measurements are typical much more critical regarding repeatability and stability than single mode measuremts. To minimize these effects it is necessary to have well defined and stable mode filling of the transmitter fiber. The N4376B has typical multimode launch conditions or power-distribution in the transmitter fiber as defined by the IEEE 802.3ae standard.

The IEEE 802.3ae power-distribution compliance of the N4376B transmitter leads to application realistic and repeatable test results.

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 at the RF amplitude at the device output to the amplitude of the modulated optical signal input. .

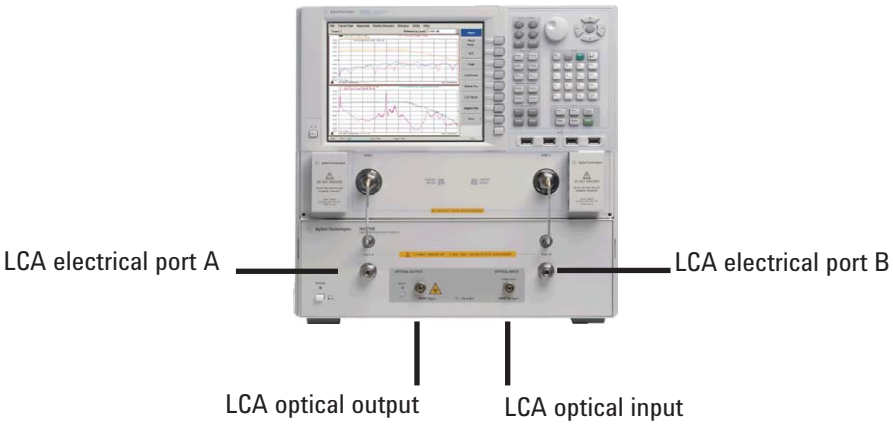
Relative frequency response uncertainty
Describes the maximum deviation of the shape of a measured trace from the (unknown) real trace. This specification has strong influence on the accuracy of the 3-dB cut-off frequency determined for the device under test.

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),
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 multimode fibers
- Optical transmission systems

Agilent N4376B Specifications

Measurement conditions
- Modulation frequency range from 10 MHz to 20.0 GHz
- Foreward RF power +3 dBm
- Reverse RF power 0 dBm
- 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"
- All network-analyzer ports configured in standard coupler configuration ("CPLR ARM" to "RCVB B in", "SOURCE OUT" to "CPLR THRU")
- After full two-port electrical calibration using an Electronic Calibration Module, Agilent N4691B, at constant temperature (±1° C)
- Modulator bias optimization set to "continous sweep"
- Measurement frequency grid equals electrical calibration grid
- 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 and RF cables in perfect condition
- 50 µm FC/APC to FC/PC patchcord at the input and output
- Launched power distribution according to IEEE 802.3ae - 2002, see fig 1
- Test performed using an optical reference source with return loss better 45 dB, spectral width FWHM < 10MHz and InGaAs detector

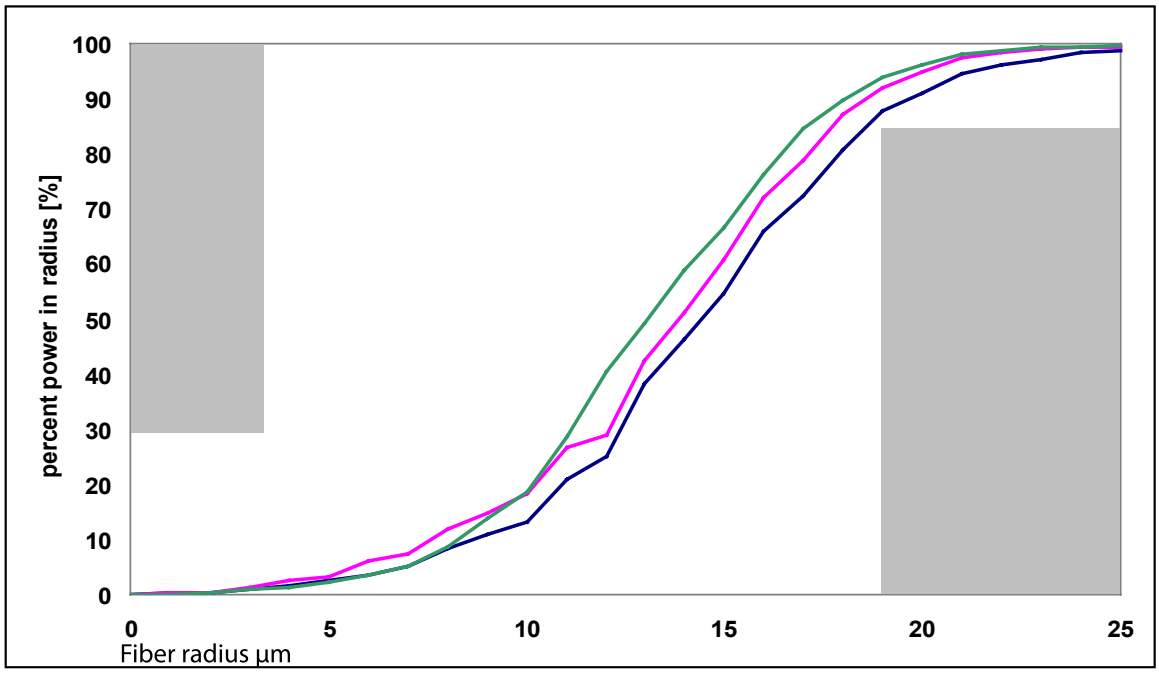


Fig 1; IEEE 802.3ae launch conditions measured with 3 examples

Transmitter and Receiver Specifications

Optical Test set		Option -322, -382	Option -312, -314, -392, -394
Operation frequency range		10 MHz to 20 GHz	10 MHz to 26.5 GHz
Connector type (optical testset)	optical input	62.5 µm MMF angled with Agilent versatile connector interface	
	optical output	50 µm MMF angled with Agilent versatile connector interface	
	RF	3.5 mm male	
LCA optical input			
Operating input wavelength range		750 nm to 1650 nm	
Maximum linear average input power [f1]		Optical input: -1 dBm	
Maximum safe average input power		Optical input: +3 dBm	
Optical return loss (typ.) [f1]		> 14 dB	
Average power measurement range[f1]		Optical input: -25 dBm to -1 dBm	
Average power measurement uncertainty (typ.) [f1]		±0.7 dBo	
LCA optical output			
Optical modulation index (OMI) at 10 GHz (typ.)		25 % @ +3 dBm RF (typ.) 31 % @ +5 dBm RF (typ.)	
Output wavelength		(850 ± 10) nm	
Lauched Power Distribution (typical)		according to IEEE 802.3ae - 2002	
Average output power range		-5 dBm to -1 dBm	
Average output power uncertainty (typ.)[f2]		±0.7 dBo	
Average output power stability, 15 minutes (typ.)		±0.5 dBo	

[f1] Wavelength within range as specified for LCA optical output
[f2] After modulator optimization

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

For detailed specification of the network analyzer see corresponding data sheet.

N4376B: option -322, -382 N5230C -225
option -312, -392 N5242A -200
option -314, -394 N5242A -400

Optical test set

Electrical loss of optical test set	< 2.0 dBe (typ.)

Specifications for electro-optical measurements at 850 nm (E/O mode)

N4376B system with network analyzer N5230C -225
N5242A -200
N5242A -400

Specifications are valid under the stated measurement conditions.

- For wavelength: (850 ±10) nm

System performance		0.05 GHz to 0.2 GHz	0.2 GHz to 10 GHz	10 GHz to 20 GHz
Relative frequency response uncertainty	DUT response			
	≥ -26 dB(W/A) [f1]	±1.0 dBe typ.	±1.3 dBe (±0.9 dBe typ)	±1.5 dBe (±1.0 dBe typ)
	≥ -36 dB(W/A)	±1.0 dBe typ.	±0.9 dBe typ.	±1.0 dBe typ.
	≥ -46 dB(W/A)	±1.1 dBe typ.	±0.9 dBe typ.	±1.3 dBe typ.
Absolute frequency response uncertainty (typ.)	DUT response			
	≥ 26 dB(W/A) [f1]	±2.1dBe	±2.0 dBe .	±2.0 dBe
Frequency response repeatability (typ.)	DUT response			
	≥ -26 dB(W/A) [f1]	±0.1 dBe	±0.1 dBe	±0.1 dBe
	≥ -36 dB(W/A)	±0.15 dBe	±0.1 dBe	±0.15 dBe
Minimum measurable frequency response (noise floor) [f2] [f4]		-65 dB(W/A)	-82 dB(W/A)	-69 dB(W/A)

[f1] For DUT optical peak output power ≤ +0 dBm.
[f2] IFBW = 10 Hz.
[f4] Note: average value over frequency range.

Specifications for opto-electrical measurements at 850 nm (O/E mode)

N4376B system with network analyzer N5230C -225
N5242A -200
N5242A -400

Specifications are valid under the stated measurement conditions.

- For wavelength: (850 ±10) nm

System performance		0.05 GHz to 0.2 GHz	0.2 GHz to 10 GHz	10 GHz to 20 GHz
Relative frequency response uncertainty	DUT response			
	≥ -21 dB(A/W) [f1]	±1.0 dBe typ.	±1.3 dBe (±0.9 dBe typ)	±1.5 dBe (±1.0 dBe typ)
	≥ -31 dB(A/W)	±1.0 dBe typ.	±0.9 dBe typ.	±1.1 dBe typ.
	≥ -41 dB(A/W)	±1.2 dBe typ.	±0.9 dBe typ.	±1.5 dBe typ.
Absolute frequency response uncertaint (typ.)	DUT response			
	≥ 21 dB(A/W) [f1]	±1.9 dBe	±1.7 dBe	±1.8 dBe
Frequency response repeatability (typ.)	DUT response			
	≥ -21 dB(A/W) [f1]	±0.25 dBe	±0.1 dBe	±0.2 dBe
	≥ -31 dB(A/W)	±0.3 dBe	±0.1 dBe	±0.25 dBe
Minimum measurable frequency response (noise floor) [f3] [f4]		-58 dB(A/W)	-77 dB(A/W)	-68 dB(A/W)

[f1] For DUT response max +15 dB (A/W)
[f2] Output power set to -1 dBm
[f3] IFBW = 10 Hz.
[f4] Note: average value over frequency range

Specifications for optical-optical measurements at 850 nm (O/O mode)

N4376B system with network analyzer N5230C -225
N5242A -200
N5242A -400

Specifications are valid under the stated measurement conditions.

- For wavelength: (850 ±10) nm

System performance		0.05 GHz to 0.2 GHz	0.2 GHz to 10 GHz	10 GHz to 20 GHz
Relative frequency response uncertainty[f2]	DUT response			
	≥ -10 dBe [f1] [f2] (≥ -5.0 dBo)	±0.5 dBe typ. (±0.25 dBo)	±0.4 dBe (±0.2 dBo)	±0.5 dBe (±0.25 dBe)
Absolute frequency response uncertainty (typ.)	DUT response			
	≥ -10 dBe [f1][f2] (≥ -5 dBo)	±1.1 dBe	±1.0 dBe	±1.0 dBe
Frequency response repeatability (typ.)	DUT response			
	≥ -10 dBe [f1] [f2] (≥ -5 dBo)	±0.15 dBe	±0.1 dBe	±0.15 dBe
Minimum measurable frequency response (noise floor) [f2] [f3] [f4]		-53 dBe (-26.5 dBo)	-70 dBe (-35 dBo)	-44 dBe (-22 dBo)

[f1] For DUT response max. 0 dB
[f2] Average power from LCA optical output set to -1 dBm.
[f3] IFBW = 10 Hz.
[f4] Note: average value over frequency range.

General Characteristics

Assembled dimensions: (H x W x D)

Option

-312, -314	41.3 cm x 43.8 cm x 53.8 cm, (16.3 in x 17.3 in x 21.2 in)
-322	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:

-312	36 kg (79.4 lbs)
-314	46 kg (101.4 lbs)
-322	34 kg (74.9 lbs)

Packaged product:

-312	56 kg (123.5 lbs)
-314	66 kg (145.7 lbs)
-322	54 kg (119 lbs)

Power Requirements

100 to 240 V~, 50 to 60 Hz

2 power cables

N5230C	max. 350 VA
N5242A	max 450 VA
Optical test set:	max. 40 VA

Network-analyzer

Option 312	N5242A -200
Option 314	N5242A -400
Option 322	N5230C- 225

Storage temperature range

-40° C to +70° C

Operating temperature range

+5° C to +32° 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 depending on option selected
1x N4376B optical test set
2x 81000 NI optical adaptor
1x 4376B-90A01 Getting started
1x 4375B-90CD1 LCA support CD
1x 1150-7896 Keyboard
1x 1150-7799 Mouse
1x 8121-1242 USB cable
1x E5525-10285 UK6 report
1x N4373-61627 electrical short cut cable
1x 9320-6677 RoHS addendum for Photonic T&M accessories
1x 9320-6654 RoHS addendum for Photonic T&M products

Additional, option dependent shipping contents:

-023 2x LC 50µm to FC/APC 0.5 m patch cord
-024 2x LC 62.5µm to FC/APC 0.5 m patch cord
-025 2x SC 50µm to FC/APC 0.5 m patch cord
-026 2x SC 62.5µm to FC/APC 0.5 m patch cord

-312, 322 2 port LCA:
1x E7342-60004 0.5 m (m) to (f) high performance RF cable
-314 4 port LCA:
2x E7342-60004 0.5 m (m) to (f) high performance RF cable

LCA connector types [1]

Optical test set

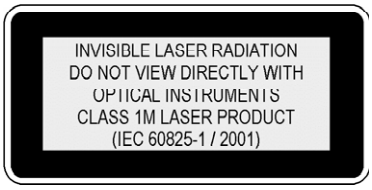
LCA port A	3.5 mm (m)
LCA port B	3.5 mm (m)
LCA optical input	62.5 µm single-mode angled [1], with Agilent universal adapter
LCA optical output	50 µm single-mode angled[1], with Agilent universal adapter

[1] The optical test set always has angled connectors.
For input and output a 50 µm or 62.5 µm angled to straight LC or SC patchcord must be selected The connection to the DUT is always either LC or SC straight.

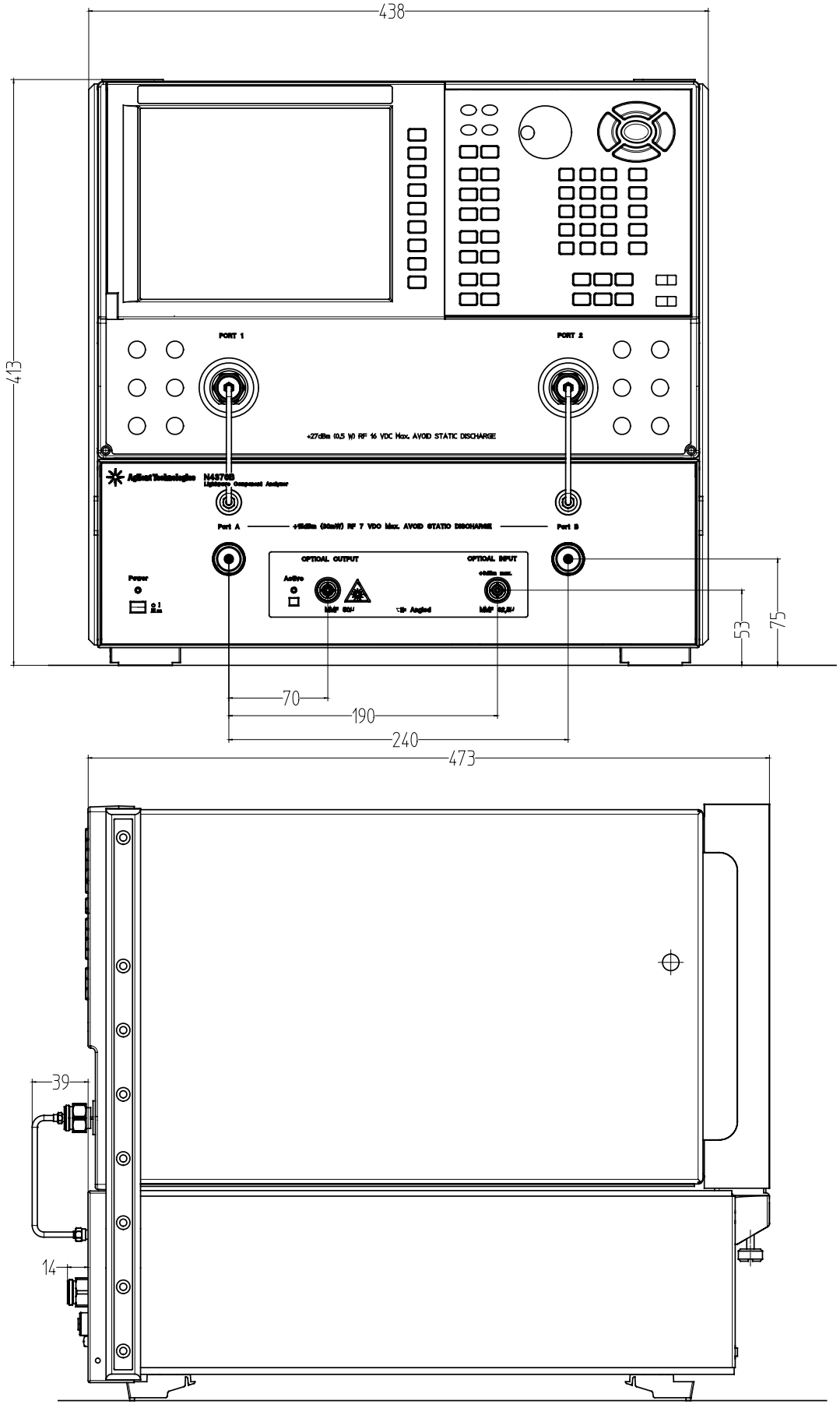
The jumper cable must always be used in front of the optical testset to protect the connectors of the optical testset.

Laser Safety Information

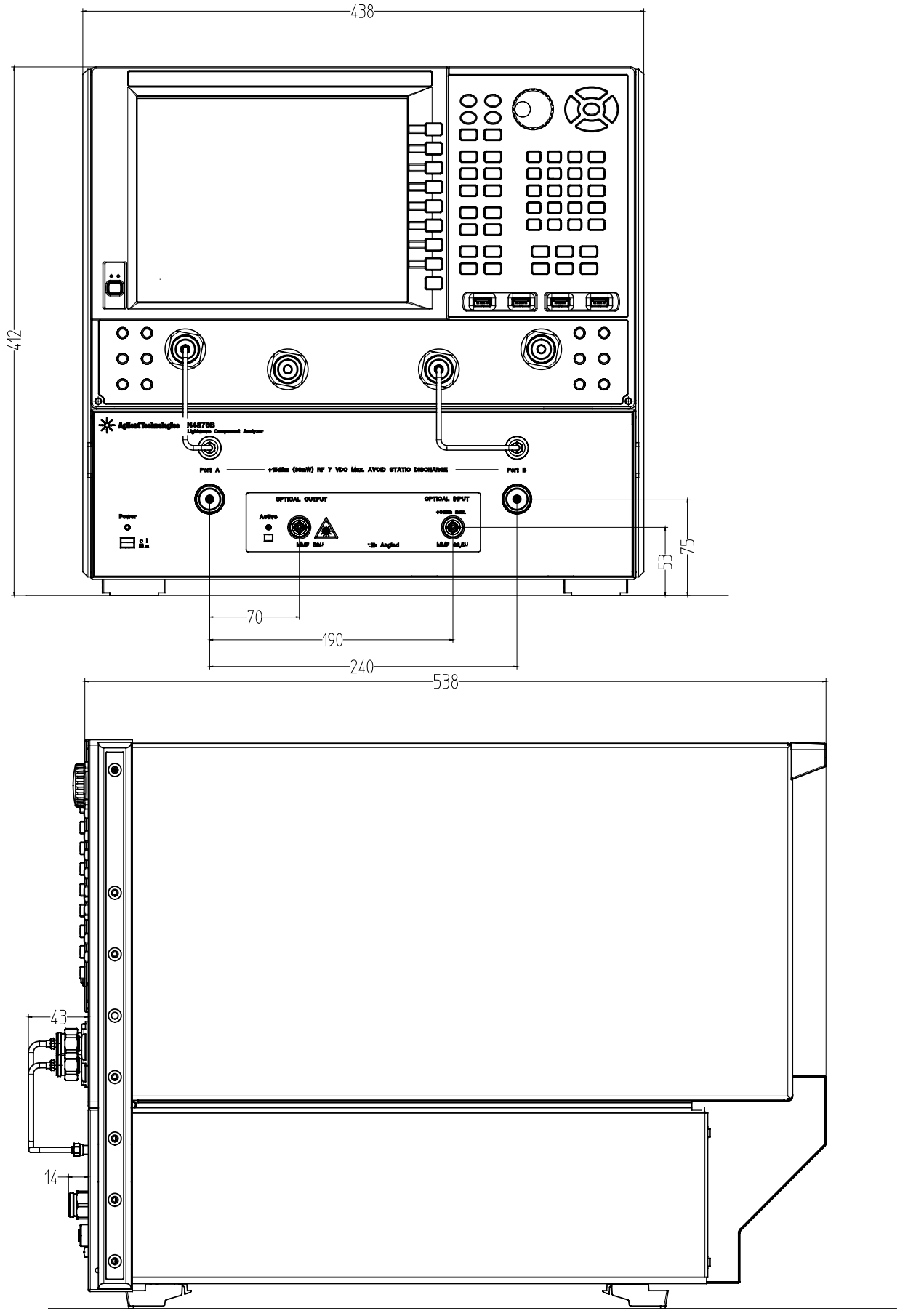
All laser sources listed above are classified as Class 1M according to IEC 60825 1 (2001).
All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2001-July-26.



Mechanical Outline Drawings, option -322, -382 (all dimensions in mm)



Mechanical Outline Drawings, option -312, -314, -392, -394 (all dimensions in mm)



Ordering informations

The N4376B 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-L or PNA-X with the optical test set as listed below.
All systems have 1 year warranty.

N4376B LCA ordering options

Network-analyzer options	
N4376B - 312	20 GHz 2 port LCA based on N5242A -200
N4376B - 314	20 GHz 4 port LCA based on N5242A -400
N4376B - 322	20 GHz 2 port LCA based on N5230C -225

Network-analyzer integration options	
N4376B - 382	Integration of customer PNA-L - N5230A/C -220, -225
N4376B - 392	Integration of customer PNA- X - N5242A -200, - N5242A -219 (all specifications typical, max Bias-T voltage 7V, max current 200mA)
N4376B - 394	Integration of customer PNA- X - N5242A -400, - N5242A -419 (all specifications typical, max Bias-T voltage 7V, max current 200mA)

Wavelength options	
N4376B - 103	850 nm optical testset

Other options	
N4376B - 010	Time domain
N4376B - 023	LC 50µm connector interface (external 0.75 m patch cord)
N4376B - 024	LC 62.5µm connector interface (external 0.75 m patch cord)
N4376B - 025	SC 50µm connector interface (external 0.75 m patch cord)
N4376B - 026	SC 62.5µm connector interface (external 0.75 m patch cord)

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

Required accessories (to be ordered separately)	
N4691B	2 port microwave electrical calibration module (-00F recommended)

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Optical instruments online information

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

Lightwave Component Analyzers
www.agilent.com/find/lca

Polarization solutions
www.agilent.com/find/pol

Spectral analysis products
www.agilent.com/comms/octspectral

Electro-optical converters
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Remove all doubt

Our repair and calibration services will get your equipment back to you, performing like new, when promised. You will get full value out of your Agilent equipment throughout its lifetime. Your equipment will be serviced by Agilent-trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements.

Agilent offers a wide range of additional expert test and measurement services for your equipment, including initial start-up assistance onsite education and training, as well as design, system integration, and project management.

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Agilent Direct

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Quickly choose and use your test equipment solutions with confidence.

Agilent Open

www.agilent.com/find/open
Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

LXI

www.lxistandard.org
LXI is the LAN-based successor to GPIB, providing faster, more efficient connectivity. Agilent is a founding member of the LXI consortium.

www.agilent.com

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	*0.125 €/minute
Germany	01805 24 6333**
	**0.14 €/minute
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
Switzerland	0800 80 53 53
United Kingdom	44 (0) 118 9276201

Other European Countries:
www.agilent.com/find/contactus

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

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