Keysight N4373E Lightwave Component Analyzer

User's Guide

KEYSIGHT TECHNOLOGIES

Notices

Manual Part Number

4373E-90B01

Edition

Edition 2.0, January 2020

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Safety Notices

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

1 Introduction

Documentation

The documentation for the Keysight N4373E Lightwave Component Analyzer consists of

- The documentation for the Keysight network analyzer. This documentation i s on the hard disk of the network analyzer. Refer to it for using the network analyzer for electrical to electrical measurements, or for the configuration of the network analyzer.
- The documentation for the optical test set and the Lightwave Component Analyzer application. Refer to this documentation for information on using the optical test set, together with the network analyzer, for optical to optical, electrical to optical and optical to electrical measurements, or for setting up your light wave component analyzer.

General Safety Considerations

This product has been designed and tested in accordance with the standards listed on the manufacturer's Declaration of Conformity (see Declaration of Conformity on page -167), and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Safety symbols

CAUTION **The caution sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.**

WARNING **The warning sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.**

Instrument markings

The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.

The laser radiation symbol. This warning symbol is marked on products which have a laser output.

The Off-On symbols are used to mark the positions of the instrument power operating switch.

The recycling symbol indicates the general ease with which the instrument can be recycled.

N10149

The C-Tick mark is the certification mark of the Australian Communications Authority.

ICES/NMB-001

ISM GRP 1-A

The CE mark is the conformity marking of the European Community.

LR 53538 C

The CSA mark is a the certification mark of the Canadian Standards Association.

WARNING If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

WARNING No operator serviceable parts inside. Refer servicing to qualified service personnel. To prevent electrical shock do not remove covers.

WARNING This is a Safety Class 1 Product (provided with protective earth). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

WARNING

To prevent electrical shock, disconnect the instrument from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

WARNING

Using controls or adjustments or performing procedures other than those specified in the documentation supplied with your equipment can result in hazardous radiation exposure.

CAUTION

This product complies with over-voltage Category II and Pollution Degree 2.

CAUTION

Ventilation requirements: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

CAUTION

Install the instrument so that the power switch is readily identifiable and is easily reached by the operator. This is the instrument disconnecting device. It disconnects the mains circuit from the mains supply before other parts of the instrument. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

CAUTION

Always use the three-prong AC power cord supplied with this instrument. Failure to ensure adequate earth grounding by not using this cord may cause instrument damage.

CAUTION This instrument has autoranging line voltage input. Be sure the supply voltage is within the specified range.

Initial safety information

The laser source used in the Lightwave Component Analyzer is 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.

Laser Safety

Laser class 1M label

Figure 1 Class 1M Safety Label

A sheet of laser safety labels is included. In order to meet the requirements of IEC 60825-1 (2014) we recommend that you stick the laser safety labels, in your language, onto a suitable location on the outside of the instrument where they are clearly visible to anyone using the instrument.

Table 1

	N4373E	
	#100, #102	#101, #102
Laser Wavelength range	1310 ± 20 nm	1550 ± 20 nm
Laser Type	DFB	DFB
Laser Class according to IEC 60825-1 (2014)	1M	1M
Max. permissible CW output power of LCA*	< 15 mW	< 15 mW
Max. permissible CW output power	300 mW	163 mW
Numerical aperture	0.1	0.1
Beam waist diameter	<10 µm	<10 µm

** CW output power is defined as the highest possible optical output power that the laser source can produce at the output connector*

WARNING

Please pay attention to the following laser safety warnings:

- Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.The laser radiation can seriously damage your eyesight.
- Do not enable the laser when there is no fiber attached to the optical output connector.
- The laser is enabled by the software or by pressing the laser switch on the front panel. The laser is on when the green LED above the switch is lit.
- The use of the instruments, such as microscopes or spectacles, with this product will increase the hazard to your eyes.
- The laser module has built-in safety circuitry which will disable the optical output in the case of a fault condition.
- Refer servicing only to qualified and authorized personnel

Line power requirements

CAUTION

The Keysight N4373E Lightwave Component Analyzer complies with over-voltage category II and can operate from the single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range 50 to 60 Hz. The maximum power consumption of the optical test set is 40 VA with all options installed.

Please refer to the documentation for your network analyzer for information on its line power requirements.

Line power connectors

In accordance with international safety standards, the instrument has a three- wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Please refer to Power Cords on page -176 for the part numbers of available power cables.

WARNING

To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.

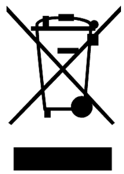
- Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not use an extension cord without a protective conductor. Using an extension cord without a protective conductor means the instrument is not earthed.
- Do not interrupt the protective earth connection intentionally.
- Do not remove protective covers. Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.
- Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.
- Defective, damaged, or malfunctioning instruments must be returned to an Keysight Technologies Service Center.
- Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Environmental information

This product is intended for indoor use only.

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.



Do not dispose in domestic household waste.

To return unwanted products, contact your local Keysight office, or see about

https://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

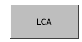
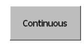
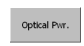
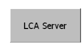
Optical Test Set Front and Rear Panels

2-port PNA version

Figure 2 Front Panel

For further information on the front panel of the network analyzer, please refer to the documentation supplied with the network analyzer.

1	Power switch	Turns on the optical test set. To turn on the PNA, press the PNA's power key.
2	Port A	**Caution:** Be sure you do not exceed the RF power values and DC levels noted on the front panel of the instrument. This is the input port of the optical test set. It is used to connect the optical test set to the PNA.
3	Laser switch	Press the switch to turn the laser on (LED on), and off (LED off). The laser can also be switched on and off from the LCA Measurement Setup Macro (in the LCA System Settings menu), or remotely. This switch overrides other. Pressing this switch during a measurement will invalidate your results.
4	Optical Output	**Warning:** Laser Radiation can damage your eyesight! Refer to Laser Safety on page -14 for safety instructions. This is the output of the optical transmitter of the lightwave component analyzer.
5	Optical Input 1 (low power)	**Caution:** Do not apply more than +7 dBm (maximum safe average input power). This input is the standard optical input to the optical test set for optical powers up to +4 dBm.
6	Optical Input 2 (high power)	**Caution:** Do not apply more than +17 dBm (maximum safe average input power). This is the input to use if your peak optical input power is between +4 dBm and +14 dBm. This input has reduced sensitivity.
7	Port B	Output port of the optical test set. It is used to connect the optical test set to the PNA.

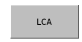
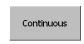
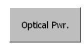
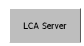
8	Function keys	Used to control the Lightwave Component Analyzer. Press the [Macro/Local] Utility button on the network analyzer to display the LCA function keys. •  : Setup an LCA Measurement •  : Perform a single sweep measurement with the current measurement setup •  : Perform continuous sweep measurements with the current measurement setup •  : Start the optical power meter •  : Start the LCA server (if not already running)
9	Network analyzer Port 2	This is an S parameter measurement port of the network analyzer. Depending on the S parameters of the measurement this can be either an RF input or an RF output.
10	Network analyzer Port 1	This is an S parameter measurement port of the network analyzer. Depending on the S parameters of the measurement this can be either an RF input or an RF output.

4-port PNA version

Figure 3 Front Panel

For further information on the front panel of the network analyzer, please refer to the documentation supplied with the network analyzer.

1	Power switch	Turns on the optical test set. To turn on the PNA, press the PNA's power key.
2	Port A	**Caution:** Be sure you do not exceed the RF power values and DC levels noted on the front panel of the instrument. This is the input port of the optical test set. It is used to connect the optical test set to the PNA.
3	Laser switch	Press the switch to turn the laser on (LED on), and off (LED off). The laser can also be switched on and off from the LCA Measurement Setup Macro (in the LCA System Settings menu), or remotely. This switch overrides other. Pressing this switch during a measurement will invalidate your results.
4	Optical Output	**Warning:** Laser Radiation can damage your eyesight! Refer to Laser Safety on page -14 for safety instructions. This is the output of the optical transmitter of the lightwave component analyzer.
5	Optical Input 1 (low power)	**Caution:** Do not apply more than +7 dBm (maximum safe average input power). This input is the standard optical input to the optical test set for optical powers up to +4 dBm.
6	Optical Input 2 (high power)	**Caution:** Do not apply more than +17 dBm (maximum safe average input power). This is the input to use if your peak optical input power is between +4 dBm and +14 dBm. This input has reduced sensitivity.
7	Port B	This is the output port of the optical test set. It is used to connect the optical test set to the PNA.

8	Function keys	Used to control the Lightwave Component Analyzer. Press the [Macro/Local] Utility button on the network analyzer to display the LCA function keys under Macro 1 group. •  : Setup an LCA Measurement •  : Perform a single sweep measurement with the current measurement setup •  : Perform continuous sweep measurements with the current measurement setup •  : Start the optical power meter •  : Start the LCA server (if not already running)
9	Network analyzer Port 1	This is an S parameter measurement port of the network analyzer. Depending on the S parameters of the measurement this can be either an RF input or an RF output.
10	Network analyzer Port 3	This is an S parameter measurement port of the network analyzer. Depending on the S parameters of the measurement this can be either an RF input or an RF output.
11	Network analyzer Port 2	This is an S parameter measurement port of the network analyzer. Depending on the S parameters of the measurement this can be either an RF input or an RF output.
12	Network analyzer Port 4	This is an S parameter measurement port of the network analyzer. Depending on the S parameters of the measurement this can be either an RF input or an RF output.

Rear panel

Figure 4 Rear Panel

For information on the rear panel of the network analyzer, please refer to the documentation supplied with the network analyzer.

1	USB	The software on the network analyzer uses the USB port to control the optical test set.
2	External Input	Plug in an external laser source.
3	Line power cable connector	Plug in your power cable here.

2 Setting Up the Instrument

Unpacking the Lightwave Component Analyzer

Unpack your shipment.

- Inspect the shipping containers for damage.
- Inspect the instruments.
- Verify that you received the options and accessories that you ordered.

Keep the shipping containers and cushioning material until you have inspected the contents of the shipment for completeness and have checked the equipment mechanically and electrically.

The shipment should contain

- 1x network-analyzer depending on the option selected
- 1x N4373E optical test set
- 2x 85058-60121 test port adapter
- 3x 81000NI optical adapter
- 1x 8121-1242 USB cable
- 1x 0960-3245 Keyboard
- 1x 0960-3248 Mouse
- 1x E5525-10285 UK 6 report
- 1x 4373E-90A01 Setup Guide
- 1x 4373B-90CD1 Support CD
- 2x Local power cord
- 1x RoHS addendum for Photonic T&M Accessories
- 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 feedthrough adapter
- -022 angled connector
  - 2x N4373-87906 0.5m FC/APC - FC/APC patch cord
  - 1x 1005-1027 FC/FC feedthrough adapter for narrow key
- -050 external optical source input
  - 1x PMF patch cord 1.0 m FC/APC narrow key
  - 1x 08154-61723 optical adapter FC (equivalent to 81000NI)

- 43.5/50 GHz LCA
  - N5224B or N5225B 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)
  - 1x 85056-60006 (2.4 mm f-f adapter)
- 67 GHz LCA
  - N5227B NA according to ordered option
  - 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 N5520B-FG (1.85 mm f-f adapter)

(Mounting Kit part number N4373-88701)

- 2x 0403-1166 Adjustable Foot 65.0 mm
- 6x 0515-0433 Screw Torx-T20 M4X0.7 8mm
- 12x 0515-1269 Screw Torx-T20 M4X0.7 10mm
- 2x 0515-1619 Screw Torx-T20 M4X0.7 25mm
- 4x 0515-2317 Screw Torx-T15 M3.5X0.6 12mm
- 2x 83427-21274 Sidebar
- 2x 83427-40072 Trim Sidebar
- 2x N4373-25271 Bracket Adapter
- 1x N4373-25290 Bracket Rear Right
- 1x N4373-25291 Bracket Rear Left

Refer also to the contents list of the network analyzer.

If anything is missing or defective, contact your nearest Keysight Technologies sales office. If the shipment was damaged, contact the carrier, then contact the nearest Keysight Technologies sales office.

Mounting the Test Set and the Network Analyzer

Preparing the Test Head

1 Use a Torx T15 screwdriver and the screws 0515-2317 to mount the left and right bracket adapter N4373-25271 to the rear side of the test head.

2 Use the screws 0515-0433 and a Torx T20 screwdriver to attach the rear brackets N4373-25290 and N4373-25291 to the right and left bracket adapter.

3 Turn the test head on its side and use a Pozidrive size 2 screwdriver to mount the adjustable feet 0403-1166 to the left and right brackets.

4 Turn the test head back to its normal position.

Preparing the Network Analyzer

5 Turn the Network Analyzer on its side. Unlock the feet to remove them from the bottom of the network analyzer.

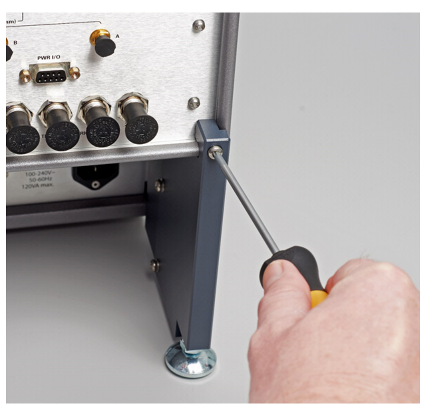
6 Using a Torx T20 screwdriver, remove the 2 lower rear feet from the rear panel of the network analyzer

Mounting the Network Analyzer on the Test Head

CAUTION The network analyzer and Lightwave Component Analyzer module are assembled as one analyzer unit. Lifting this instrument requires two people using proper lifting techniques. For the combined weight, please consult the specifications (see General Characteristics on page -161, and the user's documentation for the network analyzer).

7 Put the network analyzer on top of the test head and align it with the mounting slots of the rear brackets.

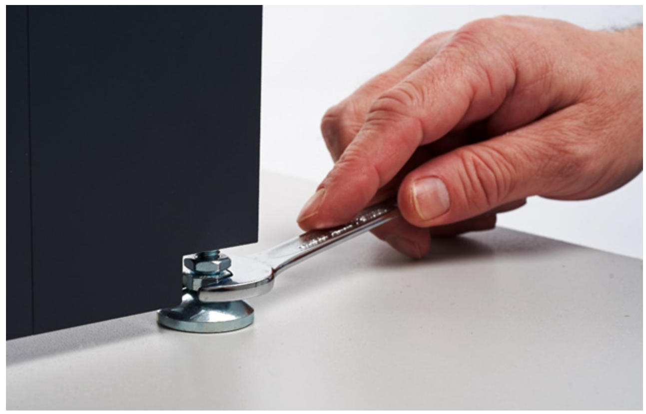
8 Use the Torx T20 screwdriver and the screws 0515-1619 to connect the network analyzer and left and right rear brackets.



9 Use a Torx T20 screwdriver to attach the side bars 83427-21274 with the screws 0515-1269 to the left and right sides of the two instruments.

10 Attach the adhesive trim covers to the left and right side bars to cover the screws.

11 Use the 13mm wrench to level the adjustable feet to the other feet of the test head. Use the upper nuts to lock the feet in place.



Setting Up the Lightwave Component Analyzer

1 Unpack and inspect the contents as described in Unpacking the Lightwave Component Analyzer on page 26.

2 Skip to step 3. if the PNA does not include a configurable test set.

- On the receiver side (Port 2 on a 2-port PNA, Port 4 on a 4-port PNA), pull the cable guard off the front panel.
- Use the 8 mm torque wrench from the calibration kit (0.90 Nm/ 8 lb.-in, part number 8710-1765) to remove the top two rigid cables from the connectors.

- Re-connect the rigid cables in a vertical position and fasten them using the same torque wrench as before.

NOTE

Before you move the system or return it to a service center, make sure you

- put the rigid cables back into the horizontal position and
- reattach the cable guard.

3 Remove the dust cover from Port B on the optical test set.

4 Attach the female to female adapter (part number 85058-60121) to Port B.

5 Screw the adapter finger-tight to Port B without rotating it.

6 Holding the adapter with the spanner wrench from the calibration kit (part number 08513-20014), use the 20mm torque wrench from the calibration kit (0.90 N.m/8 lb.in, part number 8710-1764) to tighten the adapter.

NOTE

For information on handling, calibrating or cleaning RF connectors, please refer to the “User’s and Service Guide Keysight Technologies N4697E/F 1.85 mm Flexible Cables for Test Ports”, available on the Keysight website.

For further information on the Adapter, please refer to the “User’s and Service Guide Keysight Technologies 85130H Rugged 1.85 mm to 1.85 mm Adapter Kit”.

CAUTION

Always rotate the nut and never the female to female adapter.

Rotating the adapter can damage the electrical interface of the adapter and the connector on the optical test set.

NOTE

For information on handling using and maintaining the flexible test port cables, please refer to the Operating and Service Manual, Keysight N4697E/F NMD-1.85 mm -f- to 1.85 mm Flexible Test Port Return Cables (part no. N4697-90001).

7 Remove the dust cover from Port 2 of the 2-port network analyzer, or from Port 4 of the 4-port network analyzer. Remove the dust cover from both ends of the flexible test port cable (part number N4697-60030 or 85133-60043).

8 Connect the test port cable finger-tight to Port B on the optical test set without rotating the female to female adapter. Connect the other end to Port 2 of the 2-port network analyzer or, respectively, to Port 4 of the 4-port network analyzer.

9 Holding the adapter with the spanner wrench, use the 20 mm torque wrench from the calibration kit to tighten both connections.

10 Repeat step 3. to step 9. to connect Port A on the optical test set to Port 1 on the network analyzer.

11 Remove the dust cap from the Optical Output.

12 Remove the dust cap from the optical patch cord.

13 Connect the optical patch cord.

14 Repeat step 11 to step 13 for the optical input.

CAUTION Always use optical patch cords to connect to your DUT. This protects the connectors of the optical test set, by minimizing the number of connector changes.

CAUTION Make sure to connect only matching connector types to the optical test set: connecting a straight connector to an angled port, or vice versa, will damage both interfaces.

CAUTION

Before you connect any fiber-optic cable to the Lightwave Component Analyzer, please ensure it has been properly cleaned.

Fiber-optic connectors are easily damaged when connected to dirty or damaged cables and accessories. Improper cleaning or handling may lead to expensive instrument repairs, damaged cables, or compromised measurements.

15 On the rear, connect the network analyzer to the optical test set using the supplied USB cable.

16 Connect the power cables.

17 Continue with Performance Quick Check on page -39 or Starting the Lightwave Component Analyzer on page -52.

3 Performance Quick Check

This chapter shows how to:

- Verify the optical and electrical connections to the N4373E Lightwave Component Analyzer
- Verify the performance of your N4373E Lightwave Component Analyzer
- Trouble shoot, if you think there may be a malfunction
- Perform an acceptance test

Preparation

1 Turn on the network analyzer and the optical test set.

2 Allow the optical test set and the network analyzer to warm up (refer to Measurement Conditions on page -151 for the warm up time).

3 If it is not already started, start the network analyzer application.

Consult the documentation supplied with the network analyzer if you need help with this step.

NOTE

Most performance problems are caused by damaged or dirty electrical or optical connectors.

Before starting the performance verification procedure make sure all electrical and optical connectors are in excellent condition.

For more information on cleaning procedures see Cleaning on page -120 for information on cleaning optical connections, and to the user guide of the network analyzer for information on cleaning electrical connections.

For more information on handling using and maintaining the flexible test port cables, please refer to the “User’s and Service Guide Keysight Technologies N4697E/F 1.85 mm Flexible Cables for Test Ports”, available on the Keysight website.

Network analyzer settings and electrical calibration

1 On the network analyzer make the following settings (depending on your network analyzer's maximum frequency):

- Start Frequency: 10MHz, Stop Frequency: 67 GHz (50 GHz, 43.5 GHz)
- Number of points: 6700 (5000, 4350)
- IF bandwidth: 2000 Hz
- Averages: 1
- RF output power: -15 dBm

2 Select “Stepped sweep - sweep moves in discrete steps”.

3 Calibrate the network analyzer electrically.

a Make sure the LCA has been returned to the electrical measurement mode as described in Returning to Electrical Measurements on page -74.

NOTE **To meet the technical specifications, you must use the electronic calibration module.**

b Proceed with the electrical calibration as described in Electrical calibration for single-ended measurements on page -53.

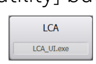
We recommend you use “Electronic Calibration Modules” for calibrating the Network Analyzer. For more information on handling using and maintaining “Electronic Calibration Modules”, refer to the “Reference Guide Keysight Technologies Electronic Calibration Modules”, available on the Keysight website.

Verifying your Electrical Calibration

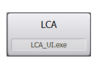
Passing this test ensures that the electrical calibration is within expected performance.

1 Follow the steps in the sections Preparation on page -40 and Network analyzer settings and electrical calibration on page -40.

2 Connect the N5520B "1.85 mm Coaxial Adapters" (or 85056-60006 "2.4 mm Coaxial Adapters") supplied between the two N4697-60200 "1.85 mm Flexible Cables for Test Ports" (or 85133-60016 "2.4 mm Flexible Cables for Test Ports") supplied.

3 Press the [Macro/Local utility] button until the Macro 1 group is highlighted and you see 

.

4 Click 

to start the LCA measurement setup.

5 Select the EE Measurement tab.

6 Click 

.

7 Make a corrected measurement with the network analyzer.

8 Inspect the results.

- Electrical return loss S11 should be similar to S22.
- Both curves should be below -20 dB over the full measurement range, with only low frequency dependence.

- Transmission loss S12 should be similar to S21.
- Both curves should be within +0.1 dB to -0.6 dB over the full measurement range, with only low frequency dependence.

If the results differ from the expected values

- Visually inspect all RF connectors. If an electrical connector seems to be damaged, contact Keysight for repair or replacement.
- Clean the RF connectors on the electronic calibration module and on the flexible test port cables. Refer to “User’s and Service Guide Keysight Technologies N4697E/F 1.85 mm (or 85133E/F 2.4mm) Flexible Cables for Test Ports”, for inspection and cleaning. Make sure the connection to the network analyzer of the two N4697-60200 “1.85 mm (or 85133E/F 2.4mm) Flexible Cables for Test Ports” supplied is tight.

Perform a new electrical calibration and retest.

If the problem persists contact Keysight for support.

Verifying the Optical Connections and Optical CW Operation

Passing these tests ensures that the transmitter and receiver are within expected optical CW performance.

1 Follow the steps in the sections Preparation on page -40 and Network analyzer settings and electrical calibration on page -40.

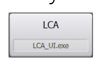
2 If you have option -021:

Connect the two straight-angled optical patch cords (N4373-87907) to the optical output and input 1 (“+7 dBm”) or input 2 (“+17 dBm”). Note that the angled connector must be attached to the optical test set. Use the FC/PC adapter (1005-0256) to connect the straight ends of the optical patch cords.

If you have option -022:

Connect the angled-angled optical patch cords (N4373-87906) to the optical output and input 1 (“+7 dBm”) or input 2 (“+17 dBm”).

Use the FC/APC through adapter (1005-1027) to connect the ends of the optical patch cords.

3 Press the [Macro/Local] utility button until the Macro 1 group is highlighted and you see 

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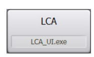
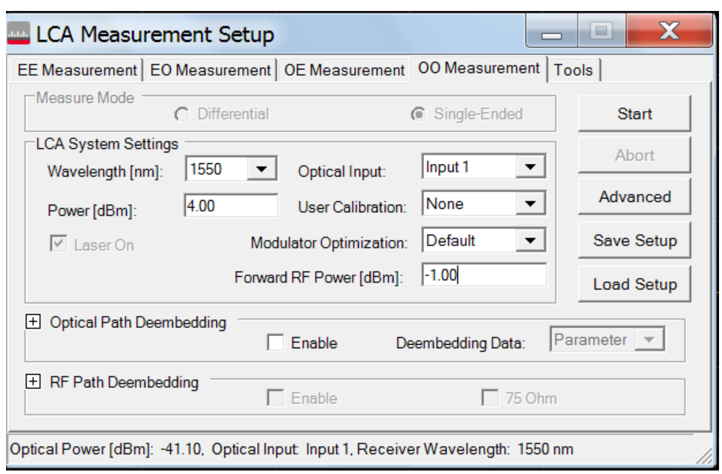
4 Press 

to start the LCA measurement setup.

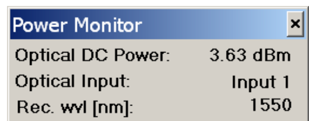
5 Select the OO measurement tab.



6 Set the following parameters:
- If you have option 102 (Dual wavelength 1310 nm, 1550 nm), select the appropriate wavelength for your DUTs.
- Laser power: +4 dBm
- Optical input: Input 1
- User Calibration: None
- Forward RF Power: -1 dBm

7 Click Start, then None to set the output power.

8 Press Optical Pwr. to start optical power meter application.

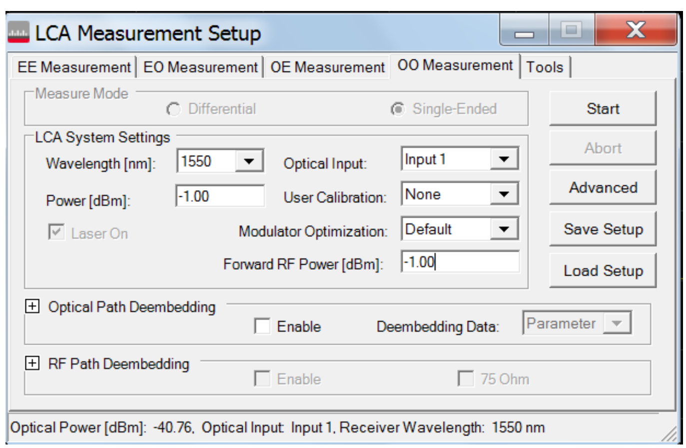


9 Read the optical power from the power meter application.
The readout should be +4 dBm ± 0. 5 dB

10 Press the [Macro/Local] utility button until the Macro 1 group is highlighted and you see LCA LCA_UI.exe.

11 Press LCA LCA_UI.exe to start the LCA measurement setup.

12 Select the OO measurement tab.



13 Set the following parameters:

- If you have option 102 (Dual wavelength 1310 nm, 1550 nm), select the appropriate wavelength for your DUTs.
- Laser power: -1 dBm
- Optical input: input1 (“+7 dBm max”) or input 2 (“+17 dBm max”).
- User Calibration: None
- Forward RF Power: -1 dBm

14 Click Start, then None to set the output power.

15 Press Optical Pwr. to start optical power meter application.

16 Read the optical power from the power meter application.

The readout should be -1 dBm ± 0. 5 dB

If the results are not as expected

- Try cleaning the optical connectors as described in Cleaning on page -120.
- With the laser switched off, inspect all optical connectors with a microscope.
  - If the connectors on the N4373E Lightwave Component Analyzer seem to be damaged contact Keysight for repair.
  - If the connectors on the patch cord seem to be damaged contact Keysight for replacements.
- Using an external optical power meter, you can verify that there is an optical signal at the optical connection on the transmitter side.

If the problem persists contact Keysight for support.

Verifying the Electrical Connection and Electro-optical Operation

The following tests ensure that the internal transmitter and receiver of the Lightwave Component Analyzer operate as expected.

1 Follow the steps in the sections Preparation on page -40 and Network analyzer settings and electrical calibration on page -40.

2 On the network analyzer make the following settings:
   - IF bandwidth: 100 Hz
   - Select “Reduce IF BW at Low Frequencies”.

3 If you have option -021:

   Connect the two straight-angled optical patch cords (N4373-87907) to the optical output and input 1 (“+7 dBm”) or input 2 (“+17 dBm”). Note that the angled connector must be attached to the optical test set.

   Use the FC/PC through adapter (1005-0256) to connect the straight ends of the optical patch cords.

   If you have option -022:

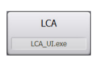
   Connect the angled-angled optical patch cords (N4373-87906) to the optical output and input 1 (“+7 dBm”) or input 2 (“+17 dBm”).

   Use the FC/APC through adapter (1005-1027) to connect the ends of the optical patch cords.

4 Connect the two supplied flexible test port cables to the RF ports of the Lightwave Component Analyzer test set.

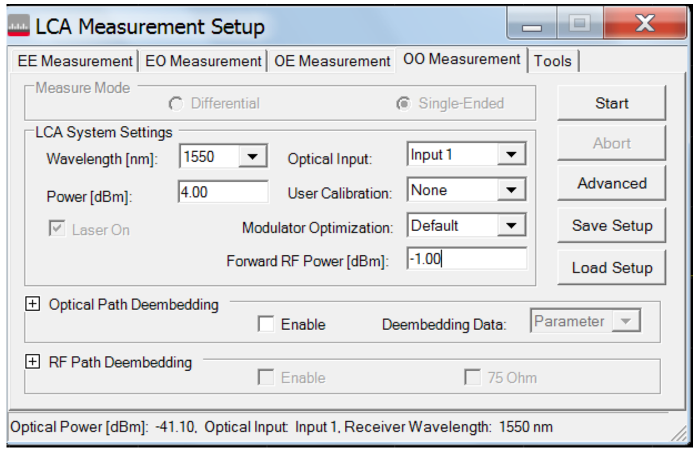
5 Press the [Macro/Local] utility button until the Macro 1 group is highlighted and you see 

.

6 Press 

to start the LCA measurement setup.

7 Select the OO measurement tab.



8 Set the following parameters:

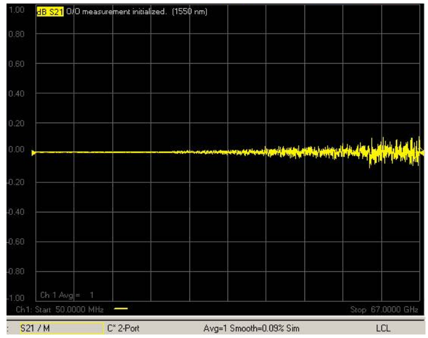
- If you have option 102 (Dual wavelength 1310 nm, 1550 nm), select the appropriate wavelength for your DUTs.
- Laser power: +4 dBm
- Optical input: input 1 (“+7 dBm max”) or input 2 (“+17 dBm max”)
- User Calibration: None
- Forward RF Power: -1 dBm

9 Click Start, then Single to set the output power.

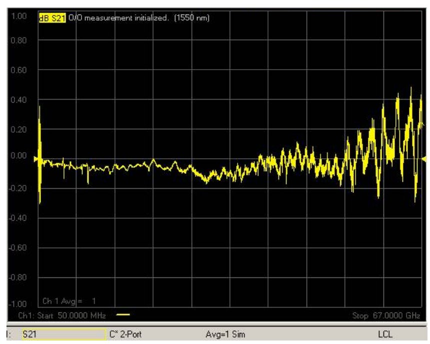
10 Right click the measurement trace, and select “Autoscale All” in the context menu.

At the end of the measurement, there should be a flat trace.

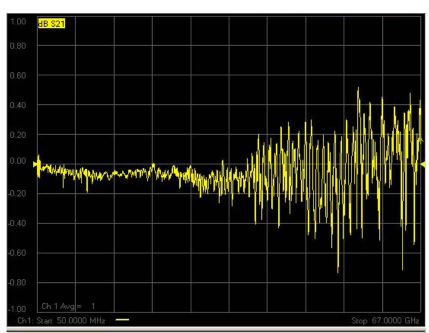
- An ideal trace might look like this:



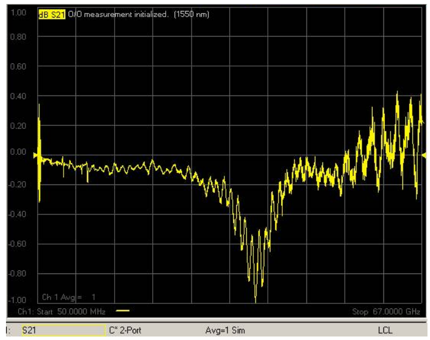
- Please note, though, that this trace is also within specifications:



- High frequency ripple indicates a faulty electrical calibration of the network analyzer. This can occur, for example, if the reference plane has been chosen too far away from the DUT:



- A notch at around 35 to 40 GHz would indicate a bad RF connection:



If the results are not as expected;

- Inspect the electrical connectors on the N4373E Lightwave Component Analyzer and on the “Flexible Cables for Test Ports” visually.
  If electrical connectors seems to be damaged contact Keysight for repair or replacement.
- Clean the electrical connectors on the N4373E Lightwave Component Analyzer and on the “Flexible Cables for Test Ports. Refer to “User’s and Service Guide Keysight Technologies N4697E/F 1.85 mm or 85133E/F 2.4mm Flexible Cables for Test Ports”, for inspection and cleaning.
- Make sure the connection to the network analyzer of the two flexible test port cables are tight.

Perform a new electrical calibration and retest.

If the problem persists, contact Keysight for support.

If you have option 102 (Dual wavelength 1310 nm, 1550 nm), and you are testing at both wavelengths, repeat the performance quick check for the second wavelength.

4 Making Measurements

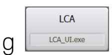
KEYSIGHT TECHNOLOGIES

Starting the Lightwave Component Analyzer

1 Turn on the network analyzer and the optical test set.

2 Allow the Lightwave Component Analyzer to warm up. Both the optical test set and the network analyzer need to stabilize their internal temperature. Please refer to Measurement Conditions on page -151 for information on settling.

3 If it did not start automatically, click on the icon on the desktop to start the network analyzer application.

4 If it is not already running, start the LCA server by pressing 

, or by clicking the LCA server icon on the desktop. See The LCA Function Keys on page -86 for information on displaying the LCA function keys.

Calibrating the Network Analyzer before Measurements

About measurements

- Always make sure that, “Stepped sweep - sweep moves in discrete steps” is selected in the sweep setup menu on the network analyzer.
- To get the best S/N ratio for your measurements, use the highest RF power your network analyzer can output without showing a “source unlevelled” error. This can be more then the maximum specified output power of the network analyzer.
- Decreasing the IF bandwidth improves the S/N ratio of the measurement. However, doing so increases the calibration and measurement times, so a suitable IF bandwidth should be selected.
- Apply appropriate averaging or smoothing for your application.
- Always perform an electrical calibration of the network analyzer or load an existing calibration set before making measurements.
- Before starting the electrical calibration of the network analyzer, make sure that the LCA is in EE measurement mode.
- For electrical calibration use the default RF power for EE measurement mode.
- After completing the electrical calibration, do not alter the IF bandwidth, start frequency, stop frequency, measurement point number or other settings. You may get measurement errors if you change any of those parameters.
- For additional information please refer to "Optimize a measurement" and "Calibrate a measurement" in the documentation of the network analyzer.

Electrical calibration for single-ended measurements

To ensure the specified performance of the LCA, you need to perform a full two-port electrical calibration. For this purpose we recommend using the automated electronic calibration kit N4694A #00F or N4694A #00A.

NOTE

When in EO, OE or OO measurement mode, you need to return to EE measurement mode first before you can perform an electrical calibration.

Calibrate before you start using the Lightwave Component Analyzer application. Alternatively, return to EE measurement mode, as described in Returning to Electrical Measurements on page -74, to calibrate. For calibrating the Lightwave Component Analyzer using an automated electrical calibration module, follow these steps:

1 Set your measurement parameters.
2 From the “Calibration” menu, select “Calibration Wizard”.
3 Select “Use Electronic Calibration”, and click [Next>].
4 Select “2 Port ECal”, and click [Next>].
5 On two-port network analyzers select port 2 as "selected 2nd port". On 4-port network analyzers select port 4 as "selected 2nd port".
6 Select “ECal Thru as Unknown”, and click [Measure].
7 After the calibration has been completed, save the calibration file.

Electrical calibration for differential OE measurements

To ensure the specified performance of the LCA, you should perform a full three- port electrical calibration. See the Keysight website for applicable calibration kits.

If you want to perform an OE user calibration (see page 61 for details), we recommend executing a full four-port calibration, or a two-port calibration between network analyzer ports 1 and 4, in addition to the three-port calibration (see Electrical calibration for single-ended measurements on page -53). Connect an additional RF cable (N4697-60035) to port 4.

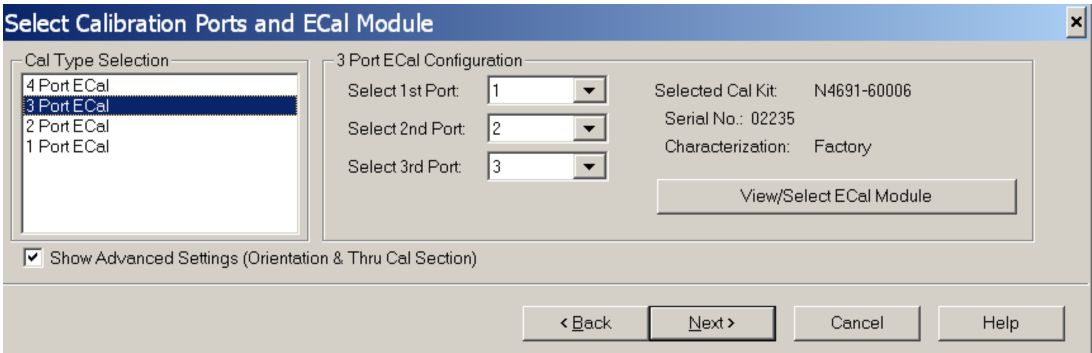
Calibrate before you start using the Lightwave Component Analyzer application. Alternatively, return to EE measurement mode, as described in Returning to Electrical Measurements on page -74, to calibrate.

NOTE **We recommend you use the torque spanner (Keysight part number 8710- 1764, 0.90 Nm, 8 lb.-in) supplied with the optical test set to tighten all RF connections during the calibration.**

For calibrating the Lightwave Component Analyzer using an automated electrical calibration module, follow these steps:

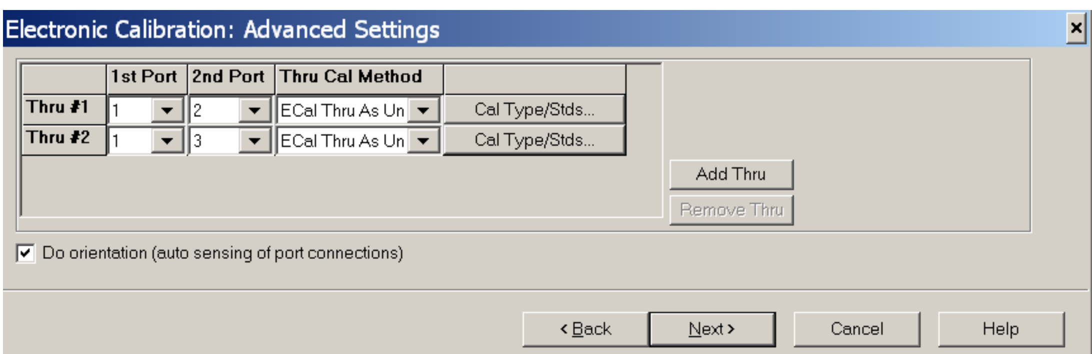
1 Set your measurement parameters.
2 From the “Calibration” menu, select “Calibration Wizard”.
3 Select “Use Electronic Calibration”, and click [Next>].
4 Make sure “Show Advanced Settings” is selected.

5 Select “3 Port ECal”, Select 3 Port ECal Configuration according to the screen shot. Select the appropriate ECal Module. Make sure "Show Advanced Settings (Orientation & Thru Cal Section)" is selected,



and click the [Next>] button.

6 Select “Thru #1 and “Thru #2” according to the screen shot.



and select the appropriate Cal Kit for each port, or “ECal Thru as Unknown”.

7 Make sure “Do orientation” is selected, and click [Next >].

8 Follow the prompts to complete the calibration:

- Connect the ECal Module to the RF Cables connected to ports 1 and 2 of the network analyzer. Click "Measure".

- Connect the ECal Module to the RF Cables connected to ports 1 and 3 of the network analyzer. Click "Measure".

9 After the calibration has been completed, save the calibration file for later reuse.

Electrical calibration for differential EO measurements

Calibrate before you start using the Lightwave Component Analyzer application. Alternatively, return to the EE measurement mode, as described in Returning to Electrical Measurements on page -74, to calibrate. For calibrating the Lightwave Component Analyzer using an automated electrical calibration module, follow these steps:

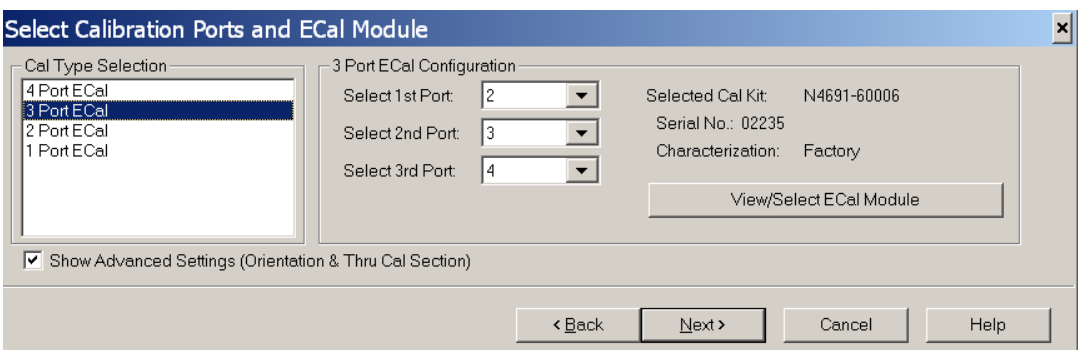
1 Set your measurement parameters.

2 From the “Calibration” menu, select “Calibration Wizard”.

3 Select “Use Electronic Calibration”, and click [Next>].

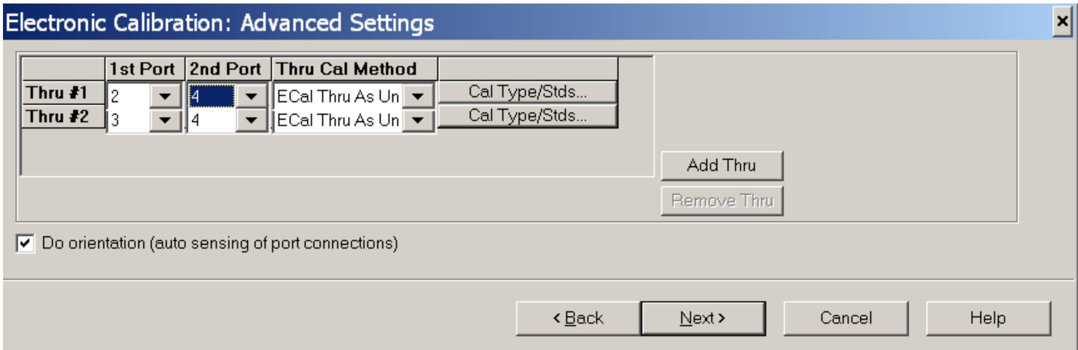
4 Make sure “Show Advanced Settings” is selected.

5 Select “3 Port ECal”, Select 3 Port ECal Configuration according to the screenshot. Select the appropriate ECal Module. Make sure "Show Advanced Settings (Orientation & Thru Cal Section)" is selected,



and click the [Next>] button.

6 Select “Thru #1 and “Thru #2” according to the screenshot.



and select the appropriate Cal Kit for each port, or “ECal Thru as Unknown”.

7 Make sure “Do orientation” is selected, and click [Next>].

8 Follow the prompts to complete the calibration:

- Connect the ECal Module to the RF Cables connected to ports 2 and 4 of the network analyzer. Click "Measure".
- Connect the ECal Module to the RF Cables connected to ports 3 and 4 of the network analyzer. Click "Measure".

9 After the calibration has been completed, save the calibration file for later reuse.

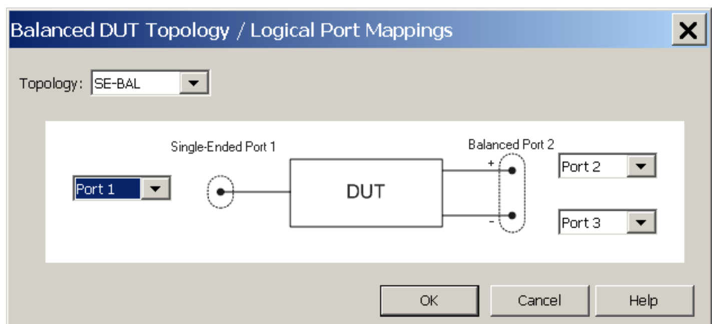
Measuring Opto-Electrical (OE) devices

Always perform an electrical calibration of the network analyzer or load an existing calibration set before you make a measurement.

For standard measurements, see Electrical calibration for single-ended measurements on page -53.

For differential measurements, see Electrical calibration for differential OE measurements on page -54.

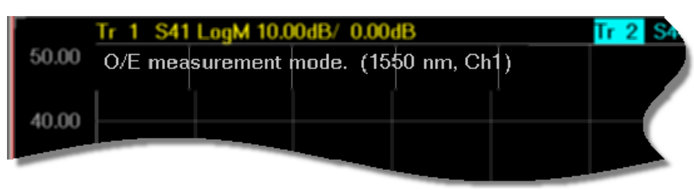
For OE measurements the single-ended (SE), logical port 1 is assigned to physical port 1 and the balanced (BAL), logical port 2 is assigned to the physical ports 2 and 3.



For OE measurements, the LCA sets up traces for S22, S21, S33, S31 by default.

For more information, see Differential Measurements (applies to 4-port PNA only) on page -110.

Before you make your first opto-electrical measurement, you must initialize the OE measurement. You can see which measurement is currently initialized at the top left of the trace screen.



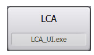
If you have already initialized the OE measurement, you can connect your device under test and make the measurement by pressing 

or 

.

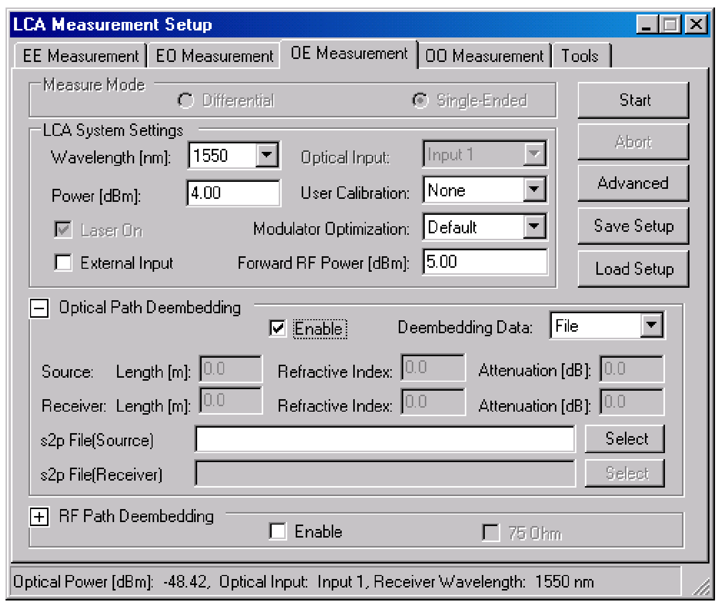
Please refer to the user's guide and online help of the network analyzer for further information.

Initializing the OE measurement

1 Press 

.

2 Select the "OE Measurement" tab.



3 If necessary, select a Differential or Single-Ended Measure Mode, depending on the type of your DUT.

4 Select the wavelength at which you are testing.

If you want to use external laser sources, select the optional External Input, and enter the wavelength of the external source.

5 Set the power of the laser to be applied to the test circuit.

If you are using the external source input, enter the value for the power emitted by the LCA optical output port. (Use an external power meter, or the LCA power meter to measure the optical power). The optical power is also displayed at the bottom of the LCA measurement setup screen.

6 If you are running measurements in an unstable environment, or need extra accuracy or long term stability, make sure to select “EverySweep” or “Continuous” for Modulator Optimization.

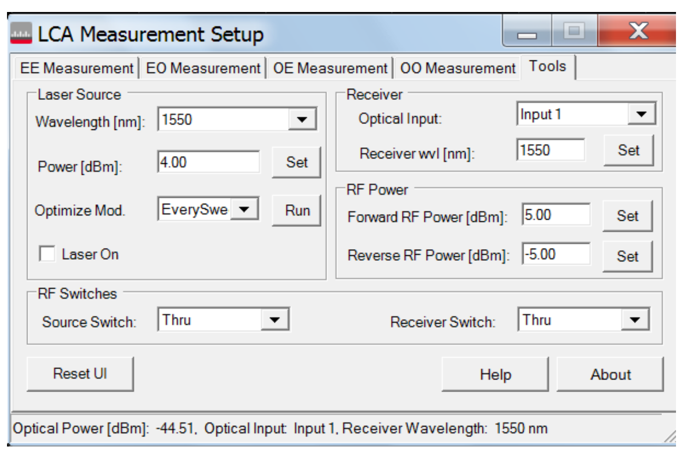
Please note, optimizing every sweep adds about 1 second to each measurement.

"Continuous" modulator bias optimization superimposes a 10 kHz pilot tone onto the signal. This improves the short and long term stability of the modulator operating point.

The pilot tone will affect measurements with IF bandwidth settings of the network analyzer >1.5 kHz.

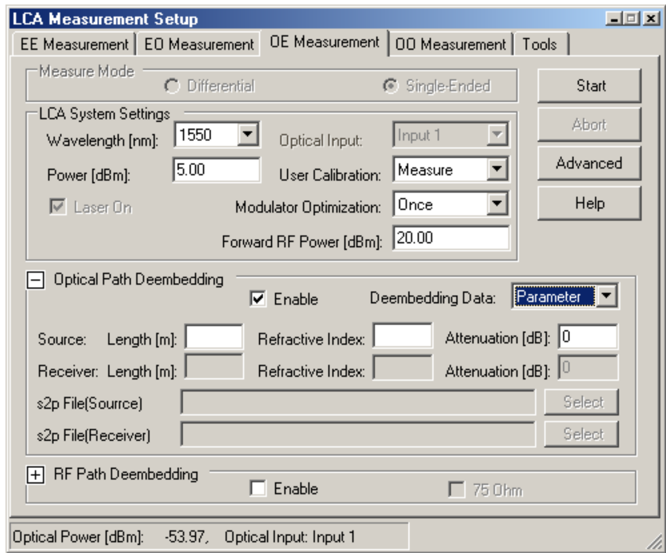
For IF bandwidth settings of the network analyzer >3 kHz we recommend setting modulator bias optimization to "Every Sweep" or "Once". Using “Continuous” modulator bias optimization slightly affects the internal transmitter calibration. We recommend you include a “User Calibration” in your setup (see the section “User Calibration” under LCA System Settings on page -92) if you are not using “Continuous” modulator bias optimization.

The system is calibrated with a default setting. You can determine the default setting by going to the "Tools" page, choosing “Reset UI”, and pressing “Run”.

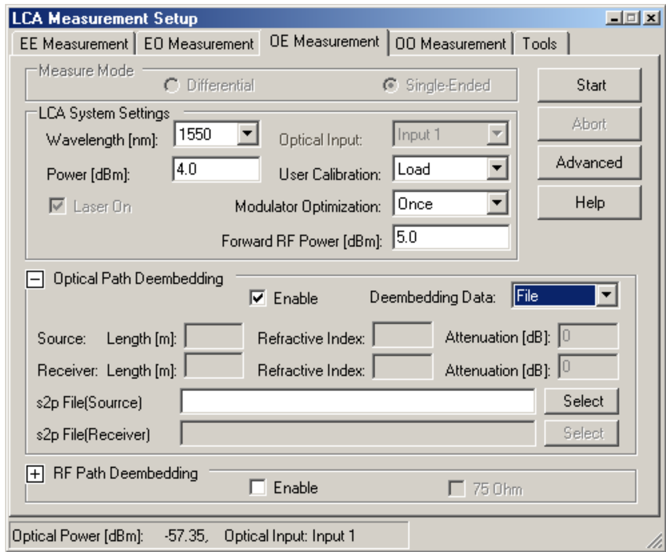


7 If you need to deembed optical components, such as attenuators, fiber optic cables or splitters, located between the laser output and your device under test, open and enable the “Optical Path Deembedding”.

Here you can enter the parameters of the optical path directly.

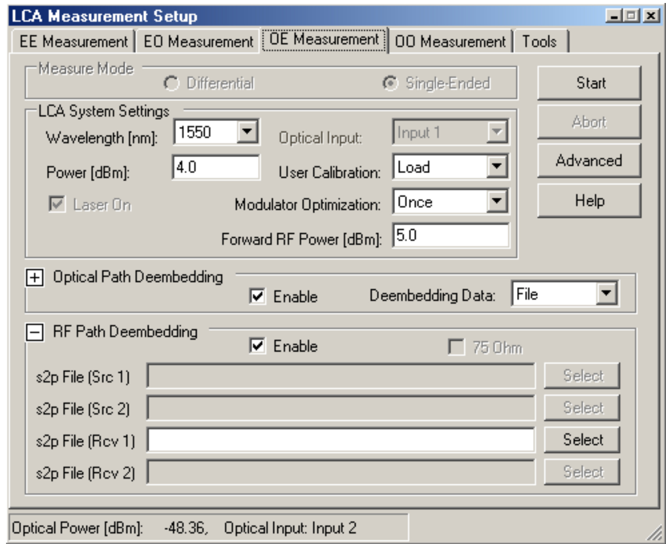


If you already have an .s2p file for your device, set "Deembedding Data" to "File" and enter or select the .s2p file name.



- For accurate measurements, you can also perform a user calibration. To do so, remove the DUT and close the optical path again. Then set "User Calibration" to "Measure" to perform a measurement of the optical path. Alternatively, select "Load" to recall an existing calibration.

8 If you need to deembed electrical components, such as RF cables, waveguide or other adapters, or probe heads, located between the device under test and the input port, open and enable the "RF Path Deembedding".



Enter or select the file name.

9 Select the appropriate type of user calibration for your measurement:

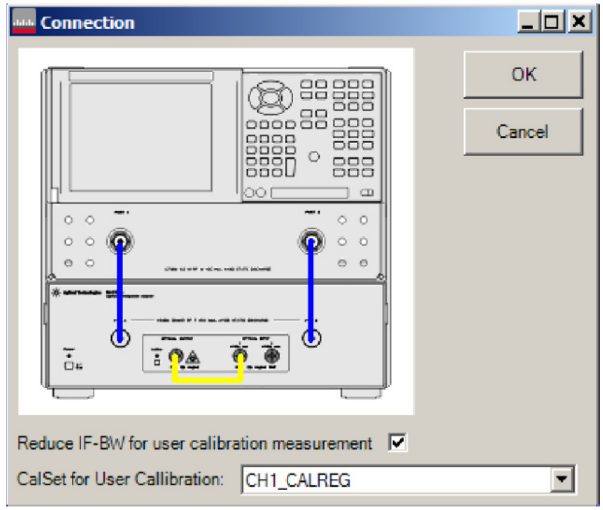
- In many cases, a User Calibration is not needed, so select "None". The LCA measures to specifications under the standard conditions.
- The frequency dependent transmission behavior of optical transmitters cannot be characterized as accurately as the behavior of receivers. So for improved results at lower frequencies, select “Measure”.
- If you want to reuse an existing user calibration, select “Load”, and select the calibration file from the Windows Explorer window.

NOTE **Optical and electrical path deembedding is not applied during a user calibration.**

10 Click 

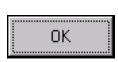
to start the measurement preparation.

If "User Calibration" mode is set to "Measure" the following screen is displayed:



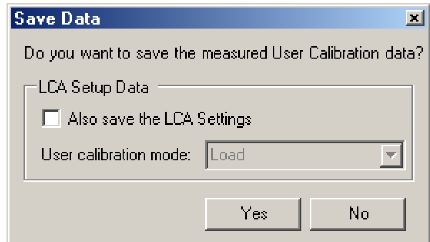
a A user calibration requires a valid electrical calibration between ports 1 and 2 for two-port network analyzers or ports 1 and 4 for four-port network analyzers, respectively. If you want to use a different electrical calibration for the user calibration measurement and for the DUT measurement, "Electrical Calibration" can be used as the user calibration measurement in the "CalSet for User Calibration" combo box. If you have performed a four-port electrical calibration before, use this one, otherwise select the corresponding two-port calibration. The selected electrical calibration will only be used for the user calibration measurement. Afterwards the LCA returns to the currently activated electrical calibration for the DUT measurements. The currently activated electrical calibration is preselected in the "CalSet for User Calibration" combo box. This preselection is fine and you have nothing to do if the same electrical calibration is used for the user calibration measurement and for the DUT measurement.

b Select “Reduce IF-BW for user calibration measurement” to reduce noise on the user calibration data. The default bandwidth reduction factor is defined in the LCAConfig.xml file.

c Click 

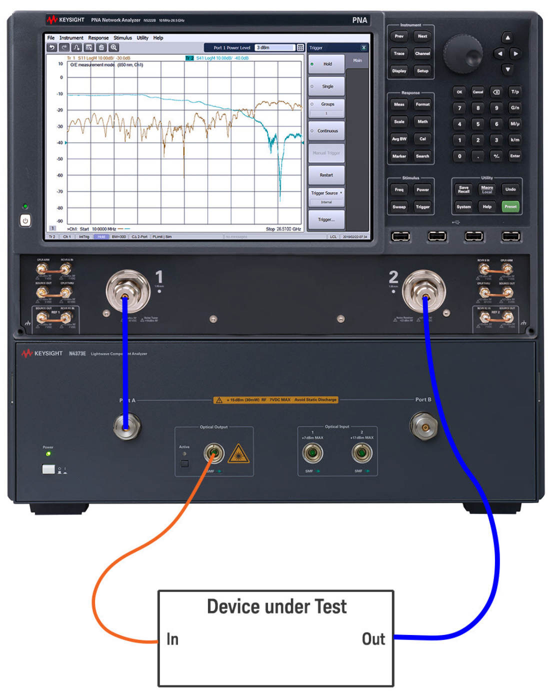
to proceed.

d Choose whether you want to save the calibration data for later use.

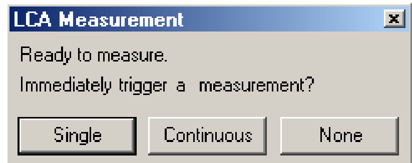


Making single-ended OE measurements

1 Connect your device under test as illustrated below:



2 When the following message is displayed, click "Single" or "Continuous" to start the first measurement.

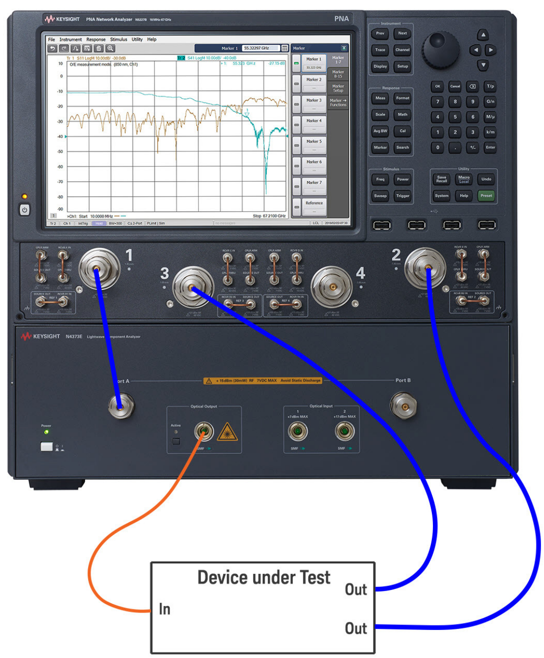


To make further measurements with these settings, press  or  to start the measurement.

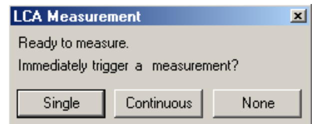
For information on further parameters, please refer to User Interface Reference on page -85.

Making differential OE measurements (applies to 4-port PNA only)

1 Connect your device under test.



2 When the following message is displayed, select "Single" or "Continuous" to start the first measurement:



3 To make further measurements with these settings, press click 

or 

to start the measurement.

For information on further parameters, please refer to User Interface Reference on page -85.

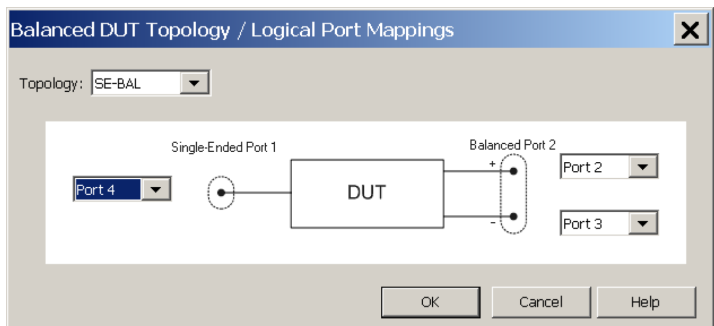
Measuring Electro-Optical (EO) Devices

Always perform an electrical calibration of the network analyzer or load an existing calibration file before you make a measurement.

For standard measurements, see
Electrical calibration for single-ended measurements on page -53.

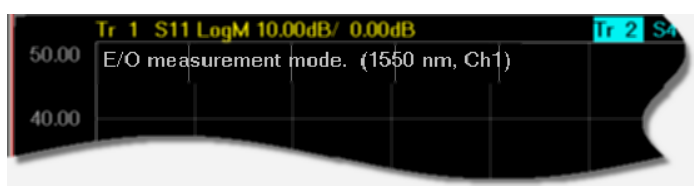
For differential measurements, see
Electrical calibration for differential EO measurements on page -56.

For EO measurements, the single-ended (SE), logical port 1 is assigned to physical port 4 and the balanced (BAL), logical port 2 is assigned to physical ports 2 and 3.

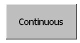


For EO measurements the LCA sets up traces for S22, S42, S33, S43 by default. For more information, see
Differential Measurements (applies to 4-port PNA only) on page -110.

Before you make your first electro-optical measurement, you must switch to EO measurement mode. You can see which measurement is currently initialized at the top left of the trace screen.



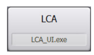
If you have already initialized the EO measurement, you can connect your device under test and start the measurement by pressing 

or 

.

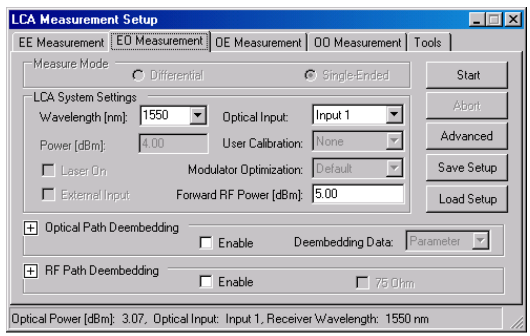
Please refer to the user's guide and online help of the network analyzer for further information.

Initializing the EO measurement

1 Press 

.

2 Select the "EO Measurement" tab.



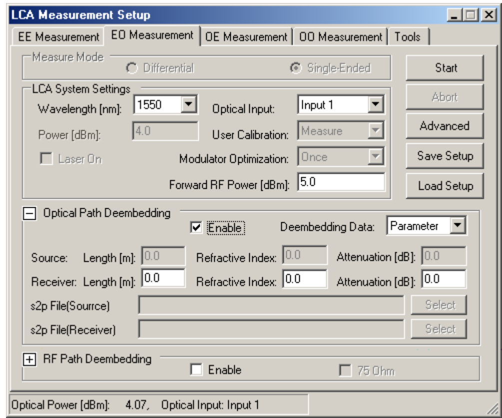
3 On a 4-port LCA, select Differential or Single-Ended Measure Mode, depending on the type of your DUT.

4 Select the optical input you are using.

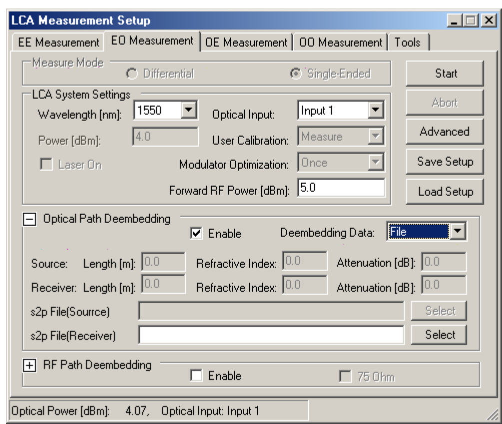
5 Select or enter the wavelength at which you are testing.

6 If you need to deembed optical components, such as attenuators, fiber optic cables or splitters, located between your device under test and the optical input, open and enable "Optical Path Deembedding".

Here you can enter the parameters of the optical path directly

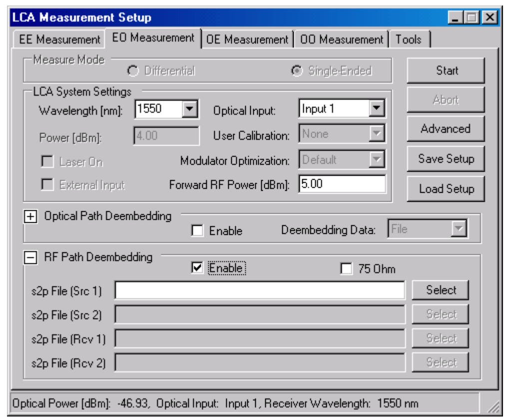


If you already have an .s2p file for your device, set "Deembedding Data" to "File" and enter or select the .s2p file name.

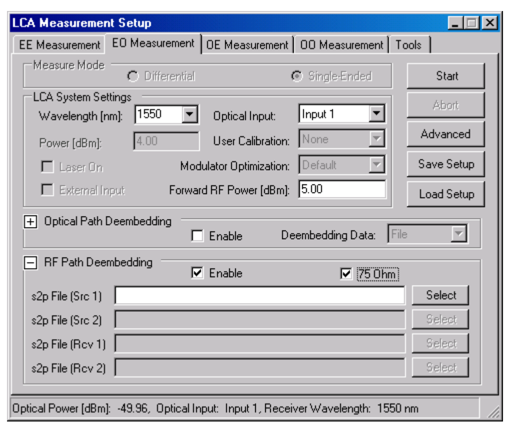


For accurate measurements, you can also perform a user calibration. To do so, remove the DUT and close the optical path again. Then set "User Calibration" to "Measure" to perform a measurement of the optical path. Alternatively, select "Load" to recall an existing calibration.

7 If you need to deembed electrical components, such as RF cables, waveguide or other adapters, or probe heads, located between the output port and your device under test, open and enable the “RF Path Deembedding”.



8 If you are using a 75 Ohm minimum loss pad, enable the RF Path Deembedding, and make sure 75 Ohm is selected.

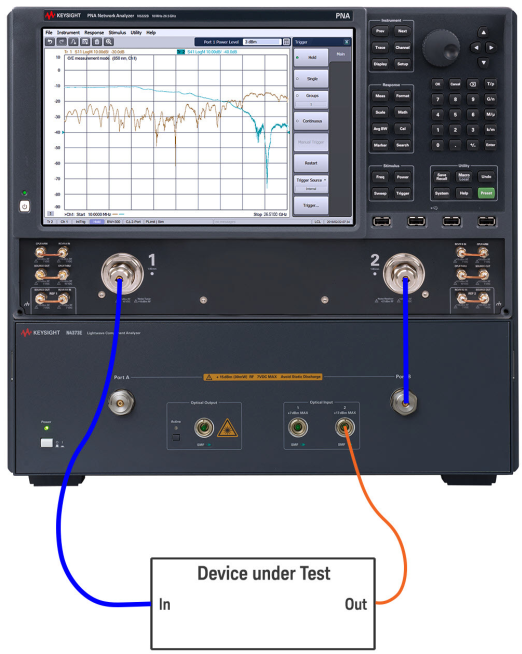


Enter or select the file with the characterization of the minimum loss pad.

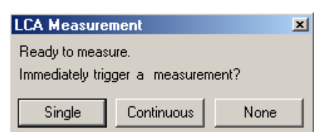
9 Click Start to start the measurement preparation.

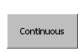
Making single-ended EO measurements

1. Connect your device under test.



2. When the following message is displayed, select "Single" or "Continuous" to start the first measurement.

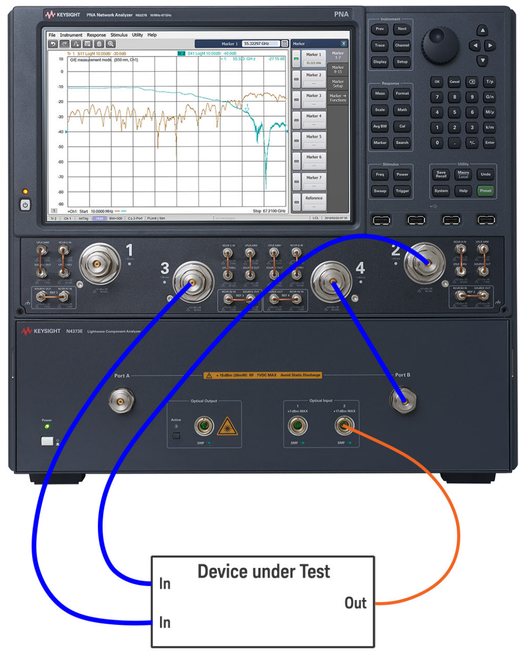


3. To make further measurements with these settings, press  or  to start the measurement.

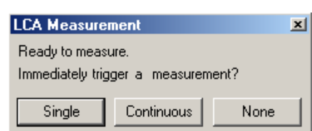
For information on further parameters, please refer to User Interface Reference on page -85.

Making differential EO measurements

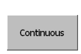
1 Connect your device under test.



2 When the following message is displayed, select "Single" or "Continuous" to start the first measurement.



3 To make further measurements with these settings, press 

or 

to start the measurement.

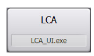
For information on further parameters, please refer to User Interface Reference on page -85.

Returning to Electrical Measurements

Before you measure purely electrical devices with the network analyzer, or perform an electrical calibration, you need to switch to "EE Measurement" mode.

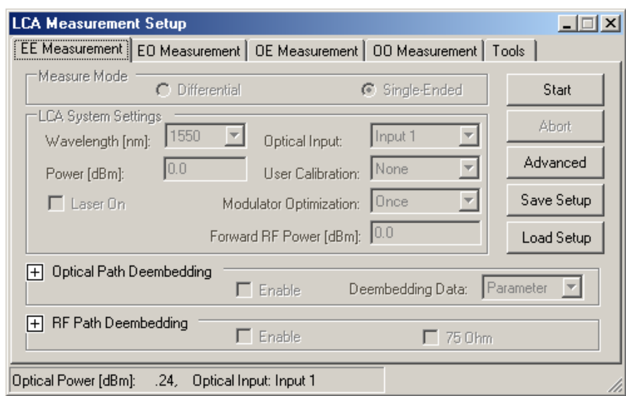
Initializing the EE Measurement as described here removes all the fixturing information in the network analyzer that is specific to the optical test set. Also, the RF power on all ports is set to the power specified for “Reverse RF Power [dBm]"

NOTE **The recommended settings for Forward and Reverse RF power depend on the type of your network analyzer. See** **RF Power on page -98.**

1 Press 

.

2 Make sure the “EE Measurement” tab is selected.



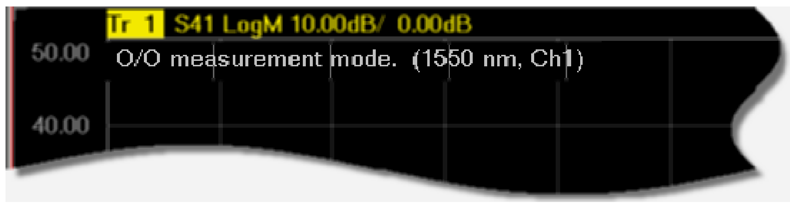
3 Click 

.

Measuring Optical-Optical (OO) Devices

Always perform an electrical calibration of the network analyzer or load an existing calibration set before you make a measurement. For standard measurements, see Electrical calibration for single-ended measurements on page -53.

Before you make your first optical-optical measurement, you must switch to OO measurement mode. You can see which measurement is currently initialized at the top left of the trace screen.



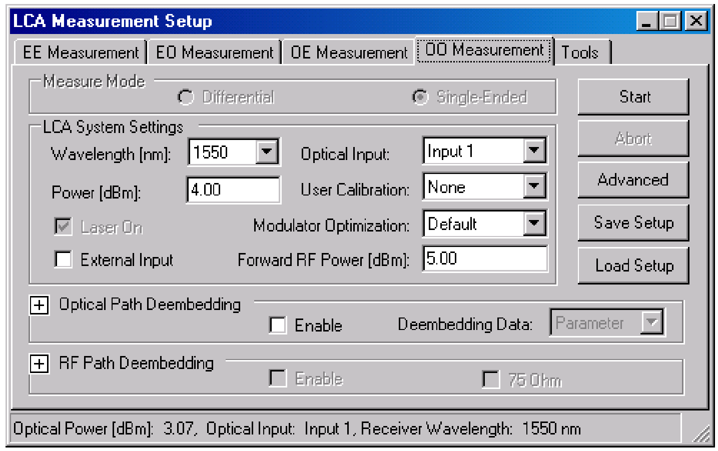
If you have already initialized the OO measurement, you can connect your device under test and start the measurement by pressing Single or Continuous.

Please refer to the user's guide and online help of the network analyzer for further information.

Initializing the OO measurement

1 Click LCA.

2 Select the "OO Measurement" tab.



3 Select the optical input you want to use.

4 Select the wavelength at which you are testing.

If you want to use external laser sources, select the optional External Input, and enter the wavelength of the external source.

5 Set the power of the laser to be applied to the test circuit.

If you are using the external source input, enter the value for the power emitted by the LCA optical output port. (Use an external power meter, or the LCA power meter to measure the optical power).

6 If you are running measurements in an unstable environment, or need extra accuracy or long term stability, make sure to select “EverySweep” or “Continuous” for Modulator Optimization.

Please note, optimizing every sweep adds about 1 second to each measurement.

"Continuous" modulator bias optimization superimposes a 10 kHz pilot tone onto the signal. This improves the short and long term signal stability of the modulator operating point.

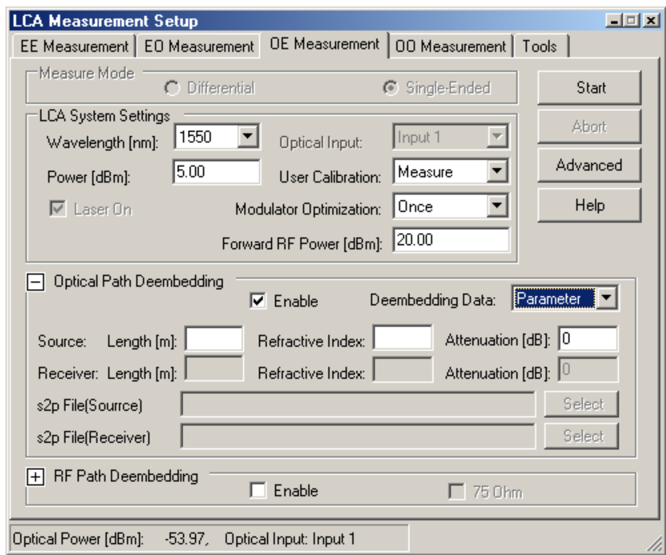
The pilot tone will affect measurements with IF bandwidth settings of the network analyzer >1.5 kHz.

For IF bandwidth settings of the network analyzer >3 kHz we recommend setting modulator bias optimization to "Every Sweep" or "Once". Not using “Continuous” modulator bias optimization affects the accuracy of the internal transmitter calibration. We recommend you include a “User Calibration” in your setup (see the section “User Calibration” under LCA System Settings on page -92) if you are not using “Continuous” modulator bias optimization.

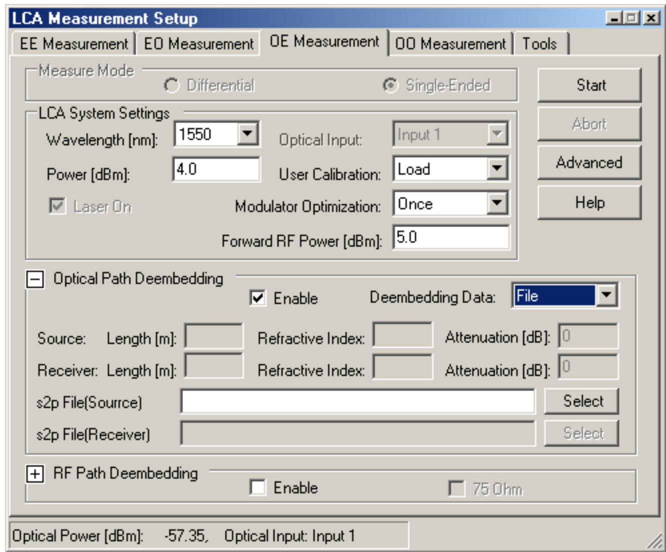
The system is calibrated with a default setting. You can determine the default setting by going to the “Tools” page, choosing “Default”, and pressing “Run”.

7 If you need to deembed optical components, such as attenuators, fiber optic cables or splitters, located between the laser output and your device under test, open and enable the “Optical Path Deembedding”.

Here you can enter the parameters of the optical path directly.



If you already have an .s2p file for your device, set "Deembedding Data" to "File" and enter or select the .s2p file name.



8 Select the appropriate type of user calibration for your measurement:

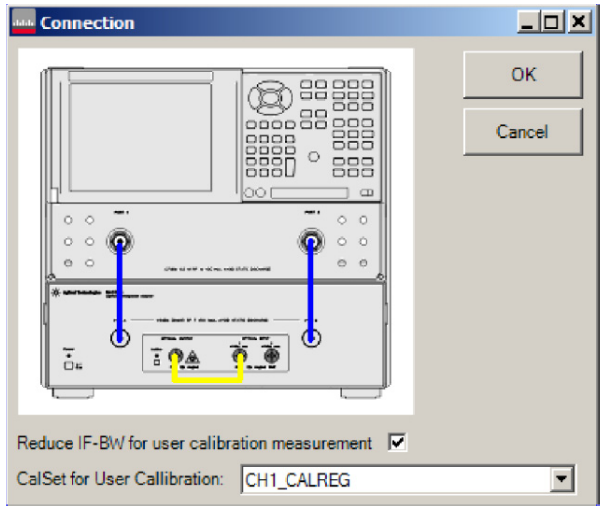
- In many cases, a User Calibration is not needed, so select "None". The LCA measures to specifications under the standard conditions.
- The frequency dependent transmission behavior of optical transmitters cannot be characterized as accurately as the behavior of receivers. So for improved results at lower frequencies, select “Measure”.
- If you want to reuse an existing user calibration, select “Load”, and select the calibration file from the Windows Explorer window.

NOTE **Optical and electrical path deembedding is not applied during a user calibration.**

9 Click 

to start the measurement preparation.

If "User Calibration" mode is set to "Measure" the following screen is displayed:

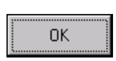


a If you want to use a different electrical calibration for the user calibration measurement and for the DUT measurement, "Electrical Calibration" can be used as the user calibration measurement in the "CalSet for User Calibration" combo box.

This electrical calibration will only be used for the “user calibration” measurements. Afterwards the LCA returns to the currently activated electrical calibration for the DUT measurements.

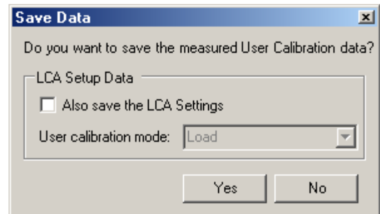
The currently activated electrical calibration is preselected in the "CalSet for User Calibration" combo box. This preselection is fine and you have nothing to do if the same electrical calibration is used for the user calibration measurement and for the DUT measurement.

b Select “Reduce IF-BW for user calibration measurement” to reduce noise on the user calibration data. The default bandwidth reduction factor is defined in the LCAConfig.xml file.

c Click 

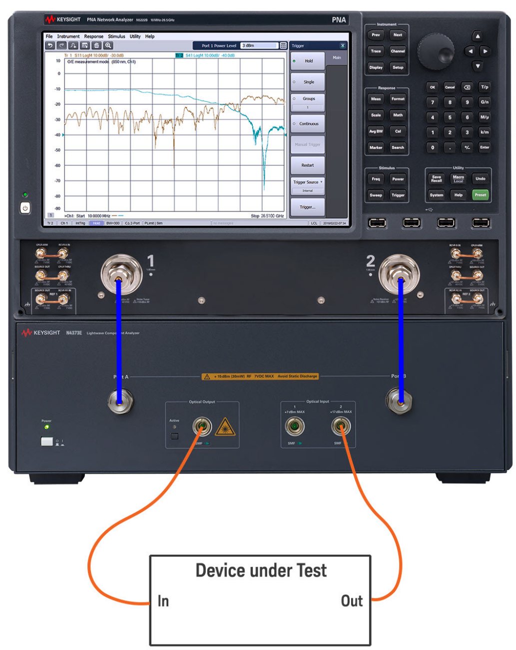
to proceed.

d Choose whether you want to save the calibration data for later use.

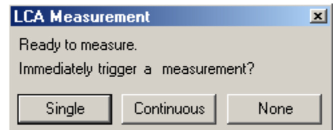


Making OO measurements

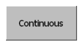
1 Connect your device under test.



2 When the following message is displayed, select "Single" or "Continuous" to start the first measurement.



3 To make further measurements with these settings, press 

 or 

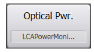
 to start the measurement.

For information on further parameters, please refer to User Interface Reference on page -85.

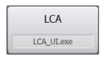
Aborting a Measurement

In some cases it can become difficult to abort continuous measurements by pressing the "Continuous" or "Single" button, since the network analyzer does not react to the keypad during measurements. Abort the measurement with the "Abort Measurement" button in the LCA Server window. For more information on triggering measurements, see Triggering Concepts on page -114.

Measuring Optical Power

Press  to measure the average optical power.

The optical power meter uses either the same Optical Input as the most recent measurement setup, or the input specified on the “Tools” tab. To set the optical input using the “Tools” tab, follow these steps:

1 Press  .
2 Select Input 2 as the Optical Input under Receiver on the “Tools” tab.
3 Under Receiver on the “Tools” tab, specify the receiver wavelength.

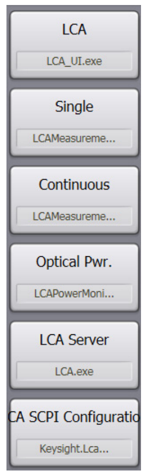
NOTE **The optical power is also displayed at the bottom of LCA measurement setup screen.**

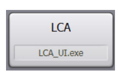
5 User Interface Reference

KEYSIGHT TECHNOLOGIES

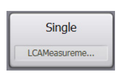
The LCA Function Keys

1 If the LCA server is running, but the function keys are not displayed, press the [Macro/Local] Utility key until Macro 1 group is shown:



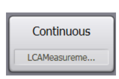
- 

: Brings the LCA user interface to the foreground, to setup an LCA measurement.

- 

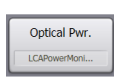
: Perform a single sweep measurement with the current measurement setup.

  Pressing this function key when a single or continuous measurement is running, stops this measurement and starts a new, single sweep measurement.

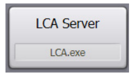
- 

: Perform continuous measurement sweeps with the current measurement setup.

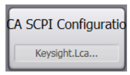
  Pressing this function key during a single or continuous measurement, stops the measurement.

- 

: Start the optical power monitor. This uses the current measurement setup to determine the wavelength and the optical input for which the average optical power is measured.

- 

: If it is not already running, this starts the LCA server. If it is already running, it brings the server to the foreground.

- 

: With the LCA SCPI Configurator you can configure the SCPI connection interface (socket or USB) and start or stop the SCPI interface.

  The LCA SCPI Interface does not start automatically. To enable control of the LCA using SCPI commands you have to start the LCA SCPI interface manually.

  To launch the LCA SCPI Configurator, you may either press the "LCA SCPI Configuration" button in the network analyzer GUI macro list under "Utilities", or use the shortcut "LCA SCPI Configuration" which you can find on the desktop or in the program menu.

For information on further function keys, please refer to the documentation supplied with the network analyzer.

NOTE

After completing the “LCA Measurement Setup” step, the network analyzer is ready for DUT measurements.

Because the receiver responsivity depends on the optical power, you should start the DUT measurements with the LCA “Single” or “Continuous” macros.

These macros perform an optical power measurement prior to each measurement sweep. This achieves the highest accuracy in EO and OO measurements.

If you do not need this accuracy, you can also start the DUT measurements with the network analyzer's trigger functions.

In some cases it can become difficult to abort continuous measurements by pressing the "Continuous" or "Single" button, since the network analyzer does not react to the keypad during measurements. In that case, abort the measurement with the "Abort Measurement" button in the LCA Server window.For more information on triggering measurements, see Triggering Concepts on page -114.

Default and Advanced Measurement Parameters

Use the **default** parameters for EO, OE and OO measurements of devices with a simple stimulus and response path. This includes devices like sources, receivers or amplifiers.

Use the **advanced** parameters for more comprehensive control of your measurements.

Saving and Loading Setups

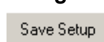
Saving setups

A setup contains the current state of the LCA user interface and optionally also the current state of the network analyzer. Setups are stored as XML-files or as compressed XML-files.

The settings on the “Tools” tab are not saved in the setup, since the settings shown on this tab always reflect the current state of the LCA hardware. After loading the setup the LCA system is configured to press “Start” from the LCA user interface.

There are two ways of saving setups.

First saving method

Click 

to save the current setup.

- If user calibration mode is set to “Measure” (only possible for OE and OO measurements), you are asked to specify the electrical calibration set to be saved with the setup.

  This is the electrical calibration set to be used during user calibration measurements.

  Only a link to the electrical calibration set is saved, not the calibration data itself.

  For more details, see Measuring Opto-Electrical (OE) devices on page -58 or Measuring Optical-Optical (OO) Devices on page -75.

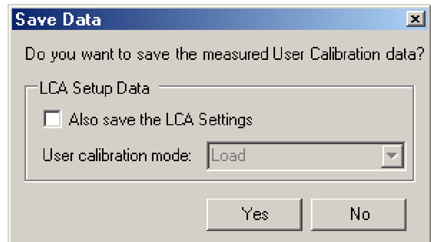
- If User Calibration is set to “Load” (only possible for OE and OO measurements), you will be asked to specify which user calibration file should be loaded.

  The filename of the calibration data is saved with the setup, not the calibration data itself.

  For more details, see Measuring Opto-Electrical (OE) devices on page -58 or Measuring Optical-Optical (OO) Devices on page -75.

Second saving method

After initializing with the User Calibration mode set to “Measure”, you are asked if you want to save the user calibration data and/or the LCA Setup.



Check “Also save the LCA Setup” if you want to save the LCA setup. Then choose between “Load” and “Measure” to specify the user calibration mode to save with the setup.

- If you selected “Load”, the “No” button is disabled to force you to store the measured user calibration data.

  After you press “Yes”, you are asked to specify the filename for the user calibration data and the filename of the LCA setup.

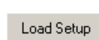
  Only the filename of the user calibration data is saved with the setup.

- If you selected “Measure”, it is also possible to press the “No” button. In this case only the LCA setup is saved.

  If you press “Yes”, you are asked for the filename of the LCA setup. The name of the electrical calibration set just used for this user calibration measurement will be saved in the LCA setup.

Before the LCA saves the setup, it asks you whether you want to save the network analyzer state with your LCA setup.

Loading setups

Click 

to retrieve an existing setup.

- After loading a setup with user calibration mode set to “Measure”, the electrical calibration set specified in this setup is preselected in the optical connection dialog shown during OE or OO initialization.

  This is different to the behavior when doing OE or OO initialization without loading a setup.

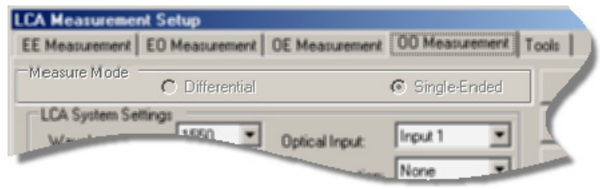
  For more details, see Measuring Opto-Electrical (OE) devices on page -58 or Measuring Optical-Optical (OO) Devices on page -75.

- After loading a setup with user calibration mode set to “Load”, the specified calibration file is preselected in the load dialog asking you for the calibration data file during OE or OO initialization.

  For more details, see Measuring Opto-Electrical (OE) devices on page -58 or Measuring Optical-Optical (OO) Devices on page -75.

The Measurement Parameters

Measure Mode



A 2-port network analyzer can only support single-ended measurements. Selecting the Measure Mode is only possible if you have a 4-port network analyzer.

Differential

If you select this mode, means the LCA uses a differential electrical input or output for this measurement.

Whether the differential signal is the input to the DUT or the output from the DUT, this uses ports 2 and 3 of a four port network analyzer.

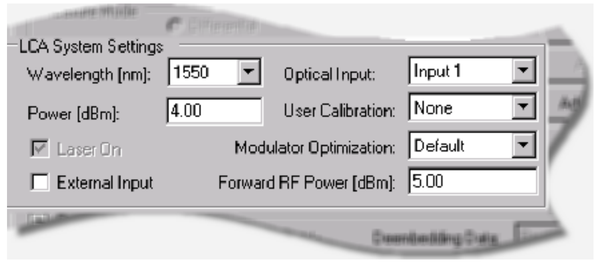
Single-Ended

If you select this mode, the LCA uses a single-ended electrical input or output for this measurement.

The electrical input to the DUT is Port 1 of the network analyzer.

The electrical output from the DUT is Port 2 on a two-port network analyzer or, respectively, Port 4 on a four-port network analyzer.

LCA System Settings



Wavelength (nm)

- If you have not selected to use the optional External Input, select the wavelength of the laser source and the optical power meter use for measurements.
- If you have selected to use the External Input, you can enter the wavelength of the external source here. This wavelength is used by the optical power meter.

Power [dBm]

Set the optical output power of the internal laser source.

If you select to use the optional External Input, enter the average optical output power at the LCA transmitter output connector.

Laser On

This control, which overrides the default behavior of the Lightwave Component Analyzer, is only enabled in Advanced mode and if you have not selected to use the optional External Input.

Select to turn the laser source on for the following LCA measurement.

Deselect to turn the laser source off for the following LCA measurement.

External Input

This control is only active for lightwave component analyzers equipped with an optional external optical input.

- Select to use a laser source connected to the external input (on the rear of the optical test set.
- Deselect to use the laser source in the optical test set.

Optical Input

Select the input to which your device under test is connected.

- For input signals up to +7 dBm (calibrated up to+5 dBm), use **Input 1**.
- For input signals up to +17 dBm (calibrated up to+15 dBm), use **Input 2**.

User Calibration

Select the calibration data you want to use.

- **None** uses the factory calibration data only (no additional user calibration data is used).
- **Measure** runs an extra calibration measurement step during the measurement setup.

  Before running the first measurement, you need to ensure the instrument has a valid electrical calibration, as described in Calibrating the Network Analyzer before Measurements on page -53.

  At the end of this calibration measurement, you can save the calibration data.

  This calibration is only used for the measurement setup for which it is specified.
- **Load** prompts you to load data from a file saved as part of a previous user calibration measurement.

Modulator Optimization

Select to how the modulator bias is to be optimized.

- Select “Once” to automatically optimize the modulator bias at the first measurement after the measurement parameters have been set.

  This is sufficient for most measurements unless the tester is subject to large changes in environmental conditions.
- Select “EverySweep” to optimize at the start of everymeasurement sweep.

  This increases accuracy, but also increases measurement times.

  This is the default modulator bias optimization mode, and is used to calibrate and verify the instrument.
- Select “Continuous” to optimize while the measurement is running.

  With “Continuous” modulator bias optimization, a 10 kHz pilot tone is applied to the signal. This improves the short and long term signal stability of the modulator working point.

  The pilot tone will affect measurements with IFBW settings of the network analyzer >1.5 kHz.

For IFBW settings of the network analyzer >3 kHz were commended you do not use “Continuous” modulator bias optimization, Use "Every Sweep" or "Once" instead.

Forward RF Power [dBm]

Sets the RF power level for the source port(s).

Optical Path Deembedding

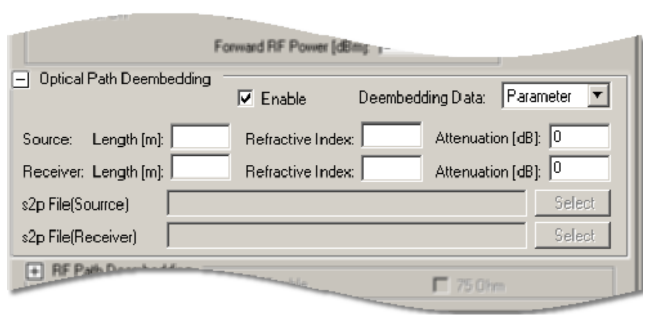
Enable

Select if you want the LCA to compensate for the optical connections to the DUT.

Deembedding Data

Select how you want to specify the characteristics of the optical path.

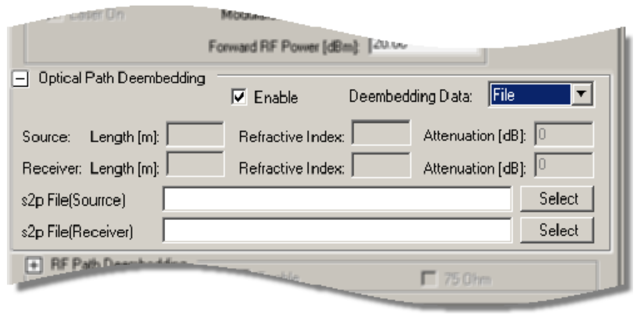
- **Parameter** lets you characterize the source or receiver optical path by its length and refractive index, and attenuation.



- **Length (m)** and **Refractive Index** can only be used together. That is, you cannot give a value just for the refractive index or just the length.

  The value for the Refractive Index of a single-mode fiber is typically 1.467 at 1310 nm and 1.468 at 1550 nm.

  The value for the Refractive Index of a graded index multi-mode fiber is 1.49 for 62.5 µm at 850 nm, 1.475 for 50 µm at 850 nm and 1.465 for 50 µm at 1300 nm.
- **Attenuation (dB)** can be used alone, or with the values for length and refractive index.
- **File** lets you use the results of a measurement of the optical path to characterize the source or receiver optical path.



These results need to be in the form of a 2-port S-parameter data files (also known as Touchstone .s2p data files).

Only the s21 values of the file are used for correction of the transmission properties. All other parameters are ignored.

To assign a file,

1 Click Select at the right of the field to which you want to assign a file.

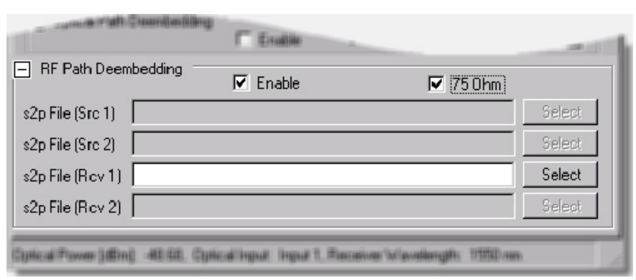
2 Locate and select the file in the explorer window.

RF Path Deembedding

Enable

Select if you want the LCA to compensate for the RF connections to the DUT.

Use the results of a measurement of the RF path to characterize the source or receiver RF path.



- For Single-Ended measurements, Src 1 corresponds to the path to network analyzer Port 1, and Rcv 1 corresponds to the path to Port 2 on a two-port network analyzer or, respectively, to Port 4 on a four-port network analyzer.
- For Differential measurements, Src 1 corresponds to the path to Port 2 (on the network analyzer), Src 2 corresponds to the path to Port 3 (on the network analyzer), Rcv 1 corresponds to the path to Port 2 (on the network analyzer), Rcv 2 corresponds to the path to Port 3 (on the network analyzer).

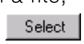
The results need to be in the form of a 2-port S-parameter data file (also known as Touchstone .s2p data files). All the S-Parameters in the supplied file are used.

Please note that 4-port S-parameter files (e.g. for differential probes) are currently not supported.

According to the convention of the LCA (where any port can be an input or an output), these values are directional. This means port 1 of the connector is always connected to the network analyzer and port 2 is always connected to the DUT.

We recommend you use the AdapterChar macro supplied with the network analyzer. This includes this directionality in its characterization. Please refer to the online help on the Network Analyzer for further details.

To assign a file,

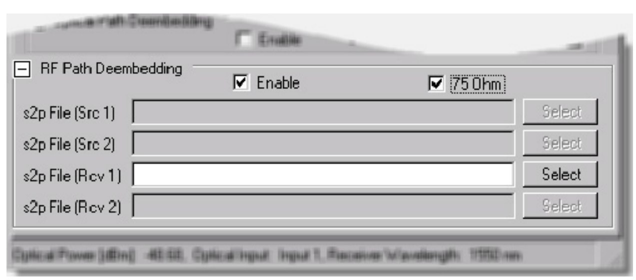
1 Click 

.

2 Locate and select the file in the explorer window.

75 Ohm

Select if you measure components with 75 Ohm impedance. Insert the s2p file name for the file that characterizes the minimum loss pad.



Tools

Some of the controls that can be selected on the Tools tab are also available on the measurement tabs. The controls on the measurement tabs are activated when you start the next measurement setup. The controls on the Tools tab are activated immediately.

The Tools tab always showing the current settings of the instrument. These may be different to what is selected on the other tabs.

Laser Source

Source Wavelength (nm)

Set the wavelength of the laser source.

Power [dBm]

Set the optical output power of the laser source.

Laser On

- Select to turn the laser source on.
- Deselect to turn the laser source off.

External Input

The External Input is an optional extra for the Lightwave Component Analyzer.

- Select to use a laser source connected to the External Input on the rear of the optical test set.
- Deselect to use the laser source in the optical test set.

Optimize ModBias

Start an immediate bias optimization for the modulator.

Receiver

Optical Input

Select the input to which your device under test is connected.

- For input signals up to +7 dBm (calibrated up to+5 dBm), use **Input 1**.
- For input signals up to +17 dBm (calibrated up to+15 dBm), use **Input 2**.

Receiver Wavelength (nm)

Set the wavelength of to be used by the optical power meter.

RF Power

Forward RF Power [dBm]

Sets the RF power level for the source port(s).

For balanced measurements (on 4-port network analyzers), Ports 2 and 3 of the network analyzer are forward for EO measurements and reverse for OE measurements.

Increasing the forward RF power for OE measurements increases the optical modulation amplitude.

Reverse RF Power [dBm]

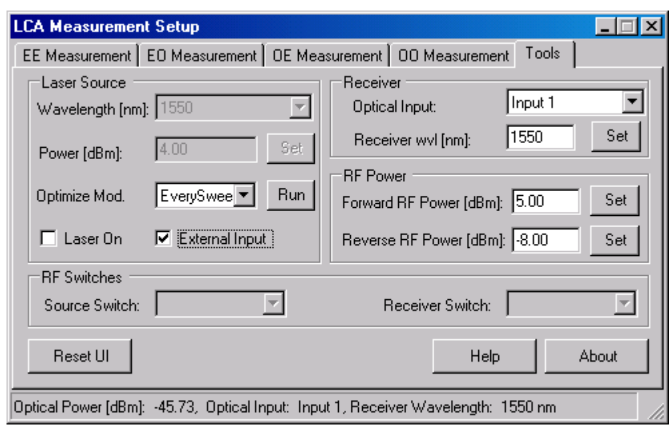
Sets the RF power level for the receiver port(s).

We recommend the factory calibrated default value for the best results.

To reset to the factory default, leave the text box empty or enter a value less than -200 dBm.

Reset UI

The "Reset UI" button resets all LCA settings to default settings.



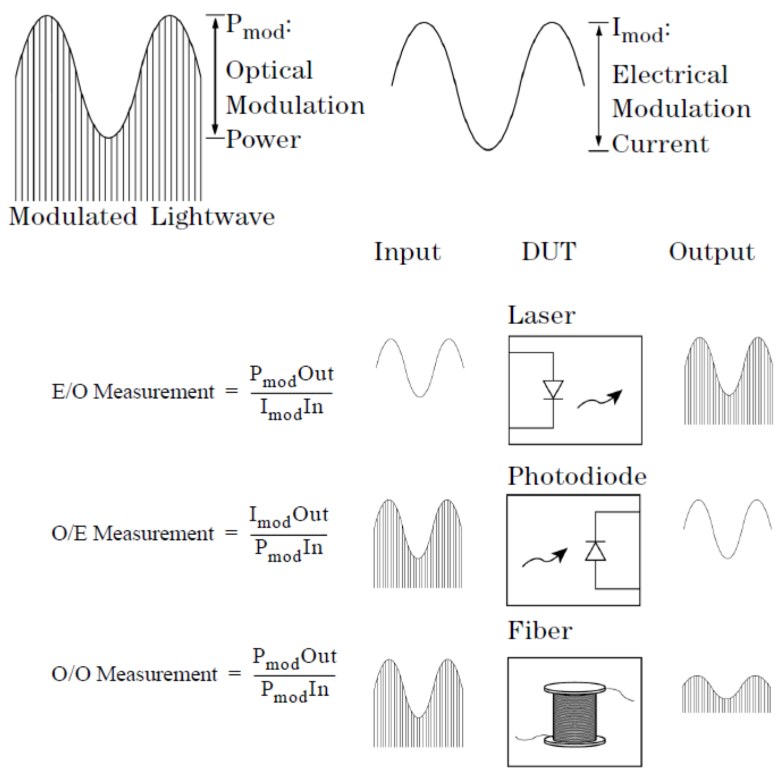
6 Measurement Concepts

KEYSIGHT TECHNOLOGIES

General Measurement Techniques and Considerations

The concept of lightwave component analysis is straightforward. Measurements are made of the small-signal linear transmission characteristics of a variety of lightwave components. A precise electrical (signal generator) or optical (laser) source is used to stimulate the component under test and a very accurate optical or electrical receiver measures the transmitted signal. Since characterization over a range of modulation frequencies is required, the frequency of modulation is normally swept over the bandwidth of interest.

Measurements are typically comprised of the appropriate ratio of microwave modulation current (or power) and lightwave modulation power.



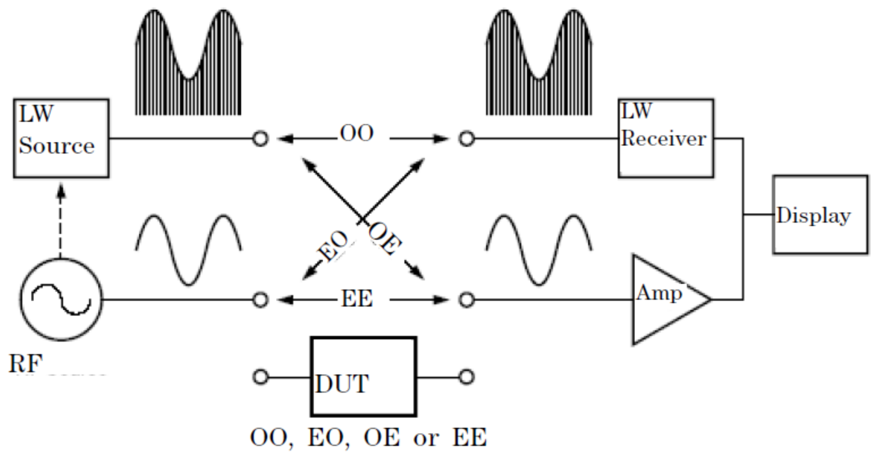
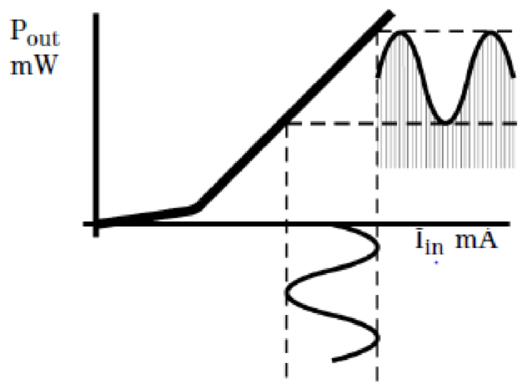


Figure 5 LCA Block Diagram

Figure 5 on page -101 demonstrates the basic concepts of lightwave component analysis. An analysis of how various signals are used in the measurement process is found in Signal Relationships in Opto-Electric Devices on page -104.

EO measurements (lasers, modulators)

The measurement of an EO transducer is a combination of input modulating current and output optical modulation power. Slope responsivity is used to describe how a change in input current produces a change in optical power. Graphically this is shown in the following figure.



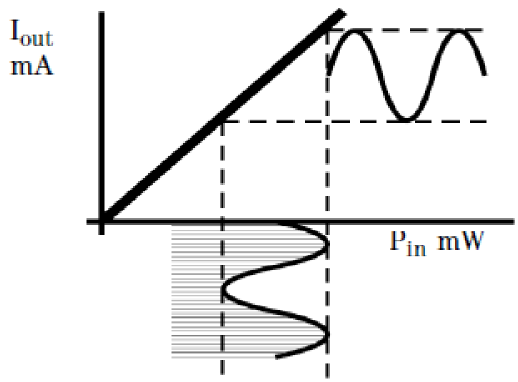
$$\text{Responsivity } R_s(W/A) = \frac{\Delta P_{out}}{\Delta I_{in}}$$

$$R_s(dB) = 20\log_{10}\frac{R_s(W/A)}{W/A}$$

An LCA measures input modulating current and output modulation power and displays the ratio of the two in Watts/Amp, either linearly or in decibels.

OE measurements (photodiodes)

The measurement process for OE devices is similar to EO devices. The measurement consists of the ratio of output electrical modulation current to input optical modulation power. Slope responsivity for OE devices describes how a change in optical power produces a change in electrical current. Graphically this is shown in the figure below.



$$\text{Responsivity } R_r(A/W) = \frac{\Delta I_{out}}{\Delta P_{in}}$$

$$R_r(dB) = 20\log_{10}\frac{R_r(A/W)}{A/W}$$

The LCA measures the input optical modulation power and output modulation current and displays the ratio of the two in Amps/Watt.

OO measurements

Characteristics of purely optical devices can also be measured. In this case, both the stimulus and response are modulated light. The ratio measurement is simply one of gain or loss versus modulation frequency.

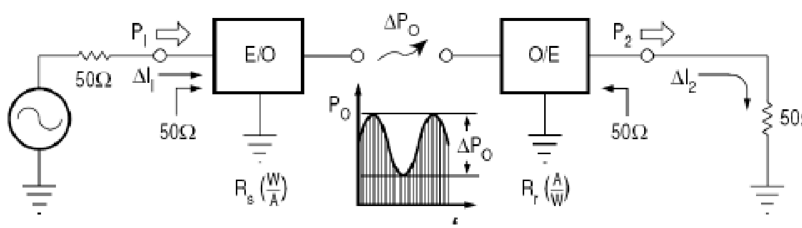
As the lightwave component analyzer is able to measure amplitude and phase, dispersion measurements can be made with very high frequency resolution. This can be used to characterize narrow band optical components with a very high frequency resolution within the modulation bandwidth.

Signal Relationships in Opto-Electric Devices

The LCA measurement technique is built upon concepts used in characterizing RF and microwave devices. “S-parameter” or scattering matrix techniques have proven to be convenient ways to characterize device performance.

The following section will discuss how similar techniques are used in characterizing devices in the lightwave domain. This is intended to show the basis on which EO and OE responsivity measurements are defined.

The figure below is a general representation of a lightwave system, showing input and output signals in terms of terminal voltages, input and output currents, and optical modulation power.



S-parameters are used to describe the transmitted and reflected signal flow within a device or network. For the model, the following S-parameters are defined:

$$S_{11} = \frac{b_1}{a_1}(a_2 = 0)$$

$$S_{22} = \frac{b_2}{a_2}(a_1 = 0)$$

where:

$$a_1 = \frac{\Delta V_1}{\sqrt{Z_0}} \qquad \text{incident on E/O device}$$

$$= \Delta I_1 \bullet \sqrt{Z_0}$$

$$b_1 = \frac{\Delta V_{1refl}}{\sqrt{Z_0}} \qquad \text{reflected from E/O device}$$

$$a_2 = \frac{\Delta V_2}{\sqrt{Z_0}} \qquad \text{incident on E/O device}$$

$$b_2 = \frac{\Delta V_{2refl}}{\sqrt{Z_0}} \qquad \text{reflected from E/O device}$$

$$= \Delta I_2 \bullet \sqrt{Z_0}$$

It is interesting to note that delta voltages and currents are used as opposed to RMS values. This is done because we deal with modulation signals in describing lightwave transducers, where a change in optical power is proportional to a change in electrical current or voltage.

The overall system forward gain is defined as:

$$S_{21} = \frac{b_2}{a_1}(a_2 = 0)$$

$$S_{12} = 0 \qquad \text{(no reverse transmission is assumed)}$$

Though the overall system gain is defined as an S-parameter, the individual transfer functions of the EO and OE devices are typically defined in terms of responsivities, because signals in both the optical and electrical domain are used and optical signals do not lend themselves conveniently to S-parameter definitions. Initially, the input impedance of the EO converter and the output impedance of the OE converter will be assumed to be Z_0 (thus S_{11} and S_{22} are zero).

$$R_s = \frac{\Delta P_0}{\Delta I_i} = \text{E/O source resp}$$

and

$$R_r = \frac{\Delta I_2}{\Delta P_0} = \text{O/E receiver res}$$

Using the above relationships, we can rewrite S_{21} in terms of the transducer responsivities R_s and R_r:

$$S_{21} = \frac{b_2}{a_1}$$

$$= \frac{\Delta I_2}{\Delta I_1}$$

$$= \frac{(R_r \bullet \Delta P)}{(\Delta P / R_s)}$$

$$= R_s \bullet R_r$$

It is convenient to express the transducer functions logarithmically in decibels. The system power gain from a Z_0 source to a Z_0 load can be defined using the above relationships:

$$|a_1|^2 = \text{Power incident on the E/O converter}$$

Power delivered to a

$$|S_{21}|^2 = \frac{|b_2|^2}{|a_1|^2}$$

$$= |R_s \bullet R_r|^2$$

$$= \text{System power gain}$$

$$20\log_{10}|S_{21}| = \text{System gain in dB}$$

$$= 20\log_{10}|R_s \bullet R_r|$$

The responsivities R_S and R_r need to be related to some value in order to have meaning as individual quantities expressed logarithmically, just as 0 dB represents an S_{21} of unity or gain of 1.

Consequently source responsivity will be expressed in Watts per Amp, which in decibels will be related to a conversion efficiency of 1 W/A. Similarly, receiver conversion efficiency will be relative to 1 A/W.

$$20\log_{10}|R_s \bullet R_r| = 20\log_{10}\frac{R_s(W/A)}{W/A} \bullet \frac{R_r(A/W)}{A/W}$$

The individual responsivities can now be expressed individually in decibels:

$$R_s(dB) = 20\log_{10}\frac{R_s(W/A)}{W/A}$$

$$R_r(dB) = 20\log_{10}\frac{R_r(A/W)}{A/W}$$

This now allows us to express the original equations for responsivity in logarithmic terms:

$$R_s(\mathrm{dB}) = 20\log_{10}\frac{\Delta P}{\Delta I_1}$$

$$R_r(\mathrm{dB}) = 20\log_{10}\frac{\Delta I_2}{\Delta P}$$

Responsivity measurements are now based on the LCA's ability to accurately measure optical modulation power (ΔP_0) and modulation current ($\Delta I_{1,2}$).

The measurement of modulation current is derived from the system characteristic impedance and a measurement of electrical power.

The measurement of optical modulation power is based on a "standard" lightwave receiver whose characteristics are predetermined and known by the LCA.

Single-Ended Measurements

Single port measurements are made on devices when the signal on the electrical port is referenced to ground. This port is described by S-parameters.

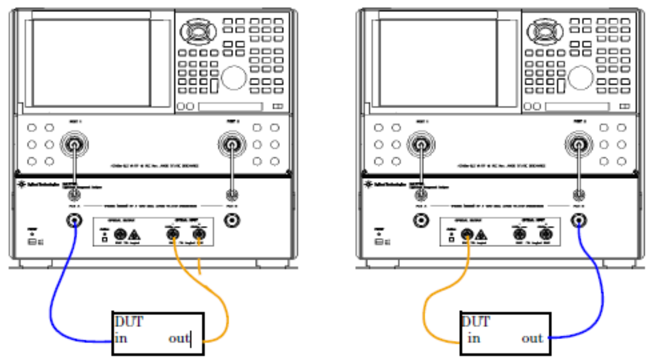


Figure 6 Single ended EO (left) and OE measurement setups (Electrical connections shown in blue, optical connections in yellow)

Differential Measurements (applies to 4-port PNA only)

Differential measurements are made on devices when the signal on the electrical port is the difference between two electrical signals, each of which is referenced to ground. A differential measurement needs two input or two output channels on the network analzyer. The optical port of the device is a third port. For valid differential measurements, make sure the electrical calibration of the network analyzer includes at least three ports.

For more details on differential measurements, please consult the network analyzers user's guide.

For differential device measurements the LCA assumes fixed port configuration. The physical ports 1 and 4 on the network analyzer connect to the LCA test set. The physical ports 2 and 3 on the network analyzer connect to the differential electrical ports of the DUT. Figure 7 on page -110 shows the physical setup for EO measurement and OE measurement, respectively.

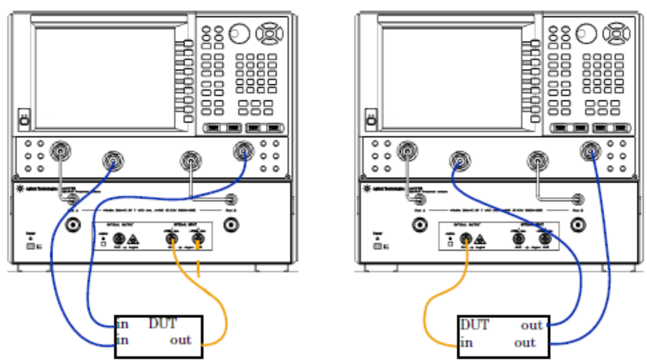


Figure 7 Differential EO (left) and OE measurement setups (Electrical connections shown in blue, optical connections in yellow)

For the differential measurement the logical port configuration of the network analyzer need to be set as follows:

- Logical port 1 is assigned to the single ended, unbalanced port and
- Logical port 2 is assigned to the balanced, differential port.

Differential OE measurements

For OE measurements the single- ended (SE), logical port 1 is assigned to physical port 1 and the balanced (BAL), logical port 2 is assigned to the physical ports 2 and 3 (see Figure 8 on page -111).

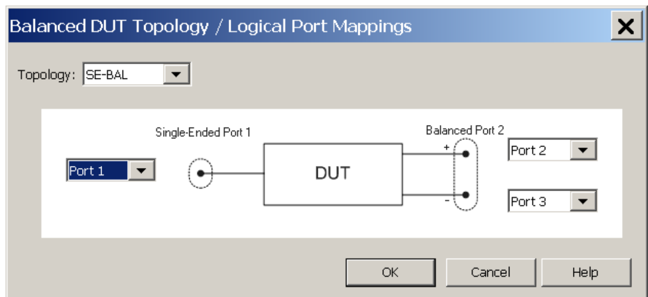


Figure 8 Logical Port Mapping for OE measurement

For OE measurements, the LCA sets up traces for S22, S21, S33, S31 by default.

Differential EO measurements

For EO measurement the single- ended (SE), logical port 1 is assigned to physical port 4 and the balanced (BAL), logical port 2 is assigned to physical ports 2 and 3 (see Figure 9 on page -111).

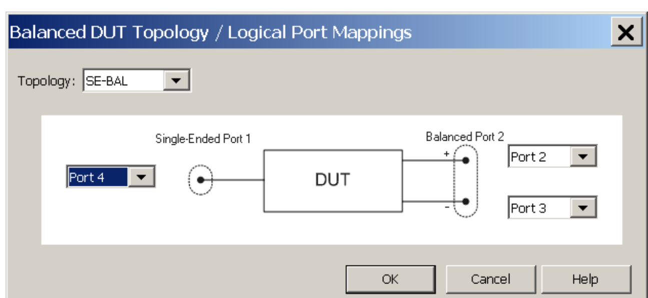


Figure 9 Logical Port Mapping for EO measurement

For EO measurements the LCA sets up traces for S22, S42, S33, S43 by default.

Differential results

When measuring differential devices, the network analyzer displays traces of interest for balanced devices. These include, differential responsivity S, common mode rejection or port imbalance.

Since opto- electronic components are unidirectional, non-reciprocal devices, only the measurement types circled in Figure 10 on page -112 are relevant.

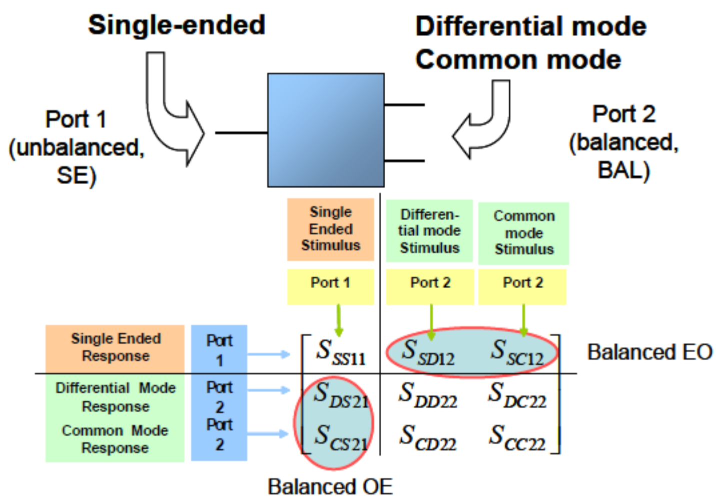


Figure 10 Balanced Measurement types for opto-electronic components

Calibration Concept

The key to making accurate EO, OE, or OO measurements is calibrated instrumentation.

There are a number of calibration stages involved.

The first stage is the electrical calibration of the network analyzer.

This calibration (described in Calibrating the Network Analyzer before Measurements on page -53) characterizes from the end of the flexible test port cable connected to Port 1, to the end of the flexible test port cable connected to Port 2 of a 2-port network analyzer, or Port 4 of a 4-port network analyzer.

This establishes the electrical calibration reference planes for the measurements. Whenever there are additional electrical adapters or elements required for connecting the device under test these electrical paths can be accounted for by "RF path deeembedding" (see RF Path Deembedding on page -95).

The second stage is the calibration of the optical test set. This is handled as a “Fixture” by the network analyzer.

For more information on Fixtures, please refer to the documentation of the network analyzer.

The instrument lightwave source and receiver are individually characterized in the factory, from the female to female adapter on Port A to the optical output, and from the optical input to the female to female adapter Port B, respectively.

This electro-optical calibration is provided by Keysight, and includes the two 85058-60121 Rugged Testport adapters supplied and connected to the optical test set. The calibration is with respect to the optical connectors on the front of the optical test set. Whenever there are additional optical adapters or elements connecting to the device under test, these optical paths can be accounted for by "optical path deeembedding" (see “Optical Path Deembedding on page -94).

The systematic responses of these two stages of calibration can then be deembedded, yielding the response of the device under test (DUT). (See Signal Relationships in Opto-Electric Devices on page -104 for more detail.)

Triggering Concepts

It is possible to trigger the DUT measurements either directly on the network analyzer or using the LCA software, by pressing the LCA "Single" or "Continuous" keys.

However there are some differences:

- when the modulator bias optimization mode is set to"Every Sweep" or "Continuous", using the LCA software starts a modulator bias optimization before starting a DUT measurement.
  This is not done when triggering the measurements directly on the network analyzer.
- when doing EO or OO measurements, using the LCA software, it measures the DC level of the optical power on the receiver, and adjusts the deembedding data if necessary. This means more accurate results than a measurement started directly on the network analyzer.During "LCA Measurement Setup" it is assumed that the DUT has no optical loss and the receiver deembedding is setup for a DC power level equal to the selected optical output power of the LCA. When the internal light source is not used (EO measurement in "Default" mode), the receiver deembedding is setup for a DC power level of 0.0 dBm.

During measurements started using the LCA software, the network analyzer does not respond to any keystrokes on the keypad. The only way to stop a measurement during a sweep is to press the "Abort Measurement" button in the LCA Server window.

When doing an OE measurement with modulator bias optimization mode set to "Single", this time window is very short, since the LCA does nothing between the sweeps. In such cases, the running measurements can always be stopped by pressing the "Abort Measurement" button on the LCA Server window.

Measuring at Different Wavelengths and with the External Optical Source Input

You can also make EO, OE and OO measurements on devices at wavelengths that are different from the default wavelengths.

For OE and OO measurements, the option 050 “External Optical Source Input” is required.

The LCA uses two wavelength correction files "LCA_TxCorr.csv" and "LCA_RxCorr.csv". These files contain typical correction data for the wavelength dependency of the LCA's internal transmitter and receiver. When starting up or resetting, the LCA server reads the data of these two files.

The files "LCA_RxCorr.csv" and "LCA_TxCorr.csv" are located in the following directory:

C:\ProgramData\Agilent\LCA\Table\SN...\

where SN... is the serial number of the optical test set.

For higher accuracy, you could measure the Rx correction data for your specific test head and wavelength and enter these values into the "LCA_RxCorr.csv" file. Since the LCA uses relative correction values between the closest internal wavelength and the wavelength you select, it is important that you measure the Rx responsivity for every internal wavelength and your additional wavelengths. Follow the following procedure:

1 In "Tools" Tab set the receiver wavelength to either 1550 nm or 1310 nm. Set receiver to input 1.
2 Apply an external laser source at wavelength set to the internal wavelengths (1310 nm and/or 1550 nm) and known power (e.g. 0 dBm) to the LCA receiver input 1.
3 Record the displayed power on the LCA using the optical power monitor. The optical power is displayed at the bottom of the LCA macro screen, or you can activate the optical power monitor display using the LCA function keys in the macro menu.
4 For every additional wavelength apply laser light with same known power (e.g. 0 dBm) and record the displayed power. Do not change the receiver wavelength setting in the "Tools" tab.
5 In the "LCA_RxCorr.csv" file, replace the default values with the recorded power values in 2nd column for input 1 for each wavelength measured (i.e. both the internal and the additional wavelengths).

Delete all other wavelength values. (Note: LCA interpolates for missing wavelengths.) Optionally repeat for input 2 and enter values in 3rd column.

We do not recommend to change the values in the "LCA_TxCorr.csv" file. Instead we recommend you measure with user calibration for measurements using an external input.

EO measurements

The wavelength box on the EO tab is an editable, drop down list. This means you can select one of the default wavelengths, or enter a different wavelength.

If you select a wavelength other than the default wavelengths, the LCA checks for the closest default wavelength. The calibration data for this wavelength is used for the LCA measurements.

Next the LCA checks if the "LCA_RxCorr.csv" file is available.

- If not, no wavelength correction is applied.
- If the file is found, the LCA performs a wavelength correction.
- If the wavelength you entered is not covered by the"LCA_RxCorr.csv" file, an error message will be shown.

If the selected wavelength is covered by the correction file, the correction factor is calculated from the values found in the file. This correction factor is applied to the values from the internal optical power meter and to the calibration data used for the LCA measurements.

OE measurements

On the OE tab of the LCA user interface, if you check the external (laser) input check box, you can edit the wavelength. The principles described for EO measurements are applied to the transmitter side, using the wavelength correction data in the file: "LCA_TxCorr.csv".

The LCA expects the power value in the "Power" box to be the optical power at the Optical Output of the LCA test head.

To set the right power value if you are using an external source:

1 Use a short patch cord to connect the Optical Output to the Optical Input.
2 Switch to the "Tools" tab of the user interface and set the receiver wavelength to the external laser wavelength and check the "External Input" check box.

3 Switch on your external source and run the modulator optimization in the "Default" mode.
4 When the optimization is finished, transfer the optical power value displayed in the status bar to the "Power" box.

OO measurements

The principles described above for EO and OE measurements also apply to OO measurements.

7 Maintenance

This system should be serviced only by authorized personnel.

WARNING **Using controls or adjustments or performing procedures other than those specified in the documentation supplied with your equipment can result in hazardous radiation exposure.**

KEYSIGHT TECHNOLOGIES

Cleaning

Safety Precautions

The following Cleaning Instructions contain some general safety precautions, which must be observed during all phases of cleaning. Consult your specific optical device manuals or guides for full information on safety matters.

Please try, whenever possible, to use physically contacting connectors, and dry connections. Clean the connectors, interfaces, and bushings carefully after use.

If you are unsure of the correct cleaning procedure for your optical device, we recommend that you first try cleaning a dummy or test device.

Keysight Technologies assume no liability for the customer's failure to comply with these requirements.

WARNING

Please follow the following safety rules:

- Do not remove instrument covers when operating.
- Ensure that the instrument is switched off throughout the cleaning procedures.
- Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.
- Make sure that you disable all sources when you are cleaning any optical interfaces.
- Under no circumstances look into the end of an optical device attached to optical outputs when the device is operational. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.
- To prevent electrical shock, disconnect the instrument from the mains before cleaning. Use a dry cloth, or one slightly dampened with water, to clean the external case parts. Do not attempt to clean internally.
- Do not install parts or perform any unauthorized modification to optical devices.
- Refer servicing only to qualified and authorized personnel.

Why is it important to clean optical devices?

In transmission links optical fiber cores are about 9 µm (0.00035") in diameter. Dust and other particles, however, can range from tenths to hundredths of microns in diameter. Their comparative size means that they can cover a part of the end of a fiber core, and as a result will reduce the performance of your system.

Furthermore, the power density may burn dust into the fiber and cause additional damage (for example, 0 dBm optical power in a single mode fiber causes a power density of approximately 16 million W/m^2). If this happens, measurements become inaccurate and non-repeatable.

Cleaning is, therefore, an essential yet difficult task. Unfortunately, when comparing most published cleaning recommendations, you will discover that they contain several inconsistencies. In this section, we want to suggest ways to help you clean your various optical devices, and thus significantly improve the accuracy and repeatability of your lightwave measurements.

What do I need for proper cleaning?

Some Standard Cleaning Equipment is necessary for cleaning your instrument. For certain cleaning procedures, you may also require certain Additional Cleaning Equipment.

Standard Cleaning Equipment

Before you can start your cleaning procedure you need the following standard equipment:

- Dust and shutter caps
- Isopropyl alcohol
- Cotton swabs
- Soft tissues
- Pipe cleaner
- Compressed air

Dust and shutter caps

All of Keysight Technologies’ lightwave instruments are delivered with either laser shutter caps or dust caps on the lightwave adapter. Any cables come with covers to protect the cable ends from damage or contamination.

We suggest these protected coverings should be kept on the equipment at all times, except when your optical device is in use. Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber too hard, as any dust in the cap can scratch or pollute your fiber surface.

If you need further dust caps, please contact your nearest Keysight Technologies sales office.

Isopropyl alcohol

This solvent is usually available from any local pharmaceutical supplier or chemist's shop.

If you use isopropyl alcohol to clean your optical device, do not immediately dry the surface with compressed air (except when you are cleaning very sensitive optical devices). This is because the dust and the dirt is solved and will leave behind filmy deposits after the alcohol is evaporated. You should therefore first remove the alcohol and the dust with a soft tissue, and then use compressed air to blow away any remaining filaments.

If possible avoid using denatured alcohol containing additives. Instead, apply alcohol used for medical purposes.

Never try to drink this alcohol, as it may seriously damage your health.

Do not use any other solvents, as some may damage plastic materials and claddings. Acetone, for example, will dissolve the epoxy used with fiber optic connectors. To avoid damage, only use isopropyl alcohol.

Cotton swabs

We recommend that you use swabs such as Q-tips or other cotton swabs normally available from local distributors of medical and hygiene products (for example, a supermarket or a chemist's shop). You may be able to obtain various sizes of swab. If this is the case, select the smallest size for your smallest devices.

Ensure that you use natural cotton swabs. Foam swabs will often leave behind filmy deposits after cleaning.

Use care when cleaning, and avoid pressing too hard onto your optical device with the swab. Too much pressure may scratch the surface, and could cause your device to become misaligned. It is advisable to rub gently over the surface using only a small circular movement.

Swabs should be used straight out of the packet, and never used twice. This is because dust and dirt in the atmosphere, or from a first cleaning, may collect on your swab and scratch the surface of your optical device.

Soft tissues

These are available from most stores and distributors of medical and hygiene products such as supermarkets or chemists' shops.

We recommend that you do not use normal cotton tissues, but multi-layered soft tissues made from non-recycled cellulose. Cellulose tissues are very absorbent and softer. Consequently, they will not scratch the surface of your device over time.

Use care when cleaning, and avoid pressing on your optical device with the tissue. Pressing too hard may lead to scratches on the surface or misalignment of your device. Just rub gently over the surface using a small circular movement.

Use only clean, fresh soft tissues and never apply them twice. Any dust and dirt from the air which collects on your tissue, or which has gathered after initial cleaning, may scratch and pollute your optical device.

Pipe cleaner

Pipe cleaners can be purchased from tobacconists, and come in various shapes and sizes.The most suitable one to select for cleaning purposes has soft bristles, which will not produces scratches.

There are many different kinds of pipe cleaner available from tobacco shops.

The best way to use a pipe cleaner is to push it in and out of the device opening (for example, when cleaning an interface). While you are cleaning, you should slowly rotate the pipe cleaner.

Only use pipe cleaners on connector interfaces or on feed through adapters. Do not use them on optical head adapters, as the center of a pipe cleaner is hard metal and can damage the bottom of the adapter.

Your pipe cleaner should be new when you use it. If it has collected any dust or dirt, this can scratch or contaminate your device.

The tip and center of the pipe cleaner are made of metal. Avoid accidentally pressing these metal parts against the inside of the device, as this can cause scratches.

Compressed air

Compressed air can be purchased from any laboratory supplier.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If not, this can lead to filmy deposits or scratches on the surface of your connector. This will reduce the performance of your transmission system.

When spraying compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty your optical device. First spray into the air, as the initial stream of compressed air could contain some condensation or propellant. Such condensation leaves behind a filmy deposit.

Please be friendly to your environment and use a CFC-free aerosol.

Additional Cleaning Equipment

Some Cleaning Procedures need the following equipment, which is not required to clean each instrument:

- Microscope with a magnification range about 50X up to 300X
- Ultrasonic bath
- Warm water and liquid soap
- Premoistened cleaning wipes
- Lens cleaning papers
- Polymer film
- Infrared Sensor Card

Microscope with a magnification range about 50X up to 300X

A microscope can be found in most photography stores, or can be obtained through or specialist mail order companies. Special fiber-scopes are available from suppliers of splicing equipment.

Ideally, the light source on your microscope should be very flexible. This will allow you to examine your device closely and from different angles.

A microscope helps you to estimate the type and degree of dirt on your device. You can use a microscope to choose an appropriate cleaning method, and then to examine the results. You can also use your microscope to judge whether your optical device (such as a connector) is severely scratched and is, therefore, causing inaccurate measurements.

Ultrasonic bath

Ultrasonic baths are also available from photography or laboratory suppliers or specialist mail order companies.

An ultrasonic bath will gently remove fat and other stubborn dirt from your optical devices. This helps increase the life span of the optical devices.

Only use isopropyl alcohol in your ultrasonic bath, as other solvents may damage.

Warm water and liquid soap

Only use water if you are sure that there is no other way of cleaning your optical device without corrosion or damage. Do not use hot water, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing-up liquid, as it can cover your device in an iridescent film after it has been air-dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

Premoistened cleaning wipes

Use pre-moistened cleaning wipes as described in each individual cleaning procedure. Cleaning wipes may be used in every instance where a moistened soft tissue or cotton swab is applied.

Lens cleaning papers

Some special lens cleaning papers are not suitable for cleaning optical devices like connectors, interfaces, lenses, mirrors and so on. To be absolutely certain that a cleaning paper is applicable, please ask the salesperson or the manufacturer.

Polymer film

Polymer film is available from laboratory suppliers or specialist mail order companies.

Using polymer film is a gentle method of cleaning extremely sensitive devices, such as reference reflectors and mirrors.

Infrared Sensor Card

Infrared sensor cards are available from laboratory suppliers or specialist mail order companies.

With this card you are able to control the shape of laser light emitted. The invisible laser beam is projected onto the sensor card, then becomes visible to the normal eye as a round spot.

WARNING **Take care never to look into the end of a fiber or any other optical component, when they are in use. This is because the laser can seriously damage your eyes.**

Preserving Connectors

Listed below are some hints on how best to keep your connectors in the best possible condition.

Making Connections

Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patch cord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

Dust Caps and Shutter Caps

Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface.

When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately.

Keep the caps on the equipment always when it is not in use.

All of Keysight Technologies' lightwave instruments and accessories are shipped with either laser shutter caps or dust caps. If you need additional or replacement dust caps, contact your nearest Keysight Technologies Sales/Service Office.

Immersion Oil and Other Index Matching Compounds

Where it is possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.

Cleaning Instrument Housings

WARNING Do not open the instruments as there is a danger of electric shock, or electrostatic discharge.

CAUTION Do not open instruments. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

CAUTION Do not use isopropyl alcohol to clean instrument housings.

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. In the case of heavy dirt, you can moisten the cotton tissue in water.

Which Cleaning Procedure should I use?

Light dirt

If you just want to clean away light dirt, observe the following procedure for all devices:

- Use compressed air to blow away large particles.
- Clean the device with a dry cotton swab.
- Use compressed air to blow away any remaining filament left by the swab.

Heavy dirt

If the above procedure is not enough to clean your instrument, follow one of the procedures below. Please consult Cleaning on page -120 for the procedure relevant for this instrument.

If you are unsure of how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

How to clean connectors

Cleaning connectors is difficult as the core diameter of a single-mode fiber is only about 9 µm. This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

In the case of scratches, or of dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be performed by skilled personal, and as a last resort as it wears out your connector.

WARNING **Never look into the end of an optical cable that is connected to an active source.**

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is project onto the card and becomes visible as a small circular spot.

Preferred Procedure

Use the following procedure on most occasions.

1 Clean the connector by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the connector:

1 Moisten a new cotton-swab with isopropyl alcohol.
2 Clean the connector by rubbing the cotton-swab over the surface using a small circular movement.

3 Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4 Blow away any remaining lint with compressed air.

An Alternative Procedure

A better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

1 Hold the tip of the connector in the bath for at least three minutes.
2 Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
3 Blow away any remaining lint with compressed air.

How to clean connector interfaces

CAUTION **Be careful when using pipe-cleaners, as the core and the bristles of the pipe-cleaner are hard and can damage the interface.**

Preferred Procedure

Use the following procedure on most occasions.

1 Clean the interface by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface:

1 Moisten a new pipe-cleaner with isopropyl alcohol.
2 Clean the interface by pushing and pulling the pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
3 Moisten a new cotton-swab with isopropyl alcohol.
4 Using a new, dry pipe-cleaner, and a new, dry cotton-swab remove the alcohol, any dissolved sediment and dust.
5 Blow away any remaining lint with compressed air.

How to clean bare fiber adapters

Bare fiber adapters are difficult to clean. Protect from dust unless they are in use.

CAUTION

Never use any kind of solvent when cleaning a bare fiber adapter as solvents can damage the foam inside some adapters.

They can deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the adapter:

1 Clean the adapter by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.

CAUTION

Be careful when using pipe-cleaners, as the core and the bristles of the pipe-cleaner are hard and can damage the adapter.

2 Clean the adapter by pushing and pulling a new, dry pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.

3 Clean the adapter by rubbing a new, dry cotton-swab over the surface using a small circular movement.

4 Blow away any remaining lint with compressed air.

How to clean lenses

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little alcohol as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred procedure

Use the following procedure on most occasions.

1. Clean the lens by rubbing a new, dry cotton swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for stubborn dirt

Use this procedure when there is greasy dirt on the lens.

1. Moisten a new cotton swab with isopropyl alcohol.
2. Clean the lens by rubbing the cotton swab over the surface using a small circular movement.
3. Using a new, dry cotton swab remove the alcohol, any dissolved sediment and dust.
4. Blow away any remaining lint with compressed air.

How to clean instruments with a fixed connector interface

You should only clean instruments with a fixed connector interface when it is absolutely necessary. This is because it is difficult to remove any used alcohol or filaments from the input of the optical block.

It is important, therefore, to keep dust caps on the equipment at all times, except when your optical device is in use.

CAUTION

Only use clean, dry compressed air. Make sure that the air is free of dust, water, and oil. If the air that you use is not clean and dry, this can lead to filmy deposits or scratches on the surface of your connector interface. This will degrade the performance of your transmission system.

Never try to open the instrument and clean the optical block by yourself, because it is easy to scratch optical components, and cause them to be misaligned.

If you do discover filaments or particles, the only way to clean a fixed connector interface and the input of the optical block is to use compressed air.

If there are fluids or fat in the connector, please refer the instrument to the skilled personnel of Keysight's service team.

How to clean instruments with a physical contact interface

Remove any connector interfaces from the optical output of the instrument before you begin the cleaning procedure.

Cleaning interfaces is difficult as the core diameter of a single-mode fiber is only about 9 mm. This generally means you cannot see streaks or scratches on the surface. To be certain of the degree of pollution on the surface of your interface and to check whether it has been removed after cleaning, you need a microscope.

WARNING **Never look into an optical output, because this can seriously damage your eyesight.**

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the interface. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred procedure

Use the following procedure on most occasions.

1 Clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.

2 Blow away any remaining lint with compressed air.

Procedure for stubborn dirt

Use this procedure when there is greasy dirt on the interface.

1 Moisten a new cotton swab with isopropyl alcohol.

2 Clean the interface by rubbing the cotton swab over the surface using a small circular movement.

3 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.

4 Blow away any remaining lint with compressed air.

How to clean instruments with a recessed lens interface

For instruments with a deeply recessed lens interface (for example the Keysight Technologies 81633A and 81634A Power Sensors) do NOT follow this procedure. Alcohol and compressed air could damage your lens even further.

Keep your dust and shutter caps on when your instrument is not in use. This should prevent it from getting too dirty.

If you must clean such instruments, please refer the instrument to the skilled personnel of the Keysight service team.

Preferred procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

If this is not sufficient, then

- *a* Clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.
- *b* Blow away any remaining lint with compressed air.

Procedure for stubborn dirt

Use this procedure when there is greasy dirt on the interface, and using the procedure for light dirt is not sufficient.

Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface.

1 Moisten a new cotton swab with isopropyl alcohol.
2 Clean the interface by rubbing the cotton swab over the surface using a small circular movement.
3 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4 Blow away any remaining lint with compressed air.

How to clean optical devices which are sensitive to mechanical stress and pressure

Some optical devices, such as Reference Reflectors, are very sensitive to mechanical stress or pressure. Do not use cotton swabs, soft tissues or other mechanical cleaning tools, as these can scratch or destroy the surface.

Preferred procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for stubborn dirt

To clean devices that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This procedure is time-consuming, but you avoid scratching or destroying the surface.

1 Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.
2 Remove the film and any dirt with special adhesive tapes.

Alternative procedure

For these types of optical devices you can often use an ultrasonic bath with isopropyl alcohol. Only use the ultrasonic bath if you are sure that it won’t cause any damage to any part of the device.

1 Put the device into the bath for at least three minutes.
2 Blow away any remaining liquid with compressed air.

If there are any streaks or drying stains on the surface, repeat the cleaning procedure.

How to clean bare fiber ends

Bare fiber ends are often used for splices or, together with other optical components, to create a parallel beam.

The end of a fiber can often be scratched. You make a new cleave. To do this:

1 Strip off the cladding.
2 Take a new soft tissue and moisten it with isopropyl alcohol.
3 Carefully clean the bare fiber with this tissue.
4 Make your cleave and immediately insert the fiber into your bare fiber adapter in order to protect the surface from dirt.

8 Troubleshooting

This system should be serviced only by authorized personnel.

WARNING **Using controls or adjustments or performing procedures other than those specified in the documentation supplied with your equipment can result in hazardous radiation exposure.**

Checking the Operation of the Lightwave Component Analyzer

1. Shut down the network analyzer, as described in the network analyzer user guide and online help.
2. Power down both the network analyzer and the optical test set.
3. Start the equipment and perform an electrical calibration of the network analyzer, as described in Starting the Lightwave Component Analyzer on page -52.
4. Perform the performance verification, as described in Performance Quick Check on page -39.

Event Log

Further troubleshooting information is available from the event log.

You can find this log in the \bin subdirectory of the directory where the LCA program is installed.

If you want to refer to the log, save a copy of it before you restart the LCA server. The log file is cleared each time the LCA server is restarted.

If you have a problem with the LCA, you can also send the event log file to your Keysight contact person to speed up diagnosis.

9 Reinstalling and Updating the Software

Backing Up your LCA Data

The information for your particular configuration of the LCA and the factory calibration data are kept in the “Table” and “Information” subdirectories of the directory in which the software is installed.

These two directories are backed up under the "LCA" directory on the "D" drive of your network analyzer. These directories are not overwritten when performing the network analyzer's system recovery process.

Please refer to the user documentation of the network analyzer for information on backing up calibration data.

Reinstalling the LCA Software

There are two cases:

- Updating the LCA software.
- Reinstalling the LCA software completely, for example after recovering the network analyzer

Updating the LCA software

1 Before updating the software, you must remove the existing software.
   a In Windows' Settings, go to the Control Panel and select Add or Remove Programs.
   b Select the LCA application from the list of programs.
   c Remove the program.
2 Start the LCA setup software *LCAInstaller.msi*.
3 Follow the instructions on the screen.

We recommend you use the default settings.

Reinstalling the LCA software

Preparing the reinstallation

1 Download the LCA software from the Keysight website to a location on the network analyzer's "D" drive.
2 Alternatively, copy the software installation file from the CD-ROM supplied with the LCA to the "D" drive, or run the software installation file directly from the CD-ROM using a USB-connected optical drive.

Reinstalling the software

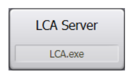
1 On the "D" drive location, or on the CD-ROM, find the directory \Reinstallation\LCA Software\<version number>\ and start the LCA installation program.
2 Follow the instructions on the screen.
   We recommend you use the default settings.
   Note the directory to which the LCA application is installed.
3 The registry script in the next step installs LCA related functions in the first 6 positions of the network analyzers macro group "Macro 1".
   In this LCA directory, right click on the file *NWAShortcuts.reg*.
4 From the context menu, select Merge.

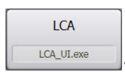
Restoring the hardware calibration files

1. On the network analyzer's "D" drive, open the directory "LCA".
2. Copy all folders (with all their sub-folders) into the LCA program data directory:
3. "C:\ProgramData\Agilent\LCA". (default directory).

Starting the LCA Server

NOTE When starting the "LCA Measurement Setup" with no server running, the server is started automatically.

1. Run the network analyzer.
2. Double-click on the "LCA Server" shortcut on the Desktop of the network analyzer.
3. Or start the LCA server by pressing 

.
4. Press 

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Keysight N4373E Lightwave Component Analyzer
User's Guide

10 Definition of Terms

KEYSIGHT TECHNOLOGIES

Definition of Terms

Absolute frequency response uncertainty

The maximum difference between measured Responsivity of a device under test and the actual (true) responsivity, expressed in dBe.

Conditions: as specified.

NOTE Any change in the cabling after calibration add to the specified absolute frequency response uncertainty.

Measurement: Based on a reference RF O/E receiver.

Average output power (optical)

The (actual or nominal) average output power from the LCA optical output.

Average output power range (optical)

The nominal (selectable) range for Average output power (optical).

Average output power stability (optical)

The variation of the optical Average output power (optical) P over time, calculated as

$$\pm\frac{\max_t\{P(t)\} - \min_t\{P(t)\}}{2}$$

where maxt{} and mint{} are the maximum and minimum value over time t.

Conditions: Time period as specified after modulator auto bias (“modulator optimization”) is performed with the selected wavelength. Other conditions as specified.

Measurement: Using an average power meter with averaging time set to 1 s.

Average output power uncertainty (optical)

The maximum difference between actual (true) Average output power (optical) and the nominal (selected) average output power.

Conditions: After modulator auto bias (“modulator optimization”) performed with the selected wavelength. Other conditions as specified.

Measurement: Using an average power meter with averaging time set to 1 s.

Average power measurement uncertainty (optical)

Maximum difference between measured average (over time) optical power and true average optical power at the LCA optical input.

Measurement: Comparison with an average power meter with averaging time set to 1 s.

Average power measurement range (optical)

The range for the average optical power where the specification for Average power measurement uncertainty (optical) applies.

Decibel (dBm, dBo, dBe)

A ratio in decibel (dB) is calculated as 10-log10{ratio}. Special cases:

- dBo: specifically the ratio of optical powers (‘o’ for ‘optical’).
- dBe: specifically the ratio of electrical powers (‘e’ for ‘electrical’).
- dBm: power level related to 1 mW (electrical or optical).

NOTE

Differences of powers in dBm are written as “dBo” for optical powers or “dBe” for electrical powers.

$dB_{W/A}$: The square of the Responsivity R divided by 1 A/W,

$$10\log_{10}\left\{\left(\frac{R}{1A/W}\right)^2\right\}$$

or

$$20\log_{10}\left\{\frac{R}{1A/W}\right\}$$

$dB_{W/A}$ is defined correspondingly to $dB_{W/A}$.

NOTE Differences of responsivities in $dB_{A/W}$ or $dB_{W/A}$ are written as “dBe”.

NOTE For O/E and E/O converters with linear relation between optical power and electrical current, optical ratios in dBo have half the magnitude of the electrical ratios in dBe.

Electrical loss of optical test set

The electrical (RF) signal loss of the optical test set between Network Analyzer electrical port and LCA electrical port. LCA set to E/E mode.

Conditions: Frequency range as specified.

Frequency response repeatability

In repeated measurements of the (absolute) frequency response under constant conditions, the repeatability ±Rep at each modulation frequency is defined as twice the standard deviation, $StDev_i$, of the measured responsivities R_i over the repetitions i:

$$Rep = 2 \times StDev_i\{R_i\}$$

Conditions: fixed cables and unchanged connections. Other conditions as specified.

Measurement: using a stable DUT.

Group delay (GD)

The signal delay time caused by a transmission path (component). The group delay is derived from the phase change dφ of a harmonic signal detected after the path (component) resulting from a small frequency change df_{mod} of the signal,

$$GD = \frac{d\varphi}{df_{mod}} / 360°$$

with phase change dφ expressed in degrees.

Group delay uncertainty

Specifies the maximum difference between measured and actual Group delay (GD).

NOTE For E/O and O/E, group delay uncertainty excludes a constant group delay offset (see Phase uncertainty). Other conditions as specified.

Measurement: Derived from Phase uncertainty.

Maximum linear average input power (optical)

The maximum average optical input power at the LCA optical input for which the system specifications apply.

Conditions: as specified.

Maximum safe average input power (optical)

Maximum optical power that can be applied to the LCA optical input without permanent change of the LCA's characteristics.

CAUTION Applying more than the specified maximum safe input power may damage the LCA.

Minimum measurable frequency response (noise floor)

The average of the Responsivity measured by the LCA on a DUT with zero output, expressed in Decibel (dBm, dBo, dBe). The value is calculated by averaging the measured responsivity in linear space (rather than decibel space) over the modulation frequency within a specified modulation frequency range.

Conditions: As specified.

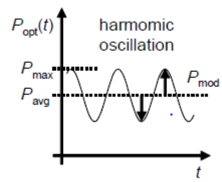
NOTE Responsivity values are converted from Decibel (dBm, dBo, dBe) values to linear values by: linear = $10^{decibel/20}$. The average is converted back to decibels by: decibel = $20*\log_{10(linear)}$.

Modulated optical power

The amplitude of a harmonic optical power modulation. The modulated optical power is calculated from the peak optical power P_{max} and the average optical power P_{avg},

in Watts: $P_{mod} = P_{max} - P_{avg}$

in dBm: $P_{mod,dB} = 10\text{-}log(P_{mod} / 1mW)$.



NOTE Modulated optical power divided by average optical power is a value between 0 (no modulation) and 1 (full modulation). See OMI (optical modulation index).

NOTE For full modulation, modulated optical power equals average optical power.

Operating frequency range (optical test set)

The modulation frequency range for which the LCA optical test set (including optical transmitter and receiver) is designed to supply give measurement results.

OMI (optical modulation index)

Specifies the Modulated optical power divided by Average output power (optical).

Condition: modulation frequency as specified.

NOTE OMI is a value between 0% (no modulation) and 100% (full modulation).

Operating input wavelength range

The wavelength range on the LCA optical input for which the LCA system is designed.

Optical return loss (LCA optical input)

Ratio between incident optical power at LCA optical input and reflected optical power, expressed in dBo.

Output wavelength

Center of gravity wavelength of the signal at LCA optical output. Wavelength is defined as wavelength in vacuum.

Phase uncertainty

When measuring the phase difference of the harmonic signals between DUT input and DUT output at a given modulation frequency, phase uncertainty specifies the maximum deviation between measured and actual phase difference.

NOTE

For E/O and O/E, phase uncertainty excludes the effect of a (constant but unknown) Group delay (GD) offset (resulting from a path length uncertainty in the LCA system). A group delay offset ΔGD at modulation frequency f_{mod} causes a phase change of $\Delta\phi = 360° - \Delta GD - f_{mod}$ expressed in degrees.

Measurement: Based on a reference RF O/E receiver.

Relative frequency response uncertainty

When taking the difference between measured Responsivity of a device under test and actual (true) responsivity in dBe over modulation frequency, the system relative frequency response uncertainty is ± half the peak- to-peak difference.

Conditions: Modulation frequency range as specified. Other conditions as specified.

NOTE

Changes in the cabling after user e-cal add to the specified relative frequency response uncertainty.

Measurement: Based on a reference RF O/E receiver.

Responsivity

The amplitude response R of a device under test (DUT) to a harmonic stimulus:

- E/O measurement: R is the ratio of Modulated optical power in Watt to the electrical stimulus amplitude in Ampere, expressed in W/A.
- O/E measurement: R is the ratio of electrical response amplitude in Ampere to the Modulated optical power in Watt, expressed in A/W.

In both cases, responsivity in Decibel (dBm, dBo, dBe) (“$dB_{W/A}$“ or “$dB_{A/W}$“) is calculated as 20-log(R).

- O/O measurement: R is the difference between the Modulated optical power in dBm at the DUT output and at the DUT input, expressed in dBo. If expressed in dBe, it is twice this number.

NOTE Responsivity of an O/E or E/O device may be called conversion efficiency. For an O/O device, R [dBo] = -(insertion loss [dB]).

References

(1) “Guide to the Expression of Uncertainty in Measurement” (“GUM”), BIPM, IEC, ISO et al. (1993)

11 Specifications

KEYSIGHT TECHNOLOGIES

Specifications

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.

Specifications require an angled connector at the source output and at optical input ports 1 and 2 of the optical receiver.

Angled contact connectors help you to control return loss.

The contact connector on your Lightwave Component Analyzer is angled, use only cables with angled connectors. The Lightwave Component Analyzer input requires angled connectors. Do not use a cable with a flat connector on either the angled input connector or on the angled output connector.

The angled connector symbol is typically colored green.

Measurement Conditions

- Network analyzer set to -1 dBm electrical output power
- Modulation frequency range from 10 MHz to 43.5/50/65 GHz, 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 differently stated)
- 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")
- 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 in front to the optical test set to protect the connectors at the optical test set and is required for performance tests.

Transmitter and Receiver Specifications

Optical test set		
Operation frequency range	N5227A/B PNA	10 MHz to 67 GHz
	N5225A/B PNA	10 MHz to 50 GHz
	N5224A/B PNA	10 MHz to 43.5 GHz
Connector type	Optical input	SMF angled with Keysight versatile connector interface
	Optical output	
	Optical source input (rear)	PMF angled, with Keysight 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 [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
		> 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 wavelength.

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 wavelength.
4. Required source characteristics: SMSR > 35 dB, line width < 10 MHz, power stability < 0.1 dB pp, PER > 20 dB, unmodulated, single mode.

Specifications for Electro-Optical Measurements at 1310 nm (E/O Mode)

N4373E system with network analyzer: N5224A/B, N5225A/B, N5227A/B 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 N5225A/B specifications are typical for frequency range 47 GHz to 50 GHz.

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) [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	DUT response	–	–	–	–	–
	≥ –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)	DUT response	–	–	–	–	–
	≥ –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
Minimum measurable frequency response (noise floor) [2, 4, 5]		–64 dB (W/A)	–64 dB (W/A)	–64 dB (W/A)	–64 dB (W/A)	–59 dB (W/A)
Phase uncertainty (typical) [3]	DUT response	–	–	–	–	–
	≥ –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. 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 $\Delta\varphi = 360° \times \Delta GD \times fmod$ (in deg).
4. Average value over frequency range.
5. 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).

Specifications for Electro-Optical Measurements at 1550 nm (E/O Mode)

N4373E system with network analyzer: N5224A/B, N5225A/B, N5227A/B 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 N5225A/B specifications are typical for frequency range 47 GHz to 50 GHz.

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) [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	DUT response	–	–	–	–	–
	≥ –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)	DUT response	–		–	–	–
	≥ –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 dBe	± 2.0 dBe
Minimum measurable frequency response (noise floor) [2,4,5]		–64 dB (W/A)	–64 dB (W/A)	–64 dB (W/A)	–64 dB (W/A)	–59 dB (W/A)
Phase uncertainty (typical) [3]	DUT response	–	–	–	–	–
	≥ –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. 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 $\Delta\varphi = 360° \times \Delta GD \times fmod$ (in deg).
4. Average value over frequency range.
5. 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).

Specifications for Opto-Electrical Measurements at 1310 nm (O/E Mode)

N4373E system with network analyzer: N5224A/B, N5225A/B, N5227A/B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.
- For external source optical input, 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 N5225A/B specifications are typical for frequency range 47 GHz to 50 GHz.

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 [2]	DUT response	–	–	–	–	–
	≥ −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]	DUT response	–	–	–	–	–
	≥ −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]	DUT response	–	–	–	–	–
	≥ −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
Minimum measurable frequency response (noise floor) [2, 3, 8, 9]		−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)	−60 dB (A/W)	−55 dB (A/W)
Phase uncertainty (typical) [2, 4]	DUT response	–	–	–	–	–
	≥ −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. 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 $\Delta\varphi = 360° \times \Delta GD \times fmod$. (in deg).
5. After CW responsivity and user calibration with external source.
6. Requires option -100 or -102.
7. Typical with internal source.
8. Average value over frequency range.
9. 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).

Specifications for Opto-Electrical Measurements at 1550 nm (O/E Mode)

N4373E system with network analyzer: N5224A/B, N5225A/B, N5227A/B option 200, 201, 219, 400, 401, or 419.

Specifications are valid under the stated measurement conditions.

- For external source optical input, 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 N5225A/B specifications are typical for frequency range 47 GHz to 50 GHz.

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 [2]	DUT response	–	–	–	–	–
	≥ –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]	DUT response	–	–	–	–	–
	≥ –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]	DUT response	–	–	–	–	–
	≥ –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
Minimum measurable frequency response (noise floor) [2, 3, 8, 9]		–60 dB (A/W)	–60 dB (A/W)	–60 dB (A/W)	–60 dB (A/W)	–55 dB (A/W)
Phase uncertainty (typical) [2, 4]	DUT response	–	–	–	–	–
	≥ –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. For DUT response max. –10 dB (A/W).
2. For +5 dBm average output power from LCA optical output.
3. IFBW = 10 Hz.
4. 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 $\Delta\varphi = 360° \times \Delta GD \times fmod$. (in deg).
5. After CW responsivity and user calibration with external source.
6. Requires option -101 or -102.
7. Typical with internal source.
8. Average value over frequency range.
9. 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).

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

N4373E system with network analyzer: N5224A/B, N5225A/B, N5227A/B 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, 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 N5225A/B specifications are typical for frequency range 47 GHz to 50 GHz.

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 [2]	DUT response	–	–	–	–	–
	≥ –3 dBe (≥ –1.5 dBo) [4]	± 0.4 dBe, typical (± 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]	DUT response	–	–	–	–	–
	≥ –3 dBe (≥ –1.5 dBo) [4]	± 0.9 dBe, typical (± 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]	DUT response	–	–	–	–	–
	≥ –3 dBe (≥ –1.5 dBo) [4]	± 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
Minimum measurable frequency response (noise floor) [1, 2, 7, 8]		–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, 3]	DUT response	–	–	–	–	–
	≥ –3 dBe [4] (≥ –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. 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).
4. For DUT response max. +6 dBe (+3 dBo) gain.
5. After CW responsivity and user calibration with external source.
6. Requires option -100 or -102.
7. Average value over frequency range.
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).

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

N4373E system with network analyzer: N5224A/B, N5225A/B, N5227A/B 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, 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 N5225A/B specifications are typical for frequency range 47 GHz to 50 GHz.

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 [2]	DUT response	–	–	–	–	–
	≥ –3 dBe (≥ –1.5 dBo) [4]	± 0.3 dBe, typical (± 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]	DUT response	–	–	–	–	–
	≥ –3 dBe (≥ –1.5 dBo) [4]	± 0.4 dBe, typical (± 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]	DUT response	–	–	–	–	–
	≥ –3 dBe (≥ –1.5 dBo) [4]	± 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) [1, 2, 7, 8]		–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, 3]	DUT response	–	–	–	–	–
	≥ –3 dBe [4] (≥ –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. 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).
4. For DUT response max. +6 dBe (+3 dBo) gain.
5. After CW responsivity and user calibration with external source.
6. Requires option 101 or -102.
7. Average value over frequency range.
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).

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

All specifications of the N5224A/B, N5225A/B, N5227A/B 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 N5224A/B, N5225A/B, N5227A/B 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).

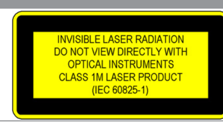
General Characteristics

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	AC 100 to 240 V ± 10%, 50/60 Hz, 120 VA max. (Optical test head only. Refer to the network analyzer documentation for the power requirements.)	

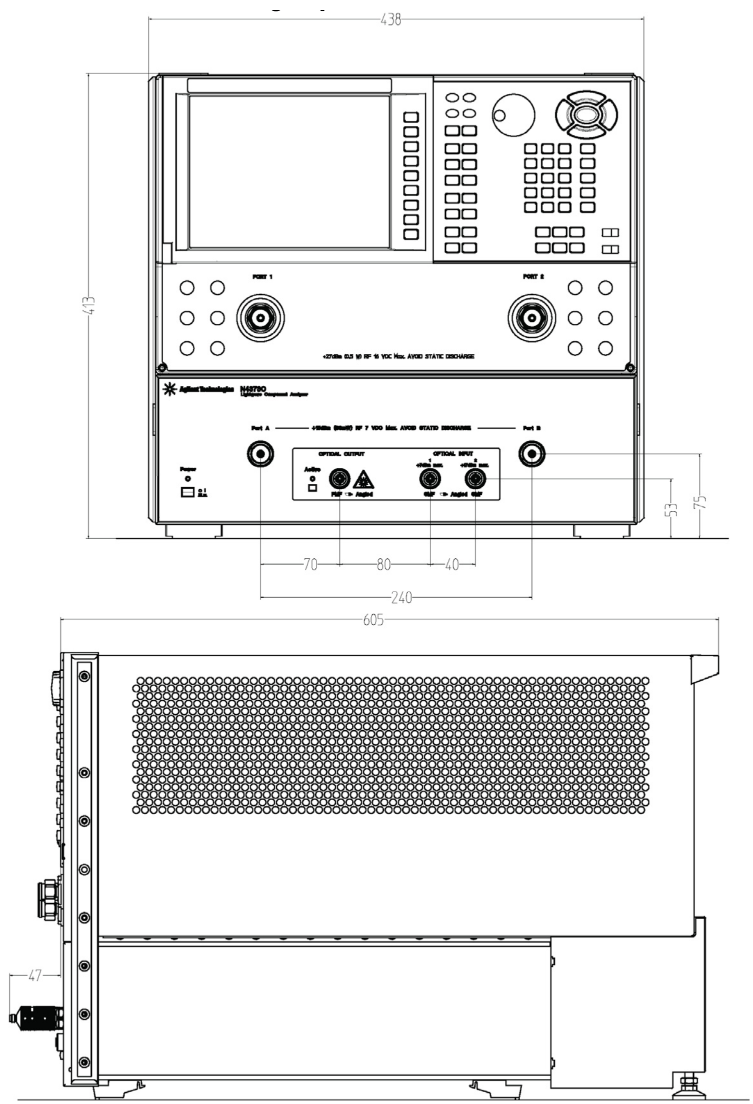
Shipping Contents	
43.5/50 GHz LCA	**67 GHz LCA**
N5224/5A/B NA according to ordered option	N5227A/B NA according to ordered option
3x 85133-60043 f-m flexible test port MW cable (4-port network analyzer) or 2x 85133-60043 f-m flexible test port MW cable (2-port network analyzer)	3x N4697-60030 f-m flexible 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 0.5m FC/APC - FC/PC patch cord and 1x 1005-0256 FC/FC feedthrough adapter (option #021), or 2x N4373-87906 0.5m FC/APC - FC/APC patch cord and 1x 1005-1027 FC/FC feedthrough adapter for narrow key (option #022) (1x PMF patchcord 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 4373E-90A01 Setup Guide	
1x LCA 4373B-90CD1 support CD	
2x local power cord	
1x RoHS addendum for photonic T&M products, 1 x RoHS addendum for photonic T&M accessories	
1 x N4373-88701 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 angled with Keysight universal adapter	9 µm single-mode angled with Keysight universal adapter
LCA external source input (Option -050 only)	**LCA optical output**
9 µm polarization maintaining single-mode angled, with Keysight universal adapter	9 µm single-mode angled with Keysight universal adapter

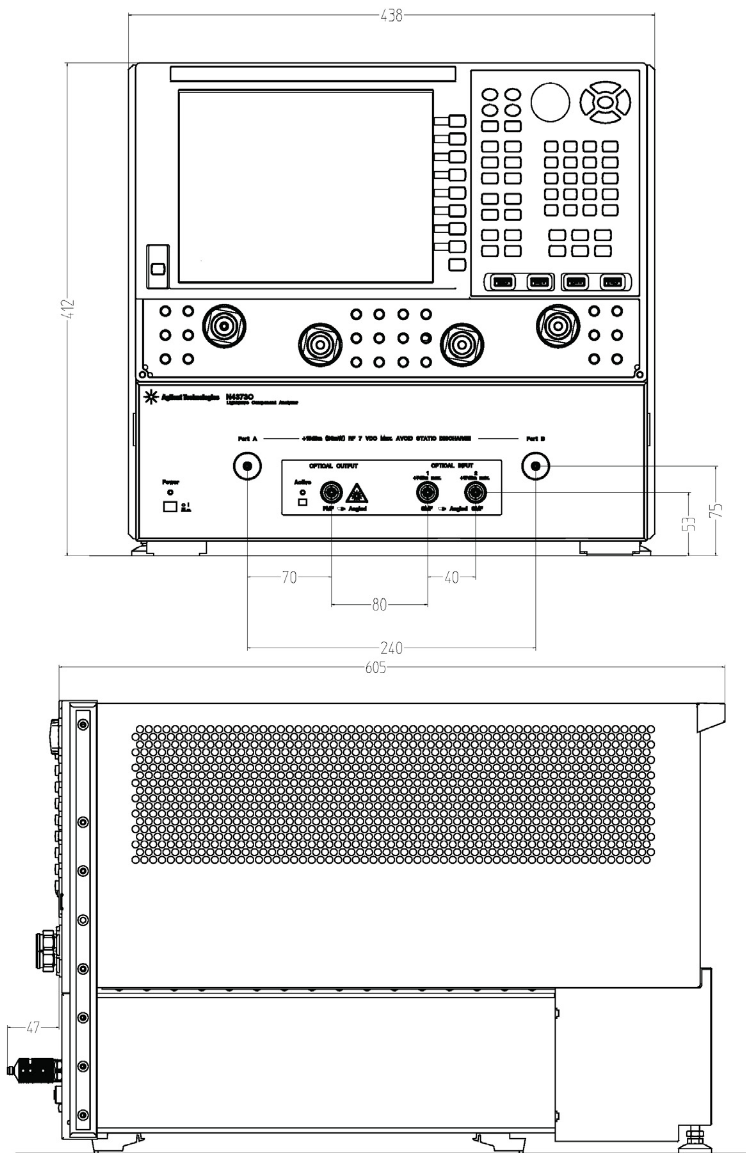
Storage temperature range
−40 °C to +70 °C
Operating temperature range
+5 °C to +35 °C
Humidity
15% to 80% relative humidity, non-condensing
Altitude (Operating)
0 ... 2000 m
Recommended recalibration period
1 year
Laser safety information
All laser sources listed above are classified as Class 1M according 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.



Mechanical Outline Drawings, options 2xx (dimensions in mm)



Mechanical Outline Drawings, options 4xx (dimensions in mm)



12 Regulatory and Warranty Information

KEYSIGHT TECHNOLOGIES

Regulatory Information

Table 2 Specifications

Power	AC 100 to 240 V ± 10%, 50 - 60 Hz, 120 VA max.
Environmental ▪ Storage temperature ▪ Operating temperature ▪ Humidity	 –40° C to +70° C +5° C to +35° C < 80% R.H. at +5° C to +35° C, non-condensing
Dimensions	430 mm x 470 mm x 145 mm
Weight	Net 8.3 kg (18.3 lb)
Max. operating altitude	2000 m (6600 ft)

NOTE This regulatory information applies to the optical test head only. Refer to the network analyzer documentation for regulatory information.

Compliance with Canadian EMC Requirements
This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Table 3 Notice for Germany: Noise Declaration

Acoustic Noise Emission
LpA < 50 dB
Operator position
Normal operation
per ISO 7779

Declaration of Conformity

For latest DoC, please visit the web link:
http://www.keysight.com/go/conformity

Warranty

All system warranties and support agreements are dependent upon the integrity of the Keysight N4373E Lightwave Component Analyzer. Any modification of the system software or hardware will terminate any obligation that Keysight Technologies may have to the purchaser. Please contact your local Keysight field engineer before embarking in any changes to the system.

System

Included in the sales price is a one-year warranty. In addition to the one-year warranty, extended warranty periods, on-site troubleshooting, reduced response times and increased coverage hours can be negotiated under a separate support agreement and will be charged at an extra cost.

Remove all doubt

Keysight 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.

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 Keysight equipment throughout its lifetime. Your equipment will be serviced by Keysight- trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements.For more information on repair and calibration services, go to www.keysight.com/find/removealldoubt

Keysight E-mail Updates

Get the latest information on the products and applications you select.

www.keysight.com/find/emailupdates

myKeysight

Quickly choose and use your test equipment solutions with confidence.

www.keysight.com/find/mykeysight

Keysight Open

Keysight Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Keysight 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.

www.keysight.com/find/open

Phone or Fax

United States:

(tel) 800 829 4444

(fax) 800 829 4433

Canada:

(tel) 877 894 4414

(fax) 800 746 4866

China:

(tel) 800 810 0189

(fax) 800 820 2816

Europe:

(tel) 31 20 547 2111

Japan:

(tel) (81) 426 56 7832

(fax) (81) 426 56 7840

Korea:

(tel) (080) 769 0800

(fax) (080) 769 0900

Latin America:

(tel) (305) 269 7500

Taiwan:

(tel) 0800 047 866

(fax) 0800 286 331

Other Asia Pacific Countries: (tel) (65) 6375 8100 (fax) (65) 6755 0042Email: tm_ap@keysight.com

Keysight 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

Spectral analysis products
www.keysight.com/find/osa

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

Optical test instruments accessories
www.keysight.com/find/octaccessories

Firmware and driver download
www.keysight.com/find/octfirmware

Keysight photonic discussion forum
http://www.keysight.com/find/photonic_forum

For Network analyzer related literature, please visit: Keysight Network Analyzers:
www.keysight.com/find/na

Mechanical and Electronic Calibration Kits:
www.keysight.com/find/ecal

RF Test Accessories, Cabinets, Cables:
ww.keysight.com/find/accessories

13 Ordering Information

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.

LCA N4373E family options	
Wavelength options	**Description**
N4373D-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 (N5225B-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]

1. Guaranteed specification applies only for the above mentioned network analyzer options.

LCA N4373E family options (continued)	
Software options [2,3]	**Description**
S93010A	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**
5063-9217	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**
5063-9214	Rack mount flange kit - 132.6 mm height for installation without handles
E3663AC	Basic rail kit (for system II instruments)

2. For detailed ordering requirements for software options, refer to the LCA configuration guide.
3. For information about other software options, refer to the network analyzer configuration guide.

Power Cords

Power Cords		
8164B-900	United Kingdom	8120-1351
8164B-901	Australia & New Zealand	8120-4419
8164B-902	Continental Europe	8120-1689
8164B-903	United States (120 V)	8120-1378
8164B-906	Switzerland	8120-2104
8164B-912	Denmark	8120-3997
8164B-917	Republic of South Africa and India	8120-4211
8164B-918	Japan	8120-4753
8164B-919	Israel	8120-5182
8164B-922	China	8120-8376
8164B-927	Brazil and Thailand	8120-8871

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This information is subject to change without notice.

Edition 2.0, January 2020

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