Agilent N4373A Lightwave Component Analyzer User's Guide

Agilent Technologies

Notices

Agilent Technologies, Deutschland GmbH
Herrenberger Straße 130
71034 Böblingen, Germany.

Manual Part Number

N4373-90A01

Edition

First edition, May 2006

Subject Matter

The material in this document is subject to change without notice.

Agilent Technologies *makes no warranty of any kind with regard to this printed material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.*

Agilent Technologies shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Printing History

New editions are complete revisions of the guide reflecting alterations in the functionality of the instrument. Updates are occasionally made to the guide between editions. The date on the title page changes when an updated guide is published. To find out the current revision of the guide, or to purchase an updated guide, contact your Agilent Technologies representative.

Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Agilent will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent. Buyer shall prepay shipping charges to Agilent and Agilent shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent from another country.

Agilent warrants that its software and firmware designated by Agilent for use with an instrument will execute its programming instructions when properly installed on that instrument. Agilent does not warrant that the operation of the instrument, software, or firmware will be uninterrupted or error free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

No other warranty is expressed or implied. Agilent Technologies specifically disclaims the implied warranties of Merchantability and Fitness for a Particular Purpose.

Exclusive Remedies

The remedies provided herein are Buyer's sole and exclusive remedies. Agilent Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages whether based on contract, tort, or any other legal theory.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products. For any assistance contact your nearest Agilent Technologies Sales and Service Office.

Certification

Agilent Technologies Inc. certifies that this product met its published specifications at the time of shipment from the factory.

Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, NIST (formerly the United States National Bureau of Standards, NBS) to the extent allowed by the Institutes's calibration facility, and to the calibration facilities of other International Standards Organization members.

ISO 9001 Certification

Produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

Troubleshooting and Maintenance 77

Specifications and Regulatory Information 109

1

Getting Started

Introduction

The Agilent N4373A Lightwave Component Analyzer (LCA) is designed for characterizing the magnitude and phase transfer functions of electrical, opto-electrical, electro-optical and optical components. Apart from classical RF components, this includes RF PIN diodes, transceivers, lasers, electro-optical modulators and optical filters.

The Agilent N4373A Lightwave Component Analyzer offers versatility and fast measurement speed to reduce cost of design and manufacturing of high-performance network components

- E/O, O/E, O/O component response vs f_{mod}
- Full S-parameter analysis for electrical measurements
- NIST traceable system specifications
- Optical Interfaces 1310/1550nm SMF or 850nm MMF
- Single and balanced measurements
- Frequency range 300kHz to 20GHz

The LCA incorporates an electrical network analyzer. By this is meant an Agilent N5230A PNA series microwave network analyzer (PNA), or an Agilent E5070/1B ENA Series RF network analyzer (ENA).
Please also refer to the user documentation and online help that comes with the network analyzer.

NOTE To get the most performance out of your Lightwave Component Analyzer, it is recommended that you read Chapter 2, “Measurement Concepts”, and either Chapter 3, “Making Measurements on the ENA” or Chapter 4, “Making Measurements on the PNA”, depending on your network analyzer. These chapters describe the different measurements, and the setup procedures.

General Safety Considerations

This product has been designed and tested in accordance with the standards listed on the manufacturer's Declaration of Conformity (see page 137), 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 AC symbol is used to indicate the required nature of the line module input power.

The ON symbols are used to mark the positions of the instrument power operating switch.

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

N10149 The C-Tick mark is a certification of the Australian Communications Authority.

The Stand-By symbols are used to mark the positions of the instrument power operating switch.

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 overvoltage 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 (2001). All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2001-July-26.

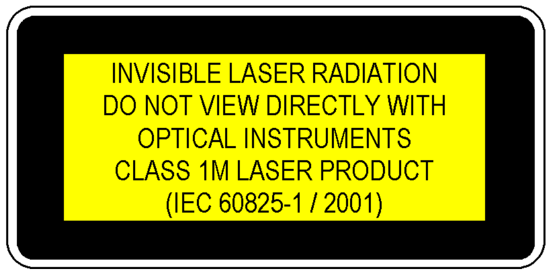


Figure 1 Class 1M Safety Label

A sheet of laser safety labels is included. In order to meet the requirements of IEC 60825-1 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

	N4373A #100, N4373A #102	**N4373A #101, N4373A #102**
Laser wavelength range	1310nm ± 20nm	1550nm ± 20nm
Laser Type	direct modulated DFB	direct modulated DFB
Laser Class according to IEC 60825-1 (2001) international	1M	1M
Maximum CW output power of LCA[a]	< 11.2mW	< 10.5mW
Maximum permissable CW output power	52mW	163mW
Numerical aperture	0.1	0.1
Beam waist diameter	< 10µm	< 10µm

[a] 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 turning the key switch clockwise from the horizontal to the vertical position. The laser is on when the green LED on above the key switch is lit.**
- **The use of the instruments 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 Agilent N4373A Lightwave Component Analyzer complies with overvoltage 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 is 50 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 141 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 withgout 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 Agilent 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 Agilent office, or see www.agilent.com/environment/product/ for more information.

Setting Up the Lightwave Component Analyzer

Setting up the hardware

1 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.

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

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. When you use improper cleaning and handling techniques, you risk expensive instrument repairs, damaged cables, and compromised measurements.

2 Put the network analyzer on top of the optical test set.

For a PNA, use microwave cables of type E7342-6004 to connect to the optical test set.

For an ENA, use microwave cables of type 8120-8862 to connect to the optical test set.

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 (“General Characteristics” on page 119 of this guide, and the user’s documentation for the network analyzer).

3 If you are working with a PNA, continue with “Performance Verification on the PNA” on page 26 or

"Starting the Lightwave Component Analyzer on the PNA" on page 56.

If you are working with a ENA, continue with "Performance Verification on the ENA" on page 23 or "Starting the Lightwave Component Analyzer on the ENA" on page 42.

NOTE

We reccomend you backup your LCA data regularly.

See "Making a backup of the LCA files" on page 99 if you are using an ENA, or "Making a backup of the LCA files" on page 100 if you are using a PNA for information on the files to backup.

20 Optical Test Set Front and Rear Panels

Laser switch.

Turn the key to upright to turn the laser on (LED on), to horizontal for off (LED off).

RF Input

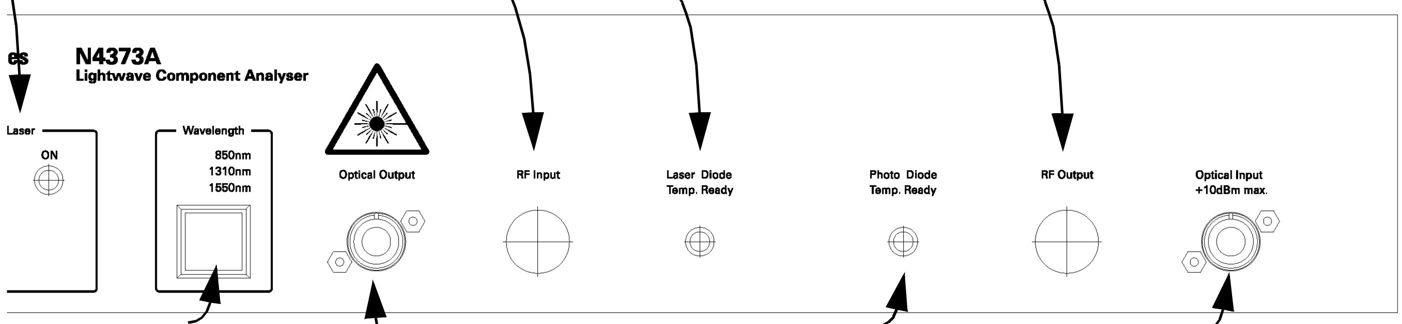
Connect to the network analyzer for O/E and O/O measurements

Laser Diode Temp. Ready

On when the laser is at its operating temperature.

RF Output

Connect to the network analyzer for E/O and O/O measurements



Power switch

Wavelength selector switch.

Press repeatedly to select the desired wavelength (multiple wavelength options only)

Optical Output

Warning: *Laser Radiation can damage your eyesight!*

Connect to the DUT input for O/E and O/O measurements.

Photo Diode Temp. Ready

On when the photo diode is at its operating temperature.

Optical Input

Connect to the DUT output for E/O and O/O measurements.

Caution: Do not apply more than 10dBm.

Figure 2 Front Panel

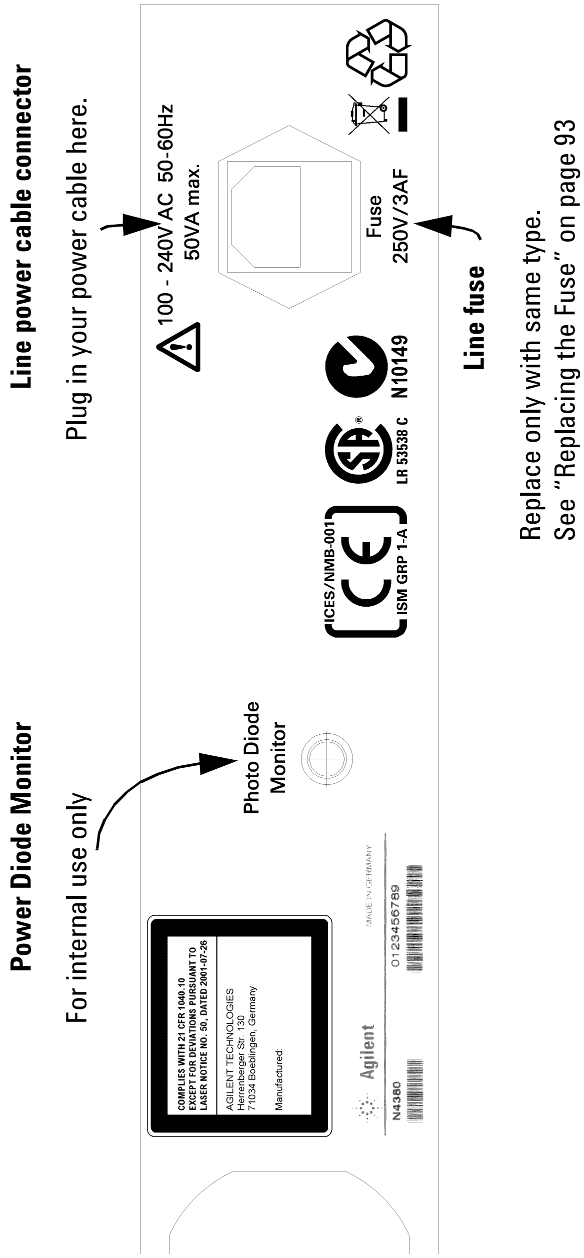


Figure 3 Rear Panel

Using the correct connectors

The Agilent N4373A Lightwave Component Analyzer is equipped with an straight contact optical output connector as standard (option -021).
Angled contact connectors are available as option -022.

Angled contact connectors help you to control return loss. With angled fiber endfaces, reflected light tends to reflect into the cladding, reducing the amount of light that reflects back to the source.

CAUTION

If the contact connector on your instrument is angled, only use cables with angled connectors with the instrument.
Using a cable with a straight connector will damage an instrument with an angled connector.

Enabling and disabling the laser output

You can switch the Laser on and off by turning the key switch.

The green LED beside the laser output indicates whether the laser is emitting radiation. If the Laser output is on, the green LED on the front panel of the module is lit. If the Laser output is off, the green LED on the front panel of the module is unlit.

Performance Verification on the ENA

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

2 Allow the Lightwave Component Analyzer to warm up, that is until the LEDs for “LD Temp Ready” and “PD Temp Ready” are lighting.

3 Turn on the laser by turning the key to the upright position.
The “On” LED lights to indicate the laser is on.

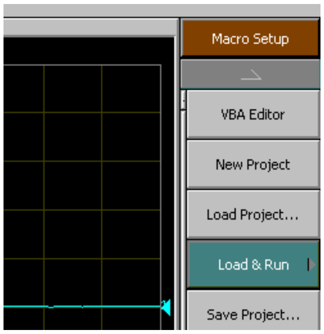
4 If your Lightwave Component Analyzer has more than one wavelength, select the wavelength at which you want to measure by pressing the button under the Wavelength LEDs.

5 Perform an electrical calibration, as described in “Calibrating the network analyzer before measurements” on page 43.

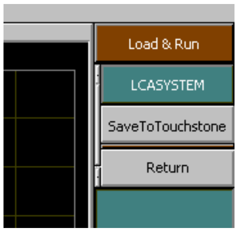
6 Load the LCA macros.

a Press the “Macro Setup” button on the front panel of the network analyzer.

b Select [Load & Run].



c Select LCASYSTEM.

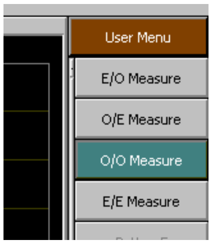


7 Allow the Lightwave Component Analyzer to warm up, that is until the LEDs for “LD Temp Ready” and “PD Temp Ready” are lighting.

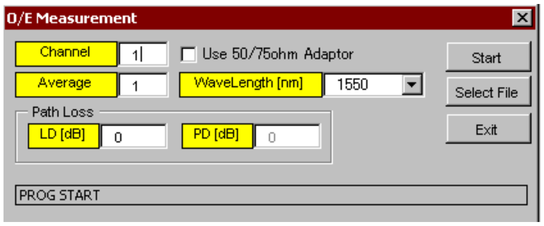
8 Turn on the laser by turning the key to the upright position.
The "On" LED lights to indicate the laser is on.

9 If your Lightwave Component Analyzer has more than one wavelength, select the wavelength at which you want to measure by pressing the button under the Wavelength LEDs.

10 Select [O/O Measurement]

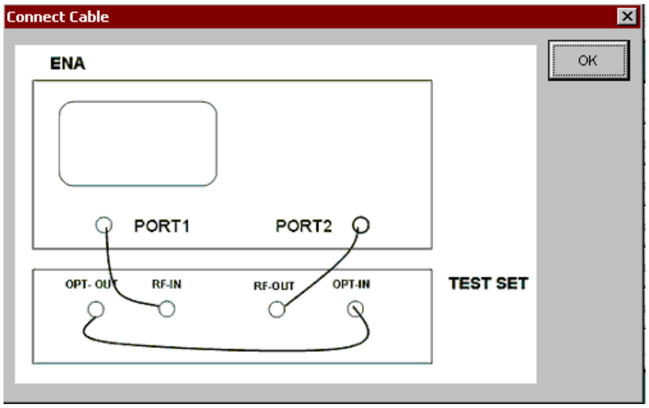


The following dialog box will be displayed:



11 Make sure the same measurement channel is selected as you used for the electrical calibration.

12 When the following screen is displayed, make sure the optical output is connected to the optical input using the patchcord supplied



Click the [OK] button to proceed.

The patchcord has the following part number:
Single-mode angled connector: N4372-87902
Single-mode straight connector: N4372-87904
Multi-mode: N4372-87903

13 When asked whether you want to save the data

- If you can use this calibration data again, click [Yes], give your calibration data file a name, and click [Save].
- If you will have no need to reuse or refer to this calibration data, click [No].

14 When the message box is displayed, click the [OK] button to start the measurement.

15 At the end of the measurement, there should be a flat trace with RMS noise of no more than approximately 0.5 dB.

More noise on the trace (± 10 to 15 dB) may indicate a badly modulated laser or poor connections.

- In this case, measure the output of the laser.
  It should be 7dBm for single-mode lasers, or -5dBm for multimode lasers.
- If the optical output power is close to the specified values (see “Specifications” on page 120), perform the troubleshooting described for the network analyzer in the network analyzer documentation.

If you still have a problem, contact Agilent for support.

Performance Verification on the PNA

To check the correct operation of the Lightwave Component Analyzer:

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

2 Allow the Lightwave Component Analyzer to warm up, that is until the LEDs for “LD Temp Ready” and “PD Temp Ready” are lighting.

3 Turn on the laser by turning the key to the upright position.
The “On” LED lights to indicate the laser is on.

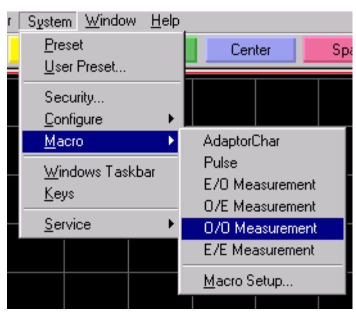
4 If your Lightwave Component Analyzer has more than one wavelength, select the wavelength at which you want to measure by pressing the button under the Wavelength LEDs.

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

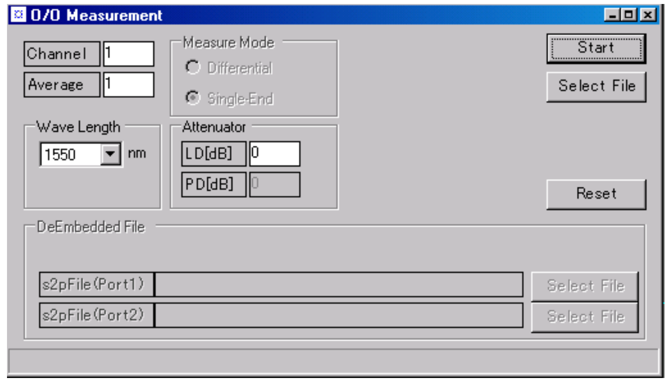
6 Perform an electrical calibration, as described in “Calibrating the network analyzer before measurements” on page 56.

7 Switch on the laser of the optical test set, with the key switch.

8 Select [System] > [Macro] > [O/O Measurement].

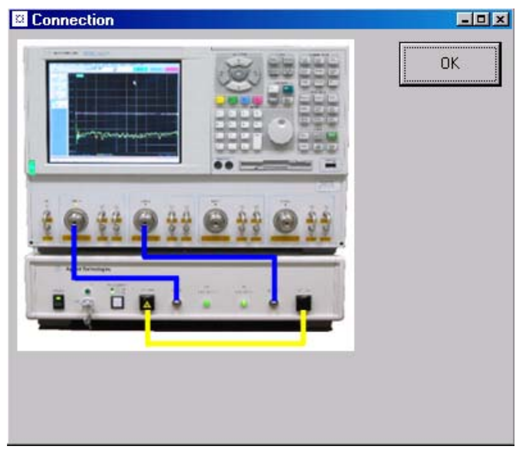


9 Click on [Start].



The Lightwave Component Analyzer prepares for the calibration.

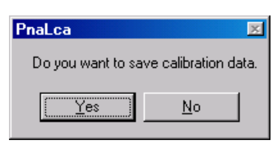
10 When prompted, connect the Optical Output to the Optical Input.
Press [OK], with the optical patchcord supplied.



The patchcord has the following part number:
Single-mode angled connector: N4372-87902
Single-mode straight connector: N4372-87904
Multi-mode: N4372-87903

The Lightwave Component Analyzer calibrates the optical/optical measurement

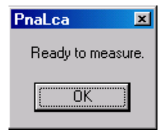
11 When asked whether you want to save the data



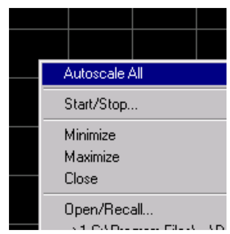
- If you want to re-use this calibration data again, click [Yes], give your calibration data file a name, and click [Save].
- If you want to calibrate the system for your measurement setup, or if you will have no need to reuse or refer to this calibration data, click [No].

The Lightwave Component Analyzer prepares to measure.

12 Click [OK].



13 Right click on the measurement trace, and select [Autoscale All] in the context menu.



14 At the end of the measurement, there should be a flat trace with RMS noise of no more than approximately 0.5 dB.

More noise on the trace (± 10 to 15 dB) may indicate a badly modulated laser or poor connections.

- In this case, measure the output of the laser. It should be 7dBm for single-mode lasers, or -5dBm for multimode lasers.
- If the optical output power is close to the specified values (see “Specifications” on page 120), perform the troubleshooting described for the network analyzer in the network analyzer documentation.

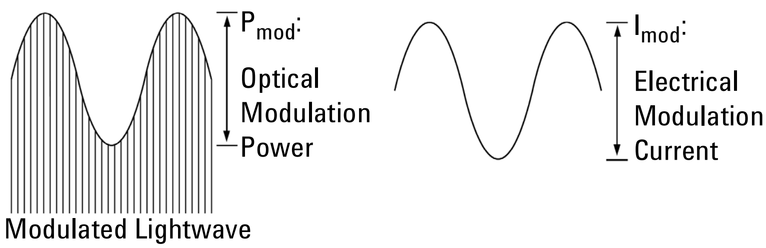
If you still have a problem, contact Agilent for support.

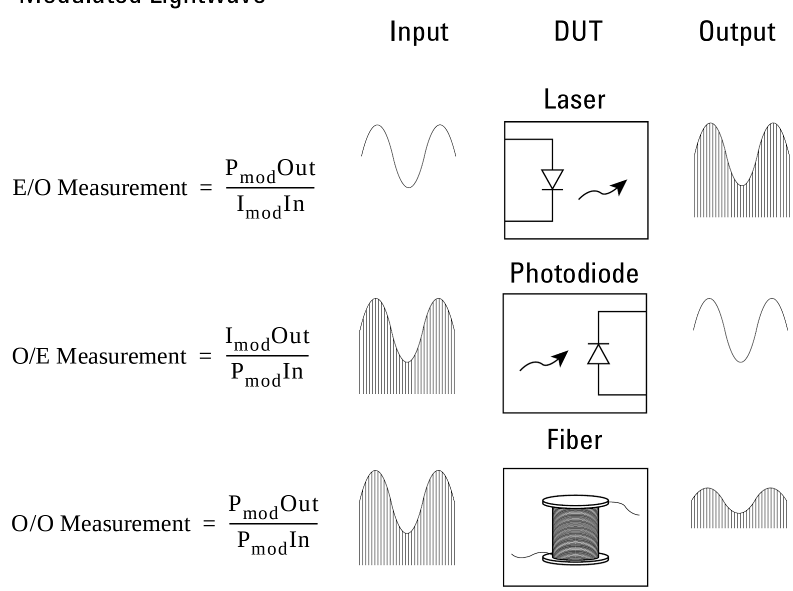
2
Measurement Concepts

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.





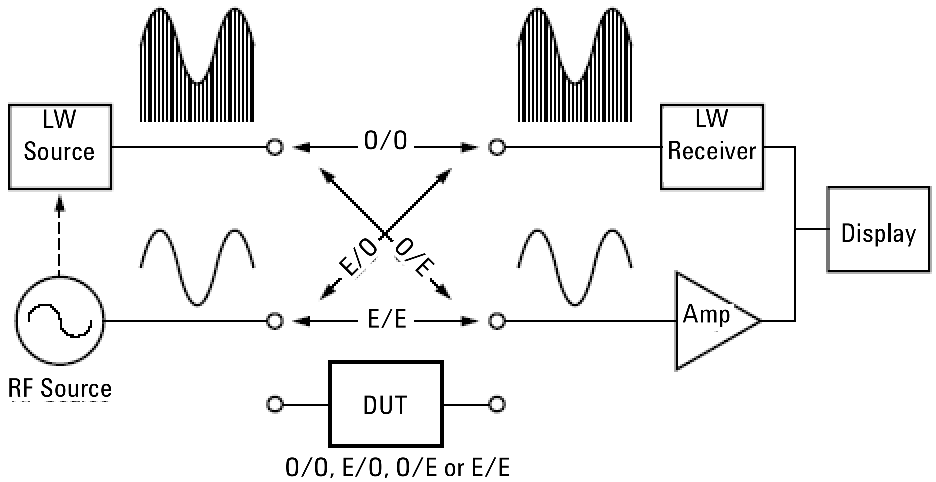


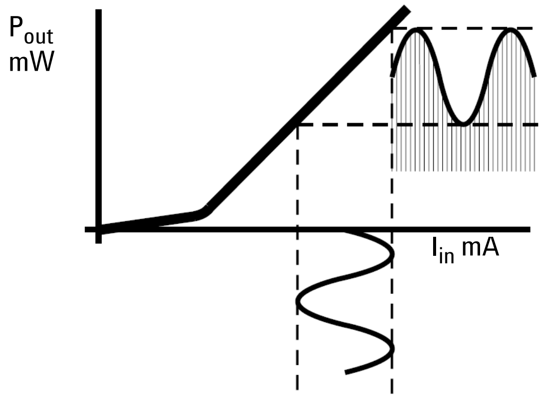
Figure 4 LCA Block Diagram

Figure 4 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 34.

E/O Measurements (Lasers, LED's)

The measurement of an E/O 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 figure below.



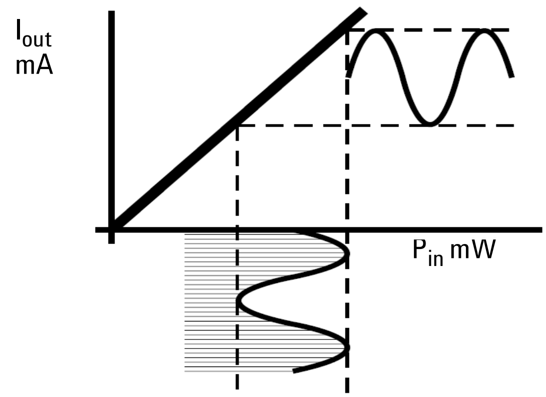
$$\text{Responsivity } R_s(W/A) = \frac{\Delta P_{out}}{\Delta I_{in}}$$

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

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.

O/E Measurements (Photodiodes)

The measurement process for O/E devices is similar to E/O devices. The measurement consists of the ratio of output electrical modulation current to input optical modulation power. Slope responsivity for O/E 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.

O/O 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.

Measurement Calibration

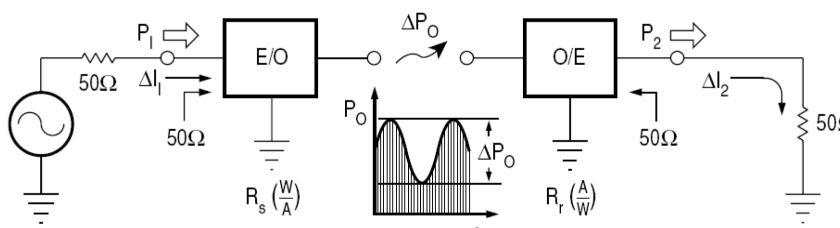
The key to making accurate E/O, O/O, or O/E measurements is calibrated instrumentation. The instrument lightwave source and receiver are individually characterized.
The systematic responses of the components making up the LCA can then be removed, yielding the response of the device under test (DUT). (See “Signal Relationships in Opto-electric Devices” on page 34 for more detail.)

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 E/O and O/E 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:

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

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

$$b_1 = \frac{\Delta V_1}{\sqrt{Z_0}} \qquad \text{reflected from E/O device}$$

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

$$b_2 = \frac{\Delta V_2}{\sqrt{Z_0}} \quad \text{transmitted from O/E device}$$

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

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:

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

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

Though the overall system gain is defined as an S-parameter, the individual transfer functions of the E/O and O/E 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 E/O converter and the output impedance of the O/E converter will be assumed to be Z_0 (thus S_{11} and S_{22} are zero).

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

and

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

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

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

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

$$= R_s \bullet R_r$$

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

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:

$$|a_1|^2 = \text{Power incident on the E/O converter}$$
$$|b_2|^2 = \text{Power delivered to a Z0 load}$$
$$|S_{21}|^2 = \frac{|b_2|^2}{|a_1|^2}$$
$$= |R_s \bullet R_r|^2$$
$$= \text{System power gain}$$
$$20\log_{10}|S_{21}| = \text{System gain in dB}$$
$$= 20\log_{10}|R_s \bullet R_r|$$

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:

$$R_s(dB) = 20\log_{10}\frac{\Delta P}{\Delta I_1}$$
$$R_r(dB) = 20\log_{10}\frac{\Delta I_2}{\Delta P}$$

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 and balanced port 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.

Balanced port measurements are only possible on the PNA. These 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 balanced measurement needs two input or two output channels on the network analzyer. The optical port of the device is a third port.
For valid balanced measurements, make sure the electrical calibration of the network analyzer includes at least three ports.

For more details on balanced port measurements, please consult the PNA user's guide.

Description of the Agilent N4373A Lightwave Component Analyzer

The optical test set of the Agilent N4373A Lightwave Component Analyzer is a passive add-on to a network analyzer. The controls for the signal applied to the device under test and the evaluation of the returning signal are all performed by the network analyzer. Therefore, refer to the user guide and online help for the network analyzer for information on setting your test parameters.

Target Test Components

O/E components

- PIN diodes
- Optical sensors
- Receivers
- ROSA

E/O components

- Lasers
- Transmitters
- TOSA
- Modulators

O/O components

- Optical passive components
- Fibers

Types of measurement performed with the Lightwave Component Analyzer

Lightwave source characterization (electrical-in and optical-out)

Source slope responsivity tests

- Modulation bandwidth
- Modulated output power flatness
- Modulation signal group delay and differential phase
- Distance-time response (requires the time domain options, see “Agilent N4373A ordering options” on page 140.

- Common mode rejection ratio

Electrical reflection tests

- Port impedance or return loss

Lightwave receiver characterization (optical-in and electrical-out)

Receiver slope responsivity tests

- Modulation bandwidth
- Modulation signal group delay and differential phase
- Common mode generation ratio

Electrical reflection tests

- Port impedance or return loss

Optical device characterization (optical-in and optical-out)

Optical transfer function tests

- Insertion loss or gain
- Modulated output power flatness
- Modulation signal group delay and differential phase
- Modal dispersion

Microwave device characterization (electrical-in and electrical-out)

Electrical transfer function tests

- Insertion loss or gain
- Output power flatness
- Group delay and deviation from linear

Electrical reflection response tests

- Port impedance or return loss

3

Making Measurements on the ENA

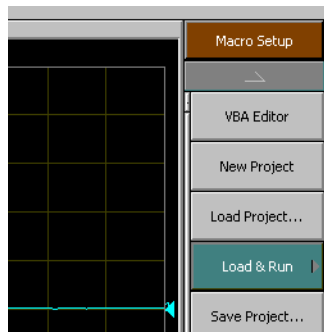
Starting the Lightwave Component Analyzer on the ENA

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

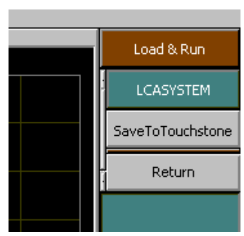
2 Load the LCA macros.

  a Press the “Macro Setup” button on the front panel of the network analyzer.

  b Select [Load & Run].



  c Select LCASYSTEM.



3 Allow the Lightwave Component Analyzer to warm up, that is until the LEDs for “LD Temp Ready” and “PD Temp Ready” are lighting.

4 Turn on the laser by turning the key to the upright position.
The “On” LED lights to indicate the laser is on.

5 If your Lightwave Component Analyzer has more than one wavelength, select the wavelength at which you want to measure by pressing the button under the Wavelength LEDs.

Calibrating the network analyzer before measurements

About measurements

- Always perform an electrical calibration of the network analyzer or load an existing calibration file before making measurements.
  If you make a measurement without a calibration, you will get an error message.
- Make a note of the channel for which you make the electrical calibration.
  Always use this channel when setting up and making the optical, electro-optical and opto-electrical measurements.
- After completing the calibration, do not alter the test port power, IF bandwidth, start frequency, stop frequency, measurement point number or other settings.
  You may get measurement errors if you change the parameters.

Keep the following points in mind during network analyzer electrical calibration.

- To improve the S/N ratio of measurements, increase the power of the network analyzer test port, though not so high as to cause distortion in E/O converter modulation characteristics.
- 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.

Electrical calibration

Calibrate the network analyzer with a short open loss test (2 port SOLT) before you start using the Lightwave Component Analyzer, or return to the electrical measurement mode, as described in “Returning to Electrical Measurements on the ENA” on page 53 to do the calibration.

Do the calibration using the network analyzer calibration kit according to the instructions in the network analyzer user guide and online help.

Measuring Electro-Optical Devices on the ENA

Before you make a measurement, always perform an electrical calibration of the network analyzer as described in "Electrical calibration" on page 43.
If you make a measurement without this calibration, you will get an error message.

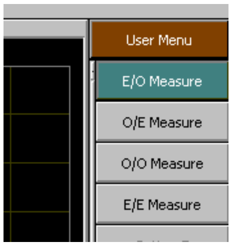
Before you make your first electro-optical measurement, you must calibrate the E/O measurement.

If you have already calibrated the E/O measurement, you can connect your device under test and make the measurement using the controls on the network analyzer.
Please refer to the user guide and online help for the network analyzer for further information.

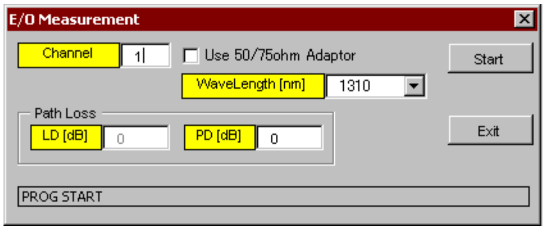
Calibrating the E/O measurement

1 If you have been measuring opto-electrical or optical/optical devices, you must first remove the correction matrix for the active measurement type (the active measurement type is shown at the top right of the trace). You do this by calibrating for an E/E measurement, as described in "Returning to Electrical Measurements on the ENA" on page 53).

2 Press the "Macro Run" button on the front panel of the network analzer.
Select [E/O Measurement]



The following dialog box will be displayed:



3 Make sure the same measurement channel is selected as you used for the electrical calibration.

4 If you are using an adaptor to connect a device with an output with 75 Ω impedance to the 50 Ω input of the ENA, please check the box here.

5 Select the wavelength at which you are testing. This should be the same as the wavelength selected on the front panel of the optical test set.

6 If you are connecting an optical attenuator to the photo-diode input of the Lightwave Component Analyzer, enter the amount of attenuation for PD[dB], in dB.

- For more accurate measurements, include the attenuator in the test circuit when calibrating the E/O measurement.

The measurement results will be displayed on the screen after correction using calculations based on photonic attenuator insertion.

7 Click on the [Start] button to start the measurement preparation.

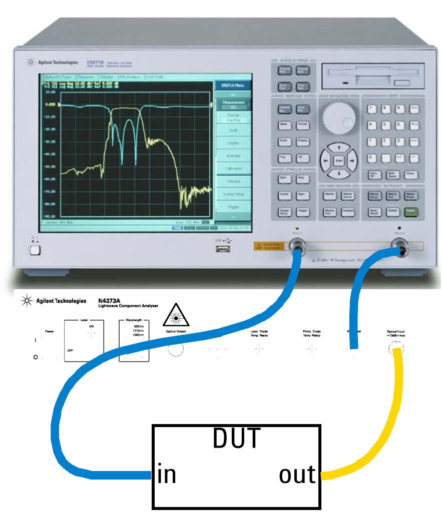
8 When the message box is displayed, click the [OK] button to start the measurement.

Making E/O measurements

You can now connect your device under test.

The measurement begins automatically.

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



Measuring Opto-Electrical Devices on the ENA

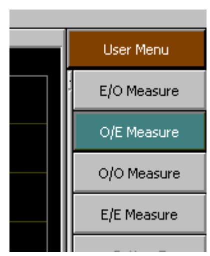
Before you make a measurement, always load an existing calibration file or perform an electrical calibration of the network analyzer as described in “Electrical calibration” on page 43.
If you make a measurement without this calibration, you will get an error message.

Before you make your first opto-electrical measurement, you must calibrate the O/E measurement.

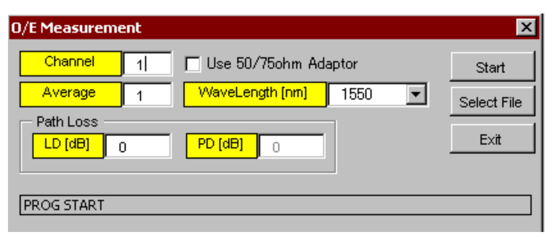
If you have already calibrated the O/E measurement, you can connect your device under test and make the measurement using the controls on the network analyzer.
Please refer to the user guide and online help for the network analyzer for further information.

Calibrating the O/E measurement

1 Press the “Macro Run” button on the front panel of the network analzer.
Select [O/E Measurement]



The following dialog box will be displayed:



2 Make sure the same measurement channel is selected as you used for the electrical calibration.

3 If you are using an adaptor to connect a device with an output with 75 Ω impedance to the 50 Ω input of the ENA, please check the box here.

4 Set the number of averaging measurements to be used for calibration.
The number of averages may be set from 1 to 1024.

5 Select the wavelength at which you are testing. This should be the same as the wavelength selected on the front panel of the optical test set.

6 If you are connecting an optical attenuator to the laser output of the Lightwave Component Analyzer, enter the amount of attenuation for LD[dB], in dB.

- For more accurate measurements, include the attenuator in the test circuit when calibrating the O/E measurement.

The measurement results will be displayed on the screen after correction using calculations based on photonic attenuator insertion.

7 If you have already saved a calibration for this test setup, you can load this now by

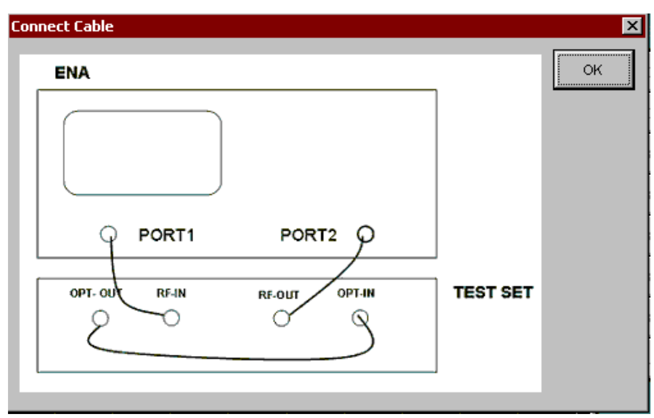
a Click on [Select File].

b Select the file from the Windows Explorer window.

c Continue with step 10.

If you do not have a saved calibration, or if you do not want to use this file, click on the [Start] button to start the measurement preparation.

8 When the following screen is displayed, make sure the optical output is connected to the optical input using the patchcord supplied
Click the [OK] button to proceed.



The patchcord has the following part number:
Single-mode angled connector: N4372-87902
Single-mode straight connector: N4372-87904
Multi-mode: N4372-87903

9 When asked whether you want to save the data

- If you can use this calibration data again, click [Yes], give your calibration data file a name, and click [Save].
- If you want to calibrate the system for your measurement setup, or if you will have no need to reuse or refer to this calibration data, click [No].

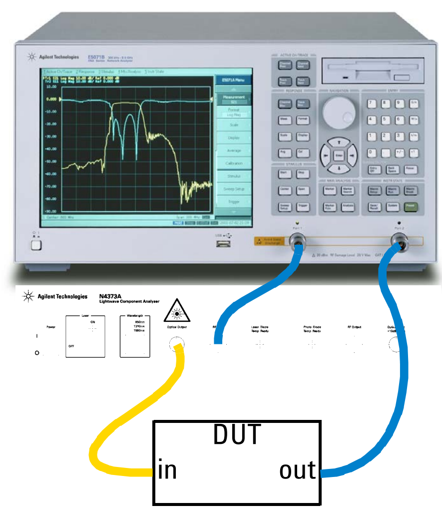
10 When the message part is displayed, click the [OK] button to start the measurement.

Making O/E measurements

You can now connect your device under test.

The measurement begins automatically.

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



Measuring Optical-Optical Devices on the ENA

Before you make a measurement, always load an existing calibration file or perform an electrical calibration of the network analyzer as described in “Electrical calibration” on page 43.
If you make a measurement without this calibration, you will get an error message.

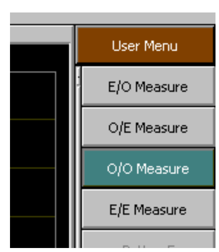
Before you make your first optical-optical measurement, you must calibrate the O/O measurement.

If you have already calibrated the O/O measurement, you can connect your device under test and make the measurement using the controls on the network analyzer.
Please refer to the user guide and online help for the network analyzer for further information.

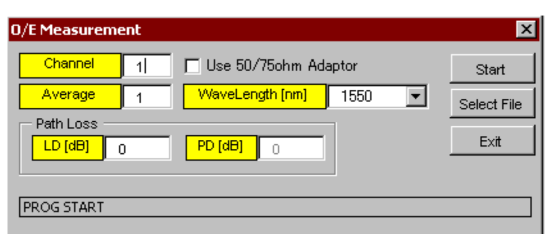
Calibrating the O/O measurement

1 If you have been measuring opto-electrical or electro-optical devices, you must first removes the correction matrix for the active measurement type (the active measurement type is shown at the top right of the trace). You do this by calibrating for an E/E measurement, as described in “Returning to Electrical Measurements on the ENA” on page 53).

2 Press the “Macro Run” button on the front panel of the network analzer.
Select [O/O Measurement]



The following dialog box will be displayed:



3 Make sure the same measurement channel is selected as you used for the electrical calibration.

4 Set the number of measurement averaging iterations to be used for calibration.
The number of iterations may be set from 1 to 1024.

5 Select the wavelength at which you are testing. This should be the same as the wavelength selected on the front panel of the optical test set.

6 If you are connecting a photonic attenuator to either the laser output of the Lightwave Component Analyzer or a photo-diode input, enter the amount of optical attenuation for LD[dB], in dB.

- For more accurate measurements, include the attenuator in the test circuit when calibrating the O/O measurement.
- Note that for O/O measurements, the logarithmic display is in dB_e, that is xdB optical attenuation is displayed as $2x$dB electrical attenuation.

The measurement results will be displayed on the screen after correction using calculations based on photonic attenuator insertion.

7 If you have already saved a calibration for this test setup, you can load this now by

a Click on [Select File].

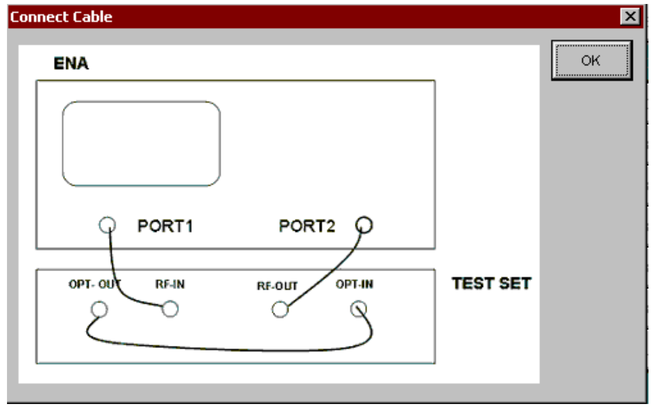
b Select the file from the Windows Explorer window.

c Continue with step 10.

If you do not have a saved calibration, or if you do not want to use this file, click on the [Start] button to start the measurement preparation.

8 When the following screen is displayed, make sure the optical output is connected to the optical input using the

patchcord supplied



Click the [OK] button to proceed.

The patchcord has the following part number:
Single-mode angled connector: N4372-87902
Single-mode straight connector: N4372-87904
Multi-mode: N4372-87903

9 When asked whether you want to save the data

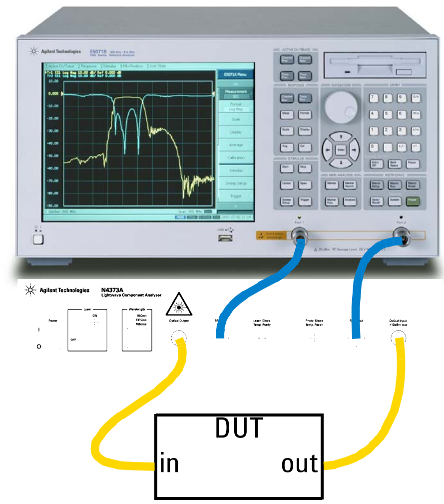
- If you can use this calibration data again, click [Yes], give your calibration data file a name, and click [Save].
- If you will have no need to reuse or refer to this calibration data, click [No].

10 When the message box is displayed, click the [OK] button to start the measurement.

Making O/O measurements

You can now connect your device under test.

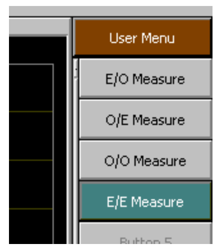
Please refer to the user guide and online help of the network analyzer for further information on measuring.



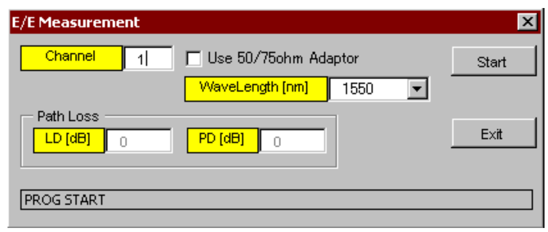
Returning to Electrical Measurements on the ENA

You should only perform this calibration if you have already calibrated for E/O, O/E or O/O measurements.

1 Press the “Macro Run” button on the front panel of the network analzer.
  Select [E/E Measurement]



  The following dialog box will be displayed:

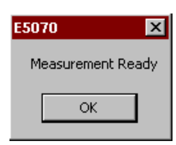


2 Make sure the same measurement channel is selected as you used for the initial electrical calibration (and the optical measurements you have made since then).

3 If you are using an adaptor to connect a device with an output with 75 Ω impedance to the 50 Ω input of the ENA, please check the box here.

4 Click on the [Start] button to start the measurement preparation.

5 When the message box is displayed, click the [OK] button to start the measurement.



  Please refer to the user guide and online help of the network analyzer for further information on electrical measurements.

4

Making Measurements on the PNA

Starting the Lightwave Component Analyzer on the PNA

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

2 Allow the Lightwave Component Analyzer to warm up, that is until the LEDs for “LD Temp Ready” and “PD Temp Ready” are lighting.

3 Turn on the laser by turning the key to the upright position.
The “On” LED lights to indicate the laser is on.

4 If your Lightwave Component Analyzer has more than one wavelength, select the wavelength at which you want to measure by pressing the button under the Wavelength LEDs.

Calibrating the network analyzer before measurements

About measurements

- Always perform an electrical calibration of the network analyzer or load an existing calibration file before making measurements.
If you make a measurement without a calibration, you will get an error message.
- Make a note of the channel for which you make the electrical calibration.
Always use this channel when setting up and making the optical, electro-optical and opto-electrical measurements.
- After completing the calibration, do not alter the test port power, IF bandwidth, start frequency, stop frequency, measurement point number or other settings.
You may get measurement errors if you change the parameters.

Keep the following points in mind during network analyzer electrical calibration.

- To improve the S/N ratio of measurements, increase the power of the network analyzer test port, though not so high as to cause distortion in E/O converter modulation characteristics.
- 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.

Electrical calibration for single-ended measurements

If you are measuring single-ended devices, calibrate the network analyzer with a 2 port short open loss test (2 port SOLT) before you start using the Lightwave Component Analyzer, or return to E/E measurement mode, as described in “Returning to Electrical Measurements on the PNA” on page 75, to do the calibration.

Do this using the network analyzer calibration kit according to the instructions in the network analyzer user guide and online help.

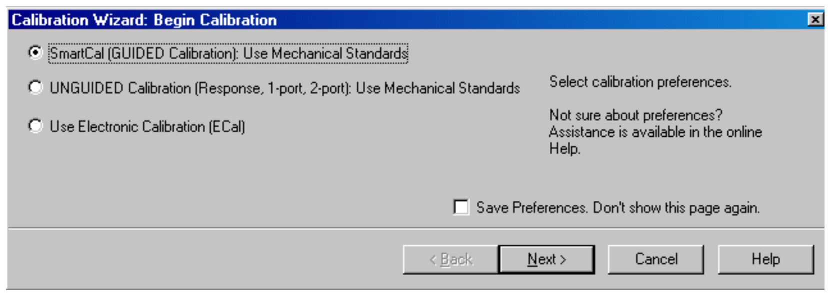
Electrical calibration for balanced measurements

If you are measuring multiport devices, calibrate the network analyzer for balanced measurements before you start using the Lightwave Component Analyzer, or return to E/E measurement mode, as described in “Returning to Electrical Measurements on the PNA” on page 75, to do the calibration.

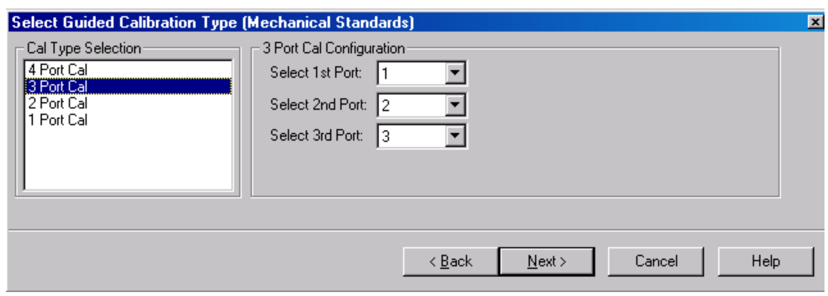
1 Perform a 3 port electrical calibration.

   a Start the Calibration wizard

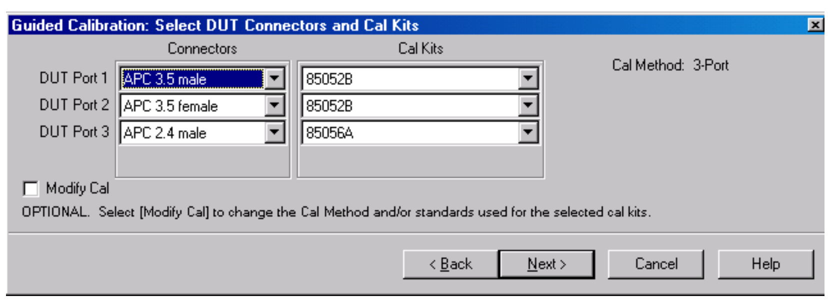
   b Select “SmartCal”, and click [Next >].



   c Select “3 Port Cal” and click [Next >].



   d Select the appropriate Cal Kit for each port, and click [Next >]..



   e Follow the instructions on the screen.

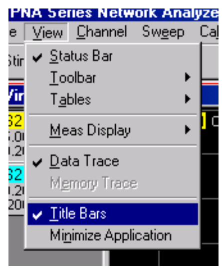
Configuring the title bar

When a measurement macro is executed, it runs in a separate window.

When the network analyzer screen is required, the macro window is sent to the background, where further macro adjustments cannot be made.

To ensure you can bring the macro window to the front again, turn on the Title Bars menu option as soon as the network analyzer is started.

The Title Bars may be turned on by selecting [View] > [Title Bars] from the PNA menu screen.



Measuring Electro-Optical Devices on the PNA

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 57.
For balanced measurements, see “Electrical calibration for balanced measurements” on page 58.
If you make a measurement without this calibration, you will get an error message.

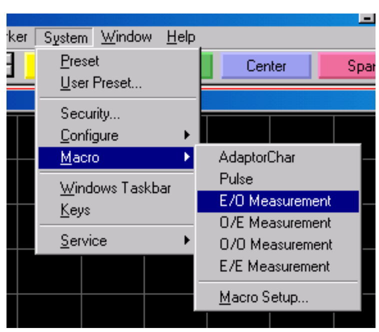
Before you make your first electro-optical measurement, you must calibrate the E/O measurement.

If you have already calibrated the E/O measurement, you can connect your device under test and make the measurement using the controls on the network analyzer.
Please refer to the user guide and online help for the network analyzer for further information.

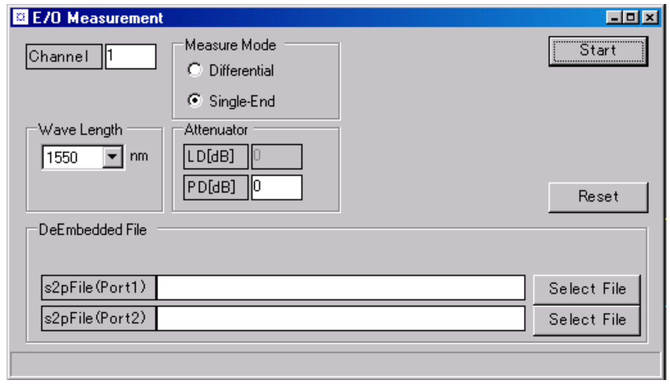
Calibrating the E/O measurement

1 If you have been measuring opto-electrical or optical/optical devices, you must first remove the correction matrix for the active measurement type (the active measurement type is shown at the top right of the trace). You do this by calibrating for an E/E measurement, as described in “Returning to Electrical Measurements on the PNA” on page 75).

2 Select [System] > [Macro] > [E/O Measurement]



The following dialog box will be displayed:



3 Make sure the same measurement channel is selected as you used for the electrical calibration.

4 Select the wavelength at which you are testing. This should be the same as the wavelength selected on the front panel of the optical test set.

5 Select the Measure Mode based on the type of DUT.

- Select Differential for balanced measurements.
- Select Single-End for standard measurements.

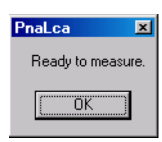
6 If you are connecting an optical attenuator to the photo-diode input of the Lightwave Component Analyzer, enter the amount of attenuation for PD[dB], in dB.

- For more accurate measurements, include the attenuator in the test circuit when calibrating the E/O measurement.

The measurement results will be displayed on the screen after correction using calculations based on photonic attenuator insertion.

7 Click on the [Start] button to start the measurement preparation.

8 When the message box is displayed, click the [OK] button to start the measurement.

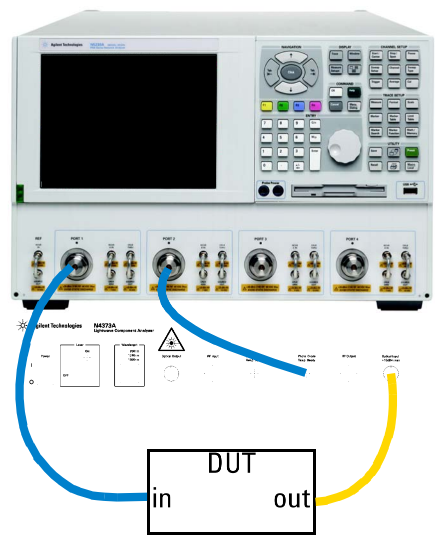


Making single-ended E/O measurements.

You can now connect your device under test.

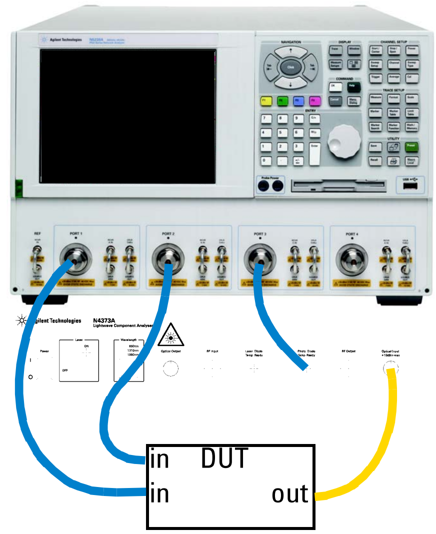
The measurement begins automatically.

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

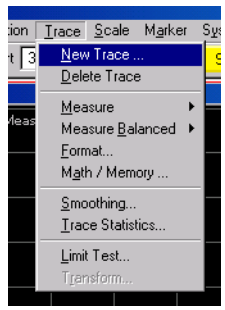


Making balanced E/O measurements.

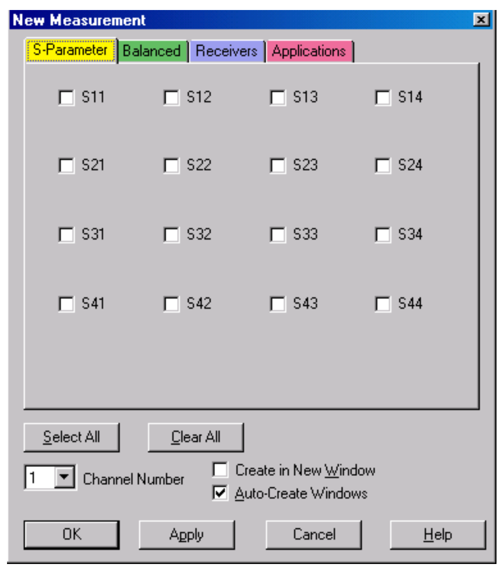
You can now connect your device under test.



1 From the [Trace] menu, select [New Trace].



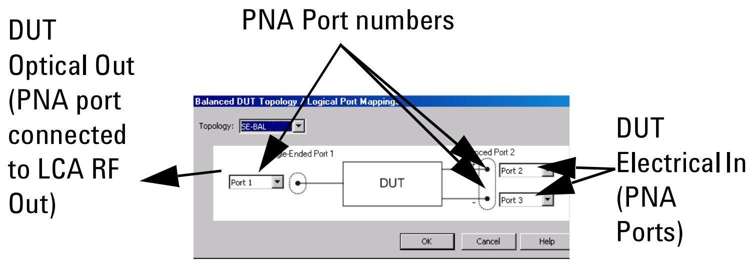
2 Select the “Balanced” tab.



3 In the “Topology / Port Mapping” section, click on [Change].

4 Make sure the Topology is selected as “SE-BAL”.

5 Allocate the PNA ports to the ports used to connect to the device under test.



6 Select the S-paramters you want to measure.
This depends on how you allocated the PNA ports to the device inputs and outputs.
Please refer to the PNA user guide and online help for more information.

Measuring Opto-Electrical Devices on the PNA

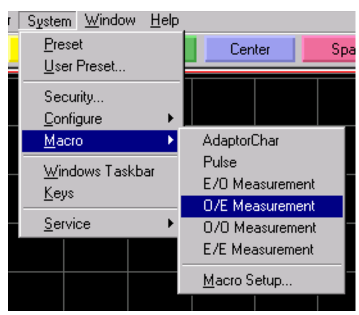
Always perform an electrical calibration of the network analyzer or load an existing calibration file before you make a measurement. If you make a measurement without this calibration, you will get an error message.
For standard measurements, see “Electrical calibration for single-ended measurements” on page 57.
For balanced measurements, see “Electrical calibration for balanced measurements” on page 58.

Before you make your first opto-electrical measurement, you must calibrate the O/E measurement.

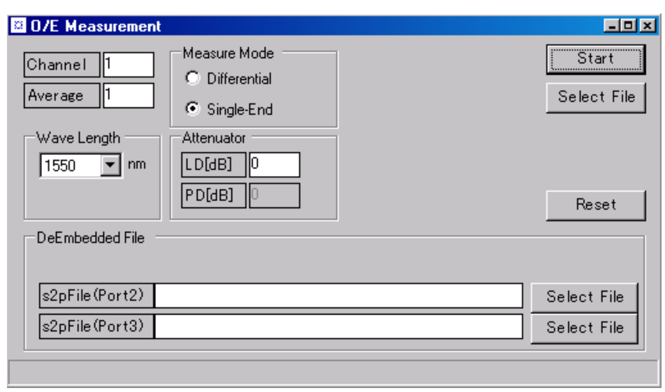
If you have already calibrated the O/E measurement, you can connect your device under test and make the measurement using the controls on the network analyzer.
Please refer to the user guide and online help for the network analyzer for further information.

Calibrating the O/E measurement

1 Select [System] > [Macro] > [O/E Measurement]



The following dialog box will be displayed:



2 Make sure the same measurement channel is selected as you used for the electrical calibration.

3 Set the number of averaging measurements to be used for calibration.
The number of averages may be set from 1 to 1024.

4 Select the wavelength at which you are testing. This should be the same as the wavelength selected on the front panel of the optical test set.

5 Select the Measure Mode based on the type of DUT.

- Select Differential for balanced measurements.
- Select Single-End for standard measurements.

6 If you are connecting an optical attenuator to the laser output of the Lightwave Component Analyzer, enter the amount of attenuation for LD[dB], in dB.

- For more accurate measurements, include the attenuator in the test circuit when calibrating the O/E measurement.

The measurement results will be displayed on the screen after correction using calculations based on photonic attenuator insertion.

7 If you have already saved a calibration for this test setup, you can load this now by

a Click on [Select File].

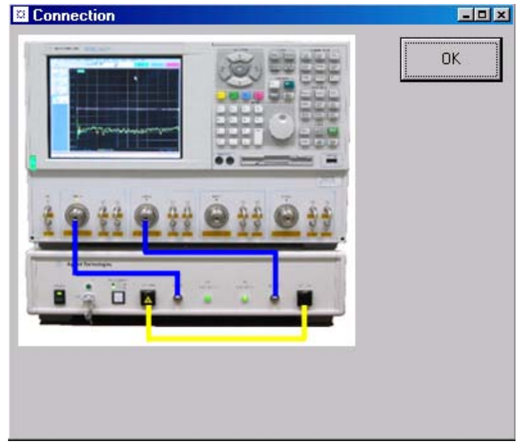
b Select the file from the Windows Explorer window.

c Continue with step 10.

If you do not have a saved calibration, or if you do not want to use this file, click on the [Start] button to start the measurement preparation.

8 When the following screen is displayed, make sure the optical output is connected to the optical input using the

patchcord supplied



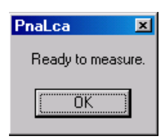
Click the [OK] button to proceed.

The patchcord has the following part number:
Single-mode angled connector: N4372-87902
Single-mode straight connector: N4372-87904
Multi-mode: N4372-87903

9 When asked whether you want to save the data

- If you can use this calibration data again, click [Yes], give your calibration data file a name, and click [Save].
- If you want to calibrate the system for your measurement setup, or if you will have no need to reuse or refer to this calibration data, click [No].

10 When the message part is displayed, click the [OK] button to start the measurement.

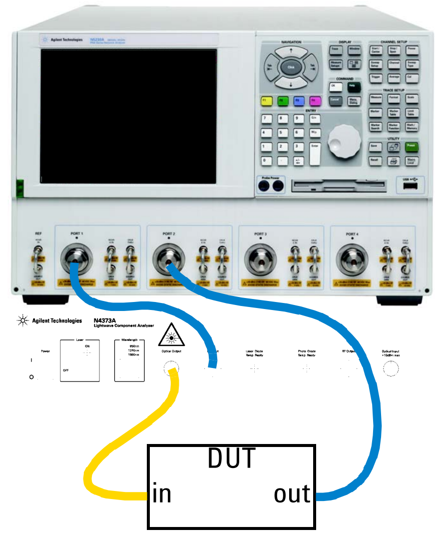


Making single-ended O/E measurements.

You can now connect your device under test.

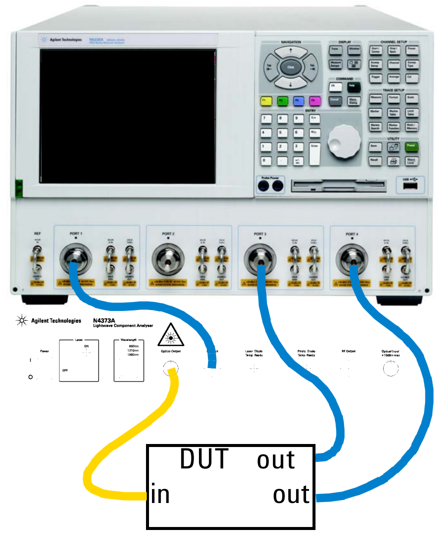
The measurement begins automatically.

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

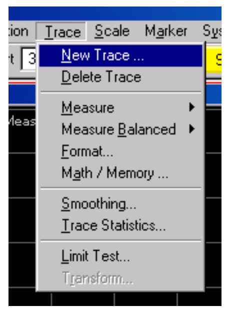


Making balanced O/E measurements

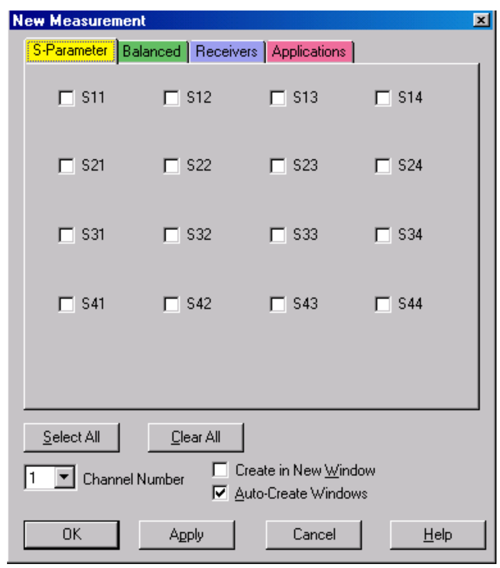
You can now connect your device under test.



1 From the [Trace] menu, select [New Trace].



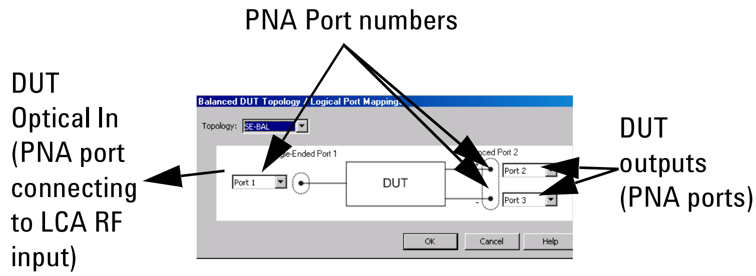
2 Select the “Balanced” tab.



3 In the “Topology / Port Mapping” section, click on [Change].

4 Make sure the Topology is selected as “SE-BAL”.

5 Allocate the PNA ports to the ports used to connect to the device under test.



6 Select the S-paramters you want to measure.
This depends on how you allocated the PNA ports to the device inputs and outputs.
Please refer to the PNA user guide and online help for more information.

Measuring Optical-Optical Devices on the PNA

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 57.
For balanced measurements, see “Electrical calibration for balanced measurements” on page 58.
If you make a measurement without this calibration, you will get an error message.

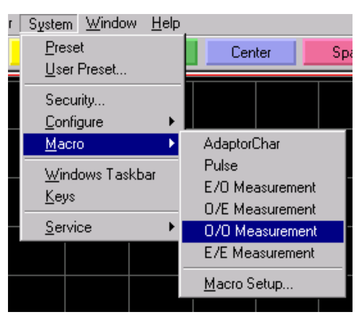
Before you make your first optical-optical measurement, you must calibrate the O/O measurement.

If you have already calibrated the O/O measurement, you can connect your device under test and make the measurement using the controls on the network analyzer.
Please refer to the user guide and online help for the network analyzer for further information.

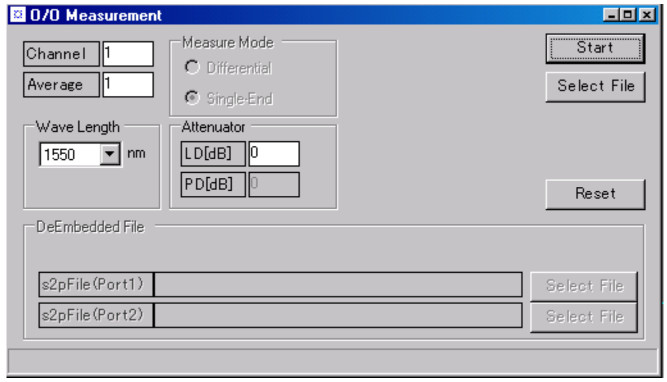
Calibrating the O/O measurement

1 If you have been measuring opto-electrical or electro-optical devices, you must first removes the correction matrix for the active measurement type (the active measurement type is shown at the top right of the trace). You do this by calibrating for an E/E measurement, as described in “Returning to Electrical Measurements on the PNA” on page 75).

2 Select [System] > [Macro] > [O/O Measurement]



The following dialog box will be displayed:



3 Make sure the same measurement channel is selected as you used for the electrical calibration.

4 Set the number of measurement averaging iterations to be used for calibration.
The number of iterations may be set from 1 to 1024.

5 Select the wavelength at which you are testing. This should be the same as the wavelength selected on the front panel of the optical test set.

6 If you are connecting a photonic attenuator to either the laser output of the Lightwave Component Analyzer or a photo-diode input, enter the amount of optical attenuation for LD[dB], in dB.

- For more accurate measurements, include the attenuator in the test circuit when calibrating the O/O measurement.
- Note that for O/O measurements, the logarithmic display is in dB_e, that is xdB optical attenuation is displayed as $2x$dB electrical attenuation.

The measurement results will be displayed on the screen after correction using calculations based on photonic attenuator insertion.

7 If you have already saved a calibration for this test setup, you can load this now by

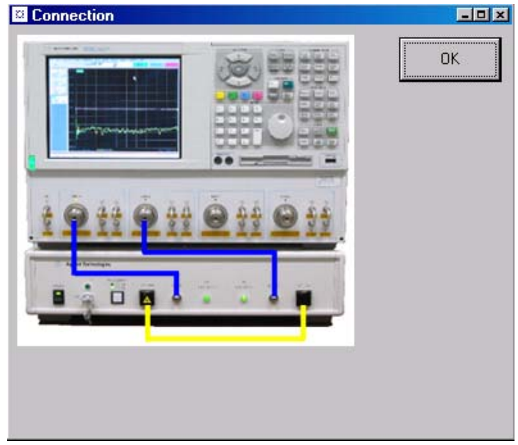
a Click on [Select File].

b Select the file from the Windows Explorer window.

c Continue with step 10.

If you do not have a saved calibration, or if you do not want to use this file, click on the [Start] button to start the measurement preparation.

8 When the following screen is displayed, make sure the optical output is connected to the optical input using the patchcord supplied



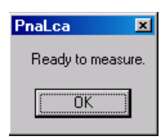
Click the [OK] button to proceed.

The patchcord has the following part number:
Single-mode angled connector: N4372-87902
Single-mode straight connector: N4372-87904
Multi-mode: N4372-87903

9 When asked whether you want to save the data

- If you can use this calibration data again, click [Yes], give your calibration data file a name, and click [Save].
- If you will have no need to reuse or refer to this calibration data, click [No].

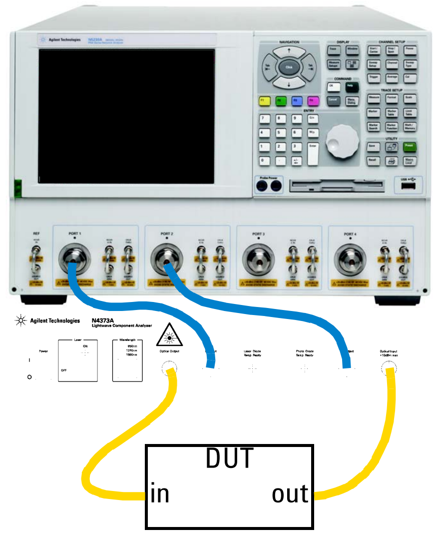
10 When the message box is displayed, click the [OK] button to start the measurement.



Making O/O measurements

You can now connect your device under test.

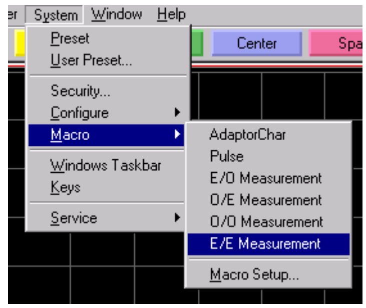
Please refer to the user guide and online help of the network analyzer for further information on measuring.



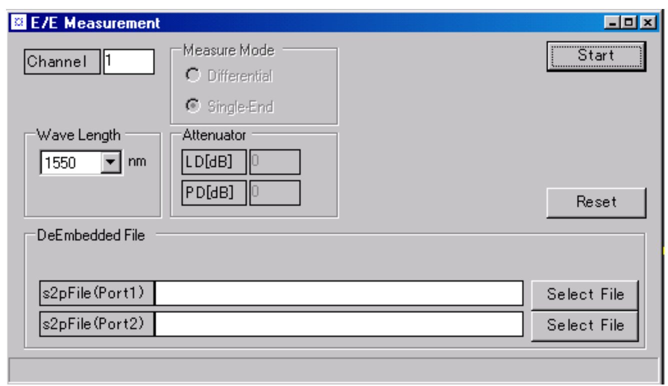
Returning to Electrical Measurements on the PNA

You should only perform this calibration if you have already calibrated for E/O, O/E or O/O measurements.

1 Select [System] > [Macro] > [E/E Measurement]



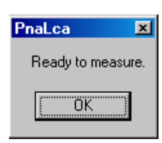
The following dialog box will be displayed:



2 Make sure the same measurement channel is selected as you used for the initial electrical calibration (and the optical measurements you have made since then).

3 Click on the [Start] button to start the measurement preparation.

4 When the message box is displayed, click the [OK] button to start the measurement.



Please refer to the user guide and online help of the network analyzer for further information on electrical measurements.

5
Troubleshooting and 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.**

Cleaning

Safety precautions

The following Cleaning Instructions contain some general safety precautions, which must be observed during all phases of cleaning.

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.

Agilent Technologies assumes no liability for the customer is 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 thus degrade the transmission quality. This 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/m2). 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. 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?

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 Agilent 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 protective 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 Agilent 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 drink this alcohol, as it may seriously damage to 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.

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 feedthrough 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 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 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 cause 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 causing corrosion or damage. Do not use water that is too hot or too cold, 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 patchcord 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.

Always keep the caps on the equipment when it is not in

use.

All Agilent 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 Agilent Technologies Sales/Service Office.

Immersion oil and other index matching compounds

Wherever 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 for optical components and connectors?

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.

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 9µm. 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 a skilled person, 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 projected 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 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.

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 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, 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;

- 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 when there is greasy dirt on the adapter.

CAUTION

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

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

3 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 become 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 oil in the connector, please refer the instrument to the skilled personnel of the Agilent 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 9µm. 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 Agilent 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 Agilent 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:

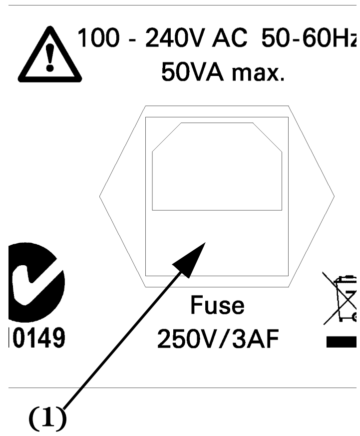
1 Strip off the cladding.

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.

Replacing the Fuse



1 On the rear of the optical test set, use a flat-tipped screwdriver to lever open the fuseholder (1).
2 Pull the fuse holder and fuse clear of the back panel.
3 Take the fuse out of the fuse cap and note the fuse rating.
4 Make sure the replacement fuse has the same rating.
5 Put the fuse into the fuse holder.
6 Put the fuse and fuse cap into the receptacle in the rear of the case and press it into place.

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 the ENA” on page 42 or “Starting the Lightwave Component Analyzer on the PNA” on page 56.

4 Perform the performance verification, as described in “Performance Verification on the ENA” on page 23 or “Performance Verification on the PNA” on page 26.

Error Codes

Please refer to the error code table below if an error message is displayed. The last three digits in the error message are the error code.

LCA Error Codes on the PNA

Table 5-1.

Error Number	Error Contents	Comments / Response
101	An incorrect average iteration number was entered.	Enter a value within the input range.
102	An incorrect channel number was entered.	Enter a channel number within the input range.
201	Unable to download the electrical calibration file (ErrTerm).	Calibration may not have been completed. Perform an electrical calibration.
202	Unable to locate the PNA catalog file.	The PNA selection parameter names (catalog file) do not exist. Preset the PNA.
203	Failed to read the O/E characteristic file S21.	The specified O/E characteristic file may not exist. Verify the file.
204	Failed to read the O/E characteristic file S22.	The specified O/E characteristic file may not exist. Verify the file.
206	Unable to start more than one LCA macro.	Make sure the previous LCA calibration has finished before starting the next.
207	The O/E characteristic file attributes do not match for S21 and S22.	The S21 and S22 file attributes (sweep type, wavelength, NOP) are different. Verify the contents of the files.
208	Failed to read the electrical calibration file.	Output during an E/E Measure. Other measurements may not have been performed in advance.
209	The maximum number of traces (4) is already displayed.	Remove at least one of the displayed traces. One window may display up to four traces.
401	A communication error occurred at the PNA.	Verify that the GPIB cable is connected (see “Measurement preparation” on page 100).

Table 5-1.

Error Number	Error Contents	Comments / Response
904	Unable to locate the O/E characteristic file S21.	Add the O/E characteristic file S21 to the RefFiles folder.
905	Unable to locate the O/E characteristic file S22.	Add the O/E characteristic file S22 to the RefFiles folder.
911	The starting frequency in the specified calibration data differs from the electrical calibration data.	Displayed during file selection for O/E and O/O measurements. Verify the selected measurement data and current calibration data.
912	The ending frequency in the specified calibration data differs from the electrical calibration data.	Displayed during file selection for O/E and O/O measurements. Verify the selected measurement data and current calibration data.
913	The measurement points in the specified calibration data differ from the electrical calibration data.	Displayed during file selection for O/E and O/O measurements. Verify the selected measurement data and current calibration data.
999	File recall operation was cancelled.	Displayed during file selection for O/E and O/O measurements. Displayed when [Cancel] is selected during file selection.

LCA Error Codes on the ENA

- Please reference the attached error code table if an error messages is displayed.
- The last three digits in the error message are the error code.

Error Number	Error Contents	Comments / Response
101	Average Number Input Error	Enter an average value within the acceptable range (numerical value).
102	Channel Number Input Error	Input the channel number within the acceptable range (numerical value).
201	Calibration Data(ErrTerm) cannot Dounload	Calibration may not have been performed. Perform calibration.

Error Number	Error Contents	Comments / Response
203	O/E characteristic File S21 Read Error	The specified O/E characteristic file may not exist. Verify the file.
204	O/E characteristic File S22 Read Error	The specified O/E characteristic file may not exist. Verify the file.
205	Display Trace Count Over	The displayable trace count has exceeded its limit. Delete the trace count.
206	O/E characteristic File is different S21 and S22	The S21 and S22 file attributes (sweep type, wavelength, NOP) are different. Verify the contents of the files.
207	Calibration Data(ErrTerm) File Read Error	Output during an E/E Measure. Other measurements may not have been performed in advance.
401	ENA(E5071B) not Response	The GPIB setting for the ENA may not be configured correctly. Verify the configuration.
901	Average File (Average.txt) not Found	Add the average file to the Conditions folder.
902	Average File(Average.txt) Read Error	The average file may not be properly specified.
903	Average File(Average.txt) Write Error	The average file may be write-protected. Change the write permissions as necessary.
904	O/E characteristic File S21 not Found	Add the O/E characteristic file S21 to the RefFiles folder.
905	O/E characteristic File S22 not Found	Add the O/E characteristic file S22 to the RefFiles folder.
911	Different Start Frequency (Between Select File and ErrTerm)	Displayed during file selection for O/E and O/O measurements. Verify the selected measurement data and current calibration data.
912	Different Stop Frequency (Between Select File and ErrTerm)	Displayed during file selection for O/E and O/O measurements. Verify the selected measurement data and current calibration data.

Error Number	Error Contents	Comments / Response
913	Different Number of Point (Between Select File and ErrTerm)	Displayed during file selection for O/E and O/O measurements. Verify the selected measurement data and current calibration data.
999	File Select Cancel	Displayed during file selection for O/E and O/O measurements. Displayed when [Cancel] is selected during file selection.

Reinstalling the Lightwave Component Analyzer software on the ENA

Making a backup of the LCA files

1 Make a regular backup of the directory

D:\LCAMeas\Table

This includes all the calibration and other data.

Restoring the LCA files

1 From the recovery CD, copy the files

LCASYSTEM.vba, and
SaveToTouchstone.VBA

to the directory

D:\VBA

2 From the recovery CD, copy the directory

\LCAMeas

to

D:\

3 Restore the calibration and other data from your most recent backup to the directory

D:\LCAMeas\Table

Reinstalling the Lightwave Component Analyzer software on the PNA

Making a backup of the LCA files

1 Make a regular backup of the directory

C:\Program Files\Agilent\Network Analyzer\Applications\LCA\Table

This includes all the calibration and other data.

Measurement preparation

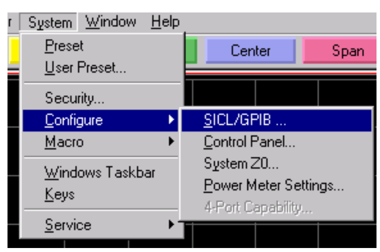
Before running a measurement, check to make sure the PNA address is set correctly.

Although no GPIB cable needs to be connected to the optical test set, GPIB is used from the internal controller by the measurement macro, so the GPIB address needs to be set.

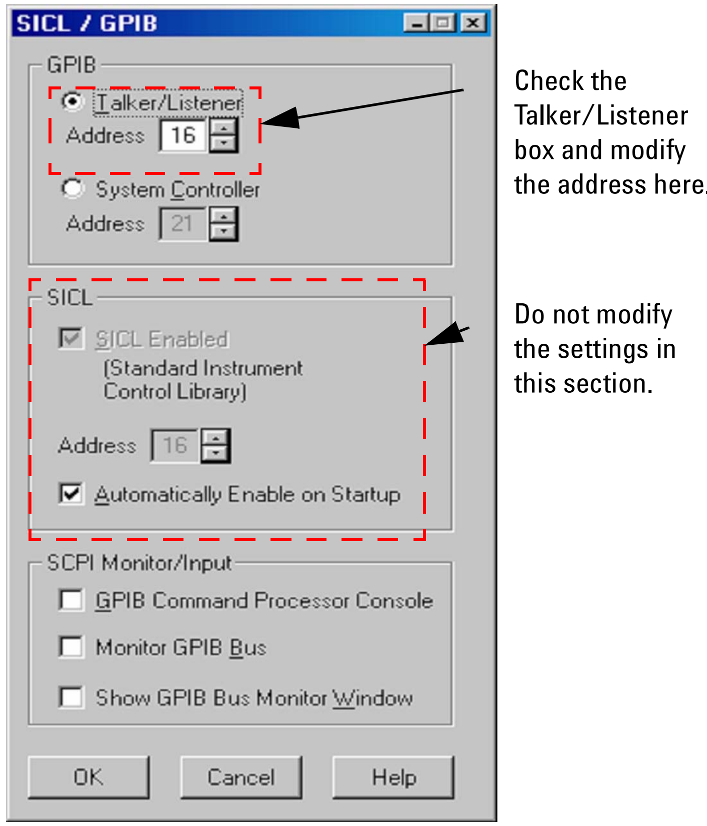
GPIB address configuration screen (measuring device)

The screen used to set the GPIB address for the measuring device is shown below.

To get to the GIPB address configuration screen, from the PNA menu screen, select [System] > [Configure] > [SICL/GPIB].



The following screen will be displayed.

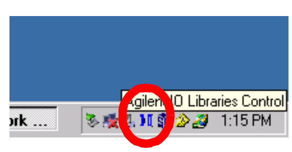


- OK button
  Confirms the GPIB address for the measuring device.
- Cancel button
  Cancels any modifications.

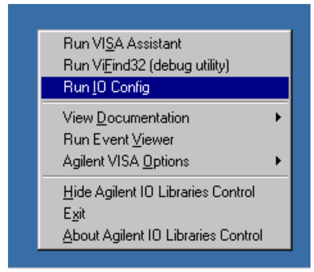
GPIB address configuration screen (controller)

Set the I/O configuration for the controlling PC.

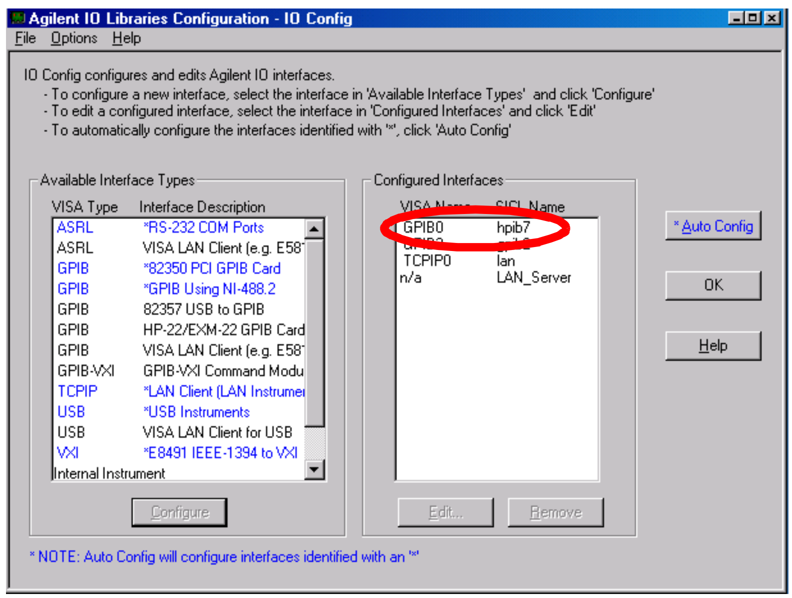
1 From the Windows taskbar, click on the icon for “Agilent IO Libraries Control”.



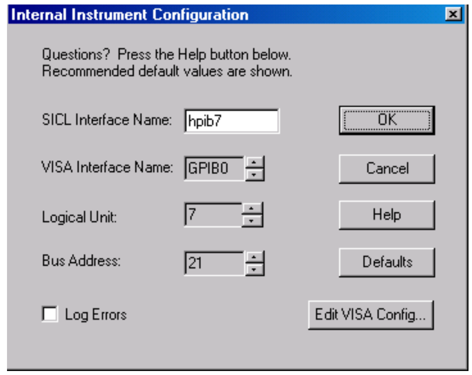
2 Select “Run IO Config”.



3 On the left side of the following screen, select “Internal Instrument”. On the right side, make sure the GIPB0 entry under VISA Name is set to hpib7 under SICL Name. If it does not, set the hpib7 for the Internal Instrument to GPIB0.



When the configuration is complete, click the Edit button, and check to make sure the following settings have been set.



Configuration of the InstrInfo.txt File

You will find this file at
C:\Program Files\Agilent\Network Analyzer\Applications\Lca\Information

```
;Inst   VISA            Model                  Live
;ID     Resource Name   Name    Option  TimeOut  Mode
;-------------------------------------------------------------
VNA1,  GPIB0: : 16: : INSTR,  PNA,    none,   5,      On
;------------------- < end of file > ----------------------
```

- Set the underlined numbers in red to the same values as the measuring device.

Reinstalling the files

1 From the recovery CD, run the program “Setup.Exe” .

2 Restore the calibration and other data from your most recent backup to the directory

C:\Program Files\Agilent\Network Analyzer\Applications\LCA\Table

Configuration

Configuring the device

The GPIB address for the Network Analyzer is 16.

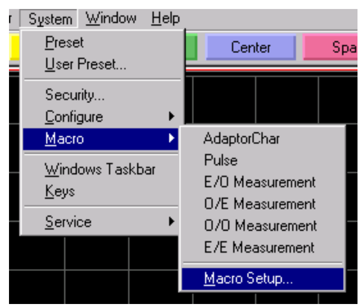
This address is set by default in the program. However, situations may arise which necessitate changing the address. If the measuring device address changes, edit the InstrInof.txt file in the Information folder.

Macro creation

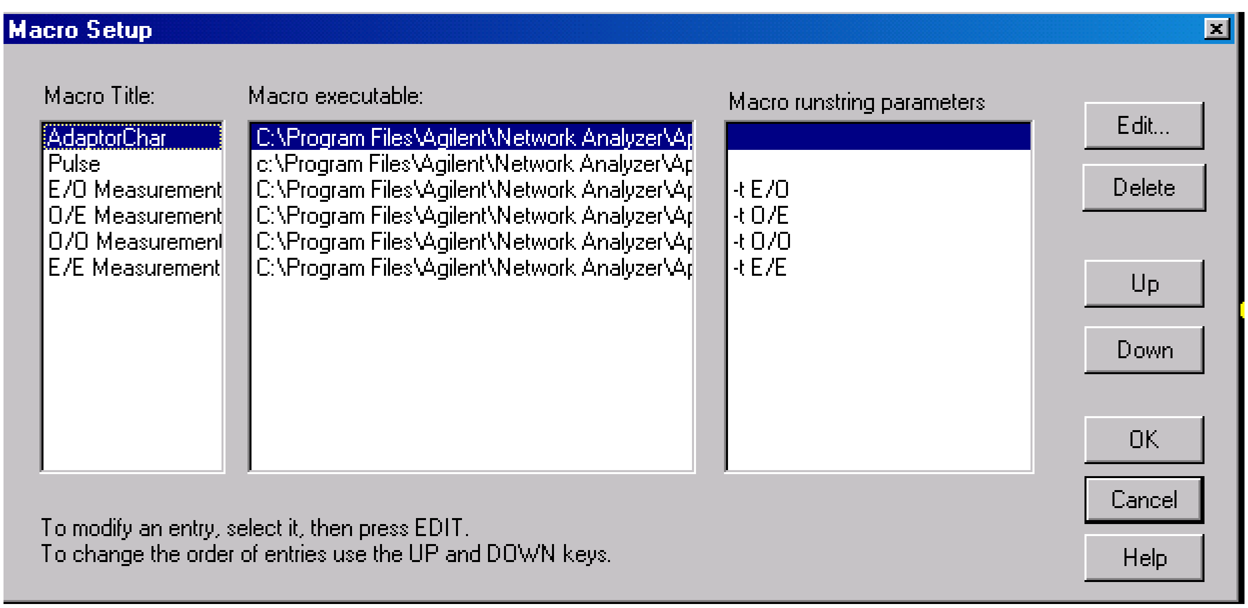
The settings for running macros from the Lightwave Component Analyzer program are shown below.

The E/O Measure, O/E measure, O/O measure, and E/E measure macros all call a common program. Each macro is executed based on the Macro Runstring Parameter settings. The common program and the Macro Runstring Parameter can be set from the Macro Setup window. The Macro Setup window is reached as follows.

1 From the top of the PNA screen, select [System] > [Macro] > [Macro Setup].



When reconfiguring, please follow the sample configuration shown below.



The program designated by the Macro Executable is found in the following location.

C: \Program Files\Agilent\Network Analyzer\Applications\Lca\Program\PnaLca\bin\PnaLca.exe

Configuration of the Parameters.txt File

You will find this file at
C:\Program Files\Agilent\Network Analyzer\Applications\Lca\Information

Edit Parameter.txt to match your instrument configuration. In particular, ensure that **Wavelength** is set to the default wavelength of your optical test set.
Leave the value for **Instrument** set to 1 even if you have a 2 port PNA.

If it is running, exit the Network Analyzer application, then restart it to reactivate the LCA macros.

NOTE Pulse is a macro included with the PNA and is unrelated to the Lightwave Component Analyzer.

Returning the Instrument for Service

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is normally available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage".

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Often, many self-help tools are available.

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

Agilent Technologies Sales and Service Offices

For more information about Agilent Technologies test and measurement products, applications, services, and for a current sales office listing, visit our web site:

http://www.agilent.com/comms/lightwave

For related literature, please visit:

http://www.agilent.com/comms/octsolutions

Phone or fax

You can also contact one of the following centers and ask for a test and measurement sales representative.

United States: (tel) 1 800 829 4444
(fax) 1 800 829 4433

Canada: (tel) 1 877 894 4414
(fax) 1 800 746 4866

Europe: (tel) +31 (0) 20 547 2111
(fax) +31 (0) 20 547 2190

Japan: (tel) 120 421 345
(fax) 120 421 678

Latin America: (tel) +55 11 4197 3600
(fax) +55 11 4197 3800

Australia: (tel) 1 800 629 485
(fax) 1 800 142 134

Asia Pacific: (tel) +852 800 930 871
(fax) +852 800 908 476

6
Specifications and Regulatory Information

Introduction

This chapter contains specifications and characteristics for the Agilent N4373A Lightwave Component Analyzer. For specifications specific to the network analyzer refer to the specifications chapter in the user's documentation for the network analyzer.

Definition of Terms

Specification: describes a guaranteed product performance that is valid under the specified conditions. Specifications are based on a coverage factor[1] of 2 (unless otherwise stated), corresponding to a level of confidence of >95%.

Typical value: a characteristic describing the product performance that is usually met but not guaranteed.

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

Specifications are valid, if not differently stated, for the stated IFBW, at maximum leveled electrical output power of the NWA, for the specified period of time after user calibration.

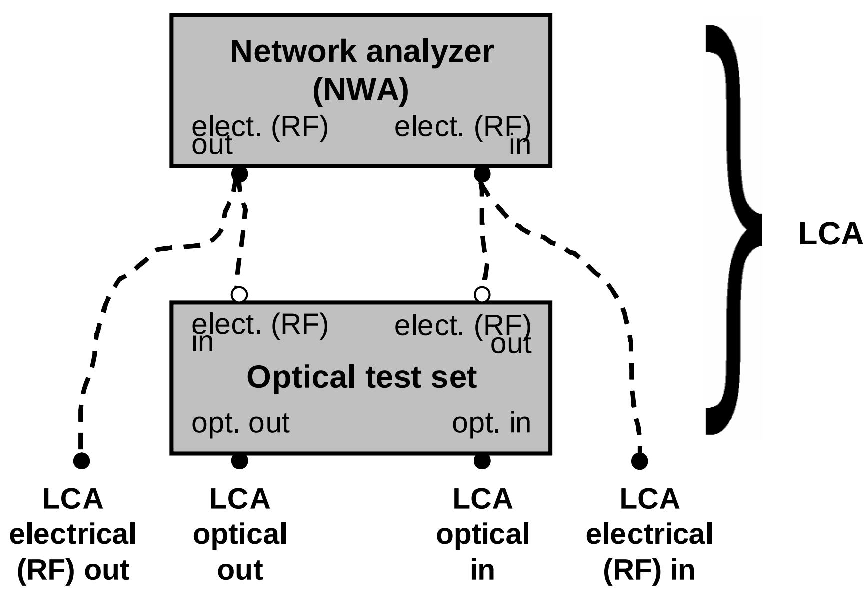


Figure 5 Naming of the connectors.

Bandwidth (of LCA optical in) The maximum modulation frequency the LCA optical in is designed for.

Decibel (dBm, dBo, dBe) A ratio in decibel (dB) is calculated as $10 \cdot \log_{10}\{\text{ratio}\}$. Special cases:

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

NOTE Differences of powers in dBm are written as "dBo" for optical powers or "dBe" for electrical powers.

- $dB_{A/W}$: the square of the Responsivity (or "conversion efficiency") R related to A/W, calculated as

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

which equals

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

NOTE Differences of responsivities in $dB_{A/W}$ are written as "dB".

Because such a difference is measured as differences of electrical (RF) powers on the Network Analyzer, it may be also written as "dBe" (with the same numerical value).

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

NOTE For O/E and E/O converters with linear relation between optical power and electrical current, values in dBo correspond to half the values in dBe. This is because the optical power is proportional to the electrical current *I* and the electrical power is proportional to the square of *I*.

Electrical noise floor (of LCA electrical in) The average electrical power displayed by the NWA when no signal is applied to LCA electrical in, expressed in dBm. No signal means:

- for O/E: the LCA electrical in port is terminated with 50 Ohm load.
- for E/O: the LCA electrical out is terminated with 50 Ohm load, LCA optical in is darkened.
- for O/O: the LCA optical in is darkened.

The average is calculated on power values in Watts over modulation frequency.

Measurement: over frequency sections of 1/10 of the specified system bandwidth.

Maximum LCA electrical in power The maximum LCA electrical in power depends on the maximum compression that the user can accept. Here the *maximum LCA electrical in power* is defined as the maximum leveled electrical out power of the network analyzer (see user's guide of the network analyzer).

Maximum linear operating input power (of LCA optical in) The maximum average optical input power P_{max} at LCA in where the small signal responsivity of the optical test set receiver, expressed in dB(A/W), degrades by less than the specified "compression point" value. Small signal means a modulation depth much smaller than 1.

Conditions: valid at LCA optical out wavelengths.

Measurement: modulation depth 10%.

Maximum modulated optical power (of LCA optical out) The Modulated optical power from LCA optical out with maximum NWA electrical output power.

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

Caution: Applying more than the specified maximum safe input power may damage the LCA!

Minimum measurable responsivity The average of the Responsivity measured by the LCA on a DUT with zero output, expressed in Decibel (dBm, dBo, dBe). The average is calculated over modulation frequency and from values in linear space (rather than decibel space).

Responsivity values are converted from Decibel (dBm, dBo, dBe) values to linear values by:

$$linear = 10^{decibel/10}.$$

The average (result) is converted back to decibels by:

$$decibel = 10 * \log_{10}(linear)$$

Measurement: Zero output is created by the following:

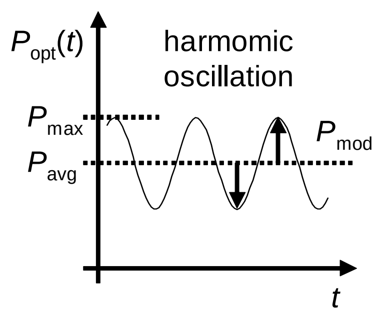
- for O/E: the LCA electrical in port is terminated with 50 Ohm load.
- for E/O: the LCA electrical out is terminated with 50 Ohm load, LCA optical in is darkened.
- for O/O: the LCA optical in is darkened.

The average is calculated within frequency sections of 1/10 of the specified system bandwidth. The result must be in limit in each section.

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: $P_{mod,dB} = 10 \cdot \log(P_{mod} / 1mW)$.



NOTE Modulated optical power divided by average optical power is a value between 0 (no modulation) and 1 (maximum modulation).

Optical noise floor (LCA optical in) The optical equivalent (see Modulated optical power) of the *Electrical noise floor (of LCA electrical in)* (with darkened LCA optical in), expressed in dBm.

NOTE The optical equivalent depends on the Responsivity of the optical receiver within the optical test set.

Responsivity The amplitude response *R* of an E/O or O/E converter to a harmonic stimulus, expressed in units of...

- W/A for an E/O converter (Modulated optical power in Watt to the electrical stimulus amplitude in Ampere).
- A/W for an O/E converter (electrical response amplitude in Ampere to the Modulated optical power in Watt).

In both cases, the responsivity in Decibel (dBm, dBo, dBe) is calculated as $\mathbf{20}\cdot\log(R)$ and may be written as “$dB_{W/A}$“ or “$dB_{A/W}$“, respectively.

For an O/O device, responsivity specifies:

- Responsivity, expressed in dBo, is the difference between the Modulated optical power, with optical powers expressed in dBm, at the output of the DUT and at the input of the DUT. Responsivity, expressed in dBe, is the difference between the electrical powers on the NWA that correspond to the optical powers.

NOTE A difference between Modulated optical power is expressed in dBo. The electrical equivalent (the responsivity) in dBe is twice the value.

NOTE Responsivity of an O/E or E/O converter is also called *conversion efficiency*.

Return loss (LCA optical in) Ratio between incident optical power at LCA optical in and reflected optical power, expressed in dBo.

System bandwidth The selectable modulation frequency range of the LCA for measurements.

NOTE System bandwidth is a nominal specification.

System dynamic range Ratio of electrical powers, expressed in *dBe*. The definition of system dynamic range depends on the type of measurement:

O/O Difference between the electrical power in dBm measured with Modulated optical power applied on LCA optical in and the Electrical noise floor (of LCA electrical in) in dBm (when no optical power is applied to LCA optical in).

Measurement: after O/O setup calibration do a measurement with darkened LCA optical in.

O/E Difference between the Maximum LCA electrical in power in dBm and the receiver Electrical noise floor (of LCA electrical in) in dBm (with terminated LCA electrical in).

Condition: wavelength as specified.

Note: O/E system dynamic range is identical to E/E system dynamic range.

E/O Difference between the electrical power in dBm measured with the largest possible Modulated optical power at the LCA optical in, and the Electrical noise floor (of LCA electrical in) in dBm.

Conditions: maximum Modulated optical power at the LCA optical in as specified.

Note: The largest possible modulated optical power at the LCA optical in is defined by the *Maximum linear operating input power (of LCA optical in)*.

Measurement:

1 Measure the Responsivity of the LCA optical receiver ($dB_{A/W}$). Using this value, calculate the electrical power (dBm) corresponding to the Maximum linear operating input power (of LCA optical in).

2 Measure the electrical noise floor (dBm) with darkened LCA optical in.

3 Calculate the difference between both (expressed in dBe).

System relative frequency response uncertainty When calculating the difference of the measured Responsivity and the actual responsivity in dBe over modulation frequency, the system relative frequency response uncertainty is ± half the peak-to-peak value, expressed in dBe.

Conditions: Measurement within a specified time after the required calibration measurements.

Measurement: calibration with a NIST calibrated O/E receiver.

Unmodulated output power (of LCA optical out) The optical power at LCA optical out when the electrical (RF) input of the optical test set is electrically terminated.

Wavelength (of LCA optical out) Peak wavelength of the signal at LCA optical out. Wavelength is defined as wavelength in vacuum.

Wavelength range (of LCA optical in) The wavelength range on the LCA optical in where measurements can be performed.

References

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

Angled Connector Specifications

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. With angled fiber endfaces, reflected light tends to reflect into the cladding, reducing the amount of light that reflects back to the source.

The contact connector on your Lightwave Component Analyzer is angled, you can only use a cable 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. You should connect straight contact fiber end connectors with neutral sleeves to straight contact connectors and connect angled contact fiber end connectors with green sleeves to angled contact connectors.

General Characteristics

Assembled dimensions: (H x W x D)

55.5 cm x 43.5 cm x 55.5 cm (21.9 in x 17.2 in x 21.9 in)

Power Requirements

100 V to 240 V~ 50 to 60 Hz

2 power cables

N5230A: max. 350 VA

Test Set: max. 40 VA

Net weight

Standard system: 54 kg (120 lbs)

Conditions

Warm-up time: 30 minutes

Storage temperature: -40°C to +70°C

Operating temperature: +5°C to +40°C

Specified temperature: +18°C to +28°C

Humidity: 15% to 80% r.h., non-condensing

Recommended re-calibration period: 1 year

Specifications

Note: All specification are valid under the following conditions:

- The network analyzers are set to maximum leveled electrical output power
- 10 Hz IFBW with 200 measurement points over whole system bandwidth (if not differentially stated)
- After warm-up. Allow additional time for acclimation if the LCA was previously stored at different temperature
- At constant temperature within 30 minutes after user calibration, with constant temperature (+-1°C)
- Tested from port 1 to port 2. The performance of other ports (where applicable) and other direction is typically the same.

System Option	#300	#301	#302	#303
	ENA 5070B	ENA 5071B	PNA 5230A #220 (2-port)	PNA 5230A #240 (4-port)
Maximum leveled electrical RF output power	+10 dBm	+5 dBm	+3 dBm	-3 dBm
System bandwidth	300 kHz to 3 GHz	300 kHz to 8.5 GHz	10 MHz to 20 GHz	300 kHz to 20 GHz
Optical-to-Optical Measurement				
System relative frequency response uncertainty [2]	±0.4 dBe typ. (±0.2 dBo typ.)	±0.4 dBe typ. (±0.2 dBo typ.)	±0.6 dBe typ. (±0.3 dBo typ.)	±0.6 dBe typ. (±0.3 dBo typ.)
Minimum measurable responsivity	-70 dBe (-35 dBo)	-70 dBe (-35 dBo) (-67 dBe / 33.5 dBo for freq. > 6.8 GHz)	-54 dBe (-27 dBo) (-50 dBe / -25 dBo for freq. > 10 GHz)	-54 dBe (-27 dBo) (-50 dBe / -25 dBo for freq. > 10 GHz)
Optical-to-Electrical Measurement				
System relative frequency response uncertainty [2]	±0.7 dBe typ.	±0.7 dBe typ.	±0.7 dBe typ.	±0.7 dBe typ.
Minimum measurable responsivity (1310 nm, 1550 nm)	-86 dB A/W	-86 dB A/W (add 12 dB A/W for freq. > 6.8 GHz)	-71 dB A/W (add 6 dB A/W for freq. > 10 GHz)	-71 dB A/W (add 6 dB A/W for freq. > 10 GHz)
Electrical-to-Optical Measurement				

System Option	#300	#301	#302	#303
	ENA 5070B	ENA 5071B	PNA 5230A #220 (2-port)	PNA 5230A #240 (4-port)
System relative frequency response uncertainty [1,2]	±0.7 dBe typ.	±0.7 dBe typ.	±0.7 dBe typ.	±0.7 dBe typ.
Minimum measurable responsivity (1310 nm, 1550 nm)	-102 dB W/A	-102 dB W/A (add 18 dB W/A for freq. > 6.8 GHz)	-84 dB W/A (add 8 dB W/A for freq. > 10 GHz)	-84 dB W/A (add 8 dB W/A for freq. > 10 GHz)

LCA Optical Input

N4373A option	# 200	# 201	# 202
Bandwidth	3 GHz	8.5 GHz	20 GHz
Connector type	single mode		
Wavelength range	800 nm to 1650 nm		
Maximum linear operating input power [3]	+10 dBm typ.		
Maximum safe input power	+16 dBm		
Return loss [4]	> 27dBo typ.		

LCA Optical Output

Wavelength options	#100 / #102	#101 / #102
Wavelength	1310 ± 20 nm typ.	1550 ± 20 nm typ.
Unmodulated output power	+7 ± 0.5 dBm typ.	

1 max. +10 dBm peak optical output power

2 At (electrical RF or optical) power levels prevailing during user calibration. Verified at 1550nm against NIST traceable reference. #302, 303 within 12.5 MHz to 20 GHz with 100 Hz IFBW and 1600 measurement points, #300, 301 within 300 kHz to 3 and 8.5 GHz, resp., with 10 Hz IFBW and 200 measurements points.

3 <1 dB small signal compression

4 Using high quality optical connectors in perfect optical condition.

Performance Tests

The procedures in this section test the optical performance of the Agilent N4373A Lightwave Component Analyzer (LCA). The LCA incorporates an Agilent network analyzer and an optical test set. The performance of the network analyzer itself can be verified with the procedures in the Service Guide of that instrument. The procedures in this document test the performance of the LCA including the optical test set.

All tests can be performed without access to the interior of the instrument.

Equipment required

The equipment required for the performance tests is listed in the table below. Any equipment which satisfies the critical specifications of the equipment given in the table may be substituted for the recommended models.

Instrument/ Accessory	Model	Required Characteristics	Alternative Models
50 Ohm RF termination	1810-0118	3.5mm SMA - female	
If Opt. 021: single-mode optical fiber patchcord (0.5m)	N4373-87904	straight-face connector;	1,2
If Opt. 022: single-mode optical fiber patchcord (0.5m)	N4373-87902	angled-face connector;	1,2
traceable reference receiver (for typical relative frequency response uncertainty specification)		calibrated to require uncertainty over required frequency range	
optical power meter	81623B	+/- 5% absolute power accuracy at LCA wavelength	
optical spectrum analyzer or wavelength meter	86146B OSA or 86122B MWM	<1nm absolute wavelength uncertainty	8614xB/A
50 Ohm RF termination (for terminating laser source)		3.5mm SMA-male	

If you are using different fibers than listed, make sure you use correct optical interfaces. These can be from different fiber optic connector manufacturer, for example http://www.diamond-fo.com/

Test Record

Results of the performance test may be tabulated on the Test Record provided at the end of the test procedures. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and setup information are printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are already familiar with the test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Agilent Technologies.

Test Failure

If the Agilent N4373A fails any performance test, return the instrument to the nearest Agilent Technologies Sales/ Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument that is certified. These specifications, listed in "Specifications" on page 120, are the performance standards or limits against which the Agilent N4373A can be tested.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Institute of Standards and Technology (NIST), will be covered in a manual change supplement, or revised manual. Such specifications supersede any that were previously published.

Test Procedure

NOTE Make sure that all optical and RF connections of the test setup given in the procedure are dry and clean. DO NOT USE INDEX MATCHING OIL. Make sure that all optical connectors are undamaged.

- Make sure that all optical cables of the test setup are fixed to the table so that they won't move during measurements.
- Make sure all RF cable connectors are clean and free of wear debris.
- Movement of the fibers and cables during the test procedures and the quality of optical connectors affect the result of power measurements.
- The environmental conditions (temperature and relative humidity) must remain constant during the test.

Test for unmodulated source output power and wavelength

1. Connect the optical fiber patch cord between the LCA Optical Output connector and the optical power meter.
2. Terminate the RF Input of the optical test set with the 50 Ohm male termination.
3. Activate the LCA laser source with the key switch.
4. Set the wavelength of the power meter to the LCA source wavelength.
5. Record the optical output power as determined by the power meter, which should be 7 dBm +/- 0.5dB, typ.
6. If the LCA has another wavelength available, change the LCA source to this wavelength and repeat Steps 4-5 for the 2nd wavelength.
7. Now disconnect the optical fiber from the power meter and attach it to the wavelength meter or optical spectrum analyzer.
8. Record the peak signal wavelength.
9. If the LCA has another wavelength available, change the LCA to this wavelength and record the peak signal wavelength for this 2nd wavelength.

LCA measurement tests

1. Set up the measurement parameters on the network analyzer according to the following table:

Parameter setting	Value
IFBW	10 Hz
Number of points	200

Number of averages	1
Smoothing	None
S Parameter to measure	S21, S22
Measurement mode	Single ended
LCA file format	.S2P “Log Mag/Angle (dB/degrees)”
Optical power meter averaging time τ_{avg}	1 s

Option #300

Frequency sweep range	Whole NWA frequency range (300 kHz...3 GHz)
RF output power	Max. (leveled) NWA output power over whole frequency range (+10 dBm)

Option #301

Frequency sweep range	Whole NWA frequency range (300 kHz … 8.5GHz)
RF output power	Max. (leveled) NWA output power over whole frequency range (+5 dBm)

Option #302

Frequency sweep range	Whole NWA frequency range (12.5 MHz ... 20 GHz)
RF output power	Max. (leveled) NWA output power over whole frequency range (+3 dBm)

Option #303

Frequency sweep range	Whole NWA frequency range (12.5 MHz .. 20 GHz)
RF output power	Max. (leveled) NWA output power over whole frequency range (-3 dBm)

2 Perform a 2-port electrical calibration of the network analyzer, including the LCA RF cables, according to the User’s Guide of that instrument. For convenience, use of an ECal module is recommended. Ports 1 and 2 are used for these procedures. After this calibration, the RF cables should not be removed from the network analyzer ports. The free end of the RF cable from Port 1 will be referred to as LCA RF Output. The free end of the RF cable from Port 2 will be referred to as LCA RF Input.

3 Connect the LCA RF Output to the RF Input connector of the optical test set.

4 Connect the LCA RF Input to the RF Output connector of the optical test set.

5 Connect the optical fiber patch cord from the LCA Optical Output connector Optical Input connector of the optical test set. Make certain that the fiber faces are clean.

6 Then activate the laser source with the key switch on the optical test set.

7 Connect the optical fiber patch cord from the LCA Optical Output connector to the Optical Input connector of the optical test set.

8 In the User Interface Display, select the **optical-to-optical measurement** by starting the **O/O Measurement** mode. Set the correct wavelength in the macro setup and with the wavelength switch on the optical test set. With the connections of Steps 3-5, run the optical calibration. When the instrument reports “Ready to Measure”, press OK.

9 At the top of the measurement graph, the O/O Measurement setting is now indicated. Without changing the connections, save a measurement trace under the name **ooIntRec**. This curve is expected to show 0 dBe over the system bandwidth range, within the O/O noise level, since the measurement represents the signal with respect to the reference calibration.

10 Then disconnect the fiber patch cord and connector adapter from the LCA Optical Input so that the Optical Input connector can be darkened with a black rubber cap. The measurement now represents the dark limit for **minimum measurable responsivity**. Save a measurement trace under the name **ooDark**.

11 If the LCA has another wavelength available, repeat Steps 7-9 for the 2^{nd} wavelength and save the corresponding files in a separate directory for the 2^{nd} wavelength.

12 In the User Interface Display, select the **optical-to-electrical measurement** by starting the **O/E Measurement** mode. Set the correct wavelength in the next macro setup panel and with the wavelength switch on the optical test set. If **Measure Mode** is available, choose **Single-End**.

13 Reattach the optical fiber as requested in the next panel and as described in Step 5. Then run the optical calibration. When the instrument reports “Ready to

Measure", press OK. At the top of the measurement graph, the O/E Measurement is now indicated.

14 Now disconnect the LCA RF Input from the RF output connector of the optical test set and terminate the LCA RF Input. The measurement now corresponds to the dark level for **O/E minimum measurable responsivity**. Save a measurement trace under the name **oeDark**.

15 If the LCA has another wavelength available, repeat Steps 11-13 for the 2^{nd} wavelength and save the corresponding files in a separate directory for the 2^{nd} wavelength.

16 In the User Interface Display, select the **electrical-to-optical measurement** by starting the **E/O Measurement** mode. Set the correct wavelength in the next macro setup window and with the wavelength switch on the optical test set. If Measure Mode is available, choose **Single-End**. When the instrument reports "Ready to Measure", press OK. At the top of the measurement graph, the E/O Measurement is now indicated.

17 Reattach the LCA RF Input to the RF output connector of the optical test set. The traceable calibration of the LCA receiver has now been loaded and the trace displays the conversion efficiency of the LCA transmitter. Save a measurement trace under the name **eoLight**.

18 Disconnect the fiber patch cord and connector adapter from the LCA Optical Input so that the Optical Input can be darkened with a black rubber cap. Disconnect the LCA RF Output and connect it to the 50 Ohm termination. The measurement now represents the dark limit for the **E/O minimum measurable responsivity**. Save a measurement trace under the name **eoDark**.

19 If the LCA has another wavelength available, repeat Steps 15-17 for the 2^{nd} wavelength and save the corresponding files in a separate directory for the 2^{nd} wavelength.

20 If the LCA has Option #302 or #303, then exit the E/O macro procedure by starting E/E Measurement mode, which restores standard network analyzer functionality. Then change the sweep setup by changing parameters according to the table below, and then repeat the electrical calibration of the network analyzer for the new parameters, as in Step 2.

IFBW	100 Hz
Number of points	1600

21 Reconnect the LCA RF Output to the RF Input connector of the optical test set.

22 Reconnect the fiber patchcord between the LCA Optical Output and Optical Input.

23 If the LCA has Option #302 or #303, then repeat Steps 7-8 using the new parameters and save the results as **ooIntRec1600**.

24 If the LCA has Option #302 or #303 and has another wavelength available, then repeat step 22 for the 2^{nd} wavelength and save the corresponding file in a separate directory for the 2^{nd} wavelength.

25 In the User Interface Display, select the **optical-to-electrical measurement** by starting **O/E Measurement** mode. Set the correct wavelength in the next macro setup panel and with the wavelength switch on the optical test set. If **Measure Mode** is available, choose **Single-End**. Then run the optical calibration. When the instrument reports "Ready to Measure", press OK.

26 Now remove the LCA RF Input from the optical test set and attach it to the RF output of the traceable reference receiver.

27 Remove the optical fiber from the Optical Input of the optical test set and attach it to the optical input of the traceable reference receiver.

28 The O/E Measurement now represents the responsivity of the reference receiver. Save the measurement as **oeRefRec**.

29 If the LCA has another wavelength available, then repeat Steps 24-27 for the 2^{nd} wavelength and save the corresponding file in a separate directory for the 2^{nd} wavelength.

Data Evaluation

30 Recall the file **ooDark**. Export the S_{21} trace in linear magnitude format. Divide the frequency range of the trace into 10 segments. For each segment, calculate the average signal level. Then convert these 10 numbers to electrical dB with the formula $20log(x)$. These values now represent the **optical-to-optical minimum measurable responsivity** vs. frequency. Depending on the NWA option of the LCA, this parameter is specified separately above and below a particular frequency. Determine the highest level of dark signal in these two frequency ranges and record the

results in the table. The results should be lower than the corresponding specification.

31 Recall the file **oeDark**. Export the S_{21} trace in linear magnitude format. Divide the frequency range of the trace into 10 segments. For each segment, calculate the average signal level. Then convert these 10 numbers to electrical dB with the formula 20*log*(x). These values now represent the **optical-to-electrical minimum measurable responsivity** vs. frequency. Depending on the NWA option of the LCA, this parameter is specified separately above and below a particular frequency. Determine the highest level of dark signal in these two frequency ranges and record the results in the table. The results should be lower than the corresponding specification.

32 Recall the file **eoDark**. Export the S_{21} trace in linear magnitude format. Divide the frequency range of the trace into 10 segments. For each segment, calculate the average signal level. Then convert these 10 numbers to electrical dB with the formula 20*log*(x). These values now represent the **electrical-to-optical minimum measurable responsivity** vs. frequency. Depending on the NWA option of the LCA, this parameter is specified separately above and below a particular frequency. Determine the highest level of dark signal in these two frequency ranges and record the results in the table. The results should be lower than the corresponding specification.

33 Recall the file **ooIntRec** (or **ooIntRec1600** for Options #302 or 303). Determine the midpoint “AvgResp_O/O” of the trace as the average of the maximum and minimum value of the trace. Then use this value to offset the **ooIntRec** trace so that it is centered at 0 dB, according to **RelResp_O/O(f) = ooIntRec(f) – AvgResp_O/O**. Check the vertical range of this trace against the specified accuracy for **optical-to-optical system relative frequency response uncertainty** and record this range in the table.

34 Recall the file **oeRefRec** and determine its offset from the calibration data of the reference receiver as: **ΔResp_O/E(f) = oeRefRec(f) – Resp_Ref(f)**. Determine the midpoint **AvgResp_O/E** of the trace **ΔResp_O/E(f)** as the average of the maximum and minimum value of the trace. Then use this value to offset the **ΔResp_O/E(f)** trace so that it is centered at 0 dB, according to: RelResp_O/E(f) = **ΔResp_O/E(f) – AvgResp_O/E**. Check the vertical range of this trace against the specified accuracy for **optical-to-electrical system relative**

frequency response uncertainty and record this range in the table.

Test Record

Agilent N4373A Lightwave Component Analyzer Performance Test

Page 1 of 3

Test Facility:

Report No.	
Date:	
Customer:	
Tested by:	

Agilent N4373A

consisting of

Network Analyzer -	**N4373A Optical Test Set** -
Product No.	Serial No.
Serial No.	Firmware Rev.
Firmware Rev.	

Ambient temperature	°C
Relative humidity	%
Line frequency	Hz

Special Notes :

Agilent N4373A Performance Test

Page 2 of 3

Agilent N4373A

Report No.	Date

Test Equipment

#	Description	Model No.	Trace No.	Cal. due date
1	Power Meter			/ /
2	Optical Spectrum Analyzer			/ /
3	Reference Receiver			/ /
4				/ /
5				/ /
6				/ /
7				/ /
8				/ /
9				/ /
10				/ /

Agilent N4373A Performance Test

Page 3 of 3

Agilent N4373A

Report No.	Date

LCA source test

	1310 nm Source	Spec.(typ.)	1550 nm Source	Spec.(typ.)
Unmodulated Output Power				
Wavelength				

LCA system minimum measurable responsivity

	1310 nm Source		1550nm Source	
Measurement Type	low freq.	high freq.	low freq.	high freq.
O/O				
O/E				
E/O				

LCA system relative frequency response uncertainty (typ.)

Measurement Type	1310 nm Source	1550 nm Source	Spec.(typ.)
O/O			
O/E			
E/O	same as O/E		

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 1 Notice for Germany: Noise Declaration

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

Declaration of Conformity

Agilent Technologies	**DECLARATION OF CONFORMITY** According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014	CE

Manufacturer's Name: Agilent Technologies International sarl
Manufacturer's Address: Rue de la Gare 29
CH-1110 Morges
Switzerland

Declares under sole responsibility that the product as originally delivered

Product Name: **Lightwave Component Analyzer**
Product Number: **N4373A**
Product Options: *This declaration covers all options of the above system.*

complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly:

- The Low Voltage Directive 73/23/EEC, amended by 93/68/EEC
- The EMC Directive 89/336/EEC, amended by 93/68/EEC

and conforms with the following product standards:

	Standard	Limit
EMC	IEC 61326:2002 / EN 61326:1997+A1:1998+A2:2001+A3 :2003	
	CISPR 11:1997+A1:1999 / EN 55011:1998+A1:1999	Group 1 Class A
	IEC 61000-4-2:2001 / EN 61000-4-2:1995+A1:1998+A2:2001	4kV CD, 8kV AD
	IEC 61000-4-3:2002+A1:2002 / EN 61000-4-3:2002+A1:2002	3 V/m, 80-1000 MHz
	IEC 61000-4-4:2001 / EN 61000-4-4:1995+A1:2001+A2:2001	0.5kV signal lines, 1kV power lines
	IEC 61000-4-5:2001 / EN 61000-4-5:1995+A1:2001	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:1995+A1:2000 / EN 61000-4-6:1996+A1:2001	3V, 0.15-80 MHz
	IEC 61000-4-8:2001 / EN 61000-4-8:1993+A1:2001	30 A/m
	IEC 61000-4-11:1994+A1:2000 / EN 61000-4-11:1994+A1:2001	1 cycle/100%
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS CISPR 11:2004	
Safety	IEC 61010-1:2001 / EN 61010-1:2001	
	Canada: CAN/CSA-C22.2 No. 61010-1:2004	
	USA: UL 61010-1:2004	

Supplementary Information:

The products were tested in a typical configuration with Agilent Technologies test systems.

This DoC applies to above-listed products placed on the EU market after:

2006-February-20
Date

Hans-Martin Fischer
Name

Product Regulations Representative
Agilent Technologies
Title

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Template:A5971-5302-2, Rev. B.00 Issue Date: 2006-February-20 Revision: A

7
Ordering Information

Ordering Information

The N4373A Lightwave Component Analyzer offers several options to satisfy customer specific measurement requirements. All configurations start with a basic system mainframe, and customers can select the desired options.

Options for customer-provided network analyzers (ENA and PNA series) are also available.

All options are available at the time of purchase. Contact your local Agilent field representative or Test and Measurement Services and Consulting Operations for details and quotes.

Agilent N4373A ordering options

N4373A Lightwave Component Analyzer		
at least one wavelength option must be ordered with the instrument		
Wavelength options	N4373A-100	1310nm Wavelength (only with #200 or 201 or 202)
	N4373A-101	1550nm Wavelength (only with #200 or 201 or 202)
	N4373A-102	1310 & 1550nm Wavelength (only with #200 or 201 or 202)
at least one frequency option must be ordered with the instrument		
Frequency options	N4373A-200	3GHz Frequency, SM Fiber
	N4373A-201	8.5GHz Frequency, SM Fiber
	N4373A-202	20GHz Frequency, SM Fiber
at least one network analyzer option must be ordered with the instrument		
Network Analyzer	N4373A-300	3GHz ENA (E5070B #214)
	N4373A-301	8.5GHz ENA (E5071B #214)
	N4373A-302	20GHz PNA-L 2ch (N5230A #220)
	N4373A-303	20GHz PNA-L 4ch (N5230A #240)
	N4373A-399	Integration of a compatible customer supplied network analyzer
one optical interface option must be ordered with the instrument		
Optical connector interface	N4373A-021	straight connector interface (single-mode)
	N4373A-022	angled connector interface (single-mode)

Customer supplied Agilent network analyzers have to be shipped to Agilent division for calibration and integration. Contact the Agilent field sales staff for more information about performing retrofits.

Power Cords

Power Cords		
N4373A-900	United Kingdom	8120-1351
N4373A-901	Australia & New Zealand	8120-1369
N4373A-902	Continental Europe	8120-1689
N4373A-903	United States (120 V)	8120-1378
N4373A-905	Systems Cabinet Use - IEC 320	8120-1860
N4373A-906	Switzerland	8120-2104
N4373A-912	Denmark	8120-3997
N4373A-917	Republic of South Africa and India	8120-4211
N4373A-918	Japan	8120-4753
N4373A-919	Israel	8120-5182
N4373A-922	China	8120-8376
N4373A-927	Thailand	8120-8871

Documentation

The main system documentation is the operating manual plus the operation manual of the selected network analyzer that describes how to operate the Agilent N4373A. Individual instrument manuals will also be supplied with supplemental documentation of any special modifications. All documentation is shipped with the product but is also available on the Agilent web site at www.agilent.com/comms/lightwave

For related literature, please visit:

Optical Component Test Solutions:

http://www.agilent.com/comms/octsolutions

Agilent Network Analyzers: www.agilent.com/find/na

Mechanical and Electronic Calibration Kits:

www.agilent.com/find/ecal

Test Accessories, Cabinets, Cables:

www.agilent.com/find/accessories

Warranty

All system warranties and support agreements are dependent upon the integrity of the Agilent N4373A. Any modification of the system software or hardware will terminate any obligation that Agilent Technologies may have to the purchaser. Please contact your local Agilent field engineer before embarking in any changes to the system.

System

Included in the sales price is an industry leading 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.

Instruments and computers

The instrument standard support life period is five years. Application software is supported only on computer and instrument configurations specified at the time of installation.

Accessories

LCA accessories:

Calibration kits:

http://www.home.agilent.com/USeng/nav/-536890127.0/pc.html

Network Analyzer time domain options:

Network Analyzer Time Domain Options:
For N5230A: N52300-010
for E5070B: E5070BU-010
for E5071B: E5071BU-010

Additional information on Agilent network analyzers:

http://www.home.agilent.com/USeng/nav/-11898.0/pc.html

SCPI command converter

Agilent provides a free command converter (cXL) to translate SCPI commands from 875X, 872X 8510 and 8703X to PNA compatible SCPI commands.

Please note, some commands are not supported, but can be emulated with macros for PNA.Macros can only be called remotely by "COM" interface. Following 8703X commands can not be supported (as the N4373A LCA does not support required measurements)

- MEASOE1(O/E measurement at RF port 1)
- MEASO1(optical reflection measurement)

The command converter and additional information is available at http://na.tm.agilent.com/pna/cxl/

Index

www.agilent.com

Printed in Germany May 2006

First edition, May 2006
N4373-90A01

Agilent Technologies