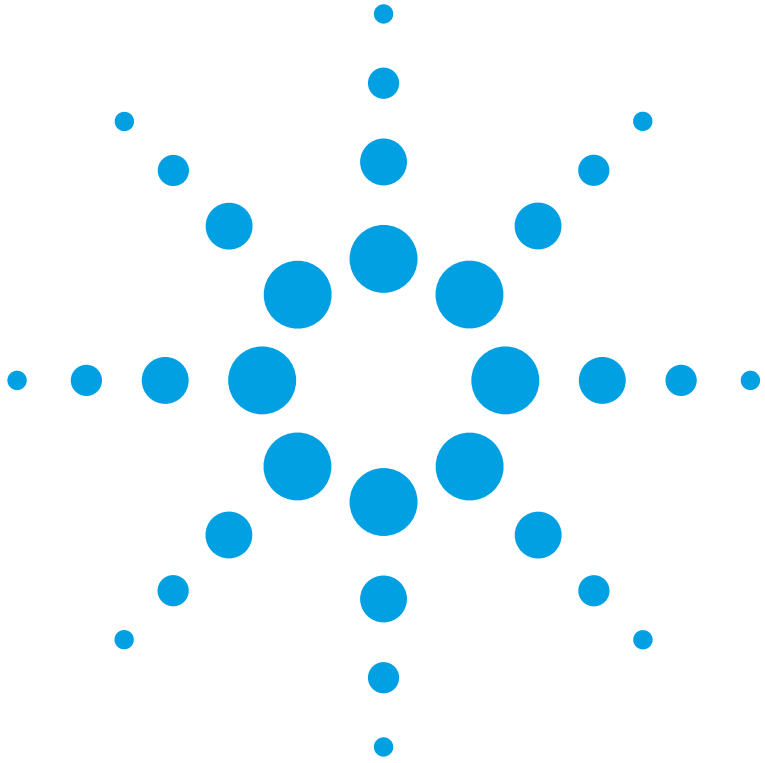
Agilent 81960A
Compact Tunable Laser Source module

User's Guide



Agilent Technologies

Notices

Manual Part Number

81960-90B01

Edition

First edition, November 2011

Agilent Technologies Deutschland GmbH
Herrenberger Straße 130
71034 Böblingen, Germany

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.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Warranty

The material contained in this document is provided "as is," and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Agilent disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

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.

Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as "Commercial computer software" as defined in DFAR 252.227-7014 (June 1995), or as a "commercial item" as defined in FAR 2.101(a) or as "Restricted computer software" as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Safety Notices

CAUTION

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

WARNING

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

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/find/lightwave

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

United States:	1 800 829 4444 1 800 829 4433 (FAX)
Canada:	1 877 894 4414 1 905 282 6495 (FAX)
Europe:	+31 20 547 2111 +31 20 547 2190 (FAX)
Japan:	120 421 345 120 421 678 (FAX)
Mexico	(52 55) 5081 9469 (52 55) 5081 9467 (FAX)
Australia:	800 629 485 800 142 134 (FAX)
Asia-Pacific:	+852 800 930 871 +852 2 506 9233(FAX)
Latin America	+55 11 4197 3600 +55 11 4197 3800 (FAX)

In This Guide...

Chapter 1, “Getting Started"

This chapter contains an introductory description of the modules and aims to make the modules familiar to you.

Chapter 2, “Accessories"

This chapter contains details of the various modules and options available.

Chapter 3, “Operating Instructions"

This chapter provides a general description of the specific features of the 81960A compact tunable laser module.

Chapter 4, “Programming Instructions"

This chapter describes the SCPI Commands for use of 81960A compact tunable laser module.

Chapter 5, “Specifications"

This chapter contains the specifications of the 81960A compact tunable laser module.

Chapter 6, “Cleaning Information"

This chapter provides the cleaning instructions.

Chapter 7, “Index"

Table of Contents

Getting Started 11

Safety Considerations 12
Safety Symbols 12
Initial Inspection 13
Line Power Requirements 13
Operating Environment 13
Storage and Shipment 13
Protecting Empty Module Slots 14
Fitting Blind Panels for Front-Loadable Module Slots 14
Fitting a Filler Module for Back-Loadable Module Slots 15
Initial Safety Information for Tunable Laser Modules 16
Laser Safety Labels 17
Laser class 1M label 17
Introduction 18
What is a Tunable Laser Source? 18
Installation 18
Front Panels 19
Front Panel Controls and Indicators 19
Typical Use Models 20
Optical Output 21
Polarization Maintaining Fiber 21
Angled and Straight Contact Connectors 22

Accessories 23

Modules and Options 24
Modules 25
Options 25
Connector Interfaces 26
User's Guides 27

Operating Instructions 29

The Graphical User Interface 31
Differences among 8164A/B, 8163A/B and 8166A/B 31

Soft Lock 31
How to Set a Parameter 32
The User Interface 34
The Module's Front Panel 34
LAN Interface 35
General Information 36
User Interface 39
What is a Tunable Laser ? 45
How to Set the Power 45
How to Set the Output Power of a CW Signal 46
What is Excessive Power ? 47
How to Set the Wavelength 48
Wavelength Range 48
How to Set the Wavelength Directly 49
How to Perform a Wavelength Sweep 50
What is a Wavelength Sweep ? 50
How to Set the Wavelength Sweep 51
How to Perform a Sweep 53
How to Modulate a Signal 58
How to Use the Internal Modulation 58
How to Use External Modulation 60
SBS Suppression 62
How to Use Triggers 64
How to Use Input Triggering 64
How to Use Output Triggering 66
How to Use Auxiliary Functions 67
Automatic Realignment 67
How to Perform a Lambda Zero 68
Programming Instructions 69
Specific Command Summary 70
System Communicate - The :SYST:COMMunicate sub tree. 74
Signal Generation – The SOURce Subsystem Measurement Operations & Settings 82
Specifications 105
Definition of Terms 106

General Definitions 108
Absolute wavelength accuracy (continuous sweep mode) 109
Absolute wavelength accuracy (stepped mode) 109
Dynamic power reproducibility (continuous sweep mode) 110
Dynamic relative power flatness (continuous sweep mode) 110
Effective linewidth 110
Internal digital modulation - duty cycle 111
Internal digital modulation - rise and fall time 111
Linewidth 111
Maximum output power 112
Mode-hop free tunability 112
Mode-hop free sweeping range 112
Operating temperature and humidity 113
Output isolation 113
Polarization extinction ratio 113
Power flatness versus wavelength 114
Power linearity 114
Power repeatability 115
Power stability 115
Relative intensity noise (RIN) 116
Relative wavelength accuracy (continuous sweep mode) 117
Relative wavelength accuracy (stepped mode) 117
Return loss 118
SBS suppression - effective linewidth 118
SBS suppression - residual amplitude modulation (depth) 118
Side-mode suppression ratio 119
Signal to source spontaneous emission (SSE) ratio 119
Signal to total source spontaneous emission ratio 120
Wavelength range 120
Wavelength repeatability (continuous sweep mode) 121
Wavelength repeatability (stepped mode) 121
Wavelength resolution 122
Wavelength stability 122
Compact Tunable Laser Module Specifications 123
Agilent 81960A Fast-Swept Compact Tunable Laser Source, 1505 nm to 1630 nm 124
Specifications 126

Cleaning Information 129

Cleaning Instructions 130
Safety Precautions 130
Why is it important to clean optical devices ? 131
What do I need for proper cleaning? 132
Preserving Connectors 136
Cleaning Instrument Housings 136
Which Cleaning Procedure should I use? 137
How to clean connectors 138
How to clean connector interfaces 140
How to clean bare fiber adapters 141
How to clean instruments with a fixed connector interface 142
Additional Cleaning Information 143
Other Cleaning Hints 144

Index 145

1
Getting Started

This chapter provides a general description of Agilent 81960A Compact TLS module.

Safety Considerations 12
Safety Symbols 12
Initial Inspection 13
Line Power Requirements 13
Operating Environment 13
Storage and Shipment 13
Protecting Empty Module Slots 14
Fitting Blind Panels for Front-Loadable Module Slots 14
Fitting a Filler Module for Back-Loadable Module Slots. 15
Initial Safety Information for Tunable Laser Modules . . . 16
Laser Safety Labels 17
Introduction. 18
What is a Tunable Laser Source? 18
Installation 18
Front Panels. 19
Front Panel Controls and Indicators 19
Typical Use Models 20
Optical Output. 21
Polarization Maintaining Fiber 21
Angled and Straight Contact Connectors 22

Safety Considerations

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

Before operation, review the instrument and manual, including the red safety page, for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

WARNING **The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, 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.**

Safety Symbols

The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

Hazardous laser radiation.

Invisible laser radiation.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

If the contents are incomplete, mechanical damage or defect is apparent, notify the nearest Agilent Technologies Sales/Service Office.

WARNING **To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).**

WARNING **You *MUST* return instruments with malfunctioning laser modules to an Agilent Technologies Sales/Service Center for repair and calibration.**

Line Power Requirements

The Agilent 81960A Compact Tunable Laser Source modules operate when installed in Agilent 8163A/B Lightwave Multimeters, Agilent 8164A/B Lightwave Measurement Systems, and Agilent 8166A/B Lightwave Multichannel Systems.

Operating Environment

The safety information in your mainframe's User's Guide summarizes the operating ranges for the Agilent 81960A Compact Tunable Laser Source modules. In order for these modules to meet specifications, the operating environment must be within the limits specified for your mainframe.

Storage and Shipment

An Agilent 81960A Compact Tunable Laser Source module can be stored or shipped at temperatures between - 40°C and + 70°C.

Protect the module from temperature extremes that may cause condensation within it.

Protecting Empty Module Slots

Fitting a Blind Panel or Filler Module helps to:

- prevent dust pollution and
- optimize cooling by guiding the air flow.

Fitting Blind Panels for Front-Loadable Module Slots

To fit the a blind panel (part number - 08163-40199), perform the following procedure.

1 Position the blind panel as shown in Figure 1. Position the end closest to the handle against the bottom edge of the slot.

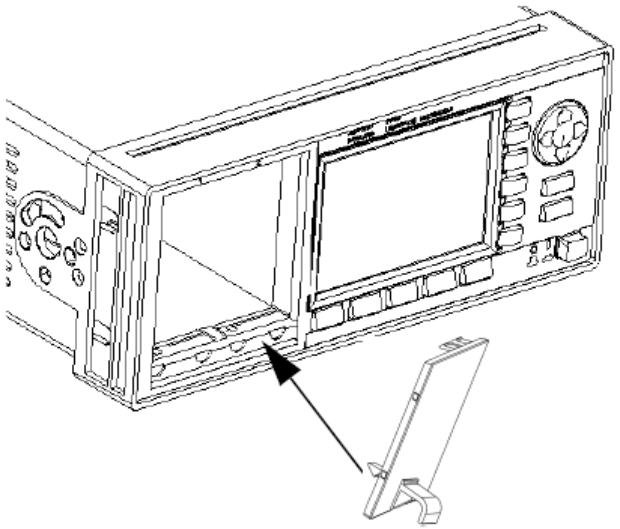


Figure 1 Fitting a Blind Panel

2 Push the top of the blind panel so that it clicks into position.

NOTE To remove a blind panel, pull the handle.

Fitting a Filler Module for Back-Loadable Module Slots

The Agilent 81960A Filler Module must be used if you have not installed a back-loadable Tunable Laser module into the Agilent 8164A/B Lightwave Measurement System.

The Agilent 81960A Filler Module can be fitted and removed in the same way as any back-loadable module.

Initial Safety Information for Tunable Laser Modules

The laser sources specified by this user guide are classified according to IEC 60825-1 (2007) Laser Notice No. 50 dated 2007-June-24.

The laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50 dated 2001-July-26:

	Agilent 81960A
Laser Type	ECL-Laser InGaAsP
Wavelength range	1505 nm-1630 nm
*Max. CW output power**	50 mW
Beam waist diameter	9 µm
Numerical aperture	0.1
Laser Class according to IEC 60825-1 (2001)- Intl.	1 M
*Max. permissible CW output power***	163 mW

* *Max. CW output power* is defined as the highest possible optical power that the laser source can produce at its output connector.
** *Max. permissible CW output power* is the highest optical power that is permitted within the appropriate laser class.

Laser Safety Labels

Laser class 1M label

Figure 2 Class 1M Safety Label - 81960A

A sheet of laser safety labels is included with the laser module as required. 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.

WARNING

Please pay attention to the following laser safety warning:

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 pressing the 'active' button close to the optical output connector on the front panel of the module. The laser is on when the green LED on the front panel of the instrument is lit.

The use of optical instruments with this product will increase eye hazard.

The laser module has a 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.

Introduction

What is a Tunable Laser Source?

A Tunable Laser Source (TLS) is a laser source for which the wavelength can be varied through a specified range. The Agilent 81960A is a TLS with continuous-sweep measurement capabilities, where wavelength and power are regulated while the laser changes wavelength at a constant rate. The Agilent Technologies range of TLS modules also allow you to set the output power, and to choose between continuous wave or modulated power.

With the 81960A, Agilent sets a new mark in tunable laser performance with faster sweep speeds and repetition rates combined with the dynamic accuracy specifications needed for DWDM component measurements, all packaged in a compact module. The new and unique capability of dynamically specified sweeps in both directions enhances the repetition rate even further for real-time use in adjustment and calibration procedures.

Installation

The Agilent 81960A Compact TLS module is a front-loadable module.

For a description of how to install your module, refer to “How to Fit and Remove Modules” in the Installation and Maintenance chapter of your mainframe’s User’s Guide.

Front Panels

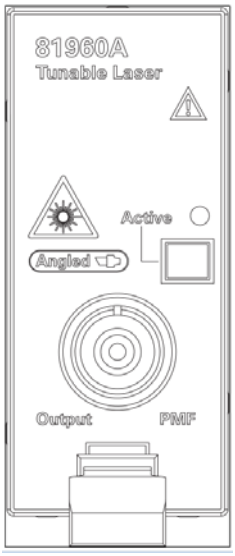


Figure 3 Agilent 81960A Compact Tunable Laser Module

Front Panel Controls and Indicators

Switch the laser source on or off using the switch on its front panel, using the [*State*] parameter in the instrument's Graphical User Interface, or remotely using SCPI commands. When the Active LED is lit the source is emitting radiation. When the Active LED is not lit the source is not emitting radiation.

Typical Use Models

The Agilent 81960A Compact TLS module provides high output power up to +14 dBm.

This module covers a total wavelength range of 125 nm in the C- and L-band.

This laser has been designed for making spectral measurements of passive fiberoptic components, where results with high wavelength accuracy and dynamic range are needed. The laser is especially well supported by the swept-wavelength measurement engines in the N7700A software suite and can be programmed directly.

The key application for this laser is high repetition-rate scanning for real-time updates, benefiting from the higher sweep speeds and acceleration, bidirectional sweeping and improved uploading of the logged wavelength monitor data. These features are best harnessed with the N7700A-102 fast spectral loss engine, which synchronizes the laser with the N7744A or N7745A power meters to produce power and loss spectra in a convenient GUI display. The wavelength resolution and 50-60 dB dynamic range achieved surpass comparable measurements with an OSA, with repetition rates better than 2 Hz for add-drop filter adjustment and calibration.

The high performance in continuous sweeps also matches this laser well to the single-sweep PDL and IL N7700A measurement engine. The dynamic wavelength accuracy will satisfy the test needs for many DWDM components at an optimized performance/price balance. The source to spontaneous noise ratio, SSE, while not as high as the 81600B series, is also sufficient to qualify the isolation of many filter devices. The higher sweep speeds save time measuring broadband devices not needing such high wavelength resolution.

These same advantages apply to use with the N7788B component analyzer for measuring PMD and DGD in addition to PDL and IL. The relative wavelength accuracy during the sweeps is especially important for accurate DGD measurements using the JME method, since the result depends on the derivatives with respect to wavelength. The high speed is great for measuring isolators, PMF and other broadband components.

The powerful lambdascan functions of the 816x Plug&Play driver for customized programs, and the N7700A IL engine which provides a GUI interface to these functions also support power and IL measurements together with any of the Agilent power meters. And the performance of swept-wavelength measurements in the N4150A PFL, including fast repetitive sweeps, are also supported with this newest member of the Agilent swept tunable lasers.

Optical Output

Polarization Maintaining Fiber

A Polarization maintaining fiber (PMF) output is standard for Agilent 81960A Compact TLS modules.

PMF is aligned to maintain the state of polarization. A well defined state of polarization helps ensure constant measurement conditions.

The fiber is of Panda type, with TE mode in the slow axis in line with the connector key.

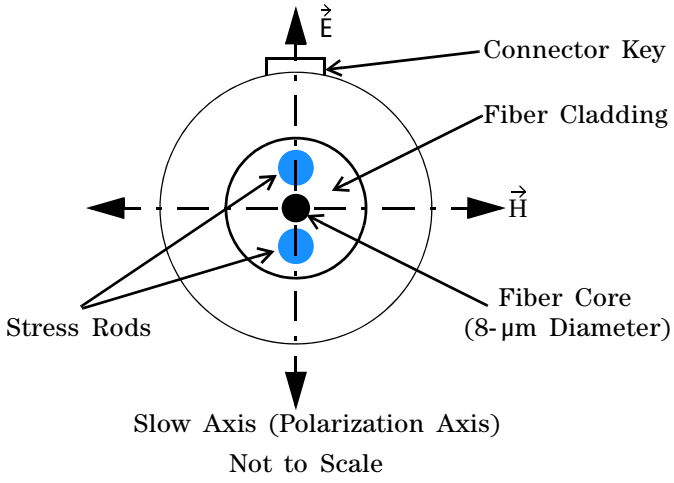


Figure 4 PMF Output Connector

See Chapter 2, “Modules and Options" for further details on connector interfaces and accessories.

Angled and Straight Contact Connectors

To ensure most accurate measurements, the Agilent 81960A Fast sweeping Compact TLS module is equipped with angled contact connectors.

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

CAUTION With the angled contact connectors on your instrument, you can only use cables with angled connectors.

Angled Contact Connector Symbol

Straight Contact Connector Symbol

Figure 5 Angled and Straight Contact Connector Symbols

Figure 5 shows the symbols that tell you whether the contact connector of your Tunable Laser module is angled or straight. The angled contact connector symbol is 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.

NOTE **Angled non-contact fiber end connectors** with orange sleeves cannot be directly connected to the instrument.

See “Connector Interfaces” on page 26 for further details on connector interfaces and accessories.

2
Accessories

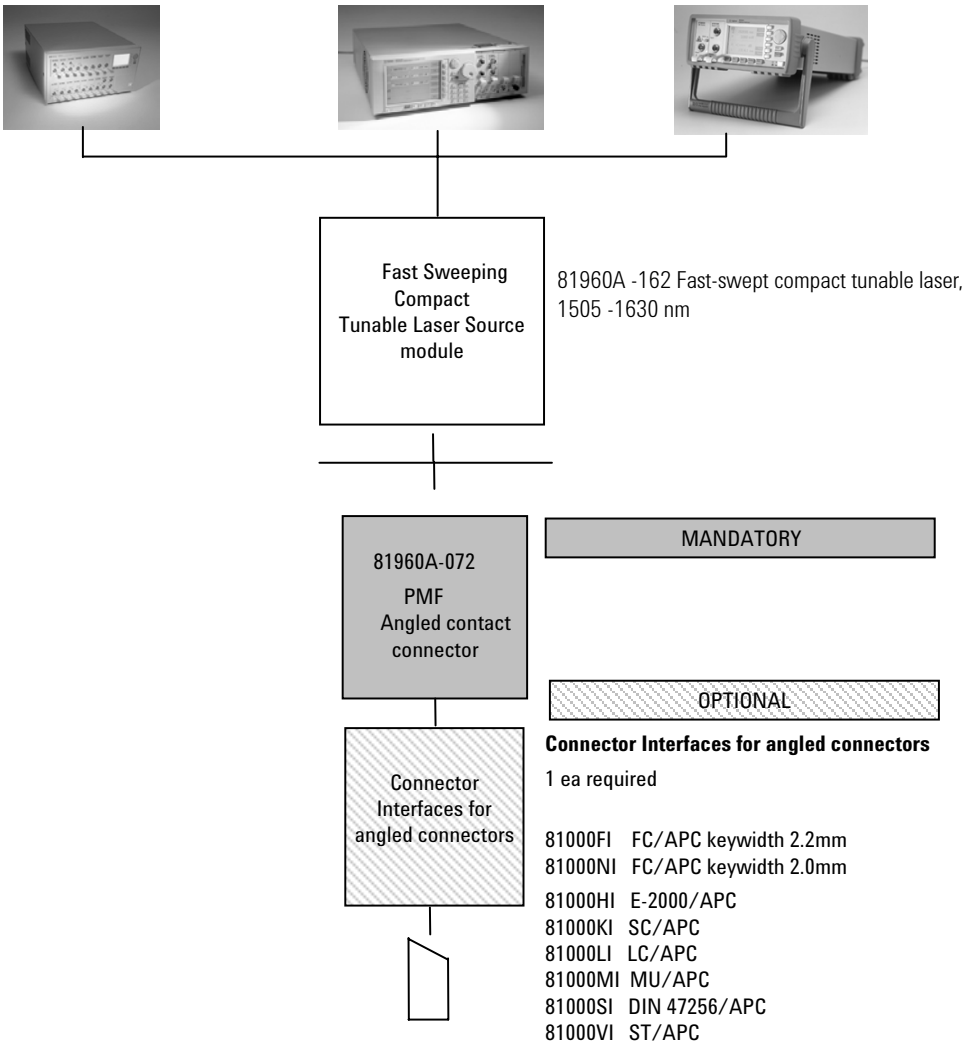
The Agilent 81960A Compact TLS module is available in various configurations for the best possible match to the most common applications.

This chapter provides information on the available options and accessories.

Modules and Options 24
Modules 25
Options 25
Connector Interfaces 26
Option 072 26
User's Guides 27

Modules and Options

Figure 6 shows all the options that are available for Agilent 81960A Compact TLS module, and the instruments that support these modules.



Note: 81960A - 072 helps to reduce front-panel reflections, which will greatly reduce interference noise and spectral ripple in the test setup.

Figure 6 Mainframes, Tunable Laser Module, and Options

Modules

Agilent 81960A Compact TLS module can be hosted by:

- Agilent 8163A and Agilent 8163B Lightwave Multimeters,
- Agilent 8164A and Agilent 8164B Lightwave Measurement Systems,
- Agilent 8166A and Agilent 8166B Lightwave Multichannel Systems.

To exploit the maximum update rate of the 81960A's swept wavelength measurements, use either an 8163B or 8164B mainframe.

Table 1 Compact Tunable Laser Modules

Model Number	Description
Agilent 81960A	Fast Swept Compact Tunable Laser, 1505 nm - 1630 nm

Options

The following options are available for this Compact TLS module:

- 81960A-162 Fast-swept tunable laser source, 1505-1630 nm
- 81960A-072 Polarization-maintaining fiber, Panda-type, for angled contact connectors

Connector Interfaces

The following connector interfaces are available for this Compact TLS module:

Option 072

Angled Contact Connectors

For angled connectors (such as E-2000 APC, SC/APC, FC/APC or DIN 47256/4108.6) to connect to the instrument, you must do the following:

1 Attach your connector interface to the interface adapter.

2 See Table 2 for a list of the available connector interfaces.

Table 2 Angled Contact Connector Interfaces

Description	Model number
E-2000 APC	Agilent 81000 HI
SC/APC	Agilent 81000 KI
FC/APC	Agilent 81000 NI (narrow key) Agilent 81000 FI (wide key)
DIN 47256 / 4108.6	Agilent 81000 SI

3 Connect your cable.

User's Guides

The following User's Guides are applicable to these Compact TLS module:

Table 3 User's Guides

Description	Part Number
Agilent 81960A Compact Tunable Laser Source module User's Guide.	81960-90B01
Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System User's Guide.	08164-90B15
Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System Programming Guide.	08164-90B64
Agilent 8163B Lightwave Multimeter, Agilent 8164B Lightwave Measurement System LAN Interface Addendum to the User and Programming Guides	5989-9352EN

This Page Intentionally Left Blank

3
Operating Instructions

This chapter explains how to control Tunable Laser modules from the user interface of the Agilent 8163A/B Lightwave Multimeter, the Agilent 8164A/B Lightwave Measurement System, and the Agilent 8166A/B Lightwave Multichannel System.

The Graphical User Interface 31
Differences among 8164A/B, 8163A/B and 8166A/B 31
Soft Lock. 31
How to Set a Parameter. 32
The User Interface 34
The Module's Front Panel 34
LAN Interface 35
General Information 36
User Interface 39
What is a Tunable Laser ? 45
How to Set the Power 45
How to Set the Output Power of a CW Signal 46
What is Excessive Power ? 47
How to Set the Wavelength 48
Wavelength Range 48
How to Set the Wavelength Directly 49
How to Perform a Wavelength Sweep 50
What is a Wavelength Sweep ? 50
How to Set the Wavelength Sweep 51
How to Perform a Sweep. 53
How to Modulate a Signal 58
How to Use the Internal Modulation 58

How to Use External Modulation 60
How to Use Triggers 64
How to Use Triggers. 64
How to Use Input Triggering 64
How to Use Output Triggering. 66
How to Use Auxiliary Functions. 67
Automatic Realignment 67
How to Perform a Lambda Zero 68

The Graphical User Interface

Differences among 8164A/B, 8163A/B and 8166A/B

Apart from the main parameters Wavelength (or Frequency or Channel, depending on the instrument/state), Power, and State (i.e. laser on or off), there is only limited space on the 8163 and 8166 displays.

Further parameters and settings are only displayed if an 8164A/B mainframe is used.

Soft Lock

When you use high-power Tunable Laser Source modules, you must enter the password to unlock the instrument. This feature is called "Soft Lock" as opposed to a lock using a key.

At power on the instrument shows a dialog and prompts the user to enter a code to unlock it. Later you can lock or unlock the instrument any time: press the [Config] key, and then select "Lock" or "Unlock". The dialog opens again and you can enter the password.

The default password is "1234".

If the instrument is locked, the status line shows "SL" (8163 A/B, 8166 A/B) or "SLock" (8164 A/B).

NOTE

The instrument can also be locked and unlocked using a remote command: "LOCK 0|1, <password>".

Example: unlock the instrument using password "1234": lock 0,1234

How to Set a Parameter

General Description

This chapter is a general description on how to set a parameter. The following chapters only describe specific details for particular parameters.

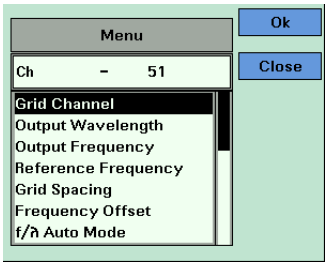
NOTE The Modify Knob and the numerical key pad are only available on the 8164 A/B.

- First select the correct module using the [Channel] hard key.
- You can switch from the Overview Screen, where you see all modules, to the Details Screen, where the whole screen is used to show a single module, and back using the topmost soft key. It is either labeled "Overview" or "Details" depending on the current view.
- Move to the parameter you want to change using the arrow keys or the Modify Knob.
- For some parameters you can now change the unit (e.g. W <–> dBm for power) or switch between frequency and wavelength using the soft keys.
- Press [Enter], the Modify Knob, or the [Edit] soft key to start editing the value.
- Enter the desired value using the Up/Down/Left/Right keys, the Modify Knob or the numerical key pad.
- When finished press [Enter], the Modify Knob, or the [OK] soft key. You can also cancel the operation using the [Cancel] soft key.

NOTE Not all parameters are available in all operation modes or instrument states.

- If a parameter is not displayed on the screen, it can alternatively be accessed using the [Menu] soft key, which opens a menu with all currently available parameters:


0
Menu
Ch - 51
Ok
Close
1
Ch -
20.000 mW
2
3
4
Grid Channel
Reference Frequency
Grid Spacing
Frequency Offset
f/λ Auto Mode
Source state
Power
Pwr unit
Pmax
Modulation State
External Mod. Input
SBSC Level
AM Level


Menu
Ch - 51
Ok
Close
Grid Channel
Output Wavelength
Output Frequency
Reference Frequency
Grid Spacing
Frequency Offset
f/λ Auto Mode

The User Interface

The Module's Front Panel

Key

The module's front panel key can be used to switch the laser on or off.

NOTES

- When the instrument's user interface is used, the laser can be switched off any time using the module's front panel key.
- The module's front panel key is disabled when the instrument is remote controlled or if it is locked.
- When the instrument is remote controlled and the [Local] soft key is pressed, the front panel key is not re-enabled until the last remote command is finished.

LED

The module's front panel LED is used to inform about the state of the module:

LED State	Module State
blinking slowly (at boot time)	initializing hardware
blinking fast	boot error
off	laser is off
on	laser is on, frequency and power are stable

LAN Interface

This chapter describes the LAN Interface in the new 8163B and 8164B Lightwave Measurement Systems.

General Information

The new generation of mainframes 8163B (starting with S/N DE48204000) and 8164B (starting with S/N DE48202000) are equipped with a LAN Interface.

The LAN Interface can be operated either with fixed or variable IP address, depending on whether a DHCP server is available and the DHCP mode is enabled.

The LAN interface

The LAN Connector is on the back of the mainframes.

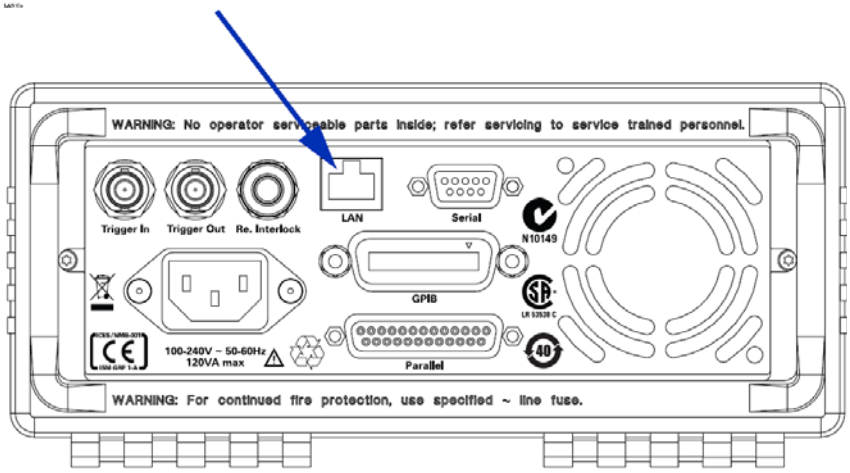


Figure 7 The LAN interface on the 8163B mainframe

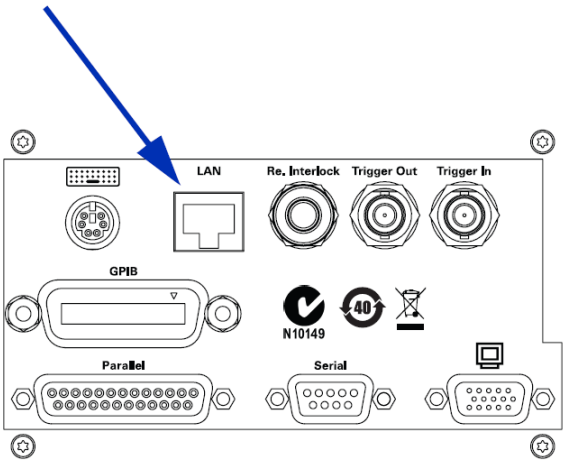


Figure 8 The LAN interface on the 8164B mainframe

Connections

Available connections:

- LAN (VXI-11 (RPC))
- LAN (TCP Socket, port 5025)
- LAN (Telnet, port 5024)

  2 VXI-11 connections and up to 10 socket or telnet connections (socket + telnet ~ 10) are possible.

  The ports for socket and telnet connections cannot be modified.

  Please note the following points:

- We recommend you use socket connections for applications.
- All LAN VXI-11 connections share their status information (Error queue, status registers).
- Socket and telnet connections are independent of each other.
- The status registers are updated if a new socket or telnet connection is opened.
- Be careful if there is more than one connection:
  - When using a VISA layer you can lock a device, so another controller accessing the same device with the same connection type (VISA VXI-11 or VISA socket) cannot access this device. However the device can be accessed with a different connection.

  This means, for example, if a device is locked in a VISA socket connection it can still be accessed with VXI-11.
  - A telnet connection cannot be locked.
  - Especially when using VXI-11 connections, lock the device. Otherwise one controller may get the reply for another controller's query.
  - If the device is locked in a VISA socket connection, you can still access it using raw sockets (that is, through directly using sockets).
- When using sockets (VISA and raw) there are some extra points to be aware of:
  - Always append a 'newline' to your command or query.
  - Don't use indefinite blocks.
  - It is the programmer's responsibility to make sure all the transmitted data is read.

- The Agilent VISA Assistant is confused by ‘newline’ inside a reply. In this case, click the button [viScanf] until the whole reply is read.

- VXI-11 connections are about 50% slower than Socket connections.

User Interface

Some new entries have been added to the Configuration menu, which can be opened with the [Config] hard key:

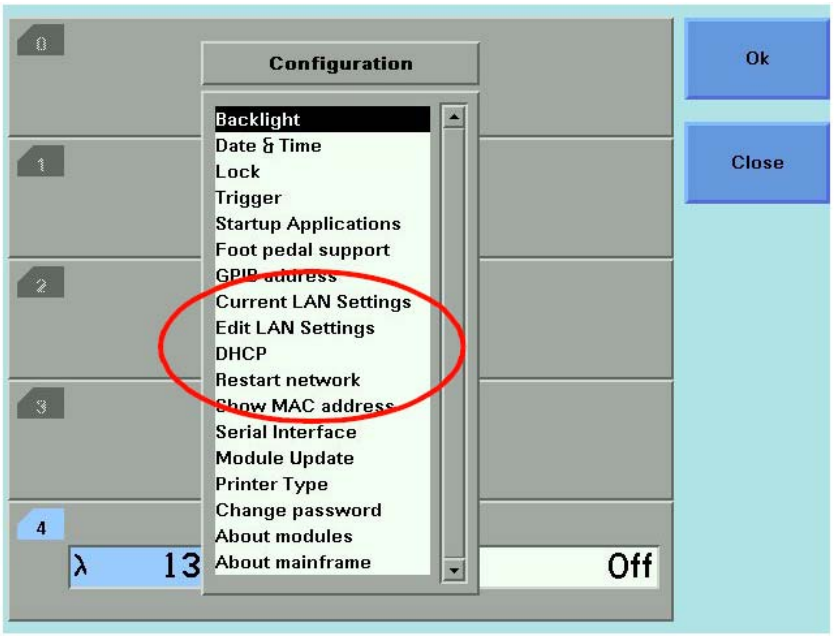


Figure 9 Setting Attenuation

Show the current LAN settings

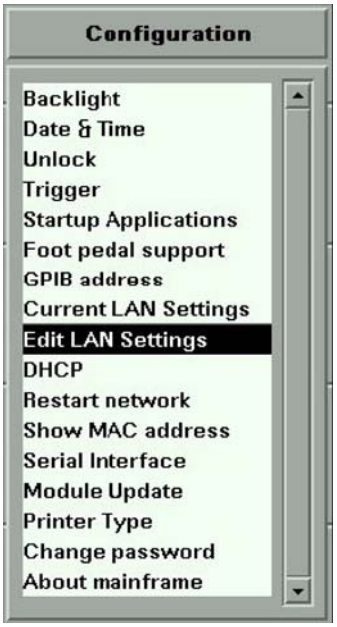
Use the cursor keys (or the modify knob on the 8164B) to select "Current LAN Settings" in the "Configuration Menu" and press the [OK] soft key to open a box displaying the currently used LAN settings.

This box displays the networking parameters currently in use. Depending on the DHCP setting these values may be supplied by the DHCP server and differ from the values entered in the "Edit LAN Settings" dialog.

The message box does not update automatically. To update the values, press the [Close] soft key then select "Current LAN Settings" again.

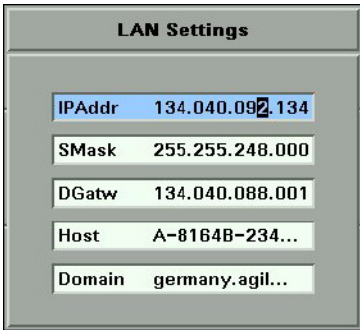
Edit LAN settings

Use the cursor keys (or the modify knob on the 8164B) to select "Edit LAN Settings" in the "Configuration Menu", then press the [OK] soft key.



Edit the IP address

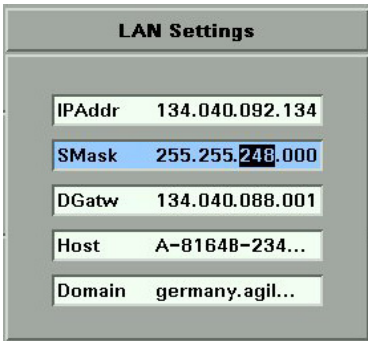
Use the cursor keys (or the modify knob and the numeric keypad on the 8164B) to edit the IP address.



Edit the subnet mask

You can edit the subnet mask with the cursor keys:

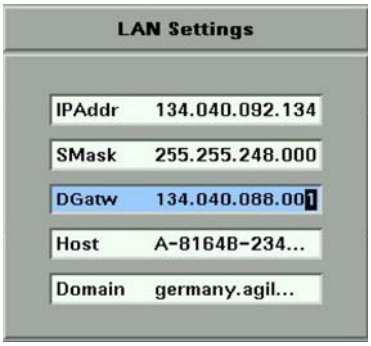
- [up] – set one more bit
- [down] – clear one more bit
- [left] – clear the actual byte and jump one byte left
- [right] set all bits in the actual byte, jump one byte right, and set the first byte in it



The modify knob on the 8164B works like the [up] and [down] buttons

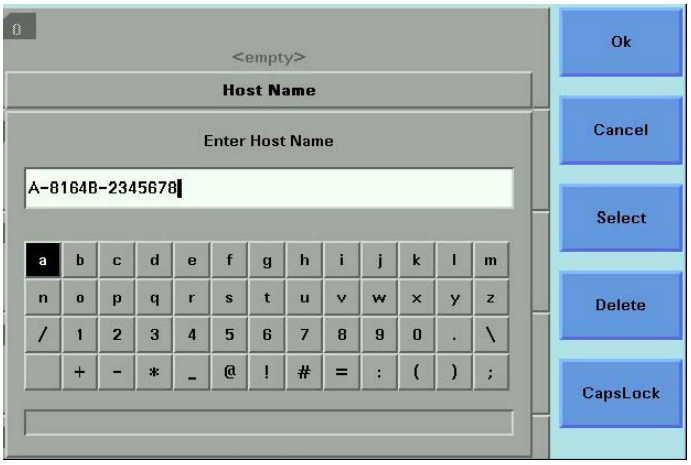
Edit the default gateway

Use the cursor keys (or the modify knob and the numeric keypad on the 8164B) to edit the IP address.



Edit the host name

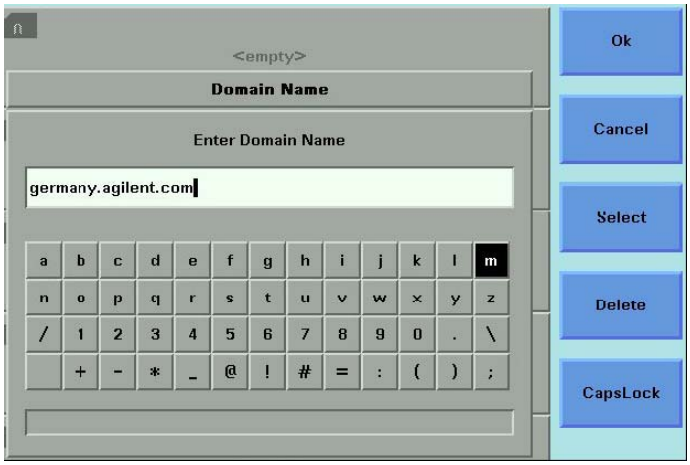
You can enter the host name in a special dialog for text input.



- Select a character by moving the highlight with the cursor keys, (or the modify knob on an 8164B/LAN), then press the [Select] soft key.
- Delete the last character using the [Delete] soft key.
- The [OK] soft key is disabled until the value in the editor is valid.
- If you try to enter a character which would create an invalid host name, the instrument beeps.
- If enter an empty host name, the host name is reset to its default value.

Edit the domain name

You can enter the domain name in a special dialog for text input.



- Select a character by moving the highlight with the cursor keys, (or the modify knob on an 8164B/LAN), then press the [Select] soft key.
- Delete the last character using the [Delete] soft key.
- The [OK] soft key is disabled until the value in the editor is valid.
- If you try to enter a character which would create an invalid domain name, the instrument beeps.

Enable or disable DHCP

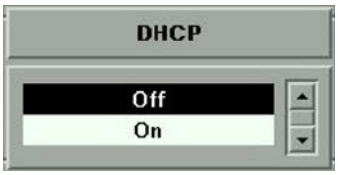
1 Use the cursor keys (or the modify knob on the 8164B) to select "DHCP" in the "Configuration Menu" and press the [OK] soft key to open a box that lets you enable or disable DHCP.

2 Use the cursor keys (or the modify knob on the 8164B) to select

– "Off" if you want to disable DHCP,

or

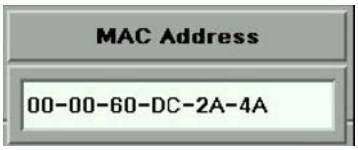
– "On" if you want to enable DHCP.



3 Press the [OK] soft key.

Show the MAC address

Use the cursor keys (or the modify knob on the 8164B) to select "Show MAC Address" in the "Configuration Menu" and press the [OK] soft key to open a box displaying the network adapters MAC address.



Restart the networking

If you have changed network parameters and want to apply them, use the cursor keys (or the modify knob on the 8164B) to select "Restart network" in the "Configuration Menu", then press the [OK] soft key.

What is a Tunable Laser ?

A tunable laser is a laser source for which the wavelength can be varied through a specified range. The Agilent Technologies Tunable Laser modules also allow you to set the output power, and to choose between continuous wave or modulated power.

How to Set the Power

The laser output can be either:

- a continuous wave (CW) signal, fixed amplitude signal, see *"How to Set the Output Power of a CW Signal" on page 46*,
- a modulated signal, see *"How to Modulate a Signal" on page 58*, or
- a signal with increased linewidth (coherence control), see *"How to Increase Linewidth" on page 62*.

If [*Mod Src*] is <*Off*>, a continuous wave signal is the chosen optical output. A continuous wave signal is the default.

If any other [*Mod Src*] source is chosen, the chosen source modulates the signal. For possible modulation sources, see *"How to Modulate a Signal" on page 58*.

How to Set the Output Power of a CW Signal

How to Set Output Power

To set the output power to 555.000 μW:

1 Move to the power parameter, [*P*], and press [Pwr unit].

2 Move to <W> and press *Enter*.

3 Press *Enter* to start editing the output power value.

4 Enter 555.000, press [Unit+] or [Unit–], as required, to select μW as the power units, and press *Enter*.

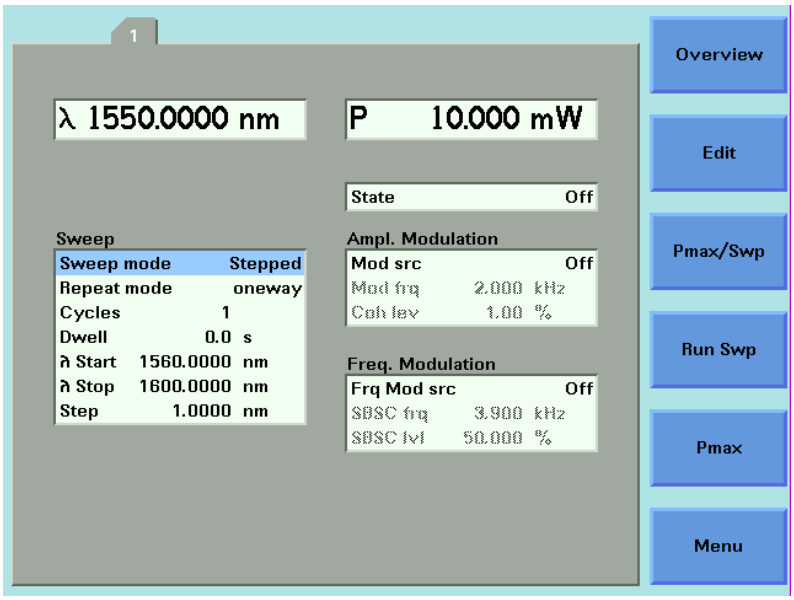


Figure 10 Setting Power parameters

How to Enable the Optical Output

1 Move to [*State*] and press *Enter*.

2 Move to <*On*>, by using the cursor key, and press *Enter* to enable the output. The LED beside the optical output is lit constantly.

What is Excessive Power ?

If the text ExP is displayed in a Tunable Laser channel, see Figure 11 , you have set an output power level that is larger than the laser diode can produce at the selected wavelength.

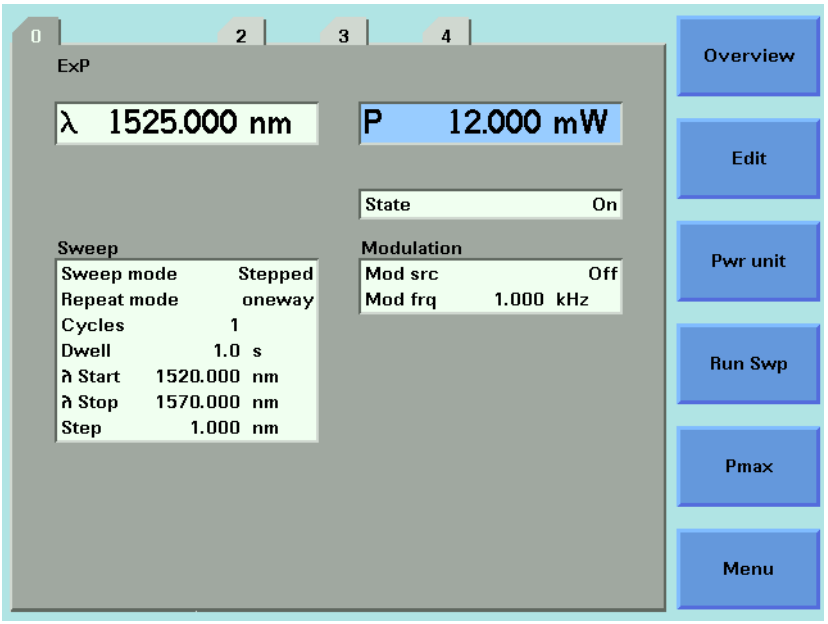


Figure 11 Excessive Power

To avoid this you can:

- reduce the optical output power,
- press [Pmax] to select the highest permissible power for the selected wavelength value, or
- press [Pmax/Swp] to select the highest permissible power for the selected wavelength sweep.

How to Set the Wavelength

There are three ways to set the wavelength of the Tunable Laser.

- You can set the wavelength (λ) directly,
- You can set the wavelength from a base wavelength and an offset in the frequency domain, or
- You can set a wavelength range for the instrument to “sweep”.

Wavelength Range

Every Tunable Laser module has a specified wavelength range. This range is available for all Tunable Laser modules. See "Agilent 81980A, 81960A, 81940A, 81989A, 81949A, and 81950A Compact Tunable Laser Sources Data Sheet, publication number 5988-8518EN".

Every Tunable Laser module has a permitted wavelength range. This range is greater than the specified range. The permitted wavelength range varies for each Tunable Laser module. You can set the wavelength to any value within the permitted wavelength range. For some specifications, a range smaller than the permitted range applies, e.g. from 1525 to 1620 nm.

Figure 12 shows an example of specified and permitted wavelength range.

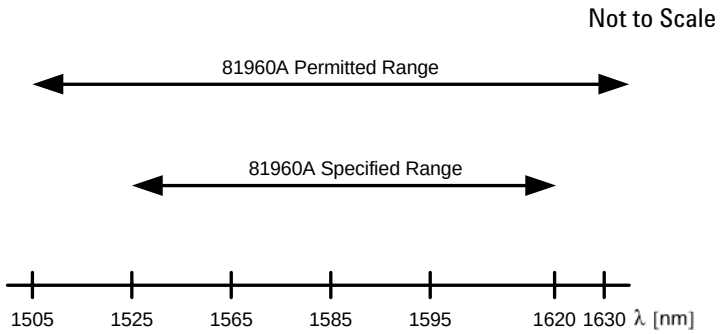


Figure 12 Specified and Permitted Wavelength Range

How to Set the Wavelength Directly

You can set a constant wavelength.

To set the wavelength to 1545.500 nm:

1 Move to the Tunable Laser channel.

2 Move to the wavelength parameter, [λ], and press *Enter*.

3 Enter 1545.500 and press *Enter*.

How to Perform a Wavelength Sweep

What is a Wavelength Sweep ?

A wavelength sweep is performed when the instrument changes the optical wavelength of the optical output across a user-defined wavelength range. You can use a wavelength sweep to measure the wavelength-dependent loss of an optical component. The laser can change the wavelength continuously at a constant rate or in steps with stops at each intermediate point.

How to Set the Wavelength Sweep

The Sweep Parameters

These are the parameters for the wavelength sweep:

- [λ *Start*], the wavelength at which the sweep begins,
- [λ *Stop*], the wavelength at which the sweep ends,
- [*Step*], the size of the change in the wavelength for each step of a stepped sweep,
- [*Cycles*], the number of times the sweep is repeated,
- [*Dwell*], the amount of time spent at the wavelength during each step, for a stepped sweep
- [*Vsweep*], the speed of a continuous sweep,
- [*Sweep mode*], see *"How to Perform a Sweep" on page 53*,
- [*Repeat mode*], see *"How to Set the Repeat Mode" on page 51*.

NOTE

For a <*Continuous*> sweep, [*Step*] sets the wavelength interval between output triggers, if you have set <*Output Trigger Mode*> to <*Step Finished*>, see *"How to Use Output Triggering" on page 66*.

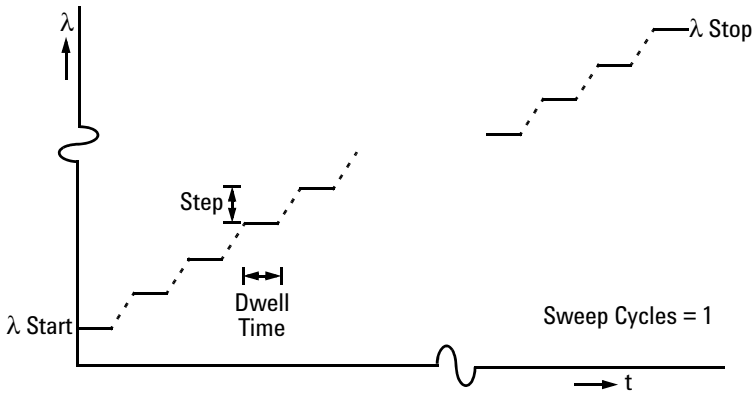


Figure 13 The Parameters for a Stepped Wavelength Sweep

How to Set the Repeat Mode

The [*Repeat Mode*] determines how the instrument performs a multi-cycle sweep.

- Select <*Twoway*>, if you want to start every odd sweep cycle at [λ *Start*] and to start each even sweep cycle at [λ *Stop*].

- Select <*Oneway*>, if you want to start every sweep cycle at [λ *Start*] and to end every sweep cycle at [λ *Stop*].

Figure 14 illustrates how these modes work for a three-cycle wavelength sweep.

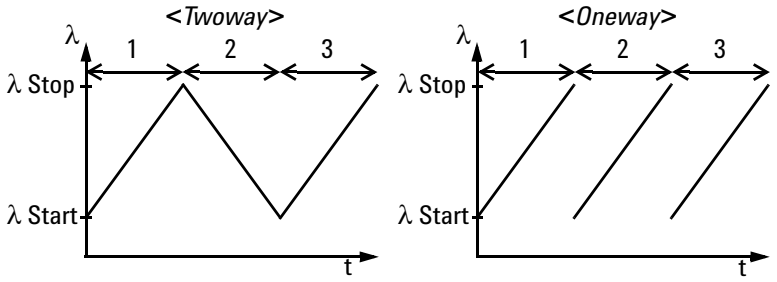


Figure 14 Repeat Modes

How to Set the Maximum Power for the Sweep Range

Pressing [Pmax/Swp] sets the power to the maximum for the selected sweep range. Alternatively, you can set a power level in the way described in *"How to Set the Output Power of a CW Signal" on page 46*. Pressing [Pmax/Swp] ensures the power will be constant for the whole sweep.

How to Perform a Sweep

There are three sweep modes:

- <*Stepped*>, which dwells at wavelengths that are separated by a certain step size,
- <*Continuous*>, which sweeps continually at the speed you set, and
- <*Manual*>, which you can run each step manually.

NOTE

You cannot turn the laser off by pressing the *Active* hardkey on the Tunable Laser front panel, while a wavelength sweep is running.

You can press [Stop] and, then, press the *Active* hardkey on the Tunable Laser front panel, to turn off the laser.

How to Execute a Stepped Sweep

To execute a stepped wavelength sweep over the range 1510 nm to 1570 nm, three times, sweeping two ways, in 1 nm steps, stopping for half a second at each wavelength step:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Sweep Mode*] and press *Enter*.

3 Move to the <*Stepped*> sweep mode and press *Enter*.

4 Move to [λ *Start*] and press *Enter*.

5 Enter 1510.000 and press *Enter*.

6 Move to [λ *Stop*] and press *Enter*.

7 Enter 1570.000, press *Enter*.

8 Move to [*Cycles*] and press *Enter*.

9 Enter 3 and press *Enter*.

10 Move to [*Repeat Mode*] and press *Enter*.

11 Move to <*Twoway*>, by using the cursor key, and press *Enter*.

12 Move to [*Step*] and press *Enter*.

13 Enter 1.000 and press *Enter*.

14 Move to [*Dwell*] and press *Enter*.

15 Enter 0.5000 and press *Enter*.

16 Press the [Active] hardkey on the front panel of your Tunable Laser module to enable the optical output.

17 Press [Run Swp] to start the sweep. The screen in Figure 15 appears.

18 The wavelength is swept automatically but you can:

a press [Stop] to end the sweep, or

b press [Pause] to pause the sweep. The screen in Figure 16 appears. You can:

- Press [Continue] to continue sweeping automatically.
- Press [Prev] or [Next] to sweep manually.
- Press [Stop] to end the sweep.

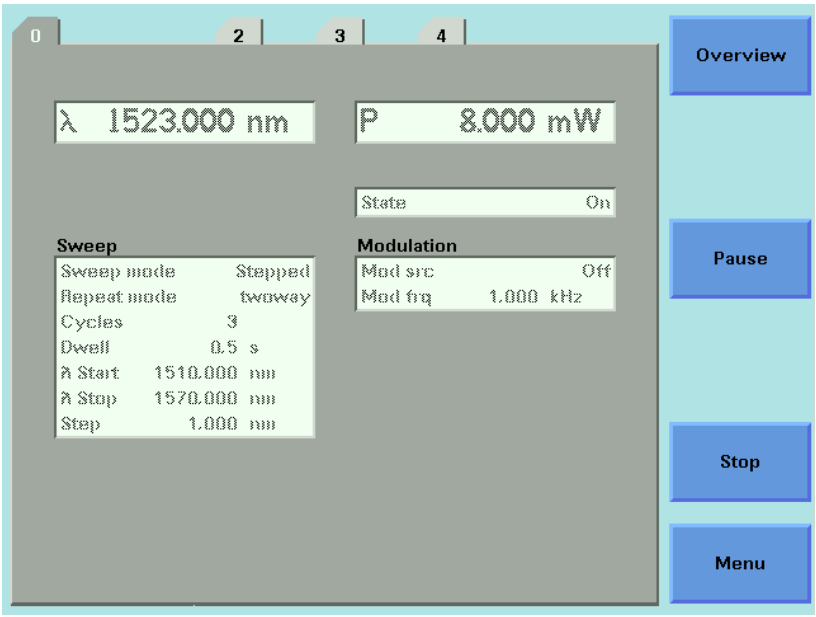


Figure 15 Executing a Stepped Sweep

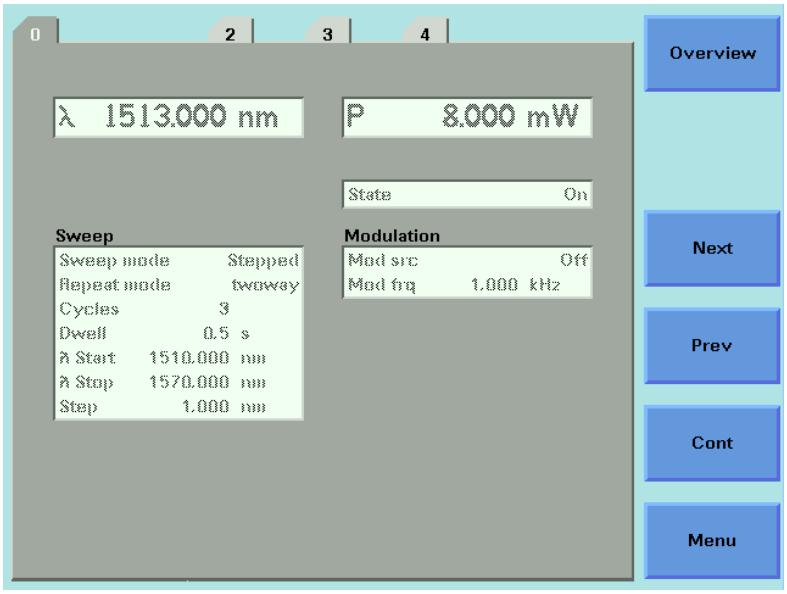


Figure 16 Pausing a Stepped Sweep

How to Execute a Continuous Sweep

NOTE

The 81960A supports sweep speeds 0.5, 1, 2, 5, 10, 20, 40, 50, 80, 100 and 200 nm/s. The step width can be set with a resolution of 0.1pm. The step duration, determined by the width and the sweep speed, can be as short as 1µs.

The 81960A also supports the "TWOWay" Mode for continuous sweeping. This increases the repetition rate.

For compatibility the Repeat Mode is not visible in the User Interface menu when the Continuous Mode is set. To change the Repeat Mode use the SCPI Command or switch temporary to the Stepped Mode, change the Repeat Mode and then switch back to Continuous Mode.

A convenient way to achieve the maximum repeat rate is to use the new N7700A-102 Fast Swept Loss Engine of the Photonic Application Suite. A repeat rate of approximately 3 updates per second is possible for 2 nm spans and more than 1 update per second for spans of 40 nm.

To execute a continuous wavelength sweep over the range 1520 nm to 1560 nm, three times, at a speed of 5 nm/s:

1. Move to the Tunable Laser channel and press [Details].
2. Move to [*Sweep Mode*] and press *Enter.*
3. Move to the <*Continuous*> sweep mode and press ENTER.
4. Move to [λ *Start*] and press *Enter.*
5. Enter 1520.000 and press *Enter*.
6. Move to [λ *Stop*] and press *Enter.*
7. Enter 1560.000, press *Enter*.
8. Move to [*Sweep Cycles*] and press *Enter.*
9. Enter 0003 and press *Enter*.
10. Move to [*Vsweep*] and press *Enter*.
11. Move to 5 nm/s, by using the cursor key, and press *Enter*.
12. Move to [*Step*] and press *Enter*.
13. Enter 1.000 and press *Enter*.

NOTE

For a <*Continuous*> sweep, [*Step*] sets the wavelength interval between output triggers, if you have set <*Output Trigger Mode*> to <*Step Finished*>, see *"How to Use Output Triggering" on page 66*.

14 Press the [Active] hardkey on the front panel of your Tunable Laser module to enable the optical output.

15 Press [Run Swp] to start the sweep.

NOTE The following table explains all possible configuration problems:

368,LambdaStop <=LambdaStart	start wavelength must be smaller than stop wavelength
369,sweepTime < min	the total time of the sweep is too small
370,sweepTime > max	the total time of the sweep is too large
371,triggerFreq > max	the trigger frequency (calculated from sweep speed divided by sweep step) is too large
372,step < min	step size too small
373,triggerNum > max	the number of triggers exceeds the allowed limit
374,LambdaLogging = On AND Modulation = On AND ModulationSource! = CoherenceControl	The only allowed modulation source with the lambda logging function is coherence control.
375,LambdaLogging = On AND TriggerOut! = StepFinished	lambda logging only works "Step Finished" output trigger configuration
376,Lambda logging in stepped mode	lambda logging can only be done in continuous sweep mode
377,step not multiple of <x>	the step size must be a multiple of the smallest possible step size

16 A continuous sweep can end in two ways:

- **a** when the sweep is completed, or
- **b** when you press [Stop].

How to Perform a Manual Sweep

You can perform a manual sweep if you choose the <*Manual*> sweep mode or if you press [Pause] during an automatic sweep. In a manual sweep you choose when you want to perform each step of a stepped sweep. You can choose to move forward or backward a wavelength or to end the sweep.

To perform a manual wavelength sweep over the range 1510 nm to 1570 nm, three times, sweeping two ways, in 1 nm steps:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Sweep Mode*] and press *Enter.*

3 Move to the <*Manual*>, by using the cursor key, and press *Enter*.

4 Perform step 4 to step 13 on page 53 to set the sweep parameters.

5 Press the [Active] hardkey on the front panel of your Tunable Laser module to enable the optical output.

6 Press [Run Swp] to start the sweep. The screen in Figure 17 then appears.

7 You can:

- press [Next] to move on to the next wavelength step,
- press [Prev] to move on to the previous wavelength step, or
- press [Stop] to end the sweep.

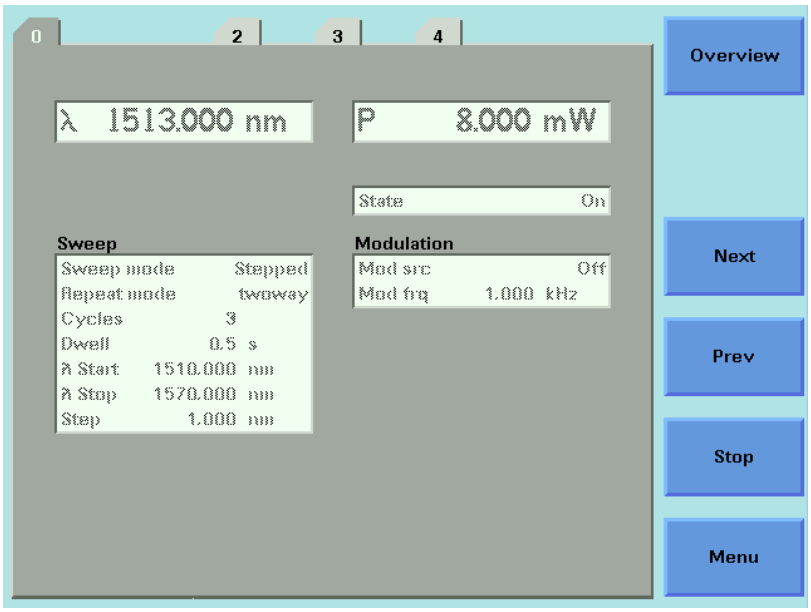


Figure 17 Performing a Manual Sweep

8 Perform step 6 until you choose to press [Stop].

How to Modulate a Signal

There are two ways of modulating the amplitude of the optical output.

- Using the internal modulation, and
- using external modulation.

How to Use the Internal Modulation

The internal modulation is a square wave with a 50% duty cycle. You can set both the amplitude and the frequency of this signal. The amplitude is set by the power parameter. This is the maximum output power of the output signal; at the minimum output power, no power is output.

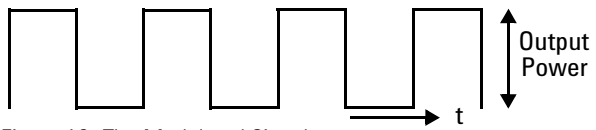


Figure 18 The Modulated Signal

How to Set the Output Power of a Modulated Signal

To set the output power to 555.000 μW:

1 Move to the Tunable Laser channel and press [Details] softkey.

2 Move to the power parameter, [*P],* and press [Pwr unit].

3 Move to <*W*>, by using the cursor key, and press *Enter*.

4 Press *Enter* to start editing the output power value.

5 Enter 555.000, press [Unit+] or [Unit–], as required, to select <μW> as the power units, and press *Enter*.

How to Set the Frequency of a Modulated Signal

To set the frequency of the modulation to 6.500 kHz:

6 Move to the frequency parameter, [*Mod Frq*], press *Enter*.

7 Enter 6.500 press *Enter*.

How to Set the Modulation Mode

8 Move to the modulation source parameter, [*Mod Src*], and press *Enter*.

9 Move to <*Internal*>, by using the cursor key, and press *Enter*. The text Int appears in the Tunable Laser channel.

How to Use External Modulation

The following external modulation modes are available:

- <*External Analog*> - External Analog Modulation. See the note.
- <*Backplane*> - External Digital Modulation using Input Trigger connector or Trigger Feedback from another module in the same mainframe.
- <*Coherence Ctrl.*> - Coherence Control

NOTE External Analog Modulation is not supported by the 81960A.
The Command and Mainframe Menu point is included for compatibility.

External Digital Modulation using Input Trigger Connector

External digital modulation uses a TTL-level signal. Apply this signal to the Input Trigger connector on the rear panel of your mainframe.

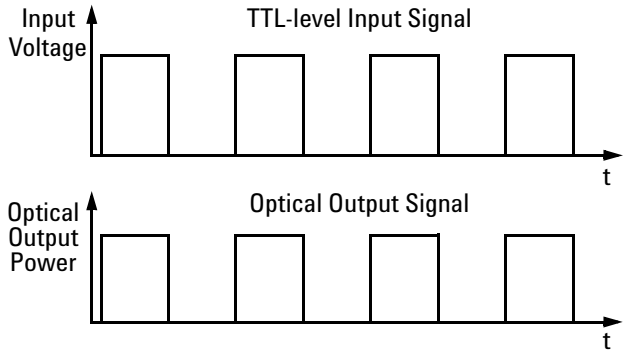


Figure 19 External Digital Modulation

Figure 19 shows how a TTL-level input signal modulates the optical output. Digital modulation sets the frequency of the output signal.

To set the amplitude of the output signal, set the power parameter. This is the maximum output power of the output signal; at the minimum output power, no power is output.

CAUTION A maximum of 5 V can be applied as an external voltage to the Input Trigger connector, see page 310.

Take care not to use the Trigger Output connector or the Remote Interlock connector for modulation. Do not apply an external voltage to these connectors.

NOTE If external digital modulation using the Input Trigger Connector, <*Backplane*>, is chosen as the modulation source, [*Mod Src*], the average power of the output signal of the Agilent 81960A Tunable Laser module varies in proportion with the change in duty cycle.

To enable external digital modulation using the Input Trigger Connector:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Mod Src*] and press *Enter*.

3 Move to <*Backplane*>, by using the cursor key, and press *Enter.* The text Back appears in the Tunable Laser channel.

External Digital Modulation Using Trigger Feedback

The trigger for External Digital Modulation can be provided by another module in the same mainframe by using the Trigger Feedback configuration as described on page 71. This can be used to synchronize the modulation of several sources. To use synchronized modulation:

1 Choose a "master" source module. Set as follows:

Menu -> Modulation Source -> internal

Menu -> Modulation Frequency -> desired value

Menu -> Output trigger mode -> Modulation

2 Set all "slave" modules:

Menu -> Modulation Source -> Backplane (new for DFB modules)

Menu -> Output trigger mode -> disabled (important)

3 To pass the master trigger to the slaves, set up the mainframe through the "Config" button under the screen:

Config -> Trigger -> Feedback

Note that the master laser must always be turned on, if one or more slaves are on.

How to Increase Linewidth

You can use coherence control to increase the linewidth of the optical signal output from your Tunable Laser module.

Enabling the coherence control increases the linewidth of the optical output signal to between 50 and 500 MHz (typically). Coherence control greatly reduces interference effects and therefore improves the power stability in sensitive test setups.

To enable coherence control:

1 Move to the Tunable Laser channel and press [Details].

2 Move to [*Mod Src*] and press ENTER.

3 Move to <*Coherence Ctrl.*>, Coherence Control, to increase linewidth to approximately 500 MHz.

4 Press *Enter.* The text CC appears in the Tunable Laser channel.

How to Set the Output Power of a Modulated Signal

All external modulation modes require you to set the output power. To set the output power, see *"How to Set the Output Power of a Modulated Signal" on page 58*.

SBS Suppression

SBS Suppression is a frequency modulation that allows you to launch high optical output power into longer fibers without the impairment to time-domain measurements that can be associated with intensity (amplitude) modulation.

To use the SBS Suppression control (SBS-C) feature:

Refer to Figure 20 on page 63.

1 Move to the Tunable Laser channel and press the [Details] softkey.

2 Set appropriate values in the Freq. Modulation box:

- The Frq Mod scr > SBS-Ctrl field is fixed, since SBS-Ctrl is the only frequency modulation source currently available.

- Set a value for the SBS suppression control frequency, SBSC frq, appropriate to your application.
- Set a value for the SBS suppression control level, SBSC lvl, appropriate to your application.

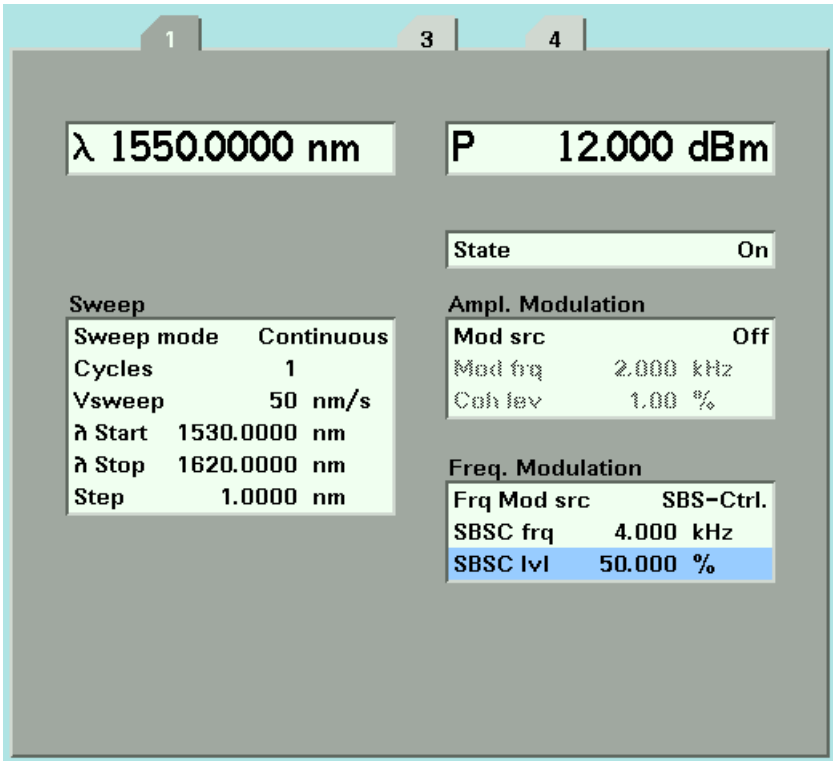


Figure 20 Updated Tunable Laser channel Details including SBS Suppression

How to Use Triggers

How to Use Input Triggering

You can configure your Tunable Laser module to perform certain tasks when you apply a trigger to the Input Trigger Connector.

CAUTION

A maximum of 5 V can be applied as an external voltage to the Input Trigger connector, see page 310.

Take care not to use the Trigger Output connector or the Remote Interlock connector for modulation. Do not apply an external voltage to these connectors.

To set your module's Input Trigger Configuration:

1 See *"How to Set the Trigger Configuration" on page 69* for how to configure the trigger connectors.

2 Move to the Tunable Laser channel and press [Menu].

3 Move to <*Input Trigger Mode*>, by using the cursor key, and press ENTER. You will see the screen in Figure 21 .

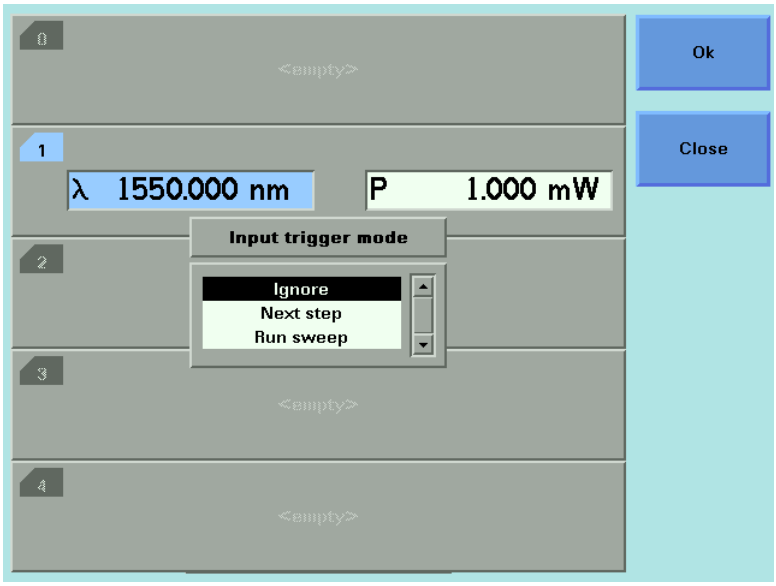


Figure 21 Input Trigger Mode

4 Move to one of the following, by using the cursor key:

- <*Ignore*>, input triggers are ignored.
- <*Next Step*>, an input trigger will cause the next step of a stepped sweep to be performed.
- <*Run Sweep*>, an input trigger will start a single sweep cycle.

5 Press *Enter.*

You can generate input triggers in any of the following ways:

- applying a trigger to the Input Trigger Connector on the rear panel of your instrument,
- setting <*Trigger Configuration*> to <*Loopback*> so that an output trigger automatically generates an input trigger, or
- using the :TRIGger GPIB command, refer to "Agilent 8163A/B, 8164A/B and 8166A/B Lightwave Measurement System User's Guide, Part No. 08164-90B15".

How to Use Output Triggering

You can configure your Tunable Laser module to output a trigger when the instrument performs certain tasks.

To set your module's Output Trigger Configuration:

1 See *"How to Set the Trigger Configuration" on page 69* for how to configure the trigger connectors.

2 Move to the Tunable Laser channel and press [Menu].

3 Move to <*Output Trigger Mode*>, by using the cursor key, and press *Enter*. You will see the screen in Figure 22 .

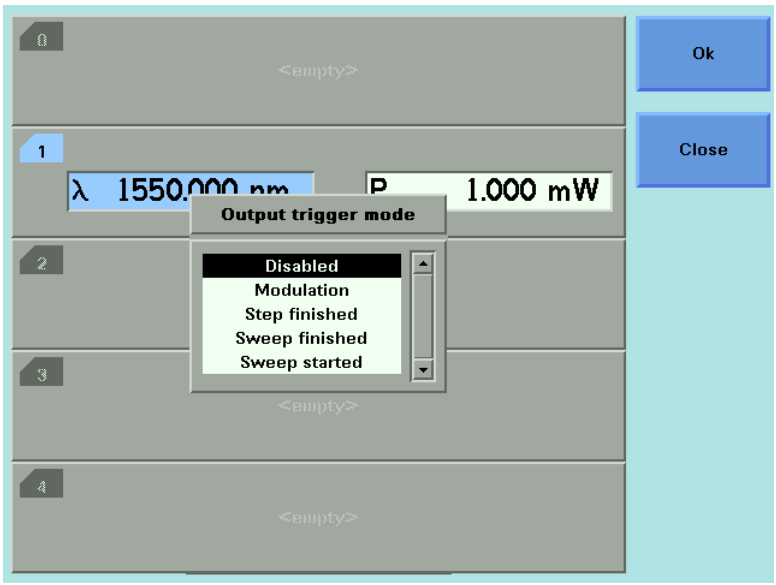


Figure 22 Output Trigger Mode

4 Move to one of the following, by using the cursor key:

- <*Disabled*>, the output trigger mode is disabled.
- <*Modulation*>, the output trigger connector outputs a TTL signal at the frequency of the internal modulation. This signal is output whether the laser is switched on or off.
- <*Step Finished*>, a trigger is output after every step of a sweep finishes.
- <*Sweep Finished*>, a trigger is output after a sweep cycle finishes.
- <*Sweep Started*>, a trigger is output after a sweep cycle starts.

5 Press *Enter*.

NOTE If you choose <*Step Finished*> and a <*Continuous*> sweep, the wavelength interval between hardware triggers is set by the [*Step*] parameter, although, the sweep is not stepped.

How to Use Auxiliary Functions

Automatic Realignment

Automatic Realignment realigns the laser cavity after Laser Protection. You should use Automatic Realignment if you have already tried to reactivate the laser and to reduce power, and this has been unsuccessful.

NOTE To get the specified performance, ensure that the warm-up time has passed before starting realignment.

To realign the laser cavity:

1. Move to the Tunable Laser channel and press *Menu*.
2. Move to <*Realign*> and press [*OK*]. You will see the screen in Figure 23 .
3. Wait several minutes.

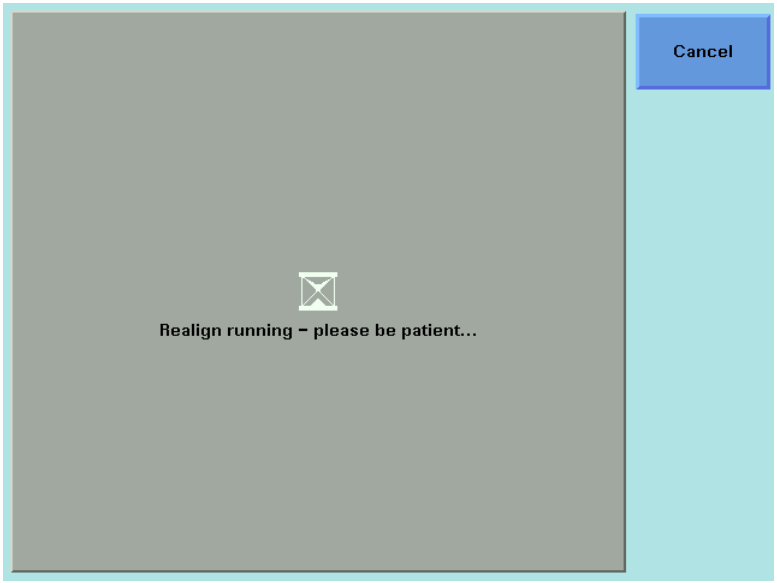


Figure 23 Realign Screen

How to Perform a Lambda Zero

Performing a Lambda Zero optimizes the performance and recalibrates the optical wavelength. This wavelength may drift due to a change in temperature and other environmental conditions.

A Lambda Zero is automatically performed when the instrument boots.

To perform a wavelength zero:

1 Move to the Tunable Laser channel and press *Menu*.

2 Move to <λ *Zeroing*> and press [OK]. You will see the screen in Figure 24 .

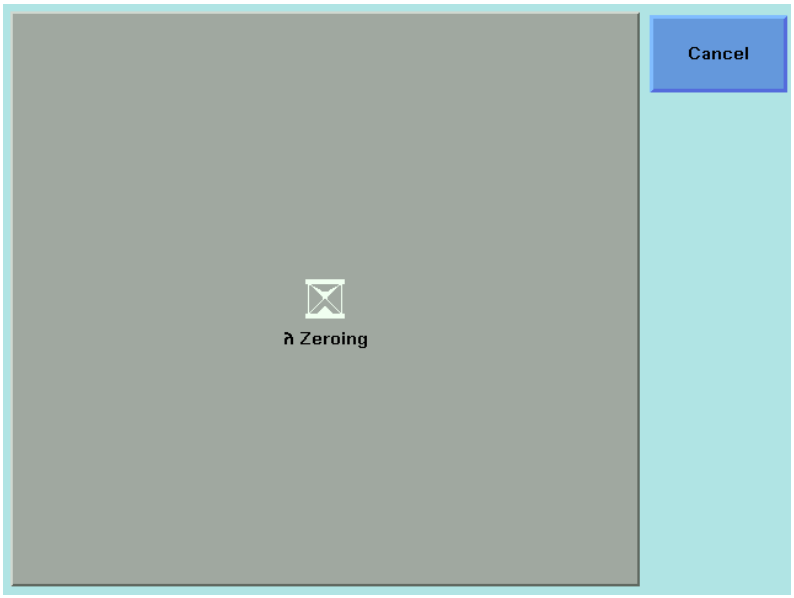


Figure 24 λ Zeroing Screen

3 Wait several minutes.

NOTE To get the specified performance, ensure that the warm-up time has passed before starting Lambda Zero.

NOTE Execute a Lambda Zero when the operating temperature has significantly changed after last Lambda Zero or after Storage or Transport.

4
Programming Instructions

This chapter describes the SCPI Commands for use of 81960A compact tunable laser modules.

Specific Command Summary 70
System Communicate - The :SYST:COMMunicate sub tree. . . 74
Signal Generation – The SOURce Subsystem Measurement Operations & Settings 82

Specific Command Summary

A list of these commands can be obtained from the instrument with the :SYST:HELP:HEAD? SCPI query.

The commands are ordered in a command tree. Every command belongs to a node in this tree.

The root nodes are also called the subsystems. A subsystem contains all commands belonging to a specific topic. In a subsystem there may be further subnodes.

All the nodes have to be given with a command. For example in the command disp:brig

- DISPlay is the subsystem containing all commands for controlling the display,
- BRIGhtness is the command selecting brightness.

Table 4 gives an overview of the command tree. You see the nodes, the subnodes, and the included commands.

Table 4 Specific Command Summary

Command	Description	Page
:SYSTem:COMMunicate:ETHernet		
:MACaddress?	Get the MAC address of the network adapter.	page 74
:IPADdress:CURRent?	Get the current IP address of the instrument.	page 75
:SMASk:CURRent?	Get the currently used subnet mask.	page 75
:HOSTname:CURRent?	Get the current host name.	page 75
:DOMainname:CURRent?	Get the currently used domain name.	page 76
:DGATeway:CURRent?	Get the currently used default gateway.	page 76
:DHCP:ENABle	Enable or disable DHCP.	page 76
:DHCP:ENABle?	Check whether DHCP is enabled or disabled.	page 77
:HOSTname	Set the host name.	page 77
:HOSTname?	Get the host name.	page 77
:IPADdress	Set the IP address of the system manually (used if DHCP is disabled).	page 77
:IPADdress?	Get the manually set IP address of the system.	page 78

Table 4 Specific Command Summary (continued)

Command	Description	Page
:DOMainname	Set the domain name (used if DHCP is disabled).	page 78
:DOMainname?	Get the domain name.	page 78
:SMASk	Set the subnet mask.	page 78
:SMASk?	Get the subnet mask.	page 79
:DGATeway	Set the default gateway.	page 79
:DGATeway?	Get the default gateway..	page 79
:RESTart	Restart the system's network interface with the new parameters.	page 79
:SLOT[*n*]		
:EMPTy?	Returns whether the module slot is empty.	page 80
:IDN?	Returns information about the module.	page 80
:OPTions?	Returns the module's options.	page 81
:TST?	Returns the latest selftest results for a module.	page 81
[:SOURce[*n*]][:CHANnel[*m*]]:AM		
[:INTernal]:FREQuency[*/*]/?	Sets or returns the frequency of an internal signal source.	page 83
:SOURce[*/*]/?	Sets or returns a source for the modulating system.	page 83
:STATe[*/*]/?	Turns Amplitude Modulation of a source on or off or queries whether Amplitude Modulation is on or off.	page 85
:COHCtrl:COHLevel[I]/?	Sets or returns the coherence level.	page 85
[:SOURce[*n*]][:CHANnel[*m*]]:FM		
:SOURce[*/*]/?	Sets or returns the type of frequency modulaion employed, specifically Simulated Brillouin Scattering (SBS) control.	page 86
:STATe[*/*]/?	Turns Frequency Modulation of a source on or off or queries whether Frequency Modulation is on or off.	page 86
:SBSCtrl:FREQuency[*/*]/?	Sets or returns the frequency of SBS Control modulation.	page 87
:SBSCtrl:LEVel[*/*]/?	Sets or returns the level of SBS Control modulation (as a percentage of maximum)	page 87
[:SOURce[*n*]][:CHANnel[*m*]:]POWer		
[:LEVel]:RISetime[*/*]/?	Sets or returns the laser rise time of a source.	page 88
:STATe/?	Sets or returns the state of the source output signal.	page 88
:UNIT/?	Sets or returns the power units.	page 89

Table 4 Specific Command Summary (continued)

Command	Description	Page
[:SOURce[*n*]][:CHANnel[*m*]:]READout		
:DATA?	Returns number of datapoints returned by the [:SOURce[n]][:CHANnel[m]]:READout:POINts? command.	page 89
:DATA:BLOCk?	Returns a specified binary block from either a lambda logging operation, or maximum power at wavelength characteristic.	page 90
:DATA:MAXBlocksize?	Returns the maximum blocksize that a lambda logging, or maximum power at wavelength characteristic will return.	page 89
:POINts?	Returns the data as a binary stream from either a lambda logging operation or the maximum power the laser can produce at each wavelength.	page 90
[:SOURce[*n*]][:CHANnel[*m*]:]WAVelength		
[:CW[/]:FIXED]	Sets the absolute wavelength of a source.	page 90
[:CW[/]:FIXED[/]]?	Returns the absolute wavelength of a source.	page 91
[:SOURce[*n*]][:CHANnel[*m*]:]WAVelength:CORRection		
:ARA	Realigns the laser cavity.	page 91
:ARA:ALL	Realigns the laser cavity of every tunable laser source in the mainframe.	page 92
:ZERO	Executes a wavelength zero.	page 92
:ZERO:ALL	Executes a wavelength zero on every tunable laser source in the mainframe.	page 92
:FREQuency[l]	Sets the frequency difference used to calculate a relative wavelength. The output wavelength is made up of the reference wavelength and this frequency difference.	page 93
:FREQuency[l]?	Returns the frequency difference used to calculate a relative wavelength.	page 93
:REFerence[l]?	Returns the reference wavelength (ë0).	page 93
:DISPlay	Sets the reference wavelength of a source to the value of the output wavelength.	page 94
:CHECkparams?	Returns whether sweep parameters set are consistent.	page 94
:CYCLes/?	Sets or returns the number of cycles.	page 95
:DWELl/?	Sets or returns the dwell time.	page 95
:EXPectedtriggers?	Returns number of triggers (used to configure power meter).	page 96

Table 4 Specific Command Summary (continued)

Command	Description	Page
:FLAG?	Returns whether waiting for trigger, or logging data available.	page 96
:LLOGging/?	Switches lambda logging on or off or queries the state of lambda logging.	page 97
:MODE/?	Sets or returns the sweep mode.	page 98
:PMAX?	Returns the highest permissible power for a wavelength sweep.	page 99
:REPeat/?	Sets or returns the repeat mode.	page 100
:SOFTtrigger	Sends a soft trigger.	page 100
:SPEed/?	Sets or returns the speed for continuous sweeping.	page 100
:STARt/?	Sets or returns the start point of the sweep.	page 101
:STOP/?	Sets or returns the end point of the sweep.	page 102
[:STATe]/?	Stops, starts, pauses or continues a wavelength sweep or returns the the state of a sweep.	page 102
[:SOURce[*n*]][:CHANnel[*m*]:]WAVelength:SWEep:STEP		
:NEXT	Performs the next sweep step.	page 103
:PREVious	Performs the previous sweep step again.	page 103
[:WIDTh]/?	Sets or returns the width of the sweep step.	page 104

System Communicate - The :SYST:COMMunicate sub tree.

We recommend you change network settings using GPIB or the local user interface.

NOTE

The instrument does not close open connections when restarting the network interface (:SYSTem:COMMunicate:ETHernet:RESTart).

This means the number of possible connections is reduced by the number of previously open connections. However, the instrument does make sure connections are still alive. It should release unused open connections after about two minutes.

Some notes on DHCP/AutoIP/DNS

- If DHCP is enabled but no DHCP server is found, the instrument tries to use AutoIP as a fallback. This may take about 2 minutes.
- Depending on the available network capabilities, the instrument tries to tell the DNS server its host name or read the host and domain named it has been assigned.

MAC address

The Media Access Control (MAC) number is a unique number associated with each network adapter.

Command	**:SYSTem:COMMunicate:ETHernet:MACaddress?**
Syntax	:SYSTem:COMMunicate:ETHernet:MACaddress?
Description	Get the MAC address of the network adapter.
Parameters	none
Response	response string (hexadecimal value without a prefix or separators).
Example	:syst:comm:eth:mac? → g0007E014AE08h<END>

Automatically set Ethernet parameters

If DHCP/AutoIP is enabled, the instrument may use other parameters than specified explicitly, that is, it will use the parameters provided by the DHCP server. It tries to use its configured host name (which may fail, depending on the network setup).

There will be an error if you try to query these parameters if the network is not connected, or before they have been set by the DHCP server.

Example:

```
>> syst:comm.:eth:ipad:curr?
>> [time-out]
>> syst:err?
<< -252, "Not allowed while (re)starting network"
```

Command	**:SYSTem:COMMunicate:ETHernet:IPADdress:CURRent?**
Syntax	:SYSTem:COMMunicate:ETHernet:IPADdress:CURRent?
Description	Get the current IP address of the instrument.
Parameters	none
Response	string
Example	:syst:comm:eth:ipad:curr? → "192.132.13.2"<END>

Command	**:SYSTem:COMMunicate:ETHernet:SMASk:CURRent?**
Syntax	:SYSTem:COMMunicate:ETHernet:SMASk:CURRent?
Description	Get the currently used subnet mask.
Parameters	none
Response	string
Example	:syst:comm:eth:smas:curr? → "255.255.255.0"<END>

Command	**:SYSTem:COMMunicate:ETHernet:HOSTname:CURRent?**
Syntax	:SYSTem:COMMunicate:ETHernet:HOSTname:CURRent?
Description	Get the current host name. The default host name is A-P...P-S...S; where A is for Agilent, P...P is the Product Number, and S...S is as many of the last digits of the Serial Number to get a 15 character host name. For example: A-8164B-1234567.
Parameters	none
Response	string
Example	:syst:comm:eth:host:curr? → "A-8164B-1234567"<END>

Command	:SYSTem:COMMunicate:ETHernet:DOMainname:CURRent?
Syntax	:SYSTem:COMMunicate:ETHernet:DOMainname:CURRent?
Description	Get the currently used domain name.
Parameters	none
Response	string
Example	:syst:comm:eth:dom:curr? → ".companyame.com"<END>

Command	:SYSTem:COMMunicate:ETHernet:DGATeway:CURRent?
Syntax	SYSTem:COMMunicate:ETHernet:DGATeway:CURRent?
Description	Get the currently used default gateway.
Parameters	none
Response	string (maximum 79 characters)
Example	:syst:comm:eth:dgat:curr? → "192.168.101.11"<END>

Explicitly set Ethernet parameters

You must reboot the instrument or send a SYST:COMM:ETH:RESTart command before any alterations to the Ethernet parameters become effective.

If you query one of the alterable parameters, you always get the most recently set value, even if you have not yet activated it.

Command	:SYSTem:COMMunicate:ETHernet:DHCP:ENABle
Syntax	:SYSTem:COMMunicate:ETHernet:DHCP:ENABle
Description	Enable or disable DHCP
Parameters	boolean (0 | 1 | off | on)
Response	none
Example	:syst:comm:eth:dhcp:enab on

Command	**:SYSTem:COMMunicate:ETHernet:DHCP:ENABle?**
Syntax	:SYSTem:COMMunicate:ETHernet:DHCP:ENABle?
Description	Check whether DHCP is enabled or disabled.
Parameters	none
Response	boolean (0 | 1)
Example	:syst:comm:eth:dhcp:enab? → 1<END>

Command	**:SYSTem:COMMunicate:ETHernet:HOSTname**
Syntax	:SYSTem:COMMunicate:ETHernet:HOSTname
Description	Set the host name
Parameters	string (maximum 19 characters, though not all characters can be used) The default host name is A-P...P-S...S; where P...P is the product Number, and S...S is as many of the last digits of the serial number as it takes to get a 15 character host name. If you set an empty host name (""), the host name will be set to its default value.
Response	none
Example	:syst:comm:eth:host "my8163B"

Command	**:SYSTem:COMMunicate:ETHernet:HOSTname?**
Syntax	:SYSTem:COMMunicate:ETHernet:HOSTname?
Description	Get the host name
Parameters	none
Response	string
Example	:syst:comm:eth:host? → "my8163B"<END>

Command	**:SYSTem:COMMunicate:ETHernet:IPADdress**
Syntax	:SYSTem:COMMunicate:ETHernet:IPADdress
Description	Set the IP address of the system manually (used if DHCP is disabled).
Parameters	string (Up to four groups of up to 3 digits, groups separated by ".". Groups with leading zeroes are interpreted as octal numbers.)
Response	none
Example	:syst:comm:eth:ipad "192.132.13.2"

Command	:SYSTem:COMMunicate:ETHernet:IPADdress?
Syntax	:SYSTem:COMMunicate:ETHernet:IPADdress?
Description	Get the manually set IP address of the system.
Parameters	none
Response	string
Example	:syst:comm:eth:ipad? → "192.132.13.2"<END>

Command	SYSTem:COMMunicate:ETHernet:DOMainname
Syntax	:SYSTem:COMMunicate:ETHernet:DOMainname
Description	Set the domain name (used if DHCP is disabled)
Parameters	string
Response	none
Example	:syst:comm:eth:dom ".companyname.com"

Command	:SYSTem:COMMunicate:ETHernet:DOMainname?
Syntax	:SYSTem:COMMunicate:ETHernet:DOMainname?
Description	Get the domain name
Parameters	none
Response	string
Example	:syst:comm:eth:dom? → ".companyname.com"<END>

Command	:SYSTem:COMMunicate:ETHernet:SMASk
Syntax	:SYSTem:COMMunicate:ETHernet:SMASk
Description	Set the subnet mask.
Parameters	string (Up to four groups of up to 3 digits, groups separated by ".". Groups with leading zeroes are interpreted as octal numbers.)
Response	none
Example	:syst:comm:eth:smas "255.255.255.0"

Command	**:SYSTem:COMMunicate:ETHernet:SMASk?**
Syntax	:SYSTem:COMMunicate:ETHernet:SMASk?
Description	Get the subnet mask.
Parameters	none
Response	string
Example	:syst:comm:eth:smas? → "255.255.255.0"<END>

Command	**:SYSTem:COMMunicate:ETHernet:DGATeway**
Syntax	:SYSTem:COMMunicate:ETHernet:DGATeway
Description	Set the default gateway.
Parameters	string (Up to four groups of up to 3 digits, groups separated by ".". Groups with leading zeroes are interpreted as octal numbers.)
Response	none
Example	:syst:comm:eth:dgat "192.168.101.11"

Command	**:SYSTem:COMMunicate:ETHernet:DGATeway?**
Syntax	SYSTem:COMMunicate:ETHernet:DGATeway?
Description	Get the default gateway.
Parameters	none
Response	string
Example	:syst:comm:eth:dgat? → "192.168.101.11"<END>

Changing the Ethernet parameters

Command	**:SYSTem:COMMunicate:ETHernet:RESTart**
Syntax	:SYSTem:COMMunicate:ETHernet:RESTart
Description	Restart the system's network interface with the new parameters. This command only works if the instrument has a working network connection at the time the command is issued. If not you either have to wait until the instrument decides on an IP address using AutoIP or reboot the instrument.
Parameters	none
Response	none
Example	:syst:comm:eth:rest

SLOT subsystem

The commands in the Slot subsystem allow you to query the following:

- a particular slot, for example, using slot1:empt?,
- or, an Optical Head attached to an Optical Head Interface Module, for example, an Optical Head Interface Module in slot1 with an Optical Head attached to channel 2, using slot1:head2:empt?.

command:	**:SLOT[*n*]:EMPTy?**	
syntax:	:SLOT[*n*]:EMPTy?	
description:	Queries whether the module slot is empty.	
parameters:	none	
response:	A *boolean* value:	0: there is a module in the slot 1: the module slot is empty
examples:	slot1:empt? → 0<END>	There is a module in slot1

command:	**:SLOT[*n*]:IDN?**	
syntax:	:SLOT[*n*]:IDN?	
description:	Returns information about the module.	
parameters:	none	
response:	HEWLETT-PACKARD: *mmmm*: *sssssss*: *rrrrrrrrr*:	manufacturer instrument model number (for example 81533B) serial number date of firmware revision
example:	slot1:idn? → HEWLETT-PACKARD, 81533B,3411G06054,07-Aug-98<END>	
NOTE	• The Agilent 81640A/80A/82A/89A Tunable Laser modules will always return Agilent Technologies as the manufacturer. • All other Agilent 8163A Series modules return Agilent Technologies as the manufacturer. • The HP 8153A Series modules will always return Agilent Technologies as the manufacturer.	
	See *"*IDN?" on page 59* for information on mainframe identity strings.	

command:	**:SLOT[*n*]:OPTions?**
syntax:	:SLOT[*n*]:OPTions?
description:	Returns information about a module's options.
parameters:	none
response:	A string.
example:	slot1:opt? → NO CONNECTOR OPTION, NO INSTRUMENT OPTIONS<END>

command:	**:SLOT[*n*]:TST?**
syntax:	:SLOT[*n*]:TST?
description:	Returns the latest selftest results for a module.
NOTE	This command does not perform a selftest. Use selfTeST command, *TST? on page 59, to perform a selftest.
parameters:	none
response:	Returns an error code and a short description of the error.
example:	slot:tst? → +0,"self test OK"<END>

Signal Generation – The SOURce Subsystem Measurement Operations & Settings

The SOURce subsystem allows you to control a laser source module, DFB source module, tunable laser module, or a return loss module that has an internal source.

command:	**:OUTPut[*n*][:CHANnel[*m*]][:STATe]**
syntax:	:OUTPut[*n*][:CHANnel[*m*]][:STATe]<wsp>OFF | ON | 0 | 1
description:	Switches the laser of the chosen source on or off.
NOTE	Same functionality as [:SOURce[n]][:CHANnel[m]]:POWer:STATe .
parameters:	0 or OFF: switch laser off 1 or ON: switch laser on
response:	none
example:	outp1 1

command:	**:OUTPut[*n*][:CHANnel[*m*]][:STATe]?**
syntax:	:OUTPut[*n*][:CHANnel[*m*]][:STATe]?
description:	Queries the laser state of the chosen source.
NOTE	Same functionality as [:SOURce[n]][:CHANnel[m]]:POWer:STATe?.
parameters:	none
response:	A *boolean* value: 0 – laser off 1 – laser on
example:	outp1? → 1<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM[:INTernal]:FREQuency[*/*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM[:INTernal]:FREQuency[*/*]<wsp><frequency> [THZ | GHZ | MHZ | KHZ | HZ]
description:	Sets the frequency of the amplitude modulation of the laser output.
parameters:	The frequency as a *float* value in Hz.
	Also allowed are: MIN: minimum programmable value MAX: maximum programmable value DEF: This is not the preset (*RST) default value but is half the sum of, the minimum programmable value and the maximum programmable value

	The default units are HZ, although KHZ, MHZ, GHZ, and THZ can also be specified. The resolution of the frequency is always 1 Hz.
NOTE	Use [*l*] to set the modulation frequency of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
response:	none
example:	sour2:am:freq 270hz

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM[:INTernal]:FREQuency[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM[:INTernal]:FREQuency[*l*]? [MIN|DEF|MAX]
description:	Returns the frequency of the amplitude modulation as a *float* value in Hertz.
parameters:	MIN: minimum modulation frequency MAX: maximum modulation frequency DEF: This is not the preset (*RST) default value but is half the sum of, the minimum modulation frequency and the maximum modulation frequency.
NOTE	Use [*l*] to query the modulation frequency of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
response:	modulation frequency relevant to the current value or specified parameter (if MIN, MAX, or DEF is chosen as a parameter).
example:	sour2:am:freq? min → +2.00000000E+002<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM:SOURce[*l*]**	
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM:SOURce[*l*]<wsp> INT|INT1|INT2|COHC|AEXT|EXT|DEXT|WVLL|BACK|0|1|2|3|5|6	
description:	Selects the type or source of the modulation of the laser output.	
parameters:	0, INT1, or INTernal:	internal digital modulation
	1, COHCtrl, or INT2:	coherence control
	2, AEXTernal, or EXT:	external analog modulation
	3 or DEXTernal:	external digital modulation
	5 or WVLLocking:	wavelength locking
	6 or BACKplane:	external digital modulation using Input Trigger Connector
NOTE	Use [*l*] to set the modulation source of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.	
response:	none	

example:	sour2:am:sour int
NOTE	External Analog Modulation is not supported by the 81960A. The Command and Mainframe Menu point is included for compatibility.

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM:SOURce[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM:SOURce[*l*]?
description:	Returns the type or source of the modulation of the laser output.
parameters:	none
NOTE	Use [*l*] to query the modulation source of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
response:	0: internal digital modulation 1: coherence control 2: external analog modulation 3: external digital modulation 5: wavelength locking 6: external digital modulation using Input Trigger Connector
example:	sour2:am:sour? → +0<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM:STATe[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM:STATe[*l*]<wsp> OFF | ON | 0 | 1
description:	Enables and disables amplitude modulation of the laser output.
parameters:	A *boolean* value: OFF or 0: amplitude modulation disabled (default) ON or 1: amplitude modulation enabled.
NOTE	Use [*l*] to enable/disable amplitude modulation for the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
NOTE	When you enable lambda logging, see *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:LLOGging" on page 97*, and modulation simultaneously, a sweep cannot be started, see *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:[STATe]" on page 102*.
response:	none
example:	sour2:am:stat 0

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM:STATe[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM:STATe[*l*]?
description:	Returns the current state of amplitude modulation.
NOTE	Use [*l*] to query the current state of modulation of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
parameters:	none
response:	A *boolean* value: 0: modulation is disabled 1: modulation is enabled
example:	sour2:am:stat? → 0<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM:COHCtrl:COHLevel[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM:COHCtrl:COHLevel[*l*]<wsp><value>[MIN | MAX | DEF]
description:	Sets the level of coherence, when using coherence control, on an arbitrary scale from 1 to 99.98%. A 100% coherence level corresponds to maximum coherence length and minimum linewidth. The coherence level required for a specific linewidth and coherence length can vary between modules.
parameters:	The excursion level as a percentage of its maximum value. Also allowed: MIN: minimum programmable value (0%) MAX: maximum programmable value (100%) DEF: default preset (*RST) value.
response:	none
example:	source2:am:cohc 50

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:AM:COHCtrl:COHLevel[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:AM:COHCtrl:COHLevel[*l*]<wsp><value>?[MIN | MAX | DEF]
description:	Queries the current level of coherence, when using Coherence Control. Coherence is expressed on an arbitrary scale from 1 to 99.98%. A 100% coherence level corresponds to maximum coherence length and minimum linewidth.
parameters:	Optional MIN: returns the minimum programmable value (0%) MAX: returns the maximum programmable value (100%) DEF: returns the default preset (*RST) value.
response:	Returns the currently set excursion level as a percentage between 0 and 99.98
example:	source2:am:cohc? → 50<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:SOURce[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:SOURce[*l*]<wsp>SBSCtrl|0
description:	Selects the type of the frequency modulation of the laser output. Currently, only parameter strings that select SBS Control are valid. Enable frequency modulation before issuing this command. Refer to *"[:SOURce[n]][:CHANnel[m]]:FM:STATe[l]" on page 86*.
parameters:	0, SBSCtrl Simulated Brillouin Scattering
NOTE	SBSCtrl (Simulated Brillouin Scattering) Control modulation suppresses SBS effects within high-power measurement setups.
response:	none
example:	sour2:fm:sour SBSC

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:SOURce[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:SOURce[*l*]?
description:	Queries the type of frequency modulation currently set. Currently, only SBS Control is available.
parameters:	none
response:	0 SBS Control
example:	sour2:fm:sour? ⟶ +0<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:STATe[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:STATe[*l*]<wsp>OFF|ON|0|1
description:	Enables and disables frequency modulation of the laser output.
parameters:	A *boolean* value: OFF or 0: disable frequency modulation ON or 1: enable frequency modulation.
response:	none
example:	sour2:fm:state 1

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:STATe[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:STATe[*l*]?
description:	Queries the current state of frequency modulation of the laser output.
parameters:	none
response:	A *boolean* value: 0: frequency modulation is disabled 1: frequency modulation is enabled.
example:	sour2:fm:state? ⟶ +1<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:FREQuency[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:FREQuency[*l*]<wsp><frequency> [MHZ|KHZ|HZ|MIN|MAX|DEF]
description:	Sets the frequency of the SBS Control modulation. Enable frequency modulation before issuing this command. Refer to *"[:SOURce[n]][:CHANnel[m]]:FM:SOURce[l]" on page 86* and *"[:SOURce[n]][:CHANnel[m]]:FM:STATe[l]" on page 86*.
parameters:	The modulation frequency as a *float* value. The default units are HZ, although KHZ, MHZ, GHZ and THZ can also be specified. Also allowed are: MIN: minimum programmable value MAX: maximum programmable value DEF: default preset (*RST) value.
response:	none
example:	sour2:fm:sbsc:freq 4000Hz

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:FREQuency[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:FREQuency[*l*]?<wsp>[MIN|MAX|DEF]
description:	Queries the currently set frequency of the SBS Control modulation.
parameters:	Optional MIN: returns the minimum programmable value MAX: returns the maximum programmable value DEF: returns the default preset (*RST) value.
response:	The modulation frequency in Hz as a *float* value
example:	sour2:fm:freq? → +4.00000E+03<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:LEVel[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:LEVel[*l*]<wsp>[MIN|MAX|DEF]
description:	Sets the excursion of the SBS Control frequency modulation to a percentage of its maximum value.
parameters:	The excursion level as a percentage of its maximum value. Also allowed: MIN: minimum programmable value (0%) MAX: maximum programmable value (100%) DEF: default preset (*RST) value.
response:	none
example:	sour2:fm:sbsc:lev 80

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:Level[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:FM:SBSCtrl:LEVel[*l*]?<wsp>[MIN|MAX|DEF]
description:	Queries the currently set excursion level of the SBS Control frequency modulation.
parameters:	Optional MIN: returns the minimum programmable value (0%) MAX: returns the maximum programmable value (100%) DEF: returns the default preset (*RST) value.
response:	Returns the currently set excursion level as a percentage of its maximum value.
example:	sour2:fm:sbsc:lev? → +8.000E+01<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:POWer:STATe**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:POWer:STATe<wsp>OFF|ON|0|1
description:	Switches the laser of the chosen source on or off.
parameters:	0 or OFF: switch laser off 1 or ON: switch laser on
response:	none
example:	sour2:pow:stat 1

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:POWer:STATe?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:POWer:STATe?
description:	Queries the laser state of the chosen source.
parameters:	none
response:	A *boolean* value: 0: Laser Off 1: Laser On
example:	sour2:pow:stat? → 1<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:POWer:UNIT**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:POWer:UNIT<wsp>DBM|0|Watt|1
description:	Sets the power units
parameters:	0 or DBM: dBm (default) 1 or W: Watts
response:	none
example:	sour2:pow:unit w

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:POWer:UNIT?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:POWer:UNIT?
description:	Return the current power units
parameters:	0: dBm 1: Watts
response:	none
example:	sour2:pow:unit? → +0<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:READout:DATA?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]:READout:DATA?
description:	Returns the data as a binary stream from either a lambda logging operation or the maximum power the laser can produce at each wavelength.
parameters:	LLOGging: Returns a binary stream that contains each wavelength step of the lambda logging operation, see *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:LLOGging" on page 97*. Each binary block is an 8-byte long **double** in Intel byte order. PMAX: Returns a binary stream that contains the maximum power the laser can produce at each wavelength. Each binary block is a 8-byte long **double** (the wavelength value) followed by a 4-byte long **float** (the power value). The stream is in Intel byte order.
response:	A binary stream in Intel byte order.
example:	sour2:read:data? llog → *the data as a binary stream*

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:READout:DATA:BLOCk?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]:READout:DATA:BLOCk?<wsp>LLOGging|PMAX,<offset>,<# of data points>
description:	Returns a specified binary block from either a lambda logging operation, or maximum power at wavelength characteristic.
parameters:	LLOGging: Returns the data block from lambda logging. The binary block is an 8-byte long **double** in Intel byte order. PMAX: Returns the data block from the power curve characteristic. Each binary block is a 8-byte long **double** (the wavelength value) followed by a 4-byte long **float** (the power value). The stream is in Intel byte order. <offset> A zero based offset that specifies the index of the first value within the block to be transferred. <# of data points> The number of points (not bytes!) in the transferred block.
response:	A binary stream in Intel byte order.
example:	sour0:read:data:block? llog,100,20000 → *the data as a binary stream*

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:READout:DATA:MAXBlocksize?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]:READout:DATA:MAXBlocksize?
description:	Returns the maximum block size for a single GPIB transfer for lambda logging functions. If your application requires more data points please use SOURce[n]][:CHANnel[m]]:READout:DATA:BLOCk? instead of SOURce[n]][:CHANnel[m]]:READout:DATA?
parameters:	none
response:	The maximum number of data points (not bytes!) in the transferred block, as an *integer* value.
example:	sour0:read:data:maxb? → 120<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:READout:POINts?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]:READout:POINts?<wsp>LLOGging|PMAX
description:	Returns the number of datapoints that the [:SOURce[*n*]][:CHANnel[*m*]]:READout:DATA? command will return.
parameters:	LLOGging: Returns the number of wavelength steps for a lambda logging operation, see *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:LLOGging" on page 97*. PMAX: Returns the number of datapoints (each datapoint contains a value for wavelength and power) the [:SOURce[*n*]][:CHANnel[*m*]]:READout:DATA? PMAX command will return, number of datapoints depends on the calibration data for your module.
response:	The number of datapoints as an *integer* value.
example:	sour2:read:poin? pmax → 120<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength[:CW[*l*]:FIXED[*l*]]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength[:CW[*l*]:FIXED[*l*]]<wsp><value>[PM|NM|UM|MM|M]
description:	Sets the absolute wavelength of the output.
parameters:	Any wavelength in the specified range (see the specifications in the appropriate *User's Guide*). The programmable range is larger than the range specified in the *User's Guide*. The programmable range is set individually for each instrument when it is calibrated during production. Also allowed are: MIN: minimum wavelength value MAX: maximum wavelength value DEF: This is not the preset (*RST) default value but is half the sum of, the minimum wavelength value and the maximum wavelength value

NOTE	Use [*l*] to set the upper or lower wavelength laser source of a dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
response:	none
example:	sour2:wav 1550NM

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength[:CW[*l*]|:FIXED[*l*]]?**	
syntax:	[:SOURce[*n*]][:CHANnel[*m*]:WAVelength[:CW[*l*]|:FIXED[*l*]]?[<wsp>[MIN|DEF|MAX]	
description:	Returns the wavelength value in meters.	
parameters:	none	
	Also allowed, for tunable laser modules only, are	MIN: minimum wavelength MAX: maximum wavelength DEF: This is not the preset (*RST) default value but is half the sum of, the minimum wavelength value and the maximum wavelength value
NOTE	Use [*l*] to query the upper or lower wavelength laser source of a dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.	
response:	The wavelength as a *float* value in meters.	
example:	sour0:wav? → +1.5672030E-006<END>	Returns the current wavelength value for a tunable laser module.
	sour0:wav? min → +1.5500000E-006<END>	Returns minimum wavelength for a tunable laser module.
	sour2:wav:fixed2? → +1.61544494E-006<END>	Returns the wavelength value of the upper wavelength source of a dual-wavelength laser source.

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ARA**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ARA
description:	Realigns the laser cavity.
parameters:	none
response:	none
example:	sour0:wav:corr:ara

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ARA:ALL**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ARA:ALL
description:	Realigns the laser cavity of every tunable laser source in a mainframe.
parameters:	none
response:	none
example:	sour0:wav:corr:ara:all

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ZERO**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ZERO
description:	Executes a wavelength zero.
parameters:	none
response:	none
example:	sour2:wav:corr:zero

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ZERO:ALL**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:CORRection:ZERO:ALL
description:	Executes a wavelength zero on every tunable laser source in a mainframe.
parameters:	none
response:	none
example:	sour2:wav:corr:zero:all

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:FREQuency[*l*]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:FREQuency[*l*]<wsp><value> [THZ|GHZ|MHZ|KHZ|HZ]
description:	Sets the frequency difference used to calculate a relative wavelength. The output wavelength is made up of the reference wavelength and this frequency difference. The default units for frequency are Hertz. The output wavelength (λ) is set from the base wavelength (λ_0) and the frequency offset (df). The formula for calculating the output wavelength is: $$\lambda = \frac{(c)}{((\lambda_o df) + c)} \lambda_o$$ where c is the speed of light in a vacuum (2.990×10^8 ms^{-1})
NOTE	Use [*l*] to set the frequency of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
parameters:	The frequency difference is a **float** value in Hz.
response:	none
example:	sour0:wav:freq -10THZ

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:FREQuency[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:FREQuency[*l*]?
description:	Returns the frequency difference used to calculate a relative wavelength.
NOTE	Use [*l*] to query the frequency of the upper or lower wavelength laser source of a dual-wavelength laser source or a return loss module with an internal dual-wavelength laser source. The default value of [*l*] is *1*, the lower wavelength source. The upper wavelength source is denoted by *2*.
parameters:	none
response:	Returns the frequency difference as a **float** value in Hz.
example:	wav:freq? → -1.00000000E+013<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:REFerence[*l*]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:REFerence[*l*]?
description:	Returns the reference wavelength (λ_0).
parameters:	none

response:	The wavelength as a *float* value in meters.
example:	sour2:wav:ref? → +1.5500000E-006<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:REFerence:DISPlay**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:REFerence:DISPlay
description:	Sets the reference wavelength to the value of the output wavelength ($\lambda \rightarrow \lambda_0$), that is, sets the frequency offset (df) to zero.
parameters:	none
response:	none
example:	sour2:wav:ref:disp

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:CHECkparams?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:CHECkparams?
description:	Returns whether the currently set sweep parameters (sweep mode, sweep start, stop, width, etc.) are consistent. If there is a sweep configuration problem, the laser source is not able to pass a wavelength sweep.
parameters:	none
response:	A *string* with a detailed description of a configuration problem, or "OK" if the sweep os configured correctly. The responses shown below are all the possible configuration problem strings:

Message	Description
368,LambdaStop <=LambdaStart	start wavelength must be smaller than stop wavelength
369,sweepTime < min	the total time of the sweep is too small
370,sweepTime > max	the total time of the sweep is too large
371,triggerFreq > max	the trigger frequency (calculated from sweep speed divided by sweep step) is too large
372,step < min	step size too small
373,triggerNum > max	the number of triggers exceeds the allowed limit
374,LambdaLogging = On AND Modulation = On AND ModulationSource! = CoherenceControl	The only allowed modulation source with the lambda logging function is coherence control.
375,LambdaLogging = On AND TriggerOut! = StepFinished	lambda logging only works "Step Finished" output trigger configuration
376,Lambda logging in stepped mode	lambda logging can only be done in continuous sweep mode
377,step not multiple of <x>	the step size must be a multiple of the smallest possible step size

	378, triggerFreq < min the number of triggers exceeds the allowed limit
example:	sour0:wav:swe:chec? → "triggerNum > max"

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:CYCLes**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:CYCLes<wsp><value>|MIN|MAX|DEF|0
description:	Sets the number of cycles.
NOTE	Cannot be set while a sweep is running.
parameters:	The number of cycles is an integer value.
	Also allowed are: MIN: minimum programmable value MAX: maximum programmable value DEF: This is not the preset (*RST) default value but is half the sum of, the minimum programmable value and the maximum programmable value 0: cycles continuously.
response:	none
example:	wav:swe:cycl 3

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:CYCLes?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:CYCLes?[<wsp>MIN|MAX|DEF]
description:	Returns the number of cycles.
parameters:	none
	Also allowed are: MIN: minimum programmable value MAX: maximum programmable value DEF: This is not the preset (*RST) default value but is half the sum of, the minimum programmable value and the maximum programmable value
response:	The number of cycles as an integer value.
example:	wav:swe:cycl? → +3<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:DWELl**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:DWELl<wsp><value>|MIN|MAX|DEF[NS|US|MS|S]
description:	Sets the dwell time. Can only be used when sweep is stepped.
NOTE	Cannot be set while a sweep is running.
parameters:	The dwell time as a *float* value. If you specify no units in your command, seconds are used as the default.

	Also allowed are: MIN: minimum programmable value MAX: maximum programmable value DEF: This is not the preset (*RST) default value but is half the sum of, the minimum programmable value and the maximum programmable value
response:	none
example:	wav:swe:dwel 500ms

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:DWELl?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:DWELl?[<wsp>MIN|MAX|DEF]
description:	Returns the dwell time. Can only be used when sweep is stepped.
parameters:	none
	Also allowed are: MIN: minimum programmable value MAX: maximum programmable value DEF: This is not the preset (*RST) default value but is half the sum of, the minimum programmable value and the maximum programmable value
response:	The dwell time in seconds.
example:	wav:swe:dwel? → +5.00000000E-001<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:EXPectedtriggers?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:EXPectedtriggers?
description:	Returns the number of triggers. A tunable laser wavelength sweep causes a number of triggers, this number is required to configure a triggering data acquisition function on a power meter. The number returned by this function can be used to configure a Power Meter for coordinated measurements with a tunable laser source.
parameters:	none
response:	the number of expected triggers as an unsigne integer value.
example:	sour0:wav:swe:exp? → 12001

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:FLAG?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:FLAG?

<table>
<tr><td>description:</td><td>The sweep flag is used to find out when logging data is available and when the next sweep cycle may be triggered.
It may also be used as a sweep cycle counter, where: flag/2 = number of sweep cycles
The flag is:
- only used in continuous sweep
- set to 0 at start/end of sweep
- incremented when the sweep is waiting for a trigger
- incremented when logging data is available
- an odd number when, waiting for a trigger
- an even number when, logging data may be read
If the trigger input isn't configured to start a sweep cycle the flag is increased by two when the logging data is available
If no logging data is calculated, because the user doesn't want lambda logging, the flag is incremented at the end of the sweep cycle regardless

<table>
<tr><th>Sweep state</th><td>Flag</td></tr>
<tr><td>start</td><td>0</td></tr>
<tr><td>sweep waiting for trigger</td><td>1</td></tr>
<tr><td>trigger →
first cycle | start moving back | do some post-processing | logging data available</td><td>2</td></tr>
<tr><td>sweep waiting for next trigger</td><td>3</td></tr>
<tr><td></td><td>.....</td></tr>
<tr><td>sweep stopped or finished</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>parameters:</td><td>none</td></tr>
<tr><td>response:</td><td>the current sweep flag value as an unsigned integer value</td></tr>
<tr><td>example:</td><td>sour0:wav:swe:flag? → 30</td></tr>
</table>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:LLOGging**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:LLOGging<wsp>OFF|ON|0|1
description:	Switches lambda logging on or off. Lambda logging is a feature that records the exact wavelength of a tunable laser module when a trigger is generated during a continuous sweep. You can read this data using the [:SOURce[*n*]][:CHANnel[*m*]]:READout:DATA? command.

NOTE	The following settings are the prerequisites for Lambda Logging: Set *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:MODE" on page 98* to CONTinuous. Set *":TRIGger[n][:CHANnel[m]]:OUTPut"* to STFinished (step finished). Set *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:CYCLes" on page 95* to 1. Set *"[:SOURce[n]][:CHANnel[m]]:AM:STATe[l]" on page 84* to OFF. If any of the above prerequisites are not met, then when the sweep is started the status "Sweep parameters inconsistent" will be returned and Lambda Logging will automatically be turned off.
NOTE	Lambda logging is disabled at the end of a sweep.
NOTE	Generally, a continuous sweep can only be started if: the trigger frequency, derived from the sweep speed and sweep step, is <= 40kHz the number of triggers, calculated from the sweep span and sweep span, is <=100001 the start wavelength is less than the stop wavelength. In addition, a continuous sweep with lambda logging requires: the trigger output to be set to step finished modulation set to coherence control or off.
parameters:	0 or OFF: switch lambda logging off 1 or ON: switch lambda logging on
response:	none
example:	wav:swe:llog 1

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:LLOGging?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:LLOGging?
description:	Returns the state of lambda logging.
parameters:	none
response:	A *boolean* value: 0 – lambda logging is switched off 1 – lambda logging is switched on
example:	wav:swe:llog? → 1<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:MODE**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:MODE<wsp><mode>
description:	Sets the sweep mode.
NOTE	Cannot be set while a sweep is running.
parameters:	STEPped: Stepped sweep mode MANual: Manual sweep mode CONTinuous: Continuous sweep mode

response:	none
example:	wav:swe:mode STEP

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:MODE?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:MODE?
description:	Returns the sweep mode.
parameters:	none
response:	STEP: Stepped sweep mode MAN: Manual sweep mode CONT: Continuous sweep mode
example:	wav:swe:mode? → STEP<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:PMAX?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:PMAX?<wsp><start wavelength>, <stop wavelength>
description:	Returns the power to the highest permissible power for the selected wavelength sweep.
parameters:	start wavelength: The wavelength at which the sweep starts as a **float** value. stop wavelength: The wavelength at which the sweep starts as a **float** value.
response:	The highest permissible power for the selected wavelength sweep as a **float** value.
example:	wav:swe:pmax? 1540nm,1550nm → +3.5500000E-004<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:REPeat**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:REPeat<wsp><mode>
description:	Sets the repeat mode. Applies in stepped-sweep and manual-sweep modes. The 81960A also supports the "TWOWay" Mode in Continuous sweep mode.
parameters:	ONEWay: Every stepped or continuous sweep cycle starts at the start wavelength of the sweep and ends at the stop wavelength of the sweep TWOWay: Every odd sweep cycle starts at the start wavelength of the sweep, and every even sweep cycle starts at the stop wavelength of the sweep. Set the start and stop wavelength of the sweep using *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:STARt" on page 101* and *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:STOP" on page 102* respectively.
response:	none
example:	wav:swe:rep twow

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:REPeat?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:REPeat?
description:	Returns the repeat mode.
parameters:	none
response:	ONEWay: Every stepped or continuous sweep cycle starts at the start wavelength of the sweep and ends at the stop wavelength of the sweep TWOWay: Every odd stepped sweep cycle starts at the start wavelength of the sweep, and every even stepped sweep cycle starts at the stop wavelength of the sweep. Set the start and stop wavelength of the sweep using *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:STARt" on page 101* and *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:STOP" on page 102* respectively.
example:	wav:swe:rep? → ONEW<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:SOFTtrigger**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:SOFTtrigger
description:	Softtrigger does the same as a normal (hardware) trigger at the backplane, but it doesn't cause a PM to take a measurement because it is only a (software) message sent to the tunable laser source. It only works in continuous sweep. Usage: - Trigger input configuration: Start Sweep - Start Sweep - SoftTrigger
parameters:	none
response:	none
example:	sour0:wav:sweep:soft

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:SPEed**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:SPEed<wsp><speed>[NM/S|UM/S|MM/S|M/S|]
description:	Sets the speed for continuous sweeping.
NOTE	Cannot be set while a sweep is running.
parameters:	Speed as a **float** value in meters per second (m/s).
response:	none
example:	wav:swe:spe 10nm/s

NOTE

The 81960A supports speeds of 0.5, 1, 2, 5, 10, 20, 40, 50, 80, 100 and 200 nm/s.

A higher speed needs a longer acceleration/deceleration span. This can reduce the usable sweep range, available sweep power and repetition rate. The speed which gives the highest repetition rate depends on the sweep span. For example, 10 nm/s is good for a 2 nm span and 100 nm/s for a 40 nm/s span.

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:SPEed?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:SPEed?[<wsp>MIN|MAX]
description:	Returns the speed for continuous sweeping.
parameters:	optional MIN Returns the minimum sweep speed available. MAX Returns the maximum sweep speed available.
response:	Speed as a **float** value in meters per second (m/s).
example:	wav:swe:spe? ⟶ +5.00000000E-008<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STARt**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STARt<wsp><start value> [PM|NM|UM|MM|M]
description:	Sets the starting point of the sweep.
NOTE	Cannot be set while a sweep is running.
parameters:	The wavelength at which the sweep starts as a **float** value. If you specify no units in your command, meters are used as the default.
response:	none
example:	wav:swe:star 1500nm

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STARt?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STARt?[<wsp>MIN|MAX]
description:	Returns the starting point of the sweep.
parameters:	optional MIN Returns the minimum start wavelength available. This value is wavelength dependent. MAX Returns the maximum start wavelength available. This value is wavelength dependent.

response:	The wavelength at which the sweep starts as a **float** value in meters.
example:	wav:swe:star? ⟶ +1.50000000E-006<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STOP**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STOP<wsp><stop value> [PM|NM|UM|MM|M]
description:	Sets the end point of the sweep.
NOTE	Cannot be set while a sweep is running.
parameters:	The wavelength at which the sweep ends as a **float** value in meters.
	If you specify no units in your command, meters are used as the default.
response:	none
example:	wav:swe:stop 1550nm

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STOP?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STOP?[<wsp>MIN|MAX]
description:	Returns the end point of the sweep.
parameters:	optional MIN Returns the minimum start wavelength available. This value is wavelength dependent.
	MAX Returns the maximum start wavelength available. This value is wavelength dependent.
response:	The wavelength at which the sweep ends as a **float** value in meters.
example:	wav:swe:stop? ⟶ +1.55000000E-006<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:[STATe]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:[STATe]<wsp> STOP|0|STARt|1|PAUSe|2|CONTinue|3
description:	Stops, starts, pauses or continues a wavelength sweep.
parameters:	0 or STOP: Stop the sweep. 1 or STARt: Start a sweep, run sweep. 2 or PAUSe: Pause the sweep. (doesn't apply for continuous sweep) 3 or CONTinue: Continue a sweep. (doesn't apply for continuous sweep)
NOTE	If you enable lambda logging (see *"[:SOURce[n]][:CHANnel[m]]:WAVelength:SWEep:LLOGging" on page 97*) and modulation (see *"[:SOURce[n]][:CHANnel[m]]:AM:STATe[I]" on page 84*) simultaneously, a sweep cannot be started.

NOTE	Generally, a continuous sweep can only be started if: the trigger frequency, derived from the sweep speed and sweep step, is <= 40kHz the number of triggers, calculated from the sweep span and sweep span, is <=100001 the start wavelength is less than the stop wavelength. In addition, a continuous sweep with lambda logging requires: the trigger output to be set to step finished modulation set to coherence control or off.
response:	none
example:	wav:swe STOP

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:[STATe]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:[STATe]?
description:	Returns the state of a sweep.
parameters:	none
response:	+0: Sweep is not running +1: Sweep is running
example:	wav:swe? → +0<END>

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:NEXT**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:NEXT
description:	Performs the next sweep step in stepped sweep if it is paused or in manual sweep.
parameters:	none
response:	none
example:	wav:swe:step:next

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:PREVious**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:PREVious
description:	Performs one sweep step backwards in stepped sweep if it is paused or in manual sweep.
parameters:	none
response:	none
example:	wav:swe:step:prev

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:[WIDTh]**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:[WIDTh]<wsp><value>[PM|NM|UM|MM|M]
description:	Sets the width of the sweep step. In continuous sweep mode, the end of a step is used for triggering.
parameters:	The width of the sweep step as a *float* value. If you specify no units in your command, meters are used as the default.
response:	none
example:	wav:swe:step 5nm

NOTE The step of the 81960A can be set with a resolution of 0.1 pm. The duration of a step in continuous sweep mode, dependent on the step width and sweep speed, can be set as short as 1 µs.

command:	**[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:[WIDTh]?**
syntax:	[:SOURce[*n*]][:CHANnel[*m*]]:WAVelength:SWEep:STEP:[WIDTh]?[<wsp>MIN|MAX]
description:	Returns the width of the sweep step
parameters:	optional MIN Returns the minimum step width available. MAX Returns the maximum step width available.
response:	The sweep step as a **float** value in meters.
example:	wav:swe:step? → +5.00000000E-009<END>

For further details please refer to the 8163A/B, 8164A/B, 8166A/B Programming Guide, Publication No. 08164-90B64. The 81960A module is command compatible to the 81940A/81980A modules.

5
Specifications

Agilent 81960A Compact TLS module is produced to the ISO 9001 international quality system standard as part of Agilent's commitment to continually increasing customer satisfaction through improved quality control.

Definition of Terms 106
Compact Tunable Laser Module Specifications 123
Agilent 81960A Fast-Swept Compact Tunable Laser Source, 1505 nm to 1630 nm 124
Specifications 126

Specifications:

Specifications apply, unless otherwise noted, for the stated environmental conditions, after warm-up, in CW mode (unmodulated output, SBS suppression off) and at uninterrupted line voltage. "Constant temperature" is a stable operating temperature within ±1 K.

Definition of Terms

This section defines terms that are used in this chapter.

Measurement principles are indicated. Alternative measurement principles of equal value are also acceptable.

General Definitions 108
Absolute wavelength accuracy (continuous sweep mode) . . 109
Absolute wavelength accuracy (stepped mode) 109
Dynamic power reproducibility (continuous sweep mode) . . 110
Dynamic relative power flatness (continuous sweep mode) . 110
Effective linewidth 110
Internal digital modulation - duty cycle 111
Internal digital modulation - rise and fall time 111
Linewidth 111
Maximum output power 112
Mode-hop free tunability 112
Mode-hop free sweeping range 112
Operating temperature and humidity 113
Output isolation 113
Polarization extinction ratio 113
Power flatness versus wavelength 114
Power linearity 114
Power repeatability 115
Power stability 115
Relative intensity noise (RIN) 116
Relative wavelength accuracy (continuous sweep mode) . . . 117
Relative wavelength accuracy (stepped mode) 117
Return loss 118
SBS suppression - effective linewidth 118
SBS suppression - residual amplitude modulation (depth) . . 118
Side-mode suppression ratio 119
Signal to source spontaneous emission (SSE) ratio 119
Signal to total source spontaneous emission ratio 120
Wavelength range 120
Wavelength repeatability (continuous sweep mode) 121

Wavelength repeatability (stepped mode) 121
Wavelength resolution. 122
Wavelength stability. 122

General Definitions

Constant Temperature

Where required, is a stable operating temperature within ±1 K.

Logged wavelength

This is the wavelength measured and recorded by the internal wavelength meter during a sweep at the corresponding trigger signal. This recorded wavelength can be read with the logging function.

NOTE **The logged wavelength positions during a sweep** depend on environmental conditions and may differ slightly between repeated sweeps.

Stepped mode

In stepped mode the tunable laser source is operated statically, so that a user's measurement is made at a fixed wavelength of the tunable laser source. When tuning to a new wavelength, the static specifications are valid after completion of the tuning operation.

Continuous sweep mode

In continuous sweep mode the tunable laser source is operated dynamically, so that a user's measurement is made while the wavelength of the tunable laser source changes in a defined way (given by start wavelength, end wavelength and sweep speed). During a continuous sweep the dynamic specifications and the "Logged wavelength" applies.

Absolute wavelength accuracy (continuous sweep mode)

The maximum difference between the "Logged wavelength" and the actual wavelength in "Continuous sweep mode". Wavelength is defined as wavelength in vacuum.

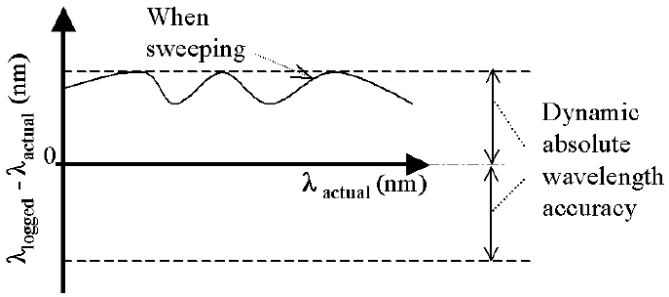


Figure 25 Absolute wavelength accuracy (continuous sweep mode)

Conditions: As specified. No mode-hop.

Absolute wavelength accuracy (stepped mode)

The maximum difference between the displayed wavelength and the actual wavelength of the tunable lase source. Wavelength is defined as wavelength in vacuum.

Conditions: Constant power level. Other conditions as specified.

Measurement: Using a wavelength meter, averaging time ≥ 1 s.

NOTE **The absolute wavelength accuracy of the low-SSE output** (if applicable) is the same as the absolute wavelength accuracy of the high power output (guaranteed by design).

Dynamic power reproducibility (continuous sweep mode)

Specifies the random uncertainty in reproducing the output power at the same actual wavelength in different sweeps. It is expressed as ± half the span between the maximum and minimum of all actual output powers.

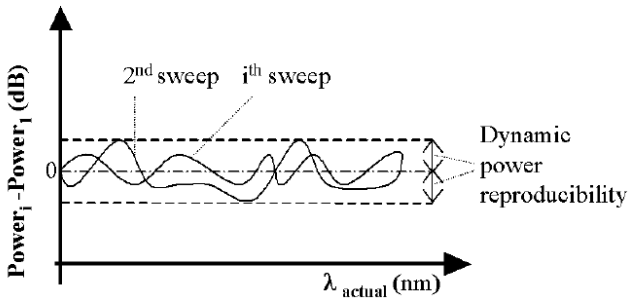


Figure 26 Dynamic power reproducibility (continuous sweep mode)

Conditions: Uninterrupted tunable laser source output power, constant temperature, no mode-hop. Other conditions as specified.

Dynamic relative power flatness (continuous sweep mode)

The high frequency part of the dynamic power flatness, obtainable by referencing the power measured at high sweep speed to the power measured at low sweep speed.

Conditions: Uninterrupted tunable laser source output power, constant power setting, constant temperature, no mode-hop. Other conditions as specified.

Measurement: Reference sweep speed value 0.5 nm/s.

Effective linewidth

The time-averaged 3 dB width of the optical spectrum, expressed in Hertz.

Conditions: Coherence control on. Other conditions as specified.

Measurement: *Using a heterodyning technique*: The output of the laser under test is mixed with another laser of the same type on a wide bandwidth photodetector. The electrical noise spectrum of the photodetector current is measured with an Agilent Lightwave signal analyzer, and the linewidth

calculated from the heterodyne spectrum. (Lightwave signal analyzer settings: resolution bandwidth 1 MHz, video bandwidth 10 kHz, sweep time 20 ms, single scan).

Internal digital modulation - duty cycle

When the laser is internally (digitally) modulated at a frequency *f*, the duty cycle is specified as $\tau_{on} \times f$, where τ_{on} is the time the laser is on during one modulation cycle (expressed in percent).

Conditions: Modulation frequency as specified.

Internal digital modulation - rise and fall time

Fall time specifies the time for the optical pulse to fall from 90% to 10% of its original power value.

Rise time specifies the time for the optical pulse to rise from 10% to 90% of its final power value.

Conditions: Modulation frequency as specified.

Measurement: Using a photoreceiver (of sufficient bandwidth) and an oscilloscope.

Linewidth

The 3 dB width of the optical spectrum, expressed in Hertz.

Conditions: Coherence control off. Other conditions as specified.

Measurement: *Using a self-heterodyning technique*: The output of the laser under test is sent through a Mach-Zehnder interferometer in which the length difference of the two arms is longer than the coherence length of the laser. The electrical noise spectrum of the photodetector current is measured using an
Agilent Lightwave signal analyzer, and the linewidth calculated from the heterodyne spectrum.

Alternatively, *Using a heterodyning technique*: The output of the laser under test is mixed with another laser of the same type on a wide bandwidth photodetector. The electrical noise spectrum of the photodetector current is measured using an Agilent Lightwave signal

analyzer, and the linewidth calculated from the heterodyne spectrum. (Lightwave signal analyzer settings:
resolution bandwidth 1 MHz, video bandwidth 10 kHz,
sweep time 20 ms, single scan).

Maximum output power

The maximum achievable output power of the tunable laser source and the maximum output power for which the tunable laser source specifications apply.

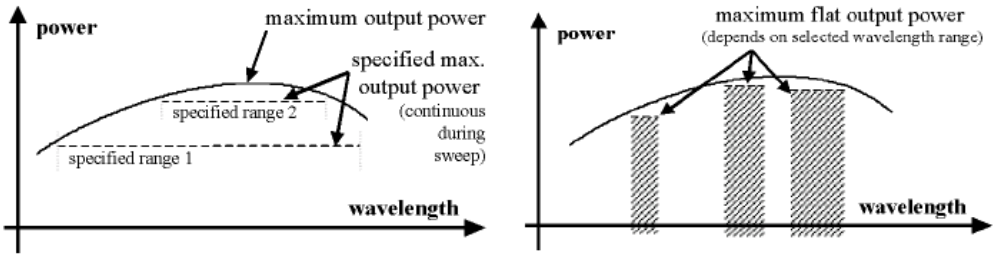


Figure 27 Maximum Output Power vs Wavelength, Maximum Flat Output Power vs Wavelength

Conditions: As specified.

Measurement: Using a power meter at the end of a 2 m single-mode fiber patchcord.

Mode-hop free tunability

Specifies the wavelength range for which no abrupt wavelength change occurs in "Stepped mode" . Abrupt change is defined as change of more than the specified "Absolute wavelength accuracy (stepped mode)" .

Mode-hop free sweeping range

Specifies the wavelength range for which no abrupt wavelength change occurs in "Continuous sweep mode" . Abrupt change is defined as change of more than the specified "Absolute wavelength accuracy" .

Conditions: Output power as specified. Ambient temperature as specified.

Operating temperature and humidity

The ambient temperature range and humidity range of the tunable laser source for which the specifications apply.

NOTE **If the optical mainframe hosting the tunable laser source module is rack-mounted** the temperature and humidity within the rack apply.

Output isolation

The insertion loss of the built-in isolator in the backward direction.

Measurement: This characteristic cannot be measured from outside the module. It is based on known isolator characteristics.

Polarization extinction ratio

Specifies the ratio of the optical power in the slow axis of a connected polarization-maintaining fiber to optical power in the fast axis, expressed in dB

NOTE **Applicable to tunable laser sources** Utilizing polarization maintaining fiber (TE mode in the slow axis and aligned with the connector key).

Measurement: Using a polarization analyzer at the end of a polarization-maintaining patchcord, by sweeping the wavelength to create circular traces on the Poincaré sphere. Calculate the polarization extinction ratio from the diameters of these circles.

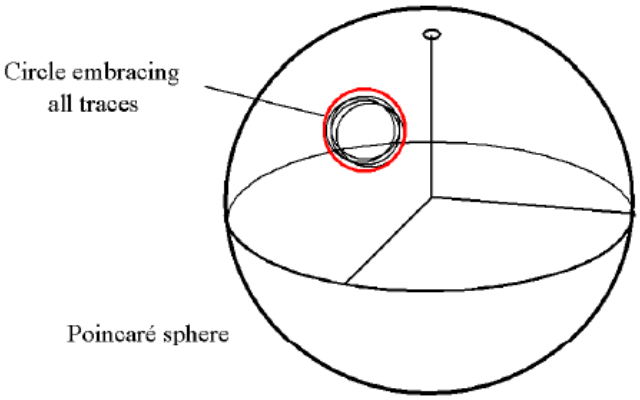


Figure 28 Circular traces on the Poincaré sphere used to calculate polarization extinction ratio.

Power flatness versus wavelength

Specifies ± half the span (in dB) between the maximum and the minimum actual power levels of the tunable laser source when changing the wavelength.

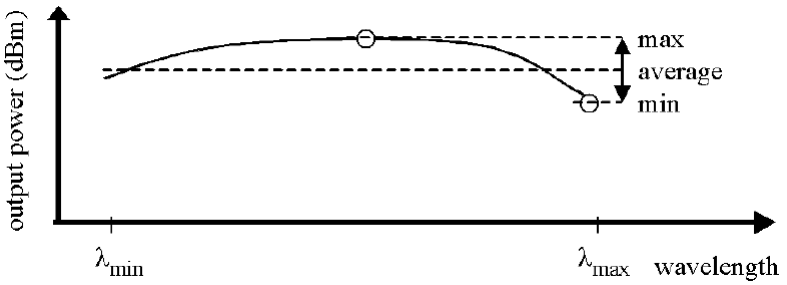


Figure 29 Power flatness vs. wavelength.

Conditions: Uninterrupted tunable laser source output power, constant power setting, constant temperature. Other conditions as specified.

Power linearity

When measuring the ratios (in dB) between the displayed power level and the actual power level for different output power levels of the tunable laser source, the power linearity is ± half the difference between the maximum and the minimum value of all ratios.

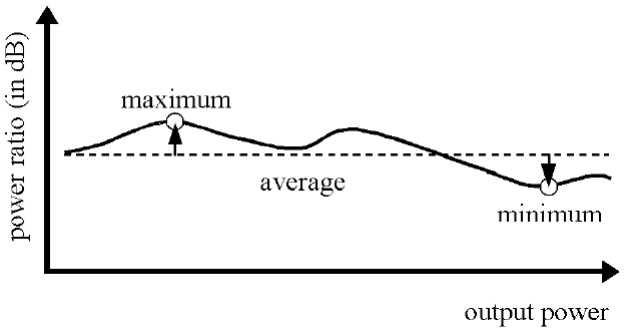


Figure 30 Power linearity.

Conditions: Uninterrupted tunable laser source output power, constant wavelength setting, constant temperature. Other conditions as specified.

Power repeatability

The uncertainty in reproducing the power level after changing and re-setting the power level. The power repeatability is ± half the span between the highest and lowest actual power.

Conditions: Uninterrupted tunable laser source output power, constant wavelength setting, constant temperature. Other conditions as specified.

NOTE **The long-term power repeatability** can be obtained by taking the power repeatability and power stability into account.

Power stability

Specifies the change of the power level of the tunable laser source over time, expressed as ± half the span (in dB) between the highest and lowest actual power.

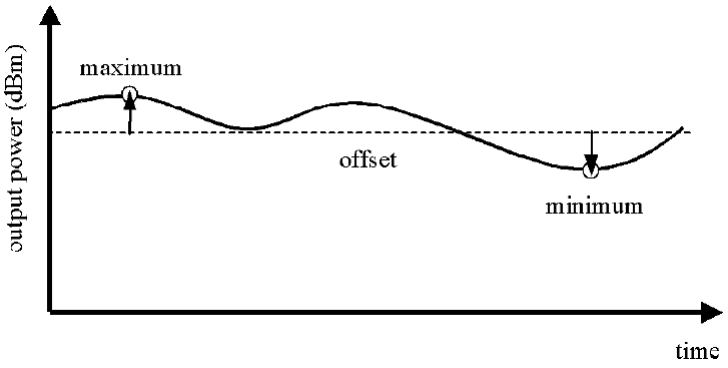


Figure 31 Power stability.

Conditions: Time span as specified. Uninterrupted tunable laser source output power, constant wavelength and power level settings, constant temperature. Other conditions as specified.

Relative intensity noise (RIN)

Specifies the ratio between the mean-square of the optical power fluctuation amplitude $\Delta P_{f,B}$ within a specified frequency range f and for bandwidth B, and the square of the average optical power P_{avg}.

$$RIN = \frac{\left\langle \Delta P_{f,B}^2 \right\rangle}{P_{avg}^{\ 2} \cdot B} \left[\frac{1}{\text{Hz}} \right]$$

RIN, if expressed as "dB/Hz", is calculated by:

$$RIN_{\text{dB/Hz}} = 10 \cdot \log\left(\frac{\Delta P_{f,B}^2 \cdot 1\,\text{Hz}}{P_{avg}^{\ 2} \cdot B} \right)$$

Conditions: As specified.

Measurement: Using an Agilent Lightwave signal analyzer and bandwidth set to 3 MHz.

Relative wavelength accuracy (continuous sweep mode)

When measuring the differences between the actual and "Logged wavelength" in "Continuous sweep mode" , the dynamic wavelength accuracy is ± half the span between the maximum and the minimum value of all differences.

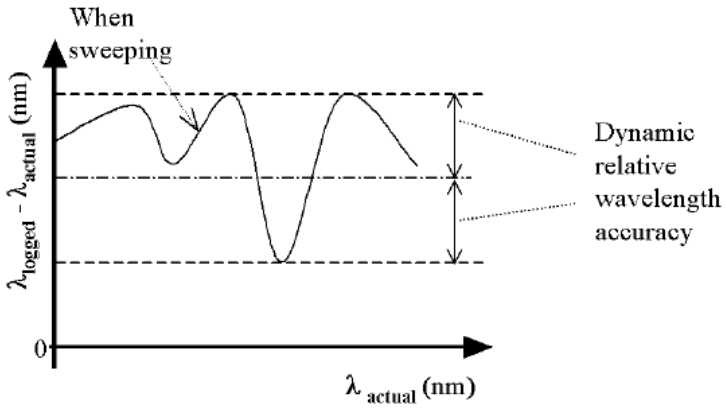


Figure 32 Relative wavelength accuracy (continuous sweep mode).

Conditions: As specified. No mode-hop.

Relative wavelength accuracy (stepped mode)

When randomly changing the wavelength and measuring the differences between the displayed and the actual wavelength, the relative wavelength accuracy is ± half the span between the maximum and the minimum value of all differences.

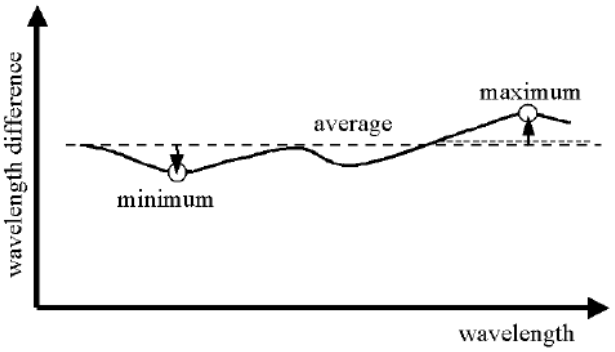


Figure 33 Relative wavelength accuracy.

Conditions: Uninterrupted tunable laser source output power, constant power setting, constant temperature. Other conditions as specified.

Measurement: Using a wavelength meter, averaging time ≥ 1 s.

NOTE **The relative wavelength accuracy of the low-SSE output** (if applicable) is the same as the relative wavelength accuracy of the high power output (guaranteed by design).

Return loss

Specifies the ratio of the optical power incident to the tunable laser source output port at the wavelength set on the tunable laser source, to the power reflected from the tunable laser source output port.

Conditions: Tunable laser source output off.

SBS suppression - effective linewidth

Specifies the peak-to-peak change of the periodically modulated wavelength resulting from the SBS suppression feature, expressed in Hertz.

SBS suppression - residual amplitude modulation (depth)

Specifies the peak-to-peak difference of the periodically modulated optical power resulting from the SBS suppression feature, divided by the sum of minimum power P_{min} and maximum power P_{max}.

$$modulation\ depth = \frac{P_{max} - P_{min}}{P_{max} + P_{min}}$$

NOTE Modulation depth is a value between 0 and 100%.

Side-mode suppression ratio

The ratio of optical power in the main mode to the optical power of the highest sidemode, expressed in dB:

$$SSR_{dB} = 10 \cdot \log\left(\frac{P_{signal}}{P_{highestsidemode}}\right)$$

Conditions: As specified.

Measurement: Using the Agilent Lightwave signal analyzer, by analyzing the heterodyning between the main signal and the highest sidemode within 0.1 GHz to 6 GHz.

Signal to source spontaneous emission (SSE) ratio

Specifies the ratio between signal power and maximum spontaneous emission (SSE) power. The SSE power is determined in a specified bandwidth within a ±3 nm window around the signal wavelength, where ±1 nm around the signal wavelength are excluded, expressed in dB per specified bandwidth.

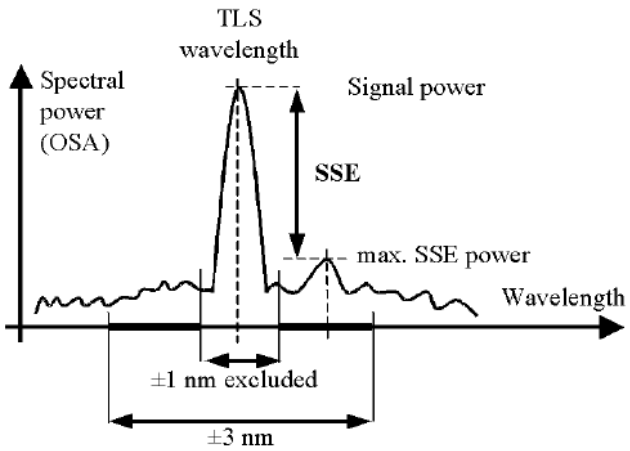


Figure 34 Signal to source spontaneous emission ratio.

Conditions: Output power as specified. Other contitions as specified.

Measurement: Using an optical spectrum analyzer (OSA) at 0.5 nm resolution bandwidth (to address the possibility of higher SSE within a narrower bandwidth), then extrapolated to 1 nm bandwidth. For the low-SSE output, if applicable, with a fiber Bragg grating inserted between the tunable laser source and the OSA to suppress the signal, thereby enhancing the dynamic range of the OSA.

Signal to total source spontaneous emission ratio

The ratio of signal power to total spontaneous emission power within the specified wavelength range, expressed in dB. The total spontaneous emission power is measured over the specified "Wavelength range" .

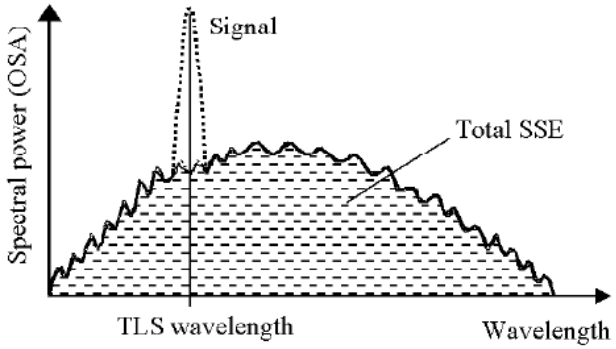


Figure 35 Signal to total source spontaneous emission ratio.

Conditions: Output power as specified. Other conditions as specified.

Measurement: Using an optical spectrum analyzer, by integrating the source spontaneous emission and excluding the remnant signal. For the low-SSE output, if applicable, with a fiber Bragg grating inserted between the tunable laser source and the OSA to suppress the signal, thereby enhancing the dynamic range of the OSA.

Wavelength range

The range of wavelengths for which the specifications apply (if not otherwise stated).

Wavelength repeatability (continuous sweep mode)

The random uncertainty of the nominal wavelength of the tunable laser source at any fixed actual wavelength in repeated sweeps. The nominal wavelength of the tunable laser source is derived from the (discrete) "Logged wavelength" s by interpolation. The repeatability is expressed as ± half the span between the maximum and the minimum value of all nominal values.

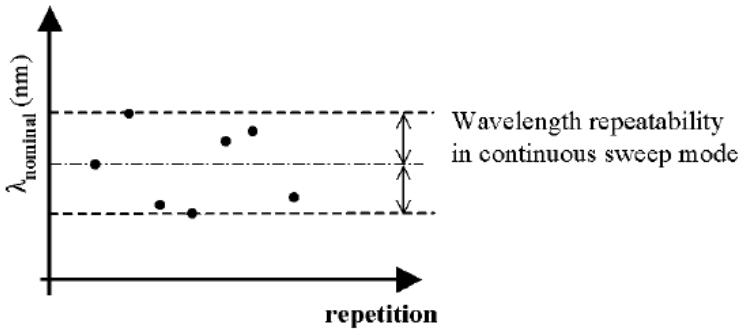


Figure 36 Wavelength repeatability (continuous sweep mode).

Conditions: As specified. No mode-hop.

Measurement: Using an optical powermeter and by performing repeated spectral loss measurement on a stable absorption peak from a reference component, then analyzing the variation of the determined (interpolated) wavelength of the peak.

Wavelength repeatability (stepped mode)

The random uncertainty in reproducing a wavelength after changing and re-setting the wavelength. The wavelength repeatability is ± half the span between the maximum and the minimum of all actual values of this wavelength.

Conditions: Uninterrupted tunable laser source output power, constant power level, constant temperature. Other conditions as specified.

Measurement: Using a wavelength meter, averaging time ≥ 1 s.

NOTE **The wavelength repeatability of the low-SSE output** (if applicable) is the same as the wavelength repeatability of the high power output (guaranteed by design).

NOTE **The long-term wavelength repeatability** can be obtained by taking the wavelength repeatability and wavelength stability into account.

Wavelength resolution

The smallest selectable wavelength increment or decrement.

Wavelength stability

Specifies the change of the actual wavelength of the tunable laser source over time, expressed as ± half the span between the maximum and minimum of all wavelengths.

Conditions: Time span as specified, uninterrupted tunable laser source output power, constant wavelength and power level settings, constant temperature. Other conditions as specified.

Measurement: Using a wavelength meter, averaging time ≥ 1 s.

Compact Tunable Laser Module Specifications

Agilent 81960A Fast-Swept Compact Tunable Laser Source, 1505 nm to 1630 nm. 124
Specifications 126

Specifications:

Describe guaranteed product performance that is valid under stated conditions. The confidence level is 95%, as recommended by the ISO standard.

Typical Values:

Describe product performance that is usually met but not guaranteed.

Supplementary performance characteristics:

Describe the module's non-warranted typical performance.

Because of the modular nature of the instrument, these performance specifications apply to these modules rather than the mainframe unit.

Agilent 81960A Fast-Swept Compact Tunable Laser Source, 1505 nm to 1630 nm

	Agilent 81960A					
Wavelength range, Option 162	1505 nm to 1630 nm					
Wavelength (frequency) resolution	0.1 pm, 12.5 MHz at 1550 nm					
Mode-hop free tunability	full wavelength range					
Absolute wavelength accuracy [1]	±10 pm; typical ± 5 pm					
Relative wavelength accuracy	±7 pm; typical ± 3 pm					
Wavelength repeatability	±2.5 pm; typical ±1.5 pm					
Wavelength stability (typical) [3]	≤ ±0.5 pm, 1 minute ≤ ±2.5 pm, 15 minutes					
Maximum output power (continuous power during sweep)	≥ +14 dBm peak, typical ≥ +13 dBm (1570 nm –1620 nm) ≥ +10 dBm (1505 nm – 1630 nm)					
Power Range (nominal)	+6 dBm to maximum output power					
Power repeatability (typical)	±0.01 dB					
Power stability [3]	±0.01 dB, 1 hour ±0.03 dB, typical, 24 hours					
Power linearity	±0.15 dB (1505 nm, 1575 nm, 1630 nm)					
Power flatness versus wavelength	±0.2 dB (1570 nm – 1620 nm, +13 dBm) ±0.3 dB (full wavelength range)					
Continuous sweep mode, both directions [7]	5 nm/s	10 nm/s	20, 40 nm/s	50 nm/s	80, 100 nm/s	200 nm/s
• Absolute wavelength accuracy (typical)	±5 pm	±10 pm	±15 pm	±8 pm	±8 pm	±15 pm
• Relative wavelength accuracy (typical)	±4 pm	±9 pm	±14 pm	±7 pm	±7 pm	±14 pm
• Wavelength repeatability (typical) [6]	±0.8 pm	±4 pm	±4 pm	±2 pm	±3 pm	±3 pm
• Dynamic power reproducibility (typical)	±0.01 dB	±0.01 dB	±0.02 dB	±0.02 dB	±0.04 dB	±0.04 dB
• Dynamic relative power flatness (typical)	±0.01 dB	±0.01 dB	±0.03 dB	±0.03 dB	±0.07 dB	±0.10 dB

Linewidth, coherence control off (typical)	100 kHz
Effective linewidth, coherence control on (typical) [2]	> 50 MHz (at max. constant output power)
Side-mode suppression ratio (typical) [2]	≥ 50 dB
Signal to source spontaneous emission ratio [2]	≥ 45 dB/nm (full wavelength range, +10 dBm) [4] ≥ 50 dB/nm (1525 nm – 1620 nm, +12 dBm) [4] ≥ 60 dB/0.1nm (typical, 1525 nm – 1620 nm, +12 dBm) [5]
Signal to total source spontaneous emission ratio (typical) [2]	≥ 25 dB (full wavelength range, +10 dBm) ≥ 30 dB (1525 nm – 1620 nm, +12 dBm)
Relative intensity noise (RIN) (typical) [2]	–145 dB/Hz (0.1 GHz – 6 GHz)
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm
Weight	0.95 kg

[1] At day of calibration.

[2] At maximum output power as specified per wavelength range.

[3] At constant temperature ±0.5 K.

[4] Value for 1 nm resolution bandwidth.

[5] Value for 0.1 nm resolution bandwidth.

[6] Repeatability within the same sweep direction.

[7] For sweep range 1510 - 1625 nm. For 200 nm/s, sweep range is 1528 - 1608 nm.

Specifications

Conditions	
Storage temperature	– 40°C to +70 °C
Operating temperature	10°C to 35 °C
Humidity	< 80% R.H. at 10°C to 35 °C
Warm-up time	1 hour, immediate operation after boot-up
Output power	Specifications are valid in non-condensing conditions, in CW operation
Laser Safety Information 	All laser sources specified by this data sheet are classified as Class 1M according to IEC 60825-1 (2007). All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated 2007, June 24.
Supplementary performance characteristics	
Internal digital modulation [1]	50% duty cycle 200 Hz to 1 MHz (extinction ration > 30 dB) Rise and fall time < 100 ns Modulation output (mainframe): TTL reference signal
External digital modulation [1]	> 45% duty cycle Fall time < 300 ns, 200 Hz to 1 MHz Modulation input (mainframe): TTL signal
Coherence control	For measurements on components with 2 m long patchcords and connectors with 14 dB return loss, the effective line width results in a typical power stability of < ±0.025 dB over 1 minute by drastically reducing interference effects in the test setup.
SBS suppression	Effective linewidth: 500 MHz Residual amplitude modulation: <±0.5%
Continuous Sweep Mode	
Mode-hop free sweeping	Full wavelength range at flat output power ≥ +10 dBm Ambient temperature within +20 °C and +30 °C

Specifications

General	
Output isolation (typical)	50 dB
Return loss (typical)	60 dB (Option 072)
Wavelength stability (typical, over 1 min)	± 0.5 pm
Fiber type	Panda
Orientation	TE mode in slow axis, in line with connector key
Polarization extinction ratio	16 dB typical
Recommended re-calibration period	2 years
Connector option (required)	Tunable laser must be ordered with connector option
• Option 072	PMF, angled contact output connector
Connector interface	One Agilent 81000xI-Series connector interface is required

[1] Displayed wavelength represents average wavelength while digital modulation is active.

This Page Intentionally Left Blank

6
Cleaning Information

The Cleaning Instructions provided in this chapter apply to a number of different types of Optical Equipment.

Cleaning Instructions for this Module If you must clean the Agilent Compact TLS module, please refer the module to the skilled personnel of Agilent's service team.

Cleaning Instructions. 130
- Safety Precautions 130
- Why is it important to clean optical devices ? 131
- What do I need for proper cleaning? 132
- Preserving Connectors. 136
- Cleaning Instrument Housings 136
- Which Cleaning Procedure should I use? 137
- How to clean connectors. 138
- How to clean connector interfaces 140
- How to clean bare fiber adapters 141
- How to clean instruments with a fixed connector interface . 142
- Additional Cleaning Information. 143
- Other Cleaning Hints 144

Cleaning Instructions

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

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

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

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

Safety Precautions

Please follow the following safety rules:

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

Why is it important to clean optical devices ?

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

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

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

What do I need for proper cleaning?

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

Standard Cleaning Equipment

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

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

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

If you need further dust caps, please contact your nearest 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 try to drink this alcohol, as it may seriously damage your health.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Compressed air Compressed air can be purchased from any laboratory supplier.

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

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

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

Additional Cleaning Equipment

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

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

Microscope with a magnification range about 50X up to 300X A microscope can be found in most photography stores, or can be obtained through or specialist mail order companies. Special fiber-scopes are available from suppliers of splicing equipment.

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

A microscope helps you to estimate the type and degree of dirt on your device. You can use a microscope to choose an appropriate cleaning

method, and then to examine the results. You can also use your microscope to judge whether your optical device (such as a connector) is severely scratched and is, therefore, causing inaccurate measurements.

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

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

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

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

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

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

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

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

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.

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.

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

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

Cleaning Instrument Housings

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

Which Cleaning Procedure should I use?

Light dirt

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

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

Heavy dirt

If the above procedure is not enough to clean your instrument, follow one of the procedures below. Please consult “Cleaning Instructions for this Module” on page 129 for the procedure relevant for this instrument.

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

How to clean connectors

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

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

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

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

Preferred Procedure

Use the following procedure on most occasions.

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

Procedure for Stubborn Dirt

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

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

An Alternative Procedure

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

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

How to clean connector interfaces

CAUTION

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

Do not use pipe-cleaners on optical head adapters, as the hard core of normal pipe cleaners can damage the bottom of an adapter.

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

Procedure for Stubborn Dirt

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

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

How to clean bare fiber adapters

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

CAUTION

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

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

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

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

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

CAUTION

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

2 Clean the adapter by 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 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.

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

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

CAUTION

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

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

Additional Cleaning Information

The following cleaning procedure may be used with other optical equipment:

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.

Other Cleaning Hints

Selecting the correct cleaning method is an important element in maintaining your equipment and saving you time and money. This Appendix highlights the main cleaning methods, but cannot address every individual circumstance.

This section contain some additional hints which we hope will help you further. For further information, please contact your local Agilent Technologies representative.

Making the connection Before you make any connection you must ensure that all lightwave cables and connectors are clean. If not, then use appropriate the cleaning methods.

When you insert the ferrule of a patchcord into a connector or an adapter, ensure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise, the fiber end will rub up against something which could scratch it and leave deposits.

Lens cleaning papers Note that 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.

Immersion oil and other index matching compounds Do not use immersion oil or other index matching compounds with optical sensors equipped with recessed lenses. They are liable to dirty the detector and impair its performance. They may also alter the property of depiction of your optical device, thus rendering your measurements inaccurate.

Cleaning the housing and the mainframe When cleaning either the mainframe or the housing of your instrument, only use a dry and very soft cotton tissue on the surfaces and the numeric pad.

Never open the instruments as they can be damaged. Opening the instruments puts you in danger of receiving an electrical shock from your device, and renders your warranty void.

Index

A

Absolute wavelength (frequency) 108
Additional Cleaning Equipment 134
Auto Cal Off 68
Automatic Realignment 67
Auxiliary Functions 67
  automatic realignment 67
  wavelength zero 68

C

Cleaning connectors 138
Coherence Control
  tunable lasers 62
Compact TLS module 105
Compact Tunable Lasers
  SBS Suppression 68
Connectors
  angled contact 22, 26
  straight contact 22

D

Definition
  absolute wavelength accuracy (continuous sweep mode) 109
  absolute wavelength accuracy (stepped mode) 109
  constant temperature 108
  continuous sweep mode 108
  dynamic power reproducibility (continuous sweep mode) 110
  dynamic relative power flatness (continuous sweep mode) 110
  effective linewidth 110
  internal digital modulation - duty cycle 111
  linewidth 111
  logged wavelength 108
  maximum output power 112
  mode-hop free tunability 112
  operating temperature and humidity 113
  output isolation 113
  polarization extinction ratio 113
  power flatness vs wavelength 114
  power linearity 114
  power repeatability 115
  power stability 115
  relative wavelength accuracy (continuous sweep mode) 117
  relative wavelength accuracy (stepped mode) 117
  return loss 118
  RIN 116
  side-mode suppression ratio 119
  signal to source (SSE) ratio 119
  signal to total source SSE ratio 120
  stepped mode 108
  wavelength range 120
  wavelength repeatability (continuous sweep mode) 121
  Wavelength repeatability (stepped mode) 121
  wavelength resolution 122
  wavelength stability 122
DFB
  modulation source 61

F

Front Panel
  Controls and Indicators 19

I

Initial Inspection 13
Inspection 13
Installation 18

L

Lambda Zero 68
Laser
  state 88
  switch on 88
Laser Safety Labels 17
Line Power Requirements 13

M

Modulation
  tunable lasers 58
Modules
  connector interfaces 26
  interface options 25
  optional features 24

O

Operating Environment 13
Optical Output 21
Option 071 26

P

Polarization Maintaining Fiber 21
Power
  tunable lasers 45
Preserving Connectors 136

R

Realignment, automatic 67

S

Safety
  Line Power 13
  Operating Environment 13
  Symbols 12
Safety Considerations 12
Safety Symbols 12
Settling 68
Signal Input 22
Signal Output 22
SLOT subsystem 80
SPECial subsystem 81
Specific Command Summary 70
Specifications 126
Standard Cleaning Equipment 132
Start
  laser 88
Stop
  laser 88
Storage 13
Subsystem
  SLOT 80
  SPECial 81

T

Triggering
  tunable lasers 64
Tunable Lasers
  atomatic realignment 67
  backplane modulation 60
  coherence control 62
  excessive power 47
  external modulation 60
  how to use 45
  increase linewidth 62
  input triggering 64
  internal modulation 58
  lambda zero 68
  low frequency coherence control 62
  modulation 58
  power 45
  triggering 64
  wavelength 48
  wavelength zero 68
Typical Use Models 20

U

Use Models 20

V

Vsweep parameter 51

W

Wavelength
  tunable lasers 48
Wavelength Sweep 50
  continuous 55
  manual sweep 57
  performing a sweep 53
  repeat mode 51
  stepped 53
  sweep parameters 51
Wavelength Zero 68

www.agilent.com

First edition, November 2011

81960-90B01

Agilent Technologies