Agilent 81689A, 81689B and 81649A Compact Tunable Laser Modules

User's Guide

Agilent Technologies

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

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81689-90A13: February 2002

Safety Summary

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.

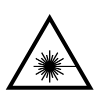
Before operation, review the instrument and manual, including the red safety page, for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

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.

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.

The Performance Tests give procedures for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, 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 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser Modules operate when installed in the Agilent 8163A and B Lightwave Multimeters, the Agilent 8164A and B Lightwave Measurement Systems, or the Agilent 8166A and B Lightwave Multichannel Systems.

Within this User's Guide, these instruments are collectively referred to as 'mainframes'.

Operating Environment

The safety information in your mainframe's User's Guide summarizes the operating ranges for the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser Modules. In order for these modules to meet specifications, the operating environment must be within the limits specified for your mainframe.

Input/Output Signals

CAUTION

There is one BNC input connector on the front panel of the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser Modules.

An absolute maximum of ± 6 V can be applied as an external voltage to any BNC connector.

Storage and Shipment

Agilent 81689A Compact Tunable Laser modules can be stored or shipped at temperatures between –20°C and +70°C.

Agilent 81689B and Agilent 81649A modules 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.

Initial Safety Information for Tunable Laser Modules

The laser sources specified by this user guide are classified according to IEC 60825-1 (2001)

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

The Specifications for these modules are as follows:

Table 1 Tunable Laser Modules Laser Safety Information

	Agilent 81689A	Agilent 81689B	Agilent 81649A
Laser Type	FP-Laser InGaAsP	FP-Laser InGaAsP	FP-Laser InGaAsP
Wavelength range	1525-1575 nm	1525-1575 nm	1570-1620 nm
*Max. CW output power**	<15 mW	<35 mW	<35 mW
Beam waist diameter	9 µm	9 µm	9 µm
Numerical aperture	0.1	0.1	0.1
Laser Class according to IEC 60825-1 (2001)- International	1M	1M	1M
Max. permissible CW output power	163 mW	163 mW	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

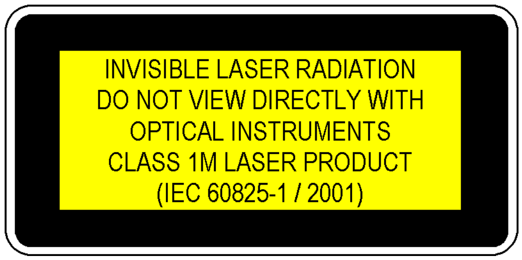


Figure 1 Class 1M Safety Label - Agilent 81649A/89A/89B

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 warnings:

- Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational. The laser radiation can seriously damage your eyesight.
- Do not enable the laser when there is no fiber attached to the optical output connector.
- The laser is enabled by pressing the gray 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 authorised personnel.

The Structure of this Manual

This manual is divided into two parts:

- Getting Started
  This section gives an introduction to the Compact Tunable Laser modules. and aims to make these modules familiar to you:
  – *"Getting Started with Tunable Laser Sources" on page 17*.
- Additional Information
  This is supporting information of a non-operational nature, concerning accessories, specifications, and performance tests:
  – *"Accessories" on page 25*,
  – *"Specifications" on page 33*, and
  – *"Performance Tests" on page 45*.

Conventions used in this manual

- Hardkeys are indicated by italics, for example, *Config*, or *Channel*.
- Softkeys are indicated by normal text enclosed in square brackets, for example, [Zoom] or [Cancel].
- Parameters are indicated by italics enclosed by square brackets, for example, [*Range Mode*], or [*MinMax Mode*].
- Menu items are indicated by italics enclosed in brackets, for example, <*MinMax*>, or <*Continuous*>.

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List of Figures

Getting Started with Tunable Laser Sources

This chapter describes the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules.

What is a Tunable Laser?

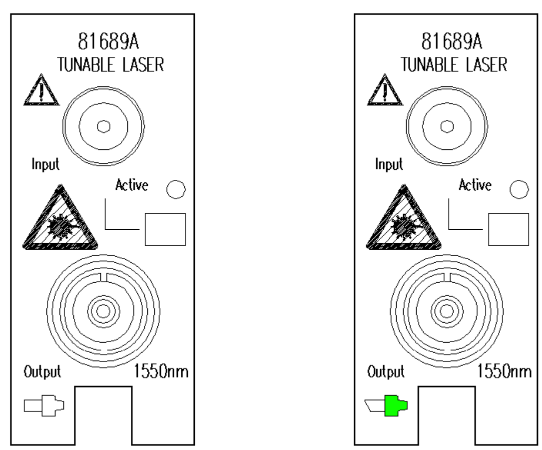
A Tunable Laser is a laser source for which the wavelength can be varied through a specified range. The Agilent Technologies range of tunable laser modules also allow you to set the output power, and to choose between continuous wave or modulated power.

The Agilent Technologies range of compact tunable laser modules are flexible stimulus modules suitable for applications such as the test of optical amplifiers, DWDM components, and complete DWDM systems.

Installation

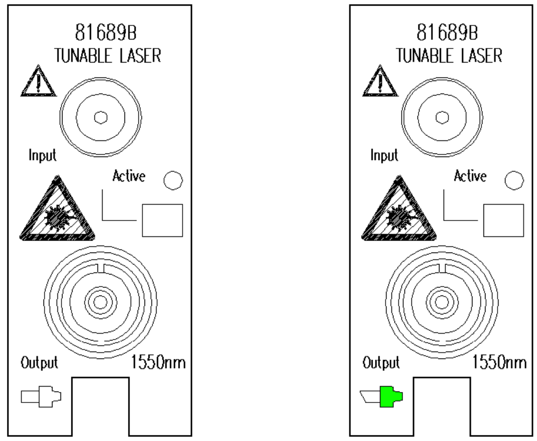
The Agilent 81689A, Agilent 81689B, and Agilent 81649A are front-loadable modules. For a description of how to install your module, refer to “How to Fit and Remove Modules” in the Installation and Maintenance chapter of your mainframe’s User’s Guide.

Agilent 81689A, 81689B, 81649A Compact Tunable Laser Module Front panels



Agilent 81689A with Straight Contact Connector   Agilent 81689A with Angled Contact Connector

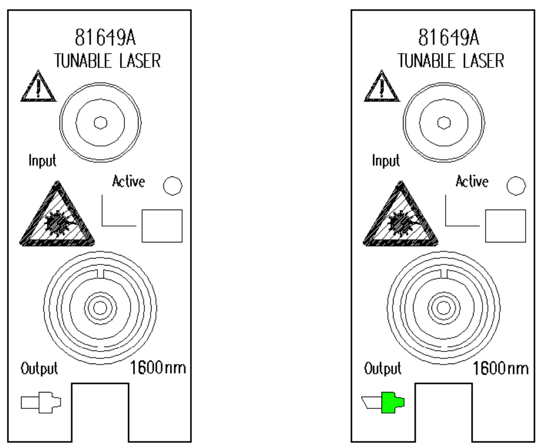
Figure 3 Agilent 81689A Compact Tunable Laser Module



Agilent 81689B with Straight Contact Connector

Agilent 81689B with Angled Contact Connector

Figure 4 Agilent 81689B Compact Tunable Laser Module



Agilent 81649A with Straight Contact Connector

Agilent 81649A with Angled Contact Connector

Figure 5 Agilent 81649A 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 GP-IB commands. When the Active LED is lit the souce is emitting radiation. When the Active LED is not lit the source is not emitting radiation.

Typical Use Models

Brief description

The Agilent 81689A Compact Tunable Laser module operates in the C-band between 1525 nm and 1575 nm.

The Agilent 81689B Compact Tunable Laser module also operates in the C-band between 1525 nm and 1575 nm. When compared with the Agilent 8169A, the Agilent 8169B offers increased output power, and higher relative wavelength accuracy and wavelength stability.

The Agilent 81649A Compact Tunable Laser module operates in the L-band between 1570 nm and 1620 nm

Test systems for optical amplifiers

You can use a selection of fully remote-controlled Agilent Compact Tunable Laser modules, in combination with an Agilent 81682A or Agilent 81642A high power Tunable Laser module, to provide the high stimulus power needed to characterize optical amplifiers intended for DWDM applications. When used with an Agilent 81651A Optical Attenuator module a dynamic range of more than 60 dB can be achieved. Without the attenuator module, the Agilent 81689A and Agilent 81649A Compact Tunable Laser modules’ output power can be attenuated by 9 dB, and the Agilent 81689B Compact Tunable Laser module’s output power can be attenuated by 10 dB, allowing you to equalize the power delivered from several sources.

Test systems for integrated optical devices

You can use Agilent Compact Tunable Laser modules that include a Panda Polarizing Maintaining Fiber (PMF) output port (optional) as the well-defined polarization sources required to test devices such as waveguides.

Test systems for DWDM multichannel transmission systems

You can use Agilent Compact Tunable Laser modules to set up a realistic multichannel test-bed for DWDM transmission systems in the C-Band or L-Band. Their continuous, mode-hop free tuning makes it quick and easy for you to set up even the most complex configurations to the target wavelengths and power levels required during installation and maintenance.

Compact spare for DFB modules in ITU grids

The Agilent 81689B Compact Tunable Laser module can replace, without power penatlty, any of a comb of Agilent 81662A DFB Laser Source modules emitting between 1525 nm and 1575 nm.

Smart loss testers with selectable wavelength

You can use an Agilent 8163A or B Lightwave Multimeter, an Agilent Power Sensor module, and an Agilent Compact Tunable Laser module as a smart loss-test set with selectable wavelength.

Optical Output

Polarization Maintaining Fiber

A Polarization maintaining fiber (PMF) output is available as an option for Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser 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..

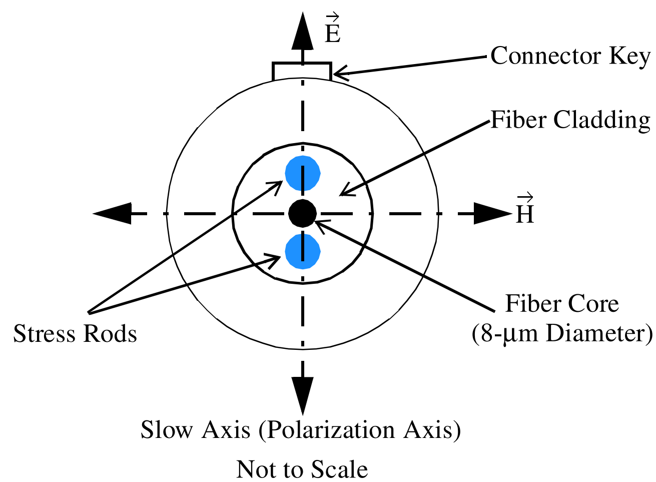


Figure 6 PMF Output Connector

See *“Accessories” on page 25* for further details on connector interfaces and accessories.

Angled and Straight Contact Connectors

Angled contact connectors are available as an option for Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules.

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

If the contact connector on your instrument is angled, you can only use cables with angled connectors with the instrument.

Figure 7 Angled and Straight Contact Connector Symbols

Figure 7 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 You cannot connect angled non-contact fiber end connectors with orange sleeves directly to the instrument.

See *"Accessories" on page 25* for further details on connector interfaces and accessories.

Signal Input and Output

CAUTION

There is one BNC input connector on the front panel of the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules

An absolute maximum of ± 6 V can be applied as an external voltage to any BNC connector.

Accessories

The Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules are 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

Figure 8 shows all the options that are available for Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules, and the instruments that support these modules.

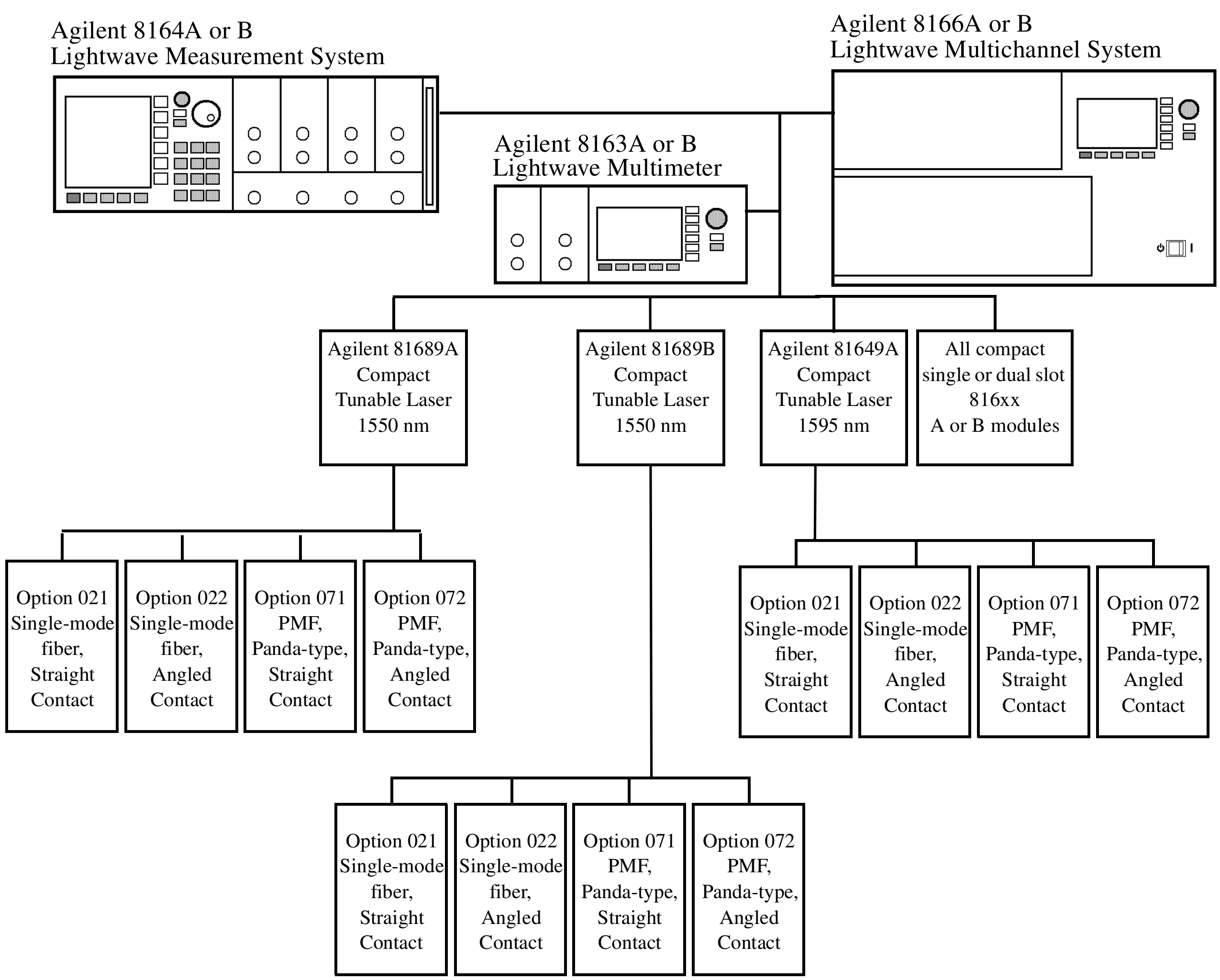


Figure 8 Mainframes, Tunable Laser Modules, and Options

Modules

Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules 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.

Compact Tunable Laser Modules	
Model No.	**Description**
Agilent 81689A	Compact Tunable Laser for Multi-Channel Test Applications, C-Band, + 6 dBm
Agilent 81689B	Compact Tunable Laser for Multi-Channel Test Applications, C-band, + 10 dBm
Agilent 81649A	Compact Tunable Laser for Multi-Channel Test Applications, L-Band, + 6 dBm

User's Guides

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Opt	**Description**	**Part No.**
8169A 0BF	Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules User's Guide	81689-90A11
0BF	Agilent 81480A, Agilent 81680A, Agilent 81640A, Agilent 81682A & Agilent 81642A Tunable Laser Modules	81680-90A17
8164B 0BF	Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System User's Guide	08164-90B12
8164B 0B2	Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System Programming Guide	08164-90B62

Options

Option 021 - Compact Tunable Laser Modules

Standard single-mode fiber, for straight contact connectors.

Option 022 - Compact Tunable Laser Modules

Standard single-mode fiber, for angled contact connectors.

Option 071 - All Tunable Laser Modules

Polarization-maintaining fiber, Panda-type, for straight contact connectors.

Option 072 - All Tunable Laser Modules

Polarization-maintaining fiber, Panda-type, for angled contact connectors.

Connector Interfaces and Other Accessories

Options 021, 071: Straight Contact Connectors

If you want to use straight connectors (such as FC/PC, Diamond HMS-10, DIN, Biconic, SC, ST or D4) to connect to the instrument, you must do the following:

1 Attach your connector interface to the interface adapter.

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

2 Connect your cable (see Figure 9).

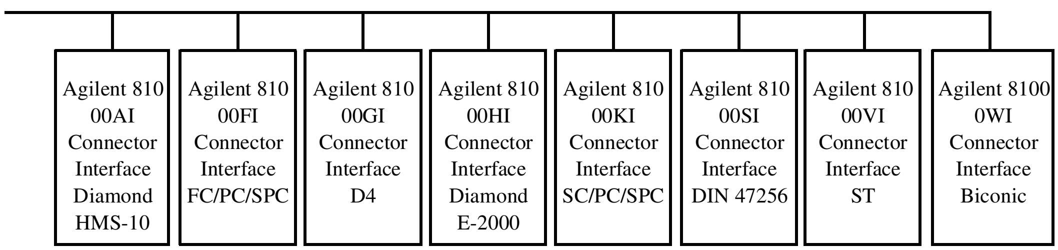

Figure 9 **Options 021, 071: Single-mode fiber/PMF with Straight Contact Connectors**

Table 2 **Straight Contact Connector Interfaces**

Description	Model No.
Biconic	Agilent 81000 WI
D4	Agilent 81000 GI
Diamond HMS-10	Agilent 81000 AI
DIN 47256	Agilent 81000 SI
FC / PC / SPC	Agilent 81000 FI
SC/PC/SPC	Agilent 81000 KI
ST	Agilent 81000 VI
Diamond E-2000	Agilent 81000 HI

Options 022, 072: Angled Contact Connectors

If you want to use angled connectors (such as FC/APC, Diamond HRL-10, or SC/APC) to connect to the instrument, you must do the following:

1 Attach your connector interface to the interface adapter.

See Table 3 for a list of the available connector interfaces.

2 Connect your cable (see Figure 10).

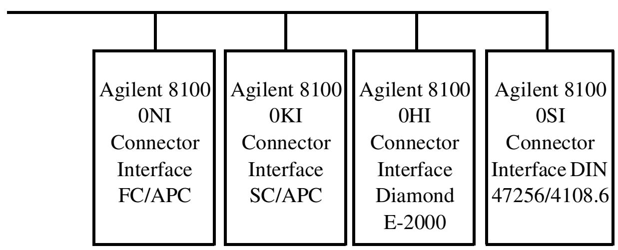

Figure 10 Options 022, 072: Single-mode fiber/PMF with Angled Contact Connectors

Table 3 Angled Contact Connector Interfaces

Description	Model No.
DIN 47256-4108.6	Agilent 81000 SI
FC / APC	Agilent 81000 NI
SC / APC	Agilent 81000 KI
Diamond E-2000	Agilent 81000 HI

Specifications

The Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules are produced to the ISO 9001 international quality system standard as part of Agilent Technologies' commitment to continually increasing customer satisfaction through improved quality control.

Specifications describe the modules' warranted performance. Supplementary performance characteristics describe the modules non-warranted typical performance.

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

Definition of Terms

This section defines terms that are used both in this chapter and *"Performance Tests" on page 45*.

Generally, all specifications apply for the given environmental conditions and after warmup time.

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

Absolute Wavelength Accuracy

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

Conditions: constant power level, temperature within operating temperature range, coherence control off, measured at high power output.

Measurement with wavelength meter. Averaging time given by wavelength meter, ≥1 s.

Linewidth

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

Conditions: temperature within operating temperature range, coherence control off, power set to maximum flat power (maximum attainable power within given wavelength range).

Measurement with 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 with an Agilent Lightwave Signal Analyzer, and the linewidth is calculated from the heterodyne spectrum (Lightwave signal analyzer settings: resolution bandwidth 1 MHz; video bandwidth 10 kHz; sweep time 20 ms; single scan).

Minimum Output Power

The minimum output power for which the specifications apply.

Modulation Extinction Ratio

The ratio of total power in on-state to total power in off-state, expressed in dB.

Conditions: Internal or external modulation, tunable laser at highest power setting.

Measurement with optical spectrum analyzer. Tunable laser switched on and off.

Modulation Frequency Range

The range of frequencies for which the modulation index is above – 3 dB of the highest modulation index. In this context, modulation index is defined as the AC power amplitude (peak-to-peak) divided by the average power.

Output Power

The achievable output power for the specified TLS tuning range.

Conditions: temperature within operating temperature range.

Measurement with power meter at the end of a single-mode fiber patchcord.

Output Isolation

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

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

Peak Power

The highest optical power within specified wavelength range.

Polarization Extinction Ratio

The ratio of optical power in the slow axis of the polarization-maintaining fiber to optical power in the fast axis within a specified wavelength range.

Conditions: only applicable for TLS with polarization maintaining fiber with the TE mode in slow axis and oriented in line with connector key, at constant power level.

Measurement with a polarization analyzer at the end of a polarization-maintaining patchcord, by sweeping the wavelength, thereby creating circular traces on the Poincaré sphere, then calculating the polarization extinction ratio from the circle diameters.

Power Flatness Over Modulation

When changing the wavelength and modulation frequency, and measuring the differences between actual and displayed power levels (in dB), the power flatness is ± half the span between the maximum and the minimum value of all differences.

Conditions: uninterrupted line voltage, constant power setting, temperature within ±2 K, external modulation ON.

Measurement with optical power meter.

Power Flatness Versus Wavelength

When changing the wavelength at constant power setting and recording the differences between actual and displayed power levels, the power flatness is ± half the span (in dB) between the maximum and the minimum of the measured power levels.

Conditions: uninterrupted TLS output power, constant power setting, temperature within ±1K.

Measurement with optical power meter.

Power Linearity

When changing the power level and measuring the differences (in dB) between actual and displayed power levels, the power linearity is ± half the span (in dB) between the maximum and the minimum value of all differences.

Conditions: power levels from within specified output power range, uninterrupted TLS output power, at fixed wavelength settings and stable temperature.

Measurement with optical power meter.

Power Repeatability

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

Conditions: uninterrupted TLS output power, constant wavelength, temperature within ±1 K, short time span.

Measurement with optical power meter.

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

Power Stability

The change of the power level during given time span, expressed as ± half the span (in dB) between the highest and lowest actual power.

Conditions: uninterrupted TLS output power, constant wavelength and power level settings, temperature within ±1 K, time span as specified.

Measurement with optical power meter.

Relative Intensity Noise (RIN)

The square of the (spectrally resolved) RMS optical power amplitude divided by the measurement bandwidth and the square of the average optical power, expressed in dB/Hz.

Conditions: at specified output power, coherence control off, temperature within operating temperature range, frequency range 0.1 to 6 GHz.

Measurement with Agilent Lightwave Signal Analyzer.

Relative Wavelength Accuracy

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

Conditions: uninterrupted TLS output power, constant power level, temperature within operating temperature range, observation time 10 minutes maximum (constant temperature), coherence control off, measured at high power output.

Measurement with wavelength meter. Averaging time given by wavelength meter, ≥1 s.

Return Loss

The ratio of optical power incident to the TLS output port, at the TLS's own wavelength, to the power reflected from the TLS output port.

Conditions: TLS disabled.

Sidemode Suppression Ratio

The ratio of average signal power to the optical power of the highest sidemode within a distance from 0.1 to 6 GHz to the signal's optical frequency, expressed in dB.

Conditions: at a specified output power and wavelength range, temperature within operating temperature range, coherence control off.

Measurement with the Agilent Lightwave Signal Analyzer, by analyzing the heterodyning between the main signal and the highest sidemode.

Signal-to-Source Spontaneous Emission (SSE) Ratio

The ratio of signal power to maximum spontaneous emission power in 1 nanometer bandwidth within a ±3 nm window around the signal wavelength, where ±1 nm around the signal wavelength are excluded, at the specified output power, expressed in dB/nm.

Conditions: output power set to specified values, at temperatures within operating temperature range, coherence control off.

Measurement with 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. On low-SSE output (if applicable), with fiber Bragg grating inserted between the TLS and the OSA in order to suppress the signal, thereby enhancing the dynamic range of the OSA.

NOTE The specified signal-to-SSE ratio is also applicable to output powers higher than the specified values.

Wavelength Range

The range of wavelengths for which the specifications apply.

Wavelength Repeatability

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

Conditions: uninterrupted TLS output power, constant power level, temperature within operating temperature range, coherence control off, short time span.

Measurement with wavelength meter at high power output. Averaging time given by wavelength meter, ≥1 s.

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

Wavelength Resolution

The smallest possible displayed wavelength increment/decrement.

Wavelength Stability

The change of wavelength during given time span, expressed as ± half the span between the maximum and the minimum of all actual wavelengths.

Conditions: uninterrupted TLS output power, constant wavelength and power level settings, coherence control off, temperature within ±1 K, time span as specified.

Measurement with wavelength meter. Averaging time given by wavelength meter, ≥1 s.

Tunable Laser Module Specifications

	Agilent 81689A	Agilent 81689B	Agilent 81649A
Wavelength range	1525 nm to 1575 nm	1525 nm to 1575 nm	1570 nm to 1620 nm
Wavelength resolution	0.01 nm, 1.25 GHz at 1550 nm	0.01 nm, 1.25 GHz at 1550 nm	0.01 nm, 1.17 GHz at 1595 nm
Absolute wavelength accuracy (typ.)[1]	± 0.3 nm	± 0.3 nm	± 0.3 nm
Relative wavelength accuracy [1]	± 0.3 nm	± 0.15 nm	± 0.15 nm
Wavelength repeatability [1]	± 0.05 nm	± 0.05 nm	± 0.05 nm
Wavelength stability [1]			
typ, over 24 h at constant temperature:	± 0.02 nm	± 0.01 nm	± 0.01 nm
typ, over 1 h at constant temperature:		± 0.005 nm	± 0.005 nm
Tuning speed (typ.)	< 10 sec / 50 nm	< 10 sec / 50 nm	< 10 sec / 50 nm
Linewidth (typ.) [2]	20 MHz	< 20 MHz	< 20 MHz
with Coherence Control ON (typ.) [2]	- -	> 100 MHz	> 100 MHz
Output power **(continuous power on during tuning)**	≥ 6 dBm (1525 - 1575 nm)	≥ 10 dBm (1525 - 1575 nm)	≥ 6 dBm (1570 - 1620 nm)
Minimum output power	– 3 dBm	0 dBm	– 3 dBm
Power stability **(at constant temperature)** [3]	± 0.03 dB over1 hour typ. ± 0.06 dB over 24 hours	± 0.015 dB over 1 hour, typ. ± 0.0075 dB over 1 hour, typ. ± 0.05 dB over 24 hours	± 0.015 dB over 1 hour, typ. ± 0.0075 dB over 1 hour, typ. ± 0.05 dB over 24 hours
Power repeatability (typ.) [3]	± 0.02 dB	± 0.02 dB	± 0.02 dB
Power linearity	± 0.1 dB	± 0.1 dB	± 0.1 dB
Power flatness versus wavelength	± 0.3 dB	± 0.2 dB	± 0.2 dB
Side-mode Suppression ratio (typ.) [2]	> 40 dBc (1525 - 1575 nm at 0 dBm)	> 45 dBc (1525 - 1575 nm at ≥ 3 dBm)	> 45 dBc (1570 - 1620 nm at ≥ 0 dBm)
Signal-to-Source Spontaneous Emission Ratio (typ.) [4]	≥ 39 dB/nm (1525 - 1575 nm at 6 dBm)	≥ 44 dB/nm (1525 - 1575 nm at 10 dBm)	≥ 42 dB/nm (1570 - 1620 nm at 6 dBm)

	Agilent 81689A	Agilent 81689B	Agilent 81649A
Relative Intensity noise (RIN, typ.)	< –137 dB/Hz (100 MHz - 2.5 GHz) at + 3 dBm	< –137 dB/Hz (100 MHz - 2.5 GHz) at + 7 dBm	< –137 dB/Hz (100 MHz - 2.5 GHz) at + 3 dBm
Dimensions	75 mm H, 32 mm W, 335 mm D (2.8″ × 1.3″ × 13.2″)	75 mm H, 32 mm W, 335 mm D (2.8″ × 1.3″ × 13.2″)	75 mm H, 32 mm W, 335 mm D (2.8″ × 1.3″ × 13.2″)
Weight	1 kg	1 kg	1 kg

1. At CW operation. Measured with wavelength meter based on wavelength in vacuum.

2. Measured by heterodyning method.

3. 500 ms after changing power.

4. Measured with optical spectrum analyzer at 1 nm resolution bandwidth.

Supplementary Performance Characteristics

Modulation

Internal Digital Modulation

50% duty cycle, 200 Hz to 300 kHz
> 45% duty cycle, 300 Hz to 1 MHz

Modulation output (via Mainframe):
TTL reference signal.

External Digital Modulation

> 45% duty cycle, fall time
< 300 ns, 200 Hz to 1 MHz

Modulation Input (via Mainframe):
TTL signal.

External Analog Modulation

≥ 15% modulation depth, 5 kHz to 1 MHz

Modulation input: 5 Vp-p

Coherence Control (Agilent 81649A and 81689B)

For measurements on components with 2 m long patchcords and connectors with 14 dB return loss, the effective linewidth results in a typical power stability of <± 0.025 dB over 1 minute by reducing interference effects in the test setup.

General

Output Isolation (typ.)	38 dB
Return loss (typ.)	55 dB (options 022, 072); 40 dB (options 021, 071).
Polarization Maintaining Fiber (Options 071, 072):	**Fiber type:** Panda. **Orientation:** TE mode in slow axis, in line with connector key. **Extinction Ratio:** 16 dB typ.
Recommended Recalibration Period:	2 years.
Warm-up Time:	< 40 min, immediate operation after boot-up.

Environmental

Storage Temperature:	–20°C to +70°C (81689A) –40°C to +70°C (81689B, 81649A)
Operating Temperature:	15°C to 35°C
Humidity:	< 80% R.H. at 15°C to 35°C Specifications are valid in non-condensing conditions.

Performance Tests

The procedures in this section tests the optical performance of the instrument. The complete specifications to which the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules are tested are given in *"Specifications" on page 33*. All tests can be performed without access to the interior of the instrument. The performance tests refer specifically to tests using the Diamond HMS-10/Agilent connector.

Required Test Equipment

The equipment required for the Performance Test is listed in Table 4. Any equipment that satisfies the critical specifications of the equipment given in Table 4 may be substituted for the recommended models.

Table 4 Equipment Required

Instrument	Description of Instrument/Accessory	#021, #071	#022, #072
Agilent 86142B[1]	Optical Spectrum Analyzer	1	1
Agilent 8164A/B[2]	Lightwave Measurement System	1	1
WA-1500[3]	Burleigh Wavemeter	1	1
81618A or 81619A[4]	Optical Head Interface Module	1	1
81626B [4]	Standard Optical Head	1	1
Agilent 81000SA	DIN 47256/4108 Connector Adapter	1	1
Agilent 81000AI	HMS-10 Connector Interface	1	
Agilent 81000SI	DIN 47256/4108 Connector Interface		1
Agilent 81000FI	FC/PC Connector Interface	1	
Agilent 81101PC	Diamond HMS-10/Agilent FC/PC Patchcord	1	
Agilent 81113PC	Diamond HMS-10/Agilent FC/Super PC Patchcord	1	1
Agilent 81113SC	Diamond HMS-10/Agilent DIN 47256/4108 Patchcord		1

1 You can use the HP 71452B or HP 71450A #100 instead of the Agilent 86142B.

2 You can use the 8163A/B or 8166A/B instead of the 8164A/B

3 You can use the 86120C instead of the WA-1500

4 For the 81689A and 81649A you can use the 81624B or 81627B, instead of the 81626B. For the 81689A, 81689B and 81649A you can use the 81525A + 81533B instead of the 81626B + 81618A

Test Record

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

Test Failure

Always ensure that you use the correct cables and adapters, and that all connectors are undamaged and extremely clean.

If the Agilent 81689A, Agilent 81689B or Agilent 81649A Compact Tunable Laser Modules fails any performance test, return the instrument to the nearest Agilent Technologies Sales/Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument which are certified. These specifications, listed in *"Specifications" on page 33*, are the performance standards or limits against which the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules can be tested.

The specifications also list some supplemental characteristics of the Agilent 81689A, Agilent 81689B and Agilent 81649A Compact Tunable Laser modules. Supplemental characteristics should be considered as additional information.

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

Performance Test Instructions

NOTE

- Make sure that all fiber connectors are clean.
- Turn the instruments on, enable the laser and allow the instruments to warm up.
- Ensure that the Device Under Test (DUT) and all the test equipment is held within the environmental specifications given in *"Specifications" on page 33*

General Test Setup

Insert an Agilent 81689A, Agilent 81689B or Agilent 81649A Compact Tunable Laser Module from the front into slot 1 of the Agilent 8164A/B Lightwave Measurement System.

Wavelength Tests

Connect the Tunable Laser module to the Wavelength Meter as shown in Figure 11.

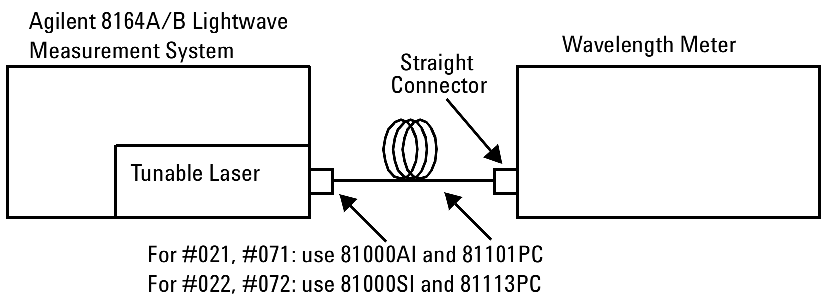

Figure 11 Test Setup for Wavelength Tests

General Settings of Wavelength Meters for all Wavelength Tests

Set the Burleigh WA-1500 to the following settings:

- Set Display to Wavelength.
- Set Medium to Vacuum.
- Set Resolution to Auto.
- Set Averaging to On.
- Set Input Attenuator to Auto.

Wavelength Accuracy

The steps below explain how to calculate the Relative Wavelength Accuracy, and the Absolute Wavelength Accuracy Result.

Relative Wavelength Accuracy

1 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

2 Set the menu parameters to the values shown in Table 5.

Table 5 Tunable Laser Channel Settings

Tunable Laser Channel Menu Parameters	Values
<Wavelength Mode>	*<λ>*
<Source State>	*<Off>*
<Power Unit>	*<dBm>*
<Power Mode>	*<Automatic>*

3 Set the wavelength and power of your Tunable Laser module to the values given in Table 6.

Table 6 Initial Wavelength and Power Settings for Relative Wavelength Accuracy Tests

Module	Wavelength [λ]	Power [*P*]
Agilent 81689A	1525.000 nm	– 3.00 dBm
Agilent 81689B	1525.000 nm	0.00 dBm
Agilent 81649A	1570.000 nm	– 3.00 dBm

4 Press the key beside the laser output to switch on the laser output.

5 Wait until the wavelength meter has settled, then note the wavelength displayed on the wavelength meter in the test record.

6 Increase the wavelength setting of the Tunable Laser module by the steps shown in the test record.

7 Repeat steps 5 and 6 up to the maximum wavelength values shown in Table 7.

Table 7 Maximum Wavelength for Relative Wavelength Accuracy Tests

Tunable Laser Module	Maximum Wavelength Value
Agilent 81689A	1575 nm
Agilent 81689B	1575 nm
Agilent 81649A	1620 nm

8 Repeat steps 3 through 7 another 4 times.

9 From each repetition of the measurements, pick the maximum and minimum deviations, and note these values in the test record.

10 Determine the **Relative Wavelength Accuracy, Summary of all Repetitions**:

a Pick the largest Maximum Deviation, and note it as the Largest Maximum Deviation in the test record.

b Pick the smallest Minimum Deviation, and note it as the Smallest Minimum Deviation in the test record.

NOTE The largest Maximum Deviation is the largest positive value and the smallest Minimum Deviation is the largest negative value (largest deviation above and below zero respectively).

11 Determine the **Relative Wavelength Accuracy Result**:

Subtract the Smallest Minimum Deviation from the Largest Maximum Deviation. Record this value as the **Relative Wavelength Accuracy Result**.

Absolute Wavelength Accuracy

12 From the measurements taken in the Relative Wavelength Accuracy test, pick the largest absolute value from either the Largest Maximum Deviation or the Smallest Minimum Deviation taken in step 11, and note this value as Absolute Wavelength Accuracy.

Wavelength Repeatability

1 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

2 Set the menu parameters to the values shown in Table 5.

3 Set the wavelength and power for each Tunable Laser module to the values given in Table 8.

Table 8 Reference Wavelength and Power Settings for Wavelength Repeatability Tests

Module	Wavelength [λ]	Power [*P*]
Agilent 81689A	1525.000 nm	– 3.00 dBm
Agilent 81689B	1525.000 nm	0.00 dBm
Agilent 81649A	1570.000 nm	– 3.00 dBm

4 Press the key beside the laser output to switch on the laser.

5 Wait until the wavelength meter has settled. Then measure the wavelength with the wavelength meter and note the result in test record as Initial Setting, the reference wavelength, "REF".

6 Set the wavelength of your Tunable Laser module to any wavelength in its range (in the test record, this is given in column “from {wavelength} to REF”).

7 Set the wavelength of your Tunable Laser module back to the Reference Wavelength and wait until the wavelength meter has settled.

8 Measure the wavelength with the Wavelength Meter and note the result in test record.

9 Repeat steps 6 through 8 with all wavelength settings given by "from {wavelength} to REF" in the test record.

10 From all wavelength measurements pick the largest measured value and the smallest measured value.

11 Calculate the wavelength repeatability by subtracting the largest measured value from the smallest measured value.

Power Tests

Maximum Output Power

Make sure the instruments have warmed up before starting the measurement.

NOTE
- Absolute Power Accuracy is not specified.
- The result of the measurement below is greatly influenced by the quality and the matching of the interconnections used.

1 Set up the equipment as shown in Figure 12.

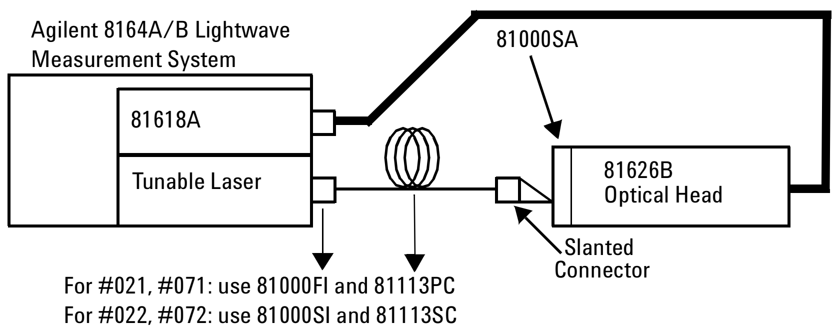

Figure 12 Test Setup for the Maximum Output Power Tests

2 Set the Power Meter to the following settings:

a Select Automatic ranging. This is the default setting.

b Set the Averaging Time to 500 ms.

c Select *dBm* as the power units.

d While the laser is switched off, Zero the power meter. From [Menu] press [Zero].

3 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

4 Set the menu parameters to the values shown in Table 5.

5 Set the wavelength and power for each Tunable Laser module to the values given in Table 9.

Table 9 Reference Wavelength and Power Values for Maximum Output Power Tests

Module	Wavelength [λ]	Power [*P*]
Agilent 81689A	1525.000 nm	+13.00 dBm
Agilent 81689B	1525.000 nm	+13.00 dBm
Agilent 81649A	1570.000 nm	+13.00 dBm

NOTE The laser output is limited to its maximum possible value at this wavelength, the display will probably show `ExP`.

6 Press the key beside the laser output to switch on the laser.

7 Set the wavelength of the 81626B to the same as your Tunable Laser module, as given in Table 9.

8 Measure the output power with the 81626B and note the result for this wavelength in the test record.

9 Increase λ, the output wavelength, of the Tunable Laser module to the next value given in the test record.

10 Increase the wavelength of the 81626B to the same value.

11 Note the measured power in the test record for each wavelength

12 Repeat item 9 to item 11 for the full wavelength range

Power Linearity

Power Linearity - High Power Test

1 Set up the equipment as shown in Figure 12.

2 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

3 Set the menu parameters to the values shown in Table 5.

4 Set the wavelength and power for each Tunable Laser module to the values given in Table 10

Table 10 Wavelength and Power Settings for High Power Linearity Tests without Attenuation

Module	Wavelength [λ]	Power [*P*]
Agilent 81689A	1540.000 nm	+6.000 dBm
Agilent 81689B	1540.000 nm	+10.000 dBm
Agilent 81649A	1600.000 nm	+6.000 dBm

5 Make sure the optical output is switched off.

6 Set the 81626B to the following settings:

a Zero the 81626B; from [Menu] press [Zero].

b Select Automatic ranging. This is the default setting.

c Set the Averaging Time to 500 ms.

d Select dB as the power units.

e Set λ, the wavelength, to the same as your Tunable Laser module, as given in Table 10.

7 Press the key beside the laser output to switch on the laser.

8 Press *Disp–>Ref* on the 81626B.

9 Change the power setting of your Tunable Laser module to the next value listed in the test record and record the power displayed by the 81626B again.

10 Record the (rel;ative) power displayed by the 81626B as the "Measured Relative Power from start".

11 Calculate the "Power Linearity at current setting” as the sum of "Measured Relative Power from start" and "Power Reduction from start".

12 Repeat item 9 to item 11 for all power levels listed in the test record.

13 Note the maximum and minimum values of the calculated Power Linearity values for the various settings and record these in the test record.

14 Subtract the minimum values from the maximum values of the Power Linearity for the various settings. Record these as the **Total Power Linearity**.

Example (Agilent 81689B)

Power Linearity

	Power Setting from start	Measured Relative Power from start		Power reduction from start		Power Linearity at current setting
Start = REF	+ 10.00 dBm	0.00 dB	+	0.00 dB	=	0.00 dB
	+ 9.00 dBm	- 1.02 dB	+	1.00 dB	=	- 0.02 dB
	+ 8.00 dBm	- 1.92 dB	+	2.00 dB	=	+ 0.08 dB
	+ 7.00 dBm	- 3.02 dB	+	3.00 dB	=	- 0.02 dB
	+ 6.00 dBm	- 3.95 dB	+	4.00 dB	=	+ 0.05 dB
	+ 5.00 dBm	- 5.07 dB	+	5.00 dB	=	- 0.07 dB
	+ 4.00 dBm	- 5.96 dB	+	6.00 dB	=	+ 0.04 dB
	+ 3.00 dBm	- 7.05 dB	+	7.00 dB	=	- 0.05 dB
	+ 2.00 dBm	- 8.01 dB	+	8.00 dB	=	- 0.01 dB
	+ 1.00 dBm	- 8.98 dB	+	8.00 dB	=	+ 0.02 dB
	0.00 dBm	- 9.95 dB	+	9.00 dB	=	- 0.05 dB

Maximum Power Linearity at current setting	+ 0.08 dB
Minimum Power Linearity at current setting	- 0.07 dB
Total Power Linearity = (Max Power Linearity - Min Power Linearity)	0.15 dBpp

Power Flatness over Wavelength

Power Flatness over Wavelength

1 Set up the equipment as shown in Figure 12

2 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

3 Set the menu parameters to the values shown in Table 5.

4 Set the wavelength and power for each Tunable Laser module to the values given in Table 11.

Table 11 Wavelength and Power Settings for Power Flatness over Wavelength at maximum output power

Module	Wavelength [λ]	Power [P]
Agilent 81689A	1525.000 nm	+6.000 dBm
Agilent 81689B	1525.000 nm	+10.000 dBm
Agilent 81649A	1570.000 nm	+6.000 dBm

5 Set the power meter channel of the 81626B to the following settings:

   a While the laser is switched off, Zero the power meter; from [Menu], select [Zero].

   b Select Automatic ranging. This is the default setting.

   c Set the Averaging Time to 500 ms.

   d Set λ, the wavelength, to the same as your Tunable Laser module, as given in Table 11.

   e Select dB as the power units.

6 Press the key beside the laser output to switch on the laser.

7 Select the channel for the 81626B. Press the *DISP->REF* hardkey.

8 Increase the wavelength of the Tunable Laser module and of the Power Meter to the next value listed in the test record.

9 Measure the change in output power. Note this value (in dB) in the test record.

10 Repeat steps 7 and 8 for the wavelength settings given in the test record.

11 From the measurement results calculate the difference between the maximum and minimum deviation from REF and note the result as the Flatness.

12 Set wavelength and power as given in Table 12..

Table 12 Wavelength and Power Settings for Power Flatness over Wavelength at minimum output power

Module	Wavelength [λ]	Power [P]
Agilent 81689A	1525.000 nm	- 3.000 dBm
Agilent 81689B	1525.000 nm	+0.000 dBm
Agilent 81649A	1570.000 nm	- 3.000 dBm

13 Set the power meter channel of the 81626B to the following settings:

- **a** Select Automatic ranging. This is the default setting.
- **b** Set the Averaging Time to 500 ms.
- **c** Set λ, the wavelength, to the same as your Tunable Laser module, as given in Table 12.
- **d** Select dB as the power units.

14 Make sure the laser is switched on.

15 Select the channel for the 81626B. Press the *DISP->REF* hardkey.

16 Increase the wavelength of the Tunable Laser module and of the Power Meter to the next value listed in the test record.

17 Measure the change in output power. Note this value (in dB) in the test record.

18 Repeat steps 15 and 16 for the wavelength settings given in the test record.

19 From the measurement results calculate the difference between the maximum and minimum deviation from REF and note the result as the Flatness.

Power Stability

Follow the steps below to measure the power stability:

1 Set up the equipment as shown in Figure 12.

2 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

3 Set the menu parameters to the values shown in Table 5.

4 Set the wavelength and power for each Tunable Laser module to the values given in Table 13.

Table 13 Wavelength and Power Settings for Power Stability Tests

Module	Wavelength [λ]	Power [*P*]
Agilent 81689A	1540.000 nm	– 3.00 dBm
Agilent 81689B	1540.000 nm	– 0.00 dBm
Agilent 81649A	1570.000 nm	– 3.00 dBm

5 Make sure the optical output is switched off.

6 Zero the power meter. From [Menu], select [Zero].

7 Press the key beside the laser output to switch on the laser.

8 Select the logging application. Press [Appl], select [Logging]

9 Within the logging application, set the power meter:

- Set λ, the wavelength, to the same as your Tunable Laser module, as given in Table 13.
- Set Range to 0 dB
- Set Ref mode to Value
- Set Samples to 4000
- Set the Average Time to 200 ms
- Set Range mode to common
- Set Power Unit to dB
- Set Ref to the value given in Table 13.

10 Start the Logging Application by pressing [Measure]
A measurement progress indicator is displayed.

11 When the measurement is completed, select [Analysis]

12 From the Statistics window, note:

- the “max” value in the Maximum Deviation field of the test record,
- the “min” value in the Minimum Deviation field of the test record,

- the "ΔP" value in the Power Stability field of the test record.

NOTE It is sufficient to test Power Stability for approximately 15 minutes, rather than 1 hour, since this ensures that the power control loop works correctly.

Optional Tests

Signal-to-Source Spontaneous Emission

See *"Specifications" on page 33* for a definition of Signal-to-Source Spontaneous Emission.

Signal-to-Source Spontaneous Emission Tests

1 Connect the Tunable Laser module to the Optical Spectrum Analyzer as shown in Figure 13.

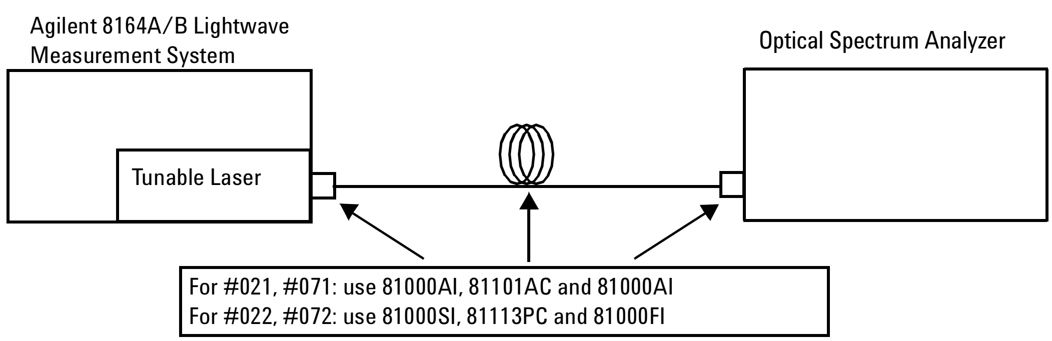

Figure 13 Test Setup for the Source Spontaneous Emission Test - High Power Outputs

2 Move to the Tunable Laser channel of the Agilent 8164A/B Lightwave Measurement System and press [Menu].

3 Set the menu parameters to the values shown in Table 5

4 Make sure that the optical power output is switched off.

5 Set the wavelenght of your Tunable Laser module to the value given in Table 14.

Table 14 Wavelength Settings for Source Spontaneous Emmission Tests

Module	**Wavelength** [λ]
Agilent 81689A	1525.000 nm
Agilent 81689B	1525.000 nm
Agilent 81649A	1570.000 nm

6 Set the power for each Tunable Laser module to the maximum specified output power given in the Test Record.

7 Press the key beside the laser output to switch on the laser.

8 Initialize the Optical Specrum Analyzer. Press [Preset] (the green hardkey) and [Auto Meas].

9 Set the Optical Spectrum Analyzer:

   a Set Span to 4 nm. Press [Span], enter the value.

   b Set the Resolution Bandwidth to 0.5 nm. Press [Res BW] and enter the value.

   c Set the Sensitivity to -60 dBm. Press [SENS], and enter the value.

10 On the Spectrum Analyser, set the Marker to the highest peak. Press [Peak Search]

11 Select a second marker. Press [Δ] (delta).

12 Use the RPG, the Modify knob, to view and move the second marker to the highest peak of the displayed side modes and note the difference, delta, between the two markers as an absolute number.

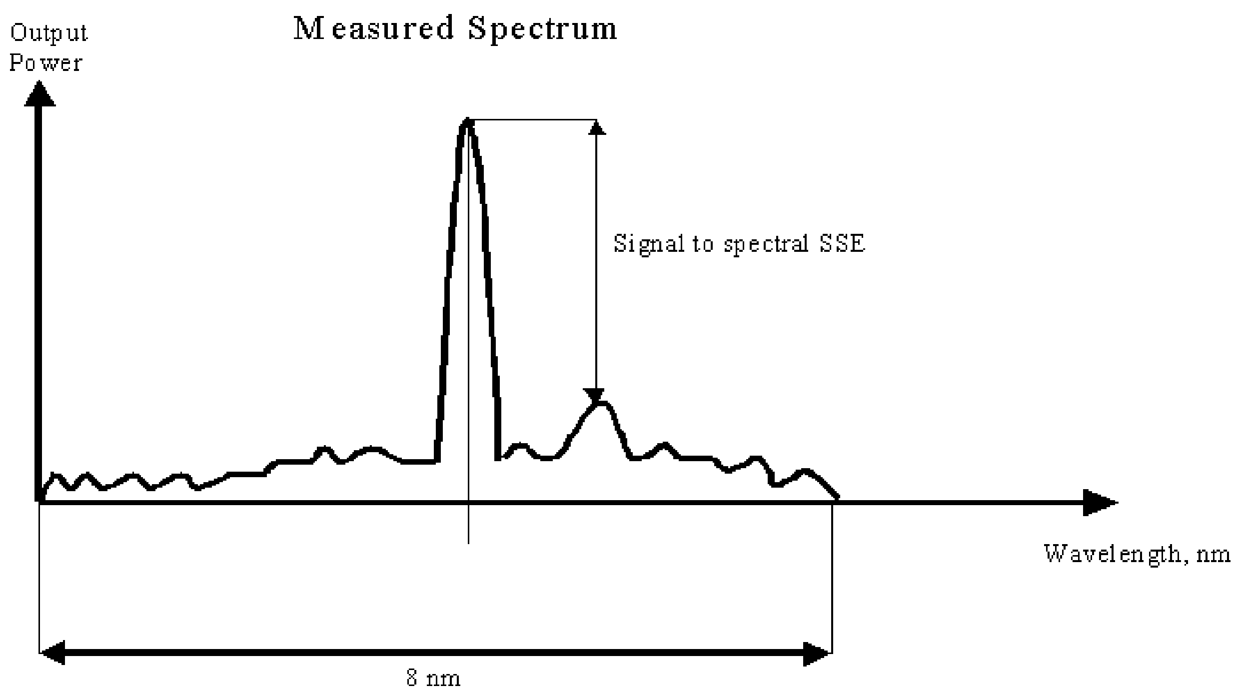

Figure 14 Signal-to-Spectral SSE Measurement

13 To reflect for a specified value at 1 nm bandwidth related to the measurement bandwidth of 0.5 nm, reduce the measured absolute value by 3 dB and note the result in the test record.

For example:

measured value at RES BW = 0.05 nm BW	- 44.5 dB
absolute of measured value at RES BW = 0.05 nm BW	44.5 dB
correction to a RES BW = 1 nm	44.5 dB - 3 dB = 41.5 dB
Result noted in Test Record	41.5 dB

14 Increase the wavelength of the Tunable Laser by 10 nm as listed in the Test Record.

Change the Center Wavelength of the Specrum analyser accordingly. Press [Center], then enter the new wavelength.

You can fine-tune the actual wavelength to the center of the display by using the Modify knob.

15 Repeat steps 10 to 14 for the wavelength range listed in the Test Record.

Test Record

Test Record

Agilent 81689A Performance Test

Page 1 of 7

Test Facility:

___________________________________ Report No. __________________

___________________________________ Date __________________

___________________________________ Customer __________________

___________________________________ Tested By __________________

Model Agilent 81689A Tunable Laser Module 1550 nm

Serial No. ______________________ Ambient temperature _________°C

Options ______________________ Relative humidity _________ %

Firmware Rev. ______________________ Line frequency _________ Hz

Special Notes:

____

____

____

____

____

____

Agilent 81689A Performance Test

Page 2 of 7

Model Agilent 81689A Tunable Laser Report No. ________ Date_______

Test Equipment Used

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	8164A/B	_________	____n/a___
2. Lightwave Multimeter	8163A/B	_________	____n/a___
3. Optical Head Interface Module	81618A	_________	____n/a___
Optical Head Interface Module	81619A	_________	____n/a___
4. Standard Optical Head	81626B	_________	_________
Standard Optical Head	___________	_________	_________
5. Optical Spectrum Analyzer	___________	_________	_________
6. Wavelength Meter	___________	_________	_________
7. __________________________	___________	_________	_________
8. __________________________	___________	_________	_________
9. __________________________	___________	_________	_________
10. __________________________	___________	_________	_________
11. __________________________	___________	_________	_________
12. __________________________	___________	_________	_________
13. __________________________	___________	_________	_________
14. __________________________	___________	_________	_________

Agilent 81689A Performance Test Page 3 of 7
Model Agilent 81689A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy

	Repetition 1		Repetition 2		Repetition 3	
Wavelength Setting	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**
1525.000 nm	nm	nm	nm	nm	nm	nm
1535.000 nm	nm	nm	nm	nm	nm	nm
1545.000 nm	nm	nm	nm	nm	nm	nm
1555.000 nm	nm	nm	nm	nm	nm	nm
1565.000 nm	nm	nm	nm	nm	nm	nm
1575.000 nm	nm	nm	nm	nm	nm	nm
Within full Tuning Range 1525 to 1575 nm						
Maximum Deviation		nm		nm		nm
Minimum Deviation		nm		nm		nm

	Repetition 4		Repetition 5	
Wavelength Setting	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**
1525.000 nm	nm	nm	nm	nm
1535.000 nm	nm	nm	nm	nm
1545.000 nm	nm	nm	nm	nm
1555.000 nm	nm	nm	nm	nm
1565.000 nm	nm	nm	nm	nm
1575.000 nm	nm	nm	nm	nm
Within full Tuning Range 1525 to 1575 nm				
Maximum Deviation		nm		nm
Minimum Deviation		nm		nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

Relative Wavelength Accuracy Largest Maximum Deviation ________nm

Summary of All Repetitions Smallest Minimum Deviation _______nm

Relative Wavelength Accuracy Result (= Largest Maximum Deviation – Smallest Minimum Deviation)
Relative Wavelength Accuracy _______nm

Specification: 0.6 nm
Measurement Uncertainty: ± 0.2 pm

Agilent 81689A Performance Test Page 4 of 7
Model Agilent 81689A Tunable Laser Report No. ________ Date________

Absolute Wavelength Accuracy Result

Largest Value of Deviation (= largest value of either Largest Maximum Deviation or Smallest Minimum Deviation)

Absolute Wavelength Accuracy ______nm

Test Limit: 1.0 nm

Specification: 0.6 nm typical

Measurement Uncertainty: ± 0.6 pm

Wavelength Repeatability

Repeatability of 1525.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1535.000 nm to REF	nm
from 1540.000 nm to REF	nm
from 1550.000 nm to REF	nm
from 1560.000 nm to REF	nm
from 1575.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Repeatability of 1550.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1525.000 nm to REF	nm
from 1535.000 nm to REF	nm
from 1540.000 nm to REF	nm
from 1560.000 nm to REF	nm
from 1575.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Repeatability of 1575.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1525.000 nm to REF	nm
from 1535.000 nm to REF	nm
from 1540.000 nm to REF	nm
from 1550.000 nm to REF	nm
from 1560.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Measurement Uncertainty: ± 0.1 pm

Agilent 81689A Performance Test

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Model Agilent 81689A Tunable Laser Report No. ________ Date_______

Maximum Power Test

Wavelength Setting	Power Measured	Minimum Specification
1525.000 nm	dBm	+ 6.00 dBm
1535.000 nm	dBm	+ 6.00 dBm
1540.000 nm	dBm	+ 6.00 dBm
1550.000 nm	dBm	+ 6.00 dBm
1560.000 nm	dBm	+ 6.00 dBm
1570.000 nm	dBm	+ 6.00 dBm
1575.000 nm	dBm	+ 6.00 dBm

Measurement Uncertainty: ± 0.10 dB

Power Linearity

	Power Setting from start	Measured Relative Power from start		Power reduction from start		Power Linearity at current setting
Start = REF	+ 6.00 dBm	0.00 dB	+	0.00 dB	=	0.00 dB
	+ 5.00 dBm	dB	+	1.00 dB	=	dB
	+ 4.00 dBm	dB	+	2.00 dB	=	dB
	+ 3.00 dBm	dB	+	3.00 dB	=	dB
	+ 2.00 dBm	dB	+	4.00 dB	=	dB
	+ 1.00 dBm	dB	+	5.00 dB	=	dB
	– 0.0 dBm	dB	+	6.00 dB	=	dB
	– 1.0 dBm	dB	+	7.00 dB	=	dB
	– 2.0 dBm	dB	+	8.00 dB	=	dB
	– 3.0 dBm	dB	+	9.00 dB	=	dB

Maximum Power Linearity at current setting ______dB

Minimum Power Linearity at current setting ______dB

Total Power Linearity = (Max Power Linearity – Min Power Linearity) ______dBpp

Specification 0.2 dBpp

Measurement Uncertainty ± 0.05 dB

Agilent 81689A Performance Test Page 6 of 7
Model Agilent 81689A Tunable Laser Report No. ________ Date_______

Power Flatness

	Wavelength	Power Deviation at P = + 6.0 dBm	Power Deviation at P = - 3.0 dBm
Start = REF	1525 nm	0.00 dB	0.00 dB
	1530 nm	dB	dB
	1540 nm	dB	dB
	1550 nm	dB	dB
	1560 nm	dB	dB
	1570 nm	dB	dB
	1575 nm	dB	dB
	Maximum deviation	dB	dB
	Minimum deviation	dB	dB
Flatness =	Maximum – Minimum Deviation	dB	dB
	Specification	0.60 dBpp	0.60 dBpp
	Measurement Uncertainty	± 0.10 dB	± 0.10 dB

Power Stability

	P = – 3.0 dBm
Maximum Deviation	dB
Minimum Deviation	dB
Power Stability[1]	dB
Specification	0.06 dBpp
Measurement Uncertainty	± 0.005 dB

[1] Power Stability = Maximum Deviation – Minimum Deviation

Agilent 81689A Performance Test | Page 7 of 7
Model Agilent 81689A Tunable Laser | Report No. ________ Date_______

Optional Test

Signal-to-Source Spontaneous Emission (BW = 1 nm)

Wavelength	Output Power	Results	Minimum Test Limit	Typical
1525 nm	+ 6.00 dBm	dB	30 dB	39 dB
1535 nm	+ 6.00 dBm	dB	30 dB	39 dB
1545 nm	+ 6.00 dBm	dB	30 dB	39 dB
1555 nm	+ 6.00 dBm	dB	30 dB	39 dB
1565 nm	+ 6.00 dBm	dB	30 dB	39 dB
1575 nm	+6.00 dBm	dB	30 dB	39 dB

Measurement Uncertainty: ± 0.20 dB

Test Record

Agilent 81689B Performance Test

Test Facility:

_________________________________ Report No. _________________

_________________________________ Date _________________

_________________________________ Customer _________________

_________________________________ Tested By _________________

Model Agilent 81689B Tunable Laser Module 1550 nm

Serial No. ____________________ Ambient temperature ________°C

Options ____________________ Relative humidity ________ %

Firmware Rev. ____________________ Line frequency ________ Hz

Special Notes:

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Agilent 81689B Performance Test

Page 2 of 7

Model Agilent 81689B Tunable Laser Report No. ________ Date_______

Test Equipment Used

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	8164A/B	_________	____n/a___
2. Lightwave Multimeter	8163A/B	_________	____n/a___
3. Optical Head Interface Module	81618A	_________	____n/a___
Optical Head Interface Module	81619A	_________	____n/a___
4. Standard Optical Head	81626B	_________	_________
Standard Optical Head	___________	_________	_________
5. Optical Spectrum Analyzer	___________	_________	_________
6. Wavelength Meter	___________	_________	_________
7. __________________________	___________	_________	_________
8. __________________________	___________	_________	_________
9. __________________________	___________	_________	_________
10. __________________________	___________	_________	_________
11. __________________________	___________	_________	_________
12. __________________________	___________	_________	_________
13. __________________________	___________	_________	_________
14. __________________________	___________	_________	_________

Agilent 81689B Performance Test Page 3 of 7
Model Agilent 81689B Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy

	Repetition 1		Repetition 2		Repetition 3	
Wavelength Setting	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**
1525.000 nm	nm	nm	nm	nm	nm	nm
1535.000 nm	nm	nm	nm	nm	nm	nm
1545.000 nm	nm	nm	nm	nm	nm	nm
1555.000 nm	nm	nm	nm	nm	nm	nm
1565.000 nm	nm	nm	nm	nm	nm	nm
1575.000 nm	nm	nm	nm	nm	nm	nm
Within full Tuning Range 1525 to 1575 nm						
Maximum Deviation		nm		nm		nm
Minimum Deviation		nm		nm		nm

	Repetition 4		Repetition 5	
Wavelength Setting	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**
1525.000 nm	nm	nm	nm	nm
1535.000 nm	nm	nm	nm	nm
1545.000 nm	nm	nm	nm	nm
1555.000 nm	nm	nm	nm	nm
1565.000 nm	nm	nm	nm	nm
1575.000 nm	nm	nm	nm	nm
Within full Tuning Range 1525 to 1575 nm				
Maximum Deviation		nm		nm
Minimum Deviation		nm		nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

Relative Wavelength Accuracy Largest Maximum Deviation ________nm

Summary of All Repetitions Smallest Minimum Deviation _______nm

Relative Wavelength Accuracy Result (= Largest Maximum Deviation – Smallest Minimum Deviation)
Relative Wavelength Accuracy _______nm

Specification: 0.3 nm
Measurement Uncertainty: ± 0.2 pm

Agilent 81689B Performance Test Page 4 of 7
Model Agilent 81689B Tunable Laser Report No. ________ Date_______

Absolute Wavelength Accuracy Result

Largest Value of Deviation (= largest value of either Largest Maximum Deviation or Smallest Minimum Deviation)

Absolute Wavelength Accuracy _______nm

Test Limit:	1.0 nm
Specification:	0.6 nm typical
Measurement Uncertainty:	± 0.6 pm

Wavelength Repeatability

Repeatability of 1525.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1535.000 nm to REF	nm
from 1540.000 nm to REF	nm
from 1550.000 nm to REF	nm
from 1560.000 nm to REF	nm
from 1575.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Repeatability of 1550.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1525.000 nm to REF	nm
from 1535.000 nm to REF	nm
from 1540.000 nm to REF	nm
from 1560.000 nm to REF	nm
from 1575.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Repeatability of 1575.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1525.000 nm to REF	nm
from 1535.000 nm to REF	nm
from 1540.000 nm to REF	nm
from 1550.000 nm to REF	nm
from 1560.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Measurement Uncertainty: ± 0.1 pm

Agilent 81689B Performance Test

Page 5 of 7

Model Agilent 81689B Tunable Laser Report No. ________ Date_______

Maximum Power Test

Wavelength Setting	Power Measured	Minimum Specification
1525.000 nm	dBm	+ 10.00 dBm
1535.000 nm	dBm	+ 10.00 dBm
1540.000 nm	dBm	+ 10.00 dBm
1550.000 nm	dBm	+ 10.00 dBm
1560.000 nm	dBm	+ 10.00 dBm
1570.000 nm	dBm	+ 10.00 dBm
1575.000 nm	dBm	+ 10.00 dBm

Measurement Uncertainty: ± 0.10 dB

Power Linearity

	Power Setting from start	Measured Relative Power from start		Power reduction from start		Power Linearity at current setting
Start = REF	+ 10.00 dBm	0.00 dB	+	0.00 dB	=	0.00 dB
	+ 9.00 dBm	dB	+	1.00 dB	=	dB
	+ 8.00 dBm	dB	+	2.00 dB	=	dB
	+ 7.00 dBm	dB	+	3.00 dB	=	dB
	+ 6.00 dBm	dB	+	4.00 dB	=	dB
	+ 5.00 dBm	dB	+	5.00 dB	=	dB
	+ 4.00 dBm	dB	+	6.00 dB	=	dB
	+ 3.00 dBm	dB	+	7.00 dB	=	dB
	+ 2.00 dBm	dB	+	8.00 dB	=	dB
	+ 1.00 dBm	dB	+	9.00 dB	=	dB
	0.00 dBm	dB	+	10.00 dB	=	dB

Maximum Power Linearity at current setting ______dB

Minimum Power Linearity at current setting ______dB

Total Power Linearity = (Max Power Linearity – Min Power Linearity) ______dBpp

Specification 0.2 dBpp

Measurement Uncertainty ± 0.05 dB

Agilent 8168B Performance Test Page 6 of 7

Model Agilent 81689B Tunable Laser Report No. ________ Date_______

Power Flatness

	Wavelength	Power Deviation at P = + 10.0 dBm	Power Deviation at P = - 3.0 dBm
Start = REF	1525 nm	0.00 dB	0.00 dB
	1530 nm	dB	dB
	1540 nm	dB	dB
	1550 nm	dB	dB
	1560 nm	dB	dB
	1570 nm	dB	dB
	1575 nm	dB	dB
	Maximum deviation	dB	dB
	Minimum deviation	dB	dB
Flatness =	Maximum – Minimum Deviation	dB	dB
	Specification	0.40 dBpp	0.40 dBpp
	Measurement Uncertainty	± 0.10 dB	± 0.10 dB

Power Stability

	P = 0.0 dBm
Maximum Deviation	dB
Minimum Deviation	dB
Power Stability[1]	dB
Specification	0.03 dBpp
Measurement Uncertainty	± 0.005 dB

[1] Power Stability = Maximum Deviation – Minimum Deviation

Agilent 81689B Performance Test Page 7 of 7
Model Agilent 81689B Tunable Laser Report No. ________ Date_______

Optional Test

Signal-to-Source Spontaneous Emission (BW = 1 nm)

Wavelength	Output Power	Results	Minimum Test Limit	Typical
1525 nm	+ 10.00 dBm	dB	40 dB	44 dB
1535 nm	+ 10.00 dBm	dB	40 dB	44 dB
1545 nm	+ 10.00 dBm	dB	40 dB	44 dB
1555 nm	+ 10.00 dBm	dB	40 dB	44 dB
1565 nm	+ 10.00 dBm	dB	40 dB	44 dB
1575 nm	+ 10.00 dBm	dB	40 dB	44 dB

Measurement Uncertainty: ± 0.20 dB

Test Record

Agilent 81649A Performance Test

Page 1 of 8

Test Facility:

____________________________________ Report No. ___________________

____________________________________ Date ___________________

____________________________________ Customer ___________________

____________________________________ Tested By ___________________

Model Agilent 81649A Tunable Laser Module 1595 nm

Serial No. ______________________ Ambient temperature _________°C

Options ______________________ Relative humidity _________ %

Firmware Rev. ______________________ Line frequency _________ Hz

Special Notes:

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Agilent 81649A Performance Test

Page 2 of 8

Model Agilent 81649A Tunable Laser Report No. ________ Date_______

Test Equipment Used

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	8164A/B	_________	____n/a___
2. Lightwave Multimeter	8163A/B	_________	____n/a___
3. Optical Head Interface Module	81618A	_________	____n/a___
Optical Head Interface Module	81619A	_________	____n/a___
4. Standard Optical Head	81626B	_________	_________
Standard Optical Head	___________	_________	_________
5. Optical Spectrum Analyzer	___________	_________	_________
6. Wavelength Meter	___________	_________	_________
7. __________________________	___________	_________	_________
8. __________________________	___________	_________	_________
9. __________________________	___________	_________	_________
10. __________________________	___________	_________	_________
11. __________________________	___________	_________	_________
12. __________________________	___________	_________	_________
13. __________________________	___________	_________	_________
14. __________________________	___________	_________	_________

Agilent 81649A Performance Test | Page 3 of 8
Model Agilent 81649A Tunable Laser | Report No. ________ Date_______

Relative Wavelength Accuracy

	Repetition 1		Repetition 2		Repetition 3	
Wavelength Setting	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**
1570.000 nm	nm	nm	nm	nm	nm	nm
1575.000 nm	nm	nm	nm	nm	nm	nm
1580.000 nm	nm	nm	nm	nm	nm	nm
1585.000 nm	nm	nm	nm	nm	nm	nm
1590.000 nm	nm	nm	nm	nm	nm	nm
1595.000 nm	nm	nm	nm	nm	nm	nm
1600.000 nm	nm	nm	nm	nm	nm	nm
1605.000 nm	nm	nm	nm	nm	nm	nm
1610.000 nm	nm	nm	nm	nm	nm	nm
1615.000 nm	nm	nm	nm	nm	nm	nm
1620.000 nm	nm	nm	nm	nm	nm	nm
Within full Tuning Range 1525 to 1620 nm						
Maximum Deviation		nm	nm		nm	
Minimum Deviation		nm	nm		nm	

	Repetition 4		Repetition 5	
Wavelength Setting	**Wavelength Measured**	**Wavelength Deviation [1]**	**Wavelength Measured**	**Wavelength Deviation [1]**
1570.000 nm	nm	nm	nm	nm
1575.000 nm	nm	nm	nm	nm
1580.000 nm	nm	nm	nm	nm
1585.000 nm	nm	nm	nm	nm
1590.000 nm	nm	nm	nm	nm
1595.000 nm	nm	nm	nm	nm
1600.000 nm	nm	nm	nm	nm
1605.000 nm	nm	nm	nm	nm
1610.000 nm	nm	nm	nm	nm
1615.000 nm	nm	nm	nm	nm
1620.000 nm	nm	nm	nm	nm
Within full Tuning Range 1570 to 1620 nm				
Maximum Deviation		nm	nm	
Minimum Deviation		nm	nm	

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

Agilent 81649A Performance Test Page 4 of 8
Model Agilent 81649A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy Largest Maximum Deviation _______nm

Summary of All Repetitions Smallest Minimum Deviation ______nm

Relative Wavelength Accuracy Result (= Largest Maximum Deviation – Smallest Minimum Deviation)
Relative Wavelength Accuracy ______nm

Specification: 0.3 nm
Measurement Uncertainty: ± 0.2 pm

Absolute Wavelength Accuracy Result Largest Value of Deviation (= largest value of either Largest Maximum Deviation or Smallest Minimum Deviation)

Absolute Wavelength Accuracy ______nm

Test Limit: 1.0 nm

Specification: 0.6 nm typical

Measurement Uncertainty: ± 0.6 pm

Wavelength Repeatability

Repeatability of 1570.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1580.000 nm to REF	nm
from 1590.000 nm to REF	nm
from 1600.000 nm to REF	nm
from 1610.000 nm to REF	nm
from 1620.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Repeatability of 1595.000 nm (= reference)	Measurement Result
Initial Setting	REF = nm
from 1570.000 nm to REF	nm
from 1580.000 nm to REF	nm
from 1590.000 nm to REF	nm
from 1610.000 nm to REF	nm
from 1620.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Measurement Uncertainty: ± 0.1 pm

Agilent 81689A Performance Test

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Model Agilent 81689A Tunable Laser Report No. ________ Date_______

Repeatability of 1620.000 nm (= reference)	**Measurement Result**
Initial Setting	REF = nm
from 1570000 nm to REF	nm
from 1580.000 nm to REF	nm
from 1590.000 nm to REF	nm
from 1600.000 nm to REF	nm
from 1610.000 nm to REF	nm
largest measured wavelength	nm
smallest measured wavelength	nm
Wavelength Repeatability	nm
= largest measured wavelength - smallest measured wavelength	
Specification	0.10 nm

Measurement Uncertainty: ± 0.1 pm

Maximum Power Test

Wavelength Setting	Power Measured	Minimum Specification
1570.000 nm	dBm	+ 6.00 dBm
1575.000 nm	dBm	+ 6.00 dBm
1580.000 nm	dBm	+ 6.00 dBm
1585.000 nm	dBm	+ 6.00 dBm
1590.000 nm	dBm	+ 6.00 dBm
1595.000 nm	dBm	+ 6.00 dBm
1600.000 nm	dBm	+ 6.00 dBm
1605.000 nm	dBm	+ 6.00 dBm
1610.000 nm	dBm	+ 6.00 dBm
1615.000 nm	dBm	+ 6.00 dBm
1620.000 nm	dBm	+ 6.00 dBm

Measurement Uncertainty: ± 0.10 dB

Agilent 81649A Performance Test

Page 6 of 8

Model Agilent 81649A Tunable Laser Report No. ________ Date_______

Power Linearity

	Power Setting from start	Measured Relative Power from start		Power reduction from start		Power Linearity at current setting
Start = REF	+ 6.00 dBm	0.00 dB	+	0.00 dB	=	0.00 dB
	+ 5.00 dBm	dB	+	1.00 dB	=	dB
	+ 4.00 dBm	dB	+	2.00 dB	=	dB
	+ 3.00 dBm	dB	+	3.00 dB	=	dB
	+ 2.00 dBm	dB	+	4.00 dB	=	dB
	+ 1.00 dBm	dB	+	5.00 dB	=	dB
	– 0.0 dBm	dB	+	6.00 dB	=	dB
	– 1.0 dBm	dB	+	7.00 dB	=	dB
	– 2.0 dBm	dB	+	8.00 dB	=	dB
	– 3.0 dBm	dB	+	9.00 dB	=	dB

Maximum Power Linearity at current setting	______dB
Minimum Power Linearity at current setting	______dB
Total Power Linearity = (Max Power Linearity – Min Power Linearity)	______dBpp
Specification	0.2 dBpp
Measurement Uncertainty	± 0.05 dB

Agilent 81689A Performance Test Page 7 of 8
Model Agilent 81689A Tunable Laser Report No. ________ Date_______

Power Flatness

	Wavelength	Power Deviation at P = + 6.0 dBm	Power Deviation at P = - 3.0 dBm
Start = REF	1570 nm	0.00 dB	0.00 dB
	1575 nm	dB	dB
	1580 nm	dB	dB
	1585 nm	dB	dB
	1590 nm	dB	dB
	1595 nm	dB	dB
	1600 nm	dB	dB
	1605 nm	dB	dB
	1610 nm	dB	dB
	1615 nm	dB	dB
	1620 nm	dB	dB
	Maximum deviation	dB	dB
	Minimum deviation	dB	dB
Flatness =	Maximum – Minimum Deviation	dB	dB
	Specification	0.40 dBpp	0.40 dBpp
	Measurement Uncertainty	± 0.10 dB	± 0.10 dB

Power Stability

	P = – 3.0 dBm
Maximum Deviation	dB
Minimum Deviation	dB
Power Stability[1]	dB
Specification	0.03 dBpp
Measurement Uncertainty	± 0.005 dB

[1] Power Stability = Maximum Deviation – Minimum Deviation

Agilent 81649A Performance Test Page 8 of 8
Model Agilent 81649A Tunable Laser Report No. ________ Date_______

Optional Test

Signal-to-Source Spontaneous Emission (BW = 1 nm)

Wavelength	Output Power	Results	Minimum Test Limit	Typical
1525 nm	+ 6.00 dBm	dB	37 dB	42 dB
1535 nm	+ 6.00 dBm	dB	37 dB	42 dB
1545 nm	+ 6.00 dBm	dB	37 dB	42 dB
1555 nm	+ 6.00 dBm	dB	37 dB	42 dB
1565 nm	+ 6.00 dBm	dB	37 dB	42 dB
1575 nm	+6.00 dBm	dB	37 dB	42 dB

Measurement Uncertainty: ± 0.20 dB

Cleaning Information

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

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

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

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

Cleaning Instructions for this Instrument

This Cleaning Information applies to a number of different types of Optical Equipment.

"How to clean instruments with a physical contact interface" on page 103 is particularly relevant to this module.

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

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

Isopropyl alcohol

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

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

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

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

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

Cotton swabs

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

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

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

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

Soft tissues

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

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

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

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

Pipe cleaner

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

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

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 cause damage.

Warm water and liquid soap

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage. Do not use 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.

Always keep the caps on the equipment 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

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

Cleaning Instrument Housings

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 Instrument" on page 90* 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 a skilled person, and as a last resort as it wears out your connector.

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

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

Preferred Procedure

Use the following procedure on most occasions.

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

2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

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

1 Moisten a new cotton swab with isopropyl alcohol.

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

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

4 Blow away any remaining lint with compressed air.

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 adapters

CAUTION

Some adapters have an anti-reflection coating on the back to reduce back reflection. This coating is extremely sensitive to solvents and mechanical abrasion. Extra care is needed when cleaning these adapters.

Preferred Procedure

Use the following procedure on most occasions.

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

2 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

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

1 Moisten a new cotton swab with isopropyl alcohol.

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

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

4 Blow away any remaining lint with compressed air.

How to clean 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 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.
- Deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

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

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 lenses

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

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

Preferred Procedure

Use the following procedure on most occasions.

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

Procedure for Stubborn Dirt

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

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

How to clean instruments with a fixed connector interface

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

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

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 become misaligned.

How to clean instruments with an optical glass plate

Some instruments, for example, the optical heads from Agilent Technologies have an optical glass plate to protect the sensor. Clean this glass plate in the same way as optical lenses (see *"How to clean lenses" on page 102*).

How to clean instruments with a physical contact interface

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

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

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

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

Preferred Procedure

Use the following procedure on most occasions.

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

Procedure for Stubborn Dirt

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

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

How to clean instruments with a recessed lens interface

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

Keep your dust and shutter caps on when your instrument is not in use. This should prevent it from getting too dirty. If you must clean such instruments, please refer the instrument to the skilled personnel of Agilent’s service team.

Preferred Procedure

Use the following procedure on most occasions.

1. Blow away any dust or dirt with compressed air.
   If this is not sufficient, then
2. 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 when there is greasy dirt on the interface, and using the preferred procedure is not sufficient. Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface:

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

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

Some optical devices, such as the Agilent 81000BR Reference Reflector, which has a gold plated surface, are very sensitive to mechanical stress or pressure. Do not use cotton swabs, soft tissues or other mechanical cleaning tools, as these can scratch or destroy the surface.

Preferred Procedure

Use the following procedure on most occasions.

1. Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

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

1 Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.

2 Remove the film and any dirt with special adhesive tapes.

Alternative Procedure

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

1 Put the device into the bath for at least three minutes.

2 Blow away any remaining liquid with compressed air.

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

How to clean metal filters or attenuator gratings

This kind of device is extremely fragile. A misalignment of the grating leads to inaccurate measurements. Never touch the surface of the metal filter or attenuator grating. Be very careful when using or cleaning these devices. Do not use cotton swabs or soft tissues, as there is the danger that you cannot remove the lint and that the device will be destroyed by becoming mechanically distorted.

Preferred Procedure

Use the following procedure on most occasions.

1 Use compressed air at a distance and with low pressure to remove any dust or lint.

Procedure for Stubborn Dirt

Do not use an ultrasonic bath as this can damage your device.

Use this procedure when there is greasy dirt on the device:

1 Put the optical device into a bath of isopropyl alcohol, and wait at least 10 minutes.

2 Remove the fluid using compressed air at some distance and with low pressure. If there are any streaks or drying stains on the surface, repeat the whole cleaning procedure.

Additional Cleaning Information

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

- How to clean bare fiber ends
- How to clean large area lenses and mirrors

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.

How to clean large area lenses and mirrors

Some mirrors, as those from a monochromator, are very soft and sensitive. Therefore, never touch them and do not use cleaning tools such as compressed air or polymer film.

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

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

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

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

CAUTION

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage.

Do not use 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.

1 Moisten the lens or the mirror with water.
2 Put a little liquid soap on the surface and gently spread the liquid over the whole area.
3 Wash off the emulsion with water, being careful to remove it all, as any remaining streaks can impair measurement accuracy.
4 Take a new, dry soft tissue and remove the water, by rubbing gently over the surface using a small circular movement.
5 Blow away remaining lint with compressed air.

Alternative Procedure A

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

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

Alternative Procedure B

If your lens is sensitive to water then:

1 Moisten the lens or the mirror with isopropyl alcohol.
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 remaining lint with compressed air.

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 the appropriate 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

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.

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