HP 81680A, HP 81682A, HP 81640A, & HP 81689A Tunable Laser Modules

User's Guide

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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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HP 81680A, HP 81682A, HP 81640A, & HP 81689A
Tunable Laser Modules

User's Guide

Safety Summary

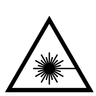
The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company 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 Hewlett-Packard 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.).**

Line Power Requirements

The HP 81680A, HP 81682A, HP 81640A, & HP 81689A Tunable Laser Modules operate when installed in the HP 8164A Lightwave Measurement System. The HP 81689A also operates when installed in the HP 8163A Lightwave Multimeter.

Operating Environment

The safety information in the HP 8163A Lightwave Multimeter & HP 8164A Lightwave Measurement System User's Guide summarizes the operating ranges for the HP 81680A, HP 81682A, HP 81640A, & HP 81689A Tunable Laser Modules. In order for these modules to meet specifications, the operating environment must be within the limits specified for the HP 8163A Lightwave Multimeter or HP 8164A Lightwave Measurement System.

Input/Output Signals

CAUTION There are two BNC connectors on the front panel of the HP 81680A, HP 81682A, and HP 81640A - a BNC input connector and a BNC output connector.

There is one BNC connector on the front panel of the HP 81689A - a BNC input connector.

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

Safety Summary

Storage and Shipment

This module can be stored or shipped at temperatures between –40°C and +70°C. Protect the module from temperature extremes that may cause condensation within it.

Safety Summary

Initial Safety Information for Tunable Laser Modules

The Specifications for these modules are as follows:

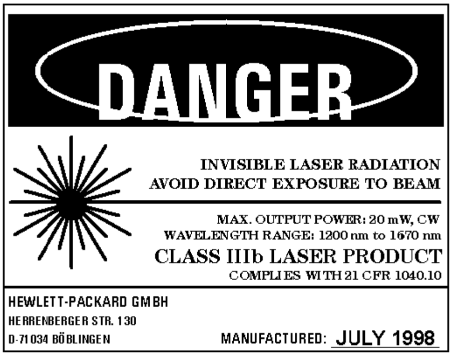
	HP 81680A	**HP 81682A**	**HP 81640A**	**HP 81689A**
Laser Type	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP
Laser Class				
According to 21 CFR 1040.10 (USA)	IIIb	IIIb	IIIb	IIIb
Permissible Output Power (CW)	<20 mW	<20 mW	<20 mW	<20 mW
Beam Diameter	9 µm	9 µm	9 µm	9 µm
Numerical Aperture	0.1	0.1	0.1	0.1
Wavelength	1200-1670 nm	1200-1670 nm	1200-1670 nm	1200-1670 nm
Laser Class				
According to IEC 825-1 (Non-USA) EN 60825-1 Europe	3A	3A	3A	3A
Permissible Output Power (CW)	<20 mW	<20 mW	<20 mW	<20 mW
Beam Diameter	9 µm	9 µm	9 µm	9 µm
Numerical Aperture	0.1	0.1	0.1	0.1
Wavelength	1400-1670 nm	1400-1670 nm	1400-1670 nm	1400-1670 nm

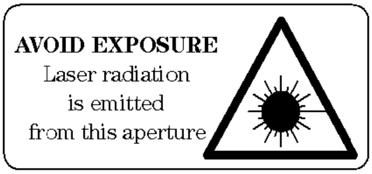
Safety Summary

NOTE

USA

The Laser safety warning labels are fixed on the instrument.



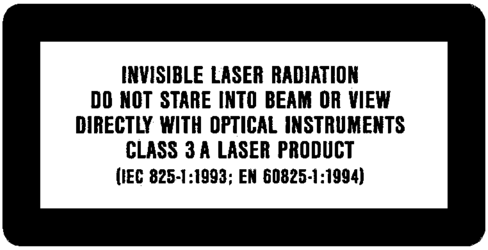


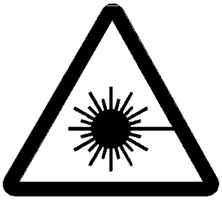
Class IIIb labels: USA only

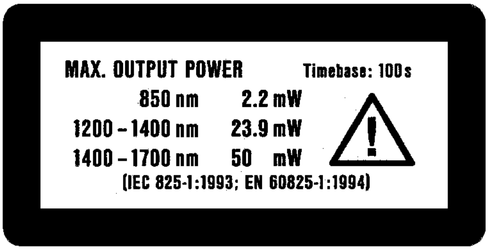
A sheet of laser safety warning labels are included with the instrument. You *MUST* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

Safety Summary

NOTE **Non-USA**



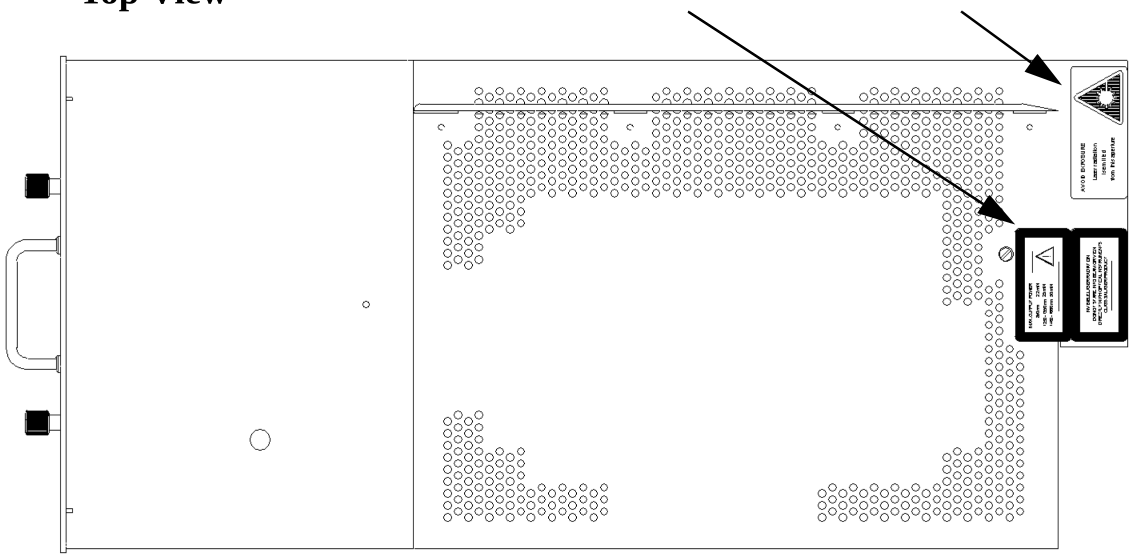




A sheet of laser safety warning labels are included with the instrument. You *MUST* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

NOTE

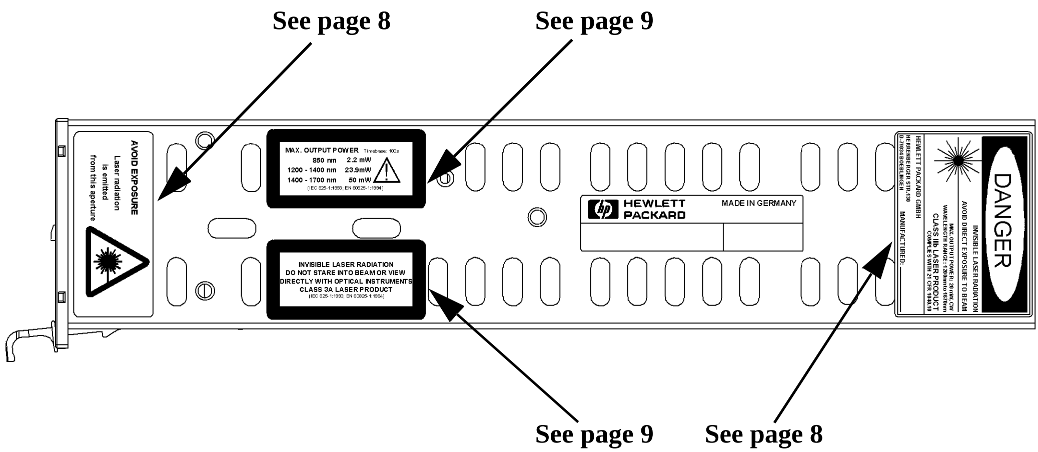
Top View



These labels are applied in these positions to every HP 81680A, HP 81682A, and HP 81640A Tunable Laser Module before shipment.

Safety Summary

NOTE



These labels are applied in these positions to every HP 81689A Tunable Laser Module before shipment.

You *MUST* return instruments with malfunctioning laser boxes to an HP Service Center for repair and calibration.

The instrument has built in safety circuitry that will disable the optical output in the case of a fault condition.

WARNING **Use of controls or adjustments or performance of procedures other than those specified for the laser source may result in hazardous radiation exposure.**

WARNING **Refer Servicing only to qualified and authorized personnel.**

Safety Summary

WARNING **Do not enable the laser when there is no fiber attached to the optical output connector on the instrument's front panel.**

The laser is enabled by pressing the gray button close to the optical output connector on the front panel. The laser is enabled when the green LED on the front panel of the instrument is lit.

WARNING **Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.**

The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

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

Safety Summary

Safety Summary

The Structure of this Manual

This manual is divided into two categories:

- Getting Started
  This section gives an introduction to the Tunable Laser modules. and aims to make these modules familiar to you: Chapter 1.
- Additional Information
  This is supporting information of a non-operational nature. this contains information concerning accessories, specifications, and performance tests: Appendixes A to E.

Conventions used in this manual

- Hardkeys are indicated by small capitals, for example, CONFIG, or CHANNEL.
- Softkeys are indicated by normal text enclosed in square brackets, for example, [Zoom] or [Cancel].
- Parameters are indicated by small capitals enclosed by square brackets, for example, [RANGE MODE], or [MINMAX MODE].
- Menu items are indicated by small capitals enclosed in brackets, for example, <MINMAX>, or <CONTINUOUS>.

Table of Contents

Table of Contents

Table of Contents

Table of Contents

1

Getting Started with Tunable Laser Modules

Getting Started with Tunable Laser Modules

This chapter describes the HP 81680A, HP 81682A, HP 81640A, and HP 81689A Tunable Laser modules.

1.1 Getting Started with 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 Hewlett-Packard Tunable Laser modules also allow you to set the output power, and to choose between continuous wave or modulated power.

HP 81680A/82A/40A Tunable Laser Modules

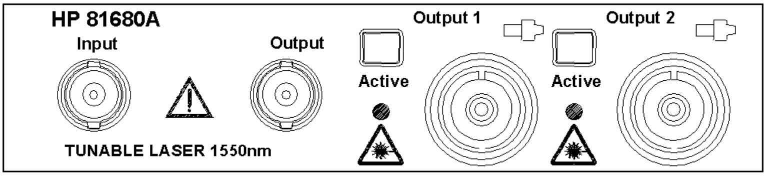


Figure 1-1 HP 81680A Tunable Laser Module (straight contact connectors)

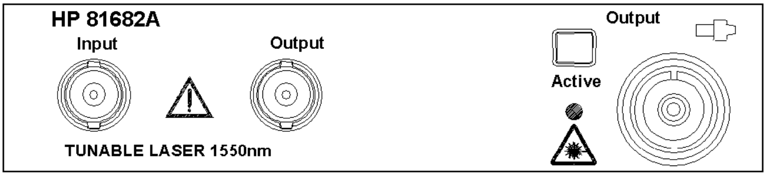


Figure 1-2 HP 81682A Tunable Laser Module (straight contact connector)

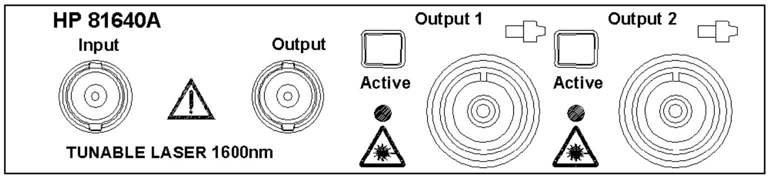


Figure 1-3 **HP 81640A Tunable Laser Module (straight contact connectors)**

The HP 81680A/82A/40A Tunable Laser modules are back-loadable modules. To fit these modules into the HP 8164A mainframe see "How to Fit and Remove Modules" in the HP 8163A Lightwave Multimeter & HP 8164A Lightwave Measurement System User's Guide.

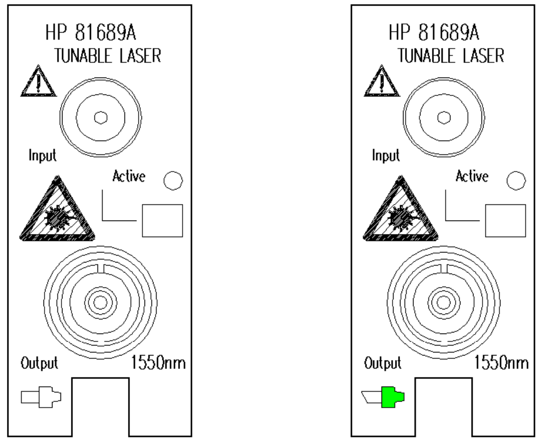
The HP 81680A/82A/40A Tunable Laser modules have a built-in wavelength control loop to ensure high wavelength accuracy. As these modules are all mode-hop free tunable with continuous output power, they qualify for the test of the most critical dense-Wavelength Division Multiplexer (dWDM) components.

The HP 81640A/80A Tunable Laser modules are equipped with two optical outputs:

- Output 1, the Low SSE output, delivers a signal with ultra-low source spontaneous emission (SSE). It enables accurate crosstalk measurement of dWDM components with many channels at narrow spacing. You can characterize steep notch filters such as Fiber Bragg Gratings by using this output and a power sensor module.
- Output 2, the High Power output, delivers a signal with high optical power. You can adjust the signal by more than 60 dB by using the in-built optical attenuator.

The HP 81682A Tunable Laser module delivers a signal with high optical power. If you choose Option 003, you can adjust the signal by more than 60 dB by using the in-built optical attenuator.

HP 81689A Tunable Laser Module



HP 81689A with Straight Contact Connector | HP 81689A with Angled Contact Connector

Figure 1-4 **HP 81689A Tunable Laser Module**

The HP 8169A Tunable Laser module is a front-loadable module. To insert this module into the HP 8163A Lightwave Multimeter or the HP 8164A Lightwave Measurement System see “How to Fit and Remove Modules” in the HP 8163A Lightwave Multimeter & HP 8164A Lightwave Measurement System User’s Guide.

You can use the HP 8169A Tunable Laser module to set up a realistic multi-channel test-bed for dWDM transmission systems. Its continuous, mode-hop free tuning makes it quick and easy to set even the most complex configurations to the target wavelengths and power levels.

The HP 8163A Lightwave Multimeter, a Power Sensor module,and a HP 8169A Tunable Laser module together represent a smart loss-test set with selectable wavelength.

Optical Output

Polarization Maintaining Fiber

If you have an instrument with a polarization maintaining fiber (PMF), the PMF is aligned to maintain the state of polarization.

The fiber is of Panda type, with TE mode in the slow axis in line with the connector key. A well defined state of polarization ensures constant measurement conditions.

The HP 81640A/80A/82A Tunable Laser modules are equipped with PMF outputs as standard.

For the HP 81689A Tunable Laser module, PMF output is available if you choose one of the following options:

- HP 81689A Option 071 PMF straight contact connector or
- HP 81689A Option 072 PMF angled contact connector.

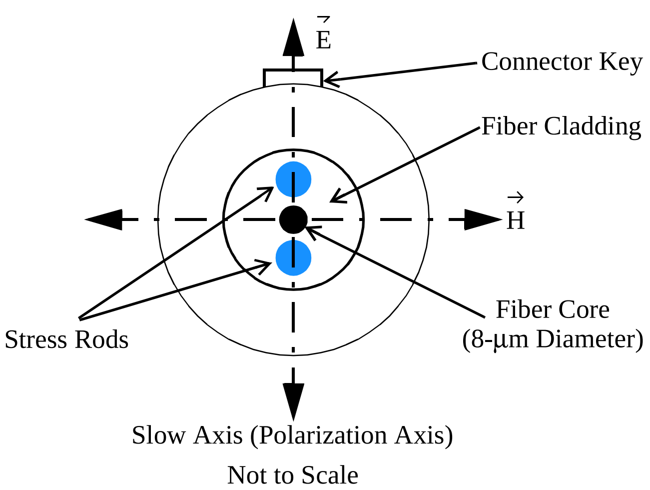


Figure 1-5 **PMF Output Connector**

Angled and Straight Contact Connectors

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

The HP 81640A/80A/82A/89A Tunable Laser modules can have the following connector interface options:

- Option 071, Polarization-maintaining fiber straight contact connectors, or
- Option 072, Polarization-maintaining fiber angled contact connectors.

Two additional connector interface options are available for the HP 81689A Tunable Laser module:

- Option 021, Standard single-mode fiber straight contact connectors, or
- Option 022, Standard single-mode fiber angled contact connectors.

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

Figure 1-6 **Angled and Straight Contact Connector Symbols**

Figure 1-6 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.

Figure 1-2 and Figure 1-7 show the front panel of the HP 81682A Tunable Laser module with straight and angled contact connectors respectively.

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.

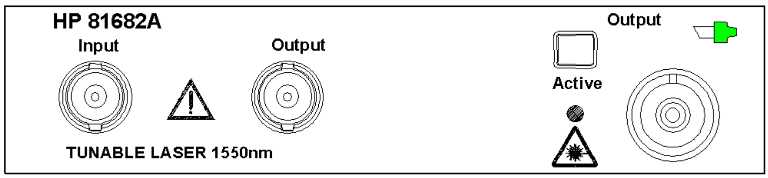


Figure 1-7 **HP 81682A Tunable Laser Module (angled contact connector)**

See “Connector Interfaces and Other Accessories” on page 32 for further details on connector interfaces and accessories.

Signal Input and Output

CAUTION

There are two BNC connectors on the front panel of the HP 81680A, HP 81682A, and HP 81640A - a BNC input connector and a BNC output connector.

There is one BNC connector on the front panel of the HP 81689A - a BNC input connector.

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

B

Accessories

Accessories

The HP 81640A/80A/82A/89A Tunable Laser Source Modules are available in various configurations for the best possible match to the most common applications.

This appendix provides information on the available options and accessories.

B.1 Modules and Options

Figure B-1 shows all the options that are available for all Tunable Laser modules and the instruments that support these modules.

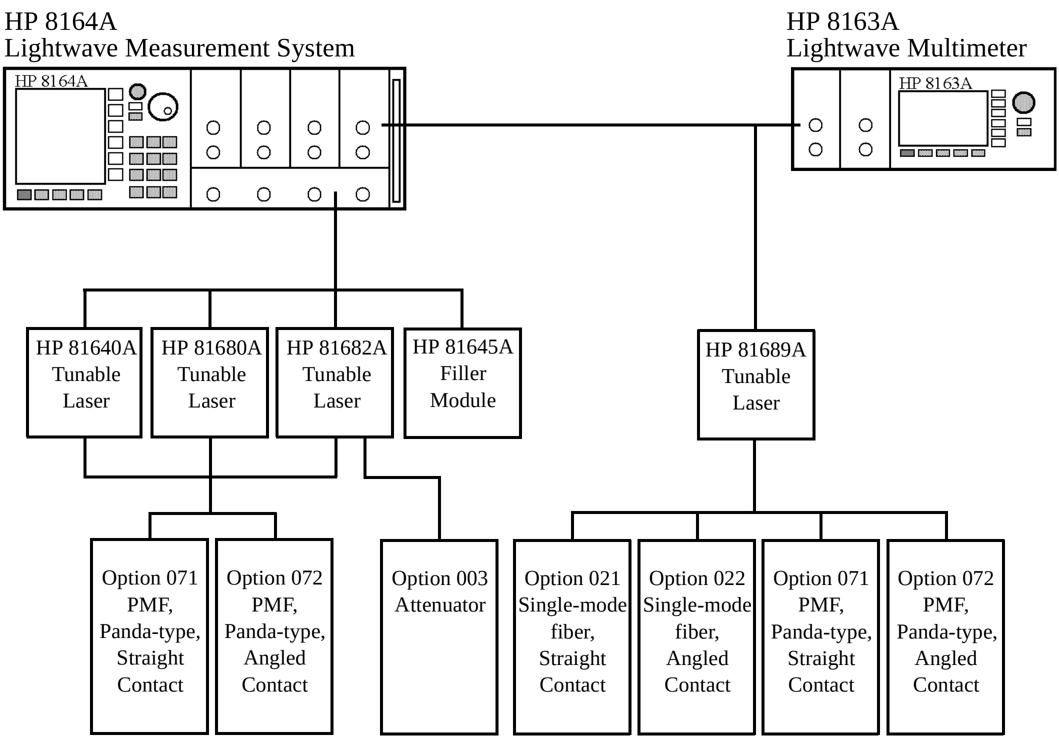


Figure B-1 **Mainframes, Tunable Laser Modules, and Options**

Modules

The HP 8164A Lightwave Measurement System supports the HP 81640A/80A/82A/89A Tunable Laser modules. In addition, the HP 8163A Lightwave Multimeter supports the HP 81689A Tunable Laser module.

Tunable Laser Modules

Model No.	Description
HP 81680A	Tunable Laser for the Test of Critical dense-WDM Components
HP 81682A	Tunable Laser for the Test of Optical Amplifiers and Passive Components
HP 81689A	Tunable Laser for Multi-Channel Test Applications
HP 81640A	Tunable Laser for the Test of Critical Components in both dense-WDM Bands, the C and L bands

Filler Module

Filler Module

Model No.	Description
HP 81645A	Filler Module

The HP 81645A Filler Module is required to operate the HP 8164A mainframe if it is used without a back-loadable Tunable Laser module. It can be used to:

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

See Appendix A of the HP 8163A Lightwave Multimeter & HP 8164A Lightwave Measurement System User’s Guide for more details on installing the HP 81645A Filler Module.

Options

Option 003 - HP 81682A

Built-in optical attenuator with 60 dB attenuation range.

NOTE **The HP 81640A/80A Tunable Laser Modules have a built-in optical attenuator as standard for Output 2, the High Power output.**

A built-in optical attenuator is not available for the HP 81689A.

Option 021 - HP 81689A

Standard single-mode fiber, for straight contact connectors.

Option 022 - HP 81689A

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.

Manual Option Numbers

Product	Opt	Description	Part Number
HP 81640A/80A/82A		Tunable Laser Module	
	ABJ	Japanese User’s Guide	81680-91514
	ABF	French User’s Guide	81680-91214
	AB0	Traditional Chinese (Taiwan) User’s Guide	81680-91714
	AB1	Korean User’s Guide	81680-91814

B.2 Connector Interfaces and Other Accessories

The HP 81640A/80A/82A/89A Tunable Laser modules are supplied with one of two connector interface options:

- Option 071, Polarization-maintaining fiber straight contact connectors, or
- Option 072, Polarization-maintaining fiber angled contact connectors.

Two additional connector interface options are available for the HP 81689A Tunable Laser module:

- Option 021, Standard single-mode fiber straight contact connectors, or
- Option 022, Standard single-mode fiber angled contact connectors.

Options 071, 021: 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 B-1 for a list of the available connector interfaces.

2. Connect your cable (see Figure B-2).

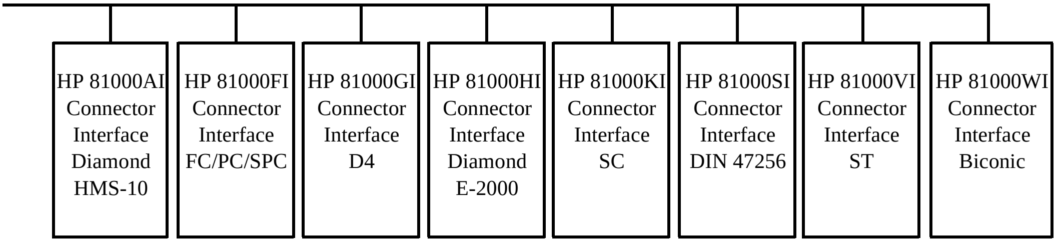


Figure B-2 **Options 021, 071: Single-mode fiber or PMF with Straight Contact Connectors**

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

Table B-1 **Straight Contact Connector Interfaces**

Options 072, 022: 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 B-2 for a list of the available connector interfaces.

2 Connect your cable (see Figure B-3).

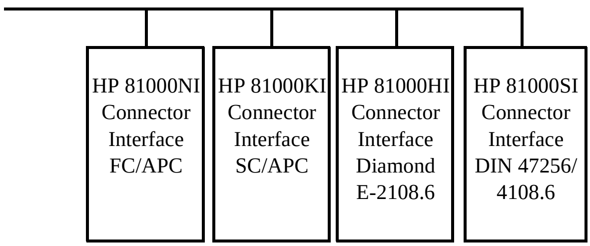


Figure B-3 **Options 022, 072: Single-mode fiber or PMF with Angled Contact Connectors**

Description	Model No.
DIN 47256-4108.6	HP 81000 SI
FC / APC	HP 81000 NI
SC / APC	HP 81000 KI
Diamond E-2108.6	HP 81000 HI

Table B-2 **Angled Contact Connector Interfaces**

C

Specifications

Specifications

The HP 81680A, HP 81682A, HP 81640A, and HP 81689A Tunable Laser modules are produced to the ISO 9001 international quality system standard as part of HP's 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. You should insert these pages into the appropriate section of the HP 8163A Lightwave Multimeter & HP 8164A Lightwave Measurement System User's Guide.

C.1 Definition of Terms

This section defines terms that are used both in Appendix C "Specifications" and Appendix D "Performance Tests".

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 measured 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.

Validity: within given time span after wavelength zeroing, at a given maximum temperature difference between calibration and measurement.

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

NOTE **The absolute wavelength accuracy of Output 1, the Low SSE Output, of the HP 81640A/80A Tunable Laser modules is the same as the absolute wavelength accuracy of Output 2, the High Power Output (guaranteed by design).**

Effective Linewidth

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

Conditions: temperature within operating temperature range, coherence control on, power set to specified value.

Measurement with heterodyning technique: the output of the laser under test is mixed with another laser of the same type on a wide bandwidth photodetector. The electrical noise spectrum of the photodetector current is measured with HP 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).

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 HP 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.

Mode-Hop Free Tuning Range

The tuning range for which no abrupt wavelength change occurs during fine wavelength stepping. Abrupt change is defined as change of more than 25 pm.

Conditions: within specified wavelength range, at specified temperature range and output power. Tuning from outside into the mode-hop free tuning range is not allowed.

Modulation Depth

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

Conditions: Tunable laser at highest power setting.

Measurement with power meter. 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 Versus Wavelength

When changing the wavelength at constant power setting and recording the differences between measured 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 measured 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 measured 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 measured 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 HP Lightwave Signal Analyzer.

Relative Wavelength Accuracy

When randomly changing the wavelength and measuring the differences between the measured 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 min maximum (constant temperature), coherence control off, measured at high power output.

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

NOTE **The relative wavelength accuracy of Output 1, the Low SSE Output, of the HP 81640A/80A Tunable Laser modules is the same as the relative wavelength accuracy of Output 2, the High Power Output (guaranteed by design).**

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 HP 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 per 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.**

Signal-to-Total-Source Spontaneous Emission

The ratio of signal power to total spontaneous emission power, at the specified achievable output power, expressed in dB.

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

Measurement with optical spectrum analyzer, by integrating the source spontaneous emission and excluding the remnant signal. 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-total-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 the wavelength after detuning and re-setting the wavelength. The wavelength repeatability is ± half the span between the maximum and the minimum value of all measured 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 wavelength repeatability of Output 1, the Low SSE Output, of the HP 81640A/80A Tunable Laser modules is the same as the relative wavelength accuracy of Output 2, the High Power Output (guaranteed by design).**

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 measured 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.

C.2 Tunable Laser Module Specifications

	HP 81680A Output 1 (Low SSE)	HP 81680A Output 2 (High Power)	HP 81640A Output 1 (Low SSE)	HP 81640A Output 2 (High Power)
Wavelength range	1460 nm to 1580 nm		1510 nm to 1640 nm	
Wavelength resolution	0.1 pm, 12.5 MHz at 1550 nm			
Mode-hop free tuning range	1460 nm to 1580 nm		1510 nm to 1640 nm	
Absolute wavelength accuracy[1, 2]	± 0.01 nm		± 0.015 nm	
Relative wavelength accuracy [1, 2]	± 5 pm, typ. ± 2 pm		± 7 pm, typ. ± 3 pm	
Wavelength repeatability [2]	± 1 pm, typ. ± 0.5 pm			
Wavelength stability (typ., 24 hours at constant temperature) [2]	≤± 1 pm			
Tuning speed (typ. for a 1/10/100 nm step)	400 ms/600 ms/2.8 s			
Linewidth (typ.), coherence control off.	100 kHz			
Effective Linewidth (typ.), coherence control on	>50 MHz (1480 to 1580 nm, at maximum flat output power)		>50 MHz (1520 to 1620 nm, at maximum flat output power)	

	HP 81680A Output 1 (Low SSE)	HP 81680A Output 2 (High Power)	HP 81640A Output 1 (Low SSE)	HP 81640A Output 2 (High Power)
Output power [3] (continuous power during tuning)	≥ –4 dBm peak typ. ≥ –6 dBm (1520-1570 nm) ≥ –10 dBm (1480-1580 nm) ≥ –13 dBm (1460-1580 nm)	≥ 6 dBm peak typ. ≥ 5 dBm (1520-1570 nm) ≥ 1 dBm (1480-1580 nm) ≥ –3 dBm (1460-1580 nm)	≥ –5 dBm peak typ. ≥ –7 dBm (1530-1610 nm) ≥ –9 dBm (1520-1620 nm) ≥ –13 dBm (1510-1640 nm)	≥ 4 dBm peak typ. ≥ 2 dBm (1530-1610 nm) ≥ 0 dBm (1520-1620 nm) ≥ –5 dBm (1510-1640 nm)
Minimum output power [3]	–13 dBm	–3 dBm (–60 dBm in attenuation mode)	–13 dBm	–5 dBm (–60 dBm in attenuation mode)
Power stability [3, 9]	± 0.01 dB, 1 hour. typ. ± 0.03 dB, 24 hours			
Power repeatability (typ.) [3]	± 0.01 dB			
Power linearity [3]	± 0.1 dB	± 0.3 dB	± 0.1 dB	± 0.3 dB
Power flatness versus wavelength [3]	± 0.2 dB, typ. ± 0.1 dB	± 0.3 dB, typ. ± 0.15 dB	± 0.2 dB, typ. ± 0.1 dB	± 0.3 dB, typ. ± 0.15 dB
Side-mode Suppression ratio (typ.) [4,8]	≥ 40 dBc (1480-1580 nm)		≥ 40 dBc (1530-1610 nm)	

	HP 81680A Output 1 (Low SSE)	HP 81680A Output 2 (High Power)	HP 81640A Output 1 (Low SSE)	HP 81640A Output 2 (High Power)
Signal-to-Source Spontaneous Emission Ratio [5,8]	≥ 63 dB/nm[7] (1520-1570 nm) ≥ 58 dB/nm[7] (typ., 1480-1580 nm) ≥ 53 dB/nm[7] (typ., 1460-1580 nm)	≥ 45 dB/nm (1520-1570 nm) ≥ 40 dB/nm (1480-1580 nm) ≥ 35 dB/nm (1460-1580 nm)	≥ 60 dB/nm[7] (1530-1610 nm) ≥ 55 dB/nm[7] (typ., 1520-1620 nm) ≥ 50 dB/nm[7] (typ., 1510-1640 nm)	≥ 45 dB/nm (1530-1610 nm) ≥ 40 dB/nm (1520-1620 nm) ≥ 35 dB/nm (1510-1640 nm)
Signal-to-Total-Source Spontaneous Emission Ratio[6,8]	≥ 60 dB [7] (1520-1570 nm) ≥ 50 dB [7] (typ., 1480-1580 nm)	≥ 30 dB (typ., 1520-1570 nm)	≥ 55 dB [7] (1530-1610 nm) ≥ 45 dB [7] (typ., 1510-1640 nm)	≥ 27 dB (typ., 1530-1610 nm)
Relative Intensity noise (RIN, typ.)[8]	– 145 dB/Hz (1480-1580 nm)		– 145 dB/Hz (1530-1610 nm)	

1 Valid for one month and within a ±5 K temperature range after wavelength zeroing.
2 At CW operation. Measured with wavelength meter based on wavelength in vacuum.
3 Applies to the selected output.
4 Measured by heterodyning method.
5 Measured with optical spectrum analyzer at 1 nm resolution bandwidth.
6 Measured with optical spectrum analyzer.
7 Measured with fiber Bragg grating to supress the signal.
8 Output power as specified per wavelength range and ouput port.
9 Warm up time: 1 hour

	HP 81682A	HP 81689A
Wavelength range	1460 nm to 1580 nm	1525 nm to 1575 nm
Wavelength resolution	0.1 pm, 12.5 MHz at 1550 nm	0.01 nm, 1.25 GHz at 1550 nm
Mode-hop free tuning range	1460 nm to 1580 nm	
Absolute wavelength accuracy	± 0.01 nm[1, 2]	± 0.3 nm, typ. [2]
Relative wavelength accuracy	± 5 pm, typ. ± 2 pm[1, 2]	± 0.3 nm [2]
Wavelength repeatability	± 1 pm, typ. ± 0.5 pm [2]	± 0.05 nm [2]
Wavelength stability (typ., over 24 hours at constant temperature)	< ± 1 pm [2]	< ± 0.02 nm [2]
Tuning speed	400 ms/600 ms/2.8 s (typ. for a 1/10/100 nm step)	< 10 sec/ 50 nm (typ.)
Linewidth (typ.)	100 kHz, coherence control off	20 MHz [3]
Effective Linewidth (typ.), coherence control on	> 50 MHz (1480 - 1580 nm, at maximum flat output power)	--
Output power (continuous power during tuning)	≥ 8 dBm peak typ. ≥ 6 dBm (1520 -1570 nm) ≥ 2 dBm (1480 -1580 nm) ≥ –3 dBm (1460-1580 nm)	≥ 6 dBm (1525 -1575 nm)
/with option #003	reduce by 1.5 dB [4]	- -

Tunable Laser Module Specifications

	HP 81682A	HP 81689A
Minimum output power **/with option #003**	–3 dBm –4.5 dBm (–60 dBm in attenuation mode)[4]	–3 dBm
Power stability	± 0.01 dB, 1 hour [10] typ. ±0.03 dB, 24 hours[10]	± 0.03 dB, 1 hour [9] ± 0.06 dB, 24 hours [9]
Power repeatability (typ.)	± 0.01 dB	± 0.02 dB [9]
Power linearity (typ.) **/with option #003**	± 0.1 dB ± 0.2 dB [4]	± 0.1 dB
Power flatness versus wavelength **/with option #003**	± 0.2 dB, typ. ± 0.1 dB ± 0.3 dB, typ. ±0.2 dB [4]	± 0.3 dB
Side-mode Suppression ratio (typ.)	≥ 40 dBc (1480-1580 nm)[5,8]	> 40 dBc (1525 - 1575 nm at 0 dBm)[5]
Signal-to-Source Spontaneous Emission Ratio	≥ 45 dB/nm (1520 -1570 nm)[6,8] ≥ 40 dB/nm (1480 -1580 nm)[6,8] ≥ 35 dB/nm (1460 -1580 nm)[6,8]	≥ 39 dB/nm (1525 - 1575 nm at 6 dBm)[6]
Signal-to-Total-Source Spontaneous Emission Ratio	≥ 30 dB (1520 - 1570 nm) [7,8]	– –
Relative Intensity noise (RIN, typ.)	–145 dB/Hz (1460 -1580 nm) [8]	< –137 dB/Hz (100 MHz – 2.5 GHz)
Dimensions	- -	75 mm H, 32 mm W, 335 mm D (2.8” × 1.3” × 13.2”
Weight	- -	1 kg

	HP 81682A	HP 81689A
1 Valid for one month and within a ±5 K temperature range after automatic wavelength zeroing. **2** At CW operation. Measured with wavelength meter based on wavelength in vacuum. **3** Measured by heterodyning method with 20 ms sweep time, 50 MHz span, 1 MHz resolution. **4** Option #003: built-in optical attenuator. **5** Measured by heterodyning method. **6** Measured with optical spectrum analyzer at 1 nm resolution bandwidth. **7** Measured with optical spectrum analyzer. **8** Output power as specified per wavelength range. **9** 500 ms after changing power. **10** Warm up time: 1 hour		

Supplementary Performance Characteristics

Modulation Modes

Internal Digital Modulation [1]

50% duty cycle, 200 Hz to 300 kHz.
Modulation output: TTL reference signal.

External Digital Modulation [1]

> 45% duty cycle, fall time < 300 ns, 200 Hz to 1 MHz.
Modulation input: TTL signal.

External Analog Modulation [1]

≥ 15% modulation depth, 5 kHz to 20 MHz (for HP 81689A, 5 kHz to 1 MHz).
Modulation input: 5 Vp-p.

External Wavelength Locking (HP 81640A/80A/82A)

> ±70 pm at 10 Hz
> ±7 pm at 100 Hz
Modulation input: ±5 V

Coherence Control (HP 81640A/80A/82A)

For measurements on components with 2-meter 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 drastically reducing interference effects in the test setup.

[1] HP 81640A/80A/82A: displayed wavelength represents average wavelength while digital modulation is active.

Sweep Modes

Continuous Sweep Mode(HP 81640A/80A/82A)

Tuning velocity adjustable to: 40 nm/s, 5 nm/s, 0.5 nm/s.

Mode-hop free span:

1520 - 1570 nm at flat output power ≥ 3 dBm (HP81680A/82A), any 50 nm within 1520 - 1620 nm at flat output power ≥ 0 dBm (HP81640A only).

Ambient temperature within +20°C and +30°C.

Stepped Sweep Mode (HP 81640A/80A/82A)

Full instrument performance (HP 81640A/80A/82A).

Please note that the laser is turned off for 3 µs after each wavelength tuning in the range 1620-1640nm (HP81640A only).

Ambient temperature within +20°C and +30°C.

General

Output Isolation (typ.):

50 dB (for HP 81689A: 38 dB)

Return loss (typ.):

60 dB (options 022, 072, for HP 81689A: 55 dB);
40 dB (options 021, 071, for HP 81689A: 40 dB).

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.

Laser Class:

Class IIIb according to FDA 21 CFR 1040.10,
Class 3A according to IEC 825 - 1; 1993.

Recommended Recalibration Period:

2 years.

Warm-up Time:

< 20 min (< 40 min for HP 81689A), immediate operation after boot-up.

Environmental

Storage Temperature:

–40°C to +70°C.

Operating Temperature:

+10°C to +35°C (+15°C to +35°C for HP 81689A).

Humidity:

< 80% R. H. at +10°C to +35°C (≤ 80% R. H. at +15°C to +35°C for HP 81689A).
Specifications are valid in non-condensing conditions.

D

Performance Tests

Performance Tests

The procedures in this section tests the optical performance of the instrument. The complete specifications to which the HP 81680A, HP 81682A, HP 81640A, and HP 81689A are tested are given in Appendix C “Specifications”. 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/HP connector.

Required Test Equipment

The equipment required for the Performance Test is listed in Table D-1. Any equipment which satisfies the critical specifications of the equipment given in Table D-1, may be substituted for the recommended models.

Instrument	Description of Instrument/Accessory	#021, #071	#022, #072
HP 71452B #E14 [1]	Optical Spectrum Analyzer	1	1
HP 8164A	Lightwave Measurement System	1	1
WA-1500	Burleigh Wavemeter	1	1
HP 8153A	Lightwave Multimeter	1	1
HP 81533B	Optical Head Interface Module	1	1
HP 81532A	Power Sensor Module	1	1
HP 81524A #C01 [2]	Standard Optical Head	1	1
N/A	Fiber Bragg Grating	1	1
HP 81001FF	10 dB Refraction Filter	1	1
HP 81000SA	DIN 47256/4108 Connector Adapter	1	1
HP 81000SI	DIN 47256/4108 Connector Interface		2
HP 81000FI	FC/PC Connector Interface	1	
HP 81101PC	Diamond HMS-10/HP FC/PC Patchcord	1	
HP 81113PC	Diamond HMS-10/HP FC/Super PC Patchcord	1	1
HP 81113SC	Diamond HMS-10/HP DIN 47256/4108 Patchcord		1

Table D-1 **Equipment Required**

[1] You can use the HP 71450A #100 instead of the HP 71452B.
[2] You can use the HP 81525A instead of a HP 81524A plus HP 81001FF.

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 Hewlett-Packard.

Test Failure

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

If the HP 81680A/82A/40A/89A Tunable Laser module fails any performance test, return the instrument to the nearest Hewlett-Packard Sales / Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument which are certified. These specifications, listed in Appendix C, are the performance standards or limits against which the HP 81680A/82A/40A/89A Tunable Laser modules can be tested. The specifications also list some supplemental characteristics of the HP 81680A/82A/40A/89A 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.

D.1 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.**

General Test Setup

Insert your Tunable Laser module into the HP 8164A Lightwave Measurement System. Insert HP 81680A, HP 81682A, and HP 81640A Tunable Laser modules from the rear. Insert HP 81689A Tunable Laser modules from the front into slot 1 of the HP 8164A Lightwave Measurement System.

Wavelength Tests

NOTE

When performing wavelength tests, zero the Tunable Laser first.

Move to Channel 0, press [Menu], select <λ ZEROING>.

Zeroing takes approximately 2 minutes.

Connect the Tunable Laser module to the Wavelength Meter as shown in Figure D-1.

If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module, connect the Output 2, the high power output.

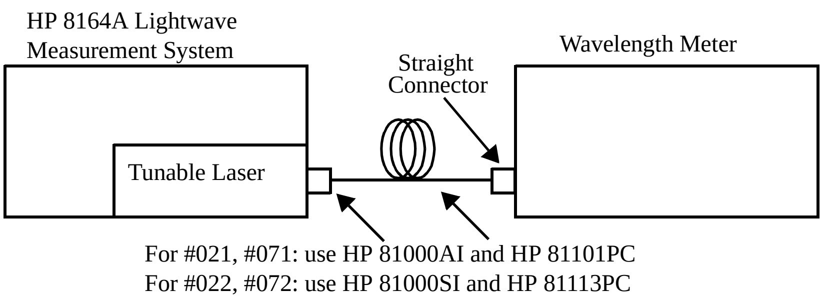


Figure D-1 **Test Setup for the Wavelength Tests**

General Settings of Wavelength Meters for all Wavelength Tests

Set the Burleigh WA-150 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, Absolute Wavelength Accuracy, and the Mode Hop Free Tuning Result.

Relative Wavelength Accuracy

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

2 Set the menu parameters to the values shown in Table D-2.

Tunable Laser Channel Menu Parameters	Values
<Wavelength Mode>	<λ>
<Source State>	<OFF>
<Power Unit>	<dBm>
<Power Mode>	<AUTOMATIC>

Table D-2 Tunable Laser Channel Settings

3 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the fiber output to Output 2, the High Power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

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

Module	Wavelength [λ]	Power [P]
HP 81680A	1460.000 nm	–5.00 dBm
HP 81682A	1460.000 nm	–5.00 dBm
HP 81682A (#003)	1460.000 nm	–5.00 dBm
HP 81640A	1510.000 nm	–5.00 dBm
HP 81689A	1525.000 nm	–5.00 dBm

Table D-3 Initial Wavelength and Power Settings for Relative Wavelength Accuracy Tests

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

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

7 Increase the wavelength setting of Tunable Laser module by the

steps shown in the test record.

8 Repeat steps 6 and 7 up to the maximum wavelength values shown in Table D-4.

Tunable Laser Module	Maximum Wavelength Value
HP 81680A	1580 nm
HP 81682A	1580 nm
HP 81640A	1640 nm
HP 81689A	1575 nm

Table D-4 **Maximum Wavelength for Relative Wavelength Accuracy Tests**

9 Repeat steps 4 through 8 another 4 times.

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

11 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).**

12 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

13 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 12 and note this value as Absolute Wavelength Accuracy.

Mode Hop Free Tuning

NOTE **This section does not apply for HP 81689A Tunable Laser module.**

14 Move to the Tunable Laser channel of the HP 8164A Lightwave Measurement System and press [Menu].

15 Set the menu parameters to the values shown in Table D-2.

16 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the High Power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

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

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

19 Then perform steps 4 through 8 once.

20 Note the wavelength displayed by the wavelength meter in the test record.

21 Increase wavelength setting on Tunable Laser by the steps shown in the test record.

22 Repeat steps 6 and 7 up to the maximum wavelength values shown in Table D-4.

23 Pick the maximum and minimum deviations, and note these values in the test record.

24 Subtract the Minimum Deviation from the Maximum Deviation. Record this value as the **Mode Hop Free Tuning Result.**

25 You do not need to repeat the Mode Hop Free Tuning test.

Wavelength Repeatability

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

2 Set the menu parameters to the values shown in Table D-2.

3 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the High Power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

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

Module	**Wavelength** [λ]	**Power [P]**
HP 81680A	1460.000 nm	–3.00 dBm
HP 81682A	1460.000 nm	–3.00 dBm
HP 81682A #003	1480.000 nm	–4.50 dBm
HP 81640A	1510.000 nm	–13.00 dBm
HP 81689A	1525.000 nm	–3.00 dBm

Table D-5 **Reference Wavelength and Power Settings for Wavelength Repeatability Tests**

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

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

7 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”).

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

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

10 Repeat steps 7 through 9 with all wavelength settings given in the “from wavelength” column of the test record.

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

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

Power Tests

Calibration of the HP 81001FF Attenuation Filter

NOTE **When a HP 81524A Optical Head is used in conjunction with a HP 81001FF Attenuation Filter, it is absolutely necessary that you calibrate the HP 81001FF Attenuation Filter before starting the power tests in the following measurement setups; it is not sufficient to use calibration factors that are derived from an earlier setup.**

1 Make sure all instruments have warmed up.

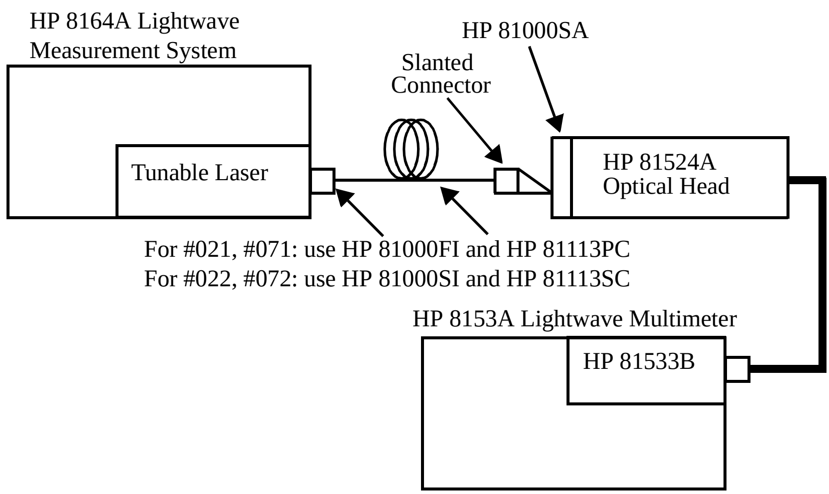


Figure D-2 **Calibration of the HP 81001FF Attenuation Filter, Reference Setup**

2 Set the power meter installed in the HP 8153A to the following values:

  a Set range to 0 dBm; press UP or DOWN as required.

  b Set T, the averaging time, to 500 ms.

  c Set λ, the wavelength, to 1550 nm.

  d Select dBm as the power units.

3 Move to the Tunable Laser channel of the HP 8164A. Set [λ], the wavelength, to 1550 nm and [P], the power, to 0 dBm.

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

5 Check if the display of HP 8153A reads 0 dBm ±2 dBm.

6 Select dB as the power units of the HP 8153A.

7 Press DISP–>REF on the HP 8153A.

8 Attach the HP 81001FF Attenuation Filter to the Optical Head as shown in Figure D-3. Move the patchcord as little as possible,

keeping the laser activated.

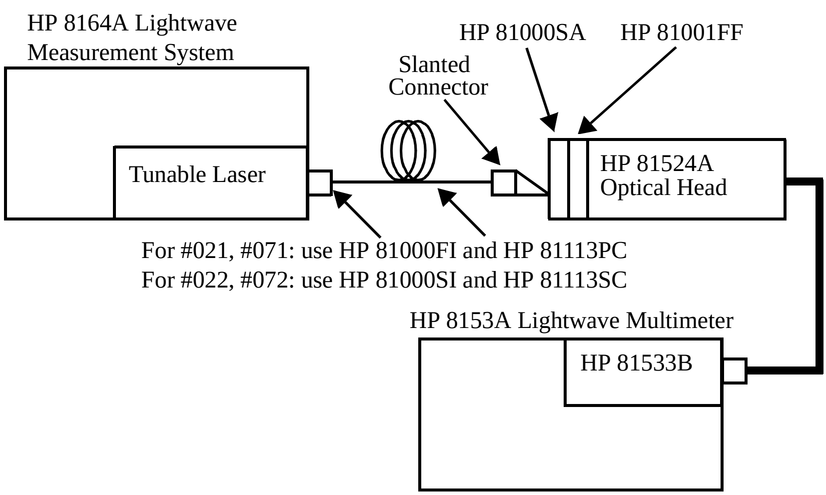


Figure D-3 **Test Setup for Calibrating the HP 81001FF Attenuation Filter**

9 On the HP 8153A Lightwave Multimeter, move to the power measurement channel where the HP 81533B is installed. Press PARAMETER until CAL is displayed. Using the Modify keys, change the CAL value until the display shows 0.00 dB.

10 For further measurements using this Attenuation Filter, you have to set the calibration factor of the HP 8153A to this value to get the absolute power reading.

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 used interconnections.**

1 Set up the equipment as shown in Figure D-4.

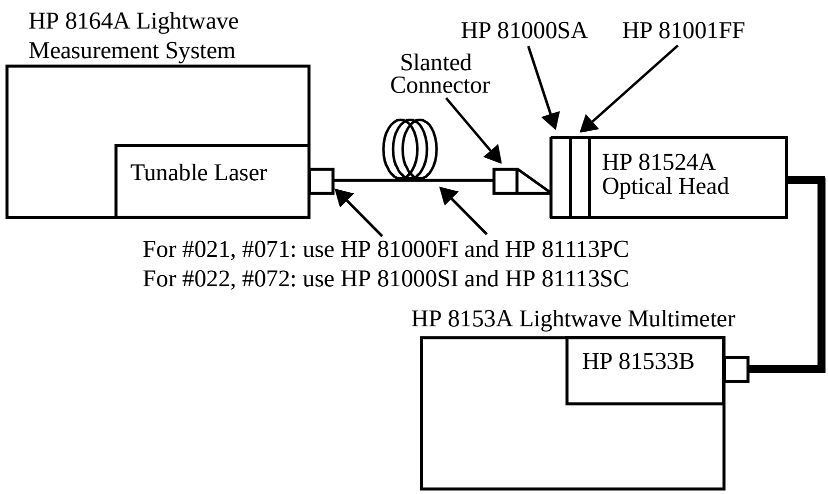


Figure D-4 **Test Setup for the Maximum Output Power Tests**

2 Set the Power Meter to the following settings:

   a Select automatic ranging; press AUTO as required.

   b Set T, the averaging time, to 500 ms.

   c Select dBm as the power units.

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

4 Set the menu parameters to the values shown in Table D-2.

5 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 1, the Low SSE output, remember to calibrate the HP 81001FF Attenuation Filter.
Set <OPTICAL OUTPUT> to <LOW SSE (1)>.

6 Set the wavelength and power for each Tunable Laser module to the values given in Table D-6.

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

Module	Wavelength [λ]	Power [P]
HP 81680A - Output 1	1460.000 nm	+0.00 dBm
HP 81680A - Output 2	1460.000 nm	+10.00 dBm
HP 81682A	1460.000 nm	+10.00 dBm
HP 81640A - Output 1	1510.000 nm	+0.00 dBm
HP 81640A - Output 2	1510.000 nm	+10.00 dBm
HP 81689A	1525.000 nm	+10.00 dBm

Table D-6 **Reference Wavelength and Power Values for Maximum Output Power Tests**

output.

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

8 Set the wavelength of the HP 8153A to the same as your Tunable Laser module, as given in Table D-6.

9 Measure the output power with the HP 8153A and note the result for this wavelength in the test record.

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

11 Increase the wavelength of the HP 8153A to the same value.

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

13 Repeat item 10 to item 12 for the full wavelength range

14 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module;
connect the output fiber to Output 2, the High Power output, remember to calibrate the HP 81001FF Attenuation Filter and set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

Then, perform steps 6 through 12 for the full wavelength range.

Power Linearity

Power Linearity - Low Power Test

To measure the power linearity of the Low SSE output, Output 1, of the HP 81680A, or the of the HP 81640A:

1 Set up the equipment as shown in Figure D-5.

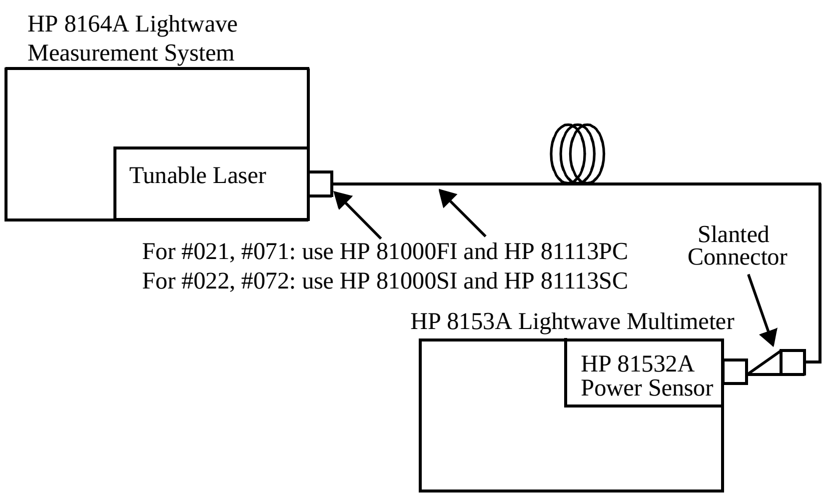


Figure D-5 **Test Setup for Low Power Linearity Tests**

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

3 Set the menu parameters to the values shown in Table D-2. <POWER MODE> does not apply.

4 Set the wavelength and power for each Tunable Laser module to the values given in Table D-7.

5 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 1, the Low SSE output.

Module	Wavelength [λ]	Power [P]
HP 81680A - Output 1	1540.000 nm	–6.00 dBm
HP 81640A - Output 1	1560.000 nm	–7.00 dBm

Table D-7 **Wavelength and Power Settings for Low Power Linearity Tests**

Set <OPTICAL OUTPUT> to <LOW SSE (1)>.

6 Make sure the optical output is switched off.

7 Set the HP 8153A to the following settings:

- **a** Zero the HP 81532A; press ZERO.
- **b** Select automatic ranging; press AUTO as required.
- **c** Set T, the averaging time, to 500 ms.
- **d** Select dB as the power units.
- **e** Set the λ, the wavelength, to the same as your Tunable Laser module, as given in Table D-7.

8 Press the key beside the laser output to switch on the laser output. For the HP 81680A and the HP 81640A, press the key beside Output 1, the Low SSE output.

9 Record the power displayed by the HP 8153A.

10 Press DISP–>REF on the HP 8153A.

11 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 HP 8153A again.

12 Record the power displayed by the HP 8153A as the "Measured Relative Power from start".

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

14 Repeat item 11 to item 13 for all power levels listed in the test record.

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

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

Example (HP 81680A Output 1)

Power Linearity Output 1

	Power Setting from start	Measured Relative Power from start		Power reduction from start		Power Linearity at current setting
Start = REF	– 6.0 dBm	0.00 dB	+	0.00 dB	=	0.00 dB
	– 7.0 dBm	– 1.02 dB	+	1.00 dB	=	– 0.02 dB
	– 8.0 dBm	– 1.92 dB	+	2.00 dB	=	+ 0.08 dB
	– 9.0 dBm	– 3.02 dB	+	3.00 dB	=	– 0.02 dB
	– 10.0 dBm	– 3.95 dB	+	4.00 dB	=	+ 0.05 dB
	– 11.0 dBm	– 5.07 dB	+	5.00 dB	=	– 0.07 dB
	– 12.0 dBm	– 5.96 dB	+	6.00 dB	=	+ 0.04 dB
	– 13.0 dBm	– 7.05 dB	+	7.00 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 Linearity - High Power Test

Follow the steps below to measure the power linearity (without using attenuation) of any one of the following:

- Output 2, the High Power output, of the HP 81640A

- Output 2, the High Power output, of the HP 81680A
- HP 81682A standard
- HP 81682A #003
- HP 81689A

1 Set up the equipment as shown in Figure D-4 (remember to calibrate the HP 81001FF Attenuation Filter).

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

3 Set the menu parameters to the values shown in Table D-2.
For HP 81640A, HP 81680A, and HP 81682A#003:
Set <POWER MODE> to <MANUAL ATT>.

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

Module	Wavelength [λ]	Power [P]	Attenuation [ATTEN]
HP 81640A - Output 2	1560.000 nm	+2.000 dBm	0.000 dB
HP 81680A - Output 2	1540.000 nm	+5.000 dBm	0.000 dB
HP 81682A	1540.000 nm	+6.000 dBm	Not applicable
HP 81682A #003	1540.000 nm	+4.500 dBm	0.000 dB
HP 81689A	1540.000 nm	+6.000 dBm	Not applicable

Table D-8 **Wavelength and Power Settings for High Power Linearity Tests without Attenuation**

NOTE **If you use the HP 81680A Output 2 or the HP 81640A Output 2 without attenuation, use the table "Power Linearity Output 2, High Power upper power levels" on page 111 or "Power Linearity Output 2, High Power upper power levels" on page 148 respectively.**

If you use the HP 81682A #003 without attenuation, use the table "Power Linearity HP 81682A #003 upper power levels" on page 130.

5 Perform the steps 5 to 16 of the "Power Linearity - Low Power Test" on page 68.

Power Linearity - Test Using Attenuation

Follow the steps below to measure the power linearity (while using attenuation) of any one of the following:

- Output 2, the High Power output, of the HP 81640A
- Output 2, the High Power output, of the HP 81680A
- HP 81682A #003

1 Set up the equipment as shown in Figure D-5.

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

3 Set the menu parameters to the values shown in Table D-2.
For HP 81640A, HP 81680A, and HP 81682A#003:
Set <POWER MODE> to <MANUAL ATT>.

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

Module	Wavelength [λ]	Power [P]	Attenuation [ATTEN]
HP 81640A - Output 2	1560.000 nm	+0.000 dBm	0.000 dB
HP 81680A - Output 2	1540.000 nm	+0.000 dBm	0.000 dB
HP 81682A #003	1540.000 nm	+0.000 dBm	0.000 dB

Table D-9 **Wavelength and Power Settings for High Power Linearity Tests with Attenuation**

NOTE **If you use the HP 81680A Output 2 or the HP 81640A Output 2 with attenuation, use the table "Power Linearity Output 2, High Power by attenuator" on page 112 or "Power Linearity Output 2, High Power by attenuator" on page 149 respectively.**

If you use the HP 81682A #003 with attenuation, use the table "Power Linearity HP 81682A #003 by attenuator" on page 131.

5 Perform the steps 5 to 16 of the "Power Linearity - Low Power Test" on page 68.

Power Flatness over Wavelength

Power Flatness over Wavelength - Without Attenuation

Follow the steps below to measure the power flatness over wavelength (without using attenuation):

1 Set up the equipment as shown in Figure D-5.

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

3 Set the menu parameters to the values shown in Table D-2.
For HP 81640A, HP 81680A, and HP 81682A#003:
Set <POWER MODE> to <MANUAL ATT>.

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

Module	**Wavelength** [λ]	**Power [P]**	**Attenuation [ATTEN]**
HP 81680A - Output 1	1460.000 nm	–13.000 dBm	Not applicable
HP 81680A - Output 2	1460.000 nm	– 3.000 dBm	0.000 dB
HP 81682A	1460.000 nm	– 3.000 dBm	Not applicable
HP 81682A #003	1460.000 nm	– 5.500 dBm	0.000 dB
HP 81640A - Output 1	1510.000 nm	–13.00 dBm	Not applicable
HP 81640A - Output 2	1510.000 nm	– 5.00 dBm)	0.000 dB

Table D-10 **Wavelength and Power Settings for Power Flatness over Wavelength Tests without Attenuation**

Module	Wavelength [λ]	Power [P]	Attenuation [ATTEN]
HP 81689A	1525.000 nm	+ 2.000 dBm	Not applicable
HP 81689A	1525.000 nm	– 3.000 dBm	Not applicable

Table D-10 **Wavelength and Power Settings for Power Flatness over Wavelength Tests without Attenuation**

5 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 1, the Low SSE output.
Set <OPTICAL OUTPUT> to <LOW SSE (1)>.

6 Set the power meter channel of the HP 8153A to the following settings:

- **a** Set range to 0 dBm. Press UP or DOWN as required.
- **b** Set T, the averaging time, to 500 ms.
- **c** Set the λ, the wavelength, to the same as your Tunable Laser module, as given in Table D-10.
- **d** Select dB as the power units.

7 Press the DISP–>REF hardkey of the HP 8153A.

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 output power. Note the result in the test record

10 Repeat steps 8 and 9 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 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the High Power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

13 Set wavelength and power as given in Table D-10.

14 Repeat steps 6 to 11.

Power Flatness over Wavelength - Using Attenuation

Follow the steps below to measure the power flatness over wavelength (while using attenuation) of any one of the following:

- HP 81640A, Output 2, High Power
- HP 81680A, Output 2, High Power
- HP 81682A #003

1 Set up the equipment as shown in Figure D-5.

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

3 Set the menu parameters to the values shown in Table D-2. Set <POWER MODE> to <MANUAL ATT>.

Module	Wavelength [λ]	Power [P]	Attenuation [ATTEN]
HP 81640A - Output 2	1510.000 nm	– 5.000 dBm	55.000 dB
HP 81680A - Output 2	1460.000 nm	– 3.000 dBm	57.000 dB
HP 81682A #003	1460.000 nm	– 5.500 dBm	54.500 dB

Table D-11 **Wavelength and Power Settings for Power Flatness over Wavelength Tests with Attenuation**

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

5 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the high power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

6 Set the power meter channel of the HP 8153A to the following settings:

a Set range to -60 dBm. Press UP or DOWN as required.

b Set T, the averaging time, to 500 ms.

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

d Select dB as the power units.

7 Press the DISP–>REF hardkey of the HP 8153A.

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 output power. Note the result in the test record

10 Repeat steps 8 and 9 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 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the High Power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

13 Set wavelength and power as given in Table D-10.

14 Repeat steps 6 to 11.

Power Stability

Follow the steps below to measure the power stability:

1 Set up the equipment as shown in Figure D-4.

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

3 Set the menu parameters to the values shown in Table D-2.

4 Set the wavelength and power for each Tunable Laser module to the values given in Table D-12.

Module	Wavelength [λ]	Power [P]
HP 81680A - Output 1	1540.000 nm	–13.000 dBm
HP 81680A - Output 2	1540.000 nm	– 3.000 dBm (**ATT = 0 dB**)
HP 81682A	1540.000 nm	– 3.000 dBm
HP 81682A #003	1540.000 nm	– 5.500 dBm (**ATT = 0 dB**)
HP 81640A - Output 1	1560.000 nm	–13.00 dBm
HP 81640A - Output 2	1560.000 nm	– 5.00 dBm (**ATT = 0 dB**)
HP 81689A	1540.000 nm	– 3.00 dBm

Table D-12 **Wavelength and Power Settings for Power Stability Tests**

5 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 1, the Low SSE output.
Set <OPTICAL OUTPUT> to <LOW SSE (1)>.

6 Ensure the optical output is switched off.

7 Set the power meter channel of the HP 8153A to the following settings:

- Enable automatic ranging; press AUTO as required.
- Set T, the averaging time, to 200 ms.

NOTE **You should record measurements after a time interval of at least 3 seconds.**

- Set the λ, the wavelength, to the same as your Tunable Laser module, as given in Table D-12.
- Select dB as the power units.
- Set HP 8153A to Logging, T_Total 15 minutes:

  a Press MENU.

  b Press RECORD to get `STABILITY`.

c Press EDIT to get `T_TOTAL`.

d Modify the display until it shows `0:15:00`.

e Press EDIT.

NOTE **To test power stability, it is sufficient to set T_Total to 15 minutes rather than 1 hour, to ensure that the power control loop works correctly.**

8 Press the key beside the laser output to switch on the laser output and wait 1 minute. For the HP 81680A or the HP 81640A, press the key beside Output 1, the Low SSE output, or the key beside Output 2, the High Power output, as appropriate.

9 On the HP 8153A, press EXEC.
Display will show `RUNNING` (blinking) for a few moments and then show the remaining time. When logging has finished the display will show `STABILITY`.

10 To see the results:

a Press MORE to get `SHOW`.

b Press EDIT to get `MAXIMUM`. Note the value in the test record.

c Press NEXT to get `MINIMUM`. Note the value in the test record.

d Press EDIT, and MODE to return to normal operation.

11 Calculate the Stability by subtracting the `MINIMUM` from the `MAXIMUM`.

12 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the high power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.
Then set the wavelength and power to the value given in Table D-12.

13 Repeat item list 6 to 11.

Signal-to-Source Spontaneous Emission

See Appendix C for a definition of Signal-to-Source Spontaneous Emission.

Signal-to-Source Spontaneous Emission Tests - High Power Outputs

Follow this procedure to test modules with high power outputs:

- HP 81640A, Output 2, High Power
- HP 81680A, Output 2, High Power
- HP 81682A standard model
- HP 81682A #003
- HP 81689A

1 Connect the Tunable Laser module to the Optical Spectrum Analyzer as shown in Figure D-6.

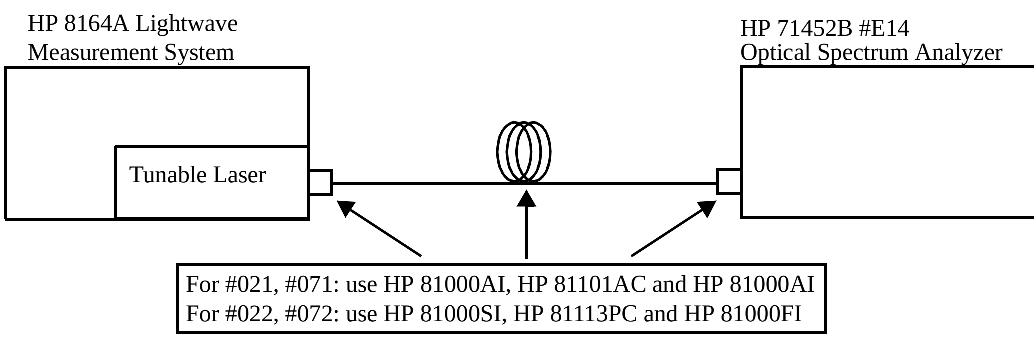


Figure D-6 **Test Setup for the Source Spontaneous Emission Test - High Power Outputs**

2 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module;
connect the one end of the fiber to Output 2, the High Power output, and the other to the Optical Spectrum Analyzer.

3 Initialize Optical Spectrum Analyzer: press PRESET the green hardkey and AUTO MEAS.

4 Set the Optical Spectrum Analyzer:

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

b Set the Resolution Bandwidth to 1 nm. Press [AMPL], press [BW Swp], and enter the value.

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

d Set the wavelength to the value given for your Tunable Laser module in Table D-13.

5 Move to the Tunable Laser channel of the HP 8164A Lightwave Measurement System and press [Menu].

6 Set the menu parameters to the values shown in Table D-2.

7 If you use the HP 81680A Tunable Laser module or the HP 81640A Tunable Laser module:
Connect the output fiber to Output 2, the High Power output.
Set <OPTICAL OUTPUT> to <HIGH POWER (2)>.

8 Ensure the optical output is switched off.

9 Set the wavelength of your Tunable Laser module to the value given in Table D-13.

Module	**Wavelength** [λ]
HP 81680A - Output 2	1460.000 nm
HP 81682A	1460.000 nm
HP 81640A - Output 2	1510.000 nm
HP 81689A	1525.000 nm

Table D-13 **Wavelength Settings for Source Spontaneous Emission Tests**

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

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

12 On the spectrum analyzer, set the Marker to the highest peak and select delta.
(Marker –> HIGHEST PEAK –> DELTA)

13 Using the MODIFY knob move the second marker to the highest peak of the displayed side modes and note the difference, delta, between the two markers in the Test Record.

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

15 Repeat steps 11 to 13 within the wavelength range of the Tunable Laser.

Signal-to-Source Spontaneous Emission Tests - Low SSE Outputs

Follow this procedure to test modules with Low SSE high power outputs:

- HP 81640A, Output 1, Low SSE
- HP 81680A, Output 1, Low SSE

The previous setup is limited by the dynamic range of the Optical Spectrum Analyzer. An improvement can be done by reducing the power of the spectral line of the Tunable Laser module by a filter, a Fiber Bragg Grating. However, by this approach, the measurement is limited to a single wavelength (that of the peak attenuation of the Fiber Bragg Grating):

The Fiber Bragg Grating has a straight connector on one end and a slanted connector on the other. Depending on the output connector option of your Tunable Laser module, the Device Under Test (DUT), the Fiber Bragg Grating should be connected with:

- a straight connector, if you use option #021 or #071, or
- the slanted connector, if you use option #022 or #072.

NOTE

Because the Tunable Laser channel displays the wavelength in air and Optical Spectrum Analyzer displays the wavelength in a vacuum there is a mismatch between the values displayed by the two instruments.

A good approximation in this wavelength range is:

$$\lambda_{OSA} = \lambda_{TLS} - 0.5 \text{ nm}$$

Use λ_{TLS} as primary reference because the specified wavelength accuracy of the Tunable Laser modules is better than the OSA.

The accuracy of the offset value in this equation does not influence the measurement accuracy of spectral and total SSE measurements.

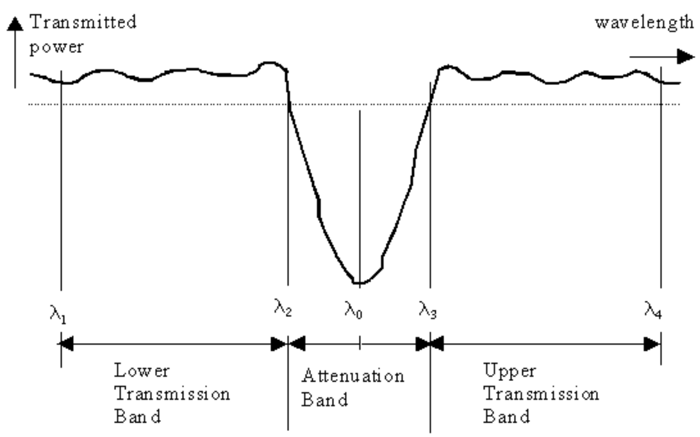


Figure D-7 **Transmission Characteristic of Fiber Bragg Grating**

Lower Transmission Band	$\lambda_1 ... \lambda_2$	
Upper Transmission Band	$\lambda_3 ... \lambda_4$	
Attenuation Band	$\lambda_2 ... \lambda_3$	< 2 nm

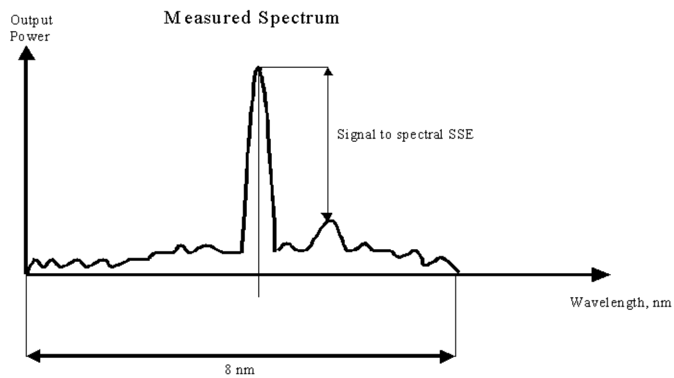


Figure D-8 **Signal-to-Spectral SSE Measurement**

1 Connect the Tunable Laser module (DUT) to the Optical Spectrum Analyzer as shown in Figure D-9. Connect the one end of the fiber to Output 1, the Low SSE output, and the other to the Optical Spectrum Analyzer.

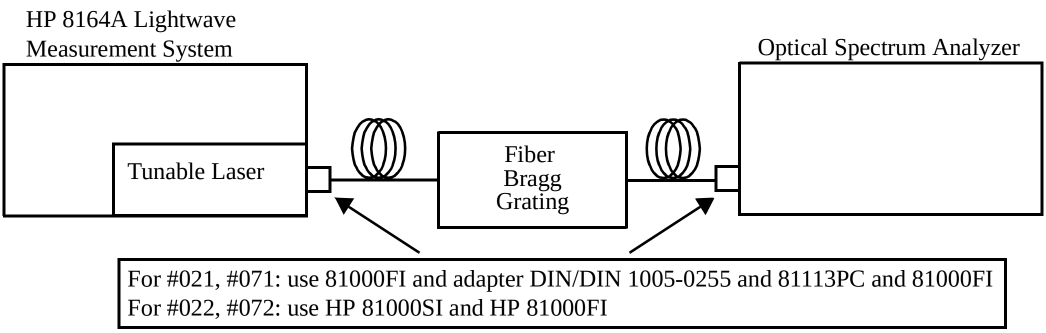


Figure D-9 **Test Setup for the Source Spontaneous Emission Test**

2 Determine the filter transmission characteristics:

a Check center wavelength, λ_{FBG}, of the Fiber Bragg Grating. This wavelength is printed on its label, for example, 1520.5 nm. This value relates to measurements performed in a vacuum.

b Set the Optical Spectrum Analyzer:

- Set the Span to 8 nm. Press SPAN and enter the value.
- Set the center wavelength to λ_{FBG} – 0.5 nm. Press CENTER and enter the value.
- Set the reference level to 0 dBm. Press [AMPL], press [Ref LVL], and enter the value.
- Set the Sensitivity to -68 dBm. Press [AMPL], press [SENS AUTO MAN], and enter the value.
- Set the resolution bandwidth to 0.1 nm. Press [BW Swp], and enter the value.

c Set the Tunable Laser module

- Set [λ], the wavelength, to λ_{FBG} – 1 nm, for example, 1520.5 nm – 1 nm = 1519.5 nm.
- Set [P], the output power, to the value in Table D-14.

Tunable Laser Module	Power [P]
HP 81680A - Output 1	-6 dBm
HP 81640A - Output 1	-7 dBm

Table D-14 **Output Power Setting - Low SSE Output**

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

e Check and note the peak power level displayed by the OSA and the wavelength at the peak power. Press PEAK SEARCH in the Marker field.

f For $\lambda_{FBG} \pm 1$ nm, check and note the power level displayed by the OSA at every 0.1 nm interval. That is, fill out the table shown in Table D-15.

Tunable Laser Module Output Wavelength Relative to λ_{FBG}	Peak Power Level	Associated Wavelength Displayed on OSA
– 1.0 nm	dBm	nm
– 0.9 nm	dBm	nm
– 0.8 nm	dBm	nm
– 0.7 nm	dBm	nm
– 0.6 nm	dBm	nm
– 0.5 nm	dBm	nm
– 0.4 nm	dBm	nm
– 0.3 nm	dBm	nm
– 0.2 nm	dBm	nm
– 0.1 nm	dBm	nm
± 0 nm = λ_{FBG}	dBm	nm
+ 0.1 nm	dBm	nm
+ 0.2 nm	dBm	nm
+ 0.3 nm	dBm	nm
+ 0.4 nm	dBm	nm
+ 0.5 nm	dBm	nm
+ 0.6 nm	dBm	nm
+ 0.7 nm	dBm	nm
+ 0.8 nm	dBm	nm

Table D-15 **Filter Transmission Characteristic**

Tunable Laser Module Output Wavelength Relative to λ_{FBG}	Peak Power Level	Associated Wavelength Displayed on OSA
+ 0.9 nm	μW	nm
+ 1.0 nm	μW	nm

Table D-15 **Filter Transmission Characteristic**

3 Determine minimum value of filter transmission and actual Fiber-Bragg-Grating center wavelength, λ_0.

a Check for minimum transmitted peak power in Table D-15.

b Mark the associated wavelength set on the Tunable Laser, TLS_λ_0, and note the value in the test record.

c Mark the associated wavelength displayed on the OSA, OSA_λ_0, and note the value in the test record.

4 Set TLS to the wavelength of minimum transmission, TLS_λ_0.

5 Record spectrum at minimum filter transmission. Set the Optical Spectrum Analyzer:

a Set the Sensitivity to –90 dBm.

b Set the resolution bandwidth to 0.5 nm.

c Set the center wavelength to OSA_λ_0.

d Set the reference level to –40 dBm.

e Set the span to 6 nm.

6 Determine limits of transmission and attenuation ranges by performing the following calculations:

a Lower Transmission Band: λ_1 ... λ_2

- TLS_λ_1 = TLS_λ_0 – 3 nm
- TLS_λ_2 = TLS_λ_0 – 0.5 × Attenuation Band
  = TLS_λ_0 – 1 nm

b Upper Transmission Band: λ_3 ... λ_4

- TLS_λ_3 = TLS_λ_0 + 0.5 × Attenuation Band
  = TLS_λ_0 + 1 nm
- TLS_λ_4 = TLS_λ_0 + 0.5 × Upper Transmission Band
  = TLS_λ_0 + 3 nm

7 Determine maximum transmitted power value inside transmission band:

a Record spectrum:

b Check for the maximum transmitted power (max_SSE_power) within Lower and Upper Transmission Bands. Do this by using the marker. Change λ by using the RPG and note the maximum value within the Lower and Upper Transmission Bands (this is one value for these bands together). Note this value in the test record. Check the associated wavelength on OSA (OSA@max_SSE_power) and note the value in the test record.

8 Set the marker of the OSA to OSA@max_SSE_power. Change [λ], the output wavelength of the TLS, so that the peak wavelength of the spectrum is at the OSA marker
Change [λ], *the output wavelength of the TLS, to the wavelength of highest SSE (TLS@max_SSE_power) using the approximation:*

TLS@max_SSE_power = OSA@max_SSE_power + 0.5 nm

9 Determine TLS@max_SSE_power as follows:
Set the Optical Spectrum Analyzer:

a Set the Sensitivity to –68 dBm.

b Set the resolution bandwidth to 0.5 nm.

c Set the center wavelength to OSA@max_SSE_power.

d Set the reference level to 0 dBm.

e Set the span to 6 nm.

f Record the spectrum.

10 Within the total spectrum, determine peak power

(power@SSE_peak) and note the value in the test record.

NOTE **This is at the wavelength the TLS is set to for this measurement and the OSA measures, respectively.**

11 Calculate spectral SSE by using the following equation:

Spectral SSE = power@SSE_peak –(max_SSE_power + 3 [dB/nm])

Note the value in the test record.

NOTE **The measurements were done with a resolution bandwidth of 0.5 nm. The additional value of 3dB takes care of a resolution of 1 nm, thus to get the SSE in [dB/nm].**

Signal-to-Total-Source Spontaneous Emission

Follow this procedure to test the Tunable Laser modules:

- HP 81640A
- HP 81680A
- HP 81682A

This test does not apply to the HP 81689A.

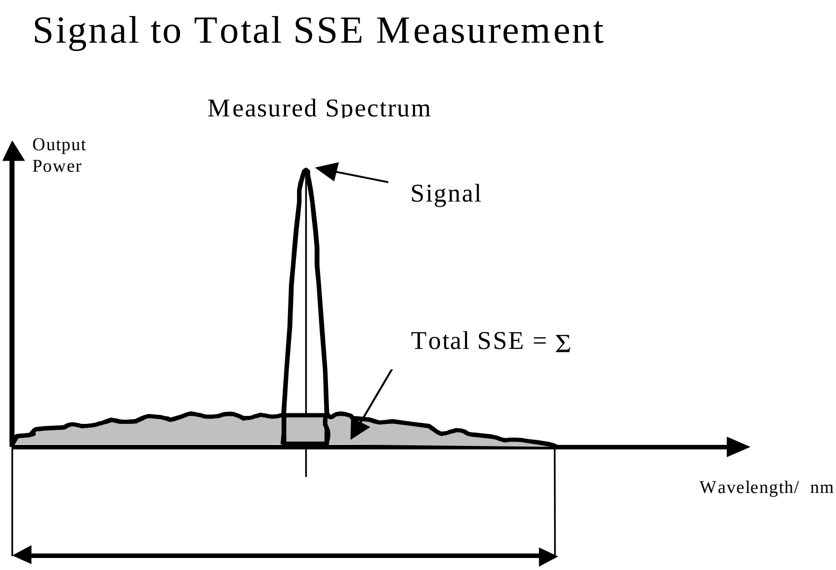


Figure D-10 **Signal to Total SSE Measurement**

Signal to Total SSE Tests - Low SSE Outputs

Follow this procedure to test modules with low SSE outputs:

- HP 81640A, Output 1, the Low SSE output
- HP 81680A, Output 1, the Low SSE output

1 Check center wavelength of Fiber Bragg Grating, FBG (λ_FBG) which is printed on its label (for example, 1520.5 nm). This value relates to vacuum conditions.

2 Determine OSA noise, that is, the noise of OSA alone without applying the Tunable Laser signal:

a Switch off the laser output of the Tunable Laser.

b Set the OSA

- Set the Span to 30 nm. Press SPAN and enter the value.

- Set the center wavelength, OSA_λ_center, to λ_{FBG} – 0.5 nm. Press CENTER and enter the value.
- Set the reference level to –40 dBm. Press [AMPL], press [Ref LVL], and enter the value.
- Set the Sensitivity to –90 dBm. Press [AMPL], press [SENS AUTO MAN], and enter the value.
- Set the resolution bandwidth to 1 nm. Press [BW Swp], and enter the value.

c Record noise spectrum for a single sweep.

d Measure partial noise of the spectrum.
With a sampling step of 1 nm on the OSA, check all 201 power levels within the recorded spectrum, starting at OSA_λ_center – 15 nm and finishing at OSA_λ_center + 15 nm.

NOTE **Note the "partial noise power level" values in a table in [pW], where 1 pW = 10^{-12} W.**

Example:

Wavelength, Relative to OSA_λ_center	Partial Noise Power levels
–15 nm	pW
– 14 nm	pW
– 13 nm	pW

Table D-16 **Signal to Total SSE Tests - Low SSE Outputs**

….	pW
….	pW
–2 nm	pW
–1 nm	pW
+/– 0 nm (= OSA_λ_center)	pW
+1 nm	pW
+ 2 nm	pW
….	pW
….	pW
+ 13 nm	pW
+ 14 nm	pW
+ 15 nm	pW
Sum of all partial noise power levels	pW

Table D-16 **Signal to Total SSE Tests - Low SSE Outputs**

e Determine total noise power by adding up all 31 partial noise power levels:
OSA_noise = Sum of all partial noise power levels

OSA_noise = __________ pW

f Note the OSA_noise value in the test record.

3 Connect the Tunable Laser (DUT) to the Optical Spectrum Analyzer as shown in Figure D-9. Connect one end of the Fiber Bragg Grating to Output 1,the Low SSE output of the TLS and the other to the Optical Spectrum Analyzer.

4 Set the TLS menu parameters to the values shown in Table D-2.

5 Set the power for each Tunable Laser module to the values given in Table D-17.

NOTE **For the HP 81640A, the laser ouput power is limited to its maximum possible value at this wavelength. The display will probably show EXP.**

Module	Power [P]
HP 81680A - Output 1	–6.00 dBm
HP 81640A - Output 1	–7.00 dBm

Table D-17 **Power Settings for Signal to Total SSE Tests - Low SSE Outputs**

6 Determine filter transmission characteristic (see Signal-to-Source Spontaneous Emission Tests - Low SSE Outputs on page 81). You may skip this step if the characteristic has already been determined.

a Determine minimum value of filter transmission and actual FBG center wavelength λ0 (see step 3 on page 86). You may skip this step if the characteristic has already been determined.

b Note the wavelength of minimum transmitted peak power the TLS is set to in the test record
TLS_λ0 = ________ nm

c Mark the associated wavelength displayed on the OSA (OSA_λ0) and note the value in the test record
OSA_λ0 = ________ nm

7 Record spectrum at minimum filter transmission:
Set TLS to the wavelength of minimum transmission (TLS_λ0)
Check that the laser output is activated.

8 Set the Optical Spectrum Analyzer:

a Set Span to 30 nm. Press SPAN, enter the value.

b Set the Resolution Bandwidth to 1 nm. Press [AMPL], press [BW Swp], and enter the value.

c Set the Sensitivity to –90 dBm. Press [AMPL], press [SENS], and enter the value.

d Set the center wavelength to OSA_λ0. Press CENTER and enter the value.

e Set the reference level to –40 dBm. Press [AMPL], press [Ref LVL], and enter the value.

9 Determine limits of SSE range by performing the following calculations:

a Lower Transmission Band: $\lambda_1 \ldots \lambda_2$

- $OSA\_\lambda_1 = OSA\_\lambda_0 - 15$ nm
- $OSA\_\lambda_2 = OSA\_\lambda_0 - 1/2 \times$ Attenuation Band
  $= OSA\_\lambda_0 - 1$ nm

b Upper Transmission Band: $\lambda_3 \ldots \lambda_4$

- $OSA\_\lambda_3 = OSA\_\lambda_0 + 1/2 \times$ Attenuation Band
  $= OSA\_\lambda_0 + 1$ nm
- $OSA\_\lambda_4 = OSA\_\lambda_0 +$ Upper Transmission Band
  $= OSA\_\lambda_0 + 15$ nm

c Note the values of OSA_λ1, OSA_λ2, OSA_λ3, OSA_λ4 in the test record:

- OSA_λ_1 = ____________ nm
- OSA_λ_2 = ____________ nm
- OSA_λ_3 = ____________ nm
- OSA_λ_4 = ____________ nm

10 Determine SSE power values inside the transmission bands:

a Ensure the TLS is set to TLS_λ0 and *is not* changed.

b On OSA, set marker to OSA_λ1.

c Check the OSA and note SSE power value in [pW] in the table below as SSE_power.

d Increase OSA marker wavelength by 1 nm.

e Repeat steps c and d until the wavelength is equal to OSA_λ2.

f Set OSA to OSA_λ3.

g Repeat steps c and d until the wavelength is equal to OSA_λ4.

h Add up all power values inside the transmissions bands to get the value of power_trans.

NOTE **Note all the power values in the table in [pW], where 1 pW = 10^{-12} W.**

Example:

Lower transmission band OSA_λ1 to OSA_λ2		Upper transmission band OSA_λ3 to OSA_λ4	
Relative Wavelength, Increments from λ_1	**SSE_power measured**	**Relative Wavelength, Increments from λ_3**	**SSE_power measured**
0 (relates to OSA_λ1)	pW	0 (relates to λ_3)	pW
+ 1 nm	pW	+ 1 nm	pW
+ 2 nm	pW	+ 2 nm	pW
+ 3 nm	pW	+ 3 nm	pW
+ 4 nm	pW	+ 4 nm	pW
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
+ 11 nm	pW	+ 11 nm	pW
+ 12 nm	pW	+ 12 nm	pW
+ 13 nm	pW	+ 13 nm	pW
+ 14 nm	pW	+ 14 nm	pW
(relates to OSA_λ2)		(relates to OSA_λ4)	

Sum of all SSE power levels:

- in lower transmission band ________ pW (1)
- in upper transmission band ________ pW (2)

Sum of all SSE power levels in transmission bands, add results in (1) and (2)

power_trans = ___________ pW

11 Determine SSE power inside the attenuation band by interpolation:

a Check the power measured at OSA_λ2 and OSA_λ3.

b Mark that power value which is the largest of both and note it as power_ OSA_λ2,3_max

c Calculate the power inside the attenuation band by using power_att = 1/2 × power_ OSA_λ2,3_max

= ___________ 10^{-12} W = ___________ pW

NOTE **Note all the power values in [pW], where 1 pW = 10^{-12} W.**

12 Determine total noise power, power_total_noise. Add the value of the power_trans and the value of power_att:
power_total_noise = power_trans + power_att

= ___________ 10^{-12} W = ___________ pW

13 Determine Peak power:

a Set the OSA:

- Set the Span to 30 nm. Press SPAN and enter the value.
- Set the center wavelength to OSA_λ0. Press CENTER and enter the value.
- Set the reference level to 0 dBm. Press [AMPL], press [Ref LVL], and enter the value.
- Set the Sensitivity to –68 dBm. Press [AMPL], press [SENS AUTO MAN], and enter the value.
- Set the resolution bandwidth to 1 nm. Press [BW Swp], and enter the value.

b Set the TLS:

- Set the wavelength to a value outside attenuation band. That is, set it to TLS_λ0 + 5 nm.
- Set the output power to the value in Table D-17.
- Ensure the laser output is activated.

c Record the spectrum for a single sweep.

NOTE **Note all the power values in [pW], where 1 pW = 10^{-12} W.**

d Find the maximum power level for the whole spectrum, power_SSE_peak, and enter the result in the test record in [pW]:
Peak_power = ____________ 10^{-12} W = ____________ pW

14 Calculate total SSE and express in decibels, [dB].

$$\text{Total SSE} = 10 \times \log \frac{\text{peak\_power}}{\text{power\_total\_noise} - \text{OSA\_noise}}$$

NOTE **Make sure that all power values are entered in the same units, for example Watts, W, or picowatts, pW. This ensures that the equation will give Total SSE in decibels, dB.**

15 Note the result in the test record:

Total SSE = _________________ dB

Optional Test

Signal to Total SSE Tests - High Power Outputs

Follow this optional procedure to test modules with high power outputs:

- HP 81640A, Output 2, the High Power output
- HP 81680A, Output 2, the High Power output
- HP 81682A, standard model
- HP 81682A, #003

1 Connect the Tunable Laser module (DUT) to the Optical Spectrum Analyzer as shown in Figure D-6. For the HP 81640A and HP 81680A make sure to connect Output 2, the High Power output, to the Optical Spectrum Analyzer.

2 Set the TLS menu parameters to the values shown in Table D-2.

3 Set the wavelength and power for each Tunable Laser module to the values given in Table D-18.

Module	Power [P]	Wavelength [λ]
HP 81680A - Output 2	+5.00 dBm	1530 nm
HP 81640A - Output 2	+2.00 dBm	1530 nm
HP 81682A - Standard	+6.00 dBm	1530 nm
HP 81682A - #003	+4.50 dBm	1530 nm

Table D-18 **TLS Settings for Signal to Total SSE Tests - High Power Outputs**

4 Set the Optical Spectrum Analyzer:

a Set Span to 30 nm. Press SPAN, enter the value.

b Set the Resolution Bandwidth to 1 nm. Press [AMPL], press [BW Swp], and enter the value.

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

5 Record Spectrum (run a single sweep):

a Press PEAK SEARCH in the Marker field.

b Set Marker to Center Wavelength and note its displayed wavelength as:
OSA_λ_center = ________________ nm

6 Find the maximum power level at OSA_λ_center, peak_power, and enter the result in the test record in [pW]:
Peak_power = ___________ 10^{-12} W = ___________ pW

7 Measure partial noise of the spectrum.
With a sampling step of 1 nm on the OSA, check all 30 power levels within the recorded spectrum, starting at

OSA_λ_center – 15 nm and finishing at OSA_λ_center + 15 nm without recording a value at OSA_λ_center.

NOTE **Note the "partial noise power level" values in the table in [pW], where 1 pW = 10^{-12} W.**

Example:

Wavelength, Relative to OSA_λ_center	Partial Noise Power levels
–15 nm	pW
– 14 nm	pW
– 13 nm	pW
….	pW
….	pW
–2 nm	pW
–1 nm	pW
+/– 0 nm (= OSA_λ_center)	pW
+1 nm	pW
+ 2 nm	pW
….	pW
….	pW
+ 13 nm	pW
+ 14 nm	pW

Table D-19 **Signal to Total SSE Tests - Low SSE Outputs**

+ 15 nm	pW
Sum of all partial noise power levels	pW

Table D-19 **Signal to Total SSE Tests - Low SSE Outputs**

8 Determine total noise power by adding up all 30 partial noise power levels:
OSA_noise = Sum of all partial noise power levels

OSA_noise = _________ pW

9 Note the OSA_noise value in the test record.

10 Determine SSE of the Tunable-Laser output signal by using the maximum value at its border:

a Note the power measured at:
OSA_λ_center – 1 nm

b Note the power measured at:
OSA_λ_center + 1 nm

c Determine the larger of these two power values and note it as SSE_power_λTLS_max.

NOTE **Note all the power values in [pW], where 1 pW = 10^{-12} W.**

d SSE_power_λTLS_max= ________ 10^{-12} W = _______ pW

11 Determine the Total SSE power, power_total_SSE.
Add the values of OSA_noise and SSE_power_λTLS_max:

power_total_SSE = OSA_noise + SSE_power_λTLS_max
= ___________ 10^{-12} W = ___________ pW

12 Calculate the Total SSE in [dB] by using the following formula:

$$\text{Total\_SSE} = 10 \times \log\frac{\text{peak\_power}}{\text{power\_total\_SSE}}$$

NOTE **Make sure you that all values are power values are entered in the same units, for example Watts, W, or picowatts, pW. This ensures that the equation will give Total SSE in decibels, dB.**

13 Note the result in the test record:

Total SSE = ______________________ dB

D.2 Test Record

HP 81680A Performance Test

Page 1 of 17

Test Facility:

_______________________________ Report No. ________________

_______________________________ Date ________________

_______________________________ Customer ________________

_______________________________ Tested By ________________

Model HP 81680A Tunable Laser Module 1550 nm

Serial No. ____________________ Ambient temperature ________°C

Options ____________________ Relative humidity ________ %

Firmware Rev. ____________________ Line frequency ________ Hz

Special Notes:

____

____

____

____

____

____

____

____

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. _________ Date________

Test Equipment Used:

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	HP 8164A	_________	__________
2. Lightwave Multimeter	HP 8153A	__________	__________
3. Optical Head Interface Module	HP 81533B	__________	__________
4. Standard Optical Head	HP 81524A #C01	__________	__________
5. Optical Spectrum Analyzer	____________	__________	__________
6. Wavelength Meter	____________	__________	__________
7. _____________________________	____________	__________	__________
8. _____________________________	____________	__________	__________
9. _____________________________	____________	__________	__________
10. _____________________________	____________	__________	__________
11. _____________________________	____________	__________	__________
12. _____________________________	____________	__________	__________
13. _____________________________	____________	__________	__________
14. _____________________________	____________	__________	__________
15. _____________________________	____________	__________	__________

HP 81680A Performance Test

Page 3 of 17

Model HP 81680A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 1 and 2

	Repetition 1		Repetition 2	
Wavelength Setting	Wavelength Measured	Wavelength Deviation[1]	Wavelength Measured	Wavelength Deviation[1]
1460.000 nm	________nm	________nm	________nm	________nm
1475.000 nm	________nm	________nm	________nm	________nm
1490.000 nm	________nm	________nm	________nm	________nm
1500.000 nm	________nm	________nm	________nm	________nm
1510.000 nm	________nm	________nm	________nm	________nm
1520.000 nm	________nm	________nm	________nm	________nm
1530.000 nm	________nm	________nm	________nm	________nm
1540.000 nm	________nm	________nm	________nm	________nm
1550.000 nm	________nm	________nm	________nm	________nm
1560.000 nm	________nm	________nm	________nm	________nm
1575.000 nm	________nm	________nm	________nm	________nm
1580.000nm	________nm	________nm	________nm	________nm

Within full Tuning Range1460 to 1580nm				
Maximum Deviation		________nm		________nm
Minimum Deviation		________nm		________nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 3 and 4

	Repetition 3		Repetition 4	
Wavelength Setting	Wavelength Measured	Wavelength Deviation[1]	Wavelength Measured	Wavelength Deviation[1]
1460.000 nm	________nm	________nm	________nm	________nm
1475.000 nm	________nm	________nm	________nm	________nm
1490.000 nm	________nm	________nm	________nm	________nm
1500.000 nm	________nm	________nm	________nm	________nm
1510.000 nm	________nm	________nm	________nm	________nm
1520.000 nm	________nm	________nm	________nm	________nm
1530.000 nm	________nm	________nm	________nm	________nm
1540.000 nm	________nm	________nm	________nm	________nm
1550.000 nm	________nm	________nm	________nm	________nm
1560.000 nm	________nm	________nm	________nm	________nm
1575.000 nm	________nm	________nm	________nm	________nm
1580.000nm	________nm	________nm	________nm	________nm
Within full Tuning Range1460 to 1580nm				
Maximum Deviation		________nm		________nm
Minimum Deviation		________nm		________nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetition 5

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Measured - Wavelength Setting
1460.000 nm	________nm	________nm
1475.000 nm	________nm	________nm
1490.000 nm	________nm	________nm
1500.000 nm	________nm	________nm
1510.000 nm	________nm	________nm
1520.000 nm	________nm	________nm
1530.000 nm	________nm	________nm
1540.000 nm	________nm	________nm
1550.000 nm	________nm	________nm
1560.000 nm	________nm	________nm
1575.000 nm	________nm	________nm
1580.000nm	________nm	________nm

Within full Tuning Range 1460 to 1580 nm

Maximum Deviation		________nm
Minimum Deviation		________nm

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy Summary of all repetitions

Largest Maximum Deviation ________nm
Smallest Minimum Deviation ________nm

Relative Wavelength Accuracy Result

(= Largest Maximum Deviation – Smallest Minimum Deviation)

________nm
Specification 0.01 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)

_______nm
Specification 0.02 nm

Measurement Uncertainty: ±0.6 pm

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Mode Hop Free Tuning

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Setting – Wavelength Measured
1460.000 nm	________nm	________nm
1461.000 nm	________nm	________nm
1462.000 nm	________nm	________nm
1463.000 nm	________nm	________nm
1464.000 nm	________nm	________nm
1465.000 nm	________nm	________nm
1466.000 nm	________nm	________nm
1467.000 nm	________nm	________nm
1468.000 nm	________nm	________nm
1479.000 nm	________nm	________nm
1470.000 nm	________nm	________nm
1570.000nm	________nm	________nm
1571.000nm	________nm	________nm
1572.000nm	________nm	________nm
1573.000nm	________nm	________nm
1574.000nm	________nm	________nm
1575.000nm	________nm	________nm
1576.000nm	________nm	________nm
1577.000nm	________nm	________nm
1578.000nm	________nm	________nm
1579.000nm	________nm	________nm
1580.000nm	________nm	________nm

Maximum Deviation ________ nm
Minimum Deviation ________ nm

Mode Hop Free Tuning Result

(= Maximum Deviation – Minimum Deviation)

________ nm

Specification 0.05 nm

Measurement Uncertainty: ±0.2 pm

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability

Repeatability of 1460.000nm (= reference)	Measurement Result	
initial setting	REF=________	nm
from 1490.000nm to REF	________	nm
from 1520.000nm to REF	________	nm
from 1550.000nm to REF	________	nm
from 1580.000nm to REF	________	nm
largest measured wavelength	________	nm
smallest measured wavelength	________	nm
Wavelength Repeatability	________	nm

(=largest measured wavelength – smallest measured wavelength)

Specification	0.002	nm
typical	0.001	nm

Repeatability of 1520.000nm (= reference)	Measurement Result	
initial setting	REF=________	nm
from 1460.000nm to REF	________	nm
from 1490.000nm to REF	________	nm
from 1550.000nm to REF	________	nm
from 1580.000nm to REF	________	nm
largest measured wavelength	________	nm
smallest measured wavelength	________	nm
Wavelength Repeatability	________	nm

(=largest measured wavelength – smallest measured wavelength)

Specification	0.002	nm
typical	0.001	nm

HP 81680A Performance Test

Page 9 of 17

Model HP 81680A Tunable Laser   Report No. ________ Date_______

Wavelength Repeatability (continued)

Repeatability of 1580.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1460.000nm to REF	________ nm
from 1490.000nm to REF	________ nm
from 1550.000nm to REF	________ nm
from 1580.000nm to REF	________ nm
largest measured wavelength	________ nm
smallest measured wavelength	________ nm
Wavelength Repeatability	________ nm

(=largest measured wavelength – smallest measured wavelength)

Specification	0.002	nm
typical	0.001	nm

Measurement Uncertainty: ±0.1 pm

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Maximum Power Test

Wavelength	Output 1		Output 2	
	Power	Minimum	Power	Minimum
Setting	Measured	Specification	Measured	Specification
1460.000 nm	______dBm	–13.00 dBm	______dBm	– 3.00 dBm
1470.000 nm	______dBm	–13.00 dBm	______dBm	– 3.00 dBm
1480.000 nm	______dBm	–10.00 dBm	______dBm	+ 1.00 dBm
1490.000 nm	______dBm	–10.00 dBm	______dBm	+ 1.00 dBm
1500.000 nm	______dBm	–10.00 dBm	______dBm	+ 1.00 dBm
1510.000 nm	______dBm	–10.00 dBm	______dBm	+ 1.00 dBm
1520.000 nm	______dBm	– 6.00 dBm	______dBm	+ 5.00 dBm
1530.000 nm	______dBm	– 6.00 dBm	______dBm	+ 5.00 dBm
1540.000 nm	______dBm	– 6.00 dBm	______dBm	+ 5.00 dBm
1550.000 nm	______dBm	– 6.00 dBm	______dBm	+ 5.00 dBm
1560.000 nm	______dBm	– 6.00 dBm	______dBm	+ 5.00 dBm
1570.000 nm	______dBm	– 6.00 dBm	______dBm	+ 5.00 dBm
1580.000nm	______dBm	–10.00 dBm	______dBm	+ 1.00 dBm

Measurement Uncertainty: ±0.10 dB

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Power Linearity Output 1, Low SSE

	Power Setting from start	Measured Relative Power from start			Power reduction from start			Power Linearity at current setting	
Start = REF	– 6.0 dBm	0.00	dB	+	0.00	dB	=	0.00	dB
	– 7.0 dBm		dB	+	1.00	dB	=		dB
	– 8.0 dBm		dB	+	2.00	dB	=		dB
	– 9.0 dBm		dB	+	3.00	dB	=		dB
	– 10.0 dBm		dB	+	4.00	dB	=		dB
	– 11.0 dBm		dB	+	5.00	dB	=		dB
	– 12.0 dBm		dB	+	6.00	dB	=		dB
	– 13.0 dBm		dB	+	7.00	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

Power Linearity Output 2, High Power upper power levels

	Power Setting from start	Measured Relative Power from start			Power reduction from start			Power Linearity at current setting	
Start = REF	+ 5.0 dBm	0.00	dB	+	0.00	dB	=	0.00	dB
	+ 4.0 dBm		dB	+	1.00	dB	=		dB
	+ 3.0 dBm		dB	+	2.00	dB	=		dB
	+ 2.0 dBm		dB	+	3.00	dB	=		dB
	+ 1.0 dBm		dB	+	4.00	dB	=		dB
	0.0 dBm		dB	+	5.00	dB	=		dB
	– 1.0 dBm		dB	+	6.00	dB	=		dB
	– 2.0 dBm		dB	+	7.00	dB	=		dB
	– 3.0 dBm		dB	+	8.00	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	0.6	dBpp
Measurement Uncertainty	± 0.05	dB

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date________

Power Linearity **Output 2, High Power** **by attenuator**

	Power Setting from start	Measured Relative Power from start		Power reduction from start			Power Linearity at current setting
Start = REF	0.0 dBm	dB	+	0.00	dB	=	dB
	– 1.0 dBm	dB	+	1.00	dB	=	dB
	– 2.0 dBm	dB	+	2.00	dB	=	dB
	– 3.0 dBm	dB	+	3.00	dB	=	dB
	– 4.0 dBm	dB	+	4.00	dB	=	dB
	– 5.0 dBm	dB	+	5.00	dB	=	dB
	– 10.0 dBm	dB	+	10.00	dB	=	dB
	– 15.0 dBm	dB	+	15.00	dB	=	dB
	– 20.0 dBm	dB	+	20.00	dB	=	dB
	– 25.0 dBm	dB	+	25.00	dB	=	dB
	– 30.0 dBm	dB	+	30.00	dB	=	dB
	– 35.0 dBm	dB	+	35.00	dB	=	dB
	– 40.0 dBm	dB	+	40.00	dB	=	dB
	– 45.0 dBm	dB	+	45.00	dB	=	dB
	– 50.0 dBm	dB	+	50.00	dB	=	dB
	– 55.0 dBm	dB	+	55.00	dB	=	dB
	– 60.0 dBm	dB	+	60.00	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	0.6 dBpp
Measurement Uncertainty	± 0.05 dB

HP 81680A Performance Test

Page 13 of 17

Model HP 81680A Tunable Laser Report No. ________ Date_______

Power Flatness

		Output 1 Low SSE	Output 2 High Power	
		P = –13 dBm	P = –3dBm ATT = 0 dB	P = –3dBm ATT = –57 dB
	Wavelength	Power Deviation	Power Deviation	Power Deviation
Start = REF	1460 nm	0.00 dB	0.00 dB	0.00 dB
	1465 nm	dB	dB	dB
	1470 nm	dB	dB	dB
	1475 nm	dB	dB	dB
	1480 nm	dB	dB	dB
	1485 nm	dB	dB	dB
	1490 nm	dB	dB	dB
	1495 nm	dB	dB	dB
	1500 nm	dB	dB	dB
	1505 nm	dB	dB	dB
	1510 nm	dB	dB	dB
	1515 nm	dB	dB	dB
	1520 nm	dB	dB	dB
	1525 nm	dB	dB	dB
	1530 nm	dB	dB	dB
	1535 nm	dB	dB	dB
	1540 nm	dB	dB	dB
	1545 nm	dB	dB	dB
	1550 nm	dB	dB	dB
	1555 nm	dB	dB	dB
	1560 nm	dB	dB	dB
	1565 nm	dB	dB	dB
	1570 nm	dB	dB	dB
	1575 nm	dB	dB	dB
	1580 nm	dB	dB	dB
	Maximum deviation	dB	dB	dB
	Minimum deviation	dB	dB	dB
Flatness =	Maximum – Minimum Deviation	dB	dB	dB
	Specification	0.40 dBpp	0.60 dBpp	0.60 dBpp
	Measurement Uncertainty	±0.1 dB	±0.1 dB	±0.1 dB

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Power Stability

	Low SSE Output 1	High Power Output 2 Att = 0 dB
Maximum Deviation	dB	dB
Minimum Deviation	dB	dB
Power Stability [1]	dB	dB
Specification	0.02 dBpp	0.02 dBpp
Measurement Uncertainty	±0.005 dB	±0.005 dB

[1] Power Stability = Maximum Deviation – Minimum Deviation

Signal-to-Source Spontaneous Emission - 81680A Output 2, High Power

Wavelength	Output Power	Results	Maximum Specification
1460 nm	-3.00 dBm	dB	35 dB
1470 nm	-3.00 dBm	dB	35 dB
1480 nm	+1.00 dBm	dB	40 dB
1490 nm	+1.00 dBm	dB	40 dB
1500 nm	+1.00 dBm	dB	40 dB
1510 nm	+1.00 dBm	dB	40 dB
1520 nm	+5.00 dBm	dB	45 dB
1530 nm	+5.00 dBm	dB	45 dB
1540 nm	+5.00 dBm	dB	45 dB
1550 nm	+5.00 dBm	dB	45 dB
1560 nm	+5.00 dBm	dB	45 dB
1570 nm	+5.00 dBm	dB	45 dB
1580 nm	+1.00 dBm	dB	40 dB

Measurement Uncertainty ±0.20 dB

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date_______

Signal-to-Source Spontaneous Emission - 81680A Output 1, Low SSE

Center Wavelength of Fiber Bragg Grating: TLS_λ_0 = ________ nm
OSA_λ_0 = ________ nm

Maximum Transmitted Power: max_SSE_power = _________ dBm
OSA@max_SSE_power = _________ nm

Peak Power: power@SSE_peak = _________ dBm

Test result: Spectral SSE = power@SSE_peak –(max_SSE_power + 3 [dB/ nm])

= ___________ dB / nm

Specification: 63 dB / nm

Measurement Uncertainty: ± 1.2 dB

HP 81680A Performance Test

Model HP 81680A Tunable Laser Report No. ________ Date________

Signal-to-Total-Source Spontaneous Emission - HP 81680A Output 1, Low SSE

Center Wavelength of Fiber Bragg Grating:	TLS_λ_0	= ________ nm
	OSA_λ_0	= ________ nm
Transmission Band Limits:	OSA_λ_1	= ________ nm
	OSA_λ_2	= ________ nm
	OSA_λ_3	= ________ nm
	OSA_λ_4	= ________ nm

	Output 1, Low SSE		
OSA_noise			__________ pW
Sum of all SSE power levels in lower transmission band	__________ pW		
Sum of all SSE power levels in upper transmission band	__________ pW		
power_trans = Sum of all SSE power levels in transmission bands		__________ pW	
power_att		__________ pW	
power_total_noise = power_trans + power_att			__________ pW
Peak_power			
Measurement Result - Total SSE			**__________ dB**
Specification			60 dB

$$\text{Total SSE} = 10 \times \log \frac{\text{peak\_power}}{\text{power\_total\_noise} - \text{OSA\_noise}}$$

Measurement Uncertainty: ± 2.00 dB

HP 81680A Performance Test

Model HP 81680A Tunable Laser   Report No. ________ Date_______

Optional Test

Signal-to-Total-Source Spontaneous Emission - HP 81680A Output 2, High Power

	Output 2, High Power	
OSA_noise	__________ pW	
SSE_power_λTLS_max	__________ pW	
Power_total_noise = OSA_noise + SSE_power_λTLS_max		__________ pW
Peak_power		__________ pW
Measurement Result - Total SSE		**__________ dB**
Specification		25 dB (30 dB typical)

$$\text{Total SSE} = 10 \times \log \frac{\text{peak\_power}}{\text{power\_total\_SSE}}$$

Measurement Uncertainty: ± 2.00 dB

Test Record

HP 81682A Performance Test

Page 1 of 17

Test Facility:

______________________________	Report No.	________________
______________________________	Date	________________
______________________________	Customer	________________
______________________________	Tested By	________________

Model HP 81682A Tunable Laser Module 1550 nm

Serial No.	___________________	Ambient temperature	________ °C
Options	___________________	Relative humidity	________ %
Firmware Rev.	___________________	Line frequency	________ Hz

Special Notes:

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HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Test Equipment Used:

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	HP 8164A	________	_________
2. Lightwave Multimeter	HP 8153A	_________	_________
3. Optical Head Interface Module	HP 81533B	_________	_________
4. Standard Optical Head	HP 81524A #C01	_________	_________
5. Optical Spectrum Analyzer	___________	_________	_________
6. Wavelength Meter	___________	_________	_________
7. __________________________	___________	_________	_________
8. __________________________	___________	_________	_________
9. __________________________	___________	_________	_________
10. __________________________	___________	_________	_________
11. __________________________	___________	_________	_________
12. __________________________	___________	_________	_________
13. __________________________	___________	_________	_________
14. __________________________	___________	_________	_________
15. __________________________	___________	_________	_________

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 1 and 2

	Repetition 1		Repetition 2	
Wavelength Setting	Wavelength Measured	Wavelength Deviation[1]	Wavelength Measured	Wavelength Deviation[1]
1460.000 nm	________nm	________nm	________nm	________nm
1475.000 nm	________nm	________nm	________nm	________nm
1490.000 nm	________nm	________nm	________nm	________nm
1500.000 nm	________nm	________nm	________nm	________nm
1510.000 nm	________nm	________nm	________nm	________nm
1520.000 nm	________nm	________nm	________nm	________nm
1530.000 nm	________nm	________nm	________nm	________nm
1540.000 nm	________nm	________nm	________nm	________nm
1550.000 nm	________nm	________nm	________nm	________nm
1560.000 nm	________nm	________nm	________nm	________nm
1575.000 nm	________nm	________nm	________nm	________nm
1580.000nm	________nm	________nm	________nm	________nm
Maximum Deviation		________nm		________nm
Minimum Deviation		________nm		________nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

HP 81682A Performance Test

Model HP 81682A Tunable Laser   Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 3 and 4

	Repetition 3		Repetition 4	
Wavelength Setting	Wavelength Measured	Wavelength Deviation[1]	Wavelength Measured	Wavelength Deviation[1]
1460.000 nm	________nm	________nm	________nm	________nm
1475.000 nm	________nm	________nm	________nm	________nm
1490.000 nm	________nm	________nm	________nm	________nm
1500.000 nm	________nm	________nm	________nm	________nm
1510.000 nm	________nm	________nm	________nm	________nm
1520.000 nm	________nm	________nm	________nm	________nm
1530.000 nm	________nm	________nm	________nm	________nm
1540.000 nm	________nm	________nm	________nm	________nm
1550.000 nm	________nm	________nm	________nm	________nm
1560.000 nm	________nm	________nm	________nm	________nm
1575.000 nm	________nm	________nm	________nm	________nm
1580.000nm	________nm	________nm	________nm	________nm

Within full Tuning Range1460 to 1580nm				
Maximum Deviation		________nm		________nm
Minimum Deviation		________nm		________nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

HP 81682A Performance Test

Model HP 81682A Tunable Laser   Report No. ________ Date_______

Relative Wavelength Accuracy - Repetition 5

Repetition 5

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Measured - Wavelength Setting
1460.000 nm	________nm	________nm
1475.000 nm	________nm	________nm
1490.000 nm	________nm	________nm
1500.000 nm	________nm	________nm
1510.000 nm	________nm	________nm
1520.000 nm	________nm	________nm
1530.000 nm	________nm	________nm
1540.000 nm	________nm	________nm
1550.000 nm	________nm	________nm
1560.000 nm	________nm	________nm
1575.000 nm	________nm	________nm
1580.000nm	________nm	________nm
Within full Tuning Range1460 to 1580nm		
Maximum Deviation		________nm
Minimum Deviation		________nm

HP 81682A Performance Test

Page 6 of 17

Model HP 81682A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy Summary of all repetitions

Largest Maximum Deviation________nm

Relative Wavelength Accuracy Result

(= Largest Maximum Deviation – Smallest Minimum Deviation)

________nm

Specification 0.01 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)

________nm

Specification 0.02 nm

Measurement Uncertainty: ±0.6 pm

HP 81682A Performance Test

Page 7 of 17

Model HP 81682A Tunable Laser Report No. ________ Date_______

Mode Hop Free Tuning

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Setting – Wavelength Measured
1460.000 nm	________nm	________nm
1461.000 nm	________nm	________nm
1462.000 nm	________nm	________nm
1463.000 nm	________nm	________nm
1464.000 nm	________nm	________nm
1465.000 nm	________nm	________nm
1466.000 nm	________nm	________nm
1467.000 nm	________nm	________nm
1468.000 nm	________nm	________nm
1479.000 nm	________nm	________nm
1470.000 nm	________nm	________nm
1570.000nm	________nm	________nm
1571.000nm	________nm	________nm
1572.000nm	________nm	________nm
1573.000nm	________nm	________nm
1574.000nm	________nm	________nm
1575.000nm	________nm	________nm
1576.000nm	________nm	________nm
1577.000nm	________nm	________nm
1578.000nm	________nm	________nm
1579.000nm	________nm	________nm
1580.000nm	________nm	________nm

Within Tuning Range	1460 to 1580 nm
Maximum Deviation	________ nm
Minimum Deviation	________ nm

Mode Hop Free Tuning Result

(= Maximum Deviation – Minimum Deviation)

________ nm

Specification 0.05 nm

Measurement Uncertainty: ±0.2 pm

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability

Repeatability of
1460.000nm (= reference) Measurement Result

initial setting	REF=________	nm
from 1490.000nm to REF	________	nm
from 1520.000nm to REF	________	nm
from 1550.000nm to REF	________	nm
from 1580.000nm to REF	________	nm
largest measured wavelength	________	nm
smallest measured wavelength	________	nm
Wavelength Repeatability	________	nm

(=largest measured wavelength – smallest measured wavelength)

Specification 0.002 nm
typical 0.001 nm

Repeatability of
1520.000nm (= reference) Measurement Result

initial setting	REF=________	nm
from 1460.000nm to REF	________	nm
from 1490.000nm to REF	________	nm
from 1550.000nm to REF	________	nm
from 1580.000nm to REF	________	nm
largest measured wavelength	________	nm
smallest measured wavelength	________	nm
Wavelength Repeatability	________	nm

(=largest measured wavelength – smallest measured wavelength)

Specification 0.002 nm
typical 0.001 nm

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability (continued)

Repeatability of 1580.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1460.000nm to REF	________ nm
from 1490.000nm to REF	________ nm
from 1520.000nm to REF	________ nm
from 1550.000nm to REF	________ nm

largest measured wavelength	________ nm
smallest measured wavelength	________ nm
Wavelength Repeatability	________ nm

(=largest measured wavelength − smallest measured wavelength)

Specification 0.002 nm
typical 0.001 nm

Measurement Uncertainty: ±0.1 pm

HP 81682A Performance Test

Page 10 of 17

Model HP 81682A Tunable Laser Report No. ________ Date_______

Maximum Power Test

Wavelength	HP 81682A		81682A #003	
	Power	Minimum	Power	Minimum
Setting	Measured	Specification	Measured	Specification
1460.000 nm	______dBm	– 3.00 dBm	______dBm	– 4.50 dBm
1470.000 nm	______dBm	– 3.00 dBm	______dBm	– 4.50 dBm
1480.000 nm	______dBm	+2.00 dBm	______dBm	+ 0.50 dBm
1490.000 nm	______dBm	+2.00 dBm	______dBm	+ 0.50 dBm
1500.000 nm	______dBm	+2.00 dBm	______dBm	+ 0.50 dBm
1510.000 nm	______dBm	+2.00 dBm	______dBm	+ 0.50 dBm
1520.000 nm	______dBm	+6.00 dBm	______dBm	+ 4.50 dBm
1530.000 nm	______dBm	+6.00 dBm	______dBm	+ 4.50 dBm
1540.000 nm	______dBm	+6.00 dBm	______dBm	+ 4.50 dBm
1550.000 nm	______dBm	+6.00 dBm	______dBm	+ 4.50 dBm
1560.000 nm	______dBm	+6.00 dBm	______dBm	+ 4.50 dBm
1570.000 nm	______dBm	+6.00 dBm	______dBm	+ 4.50 dBm
1580.000nm	______dBm	+2.00 dBm	______dBm	+ 0.50 dBm

Measurement Uncertainty: ± 0.10 dB

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Power Linearity - 81682A

	Power Setting from start	Measured Relative Power from start			Power reduction from start			Power Linearity at current setting	
Start = REF	+ 6.0 dBm	0.00	dB	+	0.00	dB	=	0.00	dB
	+ 5.0 dBm		dB	+	1.00	dB	=		dB
	+ 4.0 dBm		dB	+	2.00	dB	=		dB
	+ 3.0 dBm		dB	+	3.00	dB	=		dB
	+ 2.0 dBm		dB	+	4.00	dB	=		dB
	+ 1.0 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

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Power Linearity HP 81682A #003 upper power levels

	Power Setting from start	Measured Relative Power from start			Power reduction from start			Power Linearity at current setting	
Start = REF	+ 4.5 dBm	0.00	dB	+	0.00	dB	=	0.00	dB
	+ 3.5 dBm		dB	+	1.00	dB	=		dB
	+ 2.5 dBm		dB	+	2.00	dB	=		dB
	+ 1.5 dBm		dB	+	3.00	dB	=		dB
	+ 0.5 dBm		dB	+	4.00	dB	=		dB
	– 0.5 dBm		dB	+	5.00	dB	=		dB
	– 1.5 dBm		dB	+	6.00	dB	=		dB
	– 2.5 dBm		dB	+	7.00	dB	=		dB
	– 3.5 dBm		dB	+	8.00	dB	=		dB
	– 4.5 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	0.8 dBpp
	Typical	0.4 dBpp
	Measurement Uncertainty	±0.05 dB

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Power Linearity HP 81682A #003 by attenuator

	Power Setting from start	Measured Relative Power from start		Power reduction from start		Power Linearity at current setting
Start = REF	0.0 dBm	dB	+	0.00 dB	=	dB
	– 1.0 dBm	dB	+	1.00 dB	=	dB
	– 2.0 dBm	dB	+	2.00 dB	=	dB
	– 3.0 dBm	dB	+	3.00 dB	=	dB
	– 4.0 dBm	dB	+	4.00 dB	=	dB
	– 5.0 dBm	dB	+	5.00 dB	=	dB
	– 10.0 dBm	dB	+	10.00 dB	=	dB
	– 15.0 dBm	dB	+	15.00 dB	=	dB
	– 20.0 dBm	dB	+	20.00 dB	=	dB
	– 25.0 dBm	dB	+	25.00 dB	=	dB
	– 30.0 dBm	dB	+	30.00 dB	=	dB
	– 35.0 dBm	dB	+	35.00 dB	=	dB
	– 40.0 dBm	dB	+	40.00 dB	=	dB
	– 45.0 dBm	dB	+	45.00 dB	=	dB
	– 50.0 dBm	dB	+	50.00 dB	=	dB
	– 55.0 dBm	dB	+	55.00 dB	=	dB
	– 60.0 dBm	dB	+	60.00 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	0.8 dBpp
Typical	0.4 dBpp
Measurement Uncertainty	±0.05 dB

HP 81682A Performance Test

Page 14 of 17

Model HP 81682A Tunable Laser Report No. ________ Date________

Power Flatness

		Standard without #003 P = –3 dBm	Option #003 P = –5.5dBm ATT = 0	P = –5.5dBm ATT=54.5000 dB
Wavelength		Power Deviation	Power Deviation	Power Deviation
Start = REF	1460 nm	0.00 dB	0.00 dB	0.00 dB
	1465 nm	dB	dB	dB
	1470 nm	dB	dB	dB
	1475 nm	dB	dB	dB
	1480 nm	dB	dB	dB
	1485 nm	dB	dB	dB
	1490 nm	dB	dB	dB
	1495 nm	dB	dB	dB
	1500 nm	dB	dB	dB
	1505 nm	dB	dB	dB
	1510 nm	dB	dB	dB
	1515 nm	dB	dB	dB
	1520 nm	dB	dB	dB
	1525 nm	dB	dB	dB
	1530 nm	dB	dB	dB
	1535 nm	dB	dB	dB
	1540 nm	dB	dB	dB
	1545 nm	dB	dB	dB
	1550 nm	dB	dB	dB
	1555 nm	dB	dB	dB
	1560 nm	dB	dB	dB
	1565 nm	dB	dB	dB
	1570 nm	dB	dB	dB
	1575 nm	dB	dB	dB
	1580 nm	dB	dB	dB
	Maximum Deviation	dB	dB	dB
	Minimum Deviation	dB	dB	dB
	Flatness = Maximum – Minimum Deviation	dB	dB	dB
	Specification	0.40 dBpp	0.60 dBpp	0.60 dBpp
	Measurement Uncertainty	±0.10 dB	±0.10 dB	±0.10 dB

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Power Stability

HP 81682A	standard	#003 Att = 0dB
Maximum Deviation	dB	dB
Minimum Deviation	dB	dB
Power Stability [1]	dB	dB
Specification	0.02 dBpp	0.02 dBpp
Measurement Uncertainty	± 0.005 dB	± 0.005 dB

[1] Power Stability = Maximum Deviation – Minimum Deviation

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Signal-to-Source Spontaneous Emission - HP 81682A

	Standard Module			Option #003		
Wavelength	Output Power	Results	Maximum Specification	Output Power	Results	Maximum Specification
1460 nm	–3.00 dBm	dB	35 dB	–4.50 dBm	dB	35 dB
1470 nm	–3.00 dBm	dB	35 dB	–4.50 dBm	dB	35 dB
1480 nm	+2.00 dBm	dB	40 dB	+0.50 dBm	dB	40 dB
1490 nm	+2.00 dBm	dB	40 dB	+0.50 dBm	dB	40 dB
1500 nm	+2.00 dBm	dB	40 dB	+0.50 dBm	dB	40 dB
1510 nm	+2.00 dBm	dB	40 dB	+0.50 dBm	dB	40 dB
1520 nm	+6.00 dBm	dB	45 dB	+4.50 dBm	dB	45 dB
1530 nm	+6.00 dBm	dB	45 dB	+4.50 dBm	dB	45 dB
1540 nm	+6.00 dBm	dB	45 dB	+4.50 dBm	dB	45 dB
1550 nm	+6.00 dBm	dB	45 dB	+4.50 dBm	dB	45 dB
1560 nm	+6.00 dBm	dB	45 dB	+4.50 dBm	dB	45 dB
1570 nm	+6.00 dBm	dB	45 dB	+4.50 dBm	dB	45 dB
1580 nm	+2.00 dBm	dB	40 dB	+0.50 dBm	dB	40 dB

Measurement Uncertainty ±0.20 dB

HP 81682A Performance Test

Model HP 81682A Tunable Laser Report No. ________ Date_______

Optional Test

Signal-to-Total-Source Spontaneous Emission - 81682A

OSA_noise	pW	
SSE_power_λTLS_max	pW	
Power_total_noise = OSA_noise + SSE_power_λTLS_max		pW
Peak_power		pW
Measurement Result - Total SSE		**dB**
Specification		25 dB (30 dB typical)

$$\text{Total SSE} = 10 \times \log \frac{\text{peak\_power}}{\text{power\_total\_SSE}}$$

Measurement Uncertainty: ± 2.00 dB

Test Record

HP 81640A Performance Test

Page 1 of 17

Test Facility:

______________________________	Report No.	________________
______________________________	Date	________________
______________________________	Customer	________________
______________________________	Tested By	________________

Model HP 81640A Tunable Laser Module 1550 nm

Serial No.	____________________	Ambient temperature	________°C
Options	____________________	Relative humidity	________ %
Firmware Rev.	____________________	Line frequency	________ Hz

Special Notes:

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HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Test Equipment Used:

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	HP 8164A	________	_________
2. Lightwave Multimeter	HP 8153A	_________	_________
3. Optical Head Interface Module	HP 81533B	_________	_________
4. Standard Optical Head	HP 81524A #C01	_________	_________
5. Optical Spectrum Analyzer	___________	_________	_________
6. Wavelength Meter	___________	_________	_________
7. ___________________________	___________	_________	_________
8. ___________________________	___________	_________	_________
9. ___________________________	___________	_________	_________
10. __________________________	___________	_________	_________
11. __________________________	___________	_________	_________
12. __________________________	___________	_________	_________
13. __________________________	___________	_________	_________
14. __________________________	___________	_________	_________
15. __________________________	___________	_________	_________

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 1 and 2

	Repetition 1		Repetition 2	
Wavelength Setting	Wavelength Measured	Wavelength Deviation[1]	Wavelength Measured	Wavelength Deviation[1]
1510.000 nm	________nm	________nm	________nm	________nm
1525.000 nm	________nm	________nm	________nm	________nm
1540.000 nm	________nm	________nm	________nm	________nm
1550.000 nm	________nm	________nm	________nm	________nm
1560.000 nm	________nm	________nm	________nm	________nm
1575.000 nm	________nm	________nm	________nm	________nm
1590.000nm	________nm	________nm	________nm	________nm
1600.000 nm	________nm	________nm	________nm	________nm
1615.000 nm	________nm	________nm	________nm	________nm
1630.000 nm	________nm	________nm	________nm	________nm
1640.000 nm	________nm	________nm	________nm	________nm
Within full Tuning Range 1510 to 1640nm				
Maximum Deviation		________nm		________nm
Minimum Deviation		________nm		________nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 3 and 4

	Repetition 3		Repetition 4	
Wavelength Setting	Wavelength Measured	Wavelength Deviation[1]	Wavelength Measured	Wavelength Deviation[1]
1510.000 nm	________nm	________nm	________nm	________nm
1525.000 nm	________nm	________nm	________nm	________nm
1540.000 nm	________nm	________nm	________nm	________nm
1550.000 nm	________nm	________nm	________nm	________nm
1560.000 nm	________nm	________nm	________nm	________nm
1575.000 nm	________nm	________nm	________nm	________nm
1590.000nm	________nm	________nm	________nm	________nm
1600.000 nm	________nm	________nm	________nm	________nm
1615.000 nm	________nm	________nm	________nm	________nm
1630.000 nm	________nm	________nm	________nm	________nm
1640.000 nm	________nm	________nm	________nm	________nm
Within full Tuning Range 1510 to 1640nm				
Maximum Deviation		________nm		________nm
Minimum Deviation		________nm		________nm

[1] Wavelength Deviation = Wavelength Measured - Wavelength Setting

HP 81640A Performance Test

Page 5 of 17

Model HP 81640A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetition 5

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Measured – Wavelength Setting
1510.000 nm	________nm	________nm
1525.000 nm	________nm	________nm
1540.000 nm	________nm	________nm
1550.000 nm	________nm	________nm
1560.000 nm	________nm	________nm
1575.000 nm	________nm	________nm
1590.000nm	________nm	________nm
1600.000 nm	________nm	________nm
1615.000 nm	________nm	________nm
1630.000 nm	________nm	________nm
1640.000 nm	________nm	________nm

Within full Tuning Range 1510 to 1640nm

Maximum Deviation	________nm
Minimum Deviation	________nm

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy Summary of all repetitions

Largest Maximum Deviation________nm

Relative Wavelength Accuracy Result

(= Largest Maximum Deviation – Smallest Minimum Deviation)

________nm

Specification 0.014 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)

________nm

Specification 0.03 nm

Measurement Uncertainty: ±0.6 pm

HP 81640A Performance Test

Page 7 of 17

Model HP 81640A Tunable Laser Report No. ________ Date_______

Mode Hop Free Tuning

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Measured - Wavelength Setting
1530.000nm	________nm	________nm
1531.000nm	________nm	________nm
1532.000nm	________nm	________nm
1533.000nm	________nm	________nm
1534.000nm	________nm	________nm
1535.000nm	________nm	________nm
1536.000nm	________nm	________nm
1537.000nm	________nm	________nm
1538.000nm	________nm	________nm
1539.000nm	________nm	________nm
1540.000nm	________nm	________nm
1610.000nm	________nm	________nm
1611.000nm	________nm	________nm
1612.000nm	________nm	________nm
1613.000nm	________nm	________nm
1614.000nm	________nm	________nm
1615.000nm	________nm	________nm
1616.000nm	________nm	________nm
1617.000nm	________nm	________nm
1618.000nm	________nm	________nm
1619.000nm	________nm	________nm
1620.000nm	________nm	________nm

Maximum Deviation ________ nm

Minimum Deviation ________ nm

Mode Hop Free Tuning Result

(= Maximum Deviation – Minimum Deviation)

	_______	nm
Specification	0.05	nm

Measurement Uncertainty: ±0.2 pm

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability

Repeatability of 1510.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1525.000nm to REF	________ nm
from 1550.000nm to REF	________ nm
from 1570.000nm to REF	________ nm
from 1590.000nm to REF	________ nm
from 1615.000nm to REF	________ nm
from 1640.000nm to REF	________ nm
largest measured wavelength	________ nm
smallest measured wavelength	________ nm
Wavelength Repeatability	________ nm

(=largest measured wavelength – smallest measured wavelength)

Specification 0.002 nm
typical 0.001 nm

Repeatability of 1570.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1510.000nm to REF	________ nm
from 1525.000nm to REF	________ nm
from 1550.000nm to REF	________ nm
from 1590.000nm to REF	________ nm
from 1615.000nm to REF	________ nm
from 1640.000nm to REF	________ nm
largest measured wavelength	________ nm
smallest measured wavelength	________ nm
Wavelength Repeatability	________ nm

(=largest measured wavelength – smallest measured wavelength)

Specification 0.002 nm
typical 0.001 nm

HP 81640A Performance Test

Page 9 of 17

Model HP 81640A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability (continued)

Repeatability of 1640.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1510.000nm to REF	________ nm
from 1525.000nm to REF	________ nm
from 1550.000nm to REF	________ nm
from 1570.000nm to REF	________ nm
from 1590.000nm to REF	________ nm
from 1615.000nm to REF	________ nm
largest measured wavelength	________ nm
smallest measured wavelength	________ nm
Wavelength Repeatability	________ nm

(=largest measured wavelength – smallest measured wavelength)

Specification	0.002 nm
typical	0.001 nm

Measurement Uncertainty: ±0.1 pm

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Maximum Power Test

Wavelength Setting	Output 1 Minimum Measured	Power Specification	Output 2 Minimum Measured	Power Specification
1510.000 nm	______dBm	– 13.00 dBm	______dBm	– 5.00 dBm
1520.000 nm	______dBm	– 9.00 dBm	______dBm	0.00 dBm
1530.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1540.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1550.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1560.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1570.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1580.000nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1590.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1600.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1610.000 nm	______dBm	– 7.00 dBm	______dBm	+ 2.00 dBm
1620.000 nm	______dBm	– 9.00 dBm	______dBm	0.00 dBm
1630.000 nm	______dBm	– 13.00 dBm	______dBm	– 5.00 dBm
1640.000 nm	______dBm	– 13.00 dBm	______dBm	– 5.00 dBm

Measurement Uncertainty: ±0.10 dB

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Power Linearity Output 1, Low SSE

	Power Setting from start	Measured Relative Power from start			Power reduction from start			Power Linearity at current setting	
Start = REF	– 7.0 dBm	0.00	dB	+	0.00	dB	=	0.00	dB
	– 8.0 dBm		dB	+	1.00	dB	=		dB
	– 9.0 dBm		dB	+	2.00	dB	=		dB
	– 10.0 dBm		dB	+	3.00	dB	=		dB
	– 11.0 dBm		dB	+	4.00	dB	=		dB
	– 12.0 dBm		dB	+	5.00	dB	=		dB
	– 13.0 dBm		dB	+	6.00	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

Power Linearity Output 2, High Power upper power levels

	Power Setting from start	Measured Relative Power from start			Power reduction from start			Power Linearity at current setting	
Start = REF	+ 2.0 dBm	0.00	dB	+	0.00	dB	=	0.00	dB
	+ 1.0 dBm		dB	+	1.00	dB	=		dB
	0.0 dBm		dB	+	2.00	dB	=		dB
	– 1.0 dBm		dB	+	3.00	dB	=		dB
	– 2.0 dBm		dB	+	4.00	dB	=		dB
	– 3.0 dBm		dB	+	5.00	dB	=		dB
	– 4.0 dBm		dB	+	6.00	dB	=		dB
	– 5.0 dBm		dB	+	7.00	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	0.6	dBpp
Measurement Uncertainty	± 0.05	dB

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Power Linearity **Output 2, High Power** **by attenuator**

	Power Setting from start	Measured Relative Power from start		Power reduction from start			Power Linearity at current setting
Start = REF	0.0 dBm	dB	+	0.00	dB	=	dB
	– 1.0 dBm	dB	+	1.00	dB	=	dB
	– 2.0 dBm	dB	+	2.00	dB	=	dB
	– 3.0 dBm	dB	+	3.00	dB	=	dB
	– 4.0 dBm	dB	+	4.00	dB	=	dB
	– 5.0 dBm	dB	+	5.00	dB	=	dB
	– 10.0 dBm	dB	+	10.00	dB	=	dB
	– 15.0 dBm	dB	+	15.00	dB	=	dB
	– 20.0 dBm	dB	+	20.00	dB	=	dB
	– 25.0 dBm	dB	+	25.00	dB	=	dB
	– 30.0 dBm	dB	+	30.00	dB	=	dB
	– 35.0 dBm	dB	+	35.00	dB	=	dB
	– 40.0 dBm	dB	+	40.00	dB	=	dB
	– 45.0 dBm	dB	+	45.00	dB	=	dB
	– 50.0 dBm	dB	+	50.00	dB	=	dB
	– 55.0 dBm	dB	+	55.00	dB	=	dB
	– 60.0 dBm	dB	+	60.00	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 0.6 dBpp

Measurement Uncertainty ± 0.05 dB

HP 81640A Performance Test

Page 13 of 17

Model HP 81640A Tunable Laser Report No. ________ Date_______

Power Flatness

	Output 1 Low SSE	Output 2 High Power	
	P = –13 dBm	P = –3dBm ATT = 0 dB	P = –5dBm ATT = 55.000 dB
Wavelength	Power Deviation	Power Deviation	Power Deviation
Start = REF 1510 nm	0.00 dB	0.00 dB	0.00 dB
1520 nm	dB	dB	dB
1530 nm	dB	dB	dB
1540 nm	dB	dB	dB
1550 nm	dB	dB	dB
1560 nm	dB	dB	dB
1570 nm	dB	dB	dB
1580 nm	dB	dB	dB
1585 nm	dB	dB	dB
1590 nm	dB	dB	dB
1595 nm	dB	dB	dB
1600 nm	dB	dB	dB
1610 nm	dB	dB	dB
1620 nm	dB	dB	dB
1630 nm	dB	dB	dB
Maximum deviation	dB	dB	dB
Minimum deviation	dB	dB	dB
Flatness =	dB	dB	dB
Maximum – Minimum Deviation			
Specification	0.40 dBpp	0.60 dBpp	0.60 dBpp
Measurement Uncertainty	±0.10 dB	±0.10 dB	±0.10 dB

HP 81640A Performance Test

Page 14 of 17

Model HP 81640A Tunable Laser Report No. ________ Date_______

Power Stability

	Low SSE Output 1	High Power Output 2 Att = 0 dB
Maximum Deviation	dB	dB
Minimum Deviation	dB	dB
Power Stability [1]	dB	dB
Specification	0.02 dBpp	0.02 dBpp
Measurement Uncertainty	±0.005 dB	±0.005 dB

[1] Power Stability = Maximum Deviation – Minimum Deviation

Signal-to-Source Spontaneous Emission - 81640A Output 2, High Power

Wavelength	Output Power	Results	Maximum Specification
1510 nm	–5.00 dBm	dB	35 dB
1520 nm	0.00 dBm	dB	40 dB
1530 nm	+2.00 dBm	dB	45 dB
1540 nm	+2.00 dBm	dB	45 dB
1550 nm	+2.00 dBm	dB	45 dB
1560 nm	+2.00 dBm	dB	45 dB
1570 nm	+2.00 dBm	dB	45 dB
1580 nm	+2.00 dBm	dB	45 dB
1590 nm	+2.00 dBm	dB	45 dB
1600 nm	+2.00 dBm	dB	45 dB
1610 nm	+2.00 dBm	dB	45 dB
1620 nm	0.00 dBm	dB	40 dB
1630 nm	–5.00 dBm	dB	35 dB
1640 nm	–5.00 dBm	dB	35 dB

Measurement Uncertainty ±0.20 dB

HP 81640A Performance Test

Page 15 of 17

Model HP 81640A Tunable Laser Report No. ________ Date_______

Signal-to-Source Spontaneous Emission - 81640A Output 1, Low SSE

Center Wavelength of Fiber Bragg Grating:	TLS_λ_0	= ________	nm
	OSA_λ_0	= ________	nm
Maximum Transmitted Power:	max_SSE_power	= ________	dBm
	OSA@max_SSE_power	= ________	nm
Peak Power:	power@SSE_peak	= ________	dBm

Test result: Spectral SSE = power@SSE_peak – (max_SSE_power + 3 [dB/nm])

= ___________ dB / nm

Specification: 60 dB/nm

Measurement Uncertainty: ±1.2 dB

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date________

Signal-to-Total-Source Spontaneous Emission - 81640A Output 1, Low SSE

Center Wavelength of Fiber Bragg Grating:	TLS_λ_0	= ________	nm
	OSA_λ_0	= ________	nm
Transmission Band Limits:	OSA_λ_1	= ________	nm
	OSA_λ_2	= ________	nm
	OSA_λ_3	= ________	nm
	OSA_λ_4	= ________	nm

	Output 1, Low SSE		
OSA_noise			__________ pW
Sum of all SSE power levels in lower transmission band	__________ pW		
Sum of all SSE power levels in upper transmission band	__________ pW		
power_trans = Sum of all SSE power levels in transmission bands		__________ pW	
power_att		__________ pW	
power_total_noise = power_trans + power_att			__________ pW
Peak_power			
Measurement Result - Total SSE			**__________ dB**
Specification			55 dB

$$\text{Total SSE} = 10 \times \log \frac{\text{peak\_power}}{\text{power\_total\_noise} - \text{OSA\_noise}}$$

Measurement Uncertainty: ± 2.00 dB

HP 81640A Performance Test

Model HP 81640A Tunable Laser Report No. ________ Date_______

Optional Test

Signal-to-Total-Source Spontaneous Emission - 81640A Output 2, High Power

		Output 2, High Power
OSA_noise	_________ pW	
SSE_power_λTLS_max	_________ pW	
Power_total_noise = OSA_noise + SSE_power_λTLS_max		_________ pW
Peak_power		_________ pW
Measurement Result - Total SSE		**_________ dB**
Specification		22 dB (27 dB typical)

$$\text{Total SSE} = 10 \times \log \frac{peak\_power}{power\_total\_SSE}$$

Measurement Uncertainty: ± 2.00 dB

Test Record

HP 81689A Performance Test

Page 1 of 9

Test Facility:

________________________	Report No.	____________
________________________	Date	____________
________________________	Customer	____________
________________________	Tested By	____________

Model HP 81689A Tunable Laser Module 1550 nm

Serial No.	________________	Ambient temperature	________ °C
Options	________________	Relative humidity	________ %
Firmware Rev.	________________	Line frequency	________ Hz

Special Notes:

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HP 81689A Performance Test

Page 2 of 9

Model HP 81689A Tunable Laser Report No. ________ Date________

Test Equipment Used:

Description	Model No.	Trace No.	Cal. Due Date
1. Lightwave Measurement System	HP 8164A	________	________
2. Lightwave Multimeter	HP 8153A	________	________
3. Optical Head Interface Module	HP 81533B	________	________
4. Standard Optical Head	HP 81524A #C01	________	________
5. Optical Spectrum Analyzer	________	________	________
6. Wavelength Meter	________	________	________
7. ________________	________	________	________
8. ________________	________	________	________
9. ________________	________	________	________
10. ________________	________	________	________
11. ________________	________	________	________
12. ________________	________	________	________
13. ________________	________	________	________
14. ________________	________	________	________
15. ________________	________	________	________

HP 81689A Performance Test

Model HP 81689A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetitions 1 to 4

	Repetition 1		Repetition 2	
Wavelength Setting	Wavelength Measured	Wavelength Deviation = meas – set value	Wavelength Measured	Wavelength Deviation = meas – set value
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
1575.000nm	________nm	________nm	________nm	________nm

Within full Tuning Range 1525 to 1575nm

Maximum Deviation ________nm

Minimum Deviation ________nm

	Repetition 3		Repetition 4	
Wavelength Setting	Wavelength Measured	Wavelength Deviation = meas – set value	Wavelength Measured	Wavelength Deviation = meas – set value
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
1575.000nm	________nm	________nm	________nm	________nm

Within full Tuning Range 1525 to 1575nm

Maximum Deviation ________nm

Minimum Deviation ________nm

HP 81689A Performance Test

Page 4 of 9

Model HP 81689A Tunable Laser Report No. ________ Date_______

Relative Wavelength Accuracy - Repetition 5

Wavelength Setting	Wavelength Measured	Wavelength Deviation = Wavelength Measured – Wavelength Setting
1525.000 nm	________nm	________nm
1535.000 nm	________nm	________nm
1545.000 nm	________nm	________nm
1555.000 nm	________nm	________nm
1565.000 nm	________nm	________nm
1575.000nm	________nm	________nm

Within full Tuning Range 1525 to 1575nm

Maximum Deviation ________nm

Minimum Deviation ________nm

Relative Wavelength Accuracy Summary of all repetitions

Largest Maximum Deviation ________nm

Relative Wavelength Accuracy Result

(= Largest Maximum Deviation – Smallest Minimum Deviation)

________nm

Specification 0.6 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)

________nm

Specification 1.0 nm

0.6 nm typical

Measurement Uncertainty: ±0.6 pm

HP 81689A Performance Test

Model HP 81689A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability

Repeatability of 1525.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1535.000nm to REF	________ nm
from 1540.000nm to REF	________ nm
from 1550.000nm to REF	________ nm
from 1560.000nm to REF	________ nm
from 1575.000nm 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 1550.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1525.000nm to REF	________ nm
from 1535.000nm to REF	________ nm
from 1540.000nm to REF	________ nm
from 1560.000nm to REF	________ nm
from 1575.000nm to REF	________ nm
largest measured wavelength	________ nm
smallest measured wavelength	________ nm
Wavelength Repeatability	________ nm

(=largest measured wavelength – smallest measured wavelength)

Specification 0.10 nm

HP 81689A Performance Test

Model HP 81689A Tunable Laser Report No. ________ Date_______

Wavelength Repeatability (continued)

Repeatability of 1575.000nm (= reference)	Measurement Result
initial setting	REF=________ nm
from 1525.000nm to REF	________ nm
from 1535.000nm to REF	________ nm
from 1540.000nm to REF	________ nm
from 1545.000nm to REF	________ nm
from 1550.000nm to REF	________ nm
from 1560.000nm 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

HP 81689A Performance Test

Model HP 81689A Tunable Laser Report No. ________ Date_______

Maximum Power Test

Wavelength Setting	Power Measured	Minimum Specification
1525.000 nm	______dBm	+ 6.00 dBm
1530.000 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

HP 81689A Performance Test

Model HP 81689A Tunable Laser Report No. ________ Date_______

Power Flatness

	Wavelength	P = +2.0 dBm Power Deviation
Start = REF	1525 nm	0.00 dB
	1530 nm	dB
	1540 nm	dB
	1550 nm	dB
	1560 nm	dB
	1570 nm	dB
	1575 nm	dB
	Maximum deviation	dB
	Minimum deviation	dB
Flatness =	Maximum – Minimum Deviation	dB
	Specification	0.60 dBpp
	Measurement Uncertainty	± 0.10 dB

HP 81689A Performance Test

Model HP 81689A Tunable Laser Report No. ________ Date_______

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

Signal-to-Source Spontaneous Emission

Wavelength	Output Power	Results	Maximum Specification	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

Index